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PROGRESS REPORT

ON THE

GROUND-WATER SUPPLY

OF

NORTHERN LEA COUNTY, NEW MEXICO

By

C. S. CONOVER AND P. D. AKIN

GEOLOGICAL SURVEY

UNITED STATES DEPARTMENT OF THE INTERIOR

Prepared in Cooperation With the State Engineer
of New Mexico

1942

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GENERAL FEATURES OF AREA[1]

Lea County is in the southeastern corner of the State of New Mexico. The northern part of Lea County, covered by this report, is a typical part of the Llano Estacado, or Staked Plain, a flat-surfaced plateau that occupies part of eastern New Mexico and western Texas. This plain in Lea County is bounded on the west by an escarpment several hundred feet high overlooking the Pecos Valley to the west. The escarpment closely follows the line between Lea and Chaves Counties, and trends southward from the northwestern corner of Lea County to about the latitude of Lovington from whence it trends southeastward, decreasing in height to the vicinity of Pearl. From Pearl it runs eastward, becoming more and more indefinite, past Monument, to the Texas line.

The Llano Estacado in northern Lea County slopes east-southeastward from 10 to 15 feet to the mile. The surface of the plain is dotted with sinks which are most numerous near the western edge of the plain. There are no perennial streams on the plain and practically no developed surface drainage of any consequence.

The area is semi-arid. Most of the rainfall occurs during the growing season and crops requiring little water can be grown in wet years without irrigation. The rainfall is disposed of chiefly by evaporation, transpiration and seepage to the ground water.

The surface rock materials of most of Lea County consist of unconsolidated sand, gravel, and silt of Tertiary and Quaternary age. The thickness of the deposits ranges up to a few hundred feet. In many places the upper several feet of the fine-grained deposits are cemented by calcium carbonate, forming dense hard caliche. These materials are underlain by nearly impervious shales of Triassic and Lower Cretaceous ages. The Tertiary deposits north and east of Tatum are thin.

The main ground-water supplies are found in the Tertiary deposits. From the latitude of Tatum south to the escarpment of the plain in the vicinity of Pearl, these deposits are several hundred feet thick and contain a large volume of water. South of the escarpment the Tertiary

1. Nye, S. S., Shallow ground-water supplies in northern Lea County, N. Mex.; New Mexico State Engineer 9th Bienn. Rept., pp. 363-387, 1930. Nye, S. S., Progress report on the ground-water supply of northern Lea County, N. Mex.; New Mexico State Engineer 10th Bienn. Rept., pp. 229-251, 1932.

Theis, C. V., Progress report on the ground-water supply of Lea County, N. Mex.: New Mexico State Egnineer 11th Bienn. Rept., pp. 127-153, 1934.

and Quaternary deposits are thin and the water supplies are scant, being found in shallow buried valleys in the underlying Triassic rocks. North of Tatum the Cretaceous deposits are near the surface and ground-water supplies are on the whole scattered and meager.

Most of the irrigation wells in the county are on the Llano, in the eastern part of the county, where the water table is shallow. Besides the pumpage for irrigation, large quantities of ground water are used for rotary drilling in the oil fields. Most of the water for oil well drilling has been obtained south of the escarpment in the vicinity of Monument. Ground water is also used for domestic and stock supplies.

Recharge to the ground water occurs through seepage from rainfall on the plains. It has been estimated that the annual average recharge is equivalent to less than a half inch of water over the area of the county[2].

The natural discharge of ground-water in the county is negligible. There are a few small springs along the western escarpment and in the vicinity of Monument. Some discharge by transpiration by mesquite and other vegetation occurs south of the escarpment.

ACKNOWLEDGEMENTS

The data in this report covering the period from 1938 to the early part of 1941 were obtained by Mr. Conover, who also prepared a report for the county covering the period 1938 and 1939 which is largely incorporated in the present report. Mr. Akin continued the collection of data, after Mr. Conover joined the military forces, and prepared the present report. All the work was done under the general direction of O. E. Meinzer, Geologist in Charge of the Division of Ground Water of the Geological Survey, and the immediate direction of C. V. Theis, Geologist in Charge of Ground-Water Investigations in New Mexico. All work was done in cooperation with the State Engineer of New Mexico, T. M. McClure.

RECENT DEVELOPMENTS

In the area north and east of Tatum the Tertiary deposits are thin[3] and the Cretaceous clay and shales are at shallow depths at most places. The Cretaceous shales are exposed around the north edge of North Lake, about 15 miles northwest of Tatum, and also on the east shore of Ranger Lake, about 10 miles north of Tatum.

In February 1940 a well was drilled on the ranch of W. O. Dunlap, Jr., in the southwest corner of sec. 20, T. 12 S., R. 37 E., five miles due east of Tatum. The log of the strata encountered, as obtained by Mr. C. Love, of Lovington, from the driller, is given in the following table:

2. Theis, C. V., Progress report on the ground-water supply of Lea County, N. Mex.; New Mexico State Engineer 11th Bienn. Rept., pp. 147-153, 1934.
3. Nye, S. S., op. cit. (10th Bienn. Rept.), p. 239.
Theis, C. V., op. cit. (11th Bienn. Rept.), p. 147.

RECORD OF WELL OF W. O. DUNLAP, JR.

SW¼, sec. 20, T. 12 S., R. 37 E.

Material	Thickness (feet)	Depth (feet)
Surface rock (caliche?)	23	23
Sand, clay, and water	2	25
Yellow clay	11	36
Blue clay	129	165
Soft shale shells	3	168
Blue clay	10	178
Hard lime	5	183
Coarse blue sand, artesian water	2	185

The strata encountered in the well below a depth of 25 feet are probably of Cretaceous age[4].

The well is cased with a 6-inch casing to 36 feet and 5-inch casing to the bottom of the well with the lower section of the 5-inch casing perforated. The 6-inch casing is reported to have been tightly sealed at 36 feet, but, since the drilling of the well, the 6-inch casing was turned and the shutoff seal may have developed a leak, thus letting a part of the water under pressure seep into the upper strata. There is no surface evidence of such leakage, however.

According to the owner, the well flowed about 25 gallons a minute and had a static head of about 14 feet above the land surface when first drilled. The well was allowed to flow for some 6 or 8 months without stopping after which a standpipe was installed. The well is now used for stock and domestic purposes.

On March 29, 1941, a test was made on the well to determine its hydrologic characteristics. The static head after the well had been completely shut off for a few hours was 14.11 feet above the land surface. After flowing for about 4 hours, the drawdown of the water surface amounted to 10.65 feet with a discharge of 16 gallons a minute, giving a specific capacity of 1.5 gallons a minute per foot of drawdown. The transmissibility, as determined by the recovery method[5], was computed as 4,500, a very low value as compared to values of transmissibility ranging from 40,000 to 100,000 or more for irrigation wells in Lea County.

In 1939 an irrigation well was drilled in sec. 3, T. 13 S., R. 37 E., for Jim Simpson, a little over 2 miles southeast of Dunlap's artesian well. The strata encountered in this well, as reported by the driller, are given in the following table:

4. Theis, C. V., Personal communication.

5. Theis, C. V., The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using ground-water storage; Am. Geophys. Union Trans., pp. 519-524, 1935. See also Mimbres Valley Investigation in this volume.

RECORD OF WELL OF JIM SIMPSON

NW¼, sec. 3, T. 13 S., R. 37 E.

Material	Thickness (feet)	Depth (feet)
Soil	1	1
White rock (caliche)	31	32
Gray sand, water	18	50
Red sand, water	40	90
Sandy clay, tight, dry	30	120
Red sand, coarse, water	30	150
Yellow sandstone, hard, dry	35	185
Red sand, water	20	205
Rust sandstone, soft	10	215
White sand	12	227
Blue clay	3	230

In the absence of well cuttings the position of the contact between the Cretaceous and Tertiary deposits is obscure. The blue clay at 227 feet is almost certainly of Cretaceous age and according to the descriptions all the strata below 150 feet resemble Cretaceous deposits more than Tertiary[6].

PRECIPITATION

The precipitation in Lea County affects the ground water by a change in the amount of recharge and in the amount of pumping of ground water for irrigation. In years of deficient rainfall, the recharge to the ground water is very small and the pumping discharge for irrigation is large while in years of excessive rainfall the recharge to the ground water is increased and the pumping discharge for irrigation is reduced.

The precipitation at stations in Lea County as reported by the United States Weather Bureau is given in the following table. Crossroads is near the northern boundary of Lea County about 18 miles north of Tatum; Tatum is 23 miles north of Lovington which is near the center of the northern part of Lea County; Hobbs is at the southeastern corner of the area and Pearl is about 18 miles west of Hobbs. All of these stations are on the Llano Estacado.

6. Theis, C. V., Personal communication.

MONTHLY PRECIPITATION, IN INCHES, IN LEA COUNTY

1938	Lovington Precipitation	Lovington Departure from normal	Tatum	Crossroads	Pearl (near)	Hobbs
January	1.35	+1.07	0.75	0.26	1.11	0.71
February	1.40	+0.92	1.10	2.29	0.76	0.40
March	0.20	−0.34	0.55	0.30	0.29	0.24
April	0.20	−0.62	0.15	0.03	0.20	0.12
May	0.12	−1.06	0.14	1.50	0.04	T
June	5.05	+3.12	1.86	2.53	1.84	3.15
July	2.92	+0.44	2.68	1.89	3.33	1.74
August	0.32	−1.80	0.05	0.67	0.02	0.04
September	3.25	+0.85	2.74	2.12	1.24	1.18
October	0.64	−1.10	0.52	0.63	0.83	0.83
November	0.00	−0.62	0.07	0.02	0.09	0.09
December	0.10	−0.48	0.05	[1]0.05	0.25	0.25
The year	15.55	+0.38	10.66	[1]12.29	10.00	8.75

1 Interpolated or partly interpolated
T = trace, less than 0.01 inch.

1939	Lovington Precipitation	Lovington Departure from normal	Tatum	Crossroads	Pearl (near)	Hobbs
January	1.67	+1.39	1.57	1.11	1.30	1.10
February	0.06	−0.42	0.18	[1]0.14	T	0.15
March	0.21	−0.33	0.54	0.50	0.15	T
April	0.16	−0.66	0.07	0.25	0.07	0.10
May	1.02	−0.16	1.05	[1]0.72	1.17	1.45
June	3.42	+1.49	2.23	1.80	0.45	1.00
July	3.07	+0.59	5.15	4.90	0.40	3.61
August	2.56	+0.44	1.08	[1]5.08	[1]0.15	0.22
September	0.13	−2.27	0.44	0.50	0.15	T
October	1.44	−0.30	1.30	1.25	1.35	2.42
November	0.50	−0.12	0.44	0.54	0.63	1.59
December	0.68	+0.10	1.38	[1]1.10	0.30	0.28
The year	14.92	−0.25	15.43	[1]17.89	[1]6.12	11.92

1 Interpolated or partly interpolated
T = trace, less than 0.01 inch.

MONTHLY PRECIPITATION, IN INCHES, IN LEA COUNTY
(continued)

1940	Lovington Precipitation	Lovington Departure from normal	Tatum	Crossroads	Pearl (near)	Hobbs
January	0.03	—0.25	0.25	T	0.13	0.05
February	0.57	+0.09	0.40	0.35	0.56	0.56
March	T	—0.54	0.00	T	0.33	0.25
April	1.29	+0.47	1.37	2.60	0.81	1.25
May	1.20	+0.02	1.84	2.24	1.39	0.63
June	1.13	—0.80	3.30	2.62	3.55	4.10
July	T	—2.48	0.43	0.21	0.05	0.55
August	4.15	+2.03	4.78	3.84	2.21	2.80
September	0.06	—2.34	0.16	0.19	0.06	T
October	2.53	+0.79	1.52	0.41	2.25	3.45
November	1.40	+0.78	1.35	0.93	0.98	1.09
December	0.07	—0.51	0.08	0.00	T	0.33
The year	12.43	—2.74	15.48	13.39	12.32	15.06

T = trace, less than 0.01 inch.

1941	Lovington Precipitation	Lovington Departure from normal	Tatum	Crossroads	Pearl (near)	Hobbs
January	0.11	—0.17	0.13	0.09	0.13	0.22
February	0.95	+0.47	0.57	0.40	0.86	0.84
March	3.34	+2.80	2.90	2.90	3.35	2.88
April	1.21	+0.39	1.65	1.63	0.43	0.69
May	12.41	+11.23	13.67	13.53	12.42	9.19
June	2.35	+0.42	2.36	3.76	4.02	3.03
July	3.64	+1.16	2.83	3.74	2.70	2.32
August	1.17	—0.95	0.74	1.92	1.35	1.19
September	4.92	+2.52	4.90	6.51	5.47	6.72
October	3.88	+2.14	5.70	5.30	3.19	4.66
November	T	—0.62	0.20	0.61	0.14	0.08
December	0.83	+0.25	0.84	0.65	0.40	0.37
The year	34.81	+19.64	36.49	41.04	34.46	32.19

T = trace, less than 0.01 inch.

The following table gives the annual precipitation, annual departure from normal, and accumulated departure since 1929 at Tatum and Lovington. The departure at Lovington is computed from the normal used by the United States Weather Bureau based on a record beginning in 1906. The accumulated departure at Tatum for the years 1929-1931, for which there was no record at Lovington, is taken also as the depar-

ture for Lovington for these years. The normal precipitation at Tatum is taken as 16.11 inches annually, or 0.94 inch more than at Lovington, as during 20 years of contemporaneous record at the two localities the average rainfall at Tatum has been in excess of that at Lovington by this amount. The normal for Tatum heretofore published by the Weather Bureau is a theoretical normal based on the records of other stations, is not in agreement with those of other stations on the Staked Plain of New Mexico, and is almost certainly erroneous[7].

The average precipitation at Tatum and Lovington from 1929 to 1940 was considerably below normal. It is to be expected that the recharge to the ground-water body was probably also below normal during this period. The extraordinary rains of 1941, however, wiped out the deficiencies accumulated in these years and produced an excess rainfall over the period from 1929 to 1941 averaging over 14 inches at the two stations. The effects of the rains of 1941 on ground-water levels will be discussed later in this report.

ANNUAL PRECIPITATION, IN INCHES, AT LOVINGTON AND TATUM

	TATUM			LOVINGTON		
Year	Precipitation	Departure	Accumulated Departure	Precipitation	Departure	Accumulated Departure
1929	15.25	— 0.86	— 0.86			
1930	12.37	— 3.74	— 4.60			
1931	17.75	+ 1.64	— 2.96	(Assumed same as Tatum)		— 2.96
1932	20.62	+ 4.50	+ 1.55	23.73	+ 8.56	+ 5.60
1933	13.03	— 3.08	— 1.53	14.96	— 0.31	+ 5.39
1934	10.41	— 5.70	— 7.23	13.99	— 1.18	+ 4.21
1935	20.13	+ 4.02	— 3.21	17.17	+ 2.00	+ 6.21
1936	11.90	— 4.21	— 7.42	13.04	— 2.13	+ 4.08
1937	17.06	+ 0.95	— 6.47	15.66	+ 0.49	+ 4.57
1938	10.66	— 5.45	—11.92	15.55	+ 0.38	+ 4.95
1939	15.43	— 0.68	—12.60	14.92	— 0.25	+ 4.70
1940	15.48	— 0.63	—13.23	12.43	— 2.74	+ 1.96
1941	36.49	+20.38	+ 7.15	34.81	+19.64	+21.00

AMOUNT OF PUMPING

As there are no surface streams in Lea County, all of the needs for water in the county are supplied by ground water except for the very minor amount of water in small ephemeral ponds used for watering stock. Considerable quantities of ground-water are used for irrigation, industrial, municipal, and domestic and stock supplies.

Previous estimates of the pumpage of ground water in Lea County for irrigation indicate that about 485 acre-feet of water was used in

7. Cameron, D. C., Meteorologist in Charge, New Mexico Section, U. S. Weather Bureau, Oral communication.

1930, about 850 in 1931, about 948 in 1932, about 1,266 in 1933, and an average of about 1,500 per year in the years 1934-1937, being about 1,800 in 1937[8].

The use of ground water for irrigation in northern Lea County continued to increase during the period from 1938 to 1940, but decreased considerably during 1941 owing to the heavy general rains during the crop season. A few wells previously used have been abandoned but a number of new wells have been drilled. About 40 wells were used for irrigation in 1938 and about 55 wells in 1941. The irrigated acreage is estimated as about 1,850 acres in 1938, about 2,400 acres in 1939, about 2,950 in 1940 and about 2,600 in 1941. The estimated pumpage for irrigation for these years is about 1,700 acre-feet in 1938, about 2,200 acre-feet in 1939, about 3,200 in 1940, and about 1,550 in 1941. The greater part of the irrigated land is devoted to raising feed crops which in many years can be raised by dry farming methods. Irrigation with ground water is therefore largely supplemental to dry farming. During the last few years truck crops have been grown in some localities. The use of ground water for irrigation will increase with the development of truck farming.

The main industrial use of ground water in Lea County is for rotary drilling in the oil fields. The oil fields in Lea County that have been furnished with drilling water from or near the Staked Plain are those at Hobbs, South Lovington, Vacuum, Monument, Eunice, West Eunice, and South Eunice.

The Hobbs, South Lovington, and Vacuum oil fields are on the Staked Plain. The Hobbs field centers around the town of Hobbs, the South Lovington field lies about 7 miles south of Lovington, and the Vacuum field lies about 12 miles southwest of Lovington. Wells in these fields obtain water for drilling generally from nearby water wells. The Monument, Eunice, West Eunice and South Eunice oil fields are south of the escarpment of the Staked Plain where water supplies are scant and erratic. The Monument field centers around Monument, southwest of Hobbs, and the Eunice fields are located south of Monument. These oil fields have been supplied mainly with water piped from water wells drilled near the escarpment in the vicinity of Monument.

Most of the drilling is by means of rotary rigs powered by Diesel engines or by steam. The Diesel rigs use water to cool the engines and circulate the drilling mud, and the steam rigs use water to develop steam power and circulate the mud. Most of the steam rigs use three boilers although a few use only two.

Estimates obtained from users of water for rotary drilling give an average consumption of 1,500 barrels (63,000 gallons) of water a day to drill an oil well with a steam rig, and 80 barrels (3360 gallons) a day to drill one with a Diesel rig. It is also estimated that it takes about 1,800 barrels (75,600 gallons) of water to fill the mud pits and boilers of a steam rig and about 1,500 barrels (63,000 gallons) to fill the mud pits and radiators of a Diesel rig. The drilling time for the South Lovington and Vacuum fields averages about 35 days, and for the other

8. Theis, C. V., Op. cit. (12th and 13th Bienn. Rept.), p. 126.

fields about 30 days. As one barrel equals 42 gallons, the use of 1,500 barrels of water a day for 30 days plus 1,800 barrels of water in the pits amounts to 6.0 acre-feet per well for steam rigs and 80 barrels of water a day for 30 days plus 1,500 barrels of water for the pits amounts to 0.5 acre-foot per well for Diesel rigs. In the oil fields where drilling time averages 35 days per oil well the water consumption amounts to 7.0 acre-feet for steam rigs and 0.6 acre-foot for Diesel rigs.

It has been estimated that on the Staked Plain, where water is abundant, about one-half of the oil wells were drilled with steam rigs, whereas in the area south of the escarpment where water is relatively scarce and has to be piped from a distance, only about one-third of the wells were drilled with steam rigs. The ratio of steam to Diesel rigs in the area south of the escarpment is confirmed by figures obtained from the Lea County Water Company, which furnished drilling water for the greater part of the wells in this area. Representatives of this company stated that from January 1937 to August 1939 they furnished water for 120 steam rigs and 224 Diesel rigs.

The following table lists by years the number of oil wells drilled, both productive and dry, in each oil field and the estimated amount of water used in the drilling.

NUMBER OF WELLS DRILLED FOR OIL AND ESTIMATED AMOUNT OF WATER USED FOR OIL-WELL DRILLING IN NORTHERN LEA COUNTY, 1934-1941

	NUMBER OF WELLS							
Oil Field	1934	1935	1936	1937	1938	1939	1940	1941
Eunice	[2]32	99	206	136	41	13	9	1
Hobbs	23	33	5	7	1	0	0	3
Monument		28	233	198	20	17	3	5
S. Eunice		1	28	30	25	28	15	1
S. Lovington					[1]12	30	3	6
W. Eunice					3	7	6	9
Vacuum			[1]4	[1]3	[1]159	119	66	13
Total		161	476	374	261	214	102	38

	ACRE-FEET OF WATER USED							
Oil Field	1934	1935	1936	1937	1938	1939	1940	1941
Eunice	75	231	481	317	96	30	21	2
Hobbs	75	107	16	23	3	0	0	10
Monument		65	544	462	47	40	7	12
S. Eunice		2	65	70	58	65	35	2
S. Lovington					45	114	11	23
W. Eunice					7	16	14	21
Vacuum			15	11	603	451	247	49
Total	150	405	1,121	883	859	716	335	119

1 Obtained from U. S. Geological Survey, Oil and Minerals Leasing Division, Roswell, New Mexico. Other figures from annual reports of Lea County Operartor's Committee. Discrepancies between totals and sum of years due in part to changes in boundaries of fields.

2 Total wells drilled previous to 1935.

The following table gives the estimated pumpage by the principal users of ground water for irrigation in northern Lea County. The estimates were arrived at in various ways and represent various degrees of accuracy. The amount of water pumped from the irrigation well of Seth Alston, sec. 19, T. 13 S., R. 35 E., in 1938 is based upon an accurate record of the total hours pumped and an estimate of the discharge of the pump and for 1939 upon an estimate of the pumping time. The amount of water pumped from the well of Opal Fulton is based upon the reported fuel bill and pumping rate, and that for S. A. Richardson for 1939 upon the reported fuel bill for the year and the rated discharge. The estimate for the well of L. C. Bivins for 1939 is based on the amount of fuel used and the rated discharge. The amount of water pumped from the well of Ellis Taylor for 1939 is based upon an accurate record of the pumping time and measured rate of discharge. The pumpage for the wells of J. T. Easley, E. H. Byers, J. E. Simmons, and Dave Wilhoit are based on the metered natural gas consumption and the rated use of natural gas and discharge of pump. The pumpage figures for other wells were obtained through estimates made by the owners or by comparison with other wells.

The municipal pumpage of Lovington is metered consumption. The municipal pumpage of Hobbs is based mainly on the records of pumping time and an estimate of the average rate of discharge of the pumps. The consumption for locomotive use of the Texas-New Mexico Railway in Lovington is based upon the electrical power record. The remaining estimates of the amount of pumping were based on data obtained from the operators.

Figure 1 is a map of the northern part of Lea County showing the location of irrigation wells and wells in which monthly measurements were made in 1939.

The water supply of Lovington is obtained from one well. The waterworks of Hobbs and New Hobbs were consolidated in 1937. The Hobbs water supply was obtained from four wells prior to February 1939, when an additional well was put in use.

The non-irrigation pumpage is estimated as about 1,400 acre-feet in 1940 and 1,000 acre-feet in 1941, including the estimates for rotary drilling.

The use of ground water for irrigation has gradually increased until in 1940 the quantity pumped was more than three times the amount pumped in 1930. The municipal use did not increase significantly prior to 1941 and during that year decreased about 20%. The use of ground water for rotary oil well drilling reached a peak in 1936, declining gradually since then. As the present oil fields deriving drilling water from the plains have been about drilled out, the amount of water used will continually decrease unless new fields are opened.

It has been pointed out in a previous report[9] that the quantity of water pumped from the Staked Plain by windmills for domestic and stock use is large in the aggregate and may amount to about 5,000 acre-feet a year, a little more than the total pumpage for other uses.

9. Theis, C. V., op. cit. (11th Bienn. Rept.), p. 140.

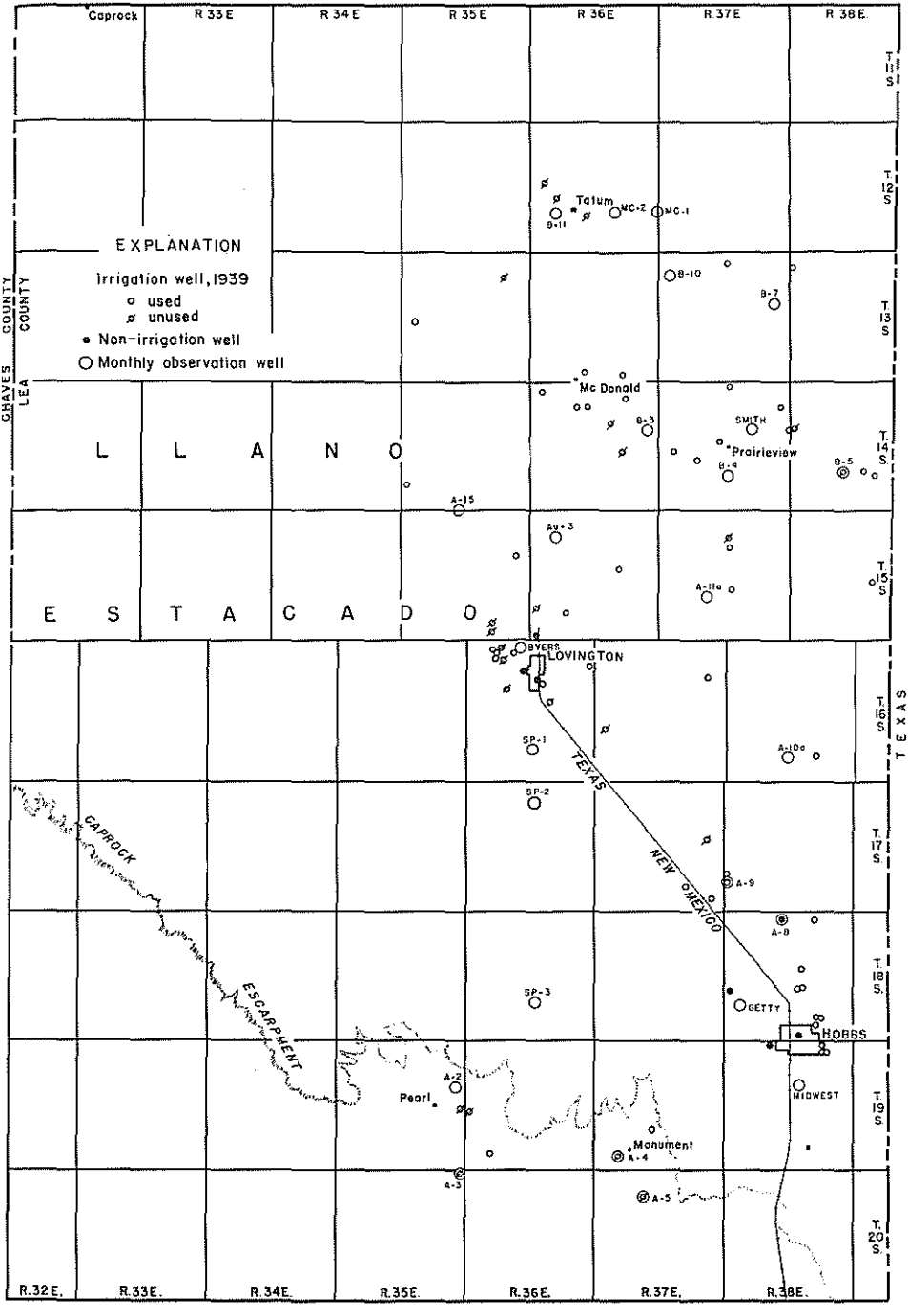

FIG. 1. Map of northern part of Lea County showing irrigation wells.

ESTIMATED AMOUNTS OF WATER PUMPED BY THE PRINCIPAL USERS IN NORTHERN LEA COUNTY, 1938-39, IN ACRE-FEET

	NAME	Location Sec.	T.S.	R.E.	Irrigation 1938 Acres irrigated	1938 Acre-feet	1939 Acres irrigated	1939 Acre-feet
1	Fox	18	12	36	0	0	0	0
2	Hoag	20	12	36	0	0	0	0
3	Allen	28	12	36	..	..	0	0
4	Green, Ashby G.	11	13	35	0	0	0	0
5	Alston, Seth	19	13	35	115	177	115	121
6	Beaman, Lewis	33	13	36	39	33	22	29
7	McClish, J. C.	35	13	36	70	78	100	134
8	Simpson, Jim H.	3	13	37	..	..	90	106
9	Fulton, Opal	6	13	38	52	41	52	43
10	Anderson, W. A.	30	14	35	50	41	50	22
11	King, Clarence M.	2	14	36	50	0	44	24
12	Richardson, S. A. and W. B.	6	14	36	50	52	50	24
13	Bivins, L. C.	9	14	36	70	58	70	87
14	Rankin, Buford	9	14	36	..	..	80	79
15	Drake, A. C.	10	14	36	0	0	0	0
16	Pior	23	14	36	0	0	0	0
17	Hobbs, Lois C.	3	14	37	80	161	80	161
18	Heidel, R.	12	14	37	55	31	55	31
19	Caswell, Grady B.	13	14	37	47	23	47	24
20	Fort, Claude	16	14	37	60	63	70	65
21	Hennington, A. B.	19	14	37	20	14	10	14
22	Hudgens, Doyle	20	14	37	0	0	42	28
23	Miller, Annie	18	14	38	..	..	0	0
24	Hennington, T. C.	27	14	38	60	86	60	86
25	Taylor, Ellis	27	14	38	80	12	80	45
26	Cox, Ida M.	28	14	38	..	..	0	0
27	Coalson Bros.	13	15	35	0	0	30	36
28	Thomas, Oma	35	50	35	55	53	0	0
29	Cook, C. F.	14	15	36	90	10	90	3
30	Hudgens, D. A.	29	15	36	50	55	50	70
31	Jackson, Tom	30	15	36	12	6	0	0
32	Simpson, W. Arthur	10	15	37	25	35	0	0
33	Mauldin, M. M.	10	15	37	30	15	30	18
34	Mauldin, S. A.	22	15	37	56	59	56	65
35	Arnett, Etta	22	15	38	..	..	..	..
36	Easley, John T.	1	16	36	100	137	100	136
37	Byers, E. H.	4	16	36	40	46	40	53
38	Robeinson, Emma J.	5	16	36	0	0	0	0
39	Phillips, J. T.	5	16	36	45	22	45	22
40	Dean, Otto	5	16	36	30	15	39	50
41	Bush, Aubry	5	16	36	12	20	12	20
42	Coxey, Mary A.	5	16	36	80	92	0	0

ESTIMATED AMOUNTS OF WATER PUMPED BY THE PRINCIPAL USERS IN NORTHERN LEA COUNTY, 1938-39, IN ACRE-FEET
(Continued)

	NAME	Location Sec.	T.S.	R.E.	Irrigation 1938 Acres irrigated	1938 Acre-feet	1939 Acres irrigated	1939 Acre-feet
43	Alston, Seth	8	16	36	0	0	0	0
44	Simmons, J. E.	10	16	36	40	37	60	42
45	Griffin, J. C.	15	16	36	..	..	0	0
46	Yadon	12	16	37	75	68	62	57
47	Montieth, H. Taylor	19	16	37	25	8	0	0
48	Spencer, F. B.	35	16	38	..	..	296	109
48	Spencer, F. B.	35	16	38	-	-	296	109
49	Catchings, John	13	17	37	0	0	0	0
50	Wilhoit, Dave	26	17	37	40	49	40	56
51	Waltman, M. J.	36	17	37	30	16	50	27
52	Martin, W. A.	30	17	38	25	8	25	24
53	Hawkins, Colan M.	30	17	38	18	16	18	12
54	Dalmont, Sam	2	18	38	38	40	38	44
55	Greebon, W. L.	16	18	38	..	..	30	16
56	Malory and Scott	22	18	38	..	..	26	16
57	Holman, R. V.	22	18	38	30	21	30	21
58	Randolph	26	18	38	..	..	10	16
59	Morrison	26	18	38	10	2	10	6
60	Hardin	35	18	38	15	15	15	15
61	Brashers, A. R.	24	19	35	0	0	0	0
62	Evans, estate, Louis G.	19	19	36	0	0	0	0
63	Jordon, S. P.	32	19	36	8	13	8	13
64	Hicks, J. M.	21	19	37	20	7	40	40
65	Anderson, E. A. (?)	32	19	37	0	0	0	0
66	Cheser (north well)	2	19	38	..	..	20	20
67	Cheser (south well)	2	19	37	..	..	28	24
68	Campbell	2	19	38	..	..	..	..
69	Wood, J. L.	1	20	35	..	..	0	0
70	Laughlin, W. H.	9	20	37	0	0	0	0
	Total irrigation				1,847	1,735	2,424	2,165
	Non-Irrigation							
71	Tex.-N. Mex. Ry. Co.	31	15	36	..	21	..	16
72	Lovington Swimming Pool	4	16	36	..	..	..	12
73	Lovington Waterworks	10	16	36	..	53	..	70
74	Swimming Pool	4	18	38	..	45	..	47
75	Shell Stripping Plant	19	18	38	..	145	..	145
76	Hobbs Waterworks	34	18	38	..	651	..	723
77	Phillips Stripping Plant	4	19	38	..	210	..	210
78	Rotary Drilling	..	..	..	..	859	..	716
	Total non-irrigation					1,984		1,939
	TOTAL					3,719		4,104

FLUCTUATIONS OF WATER LEVEL

The fluctuations of the water levels in Lea County are the result of changes in the amount of water in the ground-water body, due to variation in the amount of recharge and natural discharge and to pumping. If during any period, the recharge in an area through precipitation is less than the discharge in the area, the water levels fall and, conversely, if the recharge to the area is greater than the discharge the water levels rise. Before any wells were drilled, the natural discharge from the area was equal to the recharge to the area over a period of years so that the average amount of water in the ground-water body over a period of years in any area was constant. The use of ground-water by means of wells is an added discharge, and causes a net lowering of the water levels until the natural discharge is decreased or the recharge is increased by a net amount equal to the use.

To study these changes in the amount of water stored in a large area on the Staked Plain in the northern part of Lea County, water-level measurements have been made at monthly intervals from 1930 to 1940 in about 20 wells distributed widely over the area. From these measurements, Theis estimated that the annual average recharge to the ground water body is less than a half-inch of water over the area[10]. In latter years, other wells have been measured at yearly intervals, either in the latter part of January or in the early part of February of each year. In 1941, water level measurements were made bimonthly in 28 wells and yearly in 54 other wells.

Figure 2 shows the hydrographs for 9 of the observation wells from 1930 to 1939 and the average monthly precipitation at Tatum and Lovington for the same period. The wells were unused during this time. Well A-3 is located south of the escarpment of the Llano Estacado, near Pearl; the other wells are on the Llano Estacado and are shown on figure 1.

The hydrographs of these wells are not similar, each well having water-level fluctuations characteristic of itself. Five of these wells show decided rises in the water level at various times although the times of rise in all the wells do not coincide. These sharp rises in water level could only be caused by increases in the amount of recharge due to precipitation. These rises do not always correlate with the precipitation as recorded at Tatum and Lovington. This can be expected to a certain extent because of the large area over which these wells are located and the irregular distribution of rainfall in this locality.

The hydrograph of well A-3 shows large rises in 1932 and 1937. The rainfall at Pearl, New Mexico, a few miles from the well, was 5 inches above normal in 1932. In 1936 and 1937 there was more rainfall than in the preceding three years although about two inches below normal. The water levels in wells south of the escarpment fluctuate more than those in wells on the plains probably because of the absence of caliche[11].

10. Theis, C. V., op. cit. (11th Bienn. Rept.), pp. 147-153.
11. Theis, C. V., op. cit. (11th Bienn. Rept.), p. 144.

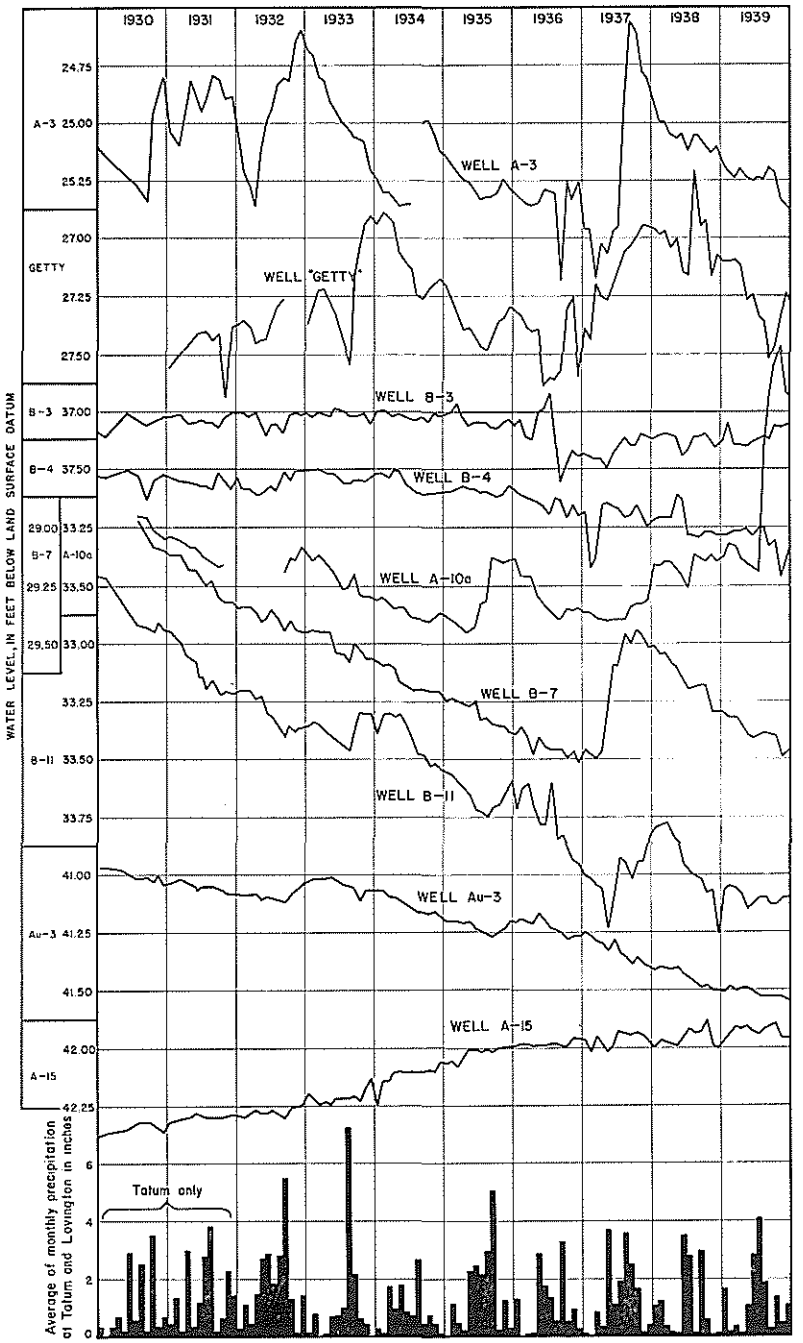

FIG. 2. Hydrographs of nine observation wells and average monthly precipitation at Tatum and Lovington, 1930-1939.

The water level in the "Getty" well also fluctuates rather widely in comparison to other wells on the plains, although the magnitude of the fluctuations are still not very large. This well is located in the oil fields near Hobbs and the water level probably fluctuates mainly in response to nearby pumping. The net rise of water level in this well during the period of record may be attributed to the recovery of water level following the large amount of pumpage in this area during the drilling of the Hobbs oil field from 1928 to 1935.

Wells B-3 and B-4 are northeast of Lovington, about four miles apart and over one mile from any pumped wells. The hydrographs show that the water level has declined only a small amount in this area.

Well A-10a is north of Hobbs about 12 miles and was far from pumped wells until 1939. The water level in this well rose a small amount near the end of 1932 and 1935 coincident with the above normal precipitation in 1932 and 1935. The water level in this well also shows other periods of high water levels such as the rise of about 1 foot in 1939, which do not correlate with the recorded rainfall at Lovington and Tatum.

Well B-7 is about 10 miles southeast of Tatum and far from any pumped wells. The hydrograph of this well probably shows a natural ground-water decline in this area. The large rise in 1937 may have been due to abnormal showers that were not recorded at Tatum or Lovington.

The hydrograph of well B-11, one mile west of Tatum, shows a gradual decline with small rises occurring at various periods, generally in response to precipitation. The gradual decline is probably due both to natural causes and to pumping of wells for domestic use at Tatum.

Well Au-3, about six miles north of Lovington, is far from pumped wells and probably shows only natural ground-water fluctuations. This well has shown a small gradual decline during the period, with small rises occurring in response to abnormal precipitations in 1933 and 1936.

The water level in well A-15 has gradually risen, particularly during the early part of the record. This well is far from pumped wells and was equipped with a windmill previous to the time water-level records were begun. This gradual rise in contrast to the gradual decline in nearly all other wells probably is the result of the recovery of the water level after pumping has ceased even though the pumping was at the low rate characteristic of a windmill[12].

In 1941 ground-water levels rose generally over the High Plains area in Lea County in response to the heavy rains that occurred in May, September, and October. A rise of 8.65 feet from January 1941 to February 1942 occurred in well 12.36.19.233, located 1 mile west and ¾ mile north of Tatum. This was the greatest rise observed in the area, although 4 other observation wells showed water-level rises of more than 4 feet. The only observed decline of the water level in the area during the year occurred in well 18.38.26.343, near Hobbs, in which the

12. Theis, C. V., (12th and 13th Bienn. Rept.), p. 133.

water level dropped 0.99 foot. The average change in all the observation wells amounted to a rise of 2.4 feet during this period.

Figure 3 is a daily hydrograph of well 12.36.29.110, (B-11), during 1941. The graph was plotted from highest daily water-level readings from records made by an automatic water-stage recorder. The graph shows the sharp rise of the water level immediately after the heavy rain in May, which is probably typical of the change in water level of most of the wells in the area at that time. The daily precipitation at Tatum during 1941 is shown in the lower half of the figure. The extraordinary character of the rainfall and recharge during 1941 is shown by a comparison of this figure with the hydrograph of this well shown in figure 2. During the entire record of 10 years previous to 1941, the water level in this well had maintained an almost constant gradual decline interrupted only by a few rises, more or less gradual in character, of a few tenths of a foot. Within a week of the heavy rains of May 1941, the water level rose over two feet and after the heavy fall rains it began a further gradual rise amounting to more than an additional 1½ feet by the end of the year and continuing for months in 1942.

The following table gives the yearly depth to water, in feet below land-surface datum, in observation wells for the period from 1938 to 1941. The land-surface datum referred to is a datum that corresponds to the actual land surface as closely as it can be determined but which is referred to one or more permanent points in the vicinity in order to make it definite.

The well location number serves the dual purpose of locating and designating the well. The number is divided into segments by periods. The first segment gives the number of the township, the second the range, the third the section. The section is divided into quarters, numbered respectively 1, 2, 3, and 4 for the NW, NE, SW and SE quarters, and each quarter is divided into 40-acre tracts on the same basis. Likewise, the 40-acre tracts are divided into 10-acre tracts. The first, second and third digits of the last segment denote respectively the quarter of the section, the 40-acre tract within the section, and the 10-acre tract within the 40-acre tract. Thus a well located in NE¼NW¼SE¼ sec. 29, T. 14 S., R. 26 E. is designated as 14.26.29.412. If for some reason a well could not be located accurately to the 10-acre tract or 40-acre tract, a zero replaces the respective digits of the last segment of the well number. For instance, the well referred to above is designated as 14.26.29.400 if the location is accurate only to the quarter section. If two or more wells are in the same 10-acre tract a letter a, b, c or d is arbitrarily added to the number designating the tract. If a well should be located on a plot in an odd-sized section the lot number preceded by the letter "L" replaces the last segment. Thus a well in lot 12, sec. 4, T. 16 S., R. 6 E., is designated as 16.6.4.L12.

Water level measurements for some of the wells have been given in reports published in the 10th, 11th, 12th, and 13th Biennial Reports. The "former number" in the table is the number by which the well was designated in the previous reports. The measurements given in the previous reports can be reduced to the land-surface datum used in the

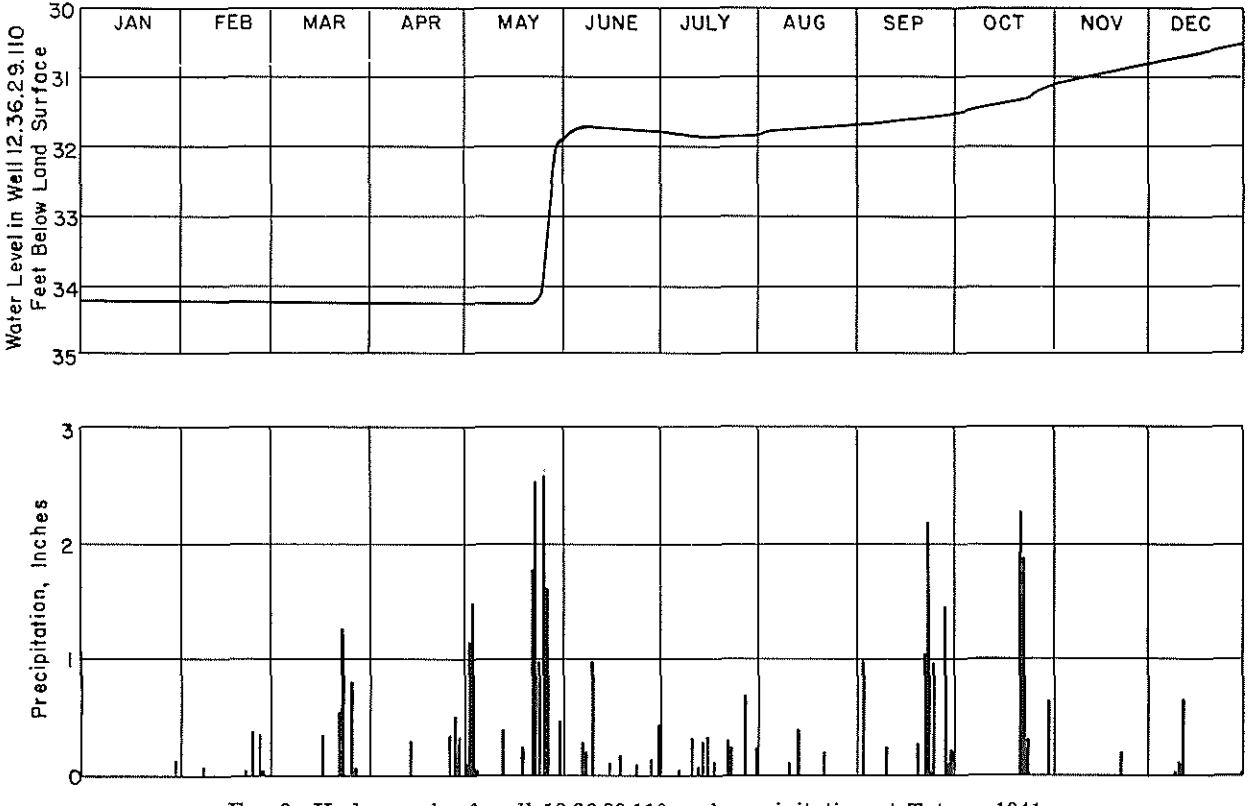

FIG. 3. Hydrograph of well 12.36.29.110 and precipitation at Tatum, 1941.

present report by adding to (+) or subtracting from (—) the previously published figures the quantities in the "correction" column. Complete records of water levels from the beginning of record to 1940 have been published[13] and later records are to be published in subsequent Water Supply Papers of the Geological Survey.

13. Meinzer, O. E., and Wenzel, L. K., and others; Water levels and artesian pressure in . . . the Southwestern States, U. S. Geol. Survey Water Supply Paper 911, pp. 177-200. 1941.

DEPTH TO THE WATER LEVEL IN OBSERVATION WELLS IN LEA COUNTY, IN FEET BELOW LAND SURFACE DATUM, IN JANUARY OR FEBRUARY OF EACH YEAR

Well location number	Former number	Correction	1938	1939	1940	1941	1942
12.36.19.223	.....	.....	.....	31.44	31.18	c32.05	23.40
12.36.24.434	.....	.....	.....	.....	.....	5.54	a 1.34
12.36.25.222	M.C.1	—0.10	24.49	24.46	24.49	24.60	21.70
12.36.27.212	M.C.2	—0.10	35.35	35.91	36.22	37.21	32.04
12.36.29.110	B-11	—0.50	33.80	34.07	34.09	34.24	30.22
12.37.20.331	.....	.....	.....	.....	.....	a13.39	a13.87
12.38.4.312	.....	.....	.....	.....	.....	43.35	40.07
13.35.11.222	.....	.....	.....	33.22	32.86	32.94	29.59
13.35.19.211	.....	.....	.....	.....	b79.48	49.07	45.55
13.36.6.221	.....	.....	.....	36.14	36.17	36.27	34.60
13.36.33.341	.....	.....	.....	42.20	41.87	43.28	40.85
13.36.35.323	.....	.....	.....	38.09	38.65	38.83	36.65
13.37.3.131	.....	.....	.....	39.31	38.59	39.86	37.94
13.37.3.133	.....	.....	.....	.....	34.65	35.67	.....
13.37.7.121	B-10	0	33.99	33.94	33.69	33.67	32.59
13.37.13.132	B-7	—1.00	29.51	29.80	29.95	30.09	26.46
13.37.28.411	.....	.....	.....	.....	.....	33.73	(e)
13.38.6.341	.....	.....	.....	.....	45.37	45.62	43.99
14.35.30.141	.....	.....	.....	48.16	48.54	48.93	45.78
14.35.33.433	A-15	—1.00	42.00	41.94	41.96	41.98	40.81
14.36.2.410	.....	.....	.....	39.99	40.40	40.88	39.53
14.36.6.420	.....	.....	.....	.....	40.68	40.96	39.38
14.36.9.111	.....	.....	.....	39.96	40.65	40.77	38.90
14.36.9.210	.....	.....	.....	41.85	42.12	42.45	40.50
14.36.13.211	B-3	0	37.12	37.13	37.05	37.18	36.42
14.36.14.121	.....	.....	.....	41.99	41.98	42.09	41.11
14.37.3.113	.....	.....	.....	34.30	34.72	34.69	.....
14.37.14.112	.....	.....	.....	36.46	36.55	36.69	35.36
14.37.16.421	.....	.....	.....	31.42	31.40	31.41	29.13
14.37.19.211	.....	.....	38.81	38.96	38.95	(e)	.....
14.37.20.410	.....	.....	.....	.....	35.21	35.36	34.13
14.37.27.130	B-4	0	37.72	37.78	37.81	37.89	36.73
14.38.27.240	.....	.....	.....	39.72	40.07	40.14	36.96
14.38.28.120	B-5	—0.28	26.42	26.53	26.85	26.94	24.28
15.35.13.110	.....	.....	.....	40.61	41.48	(e)	.....
15.35.35.112	.....	.....	.....	.....	40.71	41.51	39.97
15.36.8.131	Au - 3	—0.75	41.42	41.51	41.56	41.65	40.31
15.36.14.311	.....	.....	.....	.....	.....	43.52	42.96
15.26.29.410	.....	.....	.....	42.80	43.11	43.84	41.89
15.36.29.441	.....	.....	.....	.....	.....	c43.95	41.55
15.37.10.113	.....	.....	36.56	36.63	.....	(e)	.....
15.37.21.330	A-11a	—0.50	31.39	31.33	31.24	c39.46	29.55
15.37.27.110	.....	.....	.....	.....	.....	30.43	29.44
15.38.22.200	.....	.....	.....	.....	31.92	32.50	28.72

DEPTH TO WATER IN OBSERVATION WELLS IN LEA COUNTY, IN FEET BELOW LAND SURFACE DATUM, IN JANUARY OR FEBRUARY OF EACH YEAR
(*Continued*)

Well location number	Former number	Correction	1938	1939	1940	1941	1942
16.36.1.400	.....	.....	.....	42.25	42.63	43.84	39.73
16.36.4.433	.....	..	.. ..	... .	52.66	53.04	(e)
16.36.4.L12	Byers	—0.80	44.26	44.60	45.02	44.84	43.49
16.36.5.L10	.....	.....	.....	.	46.16	45.91	44.53
16.36.5.L14	.....	.....	.....	47.80	47.04	46.58	45.23
16.36.5.321	.....	.....	.....	47.28	46.39	46.04	44.81
16.36.5.411	.....	. ....	.. .	48.19	47.52	47.18	45.72
16.36.8.424	.....	.....	51.84	52.21	52.26	52.48	51.10
16.36.10.233	.....	.....	.....	..	51.99	52.61	50.22
16.36.15.240	.....	.....	.....	48.37	48.35	48.70	47.20
16.36.27.133	.....	.....	... ..	50.55	50.64	50.85	49.65
16.37.19.200	.....	.....	30.04	30.56	30.65	30.91	28.60
16.37.33.110	.....	.....	.....	29.90	30.28	30.63	27.48
16.38.25.144	.. ...	.....	.....	.....	.....	34.61	31.90
16.38.28.444	A-10a	0	33.41	33.38	32.69	33.00	32.66
16.38.35.110	.....	.....	.....	.....	36.38	36.57	34.63
17.34.35.130	.....	.....	.....	.....	.....	91.98	90.57
17.35.35.120	.....	.....	.....	.....	.....	41.45	39.37
17.36.3.333	.....	.....	.....	43.70	44.12	44.29	42.64
17.37.13.310	.....	.....	.....	28.40	28.56	28.84	26.08
17.37.26.330	.....	.....	.....	28.59	28.99	d41.50	26.79
17.37.34.441	.....	.....	.....	.	.....	27.22	24.68
17.37.36.141	.....	.....	.....	25.88	26.15	(b)	23.78
17.38.30.113	.....	.....	27.37	27.64	27.74	27.95	23.97
17.38.30.312	A-9	—0.50	29.81	30.11	30.13	30.44	26.47
17.38.30.331	.....	.....	.....	27.57	27.70	.....	23.90
18.36.27.111	.. ...	.....	.....	41.25	41.44	41.66	38.23
18.38.2.131	.....	.....	.....	30.28	30.64	30.52	27.48
18.38.4.232	A-8	—0.30	24.60	25.02	25.59	25.41	22.32
18.38.15.400	.....	.....	.....	.....	28.62	29.16	27.09
18.38.22.321	.....	.....	.....	.....	35.32	35.67	34.63
18.38.22.412	.....	.....	.....	.....	38.27	38.69	36.36
18.38.26.343	.....	.....	.....	...	40.66	41.22	42.21
18.38.30.200	Getty	—0.30	26.96	27.10	27.31	27.13	23.79
18.38.35.111	.....	.....	.....	.....	57.70	(e)	...
19.35.13.211	A-2	—0.33	22.40	22.56	22.91	23.42	18.38
19.35.24.222	.....	.....	.....	19.84	20.07	20.38	18.00
19.36.19.131	.....	.....	.....	17.02	17.15	.....	15.18
19.36.19.411	.....	.....	.....	.....	.....	.....	16.44
19.36.32.111	.....	.....	.....	16.77	18.60	18.59	15.15
19.36.32.321	.....	.....	.....	.....	.....	.....	23.80
19.36.32.323	.....	.....	.....	.. ..	.....	.....	23.17
19.37.32.141	A-4	+0.50	12.18	11.98	12.12	12.12	10.59
19.38.2.122	.....	.....	.....	..	46.36	46.15	43.59

DEPTH TO WATER IN OBSERVATION WELLS IN LEA COUNTY, IN FEET BELOW LAND SURFACE DATUM, IN JANUARY OR FEBRUARY OF EACH YEAR.
(*Continued*)

Well location number	Former number	Correction	1938	1939	1940	1941	1942
19.38.2.242	.....	.....	.....	.....	.....	46.97	44.38
19.38.2.424	.....	.....	.....	.....	.....	46.54	.....
19.38.10.344	Midwest	—0.08	32.78	33.18	33.37	(e)	.....
20.35.1.222	A-3	—2.00	24.91	25.17	25.39	25.63	22.07
20.37.9.110	A-5	+0.17	42.40	38.06	37.42	37.33	31.01
20.37.9.110a	.....	.....	.....	.....	.....	37.12	29.13

a Water level in feet above land surface datum.
b Well pumping
c Windmill pumping
d Well pumping 400-500 gallons a minute
e Measurements discontinued.

The following table gives the changes in water levels that have occurred in the observation wells since the first January or February. Measurements were made to January or February of 1941 and 1942. The water levels in most of the wells were lower in 1941 than when first measured, whereas in 1942 the water levels were higher in all wells except one.

CHANGE IN WATER LEVELS IN OBSERVATION WELLS IN LEA COUNTY, IN FEET.

From Measurements Made in January or February of Each Year
(+ represents a rise, — a fall, of the water level)

Well location number	Year from which change is computed	Change to 1941	Change to 1942	Change from 1941 to 1942
12.36.19.223	1939	—0.61	+8.04	+8.65
12.36.24.434	1941	.....	+6.88	+6.88
12.36.25.222	1936	—0.55	+2.35	+2.90
12.36.27.212	1935	—3.59	+1.58	+5.17
12.36.29.110	1930	—1.52	+2.50	+4.02
12.37.20.331	1941	.....	+0.38	+0.38
12.38.4.312	1941	.....	+3.28	+3.28
13.35.11.222	1930	—0.27	+3.08	+3.35
13.35.19.211	1941	.....	+3.52	+3.52
13.36.6.221	1939	—0.13	+1.54	+1.67
13.36.33.341	1939	—1.08	+1.35	+2.43
13.36.35.323	1939	—0.74	+1.44	+2.18
13.37.3.131	1939	—0.55	+1.37	+1.92
13.37.7.121	1930	+0.33	+1.41	+1.08
13.37.13.132	1930	—1.36	+2.27	+3.53
13.38.6.341	1940	—0.25	+1.38	+1.63
14.35.30.141	1940	—0.47	+2.68	+3.15
14.35.33.433	1930	+0.39	+1.56	+1.17
14.36.2.410	1939	—0.89	+0.46	+1.35
14.36.6.420	1940	—0.28	+1.30	+1.58
14.36.9.111	1939	—0.81	+1.06	+1.87
14.36.9.210	1939	—0.60	+1.35	+1.95
14.36.13.211	1930	—0.08	—0.68	+0.76
14.36.14.121	1940	—0.10	+0.88	+0.98
14.37.14.112	1939	—0.23	+1.10	+1.33
14.37.16.421	1939	+0.01	+2.29	+2.28
14.37.20.410	1940	—0.15	+1.08	+1.23
14.37.27.130	1930	—0.36	+0.80	+1.16
14.38.27.240	1939	—0.92	+2.26	+3.18
14.38.28.120	1930	—0.76	+1.90	+2.66
15.35.35.112	1941	.....	+1.54	+1.54
15.36.8.131	1930	—0.68	+0.66	+1.34
15.36.14.311	1941	.....	+0.56	+0.56
15.36.29.410	1939	—1.04	+0.91	+1.95
15.36.29.441	1941	.....	+2.40	+2.40
15.37.21.330	1931	—0.37	+1.87	+2.24
15.38.22.200	1940	—0.58	+3.20	+3.78
16.36.1.400	1939	—1.59	+2.52	+4.11
16.36.4.L12	1935	—1.18	+0.17	+1.35
16.36.5.L10	1940	+0.25	+1.63	+1.38
16.36.5.L14	1939	+1.22	+2.57	+1.35

CHANGE IN WATER LEVELS IN OBSERVATION WELLS IN LEA COUNTY, IN FEET.

From Measurements Made in January or February of Each Year

(+ represents a rise, — a fall, of the water level)

(*Continued*)

Well location number	Year from which change is computed	Change to 1941	Change to 1942	Change from 1941 to 1942
16.36.5.321	1939	+1.24	+2.47	+1.23
16.36.5.411	1939	+1.01	+2.47	+1.46
16.36.8.424	1938	—0.64	+0.74	+1.38
16.36.10.233	1940	—0.62	+1.77	+2.39
16.36.15.240	1939	—0.33	+1.17	+1.50
16.36.27.133	1939	—0.30	+0.90	+1.20
16.37.19.200	1938	—0.87	+1.44	+2.31
16.37.33.110	1939	—0.73	+2.42	+3.15
16.38.25.144	1941	.....	+2.71	+2.71
16.38.28.444	1931	+0.28	+0.62	+0.34
16.38.35.110	1941	.....	+1.94	+1.94
17.34.35.130	1941	.....	+1.41	+1.41
17.35.35.120	1941	.....	+0.16	+0.16
17.36.3.333	1941	.....	+1.65	+1.65
17.37.13.310	1939	—0.44	+2.32	+2.76
17.37.34.441	1941	.....	+2.54	+2.54
17.38.30.113	1938	—0.58	+3.40	+3.98
17.38.30.312	1930	—1.62	+2.35	+3.97
18.36.27.111	1939	—0.41	+3.02	+3.43
18.38.2.131	1939	—0.26	+2.54	+2.80
18.38.4.232	1930	—1.57	+1.52	+3.09
18.38.15.400	1941	.....	+2.07	+2.07
18.38.22.321	1940	—0.35	+0.68	+1.03
18.38.22.412	1941	.....	+2.33	+2.33
18.38.26.343	1940	—0.56	—1.55	—0.99
18.38.30.200	1931	+0.43	+3.77	+3.34
19.35.13.211	1931	+1.17	+6.21	+5.04
19.35.24.222	1939	—0.54	+1.84	+2.38
19.36.19.131	1939	—0.91	+1.84	+2.75
19.36.32.111	1939	—1.82	+1.62	+3.44
19.37.32.141	1930	—0.19	+1.34	+1.53
19.38.2.122	1941	.....	+2.56	+2.56
19.38.2.242	1941	.....	+2.59	+2.59
20.35.1.222	1930	—0.49	+3.07	+3.56
20.37.9.110	1930	—6.15	+0.17	+6.32
20.37.9.110a	1941	.....	+5.31	+5.31

CONCLUSIONS

The pumping of ground water in Lea County is a new discharge superimposed upon the previous more or less stable equilibrium between recharge and discharge of the aquifer. This new discharge must be balanced by a decrease of the natural discharge or an increase of the natural recharge, or a combination of both, if the hydrologic system is to remain in equilibrium. The nature of the natural recharge is such that it cannot be increased by pumping. The areas of discharge are so distant that the effects of pumping will not be felt for a long time. From the foregoing, it is seen that the ground water must be pumped from storage in the aquifer and that water levels must decline to some extent. Pumping in Lea County may eventually decrease the ground-water flow eastward out of the county, but such an effect will probably be small, at least for many years, and most of the pumping will be represented by a lowering of water level inside the county. If the wells are widely spaced and the pumpage not too great the lowering of water levels will proceed slowly, because the underground reservoir is large.

The rate of lowering of water levels prior to 1941 was not large and was probably due to deficiency in rainfall during the preceding years as well as to pumping for irrigation. The heavy rains of 1941 produced rises in the water-levels which more than offset the decline that had occurred in previous years. In 18 observation wells having records beginning in 1930 and 1931 the average fall of water level was 0.71 foot to January 1941, and the average rise from January 1941 to January 1942 was 2.70 feet. While heavy general rains comparable to those in 1941 cannot be expected except at very long intervals, it is believed that the preceding period of record was deficient in the large storms that apparently contribute most to the ground water. However, pumpage for irrigation has increased during the past years, and the water levels in irrigation areas may be expected to be lowered during periods deficient in rainfall, at a faster rate than in the past. The rate of lowering due to present development will probably not be excessive over a long period. Additional quantities of water could probably be pumped without serious depletion of the water supply if new developments are spread as widely as possible in order to avoid excessive pumping, and consequent excessive lowering of the water level, in any area.