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BULLETIN 79

GEOLOGY AND GROUND-WATER RESOURCES OF A PART OF SOUTH-CENTRAL KANSAS

WITH SPECIAL REFERENCE TO THE WICHITA MUNICIPAL WATER SUPPLY

By CHARLES C. WILLIAMS and STANLEY W. LOHMAN
with analyses by
ROBERT H. HESS and others

Prepared by the State Geological Survey of Kansas and the United States Geological Survey, with the coöperation of the City of Wichita, the Division of Sanitation of the Kansas State Board of Health, and the Division of Water Resources of the Kansas State Board of Agriculture

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CONTENTS

PAGE

Abstract ... 13
Introduction ... 15
Location and size of the area ... 15
Purpose and need of the investigation ... 15
History and methods of investigation ... 16
Previous geologic and hydrologic work ... 22
Permian rocks ... 22
Cretaceous rocks ... 22
Pleistocene deposits ... 23
Hydrologic studies ... 23
Acknowledgments ... 24
Geography ... 25
Topography ... 25
Relief ... 25
Drainage ... 26
Climate ... 26
Population ... 32
Transportation ... 32
Agriculture ... 35
Natural resources and industries ... 35
Geologic formations and their water-bearing properties ... 37
Summary of stratigraphy ... 37
Permian System ... 40
Wellington formation ... 40
Character and thickness ... 40
Distribution and surface form ... 40
Age and correlation ... 41
Water supply ... 41
Ninnescah shale ... 43
Character and thickness ... 43
Distribution and surface form ... 43
Age and correlation ... 46
Water supply ... 46
Stone Corral dolomite ... 47
Cretaceous System ... 47
Kiowa shale ... 49
Character and thickness ... 49
Distribution and surface form ... 54
Age and correlation ... 54
Water supply ... 56
Tertiary System ... 56
Pliocene Series ... 56
Delmore formation ... 57
Character and thickness ... 57
Origin ... 57
Distribution and surface form ... 58

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PAGE

Age and correlation 58
Water supply 59
Quaternary System 59
Pleistocene Series 59
McPherson formation 59
Character and thickness 59
Origin 64
Distribution and surface form 66
Age and correlation 67
Discussion 67
Water supply 69
Pleistocene and Recent Series 70
Dune sand 70
Distribution and surface form 70
Character and thickness 71
Age 71
Water supply 74
Recent Series 74
Alluvium 74
Distribution, thickness, and character 74
Water supply 75
Geologic history 77
Paleozoic Era 77
Mesozoic Era 78
Cretaceous Period 78
Cenozoic Era 79
Tertiary Period 79
Quaternary Period 80
Pleistocene Epoch 80
Recent development of land forms 83
Sand dunes 83
Sink holes 83
Stream terraces 87
Major streams 90
Ground water 90
Principles of occurrence 90
Physical and hydrologic properties of water-bearing materials 91
Mechanical analyses 92
Definition 92
Laboratory methods and determinations 92
Porosity 92
Definition 92
Laboratory determinations 93
Moisture equivalent, specific retention, and specific yield 93
Definitions 93
Laboratory methods and determinations 93
Permeability and transmissibility 100
Definitions and general discussion 100
Laboratory determinations 101

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PAGE

Pumping test determinations ... 101
Theis recovery method ... 101
Pumping tests ... 103
Theim method ... 104
Pumping test ... 106
Specific capacity ... 108
Fluctuations of the water table ... 110
General considerations ... 110
Fluctuations caused by changes in atmospheric pressure ... 113
Ground-water recharge ... 114
Recharge from precipitation ... 114
Recharge in areas underlain by shale of Permian age ... 117
Recharge near McPherson ... 118
Recharge in sand-dune areas ... 119
Recharge in areas underlain by sandstone ... 121
Recharge in the Arkansas Valley ... 121
Quantitative estimate of recharge ... 127
Recharge from streams ... 130
Inflow from adjacent areas ... 131
Ground-water discharge ... 132
Discharge by transpiration and evaporation ... 132
Seepage into streams ... 133
Discharge from springs ... 133
Discharge from wells ... 134
Fluctuations in water level caused by pumping ... 134
Recovery of ground water ... 142
Springs ... 142
Wells ... 142
Dug wells ... 142
Driven wells ... 143
Drilled wells ... 143
Construction of wells in consolidated rocks ... 143
Construction of wells in unconsolidated rocks ... 144
Methods of lift ... 145
Quality of water ... 145
Chemical constituents in relation to use ... 166
Dissolved solids ... 166
Hardness ... 166
Iron ... 168
Fluoride ... 168
Chloride ... 169
Salt water intrusion ... 169
Intrusion from streams ... 170
Intrusion of oil-field brines ... 173
Intrusion of oil-field brine in the Burrton oil field ... 176
Quality of water in relation to stratigraphy ... 183
Sanitary considerations ... 183
Utilization of water ... 184
Domestic and stock supplies ... 184

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PAGE
Industrial supplies ... 185
Wichita area ... 185
Hutchinson area ... 186
McPherson area ... 189
Other areas ... 189
Irrigation supplies ... 190
Public supplies ... 191
Buhler ... 191
Burrton ... 192
Canton ... 193
Galva ... 193
Halstead ... 193
Haven ... 194
Hesston ... 195
Hutchinson ... 195
Inman ... 197
Lindsborg ... 197
Marquette ... 197
McPherson ... 198
Moundridge ... 199
Mt. Hope ... 199
Newton ... 200
Sedgwick ... 202
Valley Center ... 202
Wichita ... 202
Supply prior to September 1, 1940 ... 202
History of development of new supply ... 206
New supply ... 207
Potential perennial yield of the Wichita well-field area ... 211
Definition of potential perennial yield ... 212
Summary of data available for studying perennial yield ... 212
Specific yield ... 213
Transmissibility ... 214
Recharge ... 214
Discharge ... 215
Changes in storage ... 216
Natural changes in storage ... 216
Changes in storage caused by pumping ... 217
Summary of changes in storage ... 218
Hydrologic implications ... 220
Change in specific yield ... 220
Reduction of natural discharge into Little Arkansas River ... 220
Source of the water pumped ... 221
Summary ... 222
Ground-water conditions described by localities ... 223
Lindsborg area ... 223
Northeastern upland area ... 224
Windom-Inman upland area ... 224
McPherson channel area ... 225

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PAGE
Canton-Galva area ... 226
Sand-dune area ... 226
Arkansas Valley area ... 227
Newton upland area ... 228
Southwestern upland area ... 229
Ninnescah area ... 230
Possibilities of developing additional large ground-water supplies ... 230
Lindsborg area ... 230
McPherson channel area ... 230
Arkansas Valley area ... 231
Well records ... 233
Logs of test holes and wells ... 290
References ... 448
Index ... 453

ILLUSTRATIONS

PLATE PAGE
1. Areal geology of a part of south-central Kansas, and water-table contours, 1940-44 ... (*In pocket*)
2. *A*, Test hole being drilled in McPherson County by hydraulic-rotary rig owned and operated by State Geological Survey; *B*, setting casing in cable-tool test hole drilled for City of Wichita ... 18
3. Pneumatic packers used in obtaining water samples from cable-tool test holes drilled for City of Wichita ... 19
4. *A*, Driving wells for use in tracing migration of oil-field brines; *B*, portable laboratory mounted on truck for determining chloride content of water samples ... 20
5. Depths to water level and location of wells in a part of south-central Kansas ... (*In pocket*)
5A. Location of wells in T. 27 S., R. 1 E. (including City of Wichita) (*In pocket*)
6. Geologic profiles through a part of south-central Kansas along lines A-A′, B-B′, C-C′, D-D′, E-E′, and F-F′ in Plate 7 ... (*In pocket*)
7. Locations of test holes and bedrock contours in a part of south-central Kansas ... (*In pocket*)
8. *A*, Deposits of the McPherson formation; *B*, Kiowa shale unconformably overlying the Wellington formation; *C*, gray shale and gypsum in the Wellington formation ... 42
9. Aerial photograph showing topographic expression of the Kiowa shale and Ninnescah shale in the area of outcrop ... 44
10. Aerial photograph showing the topographic expression of the Ninnescah shale in the area of outcrop ... 45
11. Cretaceous rocks in McPherson and Marion Counties. *A*, "Quartzite" showing concretionary form; *B*, sandstone and sandy shale in the Kiowa shale; *C*, slumping of the Kiowa shale ... 48
12. *A*, Zone containing pebbles and cobbles of resistant rocks at the contact between the Ninnescah shale and Kiowa shale; *B*, Delmore formation unconformably overlying sandstone of the Kiowa shale. 51

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PLATE PAGE

13. Topographic expression of the Kiowa shale in northern McPherson County 53
14. Aerial photograph showing subdued dune-like forms in southwestern Marion County 55
15. Volcanic ash in McPherson County 61
16. Gravel pits in the channel deposits of the McPherson formation 63
17. Features of the sand-dune area 72
18. Aerial photograph of sand dunes near Burrton 73
19. *A*, Cross-bedded sand and gravel in the alluvium of the Arkansas River Valley; *B*, sand pit in the McPherson formation; *C*, thinly bedded silt in the alluvium of Little Arkansas River 76
20. Sink holes in McPherson and Harvey Counties 84
21. Composite aerial photograph of Big Basin and vicinity 85
22. Aerial photograph of Lake Inman and vicinity 86
23. Composite aerial photograph showing a part of Arkansas River and vicinity 88
24. Composite aerial photograph showing a part of Smoky Hill River and vicinity 89
25. *A*, Well 609 of Kansas Gas and Electric Company discharging 1,000 gallons a minute; *B*, Wichita supply well (450) discharging 1,600 gallons a minute 102
26. *A*, Well 608 of Kansas Gas and Electric Company discharging 1,000 gallons a minute into Little Arkansas River during 19-day pumping test; *B*, bipod and orange-peel bucket used in construction of well 609 105
27. Automatic water-stage recorders on observation wells 109
28. Location of the new Wichita well-field area showing supply wells, pipe line, and observation wells ..... (*In pocket*)
29. Chloride contained in ground water in a part of south-central Kansas ..... (*In pocket*)
30. Aerial photograph showing disposal ponds and other installations in an oil field in McPherson County 174
31. Contamination of ground-water reservoirs by oil-field brines 175
32. Aerial photograph showing the confluence of Arkansas and Little Arkansas Rivers in the City of Wichita 205
33. Contour maps of the water table in the Wichita well-field area on several dates from June 1, 1940, through October 1, 1944. (*In pocket*)
34. Maps of the Wichita well-field area showing lines of equal change in water level from June 1, 1940, to October 1, 1944 ..... (*In pocket*)

FIGURE PAGE

1. Area covered by this report and other areas in Kansas for which coöperative ground-water reports have been published or are in preparation 15
2. Annual precipitation and cumulative departure from normal precipitation at Hutchinson 28
3. Annual precipitation and cumulative departure from normal precipitation at McPherson 28

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FIGURE		PAGE
4.	Annual precipitation and cumulative departure from normal precipitation at Mt. Hope	29
5.	Annual precipitation and cumulative departure from normal precipitation at Newton	29
6.	Annual precipitation and cumulative departure from normal precipitation at Sedgwick	30
7.	Annual precipitation and cumulative departure from normal precipitation at Wichita	30
8.	Monthly distribution of rainfall at Hutchinson, McPherson, Mt. Hope, Newton, Sedgwick, and Wichita	31
9.	Profile of the sand dunes along Chicago, Rock Island, and Pacific Railway from Hutchinson city limits to the Reno-McPherson County line	71
10.	Map showing the location of well 608 and nearby observation wells	106
11.	Altitude of water levels just before pumping stopped on November 26, 1937, plotted against the distance of the observation wells from pumped well 608	107
12.	Water-level fluctuations in wells 202 and 310 caused by changes in atmospheric pressure	113
13.	Water-level fluctuations in well 557 in 1938 caused by changes in atmospheric pressure	113
14.	Mass curves showing precipitation, runoff, evaporation, transpiration, and change in ground-water storage from Jan. 1, 1939 to Dec. 31, 1944, in the Wichita well-field area	115
15.	Hydrographs showing fluctuations of water levels in five wells in McPherson County, and monthly precipitation at McPherson	117
16.	Hydrographs showing the fluctuations of water level in well 557 near Valley Center, the average water level in 10 wells in the Wichita well-field area not affected by pumping, the cumulative departure from normal monthly precipitation at Sedgwick, and the monthly precipitation at Sedgwick	120
17.	Hydrographs showing the fluctuations of water level in wells 310 and 557 during parts of April and May 1944, and daily precipitation at Sedgwick during the same period	122
18.	Hydrographs showing the fluctuations of the water levels in three wells cased to different depths at the same location and in two wells cased to different depths at another location and precipitation at U. S. G. S. rain gage at Burrton	124
19.	Graphs showing cumulative departure from 6-year average monthly water-level stage in 10 wells not affected by pumping and progressive monthly average of the cumulative departure from 6-year average monthly precipitation at Sedgwick	126
20.	Graphs showing the relationship between annual cumulative rise in water level in well 557 and annual precipitation at Sedgwick	127
21.	Hydrograph of well 674 for parts of February and March 1942, showing the effect of an ice jam in Arkansas River on the ground-water level nearby	130
22.	Hydrograph showing the fluctuations of water level in well 674 in the old Wichita well field, and the monthly precipitation at Wichita	136

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FIGURE PAGE
23. Hydrographs showing fluctuations of water level in wells 674 and 568 caused by pumping nearby wells 137
24. Hydrographs showing the fluctuations of the water levels in wells in the new Wichita well-field area, pumpage from the new Wichita well field, monthly precipitation at Sedgwick, and cumulative departure from normal precipitation at Sedgwick 139
25. Graphs showing one-year progressive averages of: the average monthly stage of water levels in 6 observation wells located one-half mile from supply wells; the average monthly stage of water levels in 25 wells, each located 500 feet from supply wells; average monthly stage of water levels in 25 wells located 100 feet from supply wells; and monthly pumpage from 25 city-supply wells 140
26. Graph showing the relationship between the difference in average water levels in 10 wells not affected by pumping and 6 wells affected by pumping, and cumulative pumpage from the Wichita city water-supply wells 142
27. Map of an area in the Burrton oil field showing location of test wells and brine-disposal ponds in Survey A 177
28. Map of an area in the Burrton oil field showing location of test wells and brine-disposal ponds in Survey B 178
29. Analyses of waters from principal water-bearing formations in south-central Kansas 182
30. Map of Water Works Island showing the location of the pumping station, reservoir, and principal wells of the Wichita Water Company, 204
31. Graphs of data given in Table 36 218

TABLES

TABLE PAGE
1. Precipitation data from 6 U. S. Weather Bureau stations 27
2. Population in the counties included in this report 33
3. Population of cities in the area having public water supplies 34
4. Population in the City of Wichita and in Greater Wichita, including the city 34
5. Acreage of farms and principal crops in this area in 1945 36
6. Generalized section of the geologic formations in parts of Harvey, McPherson, Marion, Sedgwick, and Reno Counties 38
7. Physical properties of water-bearing materials 94
8. Transmissibility, permeability, and specific capacity of the new Wichita supply wells 103
9. Water-level data collected during a pumping test at well 608 106
10. Computations by the Thiem method at well 608 108
11. Observation wells in McPherson, Harvey, and Sedgwick Counties 111
12. Relation of cumulative rise in water level in well 557 to annual precipitation at Sedgwick 128
13. Analyses of water from wells in Harvey, McPherson, Reno, and Sedgwick Counties 146

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TABLE		PAGE
14.	Total and excess alkalinities of waters for which analyses are given in Table 13	165
15.	Total dissolved solids in water samples from wells in south-central Kansas	166
16.	Hardness of water samples from wells in south-central Kansas	167
17.	Iron in water samples from wells in south-central Kansas	168
18.	Chloride content of water from Arkansas River	170
19.	Chloride content of water from Rattlesnake Creek	171
20.	Chloride content of water from Cow Creek	180
21.	Chloride content at given depths in test wells	183
22.	Water level and chloride content of water in test wells 4 and 23 from 1938 through 1944	187
23.	Utilization of water pumped from private industrial wells in the City of Wichita and vicinity	188
24.	Industrial use of water from the Wichita municipal supply	190
25.	Pumpage during 1939 from 3 irrigation wells on the Harvey Hensley farm, Harvey County	191
26.	Monthly and annual pumpage of water by the City of Buhler	192
27.	Monthly and annual consumption of water by the City of Burrton	196
28.	Monthly and annual pumpage of water for the City of Hutchinson	198
29.	Monthly and annual pumpage of water by the City of McPherson	200
30.	Monthly and annual consumption of water by the City of Mt. Hope	201
31.	Monthly and annual pumpage of water by the City of Newton	208
32.	Records of new Wichita municipal supply wells	209
33.	Comparison of quality of water formerly supplied to City of Wichita with that being supplied from the new well field at end of first year's operation	209
34.	Monthly and annual pumpage of water from the new municipal well field	210
35.	Calculation of movement of water across the boundary of the new Wichita well field	215
36.	Data relative to changes in storage in the Wichita well-field area	
37.	Records of wells in Harvey, McPherson, Reno, and Sedgwick Counties,	234

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GEOLOGY AND GROUND-WATER RESOURCES OF A PART OF SOUTH-CENTRAL KANSAS

with special reference to the Wichita municipal water supply

By CHARLES C. WILLIAMS and STANLEY W. LOHMAN

ABSTRACT

This report describes the geography, geology, and ground-water resources of a region that covers about 2,340 square miles in south-central Kansas comprising all of McPherson County, nearly all of Harvey County, and smaller parts of Sedgwick, Reno, and Marion Counties. This large rectangular region was chosen for detailed study as it embraces the principal area of outcrop of the important Pleistocene water-bearing formation—the McPherson formation (the Equus beds of early reports)—which covers a broad area between the Smoky Hill and Arkansas River Valleys. This formation had long been utilized as a source of public-water supply by most of the cities in the area except Wichita and had long been regarded as a possible new source of supply for Wichita—the largest city in the State—whose ground-water supply prior to 1940 was unsatisfactory because of the poor chemical quality of the water. As a result of this investigation it was apparent that an adequate supply for Wichita could be obtained from wells in the McPherson formation about 20 miles northwest of the city. The city developed a new well field which has provided ample water of good quality since September 1, 1940. Salt-water intrusion into the water-bearing formations resulting from the improper disposal of oil-field brines in several oil fields in the area has ruined some well-water supplies, threatens others, and was given special attention during the course of the investigation—particularly in the location and development of the new Wichita well field.

The area is characterized by low topographic relief and includes large extremely flat sections; the total relief is only about 420 feet. It is drained largely by the Arkansas River and its tributaries—notably the Little Arkansas River—but parts of the area are drained by the Smoky Hill, Cottonwood, Walnut, and Ninnescah Rivers. The climate is characterized by moderate precipitation, a wide range in temperature, moderately high average wind velocity, and comparatively rapid evaporation.

Although the area is dominantly agricultural, it includes 18 cities having public-water supplies. The principal crops are wheat, corn, sorghum, oats, alfalfa, and hay, most of which are grown by dry farming methods as relatively little irrigation is practiced except in times of drought. Some areas are devoted principally to the raising of livestock. Natural gas and petroleum are produced from many oil fields and salt is mined at Hutchinson. Wichita is an important transportation and distribution center and also has important industries, especially the manufacture of aircraft.

The report includes a geologic map of the area and detailed descriptions of the geologic formations and their water-bearing properties based upon field mapping (partly on large scale aerial photos), the logs of 161 test holes drilled by the State Geological Survey, and the logs of 193 other wells and test holes. The formations mapped and described included the Permian Wellington, Ninnescah, and Stone Corral formations; the Cretaceous Kiowa shale; the Pliocene Delmore formation (formerly included in the now abandoned Emma Creek formation), which is described as a new formation; the Pleistocene McPherson formation (which includes the beds at the designated type locality of the Emma Creek formation); Pleistocene and Recent dune sand; and Recent alluvium. The Permian formations yield only meager supplies of highly mineralized water; the Delmore formation and sandstones of the Kiowa

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shale yield small supplies of relatively hard water to domestic and stock wells; and the sand dunes, though yielding only small supplies to wells, serve as important catchment areas for rainfall and hence help to recharge the adjacent McPherson formation and alluvium. Large supplies of moderately hard to hard water are obtainable from properly constructed wells in the McPherson formation and in the alluvium, which together underlie the larger part of the area. The larger supplies are obtained from the deposits of the deeply buried McPherson channel and the filled channel of the ancestral Arkansas River. These deposits yield adequate quantities of water for all public-supply, industrial, and irrigation wells in the area, and most of the domestic and stock wells. A description of the geologic history includes a discussion of the formation of the now buried McPherson channel that once united the ancestral Smoky Hill River with the ancestral Arkansas River. The McPherson channel was formed by an ancient stream which was aided by subsidence of the Wellington formation through solution of its thick beds of salt. These and other features are shown by many cross sections based upon test drilling and by a contour map of the bed rock floor.

A large amount of hydrologic data presented in 35 plates, 31 figures, and 37 tables accompanied by descriptive text, including a water-table contour map of the area (superimposed on the geologic map); a map showing depths to water level and locations of all wells visited; cross sections of the area, based on test drilling; maps showing locations of test holes and bedrock contours; maps of the Wichita well-field area showing water-table contours and lines of equal change in water level on several dates from June 1940 to October 1944; a map showing distribution of chloride in ground waters; numerous hydrographs of wells under pumping, nonpumping, or special conditions; tabulated physical properties of water-bearing materials; tabulated records of 727 water wells and 229 chemical analyses of ground waters; and logs of 354 test holes and wells.

Descriptions of the 18 public water supplies in the area, including both the old and new sources of supply for the city of Wichita, and the history of the development of the new supply are given. The average daily consumption of water by these 18 cities aggregates about 25 million gallons, of which 71 percent or about 18 million gallons is used by the City of Wichita. A special section is devoted to the potential perennial yield of the Wichita well-field area. Records of precipitation, water levels, and pumpage over a period of 7 years were correlated and studied. During this period the average precipitation was greater than normal. However, it is concluded that the potential yield had not been reached at the end of 1944 because: (1) the water levels in wells affected by pumping in the well-field area seemingly had ceased declining at the pumping rate prevailing at the time; (2) only a part of the natural discharge in the area of pumping influence was being salvaged; and (3) the Little Arkansas River remains a gaining stream, but is a potential source of increased recharge in this area. It is further concluded that the potential yield of the present well-field area is about 40,000 acre-feet a year during years of normal precipitation, or about twice the present annual pumpage. Before this potential perennial yield can be achieved a total of about 200,000 acre-feet must be removed from storage (an amount equivalent to 10 years' pumpage at the present rate assuming no replenishment from precipitation). Recharge in the well-field area during the period of record is calculated to have been equivalent to at least 20 percent of the precipitation or about 7 inches per year. This gives a total of about 365 acre-feet per year per square mile or about 31,000 acre-feet per year in the 85 square mile well-field area. Assuming that the 20-percent proportion holds during years of normal precipitation the total potential perennial yield would be about 27,000 acre-feet per year. If the potential perennial yield is ultimately reached an additional 13,000 acre-feet a year will be derived from salvaged natural discharge and influent seepage from Little Arkansas River.

The last section of the text describes ground-water conditions by localities and discusses the possibilities of developing additional large ground-water supplies. The most favorable areas for such future development are, in order of importance, the Arkansas Valley area, the McPherson channel area, and the Lindsborg (Smoky Hill River Valley) area.

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INTRODUCTION

Location and Size of the Area

That part of south-central Kansas considered in this report includes all of McPherson County, all of Harvey County except the eastern tier of 3 townships, 13 townships in north-central and northwestern Sedgwick County, the western tier of 5 townships in Marion County, and the easternmost 2 tiers of 10 townships in Reno County. The area embraces a total of 65 townships or about 2,340 square miles. The location of the area within the State is shown in Figure 1.

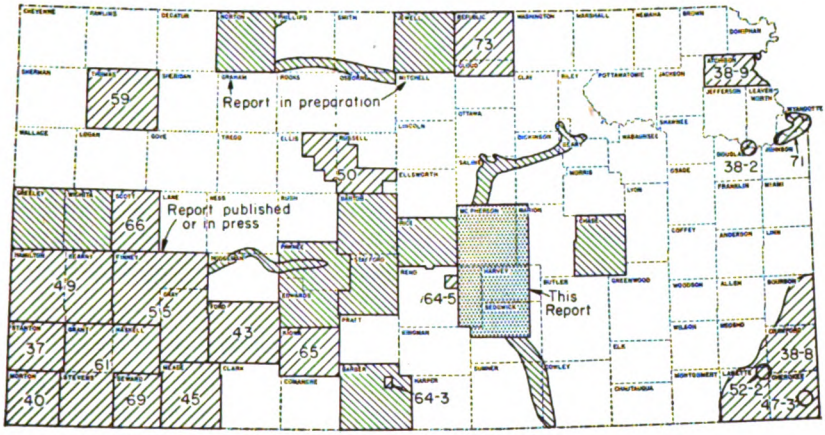

Fig. 1. Area covered by this report and other areas in Kansas for which cooperative ground-water reports have been published or are in preparation.

Purpose and Need of the Investigation

The area embraced by this report includes the principal area of outcrop of the important Pleistocene water-bearing formation—the McPherson formation (the Equus beds of early reports), which covers a broad area between the Smoky Hill and Arkansas River Valleys. The area also includes large segments of these two valleys which are underlain by alluvium and bordering areas underlain by Permian, Cretaceous, and Tertiary deposits. In 1897 attention was focused upon the McPherson formation as a productive source of ground water by Haworth and Beede. It has long been utilized as a source of public-water supply by the cities of McPherson, Galva, Canton, Inman, Buhler, Moundridge, Halstead, and Newton, and prior to this investigation it had also been regarded as a possible source of supply for the City of Wichita. The discovery and devel-

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opment of several large oil fields in the area presented a hazard to the McPherson formation and associated water-bearing formations as a source of public water supply, for, owing to improper methods of disposal, a large quantity of brine produced with the oil eventually found its way into the underground reservoirs.

These and other problems made it necessary to acquire a better understanding of the hydrology and geology of the area and led to the beginning of an investigation in the area in July 1937 by the United States Geological Survey in coöperation with the State Geological Survey of Kansas and the Division of Sanitation of the Kansas State Board of Health.

The investigation was made under the general administration of R. C. Moore and K. K. Landes, State Geologists, Earnest Boyce, Director and Chief Engineer of the Division of Sanitation of the Kansas State Board of Health, and O. E. Meinzer, geologist in Charge of the Division of Ground Water of the Federal Geological Survey. During the first year the investigation was under the immediate supervision of the late D. G. Thompson, senior geologist of the Federal Survey; thereafter it was under the immediate supervision of S. W. Lohman, Federal geologist in charge of ground-water investigations in Kansas through June 1945.

History and Methods of Investigation

1937.—After preliminary conferences with cooperating state officials, D. G. Thompson began a reconnaissance of the area in July 1937 and early in August was joined by S. W. Lohman. Thompson was called away on other work in September and for the remainder of the field season the work was carried on by Lohman, assisted part of the time by James I. Nelson. During the first field season an inventory of most of the public water supplies in the area and of many domestic, stock, and industrial wells and a few irrigation wells was made, samples of water for chemical analysis or chloride determination were collected from municipal and representative domestic and industrial wells, a 19-day pumping test was run on well 608 and a network of observation wells was laid out. In December 1937, periodic measurement of the observation wells in the area was begun by G. H. Von Hein.

1938.—The investigation was greatly enlarged and altered in scope during the summer of 1938, when the City of Wichita also began financial cooperation with the Federal and State Geological Surveys and the State Board of Health, in order to determine whether a sufficient quantity of soft, fresh water could be obtained

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within an economic distance to supply the needs of the city and to replace the then existing supply of hard, brackish water.

Nineteen cable-tool test holes (Pl. 2B) were put down in the Arkansas River Valley by the city, under the supervision of the Geological Survey, in order to determine the thickness and character of the water-bearing beds and the quality of the water. During the drilling, samples of material were collected and logs of the formations penetrated were prepared by John C. Frye, Bruce F. Latta, and Fred T. Holden. Mechanical analyses and determinations of permeability of the cuttings were made by Frye and Von Hein. By the use of pneumatic packers (Pl. 3) samples of water were obtained from each water-bearing stratum. From one to three 1¼-inch screened well points attached to 1¼-inch pipes were left in each hole to serve as observation wells. About 60 driven wells were put down by Von Hein assisted by two city employees (Pl. 4A) in part to aid in the construction of the water-table contour map (Pl. 1), but mainly to study both the lateral and vertical migrations of oil-field brines. Instrumental levels were run to all test holes and to many water wells by Ray S. Delamater, instrument man, and James S. Tandy, rodman. Additional wells were inventoried and sampled by Latta and Delamater. This and other work led to the conclusion that the quantity of fresh and relatively soft water required by the city of Wichita was obtainable from an area underlain by unconsolidated deposits south and west of Halstead, about 22 miles northwest from Wichita.

1939.—In the winter of 1939, 40 hydraulic rotary test holes were put down under the supervision of Black and Veatch, consulting engineers, for the City of Wichita in order to select the sites for the permanent water-supply wells, and a contract was let by the city to the Layne-Western Company for the construction of the 25 supply wells. During this time John C. Frye completed a reconnaissance of the geology of the area and prepared a preliminary geologic map. Additional wells were inventoried and additional levels were run.

In the summer of 1939, 40 additional test holes (Pl. 2A) were drilled in the area by Ellis D. Gordon, Perry McNally, and Fred T. Holden, using a hydraulic-rotary test drill owned and operated by the State Geological Survey.

1940.—Prior to September 1940, when the new Wichita well field, which was partly financed by the Federal Public Works Administration, was put into operation, the observation-well program was considerably intensified in the well-field area in order to provide the

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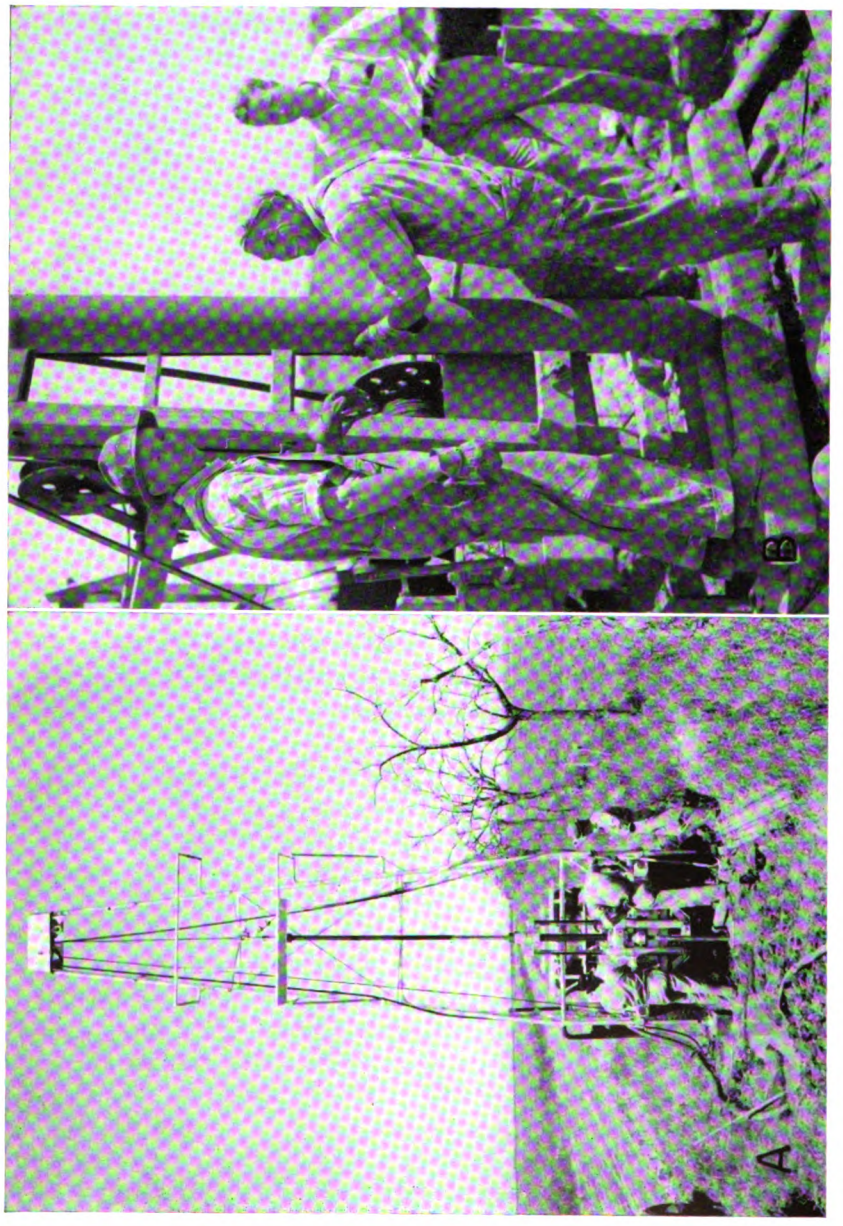

PLATE 2. *A*, Test hole being drilled in McPherson County by hydraulic-rotary rig owned and operated by State Geological Survey. *B*, Setting casing in cable-tool test hole drilled for City of Wichita. Photographs by S. W. Lohman.

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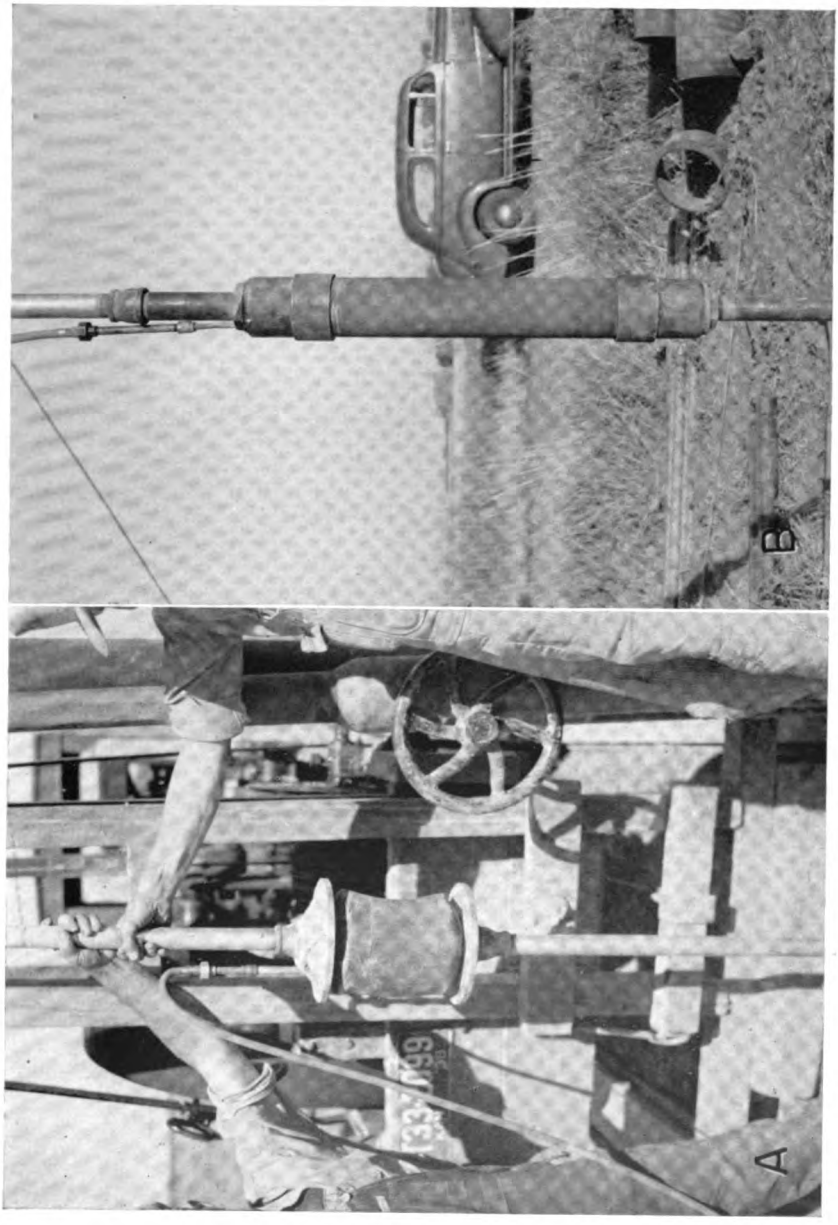

PLATE 3. Pneumatic packers used in obtaining water samples from cable-tool test holes drilled for City of Wichita. After packer and screened well point (below) are lowered into place in the test hole, compressed air expands the rubber cylinder tightly against the walls of the hole thus preventing water standing in the hole from entering the pump pipe. Photographs by S. W. Lohman.

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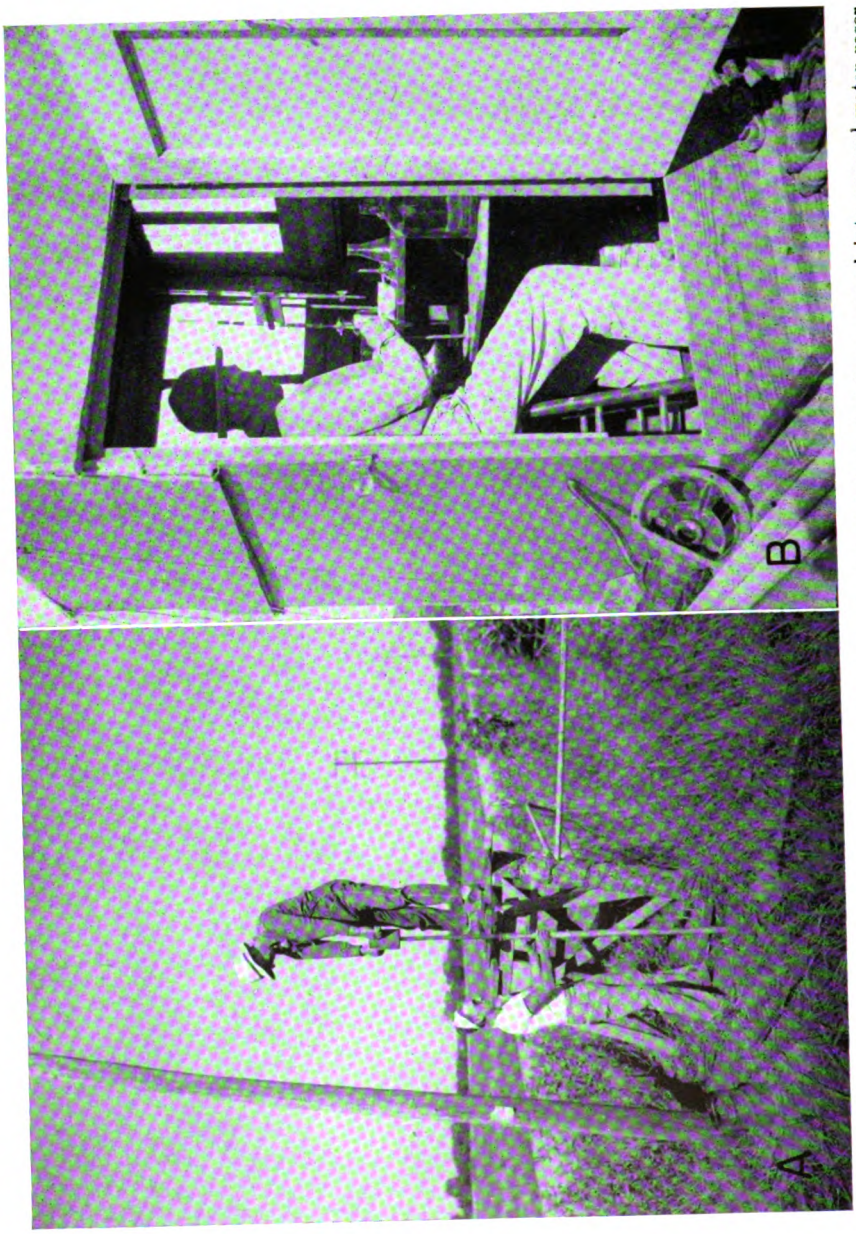

PLATE 4. *A*, Driving wells for use in tracing migration of oil-field brines that have seeped into ground-water reservoir. *B*, Portable laboratory mounted on truck for determining chloride content of water samples pumped from driven test wells. Photographs by S. W. Lohman.

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basic data necessary to later make a quantitative study of the well-field area by comparison of water-level contour maps made just before pumping began and at quarterly intervals thereafter. A preliminary report which gave a resumé of the geology and hydrology of the area was issued (Lohman and Frye, 1940).

1941-42.—In the summer of 1941 Charles C. Williams was assigned to begin study of the water-level and pumpage data from the Wichita well-field area; however, this work was interrupted in the fall of 1941.

1943.—In the summer of 1943 Williams extended the geologic mapping to include the southwestern part of the area, obtained additional data on the public-water supplies, collected auger samples from the zone of water-level fluctuations at several of the observation wells in the Wichita well-field area for determination of specific yield, and laid out sites for additional test holes. Thirty-six additional test holes were put down in 1943 by O. S. Fent, Mil Klingaman, and Glen Shanteau using the portable hydraulic-rotary rig of the State Geological Survey.

1944-45.—Additional geologic work was done by Williams in 1944, using a new base map at a scale of one inch to the mile prepared from aerial mosaics and supplemented in the field by large-scale aerial photographs. Williams was assisted for about a month by Claude W. Hibbard, formerly Curator of Vertebrate Paleontology of the Museum of Natural History, University of Kansas, and was visited in the field several times by S. W. Lohman and J. C. Frye. Results of the geologic mapping are shown on Plate 1. Hibbard collected many additional vertebrate fossils from the area and prepared a paper on the vertebrate paleontology (Hibbard, 1948). In the fall of 1944, 31 additional test holes were put down by Fent and Klingaman, and in the spring of 1945 Fent and Klingaman assisted by Clifford Dennis drilled 35 more test holes. All the drill cuttings from these test holes and those drilled earlier were examined by Williams using a binocular microscope.

In the summer of 1944 C. K. Bayne inventoried additional wells in the southwestern and northeastern parts of the area and he and R. L. Miles ran instrumental levels to these wells and to the test holes. The locations of the wells visited during the course of the investigation are shown on Plate 5, together with the depth to water level below land surface in the several parts of the area.

Preparation of report.—Final drafting of the maps and illustrations was done by Robert White, G. Riemer, and W. W. Wilson.

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Original plans for preparation of the text were interrupted by transfer of personnel. Most of the text, therefore, was prepared by Williams, who wrote all of the sections except the abstract, introduction, the section on salt-water intrusion, and the section on public-water supplies, which were written by Lohman. The base map for Plates 1, 5, 7, and 29 was prepared by Williams at a scale of one inch equals a mile from several sources: the roads and other cultural features were taken from base maps of the State Highway Department or from the new 7½-minute topographic maps of the Wichita area, supplemented by field checks and use of large-scale aerial photographs; the drainage was taken from aerial index mosaics of the Department of Agriculture. The geologic map (Pl. 1) was compiled by Williams from field mapping by Williams, Frye, and Hibbard. Part of the geologic mapping by Williams, particularly in the northern part of the area, was done on large-scale aerial photographs.

The 229 analyses of water given in Table 13, and the many additional chloride determinations (Pl. 29), were made mainly by Robert H. Hess, former chemist, in the Water and Sewage Laboratory of the State Board of Health, but in part by E. O. Holmes, Selma Gottlieb, and H. A. Stoltenberg, chemists in the same laboratory, and in part by Margaret D. Foster and W. M. Noble, chemists in the laboratory of the U. S. Geological Survey at Washington.

Previous Geologic and Hydrologic Work

Permian rocks.—The early history of geologic investigations of the upper Permian rocks in Kansas and the stratigraphy of the Permian formations in the area covered by this report were discussed by Prosser in 1897. The lithologic character and stratigraphy of the Permian rocks were described by Moore (1920), Bass (1929), Ver Wiebe (1937), and Norton (1939).

Cretaceous rocks.—Cragin (1895) described the fossiliferous sandstones and shales of Cretaceous age in this area and applied the name Mentor formation to them. Prosser (1897) reviewed the history of geologic study of Lower Cretaceous rocks in Kansas and assigned the rocks of this area to the Comanchean Series. Twenhofel (1924) described the geology and invertebrate paleontology of the Comanchean and "Dakota" formations of central and southern Kansas. Plummer and Romary (1942) described and classified the pre-Greenhorn Cretaceous beds of central Kansas. Latta (1946) reviewed the history of nomenclature and described the Comanchean stratigraphy of southern and central Kansas.

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Pleistocene deposits. — The Pleistocene age of unconsolidated stream-deposited silt, sand and gravel, and volcanic ash (Udden, 1891; Harnley, 1895) in central Kansas was established half a century ago by vertebrate fossils (Cope, 1889, 1895; Udden, 1891; Lindahl, 1892; Williston, 1897). These deposits, referred to as the "Sheridan beds" (Scott, 1897, pp. 532-533) or the "*Equus* beds," were named the McPherson *Equus* beds and described in some detail by Haworth and Beede in 1897 (pp. 285-296; Beede, 1898). Additional vertebrate fossils have been collected from this area and described (Deere, 1908; Hay, 1917, 1924, p. 48; Nininger, 1928; Harnly, 1934; Mohler, 1938; Frye and Hibbard, 1941; Hibbard, 1948). Very little geologic work was done in the area after the work of Haworth and Beede until ground-water investigations were started cooperatively by the State and Federal Geological Surveys in 1937. Preliminary results of this cooperative work have been published (Frye, 1939; Lohman and Frye, 1940; Moore, 1940; Frye and Hibbard, 1941).

Hydrologic studies.—In 1897 Haworth and Beede briefly discussed the occurrence of ground water in McPherson and Harvey Counties. The quality and availability of water in Harvey, Marion, McPherson, Reno, and Sedgwick Counties were studied and reported on by Parker (1911). In 1913, Haworth described the well waters in Kansas and included in his report a brief description of Arkansas River and a discussion of ground water in the McPherson-Newton area. In 1914, O. E. Meinzer prepared a preliminary report on ground water for irrigation in the vicinity of Wichita. Preliminary results of cooperative ground-water studies begun in 1937 by the State and Federal Geological Surveys have been published (Lohman and Frye, 1940; Moore, 1940). A report (Lohman, 1942) on the availability of ground-water supplies for national defense industries in south-central Kansas includes a brief description of the ground-water resources of this area. The ground-water conditions in the vicinity of Hutchinson were studied by Williams (1946). A paper was published in 1947 summarizing the methods used in estimating the ground-water supply in the Wichita well-field area (Williams and Lohman, 1947). An observation-well program was begun in 1937 and records of the observation wells in this area have been published by the U. S. Geological Survey in the series of Water-Supply Papers on water levels and artesian pressures in the United States (Meinzer and Wenzel, 1938, 1939, 1940, 1942, 1943, 1944, and 1946).

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Cooperative investigations of the intrusion of salt water in this area were made by the U. S. Bureau of Mines and the Kansas State Board of Health in 1934-35 (Wilhelm and Schmidt, 1935; Wilhelm, Thorne, and Pryor, 1936; and Jones, 1938).

Unpublished geologic and engineering reports on the ground-water conditions in this area have been prepared by R. C. Moore, State Geological Survey of Kansas, and by engineers of the City of Wichita, Wichita Water Company, and the Kansas Gas and Electric Company.

ACKNOWLEDGMENTS

The writers are indebted to the many well owners, well drillers, city water superintendents, and others in the area who so willingly supplied information concerning water wells. Special acknowledgment is given the late D. G. Thompson of the Federal Geological Survey for planning the initial phases of the investigation; to the district geologists of several oil companies who contributed information from core records on the depth to bedrock; to E. D. St. John, of the Kansas Gas and Electric Company, for permission to run a pumping test on well 608 at the company's Ripley Station; to O. H. Penny and Harry Boyd-Snee, Wichita representatives of the Laughlin-Simmons Company, for many elevations of section corners; to the following officials of the City of Wichita—Burt C. Wells and Alfred MacDonald, former city managers, the late P. L. Brockway, former city engineer and director of service, M. E. Rogers, former superintendent and engineer in charge of the Water Supply Division, Department of Service, and Robert H. Hess, former chemist and present superintendent and chemist in charge, for their splendid cooperation and assistance; to C. H. Kelley, former superintendent, and Robert Meeker, assistant superintendent, respectively, of the Wichita Water Company, for information on wells of the company and assistance in making the investigation; to R. O. Joslyn, president, L. M. Heckman, vice president, and Darwin Soder, Wichita representative, respectively, of the Layne-Western Company, for logs and records of many wells put down by their company; to Ray E. Lawrence, member of the consulting engineering firm of Black and Veatch, for records and logs of test holes and the new Wichita supply wells and other data; to A. W. Heffling, consulting engineer, for information on public water supplies; to Guy Hall, former McPherson county engineer, for information on fossil localities and outcrops of "quartzite" in McPherson County; to Ogden S. Jones, geologist in charge of the Oil Field Section and

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Robert Mitchell, former geologist of the Oil Field Section, both of the Division of Sanitation of the State Board of Health, and to Ludwig Schmidt and C. J. Wilhelm, U. S. Bureau of Mines, for information on salt-water intrusion in the area; to A. B. Leonard, Department of Zoology, University of Kansas, for determining the age of invertebrate fossils collected in the area; and to all others who aided in the field or in the preparation of the report. The writers are especially indebted to Claude W. Hibbard, formerly Curator of Vertebrate Paleontology, Museum of Natural History, for his assistance in the field and for preparing his paper on the vertebrate paleontology of this area, to the several field assistants listed above under "History and methods of investigation" for their able work in helping compile the field data; and to C. E. Jacob, C. V. Theis, and V. C. Fishel of the U. S. Geological Survey, for helpful advice and criticism of the material comprising the section on "Potential perennial yield of the Wichita well-field area."

The manuscript for this report, in addition to review by several members of the State and Federal Geological Survey staffs, has been read by George S. Knapp, Chief Engineer, and Robert Smrha, Assistant Chief Engineer of the Division of Water Resources, Kansas State Board of Agriculture; by Paul D. Haney, Director and Chief Engineer, and by Ogden S. Jones, Geologist, of the Division of Sanitation, Kansas State Board of Health.

GEOGRAPHY

Topography

Relief.—The region discussed in this report lies west of the flint hills and is included in the Great Bend Prairie physiographic province of Moore (1940). It is characterized by the extreme flatness of large areas and low topographic relief in parts of the area. The belt of sand dunes trending northwest-southeast along the northeast side of the Arkansas River Valley, the scarps formed by Cretaceous sandstones in the northwestern and northeastern parts of the area, and the rough area underlain by Ninnescah shale along Ninnescah River provide the only prominent relief to an otherwise nearly featureless plain.

The lowest points in the area, about 1,280 feet above sea level, occur along the Smoky Hill and Arkansas Rivers where these streams flow out of the area. The highest points occur south of Sharps Creek about 3 miles north of Windom, McPherson County, and are about 1,700 feet above sea level.

The wide, flat, poorly drained valley plain of Arkansas River,

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and the wide, flat to gently rolling surface of the ancient McPherson Valley comprise most of the area here discussed. Low terraces occur along Arkansas and Smoky Hill Rivers, but are not prominent topographic forms.

Drainage.—Most of the area covered by this report is drained by Arkansas River and its tributaries. The northwestern part of the area is drained by Smoky Hill River, a part of the Kansas River system, and the northeastern part is drained by the headwaters of Cottonwood River, a part of the Neosho River system. A few square miles southeast of Newton are drained by small tributaries of Walnut River which joins Arkansas River at Arkansas City. The central part of the area is drained by Little Arkansas River which joins the Arkansas at Wichita. The southwestern part is drained by the north fork of Ninnescah River which joins Arkansas River near Oxford in Sumner County. The more important tributaries to Little Arkansas River are Kisiwa, Emma, Turkey, and Black Kettle Creeks; the tributaries to Smoky Hill River are Sharps, Paint, Indian, and Gypsum Creeks.

Climate

The climate of this part of central Kansas is characterized by moderate precipitation, a wide range of temperature variations, moderately high average wind velocity, and comparatively rapid evaporation. The summer days generally are hot, especially during July and August. The winters are moderately cold but generally are free from excessive snowfall. All climatic data presented in this report were compiled from records of the U. S. Weather Bureau.

The mean annual temperature is 56.0° F. at McPherson, and 57.9° F. at Wichita. The highest temperatures occur during the three summer months, the monthly mean at McPherson and Wichita, respectively, being 74.7° F. and 75.0° F. in June, 80.7° F. and 80.4° F. in July, 80.0° F. and 79.6° F. in August. The lowest temperatures occur in winter, the monthly mean at McPherson and Wichita, respectively, being 33.0° F. and 34.7° F. in December, 30.1° F. and 32.1°F. in January, and 33.6° F. and 35.1° F. in February. The highest recorded temperatures at these two stations are 117° F. at McPherson and 114° F. at Wichita. The lowest recorded temperatures are –27° F. at McPherson and –22° at Wichita. The year 1936 was one of unusual extremes, the highest and lowest temperatures having been 117° and –11° F. at McPherson and 114° and –8° F. at Wichita.

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The average date of the last killing frost in the spring is April 9 at Wichita and April 22 at McPherson, but there have been killing frosts as late as May 15 at Wichita and May 27 at McPherson. The first killing frost in the fall has occurred as early as September 20 at McPherson and September 26 at Wichita, but the average date for this occurrence is October 16 at McPherson and October 22 at Wichita. The average length of the growing season is 177 days at McPherson and 196 days at Wichita.

Normal annual precipitation and other precipitation data are given in Table 1.

TABLE 1.—*Precipitation data from six U. S. Weather Bureau stations*

STATION	Length of record (years)	Normal annual precipitation (inches)	Greatest annual precipitation of record		Least annual precipitation of record	
			Year	Precipitation (inches)	Year	Precipitation (inches)
Hutchinson	54	28.53	1944	46.97	1921	16.20
McPherson	56	28.91	1944	39.98	1921	15.57
Mt. Hope	51	28.29	1944	42.64	1910	16.38
Newton	48	31.25	1922	48.69	1936	18.67
Sedgwick	28	30.20	1927	42.85	1936	16.93
Wichita	56	30.37	1944	43.53	1936	15.58

The study of data collected at six U. S. Weather Bureau stations indicates that the least recorded annual precipitation in the area was 15.57 inches at McPherson in 1921 and the greatest recorded annual precipitation was 48.69 inches at Newton in 1922. Annual precipitation at each of the stations is shown graphically in Figures 2 to 7, inclusive. Normal annual precipitation in this region is

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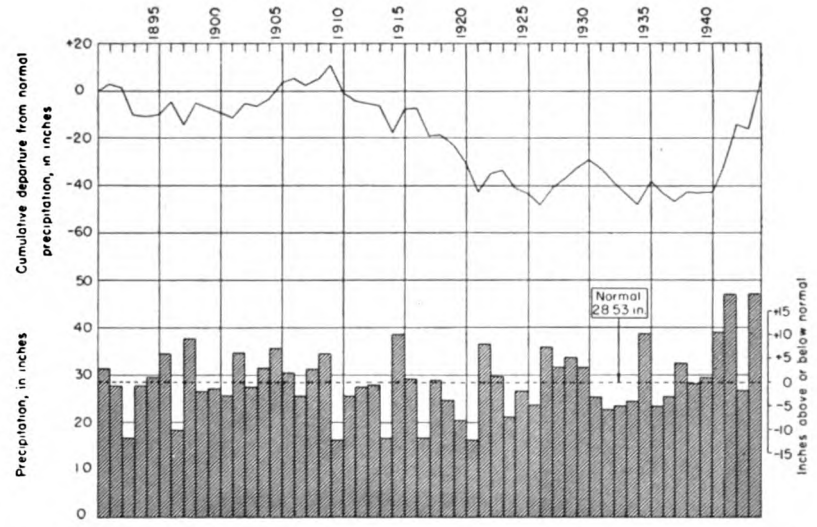

FIG. 2. Annual precipitation and cumulative departure from normal precipitation at Hutchinson.

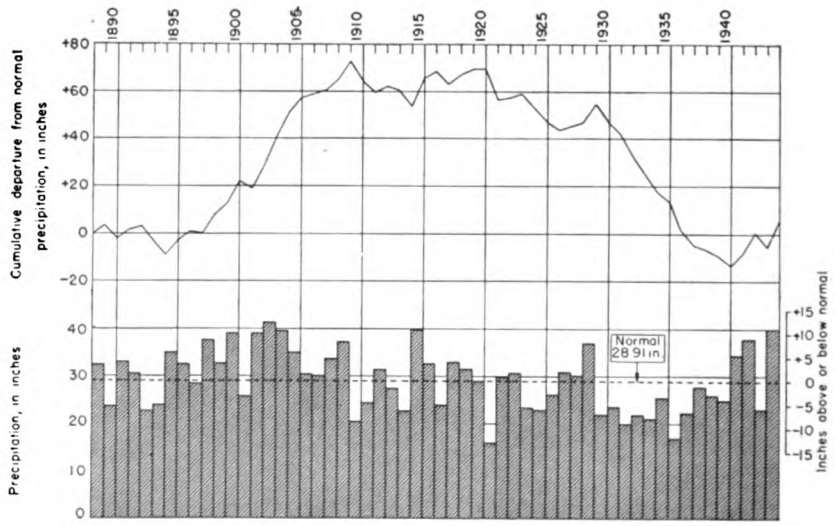

FIG. 3. Annual precipitation and cumulative departure from normal precipitation at McPherson.

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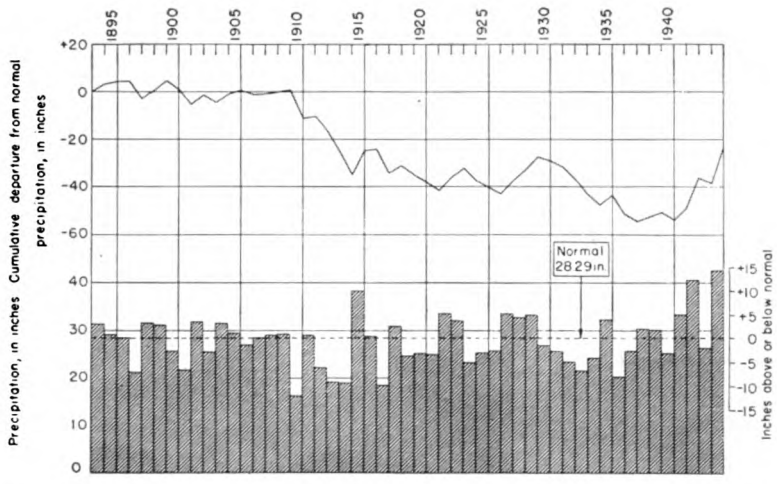

FIG. 4. Annual precipitation and cumulative departure from normal precipitation at Mt. Hope.

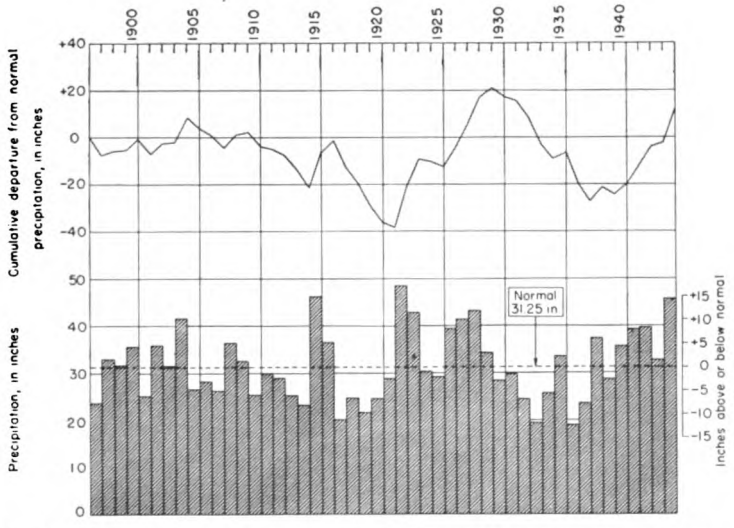

FIG. 5. Annual precipitation and cumulative departure from normal precipitation at Newton.

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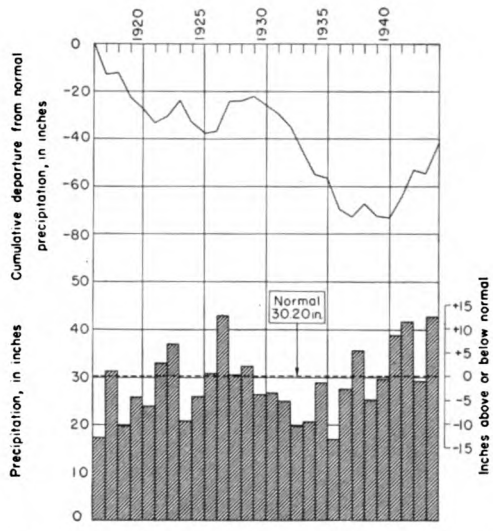

Fig. 6. Annual precipitation and cumulative departure from normal precipitation at Sedgwick.

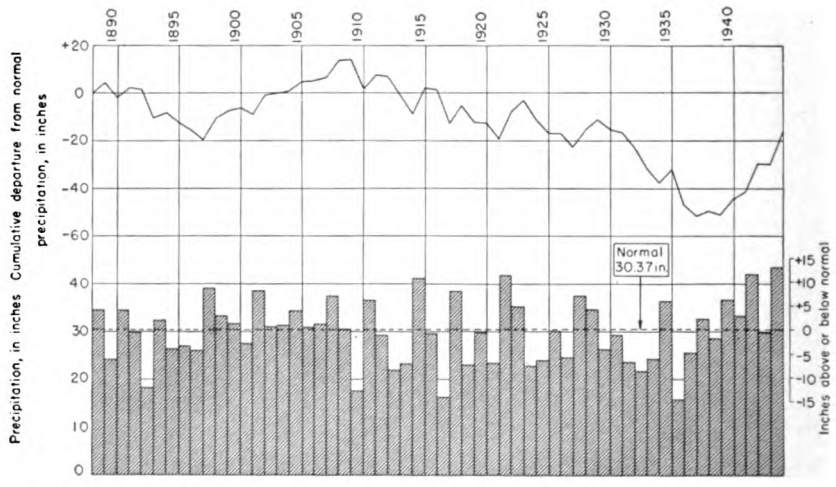

FIG. 7. Annual precipitation and cumulative departure from normal precipitation at Wichita.

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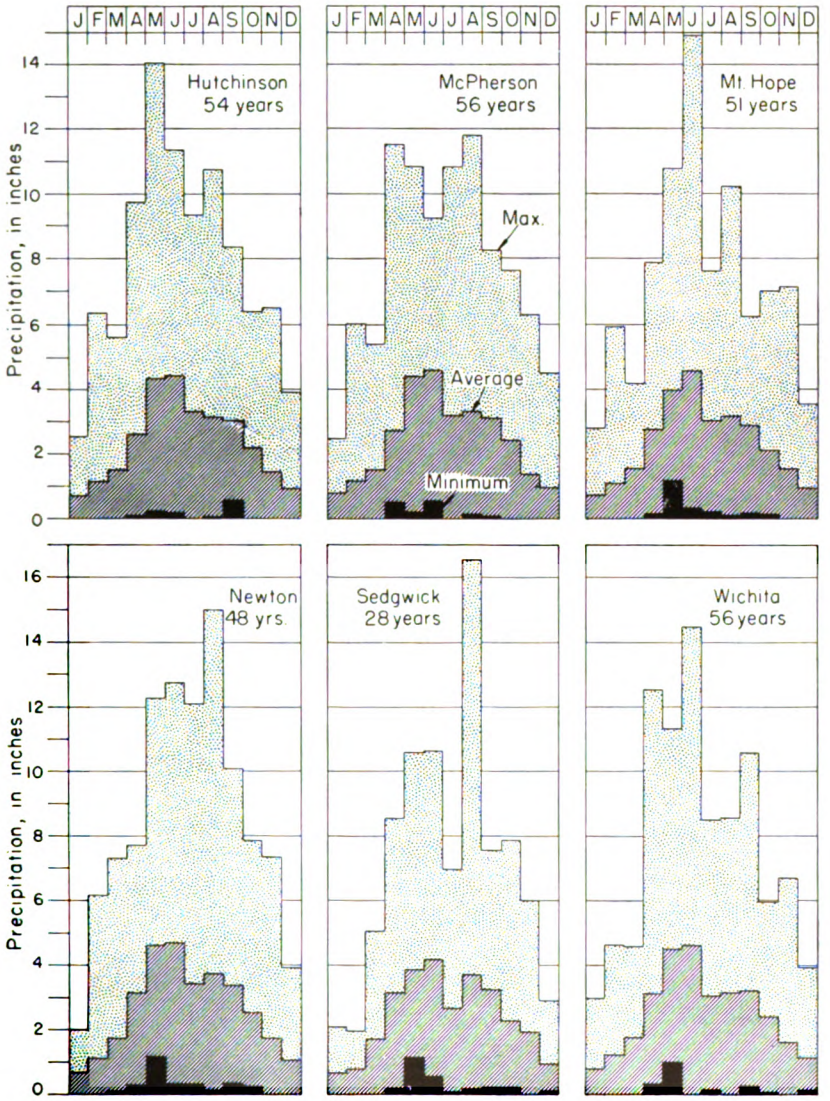

Fig. 8. Monthly distribution of rainfall at Hutchinson, McPherson, Mt. Hope, Newton, Sedgwick, and Wichita.

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about 29 inches; at Newton it is 31.25 inches, and at Hutchinson it is 28.53 inches. Deviations from the normal are frequent, however, as shown in Figures 2-7. Precipitation in this area seems to follow more or less irregular cycles in which periods of excessive moisture alternate with periods of deficient moisture or drought. A large proportion of the precipitation falls as torrential rains, followed by periods of scanty rainfall. Between 70 and 75 percent of the annual precipitation falls during the crop-growing season from April through September (Fig. 8). The normal rainfall during June, the wettest month, is about 4.5 inches; during January, the driest month, it is only about 0.7 inch.

The prevailing winds over this region are from the south, except in February when they are from the north. The greatest wind movement is in March and April, after which it decreases until August, which is the least windy month of the year. The sun shines in Wichita 68 percent of the time possible.

Population

The area included in this report is irregular as far as political boundaries are concerned. It comprises all of McPherson County and unequal parts of Harvey, Marion, Reno, and Sedgwick Counties; hence the exact population of this area is not readily determinable. The population in 1940 in each of the counties included wholly or partly in the area of this report is given in Table 2. (The reports of the U. S. Bureau of the Census are the source of population data presented here unless otherwise indicated.) The greatest average population density is in Sedgwick County, owing to the large percentage of urban population.

The population in 18 cities in this area having public water supplies is given in Table 3. The increase in population in the City of Wichita from 114,966 persons in 1940 to about 183,000 persons in 1944 (Table 4) is indicative of the magnitude of the city's participation in war industry. This city was fortunate in that just before the war period it had developed a water supply adequate to meet the demands of a rapidly expanding population and industry.

Transportation

The area is well served by lines of six railroads including two main transcontinental lines (Pl. 1). The main line of the Atchison, Topeka and Santa Fe Railway crosses the middle of the area through Newton, Halstead, Burrton, and Hutchinson; a branch line extends

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TABLE 2.—*Population in the counties included in this report*

County	Total population, 1940	Average population per square mile	Percent increase (+) or decrease (—) in population		Urban population (1940)	Rural population (1940)	Percent urban population		Total population, 1945
			From 1920 to 1930	From 1930 to 1940			1930	1940	
Harvey	21,712	40.2	+6.6	—1.8	11,048	10,664	49.9	50.9	21,030
Marion	18,951	19.8	—9.5	—8.6	.....	18,951	.....	.....	17,408
McPherson	24,151	27.0	+8.0	+2.4	7,194	16,957	26.1	29.8	22,314
Reno	52,165	41.6	+7.6	+9.2	30,013	22,152	56.7	57.5	50,607
Sedgwick	143,311	143.5	+47.8	+5.1	114,966	28,345	81.5	80.2	203,398

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TABLE 3.—*Population in 1930, 1940 and 1945 of cities in the area having public water supplies*

CITY	Population in 1930	Population in 1940	Population in 1945
Buhler	520	634	605
Burrton	649	842	787
Canton	728	796	662
Galva	358	463	384
Halstead	1,373	1,397	1,331
Haven	553	653	642
Hesston	526	403	414
Hutchinson	27,085	30,013	30,981
Inman	533	507	551
Lindsborg	2,016	1,913	1,955
Marquette	714	609	641
McPherson	6,147	7,194	7,038
Moundridge	870	864	767
Mt. Hope	466	422	458
Newton	11,034	11,048	10,970
Sedgwick	832	738	801
Valley Center	896	700	669
Wichita	111,110	114,966	155,968

TABLE 4.—*Population in the City of Wichita and in Greater Wichita, including the city*

	(1) 1930	(1) 1940	(2) 1943	(3) 1944
City of Wichita	111,110	114,966	174,000	183,000
Greater Wichita	119,831	128,010	194,000	204,000

1. From statistics published by U. S. Bureau of the Census.
2. From a publication by the City of Wichita, "Wichita's population," p. 49, Table 3.
3. From estimate by city officials, in a letter dated Nov. 28, 1944.

south from Newton through Sedgwick, Valley Center, and Wichita to points in Oklahoma and Texas; and another east-west line goes through Lehigh, Canton, Galva, McPherson, and Conway. The main line of the Chicago, Rock Island, and Pacific Railroad traverses part of the area through Canton, Galva, McPherson, Inman, Medora, and Hutchinson, and a branch line connects Wichita with states to the north and south. The Missouri Pacific Railroad has lines connecting Wichita and Hutchinson, Wichita and points south and east, and a freight line connecting Newton and McPherson through Hesston and Moundridge. A line of the St. Louis and San Francisco Railroad connects Wichita, Bentley, Burrton, Buhler, Medora, and

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points to the west. A branch line of the Union Pacific Railroad connects McPherson and Lindsborg with a through line at Salina.

The network of modern highways which traverse the area is shown on Plate 1. The greatest traffic moves on U. S. Highway 81 through Wichita, Newton, McPherson, and Lindsborg; U. S. Highway 54, east and west through Wichita; U. S. Highway 50S through Newton, Burrton, and Hutchinson; and U. S. Highway 50N, through Canton, Galva, McPherson, and Conway. Numerous improved county roads and one state highway (Kansas 17) connect with the main highways. Most of the township roads are graded.

Agriculture

This area is dominantly agricultural although recently the trend has been toward industrialization. The soils of the area are of several types, most of which are suited to the growing of wheat and other small grains. Alfalfa and other legumes are grown in the stream valleys. The sand hills and parts of the areas underlain by Cretaceous and Permian rocks comprise grazing lands. Irrigation is practiced only on a few farms. Acreages devoted to the principal crops are given in Table 5.

Natural Resources and Industries

The rich soil and abundant ground-water supply are foremost among the natural resources of this area. Natural gas and petroleum are produced from many oil fields, especially in McPherson and Harvey Counties. Salt is mined at three plants in Hutchinson and vicinity. Sand and gravel deposits are abundant in this area and the material is exploited widely from many pits (Pl. 1).

Wichita is an important transportation and distribution center and many industries and establishments in the city are devoted to these services. The City of Wichita has attained national prominence in the manufacture of aircraft and this industry employs many people living in this area. Other important industries are the production and refining of petroleum products, the milling and storage of grain, meat packing, the production and processing of salt, and the manufacture of foundry products.

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TABLE 5.—*Acreage of farms and principal crops in this area in 1945*

(From U. S. Census Bureau)

COUNTY	Number of farms	Acres in farms	Average acreage per farm	Acres of wheat	Acres of corn	Acres of sorghum	Acres of oats	Acres of alfalfa	Acres of hay crops (exclusive of alfalfa)	Acres of pasture
Harvey	1,529	323,930	211.9	110,104	24,248	25,753	28,652	21,155	2,834	77,119
Marion	2,246	579,571	258.0	123,399	51,380	51,413	56,839	17,324	10,133	216,249
McPherson	2,274	560,629	246.5	243,811	23,946	38,287	30,271	17,114	7,783	147,515
Reno	3,058	806,666	263.8	344,606	17,687	93,188	25,370	26,849	4,796	194,807
Sedgwick	3,025	582,549	192.6	214,113	45,603	34,148	50,220	36,027	9,542	126,634

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Geologic Formations and Their Water-bearing Properties

In addition to the following discussion of the geologic formations in this area a considerable amount of data concerning them is included elsewhere in this report. Logs of 354 test holes and wells are grouped at the end of the report and the locations of the test holes and wells for which logs are given are shown on Plate 7. Mechanical analyses of the unconsolidated deposits are included in the section on the physical properties of the water-bearing materials. Records of typical wells tapping the formations are given in Table 37. Analyses of water derived from the several formations are given in Table 13.

Summary of Stratigraphy *

The rock formations that crop out in the parts of Harvey, McPherson, Marion, Reno, and Sedgwick Counties included in this report are of sedimentary origin and range in age from Permian to Recent. The areas of outcrop of the various formations are shown on Plate 1. The principal water-bearing formations are the sandstones of the Kiowa shale, the Delmore formation, McPherson formation, and alluvium of the Arkansas, Little Arkansas, and Smoky Hill River Valleys. The stratigraphic relationships of these and other formations are shown on the geologic profiles (Pl. 6). The character and ground-water supply of the geologic formations in this area are described brifly in the generalized section in Table 6, and in more detail under geologic formations and their water-bearing properties.

The geologic formations in this part of Kansas were first mapped by C. S. Prosser and J. W. Beede. They were described and the unconsolidated deposits were named the McPherson Equus beds by Haworth and Beede in 1897 (also described by Beede, 1898). On the geologic map of Kansas (Moore and Landes, 1937) a large part of the sand dune area and the alluvium along Arkansas, Little Arkansas, and Smoky Hill Rivers were distinguished from the McPherson formation.

Early in the course of the present investigation, it was deemed advisable to re-map the geology of the area; therefore a reconnaissance geologic map was prepared. In a previous publication Lohman and Frye (1940) (1) restricted the McPherson formation (the

* Since the completion of field work and preparation of the manuscript for this report, further studies by the State Geological Survey have resulted in modification of the stratigraphic conclusions and classification; therefore the text of this bulletin differs from the accepted nomenclature of the Kansas Survey. The pressing need for public release of the valuable hydrologic data contained in the report, however, has prompted us to publish it as approved by the United States Geological Survey. R. C. Moore.

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TABLE 6.—*Generalized section of the geologic formations in parts of Harvey, McPherson, Marion, Sedgwick, and Reno Counties*

SYSTEM	Series	Formation	Thickness (feet)	Physical character	Water supply
Quaternary	Recent	Alluvium	0–75±	Silt, clay, and cross-bedded coarse-grained sand and gravel containing silt and clay.	Yields large to very large supplies of relatively hard water to wells in the Arkansas and Little Arkansas Valleys. Smaller quantities are obtainable from the Smoky Hill Valley.
		unconformable on older formations			
		Younger dune sand	0–50±	Fine- to medium-grained eolian quartz sand. These younger, higher dunes are subject to shifting and blowout and are devoid of vegetation.	The higher dunes are above the water table in most places but constitute a valuable intake area.
		unconformable on older dune sand			
	Recent and Pleistocene	Older dune sand	0–100±	Fine- to medium-grained, rounded eolian quartz sand, cross-bedded. Several cycles of deposition set off by soil zones. In general these dunes have a cover of vegetation and are subdued in form.	Yields small quantities of soft water to domestic and stock wells. Water contains considerable iron. Forms an important catchment area for rainfall.
		unconformable on older formations			
	Pleistocene	McPherson formation	0–260	Buff to brown silt, clay, sand, and gravel. Channel deposits composed of coarse-grained sand and gravel. Contains volcanic ash.	Yields large to very large supplies of moderately hard to hard water, especially from channel deposits, to municipal, industrial, and farm wells. A few contact springs occur at base.
		unconformable on older formations			

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TABLE 6.—*Generalized section of the geologic formations in parts of Harvey, McPherson, Marion, Sedgwick, and Reno Counties—Concluded*

SYSTEM	Series	Formation	Thickness (feet)	Physical character	Water supply
Tertiary	Pliocene	Delmore formation *unconformable on older formations*	0–75	Gray to buff silt, clay, and carbonate, fine- to medium-grained sand, small amount of gravel. Material largely derived from Cretaceous and Permian rocks in and near the area of outcrop.	Yields small supplies of relatively hard water to stock and domestic wells.
Cretaceous	Comanchean*	Kiowa shale *unconformable on older formations*	0–120	Dark gray to black, gypsiferous shale; gray to buff, sandy shale; soft, cross-bedded sandstone; hard, limonitic sandstone; "quartzite"; and thin fossiliferous limestones.	Yields small supplies of hard water to farm and stock wells, and to small springs.
Permian	Leonardian*	Stone Corral dolomite	0–8	Gray, cellular, thin-bedded dolomite on outcrop in McPherson County. Contains anhydrite and gypsum in subsurface westward.	Yields no water to wells in this area.
		Ninnescah shale	0–275	Soft to hard, brick-red shale. Contains some thin beds of gray and green shale, thin argillaceous limestone and gypsum.	Yields meager supplies of highly mineralized water to farm wells.
		Wellington formation	550±	Soft, gray, calcareous shale containing gypsum, anhydrite, salt, and thin beds of argillaceous limestone.	Yields meager supplies of highly mineralized water to farm wells from weathered surface zones and crevices in unweathered beds of shale and limestone.

* Classification of the State Geological Survey of Kansas.

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Equus beds of early reports) to include only the fluvial deposits of Pleistocene age, (2) assigned a new name, the *Emma Creek formation,* to the other beds included in the McPherson formation that they thought were of Pliocene age, and (3) mapped the "loess" as a separate unit. In the present report (1) the name *Emma Creek* is abandoned because the beds at the type locality of the formation are now determined to be Pleistocene and are now included in the McPherson, (2) other beds outside the type locality which were assigned to the Emma Creek and whose age has been verified as Pliocene are now given a new name, the Delmore formation (see text), and (3) much of the loess of Lohman and Frye (1940) is included in the McPherson (see text discussion). Further discussion of changes in mapping and in definition of stratigraphic units is included below.

Permian System

Wellington formation

Character and thickness. The lithologic character of the beds included in the Wellington formation has been described by Bass (1929, pp. 99-103), Ver Wiebe (1937), and Norton (1939, pp. 1758-1766). The part of the Wellington that crops out in the area shown on Plate 1 consists dominantly of soft calcareous gray and bluish-gray shale containing several thin beds of argillaceous limestone and gypsum. Some beds of maroon and green shale occur near the top of the formation. Beds of gypsum in the Wellington, characterized by local deformation, crop out along Gypsum Creek near its junction with Smoky Hill River and elsewhere (Pl. 8C), and thick beds of rock salt are mined from the Wellington in Reno and Rice Counties. Although the salt is not exposed in this area, it is known to underlie the western part (Bass, 1926a). Thin impure limestones of the Carlton limestone member of the Wellington crop out in the eastern part of the mapped area. Descriptions of parts of the Wellington formation penetrated in test holes are given in the logs of test holes and wells. The Milan limestone member, which marks the top of the Wellington in southern Kansas, was not recognized near Lindsborg where the upper contact was drawn at the line or zone of color change from predominantly gray shale to red shale.

The exposed part of the Wellington formation is about 150 to 200 feet thick in this area. Thicknesses as great as 550 feet have been recorded in oil and gas wells.

Distribution and surface form.—The Wellington formation forms the bedrock floor under more than half of this area and as shown

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on Plate 1 the formation crops out in the eastern and northeastern parts of the area. At Wichita and for about 15 miles north from that city the Wellington crops out along the low bluff that forms the east wall of the Arkansas Valley. In places, as at Wichita, this outcrop band is very narrow and discontinuous and is mantled by the overlying Pleistocene deposits. The soft shales and evaporites of this formation yield on erosion a gently rounded and rolling topography. Northeast of Newton thin limestones cause small "breaks" locally along drainage ways.

Age and correlation.—The term Wellington was introduced as a stratigraphic name by Cragin (1896, pp. 16-18). The original definition placed the base of the formation at the top of the "Geuda salt" (within the Wellington formation as now defined) and the top was placed at the base of the Harper sandstone. Later, Bass (1929, pp. 99-103) redefined the Wellington including in it rocks occupying the stratigraphic interval between the Herington limestone below and the "Red Beds" above. Norton (1939, pp. 1758-1766) summarized the history of the classification of the Wellington formation and, in defining the Ninnescah shale, restricted the Wellington to the interval between the Herington limestone below and the Ninnescah shale above. This definition is the one in use currently. Present classification by the State Geological Survey of Kansas places the Wellington formation at the base of the Sumner group, lowermost group of the Leonardian Series in Kansas.

Water supply.—The Wellington formation yields small quantities of water to wells in the area southeast of Lindsborg, near Roxbury, northeast and southwest of Newton, and east and northeast of Wichita. Some wells in neighboring areas derive water from both the Wellington and McPherson formations. No large supplies of water are available from the Wellington owing to the physical character of the rocks comprising it, but some domestic and stock wells are supplied with very hard water from the shallow weathered zone at the top of the shale and from deeper crevices in the shale and thin limestone beds. Most wells yield enough water in wet years for domestic and stock use, but in dry years many wells fail.

The high mineral content of the water in the Wellington formation is shown graphically on Figure 29. Samples of water collected from the Wellington contained dissolved solids ranging from 1,114 to 2,044 parts per million, total hardness ranging from 640 to 1,302 parts per million, and chloride ranging from 79 to 677 parts per million. Most of the hardness in water from the Wellington formation is noncarbonate, or permanent, hardness.

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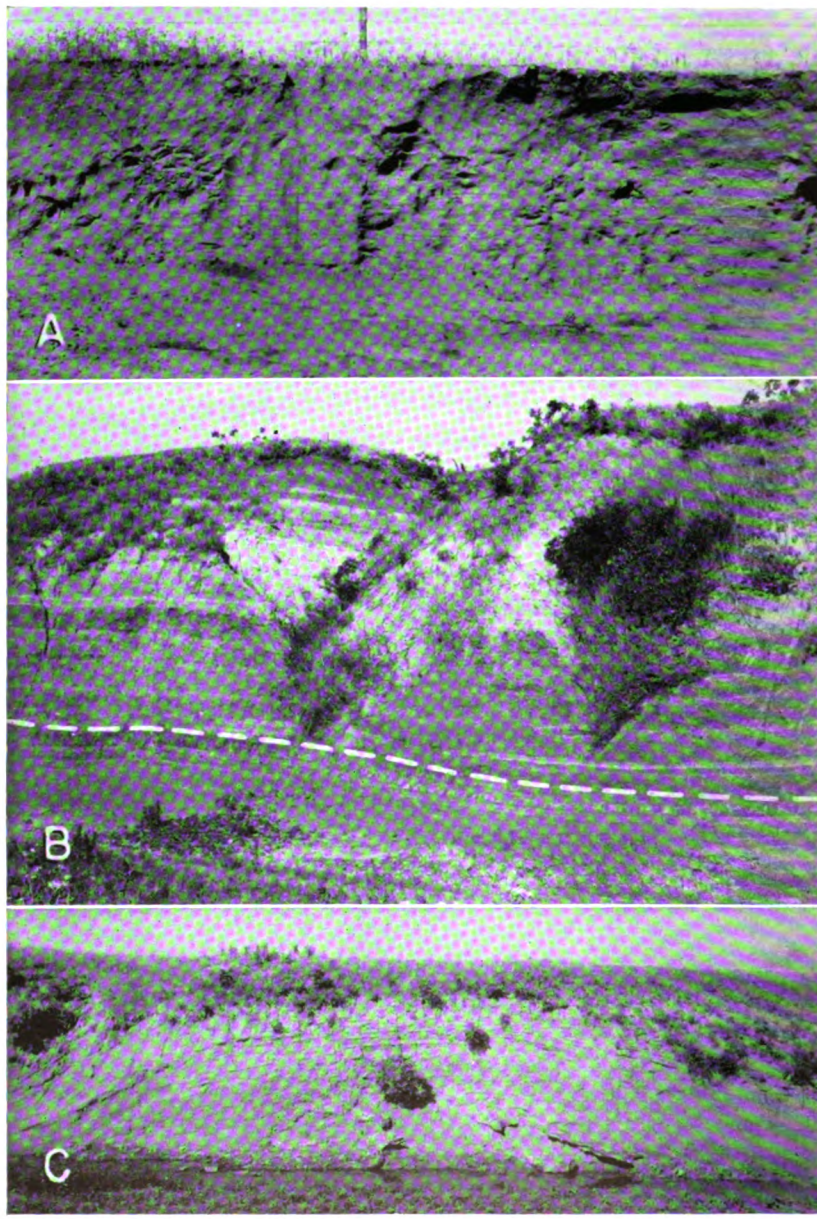

PLATE 8. *A*, Deposits of the McPherson formation in NE¼ sec. 34, T. 27 S., R. 4 W. *B*, Kiowa shale unconformably overlying shale of the Wellington formation in NW¼ sec. 32, T. 18 S., R. 1 E. *C*, Gray shale and gypsum in the Wellington formation in NE¼ sec. 3, T. 27 S., R. 1 E.; gypsum at water's edge. Small structure caused by solution. Photographs by C. C. Williams.

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Ninnescah shale

Character and thickness.—The Ninnescah shale, as the name implies, is predominantly a shale unit throughout its occurrence in Kansas. It conformably overlies the Wellington formation. It is composed largely of brick-red shale but contains some beds of green shale and thin argillaceous limestone near the base, and a rather persistent impure limestone about 5 feet thick near the middle of the formation. Thin beds of light-gray and red sandstone composed of very fine to medium grains occur in the upper part of the Ninnescah. Gypsum occurs in thin cross-cutting and intersecting veins, having been deposited secondarily in the red and green shale.

A small local occurrence of barite in the Ninnescah was observed along the west bank of a ravine near the NW cor. SE¼ sec. 3, T. 19 S., R. 5 W., in McPherson County. The barite occurs filling small spheroidal cavities in light-tan to buff soft siltstone. The barite is generally soft owing to weathering but in some cavities it is hard and unweathered. The barite, though weathered, displays fibrous crystalline form, and masses of the crystals are aranged in conical, stellate, and other forms. The siltstone containing the barite is a few feet thick and is a local facies of the red shale seen elsewhere along the ravine.

The Ninnescah shale forms the bedrock below unconsolidated materials in the western and southwestern part of the area. The Ninnescah shale attains a maximum thickness of about 275 feet in the area of outcrop. Norton (1939, pp. 1767-1774 has described the character and thickness of the Ninnescah shale in detail.

Distribution and surface form.—As shown on Plate 1, the Ninnescah shale crops out in the northwestern, west-central, and southwestern part of this area. Good exposures of parts of the Ninnescah may be seen in the northwestern part of the area especially in T. 17 and 18 S., R. 5 W. where erosion by small streams has produced the greatly dissested topography shown on Plate 9. In the southwestern part of the area along tributaries to Ninnescah River, from which the formation was named, good exposures and characteristic topographic expression of parts of the Ninnescah shale may be observed (Pl. 10).

Norton (1939, p. 1767) states:

> The [Ninnescah shale] is predominantly a shale throughout most of its occurrence in Kansas, and, because of its excellent exposures on both forks of the Ninnescah River in south-central Reno and north-central Kingman Counties, is here named the Ninnescah shale. . . . At the outcrop, it is 425 feet

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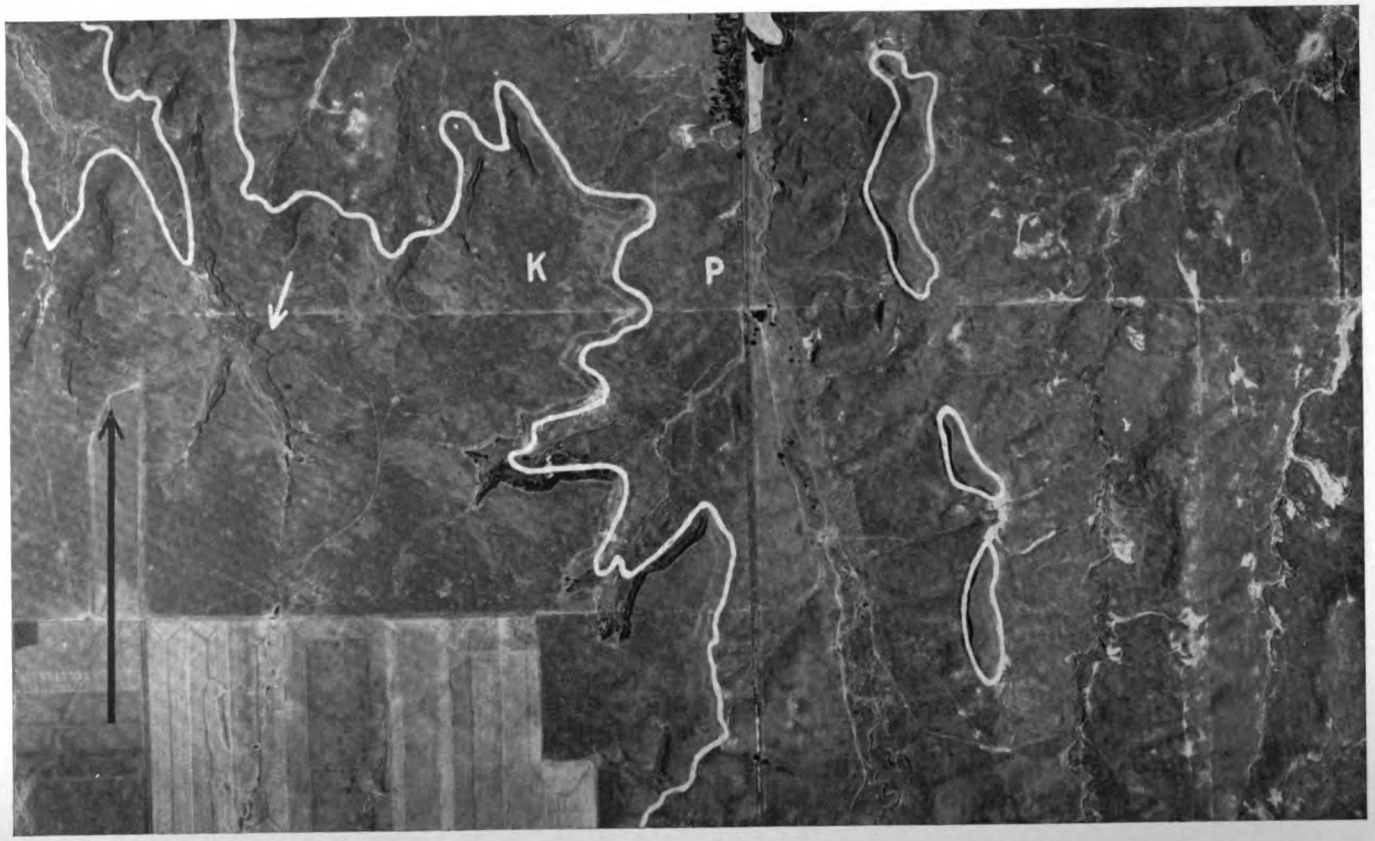

PLATE 9. Aerial photograph showing topographic expression of the Kiowa shale and the Ninnescah shale in secs. 32 and 33, T. 17 S., R. 5 W. and in secs. 4 and 5, T. 18 S., R. 5 W. Sandstone containing "Mentor" fossils caps the bluffs. The white line marks the contact between the formations. The small arrow points to the Natural Corral locality of Twenhofel. The large arrow points north and is about 0.5 mile long. U. S. Department of Agriculture photograph.

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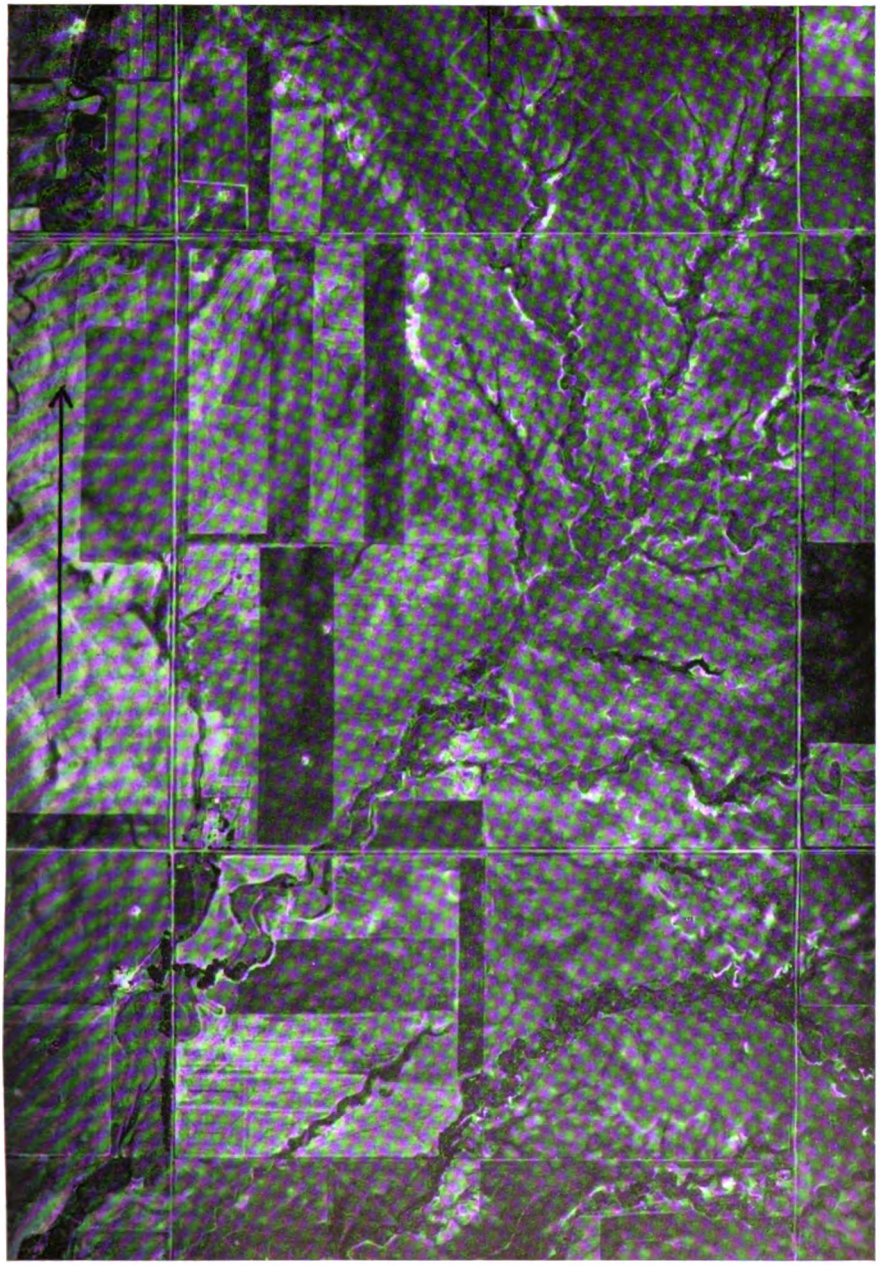

PLATE 10. Aerial photograph showing the topographic expression of the Ninnescah shale in the area of outcrop. The square mile in center is sec. 16, T. 25 S., R. 5 W. The arrow points north and is about 0.5 mile long. U. S. Department of Agriculture photograph.

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thick near the Oklahoma line, thinning to 280 feet 50 miles farther north. Though composed largely of red shales, this formation has a minor amount of gray shale beds and thin, impure, limestone beds, and beds of calcareous sandstone and sand, which maintain their lithologic character in a wide area and have been found useful in mapping the structure of south-central Kansas.

In the west-central part of this area, west of a line from Buhler to Conway, the Ninnescah is exposed only in a few localities along the eastern margin of the outcrop area and in small stream valleys south and southwest of Conway, south and southeast of Windom, and southwest of Inman. Unconsolidated materials consisting for the most part of tan to brown silt underlie an area comprising most of the southern half of T. 20 S., the northeastern part of T. 21 S., R. 5 W., and the northwestern part of T. 21 S., R. 4 W. This material is 39 feet thick at test hole 126, west of Inman, but is locally very thin and is composed of reworked wind-blown silt and slope-wash materials, products of the weathering of the Ninnescah shale near by. Paucity of exposures precluded showing these deposits on the geologic map.

Age and correlation.—As described by Norton (1939, pp. 1767-1774) the Ninnescah shale is the basal formation of the Salt Fork division, Cimarron Series. The State Geological Survey of Kansas presently classifies the Ninnescah as the middle formation of the Sumner group, Leonardian Series.

Water supply.—The Ninnescah shale yields water to wells in the west-central and southwestern parts of the area, and is very much like the Wellington formation in its water-bearing properties. Small supplies of very hard water may be derived from wells penetrating the weathered zone at the top of the shale, the thin sandstones at depth, or crevices in the shale and in the thin limestones. Few data concerning water supplies from the Ninnescah were collected, but many stock wells that yield small quantities of water from the shale were observed in T. 25 and 26 S., R. 5 W., and in T. 26 S., R. 4 W. At several of these wells salts were precipitated along the courses regularly taken by water overflowing from stock tanks. As shown on Figure 29, water from the Ninnescah is highly mineralized and is very hard. In the two samples collected from this formation, dissolved solids were 2,217 and 2,616 parts per million, total hardness 1,882 and 1,308 parts per million, and noncarbonate hardness 1,512 and 1,166 parts per million. Gypsum in the Ninnescah, as in the Wellington formation, causes most of the hardness in the water.

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Stone Corral dolomite

The Stone Corral dolomite was described in detail by Norton in 1939 (pp. 1774-1781). The type locality of the Stone Corral dolomite is in sec. 11, T. 20 S., R. 6 W., 2 miles west of the area covered by this report, where it conformably overlies the Ninnescah shale. At the type locality the Stone Corral consists of a massive porous dolomite about 6 feet thick, which forms a prominent scarp for several miles along the west side of the Little Arkansas River Valley. This formation becomes thicker in the subsurface westward, where it is composed mostly of anhydrite. The porous nature of the dolomite at the outcrops results from solution of the gypsum and anhydrite. The Stone Corral crops out in sec. 31, T. 19 S., R. 5 W., and in sec. 6, T. 20 S., R. 5 W. (Pl. 1). The topographic expression is not so pronounced in McPherson County as at the type locality in Rice County. The Stone Corral dolomite is classified by the State Geological Survey of Kansas as the upper formation of the Sumner group, Leonardian Series. The Stone Corral yields no water to wells in this area.

Cretaceous System

Cragin (1886, 1889, 1895) classified the Cretaceous sediments of southern Kansas as the Cheyenne sandstone, the Kiowa shale, and the Dakota sandstone, named in ascending order. Prosser (1897) reviewed the history of geologic study of Lower Cretaceous rocks in Kansas and assigned the Cheyenne sandstone and Kiowa shale to the Comanchean Series. Later, Gould (1898) redefined the Kiowa and Dakota of southern Kansas and described the Medicine beds between the Kiowa shale and the Dakota sandstone. Darton (1920, p. 2) subdivided the Cretaceous rocks that lie below the Graneros shale in western Kansas into the Cheyenne sandstone, the Kiowa shale, and the Dakota sandstone. Twenhofel (1924, pp. 12-34) classified the Cretaceous sediments in southern and central Kansas as Cheyenne sandstone, Belvidere formation, and "Dakota" formation, retaining the term Kiowa for the lower shale member of the revived Belvidere formation. Bass (1926, pp. 59, 73-76) used the term Dakota sandstone for all sediments between the Permian redbeds and the Graneros shale, recognizing that part of these sediments probably were equivalent to the Purgatoire formation of eastern Colorado. Elias (1931, p. 28) classified equivalent sediments in western Kansas as the Dakota group, and Tester (1931, pp. 234-283) applied the name Dakota Stage to the succession of strata occupying the interval between the Graneros shale and Penn-

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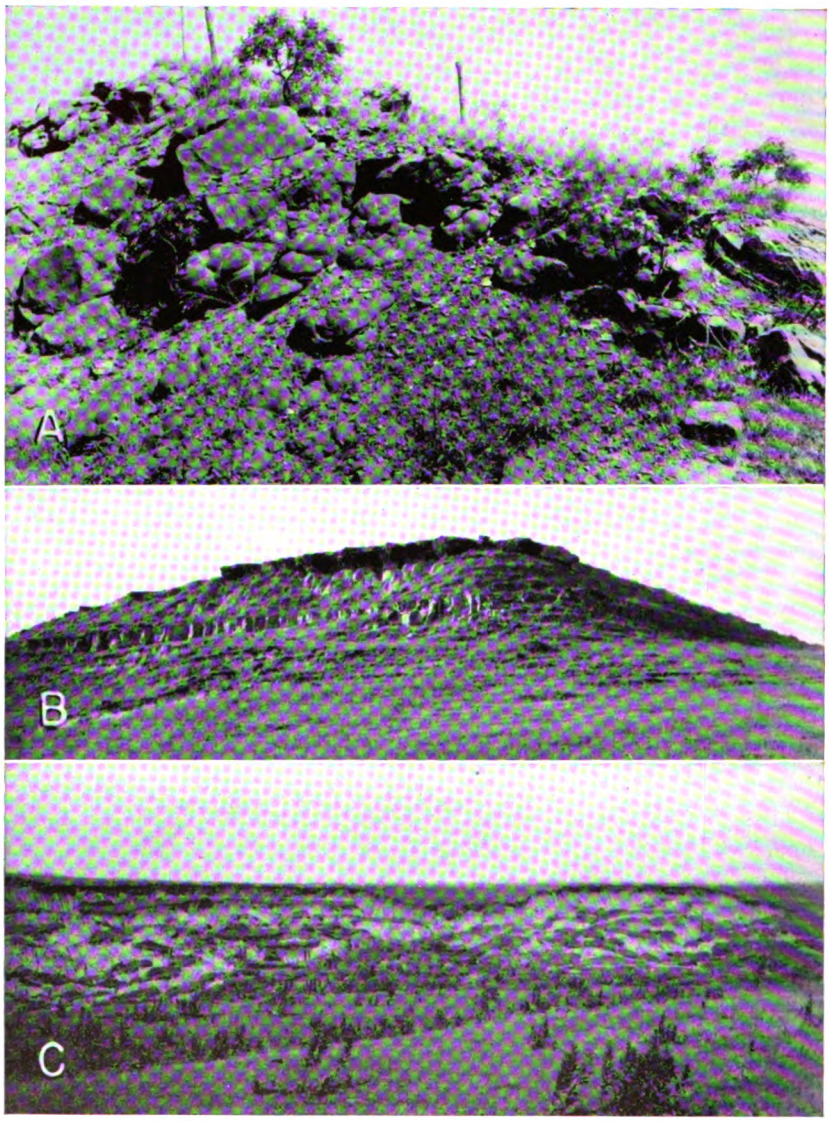

PLATE 11. Cretaceous rocks in McPherson and Marion Counties: *A*, "Quartzite" near the SW cor. sec. 24, T. 17 S., R. 2 W., showing concretionary form. *B*, Sandstone and sandy shale in the Kiowa shale in NE¼ sec. 5, T. 18 S., R. 5 W The capping sandstone contains "Mentor" fossils. *C*, Slumping of Kiowa shale along a ravine in the SE¼ sec. 28, T. 17 S., R. 1 E. A small terrace is shown in foreground. Photographs *A* and *C* by C. C. Williams; *B* bv B. F. Latta.

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sylvanian sediments at the type locality of the Dakota in northeastern Nebraska. Latta (1946) discussed in detail the stratigraphy and history of classification of the Comanchean rocks in Kansas.

The term Dakota group has been used by the State Geological Survey of Kansas (Moore and Landes, 1937; Moore, 1940, p. 40) to include all Cretaceous strata that lie below the Graneros shale. The beds formerly included in the Dakota group were studied in their outcrop area in central and north-central Kansas (although not in McPherson or Marion County) by Plummer and Romary (1942), and the terms Cheyenne sandstone, Kiowa shale, and Dakota formation were adopted to include all Cretaceous strata that lie below the Graneros shale. Subsequent reports of the State Geological Survey of Kansas (McLaughlin, 1943; Frye and Brazil, 1943; Swineford and Williams, 1945; and Latta, 1944, 1946) have followed this classification, and it is the one used in this report. Of the above closely related Cretaceous formations only the Kiowa shale is believed to be represented by the Cretaceous rocks of this area.

Kiowa shale

Character and thickness.—Included in the Kiowa shale in this area are the fossiliferous sandstones and shales comprising the Mentor formation of Cragin (1895, p. 162) and the Belvidere formation of Twenhofel (1924, pp. 31-34). In this area the Kiowa shale is composed of marine, nonmarine, hard, and soft sandstones, variegated and fissile shales, and some thin coquinoid limestones or shell beds. These beds are well exposed along ravines and canyons in sec. 5, T. 18 S., R. 5 W. (Pl. 11B). A section measured and published by Twenhofel (1924, p. 32) is characteristic of the Kiowa in this area and is included here.

Section at the Natural Corral, McPherson County, NW¼ sec. 5, T. 18 S., R. 5 W. (Twenhofel, 1924, p. 32)

		Thickness, feet
12.	Covered slope with Tertiary at the top, but float indicates the presence of red sandstone of the "Dakota".....	50
11.	Cross-laminated, highly ferruginous and concretionary coarse red sandstone. The concretions are similar to those characteristic of the "Dakota." About 4 to 6 feet from the top is a horizon containing the typical Mentor fauna. Fossils may be present in other parts of this zone but they have not been observed. There are many places in the immediate vicinity where the zone appears to contain no fossils whatever. This in part may be due to original absence, but in some cases it appears probable that it is due to the development of limonite concretionary structures whose presence in places has so completely modified the rock that all original features have been obliterated. This zone forms the rim of the canyon and the shoulders of the bluffs in the immediate vicinity.....	8

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	Thickness, feet
10. Cross-laminated, medium-grained, friable yellow sandstone; no fossils	2
9. Friable, fine-grained, yellowish sandstone with a somewhat compact 6-inch band near the middle and another similar 2-inch band about 7 feet from the top. Locally the zone contains a little shale. It forms the upper portion of the cliff above the spring at the head of the east arm of the corral, where it is thinner and more compact than indicated above. No fossils...	17.5
8. Compact yellowish-white sandstone; no fossils	7–8
7. Blue paper shale; no observed fossils	10
6. Pale yellow sandstone, containing dicotyledonous leaves	2
5. Blue gypsiferous shale	14
4. Two 6-inch layers of gray shell limestone separated by gray shale. The limestone consists almost wholly of shells. The most common species being *Ostrea kiowana, Cyprimeria kiowana, Cardium kansasensis* and *Turritella seriatim-granulata belviderii*...	3
3. Dark-blue gypsiferous shale containing many crystals of yellow selenite, nodules of pyrite and a layer of cone-in-cone limestone. The cone-in-cone layer, or one very similar, has been found in a number of localities in Saline and McPherson counties where no fossiliferous strata are present	16
2. Concealed, believed to be shale and sandstone	14
1. Permian. Red, blue and yellow shales of the Wellington formation.	25

A section of rocks measured by Plummer and Romary (1942, p. 323) indicates the nature of similar rocks at Kanopolis dam site along Smoky Hill River.

A section of the Kiowa shale along the east bank of a small tributary to Cottonwood River in the northeastern part of the area (Pl. 8B) showing the basal contact with the Wellington formation follows.

Section of the Kiowa shale in NW¼ sec. 17, T. 18 S., R. 1 E.

	Thickness, feet
CRETACEOUS—Comanchean	
Kiowa shale	
4. Sandstone, thin, buff to tan, and sandy shale; contains fragments of plant remains	9
3. Shale, light buff, sandy; a few thin sandstone beds intercalated; some selenite crystals on exposed surface	7
2. Clay shale, black and dark blue, paper thin, soft; contains much gypsum; selenite crystals abundant on exposed surface	9
PERMIAN—Leonardian	
Wellington formation	
1. Shale, hard, gray, green, and maroon; contains a few thin siltstones. Upper 1 foot composed of reworked and redeposited consolidated shale conglomerate derived from the Wellington and marks the unconformable contact	8
Total thickness exposed	33

Beds 2, 3, and 4 in this section are approximately equivalent to beds 3 to 8 in Twenhofel's section given above.

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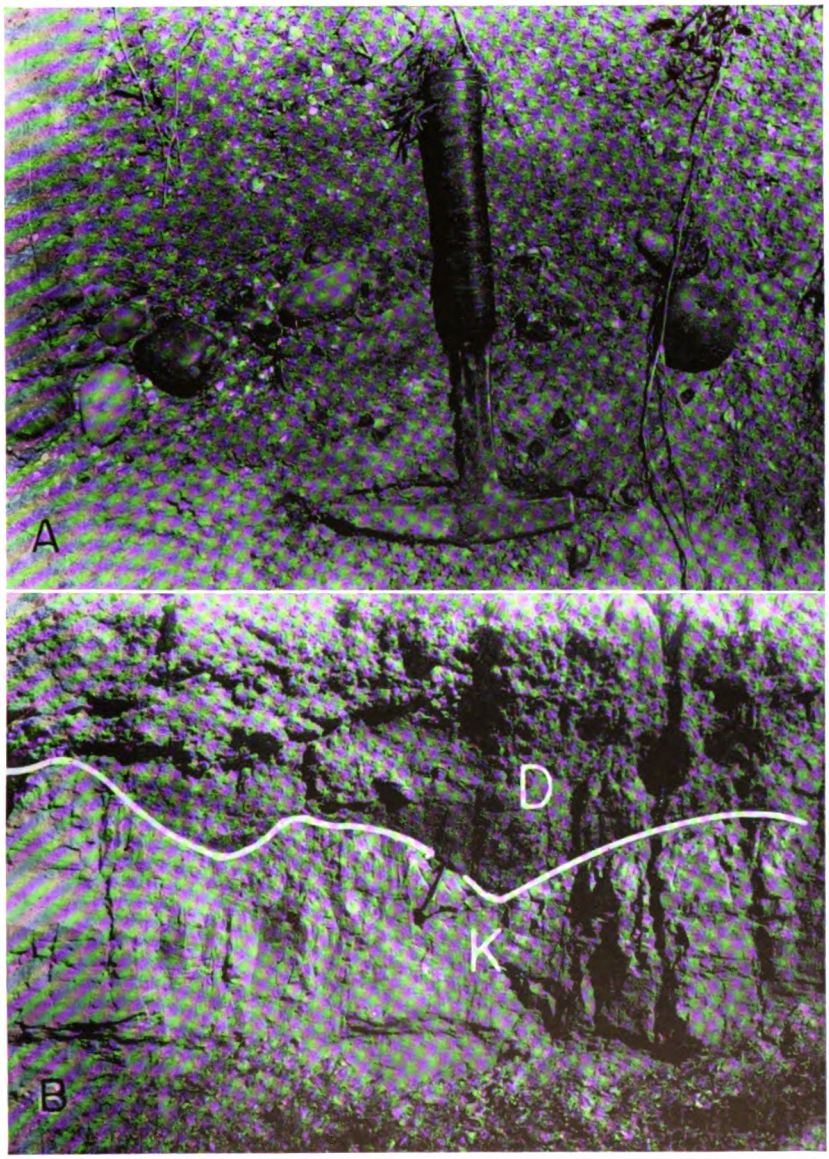

PLATE 12. *A*, Zone containing pebbles and cobbles of resistant rocks at the contact between the Ninnescah shale and Kiowa shale. *B*, Delmore formation (D) unconformably overlying sandstone of the Kiowa shale (K) in the NE¼ sec. 30, T. 18 S., R. 1 W. Photograph *A* by B. F. Latta; *B* by S. W. Lohman.

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The basal contact of the Kiowa shale with rocks of Permian age, where exposed, is in many places distinguished by the presence of a clastic deposit of either reworked Permian shale or a thin zone (1 to 2 feet thick) containing large, well-rounded pebbles and cobbles up to 3 inches in diameter composed of chert or resistant igneous rock. An exposure of this zone above the Ninnescah shale, in the SW¼ sec. 2, T. 17 S., R. 5 W., is shown in Plate 12A. This zone is not confined to the Permian-Kiowa contact but occurs rather persistently at the base of the Cretaceous section in Kansas, whatever the overlying rock may be. Plummer and Romary (1942, p. 320) note the occurrence of a similar pebble zone at the base of the Dakota formation in Clay County, and Latta (1946) has observed a similar zone at the base of the Cheyenne sandstone in Kiowa County.

Locally in McPherson County the sandstone in Twenhofel's Marquette member (1924, pp. 31-32), bed 9 of his section given above, is tightly cemented by calcite or silica or both in beds and in large concretionary forms producing very resistant ledges. This rock generally is light to dark gray or pink on fresh fracture but it weathers brown. This "quartzite," as it is known locally, is quarried and crushed for road material at several of the quarries which are indicated on Plate 1 in Ts. 17 and 18 S., R. 1 W. and in T. 18 S., R. 1 E. Samples of the rock were collected and submitted to C. S. Ross of the U. S. Geological Survey for analysis. Specimen 1 was collected in the NW¼ SW¼ sec. 15, T. 18 S., R. 1 W. and specimen 2 was collected along the road in the NE¼ sec. 24, T. 17 S., R. 2 W. The results of the analyses were reported as follows.

Specimen 1 is composed of angular to subangular quartz grains and minor amounts of plagioclase and microcline enclosed in a matrix of calcite. The quartz grains average about 0.3 mm. in diameter. The calcite forms large areas up to 4 mm. in diameter which extinguish as a unit. These calcite units contain as many as 100 or more quartz grains.

Specimen 2: Quartz grains show marked enlargement due to the deposition of secondary silica. In addition, calcedonic quartz fills or partly fills spaces between quartz grains.

It seems probable that the quartz and calcite indurating this otherwise poorly cemented sandstone were deposited by percolating ground water subsequent to the deposition of the sandstone. Although this zone of secondary cementation seems to be confined stratigraphically in this area, reports indicate that other Cretaceous sediments have been similarly affected elsewhere. Twenhofel (1924,

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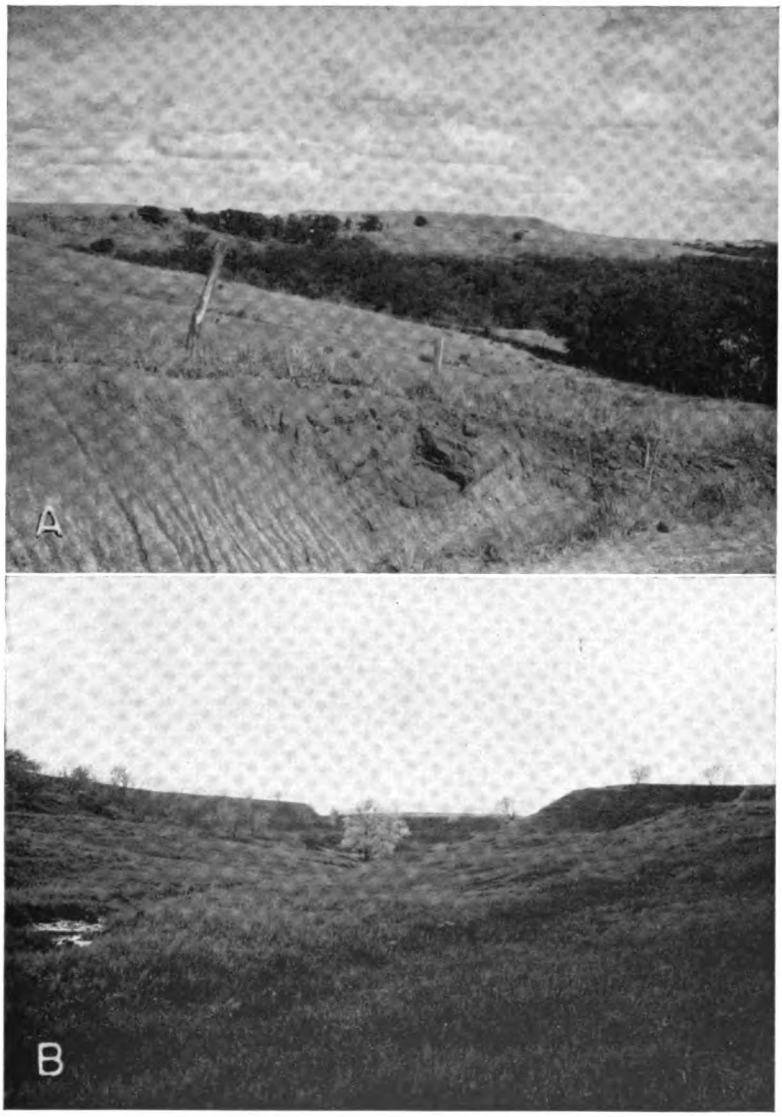

PLATE 13. Topographic expression of the Kiowa shale in northern McPherson County. *A*, View in northwestern part of T. 18 S., R. 2 W. *B*, View in the NE¼ sec. 5, T. 18 S., R. 5 W. An intermittent spring occurs at the head of this ravine. Photograph *A* by S. W. Lohman, *B* by B. F. Latta.

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p. 40) reports that the Windom member near the SW cor. sec. 16, T. 20 S., R. 6 W., in Rice County is a "quartzitic" coquina; Plummer and Romary (1942, pp. 321 and 333) describe development of "quartzitic" facies of the lower member of the Dakota formation in Lincoln and Ellsworth Counties; and McLaughlin (1943, p. 121) states that in Hamilton County, near Hartland, and in Morton County along the north fork of Cimarron River, the uppermost sandstone of the Dakota formation has been cemented by silica. Thus it seems that this zone has no regional stratigraphic significance.

The thickness of the Kiowa shale in this area ranges widely; the maximum thickness is about 120 feet. Test hole 59 penetrated 75 feet of Kiowa, and this and other logs given at the end of this report describe the character of the material composing the Kiowa in the subsurface.

Distribution and surface form.—The Kiowa shale crops out in the northwestern and northeastern parts of the area shown on Plate 1 and underlies the unconsolidated deposits in the area north of Galva and Canton and southeast of Canton toward Goessel.

In general, the dark shale and sandy shale of the Kiowa weather rapidly and the resulting topography is flat or gently rounded; hence good exposures are limited to cut banks in small gullies. The beds of sandstone form prominent ledges and cap outlying hills in places where the sandstones have been tightly cemented with calcite, silica, or limonite (Pls. 9 and 13). Elsewhere the soft sandstones weather rapidly and gently rounded hills result.

Subdued sand and silt hillocks or dune remnants sporadically occupy a long, narrow area which trends northeastward between Goessel and Canton (Pl. 14). This area has been mapped as being underlain by the McPherson formation (Pl. 1), but the deposits probably are derived from and underlain by the Kiowa.

Age and correlation.—Authors cited above (especially Cragin, Prosser, Twenhofel, and Latta) have correlated the Kiowa in McPherson County with similar rocks in Kiowa County on the basis of similar fossils found in these deposits and, in part, on similarity of lithology. Plummer and Romary (1942, p. 322-325) correlated similar rocks in Ellsworth County with the Kiowa and recognized that the fossiliferous marine sandstones (Mentor beds) occurring in Rice and Saline Counties and the unfossiliferous sands below them (Marquette sandstone) were part of the Kiowa shale. Frye and Brazil (1943, p. 21) agreed closely with Plummer and Romary

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Plate 14. Aerial photograph showing subdued dune-like land forms in southwestern Marion County. The square mile shown in upper center is sec. 32, T. 21 S., R. 1 E. The arrow points north and is about 0.5 mile long. U. S. Department of Agriculture photograph.

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but correlated the "Mentor beds" and "Marquette sandstone" with the Dakota formation.

The Kiowa shale is considered to be of Comanchean age by the State Geological Survey of Kansas, corresponding in age to some of the rocks in the Washita group of Texas.

Water supply.—The quantity and quality of the ground water available to wells from the Kiowa shale in this area are quite variable. Wells at Canton yield relatively hard water (analyses 65, B, and C) derived in part from sands in the Kiowa. No pumping-test data are available for this part of the area, but some of the sands in the Kiowa probably will yield water in sufficient quantity to supply small towns. Small-diameter drilled wells yield sufficient water for domestic and stock use throughout the areas underlain by sandstone, and small springs occur near the heads of many ravines which have cut into the sandstones. The black shale and sandy shale beds in the Kiowa yield meager supplies of very hard water to farm and stock wells. Test holes drilled east of Lindsborg (logs 1 to 13) revealed that the sandstone was not sufficiently permeable to supply the needs of that city, although the water was of comparatively good quality. Wells that penetrate the shale near Windom have been generally unsuccessful.

Tertiary System

Pliocene series

Rocks containing fossils of middle Pliocene age crop out in the north-central part of the mapped area. Rocks deposited during other epochs of the Tertiary have not been identified in this area.

Lohman and Frye (1940; also, Frye and Hibbard, 1941) named that part of the McPherson formation they considered to be of Pliocene age the Emma Creek formation. During the summer of 1944 Williams, Hibbard, and Frye restudied the formations of the area, collecting many vertebrate fossils during the course of their investigation. This study has resulted in a number of changes in the age designation of certain beds that has affected the stratigraphic nomenclature of the area. The name Emma Creek is abandoned because the beds at the locality selected as the type of the formation are Pleistocene in age. Some of the beds which Lohman and Frye (1940) and Frye and Hibbard (1941) assigned to the Emma Creek have proved to be of Pliocene age and are a separate lithologic unit; these Pliocene beds are here designated the Delmore formation.

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Delmore formation

The term Delmore formation is proposed for the Pliocene sediments underlying the area north and northwest of Canton and Galva (Pl. 1) in Delmore Township (T. 18 S., R. 2 W.) in McPherson County. These beds were originally assigned to the Emma Creek formation of Lohman and Frye (1940), the type beds of which were considered to be Pliocene in age. On the basis of the present study the beds at the type locality of the Emma Creek are now assigned to the Pleistocene and the name *Emma Creek* therefore is abandoned. The Delmore formation is lithologically distinct from the beds originally designated the Emma Creek and the Delmore does not extend into the type area selected for the Emma Creek. Good exposures of parts of the Delmore formation are found in secs. 24, 25, and 26, T. 18 S., R. 2 W. and there are many exposures along ravines in sec. 31, T. 18 S., R. 1 W. These localities lie within the area of outcrop and are considered to be the type area of the Delmore formation. This formation is believed to have been deposited during middle Pliocene time, a conclusion substantiated by the identification of vertebrate fossils collected from the outcrops and discussed by Hibbard (1948).

Character and thickness.—The Delmore formation is composed of calcareous, gray to buff silt and clay, fine- to coarse-grained sand, and some gravel. In places the calcium carbonate has been concentrated and forms irregularly shaped nodules and thin layers within the silt. About 20 feet of medium- to coarse-grained sand, overlain by 8 feet of tan silt, clay, and residual chert fragments, is well exposed at a sand pit on the J. M. Kinkerman farm in the SE¼ sec. 30, T. 18 S., R. 1 W.

Coarse pebbles of quartz and ironstone derived from Cretaceous rocks are concentrated locally at the unconformable basal contact of the Delmore with older formations (Pl. 12B). The sand grains composing the sand beds and lenses in the Delmore formation range from fine to medium grade, and are composed dominantly of quartz but include also some feldspar, mica, or other minerals common to igneous rocks. The silt is buff and sandy where not calcareous; however, most exposures are characterized by the light gray color of the silt derived from calcium carbonate grains.

The maximum thickness of the Delmore formation is about 75 feet as shown by test drilling. The character and thickness of this formation are described in logs 24, 25, 26, 27, and 66.

Origin.—The sediments comprising the Delmore formation seem-

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ingly were deposited by small tributaries that flowed southward and southwestward in McPherson County following the general depressional area, which is assumed then, as now, to have marked the outcrop of the shale of the Wellington formation. The sand in the Delmore obviously was derived from beds of sandstone in the Kiowa shale, which cropped out to the north and northeast; the silt and clay in the formation bear marked resemblance to material in the shales of the Kiowa and Wellington. The shale of the Wellington is calcareous, in part, gray to light gray in color, and is believed to have been the source of the gray color and calcium carbonate inclusions in the Delmore formation. Concretionary pink chert pebbles which characterize the Herington limestone at its outcrop and chert pebbles derived from other Permian limestone occur locally in silt in the upper part of the Delmore. These pebbles probably were brought into the area by streams and otherwise by movement down slope when tributary drainage was westward during an earlier cycle of erosion. The Flint Hills drainage divide formerly lay east of the outcrop of the Permian limestones that contributed the chert pebbles which now occur in the Delmore formation.

Distribution and surface form.—The Delmore formation crops out in northeastern McPherson County (Pl. 1) and occupies a relatively small part of the mapped area. The upper or southwestern boundary of the Delmore formation is indicated on Plate 1 by a dashed line; a more definite boundary cannot be drawn because of poor exposures. Southwestward from the heads of the ravines along which the Delmore is exposed, in the divide area between the Smoky Hill and Arkansas River drainage basins, an extremely flat topography remains undissected. The McPherson formation lies immediately south of the undissected area. Extending southwestward from the area of outcrop as far as McPherson, the Delmore formation underlies the Pleistocene McPherson formation. At McPherson a Tertiary fossil has been taken at depth from a gravel pit southeast of that city. The Delmore formation does not extend into the area designated by Lohman and Frye (1940) as the type locality for their Emma Creek formation (the beds now included in the McPherson formation). Local deposits of gray sandy silt occur along a ravine in the SW¼ sec. 15, T. 17 S., R. 1 W. This gray silt probably is a part of the Delmore but the areal extent is very small and is not shown on Plate 1.

Age and correlation.—The presence of vertebrate fossils of middle Pliocene age in the sediments of the Delmore formation and the

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presence of Pleistocene deposits unconformably overlying the Delmore signify the middle Pliocene age of this formation. No fossils of late Pliocene age have been collected from the Delmore formation. The Delmore formation is equivalent in age to part of the Ogallala formation in western Kansas but was derived from different sources.

Water supply.—The material comprising the Delmore formation is fine grained and poorly sorted compared with other unconsolidated deposits in this area, and comparatively small supplies of moderately hard water are available from the formation. Well 71, near Galva, yields about 30,000 gallons a day, and domestic and stock wells are adequately supplied from the Delmore. The City of Canton is supplied with water derived in part from this formation, and analyses 65, B, and C show the chemical character of the water at Canton.

Quaternary System

Pleistocene series

McPherson formation

The McPherson formation as redefined in this report includes all the unconsolidated stream and slope deposits of Pleistocene age which occur in this area in the McPherson Valley * and in the Arkansas River Valley. It includes all the Emma Creek formation at the type locality and much of the loess of Lohman and Frye (1940). In general, the formation consists of early Pleistocene stream deposits, later and coarser Pleistocene stream channel deposits, and still later Pleistocene silt, clay, and fine sand deposited by sluggish streams and by slope processes as the McPherson Valley became filled after diversion of the major stream.

Character and thickness.—The materials comprising the McPherson formation were deposited by streams and by slope processes operative throughout much of the Pleistocene Epoch, and the deposits vary greatly in physical character. The general character and thickness of the McPherson are shown on Plate 6 and in many of the logs of test holes and wells.

Locally a conglomeratic bed occurs at the base of the older part of the McPherson formation. It ranges from 1 to 6 feet in thickness and is composed of shale, quartz, and sandstone pebbles in varying

* *McPherson Valley* is a psysiographic term indicating the broad, north-south trending central area in McPherson and northern Harvey Counties, which has an elevation lower than the bordering areas underlain by Permian and Cretaceous rocks. The term McPherson channel is used to describe the deeply buried, stream-cut channel incised in the older deposits in the western part of the McPherson Valley. McPherson formation is the formation name applied to the earth materials with which the McPherson buried channel is filled, and to older and younger Pleistocene stream and slope deposits which extend eastward from the channel in the McPherson Valley.

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proportions, cemented with impure calcium carbonate. In many places the lowermost beds of the McPherson are composed of unconsolidated tan to gray silt and clay, derived largely from the Wellington formation. The material in the conglomerate is similar to materials comprising the so-called Abilene conglomerate, a good exposure of which is located near the NW cor. sec. 30, T. 18 S., R. 2 E., just east of the mapped area. It is believed that at various outcrops the beds which have been called the Abilene conglomerate may represent different ages; hence the "Abilene" may not have much stratigraphic significance. The conglomerate at the base of the McPherson in this area, however, may be equivalent to some exposures of the "Abilene conglomerate" in Dickinson County.

The older part of the McPherson formation, east of the McPherson channel contains much tan to buff silt, clay, and very fine-grained sand in which are many irregular nodules of calcium carbonate. This silt is exposed along U. S. Highway 81 in T. 18 S., R. 3 W. and has been considered to be loess of considerably younger age (Lohman and Frye, 1940, fig. 2). Sand and some gravel occur in the older part of the McPherson formation (Pl. 8A). Locally, as near Moundridge, this material is exploited for road and building purposes; it is composed mostly of fine to course sand but contains some fine to coarse gravel. Test drilling indicates the maximum thickness of this material to be about 60 feet.

Vocanic ash occurs locally in the McPherson formation, generally near the base of the silt. The ash is exposed in the northern part of the area, especially in T. 18 S., R. 3 W., and T. 18 S., R. 4 W. Fourteen localities at which ash is exposed and which were examined during this study are designated by A on Plate 1. At several of these localities the ash has been exploited to some extent; ash was being hauled from one of the pits intermittently during the summer of 1944. Several years ago J. A. Schriner, Windom, Kansas, prepared and packaged volcanic ash from a pit, now covered, near the SE cor. sec 28, T. 18 S., R. 5 W. The product was called Hurricane cleaner.* The ash is light gray to bluish gray where purest and is yellowish to buff where silt is admixed. It is generally from 1 to 2 feet thick; but the maximum known thickness of volcanic ash, or "silica" as it is known locally, is about 9 feet in sec. 20, T. 18 S., R. 3 W., near the exposure shown in Plate 15A.

The presence of ash in McPherson County was noted by Udden

* The labels on the cans of cleaner pictorially likened its action to that of a tornado, sweeping all in its path before it. Marketing problems plagued the venture and the product never became widely known.

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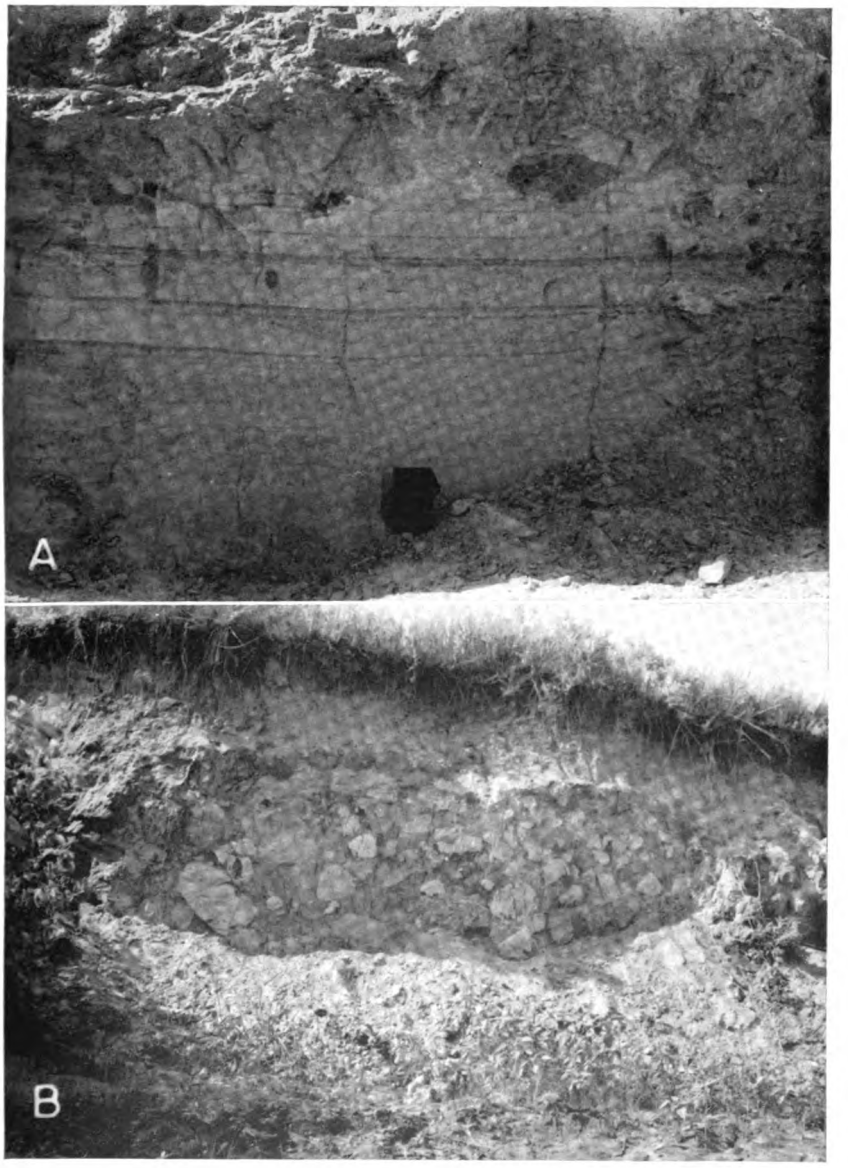

PLATE 15. Volcanic ash in McPherson County. *A*, Pit in the NW¼ sec. 20, T. 18 S., R. 3 W.; note bedding. *B*, Blocks of volcanic ash included in a deposit of sand and gravel of the McPherson formation in the SW¼ sec. 9, T. 17 S., R. 5 W. Photographs by C. C. Williams.

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(1891, pp. 340-345); and by Haworth and Beede (1897, p. 289) who described it as occurring within a clay layer and as being from 18 to 24 inches thick. Landes (1928, pp. 30-32) described ash deposits from four localities in McPherson County and inferred from one that the ash was younger than the channel gravels of the McPherson formation. Although some reworked ash does occur in the channel deposits of the McPherson, the original ash occurs in the older deposits of the McPherson formation. Boulders of volcanic ash in channel gravel deposits of the McPherson (Pl. 15B) and other deposits elsewhere indicate the older age of the ash. Lohman and Frye (1940, p. 853) described the ash as occupying a stratigraphic interval at or near the base of the loess. In the area of volcanic ash outcrop the material formerly mapped as loess is now believed to be a bed of silt in the McPherson formation. In the vicinity of McPherson, however, the "loess" is much younger, does not occupy the same stratigraphic interval as the older silt, and is included in the upper part of the McPherson formation.

The stream deposits filling the deeper channel through the McPherson Valley, here called the McPherson channel, are younger than the finer stream deposits of the McPherson formation occurring east of the channel. The channel deposits consist of sand and gravel in the lower part (Pl. 16) and silt and sand above. The coarser material ranges from medium sand to coarse gravel. The grains and pebbles of sand and gravel are composed mostly of quartz, but many are fragments of pink and white feldspar and other igneous rocks. Some pebbles are composed of blue and olive-green chert; some caliche and nodules of calcium carbonate occur in the gravel. Haworth and Beede (1897, p. 29) state that the samples of the sands and gravels of the McPherson Equus beds studied by them contained no feldspar. Lohman and Frye (1940, p. 852), and Frye and Hibbard (1941, p. 268) state that the McPherson formation contains grains of pink and red quartzite similar to that which occurs typically as erratics in the glaciated area of northeastern Kansas. During preparation of this report samples from many test holes and gravel pits were examined microscopically in the laboratory and fragments of pink and red quartzite were not observed, although pink and red feldspar is common in the samples.

The silt interbedded with and above the sand and gravel of the channel deposits is tan to buff and contains some nodules of calcium carbonate. Locally thin beds of volcanic ash, believed to be reworked from older ash deposits, occur in the channel deposits. Near the top of the McPherson formation the silt is brown.

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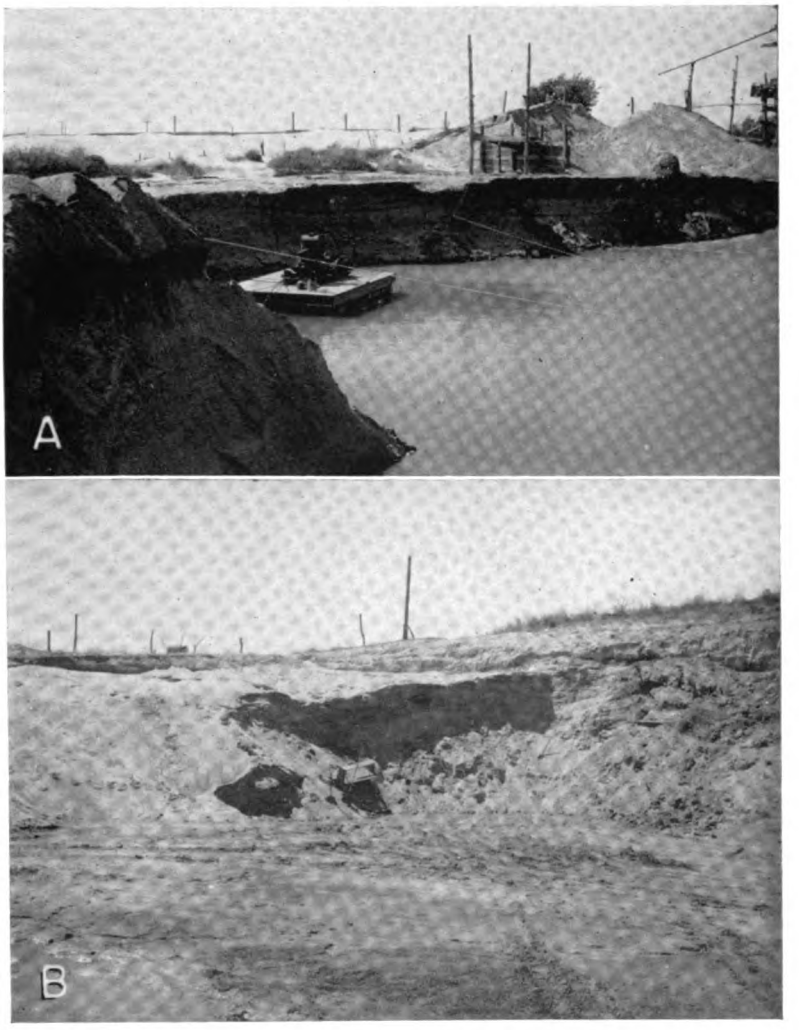

PLATE 16. *A*, Gravel pit in the McPherson formation at the NW cor. sec. 13, T. 25 S., R. 2 W. *B*, Sand pit in channel deposits of McPherson formation in the SW¼ SW¼ sec. 31, T. 18 S., R. 4 W. Floor of pit is Ninnescah shale. Photograph *A* by S. W. Lohman, *B* by J. C. Frye.

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Test drilling northwest of McPherson indicates that the maximum thickness of the McPherson formation is about 260 feet in the deepest part of the channel penetrated (Pl. 6). These deposits thin to a featheredge westward along the outcrop of the Ninnescah shale. Eastward from the McPherson channel the coarse sand and gravel become thinner, and brown and tan silt overlies the clastic deposits.

Origin.—Haworth and Beede (1897, pp. 290-295) after noting and objecting to several possible hypotheses for the origin of the McPherson formation, concluded (p. 295):

> At present it must be admitted that no satisfactory explanation of the origin of the Equus beds channel, nor the agency for the deposition of the materials, has been advanced.

One of the objections noted by these authors was that the comparative altitudes of the drainage divide near McPherson and the present Smoky Hill River between Marquette and Lindsborg were not in accord with any hopothesis postulating a southward course for Smoky Hill River, especially since no terrace deposits were known to occur along Smoky Hill River.

Frye (1939, pp. 1232-1233) postulated an eolian origin for the thick deposits of silt underlying the area of the drainage divide near McPherson. Still assuming that no terraces existed upstream along the Smoky Hill to allow a much higher former altitude for that stream, the eolian silt hypothesis was advanced to permit logically the southward course of Smoky Hill River during McPherson time.

In 1940 Lohman and Frye observed (p. 846):

> At the close of Emma Creek [early McPherson] sedimentation there appears to have been a through valley or depression extending south from a point near Lindsborg past McPherson to the Arkansas Valley, and this valley may have contained a through-flowing stream. At this time the Kansan glacier dammed the Kansas River northeast of the area. When this glacier began to melt, excessive quantities of melt water filled the Smoky Hill Valley and found an outlet through the "McPherson Valley," ultimately joining the ancestral Arkansas Valley. The glacial outwash carried by this stream was deposited to form the McPherson formation (restricted).

It is believed that direct relationship between the deposits of the McPherson formation and outwash from the glacier of the Kansan Stage should not be postulated because of the considerable difference in altitude between the McPherson formation and the glacial deposits. It is believed that the origin of the McPherson is more closely related to the later glaciation in the Rocky Mountains; at least, no grains or pebbles of rock similar to those comprising the glacial erratics in northern and northeastern Kansas were found in samples of the McPherson formation.

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Terrace deposits were described by Frye, Leonard, and Hibbard (1943, pp. 33-37) along the Smoky Hill River in Ellsworth and Russell Counties just west of this area. It was pointed out by them that the discovery of the terraces removed objections advanced by Haworth and Beede, although the silt near McPherson was still considered to be of eolian origin. Since recognition of the terraces, the hypothesis of eolian origin of the silt seems no longer necessary.

The channel sands and gravels of the McPherson formation seem to have been deposited by streams flowing southward through the McPherson Valley. The principal stream may have flowed southward following the direction of the present channel of Smoky Hill River but at a much higher level from Salina to Lindsborg and it may have continued in a direction slightly west of south past McPherson, Inman, and Buhler toward and across the present Arkansas River north of Colwich (Pl. 7). A large tributary stream occupied the course of Smoky Hill River above Marquette at the higher level, indicated by the terrace deposits there, entered the area from the northwest, and joined the main stream northwest of McPherson. These streams cut the channel and deposited the sand and gravel of the McPherson formation. It is believed that capture of the principal stream near Salina directed drainage eastward, and that after this capture and reversal of drainage some of the silt in the upper part of the McPherson was deposited by overflow during periods of flood and by filling of low areas with silt-laden water from the sides of the McPherson Valley. Some of the silt washed thusly into the valley from the sides probably was redeposited on hills and in valleys as dust from the southwest and later redeposited in the lower areas by rain wash and by other processes. The valley sides were reduced in steepness by erosion and the fine materials were deposited in the valley through which no stream was then flowing. Further local development of low areas by solution, the process which probably was responsible for the original course of the stream, continued and the resulting sinks served as traps for silt-laden water, the runoff from higher land. Some deposits of reworked volcanic ash resulted from these same processes.

The sand and gravel was derived from Cretaceous sandstones, from the Ogallala formation, from earlier Pleistocene deposits, and from igneous rocks in the Rocky Mountain area. The silt was derived from weathered shale of Cretaceous and Permian age and from the reworking of eolian silt probably transported to the area from the southwest.

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The McPherson formation in the present Arkansas River Valley was deposited by a stream entering the southern part of the area from the northwest. This stream, which was a tributary to the stream system flowing southward through the McPherson Valley, occupied approximately the same position as the present Arkansas River (Williams, 1946). Toward the close of this period, the ancestral Arkansas River flowed at a level somewhat higher than the present Arkansas River, having filled a deeply excavated channel approximately equivalent in depth and age to the McPherson channel farther north.

Most of the sediments comprising the older part of the McPherson formation, into which the McPherson channel was cut, were deposited by streams flowing southward through the McPherson Valley. Streams contributing to deposition in early McPherson time entered the area from the north, northeast, and northwest, occupying positions near the present Smoky Hill River near Marquette from the northwest and near Smoky Hill River from Lindsborg to Salina from the north. Other smaller streams entered from the east and northeast. This is a comparable drainage pattern to the one that existed during deposition of the channel deposits of the McPherson except that streams were flowing at a higher level in the early part of McPherson time, the principal streams were from the north, and the main channels were east of the later and deeper McPherson channel, as indicated by gravel deposits near Moundridge and elsewhere. Tributary drainage from the east and northeast deposited silt derived from Permian and Cretaceous shale and larger fragments and pebbles forming the zone of conglomerate. The streams were nearly at grade and much silt was deposited on flood plains.

The volcanic ash was derived from the southwest (Landes, 1928, pp. 17-19) and was transported to the area by wind before the channel deposits of the McPherson were laid down. The ash was deposited originally in valleys, depressions, and on leeward slopes. Some of the ash may have remained as first deposited, but most of it was transported from its original location down slope by water running in small streams and rivulets and redeposited elsewhere. The character of the ash shown in Plate 15A indicates redeposition. Undoubtedly some of the silt included in the McPherson formation was transported to and redeposited in the area in a similar manner.

Distribution and surface form.—The distribution of the McPherson formation is shown on Plate 1. The McPherson underlies most

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of the central part of this area from Smoky Hill River to the south border, and is known to occur southward along Arkansas River nearly to the southern boundary of Kansas.

The surface of the area underlain by the McPherson formation is generally flat or gently rolling. Extreme flatness characterizes the areas near McPherson and in the Arkansas Valley plain. The surface becomes increasingly dissected northward from McPherson toward Smoky Hill River, owing to erosion in Recent time. The buried McPherson channel is marked by a linear succession of depressional areas. (Pl. 1).

Age and correlation.—As shown by Hibbard (in press), the vertebrate fossils collected from the McPherson formation range in age from early to late Pleistocene. However, it seems inadvisable at present to assign any part of the McPherson to any particular stage of the Pleistocene as known in the upper Mississippi Valley. Part of the McPherson formation is equivalent in age to part of the Meade formation in southwestern Kansas, and the volcanic ash in the lower part of the McPherson is equivalent to Cragin's Pearlette ash in Meade County.

Discussion of age and correlation.—Certain beds named the Emma Creek formation by Lohman and Frye (1940, pp. 849-851) were later described in detail by Frye and Hibbard (1941). In defining the formation Lohman and Frye state. (p. 849):

> The term McPherson Equus beds was used by previous investigators to include all of the unconsolidated deposits in Harvey and McPherson Counties, and all of these beds were held to be of Pleistocene age. The present investigation has revealed, however, that although a part of these deposits is Pleistocene in age, a large part appears to be Pliocene in age. It is here proposed to remove the Pliocene beds from the McPherson Equus beds of Haworth and Beede and assign to them the name Emma Creek formation—from exposures along Emma Creek in southeastern McPherson County. The McPherson formation (restricted) is retained to include only the fluvial deposits of Pleistocene age.

The present definition of the McPherson formation includes most of the Emma Creek formation of Lohman and Frye (1940) and the name Emma Creek formation is eliminated as a stratigraphic term for the following reasons: (1) In the original description, deposits comprising the Emma Creek formation in the type area were placed in the same formation with unrelated Pliocene deposits in the northern part of the area, discussed above, and the entire formation was assigned to the Pliocene. Identification of fossils collected from the sediments in the type area, together with observed stratigraphic

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position, now indicate the Pleistocene age of the type Emma Creek. (2) Several of the exposures correlated with the Emma Creek and figured (Frye and Hibbard, 1941) as illustrating typical lithologic facies of the Emma Creek formation are now known to represent other sediments. The "pit in the gravel or channel phase of the Emma Creek SW½ SE¼ sec. 12, T. 18 S., R. 5 W." (Frye and Hibbard, 1941, p. 266, fig. 2) is a pit in the channel gravels of the McPherson formation from which typical McPherson fossils have been collected (Hibbard, 1948). The correct legal description of this pit is SE ¼ SW¼ sec. 12, T. 18 S., R. 5 W. The " 'Mortar bed' phase of the Emma Creek formation" (Frye and Hibbard, 1941, p. 267, fig. 3) is here correlated with similar deposits near by which contain fossils of Pleistocene age. The volcanic ash shown (1941, p. 271, fig. 6) and described as unconformably overlying deposits of the Emma Creek formation, and earlier considered as occurring at the base of the "loess" above the McPherson formation (restricted) (Lohman and Frye, 1940, p. 853), occupies a stratigraphic position which shows that it is older than the McPherson formation as restricted by Lohman and Frye, and to comprise part of the older deposits of the McPherson. Thus, the ash comprises part of the original Emma Creek formation of Lohman and Frye. The volcanic ash is shown by paleontologic evidence (Hibbard, 1948) to be of Pleistocene age, equivalent to Cragin's Pearlette ash of Meade County. (3) Differences in lithology were listed as being diagnostic in the differentiation between the McPherson formation (restricted) and the Emma Creek formation. Lohman and Frye (1940, p. 849) state:

> The sands and gravels of the Emma Creek were derived from the Cretaceous and Permian rocks adjacent to the north and east. They consist largely of quartz grains but also contain many grains and pebbles of the harder sandstones and concretions of the Dakota group, pebbles and cobbles of Permian chert, and of Cretaceous and Permian shale. The McPherson formation (restricted) comprises glacial outwash and contains grains of feldspar, acid and basic igneous rocks, and red quartzite, whereas none of these constituents is found in the Emma Creek formation.

Later (Frye and Hibbard, 1941, p. 267) this description was amplified to include:

> The "Mortar-beds" phase [of the Emma Creek formation], and related beds, on the other hand, contain a considerable percentage of granite pebbles and other western rock types.

While studying many samples of cuttings from test holes and wells it was noted that although the percentage is somewhat less

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than in other deposits, the pebbles of igneous rocks typical of the Rocky Mountain area are common in and form a considerable part of the sand and gravel in the older part of the McPherson formation, and that the channel deposits of the McPherson formation as restricted by Lohman and Frye contain most of the rock types listed as distinguishing the Emma Creek, although in different proportions.

Thus it seems that the deposits of the Emma Creek formation (excluding Pliocene deposits here placed in the Delmore formation) should be included in the McPherson formation. Indeed, the Emma Creek comprises part of the McPherson formation (restricted) because it is Pleistocene in age, is a stream deposit, and because it is lithologically indistinguishable from beds of the McPherson. A small area in the northern part of McPherson County several miles from the type locality of the Emma Creek is underlain by deposits of Pliocene age. These deposits comprise the Delmore formation described above.

Water supply.—The McPherson formation comprises the principal source of ground water in this area. The quantity of water that may be derived from the McPherson formation is variable owing to differences in the thickness and physical character of the sand and gravel in the formation. Supplies of water adequate for domestic and stock uses are available to wells in most all the area underlain by the McPherson, and large supplies have been developed from this formation at the Hutchinson Naval Air Base, at Moundridge, and, in part, at the Newton well field. In the area underlain by the McPherson channel deposits, the McPherson formation contains beds of clean gravel and coarse sand that yield water freely. The public water supplies of McPherson, Inman, and Buhler are obtained from this part of the formation. One of the municipal wells at McPherson yields 1,400 gallons a minute and the other 2,000 gallons a minute, with drawdowns of 17 and 27 feet, respectively. In the eastern part of the area, not underlain by the channel deposits of the McPherson, the McPherson formation yields water in considerably smaller quantities. In the Arkansas River Valley, the McPherson formation yields very large quantities of water to wells. The Wichita municipal water supply is derived from 25 large wells, most of which yield about 1,000 gallons a minute from the McPherson. Detailed description of this water-supply development is given below. The wells supplying water to Halstead and Newton penetrate the McPherson formation beneath Recent alluvium, and those cities obtain a part of their water supply from these deposits.

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The Cities of Burrton and Hutchinson are supplied with water derived from the McPherson formation in the Arkansas River Valley.

Many samples of water were collected from wells penetrating the McPherson formation, and analyses are given in Table 13. Variations in the quality of water are shown graphically on Figure 29. The chemical character of the water varies widely, but in general water in the McPherson is of comparatively good quality except in areas where salt water has entered the formation from natural or industrial sources. Analyses 415 and I (Fig. 29) are representative of the quality of the uncontaminated ground water in the McPherson. The two samples contained 228 and 407 parts per million of dissolved solids, respectively, 129 and 320 parts of hardness, and 10 and 33 parts of chloride. Water represented by analysis 415 is about average for the new Wichita supply, which is treated before distribution. Water shown by analysis I is used by the City of McPherson without treatment. Analysis J shows the effect of contamination near one of the oil fields in the area. Some of the other analyses given in Table 13 show greater contamination by oil-field brines.

Water in the McPherson formation contains excessive amounts of carbon dioxide in some places, as at Buhler, which corrodes mains and pipes unless it is removed. At other places, as in part of the new Wichita well field, difficulty is experienced with deposition of iron compounds in well screens and pipes. The iron-depositing organisms (*Crenothrix*) are controlled in the Wichita well field by the introduction of chlorine.

Pleistocene and Recent Series

Dune sand

Distribution and surface form.—Sand dunes extend over a wide belt northwestward from Little Arkansas River northeast of Burrton in Harvey County to a point east of Saxman in Rice County. These sand dunes occupy the central part of the area included in this report (Pl. 1) and form the only prominent topographic relief in this part of the area (Fig. 9). The higher dunes (Pl. 17), near the center of the dune area, are subject to shifting by wind owing to the scanty cover of vegetation. Small ponds are common in the interdune areas during rainy seasons. Near the edge of the dune area the dunes are lower, more rounded, have a soil zone, and, in many places, have a cover of vegetation. The subdued dunes are subject to blowout in times of prolonged drought but are relatively more stable than the higher dunes.

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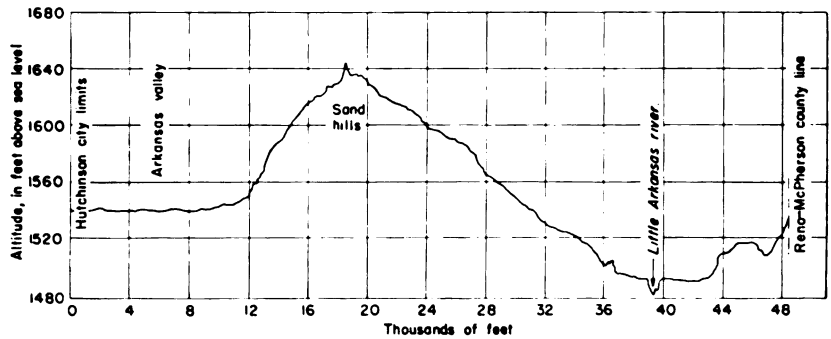

FIG. 9. Profile of the surface of the sand dunes along Chicago, Rock Island, and Pacific Railway from Hutchinson city limits to the Reno-McPherson County line.

Character and thickness.—The material comprising the sand dunes consists mainly of fine- to medium-grained, well-rounded quartz sand. Silt, clay, and organic matter locally are admixed and intercalated, probably representing soil zones which developed on the dunes in quiescent periods and interdune pond areas which later became covered with drifting sand. The sand is believed to have been derived from the deposits in the Arkansas Valley and from older Pleistocene stream deposits southwest of this area. North of Hutchinson Smith (1938) found evidence, consisting primarily of buried soil zones and variations of bedding, that indicates at least three periods of rapid growth alternated with periods of quiescence. The longitudinal dunes shown in Plate 18 indicate the south-southwesterly direction of recent dune-forming winds. The maximum thickness of the dune sand in this area is about 150 feet.

Age.—The topographic position of the sand dunes north of Burrton and Hutchinson indicates that the dunes are older than the present valley of Little Arkansas River and that they are younger than the filled McPherson channel. The dunes probably were built, for the most part, by winds blowing across the old flood plain of Arkansas River after that stream had diminished in size near the close of the Pleistocene Epoch. The older sand dunes, then, are nearly equivalent in age to the younger part of the McPherson formation along Arkansas River. The younger, higher sand dunes are of more recent formation, the sand being derived from older sand dunes near by. There is some indication that Little Arkansas River may have flowed south through the older sand dunes from Buhler toward Burrton. If this stream occupied this course, the shifting sand may have been

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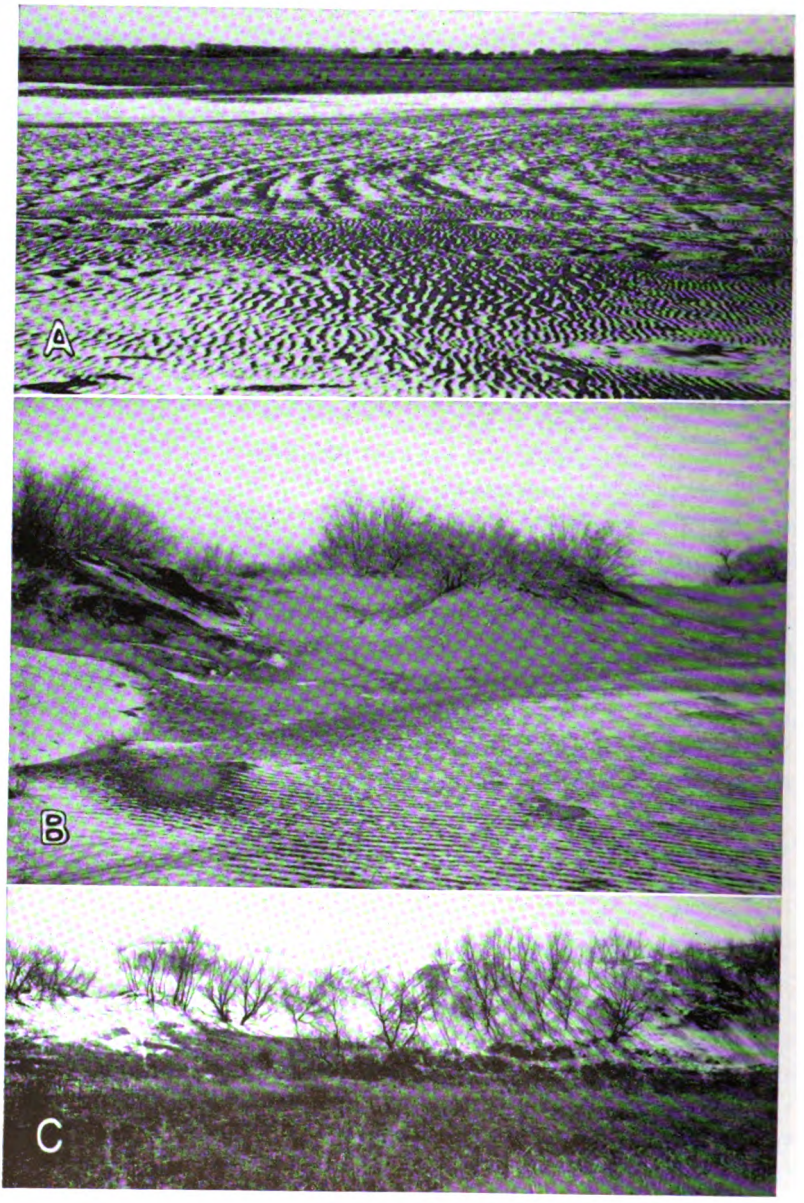

PLATE 17. Features of the sand-dune area: *A*, *B*, Actively shifting sand, NE¼ sec. 33, T. 22 S., R. 3 W. A light fall of snow accentuates the ripples. *C*, Shifting sand 5 miles northeast of Hutchinson. Photographs by J. C. Frye.

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PLATE 18. Aerial photograph of sand dunes in the northwestern part of T. 23 S., R. 3 W., north of Burrton. Note interdune ponds. Arrow points north and is about 0.5 mile long. U. S. Department of Agriculture photograph.

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the cause of the change in course and the younger sand dunes are as old as Little Arkansas River east of Buhler.

Water supply.—No large supplies of ground water have been developed in the area underlain by sand dunes. The sand hills area is range land, for the most part, and contains many stock wells yielding quantities of water sufficient for the needs of the cattle. Farms and orchards along the edge of the dune area are supplied with water for domestic, stock, and spraying purposes. The material comprising the dunes is relatively fine-grained and probably will not yield large quantities of water to wells. The sand-dune area affords an excellent catchment area for rainfall, and much of the rain that falls on the porous sand enters the dunes and moves southwestward toward the deposits of the McPherson formation. The areas near the Newton municipal well field and the southern end of the Wichita municipal well field are underlain by subdued sand dunes, and considerably larger quantities of water can be pumped in these areas because of the good facilities for recharge.

Few samples of water were collected from wells in the sand dunes; ground water from this source is known to be comparatively soft but to contain undesirable quantities of iron (Williams, 1946). Large quantities of iron in the water are indicated by slimy deposits of precipitated iron oxide which border many of the small springs flowing from the dunes. The analysis of water from well 375 is shown graphically on Figure 29. Dissolved solids in this water were 224 parts per million, the total hardness was 102 parts, and iron was 1.2 parts.

RECENT SERIES

Alluvium

Distribution, thickness, and character.—Alluvium of late Quaternary age occurs in the Arkansas River Valley, Little Arkansas River Valley, Smoky Hill River Valley, and along Sand Creek, Emma Creek, and Turkey Creek. Little or no alluvium occurs in the Ninnescah River Valley in this area. A small amount of alluvium occurs in the valley of Gypsum Creek but it is thin and is not shown on Plate 1. Some of the material currently being deposited in sink holes and other depressional areas might well be classed as alluvium but is not differentiated from the upper part of the McPherson formation.

In the Arkansas River Valley the alluvium is similar in character to the deposits of the McPherson formation and is derived largely from the McPherson. There is physical evidence of Recent deposi-

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tion in the inner valley of the river, noted above, and fossils of Recent age have been collected from the alluvium and are discussed by Hibbard (1948). However, in subsurface study no division can be made between the alluvium and the McPherson formation by differences in lithology. It is convenient to treat the entire thickness of material underlying the floodplain of Arkansas River as a unit, not only because of the similarity of the unconsolidated deposits, but also because of the similarity of the chemical quality of the ground water contained in these beds. The deposits comprising the alluvium of Arkansas River are composed of unconsolidated gravel, sand, and silt (Pl. 19A). Some of the gravel is very coarse and large yields may be expected from properly constructed wells penetrating the coarse deposits. The maximum thickness of the alluvium probably is about 75 feet.

The alluvium of the Smoky Hill Valley is composed of silt, clay, sand, and gravel in varying proportions and in general this material is finer than the alluvium of the Arkansas Valley. The character of the material composing the alluvium is described in detail in several of the logs given at the end of this report.

Most of the alluvium in the area was derived from the McPherson formation and from Tertiary deposits near by and westward, but some material in the alluvium probably was transported to its present position directly from the Rocky Mountains. Adjacent Cretaceous and Permian rocks have contributed much of the material composing the alluvium of the Smoky Hill Valley.

Water supply.—Very large supplies of water are available from the alluvium of the Arkansas Valley. The former Wichita public water supply was derived from wells tapping the alluvium in a small area near the junction of Arkansas and Little Arkansas Rivers, and this source of supply was abandoned, not because of scarcity of water, but because of the chemical character of the water. The results of the pumping test conducted at the Ripley Station of the Kansas Electric Power Company, discussed in detail below, indicate the permeable nature of the alluvial deposits of the Arkansas and Little Arkansas River Valleys near Wichita. Wells in the city of Hutchinson derive large supplies of water from the alluvium of Arkansas River and the Cities of Halstead (in part), Sedgwick, and Valley Center receive water from the alluvium of Little Arkansas River. The Cities of Lindsborg and Marquette are supplied with water from the alluvium of the Smoky Hill River Valley.

The quality of the water in the alluvium of Arkansas, Little

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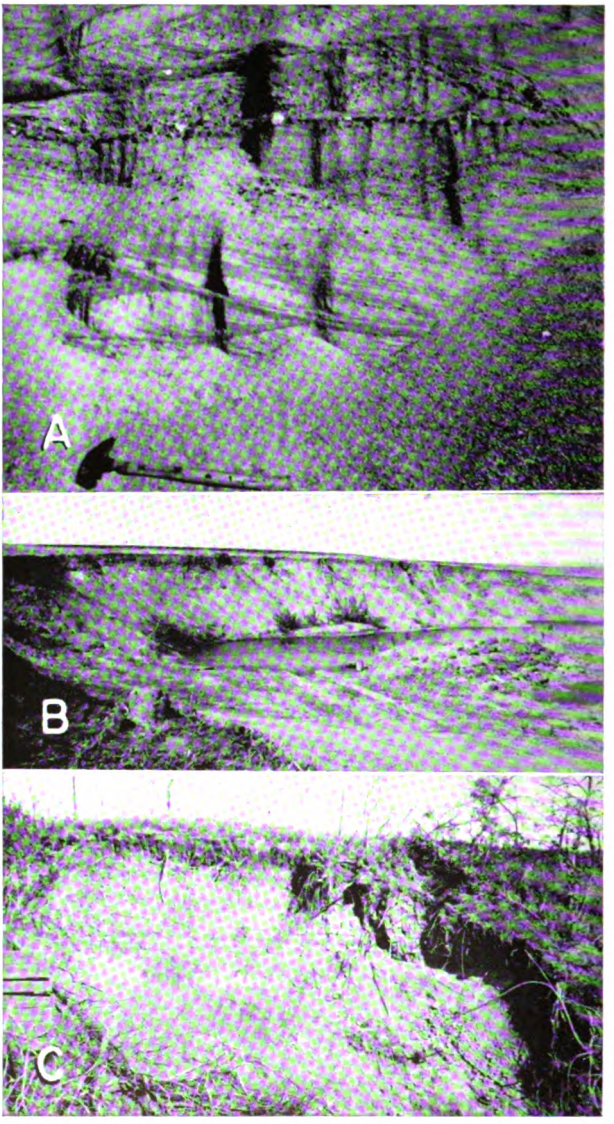

PLATE 19. *A*, Cross-bedded sand and gravel in the alluvium of Arkansas River Valley exposed during excavation for the filtration plant in the City of Wichita. *B*, Sand pit in the McPherson formation in the SE¼ SW¼ sec. 12, T. 18 S., R. 5 W. *C*, Thinly bedded silt in the alluvium of Little Arkansas River in the NW¼ sec. 19, T. 24 S., R. 1 W. Photograph *A* by G. H. von Hein, *B* and *C* by J. C. Frye.

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Arkansas, and Smoky Hill Rivers is different in each valley and varies from place to place within each valley, as shown on Figure 29. Ground water in the alluvium of the Arkansas River Valley generally is hard and contains objectionable quantities of chloride. Analyses LLL and WWW (Fig. 29) show the hardness and chloride content of water in the alluvium of the Arkansas. Analysis WWW shows the chemical character of the water with which the City of Wichita was supplied prior to Sept. 1, 1940. In general, the ground water in the alluvium near the river is of poorer quality. Wells in the alluvium of Little Arkansas River yield relatively hard water, but the water is not so highly mineralized as that in the alluvium of Arkansas River; the water pumped by the Cities of Halstead, Valley Center, and Sedgwick is not treated before use. The Cities of Lindsborg and Marquette are supplied with hard water from the alluvium of Smoky Hill River Valley. At Lindsborg (analyses 4 and A) the water contains 706 parts per million of dissolved solids and has a total hardness of 456 parts. Iron occurs in the ground water in the alluvium of Smoky Hill River and in some places renders the water undesirable.

GEOLOGIC HISTORY

The geologic history of this area is recorded in the rocks at and beneath the surface and is similar to that of much of central and western Kansas. This area is underlain by 4,000 to 4,500 feet of limestone, sandstone, shale, clay, silt, sand and gravel, and small amouts of salt and gypsum. Much of the geologic history must be inferred from studies of records of deep oil wells, but the details of this history are beyond the scope of this report. The geologic history of the area in Cenozoic time merges into the physiography and much of the more recent geologic history is interpreted from study of the landscape.

Paleozoic Era

Many oil wells have been drilled in McPherson, Harvey, Sedgwick, and Reno Counties and much of the early Paleozoic sediments is known from drill cuttings. Drills have penetrated marine limestones and shales of Cambrian, Ordovician, Silurian,* Devonian, Mississippian, Pennsylvanian, and Permian age, which indicates that the area was covered by seas during much of the Paleozoic era. The absence of deposits of Silurian and Devonian age in part of this area probably is due to erosion after those sediments were deposited, and indicates that this problably was a land area during

* Silurian and Devonian rocks do not occur in parts of this area.

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parts of the Silurian and Devonian Periods. The sedimentary record is broken at intervals, indicating that this was an emergent area for relatively short periods of time, followed by reinvasion by seas and renewed deposition of marine material.

In early Permian time marine limestones and shales of considerable thickness were deposited in this area. Rocks of the Leonardian Series indicate a change in the environment of deposition in late Permian time. The Wellington formation is composed of marine deposits, for the most part, and contains considerable amounts of salt and gypsum. The presence of these minerals indicates that the sea in this region became less extensive and that the climate then probably was arid. The Ninnescah shale and Stone Corral dolomite similarly signify the retreat of the Permian sea and the aridity of the late Paleozoic climate.

Mesozoic Era

Deposition of rock-forming materials evidently was terminated by an uplift that brought the region above sea level at the close of the Paleozoic Era. Central Kansas probably stood above sea level through the latter part, if not all, of Triassic time and through Jurassic time, during which there was little or no deposition and probably considerable erosion. No rocks of Triassic or Jurassic age are known in this area. Locally a zone of pebbles and cobbles of source unknown to the authors occurs on the irregular surface of the Permian rocks below the Cretaceous rocks in this area. These pebbles may be residual, in part, or may have been deposited in early or middle Mesozoic time; at least, they are older than the oldest Cretaceous rocks known in Kansas.

CRETACEOUS PERIOD

The Lower Cretaceous sea transgressed the land areas from Texas northward and first reached central Kansas in middle Comanchean time, for the Cheyenne sandstone present in southern Kansas does not occur in this area. In discussing the origin of the Cretaceous rocks in Kansas, Stanton (1922, p. 263) states:

> . . . During a large part of Comanche time the northern shore of the Mexican sea was in northern Texas, or not far beyond it, as evidenced by the nature of the Trinity and Paluxy sands and the northward thinning of all the limestones. In later Comanche time, however, about the beginning of the Washita, a somewhat rapid northward transgression of the sea began, which soon reached southern Kansas and by the close of the Washita had extended as far north as Salina, in central Kansas. The advance was probably of a halting nature, with possibly slight reversals of movement, so that with shallow waters, low-lying lands, shifting currents, and varying amounts of sediment

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received. the shoreline sometimes rapidly shifted many miles both north and south and east and west, thus giving alternations of purely marine beds with those that represent swamp or terrestrial conditions.

Stanton notes further (1922, p. 270):

I agree with Twenhofel's suggestion that it is reasonable to regard the Cheyenne, Kiowa, Mentor, and associated rocks as all deposited during one general transgression of the sea, but I would interpret the Dakota as representing merely a halt in that advance rather than a complete retreat of the sea from the Great Plains area.

The above remarks are in accord with the authors' field observations of the stratigraphy and lithology of the Kiowa shale in this area. The Dakota formation occurs west of McPherson County in Ellsworth and Rice Counties and probably was deposited in part of the area covered by this report, having been removed by post-Cretaceous erosion. The Upper Cretaceous shales and limestones which occur elsewhere in Kansas are absent in central Kansas and if deposited they have since been removed by erosion. At the close of the Cretaceous period orogenic movements uplifted the Rocky Mountain area and affected at least part of the rock formations in Kansas.

Cenozoic Era

TERTIARY PERIOD

After tilting of the Cretaceous and older rocks at the close of the Mesozoic Era erosion during a long period removed much of the Cretaceous sediments from this area and also much of the Pennsylvanian and Permian sediments east of this area. Erosion was active until late Tertiary time and then the sediments of the Delmore formation were deposited during middle Pliocene. The Delmore formation was laid down by streams eroding the Cretaceous and Permian rocks north and east of the area the materials having been deposited in depressional areas and valleys of southward flowing streams. Early Tertiary erosion removed overlying rocks and exposed the salt-bearing part of the Wellington formation to solution by ground and surface waters. A depressional area resulted in the eastern part of the area and became progressively deeper as solution and erosion proceeded westward down the dip of the Wellington. This stratigraphic control of erosion determined the direction of the principal late Tertiary streams in this area. The vertebrate fossils of middle Pliocene age found in McPherson County indicate a climate warmer than the present.

Sediments of late Pliocene age have not been recognized in this area and, unless removed by subsequent erosion no deposition

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occurred here during the closing part of the Pliocene. Elsewhere indications of reduced vigor and load of late Tertiary streams are recorded in the less clastic rocks deposited then. The close of the Tertiary Period in North America was marked especially by uplift of the Pacific northwest region and additional uplift of the Sierra Nevada range. The Rocky Mountains and neighboring areas were uplifted to a lesser extent at this time resulting in rejuvenation and change of existing streams and in the inception of new streams.

QUATERNARY PERIOD

Pleistocene Epoch

After the physical disturbance at the end of the Tertiary Period there was a gradual climatic change in North America which resulted in the formation of the great ice sheets which distinguish the Pleistocene Epoch. Glaciers did not reach the area covered in this report but erosion and deposition by streams which were fed by meltwater from mountain glaciers are recorded in the unconsolidated deposits of the McPherson formation. The alternating cold and mild climates of the Peistocene conditioned life in this area and the vertebrate fossils collected from the several formations reflect this climatic variation.

Early in the Pleistocene a stream flowing southwestward entered this area near Lindsborg and continued past McPherson and Moundridge southward west of Wichita. Tributary streams entered the main stream from the northwest, northeast, and east. Remnants of the highest terraces along Smoky Hill River indicate that a large tributary entered the area from the northwest, occupying nearly the same position as the present river but flowing at a much higher level. The deposits of silt, sand, and gravel of the McPherson formation in the southwestern part of the area were laid down by tributaries flowing southeastward. Sand and gravel, in part cemented, and silt occurring along the eastern margin of the alluvium of the present Arkansas and Little Arkansas Rivers in the southeastern part of the area indicate that tributaries flowed southward toward the main channel. A drainage divide now exists immediately east of the area shown on Plate 1, but the divide was at a higher level and was considerably farther east early in the Pleistocene. The finer sediments of the McPherson formation imply that the early Pleistocene streams had a lower gradient than those active in this area later in the epoch.

Volcanic ash was deposited in early McPherson time. As suggested by Landes (1928, p. 19), the original source of the ash must

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have been volcanic vents southwest of this area—perhaps the Capulin group of volcanoes in northeastern New Mexico.

Toward the close of the first stage of the Pleistocene Epoch recorded in this area the streams which had been active in eroding the McPherson Valley seemingly became overloaded and the silt in the older part of the McPherson formation was deposited over much of the valley. Solution of soluble material in the Wellington formation continued, but deposition of silt and fine sand by streams at grade characterized early McPherson time. An unconformity of some magnitude occurs between the older deposits of the McPherson formation and the channel deposits of the formation.

The streams were rejuvenated after the period of quiescence following deposition of the early sediments of the McPherson, possibly by some renewed uplift in the mountains, but largely by an increased quantity of water available to the principal stream and tributaries flowing southward through the McPherson Valley. The source of the additional water available to streams at this time may have been the melting of the ice of the mountain glaciers which may have reached their culmination during the period following deposition of the older beds of the McPherson. Continued solution of salt in the Wellington formation caused the stream to migrate westward in this area. The extent of erosion during this period is indicated by the depth of the buried McPherson channel in relation to the surface of the older sediments of the McPherson (Pl. 6). The location of the stream system which carved the McPherson channel has been described above. Terraces along Smoky Hill River northwest of this area together with test drilling furnish the basis for conclusions regarding the location and magnitude of the streams.

After underloaded streams had completed the erosion described, the streams seemingly became overloaded, because of either a smaller supply of water or an abundance of available detritus and the valleys began to be filled. Some time after this valley filling had been in progress it is believed that the stream flowing southward into the area was captured by headward erosion of an eastward-flowing stream in the vicinity of Salina and the direction of flow was reversed. The tributary stream entering the area from the northwest also flowed into this reversed drainageway and was directed northward also. This divergence into a new stream system changed the gradient of the captured streams and downcutting began anew. The junction of the two streams northwest of Mc-

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Pherson became less angular and moved northward, ultimately resulting in the anomalous bend in the present course of Smoky Hill River between Salina and Marquette. Sharps Creek, while flowing at a level somewhat higher than at present, seems to have occupied a course southeastward from the SE cor. T. 18 S., R. 5 W. at the time the major stream was captured. Later, as the junction of the principal stream and tributary moved northward and cut downward, Sharps Creek was captured and became a part of the new drainage system. A large tributary of the southward-flowing stream through the McPherson Valley entered the area from the northwest and occupied a course nearly the same as the present Arkansas River from Hutchinson to a point east of Mt. Hope where it joined the main stream. After the capture of the master stream farther north this tributary continued to flow southeastward and is represented by a section of the present Arkansas River.

The sand dunes which occupy part of the area between Little Arkansas River and Arkansas River in the west-central part of the mapped area (Pl. 1) have been in the process of formation since early McPherson time. The older dunes probably were beginning to form while the streams depositing the McPherson formation were flowing southward through the area. After the drainage of the master stream was reversed near Lindsborg the dunes formed across the old channel northwest of Burrton at the place now marked by a topographic saddle. Dune formation has continued and the higher dunes, differentiated on Plate 1, are still active, especially in times of drought. The source of the sand forming the dunes probably was from the south and southwest; at least, the prevailing winds have been from those directions during the period of record. It is noted that prevailing winds may have been from different directions during the Pleistocene.

After the McPherson Valley was abandoned by the southward flowing stream, the channel began to be filled by the slow movement of soil, silt, and other rock waste down the slope of the valley sides. At high stages the tributary occupying the course of the present Smoky Hill River near Marquette probably overflowed southwestward, depositing silt in the old channel and forming a temporary lake. The winds which deposited the sand in the dunes athwart the old channel undoubtedly carried silt and clay farther northward, depositing part of the material in and along the channel. This material was then transported down the valley sides into the old channel by rills and rivulets following heavy rains. The filling

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of the McPherson Valley is continuing by these processes today and vestiges of the old drainageway are manifest in the linear series of lakes and depressional areas which occur from a point northwest of McPherson southwestward toward Colwich.

Recent Development of Land Forms

Sand dunes.—The higher sand dunes shown on Plate 1 have been developed by the southerly and southwesterly winds prevailing at present. The effectiveness of the wind action was more pronounced during periods of drought, and the recent activity of the dunes during the decade from 1930 to 1940 is noteworthy. The winds sweeping across the Arkansas Valley plain transport sand northward adding new material, at the same time reworking sand deposited in the dunes during earlier periods. The dunes are encroaching on the channel of Little Arkansas River north and northeast of Burrton. The subdued older sand dunes which occur locally on the Arkansas Valley plain are not active at present; a soil zone sufficient to sustain cultivated crops has developed on these dunes and they are becoming less prominent land forms as farming continues.

Remnants of what probably once were sand dunes occur in a belt trending northeastward between Goessel and Canton (Pl. 14). As noted above, these dunes are believed to have developed from partly cemented sandstones in the Kiowa shale formerly cropping out in the same area now occupied by the faint dune remnants. Admixture of silt and clay and the development of a thick soil zone have stabilized these vestigial land forms.

Some recently developed small sand dunes, not shown on Plate 1, occur near Wichita and elsewhere along Arkansas and Little Arkansas Rivers. These dunes, generally occupying comparatively small areas, have been formed by winds sweeping the sandy floodplains of the streams at times of prolonged low stage. Many of these recent dunes are in locations vulnerable to flood waters and are only transient land forms.

Sink holes.—The undrained depressions in the land surface which occur in a linear area from a point north of Conway to Colwich (Pl. 1) have been developed in recent times and many of them are still subsiding. The small sink hole shown in Plate 20A and B developed about 1929. Between 1929 and September 1937, when the photograph was taken, the submerged bridge had been raised three times by McPherson County engineers. The largest sink, located in T. 19 S., R. 4 W., is known as Big Basin and occupies an area of

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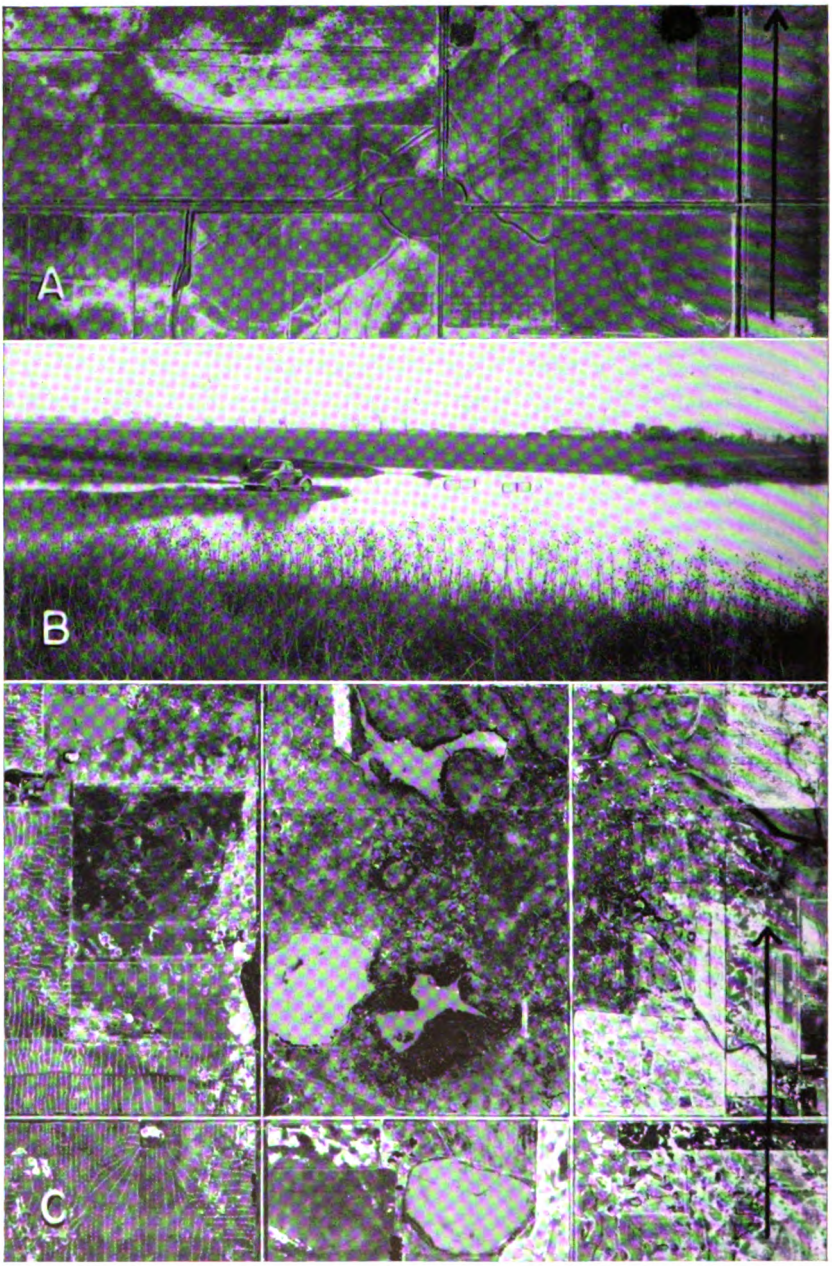

PLATE 20. Sink holes in McPherson and Harvey Counties. *A, B,* Aerial and surface photographs of a sink hole at the SW cor. sec. 22, T. 21 S., R. 4 W. *C,* Aerial photograph of sink hole in secs. 9 and 16, T. 24 S., R. 3 W. Arrows point north and are about 0.5 mile long. *A* and *C,* U. S. Department of Agriculture photographs; *B,* photograph by S. W. Lohman.

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PLATE 21. Composite aerial photograph of Big Basin and vicinity. Many small sink holes and small areas of incipient sinking also are shown. Arrow points north, is about 0.5 mile long, and is located in the E½ sec. 14, T. 19 S., R. 4 W. U. S. Department of Agriculture photograph.

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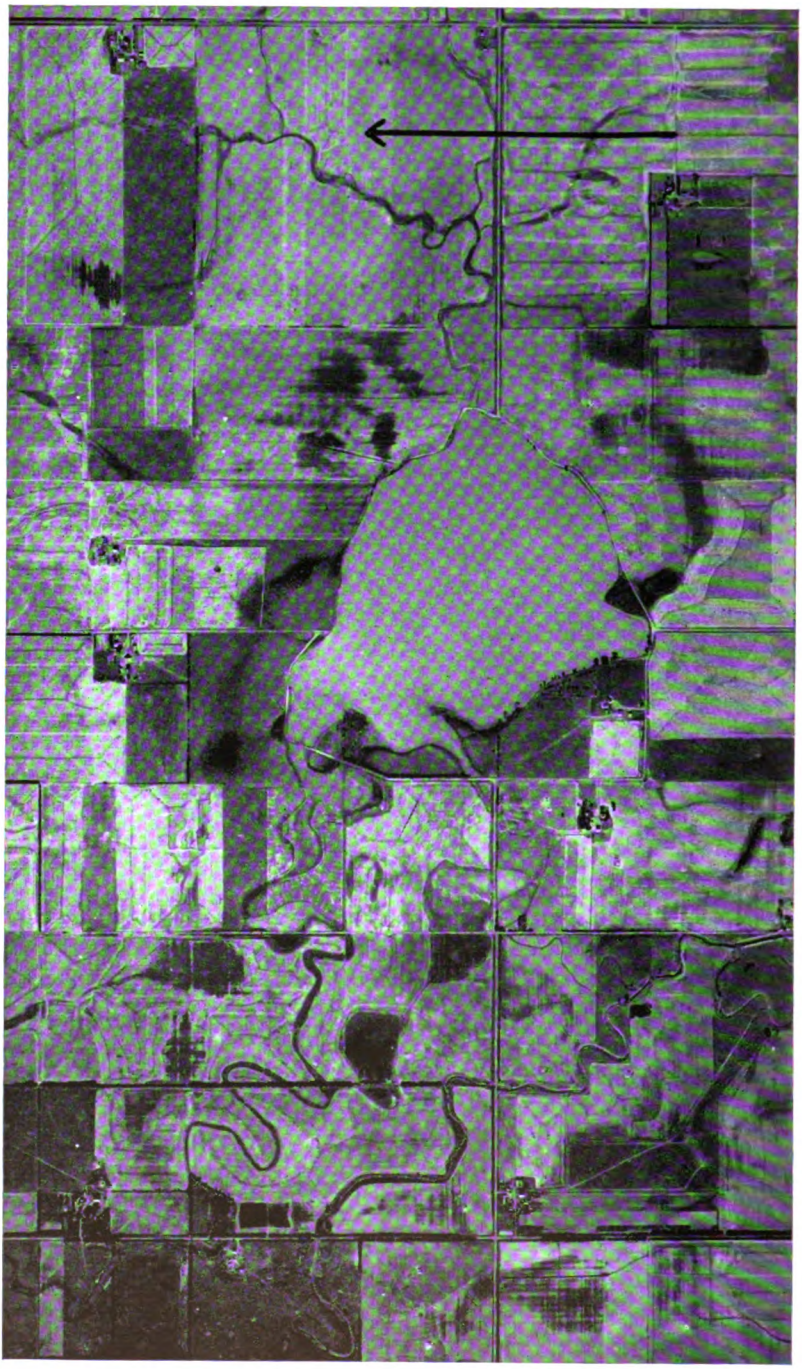

PLATE 22. Aerial photograph of Lake Inman and vicinity. The small dark areas denote incipient sinking. The arrow points north and is about 0.5 mile long. U. S. Department of Agriculture photograph.

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about 4 square miles. This area has been artificially drained but the outline of the sink is plainly marked on the aerial photograph shown on Plate 21. Lake Inman, the largest natural lake in Kansas, occupies an undrained depression covering about 160 acres. Lake Inman and smaller sinks and incipient sinks in the area around it are shown on Plate 22.

The ultimate physical cause of the sink holes has been and is the removal of salt by solution from the underlying Wellington formation. Bass (1926a) has shown that the salt beds in the Wellington extend into this area and that the line of sink holes in McPherson, Harvey, and Sedgwick Counties practically coincides with the present eastern margin of the salt beds. Although it is evident that sinking has occurred recently at many places, some filling of the sink holes has taken place concurrently. In the latter part of April 1944, after a period of excessive precipitation, many of the sinks were filled with water laden with silt and clay derived from higher parts of the area. More than 4 square miles in Big Basin and much of the area southward toward Lake Inman and Buhler were inundated by muddy water. The slow draining of the flood water allowed much of the suspended silt and clay to be deposited in the low areas. At other times, following heavy rains, soil is washed into the depressions from areas in the immediate proximity, smoothing the edges of the sink holes and contributing to their filling. As subsidence ceases the sink holes will become filled and no longer will be prominent physiographic features.

Stream terraces.—Terraces bordering streams are records of erosion by streams as they shifted course laterally while flowing at a level higher than at present. Stream terraces are preserved as topographic features owing to a change in quantity of water or load carried by streams or because of a change in gradient.

Terraces are present along Arkansas, Little Arkansas, and Smoky Hill Rivers and to a minor extent along smaller streams in this area. The margin of the alluvium along Arkansas and Little Arkansas Rivers is marked by a topographic break in most places. In some places smaller terrace remnants occur along the flood plains of the streams; such terrace remnants along Smoky Hill River are shown on Plate 1. Terraces along Arkansas River are shown on Plate 23, and those along Smoky Hill River are shown on Plate 24. Remnants of higher terraces along Smoky Hill River are shown on Plate 1 and are part of the McPherson formation. High terraces along the Smoky Hill become more nearly continuous westward in

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PLATE 23. Composite aerial photograph showing a part of Arkansas River and vicinity. Note sink holes, flood scars, scarcity of trees along the river, and extreme flatness of the terrace surface. The small stream enters the river in the NW¼ sec. 20, T. 25 S., R. 2 W. Small arrows point to terrace edge. Large arrow points north and is about 0.5 mile long. U. S. Department of Agriculture photographs.

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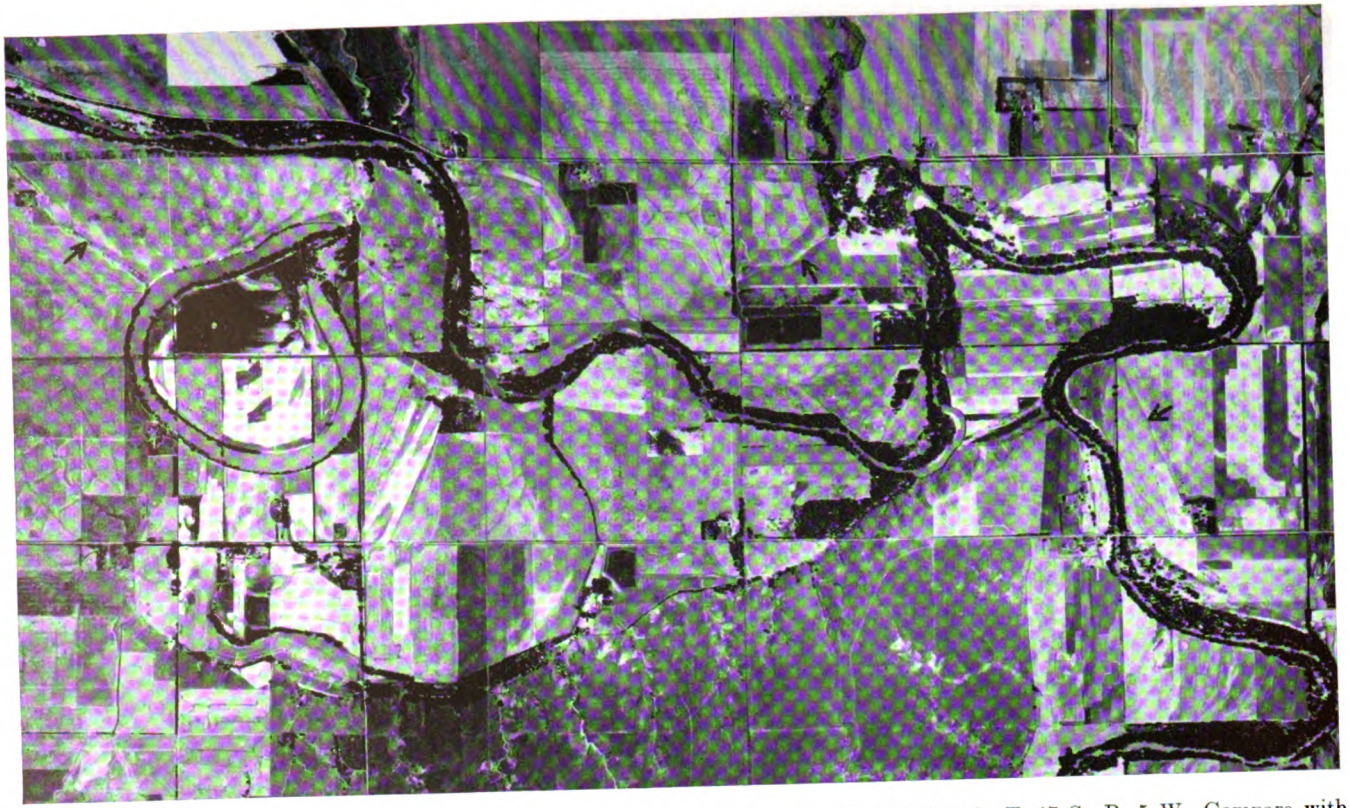

PLATE 24. Composite aerial photograph showing a part of the Smoky Hill River Valley in T. 17 S., R. 5 W. Compare with Arkansas River (Pl. 23). Note oxbow lake, left center, and imminent cutoff, right center. Small arrows point to terrace borders. Large arrow points north and is 0.5 mile long. U. S. Department of Agriculture photograph.

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Ellsworth and Russell Counties (Frye, Leonard, and Hibbard, 1943).

Lateral erosion by streams is aided by other erosional processes especially along some of the smaller tributaries. That slumping of stream banks may be a contributing factor to terrace development is illustrated by features shown on Plate 11C. Here the surface of the soft sandy Kiowa shale has become saturated following a season of excessive precipitation and slumping has occurred along the steep bank. If these slump blocks were to remain as shown and the vegetal regimen were re-established, terracettes or "sheep trails" would result. If, however, the small stream whose present channel is at the base of the bluff carries away part of the material and further slumping occurs, the valley wall will recede and a small terrace comparable to the one shown in the foreground will be developed.

Major streams.—The three major streams in the area, Arkansas, Smoky Hill, and Ninnescah Rivers, all may be classed as consequent or interrupted—consequent streams with reference to the present cycle of erosion. Arkansas River is at present an aggrading stream in this area, as indicated by the braided pattern of the sand bars and the evidence of recent deposition by the section of the river shown on Plate 23. That Smoky Hill River recently has been eroding its valley laterally and more recently has begun to cut downward entrenching its valley is apparent from the abandoned meanders and low terraces shown on Plate 24. Ninnescah River seems to be a younger stream with a steeper gradient than either the Arkansas or Smoky Hill, and little or no alluvium occurs in its valley; the Ninnescah shale is exposed along Ninnescah River throughout its course in this area. As soon as rock waste becomes available to the river it is carried away; hence the valley floor and gently sloping valley sides are nearly devoid of alluvium.

GROUND WATER

Principles of Occurrence

The fundamental principles governing the occurence and movement of ground water have been set forth in detail by Meinzer (1923), and have been summarized by Moore (1940) as they apply to Kansas. Only essential statements will be made here, and the reader is referred to the reports of Meinzer and Moore for a more detailed discussion.

Ground water is derived chiefly from water that falls as rain or snow. A part of this water runs off directly in streams to the sea,

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a part evaporates, a part is consumed by the plants, and a part sinks through pore spaces in the soil and underlying rocks to the water table where it enters the zone of saturation. Much of the water in the zone of saturation eventually returns to the surface through seeps, springs, or wells, or is discharged by plants or when it is near the surface through evaporation from the soil. Some ground water, however, percolates directly into surface streams. The porous rocks below the water table as a rule are saturated. Those that are sufficiently permeable yield water to wells sunk into them. In the more permeable rocks, such as beds of sand and gravel and some of the sandstones the individual pores are interconnected and are large enough so that the water moves freely under the influence of gravity, but in less permeable rocks, such as shale and fine-grained sandstone, the pores are so small that water moves through them with difficulty.

In this area the wells that yield the greatest quantities of water penetrate beds of unconsolidated sand and gravel. Wells that penetrate shale yield proportionately very small quantities of water.

Physical and Hydrologic Properties of Water-bearing Materials

The quantity of water that an aquifer will yield to wells depends upon the physical and hydrologic properties of the material composing it. Detailed geologic descriptions of materials encountered in drilling, such as those included in the logs at the end of this report, are useful in estimating the quantity of water available in a given area, but more exact quantitative estimates of water supplies necessarily are based on more precise analyses of these earth materials in the laboratory or by field tests.

An intensive test-drilling program was conducted during the early part of this investigation in the area in which the present Wichita well field was later located, and many samples of the water-bearing materials were carefully collected. Quanitative analyses of them were made, in part by V. C. Fishel in the hydrologic laboratory of the U. S. Geological Survey in Washington, and in part in field laboratories by G. H. von Hein and Charles C. Williams. These studies included mechanical analyses, determinations of apparent specific gravity, porosity, moisture equivalent, specific yield, and coefficient of permeability. Mechanical analyses and determinations of permeability were made for most of the samples collected, but other physical values were determined only for a part of them. The physical properties of a few samples of silt and dune sand col-

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lected from outcrops also were studied. The results of laboratory studies are summarized in Table 7.

Pumping tests were made at all of the 25 new Wichita municipal wells, at well 608 near Wichita, owned by the Kansas Gas and Electric Company, and at a few other wells in the area. The data obtained from these tests have been studied and determinations of permeability and transmissibility have been made.

MECHANICAL ANALYSES

Definition

A mechanical analysis of granular material consists of separating into groups the grains of different sizes and determining what percentage of the total sample, by weight, each size group constitutes.

Laboratory Methods and Determinations

In preparation for making the laboratory analyses, samples collected from the cable-tool test holes or from outcrops were dried, placed in a large mortar, and adhering lumps of material were gently separated. Representative samples of the desired volume were obtained by repeated quartering through a sample splitter. Mechanical analyses of carefully weighed samples that averaged about 50 grams each were made. The samples were placed in a set of standard 3-inch screens and were shaken vigorously for 30 minutes in a rotary shaker. The fractions of the sample remaining on each screen were weighed on a precision balance.

The mechanical analyses were made in order to determine the percentage of each grade of material present in the sample so that comparison with other materials could be made. Methods have been devised for making indirect determinations of physical properties from mechanical analyses, but only direct methods were employed in this study. The results of the mechanical analyses given in Table 7 illustrate the differences in the grain size of the constituent rock particles and the degree of homogeneity in the water-bearing materials in the Wichita well-field area.

POROSITY

Definition

The porosity of a rock or rock aggregate is its property of containing interstices without regard to size, shape, or arrangement of openings. Porosity is expressed as the percentage of the total volume occupied by interstices.

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Laboratory Determinations

The porosity of some of the samples studied was determined as a step in the calculation of specific yield. The porosity of the samples given in Table 7 ranged from 24.1 to 60.2 percent by volume. In general, the larger porosities occur in the finer-grained sediments and vice versa.

MOISTURE EQUIVALENT, SPECIFIC RETENTION, AND SPECIFIC YIELD

Definitions

The moisture equivalent of a water-bearing material is the ratio of (1) the weight of water which the material, after saturation, will retain against a centrifugal force 1,000 times the force of gravity, to (2) the weight of the dry material. The moisture equivalent by volume is computed by multiplying the moisture equivalent by weight by the apparent specific gravity of the material. The moisture equivalent determinations are made to ascertain the specific retention—that is, the quantity of water that a soil or rock will retain against the pull of gravity if it is drained after having been saturated, expressed as the ratio of the retained water to the total volume of material.

The specific yield of a water-bearing formation is defined as the ratio of (1) the volume of water that a saturated aquifier will yield by gravity to (2) its own volume (Meinzer, 1923, p. 28). The specific yield of a material is equal to the porosity minus specific retention. The quantity of water that an aquifier will yield from storage depends upon its specific yield. To estimate the water supply obtainable from a deposit for each foot that the water table is lowered, or to estimate the available water supply represented by each foot of rise of the water table during periods of recharge, it is necessary to determine the specific yield.

Laboratory Methods and Determinations

The specific yield of some of the samples listed in Table 7 was determined indirectly by first determining the moisture equivalent to ascertain specific retention; the moisture equivalent was then adjusted by the method suggested by Piper (1933) and subtracted from porosity for the value of specific yield. The moisture equivalent determinations were made in the hydrologic laboratory of the U. S. Geological Survey.

Samples were collected from holes bored by hand auger adjacent to eight key observation wells in the Wichita well-field area. These

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TABLE 7.—*Physical properties of water-bearing materials*

Well Number or Location	U. S. G. S. laboratory number (a)	Depth of sample (feet)		Method of sampling (b)	Mechanical analyses (percent by weight)									Apparent specific gravity	Porosity (percent by volume)	Moisture equivalent (percent by volume)	Specific yield (percent by volume)	Coefficient of permeability	Weighted average coefficient of permeability
		From	To		Medium and coarse gravel (larger than 2.0 mm)	Fine gravel (2.0–1.0 mm)	Coarse sand (1.0–0.50 mm)	Medium sand (0.50–0.25 mm)	Fine sand (0.25–0.125 mm)	Very fine sand (0.125–0.062 mm)	Silt and clay (less than 0.062 mm)	Silt (0.062–0.005 mm)	Clay (less than 0.005 mm)	Loss in acid					
SW ¼ sec. 27, T. 18 S., R. 4 W.	2397	out crop		H	.....	.....	.....	0.7	1.0	2.7	.....	55.1	28.5	12.0	1.56	40.7	40.2	.....	1.0	.....
do	2398	do		H	.....	.....	.....	.9	1.2	2.3	.....	53.1	28.4	14.1	1.58	39.2	38.8	.....	1	.....
167	2399	67.5	71.0	O	2.1	5.1	26.7	1.7	40.5	20.8	0.7	7.0	1.4	28.6	2.25	27.4	(c)2.0	25	1	.....
167	2395	85.0	110.0	O	.....	.....	.....	47.5	14.6	1.7	.....	.....	.....	.....	1.58	40.8	3.3	36	250	.....
NE ¼ sec. 33, T. 22 S., R. 3 W.		(d)	out crop	H	.1	.....	3.5	46.6	38.6	6.2	5.0	.....	.....	.....	.....	.....	.....	.....	.....	.....
do		(d)	do	H	.....	.....	.6	36.7	44.1	8.3	10.3	.....	.....	.....	.....	.....	.....	.....	.....	.....
do		(e)	do	H	.....	.....	1.4	53.2	35.6	8.0	1.8	.....	.....	.....	.....	.....	.....	.....	.....	.....
do		(e)	do	H	.2	.....	4.6	60.7	29.0	4.5	1.0	.....	.....	.....	.....	.....	.....	.....	.....	.....
do		(f)	do	H	.....	.....	1.7	56.2	36.4	5.1	.6	.....	.....	.....	.....	.....	.....	.....	.....	.....
do		(f)	do	H	.....	.....	.7	42.4	49.4	6.7	.8	.....	.....	.....	.....	.....	.....	.....	.....	.....
310	2408	31.0	32.5	C	3.3	6.8	36.5	45.9	6.5	.6	.9	.....	.....	.....	1.61	38.8	3.0	34	500	.....
310	2409	100.2	103.0	C	6.4	12.0	35.6	30.1	12.9	2.1	1.1	.....	.....	.....	1.71	36.0	1.9	33	360	.....
310	2410	125.0	129.0	C	8.7	26.0	43.4	18.8	1.7	.5	.9	.....	.....	.....	1.69	35.8	2.3	31	2100	.....
310	2411	149.0	154.5	C	8.3	24.1	30.1	26.0	5.9	2.4	3.1	.....	.....	.....	1.69	35.0	5.0	29	110	357
329	.....	25.0	27.0	C	29.1	19.3	20.7	20.4	8.8	1.1	.6	.....	.....	.....	.....	.....	.....	.....	570	.....
329	.....	27.0	29.0	C	30.5	24.5	29.2	15.0	.6	.5	.2	.....	.....	.....	.....	.....	.....	.....	2240	.....
329	.....	43.6	45.3	C	12.5	10.7	26.6	41.8	7.7	.....	.2	.....	.....	.....	.....	.....	.....	.....	970	.....
329	.....	53.4	55.0	C	45.7	39.2	12.9	1.9	.3	.....	.1	.....	.....	.....	.....	.....	.....	.....	5290	.....
329	.....	56.5	61.0	C	43.6	31.1	15.4	9.1	.6	.....	.1	.....	.....	.....	.....	.....	.....	.....	3570	.....
329	.....	62.0	64.0	C	48.1	39.1	10.3	2.1	.3	.....	.....	.....	.....	.....	.....	.....	.....	.....	10920	.....
329	2412	64.0	70.0	C	55.0	24.3	15.0	4.3	1.1	.1	.5	.....	.....	.....	1.78	32.0	2.0	28	4600	.....
329	.....	69.0	72.5	C	18.8	25.4	37.7	15.5	2.4	.2	.2	.....	.....	.....	.....	.....	.....	.....	2140	.....
329	.....	72.5	74.0	C	29.9	28.4	18.5	17.6	4.4	.6	.7	.....	.....	.....	.....	.....	.....	.....	1770	.....
329	.....	95.0	100.0	C	3.5	16.0	44.8	27.5	5.6	1.2	1.3	.....	.....	.....	.....	.....	.....	.....	140	.....

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TABLE 7.—*Physical properties of water-bearing materials—Continued*

Well Number or Location	U. S. Geological Survey laboratory number (a)	Depth of sample (feet)		Method of sampling (b)	Mechanical analyses (percent by weight)										Apparent specific gravity	Porosity (percent by volume)	Moisture equivalent (percent by volume)	Specific yield (percent by volume)	Coefficient of permeability	Weighted average coefficient of permeability
		From	To		Medium and coarse gravel (larger than 2.0 mm)	Fine gravel (2.0–1.0 mm)	Coarse sand (1.0–0.50 mm)	Medium sand (0.50–0.25 mm)	Fine sand (0.25–0.125 mm)	Very fine sand (0.125–0.062 mm)	Silt and clay (less than 0.062 mm)	Silt (0.062–0.005 mm)	Clay (less than 0.005 mm)	Loss in acid						
449		46 0	48 0	C	6 4	6 8	20 2	48 6	15 8	1 4	9								510	
449		54 0	55 5	C	10 1	15 2	31 5	31 6	5 9	2 3	3 3								410	
449		58 5	62 0	C	6 4	13 6	40 6	32 7	5 4	2 4	9								920	
449		106 0	108 0	C	2 3	16 5	43 8	31 9	4 6	.4	4								1500	
449		112 0	116 0	C	2 8	10 2	54 8	29 2	2 7	.2	2								1760	
449		161 5	166 0	C	3 5	17 6	38 8	20 3	6 0	1 4	3 5								690	
449	2420	191 0	193 0	C	11 9	25 1	33 6	19 5	7 2	.9	2 4				1 88	34 4	9 7	24	55	308
449		193 0	196 0	C	6 4	21 7	33 2	24 5	10 8	1 5	1 9								336	
472		25 0	28 0	C	15 9	23 8	32 1	16 3	9 0	1 8	1 2								270	
472		30 0	34 0	C	17 7	25 1	27 3	20 4	7 4	1 5	1 6								1050	
472		36 0	40 0	C	10 2	23 2	32 7	24 1	8 2	1 8	8								1170	
472		54 0	56 0	C	18 6	16 1	16 6	23 7	5 9	1 9	12 2								50	
472		63 5	67 5	C	26 1	22 8	20 4	23 4	6 7	.4	1 1								1050	
472		79 0	82 0	C	4 1	21 4	41 6	21 7	3 7	.8	1 1								300	
472		100 5	103 0	C	7 9	14 4	31 0	34 8	7 8	2 2	2 0								360	
472		121 0	123 5	C	5 3	14 8	33 1	42 2	4 1	.4	.3								230	
472		132 0	136 0	C	6 0	25 7	43 5	19 2	4 3	.6	.6								920	
485	2378		4 8	A			2 2	21 8	45 7	20 5	9 8								45	330
485		8 0	11 4	C			1 1	12 9	41 3	23 4	21 3				1 53	39 5		30	15	
486			5	A																
486		11 4	13 6	C		1 7	6 0	34 2	41 5	12 2	4 4								40	
486		18 2	19 4	C	3 0	3 3	12 4	47 5	29 1	4 0	.8								400	
486		21 6	22 0	C	8 3	10 7	21 2	40 5	14 4	2 4	1 8								290	
485	2379	25	1	C	6 4	12 9	20 9	41 5	17 1	1 0	2								100	
486		25 1	26 9	C	14 6	25 1	20 2	22 3	6 3	1 2	1 2								540	
486		26 9	29 7	C	9 0	12 6	22 8	48 6	4 7	1 3	1 0								460	
		29 7	32 4	C															1320	

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TABLE 7.—*Physical properties of water-bearing materials—Concluded*

Well Number or Location	U. S. G. S. laboratory number (a)	Depth of sample (feet)		Method of sampling (b)	Mechanical analyses (percent by weight)								Apparent specific gravity	Porosity (percent by volume)	Moisture equivalent (percent by volume)	Specific yield (percent by volume)	Coefficient of permeability	Weighted average coefficient of permeability
		From	To		Medium and coarse gravel (larger than 2.0 mm)	Fine gravel (2.0–1.0 mm)	Coarse sand (1.0–0.50 mm)	Medium sand (0.50–0.25 mm)	Fine sand (0.25–0.125 mm)	Very fine sand (0.125–0.062 mm)	Silt and clay (less than 0.062 mm)	Silt (0.062–0.005 mm)	Clay (less than 0.005 mm)	Loss in acid					
572		14.0	16.2	C	.1	3.2	41.6	46.7	6.4	1.9	.1							1510	
572		24.5	25.0	C	37.5	34.7	19.7	6.6	1.2	.1	.1							920	
572	2367		34.0	C	22.2	10.1	20.0	33.1	12.2	1.6	1.1			1.76	32.0			250	
572		35.8	39.2	C	13.4	10.2	15.6	39.1	20.7	.7	.3							530	
572	2368	39.5		C	43.4	17.3	16.4	16.3	6.4	1.9	.1			1.63	26.8			870	
572	2369	41.5		C	44.5	24.2	17.5	10.7	1.9	.4	.7			1.79	33.6			1300	
572	2370	62.0		C	12.6	14.4	30.0	35.0	5.9	1.2	.6			1.71	35.4			450	
572		68.5	72.6	C	6.4	16.1	33.1	35.0	6.9	.5	.2							510	
572		86.5	90.6	C	8.2	10.5	9.4	8.0	8.8	6.4	44.3		4.4						
572		93.5	100.7	C	15.6	11.9	15.8	18.7	13.3	6.0	13.7		5.2						
572		104.7	113.4	C	7.4	8.1	6.0	16.1	17.4	7.2	23.8		13.9						
572		125.0	132.4	C	.6	8.6	28.0	44.3	12.9	2.6	3.0							160	
572		132.4		C	1.4	5.1	21.7	56.0	11.9	1.9	1.6			1.63	38.6			150	
572	2371		138.0	C	.6	6.6	27.8	27.8	5.3	2.7	18.5		8.3	1.68	38.4			600	
572	2372		147.0	C	1.1	8.3	38.5	42.9	7.7	.4	.4		7.2					440	
572		154.0	156.0	C	10.4	30.2	30.2	8.2	2.7	2.2	6.6							410	
572		162.5	171.6	C		6.0	44.4	34.5	9.7	2.5	2.3								
572		181.7	189.0	C	.1	.9	2.6	3.1	6.4	8.1	65.0		10.3						
572		197.0	206.5	C	3.3	10.8	25.4	33.4	16.4	3.1	5.0		2.0						
572		207.2	0	C	.2	1.5	20.0	54.4	17.8	2.0	3.4			1.67	37.4			130	
572	2373		210.5	C	6.1	14.6	29.2	24.5	5.8	2.4	2.8		11.1					300	
572		210.5	212.6	C	1.7	16.1	34.6	27.0	8.0	1.3	2.0		7.0					130	
572		223.0	226.0	C	7.2	19.6	39.1	26.0	4.5	1.4	2.0			1.70	35.8			220	216
572	2374	226.0	0	C	1.4	3.0	6.3	19.1	21.8	17.2	27.4		3.9					30	
575		2.0	3.0	C	26.6	20.8	20.6	23.5	7.2	.8	.5							1510	
575		6.6	13.5	C	55.5	21.8	13.2	7.5	1.7	.1	.1							5520	
575		13.5	16.0	C	46.1	21.1	18.7	12.5	2.4	.1								2140	
575		25.5	29.0	C															

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575	.....	32.5	36.1	C	15.4	20.9	23.3	34.3	6.0	.1	.....	.....	.....	.....	.....	.....	.....	.....	1320	.....
575	.....	43.4	46.6	C	23.3	24.5	28.6	18.2	4.6	.5	.3	.....	.....	.....	.....	.....	.....	.....	1760	.....
575	.....	67.0	71.0	C	27.6	7.8	2.6	14.0	28.9	10.0	8.0	.....	.....	1.2	.....	.....	.....	.....	20	.....
575	.....	99.8	102.0	C	13.2	9.6	6.6	22.5	32.2	8.8	5.0	.....	.....	2.1	.....	.....	.....	.....	20	.....
575	.....	147.0	153.5	C	.....	.2	.7	11.7	39.6	.8	39.8	.....	.....	7.2	.....	.....	.....	.....	.....	.....
575	.....	177.0	180.0	C	4.2	5.4	6.6	15.6	13.2	7.8	26.4	.....	.....	20.8	.....	.....	.....	.....	6	567
577	.....	4.1	5.5	A	3.4	4.2	8.8	29.4	23.9	10.7	15.0	.....	.....	4.6	.....	.....	.....	.....	5	.....
577	.....	5.9	9.8	A	29.1	13.5	17.2	29.9	8.4	1.0	.9	.....	.....	.....	.....	.....	.....	.....	420	.....
577	2386	13.8	15.5	C	12.2	10.3	24.8	42.9	8.4	.4	.1	.....	.....	.....	.....	.....	.....	.....	1300	.....
577	.....	24.0	25.5	C	37.7	18.7	20.9	17.5	3.6	.4	1.0	.....	.....	.....	.....	.....	.....	.....	1320	.....
577	.....	31.0	33.0	C	31.8	23.5	23.6	16.3	3.6	.7	.4	.....	.....	.....	.....	.....	.....	.....	1760	.....
577	.....	35.5	45.4	C	11.4	4.2	11.4	31.4	20.5	8.6	12.2	.....	.....	.3	.....	.....	.....	.....	.....	.....
577	.....	84.0	88.0	C	.....	.1	1.6	21.1	26.6	10.3	38.6	.....	.....	1.7	.....	.....	.....	.....	.....	.....
577	.....	144.0	149.0	C	.7	17.0	4.5	26.1	18.6	9.0	20.9	.....	.....	3.2	.....	.....	.....	.....	.....	284
608	2285	6.0	15.0	O	1.2	1.0	2.1	13.1	63.6	14.1	3.5	.....	.....	.....	1.45	43.1	3.6	38	200	.....
608	2286	18.0	19.0	O	19.6	24.2	17.4	25.9	8.8	1.3	1.5	.....	.....	.....	1.54	37.0	9.7	27	30	.....
608	2287	19.0	20.0	O	25.9	33.3	27.1	11.0	1.0	.1	.4	.....	.....	.....	1.77	30.0	2.3	26	2400	.....
608	2288	20.0	22.0	O	19.1	22.2	26.9	18.6	7.1	2.9	1.4	.....	.....	.....	1.81	28.2	1.1	26	1250	.....
608	2289	22.0	25.0	O	21.2	24.2	30.2	18.1	3.6	.6	.5	.....	.....	.....	1.80	28.8	1.6	25	1400	.....
608	2290	25.0	34.0	O	53.8	16.5	14.1	11.9	2.3	.1	.1	.....	.....	.....	1.91	24.1	1.7	21	4500	.....
608	2291	34.0	36.0	O	5.6	5.2	4.2	28.9	51.4	2.4	.2	.....	.....	.....	1.67	34.4	2.4	31	490	.....
608	2292	36.0	38.0	O	21.1	17.7	25.8	23.5	9.7	.7	.2	.....	.....	.....	1.85	28.9	1.4	26	1000	.....
608	2293	38.0	41.0	O	20.7	28.3	28.9	16.3	3.5	.2	.1	.....	.....	.....	1.83	30.0	2.8	26	1800	.....
608	2294	41.0	46.5	O	16.5	20.0	25.1	31.3	4.6	.3	.1	.....	.....	.....	1.81	31.1	1.8	28	1800	2470

(*a*) Samples for which U. S. Geological Survey laboratory numbers are given were analyzed by V. C. Fishel; other samples were analyzed by G. H. von Hein and Charles C. Williams.
(*b*) Symbols in this column indicate: H, hand; O, orange peel bucket; C, cable-tool test drill; A, hand auger.
(*c*) Determined on consolidated sample; pulverized sample, 6.2 percent.
(*d*) Sample collected from oldest dunes.
(*e*) Sample collected from dunes of intermediate age.
(*f*) Sample collected from youngest dunes.

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samples were collected just above the water table, weighed, dried, and reweighed to determine the specific retention. Porosity and apparent specific gravity were then determined and the value of specific yield was calculated. The average specific yield of 13 samples collected from the zone of water-table fluctuation in the Wichita well-field area was found to be 25.2 percent. The average specific yield of 20 samples taken from points below the water table was 27.8 percent. The specific yield of all the samples collected and studied from this area ranged from 8 to 38 percent and averaged 26.8.

PERMEABILITY AND TRANSMISSIBILITY

Definitions and General Discussion

The permeability of a formation generally is expressed as a coefficient of permeability which may be defined as the number of gallons of water a day, at 60° F., that is conducted laterally through each mile of the water-bearing bed under investigation (measured at right angles to the direction of flow), for each foot of thickness of the bed, and for each foot per mile of hydraulic gradient (Meinzer's coefficient: see Stearns, 1927, p. 148). The coefficient of transmissibility (Theis, 1935, p. 520) may be expressed as the number of gallons of water a day, at the prevailing temperature, that is transmitted through each mile of the aquifer under a hydraulic gradient of 1 foot to the mile; hence it is the average coefficient of permeability multiplied by the thickness of the aquifer and adjusted for temperature.

The quantity of water that will percolate through a given cross section of water-bearing material under a known hydraulic gradient is directly proportional to the coefficient of permeability of the material. It is necessary to determine this important hydrologic property in order to compute the quantity of ground water that percolates into or out of a ground-water basin or reservoir or a specific well or well field.

Coefficients of permeability range widely. Fine-grained sand is, in general, less permeable than coarse-grained sand and therefore transmits less water through equal cross-sectional areas under the same hydraulic gradient. Clay and other fine-grained materials may, and generally do, contain more water per unit volume than sand or gravel, but the permeability generally is low and therefore the quantity of water transmitted through silt and clay is much less than through sand or gravel. Coefficients of permeability of less than 100

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are said to be low, coefficients between 100 and 1,000 are said to be medium, and coefficients above 1,000 are considered high.

Laboratory determinations

The coefficients of permeability determined for individual sam- Table 7 were determined by V. C. Fishel in the hydrologic laboratory in Washington, but some were determined in the field laboratory at Wichita. Laboratory methods employed in determining permeability have been described by Fishel (in Wenzel, 1942).

The coeffiecients of permeability determined for individual samples are given in Table 7, and range from less than 0.1 for some samples of clay and silt to 10,900 for medium and coarse gravel. The coefficient of permeability for most of the samples tested ranges from 100 to 1,000. Given also in Table 7 are weighted average coefficients of permeability computed for the entire thickness of the saturated material penetrated in a single cable-tool test hole. These weighted average coefficients of permeability range from 210 to 830 in the Wichita well-field area. The weighted average coefficient of permeability at well 608 was calculated to be 2,470.

Pumping Test Determinations

Methods of determining the permeability and transmissibility of an aquifer from data obtained from pumping tests have been developed by members of the U. S. Geological Survey and others, based on the law of flow of water through sand as propounded by Darcy in 1856. Darcy's law may be written $Q = PIA$, in which Q is the quantity of water that percolates through a cross section of water-bearing material, P is the coefficient of permeability, I is the hydraulic gradient, and A is the cross-sectional area of the material.

Theis recovery method.—Theis (1935) has shown that to the extent that Darcy's law governs the motion of ground water under natural conditions and under the artificial conditions set up by pumping, an analogy exists between the hydrologic conditions in an aquifer and thermal conditions in a similar thermal system. From his final equation expressing the relation between the drawdown and the rate and duration of discharge of a well, Theis developed the following recovery formula for determining the transmissibility of an aquifer:

$$T = \frac{264q}{s} \log_{10} \frac{t}{t^1}$$

in which T = coefficient of transmissibility, q = pumping rate, in gallons a minute, t = time since pumping began, t^1 = time since pumping stopped, s = residual drawdown at the pumped well, in feet, at time t^1.

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PLATE 25. *A*, Well (609) of Kansas Gas and Electric Company discharging 1,000 gallons a minute during pumping test. *B*, Wichita supply well (450) discharging 1,600 gallons a minute during pumping test. Photographs by S. W. Lohman.

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Pumping tests.—Pumping tests were made at each of the 25 wells in the new Wichita well field by the Layne-Western Company, well contractors, as a part of the conditions of acceptance by the city (Pl. 25B), and the data obtained from these tests were made available to the authors for study. The coefficient of transmissibility was determined for each of the 25 wells by applying the Theis recovery method. The results of the determinations, the saturated thickness of the aquifer at each well, and the weighted average coefficient of permeability are given in Table 8. The coefficients of transmissibility range from 46,000 at well 311 to 330,000 at well 455, and the average coefficient of transmissibility was computed to be 124,500. The data thus obtained have been used to determine the quantity of water that percolates through the aquifer into the Wichita well-field area.

TABLE 8.—*Transmissibility (a), permeability, and specific capacity of the new Wichita supply wells*

WELL NO.	Saturated thickness of water-bearing material (feet)	Specific capacity (gallons a minute per foot of drawdown)	Coefficient of transmissibility	Average coefficient of permeability
311	205	27.5	46,000	224
314	212	22.6	52,800	249
317	209	32.2	62,100	297
322	210	14.6	52,600	250
330	216	24.4	68,700	318
333	235	29.5	100,400	427
415	239	20.2	73,300	307
419	246	24.5	85,600	348
423	231	42.2	190,000	822
426	230	32.9	127,000	553
429	216	56.8	261,000	1,210
433	179	53.5	110,000	614
436	222	49.3	87,500	394
440	178	40.5	66,000	371
450	(*b*) 90	54.9	223,000	.....
452	176	38.9	92,400	525
455	(*b*) 108	141.0	330,000	.....
459	233	47.4	123,500	530
465	145	42.8	67,600	467
473	(*b*) 65	90.7	278,000	.....
476	(*b*) 66	34.3	198,000	.....
479	133	32.0	63,500	478
487	190	34.0	75,700	398
491	(*b*) 83	56.4	154,200	.....
494	176	45.8	123,000	690

(*a*) Determined by the Theis recovery method.
(*b*) Well does not penetrate entire acquifier.

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Thiem method.—The Thiem method of determining the permeability of a water-bearing material consists of analysis of the decline in water level during the pumping period in a pumping well and in several observation wells near the pumping well. The method is based on the consideration that after approximate equilibrium is established around a pumped well, approximately equal quantities of water move toward the well in a given unit of time through a successive series of concentric cylindrical sections around the well. Because the areas of the large cylinders through which the water percolates are greater than the areas of the smaller cylinders, the velocity of the ground water passing through the larger cylinder is proportionately less and the hydraulic gradients are proportionately smaller.

The derivation of the general Thiem formula has been discussed by Wenzel (1942, pp. 77-81). V. C. Fishel has developed a very convenient formula for determining the permeability of water-bearing material by the Thiem method:

$$P = \frac{527.7q}{m} \frac{\Delta \log_{10} r}{\Delta h}$$

in which P = coefficient of permeability (as defined above), q = discharge of the pumped well in gallons a minute, m = average saturated thickness of the water-bearing material at the observation wells after the water table has declined to an approximate equilibrium condition, r = distance of observation wells from the pumped well, in feet, h = altitude of the water table at the observation wells.

The value of the member $\frac{\Delta \log_{10} r}{\Delta h}$ is obtained by making use of the straight-line relationship that exists when the altitudes of the water levels in the observation wells are plotted on a natural scale against the distances of the observation wells from the pumped well on a logarithmic scale, and its value is given by the slope of the straight line.

Pumping test.—A pumping test was made in 1937 to determine the permeability of the water-bearing sand and gravel in the Arkansas River Valley at well 608, about 3 miles north of Wichita on the property of and with the full coöperation of the Kansas Gas and Electric Company (Pl. 26). The well is 20 inches in diameter and 45.3 feet deep. The thickness of the saturated water-bearing material just before the test was 26.8 feet. Observation wells were constructed at varying distances on four radial lines extending north, east, south, and west from the pumped well and were located

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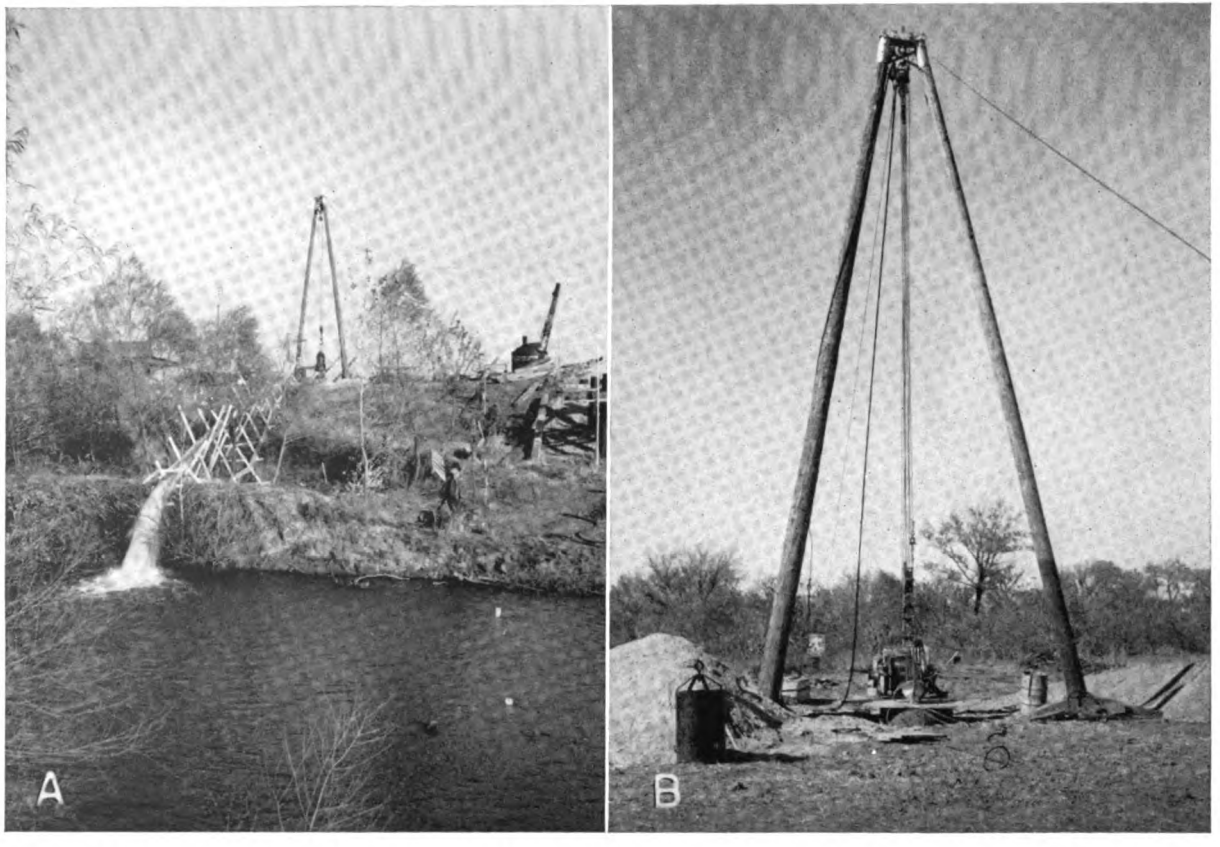

PLATE 26. *A*, Well (608) of Kansas Gas and Electric Company discharging 1,000 gallons a minute into Little Arkansas River during 19-day pumping test. *B*, Bipod and orange-peel bucket used in construction of well 609. Photographs by S. W. Lohman.

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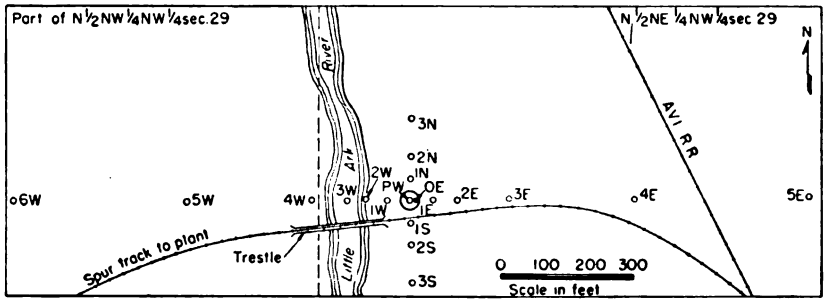

FIG. 10. Map showing the location of well 608 and the near-by observation wells of the Kansas Gas and Electric Company, sec. 29, T. 26 S., R. 1 E.

TABLE 9.—*Water level data collected during a pumping test at well 608*

Well No. and direction from pumped well	Distance from pumped well (feet)	Altitude of water levels		Drawdown (feet)
		Static level Nov. 8, 10:30 a. m. (feet)	Pumping level Nov. 26 (*a*) (feet)	
1N	49.2	1,309.62	1,303.76	5.86
2N	100.7	1,309.75	1,305.17	4.58
3N	189.4	1,309.91	(*b*) 1,306.55	3.36
1S	49.0	1,309.52	1,304.10	5.42
2S	100.4	1,309.58	1,305.37	4.21
3S	190.0	1,309.48	1,306.34	3.14
1E	49.3	1,309.67	1,303.62	6.05
2E	101.3	1,309.68	1,304.94	4.74
3E	220.9	1,309.73	1,306.62	3.11
4E	500.1	1,309.88	1,307.97	1.91
5E	900.1	1,309.99	1,308.87	1.12
1W	49.3	1,309.55	1,304.22	5.33
2W	100.5	1,309.53	1,305.43	4.10
3W	139.7	1,309.43	1,305.98	3.45
4W	222.3	1,309.52	1,307.13	2.39
5W	503.5	1,309.43	1,308.10	1.33
6W	895.0	1,309.63	1,308.69	.94
OE	(*c*) 3.2	1,309.62	1,296.90	12.72
(*d*) PW	0.0	1,309.60	1,294.70	14.90

(*a*) Average of 2 measurements made on Nov. 26.
(*b*) Interpolated.
(*c*) Measured from center of pumped well (PW), situated just outside of gravel packing.
(*d*) Pumped well.

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as shown in Figure 10. All the observation wells and the pumped well penetrated the full thickness of the aquifier. Well 608 was operated continuously at a rate of 1,000 gallons a minute from 10:33 a.m., November 8, to the afternoon of November 27, at which time the pump was unavoidably stopped. Pumping was resumed on November 28 at a rate of 750 gallons a minute and was discontinued December 8 at 9:55 a.m.

The locations and depths of the observation wells, the altitudes of the static water levels on November 8, the equilibrium pumping levels, and the drawdowns on November 26 are given in Table 9.

In Figure 11 the altitudes of the water levels on November 26, 1937, for each line of wells are plotted against the distance of the observation wells from the pumped well. The altitudes of the water

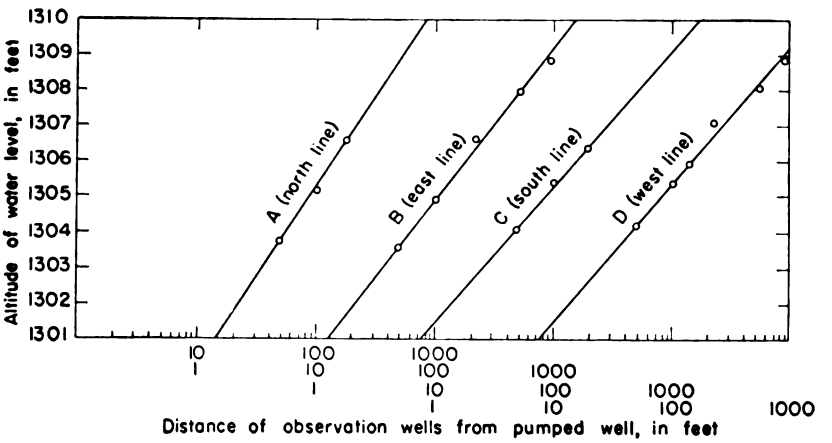

FIG. 11. Altitude of water levels just before pumping stopped on November 26, 1937, plotted against the distance of the observation wells from pumped well 608.

levels for r at distances of 10 and 100 feet were obtained from the straight line curves (Fig. 11) and are given in Table 10. The pumping rate was 1,000 gallons a minute and the average saturated thickness in the cone of depression was about 22.2 feet. The equation becomes

$$P = \frac{527.7 \times 1.000}{22.2} \frac{\triangle \log_{10} r}{\triangle h}$$

The term $\triangle \log_{10} r$ is 1 when r_2 and r_1 are 100 and 10 feet respectively, thus $\frac{\triangle \log_{10} r}{\triangle h}$ is equal to 1 divided by the difference in altitude of the water levels at 10 and 100 feet respectively from the

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pumped well. The permeability as computed for each line of observation wells is given in Table 10.

TABLE 10.—*Computations of the coefficient of permeability by the Thiem method at well 608*

Direction of observation wells from pumped well	Altitude of water level at r = 10 feet (feet)	Altitude of water level at r = 100 feet (feet)	$\triangle \log_{10} r$	$\triangle h$ (feet)	Coefficient of permeability
North	1,300.30	1,305.26	1	4.96	4,795
East	1,300.65	1,304.95	1	4.30	5,528
South	1,301.50	1,305.32	1	3.82	6,223
West	1,301.60	1,305.43	1	3.83	6,206
Average of north-south lines					5,509
Average of east-west lines					5,867
Average of all lines					5,688

The Thiem method could not be used satisfactorily in determining permeability from pumping tests of the new Wichita municipal supply wells because observation wells were too few and did not penetrate the entire aquifer.

SPECIFIC CAPACITY

The specific capacity of a well may be expressed as the number of gallons a minute that a well will yield for each foot of drawdown. It has been found experimentally that this relationship does not hold precisely except for the first few feet of drawdown and that it often fails because of differences in construction and development of wells. Comparison of the specific capacities of wells is useful, however, in estimating relative efficiency of wells and permeability of formations. The specific capacities of the 25 Wichita city wells (Tables 8 and 32) range from 14.3 at well 322 to 141 at well 455, and it is noted that the largest specific capacity and the largest coefficient of transmissibility occur for the same well (see Table 32 for pumping rates during the 36-hour tests).

The specific capacities of other wells in the area of this investigation are given in the remarks column in Table 37.

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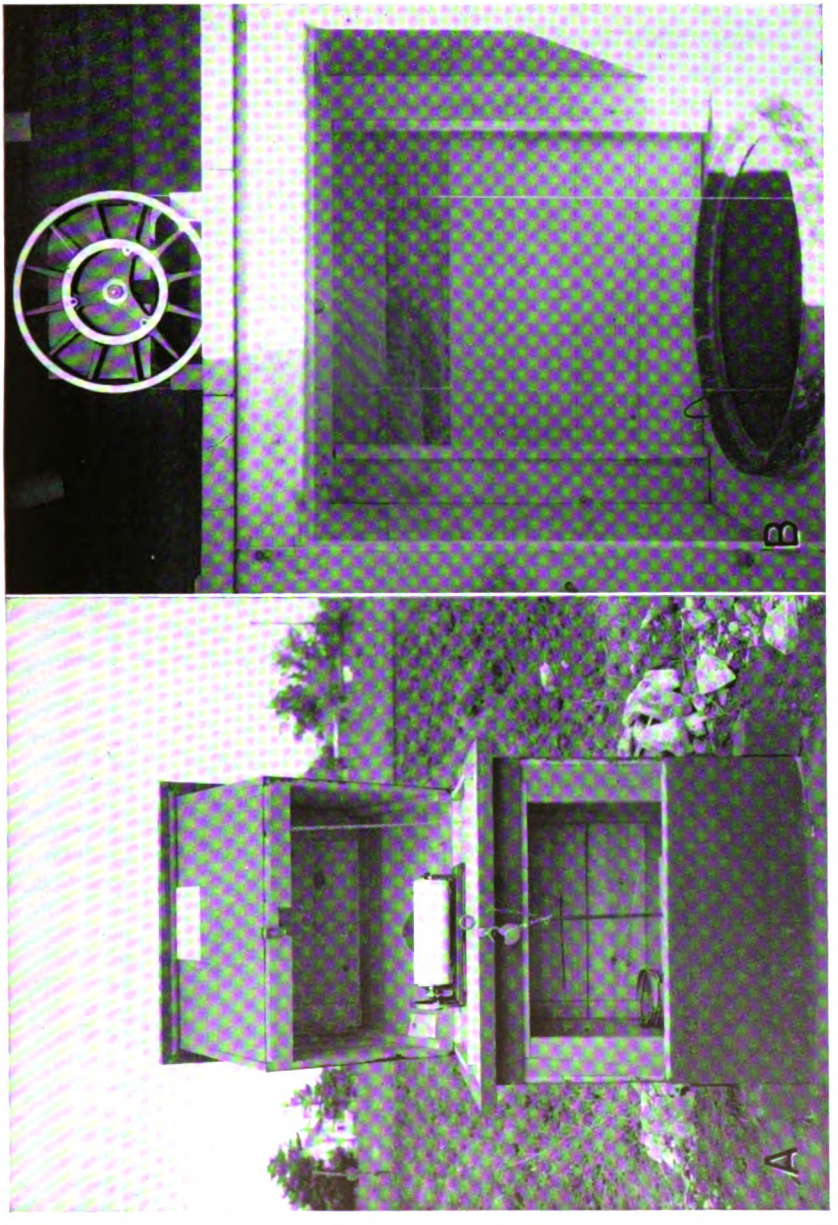

PLATE 27. Automatic water-stage recorders on observation wells. *A*, Well 86 near McPherson. *B*, Well 674 in old well field of Wichita Water Company. Photographs by S. W. Lohman.

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Fluctuations of the Water Table

General Considerations

The water table, shown by means of contours on Plate 1, does not remain static but fluctuates much like the water level of a surface reservoir. Whether the water table rises or declines depends upon the amount of recharge into the ground-water reservoir and the amount of discharge from it. If the inflow exceeds the draft, the water table will rise; conversely, if the draft exceeds the inflow into the ground-water reservoir the water table will decline. The amount of rainfall that penetrates the soil and descends to the zone of saturation is the principal factor that controls the rise of the water table. Discharge from wells, from seeps and springs, and through evaporation and transpiration are the principal factors that cause a decline in the water table. Fluctuations of the water table due to these causes are discussed and many hydrographs of observation wells are presented on succeeding pages.

The fluctuations of the water table in McPherson, Harvey, and Sedgwick Counties were determined by observing the water levels in wells. Measurements in many observation wells were begun in 1937 and are being continued at this time. Some wells are measured weekly, others are measured monthly or quarterly, while others are equipped with automatic water-stage recorders which yield a continuous record (Pl. 27). The water-level measurements have been made by G. H. von Hein and C. K. Bayne.

Water-level measurements made from 1937 through 1944 have been published annually in U. S. Geological Survey Water-Supply Papers 840, 845, 886, 908, 938, 946, 988, and 1,018, and future measurements will be published in ensuing reports of this series. The well numbers used in this report and in the Water-Supply Papers are given in Table 11.

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TABLE 11.—*Observation wells in McPherson, Harvey, and Sedgwick Counties*

Well No. in this report	Well No. in Water-Supply Paper 840, 845, 886, 908, 938, 946, 988, and 1018
McPHERSON COUNTY	
20	260
33	249
58	262
79	243
86	19
104	250
160	310
161	311
166	1501a
202	309
HARVEY COUNTY	
223	72
246	249
299	888
300	889
305	854
309	507
310	506
311	M-1
312	M-1a
313	M-1b
314	M-2
315	M-2a
316	M-2b
317	M-3
318	M-3a
319	M-3b
321	1192
322	M-4
323	M-4a
324	M-4b
325	1112
327	872
328	873
329	874
330	M-5
331	M-5a
332	M-5b
333	M-6
334	M-6a
335	M-6b
339	87
340	86
354	875
355	877
356	876
358	325
395	701
400	831
401	832
HARVEY COUNTY (Cont.)	
402	1187
403	833
404	824
405	852
407	1174
411	817
414	821
415	M-8
416	M-8a
417	M-8b
419	M-10
420	M-10a
421	M-10b
423	M-9
424	M-9a
425	M-9b
426	350
427	351
428	352
429	M-11
430	M-11a
431	M-11b
432	3
433	M-15
434	M-15a
435	M-15b
436	M-12
437	M-12a
438	M-12b
439	M-14b
440	M-16
441	M-16a
442	M-16b
445	853
446	1186
448	886
449	887
450	M-14
451	M-14a
452	M-17
453	M-17a
454	M-17b
455	M-7
456	M-7a
457	M-7b
458	1189
459	M-13
460	M-13a
461	M-13b
462	894
463	895
HARVEY COUNTY (Cld.)	
464	1188
465	M-18
466	M-18a
467	M-18b
469	2
470	883
471	884
472	885
473	M-21
474	M-21a
475	M-21b
476	M-22
477	M-22a
478	M-22b
479	M-19
480	M-19a
481	M-19b
486	839
487	M-23
488	M-23a
489	M-23b
491	M-24
492	M-24a
493	M-24b
494	M-25
495	M-25a
496	878
497	879
502	880
503	881
511	890
516	891
517	892
518	893
SEDGWICK COUNTY	
536	28
538	825
540	826
544	816
547	814
549	815
557	12
558	812
560	811
563	810
567	M-25b
568	307
572	840
575	842
578	870

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TABLE 11.—Observation wells in McPherson, Harvey, and Sedgwick Counties—*Concluded*

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SEDGWICK Co. (Cont.)		SEDGWICK Co. (Cont.)		SEDGWICK Co. (Cld.)	
582	830	627	804	660	845
588	834	628	805	663	847
593	838	634	807	664	846
606	809	636	806	674	26
609	502	637	808	715	802
619	800	642	.....		

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FLUCTUATIONS CAUSED BY CHANGES IN ATMOSPHERIC PRESSURE

In addition to the fluctuations of the water table caused by addition or withdrawal of water, minor fluctuations caused by changes in atmospheric pressure are observed in some wells. Wells that penetrate water-bearing formations having a relatively impervious bed above the zone of saturation may fluctuate inversely as the barometer fluctuates. The pressure on the water surface in a well increases directly as the increase in atmospheric pressure. If this increase in pressure is not transmitted uniformly to the groundwater body, but acts only on the exposed water surface in the well, the water level in the well fluctuates according to the changes in pressure. If the pressure is transmitted freely through the pore

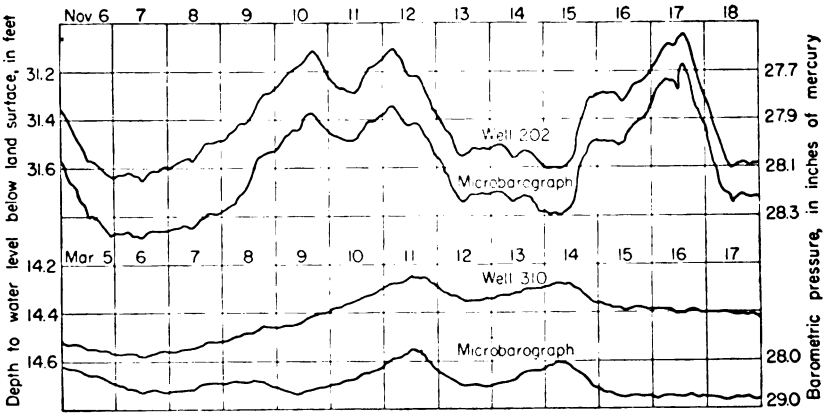

FIG. 12. Water-level fluctuations in well 202 in 1938 and 310 in 1939 caused by changes in atmospheric pressure.

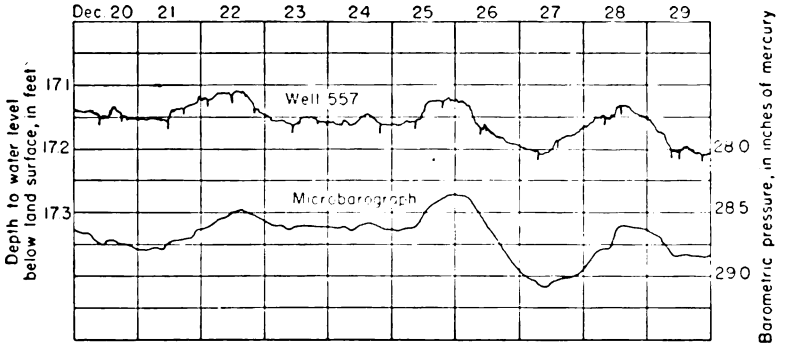

FIG. 13. Water-level fluctuations in well 557 in 1938 caused by changes in atmospheric pressure.

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spaces of the soil to the water table, the water level will reflect no appreciable barometric effect.

Hydrographs of wells 202, 310, and 557, obtained from automatic water-stage recorders and inverted barographs obtained from a recording micro-barograph in the same shelters are shown in Figures 12 and 13. Well 202 is the most efficient water barometer of the three shown. This well penetrates part of the Ninnescah shale and the water-bearing zone is overlain by near-by impervious shale. Well 310 penetrates sand and gravel of the McPherson formation, and the water-bearing bed is overlain by a comparatively thin bed of silt and clay. The gravel bed penetrated by well 557 is overlain by about 10 feet of clay and silt which acts as a confining bed, especially at high ground-water stages. The hydrograph of well 557 shows the effect of a near-by domestic well which is equipped with a small automatic pump and pressure tank. The hydrograph also shows the artesian effect produced by the clay bed above the saturated sand and gravel.

Ground-water Recharge

Recharge is the term used to denote the addition of water to the ground-water reservoir, and may be accomplished in several ways. The ultimate source of all ground water of quality suitable for ordinary uses in this area is precipitation in the area or in near-by areas. Once the water becomes a part of the ground-water body it moves in the direction of the slope of the water table, later to be discharged at some point down gradient.

The underground reservoir beneath this area is recharged principally from precipitation on the area, but some water is added by seepage from streams and by subsurface flow from near-by areas. In some of the oil fields of the area highly saline oil-field brines have been allowed to seep into the fresh water-bearing formations; this constitutes another source of water added to the aquifiers, although the quantity of water involved probably is very small compared to that received from rainfall and other sources, and the highly saline character of the water renders it very undesirable as a source of recharge.

Recharge from precipitation

According to data compiled by the United States Weather Bureau (Table 1) the normal annual precipitation in this area ranges from 28.29 inches at Mt. Hope to 31.25 inches at Newton. The amount of precipitation has ranged from 15.57 inches in 1921 at McPherson to 48.69 inches in 1922 at Newton, but the normal annual precipi-

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tation for the entire area here under consideration is about 29 inches.

Of the total precipitation, a part runs off the land surface to streams, a part is dissipated by evaporation, a part is transpired by plants from the zone of soil moisture, and a part percolates downward to the zone of saturation. Although this report is concerned mainly with that part of the precipitation that reaches the water table, a brief summary of the disposition of those parts that do not necessarily contribute to ground-water recharge seems to be in order.

A study was made during the course of this investigation of the ultimate division of rainfall in the area roughly bounded by Burrton, Halstead, Valley Center, and Patterson. Figure 14 shows the

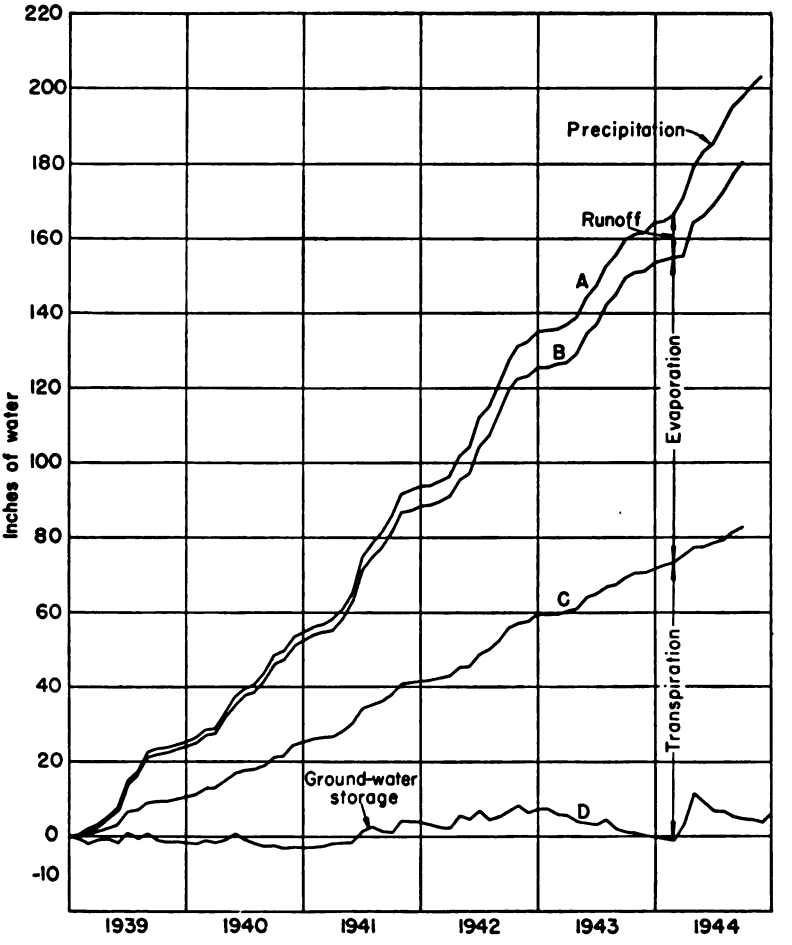

FIG. 14. Mass curves showing precipitation, runoff, evaporation, transpiration, and change in ground-water storage from Jan. 1, 1939 to Dec. 31, 1944 in the Wichita well-field area.

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magnitude of the natural disbursement of precipitation. It should be noted that ground water ultimately contributes to some of the divisions shown on the chart. Curve A shows the total cumulative precipitation at Sedgwick from January 1, 1939 to December 31, 1944. The discharge of Little Arkansas River has been measured at the gaging station at Valley Center, Kansas, and curve B was plotted by subtracting the runoff in inches from curve A. Runoff in inches, as reported by the United States Geological Survey and Kansas State Board of Agriculture, is computed as the average runoff for the entire drainage basin. This figure probably is not the exact value for runoff from the smaller area studied but probably is of the right order of magnitude. The vertical distance between curves A and B represents approximately the cumulative total runoff, that is, both surface runoff and ground-water runoff. The distance between curves B and C is an approximation of the cumulative losses to rainfall caused by evaporation from the land surface in this area. The value for evaporation was computed by using United States Weather Bureau records of mean monthly temperature at Newton and monthly precipitation at Sedgwick, Kansas, and by applying these data to Meyer's evaporation curve (Meyer, 1928, pp. 455-457). Curve D represents the cumulative change in storage in 10 observation wells not affected by pumping in this area, in inches of water. The distance above the zero line and below curve D represents cumulative additions to storage from precipitation; that is, the excess of ground-water recharge from precipitation over ground-water discharge included in the other graphs. The distance between curves C and D represents that part of the precipitation not otherwise accounted for and is believed to represent approximately the losses through transpiration.

The amount of the annual precipitation that percolates downward to the water table and recharges the ground-water reservoir is dependent on several factors, including the amount and distribution of annual rainfall, the physical character and the composition of the soil and subsoil, the proximity of the water table to the land surface, the condition of the soil before rainfall (moisture content, cultivation, etc.), and the number and depth of roots, animal burrows, and openings or cracks in the soil such as may be observed following drought. Some measure of the amount of recharge from precipitation may be gained from study of the fluctuations of water levels in wells if the specific yield of the water-bearing material is known.

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Recharge in areas underlain by shale of Permian age.—Several different types of soils have been formed in this area, owing to the differences in the parent materials from which they are derived. The soils in areas underlain by Permian and Cretaceous shales are of such composition that water percolates slowly through them and

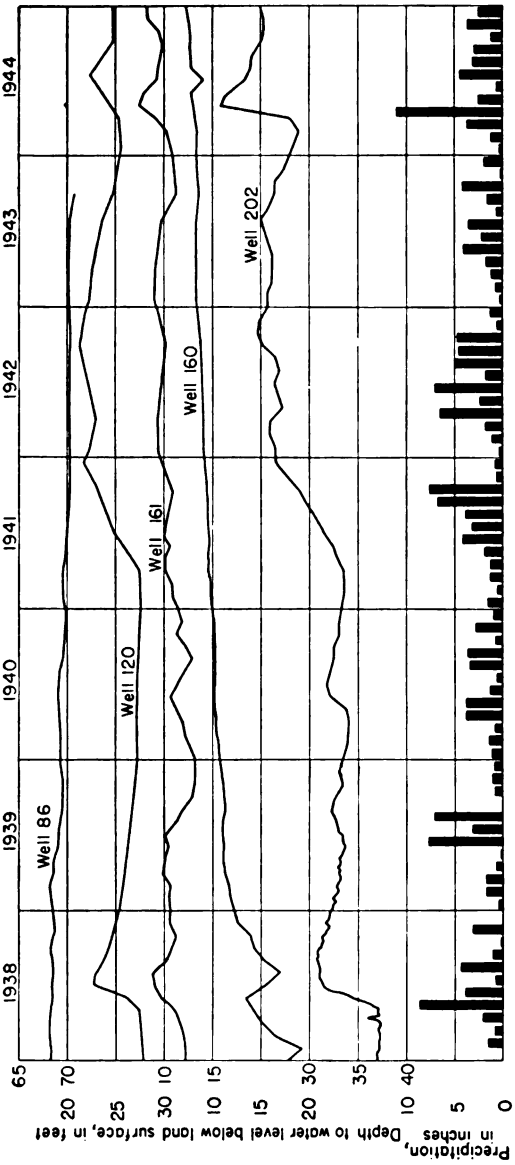

FIG. 15. Hydrographs showing fluctuations of water levels in five wells in McPherson County and monthly precipitation at McPherson.

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only a small part of the annual rainfall reaches the water table. The fluctuations of water levels in wells 160, 161, and 202, which penetrate Permian shale, are shown on Figure 15. Well 160 has shown a steady rise of about 10 feet in response to normal and above-normal precipitation from 1938 through 1944. This area had experienced a prolonged drought in the years preceding the period of record, and water levels were at an abnormally low stage. The rise in water levels in wells 160 and 202 has been somewhat greater than the rise would have been had the preceding years been more nearly normal. Fluctuations of water level in well 202 have been of greater amplitude than those observed in well 160, but the rise in water level for the period of record has been nearly the same as in well 160. As shown in Figure 12 well 202 reflects very efficiently changes in atmospheric pressure. The water level in well 161 has not risen as much as in other wells, for it is a much shallower well and derives water in part from shale and in part from a thin layer of sand and silt above the shale. The shale is saturated only in the upper few feet at this well and the water table fluctuates through a range comparatively close to the land surface. The specific yield of the shale and material derived from shale at wells 160, 161, and 202 was not determined, but is known to be very low in comparison with coarser materials; hence, the 10-foot rise in water level in well 160 shown on the hydrograph does not represent nearly the amount of recharge that would be indicated by a similar rise of water level in a well penetrating sand and gravel.

Recharge near McPherson.—An irregular area, extending several miles north, south, and west from McPherson, in which the depth to water ranges from 40 to 80 feet below land surface, is shown on Plate 5. This area is underlain by a deposit of silt which ranges in thickness from several feet to about 75 feet. Although this material is, in general, more permeable than shale, it is much less permeable than sand and gravel, and water moves slowly through it; hence, recharge from precipitation takes place very slowly and is reflected in wells by a gradual rise in water level. Test drilling in this area revealed some very porous unsaturated zones where the silt contains many large nodules of calcium carbonate. This unusual porosity probably has occurred through the action of secondary processes. Where porous zones occur at or near the surface, however, much more water may reach the zone of saturation than is possible elsewhere.

During the growing season much of the water that enters the silt

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after rains is evaporated and transpired by plants before reaching a depth beyond which it cannot be affected by these processes. If the silt were more permeable, water would move more rapidly through the zone of aeration and more water would reach the zone of saturation. The water levels observed in well 86 are shown graphically in Figure 15. This well penetrates a considerable thickness of silt and ends in sand and gravel. The hydrograph of well 86 shows that water was added to the underground reservoir at about the same rate at which it was discharged, although the decline of 2.5 feet shown on the hydrograph indicates that discharge exceeded recharge during the 6-year period of record. This well is situated within the area of pumping influence of the McPherson city water wells and the lowering observed probably was caused by pumping. The fact of principal interest indicated by this hydrograph is that the water level does not fluctuate greatly nor quickly in response to increased or decreased precipitation, differing in this respect from the fluctuation of water level in wells in areas underlain by materials having greater permeability. The depth to water level at well 86 is also a factor in producing the nearly smooth hydrograph, owing to the lag in the rise of water level in response to precipitation.

Recharge in sand-dune areas.—Sand dunes cover most of the area between Little Arkansas River and United States Highway 50S in the west-central part of the mapped area, and subdued sand dunes occur in smaller areas near Halstead and south and southeast of Burrton (Pl. 1) constituting areas important for ground-water recharge.

Water added to the ground-water reservoir in the sand-hills area is derived largely from precipitation. Because of the relatively high porosity and permeability of the dune sand and the presence of many undrained basins that serve as catchment areas for rainfall, a large percentage of the rain water percolates downward to the zone of saturation. Contours representing the shape of the ground-water surface (Pl. 1) indicate that the underground reservoir beneath the sand-hills area receives more recharge than neighboring areas. A part of the ground water derived from rainfall on this area moves down gradient southward toward the area underlain by terrace deposits and a part moves northward and eastward toward Little Arkansas River where it is discharged and contributes to the flow of that stream. Similarly in the sand-dune area east of Little Arkansas River a large percentage of the precipitation reaches the water table and is a source of water for the Newton city wells. This water also contributes to the flow of the stream.

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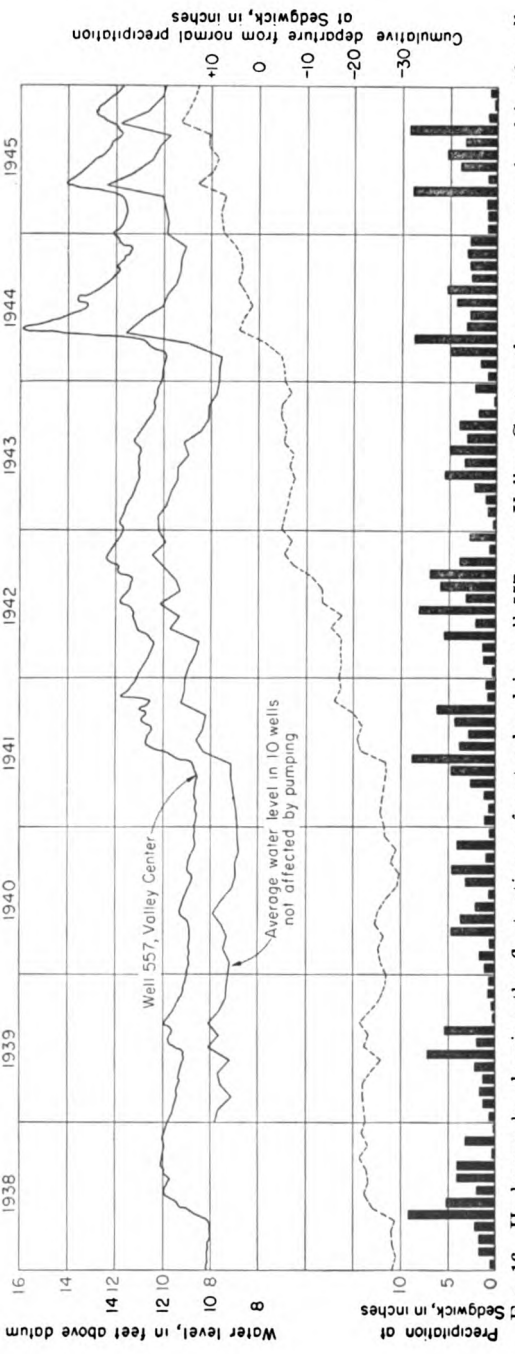

FIG. 16. Hydrographs showing the fluctuations of water level in well 557 near Valley Center, the average water level in 10 wells in the Wichita well-field area not affected by pumping, the cumulative departure from normal monthly precipitation at Sedgwick, and the monthly precipitation at Sedgwick.

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Recharge in areas underlain by sandstone.—Partly cemented sandstones in the Kiowa shale crop out (Pl. 1) in some places in the northeastern and northwestern parts of the area studied. In these places a very sandy soil is developed on the parent rock and a large percentage of the precipitation enters the sandstone. The shale of the Kiowa beneath the sandstone is relatively impermeable and definitely limits the amount of recharge that the ground-water reservoir can accommodate. When the water level is raised after rains, ground water moves laterally and emerges as springs at points where erosion has dissected the terrain and the land surface intersects the sandstone beds (Pl. 13B).

Recharge in the Arkansas River Valley.—There is little difference, hydrologically, between the alluvium of Arkansas and Little Arkansas Rivers and the McPherson formation which are shown separately on Plate 1. The soil developed on the alluvium and the McPherson ranges from sandy loam to loam over most of the area, but is very sandy in places near Arkansas River and in other places where remnants of old sand dunes exist and in some localities very porous sand and gravel occur near land surface (Pl. 16A). In general, the character of the soil, topography, depth to water level, and other factors are favorable for recharge from precipitation.

The fluctuations of water level have been observed from 1938 through 1944 in many wells that penetrate the deposits of permeable sand and gravel occurring in the alluvium and McPherson formation.

The hydrographs of well 557 which is equipped with an automatic water-stage recorder and the average water level in 10 wells (nos. 358, 445, 502, 511, 544, 549, 557, 558, 560, and 563) are shown on Figure 16. The similarity between the hydrographs and the graph of the cumulative departure from normal precipitation at Sedgwick is noteworthy.

There was no accumulated deficiency of rainfall for the middle division of Kansas, which includes this area, on December 31, 1926, calculated for all stations in the division since January 1, 1887 (Jones, 1936, Fig. 21). Shown in Figure 16 is the graph of the cumulative departure from normal precipitation at Sedgwick since December 31, 1937, calculated from December 31, 1926. The 10 wells numbered above are measured monthly and were referred to an arbitrary datum and given a stage of 10 feet above this datum on December 1, 1938. The 10 wells were chosen primarily for their length

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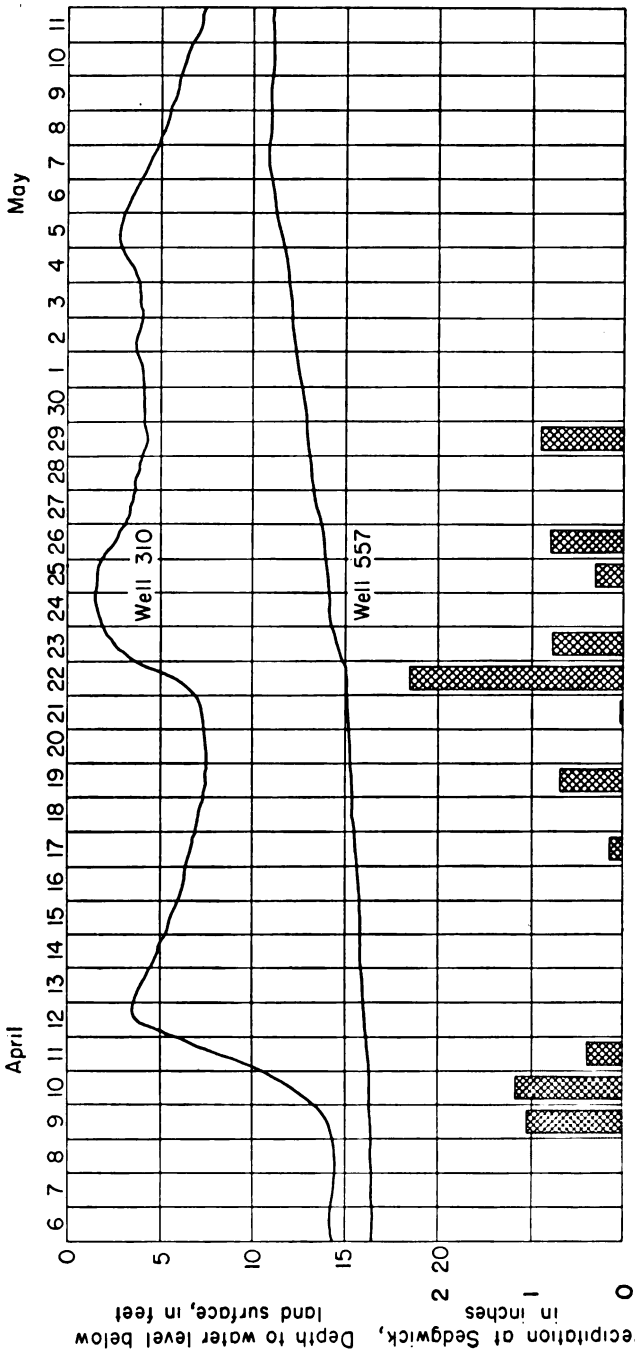

FIG. 17. Hydrographs showing the fluctuations of water level in wells 310 and 557 during parts of April and May 1944, and daily precipitation at Sedgwick during the same period.

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of record, freedom from observable effects from pumping, and geographic location with reference to the new Wichita well field. These wells are believed to represent nearly average nonpumping hydrologic conditions in the well-field area.

A tendency toward a rather close correlation between the hydrographs and the curve showing cumulative departure from normal precipitation is observable in Figure 16. There are some lags observable in the hydrographs as compared to the rainfall curve and the magnitude of the rises and declines seemingly is not constant in the two curves; however, the trends are comparable. The curves are nearly the same through the years 1938 to 1942 inclusive. Near the end of 1942 water levels had reached the highest stages recorded in response to above-normal precipitation in 1941 and 1942. During 1943 precipitation was approximately normal, but was not great enough to maintain water levels at the high stages attained previously and the graphs show that ground-water discharge exceeded ground-water recharge. In 1944 precipitation at Sedgwick was 144 percent of normal. In April 1944 a flood inundated the entire flood plain upon which well 557 is located. The water levels again rose, reaching record high stages in May; indeed, water levels in some wells were near the maximum possible stage. During the last part of 1944 discharge again exceeded recharge, and, although precipitation was greater than normal during this period, it was not great enough to maintain the exceptionally high stages attained in May.

The hydrographs of wells 310 and 557 shown on Figure 17 illustrate the differences in fluctuation of water levels that may be exhibited by different wells in the same general area during the same period. Well 310 (Pl. 5) is situated near the edge of the flood plain of Little Arkansas River. Well 557 is similarly located on the flood plain of Little Arkansas River. Peaks of the spring floods of 1944 occurred on April 12 and 23 and on May 4. The hydrograph of well 557 shows the rise in water level following excessive precipitation in April 1944. The rise in water level in response to precipitation was nearly steady in well 557 in contrast to the several fluctuations of the water level shown by the hydrograph for well 310. It is believed that the character of the material at and near the surface at well 557 inhibits rapid infiltration and thus retards the rate of recharge and prolongs the effect of recharge. The net change in water level from April 6 to May 6 was about 10 feet in well 310 and about 5 feet in well 557. From May 6 to 11 the water level declined in well 310, whereas it remained nearly constant in well 557.

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The alluvium and McPherson formation underlying the Arkansas River Valley were deposited by streams and the materials penetrated by wells are stratified, silt and clay being interbedded with or occurring as lenses in much more permeable sand and gravel. In

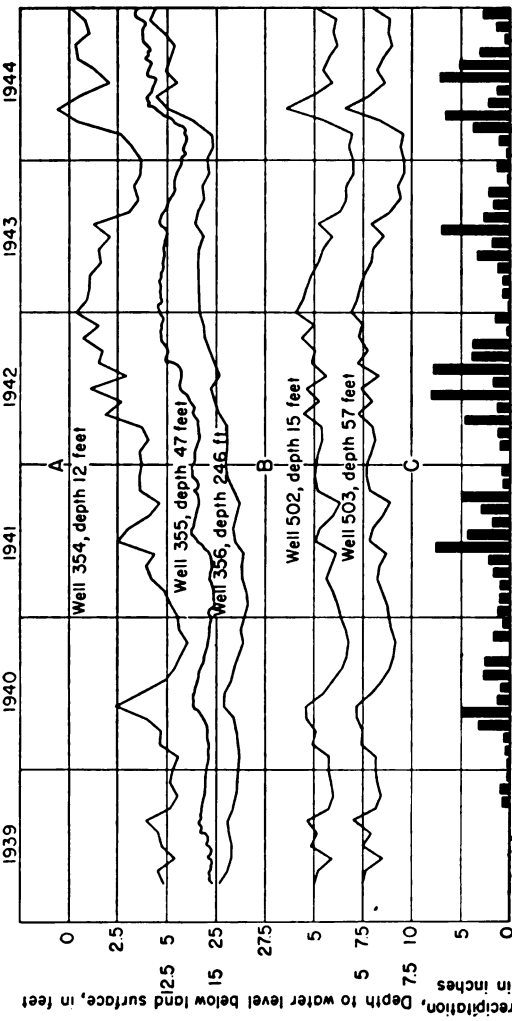

FIG. 18. Hydrographs showing the fluctuations of the water levels in (A) three wells cased to different depths at the same location and (B) in two wells cased to different depths at another location. (C) Monthly precipitation at U. S. G. S. rain gage at Burrton.

order to observe differences in water-level fluctuations, if any, due to stratification, two or more wells were constructed at the same location within a few inches of each other but were cased to different depths. Water levels in wells thus grouped have been gaged periodically at several places in the Arkansas River Valley since 1939.

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Depth of casing at each location was determined by the position of beds or lenses of silt and clay with respect to coarser material observed in drilling.

The hydrographs of two groups of wells drilled to different depths at each location are shown on Figure 18. Wells 354, 355, and 356 are 1 mile north of Burrton (Pl. 5); well 355 is equipped with an automatic water-stage recorder. The log of the test hole drilled at this location is given at the end of this report and indicates the kinds of material penetrated. The hydrograph of well 354 shows fluctuations of water level of considerable magnitude during periods of increased precipitation, and in April and May 1944 the water level in this well was above land surface. The log indicates that the upper 5 feet of the material penetrated at this place consists of clay and silt. This layer produces an artesian condition in the underlying bed of sand and gravel when the water table is at high stages. Water was not standing at the surface of the ground during this period because the small amount of water seeping upward through the relatively impermeable clay was not in excess of the demands of evaporation and transpiration. The hydrographs of well 355 and 356 show the fluctuation of water levels following precipitation. The magnitude of the fluctuations in each of these two wells is nearly the same, although considerably less than in well 354. The depth to water level below land surface is different in all three wells. At the beginning of the records, the water level was about 5 feet below land surface in well 354, about 15 feet in well 355, and about 25 feet in well 356. These differences show that the clay and silt layers intervening between the three well screens are sufficiently impermeable to produce and maintain different hydrostatic heads in each layer of gravel penetrated. The proximity of the sand dunes to this location, an area receiving much recharge, probably accounts for the upper zone of saturation and for the fluctuations in well 354 following rainfall. The smoother hydrographs for wells 355 and 356 indicate that recharge occurs more slowly, probably from a greater distance. The fact that the hydrographs of these two wells show fluctuations of similar magnitude during the same periods indicates that the area of recharge probably is nearly the same for the two permeable intervals and that the intervening impermeable layer is continuous laterally for a distance sufficient to produce differences in water level, but that the permeable zones become coextensive near the area of recharge.

The hydrographs of wells 502 and 503 are shown on Figure 18B.

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These wells are situated about 4 miles southeast of Burrton (Pl. 5) and are cased to different depths, conditions of location and construction being similar to those described above. The beds of sand and gravel with which these wells communicate are separated by

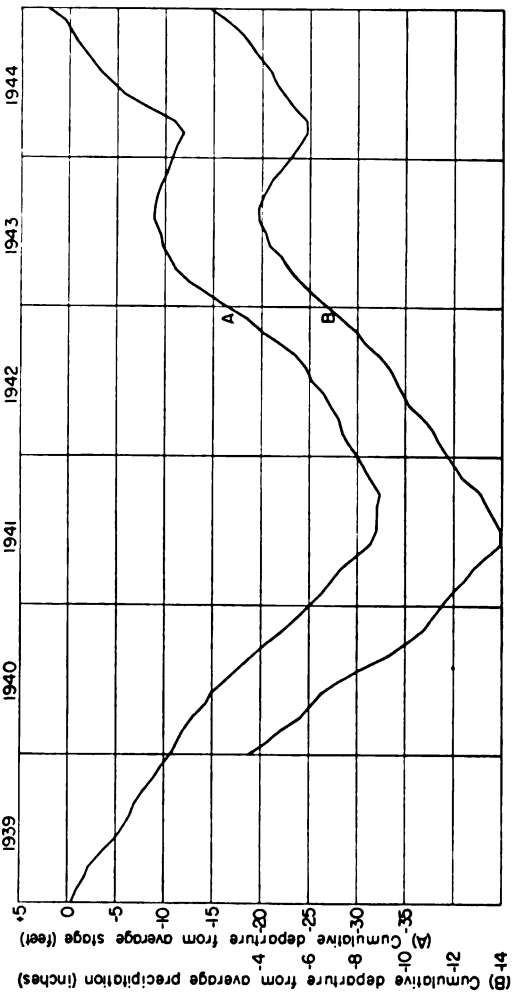

FIG. 19. Graphs showing (A) cumulative departure from 6-year average monthly water-level stage in 10 wells not affected by pumping; and (B) progressive monthly average of the cumulative departure from 6-year average monthly precipitation at Sedgwick.

about 9 feet of silt, sandy silt, and clay. In contrast to the observations made above concerning hydrologic conditions at wells 354, 355, and 356, water levels in wells 502 and 503 are the same depth below land surface and fluctuate as one in response to rainfall and drought. The layers of low permeability which occur between beds of sand and gravel at this location seemingly are not extensive laterally and

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do not cause any of the differences noted in the first group of wells.

The graphs presented above showing fluctuations in water level and departures from normal precipitation show that, in general, a relationship exists between the two phenomena. Further analysis of some of the data presented on Figure 19 is shown on Figure 20. The average monthly water-level stages in 10 wells in the new Wichita well-field area, described above, were averaged for each of the 12 months and the monthly departure from the 6-year monthly average thus obtained is shown in Figure 19A. Precipitation data, compiled by the United States Weather Bureau for the station at Sedgwick, were used in preparation of graph B. An average of the monthly precipitation during the same 6-year period as shown in Figure 19A was calculated, and the progressive monthly average of the cumulative departure from this 6-year average is shown on Figure 19B. This method of analysis eliminates effects of seasonal and other periodic variations in precipitation and illustrates the progressive and continuing correlation between variations in amount of precipitation and fluctuations in ground-water level.

Quantitative estimate of recharge.—In an attempt to evaluate quantitatively the effect of precipitation on ground-water level

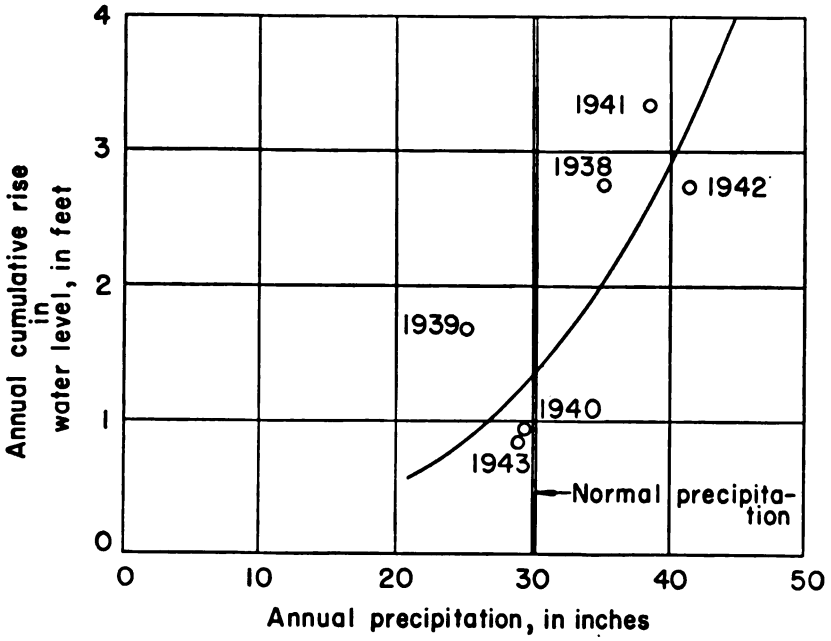

FIG. 20. Graph showing the relationship between annual cumulative rise in water level in well 557 and annual precipitation at Sedgwick.

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shown above, the continuous water-level record for well 557 (Fig. 16) was analyzed and the annual cumulative rise in water level was determined. Well 557 was chosen for this purpose because the fluctuations in water level in it are similar to the average of the fluctuations in the 10 wells shown on Figure 16, and because it is equipped with an automatic water-stage recorder. The graph of annual cumulative rise in water level in this well plotted against annual precipitation is shown on Figure 20. Annual cumulative rise in water level is the sum of the rises in water level during each year. When ground-water levels rise following precipitation, recharge during that period exceeds discharge, but the rise is not a measure of the total amount of recharge because discharge proceeds concurrently with recharge.

The specific yield of the water-bearing material in the vicinity of the new Wichita well field is believed to be about 25 percent. If this value is nearly correct, a rise of water level of 1 foot in a well represents a net addition of 3 inches of water to the underground reservoir. Analysis of net recharge as computed from the record of water-level fluctuations in well 557 in relation to precipitation is given in Table 12. Calculation of the values given in column 6 indicates that the quantity of precipitation which is measurable as net recharge has averaged about 20 percent during the period of record. The similarity between the hydrographs for well 557 and for the average of the water levels in 10 wells shown on Figure 16 indicates that the

TABLE 12.—*Relation of cumulative rise in water level in well 557 to annual precipitation at Sedgwick*

YEAR	Annual precipitation (inches)	Annual cumulative rise in water level		Cumulative annual precipitation (inches)	Accumulated cumulative rise in water level	
		Inches of water	Percentage of annual precipitation		Inches of water	Percentage of cumulative precipitation
	(1)	(2)	(3)	(4)	(5)	(6)
1938	35.42	8.25	23.3	35.42	8.25	23.3
1939	25.16	5.10	20.3	60.58	13.35	22.0
1940	29.55	2.82	9.6	90.13	16.17	18.0
1941	38.71	10.05	26.0	128.84	26.22	20.4
1942	41.45	8.25	19.9	170.29	34.47	20.2
1943	29.05	2.58	8.9	199.33	37.05	18.6

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values presented in Table 12 are applicable to the part of the Wichita well-field area not affected by pumping.

It is estimated, on the basis of the data in Table 12, that the average annual net recharge in the Arkansas River Valley in this area during the period of record was equivalent to about 20 percent of the precipitation, although this percentage may have differed considerably locally. As the average precipitation at Sedgwick was nearly 35 inches during the period, or about 5 inches more than normal, the amount of water represented by the average annual cumulative rise in water level was nearly 7 inches, or about 365 acre-feet per year per square mile, or about 31,000 acre-feet per year in the 85 square-mile well-field area. This is a minimum figure because it does not take into account the ground-water discharge that was taking place at the same time that the rises in the water level were occurring.

Assuming that the figure of 20 percent of the precipitation holds during years of normal precipitation, the recharge in such years would be equivalent to about 6 inches of water, or 320 acre-feet per year per square mile, or about 27,000 acre-feet per year in the well-field area. It is not certain that the proportion of the precipitation that reaches the water table is as great during years of average precipitation as that during the period of record; in fact, the proportion is likely to be less—perhaps substantially less. However, because the actual recharge during the period of record, including that represented by discharge which took place while the rises in water level were occurring, probably was substantially greater than 20 percent of the precipitation during that period, it is believed that 20 percent of the normal precipitation is a reasonably conservative value.

C. V. Theis and C. E. Jacob, of the United States Geological Survey, have discussed with the authors some of the sources of error inherent in the methods of analysis outlined above. Theis* has noted that caution is advisable in ascribing rise and fall of the water table as measured in wells to ground-water recharge and discharge until the mechanics of the capillary fringe have been studied further. However, it is believed that inaccuracies of interpretation of water-level fluctuations caused by imperfect knowledge of capillary phenomena probably are minor when records of sufficient length and continuity are considered. Many of the graphs presented, especially those in Figure 19, seem to substantiate this belief.

* Personal communication, dated November 16, 1944.

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RECHARGE FROM STREAMS

Little Arkansas, Smoky Hill, and Ninnescah Rivers, and most of the creeks and small tributaries in this area are gaining streams at normal stages, receiving water from the underground reservoir. Arkansas River is nearly in equilibrium with the ground-water body at normal stages, neither receiving water from nor contributing to it. The gradient of Arkansas River is nearly the same and is in the same direction as the slope of the water table (Pl. 1).

During periods of high water when the streams run bank-full or occupy the flood plains, some of the water flowing at the surface seeps downward to the ground-water reservoir. When flood flow diminishes and streams resume their normal stages, the ground water temporarily stored in the alluvium is discharged slowly until ground-water levels again approach the normal stage. The quantity of water thus added temporarily to the ground-water reservoir each year is difficult to estimate, and such estimation has not been attempted in this study. Under natural conditions the temporary nature of recharge from flood water renders its estimation profitless, but in an area where a large quantity of water has been withdrawn from alluvium near a stream, and the withdrawal has resulted in greatly lowered ground-water level, knowledge of the amount of water salvageable from flood flow would be beneficial.

Arkansas River, having nearly the same elevation as the water table in the adjacent alluvium, probably contributed water to the old Wichita well field, especially during periods when the rate of withdrawal was large. The hydrograph of well 674 (Fig. 21) shows that ground-water recharge from Arkansas River is possible and has occurred in the vicinity of the old Wichita well field. An ice jam became effective as a dam in the channel of Arkansas River about

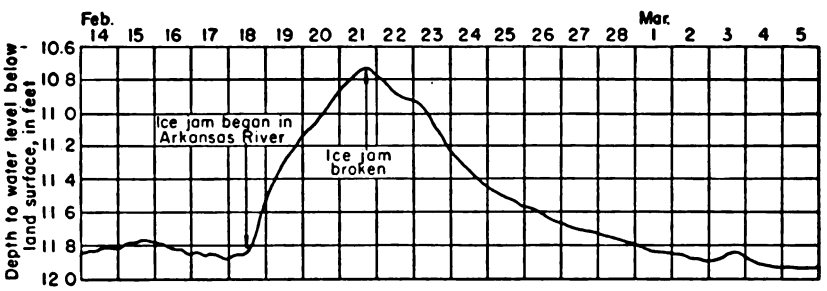

FIG. 21. Hydrograph of well 674 for parts of February and March 1942, showing the effect of an ice jam in the Arkansas River on the ground-water level near by.

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February 16, 1942. The effect of the resulting high stage in the river became noticeable at recorder well 674 on February 18 and continued until the ice jam was destroyed on February 21. By March 2 the water level in well 674 was at normal stage again. Prior to September 1, 1940 the water level in well 674 was 10 feet or more lower than in February 1942, owing to pumping of city wells near by. At that time the gradient from the river to the wells probably was greater than the gradient at the time of the ice jam, and part of the surface flow of the river probably was diverted to the aquifer in the vicinity of the pumping wells.

The aquifer in the new Wichita well field is not receiving water from the flow of Little Arkansas River, although, as noted below, pumping may have decreased ground-water discharge at low river stages along part of the course of this stream. Withdrawal of water from the Newton city supply wells (wells 290-294 inclusive) may have resulted in recharge to the aquifer from the surface flow of Emma Creek during parts of each year, but no substantiating data are at hand. Part of the small seasonal flow of Kisiwa Creek, an intermittent stream throughout most of its course, probably contributes to the ground-water reservoir in the new Wichita well-field area.

INFLOW FROM ADJACENT AREAS

Ground water moving from one area to another in the direction of the slope of the water table is sometimes referred to as inflow. The water-table contours shown on Plate 1 indicate that ground water derived from rainfall on some adjacent areas moves laterally into this area.

North of Smoky Hill River ground water moves southward into McPherson County toward the river where it is discharged. Rain falling on southern Saline County seeps downward into Cretaceous sandstones and then moves laterally into the thin alluvial material above the Permian shale a short distance north of Smoky Hill River, but much of this ground water is lost in transit before reaching the alluvium of Smoky Hill River. Ground water derived from rainfall on a small area in northeastern Rice County moves eastward into McPherson County north of United States Highway 50N through Cretaceous rocks and weathered material above them. The quantity of this water is small and much is lost through transpiration and evaporation before reaching the channel deposits of the McPherson formation. Similarly, ground water moves westward into this area from parts of Marion and Harvey Counties west of the

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Arkansas-Walnut drainage divide, but the quantity is small owing to the character of the material through which it moves.

Percolation of water through the terrace deposits and alluvium along Arkansas River west and northwest of Hutchinson contributes to the supply of ground water in this area. Rain falling on the sand dunes that extend northwestward from Hutchinson into Rice County seeps downward to the water table and part of this water migrates southeastward into the Arkansas Valley. Similarly, part of the rain falling in the Arkansas Valley west of Hutchinson moves down the valley southeastward and becomes part of the ground water moving through deposits in this area.

The quantity of ground water derived from lateral flow into this area is not known, but it is small in comparison to the quantity derived from precipitation falling directly on the area.

Ground-water Discharge

When water derived from precipitation or other sources reaches the zone of saturation in the ways described above, it moves in the direction of the slope of the water table according to the conditions existing at the point of recharge; the water remains a part of the ground-water body until removed or discharged by some natural or artificial means. Water may be removed from the aquifer by evaporation, by transpiration, by seepage into streams, by discharge from springs, or by pumping from wells. These methods of discharge operate singly or in combination in all parts of this area. Over a period of years the quantity of ground-water discharge is approximately equal to the quantity of recharge.

Discharge by transpiration and evaporation.—Water may be taken into the roots of plants directly from the zone of saturation, or from the capillary fringe above it, and discharged from the plants by the process known as transpiration. The depth from which plants will lift ground water varies with different plant species and different types of soil. The limit of lift by ordinary grasses and cultivated plants is not more than a few feet; however, alfalfa and certain types of desert plants have been known to extend their roots to depths of 60 feet or more to reach the water table (Meinzer, 1923, p. 82).

In this area the significant discharge of ground water by evaporation and transpiration occurs in the sub-areas in which the depth to water is less than 20 feet. These sub-areas (shown on Pl. 5) comprise a large part of the total area mapped. Ground water is discharged by evaporation and transpiration in the Smoky Hill River

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Valley; along Sharps Creek; in an area comprising about 100 square miles between Moundridge and Canton; in a narrow irregular area including many water-filled sink holes from Groveland south to Little Arkansas River; in the sand-hills area; and in much of the Arkansas River Valley, especially from Kisiwa Creek to the southwestern edge of the alluvium of Arkansas River. A large quantity of ground water is evaporated and transpired along the course of Big Slough south of Arkansas River.

No attempt has been made to estimate the quantity of ground water discharged by evaporation and transpiration, but it is believed that the quantity discharged through transpiration is larger than that discharged through any other means. Study of the several hydrographs showing fluctuations of water levels in wells presented above indicates that the quantity of ground-water discharge is approximately equal to the quantity of recharge over a complete climatic cycle, although records of most wells show that recharge has exceeded discharge for the period of record from 1938 through 1944. In general natural discharge occurs at a rate slower than recharge but it occurs over longer periods of time, especially in areas where the depth to water level is comparatively small.

Seepage into streams.—Stream flow at low stages in Arkansas, Little Arkansas and Smoky Hill Rivers, and the numerous small tributaries is maintained by ground-water discharge. Discharge into these streams occurs mainly through seeps along the stream channels and accounts for the moist banks commonly observable. Trees and other vegetation along the stream courses intercept much of the water that otherwise would be discharged into the streams. Indeed, the availability of ground water at shallow depth is the factor which sustains perennially the dense vegetal cover near these streams. Whenever the supply of ground water is greater than the amount required by plants along the stream courses, the excess contributes to the flow of the streams.

Discharge from springs.—There is no sharp distinction between seeps and springs, but some ground water is discharged through openings properly classed as springs in the area underlain by Cretaceous sandstone (Pl. 1). In 1944 many small springs were observed issuing from the base of the sandstone where it rests on relatively impermeable shale (Pl. 13B). Most of these springs are seasonal and cease to flow in late summer or fall. Some small springs are used to supply water to stock ponds, whereas others enter small streams through tributary gullies and part of the flow may reach

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Smoky Hill River or Gypsum Creek. Seeps and moist areas are observable in some places where the contact between the sandstone and shale is covered by rock material in transit down slope. Most of the ground water discharged at these places is evaporated or supports a luxuriant growth of water-loving grasses.

In the southeastern part of the area, north and east of Wichita, a few small springs occur at the contact of thin deposits of the McPherson formation with the Wellington shale at places where the land surface intersects this contact. Water from one such spring in sec. 27, T. 25 S., R. 1 E. has been bottled and sold commercially. The quantity of ground water discharged through springs in this area is very small in comparison to the total quantity discharged.

Discharge from wells.—Water is pumped for municipal, industrial, stock, domestic, and irrigation uses, listed in order of quantity pumped. The sub-areas in which largest withdrawals of ground water occur are the new Wichita municipal well-field area, situated west and south of Halstead, which supplies water to the residents and industries in and near Wichita; the business and industrial districts of Wichita and Hutchinson, where large quantities of ground water are used for cooling and air conditioning; the Newton well-field area, 2 miles east of Halstead, which supplies municipal and industrial needs at Newton; and the McPherson area, in which are located city and industrial wells. Ground water is pumped to supply most of the smaller cities in this area, but the quantity consumed is not great at any one place. Most of the farms are supplied with water from wells, but the quantity pumped at each farm for domestic and stock use is small; however, the aggregate quantity pumped from wells at farms in the whole of this area is considerable. There are few irrigation wells in this area. The quantity of water pumped for each of these uses, insofar as known, is presented in the section on water utilization.

Fluctuations in water level caused by pumping.—As soon as a pump begins discharging water from a well under water-table conditions, the ground-water level is lowered, thus establishing a hydraulic gradient toward the well. The water table soon assumes a form comparable to that of an inverted cone, the well being at the apex. For a short time most of the water that is pumped from a well is derived by unwatering materials close to it. As pumping is continued, more of the formation is gradually unwatered and a gradient is established sufficient that there may be transmitted to the well approximately the amount of water that is being pumped,

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most of the water being derived from ever increasing distances from the well. Thus, the cone of depression continues to expand and the water table within the cone continues to decline gradually. The development of the cone of depression may be halted if water is added to the formation by natural or artificial recharge.

After the discharge of a well has ceased, water continues to percolate toward the well for a time because the hydraulic gradient is still in that direction, but instead of being discharged at the surface the water refills the well and the adjacent material that was unwatered by pumping. As the formation near the well is refilled, the hydraulic gradient is gradually decreased and the recovery of the water level in the well becomes progressively slower. At a considerable distance from the well, the water level may continue to lower for a time after pumping has been stopped because water continues to move toward the well. In time there is a general equalization of water levels over the entire area affected, and the water table tends to assume its original form, although it may remain temporarily somewhat lower than before water was withdrawn.

In general, the hydrologic conditions near a group of pumping wells are comparable to the conditions for a single well discussed above. Pumping in the old Wichita well field affected water levels in the area bounded by the Arkansas and Little Arkansas Rivers. The pumping since September 1, 1940 from 25 wells in the new Wichita well field has affected water levels beneath a large area in and around the well field. The area affected by pumping a single well or a group of wells is herein referred to as the area of influence.

The effect of pumping on ground-water levels in the old Wichita well field is illustrated by the hydrograph of well 674, Figure 22. From January 1, 1938 to September 1, 1940 the depth to water level in well 674 averaged about 20 feet below land surface and the fluctuations caused by pumping and precipitation were mingled. When pumping ceased in this well field on August 31, 1940 the water level rose rapidly for a short time and continued to rise until a stage about 10 feet above the average pumping stage had been reached. Recharge from precipitation produced rises in water level, particularly in 1941, 1942, and 1944, as shown on the graph. In 1942, 1943, and 1944 the wells in the old well field were pumped for brief periods because of mechanical failure of the new facilities or because of short-time demands for excessive quantities of water. The effects of pumping in the old well field during these periods are shown on Figure 22.

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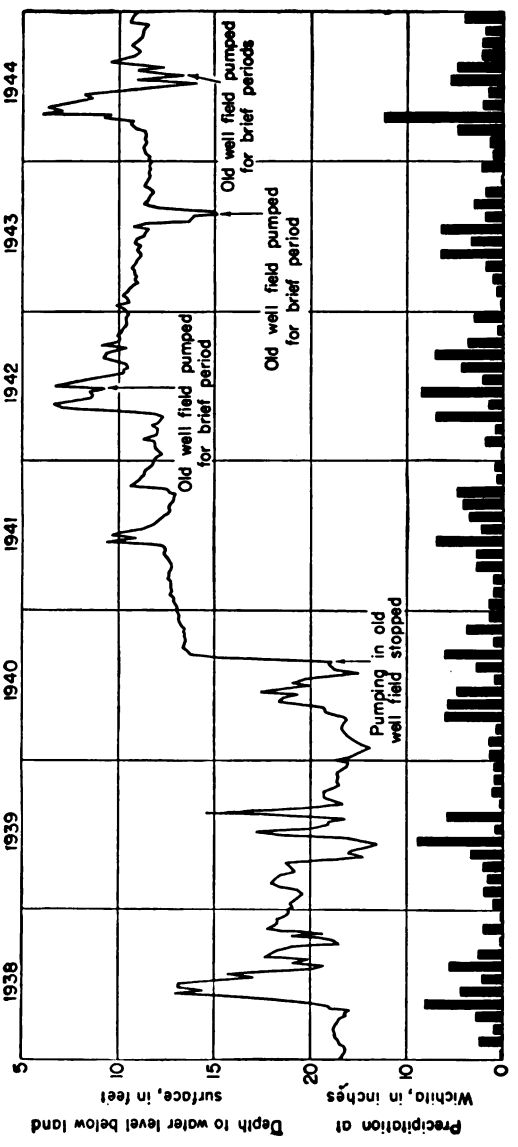

FIG. 22. Hydrograph showing the fluctuations of water level in well 674 in the old Wichita well field, and the monthly precipitation at Wichita.

Fluctuations in water level in well 674 caused by pumping wells 672 and 673 in the old Wichita well field are shown by the hydrograph on Figure 23, which were taken from automatic recorder charts. Although pumping from most of the wells in the old Wichita well field affects the water level in well 674, the greatest

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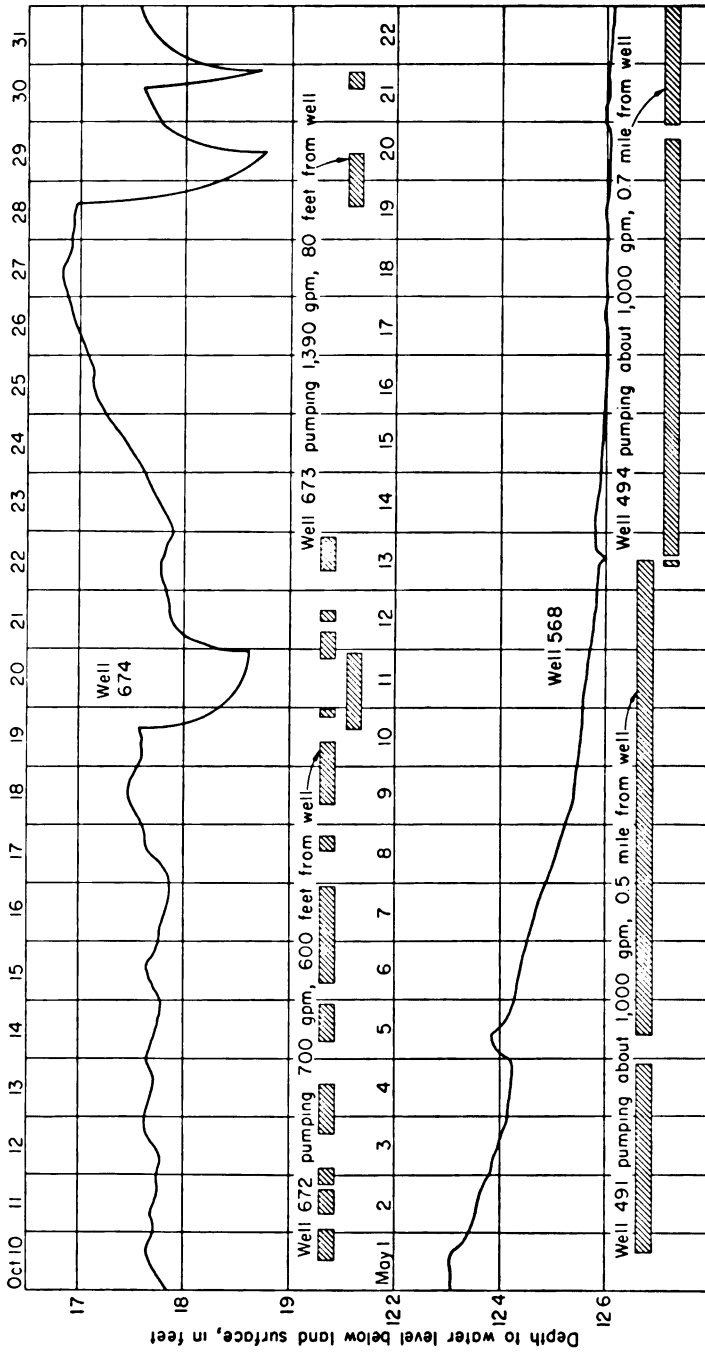

FIG. 23. Hydrographs showing fluctuations of water level in well 674 caused by pumping wells 672 and 673 in October 1937, and in well 568 caused by pumping wells 491 and 494 in May 1941.

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fluctuations are caused by wells 672 and 673 which are located only 600 feet and 80 feet respectively from well 674 and were pumped at the rates of about 700 and 1,300 gallons a minute. The hydrograph shows this greater effect of the near-by wells superimposed upon the lowered water level caused by pumping all the wells in the well field. Examination of the hydrograph shows that pumping from well 673 causes a greater lowering of the water level in well 674 than does pumping from well 672, because well 673 is much closer to the observation well and it is pumped at a greater rate. Water levels continue to decline in observation wells some distance from pumped wells for varying periods of time after pumping ceases. Comparison of the hydrograph of well 674 with the bars designating the periods of pumping at wells 672 and 673 shows that the periods of water-level decline in the observation well extend beyond the pumping periods and that recovery begins a few hours later.

The new Wichita well field (Pl. 28) supplies the largest quantity of water discharged from any one of the sub-areas mentioned above. The quantity pumped during the period from September 1, 1940 to January 1, 1945 was 23,284 million gallons, an average of 448 million gallons a month or about 15 million gallons a day. The quantity of water pumped has ranged from 248 million gallons in February 1941 to 653 million gallons in July 1943 and August 1944. The quantity of water pumped monthly is given in the section on public supplies. Hydrographs showing the fluctuations caused by pumping and by natural processes, together with graphs showing the quantity of water pumped from the city wells and the precipitation at Sedgwick are presented in Figure 24. Well 448 is situated near the center of the well field and is affected by the pumping of several near-by wells; well 568 is about half a mile south of the south end of the well field and is affected only by the pumping of wells 491 and 494. Six wells, including the two above (Nos. 327, 414, 448, 470, 486, and 568), which are located an average of about half a mile from pumped wells and hence are affected by pumping, were selected for study and the hydrograph of the average monthly water level in these wells is shown on Figure 24. From September 1, 1940 to January 1, 1945 the water level in well 448 declined 7.99 feet, the average water level in 6 wells affected by pumping declined 6.02 feet, and the water level in well 568 declined 2.36 feet as the result of pumping from the city wells. The effect of recharge on the water levels in these wells seems to have been masked except in well 568, where the effect of pumping has been less than that of

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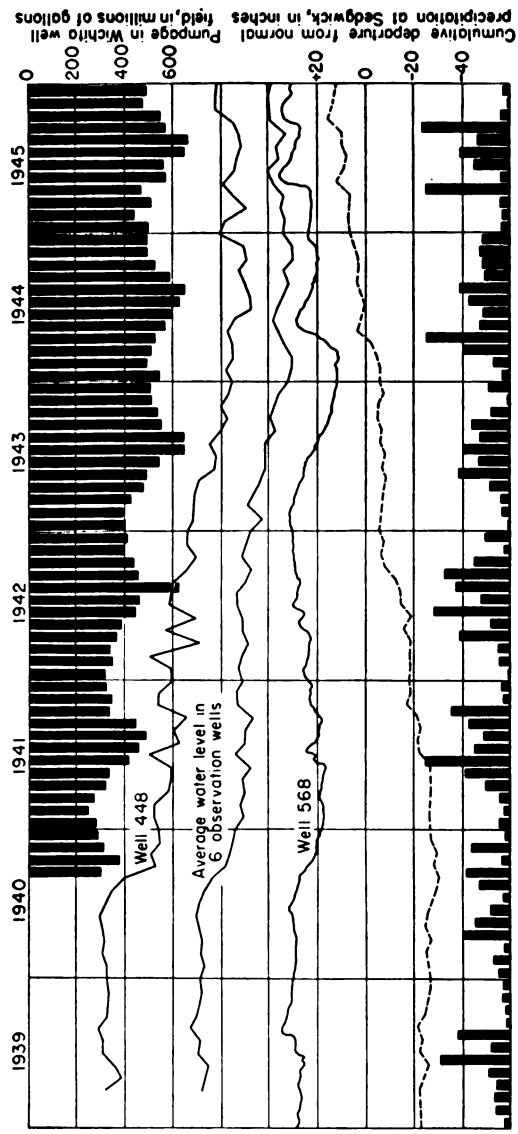

FIG 24. Hydrographs showing the fluctuations of the water levels in wells in the new Wichita well-field area, pumpage from the new Wichita well field, monthly precipitation at Sedgwick, and cumulative departure from normal precipitation at Sedgwick.

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recharge, especially in 1942 and 1944. Figure 23 shows that pumping from either or both of wells 491 and 494 lowers the water level in the observation well (568), although the amount of lowering is small owing to the distance from the points of withdrawal.

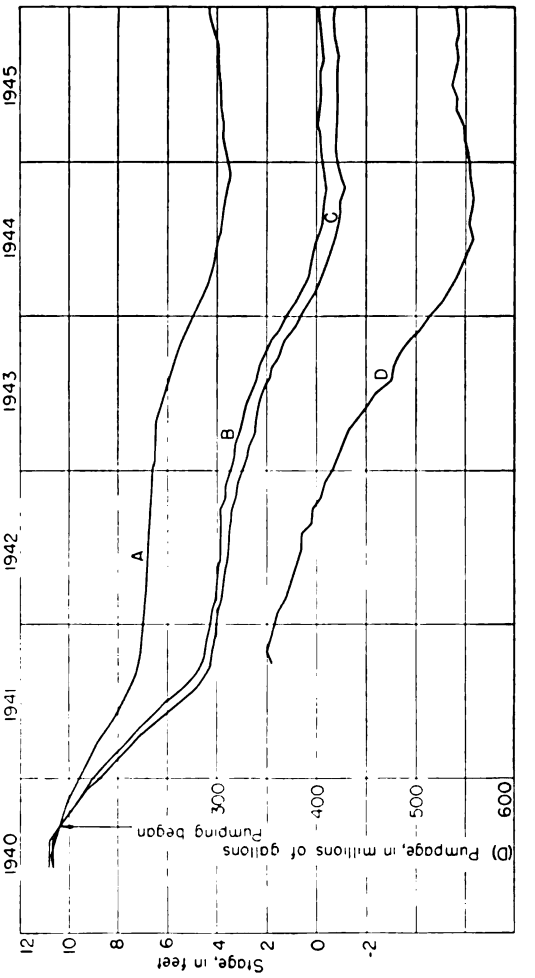

FIG. 25. Graphs showing one-year progressive averages of: (A) the average monthly stage of water levels in 6 observation wells located approximately one-half mile from supply wells; (B) the average monthly stage of water levels in 25 wells, each located 500 feet from supply wells; (C) average monthly stage of water levels in 25 wells located 100 feet from supply wells; and (D) monthly pumpage from 25 wells in the new Wichita well field.

At the time the 25 new Wichita city-supply wells were constructed, observation wells were drilled 100 feet and 500 feet from each well. These observation wells have been measured at regular intervals since construction. The effects of pumping from the supply wells on the water level in these observation wells and on

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the water level in the 6 observation wells referred to above are shown on Figure 25, together with the monthly pumpage from the supply wells. The water levels in all of the observation wells were assigned a stage of 10 feet above an arbitrary datum on June 1, 1939. The average monthly water level in 6 comparable observation wells located about half a mile from the pumped wells, in the 25 wells located 100 feet from the pumped wells, and in the 25 wells located 500 feet from the pumped wells was computed for each of these three groups of wells, and a progressive average of average monthly water level was calculated for each group, based on the year June 1, 1939 through May 30, 1940. Similarly, a graph of the progressive average of the quantity of water pumped each month from the city supply wells was prepared, based on the year September 1, 1940 through August 31, 1941, the first year of pumping. The use of progressive averages results in smoother curves than those from data plotted directly and trends of water levels and pumpage are more readily discernible. An interesting fact shown by the similar curves is that as the rate of pumping increased, the average water level in all of the wells declined and that this decline ceased toward the end of 1944 when the pumping rate became nearly constant. The graphs indicate that water levels in wells 100 feet, 500 feet, and half a mile from the pumped wells probably will remain near the average levels attained at the end of 1944 if the rate of pumping remains nearly uniform and if comparable amounts of recharge are received.

The effects of pumping on water levels shown on graphs above are superimposed upon natural fluctuations of water level caused by excess or deficient precipitation. In order to determine more nearly the effect of pumping alone, the difference between the average water level in 10 wells not affected by pumping and the average water level in 6 wells affected by pumping was calculated, and this difference in average monthly stage was plotted against cumulative pumpage from the Wichita city water-supply wells. The graph of the curve so obtained is shown on Figure 26. The 10 wells not affected by pumping are discussed above in the section concerning recharge and the 6 wells affected by pumping are discussed above in this section. All of the wells are in the new Wichita well-field area. The curve in Figure 26 shows the greater rate of lowering of water levels during the first year of pumping than in succeeding years, the nearly stabilized condition of the water levels at the end of the third year of pumping, the increase in rate of pumping in 1943 and

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1944, the readjustment of water levels to the increased rate of pumping in 1944, and the seeming restabilization of water levels at the end of 1944.

A study of the effect of pumping from the new Wichita well field on water levels in the area of pumping influence has been made and additional maps and data are presented in the section relating to the perennial yield of the aquifer.

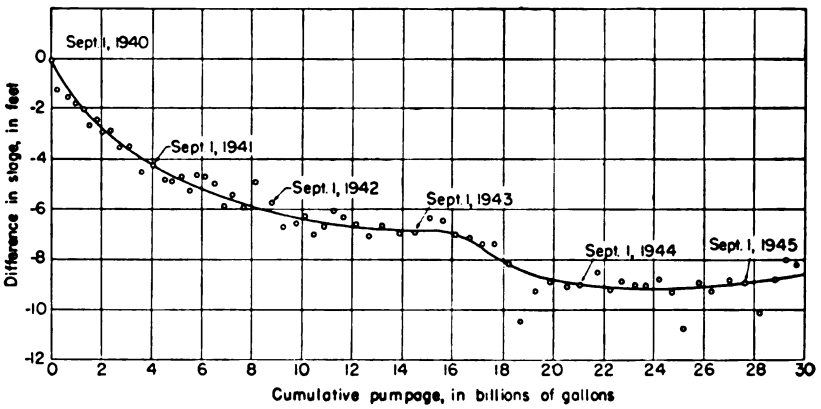

FIG. 26. Graph showing the relationship between the difference in average water levels in 10 wells not affected by pumping and 6 wells affected by pumping, and cumulative pumpage from the Wichita city water-supply wells.

RECOVERY OF GROUND WATER

SPRINGS

Improvements have been made at a few of the springs in the area underlain by Cretaceous sandstone (Pl. 1), and some of the springs are used to supply water to stock ponds. A few small springs, some of which have been developed, occur north of Wichita. Most of the springs in this area are undeveloped and a comparatively small quantity of ground water is recovered from them.

WELLS

Dug wells

Dug wells are excavated by picks and shovels or by power machinery. They are generally between 2 and 10 feet in diameter and comparatively shallow. Many of the earlier wells in this area were dug by hand, but most of these have since been replaced by drilled wells. At present there are some dug wells in the areas underlain by Permian and Cretaceous rocks. Many of the farm wells in the

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McPherson formation are dug for part of their total depth and small diameter pipes and sand points are driven below the water table.

The dug wells in this area are curbed with stone or timber. They generally are poorly sealed and may be contaminated by the entrance of surface waters. Because of the difficulties of digging by hand below the water table, dug wells generally are excavated only a few feet below the water table and are, therefore, more likely to fail during a drought than are drilled wells, which generally extend many feet below the water table.

Driven wells

Many wells in this area are driven, especially in the alluvium of Arkansas and Little Arkansas Rivers. This type of well is made by driving a small-diameter pipe (equipped at the bottom with a screened drive point) down below the water table. Such wells can be put down only where the water-bearing material is sufficiently permeable to permit water to flow freely into the screened drive point, where the material is soft enough, and where the water table is shallow. Generally a hole is augered by hand as deep as possible, then the pipe and screened drive point are put in and driven into the water-bearing material. Most driven wells are equipped either with hand-operated pitcher pumps or with windmills and submerged cylinders, and are used for domestic and stock purposes.

Drilled wells

Many of the domestic and stock wells and most of the public-supply, industrial, and irrigation wells in this area are drilled wells. Most of the smaller wells were drilled by means of portable cable-tool or hydraulic-rotary drilling machines. Most of the larger municipal and industrial wells were drilled by means of an orange peel bucket (Pl. 26B) and are known as caisson wells. A few of these wells, however, were drilled by the hydraulic rotary method. The drilled domestic and stock wells are 2 to 8 inches in diameter and those used for public supply and industrial purposes range from 8 to 50 inches. Drilled wells generally are cased with galvanized-iron, wrought-iron, or steel casing.

Construction of wells in consolidated rocks.—Many of the wells in the parts of the area underlain by Cretaceous rocks and Permian shale are drilled into consolidated rocks. Most of these wells are open-end wells; that is, the hole is cased through the overlying soil and several feet into the consolidated rocks, but the lower part of the hole is not cased. Holes drilled into consolidated rocks will as

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a rule stand open without casing, but it is sometimes necessary to extend the casing to the bottom of the hole to prevent the walls from caving. Small perforations generally are cut into the casing opposite the water-bearing beds in those wells that are cased from top to bottom.

Construction of wells in unconsolidated rocks.—Most of the drilled wells in this area obtain water from unconsolidated sand or gravel. It is necessary to case these wells the full depth of the hole in order to prevent caving of the wells. In some wells the casing is open only at the bottom, but in others the casing has been perforated in the lower part. Perforating the casing greatly increases the area of intake, and thus the specific capacity of the well is increased and the entrance velocity of the water is reduced. Well screens are used in some wells to prevent fine sand from entering the well and to increase the intake area.

Most of the municipal and industrial wells in this area are constructed by excavating a hole of large diameter and sinking a blank temporary casing as the unconsolidated material is removed. When the excavation is completed a well screen or perforated casing of smaller diameter than the hole is then lowered into place and centered opposite the water-bearing beds. Blank casing extends from the screen to the surface. The annular space between the inner and outer casings then is filled with carefully sorted gravel—preferably of a grain size slightly larger than the openings in the screen or perforated casing, and also just slightly larger than that of the water-bearing material. The outer casing is then withdrawn from the hole, except in the upper part for sanitary reasons, and ground water enters the well through the gravel packing.

The logs of some of the test holes drilled during the investigation reveal that in some places the water-bearing materials are sufficiently coarse and well sorted that large yields may be obtained without gravel packing. In such places less expensive wells employing well screens or slotted casings, but without gravel packing, are satisfactory. In places where the water-bearing materials are fine-grained or poorly sorted, however, the gravel-packed wells have several advantages that offset the greater initial cost. The envelope of selected gravel increases the effective diameter of the well, reduces the entrance velocity of the water, and increases the yield of sand-free water. The drawdown generally is less in gravel-packed wells and the cost of pumping is correspondingly less.

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A report (Davison, 1939) containing a description of different types of pumping plants, the conditions for which each is best suited, construction methods, and a discussion of construction costs is available from the division of water resources of the Kansas State Board of Agriculture. The reader is also referred to a report by Rohwer (1940) in which the various methods of constructing irrigation wells are described.

Methods of lift

Many of the domestic and stock wells in this area are equipped with lift or force pumps in which the cylinders are below the pump heads and may be far below the surface. Most of these pumps are operated by windmills. In parts of the area in which the depth to water is less than 15 feet, many wells are equipped with hand-operated pitcher pumps that have the working parts at the base of the pump heads.

Most of the large municipal and industrial wells are equipped with turbine pumps operated by electric motors. Some of the municipal wells are equipped with horizontal centrifugal pumps driven by electric or gasoline motors.

Quality of Water

The chemical character of the ground waters in this area is shown by analyses of 231 samples of water collected from test holes and wells. The results of the analyses are given in Table 13. Only partial analyses or chloride determinations were made of many samples collected from wells in the oil-field areas (Pl. 29). The analyses, which were made by R. H. Hess and others in the Water and Sewage laboratory of the Kansas State Board of Health and by Margaret D. Foster and others in the laboratory of the Quality of Water Division of the U. S. Geological Survey in Washington, show only the dissolved mineral content of the waters and do not indicate the sanitary condition of the waters. Total and excess alkalinities of waters for which analyses are given in Table 13 are listed in Table 14. The excess alkalinity is the amount of alkalinity equivalent to sodium and potassium as $CaCO_3$ and is computed by subtracting the equivalents of calcium and magnesium from the total alkalinity.

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TABLE 13.—*Analyses of water from wells in Harvey, McPherson, Reno and Sedgwick Counties, Kansas*

(Analyzed by Robert H. Hess, unless otherwise indicated by footnote in first column. Parts per million and equivalents per million[1] [in italics]).

Well No. (2)	LOCATION	Depth (feet)	Geologic subdivision	Date of collection	Temperature (°F)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness (calculated as $CaCO_3$)		
																		Total	Carbonate	Noncarbonate
(4) 4	*T. 17 S., R. 5 W.* SE NE sec. 17	73	Alluvium	Oct. 26, 1937	59	1.8	.....	135 *6.74*	29 *2.38*	61 *2.65*	9 *.23*	424 *6.95*	142 *2.96*	68 *1.92*	0.0	0.42 *.01*	706	456	348	108
A	SE NE sec. 17, and SE sec. 17	73, 96	Alluvium (composite sample from wells 4 and 5)	Sept. 11, 1939	.....	.26 *.01*	.....	141 *7.04*	28 *2.30*	64 *2.78*		448 *7.35*	139 *2.89*	65 *1.83*	.3 *.02*	4 *.06*	708	467	367	100
12	*T. 17 S., R. 4 W.* NW NW SE sec. 22	20	Ninnescah	Nov. 25, 1938	58	.0	.....	428 *21.36*	198 *16.28*	99 *4.31*		444 *7.28*	1386 *28.83*	106 *2.99*	....	177 *2.85*	2,616	1,882	364	1,512
19	SW SW sec. 32	50	Alluvium	do	58	.55	.....	95 *4.74*	29 *2.38*	43 *1.85*		393 *6.45*	103 *2.14*	11 *.31*	....	4.4 *.07*	483	358	322	36
(4a) 24	*T. 17 S., R. 5 W.* NE SE sec. 23	43	do	Jan., 1944	.....	.0	.....	147 *7.34*	29 *2.38*	38 *1.66*		378 *6.20*	114 *2.37*	46 *1.30*	.1 *.01*	93 *1.50*	709	486	310	176
33	*T. 18 S., R. 5 W.* SE cor. sec. 5	38	Wellington	do	58	.82	.....	320 *15.97*	122 *10.03*	170 *7.41*		239 *3.92*	37 *.77*	677 *19.09*	....	598 *9.63*	2,044	1,302	196	1,106
53	*T. 18 S., R. 4 W.* SW NW SW sec. 22	177	McPherson	do	58	20	.....	108 *5.39*	12 *.99*	35 *1.51*		378 *6.20*	42 *.87*	27 *.76*	....	3.3 *.06*	436	373	310	63
56	NE NE SE sec. 35	99	do	do	58	1	.....	94 *4.69*	7.6 *.63*	16 *.71*		320 *5.25*	13 *.27*	16 *.45*	....	3.3 *.06*	311	269	262	7
62	*T. 18 S., R. 5 W.* SE NE NE sec. 26	33	McPherson or Ninnescah	do	58	2.3	.....	93 *4.64*	17 *1.40*	45 *1.94*		329 *5.40*	19 *.40*	74 *2.09*	....	5.3 *.09*	420	308	270	38

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		T. 19 S., R. 1 W.																					
(4)	65	SE NE sec. 21.....	82	Kiowa and Delmore...	Oct. 26, 1937	58	.01	.....	97 *4.84*	13 *1.07*	31 *1.55*	2.6 *.07*	301 *4.93*	35 *.75*	39 *1.10*	.0	30 *.48*	440	296		246		
	B	SE NE sec. 21, NW SW sec. 22, and SW SW sec. 22	82, 82, 70	Kiowa and Delmore (composite sample from wells 65, 66, and 67)	July 17, 1939	.....	.0	.....	94 *4.69*	13 *1.07*	42 *1.84*		354 *5.81*	42 *.87*	23 *.65*	.1 *.01*	17 *.27*	445	288	(5)	288		
	C	do.....	82, 82, 70	do.....	Aug. 30, 1940	.....	.0	.....	90 *4.49*	13 *1.07*	52 *2.26*		381 *6.25*	49 *1.02*	17 *.48*	.3 *.02*	4.4 *.07*	468	278	(5)	278		
		T. 19 S., R. 2 W.																					
	74	NE SW SW sec. 22....	41	McPherson and Delmore	Aug. 27, 1940	.....	.49	.....	68 *3.39*	7.8 *.64*	20 *.89*		168 *2.76*	30 *.62*	30 *.85*	.2 *.01*	43 *.69*	375	202		138		
(4)	75	NW SE SW sec. 22....	35	McPherson and Delmore	Oct. 26, 1937	59	.01	.....	73 *3.64*	8 *.66*	20 *.87*	3.1 *.08*	261 *4.28*	14 *.29*	15 *.42*	.0	11 *.18*	290	215		214		
	D	NE SW SW sec. 22, NW, SE, SW sec. 22,	41, 35	McPherson and Delmore (composite sample from wells 74 and 75)	July 15, 1939	.....	.04	.....	61 *3.04*	7.4 *.61*	28 *1.22*		183 *3*	23 *.48*	24 *.68*	.2 *.01*	44 *.71*	301	183		150		
	E	SW SE SE sec. 22.....	.....	McPherson and Delmore	Dec. 2, 1937	.....	(7)	.....	138 *6.89*	29 *2.58*	52 *2.26*		293 *4.81*	42 *.87*	139 *3.92*	....	120 *1.93*	667	464		241		
	F	SW SW SE sec. 35....	40	do.....	do	.....	(7)	.....	138 *6.89*	23 *1.89*	106 *4.62*		293 *4.81*	19 *.40*	240 *6.77*	....	88 *1.42*	761	439		241		
	G	SW SW SE sec. 35....	140	do.....	do	.....	17	.....	2514 *125.44*	506 *41.59*	5478 *238.19*		223 *3.66*	31 *.65*	14238 *401.51*	....	.0	22,896	8,520		186	8.	
		T. 19 S., R. 3 W.																					
(4)	80	NE NW SE sec. 29....	137	McPherson.....	Oct. 22, 1937	58	.01	.....	114 *5.69*	13 *1.07*	13 *.57*	2 *.05*	317 *5.20*	19 *.40*	55 *1.55*	.0	8.5 *.14*	414	338		260		
	H	SE sec. 29.....	160, 137, 158, 146	McPherson (composite sample from wells 88, 89, 90, and 92)	Mar. 23, 1939	.....	.0	.....	113 *5.64*	11 *.90*	18 *.77*		327 *5.36*	20 *.42*	45 *1.27*	.1 *.01*	16 *.26*	430	327		268		
(6)	I	do.....	160, 137, 158, 146	do.....	Feb. 26, 1941	.....	.0	.....	110 *5.49*	11 *.90*	7.6 *.33*		327 *5.56*	16 *.33*	33 *.93*	.1 *.01*	5.3 *.09*	407	320		268		
		T. 19 S., R. 4 W.																					
	98	NW NW NE sec. 18...	100	Ninnescah.....	Nov. 25, 1938	58	.20	.....	308 *15.37*	131 *10.77*	203 *8.83*		173 *2.84*	982 *20.43*	294 *8.29*	....	212 *5.41*	2,217	1,308		142	1.	
	101	SW SE SW sec. 24....	75	McPherson.....	Nov. 23, 1938	58	43	.....	109 *5.44*	9.4 *.77*	21 *.93*		332 *5.44*	15 *.31*	46 *1.30*	....	5.8 *.09*	415	426		272		

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TABLE 13.—*Analyses of water from wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Continued*

Well No. (2)	LOCATION	Depth (feet)	Geologic subdivision	Date of collection	Temperature (°F)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (3) (Na)	Potassium (K)	Bicarbonate $H(CO_3)$	Sulfate (SO_3)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness (calculated as $CaCO_3$)		
																		Total	Carbonate	Noncarbonate
J	*T. 20 S., R. 1 W.* NW cor. sec. 7	67	McPherson	Nov. 29, 1937	.....	(7)	.....	458 *22.85*	102 *8.38*	161 *7.02*		283 *4.64*	28 *.58*	1160 *32.71*	.....	20 *.32*	2,071	1,562	232	1,330
K	*T. 20 S., R. 2 W.* NW NW NE sec. 2	35	do	Dec. 2, 1937	.....	(7)	.....	1394 *69.56*	376 *30.91*	971 *42.21*		276 *4.53*	39 *.81*	4820 *135.92*	.....	88 *1.42*	7,826	5,024	227	4,797
L	NW NW NE sec. 2	150	do	do	.....	(7)	.....	452 *22.55*	208 *17.10*	300 *13.06*		78 *1.28*	2093 *43.53*	280 *7.90*	.....	.0	3,372	1,983	64	1,919
M	NW NW sec. 2	30	do	do	.....	(7)	.....	128 *6.39*	31 *2.55*	149 *6.46*		461 *7.56*	77 *1.60*	107 *3.02*	.....	200 *3.22*	923	447	378	69
N	NW NE NE sec. 12	80	do	Nov. 29, 1937	.....	36	.....	180 *3.98*	37 *3.04*	338 *14.68*		386 *6.33*	21 *.44*	740 *20.87*	.....	22 *.35*	1,567	666	317	349
118	*T. 20 S., R. 3 W.* SE SE NE sec. 3	100	do	Nov. 25, 1938	58	25	.....	508 *25.35*	180 *14.80*	202 *8.79*		73 *1.20*	2133 *44.37*	118 *3.33*	.....	2.2 *.04*	3,205	2,075	60	2,015
127	SW SE SE sec. 26	40	do	Nov. 23, 1938	58	2.8	.....	49 *2.45*	7.4 *.61*	16 *.70*		168 *2.76*	12 *.25*	18 *.51*	.....	15 *.24*	204	161	138	23
129	SE NE SE sec. 31	75	do	do	58	.75	.....	108 *5.39*	11 *.90*	29 *1.26*		329 *5.40*	18 *.37*	61 *1.72*	.....	3.3 *.06*	396	317	270	47
131	*T. 20 S., R. 4 W.* NW NE NW sec. 1	65	do	Nov. 23, 1938	58	1.0	.....	150 *7.49*	13 *1.07*	54 *2.34*		408 *6.69*	56 *1.16*	93 *2.62*	.....	27 *.43*	598	431	334	97
155	*T. 21 S., R. 2 W.* SE SW SW sec. 15	18	do	Nov. 25, 1938	57	.5	.....	292 *14.57*	54 *4.44*	188 *8.16*		400 *6.56*	271 *5.64*	253 *7.13*	.....	487 *7.84*	1,746	952	328	624

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(6) 165	NE NE NW sec. 29...	107	do.....	Oct. 26, 1940	62	.19	.....	62 *3.09*	10 *.82*	23 *.98*		233 *3.82*	27 *.56*	17 *.48*	.2 *.01*	1.6 *.05*	291	196	191	5
(4) 166	NW NW NE sec. 29..	106	do.....	Oct. 22, 1940	58	.0	.....	60 *2.99*	9 3 *.76*	21 1.6 *.91* *.04*		230 *3.77*	24 *.50*	14 *.39*	.0	1.8 *.05*	270	188	188	0
171	SE NW NW sec. 30..	141	do.....	Nov. 23, 1938	58	.90	.....	66 *3.29*	11 *.90*	19 *.84*		259 *4.25*	17 *.35*	13 *.37*	....	4 *.06*	260	212	212	0
178	SE SW SW sec. 36...	51	do.....	do	60	.0	.....	199 *9.93*	31 *2.55*	138 *6.*		398 *6.53*	16 *.33*	104 *2.93*	....	540 *8.69*	1,227	624	326	298
195	*T. 21 S., R. 5 W.* NW cor. sec. 29.....	28	do.....	do	56	7.2	.....	126 *6.29*	16 *1.32*	49 *2.13*		451 *7.40*	30 *.62*	59 *1.66*	....	3.5 *.06*	516	400	370	30
(4) 204	*T. 21 S., R. 4 W.* SW SE SE sec. 11....	80	do.....	Oct. 28, 1937	58	.01	.....	109 *5.44*	16 *1.32*	17 1.4 *.74* *.04*		367 *6.02*	38 *.79*	23 *.65*	.0	1.1 *.02*	431	338	301	37
204a	do (from tap)...	80	do.....	Jan. 10, 1939	.....	.25	.....	110 *5.49*	16 *1.32*	25 *1.09*		373 *6.12*	41 *.85*	31 *.87*	.3 *.02*	4 *.06*	435	341	306	35
(6) 204b	do (from tap)...	80	do.....	Jan. 6, 1941	.....	(7)	.....	111 *5.54*	16 *1.32*	26 *1.14*		373 *6.12*	47 *.98*	31 *.87*	.1 *.01*	1.3 *.02*	451	343	306	37
205	SE NE sec. 12.....	82	do.....	Nov. 23, 1938	58	1.5	.....	104 *5.19*	11 *.90*	30 *1.30*		332 *5.44*	35 *.73*	42 *1.18*	....	2.2 *.04*	392	309	272	37
210	NW SW SW sec. 23...	109	do.....	do	57	11	.....	103 *5.14*	21 *1.75*	50 *2.18*		415 *6.81*	56 *1.16*	37 *1.04*	....	2.2 *.04*	488	373	340	33
213	SW SE SW sec. 26....	51	do.....	do	58	1	.....	90 *4.49*	22 *1.81*	34 *1.48*		390 *6.40*	33 *.67*	23 *.65*	.3 *.02*	2.2 *.04*	400	318	(5) 318	0
220	*T. 22 S., R. 1 W.* NW NE NE sec. 16...	24	do.....	Nov. 19, 1938	58	.70	.....	66 *3.29*	21 *1.73*	64 *2.79*		383 *6.28*	24 *.50*	29 *.82*	....	13 *.21*	409	253	(5) 253	0
(8) 222	SW NE 16.....	89	Wellington.....	Oct. 25, 1937	59	.02	.....	156 *7.79*	61 *5.02*	90 3 *3.91* *.08*		209 *3.43*	519 *10.81*	79 *2.23*	.2 *.01*	12 *.19*	1 114	640	172	468
Oa	NE sec. 16.....	30	McPherson.....	June, 1943	.....	.0	.....	94 *4.69*	18 *1.48*	85 *3.68*		404 *6.62*	26 *.54*	62 *1.75*	.4 *.02*	57 *.92*	572	308	(5) 308	0
224	NE NW NE sec. 18...	50	do.....	Nov. 19, 1938	59	(7)	.....	86 *4.29*	40 *3.29*	48 *2.09*		215 *3.53*	240 *5*	39 *1.10*	....	2.7 *.04*	563	379	176	203

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TABLE 13.—*Analyses of water from wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Continued*

Well No. (2)	LOCATION	Depth (feet)	Geologic subdivision	Date of collection	Temperature (°F)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness (calculated as $CaCO_3$)		
																		Total	Carbonate	Noncarbonate
	T. 22 S., R. 2 W.																			
232	SE SW SW sec. 10	30	McPherson	do	59	(7)	.....	94 *4.69*	15 *1.23*	81 *3.51*		295 *4.84*	22 *.46*	78 *2.20*	.....	120 *1.93*	558	296	242	54
300b	NW cor. sec. 17	128	do	Jan. 19, 1939	59	.9	.....	42 *2.10*	5.8 *.48*	22 *.94*		190 *3.12*	8.6 *.18*	6 *.17*	.5 *.03*	3.1 *.05*	183	132	(5) 132	0
300c	NW cor. sec. 17	151	do	Jan. 21, 1939	59	8.6	.....	50 *2.50*	7.2 *.59*	37 *1.62*		232 *3.80*	28 *.58*	10 *.28*	.4 *.02*	3.1 *.05*	260	178	(5) 178	2
Y	SW sec. 20	24	do	Dec. 3, 1938	61	.17	.....	21 *1.05*	4.6 *.38*	15 *.64*		76 *1.25*	9.5 *.20*	9 *.25*	.3 *.02*	23 *.37*	120	72	62	10
Z	SW cor. sec. 20	96	do	Dec. 9, 1938	59	.18	.....	40 *2*	6.4 *.53*	26 *1.12*		198 *3.25*	6.2 *.13*	8 *.23*	.4 *.02*	2.2 *.04*	188	127	(5) 127	0
AA	do	126.5	do	Dec. 10, 1938	58	.05	.....	40 *2*	6.2 *.51*	24 *1.04*		195 *3.20*	6.6 *.14*	6 *.17*	.3 *.02*	2.2 *.04*	183	126	(5) 126	0
BB	do	151.5	do	Dec. 13, 1938	58	.05	.....	38 *1.90*	5.6 *.46*	27 *1.16*		187 *3.07*	8.6 *.18*	7.5 *.21*	.4 *.02*	3.3 *.06*	184	118	(5) 118	0
CC	do	214	do	Dec. 17, 1938	58	1.3	.....	29 *1.45*	5 *.41*	15 *.65*		120 *1.97*	12 *.25*	9 *.25*	.3 *.02*	2.2 *.04*	134	97	(5) 97	0
DD	SE SW sec. 20	20	do	Nov. 18, 1938	59	(7)	.....	22 *1.10*	4.6 *.38*	19 *.83*		71 *1.16*	12 *.25*	13 *.37*	.....	33 *.53*	139	74	58	16
309	NW NE sec. 28	32	Alluvium	Oct. 5, 1938	60	1.3	.....	39 *1.95*	5.4 *.44*	29 *1.24*		188 *3.08*	15 *.31*	7 *.20*	.4 *.02*	2.2 *.04*	193	123	(5) 123	0
310	do	102	McPherson	Oct. 8, 1938	60	1.3	.....	40 *2*	7.2 *.59*	34 *1.48*		181 *2.97*	39 *.81*	9 *.25*	6 *.03*	2.2 *.04*	223	133	(5) 133	0

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310a	do	150.5	do	Oct. 13, 1938	60	4	.....	41 *2.05*	7.8 *.64*	29 *1.27*	172 *2.82*	42 *.87*	8 *.23*	....	2.2 *.04*	220	145		141	4
311	NW cor. sec. 29	220	do	Apr. 14, 1939	58	.7	.23	39 *1.95*	5 *.41*	24 *1.03*	179 *2.94*	9.1 *.19*	7 *.20*	.15 *.01*	4 *.06*	190	118	(5)	118	0
314	NW SW sec. 29	232	do	Apr. 4, 1939	59	.45	.30	38 *1.90*	6.2 *.51*	22 *.94*	176 *2.89*	12 *.25*	5 *.14*	.3 *.02*	4.4 *.07*	219	121	(5)	121	0
317	SE SE SW sec. 29	236	do	May 9, 1939	59	.30	.30	40 *2*	7.4 *.61*	27 *1.18*	183 *3*	24 *.50*	8 *.23*	.3 *.02*	3.5 *.06*	257	131	(5)	131	0
322	SE cor. sec. 30	232	do	May 14, 1939	58	.3	.23	40 *2*	6 *.49*	23 *.98*	188 *3.08*	7 *.15*	7 *.20*	.3 *.02*	2.7 *.04*	194	125	(5)	125	0
327	SE cor. sec. 31	20	do	Nov. 17, 1938	59	.5	.20	25 *1.25*	6.8 *.56*	19 *.81*	137 *2.25*	7.8 *.16*	6 *.17*	.3 *.02*	2.7 *.04*	136	92	(5)	92	0
327a	do	31	do	Oct. 13, 1938	59	1.8	.....	28 *1.40*	6.3 *.52*	24 *1.05*	96 *1.57*	25 *.52*	16 *.45*	....	27 *.43*	175	97		79	18
328	do	47	do	Oct. 15, 1938	59	4.3	.....	22 *1.10*	4.6 *.38*	20 *.86*	120 *1.92*	6.2 *.13*	7.0 *.20*	.2 *.01*	2.2 *.04*	126	86	(5)	86	0
328a	do	64	do	Nov. 17, 1938	59	5.0	.15	23 *1.15*	4.6 *.38*	19 *.81*	121 *1.98*	5.8 *.12*	7 *.20*	.2 *.01*	2.2 *.04*	127	90	(5)	90	0
329	do	120	do	Oct. 19, 1938	59	(7)	.....	36 *1.80*	6.7 *.55*	27 *1.18*	179 *2.94*	13 *.27*	10 *.28*	.3 *.02*	2.2 *.04*	185	118	(5)	118	0
329a	do	201	do	Nov. 17, 1938	59	2.1	.15	38 *1.90*	6.5 *.53*	36 *1.57*	210 *3.44*	13 *.27*	9 *.25*	.4 *.02*	2.2 *.04*	212	128	(5)	128	0
Ob	SE NE NE sec. 26	60	McPherson	Nov. 19, 1938	59	.06	.....	86 *4.29*	13 *1.07*	66 *2.88*	432 *7.08*	13 *.27*	23 *.65*	.2 *.01*	15 *.24*	432	268	(5)	268	0
P	SE SW SW sec. 34	47	do	do	58	(7)	.....	90 *4.49*	14 *1.15*	27 *1.16*	307 *5.03*	44 *.92*	28 *.79*	....	4 *.06*	361	282		252	30
Q	SW SW NW sec. 36	70	do	do	59	400	.....	3456 *172.45*	810 *66.58*	18325 *796.75*	0	37 *.77*	37200 *1049.04*	....	18 *.29*	60,246	12,668		0	12,668
245	*T. 22 S., R. 3 W.* NW NE NE sec. 14	33	do	Nov. 23, 1938	57	45	.....	109 *5.44*	9.6 *.79*	44 *1.91*	332 *5.44*	41 *.85*	63 *1.78*	....	4.4 *.07*	482	433		272	161
R	SW SW sec. 35	60	Dune sand and McPherson	Nov. 19, 1938	60	(7)	.....	51 *2.54*	4.4 *.36*	19 *.84*	215 *3.53*	3.3 *.07*	3.5 *.10*	.3 *.02*	2.2 *.04*	291	145	(5)	145	0

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TABLE 13.—*Analyses of water from wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Continued*

Well No. (2)	LOCATION	Depth (feet)	Geologic subdivision	Date of collection	Temperature (°F)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness (calculated as $CaCO_3$)		
																		Total	Carbonate	Noncarbonate
	T. 22 S., R. 4 W.																			
253	SE SE sec. 12	98	McPherson	Aug. 1, 1944		.09		137 *6.84*	29 *2.38*	54 *2.37*		368 *6.04*	182 *3.79*	61 *1.72*	.3 *.02*	1.3 *.02*	724	461	302	159
(8) 261	SW SW NW sec. 21	53	Alluvium	Oct. 28, 1937	59	.71		96 *4.79*	18 *1.48*	36 *1.57*	4.6 *.12*	330 *5.41*	68 *1.42*	34 *.96*	.0	2.1 *.03*	476	314	270	44
S	SE SE SW sec. 36	32	McPherson	Nov. 19, 1938	60	(7)		145 *7.24*	19 *1.56*	60 *2.62*		278 *4.56*	23 *.48*	24 *.68*		354 *5.70*	764	440	228	212
	T. 23 S., R. 1 W.																			
272	SE NE sec. 3	84	Wellington	do	60	1		197 *9.83*	79 *6.49*	84 *3.64*		190 *3.12*	663 *13.79*	106 *2.99*		3.3 *.06*	1,228	819	156	663
T	NE NE sec. 11	45	do	Oct. 5, 1938	60	1.3		333 *16.62*	62 *5.10*	227 *9.88*		388 *6.36*	85 *1.77*	352 *9.93*		841 *13.54*	2,095	1,090	318	772
U	SE SW SW sec. 20	32	McPherson	Nov. 23, 1938	59	.40		162 *8.08*	39 *3.21*	52 *2.46*		176 *2.89*	56 *1.16*	167 *4.71*		310 *4.99*	874	566	144	422
(8) 291	NW NW sec. 32	124	do	Oct. 25, 1937	58	.01		47 *2.35*	7.6 *.62*	21 *.91*	2.7 *.07*	188 *3.08*	25 *.52*	8 *.23*	.2 *.01*	2.7 *.04*	232	148	(5) 148	0
V	NW NW sec. 32	130, 124, 125, 130	McPherson (composite sample from wells 290, 291, 292, 293, 294, and 295)	Dec. 4, 1939		.0		54 *2.69*	8.6 *.71*	27 *1.17*		231 *3.79*	19 *.40*	12 *.34*	.1 *.01*	2.9 *.04*	271	170	(5) 170	0
(6) W	do	130, 124 125, 130	do	Nov. 15, 1940		.01		53 *2.64*	8.7 *.72*	24 *1.04*		220 *3.61*	24 *.50*	9 *.25*	.1 *.01*	2 *.04*	272	168	(5) 168	0
	T. 23 S., R. 2 W.																			
X	SE cor. sec. 7	40	Alluvium	Nov. 18, 1938	57	.85		45 *2.25*	5.6 *.46*	19 *.82*		198 *3.25*	3.7 *.08*	5.5 *.16*	.2 *.01*	2.2 *.04*	181	138	(5) 138	0

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299	NW cor. sec. 17.....	11	do.....	Jan. 10, 1939	59	1.2	.....	40 *2*	9.8 *.81*	49 *2.13*		249 *4.08*	24 *.50*	11 *.51*	.8 *.04*	3.3 *.05*	263	144	(5)	144	0
300	NW cor. sec. 17.....	74	McPherson.....	Jan. 16, 1939	59	3.2	.....	44 *2.20*	6.4 *.53*	23 *.99*		205 *5.36*	6.6 *.14*	6 *.17*	.4 *.02*	3.1 *.05*	195	145	(5)	145	0
300a	NW cor. sec. 17.....	104.5	do.....	Jan. 18, 1939	59	.04	.....	42 *2.10*	5.2 *.43*	20 *.86*		188 *5.08*	6.2 *.13*	5 *.14*	.4 *.02*	2.2 *.04*	175	127	(5)	127	0
329b	SE cor. sec. 31.....	209	McPherson.....	Oct. 26, 1938	59	10	.....	38 *1.90*	6.1 *.50*	36 *1.57*		208 *5.41*	13 *.27*	9 *.25*	.4 *.02*	2.2 *.04*	218	147	(5)	147	0
330	NW NW SW sec. 32...	236	do.....	May 23, 1939	58	.2	.20	43 *2.15*	8.6 *.71*	47 *2.06*		225 *5.69*	37 *.77*	15 *.42*	.4 *.02*	2.7 *.04*	289	143	(5)	143	0
333	SW cor. sec. 32.....	255	do.....	May 28, 1939	58	.64	.26	36 *1.80*	6 *.49*	27 *1.15*		181 *2.97*	8.6 *.18*	8 *.23*	.4 *.02*	3.5 *.06*	200	115	(5)	115	0
EE	SE SW SW sec. 33....	26	do.....	Nov. 18, 1938	59	(7)	.....	22 *1.10*	4.8 *.40*	13 *.55*		83 *1.36*	9.5 *.20*	7.0 *.20*	.....	18 *.29*	116	75		68	7
(8) 339	SW NW sec. 35.....	106	Alluvium and McPherson	Oct. 25, 1937	59	.22	.....	47 *2.35*	6.8 *.56*	47 *2.04*	1.8 *.05*	239 *5.92*	32 *.67*	10 *.28*	.0	.5 *.01*	284	146	(5)	146	0
	T. 23 S., R. 3 W.																				
FF	SE SW SE sec. 8.....	32	Dune sand.....	Nov. 25, 1938	59	.45	.....	12 *.60*	3.4 *.28*	10 *.44*		44 *.72*	5.3 *.11*	4 *.11*	.1 *.01*	24 *.58*	81	45		36	9
GG	NE SE NE sec. 14....	21	do.....	Nov. 18, 1938	60	(7)	.....	45 *2.25*	10 *.82*	27 *1.19*		78 *1.28*	29 *.60*	29 *.82*	....	97 *1.56*	276	154		64	90
354	SE cor. sec. 17.....	11	McPherson.....	Jan. 27, 1939	58	1	.....	16 *.80*	3.7 *.30*	18 *.77*		56 *.92*	12 *.25*	5 *.14*	....	35 *.56*	119	58		46	12
355	do.....	22	do.....	Feb. 14, 1939	58	22	.55	43 *2.15*	8.6 *.71*	40 *1.73*		237 *5.89*	17 *.35*	11 *.31*	.4 *.02*	2.7 *.04*	243	149	(5)	149	0
355a	do.....	42	do.....	Jan. 31, 1939	58	1.4	.05	17 *.85*	3.9 *.32*	21 *.89*		84 *1.35*	8.2 *.17*	6.0 *.17*	.04 *.02*	21 *.34*	121	63	(5)	63	0
HH	NE NW NE sec. 26...	18	do.....	Nov. 18, 1938	62	(7)	.....	28 *1.40*	9.2 *.76*	29 *1.26*		73 *1.20*	30 *.62*	11 *.31*	....	80 *1.29*	224	108		60	48
(8) 365	NW SI sec. 29.....	52	do.....	Oct. 25, 1937	59	.74	.....	42 *2.10*	11 *.90*	34 *1.48*	3.4 *.09*	162 *2.66*	39 *.81*	20 *.56*	.0	25 *.40*	279	150		133	17

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TABLE 13.—*Analyses of water from wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Continued*

Well No. (2)	LOCATION	Depth (feet)	Geologic subdivision	Date of collection	Temperature (°F)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness (calculated as $CaCO_3$)		
																		Total	Carbonate	Noncarbonate
	T. 23 S., R. 3 W. (Concluded)																			
II	SW SE sec. 29.....	52, 48	McPherson (composite sample from wells 365 and 366)	Feb. 4, 1939	.....	.9	.....	44 *2.20*	11 *.90*	35 *1.53*		164 *2.69*	41 *.85*	21 *.59*	.5 *.03*	31 *.50*	283	155	134	21
(6) JJ	do.....	52, 48	do.....	Feb. 7, 1941	.....	.8	.....	46 *2.30*	11 *.90*	29 *1.28*		154 *2.53*	45 *.94*	21 *.59*	.3 *.02*	25 *.40*	342	160	126	34
371	NE SE SE sec. 34.....	13	McPherson.....	Nov. 18, 1938	62	(7)	.....	46 *2.30*	11 *.90*	45 *1.94*		220 *3.61*	33 *.69*	26 *.73*	.4 *.02*	7.1 *.11*	278	160	(5) 160	0
KK	SE NE SE sec. 36.....	20	do.....	do	59	(7)	.....	31 *1.55*	6.4 *.53*	32 *1.40*		93 *1.53*	15 *.31*	28 *.79*	....	53 *.85*	212	104	76	28
	T. 23 S., R. 4 W.																			
375	SW SW NW sec. 4....	15	Dune sand.....	Nov. 19, 1938	61	1.2	.....	27 *1.35*	7.8 *.64*	31 *1.33*		129 *2.12*	28 *.58*	8 *.23*	.3 *.02*	23 *.37*	224	102	(5) 102	0
LL	SE NE NE sec. 25....	18	McPherson.....	do	61	.2	.....	93 *4.64*	32 *2.63*	155 *6.72*		185 *3.03*	125 *2.60*	218 *6.15*	....	137 *2.21*	853	364	152	212
MM	do.....	43	do.....	do	61	2.8	.....	34 *1.70*	9.2 *.76*	25 *1.07*		171 *2.80*	21 *.44*	9 *.25*	.3 *.02*	2.2 *.04*	189	131	(5) 131	0
NN	NE NE SE sec. 26....	18	do.....	Nov. 25, 1938	60	.8	.....	42 *2.10*	11 *.90*	31 *1.33*		207 *3.39*	22 *.46*	16 *.45*	.3 *.02*	1.8 *.03*	228	152	(5) 152	0
OO	SE SW SW sec. 35....	25	do.....	Nov. 18, 1938	61	(7)	.....	74 *3.69*	16 *1.32*	60 *2.59*		310 *5.08*	37 *.77*	58 *1.64*	.9 *.05*	7.1 *.11*	407	251	251	0
	T. 23 S., R. 5 W.																			
384	NE NE sec. 8.....	62-68	do.....	Feb., 1938	.....	2.5	.....	80 *3.99*	15 *1.23*	26 *1.13*		198 *3.25*	123 *2.56*	19 *.54*	.....	0.0 *.0*	396	261	162	99

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386	NE NW sec. 17	59	do	May, 1938		.0		38 1.90	9.4 .77	270 11.73	342 5.61	115 2.39	222 6.26	1.7 .09	8.8 .14	843	134	(5)	134	0
387	SW NW NW sec. 17	50	do	do		.1		102 5.09	20 1.64	141 6.15	317 5.20	139 2.89	152 4.29	.7 .04	31 .50	770	337		260	77
388	SW SE NW sec. 18	80	do	do		.0		185 9.25	32 2.63	383 16.64	271 4.44	192 3.99	694 19.57	.6 .03	31 .50	1,826	593		222	371
389	*T. 23 S., R. 6 W.* SW SE NW sec. 1	66	do	do		.08		87 4.34	19 1.56	123 5.34	290 4.76	97 2.02	148 4.17	.7 .04	18 .29	662	295		238	57
(4a) 390	NW NW sec. 12	60	do	Mar., 1944		.0		88 4.39	17 1.40	87 3.78	242 3.97	96 2.00	119 3.36	.6 .03	13 .21	576	290		198	92
391	SE NE sec. 12	58	do	May, 1938		.05		102 5.09	19 1.56	137 5.96	310 5.09	129 2.68	161 4.54	.9 .06	18 .29	726	333		254	79
392	SW SW sec. 12	65	do	do		.0		148 7.39	25 2.06	220 9.56	237 3.89	135 2.81	429 12.10	.3 .02	13 .21	1,198	473		194	279
393	SE SW sec. 12	75	do	do		.0		101 5.04	18 1.48	98 4.26	256 4.20	119 2.48	134 3.78	.8 .04	20 .32	662	326		210	116
PP	*T. 24 S., R. 1 E.* NW NE NE sec. 7	100	Wellington	Nov. 19, 1938	59	.40		170 8.48	68 5.59	106 4.59	276 4.53	282 5.87	194 5.47	.....	173 2.79	1,131	705		226	479
400	*T. 24 S., R. 1 W.* NE cor. sec. 19	40	Alluvium	Sept. 8, 1938	58	1		56 2.79	7 .58	29 1.25	259 4.25	8.2 .17	5.5 .16	.1 .01	2.2 .04	239	171	(5)	171	0
400a	do	40	do	Aug. 24, 1938	58	(7)		54 2.69	7.6 .62	37 1.62	273 4.48	14 .29	4.3 .12	.3 .02	2.2 .04	256	166	(5)	166	0
401	do	115	Alluvium and McPherson	do	58	.....		41 2.05	7.3 .60	17 .74	178 2.92	16 .33	3.7 .10	.5 .03	2.2 .04	176	133	(5)	133	0
401a	do	129	do	Sept. 8, 1938	58	1.8		43 2.15	7 .58	21 .92	183 3	21 .44	6 .17	.1 .01	2.2 .04	194	142	(5)	142	0
401b	do	129	do	Aug. 24, 1938	58	(7)		38 1.90	6.9 .57	20 .88	176 2.89	16 .33	4 .11	.6 .03	1.3 .02	174	124	(5)	124	0
403	SW cor. sec. 19	29	Alluvium	do	59	(7)		48 2.40	9.7 .80	41 1.77	227 3.72	32 .67	19 .54	.7 .04	2.2 .04	265	160	(5)	160	0
403a	do	55	do	do	59	(7)		56 2.79	10 .82	62 2.70	283 4.64	42 .87	27 .76	.7 .04	2.2 .04	341	181	(5)	181	0

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TABLE 13.—*Analyses of water from wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Continued*

Well No. (2)	LOCATION	Depth (feet)	Geologic subdivision	Date of collection	Temperature (°F)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness (calculated as $CaCO_3$)		
																		Total	Carbonate	Noncarbonate
	T. 24 S., R. 1 W. (Concluded)																			
QQ	NE SE NE sec. 25	33	McPherson	Nov. 19, 1938	58	.12	.....	233 *11.63*	65 *5.34*	181 *7.89*		409 *6.71*	64 *1.33*	331 *9.33*	....	465 *7.49*	1,544	849	335	514
(8) 410	NE SW NW sec. 34	46	Alluvium	Oct. 25, 1937	59	.33	.....	106 *5.29*	17 *1.40*	19 *.83*	4.3 *.11*	339 *5.56*	73 *1.52*	14 *.39*	.0	1.6 *.03*	439	334	278	56
410a	do	46	do	May 25, 1939	.....	.0	.....	106 *5.29*	17 *1.40*	17 *.73*		326 *5.35*	66 *1.37*	20 *.56*	.2 *.01*	8.8 *.14*	438	335	267	68
(6) 410b	do	46	do	Mar. 21, 1941	.....	.82	.....	103 *5.14*	17 *1.40*	13 *.57*		320 *5.25*	64 *1.33*	17 *.48*	.2 *.01*	2.7 *.04*	424	327	262	65
	T. 24 S., R. 2 W.																			
412	NW NE sec. 2	102	Alluvium and McPherson	Oct. 7, 1939	.....	.49	.....	48 *2.40*	6 8 *.56*	25 *1.08*		207 *3.39*	10 *.21*	11 *.31*	.3 *.02*	7.8 *.13*	241	148	(5) 148	0
(6) 412a	do	102	do	Oct. 31, 1940	.....	.08	.....	45 *2.25*	6 *.49*	27 *1.18*		193 *3.16*	18 *.37*	10 *.28*	.3 *.02*	5.3 *.09*	234	137	(5) 137	0
415	SE NE sec. 6	256	McPherson	June 1, 1939	59	1.1	.27	40 *2.0*	7 *.58*	31 *1.35*		205 *3.36*	12 *.25*	10 *.28*	.3 *.02*	2.2 *.04*	228	129	(5) 129	0
419	NE NW sec. 8	257	do	July 6, 1939	60	1.6	.23	41 *2.05*	8.4 *.69*	30 *1.32*		200 *3.28*	22 *.46*	10 *.28*	.3 *.02*	2.7 *.04*	227	137	(5) 137	0
422	NW NE NW sec. 8	24.75	do	Nov. 18, 1938	60	.5	.....	26 *1.30*	6.2 *.51*	23 *1*		132 *2.16*	15 *.31*	11 *.31*	.1 *.01*	1.8 *.03*	150	92	(5) 92	0
423	NW NW sec. 8	247	do	June 7, 1939	58	1.2	.27	50 *2.50*	8.2 *.67*	44 *1.92*		260 *4.26*	20 *.42*	13 *.37*	.4 *.02*	2.2 *.04*	286	159	(5) 159	0

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426	NW SE sec. 8	246	do	July 12, 1939	58	1.6	.23	45 *2.25*	7.8 *.64*	41 *1.78*	237 *3.89*	19 *.40*	12 *.34*	.3 *.02*	2.7 *.04*	248	145	(5)	145	0
429	SW NW sec. 8	226	do	June 13, 1939	58	.53	.35	52 *2.59*	8.6 *.71*	46 *1.99*	266 *4.36*	22 *.46*	15 *.42*	.4 *.02*	2.9 *.05*	296	165	(5)	165	0
433	SE NE sec. 9	191	do	Apr. 20, 1939	58	1.3	.33	39 *1.95*	6.4 *.53*	46 *2.01*	227 *3.72*	19 *.40*	11 *.31*	.3 *.02*	3.3 *.06*	260	124	(5)	124	0
436	NW SW sec. 9	234	do	June 27, 1939	59	1.6	.23	44 *2.20*	7.6 *.63*	40 *1.73*	229 *3.76*	20 *.42*	12 *.34*	.2 *.01*	2.2 *.04*	248	142	(5)	142	0
440	SE cor. sec. 9	191	do	Apr. 29, 1939	58	80	.07	40 *2*	6.8 *.56*	42 *1.83*	235 *3.85*	8.6 *.18*	11 *.31*	.4 *.02*	3.3 *.05*	258	128	(5)	128	0
443	NE cor. sec. 10	20	do	Nov. 18, 1938	50	(7)	.....	32 *1.60*	10 *.82*	35 *1.50*	85 *1.39*	37 *.77*	27 *.76*	....	62 *1*	246	121		70	51
448	NE NE NW sec. 16	14	do	Nov. 17, 1938	64	3	.....	47 *2.35*	8.3 *.68*	47 *2.03*	234 *3.84*	27 *.56*	22 *.62*	.5 *.03*	2.2 *.04*	274	160	(5)	160	0
448a	do	56	do	Nov. 25, 1938	.....	.12	.....	46 *2.30*	8.6 *.71*	40 *1.75*	249 *4.08*	16 *.33*	11 *.31*	.4 *.02*	2.2 *.04*	248	151	(5)	151	0
449	do	108	do	Nov. 30, 1938	59	.17	.....	45 *2.25*	8 *.66*	56 *2.44*	276 *4.53*	21 *.44*	12 *.34*	.6 *.03*	2.2 *.04*	282	146	(5)	146	0
449a	do	190.2	do	Dec. 7, 1938	60	.10	.....	41 *2.05*	8.8 *.72*	58 *2.53*	271 *4.44*	23 *.48*	12 *.34*	.4 *.02*	2.2 *.04*	281	139	(5)	139	0
450	NW cor. sec. 16	100	do	Apr. 7, 1939	58	2.2	.20	39 *1.95*	7.6 *.63*	34 *1.49*	203 *3.33*	15 *.31*	14 *.39*	.3 *.02*	2.2 *.04*	244	129	(5)	129	0
452	NE SE sec. 16	184	do	May 10, 1939	58	0.48	.20	45 *2.25*	7.4 *.61*	54 *2.33*	260 *4.26*	24 *.50*	13 *.37*	.3 *.02*	3.5 *.06*	308	143	(5)	143	0
455	NW SW sec. 16	120	do	Apr. 25, 1939	58	1.2	.25	54 *2.69*	10 *.82*	43 *1.86*	271 *4.44*	16 *.33*	20 *.56*	.45 *.02*	2.7 *.04*	304	176	(5)	176	0
459	NW NE sec. 17	243	do	June 20, 1939	58	.70	.20	49 *2.45*	8.4 *.69*	49 *2.11*	259 *4.25*	25 *.52*	15 *.42*	.3 *.02*	3.3 *.06*	287	157	(5)	157	0
462	NE cor. sec. 18	21	do	Oct. 31 1938	.....	2.2	.....	63 *3.14*	12 *.99*	70 *3.05*	286 *4.69*	35 *.73*	61 *1.72*	.5 *.03*	2.7 *.04*	389	208	(5)	208	0
462a	do	55	do	Nov. 1, 1938	.....	3.3	.....	57 *2.84*	10 *.82*	46 *2.01*	276 *4.53*	26 *.54*	20 *.56*	.3 *.02*	2.2 *.04*	302	192	(5)	192	0

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TABLE 13.—*Analyses of water from wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Continued*

Well No. (2)	LOCATION	Depth (feet)	Geologic subdivision	Date of collection	Temperature (°F)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness (calculated as $CaCO_3$)		
																		Total	Carbonate	Noncarbonate
	T. 24 S., R. 2 W. (Concluded)																			
463	NE cor. sec. 18	114	McPherson	Nov. 9, 1938	59	1	.....	57 *2.84*	10 *.82*	59 *2.55*		300 *4.92*	33 *.69*	20 *.56*	.4 *.03*	2.2 *.04*	332	186	(5) 186	0
463a	do	207	do	Nov. 12, 1938	59	1	.....	44 *2.20*	8.8 *.72*	62 *2.68*		283 *4.64*	28 *.58*	12 *.34*	.5 *.03*	2.2 *.04*	300	149	(5) 149	0
463b	do	237	do	Nov. 15, 1938	.....	.9	.....	42 *2.10*	8.4 *.69*	64 *2.77*		271 *4.44*	34 *.71*	13 *.37*	.3 *.02*	2.2 *.04*	300	142	(5) 142	0
RR	NE NE sec. 22	28	Alluvium	Aug. 3, 1938	.....	1.9	.....	63 *3.14*	13 *1.07*	54 *2.34*		315 *5.17*	21 *.44*	32 *.90*	.7 *.04*	2.2 *.04*	343	216	(5) 216	0
465	SE SW sec. 22	156	McPherson	Aug. 8, 1939	58	1.2	.20	64 *3.19*	11 *.90*	83 *3.60*		325 *5.33*	52 *1.08*	44 *1.24*	.1 *.01*	2.2 *.04*	450	205	(5) 205	0
470	NW cor. sec. 26	27.5	do	Dec. 16, 1938	61	.5	.....	20 *1*	5.6 *.46*	16 *.69*		49 *.80*	29 *.60*	18 *.51*	.3 *.02*	15 *.24*	129	75	40	35
471	do	63.5	do	do	54	.1	.....	62 *3.09*	12 *.99*	90 *3.94*		320 *5.25*	54 *1.12*	49 *1.38*	.3 *.02*	17 *.27*	444	205	(5) 205	0
472	do	111	do	Dec. 19, 1938	59	.07	.....	60 *2.99*	12 *.99*	87 *3.78*		325 *5.33*	56 *1.16*	43 *1.21*	.4 *.03*	3.3 *.06*	424	199	(5) 199	0
473	SW cor. sec. 26	78	do	May 5, 1939	58	2.3	.10	72 *3.59*	12 *.99*	89 *3.89*		327 *5.36*	59 *1.23*	65 *1.83*	.5 *.03*	3.1 *.05*	484	229	(5) 229	0
476	SW SE sec. 26	80	do	May 19, 1939	58	2.2	.35	72 *3.59*	12 *.99*	93 *4.06*		329 *5.40*	60 *1.25*	69 *1.95*	.4 *.03*	2.7 *.04*	473	229	(5) 229	0
479	NE cor. sec. 27	143	do	June 9, 1939	60	.6	.35	59 *2.94*	11 *.90*	83 *3.59*		311 *5.10*	53 *1.10*	42 *1.18*	.3 *.02*	2.9 *.05*	429	192	(5) 192	

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486	NE cor. sec. 35	28	do	Aug. 24, 1938	59	(7)		30 *1.50*	7.1 *.58*	36 *1.56*	142 *2.33*	22 *.46*	26 *.73*	.3 *.02*	6.6 *.11*	199	104	(5) 104	0
486a	do	59.2	do	Sept. 10, 1938	59	2.0		63 *3.14*	11 *.90*	86 *3.75*	293 *4.81*	55 *1.14*	64 *1.80*	.5 *.03*	2.2 *.04*	430	208	(5) 208	0
486b	do	190	do	do		.0		73 *3.64*	16 *1.32*	124 *5.37*	268 *4.40*	119 *2.48*	121 *3.41*		2.2 *.04*	589	248	220	28
487	SE NE sec. 35	203	do	May 30, 1939	59	.52	.53	80 *3.99*	14 *1.15*	102 *4.42*	322 *5.28*	79 *1.64*	92 *2.59*	.3 *.02*	2.9 *.06*	552	257	(5) 257	0
491	SE cor. sec. 35	95	do	June 4, 1939	58	1.4	.33	63 *3.14*	11 *.90*	54 *2.36*	281 *4.61*	33 *.69*	34 *.96*	.3 *.02*	8.4 *.14*	366	202	(5) 202	0
494	SW SE sec. 36	187	do	May 26, 1939	58	.18	.25	75 *3.74*	14 *1.15*	90 *3.92*	317 *5.20*	65 *1.35*	78 *2.20*	.4 *.03*	3.5 *.06*	495	245	(5) 245	0
(6) SS	(Composite sample of treated water from tap in city of Wichita)	80–263	do	Dec. 23, 1940		.01		39 *1.95*	8 *.66*	52 *2.24*	203 *3.33*	33 *.69*	23 *.65*	.4 *.03*	.0	282	131	(5) 131	0
	T. 24 S., R. 3 W.																		
496	SE cor. sec. 1	44	do	Nov. 2, 1938	58	.2		37 *1.85*	8 *.66*	28 *1.23*	166 *2.72*	24 *.50*	13 *.37*	.5 *.03*	10 *.16*	203	126	(5) 126	0
497	do	196	do	Nov. 17, 1938	59	1.1		48 *2.40*	9 *.74*	60 *2.59*	288 *4.72*	28 *.58*	14 *.39*	.4 *.03*	2.2 *.04*	306	160	(5) 160	0
497a	do	237	do	Nov. 21, 1938	59	2.0		48 *2.40*	8.4 *.69*	52 *2.24*	271 *4.44*	26 *.54*	11 *.31*	.6 *.03*	2.2 *.04*	285	160	(5) 160	0
TT	SW NW sec. 7	35	do	Aug. 3, 1938		.75		115 *5.74*	23 *1.89*	107 *4.64*	368 *6.04*	113 *2.35*	136 *3.84*		2.2 *.04*	680	384	302	82
UU	NW SW sec. 9	10	do	do		.35		83 *4.14*	20 *1.64*	84 *3.66*	286 *4.69*	95 *1.98*	92 *2.59*		11 *.18*	528	290	234	56
502	SE cor. sec. 11	11	do	Oct. 15, 1938		1.3		90 *4.49*	23 *1.89*	130 *5.65*	268 *4.40*	175 *3.64*	140 *3.95*		2.7 *.04*	696	323	220	103
503	do	52	do	Oct. 19, 1938	59	.5	.45	83 *4.14*	16 *1.32*	72 *3.13*	268 *4.40*	72 *1.50*	94 *2.65*		2.2 *.04*	473	273	220	53
503a	do	111	do	Oct. 21, 1938	59	(7)		92 *4.59*	19 *1.56*	65 *2.83*	293 *4.81*	78 *1.63*	89 *2.51*		2.7 *.04*	493	308	240	68

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TABLE 13.—*Analyses of water from wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Continued*

Well No. (2)	LOCATION	Depth (feet)	Geologic subdivision	Date of collection	Temperature (°F)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (3) (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness (calculated as $CaCO_3$)		
																		Total	Carbonate	Noncarbonate
	T. 24 S., R. 3 W. (Concluded)																			
503b	SE cor. sec. 11	233	McPherson	Oct. 27, 1938	59	6.3	.....	76 *3.79*	17 *1.40*	75 *3.24*		272 *4.46*	75 *1.56*	84 *2.37*	.....	2.2 *.04*	472	277	223	54
VV	NE SE sec. 13	30	do	Aug. 3, 1938	.....	(7)	0.0	94 *4.69*	20 *1.64*	92 *4.01*		281 *4.61*	100 *2.08*	128 *3.61*	0.0	2.2 *.04*	577	317	230	87
WW	NW NW sec. 14	32	do	do	.....	.30	.....	106 *5.29*	24 *1.97*	119 *5.19*		310 *5.08*	130 *2.70*	163 *4.60*	.....	4.4 *.07*	702	364	254	110
511	NE SE SE sec. 21	14	do	Jan. 3, 1939	60	1.3	.05	101 *5.04*	18 *1.48*	93 *4.05*		321 *5.26*	85 *1.77*	124 *3.50*	.....	2.7 *.04*	591	330	263	67
511a	do	61	do	Jan. 5, 1939	59	1.5	.33	90 *4.49*	18 *1.48*	108 *4.68*		329 *5.40*	82 *1.71*	124 *3.50*	.....	2.7 *.04*	591	303	270	33
XX	NE NE sec. 27	18	do	Aug. 3, 1938	.....	(7)	.....	106 *5.29*	19 *1.56*	83 *3.63*		364 *5.97*	65 *1.35*	107 *3.02*	.....	8.8 *.14*	571	343	298	45
517	SE SE sec. 31	87	do	Jan. 21, 1939	58	.12	.32	92 *4.59*	18 *1.48*	153 *6.61*		256 *4.20*	120 *2.50*	208 *5.87*	.....	6.6 *.11*	726	304	210	94
518	do	124	do	Jan. 24, 1939	58	1.2	.15	92 *4.59*	18 *1.48*	197 *8.57*		268 *4.40*	112 *2.33*	278 *7.84*	.....	4.4 *.07*	837	307	220	87
518a	do	130	do	Feb. 7, 1939	58	1.8	.90	72 *3.59*	18 *1.48*	173 *7.51*		195 *3.20*	123 *2.56*	240 *6.77*	.....	3.3 *.05*	729	259	160	99
518b	do	152	do	Jan. 31, 1939	57	.28	.0	82 *4.09*	17 *1.40*	196 *8.52*		220 *3.61*	88 *1.83*	302 *8.52*	.....	3.3 *.05*	799	276	180	96
518c	SE SE sec. 31	254.5	do	Feb. 14, 1939	58	2	.93	84 *4.19*	22 *1.81*	382 *16.63*		174 *2.85*	154 *3.20*	586 *16.53*	.....	3.1 *.05*	1,320	306	143	163

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YY	NE SE NW sec. 3		do	Nov. 18, 1938	57	.06		164 *8.18*	35 *2.88*	218 *9.47*		349 *5.72*	58 *1.21*	478 *13.48*		7.5 *.12*	1,135	553		286	267
ZZ	SE cor. sec. 9	65	do	do	60	.30		240 *11.98*	42 *3.45*	197 *8.57*		266 *4.36*	41 *.85*	660 *18.61*		11 *.18*	1,324	773		218	555
	T. 25 S., R. 1 W.																				30
AAA	SE SE NE sec. 5	22	Alluvium	Nov. 7, 1937		(7)		70.4 *3.51*	8.8 *.72*	4.4 *.19*		222 *3.64*	30 *.62*	3 *.08*		4.9 *.08*	233	212		182	
(4) 564	NW SW NE sec. 36	52	do	Nov. 2, 1937	59	.37		88 *4.39*	20 *1.64*	25 2.2 *1.09* *.06*		319 *5.23*	76 *1.58*	8 *.23*	.0 *.00*	3.2 *.05*	398	302		262	40
BBB	SW SE SE sec. 25; NW SW NE sec. 36	495, 50, 52, 51	Alluvium (composite sample from wells 555, 556, 564, and 565)	Nov. 23, 1939		.5		91 *4.45*	20 *1.64*	33 *1.44*		347 *5.69*	79 *1.64*	7 *.20*	.3 *.02*	5.3 *.09*	410	309		284	25
(6) CCC	do	495, 50, 52, 51	do	Dec. 23, 1940		.33		87 *4.34*	19 *1.56*	27 *1.17*		312 *5.12*	76 *1.58*	11 *.31*	.3 *.02*	3.5 *.06*	397	295		256	39
	T. 25 S., R. 2 W.																				
566	NE NE sec. 1	17	McPherson	Nov. 7, 1937		(7)		61 *3.03*	12.4 *1.02*	59.1 *2.57*		293 *4.81*	49 *1.02*	28 *.79*		.0 *.00*	356	203		240	37
DDD	NW cor. sec. 2	27.5	do	Sept. 26, 1938	61	.40		55 *2.74*	10 *.82*	24 *1.04*		176 *2.89*	33 *.69*	11 *.31*		44 *.71*	265	179		144	35
EEE	do	57	do	Sept. 30, 1938	61	(7)		70 *3.49*	12 *.99*	49 *2.14*		312 *5.12*	31 *.64*	29 *.82*	.4 *.02*	2.2 *.04*	349	224	(5)	224	0
FFF	do	202	do	Oct. 7, 1938	61	(7)	0	79 *3.94*	15 *1.23*	109 *4.75*		329 *5.40*	80 *1.66*	100 *2.82*	.5 *.03*	2.2 *.04*	550	259	(5)	259	0
GGG	SW SW sec. 4	13	do	Nov. 7, 1937		(7)		95 *4.75*	15 *1.23*	64.4 *2.80*		307 *5.03*	60 *1.25*	73 *2.06*		27 *.45*	489	299		252	47
572	NE NE sec. 9	21.4	do	Sept. 10, 1938	59	.62		84 *4.19*	13 *1.07*	61 *2.65*		307 *5.03*	57 *1.19*	55 *1.55*		8.8 *.14*	433	265		252	13
572a	do	42	do	do	59	.21		84 *4.19*	15 *1.23*	75 *3.25*		327 *5.36*	56 *1.16*	75 *2.12*		1.8 *.03*	471	272		268	4
572b	do	62.5	do	do	59	.07		75 *3.74*	15 *1.23*	96 *4.16*		339 *5.56*	60 *1.25*	81 *2.28*	.5 *.03*	2.2 *.04*	499	249		249	0
572c	do	137	do	do	59	.1		79 *3.94*	16 *1.32*	92 *3.98*		334 *5.48*	65 *1.35*	64 *2.37*	.7 *.04*	2.2 *.04*	503	264	(5)	264	0

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TABLE 13.—*Analyses of water from wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Continued*

Well No. (2)	LOCATION	Depth (feet)	Geologic subdivision	Date of collection	Temperature (°F)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness (calculated as $CaCO_3$)		
																		Total	Carbonate	Noncarbonate
	T. 25 S., R. 2 W. (Concluded)																			
572d	NE NE sec. 9	183	McPherson	Sept. 20, 1938	61	11	.....	72 *3.59*	16 *1.32*	92 *3.98*		307 *5.03*	70 *1.46*	84 *2.37*	.....	2.2 *.04*	501	275	252	23
572e	do	200	do	Sept. 16, 1938	60	(7)	.....	72 *3.59*	15 *1.23*	90 *3.91*		303 *4.97*	69 *1.44*	81 *2.28*	.8 *.04*	2.2 *.04*	481	241	(5) 241	0
HHH	NE NE sec. 11	.....	do	Nov. 7, 1937	.....	(7)	.....	57 *2.83*	12.4 *1.02*	46 *2*		261 *4.28*	39 *.81*	27 *.76*	.....	.0	312	193	(5)	.....
III	SW sec. 11	30	do	Nov. 7, 1937	.....	(7)	.....	76.8 *3.83*	13.8 *1.13*	55.7 *2.42*		278 *4.56*	54 *1.12*	58 *1.64*	.....	3.5 *.06*	401	248	228	20
575	NW cor. sec. 16	14	do	Sept. 20, 1938	63	.3	.....	74 *3.69*	16 *1.32*	77 *3.35*		256 *4.20*	58 *1.21*	67 *1.89*	.....	66 *1.06*	486	252	210	42
577	SW cor. sec. 16	17	Alluvium	Sept. 10, 1938	60	.2	.....	134 *6.69*	32 *2.63*	369 *16.05*		305 *5*	175 *3.64*	592 *16.69*	.....	2.2 *.04*	1,457	467	250	217
JJJ	NE SW sec. 18	14	do	Nov. 7, 1937	.....	(7)	.....	95.2 *4.75*	21.4 *1.76*	234.1 *10.18*		261 *4.28*	100 *2.08*	365 *10.29*	.....	2.2 *.04*	948	326	214	112
KKK	SE SW SW sec. 28	24	do	do	.....	(7)	.....	326.4 *16.29*	62.6 *5.15*	613.2 *26.66*		228 *3.74*	410 *8.53*	1270 *35.81*	.....	1.3 *.02*	2,798	1,072	187	885
LLL	NW NE NW sec. 36	12	do	do	.....	(7)	.....	204 *10.18*	42.8 *3.52*	430.8 *18.73*		239 *3.92*	312 *6.51*	775 *21.86*	.....	8.9 *.14*	1,888	685	196	489

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	T. 25 S., R. 3 W.																				
(4) 589	NE NE sec. 20	74	McPherson	Oct. 28, 1937	58	.0	...	74 *3.69*	14 *1.15*	66 *2.87*	2.6 *.07*	352 *5.77*	25 *.52*	47 *1.33*	.5 *.03*	3.7 *.06*	421	242	(5) 242	0
589a	do	74	do	June 5, 1939	.....	.0	.....	75 *3.74*	14 *1.15*	67 *2.93*		347 *5.71*	28 *.58*	50 *1.41*	.3 *.02*	7.5 *.12*	440	245	(5) 245	0
(6) 589b	do	74	do	Apr. 11, 1940	.....	.04	.....	75 *3.74*	14 *1.15*	69 *3.02*		364 *5.97*	24 *.50*	49 *1.38*	.1 *.01*	4 *.06*	446	245	(5) 245	0
	T. 25 S., R. 4 W.																				
(8) 594	NW NE SW sec. 5	55	do	Oct. 28, 1937	59	.0	.....	88 *4.39*	14 *1.15*	48 *2.09*	2.7 *.07*	390 *6.39*	14 *.29*	28 *.79*	.4 *.02*	5 *.08*	411	277	(5) 277	0
MMM	NW NE SW sec. 5 SW NE SW sec. 5	55, 48.3	McPherson (composite sample from wells 594, 595, and 596)	Dec. 8, 1939	.....	.06	.....	92 *4.59*	13 *1.07*	51 *2.23*		390 *6.39*	18 *.37*	34 *.96*	.1 *.01*	10 *.16*	419	283	(5) 283	0
(6) NNN	NW NE SW sec. 5, SW NE SW sec. 5	55, 48.3	do	Nov. 29, 1940	.....	.02	0.0	88 *4.39*	12 *.99*	46 *1.98*		378 *6.20*	13 *.27*	28 *.79*	.1 *.01*	5.3 *.09*	418	269	(5) 269	0
	T. 26 S., R. 1 E.																				
608	NE NW sec. 29	44	Alluvium	Nov. 9, 1937	59	(7)	.....	95.2 *4.75*	27.1 *2.23*	13 *.55*		307 *5.03*	105 *2.18*	9 *.25*	....	4.4 *.07*	407	349	252	97
	T. 26 S., R. 2 W.																				
(4a) OOO	NW cor. sec. 14	255	McPherson	Nov. 13, 1944	60	(7)	.....	50 *2.50*	13 *1.07*	481 *20.91*		333 *5.46*	167 *3.47*	550 *15.51*	.4 *.02*	1.3 *.02*	1,429	178	(5) 178	0
(4a) PPP	NE cor. sec. 16	217	do	Nov. 4, 1944	59	(7)	.....	44 *2.20*	10 *.82*	144 *6.28*		(10) 393 *6.44*	45 *.94*	66 *1.86*	.3 *.02*	2.5 *.04*	508	151	(5) 151	0
(4a) QQQ	SW cor. sec. 28	68	do	Nov. 6, 1944	59	(7)	.....	76 *3.79*	23 *1.89*	51 *2.21*		337 *5.53*	63 *1.31*	34 *.96*	.2 *.01*	5.3 *.08*	421	284	276	8
	T. 27 S., R. 1 E.																				
(4) 671	SE SW sec. 18	46	Alluvium	Oct. 20, 1937	64	.09	.....	108 *5.39*	23 *1.89*	298 *12.96*	6.6 *.17*	265 *4.34*	173 *3.60*	435 *12.27*	.4 *.02*	1.6 *.03*	1,215	364	217	147
(4) 677	SW SE sec. 18	54	do	do	63	.01	.....	100 *4.99*	21 *1.73*	148 *6.44*	5.8 *.15*	261 *4.28*	143 *2.98*	211 *5.95*	.2 *.01*	1.1 *.02*	800	336	214	122

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TABLE 13.—*Analyses of water from wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Concluded*

Well No. (2)	LOCATION	Depth (feet)	Geologic subdivision	Date of collection	Temperature (°F)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (3) (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness (calculated as $CaCO_3$)		
																		Total	Carbonate	Noncarbonate
	T. 27 S., R. 1 E. (Concluded)																			
(9) RRR	(Composite sample from tap in city of Wichita, old well field)	.....	Alluvium.....	Nov. 16, 1932	.....	.15	.....	116.8 *5.83*	29 *2.39*	374 *16.26*		244 *4.01*	234 *4.87*	552 *15.57*	1 *.05*	2 *.03*	1,499	411	200	211
(9) SSS	do.....	54	do.....	Dec. 1, 1933	.....	.05	.....	107 *5.34*	26 *2.14*	302 *13.10*		222 *3.65*	208 *4.33*	446 *12.58*	.7 *.04*	1 *.02*	1,318	374	182	192
(9) TTT	do.....	54	do.....	Jan. 10, 1935	.....	1	.....	112 *5.59*	26 *2.14*	322 *13.96*		255 *4.19*	192 *4.0*	478 *13.48*	.....	1 *.02*	1,311	386	209	177
UUU	do.....	54	do.....	Feb. 26, 1937	.....	.05	.....	114 *5.69*	27.6 *2.27*	318.5 *13.83*		239.1 *3.92*	215.5 *4.48*	473 *13.35*	.....	2.7 *.04*	1,367	398	196	202
VVV	do.....	54	do.....	Mar. 15, 1938	.....	.2	.....	118 *5.89*	27 *2.22*	364 *15.84*		256 *4.20*	196 *4.08*	554 *15.62*	.....	3.1 *.05*	1,465	406	210	196
WWW	do.....	54	do.....	Apr. 3, 1939	.....	.25	.....	122 *6.09*	28 *2.30*	363 *15.79*		246 *4.03*	256 *5.32*	522 *14.72*	.4 *.02*	6.6 *.11*	1,491	420	202	218

(1) One part per million (p.p.m.) is equivalent to one pound of substance per million pounds of water, or 8.33 pounds per million gallons of water. An equivalent per million (e.p.m.) is a unit chemical equivalent weight of solute per million unit weights of solution. Concentration in equivalents per million is calculated by dividing concentration in parts per million by the chemical combining weight of the substance or ion.
(2) The numbers listed refer to well numbers given in Table 37 and shown on Plate 5. Letters refer to samples from unnumbered wells and test holes.
(3) Figures in between the two columns indicate calculated amount of sodium and potassium. Figures given in both columns separately indicate separate determination for sodium and for potassium.
(4) Analysis by Margaret D. Foster, chemist, U. S. Geological Survey.
(4a) Analysis by Howard Stoltenberg, chemist, Division of Sanitation, Kansas State Board of Health.
(5) See Table 14 for total and excess alkalinities.
(6) Analysis by E. O. Holmes, chemist, Division of Sanitation, Kansas State Board of Health.
(7) Less than 0.15 part per million.
(8) Analysis by W. M. Noble, chemist, U. S. Geological Survey.
(9) Analysis by Selma Gottlieb, chemist, Division of Sanitation, Kansas State Board of Health.
(10) Includes equivalent of 17 parts per million of carbonate.

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TABLE 14.—*Total and excess alkalinities of waters for which analyses are given in Table 13, in parts per million*

Well or sample number	Total Alkalinity	Excess Alkalinity	Well or sample number	Total Alkalinity	Excess Alkalinity
B	290	2	415	168	39
C	312	34	419	164	27
213	320	2	RR	108	16
220	314	61	423	213	54
O	354	86	426	194	49
R	176	31	429	218	53
291	154	5	433	186	62
V	189	19	436	188	46
W	180	12	440	193	65
X	162	24	448	192	32
299	204	60	448a	204	53
300	168	23	449	226	80
300a	154	27	449a	222	83
300b	156	24	450	166	37
300c	190	12	452	213	70
Z	162	35	455	222	46
AA	160	34	459	212	55
BB	153	35	462	234	26
CC	98	1	462a	226	34
309	154	31	463	246	60
310	148	15	463a	232	83
311	147	29	463b	222	80
314	144	23	SS	258	42
317	150	19	465	266	61
322	154	29	471	262	57
327	112	20	472	266	67
328	98	12	473	268	39
328a	99	9	476	270	41
329	147	29	479	255	63
329a	172	44	486	116	12
329b	171	24	486a	240	32
330	184	41	487	264	7
333	148	33	491	230	28
339	196	50	494	260	15
355	194	45	496	136	10
355a	69	6	497	236	76
371	180	20	497a	222	62
375	106	4	TT	170	39
MM	140	9	FFF	256	32
NN	170	18	GGG	270	11
400	212	41	572c	274	10
400a	224	58	572e	248	7
401	146	13	III	214	21
401a	150	8	589	288	46
401b	144	20	589a	284	39
403	186	26	589b	298	53
403a	232	51	594	320	43
412	170	22	NNN	320	37
412a	158	21	000	310	41

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CHEMICAL CONSTITUENTS IN RELATION TO USE

The following discussion of the chemical constituents of ground water has been adapted, in part, from publications of the United States Geological Survey.

Dissolved solids.—The residue left after a natural water has evaporated consists of rock minerals, with which may be included some organic material and some water of crystallization. Waters containing less than 500 parts per million of dissolved solids are generally satisfactory for domestic use, except for the difficulties resulting from their hardness and, in some areas, excessive corrosiveness. Waters having more than 1,000 parts per million are generally not satisfactory, for they are likely to contain enough of certain constituents to produce a noticeable taste or to make the water unsuitable in some other respects.

The ground waters from more than half the wells sampled contained between 200 and 500 parts per million of total dissolved solids and 13 percent contained less than 200 parts per million (Table 15). Total dissolved solids ranged from 81 to 60,246 parts per million, the most highly mineralized water representing contamination by oil-field brines. About 18 percent of the waters sampled ranged in dissolved solids between 500 and 1,000 parts per million, and 13 percent ranged between 1,000 and 10,000 parts. These waters generally are unfit for ordinary use. Ground waters containing the least dissolved solids occur in the sand-dune areas.

TABLE 15.—*Total dissolved solids in water samples from wells in south-central Kansas*

Total dissolved solids (parts per million)	Number of samples	Percent of total
Less than 200	30	13
201–500	127	55
501–1,000	41	18
1,001–10,000	31	13
More than 10,000	2	1

Hardness.—The hardness of water, which is the property that generally receives the most attention, is most commonly recognized by its effects when soap is used with the water in washing. Calcium and magnesium cause virtually all the hardness of ordinary waters. These constituents are also the active agents in the formation of the greater part of the scale formed in steam boilers and in other vessels in which water is heated or evaporated.

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In addition to the total hardness, the table of analyses shows the carbonate hardness and the noncarbonate hardness. The carbonate hardness is that due to the presence of calcium and magnesium bicarbonates. It is almost completely removed by boiling. In some reports this type of hardness is called temporary hardness. The noncarbinate hardness is due to the presence of sulfates or chlorides of calcium and magnesium, it cannot be removed by boiling, and it has sometimes been called permanent hardness. With reference to use with soaps, there is no difference between the carbonate and noncarbonate hardness. In general, the noncarbonate hardness forms harder scale in steam boilers.

Water having a hardness of less than 50 parts per million is generally rated as soft, and its treatment for the removal of hardness under ordinary circumstances is not necessary. Hardness between 50 and 150 parts per million does not seriously interfere with the use of water for most purposes, but it does slightly increase the consumption of soap, and its removal by a softening process is profitable for laundries or other industries using large quantities of soap. Waters in the upper part of this range of hardness will cause considerable scale on steam boilers. Hardness above 150 parts per million can be noticed by anyone and if the hardness is 200 or 300 parts per million, it is common practice to provide a municipal water softening plant. Where municipal water supplies are softened, an attempt generally is made to reduce the hardness to about 60 or 80 parts per million. The additional improvement resulting from further softening of a whole public supply usually is not deemed worth the increase in cost.

Water samples collected from wells in this area ranged in hardness from 45 to 12,668 parts per million. Fifty-nine percent of the samples had a hardness between 100 and 300 parts per million (Table 16). Six percent had less than 100 parts per million of

TABLE 16.—*Hardness of water samples from wells in south-central Kansas*

Total hardness (parts per million)	Number of samples	Percent of total
Less than 100	13	6
101–200	83	36
201–300	53	23
301–500	59	25
501–1,000	12	5
More than 1,000	11	5

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hardness, 5 percent had a hardness between 500 and 1,000 parts, and 5 percent had a hardness greater than 1,000 parts.

Iron.—Next to hardness, iron is the constituents of natural waters that, in general, receives the most attention. The quantity of iron in ground waters may differ greatly from place to place, even though the waters are derived from the same formation. If a water contains much more than 0.1 part per million of iron, the excess may be precipitated as a reddish sediment. Iron, which may be present in sufficient quantity to give a disagreeable taste and to stain cooking utensils, may be removed from most waters by simple aeration and filtration, but a few waters require the addition of lime or some other substance.

Iron in the samples of water collected ranged from 0 to 400 parts per million. Forty-three percent of the samples collected contained less than 0.15 part per million (Table 17), and 7 percent contained more than 4 parts per million. In general, the highest iron content was found in waters contaminated by oil-field brine and in the sand-dunes area.

TABLE 17.—*Iron in water samples from wells in south-central Kansas*

Iron (parts per million)	Number of samples	Percent of total
Less than 0.15	101	43
0.15–1.0	70	30
1.1–2.0	32	14
2.1–3.0	9	4
3.1–4.0	4	2
More than 4.0	15	7

Fluoride.—Although determinable quantities of fluoride are not so common as fairly large quantities of the other constituents of natural water, it is desirable to know the amount of fluoride present in water that is likely to be used by children. Fluoride in water has been shown to be associated with the dental defect known as mottled enamel, which may appear on the teeth of children who, during the period of formation of the permanent teeth, drink water containing fluoride. It has been stated that waters containing more than 1.5 parts per million of fluoride are likely to produce mottled enamel. If the water contains as much as 4 parts per million of fluoride, 90 percent of the children drinking water are likely to have

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mottled enamel, and 35 percent or more of the cases will be classified as moderate or worse. Recent investigations indicate that small amounts of fluoride in drinking water, up to one part per million, may have a beneficial effect in the way of inhibiting decay of teeth.

The amount of fluoride in the water samples collected ranged from 0 to 1.7 parts per million. All but 2 of the samples contained less than one part per million of fluoride.

Chloride.—Chloride is widely distributed in nature; it is an abundant constituent of sea water and oil-field brines and is dissolved from most rock materials. Chloride has little effect on the suitability of water for ordinary use, unless there is enough present to impart a salty taste and render the water unpalatable. Waters high in chlordie content may be corrosive if used in steam boilers. Chlorides of calcium and magnesium contribute to the hardness of water in a manner similar to the sulfates and carbonates of these elements. The removal of chloride from water supplies is difficult and expensive.

The chloride content of ground waters in this area varies widely and is shown graphically on Plate 29. The highest concentration of chloride is found in ground water in the oil fields near Burrton, Canton, Galva, and the area south of McPherson. As is pointed out on succeeding pages, ground water near Arkansas River is high in chloride, which was one of the principal reasons for changing the source of the Wichita municipal water supply. Ground water in many parts of the area contains very little chloride.

SALT-WATER INTRUSION

The intrusion of salt water into streams or formations carrying fresh water is a serious matter in many parts of Kansas including parts of the area described in this report. The three principal sources of salt water that endanger fresh water supplies in Kansas are: (1) oil-field brines; (2) natural salt springs and salt marshes; and (3) industrial wastes. In this area oil-field brines are believed to be the principal sources of salt-water intrusion, but the other sources listed are important just upstream from this area; hence salt water from these sources is carried into this area—principally by Arkansas River but in part by moving ground waters and by other surface streams.

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Intrusion from Streams

Above Great Bend Arkansas River carries fresh water having a relatively low chloride content. Below Sterling and particularly below Hutchinson, however, the river water contains sufficient chloride at normal or lower stages to be classed as brackish or salty. A large part of this salt is believed to come from salt marshes along Rattlesnake Creek in Stafford and Reno Counties and from industrial wastes which enter Cow Creek in Barton and Rice Counties. The areas embraced by these marshes are underlain principally by unconsolidated Pleistocene sediments which in turn are underlain by Cretaceous sandstone and shale and by Permian rocks. Thick salt beds in the Permian rocks underlie the area westward from Hutchinson and formerly extended somewhat farther eastward. These salt beds are mined commercially at Hutchinson, Lyons, and other points west of this area, and together with oilfield waste waters disposed of in this drainage area seem to be the most likely original source of the salt water. The Cretaceous sandstones, however, are known to contain salt water farther west and may supply some of the salt marshes.

During the winter of 1934-35 the chloride content of several streams was determined by Wilhelm, Torne, and Pryor (1936, pp. 17-19) in a cooperative investigation by the U. S. Bureau of Mines and the Kansas State Board of Health. The results are given in Tables 18, 19, and 20.

TABLE 18.—*Chloride content of the Arkansas River*

(Parts per million)

SAMPLING POINT	First survey (*a*)	Second survey (*b*)
At Great Bend	102	65
At Ellinwood above Ellinwood field	98	72
Below Ellinwood field and above Silica	108	82
Below Silica and above Raymond field	194	90
Below Raymond field and above mouth of Rattlesnake Creek	214	142
Below mouth of Rattlesnake Creek	460	392
Two miles west of Hutchinson	460	392
Two miles southeast of Hutchinson below sewage outlet	1,895	750

(*a*) Discharge zero at Larned; 1 cubic foot per second at Wichita.
(*b*) Discharge 135 cubic feet per second at Wichita.

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TABLE 19.—*Chloride content of Rattlesnake Creek*

(Parts per million)

SAMPLING POINT	First survey	Second survey
Approximately 10 miles west of Richardson field	27	23
Two miles above Richardson field	1,180	700
Three miles below Richardson field	1,295	740
One mile upstream from confluence with Arkansas River	6,520	1,750

TABLE 20.—*Chloride content of Cow Creek*

(Parts per million)

SAMPLING POINT	First survey	Second survey
T. 19 S., R. 11 W., above oil production	428	610
Above Chase field	388	430
Below Chase field	340	275
Below drainage from Lyons	.....	1,400
Two miles southeast of Hutchinson	.....	620

It is evident from the analyses that most of the salt water in Rattlesnake Creek comes from the salt marshes and not from the oil fields through which the stream flows, and the same is true for Cow Creek, which actually declines in chloride content before reaching Lyons, owing to dilution from fresh-water tributaries. The effect of Rattlesnake Creek on Arkansas River is indicated by the increase in chloride content from 214 to 460 parts per million in the first survey and a comparable increase in the second survey. It is also evident, however, that the chloride content of Cow Creek increases below Lyons and that the chloride content of Arkansas River increases markedly below the sewage outlet at Huchinson. The water discharged from large salt mines situated at each of these cities probably is largely responsible for these increases. Occasional unlawful discharges of brines directly into Arkansas and Little Arkansas Rivers from the Burrton Oil Field also has contributed temporarily to the salinity of those streams below the oil field.

During the course of the present investigation chloride determinations were made on several hundred samples of water from wells

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and from a few of the streams in the area, and were analyzed by Robert H. Hess in the Water and Sewage Laboratory of the State Board of Health. These and other chloride determinations of ground waters taken from the complete analyses (Table 13) are shown on Plate 29.

At low water stages during the fall of 1937 the chloride content of Arkansas River between Hutchinson and Wichita was as high as 1,400 parts per million and generally was more than 1,000 parts. As shown on Plate 29 the chloride content of the ground water in this part of the Arkansas River Valley ranges from several hundred parts per million to as much as 1,200 parts in wells within about a mile of Arkansas River, but, excepting the high concentration encountered in some of the oil fields, the chloride content is progressively lower in wells situated farther from the river. This seems to indicate that some salt-water intrusion takes place from the river into the alluvium, even though the river normally is in essential equilibrium with the water table (Pl. 1). The chloride content of the ground waters becomes progressively less eastward from Arkansas River toward Little Arkansas River, which is in the same direction as the movement of ground water (Pl. 1), indicating that this reduction in chloride content is due to gradual dilution of the ground water by recharge from rainfall. The old well field that formerly supplied the City of Wichita lies within the belt of salty water bordering Arkansas River; hence the water contained considerable chloride. In selecting the site for the new well field an effort was made to stay as far as practicable from Arkansas River and other sources high in chloride.

Field studies by the Bureau of Mines, the Geological Survey, and the Kansas State Board of Health have indicated that some of the smaller streams in the area have been contaminated more or less temporarily by oil-field brines or industrial wastes, notably Turkey and Running Turkey Creeks, tributaries of Little Arkansas River in McPherson County (Wilhelm and Schmidt, 1935, p. 7). Although in general such contamination has not been considered serious, some ground-water supplies near such streams have been affected. Ground waters in the northern industrial area of Wichita were affected adversely by the spread of oil-field brines formerly carried by the Wichita drainage canal until a pipeline was installed for carrying the salt water safely through the city (Jones, 1938). In planning the locations of the 25 new Wichita supply wells (Pl. 28) a wider spacing of wells was used where Kisiwa Creek crosses the well field

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in order to safeguard the water supply from possible intrusion of salt water that might be carried in the future by that creek from the Burrton oil field.

Intrusion of Oil-field Brines

In the oil fields of the area considerable brine is produced with the crude petroleum, although the relative amounts of oil and salt water produced vary widely in different wells and in wells from different producing formation, and depend in part on the age of the oil field. Typical oil-field brines from this area contain from about 14,000 to about 145,000 parts per million of chloride (Schoewe, 1943, pp. 52-59).

Schmidt and Devine (1929, p. 8) list the following means by which the disposal of oil-field brines may be effected: (1) "evaporation" ponds, (2) evaporation for recovery of dissolved constituents, (3) diversion into surface streams, and (4) return to subsurface formations. In this area, as in most other parts of Kansas, oil-field brines have been disposed of mainly by methods (1) and (4), as method (2) generally is not practicable unless a sufficient quantity of rare salts can be recovered, and method (3) is prohibited by law.

The disposal pond or so-called "evaporation" pond was the most commonly used means of handling salt water in the oil fields of the area until relatively recently, owing to the comparatively low initial and operating costs (Pl. 30). Such pits commonly have an area of from 500 to 10,000 square feet and a depth of from 1 to 15 feet (Pl. 31). In most parts of the area where such ponds are used, however, most of the brine escapes by seepage into the pervious surficial materials and thence into the ground-water reservoirs or the streams or both. The intrusion of salt water from "evaporation" ponds into ground-water reservoirs has been proven in many places by analyzing samples of water from nearby wells or test holes, and by experiments indicating that the rate of disappearance of the water is several times as great as it should be, based on an approximate average rate of evaporation for Kansas. Thus Wilhelm and Schmidt (1935, p. 18) computed that of the average daily production of 16,000 barrels of brine put into "evaporation" ponds in the Ritz-Canton oil field, in McPherson County, probably only about 1,720 barrels a day were evaporated, leaving about 14,280 barrels of salt water a day that either entered the fresh-water formations or the surface streams. Some of the resulting contamination

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PLATE 30. Aerial photograph showing disposal ponds and other installations in an oil field in McPherson County. Note the extreme flatness of this area. U. S. Department of Agriculture photograph.

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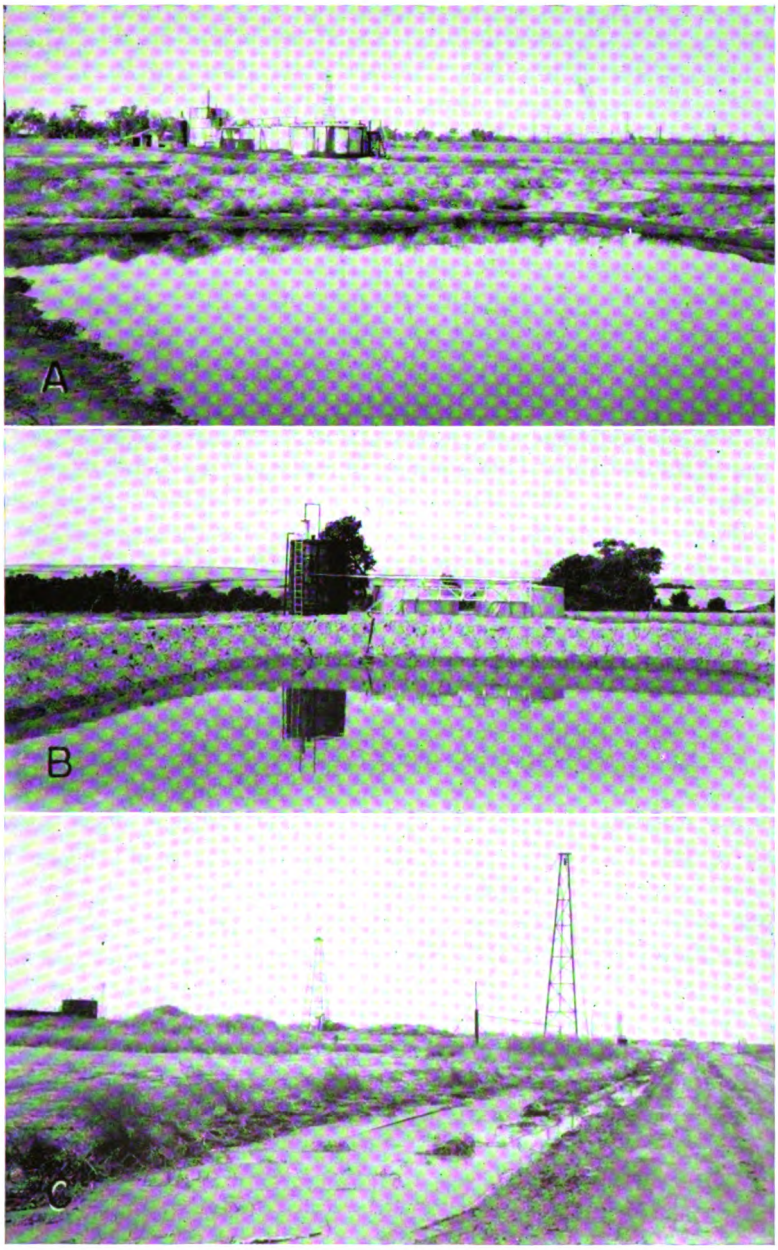

PLATE 31. Contamination of ground-water reservoirs by oil-field brines. *A, B,* Brine-disposal ponds. *C,* Brine from near-by oil wells allowed to flow along road ditch. Photographs *A* and *C* by S. W. Lohman, *B* by C. C. Williams.

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of ground waters in the Ritz-Canton area is shown on Plate 29, and has been described in detail by Wilhelm and Schmidt (1935).

Through the efforts of the Kansas State Board of Health, most ponds are being replaced by safer means of disposal but large quantities of brine already have been allowed to enter bodies of fresh ground water through disposal ponds, by careless spilling of brine on pervious surficial materials (Pl. 31C), from leaky oil-well or disposal-well casings, or from improperly plugged holes. The most satisfactory means of disposal yet devised for inland areas is the return of brines to deep subsurface formations, either through abandoned oil wells, "dry" holes, or wells put down especially for disposal (Jones, 1945).

Intrusion of oil-field brine in the Burrton oil field.—The Burrton oil field, one of the most productive in the state, occupies a large area in the Arkansas River Valley in eastern Reno County, and extends about 1½ miles into western Harvey County. The field is underlain by beds of sand, gravel, silt, and clay to depth of 100 to more than 250 feet, which in turn rest upon shale of Permian age. The aluvium contains a large supply of ground water that is fresh except near Arkansas River, as described above, and where local salt-water intrusion from oil-field brines has taken place. Salt-water intrusion in this field is a potential hazard to the new well field of the City of Wichita situated 6 miles downstream and for this reason it has been given special attention by the State Board of Health and by the State and Federal Geological Surveys.

The Burrton oil field was discovered in February 1931 before the wide-spread development of brine-disposal wells; hence for many years all the oil-field brine produced in this field was run into so-called evaporation ponds. Chloride surveys made by the State Board of Health indicated that salt-water intrusion was taking place, and that farm wells near the ponds yielded water high in chloride. Through the efforts of the State Board of Health the producers were encouraged to return the brine to subsurface formations by means of disposal wells. According to Ogden S. Jones, Geologist in Charge of the Oil-Field Section of the Division of Sanitation of the State Board of Health, of an average of 44,047 barrels of brine produced daily in 1939, 34.7 percent was handled by deep disposal wells, 27.5 percent by disposal wells of shallow or intermediate depth, and 37.8 percent by brine ponds. Shallow disposal wells into the Wellington salt proved to be unsatisfactory, as the high pressure under which the brine was forced down these wells

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caused brine to escape to the surface around the casings of nearby wells, and thereafter efforts were made to eliminate the use of shallow disposal wells. According to Mr. Jones, the completion of additional deep disposal wells in this field by late 1944 allowed the return of about 95 percent of the brine through deep disposal wells, about 3 percent through disposal wells of intermediate depth, and only about 2 percent to brine ponds. As soon as possible, it is hoped that all brine can be conducted to deep disposal wells. When this goal is reached, salt-water intrusion in this field should virtually cease, except for occasional leaks in brine lines and disposal wells. During the years in which many evaporation ponds were in use, however, a large quantity of brine found its way into the groundwater reservoir.

Studies made in the Burrton oil field by the State Board of Health have included periodic sampling of representative ground and surface waters; determinations of direction of ground-water movement using fluorescein; construction of maps showing the locations of all brine ponds, brine tanks, and pipe lines, and repressuring and dis-

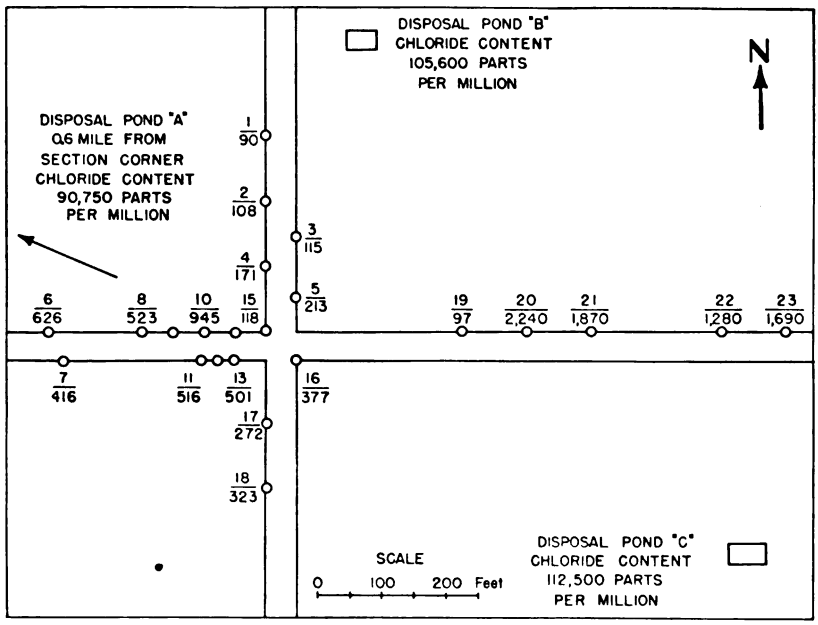

FIG. 27. Map of an area in the Burrton oil field showing location of test wells and brine-disposal ponds in survey A. Upper number corresponds to number of test well in Table 21; lower number is maximum chloride content of water, in parts per million.

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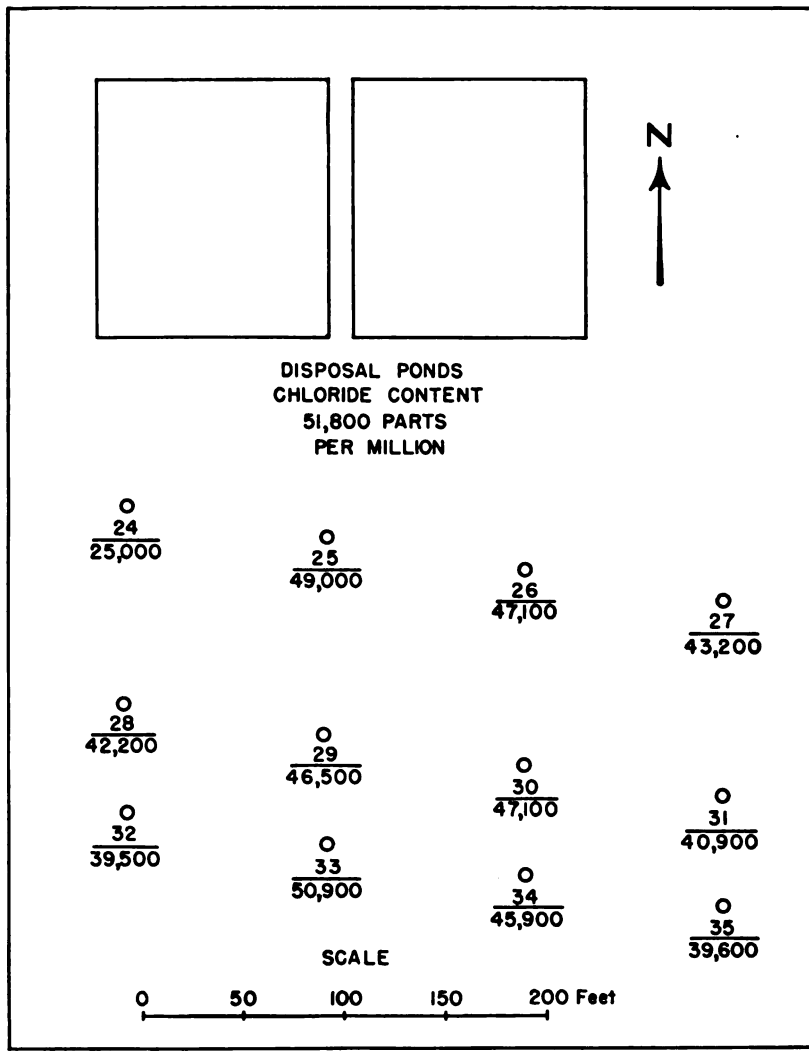

FIG. 28. Map of an area in the Burrton oil field showing location of test wells and brine-disposal ponds in survey B. Upper number corresponds to number of test well in Table 21; lower number is maximum chloride content of water encountered, in parts per million.

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posal wells; and the sinking of auger holes adjacent to brine ponds in order to determine the chloride content of the ground water.

Additional studies of salt-water intrusion were made in this field in 1938 by the State and Federal Geological Surveys in coöperation with the State Board of Health and the City of Wichita. In the course of this work 35 driven wells were put down in order to study the lateral and vertical migrations of oil-field brines. The wells were driven at selected points on the downstream sides of disposal ponds, and the water samples were taken at vertical intervals of 5 feet, using a pitcher pump. The chloride content of the waters sampled was determined in a portable laboratory mounted on a truck (Pl. 4). It was found in general that the brine, being heavier than fresh water, sinks with surprisingly little diffusion or dilution until it encounters an impervious stratum. It then flows laterally in a relatively thin layer on top of this impervious stratum. In material containing discontinuous lenses or beds of impervious clay and silt, the brine may follow a "stair-step" course from one impervious bed to another, moving gradually downward and laterally.

The results of surveys at two typical areas in the Burrton oil field that have suffered salt-water intrusion are given in Table 21, and the locations of the test wells are shown in Figures 27 and 28. In both areas tested the ground water moves in a general southwesterly direction (Pl. 1).

It will be noted that there has been very little dilution of the brine within the distances sampled in survey B (Fig. 28) but considerable dilution has taken place at most of the points tested in survey A (Fig. 27), although the moving brine seems to have followed certain "pipes" or "veins" of more permeable material rather than having diffused uniformly. Thus the movement of brine from disposal pond B in Figure 27 seems to have been more directly toward test well 20, but in a general way toward test wells 20-23.

The results given in Table 21 indicate that in most of the test wells the maximum concentration of chloride is found just above a relatively impervious stratum—generally one through which it was difficult to drive the well point. In some test wells, however, impervious strata served to separate relatively fresher water above from salty water below as in no. 7 at 37-39 feet, no. 9 at 14-31 feet, no. 18 at 38-40 feet, no. 27 at 19-21 feet, and no. 28 at 19-31 feet. In a few test wells, such as no. 4, the maximum chloride content was found just above an impervious stratum and fresher water was encountered just below this bed, suggesting that the salty water was

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TABLE 21.—*Chloride content at given depths in test wells, in parts per million*

Depth (feet)	Chloride content
(Survey A)	
Test well 1	
8–10	74
13–15	90
18–20	74
23–25	69
28–30	68
33–35	71
38–40	71
43–45	71
48–50	69
50–52	67
52–	(*a*)
Test well 2	
9–11	108
14–16	74
19–21	68
24–26	68
29–31	71
30.5–32.5	71
32.5–	(*a*)
Test well 3	
11–13	74
16–18	69
21–23	68
26–28	69
31–33	72
36–38	97
41–43	115
46–48	105
48–	(*a*)
Test well 4	
15–17	54
20–22	55
25–27	59
30–32	66
35–37	160
40–42	128
42–44	136
47–49	171
52–62	(*a*)
62–64	55
64.5–66.5	53
Test well 5	
10–12	41
15–17	40
20–22	69
25–27	80
30–32	123
34–36	213
39–46	(*b*)
Test well 6	
21–23	58
26–28	57
31–33	63
36–38	121
41–43	342
46–48	626
50.5–52.5	398
52.5–	(*b*)
Test well 7	
12–14	56
17–19	(*a*)
22–24	49
27–29	60
32–34	65
37–39	(*a*)
40–42	216
42–44	416
44–46	(*b*)
Test well 8	
15–17	136
20–22	156
25–27	101
30–32	180
35–37	272
40–42	476
45–47	523
47–49	(*b*)
Test well 9	
9–11	107
14–31	(*a*)
34–36 (*c*)	252
36–38 (*c*)	307
Test well 10	
9–11	382
14–16	63
19–21	72
24–26	130
29–31	173
34–36	302
39–41	481
44–46	653
49–51	664
53–55	945
55–	(*b*)
Test well 11	
16–18	107
21–23	92
26–28	137
31–33	152
36–38	272
Test well 11 (Cld.)	
41–43	516
46–48	470
48–	(*b*)
Test well 12	
23–25	97
28–30	142
33–35	177
38–40	362
43–45	591
48–50	691
50–52	(*b*)
Test well 13	
28–30	152
33–35	182
38–40	446
40–42	501
42–	(*b*)
Test well 14	
12–14	51
17–19	62
22–24	93
27–29	130
32–34	232
37–39	441
40.6–42.6	486
42.6–	(*b*)
Test well 15	
11–13	70
14–16	31
19–21	(*a*)
24–26	63
29–31	79
34–36	118
39–61	(*a*)
61–63	53
65–67	55
67–	(*d*)
Test well 16	
28–30	116
33–35	247
37.5–39.5 (*c*)	377
Test well 17	
24–26	84
29–31	86
34–36	255
39–41	272
44–46	142
48–50	216
50–51	(*b*)

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TABLE 21.—*Chloride content at given depths in test wells, in parts per million—Concluded*

Depth (feet)	Chloride content
Test well 18	
28–30	70
33–35	81
38–40	(*a*)
40–42	323
43–45	292
46–48	107
48–49	(*b*)
Test well 19	
20–22	71
25–27	71
30–32	83
35–37	97
40–42	91
42–44	85
44–	(*d*)
Test well 20	
28–30	69
33–35	69
38–40	71
43–45	70
47–49	2,240
49–50	(*b*)
Test well 21	
22–24	72
27–29	70
32–34	69
37–39	68
42–44	67
47–49	571
52–54	1,870
54–56	1,720
55.5–57.5	1,620
57.5–	(*b*)
Test well 22	
26–28	68
31–33	69
36–38	109
41–43	235
46–48	820
51–53	1,280
52–54	1,170
(Survey B)	
Test well 23	
18–20	77
23–25	75
28–30	69
33–35	84
38–40	203
43–45	342
48–50	701
50–52	741
53–55	1,430
56–58	1,690
57–59	(*b*)
Test well 24	
14–16	1,790
19–21	6,930
24–26	7,800
29–31	18,900
31–33	25,000
33–34	(*b*)
Test well 25	
24–26	21,500
29–31	43,400
34–36	41,500
36–38	49,000
38–39	(*b*)
Test well 26	
22–24	42,800
27–29	41,500
29–31	47,100
31–60	(*b*)
60–	(*d*)
Test well 27	
14–16	1,800
19–21	(*a*)
23–25	24,800
28–30	43,200
30–33	(*b*)
Test well 28	
14–16	630
19–31	(*a*)
33–35	17,900
38–40	42,200
40–42	(*b*)
Test well 29	
24–26	2,550
29–31	25,000
34–36	44,600
39–41	46,500
41–42	(*b*)
Test well 30	
26–28	28,400
31–33	46,500
35–37	47,100
37–38	(*b*)
Test well 31	
12–14	267
17–19	1,530
22–24	7,800
27–29	32,000
32–34	40,900
Test well 32	
32–34	14,200
37–39	39,500
39–40	(*b*)
Test well 33	
23–25	1,900
28–30	6,800
33–35	39,000
38–40	50,300
41–43	50,900
43–44	(*b*)
Test well 34	
22–24	1,920
27–29	8,500
32–34	37,000
37–39	45,900
39–40	(*b*)
Test well 35	
19–21	1,100
24–26	7,820
29–31	36,500
34–36	39,600
36–37	(*b*)

(*a*) No water obtained; probably clay or silt.
(*b*) Drove hard, no water obtained; probably hard clay or silt.
(*c*) Drove hard, probably hard silty or clayey sand.
(*d*) Could not drive deeper.

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unable to reach the lower water-bearing bed. In some test wells, such as no. 20, there was a surprisingly sharp separation between layers of fresh and salt waters, but in others, such as nos. 6, 21, 22, and 23, the chloride concentration increased gradually with increase in depth.

Two of the test wells (4 and 23) put down in survey A were left cased so that further observations could be made; the rest of the test holes put down in the two surveys were filled, pulled and plugged. The pipe in test well 4 was pulled back from an initial depth of 66.5 feet to 13 feet, but the pipe in test well 23 was left at the original depth of 59 feet. The periodic measurements of water levels and chloride determinations in these test wells through January 9, 1945 are given in Table 22. A rather gradual but noticeable in-

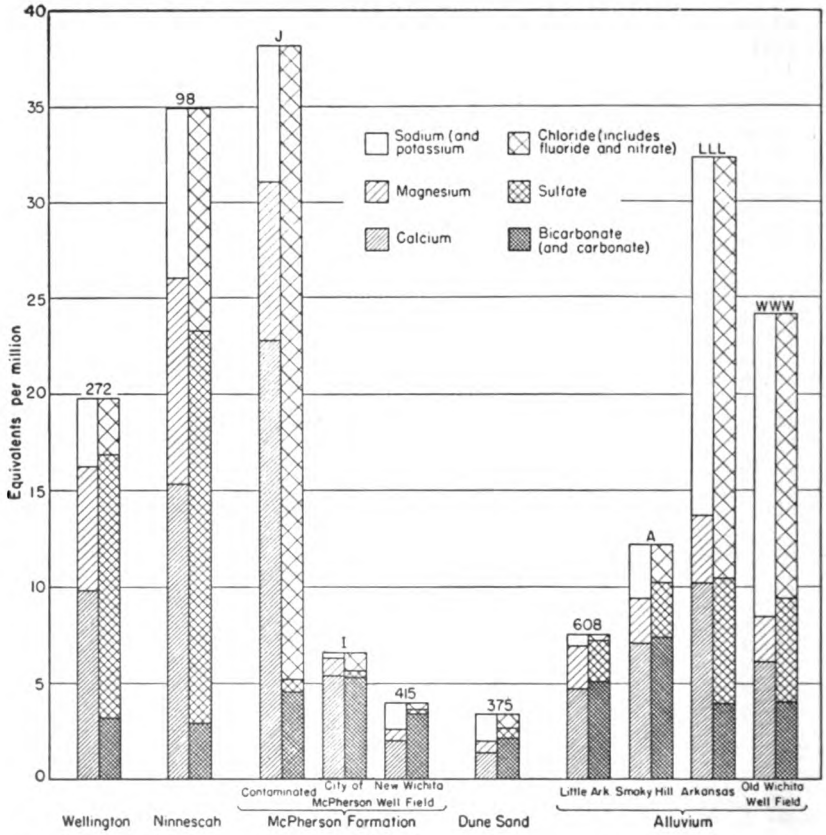

FIG. 29. Analyses of waters from principal water-bearing formations in south-central Kansas.

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crease in the chloride content took place in test well 23 throughout most of the period of record, but in test well 4 the significant increase did not occur until April 14, 1942 and later. As indicated in Table 22, the chloride content at a depth of 49 feet in test well 4 was 171 parts per million so that doubtless the chloride content at this depth by January 9, 1945 was considerably higher than 2,380 parts per million—the value for a depth of only 13 feet.

QUALITY OF WATER IN RELATION TO STRATIGRAPHY

The chemical quality of the water in the principal water-bearing formations of this area has been discussed above for each formation separately. Analyses of water representative of the several formations are shown graphically on Figure 29. The graphs afford a comparison of the different waters, show variations in quality within the McPherson formation and alluvium, and indicate the effect of contamination.

SANITARY CONSIDERATIONS

The analyses of water given in Table 13 show only the amounts of dissolved mineral matter in the water and do not indicate the

TABLE 22.—*Water level and chloride content of water in test wells 4 and 23 from 1938 through 1944*

DATE	Test well 4 (Depth 13 feet)		Test well 23 (Depth 59 feet)	
	Depth to water level (feet)	Chloride content (parts per million)	Depth to water level (feet)	Chloride content (parts per million)
Nov. 22, 1938	8.89	53	.....	.....
Dec. 23	.....	.....	10.63	1,690
July 17, 1939	9.29	69	10.86	1,930
May 14, 1940	9.52	67	11.11	2,680
Dec. 5	10.35	72	11.92	1,770
Apr. 8, 1941	10.03	70	11.65	2,430
July 16	8.36	73	10.06	2,350
Oct. 20	9.25	86	10.90	2,510
Apr. 14, 1942	8.57	550	10.25	2,390
July 13	7.69	890	9.42	3,060
Oct. 7	4.80	1,170	6.59	3,400
Apr. 8, 1943	6.13	1,480	7.79	3,440
July 24	6.04	1,700	7.66	3,520
Oct. 12	8.47	1,870	10.05	3,900
Apr. 5, 1944	7.32	2,380	9.01	3,970
July 11	.....	.....	7.27	3,640
Sept. 26	7.00	2,370	8.55	3,880
Jan. 9, 1945	7.57	2,380	5.14	4,070

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sanitary quality of the water. An abnormal amount of certain mineral matter, such as nitrate, however, may indicate pollution of the water.

A large part of the population of this area is supplied with water from carefully constructed city-supply wells which meet the requirements of and are periodically inspected by the Division of Sanitation of the Kansas State Board of Health. However, much of the population is dependent upon private water supplies from wells, and every precaution should be taken to protect these supplies from pollution. A well should not be located where there are possible sources of pollution, such as points just downstream from barnyards, privies, and cesspools, and every well should be tightly sealed down to a level somewhat below that of the water table. As a general rule, dug wells are more subject to contamination from surface water than are drilled wells, chiefly because they generally are not effectively cased or sealed at the surface. Drilled wells generally are well protected by the casing, although many are poorly sealed at the top.

UTILIZATION OF WATER

During the course of the investigation information was obtained on 727 wells in this area (Table 37). All known public-supply wells and most of the industrial wells were visited, and all available data concerning them were obtained. No attempt was made to obtain data on all the domestic and stock wells, and no well inventory was made in some parts of the area (Pl. 5).

DOMESTIC AND STOCK SUPPLIES

Most of the rural residents and the residents of some of the smaller towns in this area derive their domestic water supplies from drilled and driven wells of small diameter equipped with cylinder or pitcher pumps operated by windmill or by hand. In parts of the area underlain by Permian shale many of the domestic and stock supplies are derived from large-diameter dug wells. Some farm homes have pressure water systems and the wells are equipped with small centrifugal pumps. In the sand hills, an area largely devoted to grazing, livestock is watered from shallow driven wells. In the area underlain by Kiowa shale livestock supplies are generally derived from drilled wells equipped with windmills, although springs and seeps are important sources of stock water. Most of the domestic and livestock wells yield only a few gallons of water a minute.

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The ground waters in this area vary greatly in chemical character, but generally are satisfactory for most domestic uses. Wells that penetrate the Wellington formation and Ninnescah shales yield water that is very hard, and cisterns are used to supply water for some uses in the areas underlain by the Permian rocks.

INDUSTRIAL SUPPLIES

The industrial uses of ground water in this area include cooling and condensing, air conditioning, manufacture of ice, manufacture of fiber products, water for steam boilers, use in the refining of petroleum products, and meat packing. The suitability of ground water for most industrial uses depends upon the chemical character and temperature of the water. Water used in boilers should be relatively free from foaming and scale forming constituents. The ground water in parts of this area is not of suitable chemical character for boiler use, and therefore it is necessary to treat the water to reduce the hardness. Large quantities of ground water are used for cooling and air conditioning, and the advantage of using ground water for this purpose is its relatively low, uniform temperature throughout the year. The temperature of most waters sampled ranged from 58 to 60 degrees F.

Wichita area.—Industrial development in Wichita and vicinity has proceeded more rapidly than in other parts of this area, and the greatest use of water for industrial purposes occurs there. In 1942, G. H. von Hein made a survey of the known industrial wells in and near Wichita; a summary of the utilization of water from these wells is given in Table 23. The quantity of water pumped from private wells for industrial use in 1942 was about 2,400 million gallons, approximately one-half the amount pumped by the City of Wichita from the new well field. Of the total quantity of water pumped, about 80 percent was used for cooling and condensing in refineries, foundries, dairies, and ice plants; about 11 percent was used for air conditioning in office buildings; and about 5 percent was used for laundries in steam boilers and for washing. It is estimated that there are about 3,000 small wells in homes in Wichita from which water is pumped for air conditioning and irrigation of lawns.

Many industries in and near Wichita are supplied with water pumped from the municipal wells. Many of the industries so supplied are listed in Table 24 together with the quantity of water used by each company. The total pumpage by the city in 1942 was

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4,962.5 million gallons, and the data given in Table 24 show that about one-fourth of this quantity was used by industry. Probably a larger part of the city supply is used industrially, because the quantity of water used by railroads and some smaller industries is not included in this summary. The data in Table 24 show that in 1942 about 40 percent of the water supplied to industry by the city was used in the manufacture of aircraft, and about 30 percent was used by the meat packing industry.

Hutchinson area.—Many industrial wells are located in Hutchinson and vicinity, but a complete inventory of these wells was not made. The principal industrial use of water in Hutchinson is air conditioning in stores, hotels, restaurants, office buildings, and private residences. Ground water is used in meat packing plants, mills, foundries, creameries, laundries, and other industries for cooling and washing. Of the many industrial wells in and near Hutchinson, data were collected for only two batteries of wells. One battery of wells is owned and operated by the Central Fibre Products Company located at the NW cor. sec. 8, T. 23 S., R. 5 W. (no. 384), and the other owned and operated by the Atchison, Topeka and Santa Fe Railway Company near the NW cor. SE¼ sec. 4, T. 23 S., R. 5 W. (nos. 382 and 383). These wells are near the south edge of the sand dunes and derive water from the McPherson formation in the Arkansas River Valley northeast of Hutchinson.

Four wells (no. 384) supply water to the Central Fibre Products Company for use in the manufacture of fiber board. These wells range in depth from 62 to 68 feet and the depth to static water level is about 22 feet. The wells supply a total of 2,500 to 3,000 gallons a minute to the factory continuously. This quantity of water is approximately equal to the quantity pumped by the Hutchinson Water Company for municipal use. The wells are relatively closely spaced and mutual interference occurs when more than one well is pumping; however, an adequate supply of water is furnished by these wells from a small area. Although the water is hard, it is not nearly so highly mineralized as water from the city-supply wells and is treated by the company before it is used. An analysis of the water from one of these wells is given in Table 13.

Two wells owned by the Atchison, Topeka and Santa Fe Railway Company (nos. 382 and 383) supply water for locomotive maintenance at the railway shops, and in addition supply water to the Cessna Aircraft Company plant and the Hutchinson airport near by. These wells are similar in construction, are about 40 feet deep,

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TABLE 23.—*Utilization of water pumped from private industrial wells in the City of Wichita and vicinity*

OWNER OR COMPANY	Annual pumpage (millions of gallons)			Use
	1940	1941	1942	
Air Reduction Sales Co.	12	12	12	Cooling and condensing
Atchison, Topeka and Santa Fe	43	43	43	Locomotive maintenance
American Laundry	14	15	18	Steam boilers and laundry
Barnsdall Refining Co.	100	200	300	Cooling and condensing
Broadview Hotel	40	40	40	Air conditioning
Cardwell Mfg. Co.	.2	.6	.5	Cooling
Central Building	20	20	20	Air conditioning
Cessna Aircraft Co.	.....	.2	.2	Air conditioning
G. C. Christopher and Sons	.2	.2	.2	Cooling
Cities Service Co.	5	5	5	Cooling and condensing
City Laundry	3	3	3	Air conditioning
Coleman Lamp and Stove Co.	104	104	72	Cooling and air conditioning
Cosine and Galley Co.	.....	.....	.3	Cooling
Crystal Ice and Fuel Co.	6	6	6	Ice manufacture
DeCoursey Creamery Co.	16	7	11	Cooling and washing
Dold and Sons Packing Co.	12	12	18	Cooling and washing
Drowatsky Greenhouse Co.	.5	.....	.....	Irrigation and cooling
Dunn-Ostertag Co.	20	20	20	Cooling
Eaton Hotel	17	17	17	Air conditioning[1]
Economy Laundry Co.	4	4	5	Steam boilers and laundry
First National Bank Building	6	6	6	Air conditioning
Fourth National Bank Building	17	17	17	Air conditioning[1]
W. W. Grinder Co.	.1	.2	.3	Cooling
Allen W. Hinkel Co.	35	35	35	Air conditioning
Hyde Park Dairy Co.	32	32	36	Cooling and washing
Independent Ice Co.	7	7	8	Cooling and ice manufacturers
Independent Laundry Co.	12	13	17	Steam boilers and laundry
George Innes Co.	35	35	35	Air conditioning
Kansas Gas and Electric Co. (office)	30	30	30	Air conditioning[1]
Kansas Gas and Electric Co. (Wichita station)	157	164	175	Boilers, cooling, condensing
Kansas Gas and Electric Co. (Ripley station)	376	376	364	Boilers, cooling, condensing
Kansas Milling Co.	36	120	129	Cooling, condensing, washing
C. P. Mueller estate	1	1	1	Irrigation and cooling
Lassen Hotel	27	27	27	Steam boilers and toilets
Lassen Hotel	13	13	13	Air conditioning
Linwood Creamery Co.	25	26	29	Cooling and washing
Miller Theater	35	35	35	Air conditioning
North Wichita Ice Co.	27	28	33	Cooling and ice manufacture
Peerless Ice Co.	43	55	85	Cooling and ice manufacture
Peerless Laundry Co.	27	29	31	Steam boilers and laundry
Public Terminal Elevator Co.	3	3	3	Air conditioning
Snyder Ice Cream Co.	30	33	36	Cooling and washing
Southwest Cracker Co.	9	9	9	Air conditioning[1]
Southwest Laundry	.7	.7	.7	Air conditioning
Steffen Ice and Ice Cream Co.	207	226	260	Cooling, condensing, and washing
Wible Ice Co.	18	18	20	Cooling and ice manufacture
Wichita Creamery Co.	75	96	122	Cooling and washing
Wichita Hospital	4	8	13	Steam boilers and laundry
Wichita Ice Co.	182	184	201	Cooling and ice manufacture
Wichita Parts Co.	.....	.....	.1	Cooling
Wichita Laundry Co.	11	27	39	Steam boilers and laundry
Total	1,897	2,163	2,401	

1. Water returned to ground-water reservoir by means of disposal well.

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TABLE 24.—*Industrial use of water from the Wichita municipal supply*
(Data furnished by the Wichita Water Company)

COMPANY	Quantity of water used (millions of gallons)		
	1940	1941	1942
Aircraft Products and Supply Co	.....	.....	.2
Aircraft Spinning Co	.....	.....	.3
Aircraft Welders	.....	.....	4.5
Aero Parts Co	.1	3.9	10.7
Beardsley and Conchman Machinery Co	.....	.1	.2
Beech Aircraft Corp	9.0	47.1	110.4
Boeing Airplane Co	18.9	64.3	206.4
Cessna Airplane Co	1.1	31.0	81.7
City Laundry	22.3	22.6	24.0
Coffman Hospital	.2	.1	.1
Coleman Lamp and Stove Co	7.1	13.9	30.6
G. C. Christopher and Sons	.4	.5	.7
Cudahy Packing Co	219.1	261.4	334.3
D. and J. Parts Co	.....	.3	.4
Davis-Westholt Aircraft Prod	.....	.....	4.6
DeCoursey Creamery Co	40.3	36.1	23.6
Dold and Sons Packing Co	1.2	1.2	15.2
Dunn-Ostertag Co	1.5	2.7	3.0
G. and H. Tool Mfg. Co	.....	.2	1.9
Hyde Park Dairy	2.2	3.0	3.1
Kansas Gas and Electric Co	.6	4.5	14.9
Kansas Milling Co	6.9	24.2	25.4
Krehbiel Plaster Prod. Co	.....	.....	1.2
Langdon Tent Co	.....	.3	1.7
Linwood Creamery Co	.....	.....	1.6
Municipal Airport	6.6	10.3	9.5
Peerless Ice Co	10.6	11.1	16.9
Ponca Tent and Awning Co	.1	.1	.1
Service Foundry Co	.2	.3	.3
Snyder Ice Cream Co	.8	.5	2.7
Southwest Laundry	3.1	3.9	9.5
Southwest Uniform Co	.2	.3	.4
Steffens Ice and Ice Cream Co	.1	.1	6.9
Swallow Airplane Co	.5	.8	1.1
Unit Tool Assoc	.....	.....	1.0
Veterans Hospital	21.8	18.7	16.6
Watkins, Inc	1.6	3.4	4.9
Wesley Hospital	21.1	23.7	30.6
Western Iron and Foundry Co	.9	1.3	1.7
Wichita Creamery Co	2.6	1.5	2.8
Wichita Ice Co	5.1	6.9	6.3
Wichita School System	96.4	108.7	98.8
Wichita Towel Supply Co	.....	.....	4.5
Total	502.6	709.0	1,115.3

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are equipped with 215 gallon-a-minute turbine pumps, and are about 300 feet apart. Estimates of the railway company indicate that the quantity of water pumped is about 7.5 million gallons a month during the summer and about 3.5 million gallons a month throughout the remainder of the year.

McPherson area.—The principal industrial plants using ground water in the McPherson area are oil refineries. Smaller industries in McPherson are supplied with water from the municipal wells. Water is used industrially in the oil fields near McPherson and is derived from small wells on the leases.

The refinery of the Bay Petroleum Corporation is supplied with water from two wells (nos. 83 and 84) located on the plant property. Well 83, at the west side of the refinery grounds, yields about 600 gallons a minute with a drawdown of 56 feet. Well 84, about a quarter of a mile east from well 83, yields about 75 gallons a minute with a drawdown of 75 feet. The difference in the yield of the two wells is due mainly to the thinning of the McPherson formation eastward from the McPherson channel, and also to differences in construction of the wells. In 1944 the refinery was using all the water that could be produced from the two wells.

The refinery of the National Cooperative Refinery Association is supplied with ground water from three wells (nos. 119, 120, and 122) located in the NE¼ sec. 5, T. 20 S., R. 3 W. A fourth well (no. 121), which formerly furnished part of the supply, failed in 1943 owing to deposition of minerals from the ground water in the gravel wall and screen. Well 122 was drilled in 1944, and when tested it yielded 1,100 gallons a minute with a drawdown of 39 feet. The refinery uses about 1,500 gallons of water a minute continuously. The wells penetrate the coarse sand and gravel deposits of the McPherson channel.

Other areas.—In Newton, the Newton Ice Company operates three wells (nos. 269, 270, and 271) having an aggregate yield of 135 gallons a minute. The Halstead Ice Company is supplied with water from well 342, and uses about 3,000 gallons a day. The water pumped from the ice-plant wells is used for cooling condensers. The Kansas Power and Light Company plant near Galva uses about 30,000 gallons of water a day from well 71 in steam boilers and for cooling. The Eldon Gas Company plant is supplied with ground water for cooling purposes from wells 529 and 530.

The Missouri Pacific Railroad Company operates wells 22, 23,

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and 28 at Marquette and well 590 at Mt. Hope. Water from these wells is treated to reduce the hardness and is used in locomotive boilers. The Chicago, Rock Island, and Pacific Railway Company operates well 73 at Galva and well 144 at Groveland for locomotive use. Data are not available concerning the quantity of water pumped from these railroad wells. The Atchison, Topeka and Santa Fe Railway Company is supplied with water at Newton from the municipal wells, and uses about one-half the total quantity pumped from the Newton well field.

IRRIGATION SUPPLIES

During periods of drought, especially from 1930 to 1936, wells were drilled for irrigation in parts of this area. Most of the irrigation wells have been abandoned since 1937 and only one large pumping plant was operated during the time this investigation was in progress. A few small wells are pumped for the irrigation of small orchards, gardens, lawns, etc., but the aggregate pumpage from these wells is small, even in periods of drought.

Wells 302, 303, and 304 are owned by Mr. Harvey Hensley, Halstead, Kansas, and are used to irrigate alfalfa and corn grown in the SW¼ sec. 22, T. 23 S., R. 2 W. The wells are 48 inches in diameter, are gravel walled, and each yields about 250 gallons a minute with a small drawdown. The wells penetrate the alluvium of Little Arkansas River Valley and the McPherson formation. The Hensley farm has been irrigated for several years, but the wells were not pumped in 1944 and 1945. Pumpage for 1939 is given in Table 25.

TABLE 25.—*Pumpage during 1939 from 3 irrigation wells on the Harvey Hensley farm in the SW¼ sec. 22, T. 23 S., R. 2 W., Harvey County*

MONTH	Pumpage in millions of gallons
May	14.4
June	10.5
July	3.4
August	None
September	6
October	None
November	6.8
December	11.3
Total	52.5

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PUBLIC SUPPLIES

Eighteen cities in the area have public water supplies, all of which are obtained from wells. The average daily consumption by these 18 cities aggregates about 25.2 million gallons of which 71 percent, or about 18 million gallons, is used by the City of Wichita—the largest city in the State.

The supplies are described below in the alphabetical order of the cities.

Buhler

Buhler (population 634) was supplied by the city prior to the spring of 1938 from three drilled wells (258, 259, 261) south of the city, that yielded from 40 to 58 gallons a minute each from fine-grained sand in the alluvium of the Little Arkansas River Valley. Because of the small yield and trouble resulting from the fine sand, these wells were abandoned after construction of two new wells (253, 254) situated 4 miles east of the city. The new wells, which have supplied the city since the spring of 1938, are 98 and 88 feet deep, and obtain water from coarse sand of the McPherson formation along the western part of the McPherson channel. When drilled the wells yielded 269 and 201 gallons a minute with drawdowns of 7.7 and 2.0 feet, respectively. The water is forced through a 4-mile pipeline by the electrically driven turbine pumps on the wells and thence directly into the distribution mains, the excess water being stored in an elevated steel tank holding 50,000 gallons. The average water pressure is about 45 pounds to the square inch. Analyses of water from one well (253) in the new well field and one aban-

TABLE 26.—*Monthly and annual pumpage of water by the City of Buhler, Kansas, in thousands of gallons*

	1940	1941	1942	1943	1944
January	1,026.0	855.3	863.4	815.2	615
February	1,026.0	887.1	820.0	738.0	640
March	576.7	800.4	757.1	854.4	571
April	758.9	954.8	921.4	1,162.8	621
May	656.8	1,541.2	915.1	1,156.9	781
June	1,147.2	1,454.4	1,351.9	1,364.1	1,906
July	2,382.6	1,950.8	1,742.7	1,563	1,658
August	1,599.6	2,093.8	1,516.9	2,127	1,588
September	1,064.4	1,366.9	1,058.3	1,096	1,042
October	1,055.8	1,131.7	903.6	710	745
November	599.7	1,023.9	922.2	760	672
December	566.5	829.4	895.3	850	673
Year	11,502.2	14,889.7	12,667.9	13,179.4	11,512

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doned well in the old well field are given in Table 13. An excessive amount of carbon dioxide in the water formerly caused corrosion of the mains, but the water is now treated to remedy this difficulty. The monthly and annual pumpage for the years 1940-44 are given in Table 26. About 10 percent of the water is used by manufacturing establishments.

Burrton

Burrton (population 842) is supplied from five wells in the city near the water tank. Well 365 is a drilled well 52 feet deep and is gravel-packed. It is equipped with a cylinder pump and electric motor, but its yield is not known. The other four (366) are also equipped with cylinder pumps and electric motors, and they yield an aggregate of 75 gallons a minute. The wells obtain water from sand and gravel in the McPherson formation. The pumps on the wells deliver the water directly to the distribution mains, the excess water being stored in an elevated steel tank holding 55,000 gallons. The average pressure is 60 pounds to the square inch, but in the event of a fire the pressure can be increased to 125 pounds by disconnecting the storage tank. The monthly and annual consumption of water based upon readings of consumers' meters is given in Table 27. It is estimated that about 40 percent more water is pumped than is indicated in the table, the loss resulting from leakage, poor meters, and use of water for fighting fires and for flushing streets and sewers. Of the amounts indicated, about 300,000 to 400,000 gallons a month is used by the St. Louis and San Francisco Railroad. The water is hard, as indicated by analysis 365 in Table 13, but is not treated.

TABLE 27.—*Monthly and annual consumption of water by the City of Burrton, Kansas, in thousands of gallons*

	1939	1940	1941	1942	1943	1944
January	890	1,000	804	980	1,095	942
February	943	910	799	899	909	975
March	819	1,299	779	857	854	893
April	977	1,067	901	918	1,033	903
May	1,632	894	968	885	1,190	890
June	1,690	1,332	1,161	1,216	1,667	1,279
July	2,058	2,311	1,178	1,556	1,822	1,975
August	1,195	2,151	1,901	1,254	1,618	1,483
September	2,018	1,376	1,223	975	1,576	1,161
October	1,429	1,202	970	968	1,136	975
November	1,057	1,049	857	841	879	1,063
December	886	911	873	884	943	961
Year	15,594	15,502	12,414	12,233	14,122	13,500

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Canton

Canton (population 796) is supplied by the city from three drilled wells (65-67) situated in the city, which obtain water from sand and gravel in the McPherson formation and in part also from sandstone in the Kiowa shale. Two of the wells are 82 feet deep, are equipped with electrically driven cylinder pumps, and each yields 38 to 40 gallons a minute. One well (67) is 70 feet deep, is equipped with an electrically driven turbine pump, and is reported to yield 60 gallons a minute. The wells discharge directly into the distribution mains which are connected to an elevated steel storage tank holding 40,000 gallons. An average pressure of 55 pounds to the square inch is maintained. The average monthly consumption is about 1.25 million gallons, about 3 percent of which is used by a railroad. Formerly pumping of an ice-plant well interfered with one of the city supply wells, but the ice plant is no longer in use so that the supply is adequate for the city. The water is very hard, as indicated by analysis 65 in Table 13, but normally the water is not treated except for ocasional additions of chloride of lime.

Galva

Galva (population 463) has been supplied by the city since September 1936 from two gravel-packed drilled wells (74, 75) situated in the city, which are 41 and 35 feet deep and obtain water from sand of the McPherson formation. One well (74) yields 123 gallons a minute with a drawdown of about 16 feet, and is pumped only a few hours each day as needed. Well 75, which yields 35 gallons a minute with the same drawdown, is pumped 12 hours daily. Each well is equipped with an electrically driven turbine pump which discharges directly into the distribution mains. Storage is provided by an elevated steel tank holding 50,000 gallons, which maintains pressures ranging from 43 to 50 pounds to the square inch. The average consumption by the inhabitants ranges from 190,000 to 475,000 gallons a month; in addition, the Chicago, Rock Island, and Pacific Railroad purchases 500,000 to 1,000,000 gallons a month from the city. The water is hard, as indicated by analyses 74 and 75 in Table 13, but is not treated.

Halstead

Halstead (population 1,397) is supplied by the city from four gravel-packed drilled wells, all of which obtain water from sand and gravel in the alluvium of the Little Arkansas River Valley and the McPherson formation. Two of the wells (339) situated in the

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northern part of the city are 106 feet deep, are connected to one electrically driven centrifugal pump, and have an aggregate yield of 500 gallons a minute with a drawdown of 14 feet. One well (340) situated near the middle of the city is 110 feet deep, is equipped with a similar pump, and yields 450 gallons a minute with a drawdown of 15 feet. The fourth well (412), which is in the southern part of the city, is 102 feet deep, is equipped with an electrically driven turbine pump, and yields about 175 gallons a minute. The well pumps discharge directly into the mains, storage being provided by an elevated steel tank which holds 50,000 gallons. Normal water pressures range from 40 to 45 pounds to the square inch, but the pressure may be increased to 60 pounds in the event of a fire. The average daily consumption was about 225,000 gallons in 1937 and about 285,000 gallons in 1940 and 1943, all of which was used by the inhabitants, industrial needs being supplied from privately owned wells. The water is hard, as indicated by analyses 339 and 412 in Table 13, but is not treated.

Water levels in wells 339 and 340 were reported to be 18 feet below land surface in August 1937. In May 1941 water levels were 18.54 to 18.74 feet below land surface in these two wells. Periodic measurements begun in June 1943 and continued through 1945 show that nonpumping water levels during this period have ranged from 8.86 to 17.92 feet below land surface in well 339, and from 10.69 to 18.98 feet below land surface in well 340. Thus, it seems that pumping in the Wichita well field has not noticeably affected water levels in the Halstead municipal wells.

Haven

Haven (population 653) is supplied by the city from three gravel-packed drilled wells in and west of the city which tap sand and gravel in the McPherson formation south of Arkansas River. Well 594 formerly comprised two wells each 55 feet deep connected to one electrically driven centrifugal pump, but prior to 1943 one well was disconnected and abandoned. The aggregate yield from both wells was 300 gallons a minute with a drawdown of 2 feet. Well 595 is 55 feet deep, is equipped with a similar pump, and yields 250 gallons a minute with a drawdown of 10 feet. Well 596, which is 48.3 feet deep, is equipped with an electrically driven turbine pump and yields about 200 gallons a minute. The water is pumped directly into the distribution mains. Storage is provided by an elevated steel tank holding 55,000 gallons, which maintains pressures ranging from 45 to 50 pounds to the square inch. The average

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daily consumption ranges from less than 60,000 to as much as 100,000 gallons. Although the water is hard, as indicated by analyses 594 in Table 13, it is not treated.

Hesston

Hesston (population 403) is supplied with water by the city. Prior to about 1942 the supply was obtained from two 8-inch drilled wells (221, 222) 88 feet deep that obtained very hard water from shale in the Wellington formation. The wells, which still supply part of the water and are available for emergency use, are equipped with electrically driven turbine pumps and yield 85 and 60 gallons a minute, respectively. During the dry years from 1931 until about 1939 the hardness of the water increased steadily presumably because of reduced recharge from rainfall, and many test holes were put down in an effort to find a supply of softer water from shallow sources. In about 1942 two shallow wells were constructed in the northeastern part of the city which yield softer water and which have since supplied about 90 percent of the water. One well is a 14-inch bored hole 30 feet deep, which obtains water from 5 feet of sand of the McPherson formation just above the shale; the other is a gravel-packed dug well 42 inches in diameter having a 12-inch screen, which also obtains water from the sand just above the shale. Each well is equipped with an electrically driven cylinder pump and each yields 7 gallons a minute. The water from all wells in use is pumped directly into the distribution mains. Storage is provided by an elevated steel tank holding 58,000 gallons, which maintains an average pressure of 50 pounds to the square inch. The average daily consumption ranges in different years from 15,000 to 20,000 gallons a day, all of which is used for domestic purposes. Analyses of water from well 222 and one of the shallow wells (analysis Oa) are given in Table 13. Although the water is hard, it is served without treatment other than occasional chlorination of the water from the shallow wells.

Hutchinson

Hutchinson (population 30,013) is supplied by the privately-owned Hutchinson Water Company (formerly by the Kansas Power and Light Company) from eight gravel-walled drilled wells (386-393) situated in different parts of the city (Pl. 5), all of which obtain water from sand and gravel in the alluvium and McPherson formation in the Arkansas River Valley. The wells range in depth from 50 to 75 feet, are equipped with electrically driven turbine or

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centrifugal pumps, and each yields from 750 to 2,000 gallons a minute. The wells discharge directly into the distribution mains and there are no storage facilities, the water pressure being maintained by turning on and off the pumps on part of the wells from time to time. To facilitate this procedure the pumps on six of the wells are controlled from a central station. Because the water from the several wells differs considerably in chemical composition, particularly in chloride content (see analyses 386-393, Table 13), wells yielding water of least desirable quality are kept in reserve for peak loads or standby use. In addition, well 394 used normally for cooling in the electrical generating plant of the Kansas Power and Light Company may be connected to the city mains to help supply water in an emergency. Although the water is hard and somewhat brackish, it is served without treatment other than chlorination. Thus though the present supply is adequate in quantity, an improvement in quality would be highly desirable and could be accomplished by obtaining all or part of the supply from wells that could be drilled near the sand hills northeast of the city. The City of Hutchinson is considering this possibility and a geologic study of the ground-water conditions along the edge of the sand dunes has been made (Williams, 1946). The average daily consumption of water is about 2.75 million gallons; the monthly and annual consumption from 1941 through 1945 are given in Table 28. In addition, considerable ground water is pumped from private wells for cooling and industrial uses.

TABLE 28.—*Monthly and annual pumpage of water for the City of Hutchinson, in millions of gallons*
(Data furnished by the Hutchinson Water Company)

	1941	1942	1943	1944	1945
January	82.0	68.0	74.8	81.7	71.0
February	75.5	61.7	67.8	72.5	64.3
March	68.1	68.9	77.8	73.2	73.2
April	59.5	65.4	82.4	66.3	69.5
May	68.6	77.5	81.3	74.6	80.8
June	78.2	70.4	91.4	95.8	81.2
July	106.6	93.6	103.4	91.3	100.2
August	89.7	78.0	114.3	90.6	100.4
September	78.0	71.9	83.1	76.2	95.1
October	68.9	71.5	81.6	64.2	80.0
November	65.3	63.1	79.1	68.8	76.7
December	64.7	68.2	84.8	71.3	82.1
Year	905.1	858.2	1,021.8	926.5	974.5

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Inman

Inman (population 507) is supplied by the city from two 80-foot gravel-packed drilled wells (204) pentrating coarse deposits in the McPherson channel 2½ miles east of the city. Each well is equipped with an electrically driven turbine pump having a capacity of 75 gallons a minute. Although this quantity is adequate, the coarse sand of the McPherson formation here would readily yield larger quantities of water if needed. The well pumps force the water through a 2½-mile pipe line directly into the distribution mains. Storage is provided by an elevated steel tank holding 33,000 gallons, which maintains pressures ranging from 48 to 52 pounds to the square inch. The average daily consumption ranges from about 33,000 gallons a day in winter to about 50,000 gallons a day in summer. Although the water is hard, as indicated by analysis 204 in Table 13, it is not treated.

Lindsborg

Lindsborg (population 1,913) is supplied by the Lindsborg Water and Light Department mainly from three shallow 6-inch drilled wells near the plant, which are connected to one electrically driven centrifugal pump yielding 500 gallons a minute, but in part as needed from two gravel-packed wells (4, 5) 73 and 92 feet deep. All wells are in the city and obtain water from gravel and sand in the alluvium of the Smoky Hill River Valley. The two deeper wells are equipped with electrically driven turbine pumps having capacities of 1,000 and 750 gallons a minute, respectively. All well pumps discharge directly into the distribution mains, and normally no storage is provided. A pressure ranging from 60 to 75 pounds to the square inch is maintained. A round concrete reservoir at ground level provides 100,000 gallons of water for use only in emergencies. The average daily consumption is about 300,000 gallons, all of which is used for domestic purposes, industrial needs being supplied from private wells. Although the water is very hard and contains 1.8 parts per million of iron, as indicated by analysis 4 in Table 13, it is not treated.

Marquette

Marquette (population 609) is supplied by the city from three dug wells (24-26) 43 feet deep, which obtain water from alluvial sand and gravel of the Smoky Hill River Valley. Two of the wells are 8 feet in diameter and are equipped with electrically driven centrifugal pumps. Well 25 is 20 feet in diameter and has sixteen 16-foot slotted pipes extending laterally from the bottom in order

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to increase the intake area. It has three centrifugal pumps, two electrically driven and one driven by a gasoline engine for emergency use. The well pumps discharge directly into the mains, the pressure being regulated by three pneumatic tanks and by pnuematically controlled switches on several of the pump motors. Records of the yield of the wells and the average daily consumption are not available. An analysis of water from well 24 is given in Table 13. The water is very hard but is not treated.

McPherson

McPherson (population 7,194) is supplied by the city from four gravel-packed drilled wells (88, 89, 90, 92) situated near the municipal light plant in the western part of the city. The wells are from 137 to 160 feet deep and obtain water from sand and gravel of the McPherson formation near the eastern margin of the McPherson channel. The wells yield from 1,200 to 2,000 gallons a minute each and are among the strongest wells in the entire area. Each well is equipped with an electrically driven turbine pump which discharges directly into the mains. Storage is provided by a concrete standpipe holding 840,000 gallons and an elevated steel tank holding 270,000 gallons. The pressure ranges from 80 to 142 pounds to the square inch. The average daily consumption has ranged from as low as 500,000 gallons to as much as 3,500,000 gallons but averages from 800,000 to about 1,000,000 gallons. The monthly and annual pumpage from 1940 through 1945 is given in Table 29. An analysis of water from well 89 is given in Table 13. Although the water is hard, it is served without treatment.

TABLE 29.—*Monthly and annual pumpage of water by the City of McPherson, in millions of gallons*

	1940	1941	1942	1943	1944	1945
January	23.4	22.2	21.7	20.1	24.7	26.2
February	20.4	20.7	18.6	19.8	22.4	22.1
March	22.6	21.6	20.9	22.7	25.1	26.2
April	23.7	23.6	20.1	24.4	23.4	23.5
May	26.3	34.6	25.4	26.2	29.3	29.3
June	46.7	33.4	26.6	37.5	49.6	30.1
July	75.6	51.8	46.0	49.1	43.5	44.8
August	43.5	46.3	31.6	64.5	57.3	52.9
September	32.6	28.6	25.2	35.4	38.9	43.8
October	33.4	21.9	23.6	36.2	28.2	29.5
November	23.5	19.5	20.9	24.0	24.9	27.6
December	22.0	20.6	20.5	23.0	26.3	31.9
Year	393.7	344.8	301.1	372.9	396.6	387.9

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Moundridge

Moundridge (population 864) is supplied by the city from three gravel-packed drilled wells (165, 166, 168) situated from 2 to 2½ miles west of the city, but wells in several different areas were used formerly. At one time a deep well (160) ending in the Wellington formation and a shallow dug well (161) in thin sand of the McPherson formation were put down at the northeastern corner of the city, but the supply was inadequate and the wells were abandoned. Similarly two wells in the southwestern part of the city were used for awhile and later abandoned because the thin deposits of the McPherson formation were inadequate to supply the city's needs. Later prospecting revealed that the McPherson formation becomes thicker toward the west approaching the deep McPherson channel and several wells were put down about 2 miles west of the city. In 1937 two of these wells were in use including well 166 which still supplies most of the water. In 1938 well 167 was put down and used for awhile, but was later abandoned and filled because the yield became greatly reduced. In 1940 wells 165 and 168 were put down and are still in use. Although these are reported to be the most productive wells now in use, well 166 is used to supply most of the water at its present pumping rate of 150 gallons a minute. The three wells now in use are equipped with electrically driven turbine pumps which force the water through a pipeline to the city and thence directly into the distribution mains. Storage is provided by an elevated steel tank holding 30,000 gallons, which maintains an average pressure of about 45 pounds to the square inch. Accurate pumpage figures are not available but the average daily consumption is reported to range from about 40,000 to about 200,000 gallons, all of which is used for domestic purposes. The water is moderately hard, as indicated by analyses 165 and 166 in Table 13, but is not treated.

Mt. Hope

Mt. Hope (population 442) is supplied by the city from two 12-inch drilled wells in the city which obtain water from the McPherson formation in the Arkansas River Valley. The system was just put into operation in the summer of 1937, when the entire supply came from one well (589) 74 feet deep, which was tested at 200 gallons a minute with a drawdown of 5 feet. In 1940 or 1941 a well having the same dimensions and yield was put down 150 feet east of well 589. Both wells are equipped with electrically driven turbine pumps which discharge directly into the distribution mains. Storage

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is provided by an elevated steel tank having a capacity of 50,000 gallons, which maintains a pressure of about 52 pounds to the square inch. The average daily consumption is about 25,000 gallons, all of which is used for domestic purposes. The monthly and annual consumption for 1942, 1943, and 1944 are given in Table 30. The water is very hard, as indicated by analyses 589, 589a, and 589b in Table 13, but it is not treated.

TABLE 30.—*Monthly and annual consumption of water by the City of Mt. Hope, in thousands of gallons*

	1942	1943	1944
January	501	437	857
February	530	446	551
March	418	574	569
April	504	506	764
May	529	636	821
June	910	601	656
July	1,061	1,173	919
August	739	1,000	996
September	660	750	987
October	464	565	960
November	526	520	937
December	446	521	902
Year	7,288	7,729	9,919

Newton

Newton (population 11,048) is supplied by the city from a well field and pumping station situated along the Atchison, Topeka, and Santa Fe Railway 6 miles west-southwest of the city and just west of Emma Creek. This area is underlain to depths of 125 to 130 feet by the McPherson formation, and a small area of sand dunes southwest of the well field serves as a catchment area for rainfall and greatly adds to recharge in the well field. The city has from time to time put down many test holes and constructed about a dozen wells, some of which have been abandoned. The wells were not abandoned because of any diminution of supply attended by lowering of water levels, but rather because of the inadequate size of some of the earlier wells and because of excessive "sanding" in some wells. Several wells were cleaned out and treated with dry ice with beneficial results. In 1937, when the plant was first visited, four gravel-walled wells (290-293) were in use. They range in depth from 124 to 130 feet and had tested capacities of 240 to 635 gallons a minute, but were pumped at rates of 200 to 310 gallons a minute. Three of

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the wells were equipped with electrically driven turbine pumps and one had a cylinder pump. Wells 294 and 295, which were added in 1941, are of similar dimensions and yield, and are also equipped with electrically driven turbine pumps. When the plant was revisited in 1943, the supply was being obtained entirely from four of the six active wells. The well pumps deliver the water to a concrete reservoir near the pumping station, which holds one million gallons. From here the water is picked up by one or more of several steam and electrically driven booster pumps and forced through the pipeline to the distribution mains in the city. In the city additional storage is provided by an elevated steel tank holdng 600,000 gallons and a concrete reservoir built in 1939 which holds 3,600,000 gallons. Power for pumping the wells and delivering the water to the city is obtained from a municipal steam generating plant at the well field. The daily consumption ranges from about 1.3 to 2 million gallons and averages about 1.5 million gallons, nearly half of which is used by the Atchison, Topeka and Santa Fe Railway Company. The monthly and annual pumpage from 1938 through 1945 are given in Table 31. An analysis of water from well 291 given in Table 13 indicates a total hardness of only 148 parts per million, all of which is carbonate hardness; thus the water is softer than that used by any city in the area except that from the new supply of the City of Wichita. The water is chlorinated but receives no other treatment.

Periodic water-level measurements are being made in an abandoned well in the Newton well field. This well (known as the Cook well) is affected at all times by the pumping of the city-supply

TABLE 31.—*Monthly and annual pumpage of water by the City of Newton, in millions of gallons*

	1938	1939	1940	1941	1942	1943	1944	1945
January	45.8	39.6	49.1	44.7	45.3	54.6	60.0	64.9
February	41.1	38.0	39.1	41.9	39.1	47.6	60.0	66.4
March	45.1	42.2	42.6	43.9	43.8	56.5	53.8	60.7
April	44.2	41.7	42.8	41.3	42.9	55.7	63.1	60.1
May	43.9	51.7	41.6	47.4	47.0	59.1	65.2	61.0
June	49.4	54.9	59.6	46.3	50.8	58.5	62.4	64.5
July	58.2	65.9	67.9	61.7	55.6	72.0	77.7	77.1
August	61.4	52.5	50.6	55.7	55.9	73.5	77.5	79.7
September	49.3	59.2	45.7	48.0	52.1	57.2	75.1	70.6
October	46.8	48.9	46.2	43.9	50.8	55.0	64.7	58.9
November	41.9	42.1	43.6	42.3	50.2	54.9	63.8	53.1
December	42.8	40.7	43.6	46.3	54.5	60.4	69.6	60.7
Year	571.8	577.5	572.5	563.9	587.9	705.0	792.9	777.7

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wells. In August 1938 the depth to water level was 46.17 feet below land surface, and was 47.42 feet below land surface on June 18, 1943 when monthly measurements were begun. During the 3-year period of record, the highest water level was 39.31 feet below land surface in January 1946, and the lowest measurement was 58.29 feet in August 1946.

Sedgwick

Sedgwick (population 738) is supplied by the city from a battery of six similar gravel-packed drilled wells (410) situated 5 to 10 feet apart and connected to one electrically driven cylinder pump. The wells are 46 to 50 feet deep and obtain water from sand in the alluvium. Another similar well was constructed in July 1945. The aggregate yield of the six wells is 250 to 300 gallons a minute. The water is pumped directly into the distribution mains, the excess being stored in an elevated steel tank holding 55,000 gallons. The average daily consumption is about 120,000 gallons, all of which is used for domestic purposes. The water is hard, as indicated by analyses 410, 410a, and 410b in Table 13, but is not treated.

Valley Center

Valley Center (population 700) is supplied by the city principally from two gravel-packed drilled wells (564, 565) situated in the western part of the city. The first well (555) was put down in 1929 but was abandoned in 1934 because of corrosion of the screen. Well 556 was put down in 1934 but is no longer in use because the water later developed a bad taste. Wells 564 and 565, which were put down in 1937 and 1938, respectively, are 52 and 51 feet deep and both obtain water from gravel in the alluvium. Each well is equipped with an electrically driven turbine pump and yields about 250 gallons a minute with a drawdown of about 4 feet. The well pumps deliver the water directly into the distribution mains, storage being provided by an elevated steel tank holding 30,000 gallons. The maximum pressure is about 60 pounds to the square inch. The average daily consumption is about 100,000 gallons and the maximum quantity pumped in one day (in 1942) was 180,000 gallons. The water is hard, as indicated by analysis 564 in Table 13, but is not treated.

Wichita

(Estimated 1944 population: Wichita 183,000, greater Wichita 204,000.)

Supply prior to September 1, 1940.—From 1882 until September 1, 1940 the City of Wichita was supplied with water by the pri-

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vately owned Wichita Water Company, a subsidiary of the American Water Works and Electric Company. The water was obtained mainly from a group of wells situated on what is known as Water Works Island, which is a peninsula lying between Arkansas and Little Arkansas Rivers just above their confluence and about 1 mile west of the business district (Pl. 32).

As the need for water increased additional wells were added until ultimately 56 wells were in use. The locations of all but three of these are shown in Figure 30 (see also Pl. 5). Forty-two of the wells are 8 inches in diameter, and all are connected to a suction pump in the pumping station. In addition there are 11 usable gravel-walled wells (671-673, 675-682) on Water Works Island, one similar well (670) situated just east of Little Arkansas River on Riverview Drive north of Central, and two similar wells (665, 666) just east of Little Arkansas River and south of Twenty-first Street (Pl. 5). These 14 wells are equipped with electrically driven turbine pumps and most of them yield from 1,000 to 1,660 gallons a minute but two yield 750 and 830 gallons a minute. All of the wells obtain water from permeable sand and gravel in the alluvium.

An abandoned gravel-walled well (674) on Water Works Island is equipped with an automatic water-stage recorder and has been used as an observation well (Pl. 28B) since 1938. The record obtained shows an abrupt recovery in water level in the well following the cessation of pumping in the well field on September 1, 1940 (Fig. 22). It also shows that the water level in the well is directly affected by changes of water level in the river; the water level rose rapidly when an ice jam was formed in the river (Fig. 21) and declined somewhat less rapidly when the jam was broken.

The water from the wells on Water Works Island was discharged into two covered square concrete reservoirs (Fig. 30) which hold 3.3 million and 1.0 million gallons, from which it was pumped directly into the distribution mains by several large-capacity cylinder and centrifugal pumps. The water from wells 665, 666, and 670 was pumped from the wells directly into the mains.

The average daily consumption from the old well field ranged from 10 to 12 million gallons, but during hot, dry summers it was as high as 21.5 million gallons.

Though this supply had been adequate in quantity the water was of very poor quality because of its high hardness and high chloride content which rendered the water unpalatable and otherwise objectionable for domestic and industrial use. The water was served

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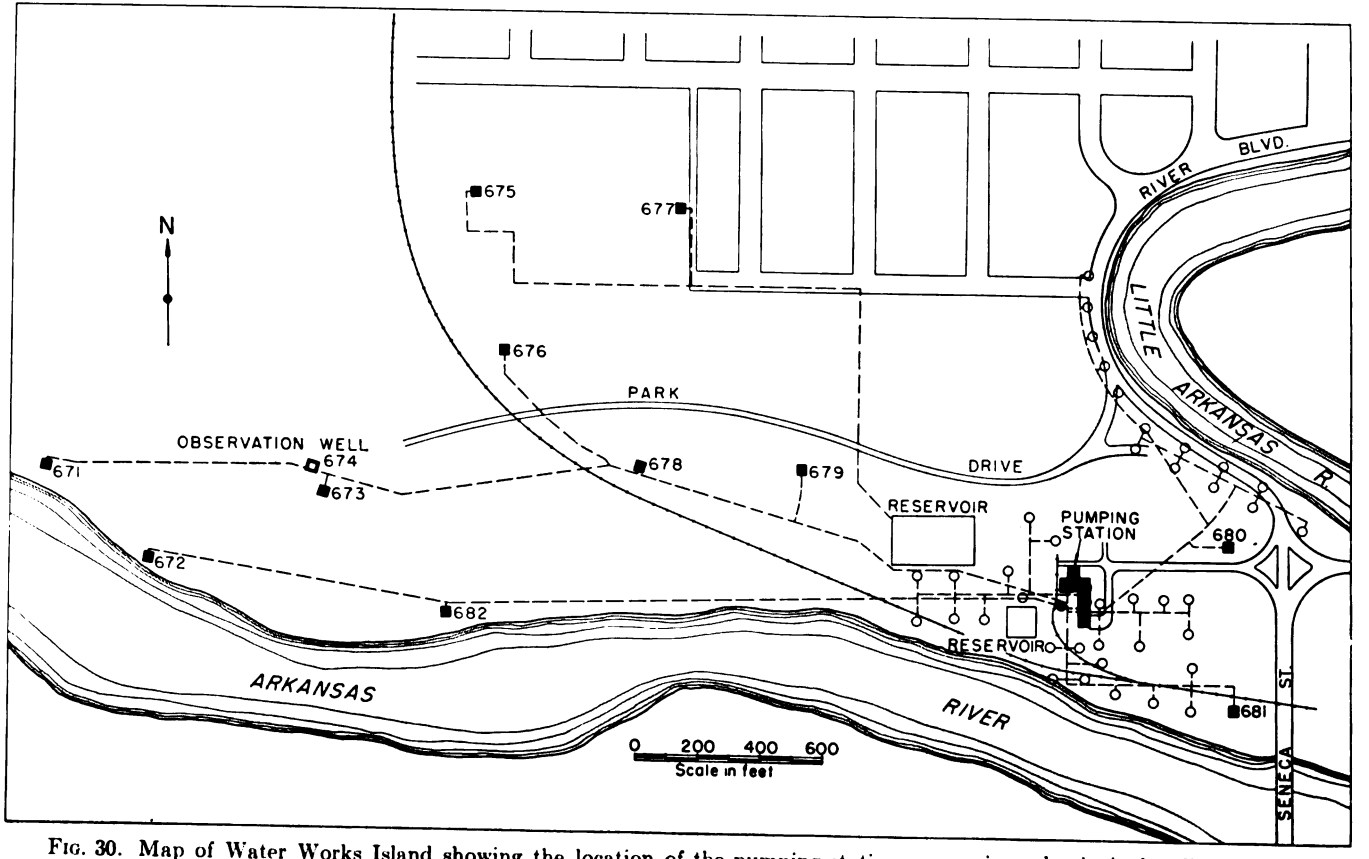

FIG. 30. Map of Water Works Island showing the location of the pumping station, reservoir, and principal wells of the Wichita Water Company. Wells of small diameter pumped by suction represented by open circles; gravel-packed wells equipped with turbine pumps represented by numbered black squares, numbers of wells corresponding to those in Table 37 and Plate 5; observation well 674 represented by open square.

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PLATE 32. Aerial photograph showing the confluence of Arkansas and Little Arkansas Rivers in the City of Wichita. Note submerged sand bar in Little Arkansas River. Arrow points north and is about 0.5 mile long. U. S. Department of Agriculture photograph.

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without treatment other than chlorination at some of the wells. Treatment for reduction of hardness would have been very costly and the chloride could not have been removed economically by treatment. The waters from the individual wells differ considerably in chemical quality; in general, the wells nearest Arkansas River yield the water of poorest quality. For this reason, wells 665, 666, and 670, which are farthest from the river, were used as much as possible. Analyses 671 and 677 (Table 13) indicate the quality of water obtained from two of the wells but do not indicate the average quality of the water from all wells or the entire well field. The average chemical character is indicated by analyses RRR-WWW (Table 13), and a comparison of waters from the old and new well fields is given in Table 33 (Fig. 29).

The old well field is kept in readiness for emergency use, and has been used for brief periods following breaks in the new pipeline and other interruptions.

History of development of new supply.—Because of the poor quality of the water obtained from the old well field, several attempts were made to find and develop a better supply.

In 1924 the City Commission requested the American Water Works and Electric Company to make an investigation of the water supply and the possibility of supplying water of better quality to the consumers served by the Wichita Water Company. In the report to the city prepared by G. W. Biggs, Jr., chief engineer, and C. E. Trowbridge, chief chemist and sanitary engineer, three possible solutions to the problem were presented (letter of August 21, 1924 to the city manager): (1) development of an underground supply from the "Equus beds," lying (within 10 miles) north of Wichita; (2) softening the present supply; and (3) development of a water supply from Little Arkansas River, augmented during peak loads from the then existing wells, and softening the water to a hardness of 100 parts per million. Plan 3 was recommended as the most practicable solution.

In the same year the State Geological Survey of Kansas also was asked to give its assistance. In an undated typewritten report to the city prepared in the fall of 1924, R. C. Moore, state geologist, was in general agreement with the conclusions reached in the report by Biggs and Trowbridge in recommending that the supply be obtained from Little Arkansas River augmented by water from the old well field, and that the water be treated. Moore also pointed out the possibility of obtaining water of good quality from wells in

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the vicinity of Big Slough and Cowskin Creeks, about 6 miles west from Wichita. These recommendations were not carried out, however.

In 1930 the Wichita Water Company put down 15 test holes along Little Arkansas River as far north as Valley Center, and on the basis of these tests constructed two gravel-walled wells about half a mile apart on the Updegraff farm northwest of Valley Center. The wells were completed in October 1930 and were pumped at rates of about 630 gallons a minute until sometime during the winter of 1931. Periodic water-level measurements were made in the wells and in a series of driven observation wells. Because of the considerable drawdown in water level that occurred during the pumping test, the wells were abandoned and no further thought was given to the possibility of obtaining the supply from the Valley Center area. The north well (557) has been used since 1937 as a recorder-observation well (Fig. 16).

In 1937 the Wichita Water Company put down several test holes in the Arkansas River Valley east of Bentley in an effort to test the possibilities of obtaining a supply from wells in that area. The tests indicated that wells in this area would yield large quantities of water, but the water was of poor quality in most of the test holes because of the proximity to Arkansas River, and this area was also abandoned as a possible source of supply. One of these test wells (568) has been used as a recorder-observation well since 1937.

The investigation begun in 1938 by the State and Federal Geological Surveys, the State Board of Health, and the City of Wichita, which ultimately led to the development of the present municipal well field, has been described. The location of the new well field (Pl. 28) was the result of a compromise in order to obtain the maximum quantity of water of the best possible quality, and with the least danger of contamination by salt water. Owing to the high salinity of the ground water in a narrow belt parallel to Arkansas River it was necessary to stay as far from this river as possible. It was also necessary to keep as far as possible from the Burrton oil field, just west of Burrton, in order to lessen the danger of contamination from oil-field brines. The supply thus developed is described below.

New supply.—The new municipal water-supply system of the City of Wichita was placed in operation on September 1, 1940. The water is obtained from 25 gravel-walled wells situated in Harvey County, southwest of Halstead (Pl. 28). The minimum spacing be-

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tween wells is half a mile and the over-all length of the well field is 9 miles. A few of the shallower wells were excavated by means of an orange-peel bucket (Pl. 26B), but the deeper wells were drilled by the hydraulic rotary method. The wells were drilled to a minimum diameter at the bottom of 30 inches, and the well screens and blank casings have an inside diameter of 18 inches. All blank casing and 23 of the 25 screens are made of 3-gauge pure ingot iron; two of the screens, however, are made of cast iron. The annular spaces around the casings and screens are filled entirely to the top with screened gravel. The wells are described in Table 37 and other pertinent data are given in Table 32.

TABLE 32.—*Records of New Wichita municipal supply wells*
(Courtesy Black and Veatch, consulting engineers)

Well No., Pls. 5 and 28, Table 37	City No.	Depth (feet)	Total screen length (feet)	Initial depth to water level	Initial 36-hour pumping test		
					Yield (gallons a minute)	Drawdown (feet)	Specific capacity (gallons a minute per foot of drawdown)
311.....	1	221.8	60	20.6	1,560	60.9	25.6
314.....	2	234	60	20.3	1,400	64.0	21.9
317.....	3	237.8	65	25.2	2,000	62.6	31.9
322.....	4	234	60	25.2	910	63.8	14.3
330.....	5	237.5	65	20.4	1,420	66.1	21.5
333.....	6	257.3	60	24.2	2,040	64.6	31.6
415.....	8	257.5	65	20.1	1,570	73.2	21.4
419.....	10	259.3	65	14.4	1,800	73.9	24.4
423.....	9	248.5	65	13.5	2,010	47.7	42.1
426.....	20	248	60	13.2	2,010	60.1	33.4
429.....	11	227.5	55	9.7	1,980	35.2	56.2
433.....	15	192.6	55	14.9	2,030	37.4	54.3
436.....	12	236.0	60	15.2	1,960	45.3	43.3
440.....	16	193.4	60	13.4	2,000	49.4	40.5
450.....	14	102.2	35	10.7	1,570	28.4	55.3
452.....	17	185.5	50	9.3	2,010	51.2	39.3
455.....	7	122.0	60	12.0	2,030	14.4	141.0
459.....	13	244.8	60	11.2	2,010	42.3	47.5
465.....	18	157.8	40	11.1	1,860	43.7	42.6
473.....	21	79.5	30	12.6	1,870	20.9	89.4
476.....	22	81.6	30	14.3	710	20.8	34.1
479.....	19	145.0	.....	14.1	1,280	40.0	32.0
487.....	23	204.5	55	13.5	1,870	56.1	33.3
491.....	24	97.0	30	13.7	1,480	26.1	56.7
494.....	25	189.0	55	10.5	1,980	43.2	45.8

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The wells are pumped by electrically-driven turbine pumps ranging in capacity from 500 to 1,000 gallons a minute, and the water discharges into the 14-inch collecting lines and thence into the main 48-inch supply line. The 25 wells are not all pumped at the same time but are pumped in groups of about 8 or 10 while the remaining wells are idle. Pumping is shifted from one group to another at intervals of several weeks. The supply pipeline extending from the 25 wells to the treatment plant at the city comprises 33 miles of cast iron pipe, most of which is 48 inches in diameter, and has a gravity capacity of 32 million gallons a day. The pump on each well is individually controlled from either the treatment plant at Wichita or from the control station in the well field by means of an electrical supervisory control system. Each supply well is equipped for periodic measurement of water level and has a pair of observation wells at distances of 100 and 500 feet from it.

TABLE 33.—*Comparison of quality of water formerly supplied to the City of Wichita with that being supplied from the new well field at end of first year's operation*

(From report of August 31, 1941, by M. E. Rogers, water-supply superintendent; analyses by Robert H. Hess, city chemist)

CONSTITUENT	Parts per million		
	Old well field	New well field	
		Raw water	Treated water
Iron (Fe)	0.10	0.96	0.00
Manganese (Mn)	Trace	.28	.01
Calcium (Ca)	134	50	37
Magnesium (Mg)	29	8.7	8.5
Sodium and Potassium (Na + K)	260–450	50	50
Carbonate (CO_3)	0	0	4
Bicarbonate (HCO_3)	232	251	206
Sulfate (SO_4)	235	29	29
Chloride (Cl)	400–700	23	23
Carbon dioxide (CO_2)	35	26	0
Oxygen (O_2)	0	0	8.2
Total dissolved solids	1,600	303	280
Total hardness	450	160	128
Carbonate hardness (Calculated as $CaCO_3$)	190	160	128
Non-carbonate hardness	259	0	0
Total alkalinity	190	206	172
Excess alkalinity	0	46	44
pH value	6.9–7.1	7.15	8.2

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In the modern treatment plant, which is situated near the pumping station of the Wichita Water Company, the water is treated for removal of iron and manganese and for reduction in hardness. Analyses of water from the 25 supply wells are given in Table 13 (Same numbers as in Table 32; see, also, analysis SS) and a comparison between the chemical quality of the water formerly supplied by the Wichita Water Company and the raw and treated water from the new municipal wells is given in Table 33. This comparison and the analyses in Table 13 show that the water now supplied to the City of Wichita is softer and less mineralized than that used by any other city in the area.

After passing through the sand filters in the treatment plant the water flows into two underground storage basins holding an aggregate of more than 4 million gallons. From these basins the water is conducted to the near-by reservoir and pumping station of the Wichita Water Company whence it is distributed through the city mains. The Wichita Water Company collects the water bills, pays the City of Wichita for pumping, treating, and delivering the water to its pumping station, and maintains its old well field for emergency use. The monthly pumpage from the new well field from September 1, 1940 through 1945 is given in Table 34 and is shown in Figures 24, 25, and 26.

The considerable increase in water consumption attending the wartime increase in population and industrial activity is clearly indicated in the table. In addition, a considerable quantity of water

TABLE 34.—*Monthly and annual pumpage of water from the new Wichita municipal well field, in millions of gallons*

	1940	1941	1942	1943	1944	1945
January	.....	277.4	317.9	393.4	542.2	505.0
February	.....	247.9	349.9	388.5	493.2	444.3
March	.....	269.7	337.5	422.6	516.3	514.8
April	.....	320.6	361.1	484.7	534.3	476.0
May	.....	336.4	381.5	495.9	570.1	578.5
June	.....	415.4	444.1	543.3	597.2	566.9
July	.....	459.6	459.9	653.6	629.7	654.6
August	.....	483.3	625.9	643.3	652.9	665.7
September	297.6	447.5	455.7	555.1	586.1	570.4
October	378.7	336.0	435.8	539.2	524.7	552.4
November	316.6	345.7	384.6	517.8	496.5	479.5
December	286.4	320.9	408.6	510.4	498.3	490.2
Year	1,279.3	4,260.4	4,962.5	6,149.8	6,641.5	6,498.3

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is pumped from private wells in the city for air-conditioning and industrial use.

In order to help safeguard the chemical quality of water obtained from the 25 supply wells, 10 pairs of 1¼-inch chloride-observation wells were put down along the eastern margin of the Burrton oil field, which lies from about 5 to 12 miles west of the supply wells. One of each pair of wells extends to a point just above the Permian bedrock at depths of 66 to 255 feet; the other well of each pair extends about half-way to bedrock. Samples of water are pumped quarterly from these wells and also from about 30 private shallow wells, and the chloride content of the samples is determined in order to detect any significant increase in chloride content far in advance of the time any body of brackish or salty water might possibly reach the municipal well field. The locations of these chloride observation wells are shown on Plate 28, and the chloride content of groundwaters in and near the Burrton oil field is shown on Plate 29. By January 1946 there had been no significant increase in chloride concentration in the deep chloride-observation wells, and only a slight increase in three of the shallow wells near Arkansas River.

The effect of pumping the 25 supply wells on the water table and other matters pertaining to the perennial yield of the Wichita well-field area are discussed in the next section.

Potential Perennial Yield of the Wichita Well-field Area

It is evident that during recent geologic time the average rate of natural discharge from the aquifers in this area, as in others, in general has been equal to the rate of recharge. Comparatively small changes in the quantity of water in an aquifer, with accompanying changes in water level, may occur as the result of temporary unbalance between discharge by natural processes and recharge, but such fluctuations balance each other over a period of years and, under natural conditions, aquifers are in a state of approximate dynamic equilibrium. Discharge by wells is thus a new discharge superimposed upon a previously stable system, and it must be balanced by an increase in the recharge to the aquifer, by a decrease in natural discharge, by a reduction of storage in the aquifer, or by a combination of these. It is necessary to recognize this principle in studying the development of large ground-water supplies. Pumping from wells may divert ground water to more beneficial use than would otherwise result; on the other hand, reduction in discharge by transpiration as a result of pumping may deprive useful plants of needed water.

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It is desirable for users of large quantities of ground water to know the quantity of water that may be derived from the aquifer for a long period of time in the area of withdrawal. One purpose of the study made of this area has been to qualify, if possible, estimates of the perennial potential yield of the aquifer which were made at the time of construction of the new Wichita city-supply wells. The present study, therefore, is an attempt to utilize the data which have become available since observations began in 1938 and especially since pumping began in the well field on September 1, 1940, and to evaluate these data insofar as they relate to the perennial yield of the aquifer.

Definition of Potential Perennial Yield

The perennial yield of the aquifer underlying an area of ground-water development, as the term is used in this study, has been regarded as the maximum rate at which water can be salvaged from the natural discharge or added to the recharge, or both. If that rate is exceeded, the water levels in and around the pumped area will continue to fall and some of the wells eventually may be abandoned (Morgan, 1938, p. 64).

The potential perennial yield of a water-bearing formation may be either greater or less than the rate of natural recharge or discharge (Meinzer, 1932, p. 119). It may be less because the natural discharge cannot be completely diverted to the wells and it may be greater because of artificial increase in recharge. In some reports the economical pumping lift has been considered to be a factor in this definition; however, the economics of recovery seem to be irrevelant to the determination of the quantity of water which an aquifer will yield and so are not considered here.

Summary of Data Availible for Studying Perennial Yield

The study of the perennial yield of the water-bearing material in the Wichita well-field area is implemented by methods based on the change in storage in the ground-water reservoir, which is revealed by periodic measurements of water levels in many wells. The data available for study have been presented in several sections above; they are: (1) records of water-level fluctuations in 10 observation wells in the general well-field area, selected from a large number of observation wells after study of the water-table fluctuations revealed that they are representative of that part of the well-field area not in the immediate area of pumping influence (Fig. 16); (2) records of water-level fluctuations in six observation wells about half a

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mile from the pumped wells (Figs. 24 and 25), in 25 wells 500 feet from the pumped wells (Fig. 25), and in 25 wells 100 feet from the pumped wells (Fig. 25), which were chosen as being representative of fluctuations of the water table in the area of pumping influence; (3) pumpage data obtained from readings made from meters at the municipal supply wells (Table 34, and Figs. 24 and 25); (4) values for the specific yield of the water-bearing materials obtained from tests made in the hydrologic laboratory of the United States Geological Survey in Washington, D. C., and in the laboratory at Lawrence, Kansas (Table 7); (5) rainfall data obtained from published records of the United States Weather Bureau (Figs. 2-8); and (6) determinations of permeability and transmissibility made by several methods and summarized in Table 35.

In addition to the data presented above, water-table contour maps of the well-field area have been prepared, based on periodic water-level measurements in about 190 wells (Pl. 33). The first of these maps was prepared from measurements made in June 1940, before pumping began. Other water-table contour maps were prepared after pumping began on September 1, 1940 from measurements made on the following dates: April 15, 1941; July 10, 1941; November 10, 1941; April 1, 1942; July 10, 1942; October 1, 1942; April 1, 1943; July 5, 1943; October 7, 1943; April 1, 1944; July 7, 1944; and October 1, 1944. Maps showing lines of equal change in water level (Pl. 34) were prepared by comparing water-table contour maps prepared for each period after pumping began with the water-table contour map prepared from measurements made before pumping began.

Specific yield.—As noted above in the section on physical properties of the water-bearing materials, the average specific yield of 13 samples collected from the zone of water-table fluctuation in the Wichita well-field area was found to be 25.2 percent. The specific yield ranged from 8 to 38 percent by volume and the average specific yield of all the samples studied from this area, both from above and below the water table, was 26.8 percent. The average computed value of specific yield has been assumed to be nearly correct and 25 percent has been used in calculation of recharge, discharge, and the changes in storage presented below. However, it is noted that the apparent specific yield in the Wichita well-field area probably increased from about 15 percent when pumping began to about 25 percent, or about the real specific yield at the end of 4 years of pumping.

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Transmissibility.—The coefficient of transmissibility at each of the Wichita city-supply wells was computed by the recovery method. The transmissibility ranged from 46,000 at well 311 to 330,000 at well 455. The average coefficient of transmissibility was computed to be 124,500.

Using the coefficients of transmissibility given in Table 35, and the natural gradient of the water table taken from Plate 1, the quantity of water moving across the boundary of the Wichita well field under nonpumping conditions was calculated. The area for which this calculation was made is shown on Plate 33 and the calculation is summarized in Table 35. The total quantity of water that moved across the line connecting the wells given in Table 35, under nonpumping conditions, is believed to have been about 5,300,000 gallons per day.

The authors are aware of the limitations of the recovery method of determining transmissibility of fine-grained materials under water-table conditions. As noted above, observation wells are located 100 feet and 500 feet, respectively, from each pumped well, and water levels in these observation wells were measured periodically during the pumping test at each well. The observation wells do not penetrate the entire aquifer and are screened at the bottom only. For these and other reasons the application of the Thiem method for determining transmissibility was not considered advisable. However, using data shown on Figure 25, the difference in average drawdown in the wells 500 and 100 feet from the 25 pumping wells at the end of 1944, and the average pumping rate in 1944, the average transmissibility as defined above was calculated to be about 250,000 using the Thiem method. Comparison shows that this value is about twice that obtained by the recovery method. The authors believe that (1) the Thiem method probably is not applicable to the data available in the Wichita well-field area; and (2) the results obtained using the recovery method may be in error, and if so, probably indicate too small a quantity of water moving into the well field.

Recharge.—Normal annual precipitation at Sedgwick, the United States Weather Bureau station nearest to the Wichita well-field, is 29.47 inches. The greatest annual precipitation of record at Sedgwick was 42.85 inches in 1927 and the least recorded annual precipitation was 16.93 inches in 1936. The average annual precipitation at Sedgwick for the 6-year period, from 1939 to 1944 inclusive, was 34.32 inches.

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TABLE 35.—*Calculation of movement of water across the boundary of the new Wichita well field*

Wells between which calculations apply	Distance between wells (miles)	Distance between wells corrected parallel to water-table contours (miles)	Average transmissibility for interval	Average hydraulic gradient (feet per mile)	Quantity of water crossing well-field boundary (gallons a day)
255–314	0.57	0.47	49,400	10.0	232,000
314–322	0.42	0.42	55,800	9.3	217,000
322–330	0.57	0.57	63,000	7.5	269,000
330–333	0.41	0.34	104,700	6.7	238,000
333–415	0.52	0.50	107,000	5.0	267,000
415–423	0.49	0.46	90,100	4.6	192,000
423–429	0.45	0.43	150,200	5.5	359,000
429–459	0.75	0.32	183,600	5.3	308,000
459–455	0.70	0.35	251,600	6.4	562,000
455–465	1.95	0.83	198,800	7.5	1,238,000
465–476	1.43	0.70	129,700	7.5	680,000
476–487	0.61	0.44	316,900	7.5	441,000
487–494	0.72	0.43	106,800	6.8	313,000
Total					5,316,000

In the section of this report in which recharge is considered, many data are presented showing that water derived from precipitation is added to the aquifer periodically. Study of the hydrographs for well 557 and for the average of the water levels in 10 wells in the part of the well-field area not affected by pumping indicates that in years of normal precipitation the average annual net recharge is equivalent to about 20 percent of the precipitation. It should be emphasized that this estimate is based on the possibly optimistic assumption that the proportion of the precipitation that reaches the water table is as large during years of normal precipitation as during the period of record, when the precipitation was above normal. However, any error that may result from this assumption is compensated by the fact that the figure of 20 percent for the period of record does not take into account the fact that discharge of ground water was occurring while the rises in water level on which the 20-percent figure is based were being measured; thus, if this discharge had not been occurring the rises in water level would have been greater and the total recharge would have been shown to be equivalent to more than 20 percent of the precipitation.

Discharge.—Ground water is discharged from the Wichita well-field area by natural processes including evaporation, transpiration,

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and ground-water runoff; in addition, large quantities of water are discharged by pumping.

Some measure of natural discharge of ground water may be gained by examination of Figure 16. This curve represents the average water level in 10 observation wells in the well-field area not affected by pumping. The declines in water level are caused by excess of discharge over concurrent recharge. The quantity of annual recharge during years of normal precipitation has been estimated to be about 20 percent of the precipitation at Sedgwick or about 6 inches of water per year, or about 320 acre-feet per square mile each year in the well-field area. Over a complete hydrologic cycle recharge and natural discharge are approximately equal.

Superimposed upon natural discharge in this area is the discharge occasioned by pumping from the supply wells in the Wichita well field, and by pumping from all other wells in the well-field area which, however, is very small compared to the amount pumped from the city supply wells. In summary, the quantity pumped from the Wichita supply wells from September 1, 1940 to January 1, 1945 was 23,284 million gallons or an average of about 15 million gallons a day. Several hydrographs showing the effect of pumping on water levels in the well field are presented above in Figures 24, 25, and 26, and indicate that water levels in much of the area affected by pumping apparently had become stabilized at the end of 1944.

CHANGES IN STORAGE

Whenever precipitation reaches the water table as recharge, such water represents, temporarily, an addition to the quantity of water in storage in the aquifer. Similarly, whenever ground water is discharged from the aquifer by natural or artificial processes such discharge is a removal of water which was in transient storage in the aquifer. Change in storage, as used here, means the net addition of water to or net withdrawal of water from the aquifer. If at the end of a given period of time the water levels in observation wells are lower than they were at the beginning of the period, it is concluded that ground-water discharge exceeded recharge and that there has been a net withdrawal of water from storage.

Natural changes in storage.—Natural changes in ground-water storage are those changes in the quantity of water in storage in the aquifer caused by natural processes as distinct from changes in storage caused by pumping. Natural changes in storage for any given period of time are measurable by comparing the water levels in wells not affected by pumping at the beginning and end of the period. If

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recharge exceeded natural discharge, then there was a net addition to storage; if natural discharge exceeded recharge, there was a net loss of water from storage during the period.

The fluctuations of the water levels in 10 wells, discussed at length above, are believed representative of the fluctuations in water level in that part of the well-field area not affected by pumping, and form the basis for calculation of natural changes in storage in the well-field area. Figure 16 shows the monthly changes in storage for 6 years as measured in these observation wells. The greatest monthly natural addition to storage occurred in April 1944 when an average net rise in water level of 2.7 feet occurred, and the greatest monthly natural discharge was in July 1942 and June 1944 when the average water levels declined 0.8 and 0.9 foot, respectively.

Changes in storage caused by pumping.—The monthly changes in storage caused by pumping may be observed by comparison of Figures 16 and 24. Figure 24 shows the trend of water levels affected by pumping and indicates withdrawal of water from storage by pumping. Figure 26 shows the relationship since pumping began between water levels in wells not affected by pumping and those in wells which are affected by pumping. These graphs indicate that water levels in the well field ceased declining at the end of 1944 and that an equilibrium gradient may be nearly established toward the pumped wells for the present average rate of pumping, and under current climatic conditions.

In order to determine the magnitude of the withdrawal of ground water from storage, 13 water-table contour maps of the well-field area were prepared. These maps represent hydrologic conditions before pumping began and at several dates since pumping began (Pl. 33). The water-table contour maps were originally prepared at a scale of 2 inches to a mile with a contour interval of 5 feet. These intervals were later divided into five equal parts and contour lines having an interval of 1 foot were interpolated. By superimposing each map prepared after pumping began upon the map prepared before pumping began and by connecting points of contour crossings, lines of equal change in water level, here called isometahydral lines, were drawn. The resulting 12 maps (Pl. 34) afford a measure of the magnitude of change in ground-water storage for each of the periods between the several water-table contour maps.

An area of 85.3 square miles bounded by the heavy line and Little Arkansas River shown on Plate 28 was selected after study of the geologic map (Pl. 1), logs of test holes, records of observation wells,

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and the water-table contour maps (Pl. 33) as being about the maximum area which may be affected by pumping in the well field. Not all of this area had been affected by pumping at the end of 1944. The areas between successive lines showing increases and decreases in ground-water storage were measured with a planimeter and multiplied by the average rise or lowering depicted by the lines, and by this method the net increase or net decrease in storage within the area was determined. Because each succeeding water-table contour map was compared with the first one which was constructed before pumping began, all of the maps show a net decrease in storage.

Summary of changes in storage.—The maps on Plate 34 show the cumulative effects of pumping on water levels in the well-field area for several dates since pumping began, superimposed upon natural changes in water level. The data relevant to and obtained from each map are given in Table 36, and parts of the data are shown graphically on Figure 31.

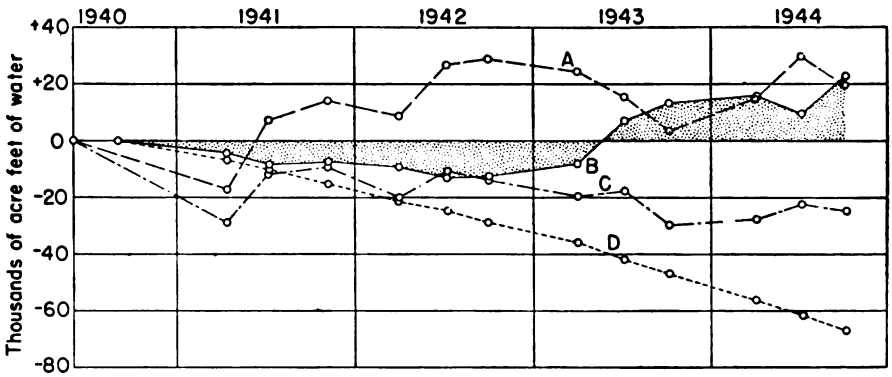

FIG. 31. Graphs of data given in Table 36: (A) column 4 of Table 36; (B, and the shaded area between B and the datum line) column 6 of Table 36; (C) column 3 of Table 36; and (D) column 5 of Table 36.

The net rise or net decline in water level from June 1, 1940, before pumping began, to the end of each map period in 10 observation wells not affected by pumping is given in column 1 of Table 36. Study of the fluctuations of water levels in many wells indicates that the fluctuations in the 10 wells chosen are representative of the behavior of the water table in the well-field area under natural conditions during the period of record. These wells are discussed above and the hydrograph is shown on Figure 16. The areas affected

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TABLE 36.—*Data relative to changes in storage in the Wichita well-field area*

Map (Plate 39)	Date from June 1, 1940, to:	(1) Net rise in water level in 10 wells not affected by pumping (Fig. 3) (feet)	(2) Area affected by pumping (square miles)	(3) Net reduction in storage (acre-feet)	(4) Net natural recharge (acre-feet)	(5) Quantity of water discharged by pumping (acre-feet)	(6) Quantity of water unaccounted for. Col. 6 = Col. 5 — (Col. 3 + Col. 4) (acre-feet)
A	4-15-41	—1.25	44.6	28,450	—17,060	6,860	—4,530
B	7-10-41	.57	57.0	10,530	7,780	10,080	—8,230
C	11-10-41	1.03	44.4	8,460	14,060	15,310	—7,210
D	4- 1-42	.66	58.7	20,060	9,010	20,100	—8,970
E	7-10-42	1.95	54.1	10,580	26,610	24,210	—12,980
F	10- 1-42	2.10	65.8	12,910	28,660	28,470	—13,100
G	4- 1-43	1.79	55.7	19,570	24,430	35,950	—8,050
H	7- 5-43	1.15	51.5	17,810	15,700	41,250	+7,740
I	10- 7-43	.23	55.2	29,940	3,140	46,750	+13,670
J	4- 1-44	1.05	56.0	28,030	14,330	55,900	+13,540
K	7- 7-44	2.19	68.8	22,290	29,890	61,450	+9,270
L	10- 1-44	1.46	64.5	24,640	19,930	66,850	+22,280

by pumping during each period (column 2), which were measured directly from large-scale maps, are the areas in which the water table lowered more than, or did not rise as much as, the average water level in the 10 wells not affected by pumping.

The area between each line of change in the base area (Pl. 28) was measured directly from each map and the net volume of water-bearing material unwatered during the map period was calculated. The net volume of water withdrawn from storage in the base area (column 3) was obtained by applying the factor for specific yield to the volume of the aquifer unwatered. The net natural recharge or net natural discharge which would have been measurable in the base area if pumping had not occurred is given in column 4. The magnitude of this quantity of water was calculated for each period from the observed average net rise or average net decline in 10 wells not affected by pumping (column 1). The quantity of water pumped during each period is given in column 5. The quantity of water needed to balance columns 3, 4, and 5 is given in column 6. Some of the reasons for and the significance of this lack of balance are discussed below.

Calculations made from the several maps (Pl. 34) indicate that

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the greatest measured net change in storage in the well-field area since pumping began occurred in October 1943 when about 30,000 acre-feet of water is calculated to have been removed from storage. The least measured net change in storage was in November 1941 when about 8,500 acre-feet was removed from storage. After four years and one month of pumping, measurements indicate that the change in storage in the base area has been about 24,600 acre-feet.

HYDROLOGIC IMPLICATIONS

Change in specific yield.—During the first pumping period studied the net reduction in storage in the base area was calculated to have been 28,450 acre-feet. The net reduction in storage in this area would have been about 17,060 acre-feet if pumping had not occurred. The quantity of water withdrawn by pumping during this period was 6,860 acre-feet. These measured and calculated volumes do not balance by 4,530 acre-feet (column 6). Study of the fluctuations of water levels shown on Figure 16 indicates that no appreciable rises of the water table occurred during this period, and that the quantity of recharge probably was small. The factor which may account for the lack of balance, however, is the specific yield. Theoretical and empirical determinations of this hydrologic factor indicate that the true value is obtained only after the saturated material has been drained for a long period of time. If incomplete drainage during the first map period is assumed and the value for specific yield is changed from 25 percent to 15 percent in the computations, the several columns in Table 36 balance. Similarly, if a sliding scale of values for specific yield ranging from 15 percent to about 30 percent is used for the other map periods, the measured and calculated volumes balance. It is believed that the laboratory determinations of specific yield, discussed above, are nearly correct and that the apparent specific yield increased from about 15 percent at the end of the first period studied to near the real or determined value of 25 percent in later periods. The value for specific yield was probably about 19 percent at the end of the second year of pumping and probably reached the real value sometime during the third year of pumping.

Reduction of natural discharge into Little Arkansas River.—Measurements made from the water-table contour maps shown on Plate 33 indicate no decrease in the average gradient along Little Arkansas River from the time pumping began until the last part of the third year after pumping began. Measurements made from map 9 show a decrease in average gradient of 1.8 feet per mile near Little

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Arkansas River, map 10 shows a decrease of 2.1 feet per mile, and map 13 shows a decrease of 2.6 feet per mile. There is no measurable difference between the gradients at the west side of the well-field area on maps 1 and 13. It is concluded, therefore, that there was no measurable change in the quantity of water entering and leaving the well field by percolation through the aquifer until about July 1943. At this time about 8 percent of the quantity of water formerly being discharged into Little Arkansas River was intercepted; by October 1943 it seems that about 10 percent of the total flow of the river derived from ground water from this area was being intercepted; and on October 1, 1944, about 12 percent of this quantity was diverted toward the well field.

On the basis of data pertaining to the physical properties of the aquifer, the slope of the water table, and the location of the well field relative to Little Arkansas River, it is calculated that the water table in the well field must be lowered about 40 feet below the initial level before all of the water percolating toward the river in this section of its course can be intercepted and the gradient reversed toward the well field from the river. Measurements made from map L (Pl. 34), prepared after four years' pumping from the well field, indicate that in the area northwest of Halstead the water table has been lowered 18 feet below the initial level. At the point of greatest lowering the water table must be lowered 10 feet farther before the water level near the wells is at the same level as the water surface in Little Arkansas River due east, and must be lowered at least 20 feet below present level to cause any significant flow from the river toward the wells. Southwest of Halstead, north of Kisiwa Creek the water table has been lowered 16 feet in one small area. At this place the water table must be lowered an additional 22 feet to be at the same level as a comparable point on Little Arkansas River. South of Kisiwa Creek, in the southern part of the well field, the water table has been lowered about 5 feet and must be lowered an additional 25 feet to be at the same level as the river, and still farther to reverse the flow from the river. It is calculated that a quantity of water of the order of magnitude of 200,000 acre-feet must be removed from storage in the well field before hydrologic conditions are such that water can percolate from Little Arkansas River toward the wells.

Source of the water pumped.—The amount of precipitation on the well-field base area since pumping began was 52.47 inches at the end of the first year of pumping (June 1, 1940 to Nov. 10, 1941)

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90.31 inches at the end of the second year, and 124.22 and 160.41 inches at the end of the third and fourth years, respectively. The quantity of recharge in this area, shown above to be about 20 percent of the precipitation, at the end of each year since pumping began was about 47,750 acre-feet, 82,200 acre-feet, 113,000 acre-feet, and 146,000 acre-feet, respectively.

Data given in Table 36 indicate that the water pumped from the municipal supply wells during the first and second years of pumping came from water in storage, including part of the water which would have been added to storage if no pumping had occurred. There was no apparent reduction in natural discharge during these years. At the end of the third year, 46,750 acre-feet of water had been pumped, of which about 33,000 acre-feet was pumped from storage and about 14,000 acre-feet was derived from the reduction of natural ground-water discharge. Under natural conditions, had no pumping occurred, 110,000 acre-feet would have been discharged. Thus about 13 percent of the quantity of ground water normally discharged was salvaged by pumping. Similarly, computations based on hydrologic data available at the end of the fourth year of pumping indicate that of the 66,850 acre-feet of water pumped during the four years, about 44,600 acre-feet was derived from storage and about 22,200 acre-feet was derived from the reduction of natural discharge. The quantity of ground water which would have been naturally discharged from the area during the four years is calculated to be 127,000 acre-feet and the quantity salvaged is about 15 percent of the total. Measurements made from map L (Pl. 34) indicate that the area affected by pumping at the end of the fourth year was about 65 square miles.

SUMMARY

On the basis of data presented above, it is concluded that the potential perennial yield of the aquifer in the Wichita well-field area had not been reached at the end of 1944 for the following reasons: (1) the water levels in wells affected by pumping in the well-field area seemingly had ceased declining at the pumping rate prevailing at that time; (2) only a part of the natural discharge in the area of pumping influence was being salvaged; and (3) Little Arkansas River remains a gaining stream, but is a potential source of increased recharge in this area.

The conclusion that the safe yield, as determined by recharge during the period of record, had not been reached at the end of 1944 does not in itself define this quantity. An estimate of the safe

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yield with the present arrangement of wells may be made, however, from data presented above. If the maximum area of influence of the present well field is about 85 square miles, it is believed that recharge in years of normal precipitation will be about 27,000 acre-feet. When the water table is lowered to a depth sufficient that all natural discharge may be salvaged, percolation into the area, including influent seepage from Little Arkansas River, will be at least 13,000 acre-feet a year. Thus the potential yield of the present well-field area during a period of normal precipitation is estimated to be about 40,000 acre-feet a year, or about twice the present annual pumpage. Before a quantity of water equal to this yield can be added to the aquifer each year, about 200,000 acre-feet must be removed from storage. This quantity is equal to that which would be pumped in 10 years at the present rate of pumping assuming that there would be no replenishment from precipitation. Any expansion of the present well field will involve a larger area of influence and the potential safe yield will be correspondingly larger.

Ground-water Conditions Described by Localities

Lindsborg area.—For purposes of this discussion the Lindsborg area comprises the northwestern part of McPherson County including the Smoky Hill River Valley. The principal aquifer in the Lindsborg area is the alluvium of the Smoky Hill River Valley. The alluvium ranges in thickness from a featheredge at the valley sides to about 90 feet in the deepest part of the valley, and consists of silt, clay, and beds of sand and gravel of varying thickness at the base (logs 14 to 23, inclusive). Where the coarse material occurs in considerable thickness, wells have been developed which yield up to 750 gallons a minute, and which supply water to the cities of Lindsborg and Marquette and to several industries. The Wellington formation and Ninnescah shale bordering the alluvium in this area are relatively impermeable, and yield only small quantities of water to large-diameter farm and stock wells. Sandstones in the Kiowa shale in the Lindsborg area yield small quantities of water to stock wells, and small springs and seeps supply water to ponds.

The depth to water level ranges from about 10 feet to about 35 feet below land surface in the alluvium of the Smoky Hill Valley, and is about 35 feet below land surface in the shale bordering the alluvium. Recharge is derived from rainfall on the area and near-by areas. In the Linsborg area ground water moves toward Smoky Hill River and is discharged by evaporation and transpiration near the stream, and by seeps and springs that flow directly into the river.

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Ground water in the alluvium is hard and contains considerable quantities of iron. Water in the Permian shale is very hard.

Northeastern upland area.—The northeastern upland area comprises the northeastern part of McPherson County and the northwestern part of Marion County. This area is underlain by the Kiowa shale, except in the valley of Gypsum Creek in McPherson County and in a small valley in the headwaters of Cottonwood River in Marion County where the Wellington formation occurs at the surface. Few data concerning ground-water conditions in this area are available, but water in the Wellington shale is very hard here as elsewhere and is available to wells only in small quantities. Gypsum Creek derives its name from the chemical character of the water flowing in it. In 1946 Wilson and Company, consulting engineers, surveyed the possibilities of developing a ground-water supply for the City of Lindsborg from sandstones in the Kiowa shale in the northeastern upland area. Test holes drilled during the investigation for the city (see logs 1 to 13 inclusive) revealed that the fine-grained sandstone was not sufficiently permeable to furnish the quantity of water needed by the City of Lindsborg from an economical number of wells. Water samples collected from the test holes indicated that ground water in the sandstone was of considerably better chemical quality than the water in the alluvium. Numerous stock wells derive water from Cretaceous sandstones in the northeastern upland area, and many small springs occur along the ravines which have cut into the sandstone.

Windom-Inman upland area.—The Windom-Inman upland area includes the area underlain by Kiowa shale near Windom, and the area underlain by Ninnescah shale southeast of Windom toward Inman and Buhler (Pl. 1).

Near Windom the sandstones in the Kiowa shale have been removed by erosion and black shale underlies the surface. Small quantities of water for domestic and stock purposes are obtained from wells drilled and dug into this shale, but these supplies generally are supplemented by cisterns and stock ponds. Southeast of Windom the Ninnescah shale yields small supplies of very hard water to farm wells, but neither the quantity nor the chemical quality is satisfactory to supply the cities of Inman and Buhler.

Fine-grained unconsolidated deposits, derived largely from the Kiowa and Ninnescah shales, underlie part of the area west of Inman. These deposits (not differentiated on Plate 1) are absent over much of the area, but locally they range in thickness from a few feet to 40 feet and yield small supplies of water to farm wells.

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McPherson channel area.—The buried McPherson channel extends from the south edge of the Smoky Hill River Valley southeast of Marquette southward past McPherson, Inman, and Buhler toward the present Arkansas River north of Colwich. The McPherson channel is shown on the geologic profiles (Pl. 6), and by means of contours on Plate 7. The following discussion of ground-water conditions in the deeply buried McPherson channel includes that part of the area underlain by channel deposits from the Smoky Hill River Valley to Little Arkansas River southeast of Buhler where sand dunes overlie the channel deposits.

The character of the water-bearing materials comprising the deposits of the McPherson channel is shown graphically on profiles A-A', B-B', and C-C' (Pl. 6) and is given in many of the logs of test holes (see Pl. 7 for numbers of test holes). In general, the channel deposits consist of coarse sand and gravel, interbedded with thin layers of silt and clay in the lower part, overlain by a considerable thickness of silt. The deposits are as much as 260 feet thick in the deepest part of the channel. In the northern part of the area, near Smoky Hill River, the channed deposits have been eroded by numerous small tributaries of the river and have been completely removed near the river.

The wells supplying water to the Cities of McPherson, Inman, and Buhler, to the National Cooperative Refinery Association near McPherson, and to the Chicago, Rock Island, and Pacific Railway at Groveland derive water from sand and gravel in the McPherson channel. These wells all have large yields, and the McPherson municipal wells are among the strongest in the entire area.

The depth to water level in the McPherson channel area ranges greatly from place to place (Pl. 5), being shallowest (less than 20 feet) in a narrow irregular area from Groveland to Little Arkansas River. The shallow-water area is bordered by a larger irregular area in which the depth to water is from 20 to 40 feet. The greatest depth to water in this area is found northwest of McPherson where the water level is 97 feet below land surface. As shown by water-table contours (Pl. 1), ground water moves toward the McPherson channel from both sides, and moves northward toward Smoky Hill River from a point southwest of McPherson, and southward from that point toward Little Arkansas River.

Ground water in the McPherson channel is hard but is used without treatment by the Cities of McPherson, Inman, and Buhler; however, most of the hardness is carbonate and the chloride content is low.

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Canton-Galva area.—The Canton-Galva area lies east of the McPherson channel and is underlain by the Delmore formation in the northern part and by the McPherson formation elsewhere, and extends, for purposes of this discussion, as far south as the line of geologic profile C-C' (Pl. 6).

The water-bearing materials underlying this area are much thinner and not so coarse as the deposits in the McPherson channel, and the relationship of the deposits beneath the two areas is shown in geologic profiles B-B' and C-C' (Pl. 6). The municipal wells at Canton and Galva yield from 40 to 120 gallons a minute, quantities which probably are representative of the yield obtainable from wells in this area. The depth to water level ranges from about 10 to about 50 feet below land surface, and the water table slopes southwestward toward Little Arkansas River.

The chemical quality of the water in this area has been affected by the intrusion of oil-field brine. Contamination by the oil-field waters has resulted in an increase in the chloride content and hardness of the ground water in parts of this area (Pl. 29).

Sand-dune area.—The principal sand dunes occur in an irregular elongate area bordering the south side of the Little Arkansas River Valley and extending eastward from the west side of the area to the sharp bend in Little Arkansas River northwest of Halstead (Pl. 1). A smaller area of sand dunes occurs east of Halstead between Little Arkansas River and Emma Creek. Other smaller areas underlain by sand dunes in the Arkansas River Valley are not included in the following discussion.

The sand dunes are composed mainly of fine- to medium-grained quartz sand, interbedded with thin discontinuous layers of silt, clay, and organic matter. No large supplies of ground water have been developed in this area. The sand-dunes area is mainly range land and many stock wells yielding quantities of water sufficient for the needs of the cattle are located in the pastures. Study of the materials comprising the dunes indicates that large yields cannot be expected from the fine sand.

The depth to water level is less than 20 feet below land surface in the sand-dune area (Pl. 5), and ground water moves northward toward Little Arkansas River and southward toward Arkansas River Valley from the central part of the area. The sand hills comprise an excellent catchment area for rainfall and much of the precipitation falling on the porous dunes recharges the ground-water reservoir in adjacent areas. The Newton municipal well field is

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located favorably for recharge from the sand-dune area east of Halstead. The water in the sand dunes is relatively very soft, but contains quantities of iron as great as 44 parts per million in some places (Williams, 1946).

Arkansas Valley area.—There has been a considerable development of ground water in the Arkansas River Valley from Hutchinson to Wichita, and the valley comprises one of the most important ground-water reservoirs in Kansas. For purposes of this discussion the Arkansas Valley includes the area south of the sand dunes, north of the terrace edge which extends southeastward south of Haven and Andale, and west of Little Arkansas River south of Halstead.

The water-bearing materials beneath this area are varied in character and range in thickness from a feather edge to a maximum of about 300 feet southwest of Patterson (Pl. 6). The deposits consist of unconsolidated gravel, sand, silt, and clay, and in most places contain thick beds of very productive water-bearing gravel and sand. The stream deposits are thickest near the junction of the buried McPherson and ancestral Arkansas channels. The maximum thickness of unconsolidated deposits near Hutchinson is about 150 feet, near Wichita about 80 feet, and near Burrton about 275 feet.

Most wells of proper construction in the valley yield as much as 1,000 gallons a minute with small drawdown, and some wells yield as much as 2,000 gallons a minute with relatively small drawndown. The depth to water level is less than 20 feet in most parts of the valley and in some parts of the area is only about 10 feet. Ground water moves northeastward toward the valley from its southwestern side, southward from the sand dunes, and, in general, moves southeastward down the valley (Pl. 1). Part of the water moving southeastward is intercepted by Little Arkansas River north of Wichita, and part continues as subsurface flow southward from Wichita. The sandy nature of the soil provides good facilities for recharge from precipitation. Exceptionally good recharge facilities are provided by the large area of sand dunes on the north side of the valley between Hutchinson and Halstead. Heavily pumped wells near Arkansas River receive additional recharge directly from the river. Little Arkansas River, however, has cut its channel below the level of the water table; hence it does not contribute water directly to near-by wells at the present rates of withdrawal, but rater, it receives water discharged from the adjacent ground-water reservoirs.

All of the cities in this part of the valley derive water supplies from wells in the alluvium and McPherson formation, and many of

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the city wells have large yields with small drawndown. Data concerning the yield of the wells and quality of the water is given above in the section on public supplies.

The ground waters along the southern part of the Arkansas Valley are very hard and contain a considerable amount of chloride; this is especially true of ground water from areas near Arkansas River. The water from individual municipal wells at Hutchinson ranges in total hardness from 134 to 593 parts per million, much of which represents noncarbonate or so-called permanent hardness. The chloride content of waters from these wells ranges from about 100 to more than 600 parts per million. At low stages the water in Arkansas River is somewhat salty, and water from wells near the river generally contains from 400 to 800 parts per million of chloride. The average hardness of water from the old Wichita well field was about 450 parts per million, most of which represented noncarbonate hardness, and the chloride content was about 500 parts per million. The poor quality of this water led to the abandonment of the old supply in favor of the new supply from the northern side of the valley. The hardness of the water from the new well field averages only 130 parts per million, all of which represents carbonate hardness, and the chloride content is only 25 parts. Some of the ground waters along the northern side of the valley contain a considerable amount of iron, whereas those along the southern side contain very little iron. In areas between Arkansas River and the new Wichita well field the ground water is intermediate in quality between the extremes given above. Thus, water from wells 2 miles distant from Arkansas River is of much better quality than water from wells within 1 mile of the river. In and near the Burrton oil field, which extends across the valley west of Burrton, the ground waters in local areas have been rendered salty because of the escape of oil-field brines into the sands and gravels. Through the efforts of the Oil-Field Waste Disposal Section of the Division of Sanitation, Kansas State Board of Health, considerable progress has been made in bettering the conditions in the Burrton oil field, and at present practically all of the brine produced is being conducted to deep disposal wells.

The quality of ground water in some parts of the valley is not suited to all industrial requirements, but even the poorest water is satisfactory for some industrial uses, and the best water is suitable for most industrial uses.

Newton upland area.—The upland area north and south of Newton is underlain principally by the Wellington formation, consisting

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mainly of shale, but also containing thin beds of limestone, gypsum, and other types of sedimentary rock. Wells pentrating the shale in this area generally yield only meager supplies of very hard water. Most wells yield enough water in wet years for domestic and stock use, but in dry years many wells fail. Ground waters in the Permian rocks in this area range in hardness from several hundred parts per million to as much as 2,000 parts, and much of the hardness is of the noncarbonate or so-called permanent type. The chloride content of waters from shallow wells generally is low but locally may exceed 100 parts per million; waters from deep wells generally have a chloride content considerably in excess of 100 parts per million. Water of this quality is unsuited for many uses.

Thin deposits of the McPherson formation occur sporadically south of Newton along the east side of the Arkansas River Valley. These deposits are thin and are composed mostly of silt and fine sand, and yield small quantities of water of relatively good chemical quality to domestic and stock wells. Some small springs and seeps occur at the base of the McPherson formation along ravines which have cut into the underlying shale. The physical character of the unconsolidated deposits is such that only small yields can be expected from wells.

Southwestern upland area.—The southwestern upland area is southwest of the Arkansas River Valley, southwest of the terrace edge which trends southeastward south of Haven and Andale (Pl. 1). This area is underlain by unconsolidated deposits of the McPherson formation which are thinner and occur at a higher elevation than the deposits of the McPherson formation in the Arkansas River Valley (Pl. 6). The McPherson formation is as much as 150 feet thick in the comparable area just southwest of Hutchinson (Williams, 1946, pl. 1), but becomes thinner southeastward and in many places only a thin mantle of fine-grained material overlies the Permian bedrock floor.

Wells 534 and 535 at the Hutchinson Naval Air Station are situated on the north edge of the upland area and are about 125 feet deep. These wells yielded 365 gallons a minute with a drawdown of 15 feet. These are the only wells in the southwestern area yielding large supplies, although small wells yield quantities sufficient for domestic and stock purposes.

The depth to water level ranges from 20 to 30 feet and ground water moves northeastward toward the Arkansas River Valley in most parts of this area. In general, the water is of comparatively good chemical quality.

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Ninnescah area.—The area referred to here is underlain by the Permian Ninnescah shale bordering the Ninnescah River (Pl. 1). The materials comprising the shale have very low permeability and wells penetrating the formation yield only small supplies of water to stock wells. The ground water in this area is very hard and its usefulness is limited.

Posssibilities of Developing Additional Large Ground-Water Supplies

The geology and ground-water conditions in parts of this area preclude the development of large quantities of water; this is true especially where shale of Cretaceous and Permian age crops out around the border of the area studied. In places in the McPherson Valley, east of the channel area, the unconsolidated deposits of the McPherson formation are thin and fine-grained and yield only moderate supplies of ground water; however, parts of the area are underlain by deposits which will yield large quantities of water to properly constructed wells, and are favorable for future development.

Lindsborg area.—It seems that moderately large supplies of ground water, from 300,000 to 1,000,000 gallons a day, can be developed from wells in the alluvium of the Smoky Hill River Valley near Lindsborg. In general, the alluvium is less productive in the valley westward from Lindsborg; wells at Lindsborg yield from 600 to 750 gallons a minute with from 10 to 13 feet drawdown, and wells near Marquette yield smaller quantities of water with greater drawdown.

As is noted above, the chemical character of the water in the Smoky Hill Valley is such that treatment is required for many industrial uses. The water is very hard and is treated by the Missouri Pacific Railway for locomotive use. The water also contains a considerable quantity of iron which is detrimental in certain industrial uses. The temperature of the water is about 60° F. and is suitable for cooling and air-conditioning purposes.

McPherson channel area.—Large quantities of water, up to 5,000,000 gallons a day, can be developed from properly located wells in several places in the McPherson channel area (Lohman, 1942). In general, largest yields may be expected from wells penetrating the deepest part of the buried channel. South of Smoky Hill River the productive water-bearing area ends about midway between McPherson and the river owing to erosion and removal of the water-bearing materials. In the productive area northwest of McPherson no large

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supplies of water have been developed, but this area is a potential source. In and near McPherson large yields are derived from wells along the eastern part of the channel area and future developments near the city probably should be located farther west in the channel. Only moderately large water supplies have been developed from wells at Inman and Buhler in the channel area between U. S. Highway 50N and the sand dunes, and this part of the channel would support many large wells. Because of the excellent facilities for recharge very large perennial yields could be expected from wells located in the Little Arkansas River Valley and in the sand hills southeast of Buhler where the river and the dunes overlie the channel deposits.

Arkansas Valley area.—Large supplies of ground water are available from the alluvium and McPherson formation in most parts of the Arkansas Valley area, but the quality of the water, and therefore its usefulness, varies greatly from place to place. In general, the water is more highly mineralized near Arkansas River than at other places in the valley. In all parts of the valley, however, the low temperature of the water (about 60° F.) is satisfactory for cooling, air conditioning, and some other industrial uses. The sandy nature of the soil provides good facilities for recharge from precipitation in most parts of the valley.

In Hutchinson and vicinity municipal and industrial supplies ranging up to 3,000,000 gallons a day have been developed successfully and it seems that additional large supplies can be developed without endangering present supplies (Williams, 1946). Ground water is very hard and the chloride content is high near the river in the vicinity of Hutchinson and is suitable only for cooling, air conditioning, and a few other uses. Water of much better chemical quality occurs along the edge of the sand hills northeast of the city, and facilities for recharge there are good.

The area bordering the south side of the sand dunes north of Burrton is quite favorable for the development of large groundwater supplies and the chemical character of the uncontaminated ground water is good. Oil wells in the area, however, may have contributed undesirable water to the aquifer.

A large supply of water of good quality has been developed by the City of Wichita in the area southwest of Halstead. It seems that additional water can be derived from the aquifer in the vicinity of the well field.

Wells having large yields could be constructed along the north

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side of Arkansas River between Patterson and Bentley, but the quality of the water is poor. The area between Patterson and Burrton is underlain by thick deposits of water-bearing material and would yield large quantities of water, but serious contamination by oil-field brine has occurred in that area (Pl. 29).

Ground water of better quality occurs in the valley south of the river, and large yields from wells may be expected southeastward from Mt. Hope in the Cowskin Creek-Big Slough area. Test drilling revealed thick deposits of coarse water-bearing materials northeast of Colwich, and it seems that a large supply of ground water of comparatively good quality could be expected there.

Very productive wells yielding water of comparatively good quality have been developed in the alluvium of Little Arkansas River from Halstead to Wichita. There are several undeveloped parts of the valley along this stream where large supplies of ground water could be developed.

Large supplies of water of quality suitable for cooling and air conditioning are available in the City of Wichita west of the east boundary of the alluvium. A large but unknown quantity of water is pumped in the city for cooling purposes, especially in the business district. Although few data are available concerning the reduction in ground-water storage in the city, it is believed that additional supplies can be developed in most parts of the business and industrial areas in the valley.

Test drilling has shown that additional supplies of water are available in the valley from Emma Creek to Little Arkansas River beneath the sand dunes south of the present Newton municipal well field (Pl. 6). The chemical character of the water and the facilities for recharge from precipitation are good, and it is believed that properly constructed wells would have large yields. Future needs of the City of Newton probably could be produced in this area.

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WELL RECORDS

Information pertaining to water wells in Harvey, McPherson, Reno, and Sedgwick Counties is tabulated in Table 37. The numbers in the first column correspond to the well numbers on the map (Pl. 5) and in the tables of analyses (Tables 13 and 14). The numbers in the first column that are in parentheses indicate wells from which samples of water were taken for analysis. The wells are listed in order by townships from north to south and by ranges from east to west. Within a township the wells are listed in the order of the sections. The measured depths to water level are given to the nearest 0.01 foot, whereas reported depths are given only to the nearest foot and are subject to error. Data pertinent to the construction and yield of the wells are given in the column headed Remarks.

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TABLE 37.—*Records of wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas*

(Wells are drilled wells unless otherwise indicated under "Remarks.")

No. on Pl. 1 (1)	LOCATION	Owner	Depth of well (feet) (2)	Diameter of well (in.)	Principal water-bearing bed		Method of lift (3)	Use of water (4)	Measuring point			Depth to water level below measuring point (feet) (6)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
					Character of material	Geologic subdivision			Description	Distance above (+) or below (—) land surface (feet)	Height above sea level (feet) (5)			
	T. 17 S., R. 2 W.													
1	SW SW sec. 31	Louise Patterson, et al	116.0	8	Shale	Wellington,	Cy, W	S	Top of casing, east side	+1.8	1,462.5	43.27	4–14–44	
	T. 17 S., R. 3 W.													
2	SE SW sec. 1	C. W. Larn	78.0	8	do	do	Cy, W	S	Top of wooden platform,	+ .7	1,318.6	13.27	6– 7–44	
3	SW SW sec. 11	Hugo Sjorgen	39.2		do	do	Cy, W	S	Top of concrete curb, west side	+1.0	1,341.0	29.40	4–12–44	Dug well. Can be pumped dry. Water reported hard
(4)	SE NE sec. 17	Lindsborg Water Co	73	49	Gravel and sand	Alluvium	T, E	P				33	9–36	Gravel packed. Reported yield 750; drawdown 10. Temp. 59° F. See log
5	SE sec. 17	do	92	38	Gravel	do	T, E	P				33	7–23	Gravel packed. Reported yield 600; drawdown 13 See log
6	SW cor. sec. 21	Emma Ahlsteadt	40.0	10	Sand	do	Cy, N	N	Top of casing, north side	.0	1,337.2	12.13	4–12–44	Dug well deepened by drilling
7	NE NE sec. 25	Oscar Samudson	36.7		Shale	Wellington	Cy, W	S	Top of wooden platform, east of pump	+ .7	1,376.9	12.69	4–12–44	Dug well. Reported adequate supply
8	SW SW sec. 29	B. A. Johnson	101	6	Red shale	Ninnescah	Cy, H	D	Top of casing, northwest side	.0	1,339	25.55	9–27–38	Cased 44 feet to shale
9	SW cor. sec. 30	Emil Lillan	51.7	10	Coarse gravel	Alluvium	Cy, G	D, S	Lower edge of platform, west side	.0	1,351	33.53	10–25–38	

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	T. 17 S., R. 4 W.													
10	NE SE NE sec. 20.	G. Dolsteen	60 0	6	Red shale	Ninnescah	Cy, W	S	Top edge of platform, north side	+ .5	1,391	12 65	10–25–38	Dug 20 feet, remainder drilled
11	SW cor. sec. 20	C. W. Dolsteen	35 0	36	Shale	do	Cy, W	S	Lower edge pump base, northeast side	+ .5	1,427	29.21	10–27–38	Dug well
(12)	NW NW SE sec. 22	A. N. Lindquist	21 3	36	do	do	Cy, W	S	Top of platform, east side	+1.5	1,385	20.50	10–25–38	Dug well. Temp. 58° F.
13	SE cor. sec. 24	Carl Franz	38 8	36	Sand	Alluvium	Cy, H	D	do	.0	1,359	34.28	10–25–38	Dug well
14	NE cor. sec. 25	Linus A. Bergstrom	63	8	Coarse sand	do	T, G	Ir				33		Ten-foot screen
15	NW NW sec. 25	John Oakleaf	50 7	10	Sand	do	Cy, H	N	Lower edge pump base, east side	.0	1,354	31.64	10–27–38	
16	NE SE NE sec. 27.	J. L. Nelson	29 0	36		do	Cy, W	D, S	Top of platform, north of pump	+1.0	1,358	27.21	10–25–38	Dug well
17	NW NE NE sec. 28	F. T. Landgren, et al	100 0		Shale	Ninnescah	Cy, H	N	Top of platform, east of pump	+1.0	1,379	38.35	10–27–38	
18	SE cor. sec. 29	O. L. Larsen	59 3	6	do	do	Cy, H	D	Top of casing, south side	+ .2	1,373	28.32	10–25–38	Water reported hard
(19)	SW SW sec. 32	J. F. Darro	45 8	8	Sand and gravel	Alluvium	Cy, W	S	Top of casing, east side.	−3 8	1,379	21.57	10–15–38	Temperature 58° F.
20	SE SE sec. 33	C. Welch	32 8	24	Shale	Ninnescah	Cy, W	D, S	Steel plate on platform	+1.5	1,370	29.35	11– 4–37	Dug observation well
21	SE SW sec. 34	L. Sundeen	51 0	24	do	do	Cy, W, G	S	Top of platform, southwest corner	+1 ±	1,387	47.39	8–31–37	Dug well
	T. 17 S., R. 5 W.													
22	SE NE sec. 23	Missouri Pacific Railroad Co.	45	30	Sand and gravel	Alluvium	T	R	Land surface			37	4–10–37	Gravel packed. Yield 135; drawdown 7. See log
23	do	do	45		do	do	C	R						Two identical wells connected to one pump
(24)	NE SE sec. 23	City of Marquette	43	96	do	do	C, E	P	do			27	11–10–44	Dug well curbed with tile
25	SE SE sec. 23	do	43	240	do	do	C, E, G	P	do			26.5	11–10–44	Dug well curbed with concrete and tile. Equipped with 3 centrifugal pumps. Sixteen 16-foot pipes driven laterally from bottom. Well extends 8 feet into shale

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TABLE 37.—*Records of wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Continued*

No. on Pl. 1 (1)	LOCATION	Owner	Depth of well (feet) (2)	Diameter of well (in.)	Principal water-bearing bed		Method of lift (3)	Use of water (4)	Measuring point			Depth to water level below measuring point (feet) (6)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
					Character of material	Geologic subdivision			Description	Distance above (+) or below (—) land surface (feet)	Height above sea level (feet) (5)			
	T. 17 S., R. 5 W. (Continued)													
26	SW SE SE sec. 23...	City of Marquette.....	43	96	Sand and gravel	Alluvium...	C, E	P	Land surface.....	.....	.....	21	11-10-44	Dug well; extends 4 feet into shale
27	NE cor. sec. 24.....	A. A. Williams.....	13.5	36	do.....	do.....	Cy, W	D, S	Top of platform, north side	+2.0	1,411	8.35	10-26-38	Dug well. Water reported hard
28	NE SE sec. 24.....	Missouri Pacific Railroad Co.	54.7	34	Coarse sand and gravel	do.....	T	R	Land surface.....	.....	.....	28.5	5- 2-42	Gravel walled, 18-inch screen. Yield 269, drawdown 25 after 10 hours
29	SW SE SE sec. 24...	E. L. Christenson.....	35.0	6	Sand.....	do.....	Cy, H	N	Top of casing, north side	+ .5	1,380	22.71	10-26-38	
	T. 18 S., R. 2 W.													
30	NE NW sec. 16.....	B. N. Prickett.....	33.0	10	.....	Delmore....	Cy, W	D, S	Top of casing, west side	+ .6	1,450.2	10.03	4-14-44	
31	NE NE sec. 28.....	L. and G. Anderson.....	100+	5	Sand.....	Kiowa.....	Cy, W	S	Top of casing, east side	+ .4	1,536.3	56.25	4-11-44	
32	NW SW SW sec. 36	Mrs. Martin Clark.....	46.2	10	.....	Delmore....	Cy, W	D, S	Steel plate under pump	.0	1,555.5	38.61	4-14-44	Reported adequate supply good water
	T. 18 S., R. 3 W.													
(33)	SE cor. sec. 5.....	Prudential Life insurance Co.	41.5	36	Shale.....	Wellington	Cy, W	D, S	Top of opening in shelter, south side	+4.0	1,457	37.69	11- 2-37	Temp. 58° F. Dug observation well
34	NW NE NW sec. 6..	John Lundstrom.....	38.0	36	Gravel.....	McPherson	Cy, W	S	Top of platform, west side	+1.0	1,364	31.22	10-27-38	Dug well
35	SW SE SW sec. 12...	Mrs. E. M. Woodward...	48.5	6	.....	Delmore....	Cy, H	D	Top of casing, south side	+ .4	1,528.3	46.13	4-14-44	Bed rock at 49 feet. Insufficient water for stock use

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36	NE cor. sec. 16	Eric Rassmussen	125	6	Shale	Ninnescah	Cy, W	D, S	Top of casing, west side	+ .5	1,444.9	17.07	4-12-44	Water reported hard
37	SW SW NW sec. 17	A. H. Nelson	39.4	48	do	do	Cy, G	S	Top of platform, west side	+1.0	1,447	38.43	10-29-37	Dug well
38	SE NW NW sec. 21	Vincel Kling	50.1	26		McPherson	N	N	do	.0	1,479	34.2	10-18-37	Dug well
39	SW SW sec. 25	Mrs. Emma Olson	39.2			do	N	N	Top of wooden windlass frame, south side	+3.7	1,531.4	22.35	4-12-44	Dug well. Insufficient water for stock use
40	SE SW SW sec. 28	Mrs. Henry Ostlind	42.5			do	Cy, N	N	Base of pump	.0	1,515.0	42.10	4-11-44	Dug well
41	NE SE SW sec. 29	Alfred Ledell	63.4	8		do	N	N	Top of casing, north side	+1.2	1,507	49.19	10-28-37	
42	SE NE sec. 31	Axel Johnston	165	2	Sand and gravel	do	Cy, W	D, S		.0	1,516	83	10- 4-38	Driven well
	T. 18 S., R. 4 W.													
43	SW NW NW sec. 2	Charles Palmquist Estate	155	36	Shale	Ninnescah	Cy, H	N	Top of platform, south of pump base	+1.5	1,383	17.56	11- 4-37	Dug and drilled. Water reported hard
44	SW NW sec. 4	F. A. Johnson	42.0	36	do	do	Cy, H	S	Top of platform, west of pump base	+ .5	1,385	37.60	11- 4-37	Dug well
45	NE SE sec. 12	Otto Juhnke	28.5	8	do	do	Cy, G	S	Top of casing, east side	+ .3	1,386	28.5	10-29-37	
46	SE NW SE sec. 13	Alfrida Johnson	41.8			McPherson	Cy, W	S	Top of platform, west of pipe	+ .6	1,446	37.07	11- 4-37	Dug well
47	NW SW NW sec. 16	Julia Murphy	15.7	36		do	Cy, H	N	Top of platform, east of pump base	+ .8	1,395	14.27	11- 4-37	Dug well. Very small yield
48	NE SE NE sec. 16	C. V. Swenson Estate	56.7	6		do	Cy, W	D, S	Top of platform, west side of opening	+ .5	1,448	53.8	11- 4-37	
49	SW NE NE sec. 18	Bengt Nelson	78.0	6	Sand	do	Cy, W	D	Top of platform, west side	+ .3	1,488	52.75	10- 4-38	Water reported hard
50	SE NW sec. 18	J. C. Muse	215	7		Ninnescah	N	N			1,523		11-16-37	Shale at 60 feet; water at 90 feet
51	NE SE SE sec. 19	Geo. Allison	16 6	48		McPherson	Cy, H	D, S	Top of platform, east of pump base	+2.0	1,457	14.85	11- 4-37	Dug well, penetrates shale 16 inches
52	SE SE NE sec. 20	J. F. Lader	20.9	5	Gravel	do	N	D, S	Top of casing, southwest side	+ .5	1,423	16.21	11-12-37	
(53)	SW NW SW sec. 22	L. F. Mikow	177		Sand	do	Cy, W	D, S	Top of casing, south side	+ .5	1,500	92 92	11-12-37	Temp. 58° F. Dry sand from 25 to 90 feet
54	NW NE NE sec. 26	A. L. Peterson	210	6	Sand and gravel	do	Cy, W	D, S	do	+1.0	1,510	95.51	11-12-37	Well did not reach shale

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TABLE 37.—*Records of wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Continued*

No. on Pl. 1 (1)	Location	Owner	Depth of well (feet) (2)	Diameter of well (in.)	Principal water-bearing bed		Method of lift (3)	Use of water (4)	Measuring point			Depth to water level below measuring point (feet) (6)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
					Character of material	Geologic subdivision			Description	Distance above (+) or below (—) land surface (feet)	Height above sea level (feet) (5)			
	T. 18 S., R. 4 W. (Continued)													
55	NW cor. sec. 32	Carrie Hobson	37.2	24		McPherson	Cy, W	S	Bottom of pump base, west side	+ .4	1,451	33.55	9-29-38	Dug well
(56)	NE NE SE sec. 35	H. A. Selbert	99.5	6		do	Cy, W	D	Top of casing, east side	+ .5	1,521	97.45	9-26-38	Temperature 58° F.
57	NE NW NW sec. 36	Harry Ledell	142	6		do	Cy, W	S	Top of casing, west side	+ .2	1,508	92.14	9-28-38	
	T. 18 S., R. 5 W.													
58	NE NW NE sec. 1	P. A. Olsen	40.5	36	Gravel	Alluvium	Cy, W	S	Top of platform, east of pump base	+1.0	1,386	31.08	11- 4-37	Dug observation well
59	NE SE sec. 1	George Palmquist	74.0	6	Shale	Ninnescah	Cy, W	D, S	Top of casing, southeast side	+1.0	1,392	35.17	10- 4-38	
60	SW SE SW sec. 12	R. Haywood	49.1	36	do	do	Cy, H	D, S	Bottom of pump base, west side	+ .6	1,386	26.69	11- 4-37	
61	SW SE SW sec. 25	L. T. Miller	37.0	48	do	do	Cy, H	N	Top of platform, west of pump base	+ .5	1,482	21.88	11- 3-37	
(62)	SE NE NE sec. 26	C. W. Tilton	33.9	36		McPherson or Ninnescah	Cy, W	D, S	do	+ .6	1,531	32.7	11- 3-37	Temperature 57° F.
	T. 19 S., R. 1 W.													
63	SW SW sec. 11	K. W. Nickl	21.0	10	Sand	Kiowa	Cy, H	D	Top of casing, northeast side of pump	+ .7	1,567.2	14.71	4-13-44	Insufficient water for stock use
64	NW NW sec. 18	John Anderson	40.2		do	Delmore	Cy, W	D, S	Top of wooden platform, south side of pump	+ .4	1,570.2	36.15	4-13-44	

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(65)	SE NE sec. 21	City of Canton	82	18	do	Kiowa and Delmore	Cy, E	P				53		Temp. 58° F. yield 38; drawdown 18, gravel packed
66	NW SW sec. 22	do	82	18	do	do	Cy, E	P				53±		Yield 40. Gravel packed
67	SW SW sec. 22	do	70	48	Sand and gravel	do	T, E	P				52		Yield 60; reported drawdown 17. See log. Gravel packed
68	SE cor. sec. 25	B. E. Steinkirchner, et al.	28.0	10		McPherson and Delmore	Cy, H	D	Top of casing, east side	+1.1	1,580.3	13.79	3-17-44	
69	NE SE NE sec. 28	G. L. Bair	43.6	6	Sand	do	Cy, W	S	Top of wooden platform, under pump	+1.5	1,582.6	40.35	5-16-44	
70	SW SW NW sec. 30	Hettie Anderson	27.0	36		do	Cy, H	D	Top of wooden platform, opening on north side	+ .2	1,559.4	20.49	3-17-44	
	T. 19 S., R. 2 W.													
71	NW SW NW sec. 4	Kansas Power and Light Co.	63.5	12.5	do	Delmore	Cy, G	In	Land surface			35	8-18-33	Pump about 30,000 gallons daily; can be pumped dry in dry weather
72	NW NW sec. 15	Elizabeth Koehn	29.5	6	do	McPherson and Delmore	Cy, H	S	Top of concrete curb, north side	+ .1	1,541.3	6.79	4-11-44	Reported adequate supply
73	SW NW sec. 22	Chicago, Rock Island Pacific Railway Co.	45	12	do	do	T, E	R						Grave. packed. Yield 75
(74)	NE SW SW sec. 22	City of Galva	41	38	do	do	T, E	P				24	10-26-37	Yield 123; drawdown 16. See log. Gravel packed, 20-foot screen
(75)	NW SE SW sec. 22	City of Galva	35	38	Sand	McPherson and Delmore	T, E	P				24	10-26-37	Temp. 59° F. Yield 35; drawdown 16. Gravel packed, 20-foot screen. See log
76	NE SW sec. 27	W. Hill	66.5	6		do	Cy, H	N	Top of casing, north side	+ .8	1,555.9	31.49	3-16-44	
77	NE cor. sec. 31	Anna E. Reed	53.3	10		do	Cy, W	D	Top of can over casing	.0	1,521.7	30.52	3-17-44	
	T. 19 S., R. 3 W.													
78	NE SW NW sec. 4	C. V. Kling	82.7	6	Sand, fine	McPherson	Cy, W	D, S	Top of casing, south side	+5.3	1,507	75.69	10-28-37	
79	SE SW SE sec. 5	Emma Bergstrom	92.6	36		do	Cy, H	D	Top of platform, south side of opening	+ .4	1,516	83.49	10-28-37	Dug observation well
80	SE NE SE sec. 8	Esta R. Johnson	149	8	Gravel	do	Cy, W	D, S	Top of concrete platform, east side of pump	+ 5	1,522.1	94.00	4-12-44	Reported adequate supply good water

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TABLE 37.—*Records of wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Continued*

No. on Pl. 1 (1)	LOCATION	Owner	Depth of well (feet) (2)	Diameter of well (in.)	Principal water-bearing bed		Method of lift (3)	Use of water (4)	Measuring point			Depth to water level below measuring point (feet) (6)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
					Character of material	Geologic subdivision			Description	Distance above (+) or below (—) land surface (feet)	Height above sea level (feet) (5)			
	T. 19 S., R. 3 W. (Continued)													
81	NE SE SE sec. 11	S. A. Burke	48.2	6		McPherson	Cy, W	D, S	Top of casing, south side	+1.3	1,539.5	26.19	4-13-44	
82	NW NW SW sec. 20	D. W. Thompson	80	6	Sandy clay	do	Cy, W	D	do	+ .3	1,499.4	69.9	9-28-38	Has been pumped dry.
83	SW SE SW sec. 22	Bay Petroleum Corp	145	12		do	T, E	In	Land surface			71	4-25-44	Yield 600; drawdown 56 after continuous pumping. Will not yield 600 indefinitely
84	SW SE sec. 22	do	110	8		do	T, E	In	do			80	4-25-44	Yield 75; drawdown 25 after several days
85	NW NE sec. 26	S. P. Crumpacker	100+	6	Gravel	do	C, W	D	Top of wooden platform, south side of pump	+1.8	1,510.2	16.39	4-13-44	Reported adequate supply good water
86	NW NE sec. 29	Scott Montgomery	98.5	6	Gravel and sand	do	N	N	Top of casing	+1.0	1,498.62	70.09	9- 1-37	Observation well
87	do	Mr. Gustafson	75.2	8		do	Ws, H	D	Top of casing, north side	+1.3		69.57	9- 1-37	
88	NE NW SE sec. 29	City of McPherson	160	38	Sand and gravel	do	T, E	P				64	1925	Yield 1,500. Gravel packed
(89)	do	do	137	38	do	do	T, E	P				64	1923	Yield 1,200. Gravel packed
90	SE NW SE sec. 29	do	158	38	do	do	T, E	P				62	1923	Yield 1,400; drawdown 17. Gravel packed. See log
91	SW SE SW sec. 29	Marvin Smith	73.3	8		do	Cy, E	D, S	Top of platform, east side	+1.6	1,485.9	54.3	11- 6-37	

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92	SW SE sec. 29	City of McPherson	146	38	do	do	T, E	P				61.09	7-37	Yield 2,000; drawdown 27. Gravel packed
	T. 19 S., R. 4 W.													
93	SW NW NW sec. 7	F. Little	22.1	24		do	N	N	Top of casing, south side	+ .15	1,489	16.82	9-28-38	Dug well
94	SE SE NE sec. 7	H. E. Potter	89	6		do	Cy, W	D		.0	1,531	77	9-29-38	
95	SW SW sec. 7	Hugh Stockham	65.0	10	Shale	Ninnescah	Cy, W	D	Top of platform, north side		1,553	53.7	9-19-38	Well reported to end in red shale
96	SW NE sec. 15	Jeff Kubin	76.5	5	Sand	McPherson	N	N	Top of casing, south side	— .5	1,496.3	69.35	11-10-37	
97	SW SE SW sec. 17	Hugh Stockham	61.3	6		do	Cy, W	D	Top of platform, west side	+ .2	1,516	32.7	9-28-38	Good supply reported. Well ends in shale
(98)	NW NW NE sec. 18	R. B. Ring	100+	6	Shale	Ninnescah	Cy, W	D	Top of platform, southwest side	+1.0	1,547	50.39	9-19-38	
99	NW NW NE sec. 20	Dahl Stockham	68.0	8		McPherson	Cy, W	D	Top of casing	—4.3	1,518	52.8	9-28-38	Good supply reported. Well ends in shale
100	SW NW SE sec. 22	J. H. Schrag	59.1	12		do	N		Top of casing, south side	—2.0	1,481	51.16	11- 5-37	
(101)	SW SE SW sec. 24	Roby Estate	77.7	6	Fine sand	do	Cy, W	D, S	Top of casing, east side	—3.0	1,502.45	72.80	11- 2-37	Well reported filling with fine sand
102	NW NE SW sec. 28	P. J. Oberst	114.0	10	Shale	Ninnescah	Cy, W	S	Top of platform, west side	+2.0	1,515.7	64.21	11- 6-37	Well reported to encounter shale at 14 feet
103	do	do	50.0	36	do	do	Cy, E	D	Top of platform, northwest side	+1.0	1,514.4	43.71	11- 6-37	Dug well
104	NE NE SE sec. 30	L. S. Wade	60.0	36	do	do	Cy, W	S	Top of platform, south side	+ .8	1,538	43.50	11- 3-37	do
	T. 19 S., R. 5 W.													
105	SE SW sec. 12	H. B. Holler	34	36	do	do	N	N	Top of platform, north side	+3.5	1,529	25.64	11- 3-37	Dug well
106	SE SE SE sec. 14	David Mills	16.0	48	do	do	N	N	Top of platform, east side	+4.0	1,545	10.95	11- 3-37	Dug observation well
107	SE SW SW sec. 24	I. Rathburn	40.8	20	do	do	Ws, H	D	Top of shelter, east side	+3.0	1,594	39.88	11- 3-37	Dug well
	T. 20 S., R. 1 E.													
108	SW SW sec. 30	P. P. Quiring	30.1	36	Sand	McPherson	Cy, W	D, S	Top of wooden box on platform, east side	+1.8	1,552.2	25.57	3-17-44	Dug well. Water reported good quality

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TABLE 37.—*Records of wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Continued*

No. on Pl. 1 (1)	LOCATION	Owner	Depth of well (feet) (2)	Diameter of well (in.)	Principal water-bearing bed		Method of lift (3)	Use of water (4)	Measuring point			Depth to water level below measuring point (feet) (6)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
					Character of material	Geologic subdivision			Description	Distance above (+) or below (—) land surface (feet)	Height above sea level (feet) (5)			
	T. 20 S., R. 1 W.													
109	SE NE sec. 9	Fred Vogts	22.9	36		McPherson	Cy, W	D, S	Top of north board on wooden platform	+ .3	1,548.4	17.21	3-16-44	Dug well. Water reported good quality
110	NE SE sec. 12	Arnold C. Reimer	31.5	36		do	Cy, W	D, S	Top of wooden platform, west side of opening	+ .6	1,561.7	23.39	3-17-44	do
111	NE NW NE sec. 30	E. H. Hein	72	6	Sand	Wellington (?)	Cy, W	S	Top of casing, south side	+1.0	1,562.0	46.68	3-17-44	Reported adequate supply good water
112	NW SW sec. 34	P. A. Voth	19.4	10	do	McPherson	Cy, H	D, S	Top of concrete curb, north side	+1.0	1,501.7	10.16	3-16-44	
	T. 20 S., R. 2 W.													
113	SW NW SW sec. 8	Ben Nelson	31.0	8		do	Cy, W	D, S	Top of casing, north side	+ .6	1,516.1	19.80	3-17-44	Reported asequate supply; water hard
114	NW NE NW sec. 11	H. A. Beckew	100+	5	Sand and gravel	McPherson	Cy, G	D, S	Top of casing, south side, in concrete lined pit	—5.0	1,532.9	11.14	5-17-44	Reported adequate supply good water
115	SW NW SW sec. 21	Martin Krehbiel	46.6	6		do	Cy, W	D, S	Top of casing, west side	+ .3	1,516.1	24.28	4-14-44	
116	SE SE SW sec. 23	Rudiger	13.5	36		do	N	N	Top of wooden casing, west side	+1.0	1,516.2	9.50	3-17-44	Unused dug stock well
117	SW cor. sec. 35	J. B. Becker	11.1	6		Wellington (?)	N	N	Top of casing, southeast side	+ .1	1,497.5	5.65	3-16-44	
	T. 20 S., R. 3 W.													
(118)	SE SE NE sec. 3	Fred Johnson	100+	10		McPherson	Cy, W	S	Top of platform, east side	+1.0	1,493	59.93	10- 5-38	Temperature 58° F.

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119	NE cor. sec. 5	National Cooperative Refinery Assn.	161	30	Sand and gravel	do	T, E	In	Land surface			72	5-41	Reported yield on test 1,000; drawdown 39; now pumped at 900. Gravel packed. See log
120	NW NE NE sec. 5	do	163	30	do	do	T, E	In				63	8 28 37	Yield 1,040; drawdown 34 Gravel packed. See log
121	NE NW NE sec. 5	do	158	30	do	do	T, E	In				55	12-17-32	Yield 800; drawdown 19.5. Gravel packed. See log. (Well failed in 1943)
122	NE SW NE sec. 5	do	168	30	do	do	T, E	In	Land surface			68	5 44	Reported yield on test 1,100; drawdown 39; now pumped at 600. Gravel packed. See log
123	SW SE SE sec. 5	A. A. Devar	91.3	6	Gravel	do	Cy, W	D, S	Top of casing, south side	+ .8	1,490.2	58 84	10- 5-38	
124	NE cor. sec. 9	Simon Stockly	78.0	6		do	Cy, H	D, S	Top of casing, southwest side	+1.0	1,488.2	54.56	10- 5-38	Quality reported poor
125	NW NE NW sec. 19	Dean and Tracy		6	Sand and gravel	do	Cy, W	D, S	Top of casing, east side	—1.5	1,483.4	48.28	11 22-37	
126	NE NE sec. 21	G. H. Johnson	38.2	8		do	Ws, H	N	Top of casing, northeast side	+2.0	1,470.0	34.16	10- 5-38	Quality and quantity reported poor
(127)	SW SE SE sec. 26	R. B. Hiner, et al	40.3	8		do	Cy, W	D, S	Top of casing, north side	+ .7	1,460.6	21 78	10-18-38	Temperature 58° F.
128	NW cor. sec. 30	P. W. Seidel	129.0		Sand and gravel	do	N	N	Land surface	.0	1,474	45.23	6- 3-39	Uncased test for irrigation well
(129)	SE NE SE sec. 31	J. B. Scragg	75	6	Sand	do	Cy, W	D, S	Top of casing, east side	+ .2	1,479.0	47.87	10- 1-38	Temperature 58° F.
	T. 20 S., R. 1 W.													
130	NE cor. sec. 1	Mrs. J. E. Carlson	100	6	do	do	Cy, W	S	Top of platform, northwest side	+ .5	1,498.0	66.27	9-17 38	
(131)	NW NE NW sec. 1	E. J. Stockham	65.0	12		do	Cy, W	D, S	do	+ .5	1,495.0	63.19	9-17-38	Temperature 58° F.
132	NW cor. sec. 3	M. G. Riddell	65	6	Sand	do	Cy, W	D, S	Top of casing, southwest side	+1.0	1,485.8	53 83	9-19-38	
133	SE SW SW sec. 3	John Moors	56.4	10		do	Cy, W	D, S	Top of platform, southwest side	+2.2	1,479.2	46.24	9-19 38	
134	NW NW NE sec. 5	J. J. Yoder	41.1	36	Shale	Ninnescah	Cy, H	D	Top of concrete platform south side	+ .3	1,538.1	32.45	10- 1-38	Dug well

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No. on Pl. 1 (1)	LOCATION	Owner	Depth of well (feet) (2)	Diameter of well (in.)	Principal water-bearing bed		Method of lift (3)	Use of water (4)	Measuring point			Depth to water level below measuring point (feet) (6)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
					Character of material	Geologic subdivision			Description	Distance above (+) or below (—) land surface (feet)	Height above sea level (feet) (5)			
	T. 20 S., R. 4 W. (Continued)													
135	NW cor. sec. 9	C. N. Spencer	118	.....	Shale	Ninnescah	Cy, W	S	Top of platform, west side	+ .6	1,520	29.80	9-30-38	Water has sulpher taste
136	SW SE NE sec. 9	E. E. Schlatter	51.6	10	.....	McPherson	Cy, W	D, S	do	+ .2	1,480.6	17.89	9-30-38	
137	NW NE NE sec. 16	O. E. Hostetler	42.3	36	.....	do	Cy, W	S	do	— .5	1,487.7	25.42	9-30-38	Dug well
138	SW SW NW sec. 16	W. and M. Cooprider	20.7	36	do	do	Cy, W	N	Lower edge of board, north side of pump base	+1.0	1,502	16.05	10- 3-38	Dug well. Water reported unfit for domestic use
139	SE SW SE sec. 16	Mildred L. Walker	93.0	6	Sand	do	Cy, G	D, S	Lower edge of pump base, north side	+ .5	1,489.6	54.79	9-30-38	
140	SE SE SW sec. 17	Sam Gatz	39.9	36	Shale	Ninnescah	Cy, W	D	Top of well cover box, south side	+2.5	1,528	39.20	10- 3-38	Dug well. Water reported hard
141	NE NW NE sec. 21	T. K. Rump	58	6	Sand	McPherson	Cy, W	D, S	Top of platform, south side	+1.0	1,491.1	56.19	9-30-38	
142	SW SW SE sec. 21	do	122	6	Shale	Ninnescah	Cy, W	S	Top of platform, north side	+ .5	1,477	38.09	9-29-38	
143	SW cor. sec. 22	do	68	6	Sand and gravel	McPherson	N	N	Top of platform	+ .6	1,483.5	48.47	9-29-38	
144	SW SW SE sec. 23	Chicago, Rock Island and Pacific Railway Co.	74.8	12	.....	do	T, E	R	.....	.....	.....	29.8	.....	Yield 117; drawdown 5.2
145	SE SW SE sec. 23	S. W. Carpenter	64	10	Sand	do	Cy, H	D	Top of casing, east side	+ .2	1,482.4	48.76	10- 1-38	

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146	NW NE NE sec. 27	R. G. Smith	60	6	Sand and gravel	do	Cy, G	D	Top of casing, south side	—1.7	1,469.8	34.15	9-29-38	
147	NE SE SE sec. 33	A. C. Rump	111	.....	Shale	Ninnescah	Cy, H	D	Top of porch, north side of opening	+1.2	1,483	23.95	9-29-38	Dug well
	T. 21 S., R. 1 W.													
148	SW SE sec. 12	J. A. Boese	26	9	.....	McPherson	Cy, W	D, S	Steel plate over casing, south side	+ .6	1,528.2	17.25	3-14-44	Water reported of good quality
149	SW SW sec. 15	W. W. Downey	86.1	8	Shale	Wellington	Cy, W	D, S	Top of casing under platform, north side	+ .2	1,511.4	22.65	3-14-44	
150	SE cor. sec. 24	Herman S. Voth	20.0	36	.....	McPherson	Cy, H	D	Top of wooden box on platform, east side	+2.4	1,506.7	15.48	3-14-44	Water reported hard, not used
151	SE NE SE sec. 31	Mary Jones Weaver	29.9	10	.....	do	Cy, H	D	Top of casing, east side	+ .7	1,466.9	18.74	3-16-44	Pumps dry. Water reported of good quality
152	SE NE SE sec. 34	H. Schilling	28.6	.....	.....	do	Cy, H	D	Top of platform, west side	+3.0	1,500	26.99	10-14-37	Dug well. Temp. 59° F.
	T. 21 S., R. 2 W.													
153	SE SE SW sec. 9	C. P. Stucky	24.1	8	.....	do	Cy, H	D	Top of concrete curb, east side	+ .3	1,491.0	13.46	3-17-44	Water reported of good quality
154	SE SE sec. 12	V. B. Koehn	28.2	36	.....	do	Cy, H	D	Top of 2 x 12, south side of pump pipe	+ .9	1,509.1	22.00	3-17-44	Reported adequate supply; water hard
(155)	SE SW SW sec. 15	G. Junhke	18.7	48	Sand	do	Cy, W	S	Top of platform, north side	+1.0	1,486	15.58	10-20-38	Temp. 57° F. Dug well. Water reported hard
156	NW NE sec. 17	P. H. Wedel	25.0	10	do	do	Cy, W	S	Top of casing, south side	+1.3	1,478.5	9.98	10-18-38	
157	SE cor. sec. 17	E. W. Schragg	109	6	Shale	McPherson and Wellington	Cy, W	S	Top of casing, north side	+2.0	.....	31.75	10-21-38	
158	SE SE NE sec. 19	J. Stucky	57.0	4	Sand	McPherson	Cy, H	D	Top of casing, east side	+1.5	1,483	49.12	10-20-38	Water reported hard
159	SE SE SW sec. 20	D. Goering	50.7	10	Sand and gravel	do	Cy, W	D	Top of casing, west side	—4.2	1,466	36.61	10-20-38	
160	SW NE SW sec. 23	City of Moundridge	206	6	Shale	Wellington	N	N	Top of casing	.0	1,482	19.39	11- 4-37	Yield 13; drawdown 19. Observation well
161	do	do	25	300	Sand	McPherson	Cy, E	P	Top of manhole, southwest side	+1.2	1,485	13 40	11- 4-37	Dug to top of shale. Yield 250 for 6 hours or less. Observation well

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No. on Pl. 1 (1)	Location	Owner	Depth of well (feet) (2)	Diameter of well (in.)	Principal water-bearing bed		Method of lift (3)	Use of water (4)	Measuring point			Depth to water level below measuring point (feet) (6)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
					Character of material	Geologic subdivision			Description	Distance above (+) or below (—) land surface (feet)	Height above sea level (feet) (5)			
	T. 21 S., R. 2 W. (Continued)													
162	SW cor. sec. 26	R. Neihage	48.5	8	Sand	McPherson	Cy, W	S	Top of casing	+ .5	1,479	25.90	10-28-38	
163	SE cor. sec. 28	John Stucky	57.0	8	Sand, fine	do	Cy, W	D	Top of casing, north side	—4.0	1,476	43.27	10-28-38	
164	SW NE NE sec. 29	B. R. Stucky	54.3	18		do	Cy, W	D	Top of casing, west side	—2.0	1,474	43.38	10-20-38	
(165)	NE NE NW sec. 29	City of Moundridge	107.0	14	Sand	do	T, E	P	Land surface			30.2	8-28-40	Yield 125; drawdown 58. Temp. 62° F. Gravel packed
(166)	NW NW NE sec. 29	do	106	24		do	T, E	P	do			27	6-31	Yield 400; drawdown 42. Temp. 58° F. Gravel packed. See log
167	NE NE NW sec. 29	do	129	38		do	T, E	P				39.65	7-38	Yield 300; drawdown 15. See log. Gravel packed. This well later abandoned and filled
168	NE NW sec. 29	do	125.0	17	Sand	do	T, E	P	Top of pump base	+2.0		40.96	11-17-40	Yield 275; drawdown 20.31. Gravel packed. Temp. 56° F. See log
169	SE SW SE sec. 29	Mrs. J. Wedel	59.3	6		do	Cy, W	D	Top of casing, north side	—4.3	1,478	41.26	10-22-38	
170	do	do	53.5	4		do	N	N	Top of casing, south side	—5.0	1,473	41.34	10-22-38	
(171)	SE NW NW sec. 30	Mrs. J. J. Goering	136	6	Sand and gravel	do	Cy, W	D, S	Top of casing, northwest side	—5.0	1,467	31.50	10-20-38	Temperature 58° F.

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172	SE SW SW sec. 30	H. P. Goering	36.0	6	Sand	do	Cy, W	D	At square valve nut on pipe	−3.0	1,457	26.32	10-22-38	
173	SW SE SE sec. 30	J. B. Flickner	55.0	8	Gravel	do	Cy, W	S	Top of casing, north side	−2.5	1,463	32.78	10-22-38	
174	NW NE NE sec. 31	do	107	4	Fine sand	do	Cy, W	D	Top of casing, east side	−4.0	1,458	33.77	10-22-38	
175	NE cor. sec. 32	P. S. Wedel	66.5	8	do	do	Cy, W	S	Top of casing, south side	+1.0	1,488	55.94	10-22-38	
176	SW SE SE sec. 32	J. W. Strausz	57.5	10	Sand	do	Cy, W	D, S	Top of casing, north side	+1.0	1,484	57.5	10-28-38	
177	SW SE SE sec. 34	J. Stucky	72.8	6	Sand and gravel	do	Cy, W	D	Top of platform	+1.2	1,468	29.74	10-29-38	
(178)	SE SW SW sec. 36	J. V. Ledbetter	51.5	8	Sand	do	Cy, H	D	Top of casing, east side	+ .5	1,480	16.18	10-29-38	Temperature 60° F.
	T. 21 S., R. 5 W.													
179	SW SE SE sec. 2	D. J. Zerger	42.8	8		do	Cy, W	S	Top of lid on casing	−3.8	1,462	29.6	10-18-38	
180	NE SW SW sec. 6	G. A. Heidebrecht		6		do	Cy, W	S	Top of casing, west side	+ .5	1,460.45	29.47	10- 6-38	
181	SW SE SE sec. 9	J. Stucky	45.4	8	Coarse sand	do	N	N	Top of casing, north side	+1.0	1,462.2	32.08	10-18-38	
182	NE NW NE sec. 10	N. P. Stucky	46.0	6	do	do	C, E	D	do	−5.0	1,463	29.43	10-18-38	
183	SE NE NW sec. 13	A. Waltner	43.5	10	Sand	do	Cy, W	D	Top of casing, south side	+1.3	1,461.6	31.12	10-18-38	
184	NW cor. sec. 16	John Fleming	36.5	6		do	N	N	Top of casing	+ .8	1,459.9	30.07	1-13-39	
185	SW NE NW sec. 17	Peter Abrahams	39.6	10	Coarse gravel	do	Cy, W	S	Top of casing, north side	+1.0	1,455.3	26.48	10- 6-38	
186	SW NW SE sec. 19	H. Pauls	25.0	36		do	Cy, W	D, S	Top of platform, north side	+ .5	1,453	20.10	10-19-38	Dug well
187	NE NE SW sec. 21	P. E. Neufeldt				do	N	N	Top of casing, north side	+ .5	1,464	36.12	11-23-37	
188	NE NW NW sec. 22	C. H. Kaufman	32.5	36	Sand	do	Cy, W	D	Top of platform, west side	+ .3	1,453	25.19	10-19-38	Dug well
189	NE NW NW sec. 23	V. B. Goering	53	6	Coarse sand	do	Cy, W	S	Top of platform, north side	+ .2	1,450	26.38	10-18-38	
190	NE NE NW sec. 24	H. B. Goering	46.5	8		do	Cy, W	D	Top of casing, south side	−3.5	1,463	29.30	10-19-38	
191	NW SW SW sec. 25	P. A. Wedel	43.3	6	Sand	do	Cy, H	D	Top of casing, west side	−4.5	1,452	25.80	10-22-38	
192	NE NE NW sec. 26	O. J. Waltner	38.0	8		do	Cy, W	S	Top of casing, south side	+ .2	1,450	25.15	10-20-38	

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TABLE 37.—*Records of wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Continued*

No. on Pl. 1 (1)	Location	Owner	Depth of well (feet) (2)	Diameter of well (in.)	Principal water-bearing bed		Method of lift (3)	Use of water (4)	Measuring point			Depth to water level below measuring point (feet) (6)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
					Character of material	Geologic subdivision			Description	Distance above (+) or below (—) land surface (feet)	Height above sea level (feet) (5)			
	T. 21 S., R. 3 W. (Continued)													
193	NE cor. sec. 27	W. J. Kaufman	33.0	.....	.....	McPherson	Cy, W	D	Top of casing, east side	—6.5	1,437	10.24	10-20-38	Water reported hard
194	NE NE NW sec. 27	J. H. Vogt	39.2	8	.....	do	Cy, W	D	do	—4.2	1,444	18.20	10-20-38	
(195)	NW cor. sec. 29	G. G. Frans	28.5	24	.....	do	Cy, W	D, S	Top of platform, west side	+1.0	1,455	26.37	10-19-38	Temp. 56° F. Dug well
196	NE NE SE sec. 30	D. G. Unruh	23.5	48	.....	do	Cy, W	S	Top of platform, east side	+1.3	1,462	24.20	10-21-38	Dug well. Water reported unfit for domestic use
197	SE NW NE sec. 31	A. J. Dyck	35.0	6	Sand	do	Cy, W	D, S	Bottom of pump base, south side	+1.0	1,454	27.71	10-21-38	Water reported hard
198	NW NW sec. 33	J. J. Schmidt	48.7	8	.....	do	Cy, W	W	Top of casing, southwest side	+ .7	1,460	36.88	10-21-38	
199	SE SE NE sec. 34	Anna Goering	51.1	10	Sand	do	Cy, W	D	Top of casing, north side	—4.1	1,451	26.95	10-21-38	
	T. 21 S., R. 4 W.													
200	NW SW NW sec. 2	E. F. Postier	37.0	48	.....	do	Ws, H	D	Top of board shelter, north side	+2.5	1,465.5	.....	.....	Dug well
201	NE NE SE sec. 3	Arney Postier	122	6	Gravel	do	Cy, H	D, S	.....	.....	.....	29	8-36	
202	SW SW sec. 9	Mrs. Ida Tuxhorn	54.1	36	Red shale	Ninnescah	N	N	Steel plate in recorder shelter	.....	1,525.4	39.72	11-11-37	Dug. Observation well
203	NW cor. sec. 11	Harvey Luty	45	6	Fine gravel	McPherson	Cy, W	D, S	Land surface	.0	1,454.0	22.0	1- 4-39	

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(204)	SW SE SE sec. 11	City of Inman	80	36	Coarse sand	do	T, E	P				22	10- 3-35	Two similar wells. Yield each, 75; drawdown 1.65. Temp. 58° F. Gravel packed. See log east well
(205)	SE NE sec. 12	J. B. Reimer	82		Coarse gravel	do	Cy, W	D	Land surface	.0	1,465.0	42	10-16-38	Driven well. Temp. 58° F.
206	NE SE NE sec. 16	J. E. Hildebrandt	28.7	36	Shale	Ninnescah	Cy, W	D	Top of barrel, south side	+3.0	1,478	22.28	10- 6-38	Dug well
207	NE SW NE sec. 21	J. Fehdray	47.0	6		McPherson and Ninnescah	Cy, W	S	Top of platform, south side	+1.0	1,461	17.75	11-10-38	Water reported hard
208	SW NW NW sec. 22	C. H. Kaufman	32.0	8		McPherson	Cy, W	S	Top of wooden block under pump base	+1.5	1,440	9.11	11- 8-38	
209	SE NE NE sec. 23	S. P. Ediger	23.8	25		do	Ws, H	N	Top of concrete wall, west side	+2.2	1,440	20.9	10- 6-38	Dug well
(210)	NW SW SW sec. 23	S. G. Unruh	110	4	Sand and gravel	do	Cy, W	D, S	Top of platform, northeast side	+1.0	1,485	14.47	10-19-38	Temperature 57° F.
211	SE NW NW sec. 25	Mrs. J. P. Enns	42	8	Gravel	do	Cy, W	D	Top of platform, west side	+1.0	1,448	23.19	10-19-38	
212	NW NW sec. 26	Geo. P. Regeher	23.5	8		do	Cy, H	D	Top of casing, south side	+ .8	1,444	20.18	10-19-38	
(213)	SW SE SW sec. 26	J. C. Wiens	46.8	6		do	Cy, W	D	Top of casing, north side	—4.0	1,437	17.75	10-21-38	Temperature 58° F. Water reported hard
214	NW NW SW sec. 28	J. E. Pauls	34.8	6		do	Cy, W	S	Top of platform, north side	+1.2	1,469.1	22.64	11- 8-38	
215	SE SE NE sec. 33	P. H. Ediger	54	8		McPherson and Ninnescah	Cy, H	D	Top of casing, north side	+ .4	1,466	24.93	11-10-38	Well ends in shale
216	SW NE SE sec. 34	E. K. Davidson	36.5	36		McPherson	Cy, W	D	Top of platform, east side	+1.0	1,453	29.54	11- 7-38	Dug well. Water reported hard
217	NE SW NE sec. 36	J. J. Enns	40.0	8		do	Cy, W	S		+ .7	1,451	23.15	10-21-38	
	T. 22 S., R. 1 W.													
218	SE NE sec. 12	Ezra Jantz	80.1	6		do	Cy, W	S	Top of concrete well curb, south side	+ .8	1,505.2	25.31	3-14-44	
219	NE NE sec. 15	J. A. Diller	20.7	36		do	Cy, H	D	Top of well shelter, west side	+2.5	1,461	17.25	10-14-37	

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TABLE 37.—*Records of wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Continued*

No. on Pl. 1 (1)	Location	Owner	Depth of well (feet) (2)	Diameter of well (in.)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic subdivision	Method of lift (3)	Use of water (4)	Measuring point: Description	Measuring point: Distance above (+) or below (−) land surface (feet)	Measuring point: Height above sea level (feet) (5)	Depth to water level below measuring point (feet) (6)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
	T. 22 S., R. 1 W. (Continued)													
(220)	NW NE NE sec. 16	A. Hetzke	25.5	36		McPherson	Cy, W	D	Top of platform, east side	+1.5	1,484.0	24.91		Temperature 58° F.
221	SW NE sec. 16	City of Hesston	88	8	Shale	Wellington	T, E	P				43	10- 7-37	Yield 85; drawdown 45
(222)	SW NE sec. 16	do	88.7	8	do	do	T, E.	P				45	10- 7-37	Yield 60; drawdown 45
223	SE SE sec. 16	Anna Hertzler	80.8	6	do	do	N	N	Top of casing, north side	+ .4	1,472.9	25.85	10- 7-37	Observation well
(224)	NE NW NE sec. 18	Frank Pullen	51	6	Sand	McPherson	Cy, W	D, S	Top of platform, south side	+1.0	1,455.8	21.03	10-29-38	Temperature 59° F.
225	SW cor. sec. 23	H. Dillman	25	30		do	Cy, E	D, S	do	+ .5	1,472.6	21.48	10-14-37	Temperature 60° F.
226	SW SE sec. 24	Ira Zoak	60	6	Shale	Wellington	Cy, E	D, S				20		
227	NW NE NW sec. 27	E. W. Steiner	60			McPherson	Cy, H	D	Top of platform, east side	+ .2	1,467	27.72	11- 9-38	Water reported hard
228	NE cor. sec. 29	David Foran	78	10	Sand	do	Cy, H	D, S	Top of casing, south side	+1.0	1,458	28.98	11- 9-38	
229	NW cor. sec. 30	A. T. Pourty	33.0	6	do	do	Cy, W	D, S	Top of casing, west side	+ .5	1,443	21.85	11- 9-38	
230	SE SW SW sec. 33	Chas. Besmer	17.8	6	Gravel	do	Cy, W	S	Top of casing, south side	+ .5	1,431.38	13.95	7-30-38	Water reported unfit for domestic use
	T. 22 S., R. 2 W.													
231	SW SE SE sec. 7	P. R. Lorenz	100		Gravel	McPherson	Cy, W	D	Top of platform, west side	.0	1,452.6	33.22	10-28-38	
(232)	SE SW SW sec. 10	M. C. Schlender	31.8	8	Sand and gravel	do	Cy, W	S	Top of platform	+1.4	1,452.7	25.49	10-28-38	Temperature 59° F

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233	SW SE SE sec. 11	A. H. Kaffman	75.2	9	Gravel	do	Cy, E	D	Top of casing, east side	—4.6	1,463.9	34 23	10-28-38	Water reported hard
234	SE cor. sec. 20	G. Jerger	73.0	4		do	Cy, W	D, S	Top of casing, south side	—4.0	1,449	41 81	11- 9-38	
235	SW NW NW sec. 26	C. F. Hege	37.5	4	Sand	do	Cy, G	Ir	Top of casing, east side	.0	1,438	22 91	11- 9-38	
236	SE SW NE sec. 30	H. Dirks	62.6	4	do	do	Cy, W	D	Top of casing, south side	+1.4		40 94	11-16-38	
237	SW SE SE sec. 32	Mr. Abbey	51.0	4		do	Cy, W	D, S	do	+ .5	1,426.3	29 19	11- 5-38	
238	SW SW SE sec. 34	D. H. Lehman	47.7	4		do	Cy, W	D,S	Top of platform, south side	+ .3	1,435.5	34 87	8- 5-38	
239	SW SE SE sec. 36	Owen Jenkins	29.6	24		do	Cy, W	D,S	Top of casing	+ .7	1,446.7	22 98	7-30-38	Temp. 58° F. Dug well
240	SE SE SE sec. 36	do	33.0	4		do	Cy, H	N	Top of platform	+1.5	1,448.6	23 12	7-30-38	
	T. 22 S., R. 3 W.													
241	NW NE NE sec. 1	E. B. Stucky	30.3	8	Sand	do	Cy, W	S	Top of casing, east side	+1.0	1,441	20 35	10-28-38	
242	NW NE NE sec. 3	H. A. Goering	53.5	8	do	do	Cy, W	D	do	+4.0	1,451	30 67	10-28-38	
243	SE SE NE sec. 5	M. G. Schroeder	56.5	6	do	do	Cy, W	D, S	Top of casing, south side	+1.0	1,450	31 84	11-10-38	Water reported hard
244	SW cor. sec. 9	A. A. Ratzlaff	57.0	8	Sand and gravel	do	Cy, W	D, S	do	+1.0	1,455.5	34 83	10-29-38	
(245)	NW NE NE sec. 14	J. Brunnel	33.5	8	Sand	do	Cy, W	S	Top of platform, south side	+ .5	1,436.3	28 05	10-28-38	Temperature 57° F.
246	SE NW sec. 17	J. B. Schmidt	97.0	7	Sand and gravel	do	N	N	Steel plate in recorder shelter	+3.0	1,463.4	43 64	12- 1-37	Observation well
247	SE SW NW sec. 19	G. A. Ediger	54.5	8	Gravel	do	Cy, W	D, S	Top of block under pump, south side	+1.2	1,445.1	22.18	11- 8-38	
248	SW SE SE sec. 21	W. W. Birket	54.7	1½	Sand	Alluvium	Cy, H	D	Top of pump base	+2.5	1,428.8	9.80	10-29-38	Driven well. Water reported hard
249	NE NE SW sec. 29	J. N. Seamans	59.0	1½	do	do	Cy, H	D	Top of pump base, south side	+4.0		12.40	11-16-38	Driven well
250	SE SW SE sec. 29	H. Ratzlaff		1½	do	Dune sand	Cy, H	S	Top of pump base	+3.5	1,436	15.54	11-24-37	do
	T. 22 S., R. 4 W.													
251	SE cor. sec. 3	C. C. Wedel	40.0	6	Gravel	McPherson	Cy, W	S	Top of platform, south side	+ .5	1,448	18 99	11- 8-38	

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TABLE 37.—*Records of wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Continued*

No. on Pl. 1 (1)	LOCATION	Owner	Depth of well (feet) (2)	Diameter of well (in.)	Principal water-bearing bed		Method of lift (3)	Use of water (4)	Measuring point			Depth to water level below measuring point (feet) (6)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
					Character of material	Geologic subdivision			Description	Distance above (+) or below (—) land surface (feet)	Height above sea level (feet) (5)			
	T. 22 S., R. 4 W. (Continued)													
252	NE SE NE sec. 4	J. B. Schroeder	44.8	6		McPherson	Cy, W	S	Top of platform, south side	+1.0	1,462	11.11	11–10–38	
(253)	SE SE sec. 12	City of Buhler	98	48	Coarse sand	do	T, E	P		+4.0		11.2	1– 7–38	Yield 269; drawdown 7.7. Gravel packed. See log. Well No. 1 (south)
254	do	do	88	48	do	do	T, E	P		+5.0		16.0	3–24–38	Yield 201; drawdown 2.0. Gravel packed. Well No. 2 (north)
255	NW NE NE sec. 13	A. T. Reimer	45.5	8	Gravel	do	Cy, W	S	Top of casing, south side	+1.0	1,443.5	19.39	11– 8–38	
256	NW NW SW sec. 14	D. T. Ediger	48.2	8		do	Cy, W	S	Top of casing, southeast side	+ .8	1,454.0	22.54	11– 7–38	Water reported hard
257	SW SW NW sec. 16	H. T. Esau	76.7	6		do	Cy, H	D	Top of casing, south side	+ .7	1,482.3	30.99	11– 7–38	
258	NE SE NE sec. 20	City of Buhler	50	38	Fine sand	Alluvium	T, E	N				20	9– 5–27	Original yield 50; drawdown 13.9. Gravel packed. See log. Abandoned public-supply well
259	SE SE NE sec. 20	do	55	38	do	do	T, E	N				20	10– 6–27	Original yield 58; drawdown 14.7; 1937 yield 25. Abandoned public-supply well
260	SE NE SE sec. 20	C. B. Frose	48.5	1.5	Sand	do	Cy, H	D	Top of pump base, east side	+2.5	1,458.8	11.59	11–16–38	Driven well

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(261)	SW SW NW sec. 21	City of Buhler	53	48	Fine sand	do	T, E	N				15	1937	Original yield 40. Temp. 59° F. See log. Abandoned public-supply well
262	NW NW SW sec. 21	E. H. Ratzlaff	23.3	8	Coarse sand	do	Cy, H	D	Top of casing, south side	+ .7	1,460.7	16.77	11- 5-38	
263	NE NE SE sec. 25	D. T. Dirks	51.0	8		McPherson	Cy, H	D	Top of platform, south side	+ .3	1,449	25.55	11- 8-38	
264	NW NW NW sec. 26	Abe Fehdrau	38.0	8		do	Cy, H	D	Top of casing, east side	+ .8	1,462	26.72	11- 7-38	
265	SW cor. sec. 26	R. G. Marshall	41.0	8	Sand	Alluvium	Cy, H	N	do	+ .8	1,461	18.28	11-16-38	
266	SE SW SW sec. 28	A. A. Schroeder	17.7	6	do	Dune sand	Cy, H	D	Top of platform, east side	+ .8	1,468.2	8.37	11- 5-38	
267	NE NE SE sec. 34	A. T. Regier	20.3	8	do	Alluvium	Cy, H	D	Top of casing, west side	+ .6	1,503	10.4	11- 7-38	
268	SE NE NE sec. 35	H. C. Friesen	40.0	6	do	do	Cy, H	D	Top of casing, north side	+ .8	1,497	11.98	11-16-38	
	T. 23 S., R. 1 E.													
269	NW NE sec. 8	D. G. Classen	12.4	36	Shale	Wellington	C, E	In	Top of cement floor	—5.5		7.91	11-22-40	Temp. 59° F. Dug well. Well ends in shale.
270	NW NW sec. 16	Newton Ice Co	17.3	36	Fine sand	McPherson	C, E	In	Top of iron well cover	.0		7.24	3-21-41	Temp. 62° F. Dug well. Yield 30; drawdown 12
271	SW NE NW sec. 19	Atchison, Topeka, and Santa Fe Railway Co.	125	8	Shale	Wellington	Cy, S	In	Top of pump base	.0		45	12-20-40	Reported yield 100. Water reported hard
	T. 23 S., R. 1 W.													
(272)	SE NE sec. 3	H. F. Deschner	84.2	8	do	do	Cy, W	D, S	Top of well cover, south side	+ .5	1,450.1	24.76	10-14-37	Temperature 60° F.
273	SE SW sec. 8	G. Lehman	35.0	30		McPherson	Cy, W	D,S	Top of well cover	+1.5	1,427.1	34.09	10- 1-37	Temperature 59° F. Dug. Observation well
274	SE cor. sec. 10	Harvey County	20.2	19	Gravel	do	Cy, E	D	Top of well opening, north side	—6.5	1,437.6	14.53	10-14-37	Dug well
275	SW SW SE sec. 12	H. Steinkerchner Estate	34.0	48	Sand	do	Cy, E	In	Top of cement well cover	+2.0		14.65	2-28-41	Temp. 52° F. Dug well. Yield 20
276	SW SE sec. 15	Benfer-Shambaugh	124.0	6	Shale	Wellington	N	N	Top of casing	+ .7		13.92	11-29-40	Temperature 58° F.
277	SW SW sec. 20	Harvey County School District No. 15	40.0	4	Fine sand	McPherson	Cy, H	N	Top of platform	+ .8	1,405.7	26.14	8-27-38	Temperature 58° F.

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No. on Pl. 1 (1)	LOCATION	Owner	Depth of well (feet) (2)	Diameter of well (in.)	Principal water-bearing bed		Method of lift (3)	Use of water (4)	Measuring point			Depth to water level below measuring point (feet) (6)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
					Character of material	Geologic subdivision			Description	Distance above (+) or below (—) land surface (feet)	Height above sea level (feet) (5)			
	T. 23 S., R. 1 W. (Continued)													
278	SE SW SW sec. 22	R. R. Royer	36.6	8	Sand	McPherson	Cy, E	Ir	Top of casing	.0	1,413.7	21.60	2-25-44	For irrigating orchard. Temperature 59° F.
279	do	do	23.5	36		do	Cy, H	D	Top of platform, west side	+ .3	1,412.3	16.52	11- 3-38	Dug well
280	SE SE SW sec. 23	Harvey County School District No. 66	37.5	6		do	Cy, H	P	Top of casing	+ .5	1,442.46	28.0	8-23-38	
281	NE NW sec. 24	O. Moorshead	87.0	8	Shale	Wellington	Cy, G	Ir	Top of cement floor	.0		5.22	11-29-40	Temp. 58° F. Dug well
282	NW NW sec. 24	do	26.7	1¼	Fine sand	McPherson	Cy, W	Ir	Top of platform	+ .2		24.92	12- 6-40	
283	SE NW sec. 24	do	44.7	6	Sand	do	Cy, W	Ir	do	+ .4		8.49	11-29-40	Temperature 59° F.
284	SW cor. sec. 26	C. F. Molzen	33.9	6		do	N	N	Top of casing, north side	+2.0	1,438.21	26.88	10-15-37	
285	NE cor. sec. 27	Park Richardson	67.7	6	Sand	do	Cy, W	S	Top of casing	+1.0	1,433.6	28.72	1-18-44	Limited supply. See log
286	NW NW NE sec. 28	C. E. Rousell	38	8	do	do	Cy, W	D, S	Top of platform, west side	+1.0	1,412.51	29.30	11- 3-38	
287	NW NE sec. 29	Grove Estate	40	6	do	do	Cy, H	D	Top of support under platform	+ .8	1,406.74	28.83	7-20-38	
288	NE NW NW sec. 30	Ben A. Graber	100	6	do	do	Cy, W	D, S	Top of casing, east side	+1.0	1,441.57	65.01	11- 2-38	
289	SW SE SW sec. 31	W. Herting	60	4	Coarse sand and gravel	do	Cy, E	D, S	Top of casing, south side	—5.0	1,398.70	28.64	11- 2-38	

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290	NW NW sec. 32	City of Newton	130	24		do	T, E	P				52	10-26-21	Yield 250; drawdown 47. Gravel packed
(291)	do	do	124	42	Sand and gravel	do	T, E	P	Land surface	.0		44	11-36	Yield 635; drawdown 54, pumped at 310. Temp. 58° F. Gravel packed. See log
292	do	do	125	24	Coarse sand	do	Cy, E	P				35	10- 6-37	Yield 240. Gravel packed
293	do	do	130	24		do	T, E	P						Yield 610; drawdown 50. See log
294	SE NW sec. 32	do	124	18	Medium sand	do	T, E	P	Land surface	.0	1,399.2	41 03	9-30-41	Yield 425; drawdown 42.5 after 24 hours. Temp. 60° F. See log
295	SW NW sec. 32	do	125	18	Sand	do	T, E	P	do	.0	1,399.0	38 5	9-26-41	Yield 375; drawdown 43 after 24 hours. Temp. 60° F. See log
296	NE NE sec. 34	Dr. A. E. Hertzler	47.1	6		do	Cy, H	D, S	Top of casing	+ .8	1,430.4	18.5	6- 9-44	Temperature 57° F.
	T. 23 S., R. 2 W.													
297	SE SW SE sec. 8	W. H. Lohmeyer	39.6	6	Gravel	Alluvium	Cy, H	S	do	+ .8	1,402.23	11.37	8- 4-38	
298	NE SE NE sec. 14	John Berger	45.5	36		McPherson	Cy, W	D, S	Top of platform	+1.0	1,436.42	34.34	10- 1-37	Temp. 61° F. Dug well
(299)	NW cor. sec. 17	C. K. Ellis	12.0	1¼		do	N	N	Top of pipe	+ .7	1,406.68	5.73	2- 2-39	Observation well. See log
(300)	do	do	151.0	1¼	Medium sand	do	N	N	do	+1.0	1,406.97	5.40	2- 2-39	do
301	SE SW sec. 20	R. Mueller	31.5	6		do	C, G	Ir	Top of casing, north side	—3.5	1,428.88	14.1	10- 1-37	
302	SW NE SW sec. 22	Harvey Hensley	50	15		Alluvium and McPherson	C, G	Ir				16	12-13-39	Reported yield 250. Temp. 58° F. Gravel packed
303	NE SW SW sec. 22	do	45	15	Sand and gravel	do	C, G	Ir	Top of concrete pit, southeast corner	.0	1,396.0	11.56	8- 5-38	Temp. 58° F. Yield 166; drawdown 16
304	do	do	47	19		do	C, G	Ir				15	10-38	Reported yield 250; drawdown 22. Temp. 58° F. Gravel packed
305	SW SW sec. 23	City of Wichita	31.8	1¼	Sand and gravel	McPherson	N	N	Top of pipe	+ .5	1,394.05	13.14	11-17-38	Temperature 58° F. Driven observation well

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TABLE 37.—*Records of wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Continued*

No. on Pl. 1 (1)	LOCATION	Owner	Depth of well (feet) (2)	Diameter of well (in.)	Principal water-bearing bed		Method of lift (3)	Use of water (4)	Measuring point			Depth to water level below measuring point (feet) (6)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
					Character of material	Geologic subdivision			Description	Distance above (+) or below (—) land surface (feet)	Height above sea level (feet) (5)			
	T. 23 S., R. 2 W. (Continued)													
306	SE SE sec. 24.....	Mrs. Maurice Alden.....	210	8	Shale.....	Wellington	Cy, H	S	Top of casing.....	.0	1,420.45	41.72	2–12–43	
307	NW cor. sec. 25.....	City of Halstead.....	55.7	1¾	.....	McPherson	N	N	Top of platform, west side	.0	1,410.87	33.29	11– 2–38	Driven well
308	SW cor. sec. 27.....	City of Wichita.....	26.9	1¼	Sand and gravel	Alluvium...	N	N	Top of pipe.....	+2.0	1,388.08	13.35	5–28–41	Temp. 56° F. Driven well
(309)	NW NE sec. 28.....	W. G. Backhaus.....	44.0	1¼	do.....	do.....	N	N	Plate on recorder instrument shelf	+3.1	1,399.97	10.23	10–22–38	Temp. 60° F. Driven observation well
(310)	NW NE sec. 28.....	W. G. Backhaus.....	139.3	6	Sand and gravel	Alluvium and McPherson	N	N	do.....	+3.1	1,399.97	17.68	10–22–38	Temp. 60° F. Recorder observation well. See log
(311)	NW cor. sec. 29.....	City of Wichita.....	221.8	36	do.....	McPherson	T, E	P	Top of casing, 0.87 foot below hole in pump base	+2.0	1,433.28	20.56	4–13–39	Temp. 58° F. Yield 1,560; drawdown 60.9. See log. Gravel packed. Observation well
312	do.....	do.....	71.0	1¼	do.....	do.....	N	N	Top of pipe.....	+ .7	1,431.85	18.86	4–13–39	Observation well. 100 feet southwest from well 311
313	do.....	do.....	69.0	1¼	do.....	do.....	N	N	do.....	+ .7	1,430.37	17.28	4–13–39	Observation well. 492 feet southwest from well 311
(314)	NW SW sec. 29.....	do.....	234.0	30	do.....	do.....	T, E	P	Top of casing, 0.87 foot below hole in pump base	+2.0	1,431.34	20.33	5– 5–39	Yield 1,390; drawdown 63.7. Temp. 59° F. See log. Gravel packed. Observation well

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315	do	do	67.0	1¼	do	do	N	N	Top of pipe	+ .7	1,430.35	19.03	5- 4-39	Observation well, 100 feet southwest from well 314
316	do	do	68.5	1¼	do	do	N	N	do	+ .5	1,430.61	21.78	5- 4-39	Observation well, 500 feet southwest from well 314
(317)	SE cor. SW sec. 29	do	237.8	36	do	do	T, E	P	Top of casing, 0.87 foot below hole in pump base	+2.0	1,428.30	25.20	5- 9-39	Yield 2,000; drawdown 62.6. Temp. 59° F. See log. Gravel packed. Observation well
318	do	do	66.0	1¼	do	do	N	N	Top of pipe	+ .9	1,426.32	24.0	5- 5-39	Observation well, 100 feet southwest from well 317
319	do	do	97	1¼	do	do	N	N	do	+1.0	1,427.36	28.0	5- 8-39	Observation well, 500 feet southwest from well 317
320	SE SE sec. 30	L. U. Becker	16.2	1¼	do	do	N	N	do	—1.2	1,430.53	15.31	9-11-39	Driven observation well
321	do	City of Wichita	20.5	1¼	do	do	N	N	do	+1.0	1,432.12	17.42	5-29-41	Temp. 55° F. Driven observation well
(322)	SE cor. sec. 30	do	234.0	30	do	do	T, E	P	Top of casing, 0.87 foot below hole in pump base	+2.0	1,432.71	25.18	5- 4-39	Yield 910; drawdown Temp. 58° F. See log. Gravel packed. Observation well
323	do	do	69.0	1¼	do	do	N	N	Top of pipe	+ .8	1,432.0	24.98	5- 4-39	Observation well, 100 feet southwest from well 322
324	do	do	69.0	1¼	do	do	N	N	do	+ .8	1,433.56	25.82	5- 4-39	Observation well, 462 feet southwest from well 322
325	NW NE sec. 31	M. H. Miller	22.7	1¼	do	do	Cy, H	D	do	+1.8	1,436.02	19.20	9-11-39	Driven observation well
326	SW SW SE sec. 31	D. C. Buller	62.0	8	do	do	Cy, H	S	Top of concrete cellar curb	.0	1,438.59	31.67	3-15-43	
(327)	SE cor. sec. 31	do	31.0	1¼	do	do	N	N	Top of pipe	+ .5	1,431.67	18.2	12- 2-38	Temp. 59° F. Observation well. See log
[illegible]	do	do	63.0	1¼	do	do	N	N	do	+ .5	1,431.59	18.14	12- 2-38	do
	SE cor. sec. 31	D. C. Buller	201.0	1¼	do	do	N	N	do	+ .5	1,431.70	21.68	12- 2-38	do

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TABLE 37.—*Records of wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Continued*

No. on Pl. 1 (1)	LOCATION	Owner	Depth of well (feet) (2)	Diameter of well (in.)	Principal water-bearing bed		Method of lift (3)	Use of water (4)	Measuring point			Depth to water level below measuring point (feet) (6)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
					Character of material	Geologic subdivision			Description	Distance above (+) or below (—) land surface (feet)	Height above sea level (feet) (5)			
	T. 23 S., R. 2 W. (Continued)													
(330)	NW cor. SW sec. 32	City of Wichita	237.5	30	Sand and gravel	McPherson	T, E	P	Top of casing, 0.87 foot below hole in pump base	+2.0	1,432.98	20.36	5-16-39	Yield 1,420; drawdown 66.1. Temp. 58° F. See log. Gravel packed. Observation well
331	do	do	70.8	1¼	do	do	N	N	Top of pipe	+ .8	1,431.77	19.16	5-16-39	Observation well, 100 feet southwest from well 330
332	do	do	59.0	1¼	do	do	N	N	do	+1.0	1,432.56	19.45	5-16-39	Observation well, 500 feet southwest from well 330
(333)	SW cor. sec 32	do	257.3	30	do	do	T, E	P	Top of casing, 0.87 foot below hole in pump base	+2.0	1,433.35	24.19	5-26-39	Yield 2,040; drawdown 64.6. Temp. 58° F. See log. Gravel packed. Observation well
334	do	do	51.0	1¼	do	do	N	N	Top of pipe	+1.0	1,432.98	20.28	5-26-39	Observation well, 100 feet northwest from well 333
335	do	do	51.0	1¼	do	do	N	N	do	+1.0	1,433.06	20.15	5-26-39	Observation well, 500 feet northwest from well 332
336	NE NW NW sec. 33	Edna Masters	26.3	1¼	do	do	N	N	do	+ .4	1,426.05	19.57	3-24-43	
337	SE SW SW sec. 33	City of Wichita	26.0	1¼	do	do	N	N	do	+1.0	1,422.68	17.91	2-21-41	Temp. 58° F. Driven well. See log
338	SW SW SE sec. 34	George Lehman	22.5	4	do	Alluvium	N	N	Top of casing, northwest side	+ .5	1,405.36	6.68	11- 2-38	

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(339)	SW NW sec. 35	City of Halstead	106.0	38	do	Alluvium and McPherson	C, E	P				18	10-25-37	Two identical wells 17 feet apart; aggregate yield 500; average drawdown 14. Temp. 59° F. See log. Gravel packed
340	NW SW sec. 35	do	110.0	34	Coarse sand	do	C, E	P				18	10-26-37	Yield 450; drawdown 15. See log. Gravel packed
341	SE SW SE sec. 35	E. J. Bookwater, et al.	50.0	4	Sand and gravel	do	C, E	D	Top of casing	+ .3	1,386	19.12	7- 1-39	Temperature 62° F.
342	NW SE SE sec. 35	G. S. Hammitt	72	18	Fine sand	Alluvium	T, E	In				18	8- 5-38	Reported yield, 250
	T. 25 S., R. 5 W.													
343	NW NW NE sec. 2	A. R. Siemans	50.3	1¼	Sand	Dune sand	Cy, H	N	Top of pump base, west side	+2.7	1,433	16.35	11- 4-38	Driven well
344	NW cor. sec. 4	City of Wichita	79.4	1¼	Sand and gravel	Dune sand and McPherson	N	N	Top of pipe	+1.4	1,445.22	9.22	6-28-39	Temp. 59° F. Chloride observation well
345	do	do	127.5	1¼	do	do	N	N	do	+1.5	1,445.59	38.28	6-28-39	do
346	SE SW SE sec. 8	E. Frederick	23.8	1¼		McPherson	N	N	do	+ .2	1,469.3	14.34	8- 6-38	Driven well
347	SE cor. sec. 8	City of Wichita	35.5	1¼	Sand and gravel	do	N	N	do	+1.5	1,473.43	18.93	6-22-39	Temp. 65° F. Chloride observation well
348	SE cor. sec. 8	do	86.5	1¼	do	do	N	N	do	+1.5	1,474.42	46.14	6-21-39	do
349	SW SE SE sec. 10	R. M. Woods	11.0		Sand	Dune sand	Cy, W	S	Bottom of pump cylinder	.0	1,471.6	7.71	8-10-38	
250	SE cor. sec. 11	A. B. Giggy	16.0	1¼	Fine sand	do	Cy, H	S	Top of pump base, east side	+2.0	1,451.86	8.25	11- 4-38	Driven well. Water reported hard
351	SE SW SE sec. 12	I. Ansel, Jr	33.0	1¼		McPherson	N	N	Top of pump base	+4.7	1,455.04	16.64	8- 4-38	Driven well
352	NE SW SW sec. 14	Byron Wood	20.9	1¼	Sand	do	Cy, H	N	Valve seat of pitcher pump	+2.2	1,452.36	14.27	12- 4-41	
353	SW NE NW sec. 16	J. H. Workentine	37.5	3	Sand and gravel	do	Cy, W	S	Top of casing	0	1,472.05	12.97	5-28-40	
(354)	SE cor. sec. 17	A. B. Havely	12.6	1¼	do	do	N	N	Top of pipe	+1.7	1,453.87	6.32	3-11-39	Driven observation well. Temp. 58° F. See log
(355)	do	do	46.3	6	do	do	N	N	Plate on recorder instrument shelf	+2.7	1,454.99	17.46	3-11-39	Recorder observation well. See log

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TABLE 37.—*Records of wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Continued*

No. on Pl. 1 (1)	Location	Owner	Depth of well (feet) (2)	Diameter of well (in.)	Principal water-bearing bed		Method of lift (3)	Use of water (4)	Measuring point			Depth to water level below measuring point (feet) (6)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
					Character of material	Geologic subdivision			Description	Distance above (+) or below (—) land surface (feet)	Height above sea level (feet) (5)			
	T. 23 S., R. 3 W. (Continued)													
356	SE Cor. sec. 17.	A. B. Hovely	246.0	1¼	Sand and gravel	McPherson	N	N	Plate on recorder instrument shelf	+2.7	1,454.99	27.65	3-11-39	Temp. 58° F. Driven observation well. See log.
357	NW cor. sec. 19	Ada M. Day	24.5	6	Gravel	do	C, G	Ir	Top of casing at seam	+ .8	1,464.06	14.32	9-39-37	Observation well
358	SW SE sec. 19	A. L. Gouldner	25.6	8	Coarse gravel	do	N	N	Top of casing	+1.2	1,459.27	13.97	11-25-37	do
359	SW cor. sec. 20	R. L. Dale	26.1	1¼	Sand	do	Cy, H	D	Top of pipe	+ .1	1,455.54	13.6	8- 5-38	Driven well. Temp. 60° F.
360	SW cor. sec. 21	City of Wichita	40.0	1¼	Sand and gravel	do	N	N	do	+2.0	1,450.38	13.54	6-19-39	Chloride observation well. Temp. 64° F. See log
361	do	do	66.0	1¼	do	do	N	N	do	+1.5	1,449.86	13.30	6-17-39	do
362	SW cor. sec. 22	Dale Pettijohn	16.7	1¼	do	do	Cy, H	Ir	Top of pump base	+0.8	1,446.2	11.72	5-25-43	Temp. 65° F. Driven well
363	SE NE NE sec. 24	J. W. McElwain	23.1	1¼	Sand		Cy, H	S	Valve seat of pump	+2.4	1,438.66	13.99	12- 4-41	
364	SE NW NE sec. 26	Mrs. Mary E. Wespe	16.6	1¼	Sand and gravel	do	N	N	Top of pipe	+ .9	1,430.52	12.95	2-19-41	Temp. 58° F. Driven well
(365)	NW SE sec. 29	City of Burton	52	48	do	do	Cy, E	P				14	10-25-37	Temp. 59° F. Gravel packed
366	do	do	48	3	do	do	Cy, E	P				15	10-15-37	Four identical wells connected to one pump. Aggregate yield 75; drawdown 16

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367	NE cor. sec. 32	City of Wichita	88.4	1¼	do	do	N	N	Top of pipe	+1.4	1,442.38	8.27	6-15-39	Chloride observation well. Temp. 64° F. See log
368	do	do	128.4	1¼	do	do	N	N	do	+1.4	1,442.90	8.57	6-14-39	do
369	SW SE sec. 32	do	42.5	1¼	do	do	N	N	do	+1.5	1,446.07	8.62	6-13-39	Chloride observation well. Temp. 60° F. See log
370	do	do	100.0	1¼	do	do	N	N	do	+2.0	1,446.71	8.71	6-13-39	do
(371)	NE SE SE sec. 34	Henry Trippel	16+	1¼	do	do	Cy, H	S	Top of valve seat	+2.9	1,441.1	15.51	9-28-37	Driven well. Temp. 62° F.
372	NW NW sec. 36	Don Ferguson	35.2	1¼	do	do	C	N	Top of bottom half of 1¼ inch union	+ .2	1,427.62	23.70	2-13-41	Driven well. Temp. 60° F.
373	SE NE NE sec. 36	H. H. Wiggers	21.2	1¼	Sand	do	N	N	Top of pipe	+ .9	1,437.77	15.84	3-26-43	
	T. 23 S., R. 4 W.													
374	NE SE SE sec. 3	H. H. Janzen	21.5	10	do	Dune sand	Cy, W	Ir	Top of casing, west side	+ .3	1,491	7.11	11- 7-38	
(375)	SW SW NW sec. 4	W. Dunkin	16.3	4	Fine sand	do	Cy, H	D	Top of casing, southwest side	+1.2	1,522.9	12.75	11- 5-38	
376	do	do	14.0	36		do	Cy, H	D	Top of cement platform, east side	+ .4	1,547.5	10.38	11- 5-38	Dug well
377	SW SE SE sec. 16	J. A. Dealy	27.0	1½	Sand	McPherson	N	N	Top of pipe, south side	+1.5	1,485.1	14.36	11- 5-38	Driven well
378	NW cor. sec. 21	W. E. Howell	27.0	1¼	Sand and gravel	do	Cy, H	D	Top of 1¼-inch coupling	+ .7	1,490.65	14.71	7-17-40	do
379	NW cor. sec. 24	Myrtle McHone	22.0	1¾	Sand	do	Cy, H	D	Top of pump base, west side	+1.0	1,465.6	7.43	11- 5-38	do
380	NW NW sec. 33	Robt. Rowlings	26.4	10		do	C,G	Ir	Top of casing, southwest side	−2.2	1,480.7	7.61	12-15-38	
381	NE SE SE sec. 36	D. E. Craven, et al	17.0	1¼		do	Cy, H	D	Top of pump valve seat	+3.3	1,459.62	12.20	10-21-37	Temp. 62° F. Driven well
	T. 23 S., R. 5 W.													
382	NW NW SE sec. 4	Atchison Topeka and Santa Fe Railway Co.	40	48	Sand and gravel	do	T, E	R, In	Land surface	.0		19.0	7- 3-43	Reported yield 215; drawdown 1.5. Gravel packed. Also supplies Cessna Aircraft Plant. See log
383	do	do	41	48	do	do	T, E	R, In	do	.0		19.0	7- 3-43	Reported yield 215; drawdown 1.5. Gravel packed. Also supplies Cessna Aircraft Plant

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No. on Pl. 1 (1)	LOCATION	Owner	Depth of well (feet) (2)	Diameter of well (in.)	Principal water-bearing bed		Method of lift (3)	Use of water (4)	Measuring point			Depth to water level below measuring point (feet) (6)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
					Character of material	Geologic subdivision			Description	Distance above (+) or below (—) land surface (feet)	Height above sea level (feet) (5)			
	T. 23 S., R. 5 W. (Continued)													
(384)	NE NE sec. 8	Central Fibre Products Co.	62–68	25	Sand and gravel	McPherson	T, E	In	Land surface	.0		22.8	7- 4–43	Four similar wells 150 to 250 feet apart. Water level given for Company's well 4. See log this well. Water treated for reduction of hardness
385	NW NE sec. 17	McArthur Packing Co	50	34	do	do		In	do	.0		18	8–22–	
(386)	NE NW sec. 17	Hutchinson Water Co	59	32	do	do	T, E	P	do	.0		14.8	1934	East Station. Yield 2,000; drawdown 15 after 7.5 hours. Gravel packed
(387)	SW NW NW sec. 17	do	50	32	do	do	C, E	P	do	.0		14		Lorraine Station. Two centrifugal pumps in pit connected in series. Reported yield 1,000, drawdown 17. Gravel packed
(388)	SW SE NW sec. 18	do	80	32	do	do	T, E	P	do	.0		14	6–22–	Cleveland Station. Pump capacity 1,500. Gravel packed. See log
	T. 23 S., R. 6 W.													
(389)	SW SE NW sec. 1	do	66	32	do	do	T, E	P						North Station. Yield 2,000; drawdown 14.7 after 12 hours. Gravel packed.

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(390)	NW NW sec. 12	do	60	32	do	do	C, E	P						Northwest Station. Pump capacity 1,500. Pump in pit. Gravel packed
(391)	SE NE sec. 12	do	58	32	do	do	C, E	P						Northeast Station. Two centrifugal pumps in pit connected in series. Pump capacity 2,000. Gravel packed
(392)	SW SW sec. 12	do	65	32	do	do	T, E	P						Adams Street Station. Pump capacity 1,500. Gravel packed
(393)	SE SW sec. 12	do	75	32	do	do	T, E	P	Land surface	.0		9	7-22-	Main Street Station. Pump capacity 1,500, pumped at 750. Gravel packed
394	NE NE sec. 13	do	51.5	32	do	do	T, E	In						South well. Gravel packed
	T. 24 S., R. 1 W.													
395	NE NE NW sec. 3	Arkansas Valley Interurban Co.	45.5	40		do	Cy, H	D	Top of platform	+ .5	1,426.23	41.49	7- 4-38	Dug. Observation well
396	NW cor. sec. 5	Dick Schowalter	92.6	6		do	Cy, W	S	Top of casing	+3.0	1,435.48	66.55	8- 4-38	
397	NE NE SE sec. 13	J. H. Briggs	14.7	8	Sand and gravel	do	Cy, G	D	Top of casing, north side	—6.0	1,412.4	10.67	9-24-37	
398	SE NE sec. 16	Walter Bierceball	45.8			do	Cy, W	D, S	Top of platform, east side	+1.4	1,396.86	31.80	9-27-37	Dug. Observation well
399	NE cor. sec. 18	W. E. Niles	50.2	6	Gravel	do	Cy, W	S	Top of platform, north side	+ .5	1,398.6	32.47	11- 2-38	
(400)	NE cor. sec. 19	City of Wichita	41.0	1¼		Alluvium	N	N	Top of pipe	+1.0	1,382.65	19.85	9- 1-38	Temp. 58° F. Driven observation well. See log
(401)	do	do	129.0	1¼		Alluvium and McPherson	N	N	do	+ .5	1,382.8	19.18	9- 8-38	Temp. 58° F. Observation well. See log
402	NW cor. sec. 19	do	39.0	1¼	Sand and gravel	Alluvium	N	N	do	+1.5	1,375.44	11.8	5-28-41	Temp. 58° F. Driven well
(403)	SW cor. sec. 19	do	57.0	1¼	Sand	do	N	N	do	+1.0	1,381.67	9.26	9-10-38	Temp. 59° F. Observation well. See log
404	SE SE sec. 22	do	41.6	1¼	Fine sand to fine gravel	Alluvium and McPherson	N	N	do	+2.6	1,387.18	16.79	9- 7-38	Temp. 58° F. Driven observation well

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TABLE 37.—*Records of wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Continued*

No. on Pl. 1 (1)	Location	Owner	Depth of well (feet) (2)	Diameter of well (in.)	Principal water-bearing bed		Method of lift (3)	Use of water (4)	Measuring point			Depth to water level below measuring point (feet) (6)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
					Character of material	Geologic subdivision			Description	Distance above (+) or below (—) land surface (feet)	Height above sea level (feet) (5)			
	T. 24 S., R. 1 W. (Continued)													
405	NW cor. sec. 29	City of Wichita	37.2	1¼	Sand and gravel	Alluvium	N	N	Top of pipe	+1.0	1,380.27	16.15	11-16-38	Temp. 57° F. Driven observation well. See log
406	SE cor. sec. 30	do	32.5	1¼	do	do	N	N	do	+1.5	1,377.03	12.30	2-13-41	Temp. 58° F. Driven well
407	SW cor. sec. 32	do	32.5	1¼	do	do	N	N	do	+1.5	1,376.79	10.28	12-20-40	Temp. 58° F. Driven observation well
408	SE NW SE sec. 33	do	32.5	1¼	do	do	N	N	do	+1.0	1,371.86	19.63	2-21-41	Temp. 58° F. Driven well
409	NW NE sec. 34	H. E. Hartford	33.0	36		McPherson	Ws, H	D	Southeast corner of windless frame	+3.2	1,398.8	27.05	9-27-37	Dug well
(410)	NE SW NW sec. 34	City of Sedgwick	46-50	48	Sand	Alluvium	Cy, E	P				27	9-23-37	Six similar gravel packed wells connected to one pump, aggregate yield about 300. Yield of one well 85; drawdown 1.5
	T. 24 S., R. 2 W.													
411	NW cor. sec. 1	City of Wichita	31.3	1¼	Fine sand	do	N	N	Top of pipe	+ .8	1,388.3	16.04	8-25-38	Driven observation well. Temp. 58° F.
(412)	NW NE sec. 2	City of Halstead	102	12	Coarse sand	Alluvium and McPherson	T, E	P				20	7-33	Reported yield 175+
413	NE NE SE sec. 4	L. O. Wiemeyer	22.7	1¼	Sand and gravel	McPherson	Cy, H	S	Valve seat of pitcher pump	+2.0	1,414.15	16.70	3-24-43	Driven well

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414	NW cor. sec. 6	City of Wichita	19.0	1¼	Coarse sand and gravel	do	N	N	Top of pipe	+1.0	1,429.47	13.26	8-31-38	Driven observation well. Temp. 60° F.
(415)	SE NE sec. 6	do	257.5	30	Sand and gravel	do	T, E	P	Top of casing, 0.87 foot below hole in pump base	+2.0	1,430.16	20.12	5-30-39	Yield 1,570; drawdown 73.22. Temp. 59° F. See log. Gravel packed. Observation well
416	do	do	50.9	1¼	do	do	N	N	Top of pipe	+ .9	1,428.21	16.20	5- 3-39	Observation well, 100-feet northeast from well 415
417	do	do	54.0	1¼	do	do	N	N	do	+1.0	1,426.98	14.81	5- 3-39	Observation well, 500 feet northeast from well 415
418	NW NW SW sec. 6	Leo Wendling	48.6	5	do	do	Cy, H	D	Top of casing	.0	1,435.01	25.99	2-24-43	See log
(419)	NE NW sec. 8	City of Wichita	259.3	30	do	do	T, E	P	Top of casing, 0.87 foot below hole in pump base	+2.0	1,422.83	15.82	7- 3-39	Yield 1,800; drawdown 73.9. Temp. 60° F. See log. Gravel packed. Observation well
420	NE NW sec. 8	City of Wichita	50.8	1¼	Sand and gravel	McPherson	N	N	Top of pipe	+ .8	1,421.51	12.76	6-16-39	Observation well, 100 feet northwest from well 419
421	do	do	50.8	1¼	do	do	N	N	do	+ .8	1,421.61	11.95	6-16-39	Observation well, 500 feet northwest from well 419
(422)	NW NE NW sec. 8	Mrs. G. A. Hege	24.7	.....	Gravel	do	Cy, H	D	Top of valve seat in pump	+3.2	1,425.5	15.74	10-21-37	Driven well. Temp. 60° F.
(423)	NW NW sec. 8	City of Wichita	248.5	30	Sand and gravel	do	T, E	P	Top of casing, 0.87 foot below hole in pump base	+2.0	1,423.45	13.50	6- 5-39	Yield 2,010; drawdown 47.75 Temp. 58° F. See log. Observation well. Gravel packed
424	do	do	50.9	1¼	do	do	N	N	Top of pipe	+ .9	1,422.08	11.88	5- 4-39	Observation well, 100 feet southwest from well 423
425	do	do	51.1	1¼	do	do	N	N	do	+1.1	1,420.92	10.84	5- 4-39	Observation well, 500 feet southwest from well 423
(426)	NW SE sec. 8	do	248.0	30	do	do	T, E	P	Top of casing, 0.87 foot below hole in pump base	+2.0	1,419.29	13.23	7-10-39	Yield 2,010; drawdown 60.06. Temp. 58° F. See log. Observation well. Gravel packed

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TABLE 37.—*Records of wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Continued*

No. on Pl. 1 (1)	Location	Owner	Depth of well (feet) (2)	Diameter of well (in.)	Principal water-bearing bed		Method of lift (3)	Use of water (4)	Measuring point			Depth to water level below measuring point (feet) (6)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
					Character of material	Geologic subdivision			Description	Distance above (+) or below (—) land surface (feet)	Height above sea level (feet) (5)			
	T. 24 S., R. 2 W. (Continued)													
427	NW SE sec. 8	City of Wichita	50.8	1¼	Sand and gravel	McPherson	N	N	Top of pipe	+ .8	1,418.20	11.64	7–10–39	Observation well, 100 feet southwest from well 426
428	do	do	50.8	1¼	do	do	N	N	do	+ .8	1,417.24	10.78	7–10–39	Observation well, 500 feet southwest from well 426
(429)	SW NW sec. 8	do	227.5	30	do	do	T, E	P	Top of casing, 0.87 foot below hole in pump base	+2.0	1,418.78	9.67	6–10–39	Yield 1,980; drawdown 35.17. Temp. 58° F. See log. Gravel packed. Observation well
430	do	do	48.0	1¼	do	do	N	N	Top of pipe	+1.0	1,417.20	8.08	5–11–39	Observation well, 100 feet noerhwest from well 429
431	do	do	47.8	1¼	do	do	N	N	do	+ .8	1,418.59	9.22	5–11–39	Observation well, 500 feet northwest from well 429
432	SE SE SW sec. 8	Emma L. Webster	60	6	do	do	N	N	Top of casing, south side	+1.6	1,415.61	10.96	8–25–37	Observation well
(433)	SE NE sec. 9	City of Wichita	192.6	36	do	do	T, E	P	Top of casing, 0.87 foot below hole in pump base	+2.0	1,410.46	14.92	4–17–39	Yield 2,030; drawdown 37.4. Temp. 58° F. Gravel packed. Observation well. See log.
434	do	do	66.7	1¼	do	do	N	N	Top of pipe	+ .7	1,408.80	13.88	4–17–39	Observation well 100 feet northeast from well 433
435	do	do	61.8	1¼	do	do	N	N	do	+ .8	1,409.74	14.95	4–17–39	Observation well, 500 feet northeast from well 433

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(436)	NW SW sec. 9	do	236.0	30	do	do	T, E	P	Top of casing, 0.87 foot below hole in pump base	+2.0	1,416.35	15.15	6-26-39	Yield, 1,960; drawdown 45.30. Temp. 59° F. Gravel packed. Observation well. See log
437	do	do	69.0	1¼	do	do	N	N	Top of pipe	+1.0	1,415.04	12.97	3-16-39	Observation well, 100 feet southwest from well
438	do	do	68.7	1¼	do	do	N	N	do	+ .7	1,415.88	13.65	3-16-39	Observation well, 500 feet southwest from well 436
439	SW cor. sec. 9	do	57.0	1¼	do	do	N	N	do	+ .8	1,414.57	8.98	4- 4-39	Observation well, 500 feet northwest from well 450
(440)	SE cor. sec. 9	do	193.4	30	do	do	T, E	P	Top of casing, 0.87 foot below hole in pump base	+2.0	1,408.53	13.55	4-27-39	Yield 2,000; drawdown 49.39. Temp. 58° F. Gravel packed. Observation well. See log
441	do	do	57.0	1¼	do	do	N	N	Top of pipe	+1.0	1,408.05	12.86	4-27-39	Observation well, 100 feet northeast from well 440
442	do	do	56.0	1¼	do	do	N	N	do	+ .5	1,407.64	12.28	4-27-39	Observation well, 500 feet northeast from well 440
(443)	NE cor. sec. 10	Jack Lewis	23.4	1¼	Sand	do	Cy, H	D	Top of pump base	+3.8	1,403.75	11.96	7-25-38	Temp. 59° F. Driven well
444	SE cor. sec. 10	City of Wichita	26.8	1¼	Sand and gravel	do	N	N	Top of pipe	+1.0	1,400.60	17.66	5-29-41	Temp. 57° F. Driven well
445	NW cor. sec. 13	do	37.2	1¼	Medium sand	Alluvium	N	N	do	+1.0	1,387.67	10.14	11-16-38	Temp. 57° F. Driven observation well
446	SW cor. sec. 13	do	20.8	1¼	Sand and gravel	do	N	N	do	+1.0	1,389.84	13.11	5-23-41	Temp. 56° F. Driven well
447	SE cor. sec. 15	Mrs. Emma Linn Webster	30.0	6	do	do	Cy, G	D	Top of casing, north side	.0	1,393.82	11.03	8- 9-43	Temperature 61° F.
(448)	NE NE NW sec. 16	F. H. Haiber	57.0	1¼	do	McPherson	N	N	Top of pipe	+ .8	1,403.03	4.25	1-14-39	Temp. 59° F. Observation well. See log
(449)	do	do	111.0	1¼	do	do	N	N	do	+ .8	1,403.07	4.28	1-14-39	Observation well. See log
(450)	NW cor. sec. 16	City of Wichita	102.2	30	do	do	T, E	P	Top of casing, 0.87 foot below hole in pump base	+2.0	1,415.78	10.68	4- 4-39	Yield 1,570; drawdown 28.44. Temp. 58° F. Gravel packed. Observation well. See log 436

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TABLE 37.—*Records of wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Continued*

No. on Pl. 1 (1)	LOCATION	Owner	Depth of well (feet) (2)	Diameter of well (in.)	Principal water-bearing bed		Method of lift (3)	Use of water (4)	Measuring point			Depth to water level below measuring point (feet) (6)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
					Character of material	Geologic subdivision			Description	Distance above (+) or below (—) land surface (feet)	Height above sea level (feet) (5)			
	T. 24 S., R. 2 W. (Continued)													
451	NW cor. sec. 16.....	City of Wichita.....	50.0	1¼	Sand and gravel	McPherson	N	N	Top of pipe.....	+ .8	1,414.47	9.11	4- 4-39	Observation well, 100 feet Northwest from well 450. See well 437
(452)	NE SE sec. 16.....	do.....	185.5	30	do.....	do.....	T, E	P	Top pf casing, 0.87 foot below hole in pump base	+2.0	1,403.98	9.30	5- 8-39	Yield 2,010; drawdown 51.23. Temp. 58° F. See log and analysis. Gravel packed
453	do.....	do.....	51.0	1¼	do.....	do.....	N	N	Top of pipe.....	+ .6	1,401.63	7.77	5- 8-39	Observation well, 100 feet northeast from well 452
454	do.....	do.....	51.0	1¼	do.....	do.....	N	N	do.....	+2.0	1,401.37	7.38	5- 8-39	Observation well, 500 feet northeast from well 452
(455)	NW SW sec. 16.....	do.....	122.0	30	do.....	do.....	T, E	P	Top of casing, 0.87 foot below hole in pump base	+2.0	1,415.10	14.26	4-24-39	Yield 2,030; drawdown 14.37. Temp. 58° F. Gravel packed. Observation well. See log
456	do.....	do.....	51.0	1¼	do.....	do.....	N	N	Top of pipe.....	+ .9	1,413.90	12.97	4-24-39	Observation well, 100 feet northwest from well 455
457	SW NW sec. 16.....	do.....	51.0	1¼	do.....	do.....	N	N	do.....	+ .8	1,414.10	12.95	4-24-39	Observation well, 500 feet northwest from well 455
458	SW cor. sec. 16.....	do.....	20.8	1¼	do.....	do.....	N	N	do.....	+2.0	1,408.21	9.85	5-28-41	Temp. 55° F. Driven well

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(459)	NW NE sec. 17	do	244.8	30	do	do	T, E	P	Top of casing, 0.87 foot below hole in pump base	+2.0	1,415.90	11.73	6-16-39	Yield 2,010; drawdown 42.26. Temp. 58° F. Gravel packed. Observation well. See log
460	do	do	50.8	1¼	do	do	N	N	Top of pipe	+ .8	1,414.59	9.74	5-19-39	Observation well, 100 feet northeast from well 459
461	do	do	50.8	1¼	do	do	N	N	do	+ .8	1,414.62	9.60	3-20-39	Observation well, 500 feet northeast from well 459
(462)	NE cor. sec. 18	H. A. Lawrence	59.3	1¼	do	do	N	N	do	+3.1	1,421.50	14.30	11-22-38	Observation well. See log
(463)	do	do	238.4	1¼	do	do	N	N	do	+2.7	1,420.99	13.90	11-22-38	do
464	NE cor. sec. 21	City of Wichita	20.8	1¼	do	do	N	N	do	+1.0	1,394.97	6.58	5-23-41	Temp. 54° F. Driven well
(465)	SE SW sec. 22	do	157.8	38	do	do	T, E	P	Top of casing, 0.87 foot below hole in pump base	+2.0	1,403.72	12.87	8- 3-39	Yield 1,860; drawdown 43.69. Temp. 58° F. Gravel packed. Observation well. See log
466	do	do	71.7	1¼	do	do	N	N	Top of pipe	+1.7	1,401.44	12.34	8- 3-39	Observation well, 100 feet southwest from well 465
467	do	do	63.2	1¼	do	do	N	N	do	+1.2	1,401.33	11.73	8- 3-39	Observation well, 500 feet southwest from well 465
468	SE cor. sec. 22	do	17.5	1¼	Medium sand	Alluvium	N	N	do	+2.5	1,398.63	13.98	8-31-38	Temp. 61° F. Driven well
469	NW SW NW sec. 23	Langwalter Estate	24.5	6	Gravel	do	N	N	Top of casing, east side	.0	1,388.92	5.89	8-25-37	
(470)	NW cor. sec. 26	Maggie Holle	38.0	1¼	Sand and gravel	McPherson	N	N	Top of pipe	+ .7	1,399.23	15.83	1-14-39	Observation well. See log
(471)	do	do	60.0	1¼	do	do	N	N	do	+ .6	1,399.17	15.76	1-14-39	do
(472)	do	do	99.0	1¼	do	do	N	N	do	+ .6	1,399.17	15.66	1-14-39	do
(473)	SW cor. sec. 26	City of Wichita	79.5	30	do	do	T, E	P	Top of casing, 0.87 foot below hole in pump base	+2.0	1,393.97	12.55	5- 3-39	Yield 1,870; drawdown 20.86. Temp. 58° F. Gravel packed. Observation well. See log
474	do	do	50.8	1¼	do	do	N	N	Top of pipe	+ .8	1,393.09	11.48	5- 3-39	Observation well, 100 feet northwest from well 473

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TABLE 37.—*Records of wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Continued*

No. on Pl. 1 (1)	Location	Owner	Depth of well (feet) (2)	Diameter of well (in.)	Principal water-bearing bed		Method of lift (3)	Use of water (4)	Measuring point			Depth to water level below measuring point (feet) (6)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
					Character of material	Geologic subdivision			Description	Distance above (+) or below (—) land surface (feet)	Height above sea level (feet) (5)			
	T. 24 S., R. 2 W. (Continued)													
475	SW cor. sec. 26	City of Wichita	50.8	1¼	Sand and gravel	McPherson	N	N	Top of pipe	+ .8	1,392.84	11.19	5- 3-39	Observation well, 500 feet northwest from well 473
(476)	SW SE sec. 26	do	81.6	30	do	do	T, E	P	Top of casing, 0.87 foot below hole in pump base	+2.0	1,393.59	14.34	5-16-39	Yield 710; drawdown 20.8. Temp. 58° F. Gravel packed. Observation well. See log
477	do	do	51.0	1¼	do	do	N	N	Top of pipe	+ .8	1,391.76	12.35	5-16-39	Observation well, 100 feet southwest from well 476
478	do	do	50.0	1¼	do	do	N	N	do	+ .9	1,392.84	13.02	5-16-39	Observation well, 500 feet southwest from well 476
(479)	NE cor. sec. 27	do	145.0	34	do	do	T, E	P	Top of casing, 0.77 foot below hole in pump base	+2.0	1,398.36	14.07	6- 6-39	Yield 1,280; drawdown 39.99. Temp. 60° F. Gravel packed. Observation well. See log
480	do	do	59.7	1¼	do	do	N	N	Top of pipe	+ .7	1,399.10	16.10	6- 6-39	Observation well, 100 feet northwest from well 479
481	do	do	51.0	1¼	do	do	N	N	do	+1.0	1,398.83	14.84	6- 6-39	Observation well, 500 feet northwest from well 479
482	SW cor. sec. 27	do	32.4	1¼		do	N	N	do	+2.0	1,405.69	14.47	12-13-40	Temp. 59° F. Driven well

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483	NE cor. sec. 29	do	26.2	1¼	do	do	N	N	do	+1.5	1,407.51	13.59	12-13-40	Driven well
484	SE SE SE sec. 30	Atlantic Refining Co	90.0	7	do	do	N	N	Top of casing	+ .5		6.04	7-17-42	Supplied water for drilling oil well
485	SW SE SW sec. 32	J. H. Baumann	15.8	1¼	do	do	Cy, H	D	Top of valve seat in pump	+3.7	1,410.33	12.55	9-28-37	Temp. 63° F. Driven well
(486)	NE cor. sec. 35	City of Wichita	27.0	1¼	Sand	do	N	N	Top of pipe	+1.0	1,390.19	12.99	9-12-38	Observation well. Temp 59° F. See log
(487)	SE NE sec. 35	do	204.5	30	Sand and gravel	do	T, E	P	Top of casing, 0.87 foot below hole in top of pump base	+2.0	1,388.59	13.51	5-29-39	Yield 1,870; drawdown 56.10. Temp. 59° F. Gravel packed. Observation well. See log
488	do	do	50.9	1¼	do	do	N	N	Top of pipe	+ .9	1,388.17	12.79	5-29-39	Observation well, 100 feet northeast from well 487
489	do	do	51.1	1¼	do	do	N	N	do	+1.1	1,387.67	12.26	5-29-39	Observation well, 500 feet northeast from well 487
490	SE SE SW sec. 35	H. A. Rowland	36.5	1¼	do	do	Cy, H	D	Top of valve seat in pump	+5.2	1,396.0	17.85	9-28-37	Driven well
(491)	SE cor. sec. 35	City of Wichita	97.0	30	do	do	T, E	P	Top of casing, 0.87 foot below hole in top of pump base	+2.0	1,389.88	13.21	6- 1-39	Yield 1,480; drawdown 26.12. Temp. 58° F. Gravel packed. Observation well. See log
492	do	do	54.0	1¼	do	do	N	N	Top of pipe	+1.0	1,389.14	12.01	4-21-39	Observation well, 100 feet southwest from well 491
493	do	do	51.0	1¼	do	do	N	N	do	+1.0	1,391.81	14.45	4-21-39	Observation well, 500 feet southwest from well 491
(494)	SW SE sec. 36	do	189.0	30	do	do	T, E	P	Top of casing, 0.87 foot below hole in top of pump base	+2.0	1,383.83	10.51	5-22-39	Yield 1,980; drawdown 43.24. Temp. 58° F. Gravel packed. Observation well. See well 555. See log
495	do	do	50.0	1¼	do	do	N	N	Top of pipe	+ .8	1,382.85	10.60	4- 2-39	Observation well, 100 feet southwest from well 494
	T. 24 S., R. 3 W.													
(496)	SE cor. sec. 1	C. Cadwell	45.0	1¼	do	do	N	N	do	+ .3	1,431.73	16.78	12- 9-38	Observation well. Temp. 58° F. See log
(497)	do	do	241.0	1¼	Sand	do	N	N	do	+ .5	1,431.55	18.38	12- 9-38	Observation well. Temp. 59° F. See log

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TABLE 37.—*Records of wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Continued*

No. on Pl. 1 (1)	LOCATION	Owner	Depth of well (feet) (2)	Diameter of well (in.)	Principal water-bearing bed		Method of lift (3)	Use of water (4)	Measuring point			Depth to water level below measuring point (feet) (6)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
					Character of material	Geologic subdivision			Description	Distance above (+) or below (−) land surface (feet)	Height above sea level (feet) (5)			
	T. 24 S., R. 3 W. (Continued)													
498	NE NE NE sec. 3	R. D. Fergussen	15.0	1¼	Sand and gravel	McPherson	N	N	Top of pipe	+1.3	1,437.83	11.52	10-23-42	Driven well
499	NW NW sec. 4	E. Regier	22.9	1¼	do	do	Cy, H	D	Top of pump base	+7.0	1,441.91	13.36	7-17-40	do
500	SE cor. sec. 6	City of Wichita	61.5	1¼	do	do	N	N	Top of pipe	+1.4	1,449.68	9.52	6- 9-39	Chloride observation well. Temp. 60° F. See log
501	do	do	97.5	1¼	do	do	N	N	do	+1.4	1,449.79	9.58	6- 8-39	do
(502)	SE cor. sec. 11	P. Miller	15.0	1¼	do	do	N	N	do	+1.3	1,425.4	7.35	11-11-38	Observation well. See log
(503)	do	do	57.0	1¼	do	do	N	N	do	+1.3	1,425.46	7.12	11-11-38	Temp. 59° F. Observation well. See log
504	NE sec. 13	J. Wendling Estate	24.0	8	Gravel	do	N	N	Top of casing, north side	+ .4	1,423.97	8.42	8-12-38	
505	NE NE sec. 16	E. S. Johnson	28.2	6		do	N	N	Top of casing	+ .5	1,434.54	5.24	8- 3-38	
506	NE SE SE sec. 16	George R. Hess	28.2	1¼	Sand and gravel	do	Cy, H	D	Top of pipe	+2.4	1,443.05	15.68	7- 8-42	Driven well
507	SW cor. sec. 17	City of Wichita	62.1	1¼	do	do	N	N	do	+1.1	1,462.19	8.20	6-30-39	Chloride observation well Temp. 62° F. See log
508	do	do	136.5	1¼	do	do	N	N	do	+1.5	1,462.46	7.58	6-30-39	Chloride observation well. Temp. 63° F. See log
509	NW cor. sec. 18	do	71.3	1¼	do	do	N	N	do	+1.3	1,457.62	13.83	6- 6-39	Chloride observation well. Temp. 59° F. See log

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510	do	do	157.3	1¼	do	do	N	N	do	+1.3	1,457.43	12.61	6- 6-39	do
(511)	NE SE SE sec. 21	J. F. Jorgenson	14.5	1¼	do	do	N	N	do	+ .3	1,432.09	5.67	3-31-39	Observation well. See log
512	SW SW sec. 22	Wichita Gun Club	23.3	6		do	N	N	Top of casing	+ .5	1,427.58	3.10	7-29-38	
513	SE SW SE sec. 24	Mary Taylor	18.2	1¼	Sand	do	Cy, H	D	Edge of pump base		1,425.17	13.71	8-10-38	Temp. 60° F. Driven well
514	SE SE SE sec. 27	Maggie Vallweider	18.8	1¼	Sand and gravel	do	Cy, H	D, S	Valve seat on pitcher pump	+2.09	1,426.06	6.29	12-17-41	Driven well
515	SW SW NW sec. 31	C. H. Smythe, et al	31.5	12	Gravel	do	C, E	Ir	Top of casing, east side	+1.0	1,440.67	4.93	8- 2-38	
516	SE SE sec. 31	A. McMurry	7.0	1¼	Sand and gravel	Alluvium	N	N	Top of pipe	+ .7	1,435.24	3.90	2- 6-40	Observation well. See log
(517)	do	do	106.0	1¼	do	McPherson	N	N	do	+1.8	1,434.16	4.87	2- 6-40	do
(518)	do	do	163.0	1¼	do	do	N	N	do	+1.9	1,434.08	4.80	2- 6-40	do
519	NE NW NW sec. 33	Maggie Vallweider	23.6	1¼	do	do	Cy, H	S	Valve seat on pitcher pump	+2.5	1,434.56	9.01	12-17-41	Driven well
520	NE NE NE sec. 36	J. A. Schowalter	25.8	1¼	do	do	Cy, H	D, S	do	+2.1	1,417.40	7.05	12-18-41	do
	T. 24 S., R. 4 W.													
521	NE cor. sec. 3	C. W. Grandon	16.8	1¼		do	Cy, H	N	Top of pump base	+1.7	1,469.42	9.99	8- 5-38	do
522	NW SW SW sec. 4	F. F. Brown	20.5	2	Gravel	do	Cy, H	D	Top of casing	+2.8	1,479.3	10.41	12-16-38	do
523	SE SE sec. 9	City of Wichita	66.5	1¼	Sand and gravel	do	N	N	Top of pipe	+1.5	1,468.83	8.89	11-22-38	Driven chloride observation well. Temp. 57° F.
524	SW SW sec. 10	do	59.0	1¼	do	do	N	N	do	+2.3	1,469.48	10.63	12-23-38	Driven chloride observation well
525	SW cor. sec. 13	do	45.8	1¼	do	do	N	N	do	+ .8	1,452.38	4.18	5-29-39	Chloride observation well. Temp. 60° F. See log
526	do	do	230.9	1¼	do	do	N	N	do	+ .9	1,452.44	4.45	5-29-39	do
527	NW NW NE sec. 15	Harris Estate	15.6	1¼		do	Cy, H	D, S	Top of pump base	+2.3	1,466.52	9.58	8-10-38	Driven well
528	NE cor. sec. 20	City of Wichita	12.1	1¼	Coarse sand and gravel	Alluvium	N	N	Top of pipe	+2.0	1,465.3	4.59	9-13-38	Temp. 64° F. Driven well
529	SW NW SW sec. 20	Eldon Gas Co	55	30	Sand and gravel	do	T. E	In				6	10-10-37	Yield 385; drawdown 14.9. Gravel packed. See log

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TABLE 37.—*Records of wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Continued*

No. on Pl. 1 (1)	LOCATION	Owner	Depth of well (feet) (2)	Diameter of well (in.)	Principal water-bearing bed		Method of lift (3)	Use of water (4)	Measuring point			Depth to water level below measuring point (feet) (6)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
					Character of material	Geologic subdivision			Description	Distance above (+) or below (—) land surface (feet)	Height above sea level (feet) (5)			
	T. 24 S., R. 4 W. (Continued)													
530	NE SW SW sec. 20	Eldon Gas Co.	102	18	Sand and gravel	Alluvium and McPherson	T, E	In	.....	.....	.....	6	10-22-37	Yield 1,030; drawdown 18. Gravel packed. See log
531	SW NW SW sec. 23	George Hinners	22.3	1¼	.....	McPherson	Cy, H	D	Top of pump base	+4.0	1,468.19	17.24	8- 3-38	Temp. 60° F. Driven well
532	SE cor. sec. 24	W. L. Hoskinson	13.9	1¼	.....	do.	N	N	Top of pipe	+2.7	1,452.1	10.87	8- 3-38	Driven well
533	SW cor. sec. 28	City of Wichita	13.1	1¼	Coarse sand and gravel	Alluvium	N	N	do.	+1.0	1,460.88	5.39	9-13-38	Temp. 64° F. Driven well
	T. 24 S., R. 5 W.													
534	NE NE NW sec. 16	U. S. Navy	123.1	16	Sand and gravel	McPherson	T, E, G	P	Top of casing, north side	+2.0	.....	44.89	9-16-42	Yield 350, drawdown 15 after 16 hours. Double gravel walled. See log
535	NW NE NW sec. 16	do.	123	16	do.	do.	T, E, G	P	Top of casing	+2.0	.....	33	10- 9-42	Yield 340, drawdown 16; yield 600, drawdown 28; after 12 hours at each rate. Double gravel walled. See log
	T. 25 S., R. 1 W.													
536	NE NW NE sec. 1	Ada M. Davis, et al.	23.0	23	.....	do.	N	N	Steel plate on platform	+1.7	1,398.48	19.99	9-20-37	Dug. Observation well
537	SE SW sec. 1	John R. Clark	42	13	do.	do.	C, G	D	.....	.....	.....	13	9- 2-37	Reported yield 160
538	NE cor. sec. 3	City of Wichita	25.1	1¼	Fine sand	do.	N	N	Top of pipe	+1.0	1,384.18	14.60	9- 7-38	Temp. 58° F. Driven observation well

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539	SW SW sec. 4	W. F. Skaer	23.9	1¼	Sand	Alluvium	Cy, H	S	Top of pump base	+2.6	1,375	21.85	9-25-37	Driven well
540	NE cor. sec. 5	City of Wichita	18.2	1¼	Sand and gravel	do	N	N	Top of pipe	+2.0	1,369.80	12.26	9- 7-38	Temp. 60° F. Driven observation well
541	SW cor. sec. 5	do	32.5	1¼	do	do	N	N	do	+1.5	1,376.52	13.45	2-13-41	Temp. 60° F. Driven well
542	NE cor. sec. 6	do	42.8	1¼	do	do	N	N	do	+1.5	1,376.05	8.14	9- 8-38	Temp. 58° F. Driven well
543	NE cor. sec. 7	J. I. Base	16.4	6	Fine sand	do	N	N	Top of casing	— .1		11.65	8-12-38	
544	SW cor. sec. 7	City of Wichita	31.1	1¼	Sand and gravel	do	N	N	Top of pipe	+1.0	1,381.62	12.16	8-25-38	Temp. 58° F. Driven observation well
545	SE SW SE sec. 10	Frank Wilson	25.1	1¼	Sand	do	Cy, H	N	Top of pump base	+1.3	1,362.87	15.11	7-26-38	Driven well
546	SE SW SE sec. 12	J. S. Congdon	30.8	36		Wellington (?)	Cy, G	D,S	Bottom face of pump base	+1.5	1,384.27	22.56	7-26-38	Temp. 62° F. Dug well
547	SE cor. sec. 14	City of Wichita	31.1	1¼	do	Alluvium	N	N	Top of pipe	+1.0	1,361.3	17.67	8-24-38	Temp. 58° F. Driven observation well
548	SW SW sec. 16	H. L. Marsh	32.2	1¼		do	Cy, H	S	Top of pump base	+2.9	1,368	11.65	9-23-37	Driven well
549	NE cor. sec. 17	City of Wichita	30.7	1¼	Sand and gravel	do	N	N	Top of pipe	+1.5	1,371.67	14.71	8-24-38	Temp. 58° F. Driven observation well
550	NW SE sec. 19	Schuyler Jones	32.2	36	Gravel	do	N	N	Top of casing, east edge	+2.8		17.06	9-29-37	
551	SE SE sec. 19	do	22.9	1¼		Alluvium	Cy, H	S	Top of pump base	+3.0	1,376.88	16.70	10-21-37	Driven well
552	do	do	42	8	Gravel	do	C, G	Ir				10+	8- 7-37	Two similar wells. Aggregate yield 1,500
553	NE SE SE sec. 22	Mrs. A. W. Jacob	32.7	1¼	Sand	do	C, E	D	Top of pipe	—5.2	1,355.11	15.79	6-20-40	Driven well
554	SW SW sec. 24	City of Wichita	36.6	1¼	do	do	N	N	do	+1.5	1,358.0	17.8	8-23-38	Temp. 58° F. Driven observation well
555	SW SE SE sec. 25	City of Valley Center	49.5	38	do	do	T, E	P				12.7	2- 2-29	Yield 350; drawdown 4.5 Gravel packed. Abandoned 1934 owing to corrosion of screen
556	do	do	50	18	Gravel	do	T, E	P				17	11- 2-37	Yield 350; drawdown 4.5 Gravel packed. See log

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TABLE 37.—*Records of wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Continued*

No. on Pl. 1 (1)	Location	Owner	Depth of well (feet) (2)	Diameter of well (in.)	Principal water-bearing bed		Method of lift (3)	Use of water (4)	Measuring point			Depth to water level below measuring point (feet) (6)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
					Character of material	Geologic subdivision			Description	Distance above (+) or below (—) land surface (feet)	Height above sea level (feet) (5)			
	T. 25 S., R. 1 W. (Continued)													
557	NW SE sec. 26	Dr. A. D. Updegraph	53.9	24	Gravel	Alluvium	N	N	Steel plate on recorder instrument shelf	+3.0	1,356.87	21.59	8-30-37	Recorder observation well
558	NW cor. sec. 27	City of Wichita	25.3	1¼	Coarse sand	do.	N	N	Top of pipe	+ .8	1,362.88	12.27	8-25-38	Temp. 58° F. Driven observation well
559	SW NW SW sec. 32	Mrs. E. A. Keeler	21	1¼	Sand	do.	Cy, H	S	Top of pump base	+2.4	1,368.58	12.38	7-20-38	Driven well
560	SE cor. sec. 33	City of Wichita	25.1	1¼	Coarse sand	do.	N	N	Top of pipe	+1.0	1,356.1	8.47	8-22-38	Temp. 58° F. Driven observation well
561	SE NE sec. 34	A. Hoefgen	22.6	1¼		do.	Cy, H	S	Top of pump base	+2.4	1,351	11.23	9-23-37	Driven well
562	SE NW sec. 35	E. G. Marshall	45	18	Gravel	do.	C, G	Ir				16	9-23-37	Two similar wells
563	NE NE SE sec. 35	City of Wichita	24.8	1¼	Sand	do.	N	N	Top of pipe	+1.3	1,348.76	12.20	8-22-38	Temp. 59° F. Driven observation well
(564)	NW SW NE sec. 36	City of Valley Center	52	18	Gravel	do.	T, E	P				16.5	11- 2-37	Yield 260; drawdown 4. Temp. 59° F. Gravel packed
565	do.	do.	51	48	do.	do.	T, E	P				16	8- 2-38	
	T. 25 S., R. 2 W.													
(566)	NE NE sec. 1	A. W. Haines	19.0	1¼		McPherson	Cy, H	D	Top of pump base	+2.3	1,381.6	11.64	9-27-37	Temp. 61° F. Driven well
567	NE NW sec. 1	City of Wichita	51.0	1¼	Sand and gravel	do.	N	N	Top of pipe	+ .8	1,384.51	9.17	5-22-39	Observation well, 500 feet southwest from well 494

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568	NW NW SW sec. 1	J. R. Clark	91	6	Gravel	do	Cy, G	N	Steel plate on recorder instrument shelf	+2.8	1,390.84	15.33	11- 3-37	Recorder observation well. See log
569	NE SE NE sec. 3	John McFarland	19.4	1¼	Sand	do	Cy, H	D	Top of 1¼ inch tee	+1.1	1,395.34	13.95	8-25-37	Driven well
570	NE cor. sec. 4	City of Wichita	20.1	1¼	Sand and gravel	do	N	N	Top of pipe	+1.5	1,401.70	12.47	12-13-40	Temp. 60° F. Driven well
571	NW NW NE sec. 5	J. H. Bauman	25+	1¼		do	Cy, H	D	Top of pump base	+4.5	1,410.23	12.30	8- 3-38	Driven well
(572)	NE NE sec. 9	C. A. Berger	61.0	1¼	Gravel	do	N	N	Top of pipe	+5.9	1,401.54	12.92	9-26-38	Temp. 59° F. Observation well. See log
573	NE NE sec. 10	Sam Stamback	40	8	do	do	C, G	Ir				8+	8-27-37	Yield 800; drawdown 8
574	NW SW sec. 14	R. W. Rine Drilling Co.	50 0	7	Sand and gravel	do	N	N	Top of casing	+ .5	1,384.67	4.13	5-14-43	Supplied water for drilling oil well. Reported yield 75; drawdown 11.8
(575)	NW cor. sec. 16	City of Wichita	15 0	1¼	do	do	N	N	Top of pipe	+1.3	1,398.30	7.55	10-11-38	Temp. 63° F. Observation well. See log
576	SE SE NE sec. 16	Claude Hand	11.3	1¼		do	Cy, H	N	Top of pump base	—1.7	1,393.61	6.74	9-29-37	Temp. 62° F. Driven well
(577)	SW cor. sec. 16	City of Wichita	21 0	1¼	Sand and gravel	Alluvium	N	N	Top of pipe	+1.0	1,392.26	4.6	9-18-38	Temp. 60° F. See log
578	NW NE NE sec. 18	W. Williams	19 0	1¼		McPherson	N	N	Top of pipe	+2.5		8.93	3-31-39	Driven well
579	NE NE SW sec. 23	Clarence Stamback	37	8	Sand and gravel	do	C, G	Ir				7	8-27-37	Reported yield of two similar wells, 1,000
580	NE cor. sec. 27	Chas. Bazore	10.8	1¼	Sand	Alluvium	Cy, H	Ir	Top of pipe	+2.4	1,383.27	5.89	7-22-38	Driven well
581	SE cor. sec. 27	City of Wichita	19.2	1¼	Sand and gravel	do	N	N	do	+1.0	1,377.42	3.75	9- 9-38	Temp. 59° F. Driven well
582	SW cor. sec. 30	do	57.3	1¼	Sand	do	N	N	do	+2.0	1,419.9	26.12	9-15-38	Temp. 58° F. Driven observation well
583	SE cor. sec. 34	J. V. Simon	18.0	1¼	Sand and gravel	do	Cy, H	D, S	Bottom of cylinder	—2.5	1,377.03	7.39	7-18-40	Driven well
	T. 25 S., R. 3 W.													
584	SW SW sec. 2	Mary Jones	15.3	1¼	Gravel	McPherson	Cy, H	S	Top of pipe	+1.6	1,423.8	13.13	9-29-37	Driven well
585	NE SE NE sec. 3	B. E. Churchman	14 0	1¼	Sand and gravel	do	Cy, H	D	Top of valve seat in pump	+3.0	1,425.7	12.80	9-28-37	Temp. 61° F. Driven well
586	SW NE sec. 5	A. G. Carlisle	34	6	Coarse gravel	Alluvium	C, G	Ir						Used to irrigate 80 acres in 1932

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No. on Pl. 1 (1)	LOCATION	Owner	Depth of well (feet) (2)	Diameter of well (in.)	Principal water-bearing bed		Method of lift (3)	Use of water (4)	Measuring point			Depth to water level below measuring point (feet) (6)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
					Character of material	Geologic subdivision			Description	Distance above (+) or below (—) land surface (feet)	Height above sea level (feet) (5)			
	T. 25 S., R. 3 W. (Continued)													
587	NW cor. sec. 9	J. C. Jorgensen	8.7	1¼	Gravel	Alluvium	C, G	Ir.	Top of vertical pipe	— .4	1,425.5	4.92	10-25-37	
588	SW cor. sec. 9	City of Wichita	18.5	1¼	Fine sand	do.	N	N	Top of pipe	+1.5	1,431.04	11.80	9-13-38	Temp. 59° F. Driven observation well
(589)	NE NE sec. 20	City of Mt. Hope	74	12	Gravel	McPherson	T, E	P				28.5	2-26-37	Yield 200; drawdown 5. Temp. 58° F. Have another similar well 150 feet east, put down in 1940 or 1941
590	SW NW sec. 21	Missouri Pacific Rly. Co.	52	14	Coarse gravel	do.	C, G	R				28	10-28-37	Yield 80; drawdown 3
591	NE SE NW sec. 26	N. B. Martin	41	72	Gravel	do.	C, G	S	Top of cap over 4 inch pipe	+ .2		14.81	10-25-37	Yield 350; drawdown 5. Dug well
592	SW SW sec. 26	do.	30.4	1¼		do.	Cy, H	S	Top of pump base	+3.0	1,419.4	19.19	8- 8-38	Temp. 60° F. Driven well
593	NE NW sec. 33	City of Wichita	49.3	1¼	Sand	do.	N	N	Top of pipe	+1.0	1,434.08	26.36	9-15-38	Temp. 58° F. Driven observation well
	T. 25 S., R. 4 W.													
(594)	NW NE SW sec. 5	City of Haven	55	12	Gravel	do.	C, E	P				28	10-28-37	Two identical wells. Aggregate yield 300; drawdown 2. Temp. 58° F.
595	SW NE SW sec. 5	do.	55	12	do.	do.	C, E	P				28	10-28-37	Yield 250; drawdown 10
596	do.	do.	48.3	10	Coarse sand	do.	T, E	P	Top of pumphouse floor	+2.0	1,479.0	26.80	8- 9-38	Yield 200; drawdown 11

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597	SE cor. sec. 9	D. Meyer	39.0	8	Sand and gravel	do	N	N	Top of casing, west side	— .2	1,479.3	33.24	6-16-44	Supplied water for drilling oil well
598	NW NW sec. 10	City of Wichita	35.2	1¼	Fine sand	do	N	N	Top of pipe	+1.0	1,469.94	25.67	9-14-38	Temp. 58° F. Driven well
599	NE NE sec. 13	R. D. Romig	35.0	1¼		do	N	N	do	—6.5	1,442.4	16.12	8- 8-38	Driven well
600	NE SE SE sec. 24	Emma Back	47.8	6	Sand	do	Cy, E	D	Top of casing, northeast side	—7.4	1,462.4	36.25	6-19-44	
601	NE NW sec. 33	C. S. Koontz	37.5	6	Shale	Ninnescah	Cy, W	D, S	Top of board over casing in pit	—4.7	1,555.5	13.35	6 16 44	
	T. 26 S., R. 1 E.													
602	SE SW SW sec. 6	Continental Oil Co	25 3	1¼	Sand	Alluvium	Cy, H	D	Top of pump base	+1.8	1,342.8	15.36	8-12-38	Temp. 59° F. Driven well
603	SE SW SW sec. 17	W. F. Perkins	24.0	1¼	Gravel	do	Cy, H	S	Top of valve seat	+2.4	1,330.83	15.10	10- 9-37	Temp. 61° F. Driven well
604	NW NW sec. 19	J. Boaz	33.0	1¼		do	Cy, H	D	Top of pump base	+4.4	1,337.38	16.80	10- 2-37	Temp. 59° F. Driven well
605	SE SW SW sec. 19	J. E. Pearson	15.5	1¼	Sand and gravel	do	N	N	Top of pipe	+2.0	1,324.9	8.70	11-14-38	do
606	NW cor. sec. 21	City of Wichita	32.2	1¼	Sand	do	N	N	do	+3.6	1,333.9	16.26	8 22-38	Temp. 58° F. Driven observation well
607	SE SW SE sec. 27	Mrs. E. L. Hart	38	40		Wellington	Cy, W	S	Top of well platform	+1.0	1,349 0	11.74	10-12-37	Dug well
(608)	NE NW sec. 29	Kansas Gas and Electric Co.	46 6	48	Gravel	Alluvium	T, E	In	Top of casing	+2.4	1,309.60	19.70	11- 8-37	Yield 1,000; Drawdown 15. Temp. 59° F. Gravel packed. See log, and p. 00
609	NW NW sec. 29	do	44	48	do	do	T, E	In	do	+1.2		10.40	6 20-38	Yield 1,016; drawdown 9.8. Gravel packed
610	SW NE NW sec. 31	Harry Stone	44.0	10	do	do	C, G	Ir	Top of casing, north side	+ .6	1,323 56	11.79	10-31-38	Reported yield 500
611	SW cor. sec. 31	H. C. Groom	16.0	1¼	Coarse sand	do	Cy, H	D	Top of pump cylinder	+2.6	1,319.04	10.40	8-16-38	Temp. 62° F. Driven well
612	NE NW sec. 33	Culver Aircraft Corp	34.8	6	Sand and gravel	do	C, E	A	Top of casing	.0		18.25	10-24-40	Yield 50; drawdown 5. Temp. 62° F.
613	do	do	36.7	7	do	do	C, E	In	do	—5.0		12 83	10-24-40	Yield 75; drawdown 6. Temp. 58° F.
614	do	do	35.0	6	do	do	C, E	A	do	+ .1		19.35	10-24-40	Reported yield 20. Temp. 58° F.

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TABLE 37.—*Records of wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Continued*

No. on Pl. 1 (1)	LOCATION	Owner	Depth of well (feet) (2)	Diameter of well (in.)	Principal water-bearing bed		Method of lift (3)	Use of water (4)	Measuring point			Depth to water level below measuring point (feet) (6)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
					Character of material	Geologic subdivision			Description	Distance above (+) or below (—) land surface (feet)	Height above sea level (feet) (5)			
	T. 26 S., R. 1 E. (Continued)													
615	NE NW se. 33	Culver Aircraft Corp.	33.3	6	Sand and gravel	Alluvium	C, E	In	Top of collar on casing	.0		18.50	10-24-40	Reported yield 12. Temp. 58° F.
616	do	do	35.3	6	do	do	N	N	Top of casing	.0		6.30	10-24-40	Disposal well for air conditioning plant
617	do	do	36.0	6	do	do	N	N	do	+ .6		18.25	10-24-40	do
618	SW SW sec. 33	S. P. Wallingford (Public Terminal Elevator)	32.8	10	do	do	C, E	In	Top of cement pump base	+ .6		18.97	10- 9-40	Yield 50; drawdown 1.5. Temp. 63° F.
619	SW cor. sec. 33	City of Wichita	37.3	1¼	Coarse sand	do	N	N	Top of pipe	+1.0	1,316.76	19.91	8-15-38	Temp. 59° F. Driven observation well
620	SW SW sec. 33	Golden Rule Oil Co.	42.3	24	Sand and gravel	do	N	N	Top of casing	+ .6		21.45	10-10-40	Temp. 59° F.
621	SE SW sec. 33	Air Reduction Sales Co.	34.3	18	do	do	C, E	In	do	—8.8		11.50	10-10-40	Yield 30; drawdown 2. Temp. 59° F.
	T. 26 S., R. 1 W.													
622	NE NW sec. 3	Robt. Fulston	30	6	Coarse gravel	do	C, G	Ir				7	8-27-37	Two indentical wells. Yield 500 each; drawdown 10
623	SE cor. sec. 3	City of Wichita	13.1	1¼	Sand and gravel	do	N	N	Top of pipe	+1.0	1,348.41	7.48	11-14-38	Temp. 62° F. Driven well
624	SW SW NE sec. 12	A. P. Wright	23.3	1-¾	do	do	N	N	do	—1.0	1,337.4	9.04	11- 1-38	Driven well
625	SW cor. sec. 13	City of Wichita	32.3	1¼	Sand	do	N	N	do	+1.6	1,336.70	6.85	8-16-38	Temp. 62° F. Driven well

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626	NW NW sec. 14	J. R. Crowley	18.8	1¼		do	Cy, H	N	Top of pump base	+3.6	1,343.55	7.99	8-11-38	Driven well
627	SE cor. sec. 16	City of Wichita	25.7	1¼	Coarse sand	do	N	N	Top of pipe	+ .6	1,340.23	2.69	8-16-38	Temp. 58° F. Driven observation well
628	NW NE sec. 19	do	41.0	1¼	do	do	N	N	do	+3.3	1,355.00	6.41	8-17-38	Temp. 59° F. Driven observation well
629	NW SW SW sec. 23	Dr. Evans	37.9	1¼		do	Cy, H	D	Top of valve seat in pump	+6.5	1,348.5	20.63	10-22-37	Driven well
630	NW NE NE sec. 25	H. P. Zieseuis	21.0	1½	Sand	do	Cy, H	D	Top of pump base east side	+6.0	1,331.6	14.98	10-31-38	do
631	SW NW NW sec. 30	G. W. Williams	32.0	1¼	Gravel	McPherson	Cy, H	S	Top of valve seat in pump	+2.8	1,368.2	23.21	10-23-37	Temp. 62° F. Driven well
632	SE SW SW sec. 31	John Faber	37.9	6	Sand and gravel	do	Cy, W	S	Top of 4 x 4 under pump, south side	+ .6	1,369.2	29.89	6-17-44	
633	SW cor. sec. 35	Harry Oldfather	44.1	1¼		Alluvium	Cy, H	D	Valve seat in pitcher pump	+5.7	1,338.96	20.35	10-22-37	Temp. 62° F. Driven well
	T. 26 S., R. 2 W.													
634	NW cor. sec. 10	City of Wichita	37.2	1¼	Coarse sand	McPherson	N	N	Top of pipe	+1.0	1,393.11	23.29	8-18-38	Temp. 58° F. Driven observation well
635	NW SW SW sec. 12	Lewis Prey	22.3	1¼	Gravel	Alluvium	Cy, H	S	Top of valve seat in pump	+1.5	1,368.1	9.13	10-23-37	Temp. 62° F. Driven well
636	NW SW sec. 15	City of Wichita	37.7	1¼	Coarse sand	McPherson	N	N	Top of pipe	+1.1	1,380.28	17.80	8-18-38	Temp. 56° F. Driven observation well
637	SW NW sec. 18	City of Wichita	49.3	1¼	Sand	do	N	N	do	+1.0	1,402.17	24.44	8-19-38	Temp. 58° F. Driven observation well
	T. 26 S., R. 3 W.													
638	SE SE NE sec. 1	M. J. Classen	20.3	36		do	Cy, W	S	Top of platform	+1.0	1,405.95	18.51	8- 8-38	Dug well
639	SW SW sec. 10	Ben Hermes	51.6	36		do	Cy, W	D, S	Steel plate under wood cover	+ .8	1,451.01	44.30	10-26-37	Temp. 59° F. Dug well. Observation well through 1938
640	NW NW sec. 15	do	49.5	36	Sand and gravel	do	N	N	Top of concrete curb, north side	+ .4	1,463.9	42.63	6-16-44	Dug well
641	NE NW sec. 19	Ida B. Sommerhauser	46.8	8		do	Cy, W	S	Top of concrere curb, south side	+ .8	1,523.1	28.77	6-16-44	Dug 12 feet, deepened by drilling
642	SE SE sec. 22	J. H. Hein	64.5	24		do	N	N	Top of platform, north side	+1.5	1,504.4	60.74	12- 4-37	Dug, observation well

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TABLE 37.—*Records of wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Continued*

No. on Pl. 1 (1)	LOCATION	Owner	Depth of well (feet) (2)	Diameter of well (in.)	Principal water-bearing bed		Method of lift (3)	Use of water (4)	Measuring point			Depth to water level below measuring point (feet) (6)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
					Character of material	Geologic subdivision			Description	Distance above (+) or below (—) land surface (feet)	Height above sea level (feet) (5)			
	T. 26 S., R. 3 W. (Continued)													
643	SE SE NE sec. 36	Chris Dold	55.5	1¼	.....	McPherson	Cy, H	D	Top of platform, east side	+1.0	1,461.9	34.11	10-13-37	Temp. 60° F. Dug well
	T. 26 S., R. 4 W.													
644	SE SE sec. 2	D. J. Smith	31.3	8	Sand and gravel	do	Cy, W	D	Top of casing, south side	+1.3	1,519.0	17.00	6-16-44	
	T. 27 S., R. 1 E.													
645	NW NW sec. 4	Atchison, Topeka and Santa Fe Railway Co.	38	10	do	Alluvium	Cy, S	In	Top of platform	+3.0	.....	30.40	10- 9-40	Yield 250; drawdown 4. Temp. 57° F. Four 10-inch wells inside dug well reservoir
646	SE NW sec. 4	Barnsdall Refining Co.	39.7	18	do	do	C, E	In	Top of motor base	+1.4	.....	38.75	10- 9-40	Yield 110; drawdown 20. Temp. 60° F.
647	do	do	41.0	24	do	do	C, E	In	do	+1.0	.....	33.68	10- 9-40	Yield 325; drawdown 20. Temp. 61° F.
648	do	do	42.0	18	do	do	N	N	do	+1.8	.....	32.48	10- 9-40	Temp. 60° F.
649	do	do	39.7	18	do	do	C, E	In	do	+1.0	.....	37.66	10- 9-40	Yield 250; drawdown 20. Temp. 60° F.
650	do	do	40.3	24	do	do	N	N	do	+1.0	.....	30.77	10- 9-40	Temp. 59° F.
651	do	do	41.6	24	do	do	C, E	In	Top of pump base	+1.3	.....	33.76	10- 9-40	Yield 120; drawdown 20. Temp. 58° F.
652	NE SW sec. 4	Wichita Union Stockyards Co.	25.0	14	do	do	T, E	N	Top of casing	—14.0	.....	11.80	10-30-40	Temp. 62° F. Well for emergency use only

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653	do	do	25.0	14	do	do	T, E	N	do	−14.0		11.90	10-30-40	do
654	SW SW sec. 4	Jacob Dold Packing Co.	41.0	48	do	do	C, E	In	do	+ .5		24.66	10-30-40	Temp. 60° F.
655	do	do	46.3	48	do	do	C, E	In	Top of 3-inch nipple	−20.7		6.48	10-30-40	Temp. 59° F.
656	do	do	42.6	45	do	do	C, E	In	Top of casing	+1.2		38.03	10-30-40	Estimated yield 150. Temp. 60° F.
657	do	do	43.5	14	do	do	C, E	In	do	−23.0		2.22	10-30-40	Temp. 60° F.
658	SE SW sec. 4	Frank Oestertag	27.8	7	do	do	C, E	In	do	+ .8		25.66	10-31-40	Temp. 58° F.
659	NE SE sec. 5	Albert Yasquez	27.8	1½	do	do	Cy, H	N	Top of pump	+2.8	1,314.65	25.90	10-31-38	Driven well
660	SW SW sec. 5	City of Wichita	25.1	1¼	do	do	N	N	Top of pipe	+1.0	1,311.10	15.77	11-11-38	Temp. 60° F. Driven observation well
661	SE SW sec. 5	E. W. Drawatzky Estate	30.4	2	do	do	Cy, E	D	Top of cylinder	−5.5		11.37	11-26-40	Estimated yield 12. Temp. 60° F. Driven well
662	do	do	39.5	1¼	do	do	Cy, E	D	Top of pipe	−1.0		15.49	11-26-40	Estimated yield 4. Temp. 60° F. Driven well
663	SW SW SE sec. 6	City of Wichita	25.2	1¼	do	do	N	N	do	+1.0	1,315.73	17.15	11-11-38	Temp. 60° F. Driven observation well
664	SW SE sec. 6	do	32.2	1¼	do	do	N	N	do	+1.0	1,314.16	17.08	11-11-38	Temp. 59° F. Driven observation well
665	NE NW sec. 8	Wichita Water Co.	43	24	do	do	T, E	P	Top of cement base in pit	−2.3		13.72	1- 7-41	Well 6. Reported yield 1,000; Temp. 58° F. Gravel packed.
666	do	do	41	24	do	do	T, E	P	do	−2.9		12.78	1- 7-41	Well 5. Reported yield 1,000. Temp. 58° F. Gravel packed
667	NE NW NW sec. 9	F. Dold and Sons Packing Co.	43.1	24	do	do	C, E	In	Top of steel plate covering well	−22.3		4.51	10-30-40	Yield 200; drawdown 2.5. Temp. 59° F.
668	NW NW SW sec. 15	Chas. P. Mueller Estate	20.5	18	Sand	do	Cy, E	In	Top of casing	−2.0		11.87	3-10-41	Yield 60; drawdown 4. Temp. 56° F.
669	do	do	18.3	24	do	do	N	N	do	.0		13.92	3-10-41	Temp. 58° F.

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TABLE 37.—*Records of wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Continued*

No. on Pl. 1 (1)	LOCATION	Owner	Depth of well (feet) (2)	Diameter of well (in.)	Principal water-bearing bed		Method of lift (3)	Use of water (4)	Measuring point			Depth to water level below measuring point (feet) (6)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
					Character of material	Geologic subdivision			Description	Distance above (+) or below (—) land surface (feet)	Height above sea level (feet) (5)			
	T. 27 S., R. 1 E. (Continued)													
670	SW SE sec. 17.....	Wichita Water Co.....	38	18	Sand.....	Alluvium...	T, E	P	Top of casing.....	—2.9	.....	10.27	1- 7-41	Well 11. Gravel packed. Temp. 54° F.
(671)	SE SW sec. 18.....	do.....	46	24	do.....	do.....	T, E	P	Top of well-house floor...	.0	.....	14.95	1- 7-41	Well 12. Reported yield 1,000. Temp. 54° F. Gravel packed
672	do.....	do.....	51	24	do.....	do.....	T, E	P	do.....	— .2	.....	12.54	1- 7-41	Well 10. Reported yield 1,700. Temp. 54° F. Gravel packed
673	SE SE SW sec. 18...	do.....	50	24	do.....	do.....	T, E	P	Top of casing.....	—4.5	.....	9.24	1- 7-41	Well 21. Reported yield 1,390. Temp. 54° F. Gravel packed
674	do.....	do.....	47.4	26	Gravel.....	do.....	N	N	Steel plate on recorder shelf	+3.0	1,301.28	19.29	9- 3-37	Recorder observation well. (Well 2)
675	SW SE sec. 18.....	do.....	51	24	Sand.....	do.....	T, E	P	Pump base at channel iron	—3.8	.....	7.97	1- 7-41	Well 17. Reported yield 1,500. Temp. 54° F. Gravel packed
676	SW SE sec. 18.....	do.....	40	24	do.....	do.....	T, E	P	Top of casing.....	—5.5	.....	6.31	1- 7-41	Well 20. Reported yield 1,390. Temp. 54° F. Gravel packed

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(677)	do	do	48	28	do	do	T, E	P	do	—6.0		7.48	1- 7-41	Well 16. Reported yield 1,500. Temp. 54° F. Gravel packed
678	do	do	41	24	Sand and gravel	do	T, E	P	do	—2.1		9.74	1- 7-41	Well 8. Reported yield 750 Temp. 54° F. Gravel packed
679	do	do	38	24	do	do	T, E	P	Top of well-house floor	—2.9		10.32	1- 7-41	Well 15. Reported yield 830. Temp. 54° F. Gravel packed
680	SE cor. sec. 18	do	37	24	do	do	T, E	P	Top of casing	—6.0		6.78	1- 7-41	Well 19. Reported yield 1,100. Temp. 54° F. Gravel packed
681	NE cor. sec. 19	do	37	24	do	do	T, E	P	do	—5.4		7.93	1- 7-41	Well 18. Reported yield 1,100. Temp. 54° F. Gravel packed
682	NW NE sec. 19	do	43	24	do	do	T, E	P	do	—4.8		9.88	1- 7-41	Well 9. Reported yield 1,660. Temp. 54° F. Gravel packed
683	NW NW SE sec. 19	Mrs. Emma Clark	27.0	1¼	Sand	do	Cy, H	D	Top of pump base, north side	+2.0	1,303.0	17.74	11- 3-38	Driven well
684	SW SW NE sec. 20	Broadview Hotel	25.8	12	Sand and gravel	do	C, E	A	Top of casing	—11.9		7.94	2-27-41	Estimated yield 250. Temp. 70° F.
685	SW NE sec. 20	First National Bank in Wichita	15.3	12	do	do	C, E	In	do	—14.8		6.35	11-27-40	Estimated yield 110; drawdown 6. Temp. 66° F. Gravel packed
686	do	do	20.2	12	do	do	C, E	A	Top of cement pump base	—13.2		7.58	11-27-40	Estimated yield 50. Temp. 66° F. Gravel packed
687	NE SE NE sec. 20	Kansas Gas and Electric Co.	22.3	16	do	do	C, E	N	Top of 16-inch pipe tee	—3.7		18.37	11-27-40	Temp. 68° F. Disposal well
688	do	do	22.0	40	do	do	C, G	A	Top of casing	—11.0		10.27	11-27-40	Estimated yield 100; drawdown 7. Temp. 64° F. Gravel packed
689	do	do	25.0	16	do	do	C, G	A	Top of steel grate in basement floor	+ .4		13.56	11-27-40	Estimated yield 100; drawdown 4.5. Temp. 64° F. Gravel packed.

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TABLE 37.—*Records of wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Continued*

No. on Pl. 1 (1)	LOCATION	Owner	Depth of well (feet) (2)	Diameter of well (in.)	Principal water-bearing bed		Method of lift (3)	Use of water (4)	Measuring point			Depth to water level below measuring point (feet) (6)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
					Character of material	Geologic subdivision			Description	Distance above (+) or below (—) land surface (feet)	Height above sea level (feet) (5)			
	T. 27 S., R. 1 E. (Continued)													
690	SE SE NE sec. 20	Hotel Lassen	18.5	18	Sand and gravel	Alluvuim	C, E	In	Top of casing	—11.3		14.13	11-14-40	Estimated yield 53; drawdown 3. Temp. 66° F.
691	do	do	21.6	10	do	do	C, E	A	Top of basement floor	—9.0		13.90	11-14-40	Estimated yield 180; drawdown 4. Temp. 68° F.
692	do	Fourth National Bank	22.3	12	do	do	C, E	A	Top of casing	—8.3		13.59	11-14-40	Estimated yield 100; drawdown 4. Temp. 66° F. Gravel packed
693	do	do	25.0	12	do	do	N	N	do				11-14-40	Disposal well
694	NE NE SE sec. 20	George Innes Co	19.1	12	do	do	T, E	A	Top of basement floor	—14.0		7.34	2-27-41	Reported yield 82; drawdown 6. Temp. 68° F.
695	do	do	19.1	12	do	do	T, E	A	do	—14.0		7.30	2-27-41	Reported yield 108; drawdown 8. Temp. 68° F.
696	do	do	19.1	12	do	do	T, E	A	do	—14.0		7.40	2 27-41	Reported yield 120; drawdown 6. Temp. 68° F.
697	do	do	19.2	12	do	do	T, E	A	do	—14.0		7.39	2-27-41	Reported yield 80; drawdown 6. Temp. 68° F.
698	NE SE sec. 20	Beacon Building Corp.	26.0	12	do	do	C, E	In	Top of casing	—9.9		13.37	11-27-40	Eatimated yield 125; drawdown 24. Temp. 64° F.
699	do	Allen W. Hinkel Co.	20.6	12	do	do	C, E	A	Top of basement floor	—7.8		13.31	11-14-40	Estimated yield 100; draw down 12. Temp. 64° F. Gravel packed

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700	do	do	24.5	12	do	do	C, E	A	Top of casing	−7.5		15.28	11-14-40	Estimated yield 200; drawdown 2. Temp. 64° F. Gravel packed
701	do	do	23.0	12	do	do	Cy, S	In	do				11-14-40	Estimated yield 75. Temp. 64° F.
702	do	do	25.5	24	do	do	C, E	A	do	−7.6		14.04	11-14-40	Estimated yield 175; drawdown 2. Temp. 64° F. Gravel packed
703	do	Central Building and Realty Co.	23.4	36	do	do	C, G	In	do	−14.2		9.44	11-27-40	Estimated yield 90; drawdown 5. Temp. 65° F. Gravel packed
704	NE NW SE sec. 20	Southwest Cracker Co	30.2	10	do	do	C, E	A	do	−3.7		17.57	3.11-41	Estimated yield 20; drawdown 2.5. Temp. 68° F.
705	do	do	21.7	8	do	do	N	N	do	−3.5		14.95	3-11-41	Disposal well
706	SW SW NW sec. 21	Buck's Department Store	19.9	24	do	do	C, E	A	do	−8.3		10.91	3-12-41	Estimated yield 150; drawdown 9. Temp. 66° F.
707	do	do	20.5	20	do	do	C, E	A	do	−8.7		10.48	3-12-41	Estimated yield 150; drawdown 9. Temp. 68° F.
708	do	do	13.6	20	do	do	C, E	A	do	−14.2		4.98	3-12-41	Estimated yield 25; drawdown 1. Temp. 66° F. Gravel packed
709	NE SW NW sec. 21	Coleman Stove and Lamp Co.	20.7	45	do	do	C, E	In	Top of basement floor	−8.0		12.16	3-11-41	Estimated yield 500; drawdown 5. Temp. 64° F. Gravel packed. Have 2 other similar wells
710	NW NE SE sec. 21	Southwest Laundry and Cleaning Corp.	23.6	48	do	do	C, E	In	Top of cement floor	+ .7		23.10	3-11-41	Aggregate yield from 4 similar wells 516; draw down 4
711	NE NW SW sec. 21	Eaton Hotel	25.0	12	do	do	C, E	A	Top of basement floor	−3.0		18.30	3-12-41	Estimated yield 150; drawdown 1. Temp. 68° F.
712	SW SW NW sec. 22	City Laundry	24.5	6	do	do	C, E	A	Top of casing	+ .4		15.26	3-12-41	Estimated yield 20; drawdown 2. Temp. 66° F.
713	do	do	21.1	12	do	do	N	N	do	+ .4		17.53	3-12-41	

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TABLE 37.—*Records of wells in Harvey, McPherson, Reno, and Sedgwick Counties, Kansas—Concluded*

No. on Pl. 1 (1)	LOCATION	Owner	Depth of well (feet) (2)	Diameter of well (in.)	Principal water-bearing bed		Method of lift (3)	Use of water (4)	Measuring point			Depth to water level below measuring point (feet) (6)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
					Character of material	Geologic subdivision			Description	Distance above (+) or below (—) land surface (feet)	Height above sea level (feet) (5)			
	T. 27 S., R. 1 E. (Continued)													
714	NE NW SW sec. 22	DeCoursey Creamery Co.	27.6	18	Sand and gravel	Alluvium...	C, E	In	Top of casing.....	+1.0	.....	20.71	3-12-41	Estimated yield 70; drawdown 4. Temp. 58° F. Have a similar well; same yield
	T. 27 S., R. 1 W.													
715	NW cor. sec. 1.....	City of Wichita.....	25.5	1¼	Coarse sand....	do.....	N	N	Top of pipe.....	+ .7	1,321.40	5.48	8-15-38	Temp. 58° F. Driven observation well
716	NW NW sec. 3.....	E. E. Sites.....	18.0	1¼	Sand.....	do.....	N	N	do.....	+1.9	1,327.4	4.30	6-17-44	
717	NE NE sec. 5.....	G. H. Kessler	35.7	6	Gravel.....	McPherson	Cy, E	D	Top of casing.....	—8.0	1,350.0	21.55	10-13-37	Temp. 62° F.
718	SW SW sec. 9.....	H. L. Parker.....	46.0	1¼	Sand and gravel	do.....	Cy, W	D, S	Top of concrete curb.....	+ .5	1,358.0	33.0	7-43	Dug well deepened by drilling
719	SW SW SE sec. 13	W. F. Vany.....	29.5	1½	Sand.....	Alluvium...	Cy, H	D	Top of pump base, west side	+2.0	1,311.84	20.43	11- 3-38	Driven well
720	NE cor. sec. 14.....	W. Weaver.....	31.0	10	Sand and gravel	do.....	Cy, G	Ir	Top of casing, south side	—5.5	1,309.8	7.59	11- 3-38	
721	SE SW SW sec. 20	Mrs. G. Curtis.....	20.6	1¼	do.....	McPherson	Cy, H	D	Valve on pitcher pump	+1.6	1,317.6	10.52	7-23-44	
722	SW SE sec. 22.....	Kuntz Estate.....	23.0	1¼	do.....	Alluvium...	Cy, H	D	do.....	+2.9	1,313.7	10.70	6-17-44	
723	NE SE SW sec. 24	Sedgwick Co. Hospital...	51.8	30	do.....	do	C, E	D, Ir	Top of iron well cover...	.0	.....	12.69	3-10-41	Reported yield 175. Temp. 58° F.

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	T. 27 S., R. 2 W.													
724	NE NE sec. 8	Mathew Schaefer	89.6	6	do	McPherson	Cy, E	D, S	Top of concrete rim over well, east side	+ .1	1,447.5	56.74	6-17-44	Dug well deepened by drilling
725	NW SE SE sec. 14	Joe Jacobs	35.5	1¼	do	do	Cy, W	D, S	Top of steel cover rim in concrete platform	+ .5	1,356.9	28.10	6-17-44	Driven well inside dug well
	T. 27 S., R. 3 W.													
726	NE NW NW sec. 2	J. Seivert	48.7	6	Gravel	do	Cy, W	D, S	Top of platform, south side	+1.0	1,480.9	33.88	10-13-37	Temp. 57° F. Dug well deepened by drilling
727	NE cor. sec. 5	P. Rausch	31.2	30		do	Cy, H	D	Top of well shelter	+3.4	1,511.0	28.07	10-13-37	Temp. 60° F. Dug well

(1) Wells 645-714 in T. 27 S., R. 1 E. (City of Wichita) shown on Plate 5. New Wichita public supply wells shown also on Plate 33. Wells 671-682 of Wichita Water Company shown also on Figure 30.
(2) Measured depths given in feet and tenths of feet, reported depths given in feet.
(3) Pump or lifting device: C, centrifugal; Cy, cylinder; T, turbine; Ws, windlass. Power: E, electric motor; G, gasoline engine; H, hand; N, none; W, wind.
(4) A, air-conditioning; D, domestic; In, industrial; Ir, irrigation; P, public supply; R, railroad; S, stock.
(5) Altitudes given in feet determined by aneroid barometer, altitudes given in feet and in tenths of feet or in tenths and hundredths of feet determined by spirit level or telescopic alidade.
(6) Measured water levels given in feet and in tenths and hundredths of feet, reported water levels given in feet.

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LOGS OF TEST HOLES AND WELLS

The following pages contain logs of 354 test holes and wells drilled in McPherson, Marion, Harvey, Reno, and Sedgwick Counties, including logs of 59 wells and 296 test holes. Samples from 218 test holes and wells were studied in the laboratory, and 136 of the logs are driller's descriptions. The logs include 158 test holes drilled by the State Geological Survey, 91 test holes and wells drilled for the City of Wichita, 19 test holes and wells drilled for the City of Hutchinson, 13 test holes and wells drilled for the City of Lindsborg, and 9 test holes and wells drilled for the City of Newton. The locations of the wells and test holes for which logs are given are described in the headings of the logs and are shown on Plate 7.

1. *Sample log of test hole at the Cen. sec. 7, T 17 S., R. 2 W., McPherson County; drilled by Sandell and Company for the City of Lindsborg, 1946. Surface altitude, 1,434 feet.* (Samples studied by Wilson and Company, engineers.)

	Thickness, feet	*Depth, feet*
CRETACEOUS—Comanchean		
Kiowa shale		
Clay, red	8	8
Clay, yellow	34	42
Clay, sandy	9	51
Clay and sand, fine	9	60
Sand, fine to coarse	12	72
Sand, fine	3	75
PERMIAN—Leonardian		
Wellington formation		
Shale, blue	3	78

2. *Sample log of test hole at the NE cor. sec. 8, T. 17 S., R. 2 W., McPherson County; drilled by Sandell and Company for the City of Lindsborg 1946. Surface altitude, 1,449 feet.* (Samples studied by Wilson and Company, engineers.)

	Thickness, feet	*Depth, feet*
CRETACEOUS—Comanchean		
Kiowa shale		
Clay, sandy, red	8	8
Sandstone, buff	7	15
Clay, blue	2	17
Sandstone, buff	36	53
Sand, fine, rust-colored	8	61
Sand, fine, gray	6	67
Sand, fine to medium, gray, partly cemented	3	70
Sandstone, buff	3	73
PERMIAN—Leonardian		
Wellington formation		
Shale, blue	1	74

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3. *Sample log of test hole at the NW cor. sec. 8, T. 17 S., R. 2 W., McPherson County; drilled by Sandell and Company for the City of Lindsborg, 1946. Surface altitude, 1,375 feet.* (Samples studied by Wilson and Company, engineers.)

	Thickness, feet	Depth, feet
CRETACEOUS—Comanchean		
Kiowa shale		
Sand, fine, buff	8	8
PERMIAN—Leonardian		
Wellington formation		
Shale, hard, blue	7	15

4. *Sample log of test hole at the Cen. sec. 8, T. 17 S., R. 2 W., McPherson County; drilled by Sandell and Company for the City of Lindsborg, 1946. Surface altitude, 1,411 feet.* (Samples studied by Wilson and Company, engineers.)

	Thickness, feet	Depth, feet
CRETACEOUS—Comanchean		
Kiowa shale		
Sand, fine, buff	12	12
Sand, fine, and clay	16	28
Sand, fine; contains streaks of clay	16	44
Sand, fine, buff	8	52
PERMIAN—Leonardian		
Wellington formation		
Shale, blue	1	53

5. *Sample log of test hole at the SW cor. sec. 10, T. 17 S., R. 2 W. McPherson County; drilled by Sandell and Company for the City of Lindsborg, 1946. Surface altitude, 1,449 feet.* (Samples studied by Wilson and Company, engineers.)

	Thickness, feet	Depth, feet
CRETACEOUS—Comanchean		
Kiowa shale		
Clay, sandy	5	5
Clay, brown	24	29
Sand, brown	9	38
Sand, fine, buff	28	66
Sand, fine to medium, gray	3	69
PERMIAN—Leonardian		
Wellington formation		
Shale, blue	1	70

6. *Sample log of test hole at Cen. sec. 16, T. 17 S., R. 2 W. McPherson County; drilled by Sandell and Company for the City of Lindsborg, 1946. Surface altitude, 1,471 feet.* (Samples studied by Wilson and Company, engineers.)

	Thickness, feet	Depth, feet
CRETACEOUS—Comanchean		
Kiowa shale		
Clay, sandy, red	3	3
Sand, fine to medium, buff	7	10
Sand, fine to coarse	4	14
Sand, containing clay, buff	31	45
Sand, fine, buff	6	51
Sand, fine, buff, and water	31	82

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PERMIAN—Leonardian Wellington formation	*Thickness, feet*	*Depth, feet*
Shale, blue	1	83

7. *Sample log of test hole in the NE cor. sec. 17, T. 17 S., R. 2 W. McPherson County; drilled by Sandell and Company for City of Lindsborg, 1946. Surface altitude, 1,431 feet.* (Samples studied by Wilson and Company, engineers.)

CRETACEOUS—Comanchean Kiowa shale	*Thickness, feet*	*Depth, feet*
Clay, sandy, red	5	5
Sand, very fine, and some buff clay	20	25
Sand, very fine, buff	6	31
Sand, fine to medium, partly cemented	20	51
Sand, fine, dark gray	3	54
Sand, fine to medium, dark gray, contains some clay and silt; water very dirty	6	60
PERMIAN—Leonardian Wellington formation		
Shale, blue	1	61

8. *Sample log of test hole at the NW cor. sec. 17, T. 17 S., R. 2 W., McPherson County; drilled by Sandell and Company for the City of Lindsborg, 1946. Surface altitude, 1,449 feet.* (Samples studied by Wilson and Company, engineers.)

	Thickness, feet	*Depth, feet*
Soil	2	2
CRETACEOUS—Comanchean Kiowa shale		
Sandstone, buff	29	31
Clay, sandy, gray	4	35
Clay, blue	22	57
Clay, sandy, blue	4	61
Sand, very fine, buff	2	63
Sand, fine, buff	13	76
Sand, gray; contains nodules of pyrite	1	77
Sand, fine, gray	18	95
PERMIAN—Leonardian Wellington formation		
Shale, blue	1	96

9. *Sample log of test hole at the Cen. sec. 17, T. 17 S., R. 2 W., McPherson County; drilled by Sandell and Company for the City of Lindsborg, 1946. Surface altitude, 1,437.* (Samples studied by Wilson and Company, engineers.)

CRETACEOUS—Comanchean Kiowa shale	*Thickness, feet*	*Depth, feet*
Clay, sandy, red	3	3
Sand, fine, buff	22	25
Sand, fine, and clay	17	42
Sand, fine, buff	13	55

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PERMIAN—Leonardian	Thickness, feet	Depth, feet
Wellington formation		
Shale	1	56

10. *Sample log of test hole at the NW cor. SW¼ sec. 17, T. 17 S., R. 2 W., McPherson County; drilled by Sandell and Company for the City of Lindsborg, 1946. Surface altitude, 1,397 feet.* (Samples studied by Wilson and Company, engineers.)

CRETACEOUS—Comanchean	Thickness, feet	Depth, feet
Kiowa shale		
Clay, brown	15	15
Clay, sandy, light brown	9	24
Clay, black	12	36
PERMIAN—Leonardian		
Wellington formation		
Shale, blue	1	37

11. *Sample log of test hole at the Cen. SW¼ sec. 17, T. 17 S., R. 2 W., McPherson County; drilled by Sandell and Company for the City of Lindsborg, 1946. Surface altitude, 1,419 feet.* (Samples studied by Wilson and Company, engineers.)

CRETACEOUS—Comanchean	Thickness, feet	Depth, feet
Kiowa shale		
Sand, fine, buff, and clay	26	26
Sand, fine, buff	29	55
PERMIAN—Leonardian		
Wellington formation		
Shale, blue	1	56

12. *Sample log of test hole at the SW cor. sec. 17, T. 17 S., R. 2 W., McPherson County; drilled by Sandell and Company for the City of Lindsborg, 1946. Surface altitude, 1,447 feet.* (Samples studied by Wilson and Company, engineers.)

CRETACEOUS—Comanchean	Thickness, feet	Depth, feet
Kiowa shale		
Clay, reddish	5	5
Sandstone, buff	13	18
Sand, clayey, buff	4	22
Sandstone, buff	11	33
Clay, blue	8	41
Sand, very fine	5	46
Sand, fine	5	51
Sand, fine, buff	14	65
Sand, fine to medium, buff; contains some rounded sandstone boulders of varying size	1	66
PERMIAN—Leonardian		
Wellington formation		
Shale, blue	1	67

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13. *Sample log of test hole at the SE cor. sec. 17, T. 17 S., R. 2 W., McPherson County; drilled by Sandell and Company for the City of Lindsborg, 1946. Surface altitude, 1,485 feet.* (Samples studied by Wilson and Company, engineers.)

	Thickness, feet	Depth, feet
CRETACEOUS—Comanchean		
Kiowa shale		
Clay, sandy, red	3	3
Sand, fine to medium, buff; contains some clay	28	31
Sand, fine, buff	3	34
Sand, fine, gray	6	40
Clay, sandy, gray	16	56
Clay, sandy, buff	9	65
Sand, fine, buff	5	70
Sand, fine to medium	2	72
Sand, fine, buff, mixed with fine gravel and particles of friable sandstone; contains some calcareous nodules of partly cemented white sand	11	83
Sandstone, hard, reddish buff	10	93
PERMIAN—Leonardian		
Wellington formation		
Shale, blue	1	94

14. *Driller's log of well 4 in the SE¼ NE¼ sec. 17, T. 17 S., R. 3 W., McPherson County; drilled by Dunlap and Company for the City of Lindsborg, 1936.*

	Thickness, feet	Depth, feet
QUATERNARY—Recent		
Alluvium		
Silt	33	33
Clay, sandy, black	10	43
Sand, medium to coarse	4	47
Sand and gravel	26	73
PERMIAN—Leonardian		
Ninnescah shale		
Shale	1	74

15. *Driller's log of well 5 in the SE¼ sec. 17, T. 17 S., R. 3 W., McPherson County; drilled by Kelly Well Company for the City of Lindsborg, 1923.*

	Thickness, feet	Depth, feet
QUATERNARY—Recent		
Alluvium		
Silt	24	24
Clay	10	34
Sand, fine	5	39
Sand and clay	4	43
Sand, black	6	49
Sand	2	51
Sand, clean	14	65
Silt and clay, black	5	70
Gravel and sand	5	75
Gravel	17	92

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PERMIAN—Leonardian Ninnescah shale	Thickness, feet	Depth, feet
Shale	1	93

16. *Sample log of test hole at the NE cor. SE¼ SE¼ sec. 22, T. 17 S., R. 4 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,365.2 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Recent Alluvium	Thickness, feet	Depth, feet
Silt and clay, brown	6	6
Silt and clay, light gray to buff	28	34
Clay, soft, gray green; contains limestone and shale fragments	4	38
PERMIAN—Leonardian Ninnescah shale		
Shale, purple, red, and gray green	2	40

17. *Sample log of test hole at the SE cor. sec. 22, T. 17 S., R. 4 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,364.4 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Recent Alluvium	Thickness, feet	Depth, feet
Silt and clay, brown	4	4
Silt and clay, dark gray to tan	30	34
Silt, soft, sandy, gray green	9	43
Silt and clay, gray	11	54
Sand, coarse to fine, and gravel, fine	6	60
Gravel, coarse to fine, and sand	10	70
Gravel, medium to fine	9	79
PERMIAN—Leonardian Wellington formation		
Shale, hard, laminated, blue gray	1	80

18. *Sample log of test hole in the NE cor. SE¼ NE¼ sec. 27, T. 17 S., R. 4 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,356.2 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Recent Alluvium	Thickness, feet	Depth, feet
Silt, light brown, and sand, fine to medium	5	5
Silt and clay, buff to tan	29	34
Silt and clay, blue gray	6	40
Sand, medium to fine; contains dark-gray silt	10	50
Gravel, medium to fine, and coarse to medium sand	10	60
Gravel, medium to fine, and coarse sand	12	72
PERMIAN—Leonardian Wellington formation		
Shale, hard, brittle, gray	2	74

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19. *Sample log of test hole in the NE cor. SE¼ SE¼ sec. 27, T. 17 S., R. 4 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,358.5 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	*Depth, feet*
QUATERNARY—Recent		
Alluvium		
Soil	3	3
Silt, soft, gray, and medium to fine sand	3	6
Silt and clay, light gray to tan	14	20
Silt, soft, buff, and fine to coarse sand	7	27
Sand, coarse to fine, and fine gravel	13	40
Silt, soft, blue gray	6	46
Gravel, fine, and coarse sand	4	50
Gravel, coarse to fine	13	63
PERMIAN—Leonardian		
Wellington formation		
Shale, gray	7	70

20. *Sample log of test hole in the NE cor. SE¼ NE¼ sec. 34, T. 17 S., R. 4 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,353.5 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	*Depth, feet*
QUATERNARY—Recent		
Alluvium		
Silt and clay, brown	13	13
Silt, soft, buff, and fine to medium sand	12	25
Sand, coarse to fine, and fine gravel	15	40
Gravel, coarse to fine, and coarse sand	10	50
Silt, soft, blue gray; contains fine to medium sand	10	60
Gravel, medium to fine, and coarse sand	12	72
PERMIAN—Leonardian		
Wellington formation		
Shale, gray and maroon	6	78

21. *Sample log of test hole in the SE cor. NE¼ SE¼ sec. 34, T. 17 S., R. 4 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,360.8 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	*Depth, feet*
QUATERNARY—Recent		
Alluvium		
Silt, dark gray to brown	7	7
Silt, soft, brown; contains fine to medium sand	11	18
Sand, coarse to fine, and fine to medium gravel	12	30
Gravel, medium to fine, and coarse sand	5	35
Silt and clay, blue gray	5	40
Gravel, fine to medium, and coarse sand	4	44
PERMIAN—Leonardian		
Wellington formation		
Shale, gray and maroon	2	46

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22. *Driller's log of well 22 in the SE¼ NE¼ sec. 23, T. 17 S., R. 5 W., McPherson County; drilled by Layne-Western Company for the Missouri Pacific Railway Company, 1937.*

	Thickness, feet	Depth, feet
QUATERNARY—Recent		
Alluvium		
Soil	3	3
Clay and silt	9	12
Clay and silt, sandy	10	22
Sand, fine to medium	3	25
Sand, coarse	5	30
Sand and gravel	9	39
Gravel, fine to coarse	5	44
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red	1	45

23. *Sample log of test hole in the SE cor. SW¼ sec. 9, T. 18 S., R 2 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,441.8 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Recent		
Alluvium		
Sand, very fine to fine, and dark-gray to brown silt	6	6
Silt and clay, light gray, and very fine to medium sand; contains many fragments of shale, sandstone, and caliche	10	16
Silt, gray, and some sand, very fine to coarse; contains fragments of shale, sandstone, and caliche	9	25
PERMIAN—Leonardian		
Wellington formation		
Shale, dark gray	5	30

24. *Sample log of test hole at the NE cor. NW¼ sec. 15, T. 18 S., R. 2 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,473.3 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
TERTIARY—Pliocene		
Delmore formation		
Silt, brown, calcareous light-gray clay, and some very fine to medium sand	3	3
Silt and clay, calcareous, light gray, and very fine sand	17	20
CRETACEOUS—Comanchean		
Kiowa shale		
Clay and shale, blue gray, yellow, brown	20	40
Clay, laminated, blue gray to yellow; contains streaks of red colored clay and thin layers of very fine to fine sand	6	46
Clay, gray to yellow; contains streaks of carbonaceous material	2	48
Clay, yellow to gray, sandy	4	52

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PERMIAN—Leonardian Wellington formation	*Thickness, feet*	*Depth, feet*
Shale, calcareous, dark to light gray.....	8	60

25. *Sample log of test hole at the NE cor. sec. 17, T. 18 S., R. 2 W., McPherson County; drilled by Federal Geological Surveys, 1943. Surface altitude, 1,489.6.* (Samples studied by O. S. Fent and Charles C. Williams.)

TERTIARY—Pliocene Delmore formation	*Thickness, feet*	*Depth, feet*
Silt and clay, calcareous, tan, and very fine to fine sand; contains few nodules of caliche.....	16	16
Silt, calcareous, tan to buff, and very fine to medium sand; contains fragments of ironstone and nodules of calcium carbonate	4	20
Silt and clay, calcareous, tan to dark gray, and very fine to medium sand; contains fragments of ironstone and sandstone and small nodules of calcium carbonate....	8	28
CRETACEOUS—Comanchean Kiowa shale		
Shale, sandy, light blue, tan, and brown, and fine to medium-grained, light-brown sandstone.....	7	35

26. *Sample log of test hole 0.1 mile east of NW cor. sec. 17, T. 18 S., R. 2 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,464.9 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

TERTIARY—Pliocene Delmore formation	*Thickness, feet*	*Depth, feet*
Sand, very fine to medium, and dark-gray silt.....	8	8
Sand, very fine to medium, and gray to buff silt; contains fragments of sandstone and caliche.....	1	9
Sand, very fine to fine, and light-gray silt.....	9	18
Sand, very fine to medium, and light-gray to tan silt....	22	40
Sand, very fine to medium, and tan silt; contains nodules of calcium carbonate and fragments of ironstone.....	10	50
CRETACEOUS—Comanchean Kiowa shale		
Clay, light gray, and very fine-grained, soft sandstone...	10	60

27. *Sample log of test hole at the NW cor. sec. 18, T. 18 S., R. 2 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,490.0 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

TERTIARY—Pliocene Delmore formation	*Thickness, feet*	*Depth, feet*
Sand, very fine to medium, and buff to brown silt.....	10	10
Sand, medium to fine, and some buff silt.....	3	13
Silt, gray to tan, and very fine to medium sand.....	7	20
Silt and clay, calcareous, tan to gray, and medium to fine sand; contains fragments of ironstone and nodules of calcium carbonate.....	18	38

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	Thickness, feet	Depth, feet
Silt, light gray to brown and very fine to medium sand; contains nodules of calcium carbonate	6	44
Gravel, coarse to medium, composed of fragments of ironstone and sandstone, coarse to very fine sand, and some tan silt	9	53
Silt, tan, and very fine to coarse sand	7	60
Silt and clay, light gray to buff and very fine to medium sand	17	77
Sand, very fine to medium, and gray to yellow silt	10	87
Silt and clay, gray to tan, fine to coarse sand, and some medium to fine gravel, composed of fragments of ironstone	2	89
PERMIAN—Leonardian		
Wellington formation		
Shale, calcareous, gray and maroon	11	100

28. *Sample log of test hole in the NW cor. sec. 5, T. 18 S., R. 3 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,359.4 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Clay and silt, brown to tan	17	17
Silt, buff; contains some sand and gravel	5	22
Silt and clay, gray, and coarse to medium gravel	6	28
PERMIAN—Leonardian		
Wellington formation		
Shale, gray	2	30

29. *Sample log of test hole at the NE cor. NW¼ sec. 6, T. 18 S., R. 3 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,343.4 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt and clay, brown to gray	6	6
Silt, calcareous, buff to tan, fine to coarse sand, and medium to fine gravel, derived from Cretaceous sandstone	4.5	18.5
Silt and clay, light gray; contains some fine to medium,	6.5	25
Silt, buff, fine to coarse sand, and some medium to fine gravel composed of ironstone, shale, and caliche fragments	2	27
Silt, buff; contains nodules of calcium carbonate	21	27
Clay, gray green	5	32
Gravel, medium to fine, and coarse sand	11	43
PERMIAN—Leonardian		
Wellington formation		
Shale, blue gray and maroon	4	47

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30. *Sample log of test hole at the SW cor. sec. 8, T. 18 S., R. 3 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,446.4 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt and clay, dark brown to gray	6	6
Silt and clay, buff, and some fine to medium sand, contains nodules of calcium carbonate	8	14
PERMIAN—Leonardian		
Ninnescah shale		
Shale, thin-bedded, red and green gray	7	34

31. *Sample log of test hole at the SW cor. sec. 12, T. 18 S., R. 3 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,463.0 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil	2	2
Silt, buff, calcareous, and very fine to medium sand; contains streaks of limonite and nodules of calcium carbonate	26	28
TERTIARY—Pliocene		
Delmore formation		
Silt, green gray to tan, and fine to medium sand contains small nodules of calcium carbonate and few fragments of ironstone	12	40
Silt, tan, and very fine to medium sand	10	50
Silt, red brown, and medium to fine sand	4	54
Sand, medium to coarse, and same coarse to fine gravel composed of ironstone fragments	3	57
Silt, red brown, and medium to fine sand	3	60
Sand, medium to fine, and some tan silt	4	64
CRETACEOUS—Comanchean		
Kiowa shale		
Clay, gray green, gray, and brown, and very fine sand	6	70
Shale, sandy, gray green, gray clay, and some very fine sand, driller reports pyrite	13	83
PERMIAN—Leonardian		
Wellington formation		
Shale, silty, maroon and dark gray	7	90

32. *Sample log of test hole at the NE cor. NW¼ sec. 13, T. 18 S., R. 3 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,479.3 feet.* (Samples studied by O. S. Fent and Charles C Williams.)

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	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt, dark gray, and fine to medium sand	10	10
Silt, calcareous, gray to buff, and very fine to medium sand, contains nodules of calcium carbonate	13	23
TERTIARY—Pliocene		
Delmore formation		
Sand, fine to medium, and green-gray to tan silt	7	30
Sand, medium to very fine, and light-gray silt, silt and sand cemented in streaks by calcium carbonate	7	37
Sand, medium to fine, and tan silt	13	50
Sand, medium to fine, and some gray to tan clay	10	60
CRETACEOUS—Comanchean		
Kiowa shale		
Clay, limonitic, blue gray, and some very fine to fine sand, driller reports soft sandstone	10	70
Sandstone, medium to fine-grained, red brown, and some blue-gray clay	20	90
Shale, light to dark gray; contains very fine to fine sand	10	100

33. *Sample log of test hole at the NE cor. sec. 15, T. 18 S., R. 3 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,528.7 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt and clay, brown to tan, and some very fine to fine sand	6	6
Silt, buff to tan, and very fine sand	14	20
Silt and clay, buff; contains nodules of calcium carbonate	15	35
Volcanic ash, weathered	2	37
Silt and clay, calcareous, tan	23	60
Silt, calcareous, gray to brown; contains nodules of calcium carbonate	33	93
TERTIARY—Pliocene		
Delmore formation		
Silt, gray to tan, and fine to medium sand, contains fragments of shale, ironstone, and caliche	7	100
Silt, buff to yellow, and very fine to fine sand; contains fragments of shale and ironstone	8.5	108.5
CRETACEOUS—Comanchean		
Kiowa shale		
Sandstone, fine-grained, calcareous, white, and some green-gray clay	5	113.5

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34. *Sample log of test hole at the NW cor. sec. 15, T. 18 S., R. 3 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,447.8 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil	2	2
Silt, light gray, and very fine sand	6	8
Silt and clay, light gray to tan, and very fine to fine sand	22	30
Silt and clay, tan, and some very fine to medium sand; contains nodules of calcium carbonate and some ironstone fragments	7	37
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red and gray green	3	40

35. *Sample log of test hole at the NE cor. sec. 17, T. 18 S., R. 3 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,461.6 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt, buff; contains nodules of calcium carbonate	10	10
Silt, calcareous, buff	10	20
Silt and clay, light buff to gray, and some very fine to medium sand	5	25
Silt and clay, gray to buff; contains nodules of calcium carbonate	15	40
Silt and clay, tan, and some very fine to medium sand	20	60
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red and gray green	5	65

36. *Sample log at the NE cor. NW¼ sec. 18, T. 18 S., R. 3 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,454.7 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt, gray to brown, and some very fine to medium sand,	6	6
Silt and clay, tan to light gray; contains streaks of limonite and nodules of calcium carbonate	24	30
Silt, buff, and fine to medium sand; contains nodules of calcium carbonate	10	40
Silt and clay, buff, and some fine to medium sand; contains nodules of calcium carbonate	10	50
Silt, tan, fine to coarse sand, and some ironstone gravel	14	64
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red and gray	6	70

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37. *Driller's log of test hole at the SW cor. SE¼ sec. 20, T. 18 S., R. 3 W., McPherson County; drilled by Layne-Western Company for Kansas Pipeline Company, 1937. Surface altitude, 1,479 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Clay, black	8	8
Clay, gray	7	15
Clay, yellow	45	60
Clay, gray	14	74
Sand, medium	1	75
Clay	3	78
Sand, medium	2	80
Clay, red	13	93
PERMIAN—Leonardian		
Wellington formation		
Clay, with streaks of rock on rock	4	97

38. *Driller's log of test hole at the SW cor. SE¼ sec. 28, T. 18 S., R. 3 W., McPherson County; drilled by Layne-Western Company for Kansas pipeline Company, 1937. Surface altitude, 1,515 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil	2	2
Clay	81	83
Clay, sandy	10	93
PERMIAN—Leonardian		
Wellington formation		
Shale, blue	5	98

39. *Driller's log of test hole at the SW cor. sec. 31, T. 18 S., R. 3 W., McPherson County; drilled by Layne-Western Company for Kansas Pipeline Company, 1937. Surface altitude, 1,507 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil	2	2
Silt, black	6	8
Clay, yellow	12	20
Clay, gray	13	33
Clay, yellow	88	121
Sand, medium	12	133
Sand, coarse, and fine gravel	14	147
Clay, yellow, on rock	5	152

40. *Driller's log of test hole at the SW cor. SE¼ sec. 32, T. 18 S., R. 3 W., McPherson County; drilled by Layne-Western Company for Kansas Pipeline Company, 1937. Surface altitude, 1,514 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil	2	2
Clay, black	6	8
Clay, yellow	95	103

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	Thickness, feet	*Depth, feet*
Clay, gray	27	130
Sand, medium	8	138
Sand, medium to coarse	2	140
Clay, sandy, gray	12	152
PERMIAN—Leonardian		
Wellington formation		
Shale	3	155

41. *Sample log of test hole in the NE cor. sec. 1, T. 18 S., R. 4 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,333.3 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Silt and clay, brown	7	7
Silt and clay, gray to tan	2	9
Silt, tan; contains fine to coarse sand	5	14
Silt, buff; contains nodules of calcium carbonate	6	20
Gravel, medium to fine, and coarse to medium sand	9	29
PERMIAN—Leonardian		
Wellington formation		
Shale, gray	1	30

42. *Sample log of test hole in the NW cor. NE¼ sec. 1, T. 18 S., R. 4 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,317.2 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Silt, soft, tan; contains fine sand	1	1
Silt and clay, dark gray	2	3
Silt, buff, and fine to coarse sand	7	10
Silt, buff and fine sand	10	20
Silt and clay, gray; contains nodules of calcium carbonate	6	26
Gravel, fine, and coarse to medium sand	4	30
Gravel, fine to coarse, and coarse to medium sand	16	46
PERMIAN—Leonardian		
Wellington formation		
Shale, gray	4	50

43. *Sample log of test hole at the SW cor. sec. 7, T. 18 S., R. 4 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,530.6 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Soil, light brown	3	3
Silt, buff, and very fine sand; contains some limonite and calcium carbonate	17	20

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	Thickness, feet	Depth, feet
Silt and clay, buff to gray	14	34
Gravel, fine, and coarse to medium sand	28	62
Silt, light gray to yellow, and very fine sand	1	63
Gravel, medium to fine, and coarse to fine sand	16	79
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red and green	4	83

44. *Sample log of test hole in the SE cor. sec. 8, T. 18 S., R. 4 W., McPherson County; drilled by State Survey, 1943. Surface altitude, 1,390.0 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, sandy, gray	3	3
Silt, buff; contains medium to fine gravel and coarse to fine sand	3	6
Gravel, fine to coarse, and coarse to medium sand	11	17
PERMIAN—Leonardian		
Ninnescah shale		
Shale, gray green	1	18

45. *Sample log of test hole in the SE¼ SW¼ sec. 10, T. 18 S., R. 4 W., McPherson County; drilled by State Geological Survey, 1943. Surface elevation, 1,484.5 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt, light brown, and fine to very fine sand	3	3
Silt, light gray to buff; contains many nodules and grains of calcium carbonate	17	20
Sand, fine to medium, and light-gray silt; partly cemented by calcium carbonate	15	35
Silt, buff, and light gray; contains volcanic ash	5	40
Silt, light gray; contains limonite	20	60

46. *Sample log of test hole at the SW¼ SE¼ sec. 10, T. 18 S., R. 4 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,465.6 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil; silt, brown	2	2
Silt, buff to gray, calcareous, and some fine to medium sand	65	67
Sand, coarse to medium, and fine to medium gravel; partly cemented by calcium carbonate; contains fragments of red and green shale	13	80
Sand, coarse to medium, and some fine gravel, interbedded with buff silt and clay	20	100

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	Thickness, feet	Depth, feet
Sand, coarse to medium, and fine to medium gravel; contains many fragments of red shale	12	112
Silt, buff to gray; contains shell fragments	18	130
Silt, buff to gray, and some fine to coarse sand	38	168
Sand, coarse to medium, and fine to medium gravel	18	186
Silt, light gray, and fine to coarse sand	1	187
Gravel, fine to coarse, and coarse to medium sand; contains many fragments of shale	9	196
PERMIAN—Leonardian		
Wellington formation		
Shale, calcareous, gypsiferous, light gray	14	210

47. *Sample log of test hole at the SW cor. sec. 11, T. 18 S., R. 4 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,450.5 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt, buff to gray, and very fine sand, contains disseminated volcanic ash and nodules of calcium carbonate	14	14
Silt and clay buff, tan, and gray; contains streaks of limonite	13	27
Silt, buff, and sand, very fine to medium	3	30
Silt and clay, light gray to buff; contains limonite	20	50
Silt, buff; contains nodules of calcium carbonate	30	80
Silt, buff, and very fine sand	16	96
Gravel, fine to medium, and coarse sand; contains nodules of calcium carbonate	4	100
Silt, light gray, and buff clay, contains some very fine to medium sand	4	104
Gravel, fine to coarse, and coarse to fine sand; contains fragments of shale, ironstone, and sandstone	22	126
Silt, light gray, and fine to coarse sand	6.5	132.5
Gravel, fine to medium, and coarse to fine sand; contains many shale fragments	4.5	137
PERMIAN—Leonardian		
Wellington formation		
Shale, light gray and maroon	3	140

48. *Sample log of test hole at the SW cor. SE¼ SW¼ sec. 12, T. 18 S., R. 4 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,407.3 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt, brown to gray, and very fine to medium sands	6	6
Silt, buff, and fine to coarse sand, contains nodules of calcium carbonate	14	20

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	Thickness, feet	Depth, feet
Sand, fine to coarse, and some fine gravel	8	28
Silt, buff to gray, and very fine to coarse sand	2	30
Sand, medium to coarse, and fine to medium gravel, contains some buff silt in upper part of interval	20	50
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red	3	53

49. *Sample log of test hole at the NE cor. sec. 13, T. 18 S., R. 4 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,407.7 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt, gray, contains some fine to coarse sand	7	7
Silt and clay, light gray and buff; contains some fine to medium sand and nodules of calcium carbonate	3	10
Sand, medium to coarse, and some fine to medium gravel; contains fragments of shale	10	20
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red and light green	4	24

50. *Sample log of test hole at the NW cor. sec. 13, T. 18 S., R. 4 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,441.7 feet. Hole abandoned at 24 feet owing to loss of circulation.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt, light brown, and very fine sand	4	4
Silt, buff, porous, and very fine to medium sand; contains nodules of calcium carbonate	20	24

51. *Sample log of test hole in the NW¼ NE¼ sec. 14, T. 18 S., R. 4 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,403.6 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt, gray to buff	13	13
Silt, gray; contains some fine to very fine sand	11	24
Silt and clay, dark gray and blue gray	16	40
Silt, carbonaceous, light gray to brown; contains some very fine to medium sand	6	46
Sand, coarse to medium, and fine to medium gravel	4	50
Silt gray, interbedded with fine to medium gravel and coarse to fine sand; gravel cemented by calcium carbonate at base	12	62
Sand, coarse to medium, and fine to medium gravel	8	70
Gravel, fine to medium; contains fragments of shale	7	77

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PERMIAN—Leonardian Wellington formation	*Thickness, feet*	*Depth, feet*
Shale, silty, blue gray; contains thin beds of limestone..	6	83

52. *Sample log of test hole in the NE¼ NW¼ sec. 14, T. 18 S., R. 4 W., McPherson County; drilled by State Geological Survey, 1943. Hole abandoned at 20 feet because of circulation loss in porous silt.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Soil	2	2
Silt, tan to gray; contains nodules of calcium carbonate,	8	10
Silt, buff; contains some fine sand	10	20

53. *Sample log of test hole at the NW cor. sec. 15, T. 18 S., R. 4 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,453.5 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Soil, sandy, light brown	3	3
Silt, light gray; contains very fine sand and tubules of calcium carbonate	7	10
Sand, medium to fine, and gray silt; partly cemented by calcium carbonate	5	15
Silt and clay, light gray to buff, and some fine sand; cemented in streaks by calcium carbonate	82	97
Gravel, fine, and coarse to fine sand; partly cemented by calcium carbonate	4	101
Silt, light gray, and fine to very fine sand	2	103
Gravel, medium to fine, and coarse to medium sand	7	110
Silt, light gray, and very fine to coarse sand	3	113
Gravel, medium to fine, and course to fine sand; partly cemented by calcium carbonate	22	135
PERMIAN—Leonardian Wellington formation		
Shale, maroon and gray	5	140

54. *Sample of test hole at the NE corner sec. 18, T. 18 S., R. 4 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,477.8 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Silt, brown to light gray, and fine sand	16	16
Gravel, fine to medium, sand coarse to fine sand	10	26
Silt, yellow to gray; contains some medium sand	6	32
Gravel, medium to fine, and coarse to fine sand	5	37
PERMIAN—Leonardian Ninnescah shale		
Shale, brick red and light green	3	40

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55. *Sample log of test hole at the NE cor. NW¼ sec. 18, T. 18 S., R. 4 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,517.6 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, brown	2	2
Silt, calcareous, light gray; contains nodules of calcium carbonate in upper part	15	17
Sand, coarse to medium, and fine to medium gravel	33	50
Gravel, fine to coarse, and coarse to medium sand	11	61
PERMIAN—Leonardian		
Ninnescah shale		
Shale, brick red	2	63

56. *Sample log of test hole at the NW cor. sec. 13, T. 18 S., R. 5 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,424.9 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Recent		
Alluvium		
Silt, dark gray	2	2
Silt, buff; contains some clay and nodules of calcium carbonate	11	13
Silt, buff, and medium to fine sand	5	18
Silt and clay, dark gray	20	38
Gravel, coarse to fine, and some coarse sand	2.5	40.5
PERMIAN—Leonardian		
Ninnescah shale		
Shale, maroon and light gray	2.5	43

57. *Sample log of test hole 0.1 mile east of NW cor. sec. 14, T. 18 S., R. 5 W., McPherson County; drilled by State Geological Survey, 1943. Surface altitude, 1,477.6 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Recent		
Alluvium		
Silt, brown	5	5
Silt and clay, red and tan	2	7
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red and green	3	10

58. *Sample log of test hole at the SW cor. sec. 9, T. 19 S., R. 1 W., McPherson County; drilled by State Geological Survey, 1945. Surface altitude, 1,579.6 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY AND TERTIARY—Pliocene and Pleistocene		
McPherson and Delmore formations		
Soil	3	3
Silt, brown to buff	5	8

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	Thickness, feet	*Depth, feet*
Silt, gray to buff; contains coarse sand, fine gravel, and pebbles of caliche	16	24
Sand, coarse to fine, and gray silt	21	45
Sand, medium to fine, and buff silt	15	60
Sand, coarse to fine, and fine to medium gravel	4	64
Silt, buff, and very fine to fine sand; contains nodules of calcium carbonate	4	68
Sand, coarse to fine, and fine gravel; contains fragments of shale	11	79
CRETACEOUS—Comanchean		
Kiowa shale		
Shale, dark gray; contains streaks of limonite	11	90
Shale, dark to light gray; contains pyrite; many thin beds of sandstone in interval	13	103
Shale, gray; contains pyrite	7	110
Shale, gray; contains fragments of charcoal and pyritized wood. Interval includes a thin layer of limestone	5	115
Clay, pink; contains very fine sand	3	118
Shale, sandy, and sandstone; partly cemented; contains fragments of charcoal and pyritized wood	10	128
PERMIAN—Leonardian		
Wellington formation		
Shale, gray, light green, and purple	12	140

59. *Sample log of test hole at the NE cor. sec. 14, T. 19 S., R. 1 W., McPherson County, drilled by State Geological Survey, 1939. Surface altitude, 1,534.7 feet.* (Samples studied by Charles C. Williams.)

	Thickness, feet	*Depth, feet*
CRETACEOUS—Comanchean		
Kiowa shale		
Soil, sandy, brown	6	6
Clay, sandy, limonitic	9	15
Sandstone, very fine to fine-grained, micaceous, calcareous	13	28
Shale, sandy, gray	6	34
Sandstone, fine grained, partly cemented	10	44
Shale, sandy, micaceous	6	50
Sandstone, partly cemented, and loose sand	4	54
Shale, gray to yellowish gray; contains thin beds of sandstone	6	60
Clay, gray and tan	15	75
PERMIAN—Leonardian		
Wellington formation		
Shale, dark gray	5	80

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60. *Sample log of test hole at the NW cor. sec. 14, T. 19 S., R. 1 W., McPherson County; drilled by State Geological Survey, 1945. Surface altitude, 1,550.5 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY AND TERTIARY—Pliocene and Pleistocene McPherson and Delmore formations	*Thickness, feet*	*Depth, feet*
Soil, brown	2	2
Silt, brown and coarse to fine sand	4	6
Silt, gray, contains very fine to coarse sand	5	11
Sand, coarse to fine, and some fine to medium gravel	4	15
Silt, light buff; contains coarse to fine sand	2	17
CRETACEOUS—Comanchean		
Kiowa shale		
Shale, light blue gray and yellow	13	30
Shale and clay, gray and maroon	6	36
Shale, dark gray, and thin beds of sandstone	4	40
Shale, yellow gray	2	42
Shale, dark gray, and thin beds of limestone	8	50
Clay, sandy, and very fine sand	5	55
Shale, gray, contains carbonaceous material and pyrite	4	59
Shale, gray, sandy	13	72
PERMIAN—Leonardian		
Wellington formation		
Shale, calcareous, gray and maroon	5	77

61. *Sample log of test hole at the NW cor. sec. 15, T. 19 S., R. 1 W., McPherson County; drilled by State Geological Survey, 1945. Surface altitude, 1,564.9 feet.* (Samples studied by O. S. Fent and Charles C. Wiliams.)

QUATERNARY AND TERTIARY—Pliocene and Pleistocene McPherson and Delmore formations	*Thickness, feet*	*Depth, feet*
Soil, sandy	3	3
Sand, medium to fine	10	13
Silt, tan to buff; contains very fine to medium sand	9	22
Sand, coarse to fine; contains limonite and some gray silt	25	47
CRETACEOUS—Comanchean		
Kiowa shale		
Shale, gray and yellowish gray	9	56
Shale, blue gray	11	67
Shale, dark gray, and thin beds of fine-grained sandstone	7	74
Shale, light gray	3	77
Shale, sandy, gray	15	92
Sand, partly cemented, and sandy shale	11	103
PERMIAN—Leonardian		
Wellington formation		
Shale, gray, maroon, and purple	7	110

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62. *Driller's log of test hole at the SW cor. sec. 16, T. 19 S., R. 1 W., McPherson County; drilled by Wichita Pump and Supply Company for the City of Canton, 1938,*

	Thickness, feet	Depth feet
QUATERNARY AND TERTIARY—Pliocene and Pleistocene		
McPherson and Delmore formations		
Clay, red	15	15
Clay, sandy, gray	12	27
Clay, brown	3	30
Clay, gray	2	32
Clay, sandy, gray	3	35
Clay, gray, contains lime nodules	3	38
CRETACEOUS—Comanchean		
Kiowa shale		
Sand, fine	20	58
Clay	1	59
Sand, fine	4	63
Clay, sandy, soft	16	79
Clay and shale, blue	6	85
PERMIAN—Leonardian		
Wellington formation		
Shale, dark	27	112

63. *Sample log of test hole at the NW cor. sec. 17, T. 19 S., R. 1 W., McPherson County; drilled by State Geological Survey, 1939. Surface altitude, 1,574.6 feet.* (Samples studied by Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY AND TERTIARY—Pliocene and Pleistocene		
McPherson and Delmore formations		
Silt, brown, and very fine to medium sand	5	5
Silt and clay, gray to brown	10	15
Sand, coarse to fine	21	36
Silt, calcareous, tan to buff	4	40
Sand, medium to very fine, contains some buff silt and nodules of calcium carbonate	8	48
Caliche, gray to white	2	50
Sand, medium to coarse, and fine to medium gravel; gravel composed of pebbles derived from Cretaceous sandstone and shale	9	59
Sand, fine to medium; contains some silt, clay, and pebbles of caliche	7	66
Sand, coarse to medium	9	75
CRETACEOUS—Comanchean		
Kiowa shale		
Sandstone, partly cemented, and clay	21	96
PERMIAN—Leonardian		
Wellington shale		
Shale, dark gray	11	107

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64. *Driller's log of test hole at the Cen. NE¼ sec. 21, T. 19 S., R. 1 W., McPherson County; drilled by Layne-Western Company for the City of Canton, 1937.*

QUATERNARY AND TERTIARY—Pliocene and Pleistocene McPherson and Delmore formations	*Thickness, feet*	*Depth, feet*
Soil	4	4
Clay, brown	8	12
Clay, gray	8	20
Clay, sandy	5	25
Clay, gray	3	28
Clay, sandy	17	45
Clay, gray	15	60
CRETACEOUS—Comanchean		
Kiowa shale		
Clay, with streaks of rock	7	67
Sand, coarse, silty	10	77
Sand, medium, with clay beds	6	83

65. *Driller's log of well 67 in the SW¼ SW¼ sec. 22, T. 19 S., R. 1 W., McPherson County; drilled by Wichita Pump and Supply Company for the City of Canton,* 1937.

QUATERNARY AND TERTIARY—Pliocene and Pleistocene McPherson and Delmore formations	*Thickness, feet*	*Depth, feet*
Soil, black	1	1
Clay, sandy, red	13	14
Clay, brown	8	22
Clay, gray, and gyp	2	24
Clay, gray	7	31
Clay, gray and brown	4	35
Sand, gray	1	36
Clay, gray	1	37
Clay, gray, and sand	1	38
Clay, gray and brown	10	48
Sand, gray, and clay	1	49
CRETACEOUS—Comanchean		
Kiowa shale		
Sand; water rose 4 feet	4	53
Sand, medium to fine	3	56
Sand, medium, plastering size	12	68
Sand, medium	2	70
Clay, hard	2	72
Sand, fine	9	81
Clay, yellow	1	82

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66. *Sample log of test hole at the NE cor. sec. 1, T. 19 S., R. 2 W., McPherson County; drilled by State Geological Survey, 1945.* (Samples studied by O. S. Fent and Charles C. Williams.)

TERTIARY—Pliocene Delmore formation	*Thickness, feet*	*Depth, feet*
Soil; silt, brown	4	4
Silt, dark brown to gray; contains fine gravel, sand, and pellets of limonite	6	10
Sand, fine to medium, and light-gray to yellow silt	13	23
Gravel, fine to medium, and medium to coarse sand; contains nodules of calcium carbonate	5	28
Sand, coarse to fine, micaceous, partly cemented with limonite; contains fine gravel and some layers of silt and clay	5	33
Silt, red to tan, and coarse to fine sand	4	37
Gravel, fine to medium, and coarse to medium sand; contains some light-gray silt and nodules of calcium carbonate	6	43
Silt, buff to brown, and fine to coarse sand; contains some fine to medium gravel and nodules of calcium carbonate	13	56
CRETACEOUS—Comanchean Kiowa shale		
Sandstone, fine-grained, brown, and some thin beds of light-gray clay shale	18	74

67. *Sample log of test hole at the SW cor sec. 8, T. 19 S., R. 2 W., McPherson County; drilled by State Geological Survey, 1939. Surface altitude, 1,523.8 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY AND TERTIARY—Pliocene and Pleistocene McPherson and Delmore formations	*Thickness, feet*	*Depth, feet*
Soil, tan to brown	2	2
Silt, tan, slightly calcareous; contains very fine sand and nodules of calcium carbonate	6	8
Silt and clay, light gray; contains some very fine to fine sand	9	17
Sand, fine to very fine, and gray silt; contains nodules of calcium carbonate and streaks of limonite	3	20
Silt, tan to gray, and very fine to fine sand; some thin layers in interval cemented by calcium carbonate	19	39
Sand, very fine to fine, and slightly calcareous tan to buff silt	6	45
Silt, tan to gray, and very fine to fine sand	10	55
Sand, very fine to fine, and buff to tan silt; contains nodules of calcium carbonate	5	60
Sand, fine to medium; contains grains and pebbles of caliche; most sand grains composed of quartz but some are composed of pink and white feldspar and dark-gray chert	1.5	61.5

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	Thickness, feet	Depth, feet
Silt, buff to gray, and fine to very fine sand; contains nodules of calcium carbonate	12.5	74
Silt, tan to gray, and fine to very fine sand; contains nodules of calcium carbonate and fragments of carbonaceous material	11	85
Silt and clay, light gray	3	88
PERMIAN—Leonardian		
Wellington formation		
Shale, maroon and dark gray	12	100

68. *Sample log of test hole at the SE cor. sec. 9, T. 19 S., R. 2 W., McPherson County; drilled by State Geological Survey, 1945. Surface altitude, 1,545.7 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY AND TERTIARY—Pliocene and Pleistocene McPherson and Delmore formations	Thickness, feet	Depth, feet
Soil	2	2
Silt and clay, dark gray	3	5
Silt, limonitic, light gray to yellow; contains some very fine sand	6	11
Silt, light gray; contains thin beds of sand and gravel	4	15
Silt, gray; contains streaks of limonite, nodules of calcium carbonate, and medium to fine sand	14	29
Sand, very fine to medium, and gray silt; partly cemented with calcium carbonate	5	34
Sand, coarse to medium, and fine gravel; contains some gray silt	32	66
Silt, gray, and fine to medium sand; contains nodules of calcium carbonate	2	68
Gravel, fine to medium, and coarse to medium sand	11	79
PERMIAN—Leonardian		
Wellington formation		
Shale, gray to yellowish green	6	85

69. *Sample log of test hole at the SW cor. sec. 12, T. 19 S., R. 2 W., McPherson County; drilled by State Geological Survey, 1945. Surface altitude, 1,556.7 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY AND TERTIARY—Pliocene and Pleistocene McPherson and Delmore formations	Thickness, feet	Depth, feet
Soil	3	3
Silt, gray	3	6
Sand, fine to coarse, and gray silt	2	8
Sand, coarse to fine; contains some fine gravel and gray silt	20	28
Silt, buff, and fine to coarse sand	2	30
Sand, coarse to fine, and fine gravel	4	34
Silt, light gray to buff, and coarse to fine sand; contains nodules of calcium carbonate	7	41

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	Thickness, feet	*Depth, feet*
Sand, coarse to fine, and some fine gravel	9	50
Gravel, fine to medium, and coarse to medium sand	11	61
CRETACEOUS—Comanchean		
Kiowa shale		
Sandstone, partly cemented, brown	1	62
Clay, dark and light gray	3	65
Shale, dark gray, soft, contains pyrite	12	77

70. *Sample log of test hole at the NE cor. sec. 13, T. 19 S., R. 2 W., McPherson County; drilled by State Geological Survey, 1945. Surface altitude, 1,568.8 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY AND TERTIARY—Pliocene and Pleistocene McPherson and Delmore formations	*Thickness, feet*	*Depth, feet*
Soil	3	3
Silt, gray; contains some sand and gravel	7	10
Gravel, fine to medium, coarse to fine sand, and gray silt,	4	14
Sand, coarse to fine, and fine to medium gravel	14	28
Silt, gray to buff	2	30
Sand, coarse to fine; contains some medium to fine gravel and light-gray silt	21	51
Silt, greenish gray and buff; contains some fine to coarse sand and nodules of calcium carbonate	13	64
Sand, coarse to fine, and fine to medium gravel; contains buff silt, and fragments of shale	13	77
CRETACEOUS—Comanchean		
Kiowa shale		
Shale, thinly laminated, yellow gray and gray	3	80

71. *Sample log of test hole at the NE cor. sec. 15, T. 19 S., R. 2 W., McPherson County; drilled by State Geological Survey, 1939. Surface altitude, 1,557.5 feet.* (Samples studied by Charles C. Williams.)

QUATERNARY AND TERTIARY—Pliocene and Pleistocene McPherson and Delmore formations	*Thickness, feet*	*Depth feet*
Soil, dark gray to brown	6	6
Silt, calcareous, gray to buff, and very fine to medium sand; contains nodules of calcium carbonate	12	18
Sand, fine to medium	11	29
Silt and clay, calcareous, tan to gray, and very fine to medium sand	9	38
Sand, medium to very fine, and some coarse sand	9	47
Sand, medium to coarse, and some fine gravel	13	60
Sand, fine to medium, and some coarse sand	25	85
PERMIAN—Leonardian		
Wellington formation		
Shale, gray	10	95

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72. *Sample log of test hole at the NE cor. sec. 17, T. 19 S., R. 2 W., McPherson County; drilled by State Geological Survey, 1945. Surface altitude, 1,545.4 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY AND TERTIARY—Pliocene and Pleistocene McPherson and Delmore formations	*Thickness, feet*	*Depth feet*
Soil, brown	3	3
Silt, gray to buff, and very fine sand; contains streaks of limonite and nodules of calcium carbonate	32	35
Silt, light gray, and medium to fine sand	5	40
Silt, light gray and light buff; contains sand, gravel, and nodules of calcium carbonate	18	58
PERMIAN—Leonardian		
Wellington formation		
Shale, maroon, yellow gray, and gray	7	65

73. *Sample log of test hole at the NW cor. sec. 18, T. 19 S., R. 2 W., McPherson County; drilled by State Geological Survey, 1945. Surface altitude, 1,574.4* feet. (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY AND TERTIARY—Pliocene and Pleistocene McPherson and Delmore formations	*Thickness, feet*	*Depth, feet*
Soil	2	2
Silt, brown; contains coarse sand	4	6
Silt and clay, gray to buff; contains coarse to fine sand, and nodules of calcium carbonate	36	40
Silt, tan; contains very fine to coarse sand	5	45
Sand, coarse to fine, and some medium to fine gravel; interval includes thin beds of buff to gray silt	3	48
Silt, light gray to buff; contains fine to coarse sand and fine gravel	18	66
PERMIAN—Leonardian		
Wellington formation		
Shale, light and dark gray	24	90

74. *Driller's log of well 74 in the NE¼ SW¼ SW¼ sec. 22, T. 19 S., R. 2 W., McPherson County; drilled by Layne-Western Company for the City of Galva, 1937.*

QUATERNARY AND TERTIARY—Pliocene and Pleistocene McPherson and Delmore formations	*Thickness, feet*	*Depth feet*
Soil, black	3	3
Clay and cemented sand	5	8
Sand, coarse	7	15
Sand, cemented, and clay	5	20
Sand, medium	11	31
Sand, coarse	9	40

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75. *Driller's log of well 75 in the NW¼ SE¼ SW¼ sec. 22, T. 19 S., R. 2 W., McPherson County; drilled by Layne-Western Company for the City of Galva, 1936.*

QUATERNARY AND TERTIARY—Pliocene and Pleistocene McPherson and Delmore formations	*Thickness, feet*	*Depth, feet*
Soil, black	2	2
Clay, hard	6	8
Sand, coarse; contains clay balls	7	15
Sand, coarse, and clay	5	20
Sand, partly cemented	2	22
Sand, coarse	11	33
Sand, fine	2	35
Clay	6	41

76. *Sample log of test hole at the SE cor. SW¼ sec. 7, T. 19 S., R. 3 W., McPherson County; drilled by State Geological Survey, 1945. Surface altitude, 1,507.6 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Soil	3	3
Silt, compact, light brown	8	11
Silt, buff to tan; contains fine to medium sand and nodules of calcium carbonate	25	36
Silt, tan; contains abundant nodules of ironstone and calcium carbonate	2	38
Silt and clay, buff to gray	13	51
Silt, gray to buff; silt very porous in lower part	72	123
Gravel, fine, and coarse sand; thin cemented zones within interval	7	130
Gravel, fine to medium, and coarse sand	18	148
Silt, light gray	6	154
Gravel, fine to medium, and coarse to medium sand	56	210
PERMIAN—Leonardian Wellington formation		
Shale, blue gray, and thin limestone layer	8	218

77. *Sample log of test hole at the SE cor. sec. 7, T. 19 S., R. 3 W., McPherson County; drilled by State Geological Survey, 1945. Surface altitude, 1,498.4 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Road material and soil	3	3
Silt, compact, gray	4	7
Silt, light buff; contains streaks of limonite and nodules of calcium carbonate	13	20
Silt, tan to buff, and very fine to medium sand; contains nodules of calcium carbonate	17	37
Silt, light gray; contains very fine to medium sand	31	68

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	Thickness, feet	Depth, feet
Silt, tan to gray; several thin zones within interval composed of fine to coarse sand	52	120
Silt, tan to buff; contains nodules of calcium carbonate,	31	151
Silt, buff, and medium to fine sand; contains nodules of calcium carbonate	9	160
Gravel, fine, and coarse to medium sand	20	180
Gravel, fine to medium; contains some gray silt and pebbles of caliche	13	193
PERMIAN—Leonardian		
Wellington formation		
Shale, light to dark gray; zone of greenish weathered material at top of interval	7	200

78. *Sample log of test hole at the SW cor. SE¼ sec. 8, T. 19 S., R. 3 W., McPherson County; drilled by State Geological Survey, 1945. Surface altitude, 1,510.9 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil	4	4
Silt, compact, tan to buff; contains nodules of calcium carbonate	26	30
Sand, very fine to medium, and light-gray to buff calcareous silt	10	40
Silt, light gray, and fine sand	4	44
Silt, buff to gray; contains very fine to medium sand	26	70
Silt, light gray; interval includes several thin layers of fine to coarse sand	12	82
Silt, tan	6	88
Silt, buff to gray; contains very fine to fine sand, and nodules of calcium carbonate	60	148
Gravel, fine, coarse to medium sand, and gray silt	9	157
Silt, gray to buff; contains some fine to coarse sand	8	165
Gravel, fine to medium, and coarse sand	3	168
Silt, light gray	6	174
Gravel, fine to medium, and coarse sand	27	201
PERMIAN—Leonardian		
Wellington formation		
Shale, dark gray	4	205

79. *Driller's log of test hole at the SW cor. sec. 12, T. 19 S., R. 3 W., McPherson County; drilled by Layne-Western Company. Surface altitude, 1,528.7 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil	2	2
Clay	12	14

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	Thickness, feet	*Depth, feet*
Sandrock	3	17
Clay	43	60
Clay, sandy, on rock	4	64

80. *Sample log of test hole at the NW cor. NE¼ sec. 14, T. 19 S., R. 3 W., McPherson County; drilled by State Geological Survey, 1945. Surface altitude, 1,519.6 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	*Depth, feet*
QUATERNARY—Pleistocene		
McPherson formation		
Soil	3	3
Silt, compact, gray	4	7
Silt and clay, gray, greenish gray, and yellow; contains streaks of limonite and nodules of calcium carbonate,	105	112
Silt and clay, yellow green and blue gray, interbedded with thin layers of coarse sand, and fine gravel; sand and gravel contains fragments of gray shale	14	126
Silt, tan to brown, and very fine to medium sand; contains fragments of gray shale	11	137
PERMIAN—Leonardian		
Wellington formation		
Shale, light gray; included in interval are thin layers of limestone	6	143

81. *Sample log of test hole at the NW cor. sec. 15, T. 19 S., R. 3 W., McPherson County; drilled by State Geological Survey, 1945. Surface altitude, 1,492.4 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	*Depth, feet*
QUATERNARY—Pleistocene		
McPherson formation		
Soil	2	2
Silt, light gray, and very fine to medium sand	11	13
Sand, medium to fine; contains some gray silt, and pebbles of caliche	2	15
Silt and clay, buff to gray; contains nodules of calcium carbonate	21	36
Silt, gray	12	48
Silt, buff to gray; contains nodules of calcium carbonate,	12	60
Silt, tan to gray; contains very fine to medium sand	30	90
Silt, compact, buff to gray; contains thin layers of medium to coarse sand, and nodules of calcium carbonate	35	125
Silt, yellow gray, and very fine sand	4	129
Sand, coarse to fine, interbedded with gray silt	8	137
PERMIAN—Leonardian		
Wellington formation		
Shale, light gray and maroon	7	144

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82. *Sample log of test hole at the NE cor. NW¼ sec. 16, T. 19 S., R. 3 W., McPherson County; drilled by State Geological Survey, 1945. Surface altitude, 1,506.1 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil	2	2
Silt, compact, light gray to tan	13	15
Silt, buff; contains nodules of calcium carbonate	50	65
Sand, fine to coarse, and some fine gravel; thin layers within interval cemented with calcium carbonate	15	80
Sand, fine to coarse, interbedded with gray silt	6	86
Silt, light gray, and very fine to coarse sand	10	96
Silt and clay, tan to light gray; contains nodules of calcium carbonate	39	135
Gravel, fine and coarse to medium sand	8	143
PERMIAN—Leonardian		
Wellington formation		
Shale, maroon and gray; contains thin layers of argillaceous limestone	7	150

83. *Sample log of test hole at the NE cor. sec. 17, T. 19 S., R. 3 W., McPherson County; drilled by State Geological Survey, 1945. Surface altitude, 1,510.2 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil	3	3
Silt, compact, brown to light gray; contains streaks of limonite	15	18
Silt, light gray to buff, calcareous; very porous zone in lower part of interval	82	100
Gravel, fine to medium, and coarse sand; contains some gray silt, and pebbles of caliche	23	123
Silt, gray to buff; contains fine to coarse sand	5	128
Silt, bluish gray	9	137
Gravel, fine, and coarse sand; contains some gray silt	16	153
Silt, compact, buff	4	157
Gravel, fine, and coarse sand; contains gray silt in thin layers	13	170
Gravel, medium to fine, and coarse sand	23	193
PERMIAN—Leonardian		
Wellington formation		
Shale, blue gray	4	197

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84. *Sample log of test hole at the NW cor. sec. 18, T. 19 S., R. 3 W., McPherson County; drilled by State Geological Survey, 1939. Surface altitude, 1,497.4 feet.* (Samples studied by Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Soil, brown	2	2
Silt, gray to buff, and very fine sand	8	10
Silt, calcareous, light gray to buff; contains very fine sand, streaks of limonite, and nodules of calcium carbonate	39	49
Silt, buff to tan; contains very fine sand, and fragments of carbonaceous material	11	60
Silt, tan, calcareous, and very fine sand	38	98
Sand, medium to coarse, and some fine gravel; contains some pebbles of caliche	29	127
Silt, buff, and very fine to fine sand	2	129
Sand, coarse to medium, and fine to medium gravel; contains pebbles of caliche	21	150
Sand, medium to fine	4	154
Sand, coarse to medium, and fine gravel	8	162
Gravel, fine to coarse, and coarse to medium sand	11	173
Sand, medium to coarse, and fine to coarse gravel	7	180
Sand, medium to coarse	7	187
Silt, calcareous, buff, and very fine sand	1	188
Sand, medium to coarse	2	190
Sand, medium	3	193
Sand, medium to coarse, and fine to medium gravel	7	200
Silt and clay, calcareous, buff to tan	3	203
Sand, coarse to medium, and fine to coarse gravel	3	206
PERMIAN—Leonardian Wellington formation		
Shale, calcareous, gray	11	217

85. *Driller's log of test hole in the SW¼ SE¼ NE¼ sec. 29, T. 19 S., R. 3 W., McPherson County; drilled by Layne-Western Company for the City of McPherson.*

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Soil	3	3
Clay	41	44
Sand, fine	3	47
Clay	4	51
Sand, coarse	25	76
Clay	4	80
Sand and gravel	6	86
Clay	2	88
Sand, coarse	2	90
Clay	3	93
Sand, fine	7	100
Clay	2	102

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	Thickness, feet	Depth, feet
Sand and gravel	25	127
Clay	1	128
Sand, fine	6	134
Clay	19	153
Sand, coarse	8	161
PERMIAN—Leonardian		
Wellington formation		
Shale	4	165

86. *Driller's log of well 90 in the SE¼ NW¼ SE¼ sec. 29, T. 19 S., R. 3 W., McPherson County; drilled by Kelly Well Company for the City of McPherson, 1937.*

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Sand	2	2
Clay	41	43
Clay, sandy	3	46
Sand, fine	2	48
Clay	2	50
Sand, fine	4	54
Clay	1	55
Sand and gravel	3	58
Clay	4	62
Sand, fine	6	68
Clay	5	73
Sand and gravel	15	88
Sand, fine, and clay	11	99
Sand and gravel	39	138
Clay, and sand, fine	7	145
Sand, coarse	9	154
Clay	4	158
PERMIAN—Leonardian		
Wellington formation		
Shale	2	160

87. *Driller's log of well 92 in the SW ¼ SE¼ sec. 29, T. 19 S., R. 3 W., McPherson County; drilled by Kelly Well Company for the City of McPherson, 1937.*

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Clay	55	55
Sand, fine	9	64
Clay, sandy	8	72
Sand, coarse	11	83
Clay	3	86
Sand, fine to coarse; contains clay	7	93
Sand, coarse; contains clay balls	8	101
Sand, coarse, and gravel	22	123
Sand, fine	2	125
Sand, coarse; contains clay balls	21	146

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88. *Sample log of test hole 0.35 mile west of the SE cor. sec. 7, T. 19 S., R. 4 W., McPherson County; drilled by State Geological Survey, 1945. Surface altitude, 1,542.0 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	*Depth, feet*
QUATERNARY—Pleistocene		
McPherson formation		
Soil	1	1
Silt, compact, light and dark gray	3	4
Silt, buff; contains coarse to fine sand and ironstone fragments	5	9
PERMIAN—Leonardian		
Ninnescah shale		
Shale, green to gray	4	13

89. *Sample log of test hole at the SW cor. sec. 8, T. 19 S., R. 4 W., McPherson County; drilled by State Geological Survey, 1939. Surface altitude, 1,526.1 feet.* (Samples studied by Charles C. Williams.)

	Thickness, feet	*Depth, feet*
QUATERNARY—Pleistocene		
McPherson formation		
Soil, mostly silt, dark gray to brown	5	5
Silt, calcareous, buff to tan, and very fine to fine sand; contains streaks of limonite and nodules of calcium carbonate	27	32
Silt, gray; contains pebbles of brown chert; the chert pebbles range from ¼ to ½ inch in least dimension, are granular, and contain ostracodes and foraminifera,	1	33
Silt, tan to buff, and very fine sand; contains fragments of charcoal and nodules of calcium carbonate,	24	57
Silt and clay, calcareous, buff to tan; contains some very fine sand	4	57
Silt, gray, calcareous, and very fine to medium sand	5	66
Sand, fine to medium, and some coarse sand	12	78
Sand, coarse to medium; contains some fine gravel	2	80
Gravel, fine to coarse; most pebbles are quartz, but some are composed of feldspar, chert, shale, and ironstone	1	81
PERMIAN—Leonardian		
Ninnescah shale		
Shale, greenish gray and red	10	91

90. *Sample log of test hole at the SE cor. sec. 8, T. 19 S., R. 4 W., McPherson County; drilled by State Geological Survey, 1939. Surface altitude, 1,525.4 feet.* (Samples studied by Charles C. Williams.)

	Thickness, feet	*Depth, feet*
QUATERNARY—Pleistocene		
McPherson formation		
Silt and clay, slightly calcareous, gray to buff; contains some fine sand	10	10
Silt, brown; contains streaks of limonite	15	25
Silt, buff; contains nodules of calcium carbonate, fragments of carbonaceous material, and very fine to fine sand	9	34

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	Thickness, feet	Depth, feet
Clay and silt, very calcareous, buff to gray; contains streaks of limonite, nodules of calcium carbonate and fragments of carbonaceous material	21	55
Sand, medium to coarse; most grains sub-angular and composed of quartz, but some are composed of pink and white feldspar and reddish-brown fragments of granite	6	61
Sand, coarse, and fine gravel	3	64
PERMIAN—Leonardian		
Ninnescah shale		
Shale, brick red and light green	6	70

91. *Sample log of test hole at the SW cor. sec. 11, T. 19 S., R. 4 W., McPherson County; drilled by State Geological Survey, 1939. Surface altitude, 1,5048 feet.* (Samples studied by Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt, buff to tan, contains very fine sand	10	10
Silt, buff, calcareous, and very fine sand; contains nodules of calcium carbonate	38	48
Sand, medium to very fine; contains silt and buff clay,	4	52
Sand, medium, and some fine sand	8	60
Sand, coarse, and fine gravel	5	65
Sand, medium to coarse	7	72
Sand, medium, and some fine sand; contains small nodules of calcium carbonate	8	80
Gravel, fine to medium and coarse to medium sand; contains pebbles of caliche	3	83
Sand, medium to coarse, and fine to coarse gravel; contains pebbles of shale and caliche	5	88
Sand, fine to medium	12	100
Silt, calcareous, gray to buff, and very fine sand	14	114
Sand, fine	6	120
Sand, coarse to medium, and fine gravel; most grains and pebbles are composed of clear or yellowish quartz but some are composed of pink and white feldspar and dark-green chert	8	128
Sand, coarse, and fine gravel; contains pebbles of clay	2	130
Silt, calcareous, gray, and very fine sand	8	138
Sand, coarse to fine, and fine gravel	30	168
Sand, fine to medium	2	170
Sand, coarse to medium, and fine gravel	7	177
Sand, medium to fine	6	183
Sand, medium to coarse, and fine gravel; contains pebbles of caliche	26	209
Sand, medium to coarse; contains fragments of red and gray shale and ironstone	16	225
PERMIAN—Leonardian		
Wellington formation		
Shale, calcareous, gray	10	235

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92. *Sample log of test hole at the NE cor. sec. 14, T. 19 S., R. 4 W., McPherson County; drilled by State Geological Survey, 1939. Surface altitude, 1,508.7 feet.* (Samples studied by Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Soil, dark brown	1.5	1.5
Silt, slightly calcareous, gray to buff; contains some very fine sand and streaks of limonite	6.5	8
Silt and clay, calcareous; contains very fine sand, nodules of calcium carbonate, and fragments of carbonaceous material	53	61
Sand, medium to coarse, and fine gravel	13	74
Sand, medium	5	79
Sand, medium to coarse; contains pebbles of red shale	6	85
Sand, medium	10	95
Sand, medium to coarse, and fine gravel	6	101
Silt, very calcareous, gray, and very fine to fine sand	6	107
Sand, fine to medium; contains fragments of snail shells	10	117
Silt, gray to buff, calcareous	1.5	118.5
Sand, medium to coarse	1	119.5
Silt, very calcareous, gray to buff, and very fine sand	18.5	138
Sand, fine to medium	10	148
Sand, medium to coarse, and fine gravel; poorly sorted,	12	160
Sand, coarse to medium, and fine to medium gravel; contains pebbles of shale and caliche	13	173
Gravel, fine to coarse, and coarse sand; contains pebbles and grains of caliche, chert, ironstone, and feldspar in addition to quartz	5	178
Silt, very calcareous, gray, and very fine sand	24	202
Sand, medium to fine	9	211
Sand, medium to coarse, and fine gravel	21	232
Sand, medium to coarse, and buff silt	2	234
Gravel, fine, and coarse to medium sand	6	240
Sand, fine to coarse, and fine gravel; poorly sorted	4	244
Gravel, fine, and coarse to medium sand	3	247
Sand, medium to coarse	8	255
Sand, coarse to medium, and fine gravel	5	260
PERMIAN—Leonardian Wellington formation		
Shale, calcareous, gypsiferous, gray	5	265

93. *Sample log of test hole at the NW cor. sec. 15, T. 19 S., R. 4 W., McPherson County; drilled by State Geological Survey, 1939. Surface altitude, 1,489.1 feet.* (Sample studied by Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Silt, dark gray to brown; containing clay and fine sand,	5	5
Silt and clay, slightly calcareous, gray to buff	6	11
Silt and clay, gray and very fine sand	7	18

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	Thickness, feet	Depth, feet
Silt, gray to buff, and very fine to fine sand	12	30
Silt, and clay, gray to buff; contains some very fine sand, streaks of limonite, and fragments of carbonaceous material	12	42
Silt and clay, calcareous, gray to buff	8	50
Sand, medium to coarse; most grains composed of quartz, but some are feldspar and other granitic materials	10	60
Sand, coarse to medium, and fine gravel	7	67
Silt and clay, calcareous; contains flakes of limonite and fragments of carbonaceous material	9	76
Sand, medium to coarse	10	86
Gravel, fine, and coarse to medium sand	9	95
Sand, medium to fine	24	119
Gravel, fine to medium, and coarse sand	1	120
Sand, medium to coarse, and fine gravel; poorly sorted,	1	121
PERMIAN—Leonardian		
Wellington formation		
Shale, slightly calcareous, brittle, gray, and very thinly bedded argillaceous limestone	9	130

94. *Driller's log of well 119 in the NE cor. sec. 5, T. 20 S., R. 3 W., McPherson County; drilled by Layne-Western Company for National Cooperative Refining Company (formerly Globe Oil and Refining Company) 1941.*

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil, black	1	1
Clay	11	12
Clay, jointed, red	8	20
Clay, white	28	48
Clay, sandy	10	58
Sand, fine	3	61
Clay	1	62
Sand, coarse	4	66
Clay	5	71
Sand, coarse, and gravel	16	87
Clay	3	90
Sand, fine	3	93
Sand and gravel	22	115
Clay	1	116
Sand, fine	4	120
Sand and gravel	9	129
Sand, fine	2	131
Sand and gravel	14	145
Sand, coarse, and gravel; contains streaks of clay	16	161
PERMIAN—Leonardian		
Wellington formation		
Shale	4	165

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95. *Driller's log of well 120 in the NW¼ NE¼ NE¼ sec. 5, T. 20 S., R. 5 W., Mc-Pherson County; drilled by Layne-Western Company for National Cooperative Refinery Association (formerly Globe Oil and Refining Company), 1933.*

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Sand	3	3
Clay	35	38
Sand	6	44
Clay	2	46
Sand, fine	17	63
Clay	9	72
Sand, coarse	7	79
Clay	4	83
Sand, coarse	3	86
Clay	2	88
Sand, fine	5	93
Sand and gravel	7	100
Clay	3	103
Sand and gravel	10	113
Clay	5	118
Sand, fine	2	120
Sand and gravel	26	146
Clay	1	147
Sand and gravel	2	149
Clay	1	150
Sand and gravel	8	158
Clay	1	159
PERMIAN—Leonardian Wellington formation		
Shale	1	160

96. *Driller's log of well 121 in the NE¼ NW¼ NE¼ sec. 5, T. 20 S., R. 3 W., McPherson County; drilled by Layne-Western Company for National Cooperative Refinery Association (formerly Globe Oil and Refining Company), 1932.*

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Soil	3	3
Clay	19	22
Sand	1	23
Clay	5	28
Sand	2	30
Sand, fine	5	35
Clay	3	38
Sand, fine	17	55
Sand, coarse	11	66
Clay	2	68
Sand, coarse	3	71
Sand and gravel	8	79

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	Thickness, feet	Depth, feet
Clay	6	85
Sand	3	88
Clay	2	90
Sand and clay	8	98
Sand, fine	7	105
Clay	3	108
Sand and gravel	19	127
Clay	4	131
Sand, coarse	5	136
Clay	5	141
Sand, fine	12	153
Clay	1	154
PERMIAN—Leonardian		
Wellington formation		
Shale	1	155

97. *Driller's log of well 122 in NE¼ SW¼ NE¼ sec. 5, T. 20 S., R. 5 W., McPherson County; drilled by Guyer Drilling Company for National Cooperative Refining Association (formerly Globe Oil and Refining Company), 1944.*

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil	5	5
Clay, jointed	20	25
Clay, yellow	25	50
Sand	4	54
Clay and sand	16	70
Sand, fine	10	80
Clay and gyp	15	95
Sand, coarse	23	118
Clay and sand	26	154
Clay, green	4	158
Gravel, coarse	12	170
PERMIAN—Leonardian		
Wellington formation		
Shale	1	171

98. *Sample log of test hole at the SE cor. sec. 8, T. 21 S., R. 1 E., Marion County; drilled by State Geological Survey, 1945. Surface altitude, 1,545.7 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Silt, tan contains some fine gravel, and coarse to medium sand	5	5
Gravel, fine to medium, and coarse to medium sand	1	6
Silt, light gray to buff, and very fine sand	13	19
Silt, buff; contains fine gravel, and coarse to fine sand	8	27
Gravel, fine to medium, and coarse to medium sand	4	31

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	Thickness, feet	Depth, feet
PERMIAN—Leonardian		
Wellington formation		
Shale, laminated, light gray and maroon	2	33

99. *Sample log of test hole at the NW cor. sec. 17, T. 21 S., R. 1 E., Marion county; drilled by State Geological Survey, 1939. Surface altitude, 1,524.1 feet.* (Samples studied by Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, sandy, brown	2	2
Sand, medium to coarse; most grains are composed of quartz, but some are composed of pink and gray feldspar and olive-green chert	3	5
Sand, coarse to medium; contains some fine gravel and some pebbles of gray-green shale	2	7
Gravel, fine to coarse, and coarse to medium sand; partly cemented with calcium carbonate	3	10
Sand, medium to coarse; contains some fine to medium gravel	4	14
Sand, medium, to fine gravel; the larger pebbles are composed of shale and ironstone	7	21
PERMIAN—Leonardian		
Wellington formation		
Shale, gray and maroon	9	30

100. *Sample log of test hole at the SE cor. sec. 9, T. 21 S., R. 1 W., McPherson County; drilled by State Geological Survey, 1939. Surface altitude, 1,501.5 feet.* (Samples studied by Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, sandy, brown	3	3
Sand, fine to coarse, and calcareous buff silt	2	5
Sand, medium	.5	5.5
Calcium carbonate, soft to powdery; contains some fine to medium sand	6.5	12
Caliche and fine to medium sand	4	16
Sand, fine to medium, and gray to buff silt; contains pebbles of caliche and nodules of calcium carbonate,	3	19
Silt, very calcareous, buff, and fine to medium sand	8	27
Caliche, buff silt, and fine to medium sand	3	30
Caliche and calcium carbonate, soft; contains some sand and fragments of ironstone	3	33
Caliche, and gravel, coarse; contains buff silt; most pebbles of gravel composed of ironstone	2	35
PERMIAN—Leonardian		
Wellington formation		
Shale, gray	3	38
Shale, gypsiferous, gray, green, and maroon	2	40

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101. *Sample log of test hole at the SE cor. sec. 10, T. 21 S., R. 1 W., McPherson County; drilled by State Geological Survey, 1945. Surface altitude, 1,522.1 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, dark gray	2	2
Silt, compact gray	6	8
Silt, light gray; contains fine to coarse sand and streaks of limonite	2	10
Sand, very fine to medium; contains limonitic light brown silt	4	14
Silt, light gray to tan, and fine to coarse sand; sand grains stained with limonite	3	17
Sand, coarse to medium, and fine to medium gravel	20	37
Gravel, fine to medium, and coarse to medium sand; interval includes a few thin beds of dark-gray silt	3	40
PERMIAN—Leonardian		
Wellington formation		
Shale, calcareous, maroon and gray	4	44

102. *Sample log of test hole at the NE cor. sec. 13, T. 21 S., R. 1 W., McPherson County; drilled by State Geological Survey, 1945. Surface altitude, 1,529.4 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, dark gray	2	2
Silt, tan, fine to medium gravel, and coarse to very fine sand	5	7
Silt, light gray to buff; contains coarse to fine sand, fine gravel, and nodules of calcium carbonate	8	15
Gravel, fine, and coarse to medium sand	5	20
Gravel, fine to medium, and coarse sand; contains buff silt	8	28
Silt, green gray; contains fine to medium sand	1	29
Gravel, fine to medium, and coarse to medium sand	5	34
Silt, light buff, and fine sand	1	35
Sand, coarse to medium	2	37
Sand, very fine to fine, and light-gray silt	.5	37.5
PERMIAN—Leonardian		
Wellington formation		
Shale, thin-bedded, maroon		

103. *Sample log of test hole at the NW cor. sec. 13, T. 21 S., R. 1 W., McPherson County; drilled by State Geological Survey, 1939. Surface altitude, 1,525.4 feet.* (Samples studied by Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, brown	4	4
Silt, tan, and coarse to fine sand; contains some ironstone gravel	2	6

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	Thickness, feet	Depth, feet
Sand, coarse to fine, and fine to coarse gravel; many pebbles composed of shale, chert, clay, and sandstone; very poorly sorted	8	14
Silt, buff to tan, and very fine to fine sand; contains some large ironstone pebbles	2	16
Silt, buff, and very fine to fine sand; contains some granular gypsum	8	24
Silt, buff; contains very fine to fine sand	6	30
Sand, coarse, and some medium to fine sand; contains pebbles of gray shale	2	32
PERMIAN—Leonardian		
Wellington formation		
Shale, greenish gray; contains crystalline gypsum	5	37
Shale, maroon	3	40

104. *Sample log of test hole at the NW cor. sec. 17, T. 21 S., R. 1 W., McPherson County; drilled by State Geological Survey, 1939. Surface altitude, 1,502.8 feet.* (Samples studied by Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, dark gray to dark brown	3	3
Silt, gray to brown	2	5
Silt and clay, very calcareous, gray; contains some very fine sand	3	8
Silt, gray to buff, calcareous; contains very fine to fine sand and nodules and pebbles of calcium carbonate	4	12
Sand, medium to coarse; most grains composed of quartz, but some are composed of feldspar and chert,	4	16
Silt, light gray; contains very fine to fine sand	2	18
Sand, coarse to medium, and fine gravel	2	20
Silt, gray, and very fine to fine sand	1	21
Sand, coarse to medium, and fine to medium gravel	2	23
Silt, calcareous, buff to gray; contains very fine to fine sand	16	39
Silt, calcareous, gray to buff; contains very fine to medium sand and many fragments of argillaceous limestone and shale	13	52
PERMIAN—Leonardian		
Wellington formation		
Shale, calcareous, light gray	4	56
Shale, dark gray	4	60

105. *Sample log of test hole at the NW cor. sec. 18, T. 21 S., R. 1 W., McPherson County; drilled by State Geological Survey, 1945. Surface altitude, 1,506.6 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, dark gray	2	2
Silt, compact, gray	5	7

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	Thickness, feet	Depth feet
Silt, calcareous, buff to light gray; contains very fine to medium sand and nodules of calcium carbonate....	26	33
Gravel, fine to medium, and coarse to medium sand...	2	35
Silt, calcareous, light gray to buff; contains sand and nodules of calcium carbonate.....	2	37
Sand, coarse to medium, and some fine gravel.....	2	39
Silt, calcareous, light gray to buff; contains some sand, gravel, and nodules of calcium carbonate.....	13	52
Sand, coarse to medium, and fine to medium gravel; contains some gray silt	31	83
PERMIAN—Leonardian		
Wellington formation		
Shale, dark gray and maroon.....	3	86

106. *Sample log of test hole at the SW cor. sec. 10, T. 21 S., R. 2 W., McPherson County; drilled by State Geological Survey, 1939. Surface altitude, 1,497.4 feet.* (Samples studied by Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil, mostly silt, brown.....	2.5	2.5
Silt, brown to tan; contains very fine sand.....	5	7.5
Silt, tan, and very fine sand.....	1.5	9
Calcium carbonate, soft, powdery; contains some buff silt, and very fine sand.....	1	10
Silt, buff to tan; contains much calcium carbonate and some fine to very fine sand.....	5	15
Silt, buff, calcareous; contains very fine to fine sand.....	10	25
Sand, medium to coarse; contains some fine sand and nodules of calcium carbonate.....	7	32
Sand, very fine to medium, and buff silt.....	5	37
Sand, medium to coarse.....	8	45
PERMIAN—Leonardian		
Wellington formation		
Shale, calcareous, gray and maroon.....	5	50

107. *Sample log of test hole at the SE cor. sec. 10, T. 21 S., R. 2 W., McPherson County; drilled by State Geological Survey, 1945. Surface altitude, 1,493.5 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil, dark gray.....	2	2
Silt, compact, light gray.....	4	6
Silt, light gray to buff; contains very fine to fine sand..	9	15
Sand, coarse to fine, fine gravel, and light-gray silt....	1	16
Silt, compact, light gray.....	3	19
Gravel, fine, and coarse to medium sand.....	5	24
Silt, light gray to buff; contains very fine to medium sand	6	30

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	Thickness, feet	Depth, feet
Sand, coarse to medium, and fine gravel	2	32
Sand, very fine to fine, and soft powdery calcium carbonate	5	37
Sand, coarse to medium, and fine to medium gravel; contains pebbles of shale	3	40
PERMIAN—Leonardian		
Wellington formation		
Shale, calcareous, gray and maroon	5	45

108. *Sample log of test hole at the NW cor. sec. 13, T. 21 S., R. 2 W., McPherson County; drilled by State Geological Survey, 1939. Surface altitude, 1,491.9 feet.* (Samples studied by Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil	3	3
Silt, buff to gray; contains very fine to fine sand	1	4
Sand, fine to coarse; contains fine gravel and nodules of calcium carbonate	2	6
Sand, very fine to fine, and buff silt	6	12
Silt, calcareous, buff, and fine sand; contains many nodules of calcium carbonate	.5	12.5
Sand, fine to very fine; contains calcareous buff silt	2.5	15
Sand, medium to coarse; contains nodules of calcium carbonate	3	18
Sand, very fine to fine, and calcareous buff silt; contains nodules of calcium carbonate	2	20
Sand, medium to coarse, and some fine sand	10	30
Sand, medium, well sorted; most grains are subangular and composed of quartz, but some are composed of chert and feldspar	10	40
Sand, medium to fine	10	50
Sand, medium to coarse	5	55
PERMIAN—Leonardian		
Wellington formation		
Shale, dark gray, light gray, and maroon	10	65

109. *Sample log of test hole at the NW cor. sec. 16, T. 21 S., R. 2 W., McPherson County; drilled by State Geological Survey, 1945. Surface altitude, 1,488.7 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, dark gray to brown	1	1
Silt and clay, light gray	4	5
Silt, buff, coarse to very fine sand, and fine to medium gravel; very poorly sorted	5	10
Sand, fine to coarse; contains fine gravel	1	11

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	Thickness, feet	Depth, feet
Silt, light gray to buff; contains fine to coarse sand and fine gravel; streaked with limonite	12	23
Silt, tan to red brown	4	27
Sand, coarse, and fine gravel	5	32
PERMIAN—Leonardian		
Wellington formation		
Shale, calcareous, soft, light gray	6	38

110. *Sample log of test hole at the NE cor. sec. 18, T. 21 S., R. 2 W., McPherson County; drilled by State Geological Survey, 1939. Surface altitude, 1,481.8 feet.* (Samples studied by Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil, brown	3	3
Silt, buff to tan; contains very fine sand and flakes of limonite	2	5
Sand, coarse to fine; contains fine to coarse gravel and tan silt; very poorly sorted	5	10
Silt, and clay, tan to buff; contains very fine sand	9	19
Sand, medium to fine	1	20
Gravel, fine to medium, and coarse to medium sand	4	24
Silt, calcareous, tan to buff	5	29
Sand, medium to fine; contains nodules of calcium carbonate	10	39
Silt, calcareous, buff to tan; contains very fine to fine sand	8	47
Sand, medium to coarse; contains fine sand, fine gravel and fragments of clay balls	3	50
Sand, medium to fine, and coarse sand; contains fine to medium gravel and fragments of tan clay balls; gravel composed of quartz, feldspar, and brown ironstone	10	60
Sand, fine to very fine; contains tan silt	5	65
Sand, medium; contains coarse sand and fine gravel	5	70
Sand, very fine to fine; contains buff silt	8	78
Sand, medium to coarse; contains fine sand and fine gravel; most grains and pebbles composed of quartz, but some are composed of pink and gray feldspar, chert, and ironstone	10	88
Sand, medium to coarse, and fine to medium gravel	6	94
PERMIAN—Leonardian		
Wellington formation		
Shale, calcareous, gray and maroon	16	110

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111. *Sample log of test hole at the NW cor. sec. 18, T. 21 S., R. 2 W., McPherson County; drilled by State Geological Survey, 1945. Surface altitude, 1,472.1 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Soil	3	3
Silt and clay, gray to brown	4	7
Silt, tan, and fine to medium sand	13	20
Gravel, fine, and coarse to fine sand; contains some buff silt	4	24
Silt, buff to gray, and fine to coarse sand	19	43
Sand, coarse to medium; contains silt	7	50
Sand, coarse to medium	8	58
Silt, yellow buff; contains fine to medium gravel, coarse to fine sand, and nodules of calcium carbonate	3	61
Sand, coarse to medium, and fine gravel; contains buff silt and nodules of calcium carbonate	9	70
Gravel, fine to medium, and coarse sand; contains nodules of calcium carbonate	24	94
Silt, light gray to tan, and coarse to fine sand	6	100
Silt, buff, and very fine to fine sand; contains nodules of calcium carbonate	4	104
Gravel, fine to medium, and coarse sand, interbedded with buff silt	9	113
Silt, light gray to buff; contains medium to fine sand and pebbles of ironstone and caliche	5	118
PERMIAN—Leonardian		
Wellington formation		
Shale, hard, light gray	2	120

112. *Driller's log of well 166 in the NW¼ NW¼ NE¼ sec. 29, T. 21 S., R. 2 W., McPherson County; drilled by Kelly Well Company for the City of Moundridge, 1940.*

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Soil	3	3
Silt and clay, sandy, tan	8	11
Silt and clay, gray to brown	17	28
Sand, fine to medium	7	35
Sand, medium to coarse	4	39
Sand, coarse to fine and fine gravel	6	45
Silt and clay, calcareous, tan	26	71
Sand, fine to medium; contains silt and clay	3	74
Sand, fine to medium	6	80
Sand, coarse to fine, and fine gravel	5	85
Sand, fine to medium	5	90
Sand, medium to coarse	5	95
Silt and clay, tan	3	98

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	Thickness, feet	Depth, feet
Sand, fine to medium	6	104
Sand, fine to coarse	3	107
PERMIAN—Leonardian		
Wellington formation		
Shale, gray blue	1	108

113. *Driller's log of well 167 in the NE¼ NE¼ NW¼ sec. 29, T. 21 S., R. 2 W., McPherson County; drilled by Wichita Pump and Supply Company for the City of Moundridge, 1938.*

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Silt and clay, brown	10	10
Sand, dry	17	27
Silt and clay, brown	13	40
Silt and clay, sandy	3	43
Sand, medium to fine	8	51
Silt, and clay, gray	13	64
Silt and clay, brown	4	68
Sand, partly cemented	3	71
Sand, fine	9	80
Silt and clay, reddish brown	5	85
Sand, fine, and silt	5	90
Sand, medium to fine	30	120
Silt and clay	1	121
Sand, fine	2	123
Sand, medium to fine	6	129
PERMIAN—Leonardian		
Wellington formation		
Shale	1	130

114. *Driller's log of well 168 in the NE¼ NW¼ sec. 29, T. 21 S., R. 2 W., McPherson County; drilled by Kelly Well Company for City of Moundridge, 1940.*

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil	3	3
Silt and clay, brown	5	8
Sand, fine to medium	12	20
Sand, coarse to fine, and fine to medium gravel	18	38
Silt and clay, buff; contains large nodules of calcium carbonate	17	55
Sand, fine, and tan silt and clay	6	61
Sand, coarse, and fine to coarse gravel	3	64
Silt and clay, tan to brown	6	70
Sand, fine to medium	5	75
Sand, coarse to fine, and fine to medium gravel	10	85
Sand, fine to medium	3	88
Sand, coarse, and fine to coarse gravel	7	95

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	Thickness, feet	Depth, feet
Sand, fine to medium	10	105
Sand, coarse to fine, and fine gravel	19	124
PERMIAN—Leonardian		
Wellington formation		
Shale, greenish gray	1	125

115. *Driller's log of test hole at the NE cor. sec. 30, T. 21 S., R. 2 W., McPherson County; drilled by Kelly Well Company for the City of Moundridge, 1940.*

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil	3	3
Silt and clay, sandy, tan	4	7
Silt and clay, gray	14	21
Silt and clay, calcareous, tan	19	40
Sand, fine to coarse	7	47
Silt and clay, calcareous, tan	9	56
Sand, fine to coarse	11	67
Silt and clay, tan	11	78
Sand, fine to coarse; contains streaks of clay	63	141
PERMIAN—Leonardian		
Wellington formation		
Shale, gray blue	1	142

116. *Sample log of test hole at the SW cor. SE¼ sec. 9, T. 21 S., R. 3 W., McPherson County; drilled by State Geological Survey, 1945. Surface altitude, 1,465.4 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil	4	4
Silt, gray to tan	6	10
Silt, tan to buff; contains very fine to fine sand	30	40
Silt, yellow gray, interbedded with thin layers of medium to coarse sand and fine gravel	6	46
Silt, gray	4	50
Silt, gray to buff, interbedded with fine gravel and coarse to fine sand	6	56
Gravel, fine, and coarse to medium sand	14	70
Gravel, medium to fine; contains some sand and silt	41	111
Silt, buff, interbedded with fine gravel and coarse to medium sand	9	120
Gravel, medium to fine, and coarse sand; contains pebbles and fragments of shale	32	152
PERMIAN—Leonardian		
Wellington formation		
Shale, calcareous, maroon and light gray	8	160

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117. *Sample log of test hole at the NW cor. sec. 13, T. 21 S., R. 3 W., McPherson County; drilled by State Geological Survey, 1939. Surface altitude, 1,468.5 feet.* (Samples studied by Fred T. Holden.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, brown	5	5
Silt and clay, brown to tan	37	42
Sand	18	60
Clay, yellow	4	64
Sand, medium	9	73
Gravel, fine, and coarse sand	44	117
Sand, coarse, and fine gravel; contains pebbles of shale and fragments of vertebrate fossils	4	121
Sand, medium	7	128
Sand, coarse	7	135
Sand, medium	7	142
PERMIAN—Leonardian		
Wellington formation		
Shale, gray; contains gypsum	8	150

118. *Sample log of test hole at the NW cor. NE¼ NE¼ sec. 15, T. 21 S., R. 3 W., McPherson County; drilled by State Geological Survey, 1945. Surface altitude, 1,453.4 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil	2	2
Silt, brown to tan	5	7
Silt, tan to gray	13	20
Silt, buff; contains fine sand and nodules of limonite and calcium carbonate	10	30
Silt, buff; contains some medium to fine sand	4	34
Silt, light gray, and dark-gray calcareous clay; contains nodules of calcium carbonate and streaks of limonite	5	39
Gravel, medium to fine, and coarse sand, partly cemented with calcium carbonate, interbedded with buff silt and gray clay	26	65
Silt, light and dark gray	10	75
Gravel, medium to coarse, and fine gravel	15	90
Gravel, medium to fine, and coarse to medium sand; contains thin beds of silt and nodules of calcium carbonate	27	117
Silt, buff; contains fine to coarse sand	3	120
Gravel, medium to fine and coarse to medium sand	26	146
PERMIAN—Leonardian		
Wellington formation		
Shale, gray and purple, calcareous	4	150

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119. *Sample log of test hole at the NE cor. sec. 16, T. 21 S., R. 3 W., McPherson County; drilled by State Geological Survey, 1939. Surface altitude, 1,440.8 feet. Drilling discontinued at 80 feet owing to loss of circulation.* (Samples studied by Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Soil, brown	3	3
Silt, buff to tan, and very fine to fine sand	12	15
Sand, medium to fine; contains some tan silt and clay	1.5	16.5
Silt, gray to buff, and very fine to fine sand; contains some gray clay	2.5	19
Silt, tan to buff; contains fine to very fine sand and nodules of calcium carbonate	7	26
Sand, medium to fine; most grains subangular and composed of quartz, but some are composed of pink and gray feldspar	13	39
Sand, medium to coarse; contains fine gravel and pebbles of caliche	10	49
Gravel, fine; well sorted	1	50
Sand, coarse to medium; most grains composed of quartz, but some are composed of pink and white feldspar and olive-green chert	15	65
Sand, coarse to medium, and fine gravel	15	80

120. *Sample log of test hole at the NW cor. sec. 17, T. 21 S., R. 3 W., McPherson County; drilled by State Geological Survey, 1939. Surface altitude, 1,472.3 feet.* (Samples studied by Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Soil, dark brown	6	6
Silt, brown to tan; contains very fine sand	17	23
Silt, buff, and gray calcareous clay; contains nodules of calcium carbonate	13	36
Sand, fine to medium; contains some silt and clay	2	38
Silt, buff, calcareous; contains very fine sand and nodules of calcium carbonate	6	44
Sand, medium to fine; most grains composed of quartz, but some composed of pink and white feldspar	6	50
Sand, medium to coarse, and some fine gravel; most grains composed of quartz, but some are composed of feldspar, caliche, and clay balls	12	62
Sand, medium to coarse, and fine to coarse gravel	3	65
Silt, gray, calcareous, and very fine to fine sand	3	68
Sand, medium to coarse, and fine to coarse gravel; contains pebbles of caliche	32	100
Gravel, fine to coarse; most pebbles composed of quartz, but some are composed of chert, feldspar, and caliche	3	103
Sand, coarse to medium, and fine to medium gravel;		

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	Thickness, feet	Depth, feet
contains pebbles of caliche and some calcareous gray clay		
Silt, calcareous, gray; contains very fine to fine sand..	16	136
Sand, coarse to medium, and fine gravel; contains some pebbles of shale and caliche	2	138
Silt, calcareous, buff; contains clay and fine sand	1	139
Sand, medium to coarse; contains pebbles of caliche	12	151
Sand, medium to coarse; and fine gravel	2	153
Sand, medium; contains some fine and coarse sand	5	158
Sand, coarse to medium, and fine to medium gravel	11	169
Gravel, fine to medium, and coarse sand; contains pebbles of caliche	2	171
Silt, calcareous, buff; contains nodules of calcium carbonate	20	191
Sand, coarse, and fine gravel	14	205
Gravel, fine to coarse, and coarse sand	4	209
Sand, medium to coarse, and fine gravel	1	213
PERMIAN—Leonardian		
Wellington formation		
Shale, calcareous, dark gray	7	220

121. *Sample log of test hole at the NW cor. sec. 18,T. 21 S., R. 3 W., McPherson County; drilled by State Geological Survey, 1945. Surface altitude, 1,450.6 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil	2	2
Silt, compact, gray to brown	12	14
Silt, buff, and very fine to fine sand	4	18
Sand, fine to coarse, interbedded with buff silt	9	27
Gravel, fine to medium, and coarse sand; contains some buff silt	23	50
Gravel, medium to fine, coarse to medium sand, and light-gray silt	14	64
Silt, tan, and very fine to fine sand	3	67
Gravel, fine; contains sand and silt	3	70
Gravel, medium to fine, and coarse sand	12	82
Silt, dark gray; contains fine sand	12	94
Gravel, fine to medium, and coarse sand	6	100
Silt, light gray; contains fine sand	10	110
Gravel, medium to fine, and coarse sand	17	127
Silt, brown to buff, and fine to very fine sand	5	132
Gravel, fine to medium, and coarse to medium sand; contains some gray silt	20	152
Silt and clay, buff; streaks cemented by calcium carbonate	15	167

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	Thickness, feet	Depth, feet
Silt and clay, buff; streaks cemented by calcium carbonate	15	167
Gravel, medium to fine, and coarse to medium sand; contains pebbles and fragments of shale	39	206
PERMIAN—Leonardian		
Wellington formation		
Shale, calcareous, light to dark gray	4	210

122. *Driller's log of well 204 in the SW¼ SE¼ SE¼ sec. 11, T. 21 S., R. 4 W., McPherson County; drilled by Wichita Pump and Supply Company for the City of Inman, 1935.*

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil	3	3
Clay, brown	11	14
Clay, gray	7	21
Clay, brown	1	22
Sand	1	23
Clay, brown	11	34
Clay, gray	8	42
Sand, medium to fine	18	60
Sand, medium to coarse, and fine gravel	20	80
Clay, sandy, gray	3	83
Sand, coarse	2	85

123. *Sample log of test hole at the NW cor. sec. 13, T. 21 S., R. 4 W., McPherson County; drilled by State Geological Survey, 1939. Surface altitude, 1,450.2 feet.* (Samples studied by Fred T. Holden.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil, brown	3	3
Silt and clay, dark gray	3	6
Silt, tan; contains nodules of calcium carbonate	10	16
Gravel; contains some silt	2	18
Silt and clay, tan; contains nodules of calcium carbonate	17	35
Sand, coarse	1	36
Silt, clay, and fine sand	1	37
Sand, medium to coarse, and fine gravel	23	60
Silt and clay, gray to tan	32	92
Sand, coarse to medium; contains balls of clay	2	94
Clay and silt, gray	8	102
Sand, coarse to medium, and fine gravel	63	165
Gravel; contains pebbles of green shale	13	178
Sand, coarse to medium	10	188
PERMIAN—Leonardian		
Wellington formation		
Shale, light gray; contains gypsum	4	192

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124. *Sample log of test hole in the SW¼ NW¼ NW¼ sec. 14, T. 21 S., R. 4 W., McPherson County; drilled by State Geological Survey, 1945.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil	4	4
Silt, gray, contains fine to medium sand	3	7
Silt, gray to tan; contains streaks and nodules of limonite	11	18
Silt, gray to yellow, and very fine to fine sand	15	33
Silt, buff; contains fine to coarse sand and pebbles of shale	5	38
Clay and silt, buff to tan	6	44
Silt, gray to tan, and fine to medium sand	2	46
Gravel, fine to medium, and coarse to medium sand	27	73
PERMIAN—Leonardian		
Wellington formation		
Shale, calcareous, light gray	5	78

125. *Sample log of test hole at the NW cor. sec. 15, T. 21 S., R. 4 W., McPherson County; drilled by State Geological Survey, 1939. Surface altitude, 1,448.0 feet.* (Samples studied by Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, dark brown	2	2
Silt and clay, dark gray to brown, and some very fine sand	3	5
Silt, light gray, calcareous; contains fragments of snail shells	5	10
Silt; contains large nodules of calcium carbonate and pebbles of red and green shale	1	11
PERMIAN—Leonardian		
Ninnescah shale		
Shale, greenish gray	3	14
Shale, brick red	.5	14.5

126. *Sample log of test hole at the NW cor. sec. 13, T. 21 S., R. 5 W., McPherson County; drilled by State Geological Survey, 1939. Surface altitude, 1,539.2 feet.* (Samples studied by Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, dark brown	4	4
Silt, calcareous, gray to buff, and very fine to fine sand,	4	8
Silt, buff to tan; contains very fine to fine sand and nodules of calcium carbonate	20	28
Silt, calcareous, buff; contains fine sand, pebbles of caliche, and some carbonaceous material	10	38
Silt, calcareous, buff; contains fine sand, pebles of caliche, and fragments of gray and red shale	1	39

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PERMIAN—Leonardian Ninnescah shale	*Thickness, feet*	*Depth, feet*
Shale, greenish gray	3	42
Shale, brick red	2	44

127. *Driller's log of well 253 at the SE cor. sec. 12, T. 22 S., R. 4 W., Reno County; drilled by Wichita Pump and Supply Company for the City of Buhler, 1938.*

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Silt, brown	8	8
Clay, gray	22	30
Clay, sandy, brown	17	47
Clay, gray, and fine sand	6	53
Sand, coarse to medium	11	64
Gravel and sand	1	65
Sand, packed hard	6	71
Sand, medium to coarse	26	97

128. *Driller's log of test hole at the NE cor. sec. 13, T. 22 S., R. 4 W., Reno County; drilled by Wichita Pump and Supply Company for the City of Buhler, 1938.*

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Silt	8	8
Clay	5	13
Clay, sandy	2	15
Clay	23	38
Clay, hard	2	40
Clay, and fine sand	10	50
Sand, fine	7	57
Sand, fine to medium	7	64
Gravel	1	65
Clay, sandy, blue	10	75
Clay, sandy, gray	14	89

129. *Driller's log of test hole in the NW¼ NW¼ NE¼ sec. 20, T. 22 S., R. 4 W., Reno County; drilled by Layne-Western Company for the City of Buhler, 1927.*

QUATERNARY—Recent Alluvium	*Thickness, feet*	*Depth, feet*
Silt	5	5
Clay, jointed	10	15
Clay	25	40
Clay, sandy	3	43
Clay	3	46
PERMIAN—Leonardian Ninnescah shale		
Shale	1	47

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130. *Driller's log of well 258 in the NE¼ SE¼ NE¼ sec. 20, T. 22 S., R. 4 W., Reno County; drilled by Layne-Western Company for the City of Buhler, 1927.*

QUATERNARY—Recent Alluvium	Thickness, feet	Depth, feet
Soil	5	5
Clay	7	12
Sand, fine, brown	3	15
Clay	21	36
Sand, fine	16	52
Clay, on shale	54	106

131. *Driller's log of test hole at the NE¼ SE¼ SE¼ sec. 20, T. 22 S., R. 4 W., Reno County; drilled by Layne-Western Company for the City of Buhler, 1927.*

QUATERNARY—Recent Alluvium	Thickness, feet	Depth, feet
Silt	3	3
Clay, sandy	7	10
Sand, fine, brown	5	15
Clay, sandy	25	40
Sand, fine	6	46
Clay, sandy	11	57
Sand, fine	8	65
Clay, red	25	90
Clay, sandy	8	98
Sand, on rock	2	100

132. *Driller's log of test hole at the NW cor. sec. 21, T. 22 S., R. 4 W., Reno County; drilled by Layne-Western Company for the City of Buhler, 1927.*

QUATERNARY—Recent Alluvium	Thickness, feet	Depth, feet
Silt and clay	39	39
Clay and gravel	2	41
PERMIAN—Leonardian		
Ninnescah shale		
Shale	1	42

133. *Sample log of test hole at the NW cor. NE¼ sec. 19, T. 22 S., R. 5 W., Reno County; drilled by Claude Price for the City of Hutchinson, November 1945. Surface altitude, 1,643.8 feet.* (Samples studied by C. K. Bayne and Charles C. Williams.)

QUATERNARY—Pleistocene and Recent Dune sand	Thickness, feet	Depth, feet
Sand, fine to medium; contains very fine sand and brown silt	2	2
Sand, fine to medium	12	14
Sand, fine to medium, and buff clay; contains some very fine sand	14	28
Sand, medium to very fine, and buff clay	10	38
Clay and silt, gray to brown; contains fine sand	28	66

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	Thickness, feet	Depth, feet
Sand, medium to fine	26	92
Clay, gray to brown; contains some caliche at base of interval	24	116
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red	1	117

134. *Sample log of test hole in the NE¼ SE¼ sec. 28, T. 22 S., R. 5 W., Reno County; drilled by Claude Price for the City of Hutchinson, November 1945. Surface altitude, 1,616.4 feet.* (Samples studied by Charles C. Williams.)

QUATERNARY—Pleistocene and Recent	Thickness, feet	Depth, feet
Dune sand		
Sand, medium to fine	29	29
Sand, medium to very fine; contains buff silt and clay	5	34
Sand, medium to fine, and tan silt and clay; contains very fine sand	31	65
Sand, fine to medium, and gray clay; contains some very fine sand	20	85
Sand, medium to fine; grains stained red brown	31	116
Clay, gray	2	118
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red	2	120

135. *Sample log of test hole at the NW cor. SW¼ sec. 30, T. 22 S., R. 5 W., Reno County; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,544.9 feet.* (Samples studied by Charles C. Williams.)

QUATERNARY—Pleistocene	Thickness, feet	Depth, feet
McPherson formation		
Soil, very sandy	3	3
Clay, gray to tan; contains some fine to medium sand	8	11
Gravel, coarse to fine; contains some coarse to medium sand	9	20
Gravel, medium to coarse, and fine gravel	8	28
Gravel, fine to coarse; contains coarse sand	4	32
Gravel, coarse to fine; contains some coarse sand	2	34
PERMIAN—Leonardian		
Ninnescah shale		
Shale, gray green and brick red	1	35

136. *Sample log of test hole at the SW cor. SE¼ sec. 30, T. 22 S., R. 5 W., Reno County; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,540.5 feet.* (Samples studied by Charles C. Williams.)

QUATERNARY—Pleistocene	Thickness, feet	Depth, feet
McPherson formation		
Soil, very sandy, brown	3	3
Sand, fine to medium, and gray clay	5	8

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	Thickness, feet	Depth, feet
Clay, gray	4	12
Gravel, fine to coarse, and coarse sand	6	18
Sand, coarse to medium, and fine to medium gravel	7	25
Gravel, fine to medium, and coarse to medium sand	6	31
Gravel, fine to medium, coarse to fine sand; poorly sorted	3	34
PERMIAN—Leonardian		
Ninnescah shale		
Shale, brick red	1	35

137. *Sample log of test hole at the NE cor. SE¼ sec. 31, T. 22 S., R. 5 W., Reno County; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,536.7 feet.* (Samples studied by Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, very sandy	3	3
Silt and clay; contains fine to medium sand	8	11
Sand, medium to fine; contains some gravel and silt; very poorly sorted	3	14
Gravel, fine to medium, and coarse to fine sand	6	20
Gravel, coarse to fine; contains some coarse to medium sand	14	34
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red	1	35

138. *Sample log of test hole at the SE cor. sec. 32, T. 22 S., R. 5W., Reno County; drilled by Claude Price for the City of Hutchinson, October 1945... Surface altitude, 1,533.7 feet.* (Samples studied by Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, very sandy, brown	4	4
Clay and silt, gray to tan; contains fine sand	4	8
Clay and silt, gray to blue gray; interval contains thin layers of fine sand	8	16
Gravel, fine to medium, and coarse sand	15	31
PERMIAN—Leonardian		
Ninnescah shale		
Shale, gray green and brick red	2	33

139. *Sample log of test hole at the NW cor. sec. 18, T. 23 S., R. 1 E., Harvey County; drilled by State Geological Survey, 1945. Surface altitude, 1,437.3 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil	2	2
Silt, dark gray	1	3

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	Thickness, feet	*Depth, feet*
Silt and clay, dark and light gray; contains medium to fine gravel and coarse to fine sand	11	14
Silt and clay, tan to gray	3	17
Gravel, medium to fine, and coarse to medium sand	2	19
Silt, light gray to buff	7	26
Gravel, medium to fine; contains coarse to fine sand and light-gray silt	1	27
PERMIAN—Leonardian		
Wellington formation		
Shale, calcareous, light gray	3	30

140. ***Sample log of test hole in the SE¼ SW¼ sec. 7, T. 23 S., R. 1 W., Harvey County; drilled by State Geological Survey, 1945.*** (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	*Depth, feet*
QUATERNARY—Pleistocene		
McPherson formation		
Soil	2	2
Silt, tan; contains some fine to medium gravel and coarse sand	5	7
Silt and clay, tan to light gray; contains some fine to coarse sand and nodules of calcium carbonate	11	18
Gravel, fine to coarse, and coarse to medium sand	5	23
Silt and clay, tan to light gray; contains some fine to medium sand interval includes several zones in which the material is cemented by calcium carbonate	8	31
Gravel, fine to medium, and coarse to medium sand	1	32
Silt, light gray to tan	11	43
Clay and silt, green gray to tan	5	48
Silt, buff, and very fine to medium sand	8	56
Gravel, fine to medium, and coarse to medium sand	12	68
Silt, gray to buff, and fine to medium sand	4	72
Gravel, fine to coarse, and coarse to medium sand; interval includes several thin zones in which the material is cemented by calcium carbonate	6	78
Silt, brown to gray; contains nodules of calcium carbonate	2	80
Gravel, fine to medium, coarse to medium sand, and dark-gray silt; material partly cemented by calcium carbonate	7	87
PERMIAN—Leonardian		
Wellington formation		
Shale, dark gray	3	90

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141. *Sample log of test hole at the SW cor. sec. 9, T. 23 S., R. 1 W., Harvey County; drilled by State Geological Survey, 1939. Surface alttitude, 1,416.5 feet.* (Samples studied by Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil, brown	2	2
Silt, tan, and very fine to fine sand	4	6
Silt, buff to tan, coarse to fine sand, and fine gravel,	3	9
Silt, buff: contains very fine to fine sand	7	16
Silt, buff, and medium to coarse sand	6	22
Silt, buff, and very fine to fine sand	1	23
Sand, medium to coarse	2	25
Sand, coarse, and fine gravel; contains some fine sand; most grains composed of quartz, but some are composed of feldspar and chert	1	26
Gravel, fine to coarse, and coarse to medium sand	2	28
Sand, medium to fine; contains coarse sand	5	33
Gravel, fine to coarse, and coarse to fine sand; contains many fragments of limestone	1	34
Silt, tan, and very fine to fine sand	11	45
PERMIAN—Leonardian Wellington formation		
Limestone, argillaceous, thin bedded, light grey	3	48
Shale, calcareous, light gray	7	55
Shale, green gray	5	60

142. *Sample log of test hole at the SW cor. sec. 11, T. 23 S., R. 1 W., Harvey County; drilled by State Geological Survey, 1939. Surface altitude, 1,442.4 feet.* (Samples studied by Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil, tan	3	3
Sand, medium to coarse; contains fine sand and fine gravel	4	7
Sand, coarse to medium, and fine gravel	7	14
Sand, fine to medium, and calcareous gray silt and clay,	4	18
Sand, medium to fine	3	21
Silt, gray	4	25
PERMIAN—Leonardian Wellington formation		
Shale, calcareous, gray; contains gypsum	5	30

143. *Sample log of test hole at the NW cor. sec. 13, T. 23 S., R. 1 W., Harvey County; drilled by State Geological Survey, 1939. Surface altitude, 1,452.6 feet.* Samples studied by Fred T. Holden.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil, dark gray	5	5
Clay and silt, sandy, light gray	2	7
Sand, fine to medium	7	14
Sand and gravel, contains clay balls	7	21

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	Thickness, feet	Depth, feet
Clay and silt, sandy, yellow and gray; contains lime nodules	9	30
Clay and silt, sandy, gray and yellow	6	36
Sand, fine; contains clay and silt	4	40
Sand and gravel; contains fragments of brown sandstone and shale	3	43
PERMIAN—Leonardian		
Wellington formation		
Shale, green	7	50

144. *Sample log of test hole at the NW cor. sec. 15, T. 23 S., R. 1 W., Harvey County; drilled by State Geological Survey, 1939. Surface altitude, 1,422.7 feet.* (Samples studied by Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil, dark brown	3	3
Silt, buff to tan; contains some very fine sand	5	8
Sand, medium to fine; contains some coarse sand	1	9
Silt, buff to tan, and very fine sand; contains some coarse sand and fine gravel	7	16
Sand, coarse to medium; contains fine gravel; most grains and pebbles composed of quartz, but some are composed of feldspar	3	19
Gravel, fine to coarse, and coarse to medium sand	2	21
Clay and silt, gray to buff	5	26
Clay, gray, calcareous; contains nodules of calcium carbonate	2	28
Silt, gray, calcareous, and very fine to fine sand	2	30
Sand, coarse to fine, and gray calcareous silt; contains nodules of calcium carbonate	3	33
Sand, coarse to medium	4	37
Sand, medium to coarse, gray to tan silt, and gray clay; sample very poorly sorted	5	42
Sand, coarse to medium; contains pebbles of shale, quartzite, and fragments of bone	1	43
PERMIAN—Leonardian		
Wellington formation		
Shale, light gray	7	50

145. *Sample log of test hole at the NW cor. sec. 17, T. 23 S., R. 1 W., Harvey County; drilled by State Geological Survey, 1945. Surface altitude, 1,416.5 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil	2	2
Silt and clay, tan; contains some fine to medium sand and nodules of calcium carbonate	8	10
Silt, tan to light gray; contains some coarse to fine sand	7	17

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	Thickness, feet	Depth, feet
Sand, coarse to fine, and tan to light-gray silt; contains some fine gravel	5	22
Silt and clay, light gray	1	23
Sand, coarse to fine; contains medium to fine gravel	7	30
Gravel, fine to medium, and coarse to medium sand; contains some light-gray silt	12	42
Silt and clay, light gray to buff; contains fine to coarse sand and nodules of calcium carbonate	14	56
Sand, coarse to fine; contains fine gravel and light-gray to brown silt	4	60
PERMIAN—Leonardian		
Wellington formation		
Shale, light to dark gray	4	64

146. *Sample log of test hole at the NW cor. sec. 18, T. 23 S., R. 1 W., Harvey County; drilled by State Geological Survey, 1939. Surface altitude, 1,428.9 feet.* (Samples studied by Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, dark brown	2	2
Silt, tan; contains some very fine to coarse sand	2	4
Sand, fine to medium	5	9
Sand, medium to fine; contains some fine to coarse gravel; very poorly sorted; larger pebbles composed of limestone, shale, and ironstone	12	21
Sand, fine to medium; contains coarse sand	4	25
Sand, coarse to fine; contains fine to coarse gravel; larger pebbles composed of shale	3	28
Silt, calcareous, buff; contains very fine to fine sand	7	35
Sand, medium to coarse	2	37
Sand, fine to coarse, and fine to coarse gravel; larger pebbles composed of shale, ironstone, and limestone,	1	38
Silt, calcareous, buff; contains some very fine to fine sand	6	44
Sand, medium to fine; contains coarse sand and fine to to coarse gravel; larger pebbles composed of shale, ironstone, and limestone	2	46
Calcium carbonate and caliche	.5	46.5
Sand, fine to medium; contains fine to coarse gravel; larger pebbles composed of shale, ironstone, and limestone	32.5	79
Sand, medium to coarse; contains many fragments and pebbles of shale	5	84
PERMIAN—Leonardian		
Wellington formation		
Shale, calcareous, gray	36	120

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147. *Sample log of well 285 at the NE cor. sec. 27, T. 23 S., R. 1 W., Harvey County; drilled for Mr. Park Richardson by C. Hertzler, 1944. Surface altitude, 1,433.6 feet.* (Samples studied by Charles C. Williams.)

	Thickness, feet	*Depth, feet*
QUATERNARY—Pleistocene		
McPherson formation		
Soil, dark brown	3	3
Silt, tan, and very fine to fine sand	9	12
Sand, medium to coarse; contains buff silt	6	18
Silt, tan; contains some very fine to fine sand; large core sample contains calcium carbonate nodules up to 1 inch in diameter	4	22
Sand, coarse to fine; contains fine gravel	9	31
Sand, fine to coarse; contains fine gravel	15	46
Sand, coarse to fine, and fine gravel; contains fragments of green and gray shale	1	47

148. *Sample log of test hole at the NE cor. SE¼ sec. 28, T. 23 S., R. 1 W., Harvey County; drilled by State Geological Survey, 1944. Surface altitude, 1,410.2 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	*Depth, feet*
QUATERNARY—Pleistocene		
McPherson formation		
Silt and clay, yellow and gray	3	3
Silt, greenish gray to buff; contains thin layer of sand and gravel	16	19
PERMIAN—Leonardian		
Wellington formation		
Shale, calcareous, gray and maroon	5	24

149. *Driller's log of test hole in the SW¼ NE¼ sec. 31, T. 23 S., R. 1 W., Harvey County; drilled by Kelly Well Company for the City of Newton, 1940. Surface altitude, 1,409 feet.*

	Thickness, feet	*Depth, feet*
QUATERNARY—Pleistocene and Recent		
Dune sand		
Silt, tan, sandy	3	3
Sand, fine to medium	6	9
Silt, tan; contains thin layers of fine sand	3	12
McPherson formation (Pleistocene)		
Silt and clay, tan	15	27
Silt and clay, gray	16	43
Sand, fine to medium	5	48
Sand, fine to coarse	16	64
Silt, gray, sandy	2	66
Sand, fine to medium	24	90
Sand, fine to coarse	8	98
Sand, fine to medium; contains thin layers of clay	8	106
Sand, fine to coarse	15	121
Silt and clay, tan	11	132
Silt and clay, sandy	6	138
Sand, fine to medium	10	148

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PERMIAN—Leonardian Wellington formation	Thickness, feet	Depth, feet
Shale, blue gray	3	151

150. *Driller's log of test hole in the NE cor. sec. 32, T. 23 S., R. 1 W., Harvey County; drilled by Kelly Well Company for the City of Newton, 1940. Surface altitude, 1,401 feet.*

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Silt and clay, sandy	28	28
Sand, fine to medium	3	31
Sand, fine to coarse	18	49
Silt and clay, gray	1	50
Sand, fine to medium	7	57
Sand, fine to coarse; contains thin layers of silt and clay,	28	85
Sand, fine to medium	12	97
Silt and clay, tan	4	101
Silt and clay, gray	4	105
PERMIAN—Leonardian Wellington formation		
Shale, gray green	10	115

151. *Driller's log of city-supply well 291 in the NW¼ NW¼ sec. 32, T. 23 S., R. 1 W., Harvey County; drilled by Kelly Well Company for the City of Newton, 1936.*

QUATERNARY—Pleistocene and Recent Alluvium and McPherson formation	Thickness, feet	Depth, feet
Silt and clay	5	5
Clay and silt, sandy	7	12
Sand, fine	2	14
Clay, black	8	22
Silt and sand	13	35
Silt and clay, sandy	18	53
Sand, fine	12	65
Silt and clay, sandy	10	75
Sand, fine to coarse	7	82
Clay, hard	2	84
Sand and gravel	7	91
Clay, hard, red	7	98
Sand, fine to coarse, contains clay balls	17	115
Sand, coarse to fine	9	124
PERMIAN—Leonardian Wellington formation		
Shale	1	125

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152. *Driller's log of city-supply well 293 in the NW¼ NW¼ sec. 32, T. 23 S., R. 1 W., Harvey County; drilled by Layne-Western Company for the City of Newton, 1928.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt and clay	18	18
Sand	5	23
Silt and clay	10	33
Sand	8	41
Silt and clay	22	63
Gravel	3	66
Silt and clay	3	69
Sand	61	130
PERMIAN—Leonardian		
Wellington formation		
Shale	2	132

153. *Driller's log of city-supply well 294 in the SE¼ NW¼ sec. 32, T. 23 S., R. 1 W., Harvey County; drilled for the City of Newton, 1941.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Alluvium and McPherson formation		
Silt, and sand, fine	15	15
Silt, gray	5	20
Silt and clay, sandy	10	30
Sand	5	35
Sand and silt	3	38
Sand	14	52
Silt and clay, buff	8	60
Sand; contains silt	5	65
Sand	13	78
Sand and gravel	17	95
Sand and silt	7	102
Sand	7	109
Sand, medium	16	125
PERMIAN—Leonardian		
Wellington formation		
Shale, gray	5	130

154. *Driller's log of city-supply well 295 in the SW¼ NW¼ sec. 32, T. 23 S., R. 1 W., Harvey County; drilled for the City of Newton, 1941.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Dune sand		
Sand, fine, and silt	5	5
Clay, sandy	3	8
Sand	1	9
Clay	6	15
Sand	5	20
McPherson formation (Pleistocene)		
Sand and gravel	8	28
Silt, gray	2	30

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	Thickness, feet	Depth, feet
Silt, yellow	16	46
Sand and silt	2	48
Sand, fine	8	56
Silt and clay, tan	5	61
Sand	4	65
Silt and clay, tan	8	73
Silt and sand	10	83
Sand, tan	5	88
Silt and sand	3	91
Sand, medium	36	127
Sand and gravel	5	132
PERMIAN—Leonardian		
Wellington formation		
Shale, gray	7	139

155. *Sample log of test hole at the SE cor. NE¼ sec. 32, T. 23 S., R. 1 W., Harvey County; drilled by State Geological Survey, 1944. Surface altitude, 1,399.5 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt and clay, light brown	4	4
Silt, buff; contains medium to fine sand; contains some gravel near base	12	16
Silt, buff; contains medium to fine sand	10	26
Gravel, fine to medium, and coarse to medium sand; contains some silt in lower part	34	60
Gravel, fine, and coarse to medium sand; contains some greenish-gray clay	5	65
Gravel, medium to fine, and coarse to medium sand, interbedded with greenish-gray clay	5	70
Gravel, fine and coarse to medium sand	18	88
Silt, buff	5	93
Sand, coarse to fine; contains some fine to medium gravel	5	98
PERMIAN—Leonardian		
Wellington formation		
Shale, greenish gray to white, calcareous	2	100
Shale, dark gray	2	102

156. *Sample log of test hole at the NW cor. NE¼ sec. 33, T. 23 S., R. 1 W., Harvey County; drilled by State Geological Survey, 1944. Surface altitude, 1,410.1 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, dark gray	2	2
Silt and clay, dark to light gray	6	8
Sand, coarse to fine, and light-gray silt	4	12
Silt and clay, light gray and buff	18	30

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	Thickness, feet	Depth, feet
Silt, gray to buff, and coarse to fine sand	9	39
Sand, coarse to fine, and buff silt	11	50
Sand, coarse to fine; contains fine gravel	22	72
Sand, coarse to fine, partly cemented by calcium carbonate	13	85
PERMIAN—Leonardian		
Wellington formation		
Shale, thinly bedded, blue gray	5	90

157. *Sample log of well 296 in the NE¼ SE¼ NE¼ sec. 34, T. 23 S., R. 1 W., Harvey County; drilled by C. Hertzler, 1944. Surface altitude, 1,429.6 feet.* (Samples studied by Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil; brown silt and sand which contains a few pebbles of gravel	3	3
Silt, brown, and very fine to medium sand	5	8
Sand, coarse to fine; contains brown silt and fine gravel,	2	10
Sand, fine to coarse, and buff silt	10	20
Silt, very calcareous, light gray	5	25
Silt, very calcareous, buff, contains remains of plants	15	40
PERMIAN—Leonardian		
Wellington formation		
Shale, gray		

158. *Sample log of test hole at the SW cor. sec. 7, T. 23 S., R. 2W., Harvey County; drilled by State Geological Survey, 1945. Surface altitude, 1,442.4 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Dune sand		
Sand, medium to fine; contains some buff to gray silt,	22	22
McPherson formation (Pleistocene)		
Silt, tan to gray, and medium to fine sand	7	29
Silt and clay, buff; contains nodules of calcium carbonate	6	35
Silt and clay, light gray to buff	28	63
Gravel, fine, and coarse to medium sand	7	70
Gravel, fine to medium, and coarse sand	8	78
Silt and clay, light gray	5	83
Gravel, fine to medium, and coarse sand; contains light-gray silt	7	90
Gravel, fine, and coarse to medium sand	24	114
Silt, light to dark gray; contains some fine sand	6	120
Silt, dark gray	36	156
Gravel, medium to fine, and coarse to medium sand; contains some light-gray silt	52	208
PERMIAN—Leonardian		
Wellington formation		
Shale, light gray and maroon	7	215
Shale, dark gray	2	217

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159. *Sample log of test hole at the SW cor. sec. 10, T. 23 S., R. 2 W., Harvey County; drilled by State Geological Survey, 1939. Surface altitude, 1,400.5 feet.* (Samples studied by Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Alluvium (Recent)		
Soil, dark brown	4	4
Silt, buff to tan	6	10
Silt, dark gray to brown; contains very fine sand	5	15
Silt, buff; contains fine to very fine sand	2	17
Silt, light gray; contains fine to very fine sand	3	20
McPherson formation (Pleistocene)		
Sand, fine to medium, well sorted	3	23
Sand, medium to fine; contains some coarse sand and some fine gravel	9	32
Sand, coarse to medium; contains fine gravel	13	45
Sand, coarse to fine; contains some fine gravel	3	48
Gravel, fine, and coarse sand; contains medium sand and medium gravel	2	50
Clay, gray, and calcareous buff silt; contains some fine sand	10	60
Silt, buff, calcareous, and fine to medium sand	10	70
Sand, medium to fine	2	72
Sand, coarse to medium, and fine gravel	3	75
Silt, buff, and calcareous gray clay; contains some fine sand	14	89
Sand, medium to fine; contains coarse sand	11	100
Sand, fine	3	103
Sand, medium to coarse; contains fine sand	5	108
Sand, coarse to medium; contains fine gravel	8	116
Sand, coarse, and fine gravel	4	120
Sand, medium to fine; contains coarse sand	4	124
Sand, medium; contains coarse sand and fine gravel; larger pebbles composed of ironstone and shale	4	128
Gravel, fine to coarse, and coarse to medium sand; larger pebbles composed of siltstone, shale, and ironstone	2	130
Sand, medium to fine	2	132
Sand, coarse, and fine gravel; contains fragments of shale	1	133
PERMIAN—Leonardian		
Wellington formation		
Shale, calcareous, dark gray	7	140

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160. *Sample log of test hole at the NW cor. sec. 13, T. 23 S., R. 2 W., Harvey County; drilled by State Geological Survey, 1945. Surface altitude, 1,438.9 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil	3	3
Clay and silt, light gray; contains nodules of calcium carbonate and streaks of limonite	24	27
Clay and silt, dark gray	58	85
Sand, coarse to fine; contains pebbles and fragments of shale and some dark-gray clay	8	93
Clay, light gray; contains fragments of shale	15	108
PERMIAN—Leonardian		
Wellington formation		
Shale, yellowish gray to light gray	5	113
Shale, dark gray	2	115

161. *Sample log of test hole at the NE cor. sec. 15, T. 23 S., R. 2 W., Harvey County; drilled by State Geological Survey, 1939. Surface altitude, 1,434.1 feet.* (Samples studied by Fred T. Holden.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, dark brown	2	2
Clay and silt, tan	6	8
Sand, tan	5	13
Clay and silt, sandy, dark to light gray	57	70
Clay and silt, dark gray	22	92
PERMIAN—Leonardian		
Wellington formation		
Shale, dark gray	8	100

162. *Sample log of test hole at the NW cor. sec. 16, T. 23 S., R. 2 W., Harvey County; drilled by State Geological Survey, 1939. Surface altitude, 1,402.9 feet.* (Samples studied by Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Alluvium (Recent)		
Soil, sandy, brown	2	2
Silt, buff, and very fine to medium sand	4	6
Silt, buff to gray, and very fine sand	12	18
Silt, gray	5	23
McPherson formation (Pleistocene)		
Sand, medium to fine, and some coarse sand	5	28
Sand, fine to medium	12	40
Sand, medium; contains some coarse sand	25	65
Sand, medium to coarse	10	75
Sand, fine to medium	15	90
Sand, medium	8	98
Sand, medium to coarse	32	130
Sand, coarse to medium	10	140

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	Thickness, feet	Depth, feet
Sand, coarse, and fine gravel	12	152
Gravel, medium; contains fragments of gray shale	4	156
PERMIAN—Leonardian		
Wellington formation		
Shale, dark gray	24	180

163. *Sample log of test hole at the NW cor. sec. 17, T. 23 S., R. 2 W., Harvey County; drilled by the City of Wichita, 1939. Surface altitude, 1,406.8 feet.* (Samples studied by Fred T. Holden.)

QUATERNARY—Pleistocene and Recent	Thickness, feet	Depth, feet
Dune sand		
Sand, fine, and tan to gray silt	13	13
McPherson formation (Pleistocene)		
Silt and clay, light to dark gray	17	30
Sand, fine, and brown silt and clay	13	43
Silt and clay, tan to gray	25	68
Sand, fine, and brown and tan silt	7	75
Sand, medium to fine; contains pebbles of shale and nodules of calcium carbonate	7	82
Silt and clay, dark gray	10	92
Sand, fine to medium	22	114
Silt and clay; contains sand	9	123
Sand; contains clay balls and ferruginous sandstone pebbles	14	137
Silt and clay, tan to gray	6	143
Sand; contains clay balls and nodules of calcium carbonate	21	164
Silt and clay, light gray	1	165
PERMIAN—Leonardian		
Wellington formation		
Shale, maroon	1	166
Gypsum	.5	166.5
Shale, maroon and dark gray	7.5	174

164. *Driller's log of test hole at the NW cor. sec. 20, T. 23 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,429 feet.* (Courtesy Black and Veatch, engineers.)

QUATERNARY—Pleistocene	Thickness, feet	Depth, feet
McPherson formation		
Top soil	5	5
Clay	15	20
Clay and sand	5	25
Clay	25	50
Clay and gravel	10	60
Sand	5	65
Clay and sand	5	70
Sand	5	75
Sand, coarse	5	80

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	Thickness, feet	Depth, feet
Clay and sand	20	100
Clay	30	130
Clay and sand	35	165
Sand	15	180
Clay	5	185
PERMIAN—Leonardian		
Wellington formation		
Clay and shale	15	200

165. *Driller's log of test hole at the NW cor. SW¼ sec. 20, T. 23 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,432 feet.* (Courtesy Black and Veatch, engineers.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Top soil	12	12
Sand, coarse	22	34
Clay	41	75
Gravel, fine	41	116
Clay	42	158
Sand, fine	5	163
Sand, coarse	29	192
Sand, hard	6	198
Gravel	3	201
Sand, fine	7	208
PERMIAN—Leonardian		
Wellington formation		
Clay and shale	6	214

166. *Sample log of test hole drilled at the SW cor. sec. 20, T. 23 S., R. 2 W., Harvey County; drilled by the City of Wichita, 1938. Surface altitude, 1,430.8 feet.* (Samples studied by B. F. Latta and Fred T. Holden.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Silt, dark gray to buff	7	7
Sand, very fine to medium, and buff silt	7	14
Sand, fine to coarse, and tan silt	6	20
Sand, medium to coarse, and fine gravel	5	25
Silt and clay, tan to dark gray	33	58
Sand, fine, and dark-gray silt	8	66
Sand; contains clay balls	4	70
Silt and clay, gray	18	88
Sand and silt; contains clay balls, bone fragments, and gravel	45	133
Sand, fine, and gray silt	11	144
Sand, coarse to medium	8	152
Sand, fine to coarse	5	157
Silt and clay, gray to tan	48	205
Sand, medium to coarse	14	219

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	Thickness, feet	Depth, feet
Gravel, fine, and coarse sand	6	226
Sand, medium to coarse; contains clay balls and shale pebbles	16	242
PERMIAN—Leonardian		
Wellington formation		
Shale, blue gray; contains gypsum	4	246

167. *Sample log of test hole at the NW cor. NE¼ sec. 28, T. 23 S., R. 2 W., Harvey County, drilled by the City of Wichita, 1938. Surface altitude, 1,397.9 feet.* (Samples studied by Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Alluvium and McPherson formation		
Soil; composed of brown silt and very fine to fine sand,	3	3
Sand, fine to coarse, and fine to medium gravel	3	6
Sand, medium to fine, and coarse sand	1	7
Silt, gray, and very fine to fine sand	3	10
Silt and clay, gray; contains very fine to fine sand	9	19
Sand, very fine to fine, and light-gray silt	2	21
Sand, coarse to medium; contains some fine gravel	11	32
Gravel, fine to medium, and coarse to medium sand; contains some silt and gray clay	6	38
Gravel, fine, and coarse sand; well sorted	4	42
Gravel, medium to fine, and coarse sand; contains fragments of bone	5	47
Silt, gray to buff, and very fine to fine sand; contains remains of plants	2	49
Gravel, fine, and coarse sand; well sorted	4	53
Gravel, fine to coarse, and coarse to medium sand; contains fragments of silt and clay balls	5	58
Sand, coarse, and fine to medium gravel	4	62
Silt, calcareous, gray to buff, and very fine to medium sand; contains nodules of calcium carbonate	4	66
Sand, fine to coarse; contaains gray silt and nodules of calcium carbonate	7	73
Sand, very fine to coarse; contains some calcareous gray silt	17	90
Sand, coarse to medium, and fine to coarse gravel; contains some fragments of silt and clay balls; some pebbles composed of ironstone, chert, and shale	6	96
Gravel, fine to medium, and coarse to medium sand; most grains and pebbles composed of quartz, but some are feldspar, chert, ironstone, and shale	3	99
Silt, buff to gray, and very fine to medium sand	2	101
Gravel, fine, and coarse to medium sand; contains some pebbles of chert, ironstone, and shale	5	106
Sand, very fine to coarse; contains some buff silt	7	113
Sand, fine to coarse, and fine gravel; contains fragments of reddish-buff clay balls	5	118

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	Thickness, feet	Depth, feet
Sand and gravel	95	170
Silt and clay, blue gray	10	180
Sand and gravel	23	203
Silt and clay, dark gray	4	207
Sand and gravel	31	238
PERMIAN—Leonardian		
Wellington formation		
Shale, blue gray	3	241

173. *Sample log of test hole at the SE cor. sec. 31, T. 23 S., R. 2 W., Harvey County; drilled by the City of Wichita, 1938. Surface altitude, 1,431.2 feet.* (Samples studied by Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil; composed of brown silt, and very fine to medium sand	4	4
Sand, very fine to medium, and tan silt	11	15
Sand, coarse to medium, and fine to medium gravel	8	23
Sand, fine to coarse; contains fine gravel	1	24
Sand, coarse to medium, and fine to coarse gravel	1	25
Gravel, fine to coarse, and coarse sand	5	30
Silt, buff, and very fine to medium sand	6	36
Sand, medium to coarse; contains fine to medium gravel,	6	42
Gravel, fine to medium, and coarse to medium sand	3	45
Gravel, fine to coarse; contains coarse sand	2	47
Sand, coarse to medium, and fine gravel	2	49
Silt and clay, buff to tan	4	53
Gravel, medium to fine, and coarse sand	3	56
Sand, coarse to medium, and fine to coarse gravel; contains fragments of silt and clay balls	1	57
Gravel, fine to coarse, and coarse sand; contains pebbles up to 15 mm in diameter	4	61
Gravel, medium to coarse; contains some fine gravel	4	65
Gravel, fine to coarse, and coarse sand; contains many fragments of silt and clay balls	3	68
Sand, coarse to fine, and fine to medium gravel	1	69
Gravel, fine to medium, and coarse sand	3	72
Gravel, fine to coarse; contains coarse sand	2	74
Silt, buff, and very fine to fine sand	6	80
Silt, gray to buff; contains very fine to fine sand	12	92
Silt, tan	3	95
Gravel, fine, and coarse to medium sand	5	100
Gravel, fine to medium, and coarse sand	4	104
Sand, medium to coarse; contains fine gravel and fragments of silt and clay balls	3	107
Sand, medium to fine; contains some coarse sand	1	108
Silt, buff, and very fine to fine sand	1	109
Sand, coarse to medium; contains fine gravel	8	117

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	Thickness, feet	Depth, feet
Sand, medium to fine; contains some coarse sand.....	3	120
Gravel, fine to medium, and coarse sand	5	125
Silt and clay, calcareous, light gray; contains nodules of calcium carbonate	6	131
Silt, calcareous, gray; contains very fine to fine sand...	6	137
Silt, very calcareous, gray to buff	21	158
Silt and clay, calcareous, dark gray; contains nodules of calcium carbonate	1	159
Silt and clay, calcareous, gray to buff, and very fine to fine sand	11	170
Silt and clay, calcareous, bluish gray, and very fine to fine sand	7	177
Clay and silt, calcareous, dark gray	3	180
Silt and clay, buff to gray; contains very fine to fine sand	2	182
Sand, coarse to medium, and fine gravel	1	183
Gravel, fine to medium, and coarse sand; most pebbles composed of quartz, but some are pink and white feldspar, chert, and shale.....	3	186
Gravel, fine to medium, and coarse to medium sand..	4	190
Sand, coarse to medium; well sorted	1	191
Gravel, fine to medium, and coarse sand	12	203
Sand, coarse, and fine to medium gravel	12	215
Gravel, fine, and coarse sand	3	218
Sand, coarse to medium, and fine to medium gravel,	1	219
Gravel, fine to medium, and coarse sand	7	226
Silt, gray, and very fine to medium sand	11	237
Sand, coarse to medium, and fine to medium gravel..	12	249
Gravel, fine to medium, and coarse sand; contains some buff silt	4	253
Silt and clay, gray to buff	1	254
PERMIAN—Leonardian		
Wellington formation		
Shale, calcareous, soft, dark gray; weathered zone....	2	256
Shale, calcareous, dark gray	4	260

174. *Driller' log of test hole at the NW cor. NE¼ sec. 32, T. 23 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,426 feet.* (Courtesy Black and Veatch, engineers.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil	15	15
Sand, coarse	15	30
Clay and gravel.....	35	65
Sand, fine	35	100
Sand, coarse	40	140
Clay and gravel.....	10	150

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	Thickness, feet	Depth, feet
Sand	65	215
Sand, coarse	10	225
PERMIAN—Leonardian		
Wellington formation		
Clay and shale	13	238

175. *Driller's log of test hole at the NW cor. sec. 32, T. 23 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,432 feet.* (Courtesy Black and Veatch, engineers.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Top soil	10	10
Sand, fine	15	25
Clay	35	60
Sand, coarse	90	150
Clay, sandy	30	180
Clay	10	190
Sand, fine	30	220
Clay and sand	25	245
PERMIAN—Leonardian		
Wellington formation		
Shale	4	249

176. *Driller's log of test hole at the NW cor. SW¼ sec. 32, T. 23 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,432 feet.* (Courtesy Black and Veatch, engineers.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil	10	10
Sand	55	65
Sand, coarse	25	90
Clay	20	110
Sand, fine	10	120
Clay	20	140
Clay, sandy	35	175
Clay, blue	25	200
Sand	45	245
PERMIAN—Leonardian		
Wellington formation		
Shale	2	247

177. *Driller's log of Wichita city-supply well 330 at the NW cor. SW¼ sec. 32, T. 23 S., R. 2 W., Harvey County; drilled by Layne-Western Company, 1939. Surface altitude, 1,431.0 feet.*

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil, sandy, gray to brown	2	2
Silt and clay, brown	13	15
Sand, fine, tan	5	20

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	Thickness, feet	Depth, feet
Silt and clay, yellow brown	1	21
Sand, stained tan; contains clay balls	34	55
Sand, fine, and gray to tan silt	25	80
Sand and gravel	15	95
Sand, fine	15	110
Sand, fine, and buff to tan silt	45	155
Silt and clay, gray to tan	15	170
Sand, fine, and gray silt	10	180
Sand, coarse	22	202
Silt and clay, blue gray	6	208
Sand	31	239
PERMIAN—Leonardian		
Wellington formation		
Shale, blue gray	3	241

178. *Driller's log of Wichita city-supply well 333 at the SW cor. sec. 32, T. 23 S., R. 2 W., Harvey County; drilled by Layne-Western Company, 1939. Surface altitude, 1,413 feet.*

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil, sandy, dark brown	3	3
Sand, fine, and gray to tan silt	17	20
Sand, coarse	35	55
Sand and gravel; contains thin beds of clay	45	100
Sand, coarse	7	107
Sand and gravel	13	120
Silt and clay, blue gray	10	130
Sand, coarse	18	148
Silt and clay, blue and tan	24	172
Sand, fine, and gray to tan silt	12	184
Sand and gravel	73	257
PERMIAN—Leonardian		
Wellington formation		
Shale, blue gray	2	259

179. *Driller's log of city-supply well 339 in the SW¼ NW¼ sec. 35, T. 23 S., R. 2 W., Harvey County; drilled by Kelly Well Company for the City of Halstead, 1928.*

QUATERNARY—Pleistocene and Recent Alluvium and McPherson formation	Thickness, feet	Depth, feet
Silt and clay	20	20
Sand, fine	8	28
Sand	9	37
Sand and silt	3	40
Sand, coarse	3	43
Silt and clay	3	46
Sand	8	54
Silt and clay, sandy	15	69

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	Thickness, feet	Depth, feet
Clay	4	73
Sand, fine	3	76
Silt and clay	1	77
Sand, fine	3	80
Silt and clay, sandy	3	83
Clay	2	91
Sand, coarse	5	96
Sand, medium (on hard clay)	10	106

180. *Driller's log of city-supply well 340 in the NW¼ SW¼ sec. 35, T. 23 S., R. 2 W., Harvey County; drilled by Kelly Well Company for the City of Halstead, 1923.*

QUATERNARY—Pleistocene and Recent Alluvium and McPherson formation	Thickness, feet	Depth, feet
Silt and clay	25	25
Sand	4	29
Sand, fine to medium; contains streaks of clay	27	56
Silt and clay	18	74
Clay	2	76
Sand, fine	1	77
Silt and clay, sandy	7	84
Sand, fine	6	90
Silt and clay	2	92
Sand, coarse to medium (on hard clay)	18	110

181. *Driller's log of test hole in the NE¼ SW¼ sec. 36, T. 23 S., R. 2 W., Harvey County; drilled by Kelly Well Company for the City of Newton, 1940. Surface altitude, 1,386 feet.*

QUATERNARY—Pleistocene and Recent Alluvium and McPherson formation	Thickness, feet	Depth, feet
Silt and clay, sandy	18	18
Silt and sand, fine	7	25
Sand, fine to coarse	13	38
Sand, fine to medium	12	50
Sand, fine to coarse	7	57
Sand, fine to medium; contains layers of silt	7	64
Silt and clay, gray	1	65
Sand, fine to medium	12	77
Sand, fine to coarse	13	90
Silt and clay, gray; contains some sand	17	107
Gravel, fine to coarse, and coarse sand	13	120
PERMIAN—Leonardian		
Wellington formation		
Shale, blue gray	2	122

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182. *Driller's log of test hole at the NE cor. NW¼ SE¼ sec. 36, T. 23 S., R. 2 W., Harvey County; drilled by Kelly Well Company for the City of Newton, 1940. Surface altitude, 1,390 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Alluvium and McPherson formation		
Sand, fine to medium, and brown silt	9	9
Sand, fine to coarse	3	12
Silt and clay, tan to gray	18	30
Sand, fine to medium	2	32
Sand, fine to coarse	16	48
Silt and clay, gray	1	49
Sand, fine to coarse	16	65
Silt and clay, gray; contains thin beds of sand	32	97
Sand, coarse, and fine to coarse gravel	3	100
Sand, fine to coarse; contains layers of silt	25	125
Gravel, fine to coarse; contains thin layers of silt	5	130
PERMIAN—Leonardian		
Wellington formation		
Shale, blue gray	1	131

183. *Driller's log of test hole at the NE cor. SE¼ sec. 36, T. 23 S., R. 2 W., Harvey County; drilled by Kelly Well Company for the City of Newton, 1940. Surface elevation, 1,404 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Alluvium and McPherson formation		
Silt and fine sand	1	1
Sand, tan	7	8
Silt and clay, tan	13	21
Sand, medium to fine	5	26
Silt, sandy, tan	3	29
Sand, fine to medium	3	32
Sand, fine to coarse; contains calcareous nodules	4	36
Silt, tan, and fine to medium sand	7	43
Sand, coarse to fine, and fine gravel	4	47
Sand, fine to medium	2	49
Sand, coarse to fine, and fine gravel	6	55
Sand, fine to coarse	9	64
Silt and clay, gray	19	83
Sand, fine to coarse	5	88
Sand, coarse to fine, and fine gravel	44	132
Sand, fine to medium, and tan silt	15	147
PERMIAN—Leonardian		
Wellington formation		
Shale, blue gray	1	148

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184. *Sample log of test hole at the SE cor. sec. 8, T. 23 S., R. 3 W., Harvey County; drilled by State Geological Surveys, 1945. Surface altitude, 1,473.6 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Dune sand		
Sand, medium to fine	25	25
McPherson formation (Pleistocene)		
Sand, coarse to fine; contains fine to medium gravel	11	36
Silt, buff to gray	4	40
Silt and clay, light to dark gray	10	50
Silt, buff, interbedded with fine sand	23	73
Sand, coarse to fine; contains some buff to gray silt and nodules of calcium carbonate	13	86
Silt, dark gray to buff, interbedded with coarse to fine sand	11	97
Sand, coarse to fine, and fine gravel	23	120
Sand, coarse to fine	27	147
Silt, gray	5	152
Sand, coarse to fine; contains fine gravel	70	222
Silt, light gray	11	233
Sand, coarse to fine, and fine gravel	7	240
Gravel, fine to medium, and coarse to medium sand	16	256
PERMIAN—Leonardian		
Wellington formation		
Shale, dark gray	11	267

185. *Sample log of test hole at the SW cor. sec. 10, T. 23 S., R. 3 W., Harvey County; drilled by State Geological Survey, 1944. Surface altitude, 1,470.5 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Dune sand		
Sand, medium to fine; contains some tan silt	37	37
McPherson formation (Pleistocene)		
Silt, buff to gray; contains medium to fine sand	16	53
Sand, medium to fine, and tan to gray silt	14	67
Silt, buff to gray; contains fine sand	6	73
Silt and clay, dark to light gray	5	78
Gravel, fine, and coarse to medium sand; contains some medium gravel and fragments of light-green clay balls	22	100
Sand, coarse to fine; contains fine gravel and light-green silt	20	120
Gravel, fine, and coarse to medium sand; contains gray-green silt and medium gravel	31	151
Silt, buff; contains nodules of calcium carbonate	19	170
Silt and clay, dark gray	3	173
Sand, coarse to fine, and dark-gray silt	7	180
Silt and clay, dark to light gray	9	189
Gravel, fine, and coarse to medium sand; contains light-gray silt and some medium gravel	21	210

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	Thickness, feet	Depth, feet
Gravel, fine, and coarse to medium sand	26	236
Silt, light gray	2	238
Gravel, fine, and coarse to medium sand	14	252
Silt, buff; contains medium to fine sand	8	260
Sand, coarse to fine, and buff silt	4	264
Mortar bed; sand and gravel cemented by calcium carbonate	2	266
Gravel, fine, and coarse to medium sand; contains some buff silt	4	270
PERMIAN—Leonardian		
Wellington formation		
Shale, gray	5	275

186. *Sample log of test hole at the SE cor. sec. 11, T. 23 S., R. 3 W., Harvey County; drilled by State Geological Survey, 1944. Surface altitude, 1,450.0 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Dune sand		
Sand, medium to fine; contains some buff silt	31	31
McPherson formation (Pleistocene)		
Silt and clay, tan to light gray; contains nodules of calcium carbonate	9	40
Silt and clay, light gray	10	50
Sand, coarse to fine; contains buff to light gray silt and nodules of calcium carbonate	20	70
Sand, coarse to fine; contains fragments of shale	44	114
Silt, soft, light gray to dark gray	106	220
Clay, laminated, dark gray; contains some medium to fine sand	14	234
Sand, medium to fine, and light-gray silt	6	240
Gravel, fine, and coarse to medium sand; contains some light to dark-gray silt	24	264
PERMIAN—Leonardian		
Wellington formation		
Shale, calcareous, hard, gray, and thin-bedded argillaceous limestone	3	267

187. *Sample log of test hole at the NW cor. sec. 14, T. 23 S., R. 3 W., Harvey County; drilled by State Geological Survey, 1939. Surface altitude, 1,462.4 feet.* (Samples studied by Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Dune sand		
Sand, fine to medium	2.5	2.5
Sand, medium to fine; grains stained tan by limonite	17.5	20
Sand, fine to medium	20	40
Sand, medium to fine	6	46
McPherson formation (Pleistocene)		
Silt, buff, and medium to fine sand; contains grains and nodules of calcium carbonate	14	60

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	Thickness, feet	*Depth, feet*
Silt, buff, and gray clay; contains medium to fine sand and nodules of calcium carbonate	15	75
Sand, medium to fine	11	86
Sand, coarse to medium	11	97
Gravel, fine, and coarse sand	5	102
Sand, coarse to medium	8	110
Sand, medium to coarse	3	113
Sand, coarse to medium, and fine gravel	7	120
Gravel, fine, and coarse to medium sand	1	121
Sand, medium to coarse	9	130
Sand, fine to medium	3	133
Sand, medium to fine, and some coarse sand	3	136
Sand, medium to coarse, and some fine gravel	4	140
Sand, medium	2	142
Sand, coarse to medium; contains some fine sand	18	160
Sand, coarse to medium; contains some fine gravel	2	162
Sand, medium to fine	2	164
Sand, medium to coarse	16	180
Sand, medium; contains some fine sand	10	190
Sand, medium to coarse	10	200
Sand, medium; contains some silt and fine sand	10	210
Sand, medium to coarse	10	220
Sand, medium	29	249
PERMIAN—Leonardian		
Wellington formation		
Shale, dark gray	21	270

188. *Sample log of test hole in the NW¼ NW¼ sec. 17, T. 23 S., R. 3 W., Harvey County; drilled by State Geological Survey, 1944. Surface altitude, 1,467.9 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Pleistocene and Recent	*Thickness, feet*	*Depth, feet*
Dune sand		
Sand, medium to fine, and buff silt	12	12
McPherson formation (Pleistocene)		
Gravel, fine to medium, and coarse to medium sand	8	20
Sand, coarse to fine; contains fine to medium gravel	7	27
Silt, light gray to buff, and fine to medium sand	33	60
Sand, coarse to fine, and buff to gray silt	10	70
Gravel, medium to fine, and coarse to medium sand; contains some buff silt	10	80
Gravel, fine, and coarse to medium sand; contains gray silt	10	90
Gravel, fine to medium, and coarse to medium sand; contains gray silt	28	118
Silt, light gray	22	140
Sand, coarse to fine, and gray silt	7	147

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	Thickness, feet	Depth, feet
Silt, gray green, and very fine to fine sand; partly cemented with calcium carbonate	21	168
Silt and clay, light gray to buff	30	198
Sand, coarse to fine, and gray silt; contains nodules of calcium carbonate	10	208
Gravel, fine, and coarse to medium sand	2	210
Silt, buff; contains nodules of calcium carbonate	21	231
Sand, coarse to fine; contains fine gravel and buff silt	9	240
Gravel, fine, and coarse to medium sand; contains some medium gravel and buff silt	10	250
PERMIAN—Leonardian		
Wellington formation		
Shale, hard, dark gray	7	257

189. *Sample log of test hole at the NW cor. sec. 18, T. 23 S., R. 3 W., Harvey County; drilled by State Geological Survey, 1939. Surface altitude, 1,467.6 feet.* (Samples studied by Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Dune sand		
Soil, sandy	2	2
Sand, medium to fine	6	8
Sand, fine to coarse; contains some fine gravel	7	15
McPherson formation (Pleistocene)		
Gravel, fine to medium, and coarse to medium sand	3	18
Sand, fine to medium; contains gray silt	6	24
Sand, very fine, and gray to buff silt	6	30
Sand, medium to fine	8	38
Sand, medium to coarse	2	40
Sand, medium to fine	50	90
Sand, medium to fine, and some coarse sand	25	115
Sand, fine, and gray to buff silt; contains nodules of calcium carbonate about 2 mm in diameter	10	125
Sand, medium to coarse; contains nodules of calcium carbonate	17	142
Sand, coarse to medium; many grains stained with limonite	11	153
Sand, medium to coarse	17	170
Sand, very fine to medium, and calcareous gray silt; contains some coarse sand and nodules of calcium carbonate	11	181
Silt, calcareous, gray; contains very fine to medium sand and nodules of calcium carbonate	24	205
Silt, calcareous, buff	10	215
Sand, coarse to fine, and buff silt; contains nodules of calcium carbonate and fragments of shale	12	227
PERMIAN—Leonardian		
Wellington formation		
Shale, gray and maroon	13	240

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190. *Sample log of test hole at the SE cor. sec. 17, T. 23 S., R. 3 W., Harvey County; drilled by the City of Wichita, 1939. Surface altitude, 1,452.3 feet.* (Samples studied by Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Silt and clay, dark gray to tan	5	5
Sand, fine to medium	5	10
Sand, coarse to medium, and fine to medium gravel	5	15
Sand, fine to coarse	1	16
Silt and clay, gray to tan	9	25
Silt, buff, and very fine to coarse sand; poorly sorted	7	32
Sand, coarse to fine, and fine to medium gravel	10	42
Gravel, fine to coarse, and coarse to medium sand	3	45
Silt, gray; contains very fine to medium sand	9	54
Silt, calcareous, buff	28	82
Sand, very fine to medium; contains buff silt	10	92
Silt and clay, calcareous, buff to gray	7	99
Sand, very fine to fine, micaceous, and calcareous buff silt	15	114
Sand, fine to coarse, and buff silt; contains nodules of calcium carbonate	5	119
Sand, coarse to fine, and fine gravel	11	130
Silt, buff	17	147
Silt and clay, light brown; contains nodules of calcium carbonate	33	180
Silt and clay, buff to brown; contains fine sand	3	183
Silt and clay, gray to black	7	190
Silt, buff; contains nodules of calcium carbonate	9	199
Sand, coarse to fine; contains buff silt	9	208
Sand, coarse to fine, and fine gravel; contains fragments of clay balls	17	225
Sand, medium to coarse, and fine gravel	10	235
Gravel, fine to coarse, and coarse sand	3	238
Sand, coarse to fine; contains buff silt	3	241
Sand, medium to coarse, and fine gravel	3	244
PERMIAN—Leonardian		
Wellington formation		
Shale, soft, calcareous, light gray	3	247
Shale, maroon	5	252
Shale, dark gray	3	255

191. *Driller's log of test hole at the SW cor. sec. 21, T. 23 S., R. 3 W., Harvey County; drilled by Layne-Western Company for the City of Wichita, 1939. Surface altitude, 1,448.4 feet.*

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Silt, sandy, dark gray	7	7
Sand and gravel	31	38
Silt, gray	8	46
Sand and gravel	20	66

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	Thickness, feet	Depth, feet
Silt and clay, light gray	14	80
Silt, dark gray	30	110
Silt, yellow	60	170
Sand, coarse to fine	12	182
PERMIAN—Leonardian		
Wellington formation		
Shale, blue	3	185

192. *Driller's log of test hole at the NE cor. sec. 32, T. 23 S., R. 3 W., Harvey County; drilled by Layne-Western Company for the City of Wichita, 1939. Surface altitude, 1,441.5 feet.*

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Silt and clay, sandy, brown to gray	9	9
Sand and gravel	5	14
Silt, buff	17	31
Sand and gravel	12	43
Silt and clay, dark gray	12	55
Sand and gravel, gray	11	66
Silt and clay, dark gray	2	68
Sand and gravel	2	70
Silt, tan	3	73
Sand and gravel	14	87
Silt and clay, gray	11	98
Sand and gravel	29	127
Silt and clay, tan	49	176
PERMIAN—Leonardian		
Wellington formation		
Shale	2	178

193. *Driller's log of test hole at the SW cor. SE¼ sec. 32, T. 23 S., R. 3 W., Harvey County; drilled by Layne-Western Company for the City of Wichita, 1939. Surface altitude, 1,445.6 feet.*

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Silt, brown to tan	6	6
Sand and gravel, iron stained	6	12
Sand and gravel	9	21
Silt and clay, gray	7	28
Sand	13	41
Silt and clay, tan to gray	9	50
Sand and gravel	23	73
Sand	2	75
Sand and gravel	25	100
Silt and clay, tan	36	136
PERMIAN—Leonardian		
Wellington formation		
Shale, maroon	2	138

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194. *Sample log of test hole at the SW cor. sec. 8, T. 23 S., R. 4 W., Reno County; drilled by State Geological Survey, 1945. Surface altitude, 1,580.2 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Pleistocene and Recent Dune sand and terrace deposits	*Thickness, feet*	*Depth, feet*
Sand, medium to fine	22	22
Silt, light gray to buff, and medium to fine sand	19	41
Sand, medium to fine; contains some buff silt	25	66
Silt, light gray to buff; contains some medium to fine sand	14	80
Sand, medium to fine, and yellow-buff silt	3	83
Silt, buff; contains some medium to fine sand and nodules of calcium carbonate	7	90
PERMIAN—Leonardian		
Ninnescah shale		
Shale, brick red and gray green	2	92

195. *Sample log of test hole at the NE cor. sec. 14, T. 23 S., R. 4 W., Reno County; drilled by State Geological Survey, 1945. Surface altitude, 1,480.1 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Pleistocene and Recent Dune sand	*Thickness, feet*	*Depth, feet*
Sand, medium to fine; contains buff to light gray silt	27	27
McPherson formation (Pleistocene)		
Silt, light gray, yellow, and buff; contains medium to fine sand	10	37
Sand, medium to fine, and gray and green-gray silt	29	66
Silt, light gray; contains some medium to fine sand	9	75
Sand, medium to fine, and dark to light-gray silt	13	88
Silt, light gray to buff; contains medium to fine sand	12	100
Sand, medium to fine, and tan to light-gray silt	26	126
Silt, light gray to tan; contains medium to fine sand and nodules of calcium carbonate	34	160
Silt, tan; contains ironstone gravel and nodules of calcium carbonate	6	166
PERMIAN—Leonardian		
Wellington formation		
Shale, light gray, calcareous	9	175

196. *Sample log of test hole at the NW cor. sec. 14, T. 23 S., R. 4 W., Reno County; drilled by State Geological Survey, 1939. Surface altitude, 1,498.9 feet.* (Samples studied by Charles C. Williams.)

QUATERNARY—Pleistocene and Recent Dune sand	*Thickness, feet*	*Depth, feet*
Soil, very sandy	2	2
Sand, medium to very fine; contains tan silt	7	9
Sand, medium to fine; many grains stained tan by limonite	17	26
McPherson formation (Pleistocene)		
Sand, very fine to fine, and buff to tan silt	4	30

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	Thickness, feet	Depth, feet
Sand, medium to very fine, and buff to tan silt	7	37
Silt, tan, and very fine to fine sand	2	39
Sand, medium to very fine, and buff silt	3	42
Sand, medium to fine	8	50
Sand, medium	5	55
Sand, medium to fine, and buff silt	7	62
Sand, medium to fine	10	72
Sand, fine to very fine, and gray silt and clay	8	80
Sand, medium to fine	4	84
Sand, medium to very fine; contains buff silt	6	90
Sand, medium to fine	11	101
Sand, medium to fine; contains some very fine sand and buff silt	11	112
Sand, medium to coarse; contains some fine sand; many grains stained tan by limonite	18	130
Silt, buff; contains some very fine to fine sand	10	140
Silt, buff; contains some very fine to fine sand and many nodules of calcium carbonate	35	175
PERMIAN—Leonardian		
Wellington formation		
Shale, greenish gray and red	15	190

197. *Sample log of test hole at the NE cor. sec. 16, T. 23 S., R. 4 W., Reno County; drilled by State Geological Survey, 1945. Surface altitude, 1,529.8 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Dune sand		
Sand, medium to fine; contains some light gray to buff silt	60	60
McPherson formation (Pleistocene)		
Silt, light gray to buff; contains medium to fine sand	17	77
Sand, medium to fine; contains light gray to tan silt	15	92
Silt, light gray to buff; contains medium to fine sand	11	103
Sand, medium to fine, and gray to buff silt	2	105
Silt, light gray to buff; contains some medium to fine sand and nodules of calcium carbonate	11	116
PERMIAN—Leonardian		
Ninnescah shale		
Shale, brick red and green gray	12	128

198. *Sample log of test hole at the NW cor. sec. 16, T. 23 S., R. 4 W., Reno County; drilled by State Geological Survey, 1945. Surface altitude, 1,570.4 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Dune sand		
Sand, medium to fine; contains small amount of light-gray silt	26	26
Silt, light gray to buff	4	30
Sand, medium to fine, and light-gray, yellow, and buff silt	38	68

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	Thickness, feet	Depth, feet
McPherson formation (Pleistocene)		
Silt, light gray to buff; contains medium to fine sand..	37	105
Silt, gray; contains some fine to medium sand.....	28	133
Silt and clay, tan to buff.....	6	139
PERMIAN—Leonardian		
Ninnescah shale		
Shale, brick red and green gray.....	1	140

199. *Sample log of test hole at the NW cor. sec. 18, T. 23 S., R. 4 W., Reno County; drilled by State Geological Survey, 1945.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Pleistocene and Recent Dune sand	Thickness, feet	Depth, feet
Sand, medium to fine; contains some dark-gray silt....	6	6
Sand, coarse to fine; contains medium to fine gravel and nodules of limonite.....	5	11
Silt, light gray, and medium to fine sand.....	5	16
Sand, medium to fine, and light-gray silt.....	12	28
Sand, medium to fine.....	3	31
Silt, gray to tan.....	9	40
Silt, buff; contains nodules of calcium carbonate.....	11	51
PERMIAN—Leonardian		
Ninnescah shale		
Shale, brick red and green gray.....	6	57

200. *Sample log of test hole in the NW¼ SW¼ SW¼ sec. 18, T. 23 S., R. 4 W., Reno County; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,500.8 feet.* (Samples studied by C. K. Bayne and Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Sand, medium to fine; contains some coarse sand and brown silt	6	6
Clay, tan to gray.....	4	10
Gravel, medium to fine; contains coarse gravel and coarse sand	33	43
Clay, blue gray.....	3	46
PERMIAN—Leonardian		
Ninnescah shale		
Shale, hard, red.....	1	47

201. *Sample log of test hole at the NE cor. SE¼ SE¼ sec. 2, T. 23 S., R. 5 W., Reno County; drilled by State Geological Survey, December 1945. Surface altitude, 1,601.4 feet.* (Samples studied by J. B. Cooper and Charles C. Williams.)

QUATERNARY—Pleistocene and Recent Dune sand	Thickness, feet	Depth, feet
Silt, red brown, and loose fine sand.....	7	7
Silt, light gray; contains fine sand.....	21	28
Sand, fine to medium.....	4	32

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	Thickness, feet	Depth, feet
Silt, brown, and fine to medium sand	26	58
Sand, fine to very fine	16	74
Silt, light brown to gray	13	87
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red brown, gray, and blue green	3	90

202. *Sample log of test hole at the NE cor. sec. 3, T. 23 S., R. 5 W., Reno County; drilled by Claude Price for the City of Hutchinson, November 1945. Surface altitude, 1,624.5 feet.* (Samples studied by C. K. Bayne and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Dune sand		
Sand, fine to medium	5	5
Sand, medium to very fine, and blue-gray silt and clay,	11	16
Sand, medium to fine	12	28
Sand, medium to fine, and blue-gray silt and clay	3	31
Sand, medium to fine	10	41
Sand, medium to fine; grains stained red brown	6	47
Sand, medium to fine; contains some coarse sand and tan clay	10	57
Sand, medium to very fine; contains gray silt and clay,	41	98
Sand, medium to fine, and gray clay	9	107
Sand, medium to fine; contains some coarse sand	2	109
Sand, medium to very fine, and gray to tan clay	14	123
PERMIAN—Leonardian		
Ninnescah shale		
Shale, blue gray and red	1	124

203. *Driller's log of wells 382 and 383 in the NW¼ NW¼ SE¼ sec. 4, T. 23 S., R. 5 W., Reno County; drilled by the Atchison, Topeka and Santa Fe Railway Company, June 1944. Surface altitude, 1,528.3 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Sand, fine	12	12
Sand, medium to coarse	3	15
Gravel, fine, and dirty sand	4	19
Sand and gravel, clean, sharp	4	23
Sand, coarse	2	25
Gravel, fine	1	26
Gravel and sand, coarse	14	40

204. *Sample log of test hole at the SE cor. sec. 6, T. 23 S., R. 5 W., Reno County; drilled by Claude Price for the City of Hutchinson, October, 1945. Surface altitude, 1,528.8 feet.* (Samples studied by C. K. Bayne and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, sandy, dark brown	4	4
Silt and clay, gray to brown; contains fine sand	7	11

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	Thickness, feet	*Depth, feet*
Gravel, coarse to fine, and coarse sand; contains some very coarse gravel	29	40
Gravel, coarse to fine	8	48
Gravel, medium to fine; contains coarse gravel and coarse sand; grains and pebbles stained red brown,	18	66
PERMIAN—Leonardian		
Ninnescah shale		
Shale, soft, gray green	2	68

205. *Sample log of well 384 at the NE cor. sec. 8, T. 23 S., R. 5 W., Reno County; drilled by the Layne-Western Company for the Central Fibre Products Company, June 1943. Surface altitude, 1,528.1 feet.* (Samples studied by C. P. Kaiser and Charles C. Williams.)

	Thickness, feet	*Depth, feet*
QUATERNARY—Pleistocene		
McPherson formation		
Soil, brown	3	3
Silt, brown, and very fine sand	2	5
Sand, medium to coarse; contains fine gravel and fine sand	18	23
Gravel, fine to coarse, and coarse sand	7	30
Sand, coarse to medium, and fine to coarse gravel	12	42
Gravel, coarse to fine; contains coarse sand	15	57
Sand, coarse to medium, and fine to coarse gravel	5	62
PERMIAN—Leonardian		
Ninnescah shale		
Shale, micaceous, light brown	1	63

206. *Sample log of test hole in the NW¼ SW¼ sec. 11, T. 23 S., R. 5 W., Reno County; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,515.2 feet.* (Samples studied by Charles C. Williams.)

	Thickness, feet	*Depth, feet*
QUATERNARY—Pleistocene		
McPherson formation		
Soil, brown, very sandy	3	3
Sand, medium to fine; contains coarse sand	7	10
Gravel, coarse to fine; contains some very coarse gravel,	16	26
Gravel, coarse to fine	10	36
PERMIAN—Leonardian		
Ninnescah shale		
Shale, green	1	37

207. *Sample log of test hole at the SE cor. sec. 13, T. 23 S., R. 5 W., Reno County; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,499.4 feet.* (Samples studied by C. K. Bayne and Charles C. Williams.)

	Thickness, feet	*Depth, feet*
QUATERNARY—Pleistocene		
McPherson formation		
Sand, medium to fine	6	6
Clay, gray; contains fine sand	4	10

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	Thickness, feet	Depth, feet
Gravel, coarse to fine; contains coarse sand; grains and pebbles stained red brown	18	28
Gravel, fine to coarse, and coarse sand	13	41
Silt, tan, soft	12	53
Gravel, fine to medium, and coarse to medium sand	48	101
Gravel, medium to fine, and coarse sand	36	137
PERMIAN—Leonardian		
Ninnescah shale		
Shale, blue gray	2	139

208. *Sample log of test hole at the NE cor. sec. 14, T. 23 S., R. 5 W., Reno County; drilled by State Geological Survey, 1945. Surface altitude, 1,520.5 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Sand, medium to fine	3	3
Silt, blue gray, interbedded with medium to fine limonitic sand	14	17
Silt, brown; contains much organic material	3	20
Gravel, coarse to fine, and coarse sand	10	30
Gravel, medium to fine, and coarse sand	4	34
PERMIAN—Leonardian		
Ninnescah shale		
Shale, brick red	2	36

209. *Sample log of test hole at the NE cor. SE¼ sec. 14, T. 23 S., R. 5 W., Reno County; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,503.8 feet.* (Samples studied by C. K. Bayne and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Sand, medium to fine; contains some coarse sand	4	4
Sand, medium to fine; contains tan silt and clay and some coarse sand	3	7
Gravel, fine to coarse, and coarse sand	35	42
Gravel, fine to medium, and coarse sand	5	47
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red and blue gray	2	49

210. *Sample log of test hole at the NE cor. sec. 15, T. 23 S., R. 5 W., Reno County; drilled by State Geological Survey, 1945. Surface altitude, 1,511.4 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, very sandy, brown	2	2
Silt, yellow gray; contains fine gravel and coarse to fine sand	4	6
Gravel, fine to coarse, and coarse to medium sand	4	10

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	Thickness, feet	Depth, feet
Sand, coarse to fine; contains some fine to medium gravel	10	20
Gravel, medium to fine, and coarse sand; interval includes a few thin beds of green clay	33	53
PERMIAN—LEONARDIAN		
Ninnescah shale		
Shale, thin-bedded, brick red, and some green shale	4	57

211. *Sample log of test hole at the SE cor. sec. 15, T. 23 S., R. 5 W., Reno County; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,507.1 feet.* (Samples studied by Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil, brown, sandy	3	3
Clay, gray to tan	5	8
Gravel, fine to coarse, and coarse sand	6	14
Gravel, coarse to fine	4	18
Gravel, coarse to fine, and coarse sand	27	45
Clay, green to tan	1	46
Gravel, fine to coarse, and coarse sand	13	59
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red brown	1	60

212. *Sample log of test hole at the NE cor. sec. 16, T. 23 S., R. 5 W., Reno County; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,517.5 feet.* (Samples studied by Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil, brown, sandy	3	3
Clay, tan to gray	7	10
Gravel, coarse to fine; contains some coarse sand	8	18
Gravel, very coarse to fine	17	35
Gravel, coarse to fine, and coarse sand	11	46
Clay, tan	2	48
Gravel, coarse to fine	15	63
PERMIAN—Leonardian		
Ninnescah shale		
Shale, brick red and gray green	1	64

213. *Driller's log of city-supply well 388 (Cleveland St. well) at the NE cor. NW¼ SW¼ sec. 18, T. 23 S., R. 5 W., Reno County; drilled for United Gas, Water, and Electric Company (now owned by Hutchinson Water Company), June 1922. Surface altitude, 1,531.0 feet.*

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Sand and gravel	10	10
Gravel and clay balls	18	28

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	Thickness, feet	Depth, feet
Clay balls and gravel	20	48
Good clean sand	13	61
Fine sand	17	78

214. *Sample log of test hole at the NE cor. sec. 21, T. 23 S., R. 5 W., Reno County; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,514.4 feet.* (Samples studied by C. K. Bayne and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, brown, very sandy	2	2
Clay, buff to tan	9	11
Gravel, very coarse to fine	24	35
Gravel, coarse to fine; contains thin layers of clay in lower part of interval	25	60
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red	2	62

215. *Sample log of test hole at the SE cor. sec. 23, T. 23 S., R. 5 W., Reno County; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,498.1 feet.* (Samples studied by C. K. Bayne and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, very sandy, brown	2	2
Clay, soft, tan	2	4
Gravel, coarse to fine, and coarse sand	42	46
Gravel, fine to medium, and coarse to medium sand; grains stained red brown	4	50
Gravel, coarse to fine	47	97
PERMIAN—Leonardian		
Ninnescah shale		
Shale, blue green	3	100

216. *Sample log of test hole at the SE cor. NE¼ sec. 24, T. 23 S., R. 5 W., Reno County; drilled by State Geological Survey, December 1945. Surface altitude, 1,495.0 feet.* (Samples studied by J. B. Cooper and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, brown	4	4
Silt and clay, plastic, light gray	5	9
Gravel, fine to medium, and coarse to medium sand; contains some gray silt	59	68
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red and blue green	4	71

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217. *Sample log of test hole at the NE cor. sec. 29, T. 23 S., R. 5 W. Reno County; drilled by Claude Price for the City of Hutchinson, October, 1945. Surface altitude, 1,515.5 feet.* (Samples studied by C. K. Bayne and Charles C. Williams).

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, sandy, brown to gray	2	2
Clay, gray	5	7
Clay and silt, gray to tan; contains fine sand	4	11
Gravel, fine to coarse, and coarse sand	24	35
Gravel, coarse to fine, and coarse sand	12	47
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red	3	50

218. *Sample log of test hole at the NW cor. sec. 32, T. 23 S., R. 5 W., Reno County; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,512.1 feet.* (Samples studied by C. K. Bayne and Charles C. Williams).

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Alluvium and McPherson formation		
Soil, sandy, dark gray to brown	2	2
Gravel, coarse to fine; contains clay balls near middle of interval	31	33
Gravel, coarse to fine	25	58
PERMIAN—Leonardian		
Ninnescah shale		
Shale, gray green	2	60

219. *Sample log of test hole at the SE cor. sec. 4, T. 24 S., R. 1 W., Harvey County; drilled by State Geological Survey, 1944. Surface altitude, 1,403.5 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt, tan; contains some fine sand	7	7
Sand, coarse to fine; contains medium to fine gravel,	4	11
Silt, buff to gray; contains some sand and nodules of of calcium carbonate	7	18
Sand, coarse to fine; contains some medium to fine gravel	3	21
Silt, tan to gray, and coarse to fine sand	5	26
Sand, coarse to fine; contains some gray silt	4	30
Silt, gray to tan, and coarse to fine sand	7	37
Sand, coarse to fine; contains several thin beds of silt and nodules of calcium carbonate	81	118
PERMIAN—Leonardian		
Wellington formation		
Shale, soft, blue gray, contains thin layers of limestone,	12	130

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220. *Sample log of test hole at the NW cor. NE¼ sec. 5, T. 24 S., R. 1 W., Harvey County; drilled by State Geological Survey, 1944. Surface altitude, 1,395.6 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Alluvium and McPherson formation		
Sand, medium to fine	1.5	1.5
Silt and clay, light tan and greenish gray	30.5	32
Clay and silt, greenish gray	7	'39
Gravel, fine, and coarse to medium sand	13	52
Silt and clay, buff	5	57
Sand, coarse to fine; contains some fine gravel and greenish gray silt	13	70
Clay and silt, dark gray	6	76
Gravel, fine, and coarse to medium sand; contains some dark-gray silt	4	80
Gravel, fine to medium, and coarse to medium sand	13	93
Silt and clay, buff	9	102
Gravel, fine to medium, and coarse to medium sand	21	123
PERMIAN—Leonardian		
Wellington formation		
Shale, dark gray to light gray	7	130

221. *Sample log of test hole at the NE cor. SE¼ sec. 6, T. 24 S., R. 1 W., Harvey County; drilled by State Geological Survey, 1944. Surface altitude, 1,426.5 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Dune sand		
Sand, medium to fine; contains some tan silt	20	20
McPherson formation (Pleistocene)		
Silt, tan to gray	7	27
Silt and clay, buff to gray	3	30
Silt, tan; contains very fine to medium sand	7	37
Silt, tan, interbedded with coarse to fine sand and fine gravel	5	42
Gravel, fine, and coarse to medium sand	4	46
Clay and silt, yellow gray to dark gray; contains nodules of calcium carbonate and some fine to coarse sand,	23	69
Gravel, fine to medium, and coarse to medium sand	13	82
Silt and clay, gray	6	88
Gravel, fine, and coarse to medium sand	8	96
Silt, buff	1	97
Gravel, fine, and coarse to medium sand	3	100
Silt, buff, and very fine to fine sand	3	103
Gravel, medium to fine, and coarse to medium sand; contains some thin beds of buff to gray silt	17	120
Gravel, fine to medium, and coarse to medium sand; contains some thin beds of buff silt in lower part	21	141

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	Thickness, feet	*Depth, feet*
Silt, buff to gray	4	145
Gravel, fine, and coarse to medium sand	26	171
Silt, buff; contains nodules of calcium carbonate	7	178
Gravel, fine, and coarse to medium sand	1	179
PERMIAN—Leonardian		
Wellington formation		
Shale, very hard, blue gray	1.5	180.5

222. *Sample log of test hole at the NW cor. sec. 7, T. 24 S., R. 1 W., Harvey County; drilled by State Geological Survey, 1944. Surface altitude, 1,398.2 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Pleistocene and Recent Alluvium and McPherson formation	*Thickness, feet*	*Depth, feet*
Silt, sandy	3	3
Silt and clay, tan; contains fine to coarse sand	14	17
Clay and silt, greenish gray to buff	18	35
Gravel, medium to fine, and coarse to medium sand; includes thin beds of light-gray clay	18	53
Clay and silt, dark to light gray	17	70
Clay, gray	10	80
Clay and silt, light gray to white	14	94
Sand, coarse to fine; contains fine gravel	6	100
Gravel, fine to medium, and coarse to medium sand; contains some thin beds of buff silt	53	153
PERMIAN—Leonardian		
Wellington formation		
Shale, greenish gray; contains thin limestone beds	4	157

223. *Sample log of test hole at the SW cor. NW¼ sec. 7, T. 24 S., R. 1 W., Harvey County; drilled by State Geological Survey, 1944. Surface altitude, 1,385.6.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Pleistocene and Recent Alluvium and McPherson formation	*Thickness, feet*	*Depth, feet*
Silt and clay, gray to brown	5	5
Silt and clay, buff to gray	16	21
Silt and clay, dark gray to black	4	25
Silt and clay, green	2	27
Sand, coarse to fine; contains some fine gravel	13	40
Gravel, fine to medium, and coarse to medium sand	17	57
Silt, yellow, buff, and gray; contains some fine sand	3	60
Silt and clay, gray to buff; contains some coarse to fine sand and nodules of calcium carbonate	17	77
Gravel, fine, and coarse to medium sand; contains thin layers of green clay	7	84
Silt and clay, buff; contains some medium to fine sand	9	93
Sand, coarse to fine; contains some buff silt and nodules of calcium carbonate	17	110

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	Thickness, feet	Depth, feet
Clay and silt, light to dark gray	10	120
Silt, buff, and medium to fine sand	3	123
Sand, coarse to fine, and buff silt	7	130
Gravel, fine, and coarse to medium sand; contain nodules of calcium carbonate and pebbles of caliche	12	142
PERMIAN—Leonardian		
Wellington formation		
Shale, dark gray	8	150

224. *Sample log of test hole at the SE cor. sec. 8, T. 24 S., R. 1 W., Harvey County; drilled by State Geological Survey, 1944. Surface altitude, 1,386.4 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Pleistocene and Recent Dune sand	Thickness, feet	Depth, feet
Silt, gray to brown, and sand, medium to fine	7	7
Sand, medium to fine	5	12
McPherson formation (Pleistocene)		
Sand, coarse to fine; contains thin beds of gray silt	6	18
Silt, gray; contains coarse to fine sand	8	26
Sand, coarse to fine, contains fine to medium gravel	14	40
Gravel, medium to fine, and coarse sand	6	46
Silt and clay, light gray; contains some coarse to fine sand	14	60
Sand, coarse to fine; contains light gray silt and pellets of limonite	11	71
Silt, dark to light gray	8	79
Sand, coarse to fine; contains gray to buff silt	30	109
Silt, buff	6	115
Silt and clay, green gray	7	122
Gravel, fine, and coarse sand	4	126
Silt and clay, green gray	8	134
Sand, coarse to fine; contains fine gravel	6	140
Gravel, fine to medium, and coarse sand	13	153
PERMIAN—Leonardian		
Wellington formation		
Shale, gray green to blue gray; contains thin layers of argillaceous limestone	3	156

225. *Sample log of test hole at the NE cor. sec. 19, T. 24 S., R. 1 W., Harvey County; drilled by the City of Wichita, 1938. Surface altitude, 1,381.6 feet.* (Samples studied by John C. Frye.)

QUATERNARY—Pleistocene and Recent Alluvium and McPherson formation	Thickness, feet	Depth, feet
Soil, brown to black	6	6
Silt, tan; contains clay and fine sand	5	11
Silt and clay, laminated; contains some sand	6	17
Clay and silt, gray to tan	8	25
Sand and silt, gray green	4	29

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	Thickness, feet	*Depth, feet*
Sand and gravel, fine	5	34
Clay and silt, gray green, and fine sand	4	38
Silt, sand, and fine gravel	2	40
Sand, coarse	2	42
Silt and clay, tan	1	43
Silt and clay, gray, and fine sand	1	44
Silt, tan, and fine sand	5	49
Sand, medium	2	51
Silt, tan, and fine sand; laminated	1	52
Silt and clay, gray to brown, and fine sand	7	59
Sand, medium, and buff silt	16	75
Sand, fine, and silt; contains pebbles of blue-gray shale,	3	78
Sand, and gravel, fine; contains pebbles of shale and ironstone	2	80
Silt, tan, and sand	3	83
Sand, fine, and green silt and clay	14	97
Silt and clay, yellow tan	6	103
Silt and fine sand; contains pebbles of green shale	4	107
Sand, coarse, and fine gravel; contains pebbles of green and gray shale	4	111
Sand, coarse, and fine gravel; contains silt and clay	4	115
Sand, medium to coarse	1	116
Silt and clay, gray; contains some sand	3	119
Sand, coarse, and fine gravel	5	124
Sand, medium to coarse; contains clay bells	12	136
Sand, medium; contains pebbles of green shale	3	139
Sand, fine	6	145
Gravel, fine and coarse sand	3	148
Clay and silt, dark gray, and sand	6	154
PERMIAN—Leonardian		
Wellington formation		
Shale, dark gray; contains gypsum	23	177

226. *Sample log of test hole at the SW cor. sec. 19, T. 24 S., R. 1 W., Harvey County; drilled by the City of Wichita, 1938. Surface altitude, 1,380.7 feet.* (Samples studied by Charles C. Williams.)

QUATERNARY—Pleistocene and Recent Alluvium and McPherson formation	*Thickness, feet*	*Depth, feet*
Soil, sandy, brown	3	3
Silt, gray to buff; contains clay and very fine to fine sand	1	4
Silt, very calcareous, gray to buff; contains very fine to fine sand and nodules of calcium carbonate	1	5
Sand, very fine to fine, mostly quartz; contains some buff to gray silt	3	8
Silt and clay, gray, and very fine sand; contains some carbonaceous material	9	17

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	Thickness, feet	Depth, feet
Silt and clay, dark gray to black; contains abundant snail shells and carbonaceous material, and hollow, tubular, and spherical accumulations of calcium carbonate; material indicates deposition in a boggy environment	5	22
Sand, very fine to medium; contains some tan silt	3	25
Sand, medium to coarse, and fine gravel	5	30
Gravel, fine to coarse, and coarse to medium sand	2	32
Sand, medium to coarse; contains fine gravel	8	40
Sand, coarse to medium; well sorted	1	41
Sand, coarse to medium; contains some fine to medium gravel and clay balls	3	44
Silt and clay, gray; contains fragments of snail shells and nodules of calcium carbonate	4	48
Sand, coarse to medium, and fine to coarse gravel	2	50
Gravel, fine to coarse, and coarse sand; pebbles range in size to 15 mm in diameter and consist of quartz, pink and white feldspar, and greenish-brown chert	3	53
Gravel, medium to coarse	2	55
Gravel, fine to coarse, and coarse sand; most grains and pebbles composed of quartz, but some are feldspar and chert	3	58
Silt and clay, calcareous, buff to gray; contains some shell fragments and plant remains	9	67
Silt and clay, calcareous, gray, and very fine to fine sand	17	84
Silt and clay, calcareous, gray; contains fragments of snail shells	3	87
Silt and clay, calcareous; contains some sand and gravel and irregular nodules of calcium carbonate	36	123
Sand, coarse to medium, and fine to coarse gravel; contains some buff silt, abraded pebbles of calcium carbonate, and pebbles of shale and olive-green chert,	10	133
Sand, medium to fine	5	138
Silt, calcareous, buff	3	141
Sand, medium to fine, and calcareous buff silt	12	153
Silt and clay, calcareous, light to dark gray	12	165
PERMIAN—Leonardian		
Wellington formation		
Shale, calcareous, soft, gray; contains crystals and grains of gypsum	11	176
Shale, calcareous, very soft, gray	8	184
Shale, calcareous, gray; contains gypsum	3	187

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227. *Driller's log of test hole at the NE cor. NW¼ sec. 5, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,421 feet.* (Courtesy Black and Veatch, engineers.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Top soil	5	5
Sand	75	80
Clay	10	90
Sand, coarse	80	170
Clay	20	190
Sand	65	255
Clay	5	260
PERMIAN—Leonardian		
Wellington formation		
Shale or clay	8	268

228. *Driller's log of test hole at the SW cor. NW¼ sec. 5, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,430 feet.* (Courtesy Black and Veach, engineers.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Top soil	5	5
Clay and sand, fine	5	10
Sand and clay, yellow	10	20
Sand	5	25
Sand, coarse	5	30
Sand, fine	15	45
Sand, coarse	5	50
Sand, fine, dirty	5	55
Sand, coarse	15	70
Sand and clay	5	75
Gravel, fine	35	110
Sand, fine	35	145
Sand and clay	25	170
Clay	40	210
Clay and sand, fine	25	235
Sand, fine	20	255
PERMIAN—Leonardian		
Wellington formation		
Shale and clay	14	269

229. *Driller's log of test hole at the NE cor. SE¼ sec. 5, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,424 feet.* (Courtesy Black and Veatch, engineers.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Top soil	10	10
Clay	5	15
Sand	25	40
Gravel	5	45

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	Thickness, feet	Depth, feet
Clay and sand	15	60
Clay	10	70
Sand	5	75
Clay and sand	5	80
Clay	5	85
Clay and sand	5	90
Sand	30	120
Sand and clay	5	125
Sand, coarse	5	130
Clay and sand	5	135
Sand	20	155
Clay and sand	30	185
Clay	15	200
Clay and sand	10	210
Sand	5	215
Sand and clay	20	235
PERMIAN—Leonardian		
Wellington formation		
Shale	11	246

230. *Driller's log of Wichita city-supply well 415 in the SE¼ NE¼ sec. 6 T. 24 S., R. 2 W., Harvey County; drilled by Layne-Western Company, 1939. Surface altitude, 1,428.2 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, sandy, dark brown	5	5
Sand, fine, and tan silt	10	15
Sand	5	20
Sand, fine, and gray to tan silt	6	26
Sand	19	45
Sand, coarse	35	80
Sand, fine	82	162
Silt and clay, tan	4	166
Sand	8	174
Silt and clay, blue gray	11	185
Sand and gravel	74	259
PERMIAN—Leonardian		
Wellington formation		
Shale, blue gray	4	263

231. *Driller's log of test hole at the NW cor. NE¼ sec. 8, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,421 feet.* (Courtesy Black and Veatch, engineers.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Top soil	5	5
Clay	5	10
Sand, fine	5	15

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	Thickness, feet	Depth, feet
Sand, medium to coarse	5	20
Clay and sand	30	50
Clay	10	60
Sand and clay	10	70
Sand, medium to coarse	15	85
Gravel	5	90
Gravel; contains clay	5	95
Sand and clay	5	100
Clay, blue	15	115
Clay and gravel	5	120
Sand, medium to coarse	15	135
Sand, fine	5	140
Sand and clay	5	145
Sand, fine	20	165
Clay	30	195
Clay and gravel	25	220
Gravel	10	230
Sand, coarse	5	235
Sand, fine	10	245

232. *Driller's log of Wichita city-supply well 419 in the NE¼ NW¼ sec. 8, T. 24 S., R. 2 W., Harvey County; drilled by Layne-Western Company, 1939. Surface altitude, 1420.8 feet.*

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil, dark brown	2	2
Silt, tan, and fine sand	13	15
Sand; contains streaks of clay	19	34
Sand, coarse	60	94
Sand, fine	15	109
Sand and gravel	9	118
Clay, blue and yellow	9	127
Sand, coarse, and gravel	14	141
Clay, yellow	6	147
Sand, coarse, and gravel	20	167
Sand, coarse; contains streaks of clay	17	184
Sand, fine; contains streaks of clay	6	190
Sand, fine	4	194
Sand, fine; contains streaks of clay	15	209
Sand, fine	39	248
Sand, fine; contains streaks of clay	13	261
PERMIAN—Leonardian Wellington formation		
Shale, blue gray	4	265

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233. *Driller's log of Wichita city-supply well 423 in the NW¼ NW¼ sec. 8, T. 24 S., R. 2 W., Harvey County; drilled by Layne-Western Company, 1939. Surface altitude, 1,421.4 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, sandy, brown	3	3
Silt and sand, fine	29	32
Sand, medium	15	47
Sand, fine, and tan silt	10	57
Sand, coarse	55	112
Sand, fine, and tan silt	3	115
Sand	4	119
Silt and clay, tan	3	122
Sand, coarse; contains streaks of clay	8	140
Sand, medium to coarse	8	162
Sand and gravel	6	168
Sand; contains streaks of clay	6	174
Sand, medium to coarse	29	203
Sand, coarse; contains streaks of clay	27	230
Sand and gravel	4	234
Sand	11	245
PERMIAN—Leonardian		
Wellington formation		
Shale, soft, blue gray	11	256

234. *Driller's log of test hole at the NW cor. sec. 8, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,422 feet.* (Courtesy Black and Veatch, engineers.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Top soil	15	15
Clay, sandy	15	30
Gravel, coarse	60	90
Gravel and clay	12	102
Clay	38	140
Sand	16	156
Gravel	6	162
Sand	27	189
Clay	35	224
Sand, fine	22	246
PERMIAN—Leonardian		
Wellington formation		
Shale	1	247

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235. *Driller's log of test hole at the SW cor. NW¼ sec. 8, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,418 feet.* (Courtesy Black and Veatch, engineers.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Top soil	5	5
Clay	10	15
Clay and sand	20	35
Sand	5	40
Sand, coarse	60	100
Clay and sand	20	120
Clay and gravel	10	130
Clay	10	140
Sand, fine	10	150
Clay and sand	35	185
Sand, fine	40	225
PERMIAN—Leonardian		
Wellington formation		
Shale	3	228

236. *Driller's log of Wichita city-supply well 429 in the SW¼ NW¼ sec. 8, T. 24 S., R. 2 W., Harvey County; drilled by Layne-Western Company, 1939. Surface altitude, 1,416.8 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, brown	2	2
Sand, fine, and brown to gray silt	13	15
Sand and gravel, fine	97	112
Silt and clay, gray blue	14	126
Sand, gravel, and gray silt	27	153
Sand and gravel	22	175
Silt and clay, blue gray, and fine sand	15	190
Sand, fine	35	225
Silt, clay, and fine sand	4	229
PERMIAN—Leonardian		
Wellington formation		
Shale, blue gray	4	233

237. *Driller's log of Wichita city-supply well 426 in the SW¼ NE¼ sec. 8, T. 24 S., R. 2 W., Harvey County; drilled by Layne-Western Company, 1939. Surface altitude, 1,417.3 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, sandy, brown	4	4
Silt, tan, and fine sand	11	15
Sand, brown	5	20
Sand, coarse, and gravel	5	25
Sand, coarse	99	124

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	Thickness, feet	Depth, feet
Sand, coarse; contains streaks of clay	14	138
Silt, clay, and fine sand	33	171
Sand, coarse, and gravel	27	198
Silt and clay, buff	14	212
Sand, medium to coarse	26	238
Sand and gravel	2	240
Sand and silt	3	243
PERMIAN—Leonardian		
Wellington formation		
Shale, blue gray	3	246

238. *Driller's log of test hole at the NW cor. NE¼ sec. 9, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938.* (Courtesy Black and Veatch, engineers.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil	5	5
Clay	10	15
Sand	30	45
Clay	30	75
Clay, sandy	60	135
Clay	25	160
Clay and gravel	15	175
Clay	20	195
Sand	20	215
PERMIAN—Leonardian		
Wellington formation		
Shale	10	225

239. *Driller's log of test hole at the NW cor. sec. 9, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,417 feet.* (Courtesy Black and Veatch, engineers.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Top soil	5	5
Sand and clay	50	55
Clay and gravel	10	65
Clay and streaks of sand	60	125
Sand	30	155
Clay and streaks of sand	55	210
Sand, coarse, and gravel	30	240
PERMIAN—Leonardian		
Wellington formation		
Clay and shale	3	243

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240. *Driller's log of Wichita city-supply well 433 in the SE¼ NE¼ sec. 9, T. 24 S., R. 2 W., Harvey County; drilled by Layne-Western Company, 1939. Surface altitude, 1,408.5 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, sandy, dark gray	1	1
Silt, dark gray, and fine sand	4	5
Silt and clay, tan to yellow	4	9
Sand and gravel	20	29
Silt and clay, blue gray; contains sand	23	52
Sand, coarse to fine	8	60
Sand and gravel	32	92
Silt and clay, gray; contains sand	6	98
Sand, medium	10	108
Silt and clay, blue gray; contains sand	21	129
Sand, coarse	27	156
Silt and clay, blue gray; contains sand	20	176
Sand, coarse	17	193
Gravel, coarse; contains clay balls	1	194
PERMIAN—Leonardian		
Wellington formation		
Shale, blue gray	2	196

241. *Driller's log of test hole at the NW cor. SW¼ sec. 9, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,406 feet.* (Courtesy Black and Veatch, engineers.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil	5	5
Clay, sandy	5	10
Sand; contains clay streaks	15	25
Sand and clay	25	50
Coarse sand	20	70
Clay; contains sand streaks	55	125
Sand, fine	35	160
Sand, fine, and gravel	25	185
Sand, fine	45	230
Sand and clay	5	235
PERMIAN—Leonardian		
Wellington formation		
Shale	3	238

242. *Driller's log of Wichita city-supply well 436 in the NW¼ SW¼ sec. 9, T. 24 S., R. 2 W., Harvey County; drilled by Layne-Western Company, 1939. Surface altitude, 1,414.3 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, dark brown	3	3
Sand, fine, light brown	12	15
Silt and clay; contains sand	10	25

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	Thickness, feet	Depth, feet
Silt and clay	12	37
Silt and clay; contains sand	25	62
Sand, loose	25	87
Sand, fine; contains silt and clay	25	112
Sand, coarse, and gravel	15	127
Sand, fine, and gray silt	14	141
Silt and clay	2	143
Sand and gravel	10	153
Silt and clay, tan to gray	10	163
Sand, coarse	6	169
Silt, gray blue, and fine sand	4	173
Sand, coarse, and gravel	17	190
Silt and clay, gray blue	5	195
Sand gravel; contains nodules of calcium carbonate	34	229
Silt and clay, tan to gray, and fine sand	5	234
Sand and gravel; contains gray silt and nodules of calcium carbonate	3	237
PERMIAN—Leonardian		
Wellington formation		
Shale, blue gray	3	240

243. *Driller's log of test hole at the NE cor. SE¼ sec. 9, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,408 feet.* (Courtesy Black and Veatch, engineers.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil	5	5
Sand	20	25
Sand, coarse	70	95
Clay	15	110
Clay, soft	10	120
Sand, coarse	35	155
Clay	10	165
Sand, coarse	20	185
PERMIAN—Leonardian		
Wellington formation		
Shale	16	201

244. *Driller's log of test hole at the SE cor. sec. 9, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,407 feet.* (Courtesy Black and Veatch, engineers.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil	5	5
Clay, sandy	5	10
Gravel	80	90
Clay and gravel	20	110
Gravel	55	165

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	Thickness, feet	Depth, feet
Sand	5	170
Clay	5	175
Sand	5	180
PERMIAN—Leonardian		
Wellington formation		
Clay and shale	10	190

245. *Driller's log of Wichita city-supply well 440 at the SE cor. sec. 9, T. 24 S., R. 2 W., Harvey County; drilled by Layne-Western Company, 1939. Surface altitude, 1,406.6 feet.*

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil, brown, sandy	2	2
Silt and clay, tan to brown	8	10
Sand and gravel; contains some clay, tan	20	30
Silt, tan, and fine sand	10	40
Sand and gravel; contains several thin layers of silt and clay	70	110
Silt and clay, blue green	2	112
Sand and gravel	15	127
Silt and clay, light gray, very calcareous	1	128
Sand and gravel	34	162
Sand; contains some tan silt	7	169
Silt and clay, buff to tan	7	176
Sand and gravel; contains nodules of calcium carbonate,	10	186
Sand, fine, and tan silt	6	192
PERMIAN—Leonardian		
Wellington formation		
Shale, gray	4	196

246. *Sample log of test hole at the NW cor. NE¼ sec. 13, T. 24 S., R. 2 W., Harvey County; drilled by State Geological Survey, 1944. Surface altitude, 1,383.9 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Pleistocene and Recent Alluvium and McPherson formation	Thickness, feet	Depth, feet
Clay, dark gray	10	10
Silt and clay, buff	6	16
Silt and clay, dark gray	10	26
Sand, coarse to fine; contains some fine to medium gravel and gray silt and clay	4	30
Gravel, medium to fine, and coarse to medium sand; contains some coarse gravel	6	36
Clay and silt, greenish gray	11	47
Silt and clay, sandy, greenish gray and yellow; in-thin beds of sand and gravel	8	55
Gravel, fine to medium, and coarse to medium sand,	21	76
Silt, greenish gray, and fine to medium sand	9	85

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	Thickness, feet	Depth, feet
Gravel, fine to medium, and coarse to medium sand..	36	121
Silt, buff; contains some fine sand and nodules of calcium carbonate	11	132
Sand, coarse to fine	8	140
Silt, buff; contains some fine sand and nodules of calcium carbonate	2	142
Gravel, fine, and coarse to medium sand	5	147
Silt; contains medium to fine sand; partly cemented by calcium carbonate	2	149
Gravel, fine, and coarse to medium sand; partly cemented by calcium carbonate	7	156
PERMIAN—Leonardian		
Wellington formation		
Shale, hard, greenish gray; thin layer of hard limestone at top	2	158

247. *Sample log of test hole at the NW cor. SW¼ sec. 13, T. 24 S., R. 2 W., Harvey County; drilled by State Geological Survey, 1944. Surface altitude, 1,388.2 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Alluvium and McPherson formation		
Soil, dark gray to black	1.5	1.5
Silt and clay, light brown to gray	4.5	6.0
Silt and clay, dark gray to buff; contains some medium to fine sand and nodules of calcium carbonate	4	10
Silt and clay, tan to gray	8	18
Silt, blocky, brown to black	3	21
Clay, gray to green	3	24
Clay and silt; contains carbonaceous material	3	27
Gravel, medium to fine, and coarse to medium sand; contains some coarse gravel, and light-gray silt	23	50
Gravel, fine, and coarse to medium sand; contains some greenish-gray silt	14	64
Clay, yellowish green	4	68
Sand, coarse to fine; contains light-gray silt and clay,	12	80
Gravel, fine, and coarse to medium sand; contains some yellowish-green silt	17	97
Silt and clay, gray to buff; contains some fine sand and nodules of calcium carbonate	19	116
Silt and clay, dark gray	14	130
Silt and clay, light gray to buff	10	140
Clay, gray and greenish gray	7	147
PERMIAN—Leonardian		
Wellington formation		
Shale, dark to light gray	3	150

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248. *Driller's log of test hole at the SW cor. sec. 14, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,395 feet.* (Courtesy Black and Veatch, engineers.)

QUATERNARY—Pleistocene and Recent Alluvium and McPherson formation	*Thickness, feet*	*Depth, feet*
Top soil	5	5
Sand	5	10
Gravel	65	75
Gravel, coarse	50	125
Clay	25	150
Gravel	5	155
PERMIAN—Leonardian		
Wellington formation		
Shale	6	161

249. *Sample log of test hole at the NE cor. NW¼ sec. 16, T. 24 S., R. 2 W., Harvey County; drilled by City of Wichita, 1938. Surface altitude, 1,402.2 feet.* (Samples studied by Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Silt, brown to buff	5	5
Sand, fine to coarse; contains brown silt	1	6
Silt and clay, dark gray	3	9
Gravel, fine to coarse, and coarse to fine sand	2	11
Sand, coarse to medium, and fine to medium gravel,	7	18
Silt, gray, and very fine to fine sand	12	30
Sand, medium to very fine	2	32
Silt and clay, gray to buff	5	37
Sand, fine to medium	1	38
Sand, coarse to medium, and fine gravel	12	50
Gravel, coarse to fine, and coarse sand	6	56
Sand, coarse to medium, and fine gravel	3	59
Gravel, fine to medium, and coarse sand	7	66
Sand, coarse to meduim	6	72
Silt and clay, gray to buff	14	86
Silt, buff; contains nodules of calcium carbonate	10	96
Sand, coarse to medium, and fine gravel	4	100
Gravel, fine to medium, and coarse sand	25	125
Sand, coarse to medium, and fine gravel	8	133
Gravel, fine to medium, and coarse sand	2	135
Sand, coarse to medium, and fine gravel	13	148
Silt, buff, calcareous	5	153
Sand, fine to coarse	8	161
Gravel, fine to medium, and coarse sand	5	166
Silt, light gray, and very fine to fine sand	3	169
Silt and clay, dark gray	19	188
Sand, coarse to medium, and fine gravel	3	191
Gravel, fine to medium, and coarse sand	5	196

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	Thickness, feet	Depth, feet
Sand, coarse to medium, and fine gravel	4	200
Gravel, fine, and coarse to medium sand	2	202
PERMIAN—Leonardian		
Wellington formation		
Shale, weathered, calcareous, gray	3	205
Shale, calcareous, soft, gray	8	213
Shale, calcareous, gray	9	222

250. *Driller's log of Wichita city-supply well 450 at the NW cor. sec. 16, T. 24 S., R. 2 W., Harvey County; drilled by Layne-Western Company, 1939. Surface altitude, 1,413.8 feet.*

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil, brown, sandy	1	1
Silt, clay, and fine sand	3	4
Sand, fine, and tan silt	7	11
Sand, medium	6	17
Silt, clay, and fine sand	11	28
Sand, fine, and tan to gray silt	11	39
Gravel and sand; contains clay balls	23	62
Silt and clay, gray to tan, and fine sand	26	88
Sand	12	100
Silt, clay, and fine sand	1	101

251. *Driller's log of test hole at the NW cor. sec. 16, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,415 feet.* (Courtesy Black and Veatch, engineers.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Top soil	5	5
Clay	5	10
Sand, coarse	75	85
Clay	140	225
Clay and sand	9	234

252. *Driller's log of test hole at the SW cor. NW¼ sec. 16, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,414 feet.* (Courtesy Black and Veatch, engineers.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Top soil	5	5
Clay	15	20
Sand and clay	5	25
Sand, fine, and clay	20	45
Sand	5	50
Sand and clay	10	60
Sand, coarse	10	70
Sand	10	80

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	Thickness, feet	Depth, feet
Sand, coarse	15	95
Gravel	25	120
Clay	5	125
Clay and gravel	5	130
Clay	25	155
Clay and gravel	5	160
Clay	20	180
Clay and sand	4	184

253. *Driller's log of test hole at the SE cor. NE¼ sec. 16, T. 24 S. R 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,403 feet.* (Courtesy Black and Veatch, engineers.)

QUATERNARY—Pleistocene and Recent Alluvium and McPherson formation	Thickness, feet	Depth, feet
Soil	5	5
Sand	40	45
Gravel	10	55
Clay and gravel	30	85
Clay	20	105
Sand and clay	75	180
PERMIAN—Leonardian		
Wellington formation		
Clay and shale	5	185
Shale	1	186

254. *Driller's log of Wichita city-supply well 452 in the NE¼ SE¼ sec. 16, T. 24 S., R. 2 W., Harvey County; drilled by Layne-Western Company, 1939. Surface altitude, 1,402.0 feet.*

QUATERNARY—Pleistocene and Recent Alluvium and McPherson formation	Thickness, feet	Depth, feet
Soil, sandy, dark brown	1	1
Silt and clay, tan	3	4
Sand, fine, and tan silt	6	10
Sand and gravel	38	48
Silt and clay, tan; contains gravel	2	50
Sand and gravel	25	75
Silt and clay, tan	13	88
Sand, fine	17	105
Sand, medium to fine	13	118
Sand and gravel; contains clay balls	6	124
Sand, medium to fine	7	131
Silt and clay, light gray	8	139
Sand, medium to fine	6	145
Sand, medium to coarse	14	159
Sand, coarse, and gravel; contains clay balls	6	165
Sand, coarse, and gravel	20	185
PERMIAN—Leonardian		
Wellington formation		
Shale	6	191

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255. *Driller's log of Wichita city-supply well 455 in the NW¼ SW¼ sec. 16, T. 24 S., R. 2 W., Harvey County; drilled by Layne-Western Company, 1939. Surface altitude, 1,413.1 feet.*

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Soil, brown	2	2
Sand, fine, and tan silt	13	15
Sand, tan	3	18
Sand; contains gravel	65	83
Sand; contains gray clay balls	14	97
Sand; contains some silt and gravel	3	100
Sand, tan	7	107
Sand, fine to medium	10	117
Sand and silt, tan	2	119
Sand and gravel	3	122

256. *Driller's log of test hole at the SE cor. SW¼ sec. 16, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,412 feet.* (Courtesy Black and Veatch, engineers.)

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Top soil	5	5
Clay	15	20
Clay and sand	5	25
Clay, sandy	15	40
Sand, coarse	25	65
Sand, fine	15	80
Sand, coarse	5	85
Sand, fine	10	95
Sand	10	105
Clay	5	110
Clay, sandy	10	120
Clay	40	160
PERMIAN—Leonardian Wellington formation		
Shale	1	161

257. *Driller's log of test hole at the SE cor. sec. 16, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938.* (Courtesy Black and Veatch, engineers.)

QUATERNARY—Pleistocene and Recent Alluvium and McPherson formation	*Thickness, feet*	*Depth, feet*
Soil	5	5
Clay	5	10
Sand, coarse, and clay	10	20
Sand, coarse	15	35
Sand, fine	5	40
Sand, coarse	10	50
Gravel	5	55
Gravel and clay	5	60

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	Thickness, feet	Depth, feet
Gravel	5	65
Gravel and clay	5	70
Sand, fine	5	75
Sand, fine and clay	25	100
Sand, fine	5	105
Gravel	5	110
Sand and gravel	35	145
Sand, coarse	45	190
Sand and clay	5	195
PERMIAN—Leonardian		
Wellington formation		
Shale	9	204

258. *Driller's log of Wichita city-supply well 459 in the NW¼ NE¼ sec. 17, T. 24 S., R. 2 W., Harvey County; drilled by Layne-Western Company, 1939. Surface altitude, 1,413.9 feet.*

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil, dark brown	2	2
Silt, brown, and sand	8	10
Sand and gravel	23	33
Sand and silt, gray	9	42
Sand and gravel	24	66
Silt and clay, blue gray	6	72
Sand	49	121
Silt, blue gray, and fine sand	39	160
Sand, fine	62	222
Sand; contains gray silt	10	232
Silt and clay, tan	10	242
Sand and silt, gray	2	244
PERMIAN—Leonardian		
Wellington formation		
Shale, blue gray	4	246

259. *Driller's log of test hole at the NE cor. NW¼ sec. 17, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,415 feet.* (Courtesy Black and Veatch, engineers.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Top soil	5	5
Clay	5	10
Sand and clay	110	120
Sand, coarse	55	175
Gravel	10	185
Sand and clay	35	220
Sand, medium to coarse	20	240
PERMIAN—Leonardian		
Wellington formation		
Shale	1	241

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260. *Sample log of test hole at the NE cor. sec. 18, T. 24 S., R. 2 W., Harvey County; drilled by the City of Wichita, 1938. Surface altitude, 1,417.2 feet.* (Samples studied by Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt and clay, brown to gray	5	5
Sand, fine to medium; contains tan silt	5	10
Silt, buff, and very fine to fine sand	2	12
Sand, fine to medium, micaceous	2	14
Silt, gray	2	16
Sand, fine to medium	6	22
Sand, coarse to fine, and fine gravel	3	25
Clay, gray, and buff silt	1	26
Sand, fine to coarse, and fine to medium gravel	3	29
Gravel, fine to coarse, and coarse sand	7	36
Silt, buff	2	38
Sand, medium	5	43
Sand, coarse to medium, and fine to coarse gravel	10	53
Gravel, fine to coarse, and coarse to medium sand	16	69
Sand, coarse to medium, and fine gravel	5	74
Gravel, fine to medium, and coarse to medium sand	3	77
Sand, coarse to medium, and fine gravel	7	84
Silt, buff	4	88
Sand, medium to coarse, and fine gravel	4	92
Silt and clay, buff to gray	11	103
Gravel, fine to medium, and coarse sand	12	115
Silt and clay, calcareous, gray	22	137
Gravel, fine, and coarse sand	1	138
Silt and clay, calcareous, gray	38	176
Silt, calcareous, buff	11	187
Sand, medium to fine	3	190
Sand, coarse to medium, and fine gravel	21	211
Silt, calcareous, buff	6	217
Sand, coarse to medium	10	227
Silt, calcareous, buff	5	232
Gravel, fine to medium, and coarse to medium sand	12	244
PERMIAN—Leonardian		
Wellington formation		
Shale, soft, calcareous, gray	5	249

261. *Driller's log of test hole at the SE cor. NE¼ sec. 21, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,406 feet.* (Courtesy Black and Veatch, engineers.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Top soil	5	5
Sand, coarse	5	10
Sand and clay	5	15
Clay and gravel	10	25
Sand and clay	5	30

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	Thickness, feet	Depth, feet
Gravel and clay	35	65
Clay and sand	5	70
Sand, coarse	5	75
Clay and sand, coarse	5	80
Clay and sand, fine	5	85
Clay and sand, coarse	5	90
Clay, very hard, and coarse sand	5	95
Clay	15	110
Sand, coarse, and clay	5	115
Clay	30	145
PERMIAN—Leonardian		
Wellington formation		
Clay and soap stone	29	174

262. *Driller's log of test hole at the NW cor. NE¼ sec. 22, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,395 feet.* (Courtesy Black and Veatch, engineers.)

QUATERNARY—Pleistocene and Recent Alluvium and McPherson formation	Thickness, feet	Depth, feet
Top soil	5	5
Clay	5	10
Clay and sand	5	15
Sand, coarse	25	40
Gravel	5	45
Clay and gravel	40	85
Clay and sand	70	155
PERMIAN—Leonardian		
Wellington formation		
Clay and shale	9	164

263. *Driller's log of test hole at the SE cor. SW¼ sec. 22, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,401 feet.* (Courtesy Black and Veatch, engineers.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Top soil	5	5
Clay	15	20
Gravel	20	40
Clay	5	45
Clay and sand	5	50
Sand, fine	5	55
Sand, fine, and clay	5	60
Sand and clay	5	65
Sand, fine	15	80
Sand and clay	10	90
Clay, sandy	5	95
Clay	10	105
Sand and clay	5	110

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	Thickness, feet	Depth, feet
Clay, sandy	5	115
Sand and clay	15	130
Sand, fine	15	145
Sand and clay	15	160
Clay	5	165
Sand and clay	15	180
Clay	10	190
PERMIAN—Leonardian		
Wellington formation		
Shale and clay	4	194

264. *Driller's log of Wichita city-supply well 465 in the SE¼ SW¼ sec. 22, T. 24 S., R. 2 W., Harvey County; drilled by Layne-Western Company, 1939. Surface altitude, 1,401.7 feet.*

QUATERNARY—Pleistocene and Recent Dune sand	Thickness, feet	Depth, feet
Soil, sandy, brown	4	4
Silt, tan, and fine sand	12	17
McPherson formation (Pleistocene)		
Sand and gravel	13	30
Silt, dark gray; contains carbonaceous material	2	32
Sand and gravel	3	35
Silt and clay, dark gray	7	42
Sand and gravel; contains clay balls	36	78
Silt and clay, brown	2	80
Sand and gravel	10	90
Silt and clay, tan, and fine sand	45	135
Sand and gravel	2	137
Silt, gray, and fine sand	2	139
Sand and gravel	9	148
Silt and clay, buff to tan	2	150
Sand, coarse; contains clay balls	2	152
Sand, silt, clay, and gravel	3	155

265. *Driller's log of test hole at the SW cor. NW¼ sec. 23, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,396 feet.* (Courtesy Black and Veatch, engineers.)

QUATERNARY—Pleistocene and Recent Alluvium and McPherson formation	Thickness, feet	Depth, feet
Top soil	5	5
Clay	20	25
Gravel	5	30
Sand	5	35
Sand and gravel, coarse	20	55
Sand	10	65
Sand and clay	5	70
Sand	10	80

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	Thickness, feet	Depth, feet
Clay and sand	15	95
Clay	35	130
Clay and gravel	20	150
Clay	25	175
PERMIAN—Leonardian		
Wellington formation		
Shale and clay	3	178

266. *Driller's log of test hole at the NW cor. SW¼ sec. 25, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,388 feet.* (Courtesy Black and Veatch, engineers.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Top soil	5	5
Clay	20	25
Gravel	5	30
Sand	5	35
Sand and gravel, coarse	15	50
Clay and sand	5	55
Sand	10	65
Sand, clay, and gravel	5	70
Sand	10	80
Clay and sand	105	185
Sand	10	195
PERMIAN—Leonardian		
Wellington formation		
Shale	6	201

267. *Driller's log of test hole at the SW cor. SE¼ sec. 25, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,386 feet.* (Courtesy Black and Veatch, engineers.)

QUATERNARY—Pleistocene and Recent Alluvium and McPherson formation	Thickness, feet	Depth, feet
Top soil	5	5
Sand, dark	5	10
Clay	5	15
Sand, fine	5	20
Sand	20	40
Sand, coarse	25	65
Gravel	10	75
Sand	10	85
Clay and sand	25	110
Clay	30	140
Clay and sand	30	170
Sand	5	175
PERMIAN—Leonardian		
Wellington formation		
Shale	5	180

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268. *Driller's log of test hole at the NW cor. NE¼ sec. 26, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,392 feet.* (Courtesy Black and Veatch, engineers.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Alluvium and McPherson formation		
Top soil	5	5
Clay	10	15
Clay and gravel	5	20
Clay and sand	5	25
Gravel	40	65
Clay and gravel	10	75
Clay	10	85
Clay and gravel	20	105
Clay and sand	5	110
Clay	15	125
Clay and sand	20	145
Clay	5	150
PERMIAN—Leonardian		
Wellington formation		
Clay and shale	20	170

269. *Sample log of test hole at the NW cor. sec. 26, T. 24 S., R. 2 W., Harvey County; drilled by the City of Wichita, 1938. Surface altitude, 1,398.5 feet.* (Samples studied by Bruce F. Latta.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Alluvium and McPherson formation		
Silt, dark brown to gray	6	6
Silt and clay, tan	3	9
Silt, tan, and fine sand	7	16
Sand, fine to medium	2	18
Silt and clay, tan to gray, and fine sand	6	24
Sand	6	30
Gravel and sand; contains clay balls	17	47
Sand	2	49
Sand and gravel	23	72
Sand, fine to coarse; contains tan silt	7	79
Sand, coarse, and fine gravel; contains clay balls and lime nodules	3	82
Sand, and fine gravel	35	117
Gravel, fine, and coarse sand	6	123
Sand, contains shale pebbles and lime nodules	16	139
Silt, tan	5	144
Sand, fine to coarse	16	160
Silt and clay, gray	10	170
PERMIAN—Leonardian		
Wellington formation		
Shale, weathered, blue gray	2	172
Shale, blue gray	15	187

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270. *Driller's log of test hole at the NW cor. SW¼ sec. 26, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,396 feet.* (Courtesy Black and Veatch, engineers.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil	5	5
Sand	10	15
Gravel	50	65
Clay	5	70
Clay, soft	15	85
Clay, hard	15	100
Gravel	80	180
PERMIAN—Leonardian		
Wellington formation		
Clay and shale	5	185
Shale	2	187

271. *Driller's log of test hole at the SW cor. sec. 26, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,393 feet.* (Courtesy Black and Veatch, engineers.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Top soil	5	5
Clay	5	10
Clay, sandy	5	15
Clay	5	20
Clay, sandy	10	30
Sand, coarse	65	95
Sand and clay	20	115
Clay and gravel	10	125
Clay	10	135
Clay and gravel	5	140
Clay and sand	5	145
Clay	10	155
Clay, sandy	10	165
Clay	5	170
Sand and clay	45	215
PERMIAN—Leonardian		
Wellington formation		
Shale	5	220

272. *Driller's log of Wichita city-supply well 473 at the SW cor. sec. 26, T. 24 S., R. 2 W., Harvey County; drilled by Layne-Western Company, 1939. Surface altitude, 1,392.0 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, sandy, tan to gray	1	1
Silt and clay, gray, and fine sand	8	9

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	Thickness, feet	Depth, feet
Sand, fine	9	18
Sand and gravel	4	22
Silt and clay, gray green, and fine sand	2	24
Sand and fine gravel	26	50
Silt and clay, gray, and fine sand	8	58
Sand and gravel	20	78
Silt and clay, green to tan, and fine sand	1	79

273. *Driller's log of Wichita city-supply well 476 in the SW¼ SE¼ sec. 26, T. 24 S., R. 2 W., Harvey County; drilled by Layne-Western Company, 1939. Surface altitude, 1,391.6 feet.*

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil, sandy, gray tan	3	3
Silt and clay, gray	12	15
Sand, tan	10	25
Sand and gravel	20	45
Silt, green gray, and fine sand	7	52
Sand and gravel	3	55
Silt, gray, and fine sand	3	58
Sand and gravel; contains clay balls	15	73
Sand, and silt, gray; contains nodules of calcium carbonate	7	80
Silt and clay, gray and fine sand	1	81

274. *Driller's log of Wichita city-supply well 479 at the NE cor. sec. 27, T. 24 S., R. 2 W., Harvey County; drilled by Layne Western Company, 1939. Surface altitude, 1,396.4 feet.*

QUATERNARY—Pleistocene and Recent Alluvium and McPherson formation	Thickness, feet	Depth, feet
Soil, sandy, brown	3	3
Sand	39	42
Silt and clay, gray, and fine sand	8	50
Sand	4	54
Silt, tan, and fine sand	4	58
Sand	17	75
Silt and clay, tan	2	77
Sand	15	92
Silt and clay, gray	6	98
Sand; contains gravel, clay balls, and nodules of calcium carbonate	17	115
Clay and silt, tan	1	116
Sand	10	126
Silt, tan, and fine sand	4	130
Sand and gravel; contains clay balls and nodules of calcium carbonate	15	145

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275. *Driller's log of test hole at the NE cor. sec. 28, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,407 feet.* (Courtesy of Black and Veatch, engineers.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil	5	5
Clay	10	15
Sand	35	50
Sand, coarse	20	70
Sand	15	85
Sand and clay	10	95
Clay	75	170
Sand and clay	55	225
Clay	15	240
PERMIAN—Leonardian		
Wellington formation		
Clay and shale	9	249

276. *Sample log of test hole at the NE cor. sec. 35, T. 24 S. R. 2 W., Harvey County; drilled by the City of Wichita, 1938. Surface altitude, 1,389.2 feet.* (Samples studied by John C. Frye and Fred T. Holden.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, sandy, brown	3	3
Sand, medium to fine, and brown silt	8	11
Sand, medium	11	22
Silt, gray to brown, and fine sand	1	23
Clay, silt, and sand	2	25
Sand, coarse, and fine gravel	8	33
Silt and clay, gray to brown, and fine sand	12	45
Gravel, fine to medium, and coarse sand; contains clay balls	11	56
Silt and clay, gray	1	57
Sand, coarse, and fine gravel	3	60
Sand, medium; contains clay balls	19	79
Sand, coarse, and fine gravel; contains clay balls, calcareous nodules, and fragments of sandstone and bone,	6	85
Clay, silt, and fine sand	52	137
Sand, fine to medium, and tan silt	5	142
Sand, coarse to medium; contains clay balls and fragments of shale	9	151
Gravel, fine; contains pebbles of blue-green shale and nodules of calcium carbonate	2	153
Sand, and silt; contains clay balls	1	154
Gravel, fine, and fine to coarse sand	2	156
Sand, fine, and gray to buff silt	12	168

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	Thickness, feet	Depth, feet
Sand, medium; contains pebbles of green shale.....	10	178
Gravel, fine, and coarse to fine sand	2	180
Gravel	2	182
Clay, sandy, gray; contains calcareous nodules and pebbles of shale	3	185
PERMIAN—Leonardian		
Wellington formation		
Shale, blue gray	8	193

277. *Driller's log of test hole at the NW cor. NE¼ sec. 35, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,392.* (Courtesy Black and Veach, engineers.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil	5	5
Sand	5	10
Gravel	65	75
Gravel, coarse	50	125
Clay	25	150
Gravel	10	160
Clay	35	195
PERMIAN—Leonardian		
Wellington formation		
Shale	2	197

278. *Sample log of test hole at the NE cor. SE¼ sec. 35, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,388 feet.* (Courtesy, Black and Veatch, engineers.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Top soil	5	5
Sand, fine	15	20
Clay, sandy	5	25
Sand, coarse	10	35
Sand, fine	5	40
Sand, coarse	30	70
Sand, fine	35	105
Clay and sand	5	110
Sand, coarse, and clay.....	5	115
Sand and clay	5	120
Clay and gravel	5	125
Sand and Clay	25	150
Sand, fine	55	205

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279. *Driller's log of Wichita city-supply well 487 in the SE¼ SE¼ sec. 35, T. 24 S., R. 2 W., Harvey County; drilled by Layne-Western Company, 1939. Surface altitude, 1,386.6 feet.*

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Soil, sandy, dark brown	2	2
Silt, tan to brown, and sand	20	22
Sand and gravel; contains clay balls	64	86
Silt and clay, gray, and fine sand	36	122
Silt and sand; contains carbonaceous material	12	134
Silt, tan, and fine sand	11	145
Sand; contains nodules of calcium carbonate	59	204
PERMIAN—Leonardian		
Wellington formation		
Shale, blue gray	4	208

280. *Driller's log of Wichita city-supply well 491 at the SE cor. sec. 35, T. 24 S., R. 2 W., Harvey County; drilled by Layne-Western Company, 1939. Surface altitude, 1,387.9 feet.*

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Soil, sandy, light brown	2	2
Silt and clay, buff to gray	3	5
Sand	4	9
Silt and clay, tan, and fine sand	5	14
Sand	4	18
Silt and clay, tan	4	22
Sand and gravel	32	54
Silt, tan, and fine sand	1	55
Sand and gravel	30	85
Sand; contains clay balls and nodules of calcium carbonate	10	95
Silt and clay, gray green; contains clay balls, fragments of wood, mollusk shells, and bone	1	96

281. *Driller's log of test hole at the NE cor. SE¼ sec. 36, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,379 feet.* (Courtesy Black and Veatch, engineers.)

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Top soil	5	5
Clay	15	20
Clay and sand	5	25
Sand, coarse	5	30
Gravel and sand	5	35
Gravel	15	50
Clay	70	120
Clay and sand	15	135

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	Thickness, feet	Depth, feet
Clay	15	150
Clay and sand	15	165
PERMIAN—Leonardian		
Wellington formation		
Shale	5	170

282. *Driller's log of test hole at the SE cor. SW¼ sec. 36, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,383 feet.* (Courtesy Black and Veatch, engineers.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Top soil	5	5
Clay	5	10
Sand, coarse	65	75
Clay and gravel	15	90
Clay	45	135
Sand and gravel	50	185
PERMIAN—Leonardian		
Wellington formation		
Shale	2	187

283. *Driller's log of Wichita city-supply well in the SW¼ SE¼ sec. 36, T. 24 S., R. 2 W., Harvey County; drilled by Layne-Western Company, 1939. Surface altitude, 1,381.8 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, brown	1	1
Silt and clay, tan to brown, and fine sand	25	26
Sand; contains gravel	64	90
Silt and clay, blue gray, and sand	18	108
Sand	14	122
Silt and clay, blue green	3	125
Sand and gravel, interbedded with silt and clay	12	137
Sand; contains pebbles of shale	20	157
Silt and clay, gray, and sand	3	160
Sand and gravel; contains fragments of shale	26	186
PERMIAN—Leonardian		
Wellington formation		
Shale, blue gray	2	188

284. *Driller's log of test hole at the SE cor. sec. 36, T. 24 S., R. 2 W., Harvey County; drilled for the City of Wichita, 1938. Surface altitude, 1,379 feet.* (Courtesy Black and Veatch, engineers.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Top soil	10	10
Clay, sandy	50	60
Clay	20	80

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	Thickness, feet	Depth, feet
Clay, sandy	5	85
Clay	75	160
Clay and sand	20	180
PERMIAN—Leonardian		
Wellington formation		
Shale	5	185

285. *Sample log of test hole at the SE cor. sec. 1, T. 24 S., R. 3 W., Harvey County; drilled by the City of Wichita, 1938. Surface altitude, 1,431.4 feet.* (Samples studied by Fred T. Holden.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil, brown to tan	6	6
Silt and clay, red brown, and fine sand	19	25
Sand; contains some tan silt and gravel	5	30
Sand, fine, and gray silt and clay	4	34
Silt, brown to gray, and sand; contains some clay and gravel	8	42
Gravel, medium to coarse	2	44
Sand, coarse, and fine gravel	20	64
Silt and clay, gray to tan, and fine sand	20	84
Sand; contains pebbles of shale and nodules of calcium carbonate	35	119
Silt and clay, tan, and fine sand	2	121
Sand	6	127
Sand, fine, and tan silt and clay	4	131
Silt and clay, gray to tan, and fine sand	48	179
Sand; contains clay balls	3	182
Silt and clay, brown	6	188
Sand; contains clay balls, nodules of calcium carbonate, and pebbles of shale	13	201
Silt and clay, gray to tan	10	211
Sand	12	223
Clay and silt, tan	2	225
Sand, coarse; contains clay balls	7	232
Clay and silt, gray green	1	233
Sand; contains pebbles of green shale	19	252
Clay and silt, gray	2	254
Sand, fine to medium	1	255
PERMIAN—Leonardian		
Wellington formation		
Shale, dark gray	19	274

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286. *Driller's log of test hole at the SE cor. sec. 6, T. 24 S., R. 3 W., Harvey County; drilled by Layne-Western Company for the City of Wichita, 1939. Surface altitude, 1,448.3 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt and clay, sandy, tan	5	5
Sand and gravel	24	29
Silt and clay, gray	8	37
Sand	12	49
Sand and gravel	12	61
Silt and clay, tan	7	68
Sand and gravel	29	97
PERMIAN—Leonardian		
Wellington formation		
Shale, blue	11	108

287. *Sample log of test hole at the SE cor. sec. 11, T. 24 S., R. 3 W., Harvey County; drilled by the City of Wichita, 1938. Surface altitude, 1,424.1 feet.* (Samples studied by Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, brown; composed of silt and very fine sand	2	2
Silt and clay, buff ot brown, calcareous	1	3
Sand, fine to very fine, and buff to brown calcareous silt; contains many small nodules of calcium carbonate	1	4
Sand, medium to fine, and coarse sand; contains some large pebbles of gravel and some nodules of calcium carbonate	3	7
Gravel, fine to coarse, and coarse to medium sand	1	8
Sand, coarse to medium, and fine to coarse gravel; poorly sorted	3	11
Silt and clay, gray to buff; contains very fine to fine sand	2	13
Sand, medium to coarse, and fine to medium gravel	6	19
Gravel, fine to medium, and coarse to medium sand	4	23
Sand, coarse to medium, and fine gravel	2	25
Gravel, fine to coarse, and coarse sand; contains fragments of silt and clay balls	7	32
Silt, buff; contains some very fine sand	11	43
Sand, coarse to medium, and fine to medium gravel	7	50
Gravel, coarse to fine, and coarse sand	6	56
Sand, coarse to medium, and fine to medium gravel	6	62
Silt, gray to buff, and very fine sand	5	67
Silt, very calcareous, gray, and very fine sand; contains plant remains and fragments of snail shells	11	78
Silt, calcareous, buff	5	83
Sand, medium to very fine; contains calcareous buff silt,	5	88

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	Thickness, feet	*Depth, feet*
Sand, medium to fine, and coarse sand	3	91
Sand, coarse to fine; contains some fine gravel	2	93
Gravel, fine, and coarse to fine sand; poorly sorted	2	95
Gravel, fine, and coarse sand	3	98
Sand, coarse to medium, and fine gravel	2	100
Sand, coarse; contains some medium sand; well sorted	2	102
Silt, very calcareous, gray, and very fine to fine sand; contains many nodules of calcium carbonate	1	103
Gravel, fine, and medium to coarse sand; contains some gray silt	4	107
Gravel, fine; well sorted	1	108
Gravel, fine to medium; contains fragments of silt and clay balls	3	111
Sand, medium to coarse, and buff silt	4	115
Silt, very calcareous, gray; contains very fine to fine sand	2	117
Sand, coarse to medium	1	118
Silt, buff, and sand, very fine to fine	4	122
Silt and clay, calcareous, gray to buff; contains very fine to fine sand, nodules of calcium carbonate, and fragments of snail shells	10	132
Sand, coarse to fine, and buff silt	8	140
Sand, medium to fine, and coarse sand	17	157
Sand, medium to fine; contains some silt	5	162
Silt, buff, and very fine to fine sand; contains limonite	11	173
Silt, calcareous, buff, and very fine to fine sand	27	200
Silt and clay, very calcareous, gray, and very fine to fine sand; contains many nodules of calcium carbonate	5	205
Silt, calcareous, buff, and very fine to fine sand; contains nodules of calcium carbonate	13	218
Sand, coarse to fine; contains some calcareous buff silt,	6	224
Sand, coarse to fine, and fine gravel; contains nodules of calcium carbonate	4	228
Gravel, fine, and coarse sand; well sorted	3	231
Gravel, fine to medium, and coarse sand; contains pebbles of chert and nodules of calcium carbonate	4	235
Sand, medium to coarse, and fine sand	2	237
Sand, medium to fine, and coarse sand; contains fragments of snail shells	1	238
Sand, medium to fine, coarse sand, and fine gravel	8	246
Silt, calcareous, buff, and very fine to coarse sand	1	247
Sand, medium to coarse; contains large pebbles of greenish gray shale	1	248
PERMIAN—Leonardian		
Wellington formation		
Shale, calcareous, bluish gray	8	256

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288. *Driller's log of test hole at the SW cor. sec. 17, T. 24 S., R. 3 W., Harvey County; drilled by Layne-Western Company for the City of Wichita, 1939. Surface altitude, 1,461.1 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt, sandy, brown to tan	5	5
Sand and gravel; contains silt	13	18
Sand and gravel	13	61
Silt and clay, tan	17	78
Silt, yellow, and fine sand	5	83
Sand and gravel	18	101
Silt, tan, and fine sand	5	106
Sand, medium to fine	7	113
Sand and gravel	22	135
Sand, fine to medium, and brown silt	8	143
PERMIAN—Leonardian		
Wellington formation		
Shale, blue	5	148

289. *Driller's log of test hole at the NW cor. sec. 18, T. 24 S., R. 3 W., Harvey County; drilled by Layne-Western Company for the City of Wichita, 1939. Surface altitude, 1,466.3 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt and clay, sandy, tan	10	10
Sand and gravel	10	20
Silt, gray	13	33
Sand	7	40
Sand and gravel	10	50
Sand, fine, and tan silt	3	53
Sand, fine, and gray silt	2	55
Sand and gravel	15	70
Silt and clay, yellow	33	103
Sand and gravel	12	115
Silt and clay, tan	35	150
Sand and gravel	6	156
Silt and clay, tan	4	160
PERMIAN—Leonardian		
Wellington formation		
Shale, blue	3	163

290. *Sample log of test hole in the NE¼ SE¼ SE¼ sec. 21, T. 24 S., R. 3 W., Harvey County; drilled by the City of Wichita, 1939. Surface altitude, 1,431.8 feet.* (Samples studied by Bruce F. Latta.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, black to gray brown	6	6
Sand, fine, and gray to tan silt	4	10
Sand and gravel	19	29

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	Thickness, feet	Depth, feet
Sand	8	37
Sand and gravel	40	77
Sand	10	87
Sand, fine, and tan to brown silt	22	109
Silt and clay, tan, and fine sand; contains nodules of calcium carbonate	18	127
PERMIAN—Leonardian		
Wellington formation		
Shale, greenish gray and dark gray; weathered zone at top	36	163

291. *Sample log of test hole at the NW cor. sec. 23, T. 24 S., R. 3 W., Harvey County; drilled by State Geological Survey, 1944. Surface altitude, 1,430.4 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Clay and silt, gray	6	6
Silt, light brown; contains some coarse to fine sand...	2	8
Gravel, medium to fine, coarse to fine sand, and buff silt	2	10
Gravel, coarse to fine, and coarse sand	30	40
Gravel, fine, and coarse to medium sand	12	52
Silt, buff, and medium to fine sand	20	72
Silt, greenish gray; contains some meduim to fine sand,	9	81
Gravel, medium to fine, and coarse sand; contains light-gray silt	20	101
Silt, greenish gray; contains some coarse to fine sand..	6	107
Gravel, medium to fine, and coarse sand; contains light-gray silt	20	127
Silt, buff to gray; contains some medium to fine sand,	11	138
Sand, coarse to fine; contains fiine gravel and gray silt,	7	146
Silt, light brown to gray; contains coarse to fine sand,	9	154
Gravel, fine, and coarse sand; contains light-gray silt,	19	173
Silt, buff to gray; contains nodules of calcium carbonate,	22	195
Silt, buff; contains gravel and sand and nodules of calcium carbonate	3	198
PERMIAN—Leonardian		
Wellington formation		
Shale, gray to maroon	8	206

292. *Sample log of test hole at the SE cor. sec. 29, T. 24 S., R. 3 W., Harvey County; drilled by State Geological Survey, 1944. Surface altitude, 1,434.2 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Silt and clay, brown to gray	8	8
Sand, medium to fine; contains some fine gravel	7	15

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	Thickness, feet	Depth, feet
Silt, greenish gray; contains some coarse to fine sand,	4	19
Sand, medium to fine	8	27
Silt, greenish gray	9	36
Sand, coarse to fine	4	40
Gravel, fine to coarse, and coarse sand; contains some gray silt	10	50
Gravel, coarse to fine; and coarse to medium sand; contains buff to gray silt	20	70
Silt, yellow to buff, and fine sand	6	76
Gravel, fine to coarse, and coarse sand	4	80
Silt, buff; contains fine gravel, coarse sand, and nodules of calcium carbonate	13	93
Gravel, medium to fine, and coarse sand; contains buff silt	60	153
PERMIAN—Leonardian		
Wellington formation		
Shale, gray green and blue gray	7	160

293. *Sample log of test hole at the SE cor. sec. 31, T. 24 S., R. 3 W., Harvey County; drilled by the City of Wichita, 1939. Surface altitude, 1,434.3 feet.* (Samples studied by John C. Frye, Bruce F. Latta, and Fred T. Holden.)

QUATERNARY—Pleistocene and Recent Alluvium and McPherson formation	Thickness, feet	Depth, feet
Soil, grey to brown	3	3
Sand, fine, and yellow to blue-gray silt	6	9
Sand, coarse, and fine gravel	17	26
Silt, gray to tan; contains fine sand and clay	56	82
Sand	11	93
Sand and gravel	14	107
Silt, tan, and fine sand	11	118
Sand and gravel	14	132
Silt, tan; contains sand and clay	12	144
Sand, coarse, and fine gravel; contains clay balls	25	169
Sand; contains clay balls	37	206
Gravel	1	207
Silt, clay, and fine sand	12	219
Sand and gravel	23	242
Sand, medium; contains tan silt	19	261
Sand and gravel; contains clay balls	3	264
Sand, silt, and gravel; contains pebbles of shale and ironstone and nodules of calcium carbonate	3	267
PERMIAN—Leonardian		
Wellington formation		
Shale, lead gray	6	273

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294. *Driller's log of test hole at the SW cor. sec. 13, T. 24 S., R. 4 W., Reno County; drilled by Layne-Western Company for the City of Wichita, 1939. Surface altitude, 1,451.6 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt, dark brown, and fine sand	9	9
Sand and gravel	16	25
Silt, clay, and fine sand	3	28
Sand and gravel	17	45
Sand	21	66
Silt and clay, blue green	36	102
Sand and gravel	33	135
Silt and clay	3	138
Sand and gravel	77	215
Silt and clay, sandy, tan	10	225
PERMIAN—Leonardian		
Ninnescah shale		
Shale, green	5	230

295. *Driller's log of test hole in the NE¼ NE¼ NW¼ sec. 16, T. 42 S., R 5 W., Reno County; drilled by Layne-Western Company for U. S Navy, 1942.*

	Thickness, feet	Depth feet
QUATERNARY—Pleistocene		
McPherson formation		
Clay	41	41
Sand, fine	9	50
Sand, medium to coarse	16	66
Clay and sand	6	72
Sand, medium to coarse, silty	28	100
Clay, gray	7	107
Sand, silty	21	118
Sand, medium to coarse, and gravel	9	127
PERMIAN—Leonardian		
Ninnescah shale		
Shale	1	128

296. *Driller's log of well 535 in the NW¼ NE¼ NW¼ sec. 16, T. 24 S., R. 5 W., Reno County; drilled by Layne-Western Company for U. S. Navy, 1942.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt	3	3
Clay, sandy	17	20
Sand, fine	15	35
Sand, medium	10	45
Sand, coarse	7	52
Clay, yellow	13	65
Sand coarse	17	82

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	Thickness, feet	Depth, feet
Sand, coarse, and gravel	14	96
Sand, medium to coarse	29	125
PERMIAN—Leonardian		
Ninnescah shale		
Shale	1	126

297. *Driller's log of well 529 in the SW¼ NW¼ SW¼ sec. 20, T. 24 S., R. 4 W., Reno County; drilled by Layne-Western Company for Eldon Gasoline Company, 1937.*

QUATERNARY Alluvium and McPherson formation	Thickness, feet	Depth, feet
Silt, sandy	3	3
Sand, fine	5	8
Sand, medium	4	12
Sand, coarse, and gravel	5	17
Sand, medium	31	48
Clay	1	49
Sand, medium	6	55

298. *Driller's log of test hole in the SW¼ NW¼ SW¼ sec. 20, T. 24 S., R. 4 W., Reno County; drilled by Layne-Western Company for the Eldon Gasoline Company, 1937.*

QUATERNARY—Pleistocene and Recent Alluvium and McPherson formation	Thickness, feet	Depth, feet
Silt, sandy	3	3
Sand, fine	7	10
Sand and gravel	25	35
Sand, coarse	5	40
Sand and gravel	5	45
Clay	4	49
Sand, coarse	19	68
Sand, medium to fine	25	93
Sand, coarse	10	103
Sand, coarse, and gravel	16	119
Clay, gray	7	126
Sand, fine	4	130
Sand, coarse to medium	18	148
Sand, fine	7	155
Clay, sandy	3	158

299. *Driller's log of well 530 in the NE¼ SW¼ SW¼ sec. 20, T. 24 S., R. 4 W., Reno County; drilled by Layne-Western Company for Eldon Gasoline Company, 1937.*

QUATERNARY—Pleistocene and Recent Alluvium and McPherson formation	Thickness, feet	Depth, feet
Silt, sandy	6	6
Sand, fine	3	9
Sand, coarse	2	11
Sand, medium; contains clay balls	8	19

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	Thickness, feet	Depth, feet
Sand, coarse, and gravel	25	44
Clay	12	56
Sand, fine	1	57
Sand, medium	8	65
Sand, fine	5	70
Sand, medium	10	80
Sand, fine	22	102

300. *Driller's log of test hole in the SW¼ SE¼ SW¼ sec. 20, T. 24 S., R. 4 W., Reno County; drilled by Layne-Western Company for Eldon Gasoline Company, 1937.*

QUATERNARY—Pleistocene and Recent Alluvium and McPherson formation	Thickness, feet	Depth, feet
Silt, sandy	3	3
Sand, fine	5	8
Clay	21	29
Sand, gravel, and clay	1	30
Sand and gravel	15	45
Clay	11	56
Sand, coarse	1	57
Sand and gravel	6	63
Sand	12	75
Sand, medium to fine	5	80
Sand, coarse, and gravel	18	98
Sand, medium to fine	21	119
Clay	1	120
Sand, fine	8	128
Clay	1	129
Sand, fine	14	143
Clay, sandy	5	148

301. *Sample log of test hole at the SE cor. NW¼ sec. 6, T. 25 S., R. 1 W., Sedgwick County; drilled by Wichita Water Company, 1937.* (Samples studied by S. W. Lohman.)

QUATERNARY—Pleistocene and Recent Alluvium and McPherson formation	Thickness, feet	Depth, feet
Soil and silt, sandy	25	25
Sand, fine	3	28
Gravel, fine, and coarse sand	4	32
Sand, medium to coarse, and fine gravel	8	40
Gravel, coarse to fine	2	42
Sand, coarse, and fine gravel	2	44
Gravel, coarse to fine	6	50
Sand, coarse, and fine gravel	1	51
Sand, medium to coarse	3	54
Sand, coarse, and fine gravel	7	61
Gravel, coarse to fine	14	75
Sand, coarse, and fine gravel	2	77
Clay, white, soft, very calcareous	10	87

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302. *Driller's log of city-supply well 555 in the SW¼ SE¼ SE¼ sec. 25, T. 25 S., R. 1 W., Sedgwick County; drilled by Wichita Pump and Supply Company for the City of Valley Center, 1938.*

QUATERNARY—Recent Alluvium	*Thickness, feet*	*Depth, feet*
Silt	17	17
Gravel, coarse	4	21
Sand, rusty	11	32
Sand, fine	3	35
Sand, coarse	15	50
PERMIAN—Leonardian Wellington formation		
Shale, blue	1	51

303. *Sample log of well 568 at the NW cor. SW¼ sec. 1, T. 25 S., R. 2 W., Sedgwick County; drilled by Wichita Water Company, 1937. Surface altitude, 1,388 feet.* (Samples studied by S. W. Lohman.)

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Soil and clay	23	23
Gravel, and coarse sand; contains silt	7	30
Sand, coarse, and fine gravel	2	32
Sand, medium to coarse, and fine gravel	6	38
Sand, coarse, and fine gravel	14	52
Sand, medium to fine	2	54
Sand, medium to coarse, and fine gravel	6	60
Gravel, fine to medium, and coarse sand	13	73
Sand, coarse to medium, and fine gravel	2	75
Gravel, fine, and coarse sand	3	78
Sand, medium to coarse	2	80
Sand, medium to fine	5	85
Sand, medium	6	91
Clay	2	93

304. *Driller's log of test hole at the NE cor. sec. 2, T. 25 S., R. 2 W., Sedgwick County; drilled for the City of Wichita, 1938. Surface alittude 1,389 feet.* (Courtesy Black and Veatch, engineers.)

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Top soil	5	5
Sand, coarse	15	20
Sand and clay	15	35
Sand, fine	5	40
Gravel	10	50
Clay and gravel	15	65
Gravel	20	85
Sand, coarse	5	90
Clay and gravel	10	100
Clay	60	160

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	Thickness, feet	Depth, feet
Clay and sand	25	185
Sand, fine	10	195
PERMIAN—Leonardian		
Wellington formation		
Shale	4	199

305. *Sample log of test hole at the NW cor. sec. 2, T. 25 S., R. 2 W., Sedgwick County; drilled for the City of Wichita, 1938. Surface altitude 1,391.2 feet.* Samples studied by Fred T. Holden.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Soil, brown	3	3
Sand, medium, and tan silt	2	5
Sand, medium, and gravel	1	6
Silt, tan to gray, and fine sand	11	17
Sand, coarse, and fine gravel; contains silt, tan	8	25
Sand, fine to medium; contains silt and clay balls	1	26
Silt and clay, gray to tan, and fine sand	4	30
Sand, fine to medium; contains fine gravel and tan silt,	5	35
Silt and clay, dark gray, and fine sand	21	56
Silt, tan, and fine sand	6	62
Sand, coarse, and fine gravel	1	63
Sand, medium to fine	3	66
Sand, fine, and gray-green silt	1	67
Sand, fine to coarse, contains thin beds of gray silt	20	87
Silt and clay, gray	1	88
Sand, coarse; contains fragments of silt and clay balls and nodules of calcium carbonate	14	102
Silt and clay, gray, and fine sand	37	139
Sand, fine, and gray silt; contains shells of snails and clams, and fragments of bone	7	146
Sand, medium; contains silt and clay balls	14	160
Sand, fine, and gray silt	1	161
Sand, medium to fine; contains fragments of bone	1	162
Silt and clay, gray-green	11	173
Sand, coarse; contains clay balls and calcareous nodules,	2	175
Silt, gray, and fine sand	1	176
Sand, medium	13	189
Silt, gray green; contains fine sand and clay	7	196
Sand, fine to coarse, and light-tan silt	9	205
Silt and clay, gray green	1	206
Sand, fine to coarse; contains nodules of calcium carbonate	8	214
Silt, dark gray	1	215
Silt and clay, gray to brown	26	241
PERMIAN—Leonardian		
Wellington formation		
Shale, dark gray to green gray	6	247

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306. *Sample log of test hole at the NE cor. sec. 9, T. 25 S., R. 2 W., Sedgwick County; drilled by the City of Wichita, 1938. Surface autitude, 1,395.6 feet.* (Samples studied by Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Soil, sandy	2	2
Silt, buff, and very fine sand; contains nodules of calcium carbonate	2	4
Sand, medium to fine; contains some coarse sand and fine gravel	2	6
Sand, medium to coarse, and fine to coarse gravel	3	9
Gravel, fine to coarse, and coarse sand	5	14
Sand, coarse to medium	2	16
Gravel, coarse to fine, and coarse to medium sand	6	22
Gravel, coarse to fine	2	24
Gravel, fine to coarse, and coarse to medium sand	2	26
Silt, gray, and very fine to fine sand	1	27
Gravel, fine to medium, and coarse to medium sand	2	29
Sand, fine to coarse; contains fine to medium gravel and gray silt; poorly sorted	2	31
Gravel, fine to coarse, and coarse to medium sand	4	35
Sand, medium to coarse, and fine to coarse gravel; poorly sorted	4	39
Sand, fine to coarse, and fine to medium gravel; contains some buff silt and clay	2	41
Gravel, fine to coarse, and coarse to medium sand	1	42
Sand, very fine to medium, and buff silt	12	54
Sand, coarse to medium, and fine to medium gravel	6	60
Silt, buff, and very fine to fine sand	1	61
Sand, medium to coarse, and fine to medium gravel,	1	62
Sand, fine to coarse, and fine to medium gravel; contains fragments of silt and clay balls	5	67
Sand, coarse to fine, and fine to medium gravel; contains silt and clay	5	72
Gravel, fine to medium, and coarse to medium sand	1	73
Silt and clay, very calcareous, buff, and very fine to fine sand	18	91
Silt and clay, calcareous, buff; contains thin beds of fine to coarse gravel	22	113
Silt, calcareous, buff, and very fine to medium sand	8	121
Sand, fine to coarse, and buff silt	4	125
Sand, coarse to fine, and fine gravel	7	132
Sand, coarse to medium; contains buff silt	6	138
Sand, medium, mostly quartz, very well sorted	2	140
Sand, medium to coarse, mostly quartz	1	141
Silt, very calcareous, buff, and coarse to fine sand	2	143
Sand, coarse to fine; most grains composed of quartz but some are feldspar and blue-green chert	7	150
Sand, coarse to medium; contains clay balls	4	154

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	Thickness, feet	Depth, feet
Gravel, coarse to medium, and coarse to medium sand,	2	156
Sand, coarse to medium, and fine gravel; most grains and pebbles composed of quartz, but some are feldspar and olive-green chert	3	159
Sand, medium to coarse	1	160
Silt, calcareous, buff, and very fine to fine sand; contains nodules of calcium carbonate	7	167
Sand, coarse to medium, and fine gravel	5	172
Sand, coarse to fine; contains fine to coarse gravel, buff silt, pebbles of green-gray shale, and nodules of calcium carbonate	5	177
Sand, coarse to medium, and fine gravel; contains pebbles of green-gray shale and nodules of calcium carbonate	3	180
Silt, calcareous, buff, and very fine sand; contains nodules of calcium carbonate	17	197
Sand, fine to coarse, and fine to medium gravel; poorly sorted	9	206
Sand, coarse to medium; contains fine gravel	3	209
Sand, coarse to fine, and fine gravel; contains fragments of silt, clay balls, and nodules of calcium carbonate	4	213
Sand, fine to coarse; contains some fine gravel	10	223
Sand, fine to coarse, and fine to coarse gravel; poorly sorted; contains pebbles of shale and nodules of calcium carbonate	5	228
PERMIAN—Leonardian		
Wellington formation		
Shale, calcareous, gray, and thin beds of gray limestone	5	233

307. *Sample log of test hole at the NW cor. sec. 16, T. 25 S., R. 2 W., Sedgwick County; drilled by the City of Wichita, 1938. Surface altitude, 1,397.0 feet.* (Samples studied by Charles C. Williams.)

QUATERNARY—Pleistocene and Recent Alluvium and McPherson formation	Thickness, feet	Depth, feet
Soil, sandy		
Sand, fine to coarse, and tan silt	4	4
Sand, fine to coarse, and fine to medium gravel poorly sorted	1	5
Gravel, fine to coarse, and coarse to fine sand; poorly sorted	8	13
Gravel, coarse to fine, and coarse to medium sand	16	29
Sand, coarse to fine, and fine to medium gravel; contains fragments of silt and clay balls	2	31
Gravel, fine to medium, and coarse to medium sand	5	36
Sand, coarse to fine, and fine to medium gravel; contains fragments of silt and clay balls	18	54

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	Thickness, feet	Depth, feet
Gravel, medium to fine, and coarse to medium sand....	3	57
Gravel, coarse to medium	1	58
Sand, fine to coarse, and fine to coarse gravel; poorly sorted; contains silt and clay.....	1	59
Silt, buff, and very fine to fine sand.....	8	67
Sand, very fine to fine, and buff silt	19	86
Sand, very fine to fine	4	90
Sand, fine to coarse, contains some fine to medium gravel	12	102
Sand, fine to very fine, and buff silt	9	111
Silt, buff, and very fine to fine sand.....	8	119
Sand, fine to very fine, and buff silt	10	129
Silt, buff, and very fine to fine sand	28	157
Sand, very fine, and buff silt; contains nodules of calcium carbonate	4	161
Silt, calcareous, buff, and very fine to fine sand; contains nodules of calcium carbonate and fragments of light-green calcareous shale	33	194
Sand, fine to medium; contains buff silt.....	6	200
Sand, very fine to fine, and buff silt	1	201
Silt, very calcareous, gray to buff; contains nodules of calcium carbonate and fragments of gray calcareous shale	2	203
PERMIAN—Leonardian		
Wellington formation		
Shale, calcareous, light to dark gray; contains thin beds of limestone	7	210

308. *Sample log of test hole at the SW cor. sec. 16, T. 25 S., R. 2 W., Sedgwick County; drilled by the City of Wichita, 1938. Surface altitude, 1,391.3 feet.* (Samples studied by Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Alluvium and McPherson formation		
Soil, sandy, brown	2	2
Sand, fine to medium, very fine sand, and brown silt...	4	6
Sand, coarse to fine, and fine to coarse gravel; pebbles as much as ½ inch in diameter	4	10
Gravel, fine to coarse.....	4	14
Sand, coarse to medium, and fine to medium gravel..	5	19
Sand, medium to coarse; very well sorted	1	20
Sand, coarse to medium, and fine gravel	4	24
Gravel, fine to coarse, and coarse to medium sand....	4	28
Gravel, fine to medium; contains some coarse sand ..	7	35
Silt, gray, and very fine to fine sand.....	11	46
Sand, very fine to fine, and gray silt	4	50
Silt, gray to buff, and very fine to medium sand	10	60
Sand, medium to fine; contains some gray silt	17	77

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	Thickness, feet	Depth, feet
Silt, buff, and very fine to fine sand	15	92
Sand, fine to medium	12	104
Sand, very fine to medium, and buff silt	4	108
Silt, buff, and very fine to medium sand	8	116
Sand, medium to fine	14	130
Sand, very fine to fine, and buff silt	8	138
Silt, buff, and very fine to fine sand; contains fragments of plants	6	144
Clay and silt, calcareous, light gray	8	152
PERMIAN—Leonardian		
Wellington formation		
Shale, calcareous, soft, light gray, and thin beds of gray limestone	4	156

309. *Driller's log of test hole at the SW cor. sec. 24, T. 25 S., R. 2 W., Sedgwick County; drilled, 1941. Surface altitude, 1,378 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Alluvium and McPherson formation		
Silt	12	12
Sand and gravel	16	28
Silt and clay	5	33
Sand	27	60
Silt and clay	5	65
Sand	5	70
Silt and clay	2	72
Sand and gravel	93	165
Silt and clay	7	172
Sand	28	200
PERMIAN—Leonardian		
Wellington formation		
Shale	1	201

310. *Driller's log of test hole at the SW cor. sec. 26, T. 25 S., R. 2 W., Sedgwick County; drilled, 1941. Surface altitude, 1,378 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Alluvium and McPherson formation		
Sand	65	65
Gravel	10	75
Silt and clay	5	80
Sand	71	151
Silt and clay	43	194
Sand and gravel	18	212
Silt and clay	7	219
Sand	8	227
PERMIAN—Leonardian		
Wellington formation		
Shale	1	228

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311. *Sample log of test hole at the NW cor. sec. 29, T. 25 S., R. 2 W., Sedgwick County; drilled by State Geological Survey, 1939. Surface altitude, 1,393.4 feet.* (Samples studied by Fred T. Holden.)

QUATERNARY—Pleistocene and Recent Alluvium and McPherson formation	*Thickness, feet*	*Depth, feet*
Soil, sandy, brown	3	3
Silt and clay, brown; contains sand	4	7
Gravel, coarse; contains clay balls	38	45
Silt and clay, tan; contains sand	25	70
Gravel, coarse	53	123
PERMIAN—Leonardian		
Wellington formation		
Shale, gray	7	130

312. *Sample log of test hole at the NW cor. sec. 31, T. 25 S., R. 2 W., Sedgwick County; drilled by State Geological Survey, 1939. Surface altitude, 1,417.2 feet.* (Samples studied by Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Soil, brown	3	3
Silt, light brown	8	11
Silt, tan to buff; contains very fine to fine sand	16	27
Silt, gray to buff, and very fine to fine sand	9	36
Sand, coarse to medium, and fine gravel	9	45
Sand, coarse to medium, and fine to coarse gravel; poorly sorted	6	51
Gravel, fine to coarse, and coarse to medium sand	9	60
Sand, coarse to medium; contains some fine gravel	9	69
Sand, medium to coarse, and coarse to fine gravel	11	80
Gravel, fine to medium, and coarse to medium sand	5	85
Silt and clay, green gray, and very fine to medium sand,	1	86
Gravel, fine to medium, and coarse to medium sand	4	90
Gravel, fine to coarse; contains coarse sand	10	100
Sand, coarse to medium, and fine to coarse gravel	18	118
Sand, very fine to medium, and buff to gray silt	2	120
Sand, coarse to medium, and fine to medium gravel	7	127
Gravel, fine to coarse; contains coarse to medium sand,	3	130
Silt, gray to buff, and very fine to fine sand	5	135
Sand, coarse to medium; and fine gravel	10	145
Silt, tan to buff, and very fine to medium sand	5	150
Sand, coarse to medium, and fine to medium gravel	15	165
Gravel, medium to fine, and coarse sand	2	167
Gravel, medium to coarse; contains some coarse sand and fine gravel	3	170
Sand, coarse to medium, and fine to medium gravel	5	175
Gravel, fine to medium, and coarse sand	2	177
Sand, coarse to medium, and fine gravel	16	193
Gravel, fine to medium; contains coarse sand	4	197

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	Thickness, feet	Depth, feet
Gravel, medium to coarse; contains some coarse sand and fine gravel	4	201
Sand, medium to fine; contains some coarse sand and fine gravel	5	206
Sand, coarse, and fine to medium gravel; contains a silified speciment of *Triticites* and pebbles of gray limestone	8	214
Gravel, fine, and coarse sand; contains pebbles of gray limestone	8	222
PERMIAN—Leonardian		
Wellington formation		
Shale, light to dark gray	2	224
Shale, calcareous, light gray	6	230

313. *Sample log of test hole at the NW cor. sec. 7, T. 25 S., R. 3 W., Sedgwick County; drilled by State Geological Survey, 1939. Surface altitude, 1,433.2 feet.* (Samples studied by Fred T. Holden.)

QUATERNARY—Pleistocene and Recent Alluvium and McPherson formation	Thickness, feet	Depth, feet
Soil, sandy, brown	4	4
Clay and silt, red brown	2	6
Sand and gravel	3	9
Sand	24	33
Sand; contains clay balls	2	35
Sand and gravel	12	47
Gravel	4	51
Sand, coarse, interbedded with coarse gravel	129	180
PERMIAN—Leonardian		
Wellington formation		
Shale, gray	20	200

314. *Driller's log of test hole in the SW¼ SE¼ NW¼ sec. 5, T. 25 S., R. 4 W., Reno County drilled by Wichita Pump and Supply Company for Panhandle Eastern Company, 1936.*

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Silt and clay, hard	23	23
Silt and sand, fine	2	25
Silt and clay	2	27
Clay and sand	15	42
Clay, gray	8	50
Sand, coarse, and gravel	8	58
Clay, soft, red	6	64
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red	1	65

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315. *Driller's log of test hole in the SE¼ NW¼ NW¼ sec. 6, T. 25 S., R. 4 W., Reno County; drilled by Wichita Pump and Supply Company for Panhandle Eastern Company, 1936.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt, sandy	3	3
Clay, sandy, soft	57	60
Clay, sandy	7	67
Sand, fine	2	69
Clay, sandy	8	77
PERMIAN—Leonardian		
Ninnescah shale		
Shale, soft, red	9	86
Shale, red	16	102
Shale, red and gray	23	125
Shale, gray	10	135

316. *Sample log of test hole at the SW cor. sec. 12, T. 25 S., R. 4 W., Reno County; drilled by State Geological Survey, 1939 Surface altitude, 1,455.0 feet.* (Samples studied by Fred T. Holden.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Soil, sandy, brown	2	2
Silt, red brown	6	8
Clay and silt, sandy, tan to gray	12	20
Sand	3	23
Gravel	7	30
Sand	10	40
Gravel	5	45
Sand	7	52
Sand; contains fragments of green shale	3	55
PERMIAN—Leonardian		
Wellington formation		
Shale, gray	5	60

317. *Sample log of test hole at the SW cor. sec. 14, T. 25 S., R. 4 W., Reno County; drilled by State Geological Survey, 1939. Surface altitude, 1,483.7 feet.* (Samples studied by Fred T. Holden.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt, sandy, red brown	8	8
Clay and silt, sandy, gray to brown; contains fragments of shale	2	10
Clay and silt, sandy, dark brown	6	16
Clay and silt, red brown	26	42
Clay and silt, yellow to greenish gray	8	50
Sand and gravel	17	67
Gravel	1	68
PERMIAN—Leonardian		
Ninnescah shale		
Shale, brick red and green	12	80

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318. *Sample log of test hole at the SW cor. sec. 28, T. 25 S., R. 4 W., Reno County; drilled by State Geological Survey, 1939. Surface altitude, 1,455 feet.* (Samples studied by Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt, dark brown	2	2
Silt, tan	2	4
Silt, buff to tan; contains nodules of calcium carbonate,	4	8
Sand, coarse to fine; contains fragments of green shale,	2	10
Sand, medium; contains fragments of shale	4	14
PERMIAN—Leonardian		
Ninnescah shale		
Shale, tan and greenish gray	3	17
Shale, brick red	3	20

319. *Sample log of well 608 in the NE¼ NW¼ sec. 29, T. 26 S., R. 1 E., Sedgwick County; drilled by Layne-Western Company for Kansas Gas and Electric Company, 1937. Surface altitude, 1,307.2 feet.* Samples studied by S. W. Lohman.)

	Thickness, feet	Depth, feet
QUATERNARY—Recent		
Alluvium		
Silt and clay	6	6
Sand, fine to medium	9	15
Sand, fine	3	18
Gravel, fine, and coarse sand	2	20
Sand, coarse, brown, and fine gravel	5	25
Gravel, fine to coarse; contains some coarse sand	9	34
Sand, fine	2	36
Sand, coarse to medium, and fine gravel	2	38
Sand, coarse, and fine gravel	8	46
PERMIAN—Leonardian		
Wellington formation		
Shale, hard, blue gray	1	47

320. *Sample log of test hole in the NW¼ NW¼ sec. 29, T. 26 S., R. 1 E., Sedgwick County; drilled by Layne-Western Company for Kansas Gas and Electric Company, 1937.* (Samples studied by S. W. Lohman.)

	Thickness, feet	Depth, feet
QUATERNARY—Recent		
Alluvium		
Silt, sandy	4	4
Sand, coarse, and fine gravel	11	15
Sand, medium to coarse, and fine gravel	5	20
Sand, medium to coarse	5	25
Gravel, fine, and coarse sand	10	35
Gravel, fine to medium, and coarse sand	11	46
PERMIAN—Leonardian		
Wellington formation		
Shale, blue	4	50

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	Thickness, feet	Depth, feet
Shale, hard, blue	7	57
Gypsum	1	58
Shale, hard, blue; contains gypsum	8	66
Shale, hard, blue	3	69
Shale and gypsum	11	80

321. *Sample log of test hole in the SW¼ NW¼ sec. 29, T. 26 S., R. 1 E., Sedgwick County; drilled by Layne-Western Company for Kansas Gas and Electric Company, 1937.* (Samples studied by S. W. Lohman.)

	Thickness, feet	Depth, feet
QUATERNARY—Recent		
Alluvium		
Silt and fine sand	6	6
Sand, fine to coarse	4	10
Sand, coarse	7	17
Gravel, medium to fine, and coarse sand	18	35
Gravel, fine, and coarse sand	11	46
Sand, coarse, and fine gravel	5	51
PERMIAN—Leonardian		
Wellington formation		
Shale, hard, blue	9	60

322. *Sample log of test hole at the NW cor. sec. 6, T. 26 S., R. 1 W., Sedgwick County; drilled by Phillips Petroleum Company, 1940.* (Samples studied by Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Alluvium and McPherson formation		
Sand, medium to fine	20	20
Sand, coarse to medium	5	25
Gravel, medium to fine	5	30
Sand, coarse, and fine gravel	5	35
Sand, coarse to medium, and fine gravel	5	40
Gravel, coarse to fine, and coarse to medium sand	50	90
Sand, coarse to fine; contains some buff silt	20	110
Sand, coarse to fine, and coarse to medium gravel	5	115
Sand, coarse to fine; contains some buff silt	10	125
Silt and clay, tan, calcareous	5	130
Sand, coarse to fine	15	145
Sand, fine to coarse, and tan silt	5	150
Sand, medium to fine	10	160
Sand, coarse to fine, and fine gravel	5	165
Gravel, fine to medium, and coarse to medium sand	20	185
Gravel, fine to coarse, and coarse sand	5	190
PERMIAN—Leonardian		
Wellington formation		
Shale, gray, calcareous	6	196

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323. *Sample log of test hole at the SW cor. sec. 6, T. 26 S., R. 1 W., Sedgwick County; drilled by State Geological Survey, 1944. Surface altitude, 1,361 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Alluvium and McPherson formation		
Silt, brown to gray	2	2
Gravel, fine to medium, and coarse to medium sand	43	45
Silt, gray to buff; contains fine to medium sand	3	48
Sand, medium to fine	2	50
Gravel, fine, and coarse to medium sand	42	92
Silt and clay, buff to gray	18	110
Silt, buff, and fine sand	10	120
Gravel, fine, and coarse to medium sand	8	128
Silt, brown to buff	4	132
Gravel, fine, and coarse to medium sand	6	138
Clay, gray	9	147
Gravel, fine, and coarse to medium sand; contains thin layers of silt	41	188
PERMIAN—Leonardian		
Wellington formation		
Shale, hard, gray	5	193

324. *Driller's log of test hole at the SW cor. sec. 8, T. 26 S., R. 1 W., Sedgwick County; drilled, 1941. Surface altitude, 1,354 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Alluvium and McPherson formation		
Silt	3	3
Sand and gravel	77	80
Silt and clay	18	98
Sand	13	111
Silt and clay	9	120
Sand and gravel	40	160
PERMIAN—Leonardian		
Wellington formation		
Shale	1	161

325. *Driller's log of test hole at the SW cor. sec. 18, T. 26 S., R. 1 W., Sedgwick County; drilled, 1941. Surface altitude, 1,356 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Alluvium and McPherson formation		
Silt	8	8
Sand and gravel	72	80
Silt and clay	13	93
Sand	42	135
Silt and clay	10	145
Sand	30	175
PERMIAN—Leonardian		
Wellington formation		
Shale	1	176

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326. *Driller's log of test hole at the NE cor. sec. 2, T. 26 S., R. 2 W., Sedgwick County; drilled, 1941. Surface altitude, 1,370 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene and Recent		
Alluvium and McPherson formation		
Silt	6	6
Sand and Gravel	21	27
Silt and clay	7	34
Sand	96	130
Silt and clay	10	140
Sand	11	151
Silt and clay	7	158
Sand	60	218
PERMIAN—Leonardian		
Wellington formation		
Shale	1	219

327. *Driller's log of test hole at the SE cor. sec. 3, T. 26 S., R. 2 W., Sedgwick County; drilled, 1941. Surface altitude, 1,382 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt	21	21
Sand and gravel	109	130
Silt and clay	8	138
Sand	22	160
Silt and clay	20	180
Sand	12	192
Silt and clay	17	209
Sand	11	220
Silt and clay	7	227
PERMIAN—Leonardian		
Wellington formation		
Shale	1	228

328. *Driller's log of test hole at the SE cor. sec. 7, T. 26 S., R. 2 W., Sedgwick County; drilled, 1941. Surface altitude, 1,380 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt and clay	21	21
Sand and gravel	87	108
Silt and clay	17	125
Sand and gravel	29	154
Silt and clay	22	176
PERMIAN—Leonardian		
Wellington formation		
Shale	1	177

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329. *Driller's log of test hole at the NE cor. sec. 9, T. 26 S., R. 2 W., Sedgwick County; drilled, 1941. Surface altitude, 1,392 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt	22	22
Sand	56	78
Gravel	4	82
Sand	13	95
Sand and gravel	29	124
Silt and clay	11	135
Sand and gravel	45	180
Silt and clay	7	187
Sand and gravel	71	258
Silt and clay	2	260
PERMIAN—Leonardian		
Wellington formation		
Shale	1	261

330. *Driller's log of test hole at the NW cor. sec. 9, T. 26 S., R. 2 W., Sedgwick County; drilled, 1941. Surface altitude, 1,398 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt	24	24
Sand	9	33
Sand and gravel	33	66
Silt and clay	13	79
Sand and gravel	195	274
Silt and clay	2	276
PERMIAN—Leonardian		
Wellington formation		
Shale	1	277

331. *Driller's log of test hole at the SE cor. sec. 11, T. 26 S., R. 2 W., Sedgwick County; drilled, 1941 Surface altitude, 1,368 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt	12	12
Sand	6	18
Sand and gravel	36	54
Sand	15	69
Silt and clay	11	80
Sand and gravel	66	146
Silt and clay	8	154
Sand and gravel	45	199
PERMIAN—Leonardian		
Wellington formation		
Shale	1	200

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332. *Sample log of test hole at the NW cor. sec. 14, T. 26 S., R. 2 W., Sedgwick County; drilled by State Geological Survey, 1944. Surface altitude, 1,364.3* (Samples studied by O. S. Fent and Charles C. Williams.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt and clay, tan to gray	4	4
Silt, tan; contains fine to coarse sand	9	13
Sand, coarse to fine	7	20
Gravel, medium to fine, and coarse sand	30	50
Gravel, fine, and coarse sand; contains some tan silt	16	66
Silt, dark gray; contains thin beds of fine sand	18	84
Gravel, fine to medium, and coarse sand	16	100
Gravel, fine, and coarse to medium sand; contains some tan silt	53	153
Silt, dark gray	7	160
Gravel, fine, and coarse to medium sand; contains some tan to gray silt	10	170
Silt, buff to gray	15	185
Silt, tan, and fine to coarse sand; contains nodules of calcium carbonate	10	195
Gravel, medium to fine, and coarse sand	15	210
Sand, coarse to fine, and fine gravel	16	226
Silt, gray; contains some sand	4	230
Gravel, fine to medium, and coarse to medium sand	25	255
PERMIAN—Leonardian		
Wellington formation		
Shale, blue gray	10	265

333. *Driller's log of test hole at the SW cor. sec. 14, T. 26 S., R. 2 W., Sedgwick County; drilled, 1941. Surface altitude, 1,370 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt	15	15
Sand and gravel	55	70
Silt and clay	5	75
Sand	23	98
Silt and clay	32	130
Sand	10	140
Sand and gravel	30	170
Silt and clay	5	175
Sand	50	225
Silt and clay	5	230
PERMIAN—Leonardian		
Wellington formation		
Shale	1	231

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334. *Driller's log of test hole at the NE cor. sec. 16, T. 26 S., R. 2 W., Sedgwick County; drilled, 1941. Surface altitude, 1,386 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt	28	28
Sand	55	83
Silt and clay	14	97
Sand	93	190
Silt and clay	5	195
Sand	2	197
Silt and clay	4	201
Sand and gravel	41	242
Silt and clay	5	247
PERMIAN—Leonardian		
Wellington formation		
Shale	1	248

335. *Driller's log of test hole at the NE cor. sec. 20, T. 26 S., R. 2 W., Sedgwick County; drilled, 1941. Surface altitude, 1,378 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt and clay	23	23
Sand	59	92
Gravel	6	98
Sand	22	120
Gravel	8	128
Silt and clay	12	140
Sand	11	151
Gravel	7	158
Gravel and sand	18	176
Silt and clay	4	180
PERMIAN—Leonardian		
Wellington formation		
Shale	1	181

336. *Driller's log of test hole at the SW cor. sec. 22, T. 26 S., R. 2 W., Sedgwick County; drilled, 1941. Surface altitude, 1,368 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt and clay	51	51
Sand and gravel	29	80
Silt and clay	14	94
Sand and gravel	81	175
Silt and clay	4	179
PERMIAN—Leonardian		
Wellington formation		
Shale	1	180

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337. *Sample log of test hole at the NE cor. sec. 26, T. 26 S., R. 2 W., Sedgwick County; drilled by State Geological Survey, 1944. Surface altitude, 1,366.4 feet.* (Samples studied by O. S. Fent and Charles C. Williams.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt and clay, brown to gray	4	4
Silt and clay, buff; contains fine to medium sand	2	6
Sand, coarse to fine; contains silt	4	10
Sand, coarse to fine, and fine gravel	10	20
Gravel, fine to medium, and coarse sand	35	55
Silt, buff to gray	9	64
Gravel, medium to fine, and coarse to medium sand	21	85
Silt, gray	2	87
Gravel, medium to fine, and coarse sand; contains some thin beds of silt	29	116
Silt, light gray	2	118
Sand, coarse to fine; contains some fine gravel	82	200
Gravel, fine to medium, and coarse sand	16	216
PERMIAN—Leonardian		
Wellington formation		
Shale, blue gray	4	220

338. *Sample log of test hole at the SW cor. sec. 26, T. 26 S., R. 2 W., Sedgwick County; drilled by State Geological Survey, 1944. Surface altitude, 1,355.0 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt, brown to dark gray	3	3
Silt and clay, light gray	6	9
Sand, medium to fine	2	11
Silt, gray green	6	17
Sand, coarse to fine; contains fine gravel	13	30
Gravel, medium to fine, and coarse sand	6	36
Silt, dark gray; contains fine to medium sand	11	47
Sand, coarse to fine	13	60
Gravel, medium to fine, and coarse sand	10	70
Silt, buff; contains some sand and nodules of calcium carbonate	11	81
Gravel, fine, and coarse to medium sand	7	88
Silt, buff; contains thin beds of sand and gravel	9	97
Gravel, medium to fine, and coarse sand	33	130
Gravel, coarse to fine, and coarse sand	5	135
Silt, light gray	11	146
Gravel, fine, and coarse to medium sand	24	160
Gravel, fine, and coarse sand	16	176
PERMIAN—Leonardian		
Wellington formation		
Shale, gray	9	185

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339. *Sample log of test hole at the SW cor. sec. 28, T. 26 S., R. 2 W., Sedgwick County; drilled by State Geological Survey, 1944. Surface altitude, 1,386.4 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt and clay, brown	3	3
Silt, brown to tan; contains some fine to medium sand,	17	20
Sand, coarse to fine; contains some fine gravel	10	30
Gravel, fine to medium, and coarse to medium sand	15	45
Silt, buff	6	51
Gravel, fine to medium, and coarse to medium sand	11	62
Silt, gray	4	66
Gravel, medium to fine, and coarse sand	2	68
PERMIAN—Leonardian		
Wellington formation		
Shale, gray green	2	70

340. *Sample log of test hole at the NE cor. sec. 30, T. 26 S., R. 2 W., Sedgwick County; drilled by State Geological Survey, 1944. Surface altitude, 1,396.7 feet.* (Samples studied by O. S. Fent and Charles C. Wliliams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt and clay, brown to gray	4	4
Silt, tan; contains some fine to medium sand	16	20
Silt, buff, and medium to fine sand	6	26
Sand, coarse to fine; contains fine gravel	2	28
Silt, tan to gray	6	34
Sand, coarse to fine, and fine to medium gravel	6	40
Gravel, coarse to fine, and coarse sand	15	55
PERMIAN—Leonardian		
Wellington formation		
Shale, gray	5	60

341. *Sample log of test hole at the SE cor. sec. 31, T. 26 S., R. 2 W., Sedgwick County; drilled by State Geological Survey, 1944. Surface altitude, 1,453.3 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt, dark gray to brown	6	6
Silt and clay, tan	31	37
Silt and clay, light gray; contains nodules of calcium carbonate	11	48
Silt and clay, tan	5	53
Silt and clay, gray; contains coarse to fine sand	2	55
PERMIAN—Leonardian		
Wellington formation		
Shale calcareous, gray	3	58

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342. *Sample log of test hole at the NE cor. sec. 2, T. 26 S., R. 3 W., Sedgwick County; drilled by State Geological Survey, 1939. Surface altitude, 1,407.6 feet.* (Samples studied by Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Soil, brown	3	3
Silt and clay, gray to buff; contains very fine to fine sand	9	12
Silt, buff, and very fine to medium sand	2	14
Silt, buff to tan; contains very fine to fine sand	5	19
Silt, buff to gray, and very fine to coarse sand; contains fine gravel and carbonaceous material	10	29
Gravel, fine to coarse; many pebbles composed of pink and white feldspar	14	43
Gravel, fine to coarse, and coarse to medium sand	5	48
Gravel, coarse to fine	12	60
Gravel, coarse to medium; contains pebbles up to 10 cm in diameter	10	70
Gravel, coarse to fine; contains coarse sand	27	97
Silt, calcareous, tan, and fine to coarse sand; contains nodules of calcium carbonate	5	102
Gravel, fine to medium, and coarse to medium sand	8	110
Silt, calcareous, buff to gray; contains fine to very fine sand and nodules of calcium carbonate	5	115
Gravel, coarse to fine; contains nodules of calcium carbonate	6	121
Sand, coarse to fine, and fine to coarse gravel	22	143
Gravel, fine to coarse, and coarse to medium sand	12	155
Gravel, coarse to fine, and coarse to medium sand; contains many nodules of calcium carbonate	10	165
Calcium carbonate and caliche, hard	2	167
Gravel, fine to coarse, and coarse to fine sand; contains pebbles of ironstone	11	178
PERMIAN—Leonardian Wellington formation		
Shale, calcareous, soft, dark gray	12	190

343. *Sample log of test hole at the SW cor. NW¼ sec. 2, T. 26 S., R. 3 W., Sedgwick County; drilled by the State Geological Survey, 1944. Surface altitude, 1,418.2 feet.* (Samples studied by O. S. Fent and Charles C., Williams.)

QUATERNARY—Pleistocene McPherson formation	*Thickness, feet*	*Depth, feet*
Soil	2	2
Silt and clay, dark gray to light gray	6	8
Silt, tan	9	17
Silt, tan to light gray, and fine sand	11	28
Sand, coarse to fine; contains medium to fine gravel	12	40
Gravel, fine to medium, and coarse sand	6	46

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	Thickness, feet	Depth, feet
Silt, tan to yellow	1	47
Gravel, fine to medium, and coarse sand; contains some yellow to tan silt	13	60
Gravel, fine to coarse, and coarse sand	8	68
Silt, tan to yellow	3	71
Gravel, medium to fine, and coarse to medium sand	25	96
PERMIAN—Leonardian		
Wellington formation		
Shale, blocky, gray green	4	100

344. *Sample log of test hole in the NW¼ sec. 10, T. 26 S., R. 3 W., Sedgwick County; drilled by State Geological Survey, 1944. Surface altitude, 1,437.3 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Silt, tan	30	30
Silt, light brown to gray	5	35
Sand, medium to fine	6	41
Silt, buff to gray, and fine sand	8	49
Gravel, medium to fine, and coarse to medium sand; contains some buff silt	6	55
PERMIAN—Leonardian		
Wellington formation		
Shale, gray green to blue gray	2	57

345. *Sample log of test hole at the SE cor. sec. 13, T. 26 S., R. 3 W., Sedgwick County; drilled by State Geological Survey, 1944. Surface altitude, 1,405.1 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Silt and clay, gray to brown	8	8
Silt, tan; contains fine to coarse sand	16	24
Sand, coarse to fine	6	30
Sand, coarse to fine, and fine to medium gravel	10	40
Gravel, medium to fine, and coarse sand	35	75
PERMIAN—Leonardian		
Wellington formation		
Shale, gray and maroon	2	77

346. *Sample log of test hole at the NW cor. NE¼ sec. 16, T. 26 S., R. 3 W., Sedgwick County; drilled by State Geological Survey, 1944. Surface altitude, 1,472.0 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Silt, tan	6	6
Silt, brown to gray; contains fine to coarse sand	4	10
Silt, buff, and fine to coarse sand; contains nodules of calcium carbonate	9	19

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	Thickness, feet	Depth, feet
Clay and silt, gray to green, and coarse to fine sand....	9	28
PERMIAN—Leonardian		
Wellington formation		
Shale, maroon, gray, and green.....	8	36

347. *Sample log of test hole at the SE cor. SW¼ sec. 17, T. 26 S., R. 3 W., Sedgwick County; drilled by State Geological Survey, 1944. Surface altitude, 1,482.9 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt and clay, tan.....	6	6
Silt and clay, buff to gray; contains nodules of calcium carbonate	22	28
PERMIAN—Leonardian		
Wellington formation		
Shale, maroon and gray.....	2	30

348. *Sample log of test hole at the NE cor. sec. 26 T. 26 S., R. 3 W., Sedgwick County; drilled by State Geological Survey, 1944. Surface altitude, 1,442.9 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt, brown to gray.....	4	4
Silt, buff; contains fine to coarse sand.....	13	17
Sand, medium to fine, and some coarse sand.....	3	20
Sand, coarse to fine; contains fine to medium gravel....	1	21
PERMIAN—Leonardian		
Wellington formation		
Shale, calcareous, gray green.....	2	23

349. *Sample log of test hole at the SW cor. NW¼ sec. 30, T. 26 S., R. 3 W., Sedgwick County; drilled by State Geological Survey, 1944. Surface altitude, 1,539.4 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt, light brown, and coarse to fine sand.....	5	5
Silt and clay, gray.....	5	10
Silt and clay, buff; contains nodules of calcium carbonate	16	26
Silt and clay, buff to gray, and coarse to fine sand; contains nodules of calcium carbonate.....	13	39
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red	1	40

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350. *Sample log of test hole at the SE cor. sec. 33, T. 26 S., R. 3 W., Sedgwick County; drilled by State Geological Survey, 1944. Surface altitude, 1,497.0 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt and clay, brown to gray	5	5
Silt, tan; contains nodules of calcium carbonate	5	10
Clay and silt, buff to light gray; contains nodules of calcium carbonate	22	32
PERMIAN—Leonardian		
Wellington formation		
Shale, block, maroon	2	34

351. *Sample log of test hole at the NE cor. sec. 36, T. 26 S., R. 3 W., Sedgwick County; drilled by State Geological Survey, 1944. Surface altitude, 1,457.1 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt and clay, gray to tan	7	7
Silt, buff; contains nodules of calcium carbonate	14	21
Silt and clay, gray to buff, contains nodules of calcium carbonate	9	30
Silt and clay, buff; contains fine to medium sand	3	33
PERMIAN—Leonardian		
Wellington formation		
Shale, calcareous, gray to green	7	40

352. *Sample log of test hole at the SW cor. sec. 6, T. 26 S., R. 4 W., Reno County; drilled by State Geological Survey, 1939. Surface altitude, 1,434.2 feet.* (Samples studied by Charles C. Williams.)

	Thickness, feet	Depth, feet
PERMIAN—Leonardian		
Ninnescah shale		
Silt and clay, brown; weathered shale	2	2
Shale, brick red, blocky	1	3
Shale, soft, calcareous, light gray	2	5
Shale, blocky, brick red	5	10
Shale, brick red and greenish gray	10	20

353. *Sample log of test hole at the NW cor. sec. 3, T. 27 S., R. 2 W., Sedgwick County; drilled by State Geological Survey, 1944. Surface altitude, 1,367.9 feet.* (Samples studied by O. S. Fent and Charles C. Williams.)

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
McPherson formation		
Silt and clay, brown to gray	8	8
Silt and clay, tan; contains fine to medium sand	12	20
Sand, coarse to fine; contains fine to medium gravel	10	30
Gravel, medium to fine, and coarse sand	20	50
Silt, gray to buff	18	68

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	Thickness, feet	Depth, feet
Gravel, medium to fine, and coarse sand	7	75
PERMIAN—Leonardian		
Wellington formation		
Shale, blue gray	3	78

354. *Sample log of test hole at the NW cor. sec. 9, T. 27 S., R. 2 W., Sedgwick County; drilled by State Geological Survey, 1944. Surface altitude, 1,444.5 feet,* (Samples studied by O. S. Fent and Charles C. Williams.)

QUATERNARY—Pleistocene McPherson formation	Thickness, feet	Depth, feet
Silt, tan	10	10
Silt, buff	20	30
Silt, tan; contains nodules of calcium carbonate	20	50
Silt, buff	10	60
Silt, buff; contains fine to coarse sand and nodules of calcium carbonate	5	65
Silt and clay, light gray	12	77
Silt, gray; contains fine to coarse sand	3	80
Sand, coarse to fine; contains buff silt	14	94
Silt, buff	4	98
Sand, coarse to fine, partly cemented	2	100
Sand, medium to fine, and gray silt	11	111
PERMIAN—Leonardian		
Shale, maroon and gray	3	114

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REFERENCES

BASS, N. W., *1926,* The geology of Hamilton County, Kansas: Kansas Geol. Survey, Bull. 11, pt. 2, pp. 53-83, figs. 13-26, pls. 5-6.

———, *1926a,* Structure and limits of the Kansas salt beds: Kansas Geol. Survey, Bull. 11, pt. 4, pp. 90-95, pls. 8-9.

———, *1929,* The geology of Cowley County, Kansas, with special reference to the occurrence of oil and gas: Kansas Geol. Survey, Bull. 12, pp. 1-203, figs. 1-23, pls. 1-12.

BEEDE, J. W., *1898,* The McPherson Equus beds: Kansas Acad. Sci. Trans., vol. 15, pp. 104-110, pls. 2-4.

COPE, E. D., *1889,* The Edentata of North America: Am. Naturalist, vol. 23, pp. 657-664.

———, *1895,* The antiquity of man in North America: Am. Naturalist, vol. 29, pp. 593-599.

CRAGIN, F. W., *1886,* Further notes on the Dakota gypsum of Kansas: Washburn Coll. Lab. Nat. History, vol. 1, no. 4, pp. 166-168.

———, *1889,* Contributions to the paleontology of the plains: Washburn Coll. Lab. Nat. History, vol. 2, no. 10, pp. 65-68.

———, *1895,* The Mentor beds, a central Kansas terrane of the Comanche Series: Am. Geologist, vol. 16, pp. 162-165.

———, *1896,* The Permian System in Kansas: Colorado Coll. Studies, vol. 6, pp. 1-48.

DARTON, N. H., *1920,* Description of the Syracuse and Lakin quadrangles, Kansas: U. S. Geol. Survey, Geol. Atlas, Folio 212, pp. 1-10, figs. 1-7, pls. 1-6.

DAVISON, M. H., *1939,* Irrigation pumping plants—construction and costs: Kansas State Bd. of Agri., Div. Water Resources, Rept. for the quarter ending June 1939, vol. 58, no. 231-C, pp. 1-52.

DEERE, E. O., *1908,* A fossil tusk found in the Equus beds in McPherson County: Kansas Acad. Sci. Trans., vol. 21, pt. 1, pp. 115-117.

ELIAS, M. K., *1931,* The geology of Wallace County, Kansas: Kansas Geol. Survey, Bull. 18, pp. 1-252, figs. 1-7, pls. 1-42.

FRYE, J. C., *1939,* Physiographic significance of loess near McPherson, Kansas: Am. Assoc. Petroleum Geologists Bull., vol. 23, no. 8, pp. 1232-1233.

FRYE, J. C., and BRAZIL, J. J., *1943,* Ground water in the oil-field areas of Ellis and Russell Counties, Kansas: Kansas Geol. Survey, Bull. 50, pp. 1-104, figs. 1-9, pls. 1-2.

FRYE, J. C., and HIBBARD, C. W., *1941,* Stratigraphy and paleontology of a new middle and upper Pliocene formation of south-central Kansas: Jour. Geology, vol. 49, pp. 261-278, figs. 1-6.

FRYE, J. C., LEONARD, A. B., and HIBBARD, C. W., *1943,* Westward extension of the Kansas "Equus beds": Jour. Geology, vol. 51, pp. 33-47, figs. 1-3.

GOULD, C. N., *1898,* On a series of transition beds from the Comanche to the Dakota Cretaceous: Am. Jour. Sci., 4th ser., vol. 5, pp. 169-175.

HARNLY, H. J., *1895,* Volcanic dust: Science, n. ser., vol. 2, pp. 77-78.

———, *1934,* Vertebrate fossils from McPherson Equus beds: Kansas Acad. Sci. Trans., vol. 37, p. 151.

HAWORTH, ERASMUS, *1913,* Special report on well waters in Kansas: Kansas Univ. Geol. Survey, Bull. 1, pp. 1-110, figs. 1-9, pls. 1-6.

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HAWORTH, ERASMUS, and BEEDE, J. W., *1897*, The McPherson Equus beds: Kansas Univ. Geol. Survey, vol. 2, pp. 287-296, pls. 45-46.

HAY, O. P., *1917*, Description of a new species of Mastodon, *Gomphotherium elegans*, from the Pleistocene of Kansas: U. S. Natl. Mus. Proc., vol. 53, pp. 219-221, pl. 26.

———, *1924*, The Pleistocene of the middle region of North America and its vertebrated animals: Carnegie Inst., Washington, publ. no. 322A, pp. 1-385.

———, *1925*, On the correlation of certain Pleistocene deposits and their fossils: Washington Acad. Sci. Jour., vol. 15, no. 11, pp. 239-246.

HIBBARD, C. W., *1942*, Pleistocene mammals from Kansas: Kansas Geol. Survey, Bull. 41, pt. 6, pp. 262-269, pl. 1.

———, *1944*, Stratigraphy and vertebrate paleontology of Pleistocene deposits of southwestern Kansas: Geol. Soc. American Bull., vol. 55, pp. 707-745, figs. 1-20, pls. 1-3.

———, *1948*. Vertebrate fossils from late Cenozoic deposits of south-central Kansas. Memorandum in files of State Geological Survey of Kansas.

JONES, J. O., *1936*, Notes on the hydrology of Kansas: Kansas Univ., Engr. Bull. 20, pp. 1-175, pls. 1-31, figs. 1-52.

JONES, O. S., *1938*, Chloride survey in the north portion of Wichita, Kansas: Kansas State Bd. Health, pp. 1-7, figs. 1-3.

———, *1945*, Disposition of oil-field brines, pp. 1-192, Univ. of Kansas Press, Lawrence, Kansas.

LANDES, K. K., *1928*, Volcanic ash resources of Kansas: Kansas Geol. Survey, Bull. 14, pp. 1-57, figs. 1-3, pls. 1-5.

LATTA, B. F., *1944*, Geology and ground-water resources of Finney and Gray Counties, Kansas: Kansas Geol. Survey, Bull. 55, pp. 1-272, figs. 1-21, pls. 1-12.

———, *1946*, Cretaceous stratigraphy of the Belvidere area, Kiowa County, Kansas: Kansas Geol. Survey, Bull. 64, pt. 6, pp. 217-260, figs. 1-4, pls. 1-3.

LINDAHL, JOSUA, *1892*, Description of a skull of *Megalonyx leidyi*, n. sp.: Am. Philos. Soc. Trans., vol. 17, pp. 1-10.

LOHMAN, S. W., *1942*, Ground-water supplies available for national defense industries in south-central Kansas: Kansas Geol. Survey, Bull. 41, pt. 1, pp. 1-20, figs. 1-5.

LOHMAN, S. W., and FRYE, J. C., *1940*, Geology and ground-water resources of the "Equus beds" area in south-central Kansas: Economic Geology, vol. 35, no. 7, pp. 839-866, figs. 1-5.

MCLAUGHLIN, T. G., *1943*, Geology and ground-water resources of Hamilton and Kearny Counties, Kansas: Kansas Geol. Survey, Bull. 49, pp. 1-220, figs. 1-18, pls. 1-17.

MEINZER, O. E., *1914*, Preliminary report on ground water for irrigation in the vicinity of Wichita, Kansas: U. S. Geol. Survey, Water-Supply Paper 345, pp. 1-9.

———, *1923*, The occurrence of ground water in the United States, with a discussion of principles: U. S. Geol. Survey, Water-Supply Paper 489, pp. 1-321, figs. 1-110, pls. 1-31.

———, *1932*, Outline of methods for estimating ground-water supplies: U. S. Geol. Survey, Water-Supply Paper 638-C, pp. 99-144.

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MEINZER, O. E., and WENZEL, L. K., *1938,* Water levels and artesian pressure in observation wells in the United States in 1937: U. S. Geol. Survey, Water-Supply Paper 840, pp. 1-657, figs. 1-20.

———, *1939,* Water levels and artesian pressure in observation wells in the United States in 1938: U. S. Geol. Survey, Water-Supply Paper 845, pp. 1-724, figs. 1-9.

———, *1940,* Water levels and artesian pressure in observation wells in the United States in 1939: U. S. Geol. Survey, Water-Supply Paper 886, pp. 1-933, figs. 1-34.

———, *1942,* Water levels and artesian pressure in observation wells in the United States in 1940: U. S. Geol. Survey, Water-Supply Paper 908, pt. 3, pp. 1-288, figs. 1-7.

———, *1943.* Water levels and artesian pressure in observation wells in the United States in 1941: U. S. Geol. Survey, Water-Supply Paper 938, pt. 3, pp. 1-232, figs. 1-5.

———, *1944,* Water levels and artesian pressure in observation wells in the United States in 1942: U. S. Geol. Survey, Water-Supply Paper 946, pt. 3, pp. 1-278, figs. 1-11.

———, *1946,* Water levels and artesian pressure in observation wells in the United States in 1943: U. S. Geol. Survey, Water-Supply Paper 988, pt. 3, pp. 1-352, figs. 1-10.

MEYER, A. F., *1928,* The elements of hydrology, 2d ed., pp. 1-522, figs. 1-287, John Wiley & Sons, New York.

MOHLER, R. E., *1938,* A new *Amebelodon* for Kansas: Kansas Acad. Sci. Trans., vol. 41, pp. 219-221.

MOORE, R. C., *1930,* Oil and gas resources of Kansas: Kansas Geol. Survey, Bull. 6, pt. 2, pp. 1-98, pls. 1-17, figs. 1-12.

———, *1940,* Ground-water resources of Kansas: Kansas Geol. Survey, Bull. 27, pp. 1-112, figs. 1-28, pls. 1-34.

MOORE, R. C. and LANDES, K. K., *1937,* Geologic Map of Kansas: Kansas Geol. Survey, scale 1:500,000.

MORGAN, A. M., *1938,* Geology and shallow water resources of the Roswell artesian basin, New Mexico; New Mexico State Engineer, Bull. 5, pp. 1-95, figs. 1-5, pls. 1-5.

NININGER, H. H., *1928,* Pleistocene fossils from McPherson County, Kansas: Kansas Acad. Sci. Trans., vol. 31, p. 97.

NORTON, G. H., *1939,* Permian redbeds of Kansas: Am. Assoc. Petroleum Geologists Bull., vol. 23, no. 12, pp. 1751-1815, figs. 1-24.

PARKER, H. N., *1911,* Quality of water supplies of Kansas: U.S. Geol. Society, Water-Supply Paper 273, pp. 1-375, fig. 1, pl. 1.

PIPER, A. M., *1933,* Notes on the relation between the moisture equivalent and the specific retention of water-bearing materials: Am. Geophysical Union Trans., 14th Ann. Meeting, pp. 481-487, figs. 1-2.

PLUMMER, NORMAN, and ROMARY, J. F., *1942,* Stratigraphy of the pre-Greenhorn Cretaceous beds of Kansas: Kansas Geol. Survey, Bull. 41, pt. 9, pp. 313-348, figs. 1-4, pls. 1-2.

PROSSER, C. S., *1897,* Comanche Series of Kansas: Kansas Univ. Geol. Survey, vol. 2, pp. 96-181, figs. 6-9, pls. 15-21.

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ROHWER, CARL, *1940*, Putting down and developing wells for irrigation: U. S. Dept. Agr., Circ. 546, pp. 1-86, figs. 1-41.

SCHOEWE, W. H., *1943*, Kansas oil field brines and their magnesium content: Kansas Geol. Survey, Bull. 47, pt. 2, pp. 41-76, figs. 1-3.

SCHMIDT, LUDWIG, and DEVINE, J. M., *1929*, The disposal of oil-field brines: U. S. Bur. Mines, Rept. of Investigations 2945, pp. 1-17, figs. 1-3.

SCOTT, W. B., *1897*, An introduction to geology, pp. 1-573, Macmillan Company, New York.

SMITH, H. T. U., *1938*, Quaternary dune building in central Kansas: Geol. Soc. America Proc., 1937, p. 115.

STANTON, T. W., *1922*, Some problems connected with the Dakota sandstone: Geol. Soc. America Bull., vol. 33, No. 1, pp. 255-272, pls. 4-5.

STEARNS, N. D., *1927*, Laboratory tests on physical properties of water-bearing materials: U. S. Geol. Survey, Water-Supply Paper 596-F, pp. 121-176, figs. 18-26, pls. 11-13.

SWINEFORD, ADA, and WILLIAMS, H. L., *1945*, The Cheyenne sandstone and adjacent formations of a part of Russell County, Kansas: Kansas Geol. Survey, Bull. 60, pt. 4, pp. 101-168, figs. 1-9, pls. 1-2.

TESTER, A. C., *1931*, The Dakota stage of the type locality: Iowa Geol. Survey, vol. 35, pp. 199-332, figs. 25-44, pls. 3-4.

THEIS, C. V., *1935*, The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using ground-water storage: Am. Geophysical Union Trans., 16th Ann. Meeting, pt. 2, pp. 519-524, figs. 1-3.

TWENHOFEL, W. H., *1924*, Geology and invertebrate paleontology of the Comanchean and "Dakota" formations of Kansas: Kansas Geol. Survey, Bull. 9, pp. 1-135, pls. 1-23.

UDDEN, J. A., *1891*, *Megalonyx* beds in Kansas: Am. Geologist, vol. 7, no. 6, pp. 340-345.

VER WIEBE, W. A., *1937*, The Wellington formation of central Kansas: Wichita Municipal Univ. Studies, Bull. 2, pp. 1-18, figs. 1-2.

WENZEL, L. K., *1942*, Methods for determining permeability of water-bearing materials: U. S. Geol. Survey, Water-Supply Paper 887, pp. 1-192, figs. 1-17, pls. 1-6.

WILHELM, C. J. and SCHMIDT, LUDWIG, *1935*, Preliminary report on the disposal of oil-field brines in the Ritz-Canton oil field, McPherson County, Kansas: U. S. Bur. Mines, Rept. of Investigations 3297, pp. 1-20, figs. 1-6.

WILHELM, C. J., THORNE, H. M., and PRYOR, M. F., *1936*, Disposal of oil-field brines in the Arkansas River drainage area in western Kansas: U. S. Bur. Mines, Rept. of Investigations 3318, pp. 1-28, figs. 1-3.

WILLIAMS, C. C., *1946*, Ground-water conditions in Arkansas River Valley in the vicinity of Hutchinson, Kansas: Kansas Geol. Survey, Bull. 64, pt. 5, pp. 145-216, figs. 1-11, pls. 1-6.

WILLIAMS, C. C., and LOHMAN, S. W., *1947*, Methods used in estimating the ground-water supply of the Wichita, Kansas, well-field area: Am. Geophysical Union Trans., vol. 27, no. 6, pp. 120-131, figs. 1-10.

WILLISTON, S. W., *1897*, The Pleistocene of Kansas: Kansas Univ. Geol. Survey, vol. 2, pp. 297-308.

WOOD, H. E., *et al.*, *1941*, Nomenclature and correlation of the North American continental Tertiary: Geol. Soc. America Bull., vol. 52, no. 1, pp. 1-48, pl. 1.

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INDEX

Abilene conglomerate, 60
Abstract, 13
Acknowledgments, 24
Agriculture, 35
Alluvium, 74, 223, 227, 230, 231, 232
Analyses of water, 146, 165
Arkansas River, 25, 26, 64, 87, 90, 170, 227
Bibliography, 448
Big Basin, 83
Buhler, population of, 34
  water supply of, 191, 225
Burrton, population of, 34
  water supply of, 192
Canton, population of, 34
  water supply of, 193, 226
Capacity of wells, 65
Cenozoic era, 79
Chemical constituents of ground water in relation to use, 166
Chloride, 169
Climate, 26
Cottonwood River, 26, 224
Cretaceous period, 78
Cretaceous system, 22, 47
Crops, 35
Delmore formation, 40, 57, 226
Discharge of ground water, 132, 215, 220
  by springs and seeps, 133
  by transpiration and evaporation, 132
  by wells, 134
Disposal wells, 176, 177, 228
Dissolved solids in water, 166
Domestic wells, 184
Drainage, 26
Drilled wells, 143
  in consolidated deposits, 143
  in unconsolidated deposits, 144
Dune sand, 70, 82, 83, 119, 134
Emma Creek formation, 40, 59, 64, 67, 69
Equus beds, 37, 67, 68, 206
Evaporation, discharge of ground water by, 132
Evaporation ponds, 123
Field work, 16
Fluoride in water, 168
Fluctuations of water level, 110
Galva, population of, 34
  water supply of, 193, 226
Geography, 25
Geologic formations, 37
  Alluvium, 74, 75, 223, 227, 230, 231, 232
  Delmore formation, 40, 57, 226
  Emma Creek formation, 40, 59, 64, 67, 69
  Dune sand, 70, 82, 83, 119, 134
  generalized section of, 38
  Kiowa shale, 106, 223, 224
  McPherson formation, 69, 226, 231
  Ninnescah shale, 223, 224, 230
  Terrace deposits, 65, 87
  Wellington formation, 223, 224 228
Geologic history, 77
Geologic work, previous, 22
Ground water, 90
  availability of large supplies, 230
  change in storage, 216
  described by areas, 223
  discharge of, 132, 215
  principles of occurrence, 90
  quality of, 145
  recharge of, 114, 214
  recovery of, 142
  source, 221
Ground-water areas, 223
  Arkansas Valley area, 227, 231
  Canton-Galva area, 226
  Lindsorg area, 223, 230
  McPherson Channel area, 225, 230
  Newton upland area, 228
  Ninnescah area, 230
  Northeastern upland area, 224
  Southwestern upland area, 229
  Windom-Inman upland area, 224
Growing season, length of, 27
Gypsum creek, 224
Halstead, population of, 34
  water supply of, 193
Hardness of water, 166
Haven, population of, 34
  water supply of, 194
Hesston, population of, 34
  water supply of, 195
Highways, 35
Hutchinson, population of, 34
  precipitation at, 27, 28
  water supply of, 195, 228
Hydrographs of water levels, 113, 117, 120, 122, 124, 130, 136, 137, 139
Hydrologic studies, 23, 211
Industrial wells, 185
Industries, 35
Inman, population of, 34
  water supply of, 197, 225
Iron in water, 168
Irrigation, 190
Irrigation wells, 190
Kansas Gas and Electric Co. well, 92, 104
Kiowa shale, 49
Lake Inman, 87
Lindsborg, population of, 34
  water supply of, 197, 223, 224

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Little Arkansas River, 26, 220, 226, 227
Location and size of area, 15
Loess, 40, 59, 62
Logs of wells, 290
Marquette, population of, 34
  water supply of, 197, 223
McPherson, population of, 34
  precipitation at, 27, 38
  water supply of, 198, 225
McPherson channel, 59, 225, 230
McPherson formation, 37, 59, 226, 231
McPherson Valley, 59, 64, 81, 82
Mechanical analyses, 92
Mesozoic era, 78
Methods of investigation, 16
Methods of lift, 145
Mineral resources, 35
Moisture, equivalent, 93
Mortar bed, 68
Moundridge, population of, 34
  water supply of, 199
Movement of water, 214, 215
Mt. Hope, population of, 34
  precipitation at, 27, 29
  water supply of, 199
Natural resources, 35
Newton, population of, 34
  precipitation at, 27, 29
  water supply of, 200, 226
Ninnescah River, 25, 26, 90
Ninnescah shale, 43
Observation wells, 111
Oil-field brines, 173, 226
Paleozoic era, 77
Pearlette ash, 67
Permeability, 100
Permian system, 22, 40
Pleistocene epoch, 80
Pleistocene series, 23, 59, 70
Pliocene series, 56
Population, 32
Porosity, 92
Precipitation, 27
  recharge from, 114
Previous geologic and hydrologic work, 22
Public-supply wells, 191
Pumping tests, 92, 101, 103
Quality of water, 145
  relation to stratigraphy, 183
Quaternary period, 80
Quaternary system, 59
Railroads, 32
Rattlesnake Creek, 171
Recent series, 70, 74
Recharge of ground water, 114, 214
  by precipitation, 114
  from streams, 130
  by subsurface inflow, 131
Recovery, 142
Recovery formula, 101
References, 448
Relief, 25
Safe yield, 222, 223
Salt-water intrusion, 169
Sand dunes, 70, 82, 83, 119, 184
Sanitary considerations, 183
Sedgwick, population of, 34
  precipitation at, 27, 30
  water supply of, 202
Seeps, discharge of groundwater by, 133
Sinkholes, 88
Smoky Hill River, 25, 26, 64, 87, 90, 223
Specific capacity of wells, 108
Specific retention, 93
Specific yield, 93, 213, 220
Springs, 142, 223, 229
Stock wells, 184
Stone corral dolomite, 47
Storage, change in, 216
Stratigraphy, summary of, 37
Subsurface inflow, recharge by, 131
Temperature, 26
Terrace deposits, 65, 87
Tertiary system, 56, 79
Test holes, 17, 21
  logs of, 290
Theis recovery method, 101
Thiem method, 104
Topography, 25
Transmissibility, 100, 214
Transpiration, discharge of ground water by, 132
Transportation, 32
Utilization of water, 184
Valley Center, population of, 34
  water supply of, 202
Volcanic ash, 60, 61, 62, 66, 68, 80
Water-bearing materials, 91
  hydrologic properties, 91
  mechanical analyses, 92
  porosity, 93
  moisture equivalent, 93
  specific retention, 93
  specific yield, 93, 213, 220
  potential perennial yield, 212
Water, utilization of, 184
Water level, fluctuations in, 110
  caused by changes in atmospheric pressure, 113
  caused by precipitation, 114
  caused by seepage, 133
  caused by pumping, 134
Water supplies, 184
  domestic, 184
  industrial, 185
  irrigation, 190
  public, 191
  stock, 184
Water supply of—
  Alluvium, 75, 223, 227, 230, 231, 232
  Delmore formation, 59, 226
  Dune sand, 74
  Kiowa shale, 56, 223, 224
  McPherson formation, 69, 225, 230

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Ninnescah shale, 46, 223, 224, 230
Stone corral dolomite, 47
Wellington formation, 41, 223, 224, 228
Well logs, 290
Well records, 233
Wellington formation, 40
Wells, construction of, 143
discharge of water by, 134
domestic, 184
drilled, 143
driven, 143
dug, 142
industrial, 185
irrigation, 190
logs of, 290
methods of lift, 145
public-supply, 191
records of, 233
specific capacity of, 108
stock, 184
Wichita, population of, 34
precipitation at, 27, 30
water supply of, 202, 211, 228
well-field area, 211

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AREAL GEOLOGY OF A PART OF SOUTH-CENTRAL KANSAS AND WATER-TABLE CONTOURS, 1940-1944

State Geological Survey of Kansas

by Charles C. Williams and Claude W. Hibbard

Bulletin 79
Plate 1

R.5 W. R.4 W. R.3 W. R.2 W. R.1 W. R.1 E.

T. 17 S. T. 18 S. T. 19 S. T. 20 S. T. 21 S. T. 22 S. T. 23 S. T. 24 S. T. 25 S. T. 26 S. T. 27 S.

EXPLANATION

Qal — Alluvium
Silt, clay, and coarse sand and gravel. Yields very large quantities of moderately hard to hard water to wells in Arkansas and Little Arkansas River Valleys; smaller quantities in Smoky Hill Valley.

Qds — Dune sand
Fine to medium grained eolian quartz sand. Recently formed dunes subject to shifting and blow-out are above water table in most places, but constitute valuable intake area.

RECENT

Qds — Dune sand
Fine to medium grained eolian quartz sand. Subdued dunes yield small quantities of relatively soft water to stock and domestic wells. Important catchment areas for recharge of the ground-water reservoir.

PLEISTOCENE AND RECENT

QUATERNARY

Qmc — McPherson formation
Silt, clay, and coarse sand and gravel. Contains volcanic ash. Coarse channel deposits yield large quantities of moderately hard water to domestic and municipal wells. Smaller quantities available from other parts of the formation.

PLEISTOCENE

Td — Delmore formation
Silt, clay, carbonate, sand and gravel, largely derived from Cretaceous and Permian rocks. Yields small supplies of moderately hard water to domestic and stock wells.

PLIOCENE

TERTIARY

Kk — Kiowa shale
Dark gypsiferous shale, gray sandy shale, soft cross-bedded sandstone, "quartzite", and thin fossiliferous limestones. Sandstones yield small supplies of hard water to small springs and stock wells.

COMANCHEAN

CRETACEOUS

Pw — Stone Corral dolomite
Gray, cellular, thin-bedded dolomite on outcrop in McPherson County. Contains anhydrite and gypsum in subsurface westward. Yields no water to wells in this area.

Pn — Ninnescah shale
Soft to hard brick-red shale. Contains some beds of gray and green shale, thin argillaceous limestones and gypsum. Yields meager supplies of very hard water to wells.

LEONARDIAN

PERMIAN

Pw — Wellington shale
Gray, calcareous shale, containing gypsum, anhydrite, salt, and thin beds of argillaceous limestone. Yields meager supplies of very hard water to stock and domestic wells.

Contour interval 10 feet

1500 — Water-table contours based on instrumental levels

1433.6 — Well location. Number refers to altitude of water level

- ●A — Volcanic ash pit or exposure
- Gravel pit or stone quarry
- Federal or State highway
- Graded road
- Section line (no road)
- Township line (no road)
- County line (no road)
- Railroad

0 1 2 3 Scale in miles

Drainage from aerial photographs of the U. S. Dept. of Agriculture

Base map prepared from aerial photographs of U. S. Department of Agriculture, maps of U. S. Geological Survey, and maps of Kansas Highway Department.

DEPTHS TO WATER LEVEL AND LOCATION OF WELLS IN A PART OF SOUTH-CENTRAL KANSAS

State Geological Survey of Kansas

by Charles C. Williams and Stanley W. Lohman

Bulletin 79
Plate 5

R. 5 W. R. 4 W. R. 3 W. R. 2 W. R. 1 W. R. 1 E.

T. 17 S. T. 18 S. T. 19 S. T. 20 S. T. 21 S. T. 22 S. T. 23 S. T. 24 S. T. 25 S. T. 26 S. T. 27 S.

EXPLANATION

Depth to water level below land surface, in feet

- Less than 20
- 20-40
- 40-60
- 60-80
- More than 80

Area in which no well inventory was made

Small to moderate supplies of ground water available from Cretaceous and Permian formations.

- Domestic and stock wells
- Public supply well
- Industrial well
- Irrigation well
- Observation well

[232] / 24 — Upper number is well number used in well tables. Brackets around upper number, [232], indicate that analysis of water is given. Lower number is depth to water level below land surface, in feet.

- Federal or State highway
- Graded road
- Section line (no road)
- Township line (no road)
- County line (no road)
- Railroad

Scale in miles: 0 1 2 3

Drainage from aerial photographs of the U. S. Dept. of Agriculture

Base map prepared from aerial photographs of U. S. Department of Agriculture, maps of U. S. Geological Survey, and maps of Kansas Highway Department.

Wells in T. 27 S., R. 1 E. Shown on Plate 5a

LOCATION OF WELLS IN T. 27 S., R. 1 E., INCLUDING CITY OF WICHITA

State Geological Survey of Kansas

by

Stanley W. Lohman

Bulletin 79
Plate 5a

EXPLANATION

- Domestic and stock wells
- Public supply well
- Industrial well
- Observation well

[677]/13 — Upper number is well number used in well tables. Brackets around upper number, [677], indicate that analysis of water is given. Lower number is depth to water level below land surface, in feet.

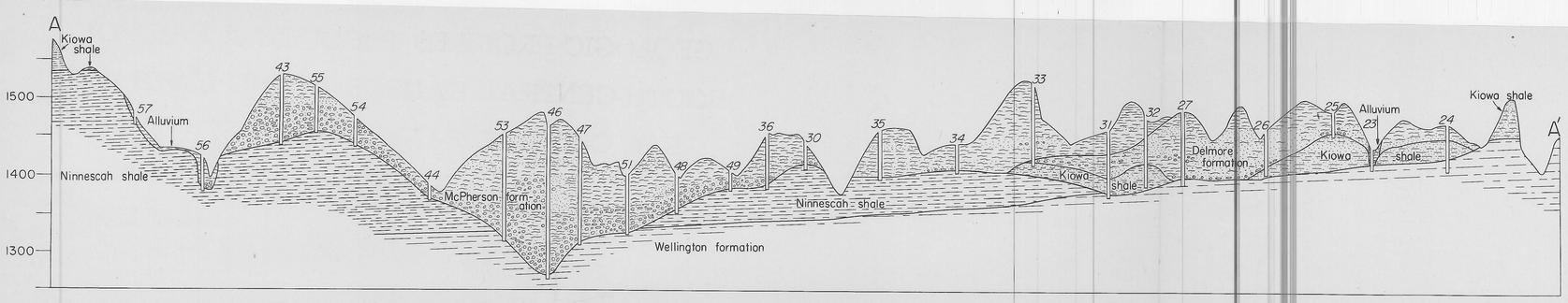
Base map prepared from maps of the City of Wichita and aerial photographs of U. S. Department of Agriculture.

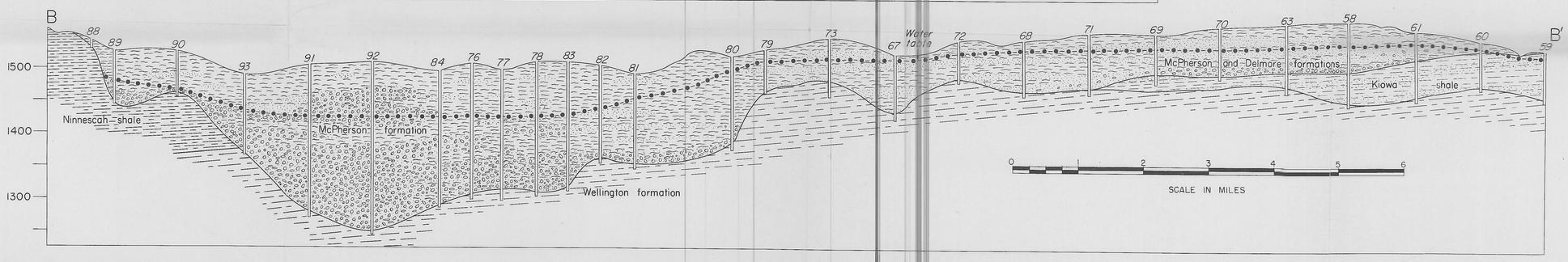
GEOLOGIC PROFILES THROUGH A PART OF SOUTH-CENTRAL KANSAS ALONG LINES A-A', B-B', C-C', D-D', E-E', and F-F' IN PLATE 7

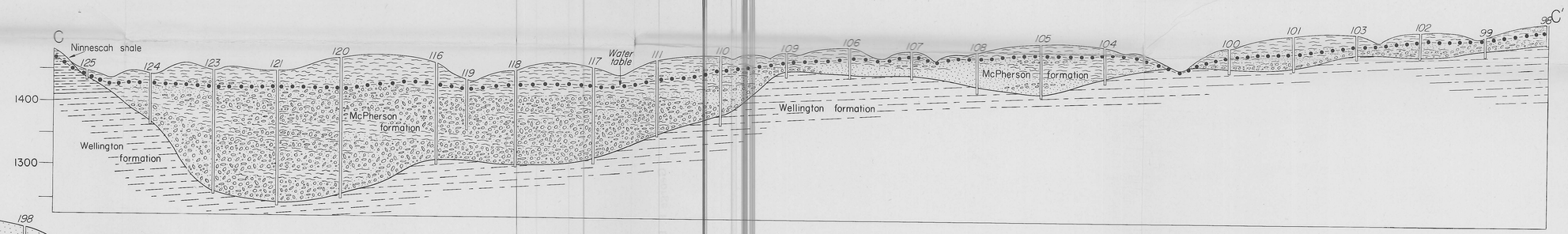
by Charles C. Williams

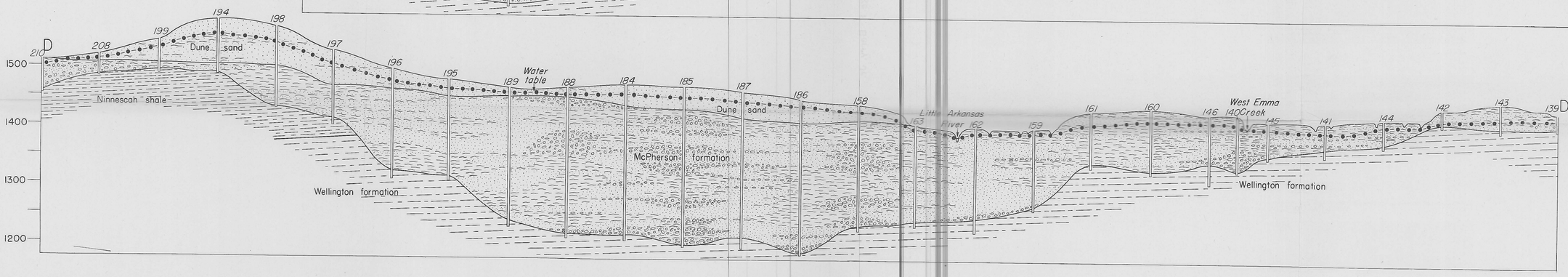
State Geological Survey
of Kansas

Bulletin 79
Plate 6

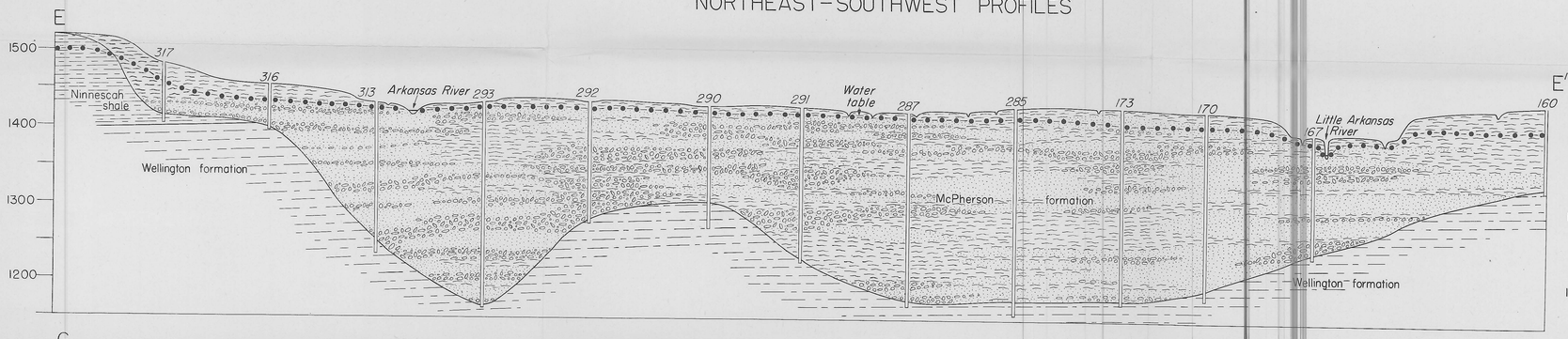


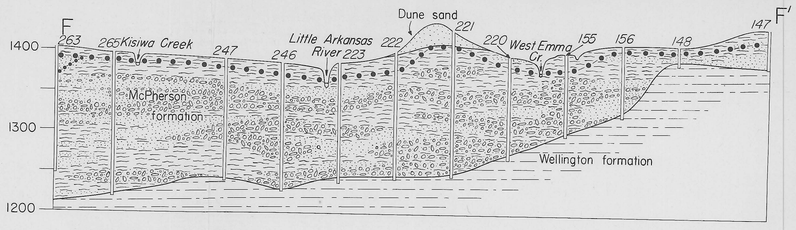


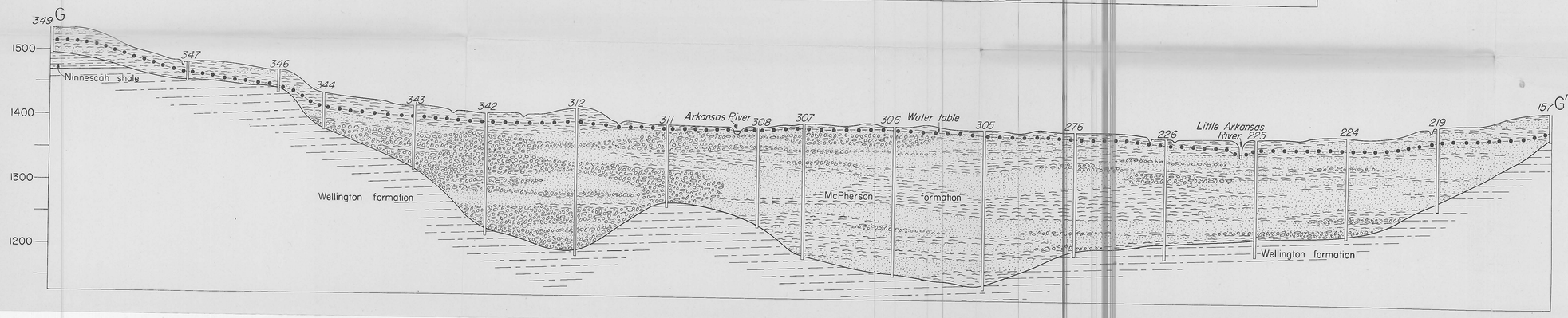




NORTHEAST–SOUTHWEST PROFILES







LOCATIONS OF TEST HOLES, AND BEDROCK CONTOURS IN A PART OF SOUTH-CENTRAL KANSAS

State Geological Survey of Kansas

by Charles C. Williams

Bulletin 79
Plate 7

R.5 W. R.4 W. R.3 W. R.2 W. R.1 W. R.1 E.

T. 17 S. T. 18 S. T. 19 S. T. 20 S. T. 21 S. T. 22 S. T. 23 S. T. 24 S. T. 25 S. T. 26 S. T. 27 S.

LINDSBORG MARQUETTE FREMONT ROXBURY CANTON LEHIGH McPHERSON GALVA CONWAY WINDOM GROVELAND ELYRIA INMAN GOESSEL MOUNDRIDGE MEDORA BUHLER HUTCHINSON HESSTON NEWTON BURRTON HALSTEAD PATTERSON SEDGWICK HAVEN BENTLEY MOUNT HOPE VALLEY CENTER COLWICH ANDALE MAIZE KECHI GARDEN PLAIN GODDARD WICHITA

MC PHERSON COUNTY / MARION COUNTY / RENO COUNTY / HARVEY COUNTY / SEDGWICK COUNTY

Smoky Hill River; Missouri Pacific Railroad; Kan. 4; U.S. 81; Gypsum Creek; Big Bend; Union Pacific Railroad; Missouri Pacific Railroad; Atchison, Topeka and Santa Fe Railroad; U.S. 50 N; U.S. 50 S; Kan. 17; Kan. 15; Kan. 96; Rock Island; St. Louis; Chicago, Rock Island and Pacific; Missouri; Arkansas; Kisima Creek; Turkey Creek; Little Arkansas; Sand Creek; Cowskin Creek; North Fork of Ninnescah River; Ninnescah River; Chisholm Creek; Chicago, Rock Island and Pacific; Missouri Pacific; St. L. A. & S. F.; A. T. and S. F.; Kan. 42; Santa Fe; Railroad

EXPLANATION

- Location of test hole or well for which sample log is given.
- Location of test hole or well for which driller's log is given.
- 121 / 1245 — Upper number is log number. Lower number is altitude of bedrock at base of unconsolidated deposits, in feet above sea level.
- X1217 — Cross marks location for which the reported altitude of bedrock, 1217 feet above sea level, is given.
- —1300— Bedrock contours based on instrumenal levels
- Heavy lines mark lines of geologic profiles shown on Plate 6.

Federal or State highway
Graded road
Section line (no road)
Township line (no road)
County line (no road)
Railroad

Drainage from aerial photographs of the U. S. Dept. of Agriculture

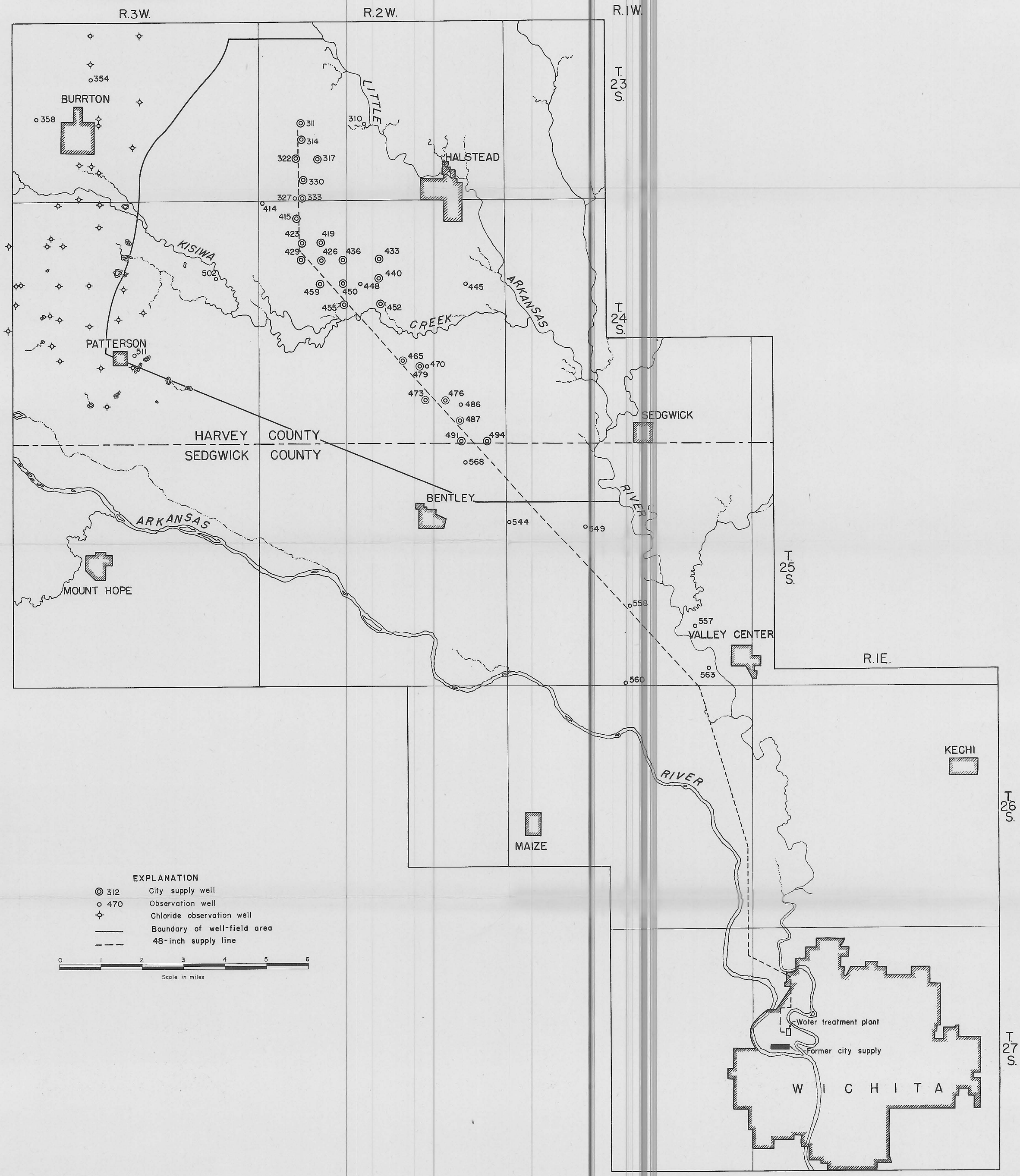
Base map prepared from aerial photographs of U. S. Department of Agriculture, maps of U. S. Geological Survey, and maps of Kansas Highway Department.

WICHITA WELL-FIELD AREA

Showing Supply Wells, Supply Line, and Observation Wells

State Geological Survey
of Kansas

Bulletin 79
Plate 28



EXPLANATION

◎ 312	City supply well
o 470	Observation well
✧	Chloride observation well
———	Boundary of well-field area
– – –	48-inch supply line

0 1 2 3 4 5 6

Scale in miles

CHLORIDE CONTAINED IN GROUND WATER IN A PART OF SOUTH-CENTRAL KANSAS

State Geological Survey of Kansas

by Stanley W. Lohman and Charles C. Williams

Bulletin 79
Plate 29

R.5 W. R.4 W. R.3 W. R.2 W. R.1 W. R.1 E.

T. 17 S. T. 18 S. T. 19 S. T. 20 S. T. 21 S. T. 22 S. T. 23 S. T. 24 S. T. 25 S. T. 26 S. T. 27 S.

LINDSBORG MARQUETTE FREMONT ROXBURY CANTON LEHIGH WINDOM CONWAY McPHERSON GALVA GROVELAND ELYRIA INMAN LAKE INMAN GOESSEL MOUNDRIDGE MEDORA BUHLER HESSTON HUTCHINSON BURRTON HALSTEAD NEWTON EDGWICK HAVEN PATTERSON MOUNT HOPE BENTLEY VALLEY CENTER ANDALE COLWICH MAIZE KECHI GARDEN PLAIN GODDARD

MC PHERSON COUNTY MARION COUNTY RENO COUNTY HARVEY COUNTY MC PHERSON COUNTY RENO COUNTY MC PHERSON COUNTY HARVEY COUNTY MARION COUNTY HARVEY COUNTY RENO COUNTY HARVEY COUNTY SEDGWICK COUNTY RENO COUNTY SEDGWICK COUNTY

Smoky Missouri Pacific Mo. Pac. U.S. 81 Gypsum Creek Kan. 4 Railroad Hill River Sharps Creek Union Pacific Atchison U.S. 50 N Topeka Santa Fe Big Basin Missouri Rock Island St Louis Kan. 17 Turkey Creek Little Arkansas Chisholm Creek Cow Creek North Fork of Ninnescah River Kan. 15 Kan. 96 Emma Sand Creek Kishwa Creek Big Slough Chicago Rock Island and Pacific Mo Pac A T & S F Kan. 42

EXPLANATION

Chloride, in parts per million

- ○ Less than 50
- ◔ 50-100
- ◑ 101-500
- ◕ 501-1000
- ● More than 1000

Federal or State highway
Graded road
Section line (no road)
Township line (no road)
County line (no road)
Railroad

65/36 — Upper number indicates chloride content; lower number is depth in feet from which sample was taken.

55/21 75/42 81/63 — Chloride content of water at one location, sampled from different depths.

139,221/17 — Chloride content of water from one location and from one depth, but sampled on different dates. Chloride in samples given in chronological order.

Base map prepared from aerial photographs of U. S. Department of Agriculture, maps of U. S. Geological Survey, and maps of Kansas Highway Department.

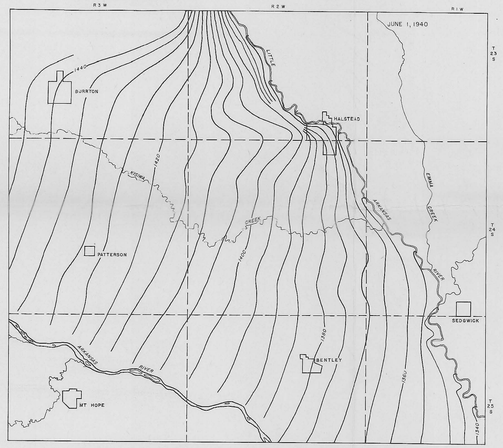
Drainage from aerial photographs of the U. S. Dept. of Agriculture

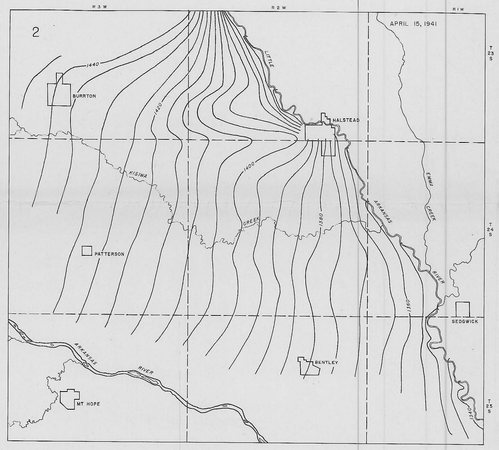
CONTOUR MAPS OF THE WATER TABLE IN THE WICHITA WELL-FIELD AREA ON SEVERAL DATES FROM JUNE 1, 1940 THROUGH OCTOBER 1, 1944

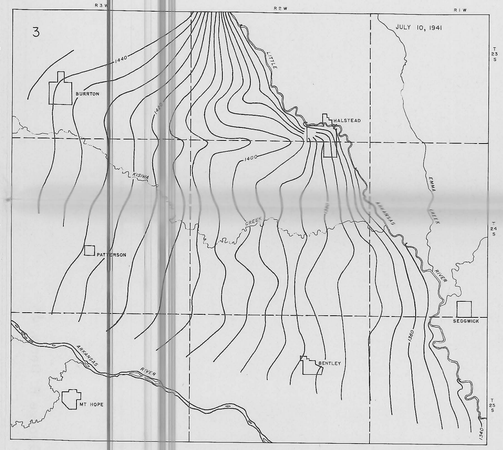
State Geological Survey
of Kansas

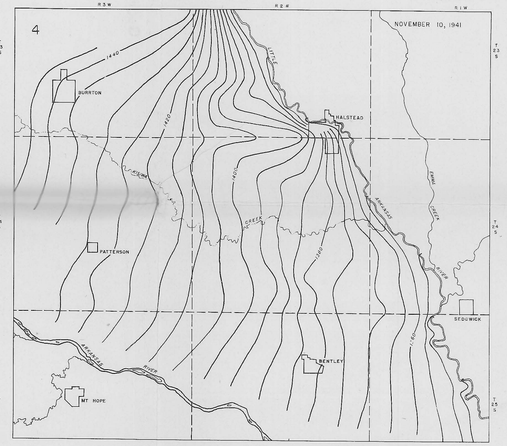
by Charles C. Williams

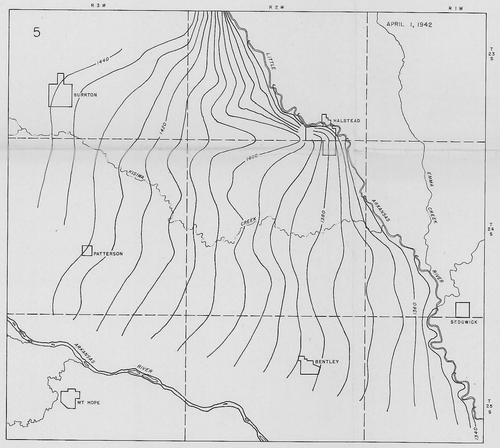
Bulletin 79
Plate 33

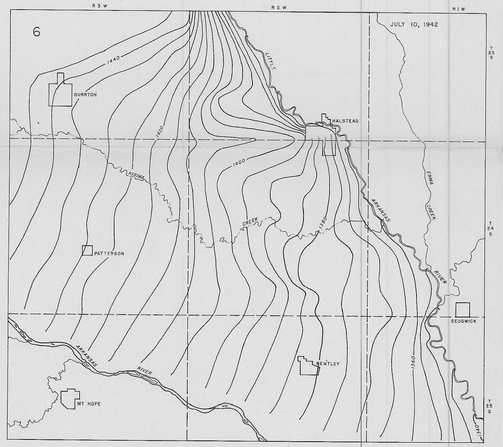


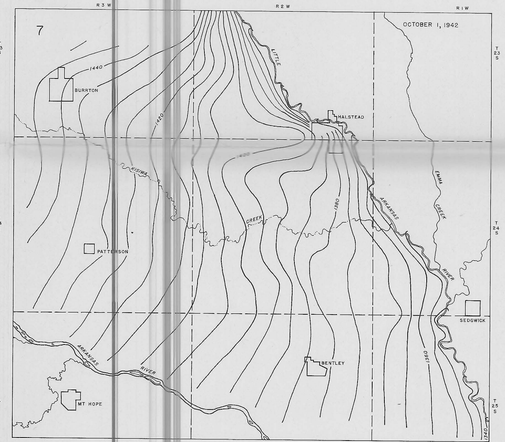


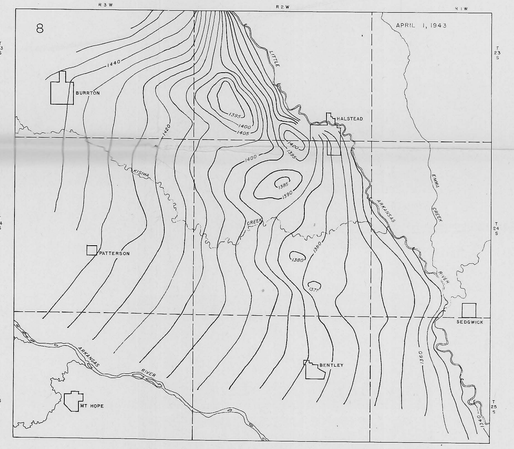


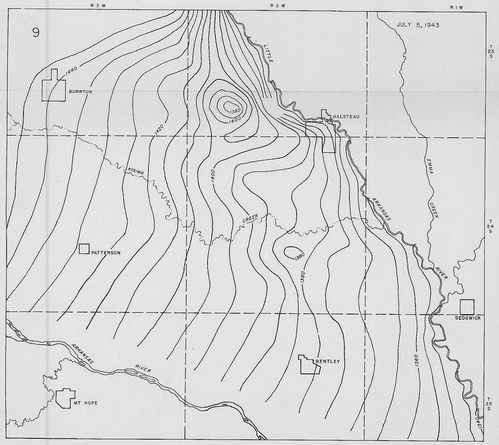


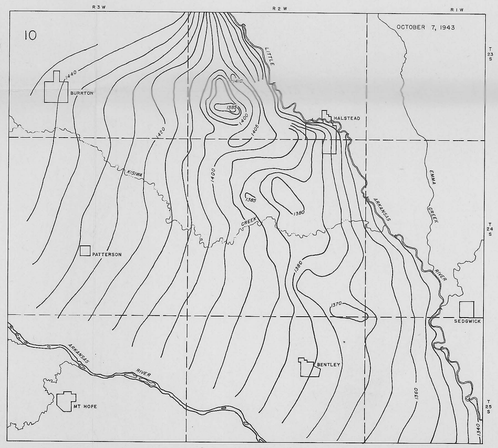


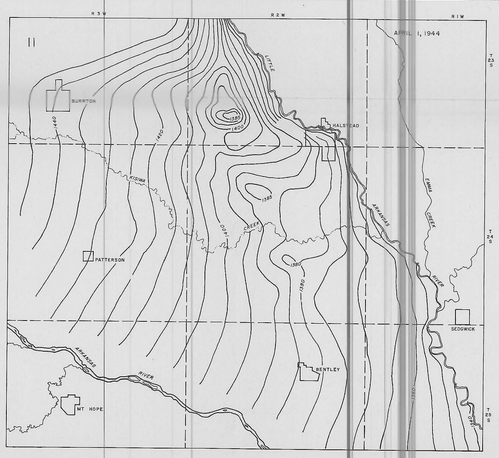


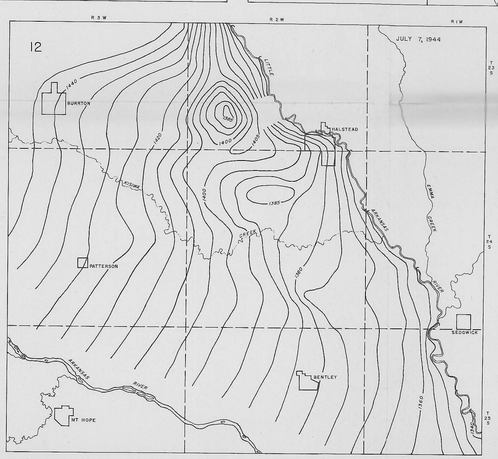


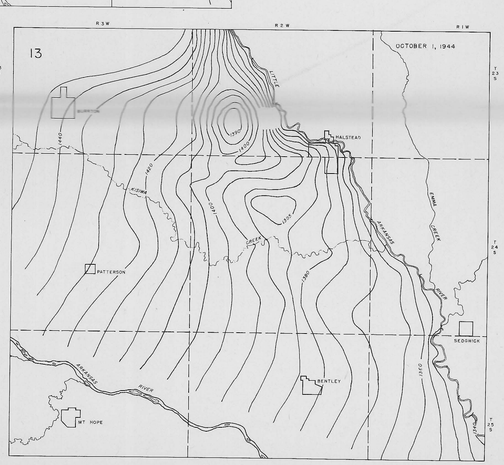












MAPS OF THE WICHITA WELL-FIELD AREA SHOWING LINES OF EQUAL CHANGE IN WATER LEVEL FROM JUNE 1, 1940 TO OCTOBER 1, 1944

State Geological Survey of Kansas

by Charles C. Williams

Bulletin 79
Plate 34