MEMORANDUM ON GROUND WATER RESOURCES OF THE EL PASO, TEXAS, AREA

P R O G R E S S R E P O R T

By

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Prepared in cooperation between the Geological Survey, United States Department of the Interior, Texas State Board of Water Engineers, and City of El Paso

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PROGRESS REPORT

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Introduction

The Geological Survey, United States Department of the Interior, in cooperation with the city of El Paso and the Texas State Board of Water Engineers began an intensive study of the ground-water resources of the El Paso area in 1935. A comprehensive report [1] on the results of this study released early in 1937, contains a discussion of the geology of the area with particular reference to the occurrence and source of the ground water; reaches tentative conclusions regarding the amount of ground water that is available; and submits recommendations regarding the future development of ground water in that area. It also discloses the need for more information perteining to the thickness, permeability, porosity and specific yield of the water-bearing beds below the Mesa, the quantity of water in storage, the amount of recharge to the underground reservoir, and the danger of salt water intrusion. With this need in mind a large number of test wells were put down in 1937-38 and since then a cooperative program has been maintained which included measuring, each month, the water levels in many wells throughout the area; periodically collecting and analyzing samples of water from selected wells to determine whether any change has occurred in the chemical character of the water; making a complete inventory of the amount of water pumped each year; and collecting other ground-water data as it becomes available. This information has been studied and released from time to time in memoranda or progress reports.

In all, seven memoranda and progress reports [2] have been released since 1937. The last progress report, released in August 1944 discusses the amount of water pumped in that area each year from 1938 to 1943; the changes in the water levels in

observation wells from 1936 through 1942; the results of chemical analyses of water from wells to May 1944, and the amount of ground water withdrawn from storage from 1936 through 1942.

The present memorandum discusses the amount of water pumped in 1944; the decline in water levels in 1943 and 1944; and the removal of water from storage on the Mesa during 1943 and 1944.

Pumpage in 1944 Compared with that in 1943

In 1944 the withdrawal of ground water from deep wells in the El Paso area, including Juarez, averaged about 23,500,000 gallons a day of which about 9,200,000 gallons a day was withdrawn from wells on the Mesa, about 260,000 gallons a day from the Montana well field and about 14,000,000 gallons a day from wells in the downtown and industrial areas of El Paso and Juarez, Mexico.

The total average daily pumpage in 1944 was about 2,100,000 gallons a day less than it was in 1943; the average from wells on the Mesa was about 2,300,000 gallons a day less and that from the Montana well field about 900,000 gallons a day less in 1944 than it was in 1943. In the downtown and industrial areas of El Paso and Juarez, however, the average was about 1,100,000 gallons a day more in 1944 than it was in 1943. The following table shows the estimated total average daily pumpage in 1944 by months.

ESTIMATED TOTAL AVERAGE PUMPAGE FROM DEEP WELLS IN THE EL PASO AREA DURING EACH MONTH IN 1944, IN GALLONS A DAY

	El Paso public supply	Other supplies (including Juarez public and El Paso industrial supplies)	Total
January	9,140,000	17,860,000	27,000,000
February	8,750,000	11,230,000	19,970,000
March	8,700,000	12,180,000	20,880,000
April	9,390,000	13,090,000	22,480,000
May	9,900,000	14,350,000	24,250,000
June	10,680,000	15,540,000	26,220,000
July	10,490,000	14,300,000	24,790,000
August	10,230,000	13,960,000	24,190,000
September	7,320,000	13,570,000	20,890,000
October	10,680,000	12,840,000	23,520,000
November	6,880,000	11,270,000	18,150,000
December	10,670,000	11,260,000	21,930,000

The following table shows the estimated pumpage from deep wells in the El Paso area from 1936 to 1944 inclusive in gallons a day.

ESTIMATED TOTAL AVERAGE PUMPAGE FROM DEEP WELLS IN THE EL PASO AREA FROM 1936 to 1944 INCLUSIVE IN GALLONS A DAY

Year	Valley area including Juarez	Montana Well field	Mesa Area	Total
1936	5,000,000	3,200,000	7,500,000	15,700,000
1937	8,200,000	3,400,000	5,100,000	16,700,000
1938	8,600,000	2,700,000	4,900,000	16,200,000
1939	8,400,000	1,900,000	6,500,000	16,800,000
1940	9,300,000	2,300,000	6,800,000	18,400,000
1941	10,100,000	1,300,000	8,200,000	19,600,000
1942	9,400,000	800,000	11,800,000	22,000,000
1943	12,900,000	1,200,000	11,500,000	25,600,000
1944	14,000,000	260,000	9,200,000	23,500,000

ESTIMATED TOTAL AVERAGE PUMPAGE FROM DEEP WELLS IN THE EL PASO AREA DURING EACH MONTH in 1945, IN GALLONS A DAY

	El Paso Public Supply	Other supplies (including Juarez public and El Paso industrial supplies)	Total
January	9,170,000	9,280,000	18,450,000
February	9,950,000	10,160,000	20,110,000
March	8,470,000	9,810,000	18,280,000
April	7,980,000	11,420,000	19,400,000
May	12,630,000	11,920,000	24,550,000
June	14,080,000	12,870,000	26,950,000
July	13,110,000	12,250,000	25,360,000
August	14,320,000	12,100,000	26,420,000
September	12,330,000	12,180,000	24,510,000
October	6,900,000	10,120,000	17,020,000
November	5,960,000	9,980,000	15,940,000
December	8,400,000	9,670,000	18,070,000

Decline in Water Levels

Mesa Area

Although about 20 percent less water was pumped from wells on the Mesa in 1944 than in 1943, the monthly measurements of water levels in wells in that area reveal that in general the rate of decline was about the same in 1944 as it was in 1943. Exception to this general rule was shown in well 76, located in the western part of the Mesa well field, which had a small net rise of water level in 1944. The changes in water levels in observation wells 143A, 139A, 136, 130, 780, 64 and 76 from 1936 to 1944 are shown graphically in figure 1. The approximate location of these wells is indicated in the sketch map, figure 2.

Valley area including Montana well field

The deep wells in the valley of El Paso are under artesian pressure, and the water levels in the observation wells respond quickly to changes in the rate of pumping from the well itself and from other wells in the adjacent territory. This is illustrated by the graphs in figure 3 showing changes in artesian pressure in observation wells 29A, 48B and 53. Well 29A is located in a center of heavy pumping in downtown El Paso; well 53 is in the Montanawell field where pumpage has been substantially reduced, and observation well 48B is in the valley, at a considerable distance from heavy pumping. Observation wells 29A and 53 have fluctuated as much as 18 feet in a season. All other observation wells in the valley show rather wide variations in water levels each season. However, none of them has shown a sustained downward trend since the start of the records.

The following tables give the altitude of the water levels or artesian pressure in feet above sea level in the observation wells in the El Paso area during the years 1943 and 1944.

Water Levels in Observation Wells in the El Paso Area in 1943 (feet above mean sea level)

WELL NUMBER	January	February	March	April	May	June
8	3695.45		3694.12	3693.37	3693.09	3693.07
9	3697.43		3695.46	3695.51	3696.28	3696.74
10	3697.01		3695.33	3695.12	3695.77	3696.16
12						3618.97
18	3665.82		3662.78			3654.48
19	3678.34		3687.15			3681.68
19-a	3695.27		3695.34			3695.22
20-a				3656.45		
21	3681.78		3683.37			
22-a	3693.28				3692.98	3692.98
28	3669.08					3642.57
29-a	3664.03		3660.44		3655.21	3653.35
30-a	3647.44		3643.69	3639.04	3638.09	3636.39
32-a	3640.21		3637.80	3635.41	3634.76	3633.48
36	3678.97		3672.31			
39	3665.58		3664.54	3657.54	3645.20	3653.54
40	3688.98		3688.78	3686.06	3687.55	3687.33
42	3670.42			3626.22	3624.12	3624.91
42-a	3670.42				3689.85	3689.50
44	3672.03		3667.39	3661.55		3656.63
48-a	3676.03		3671.07	3625.97	3622.15	
48-b	3676.96		3673.87	3668.82	3667.44	3666.99
49	3673.22		3667.66	3602.69	3600.91	3600.31
50	3672.53		3669.44	3656.11	3653.33	3652.79
51	3672.99		3666.74	3653.48	3651.00	3650.46
52	3672.41		3667.49	3637.30	3635.34	3634.77
53	3669.04		3665.37	3656.95		3654.42
55	3672.55		3667.21	3665.47	3663.97	3664.87
58						3664.28
59	3669.60		3663.95			3656.46
59-a	3665.75		3668.61			3662.70
64	3679.39		3678.24	3678.53	3678.09	3677.85
67-b	3664.27		3663.96	3659.46	3657.38	3655.81
72	3655.87		3659.61	3644.17	3650.69	3651.63
75-b	3664.93	3665.00	3665.29	3664.75	3664.17	3663.25
76	3676.32	3667.83	3674.94	3674.51	3673.98	3670.81
77			3656.30	3654.48		3647.99
78-c	3675.17		3675.84	3675.58	3675.24	3674.54
82-a	2602.41		3600.49	3697.88	3697.04	3695.49
112	3664.34		3660.55	3659.87	3655.45	
128-c	3685.45		3684.40	3684.18	3682.97	3683.64
130	2685.76		3684.24	3684.06	2683.60	3683.48
136	3698.56	3698.69	3698.34	3698.32	3698.38	3698.18
139-a	3709.41		3709.22	3709.22	3709.17	3709.22
143-a	3723.48		3723.29	3723.36	3723.24	3723.39
160	3670.58					
166	3656.32					

Water Levels in Observation Wells in the El Paso Area in 1943 (feet above mean sea level)

WELL NUMBER	July	August	September	October	November	December
8	3691.82	3692.18	3693.45	3693.45	3693.40	
9			3694.12	3695.04	3695.55	
10	3693.52	3692.55	3693.38	3694.39		
19			3688.27			
19-A			3694.17			
21	3676.05		3672.65	3677.61	3680.22	
22-A			3692.59			
28	3649.29	3649.62				
29-A	3653.22	3653.42	3661.64	3668.28	3670.29	
30-A	3636.71	3636.68	3664.15	3642.19		
32-A	3633.75	3638.36	3636.95	3673.00		
38-A				3674.34		
39	3654.15	3654.02	3661.71	3660.45		
40	3687.70	3686.97	3687.28			
42			3663.25	3660.25	3670.74	
42-A				3689.46		
44		3663.22				
48-A			3668.63	3669.40		
48-B	3667.50	3667.13	3671.92	3672.53	3676.32	
49	3600.69	3600.83	3664.87	3667.68	3672.11	
50	3663.88	3663.70	3664.76	3668.52	3672.48	
51	3651.04	3650.04	3664.80	3667.59	3671.51	
52	3635.71	3634.97	3664.46	3667.58	3672.14	
53	3654.78	3654.40	3662.34	3665.29	3668.65	
55	3664.81	3663.06	3662.34	3667.82	3670.78	
64	3677.75	3677.83	3677.62	3667.69	3677.99	
58			3669.35			
59			3660.11			
59-A			3668.50			
67-B	3658.87	3665.91	3660.42	3662.64	3665.08	
72	3646.54	3639.09	3654.31	3655.56	3652.26	
75-B	3664.00	3662.77	3661.55	3664.95	3661.55	
75-D				3662.32	3664.69	
76	3671.33	3670.20	3671.00	3672.15	3674.79	
77	3662.44		3657.16	3659.76	3661.08	
77-B	3659.04					
78-C	3674.89	3674.57	3675.07	3675.02	3674.78	
79	3655.61		3660.85	3661.05	3661.71	
82-A	3596.20	3595.77	3664.65	3602.30	3601.95	
112	3658.66	3655.81	3662.51	3662.83	3660.55	
128-B	3629.52	3639.67	3630.96	3630.93		
128-C	3683.59	3683.45	3683.27	3682.30	3682.94	
128-D				3630.81		
130		3683.12		3683.04		
136	3698.14	3698.18	3698.06	3698.19	3698.14	
139-A	3709.12	3709.27	3709.09	3709.25		
143-A	3723.36	3723.49	3723.27	3723.46		

Water Levels in Observation Wells in the El Paso Area in 1944 (feet above mean sea level)

WELL NUMBER	Jenuary	February	March	April	May	June
8		3693.05	3692.79	3692.97		3691.15
9		3694.96	3692.98	3694.60		
10		3694.63	3643.57	3694.02		3689.95
12		3621.52				3648
18		3665.35		3664.10		3651.84
19		3688.23		3698.09		3687.43
19-a		3694.32				
21		3681.79		3682.05		3681.79
28		3688.00	3669.16	3669.31		3669.57
29		3662.97	3662.38	3667.74		3657.89
30		3643.40		3669.14		3640.74
32-A		3665.01	3638.66	3669.21		3636.34
39		3664.94		3667.45		3660.95
42				3668.83		3625.98
44		3673.24	3672.61	3671.51		3660.75
48-a		3669.95	3672.49	3671.52		3626.10
48-b		3673.62	3674.22	3675.87		3671.63
49		3669.83	3670.14	3670.91		3663.19
50		3671.44	3671.76	3672.71		3667.22
51		3670.03	3670.11	3670.16		3661.33
52		3669.58	3669.98	3670.04		3634.71
53		3668.91	3668.20	3667.40		3661.36
55		3669.67		3669.63		3666.68
58		3670.55				
59		3664.56		3663.05		3663.51
59-a		3667.39		3667.20		3667.63
64		3678.18	3697.68	3676.65		3677.30
67-b		3665.23	3665.82	3664.00		3661.23
72		3657.93	3665.20	3663.95		3664
75-b		3666.31	3665.99			3661.66
75-d		3667.26				3638.31
76		3675.94	3675.71	3674.43		3675.72
77		3663.66	3662.17	3658.83		3650.31
78-c		3674.91	3674.68	3674.67		3674.06
79		3663.64	3662.49	3659.78		3599.68
82-a		3601.51	3599.49	3599.18		3597.92
112		3664.73	3664.15	3662.76		
128-b		3631.60	3632.02	3630.89		3630.26
128-c		3682.88	3682.49	3682.46		3681.96
130		3682.76	3680.35	3682.25		3681.82
136		3697.99	3698.01	3697.92		3697.72
139-a		3709.01				3709.06
143-a		3722.99				3723.28
160		3670.65				
166		3657.67				

Water Levels in Observation Wells in the El Paso Area in 1944 (feet above mean sea level)

WELL NUMBER	July	August	September	October	November	December
8	3693.57	3693.07	3693.35	3692.89	3692.89	3693.10
9		3694.04	3693.64	3693.81	3694.13	3695.52
10	3689.91	3691.48	3692.93	3693.31	3693.80	3694.16
12			3649.62			
18			3660.30			
19		3687.69			3682.91	
21	3682.15	3681.93	3682.28	3682.58		3648.10
22-a				3691.98		3692.12
29-a	3665.29	3657.97	3667.40	3658.92	3670.04	3667.24
30-a	3669.58	3641.72	3669.58	3641.56	3672.79	3670.62
32-a	3666.93	3636.76	3668.70	3636.82		3638.66
39	3664.52		3669.60	3636.82	3672.07	3671.05
42	3664.79	3626.13	3670.04	3618.82	3670.30	3671.65
42-a	3689.30			3688.92		3689.05
44	3662.44	3659.30		3662.73		3671.19
48-a	3668.92		3674.31	3668.96	3675.58	3675.95
48-b	3672.36	3673.61	3676.38	3672.77	3676.65	3676.64
49	3664.32	3668.26	3671.90	3666.86	3672.79	3672.76
50	3668.71	3671.56	3673.95	3670.85	3675.79	3676.51
51	3662.52	3668.69	3671.57	3667.31	3672.18	3672.44
52	3636.77	3668.53	3671.35	3667.40	3671.83	3672.63
53	3661.31	3666.63	3669.75	3665.55	3670.15	3671.25
55	3667.45		3670.02	3668.27	3670.47	3671.04
59			3664.38	3662.65		3664.75
59-a			3669.83	3667.20		3668.62
64	3677.34	3677.40	3677.28	3676.91	3677.01	3675.96
67-b	3663.31				3664.78	
72	3647.48					3660.88
75-b	3663.12	3663.50	3663.88	3662.38	3661.80	3664.75
76	3673.57	3673.98	3674.05	3673.97	3674.40	3674.50
77	3657.43	3656.61	3674.05	3695.87	3661.59	3663.00
77-b	3659.04					
78-c	3674.25	3674.11	3674.19	3674.11	3674.03	3674.00
79		3658.64				3663.89
82-a	3662.72	3601.85	3665.91	3666.21	3667.39	3669.11
112	3656.35	3661.02	3657.57	3657.64	3658.81	3664.66
128-b	3633.43	3631.82	3634.11	3633.18	3635.58	3634.54
128-c	3681.95	3681.84	3681.80	3681.61	3681.66	3681.51
130	3680.81	3680.86	3681.03	3680.46	3680.64	3681.88
136	3697.69	3697.61	3697.62	3697.51	3697.62	3697.52
139-a	3709.20	3709.20	3709.04	3709.23	3709.02	3709.07
143-a	3724.37	3723.33	3723.29	3723.43	3723.55	3723.29

Removal of Water from Storage on the Mesa in 1943 and 1944

Based on the records of water level measurements, it was estimated in the 1944 report that the material unwatered on the Mesa amounted to about 23,000 acre-feet from 1936 to 1939 and about 183,000 acre-feet from 1939 to 1943. Using the same method it is estimated that an additional 100,000 acre-feet of material was unwatered during the two years 1943 and 1944. The total amount of material unwatered from 1936 through 1944 as thus computed was about 306,000 acre-feet.

In the 1944 report, the value 17½ percent was used for the specific yield and it was computed that the amount of water removed from storage amounted to about 1,200,000 gallons a day from 1936 to 1939, and about 4,100,000 gallons a day from 1939 to 1943. Using the same value for the specific yield the figure of approximately 8,000,000 gallons a day is reached as the amount removed from storage during 1943 and 1944. The source of the pumped water which was not obtained from the computed unwatering is explained as follows on page 16 of the 1944 report:

> "It is believed that the pumped water which was not obtained from the computed unwatering, was derived largely by recharge from mountain runoff perhaps in Mexico as well as on the American side of the border and a small part was obtained from storage in the artesian water-bearing beds of the Valley. In part it may have been derived by unwatering on the Mexican side of the Rio Grande Valley; by replacement of fresh ground-water with overlying mineralized water in the Valley, which in turn was replaced by water from the Rio Grande; and possibly by rise of underlying salt water, which might in turn have been replaced by inward percolation from more distant sources."

The difference between the volume of water pumped and the computed volume removed from storage on the Mesa amounted to about 16,000,000 gallons a day from 1936 to 1939, about 15,100,000 gallons a day from 1939 to 1943, and about 16,600,000 gallons a day from 1943 through 1944. The increase in the difference during the last two years is partly explained by the fact that in 1944 the pumpage was reduced in the Mesa and Montana areas and increased in the valley areas, thus moving the center

of pumping farther south, so that more water was being withdrawn from storage on the Mexican side.

In the 1944 report, in computing the amount of material unwatered, the rim rock was assumed to be the dividing line between water table and artesian conditions in the underground reservoir. Fort Bliss and all of the Mesa well field lie to the north of the rim rock and both locations, therefore, were assumed to be in the water table area.

To check this assumption, a pumping test was made at Fort Bliss by the writer, assisted by C. E. Jensen of the City Water Department during March 26 - 28, 1945. In this test Fort Bliss well 6 was pumped continuously at the rate of 810 gallons a minute for 48 hours and the resulting drawdowns in wells 2 and 3 respectively 265 and 540 feet from well 6, were observed.

From the results of this test the coefficients of transmissibility and storage for the water-bearing material were computed mathematically by means of the Theis non-equilibrium method. The coefficient of transmissibility is defined as the number of gallons of water that will move in one day through a vertical strip of the aquifer one foot wide and having the height of the aquifer when the gradient is unity. The coefficient of storage is defined as the volume of water measured in cubic feet, released from storage in each column of the aquifer having a base one foot square and a height equal to the thickness of the aquifer, when the artesian head is lowered one foot.

In the Fort Bliss test the values .00025 and .00063 were obtained for the coefficients of storage from the drawdowns in wells 2 and 3 respectively. These figures are very low and indicate that the aquifer in that locality is artesian. Also the data obtained by Penn Livingston of the Geological Survey at the Mesa well field in a pumping test and described in the 1937 report have been analyzed by means of the

Theis non-equilibrium method. The results show relatively low figures for the coefficients of storage and seem to indicate that semi-artesian conditions may occur in the southern part of the Mesa field. The coefficients of storage and transmissibility obtained from the tests at Fort Bliss and in the southern part of the Mesa field are given below:

Coefficients of Transmissibility and Storage Computed from Pumping Test at Ft. Bliss

Well	Coefficient of Transmissibility	Coefficient of Storage	Remarks
6	---	---	Pumped well
2	52,000	.00025	
3	56,500	.00063	

Coefficients of Transmissibility and Storage Computed from pumping tests in the Mesa Well Field

Well	Coefficient of Transmissibility	Coefficient of Storage	Remarks
78	---	---	Pumped well
112	108,500	.0976	
114	91,400	.0860	
120	77,300	.0755	
119	59,700	.00777	
77	108,500	.0644	

The data still are not adequate for fixing the exact boundary between the artesian and water table areas. However, water-table conditions undoubtedly prevail beneath most of the large area of the Mesa and the error in the computations based on the assumption that the rim rock is the true boundary between water-table and artesian areas cannot be very great.

Quality of Water

Water samples have been obtained periodically from a large number of wells in the El Paso area, and analyses of these samples have been made either by the U. S. Geological Survey or the city of El Paso. These samples have been obtained from pumped wells, usually twice a year--one sample near the end of the season of slack pumping in the spring and one during the season of heavy pumping. A tabulation of

of the analyses of these samples to the spring of 1944 is given in the report of August 1944.

Analyses made since the spring of 1944 show no material change in the chemical quality of the water.

Summary

The pumpage in the El Paso area including Juarez averaged about 23,500,000 gallons a day in 1944 compared with 25,600,000 gallons a day in 1943. The decline was due to a material reduction in the Mesa and Montana well fields where the combined average was about 3,200,000 gallons a day less in 1944 than it was in 1943. In the downtown and industrial areas , however, the pumpage averaged about 1,100,000 gallons a day greater in 1944.

On the Mesa the rate of decline in water levels in the observation wells was about the same in 1944 as it was in 1943, although the pumpage was considerably less. It is roughly computed that as a result of the decline about 100,000 acre-feet of material was unwatered and an average of about 8,000,000 gallons a day was removed from storage during 1943 and 1944, as compared with an average of about 1,200,000 gallons a day between 1936 and 1939, and 4,100,000 gallons a day between 1939 and 1943.

In the downtown and industrial area the wells are under artesian pressure and the pressure changes rapidly, depending upon the amount of water pumped in the area. Although there are wide ranges in the artesian pressure each season in each observation well, the records show that there has been no sustained downward trend in pressures and, therefore, no material change in the volume in storage since the start of the records.

References

1/ A. N. Sayre and Penn P. Livingston, Ground Water Resources of the El Paso Area, Texas, released to the city of El Paso January, 1937.

2/ (1) A. N. Sayre, Estimating safe yield as Illustrated by El Paso, Texas, Ground water investigation, Econ. Geol. 33 (7): 697-708, November, 1938.

(2) A. N. Sayre and Penn P. Livingston, Ground Water Resources of the El Paso area, Texas, complete report in press as Water-Supply Paper 919, released to the city of El Paso, March, 1940.

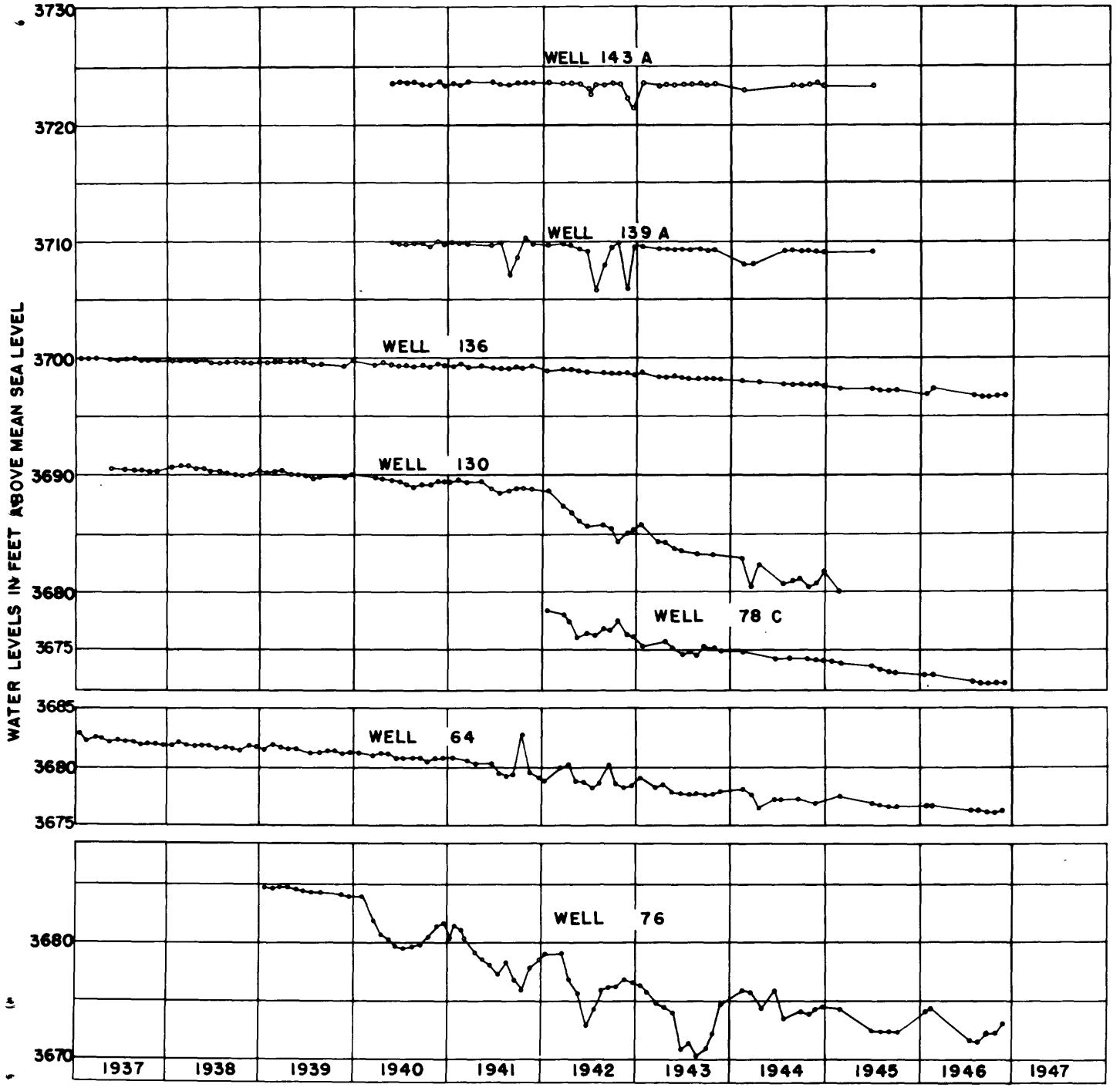
(3) A. N. Sayre, Ground Water Supply of El Paso Area, Texas, released to the city of El Paso, August, 1940.

(4) A. N. Sayre, Memorandum regarding the development of New Well Supply in El Paso area, released to the city of El Paso and Engineering Corps of the U. S. Army, November, 1942.

(5) W. N. White, Ground Water Sypply of El Paso Area, Texas, memorandum to District Engineer, U. S. Engineers of Albuquerque, New Mexico, March, 1943.

(6) Penn P. Livingston and J. M. Birdsall, Progress Report on the Ground Water Supply of the El Paso area, released to the City of El Paso, August, 1944.

— Figure 1



WATER LEVELS IN OBSERVATION WELLS IN THE MESA AREA
EL PASO, TEXAS

Figure 2

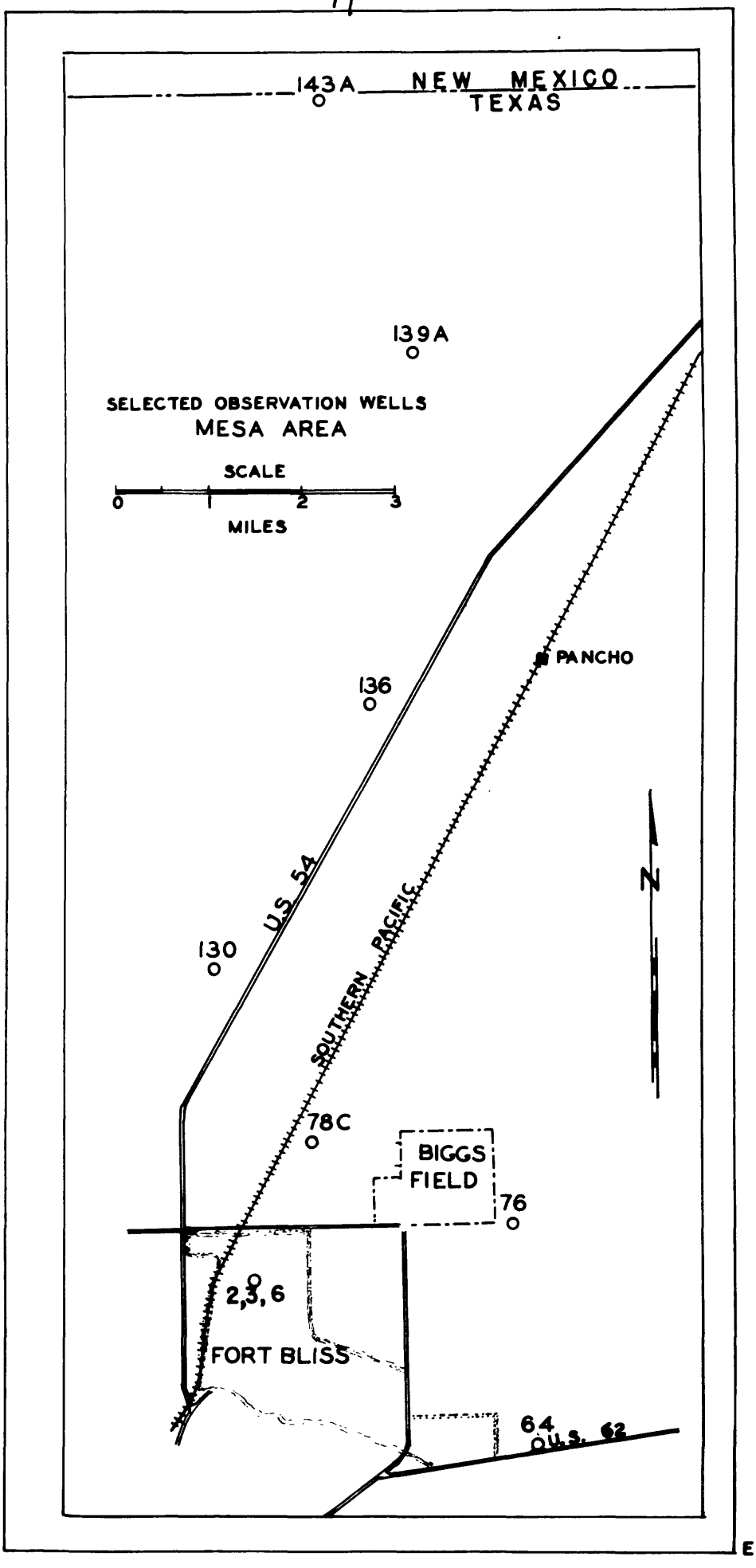
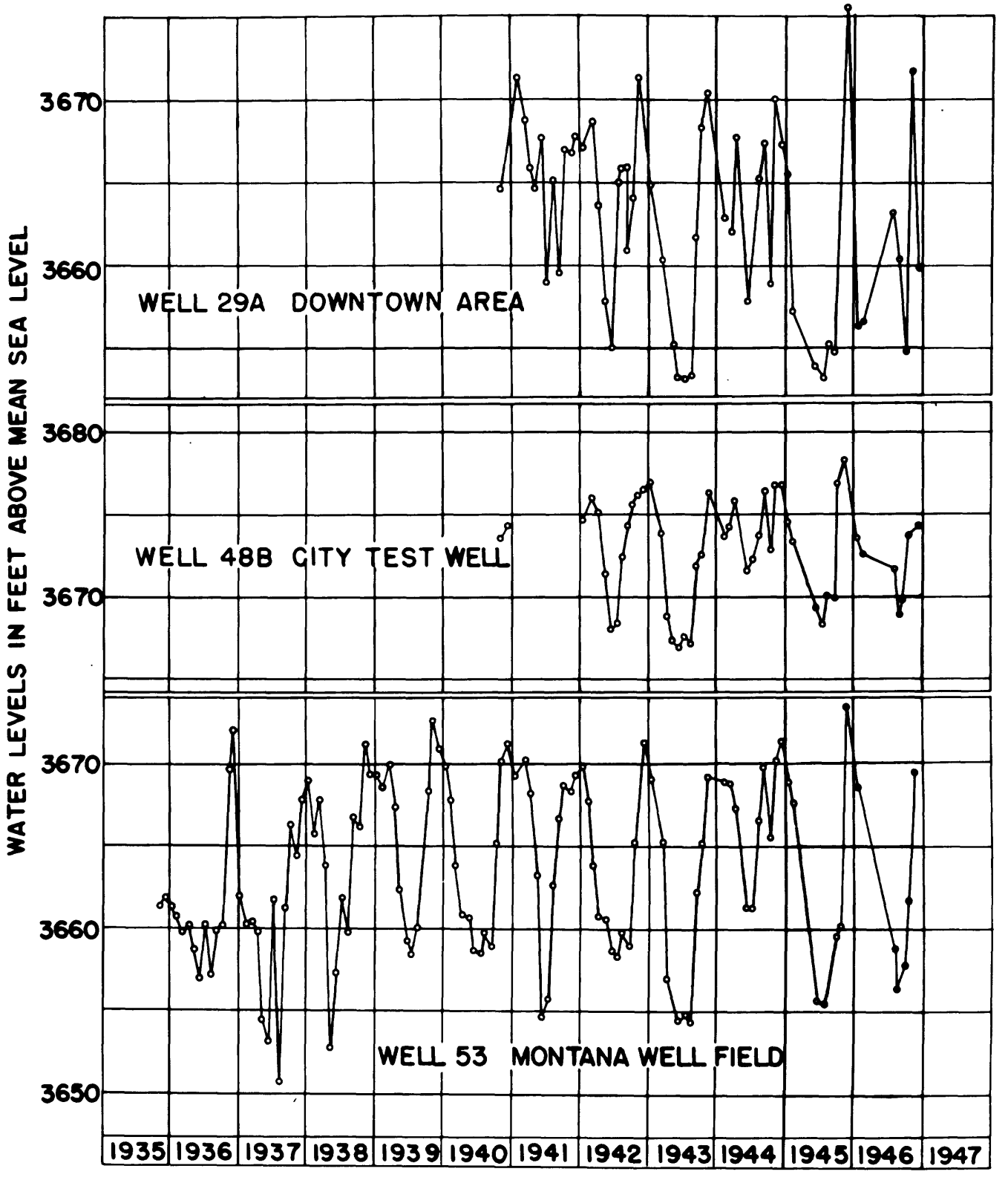

143A
NEW MEXICO
TEXAS
139A
SELECTED OBSERVATION WELLS
MESA AREA
SCALE
0
1
2
3
MILES
PANCHO
136
US 54
130
SOUTHERN PACIFIC
N
78C
BIGGS
FIELD
76
2,3,6
FORT BLISS
64
U.S. 62
EL PASO

Figure 3



WATER LEVELS IN OBSERVATION WELLS IN THE ARTESIAN AREA-EL PASO