

TEXAS BOARD OF WATER ENGINEERS

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THE HOUSTON DISTRICT, TEXAS  
PUMPAGE AND DECLINE OF ARTESIAN PRESSURE DURING 1950-51

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PREPARED IN COOPERATION WITH THE GEOLOGICAL SURVEY,  
UNITED STATES DEPARTMENT OF THE INTERIOR

JANUARY 1952

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ABSTRACT

The withdrawal of ground water in the Houston district averaged 254,000,000 gallons a day in 1950 as compared to 248,000,000 gallons a day in 1949. The largest increase was in the Pasadena area where the pumpage increased from 60,000,000 to 65,000,000 gallons a day. The Houston Water Department increased its pumpage from 60,400,000 gallons a day in 1949 to 64,200,000 gallons a day in 1950, whereas the small industrial wells and suburban public supplies showed a decrease from 30,000,000 to 27,000,000 gallons a day during the same period. In the Katy area the average daily pumpage was 98,000,000 gallons in 1950, the same as in 1949.

Inasmuch as the increase in pumpage from 1949 to 1950 was concentrated in the Pasadena industrial wells and the Houston municipal wells, the greatest declines of artesian pressure were similarly concentrated. Declines of artesian pressure from 1950 to 1951 averaged 15.9 feet within a radius of  $5\frac{1}{2}$  miles of Pasadena; the maximum recorded decline was 23.9 feet.

The increase in pumpage from the Houston municipal wells was largely concentrated in the newer wells, which draw principally from the deeper sands. Consequently, large declines were recorded between 1950 and 1951 in many of those wells. Much smaller declines were recorded in wells that draw only from the shallower sands. These differences in decline between the deep and shallow sands are particularly noticeable in the northern and central parts of the Houston area.

Decline of artesian pressure in 1950 in the Katy rice-irrigation area continued but at a slower rate than in 1948 and 1949.

## INTRODUCTION

## LOCATION OF DISTRICT

The Houston district, as the term is used in this report, consists of an area of about 1,800 square miles which includes Harris County west of the San Jacinto River and adjoining parts of Montgomery, Waller, and Fort Bend Counties, Tex. (figs. 1 and 2). The ground-water pumping in the district is largely concentrated in three major areas, as follows: (1) The Houston area, which consists of the city of Houston and the closely adjoining territory except on the east; (2) the Pasadena area, which includes the heavily industrialized zone that extends from east Houston along the Houston Ship Channel to the vicinity of Deer Park; and (3) the Katy area, which is the rice-irrigation area that occupies much of western Harris County, southeastern Waller County, and northern Fort Bend County.

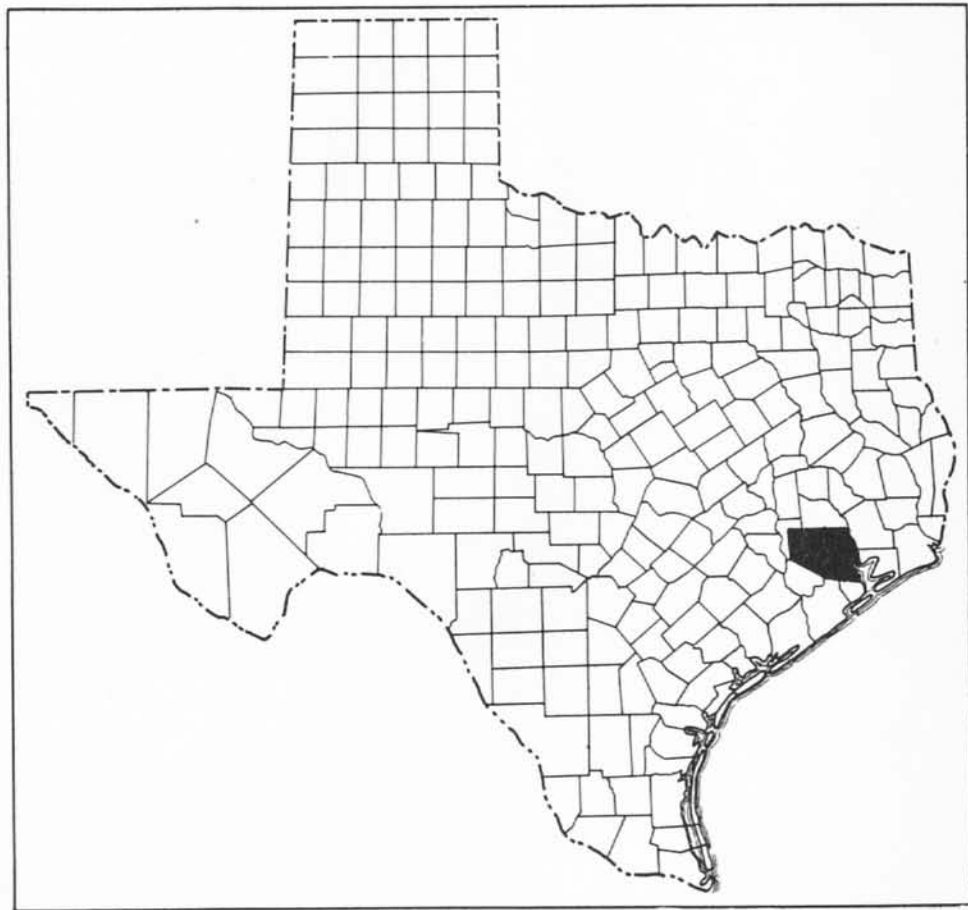
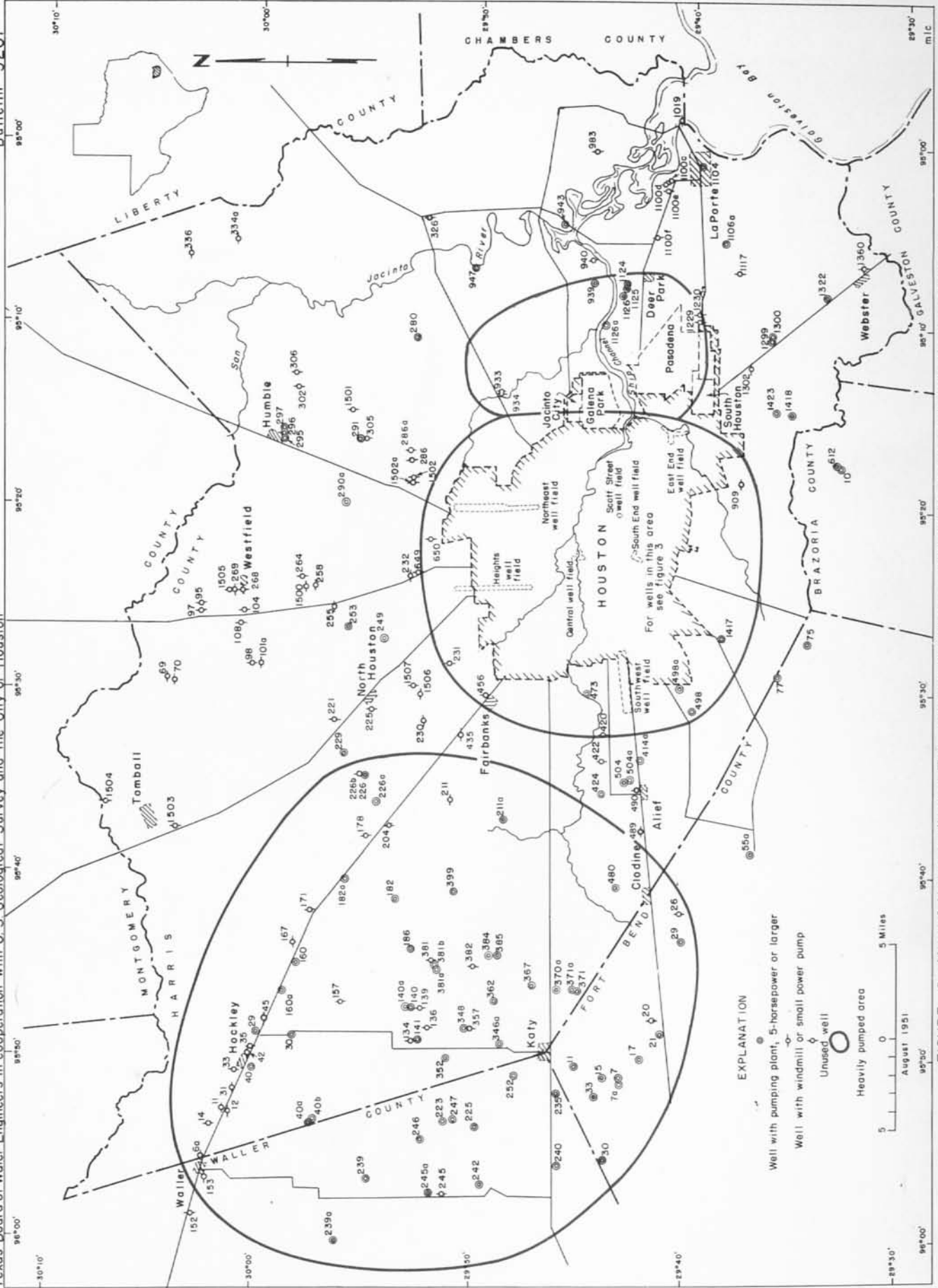


FIGURE I.-Map of Texas showing location of the Houston district.

Texas Board of Water Engineers in cooperation with U.S. Geological Survey and the City of Houston



EXPLANATION

- Well with pumping plant, 5-horsepower or larger
- Well with windmill or small power pump
- Unused well
- Heavily pumped area



FIGURE 2.-Map of Houston district, Tex., showing location of observation wells and heavily pumped areas.



## PURPOSE AND SCOPE OF THIS REPORT

In 1930 the United States Geological Survey, in cooperation with the Texas Board of Water Engineers, started a systematic study of the ground-water resources of the Houston district. Since 1938 the work has been financed by the Survey, the Board, and the city of Houston. From time to time reports have been published giving the results of these investigations. The 1950 report, Texas Board of Water Engineers Bulletin 5001, gives a rather comprehensive discussion of the ground-water resources of the Houston district and their relation to the geology. The present report is intended to supplement that report and bring up to date the information on pumpage and decline of artesian pressure in the district.

The field work was done and this report was prepared under the administrative direction of A. N. Sayre, Chief of the Ground Water Branch of the United States Geological Survey, and under the direct supervision of W. L. Broadhurst, district geologist in charge of ground-water investigations in Texas.

## VOLUME AND DISTRIBUTION OF PUMPAGE AND DECLINE OF ARTESIAN PRESSURE IN THE HOUSTON DISTRICT

The withdrawal of ground water in the Houston district averaged 254,000,000 gallons a day during 1950. The average daily pumpage from 1930 to 1950, inclusive, is shown graphically in figure 4. The graph includes the pumpage from all plants that yield more than 5,000 gallons a day. Accurate data were obtained from meter records for most of the municipal supplies and many of the large industries. Estimates were made for many of the smaller industries and public supplies. In the Katy area the pumpage for 1950 was based on the number of acres irrigated, the duty of water per acre, and the amount of rainfall during the pumping season.

Nearly all the ground water that was used in the Houston district during 1950 was pumped from about 510 wells, of which approximately 340 are in the Houston and Pasadena areas and 170 in the Katy area.

Figure 4 shows that in 1950 the average daily pumpage in the Houston and Pasadena areas increased slightly over the 1949 pumpage. In 1950 the pumpage in the two areas averaged 156,000,000 gallons a day as compared to 150,000,000 in 1949. The average daily pumpage in the Katy area was 98,000,000 gallons, the same as in 1949 but somewhat less than in 1948.

## PUMPAGE AND DECLINE OF ARTESIAN PRESSURE IN THE HOUSTON AND PASADENA AREAS

### PUMPAGE

The average daily pumpage in the Houston and Pasadena areas from 1930 through 1950 is shown graphically in figure 5. This graph shows also a breakdown into the three principal types of wells in the areas; the Houston municipal wells, the Pasadena industrial wells, and the suburban public supplies and small industrial wells.



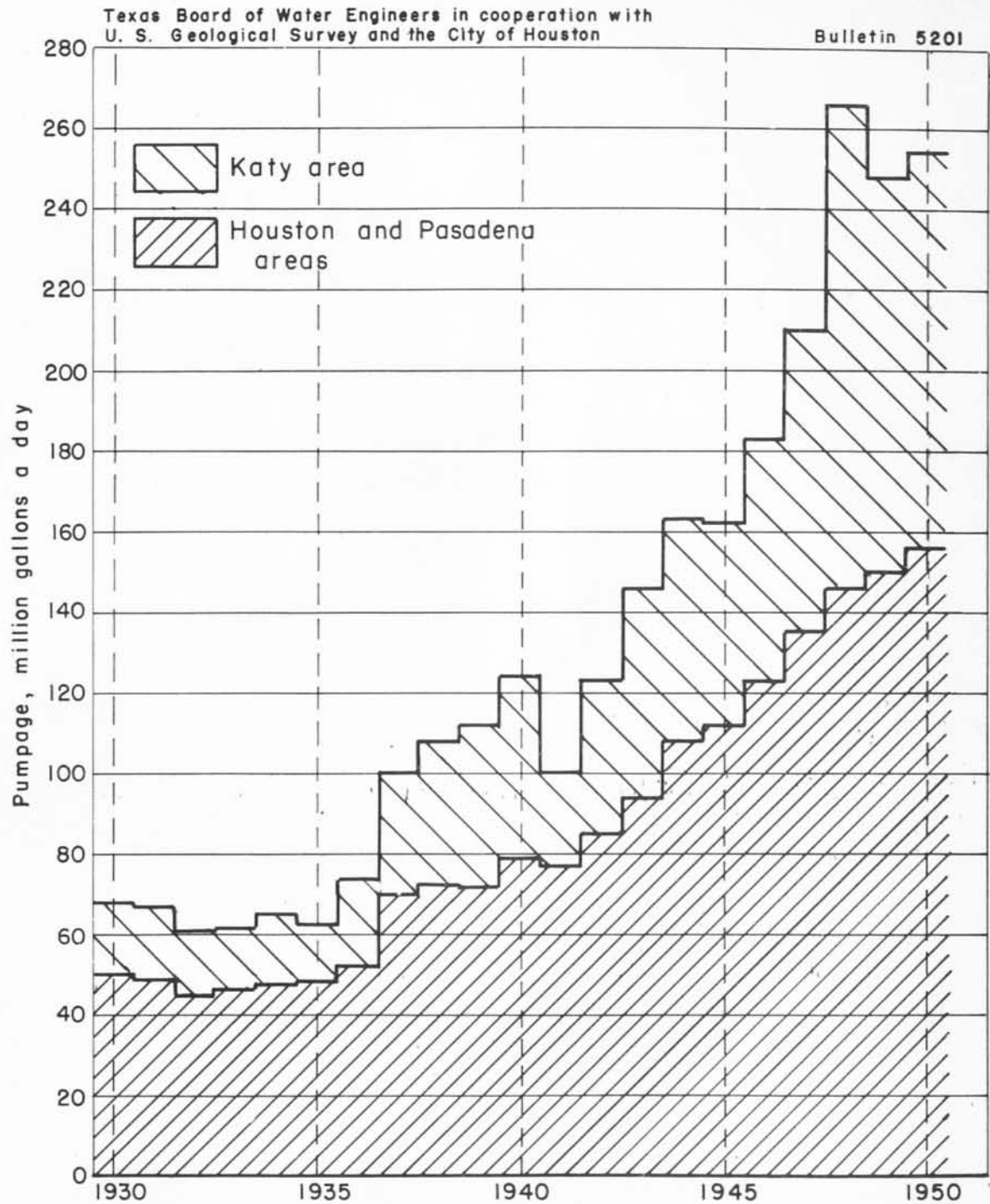


FIGURE 4. - Average daily pumpage in the Houston district, 1930-50.

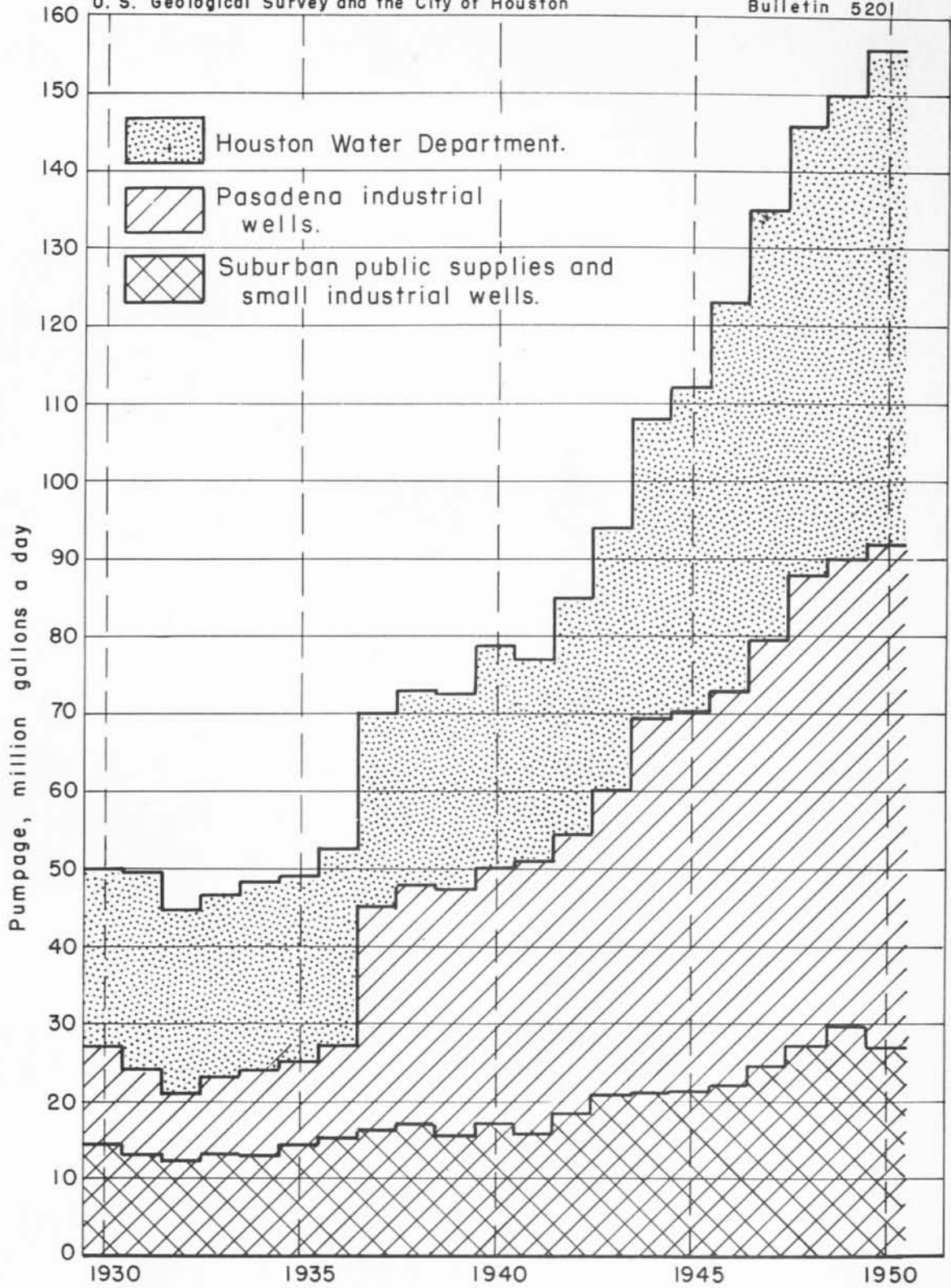


FIGURE 5.-Average daily pumpage in the Houston and Pasadena areas, 1930-50.

The average daily pumpage by the Houston Water Department was 64,200,000 gallons in 1950 as compared to 60,400,000 gallons in 1949. Much of this increase was due to the 1950 annexation program of the city. In January 1950 several water districts that supplied outlying sections were annexed and their operation by the city was begun at that time. Another factor contributing to the increase in the city's pumpage is the continued decline in artesian pressure, which has caused many small industrial users to abandon their wells and obtain water from the city system. These two factors are indicated also in the decrease in the average daily pumpage for the suburban public supplies and small industrial wells from 30,000,000 gallons a day in 1949 to 27,000,000 gallons in 1950.

The average daily pumpage in 1950 from the Pasadena industrial wells was 65,000,000 gallons, as compared to 60,000,000 in 1949. This increase in pumpage appeared to be general throughout the Pasadena industrial area rather than concentrated in any particular section.

Table 1 shows the average daily pumpage of ground water for public and industrial supplies in the Houston and Pasadena areas in 1950. The table is subdivided to show the different classes of users.

Table 1.- Estimated average daily pumpage for public and industrial supplies in the Houston and Pasadena areas during 1950

	Number of plants	Number of wells	Pumpage (million gallons a day)
Public supplies			
Houston Water Department	7	51	64.2 <sup>1/</sup>
Suburban	32	64	9.5
Industrial supplies			
Paper mill	1	9	20.0
Chemical plants	16	30	10.6
Oil refineries	8	27	22.0
Steel mills	4	11	9.2
Ice plants	19	20	2.4
Power plants	4	15	5.1
Tool companies	6	12	1.6
Railroads and allied plants	9	11	3.1
Meat packing plants	3	4	.6
Laundries	6	6	.3
Shipyards	1	2	.2
Miscellaneous supplies			
Office buildings, hotels, theaters, country clubs, and other plants that use more than 5,000 gallons a day	60	77	6.9
Totals	176	339	155.7

<sup>1/</sup> Includes pumpage for districts annexed by city for that part of year operated by city.

In 1950 the Houston Water Department operated 51 wells in seven well fields within and adjacent to the city. As mentioned previously, in 1950 the city also began the operation of several water districts which were included in the territory annexed by the city. Figures 6 and 7 show the average daily pumpage from each of the city's well fields and hydrographs of representative wells in each field.

#### DECLINE OF ARTESIAN PRESSURE

The average daily pumpage in the Houston and Pasadena areas was 150,000,000 gallons in 1949 as compared to 146,000,000 gallons in 1948. However, records show that this increase was from the suburban public supplies and small industrial wells and was widely distributed throughout the two areas. Furthermore, as there was no increase in pumpage from the highly concentrated Pasadena industrial wells and the Houston municipal wells, there was little decline in artesian pressure in 1949. However, in 1950 there was an increase in pumpage of 5,000,000 gallons a day from the Pasadena industrial wells and 3,800,000 gallons a day from the Houston well fields. Inasmuch as this pumpage increase was in the areas of more highly concentrated withdrawal, large declines of artesian pressure from the spring of 1950 to the spring of 1951 were recorded in parts of the Houston and Pasadena areas.

*Pasadena area* - In the industrialized area in the vicinity of Pasadena, the more heavily pumped sands are at depths below 600 feet. Large declines of artesian pressure occurred during 1950 in these sands, owing to increases in pumpage in this area. Measurements of artesian pressure in eight observation wells within a radius of 5½ miles from Pasadena show declines ranging from 7.5 to 23.9 feet and averaging 15.9 feet from 1950 to 1951. Hydrographs of two wells in this area (nos. 1170 and 1230) are shown in figure 8.

In the eastern part of the ship-channel area, which extends from eastern Pasadena to the Deer Park-La Porte area, large quantities of ground water are pumped from wells about 500 feet in depth. These wells draw from a sand which is connected remotely, if at all, to the deeper sands in the area. The artesian pressure in this sand is considerably higher than in the deeper sands and the decline in pressure from 1950 to 1951 was much less. Figure 9 illustrates the difference in the artesian head in the two sands. The figure shows hydrographs of two wells at the same plant, which are screened in the two different sands.

*Houston area* - The decline of artesian pressure in the Houston area varies greatly, depending on the location of the wells and the depths to the sands. In eastern Houston, immediately adjacent to the Pasadena area, and in the Pasadena area, essentially the same sands are heavily pumped. In eastern Houston, in nine observation wells screened opposite these sands, declines ranged from 12.8 to 20.9 feet and averaged 15.8 feet from 1950 to 1951. In the East End well field declines in four wells ranged from 19.6 to 42.5 feet and averaged 30.9 feet during the same period. However, the wells in the East End field are much deeper than the industrial wells and draw much of their water from deeper sands. Hydrographs for three industrial wells (nos. 751, 759, and 881) in eastern Houston are shown in figure 10.

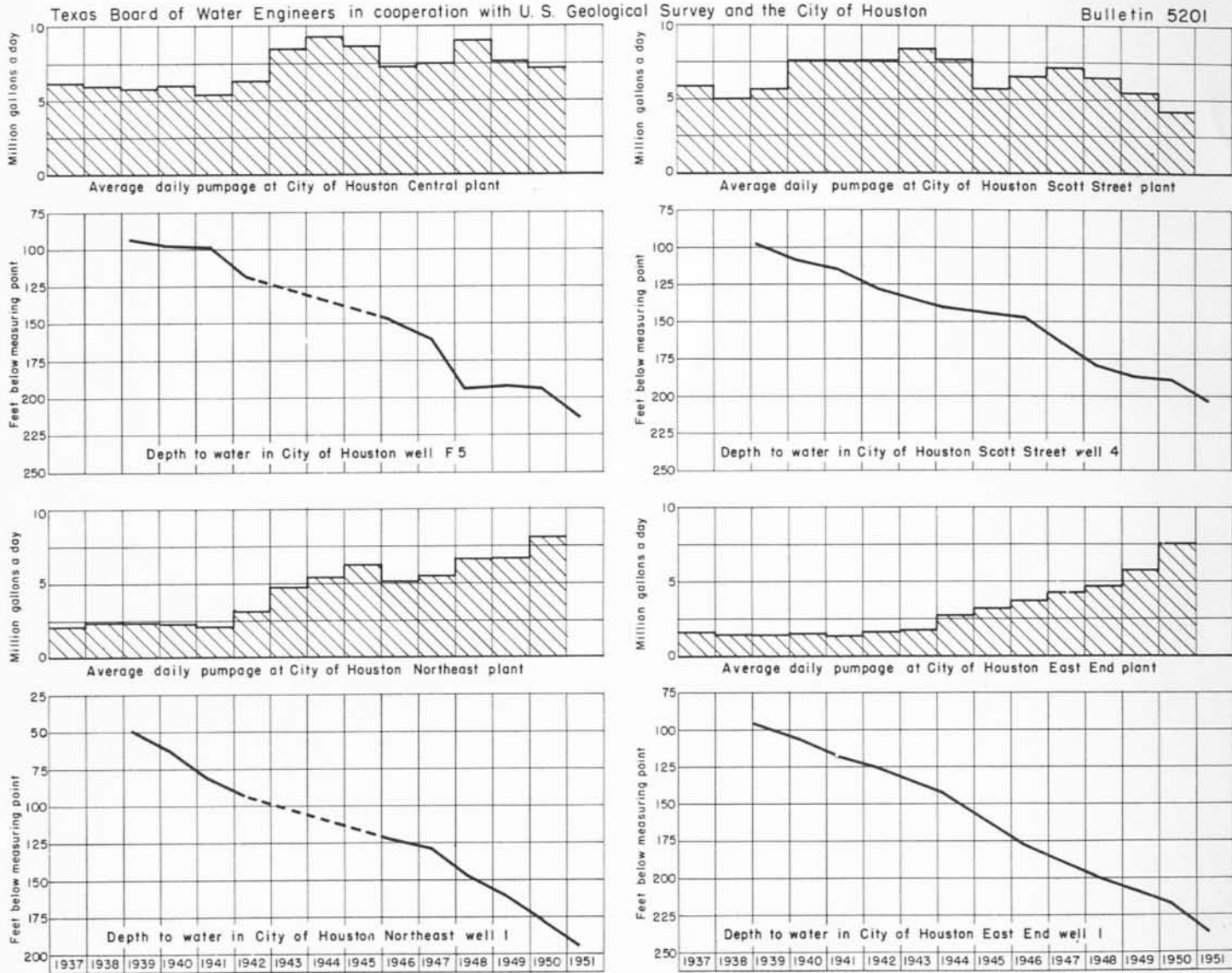


FIGURE 6.-Relation of pumpage to artesian pressure in Houston Central, Scott Street, Northeast, and East End well fields.

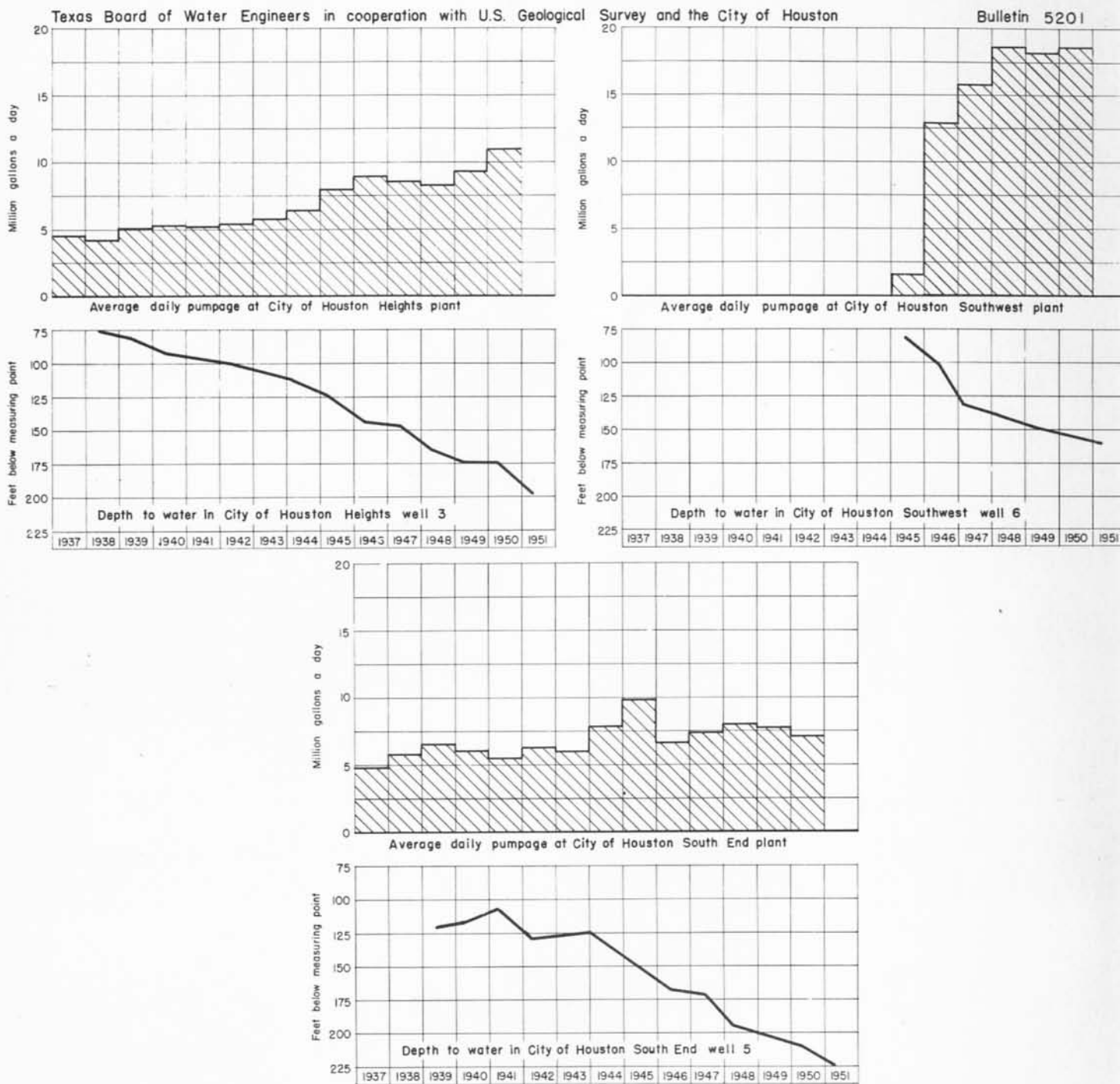


FIGURE 7.-Relation of pumpage to artesian pressure in Houston Heights, Southwest, and South End well fields.



FIGURE 8.- Decline of artesian pressure in the Pasadena area, Tex.



FIGURE 9.- Comparison of declines of artesian pressure in a shallow well and a deep well in the eastern Ship Channel-Pasadena area, Tex.



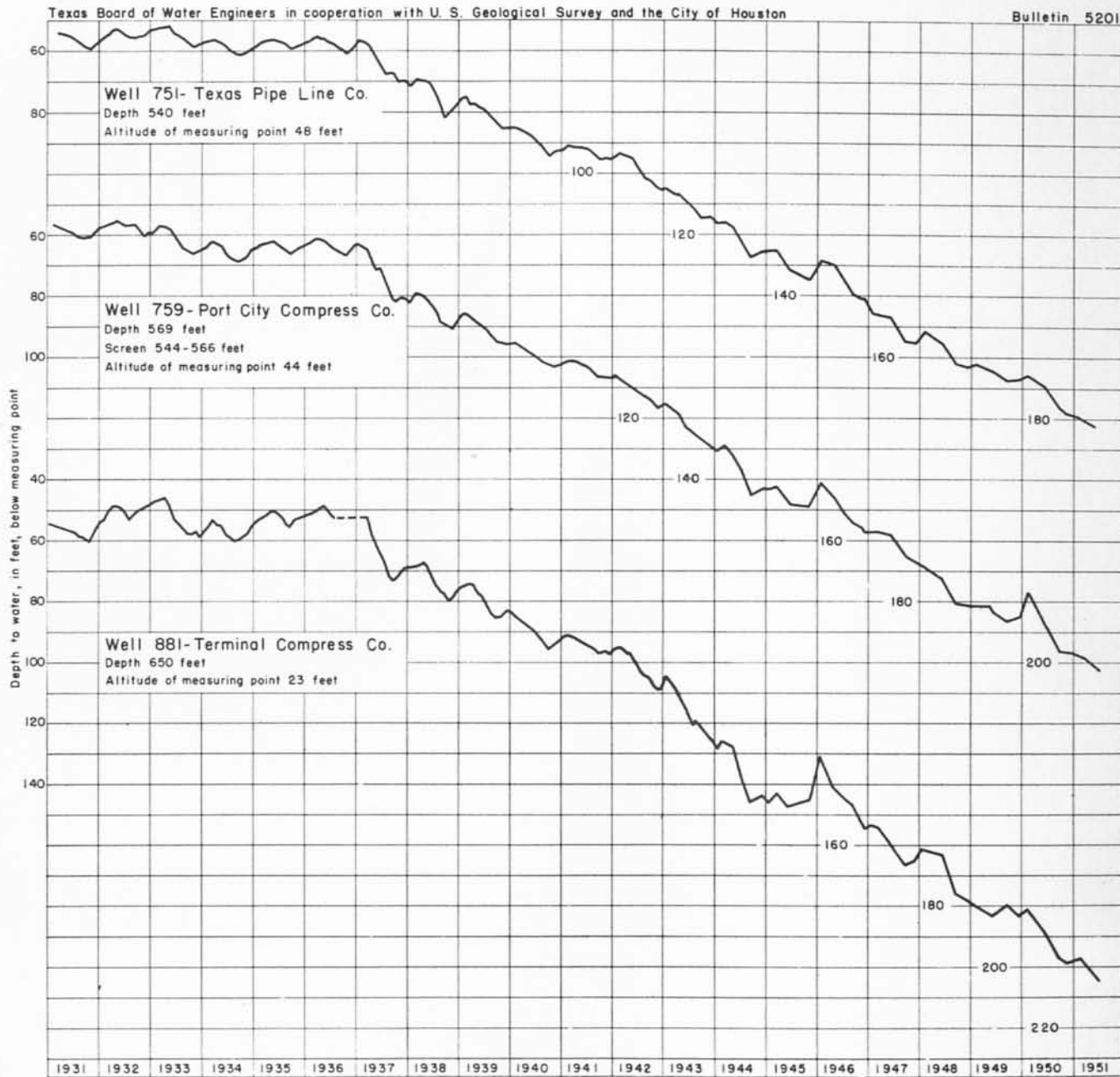


FIGURE 10.- Decline of artesian pressure in eastern Houston, Tex.

Throughout the remainder of the Houston area, the heavily pumped sands are those from which the city wells are drawing. These sands are, for the most part, the deeper sands. A large decline in artesian pressure in these deeper sands occurred between the spring of 1950 and the spring of 1951, whereas the decline in the shallower sands were much less.

In the Northeast well field large declines in artesian pressure were recorded in all the wells except well 2, which is mainly screened opposite the shallower sands. The decline in this well was 8.0 feet between the spring measurements of 1950 and 1951. The declines in eight of the deeper wells in the Northeast well field ranged from 17.6 to 46.6 feet and averaged 29.6 feet. However, it should be pointed out that the year 1950 was the first year of operation for eight new wells in the Northeast field and the large decline in artesian pressure were to be expected. Declines of 10.9, 8.8, and 1.4 feet were measured in three industrial wells within  $1\frac{1}{2}$  miles of the Northeast field. However, these wells are 700 feet or less in depth and showed little effect of the increased pumpage from the nearby deeper municipal wells. The hydrograph of one of these wells (no. 656) is shown in figure 11.

In the Heights well field, seven new wells were put in operation in 1950. The decline in artesian pressures caused by the additional pumpage from these wells was concentrated in the deeper sands. Well 7, which is screened at intervals between 561 and 1,454 feet, had a decline of 6.1 feet between the spring measurements of 1950 and 1951. Well 8, screened between 556 and 1,240 feet, had a decline of 1.5 feet, whereas well 6, screened between 581 and 1,226 feet, showed a rise of 3.0 feet; however, these wells are not screened opposite the deepest sands screened in well 7. Well 3, screened at intervals from about 514 to 1,034 feet, had a decline of 22.9 feet, however this well is greatly affected by interference from two nearby wells. The hydrograph for this well is shown in figure 7. Well 5, screened at intervals between 410 and 1,858 feet, had a decline of 22.6 feet. Wells 9 and 10, screened at intervals from 600 feet to about 1,800 feet, had declines of 43.0 and 21.7 feet, respectively. Wells 13 and 14, screened between 900 and 1,800 feet, had declines of 69.4 and 60.9 feet, respectively; however, these wells are not screened opposite the upper sands that are screened in wells 9 and 10. The decline figures are not strictly comparable in all the wells, because the length of shut-down at the time of the measurements was not always the same. However, it is evident that the wells screened opposite only the deeper sands had large declines in artesian pressures, whereas the wells screened opposite only the shallower sands showed smaller declines. Wells screened in both the shallow and deep sands showed rather large declines in pressure but not as large as in those screened only in the deeper sands.

In central Houston the greater decline in artesian pressure is concentrated in the deeper sands. Wells less than 800 feet in depth showed considerably smaller declines in artesian pressure than the deeper wells. In eight wells in the Central well field, all more than 800 feet deep, the declines between the 1950 and 1951 measurements ranged from 14.6 to 23.2 feet and averaged 17.8 feet, whereas well 619, an abandoned well 625 feet deep in the Central field, had a decline of only 9.8 feet for the same period. The hydrograph for well 619 is shown in figure 12.

At the Scott Street plant the difference in declines of artesian pressure in the different sands is not evident. Declines in three wells ranged from 14.0 to 14.6 feet and averaged 14.2 feet between the spring measurements of 1950 and 1951.



FIGURE 11.-Decline of artesian pressure in northern Houston, Tex.

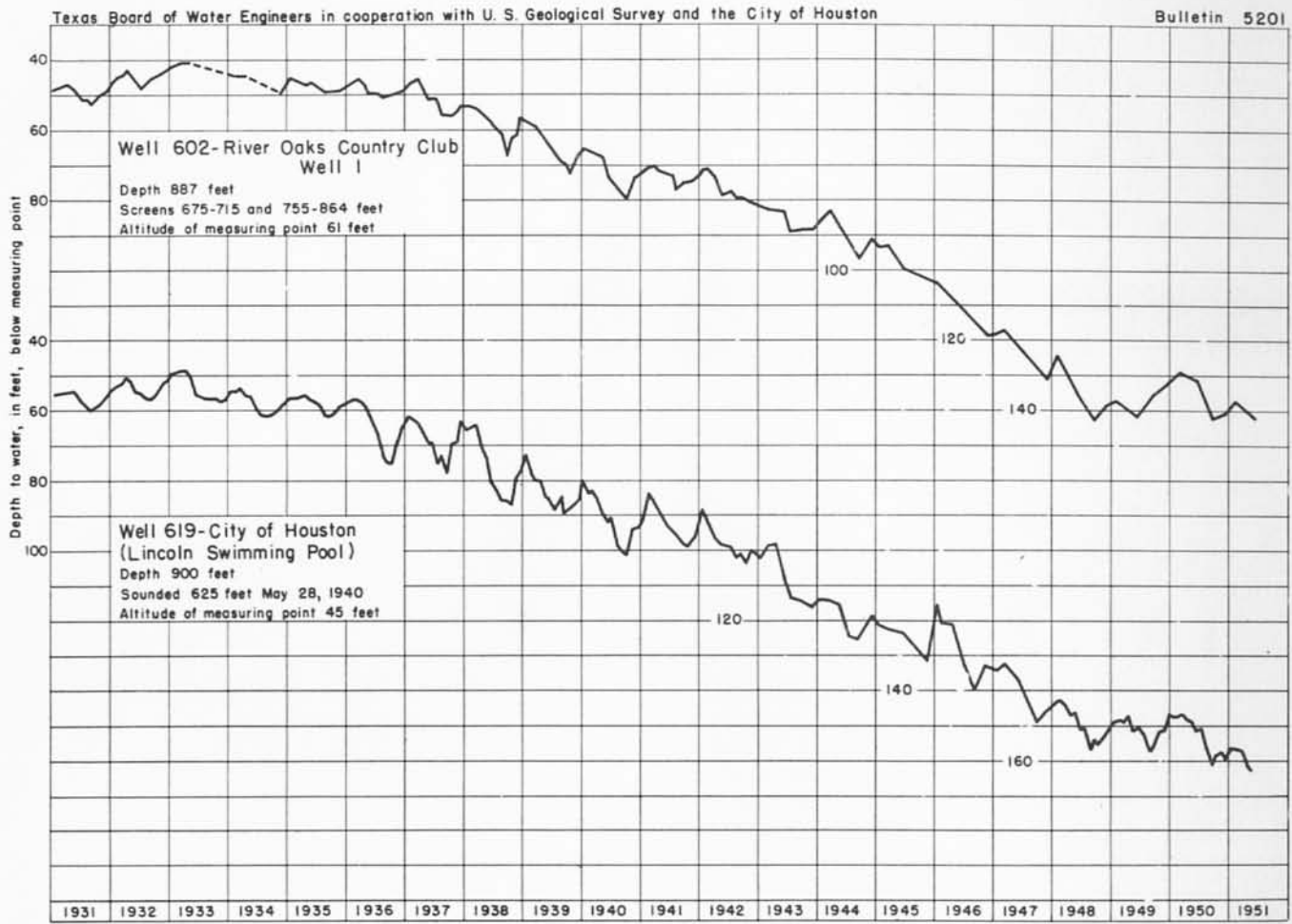


FIGURE 12.-Decline of artesian pressure in central and western Houston, Tex.

At the South End plant it appears that the shallower wells showed the greater declines of artesian pressure. Well 7, screened at intervals between 1,365 and 1,932 feet, showed a decline of 3.2 feet between the spring measurements of 1950 and 1951. Well 5, screened between 1,275 and 1,594 feet, had a decline of 13.6 feet and well 2, screened between 489 and 824 feet, had a decline of 23.4 feet. However, the measurements for wells 7 and 2 are not strictly comparable because of too-great differences in the times of shut-down before the measurements were taken. The large declines in the shallower sands are probably due principally to the heavy pumping from wells at West University Place, Southside Place, Bellaire, and the city's Southwest well field, most of which are screened opposite the shallow sands.

In the western part of the Houston area the decline of artesian pressure is largely caused by the pumping from the city's Southwest well field and wells of neighboring municipalities. Wells 1, 3, and 4 in the eastern part of the Southwest field had declines of 27.2, 25.3, and 22.9 feet respectively from 1950 to 1951, whereas well 7 near the west end of the field had a decline of only 2.2 feet. Elsewhere in the western part of the Houston area, declines in five observation wells ranged from 6.6 to 10.2 feet and averaged 8.6 feet. The hydrograph of one of these wells (no. 602) is shown in figure 12.

The net declines of artesian pressure in the Houston municipal wells are shown in table 2.

In the area north of Houston moderate declines of artesian pressure were recorded between the spring measurements of 1950 and 1951. In 13 observation wells the declines ranged from 2.8 to 8.8 feet and averaged 6.6 feet.

## PUMPAGE AND DECLINE OF ARTESIAN PRESSURE IN THE KATY AREA

### PUMPAGE

The Katy area is the rice-irrigation area occupying parts of western Harris County, northern Fort Bend County, and eastern Waller County. All the rice in this area is irrigated from wells that range in depth from about 200 to 1,600 feet. Figure 13 shows the number of acres irrigated and the number of wells in use in the Katy area from 1937 through 1950. The average pumpage in million gallons a day from 1930 through 1950 is shown in figure 4. It should be pointed out that the pumpage is shown as a daily average for the whole year, although the irrigation season is a period of about 5 months. This is done for purposes of comparison with daily average pumpage figures for the remainder of the Houston district. The average daily pumpage in the Katy area during 1950 was 98 million gallons, the same as in 1949.

### DECLINE OF ARTESIAN PRESSURE

The Katy area occupies part of the outcrop of the sands that furnish water to the Houston and Pasadena areas, and consequently any material changes of artesian pressure or water levels in wells are especially significant. Rather large declines were recorded between the spring measurements of 1948 and 1949, owing to the unusually heavy pumping in 1948. Inasmuch as the pumpage in 1949 and 1950 was less than in 1948, the decline in artesian pressure generally was less. In 33 observation wells in the Katy area declines of water levels ranged from 0.7 foot to 5.6 feet and averaged 2.3 feet between the spring measurements of 1950 and 1951. In two wells the water levels rose 1.0 foot and 1.7 feet. Hydrographs showing the fluctuations in artesian pressure in two wells (Harris County no. 186 and Waller County no. 223) in the Katy area are shown in figure 14. Figure 15 illustrates the decline in artesian pressure in the Katy area from 1950 to 1951.

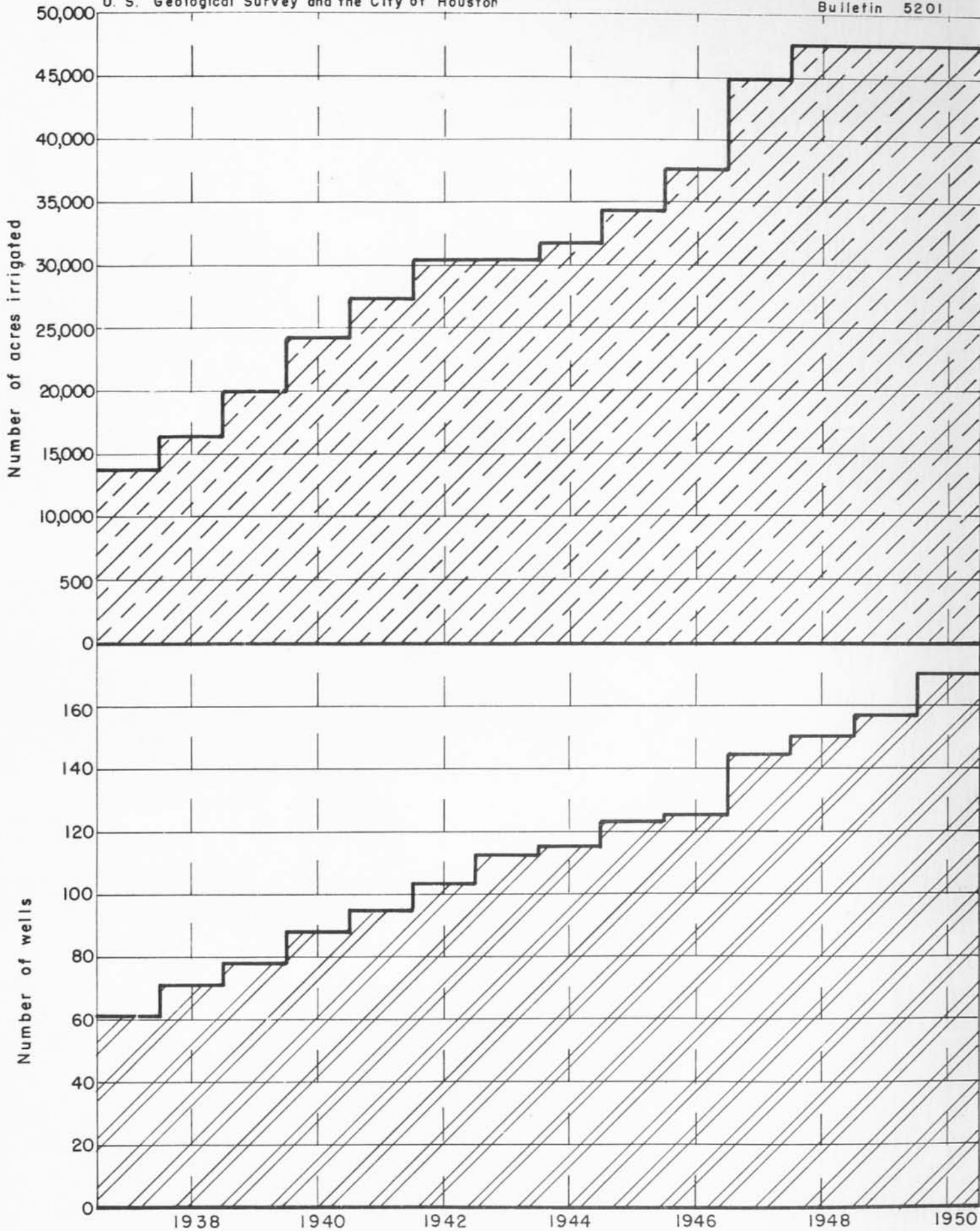


FIGURE 13.-Relation of acres irrigated to number of wells in use in Katy area, 1937-50.

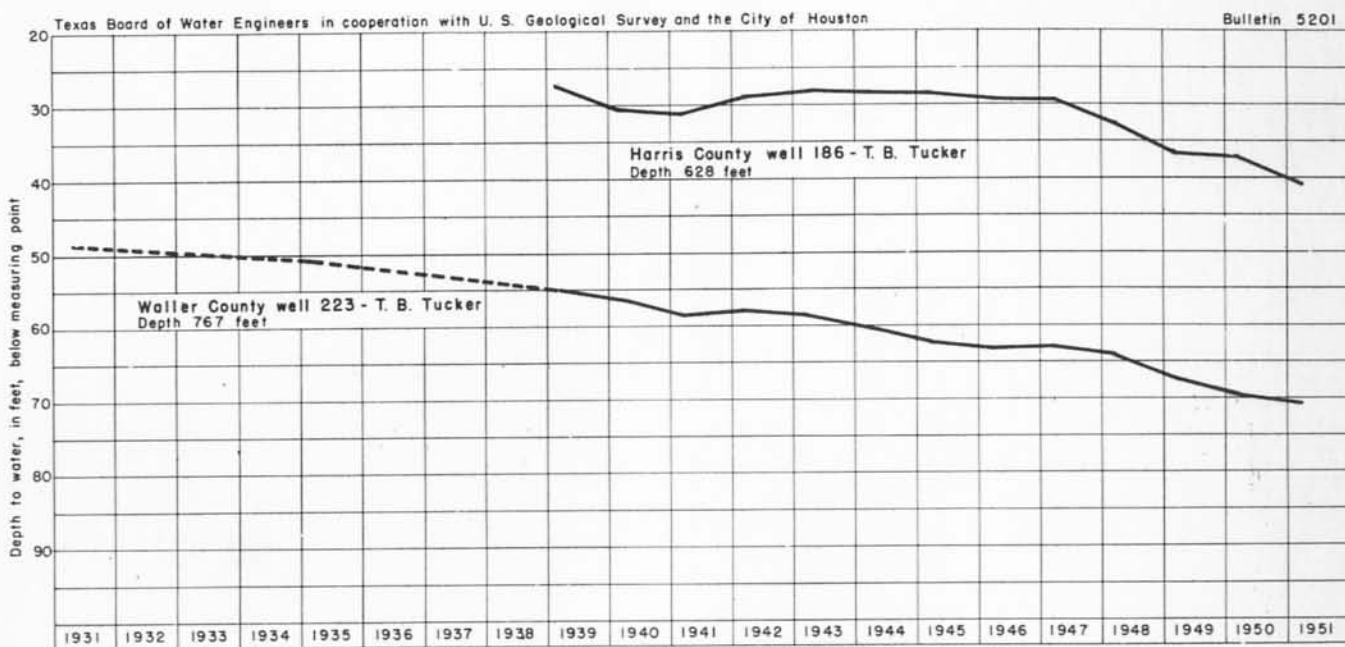


FIGURE 14.- Decline of artesian pressure in the Katy area, Tex.

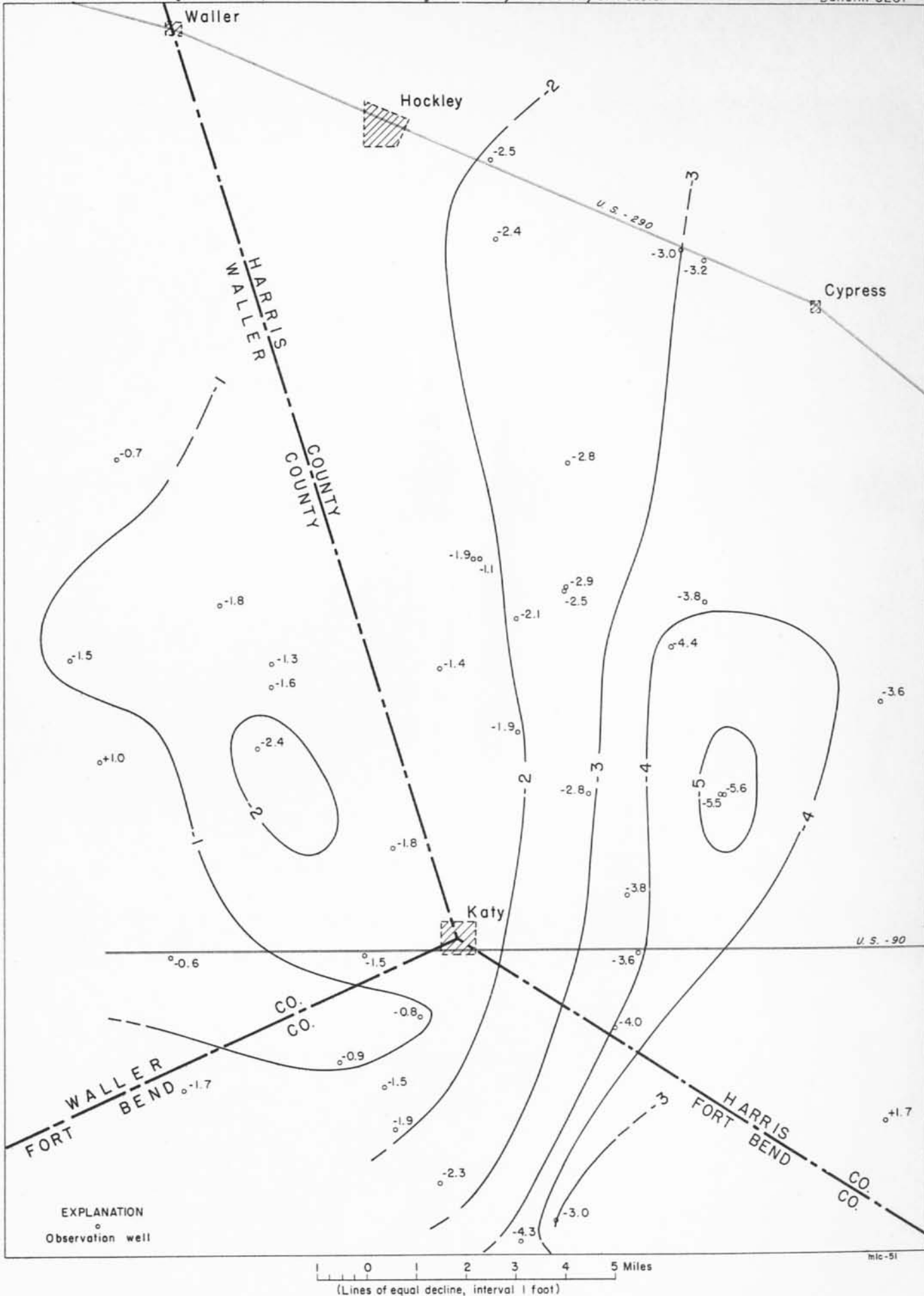


FIGURE 15.-Decline of artesian pressure, in feet, Katy area, Tex., spring 1950 to spring 1951.



## PIEZOMETRIC MAPS OF THE HOUSTON DISTRICT

Maps based on spring water-level measurements are prepared annually, showing the altitude of water levels in wells that penetrate the most heavily pumped sands in the Houston district. Many of these maps have been published in earlier reports. The map for 1941 (fig. 16) is reproduced for the purpose of comparison with the map for 1951 (fig. 17).

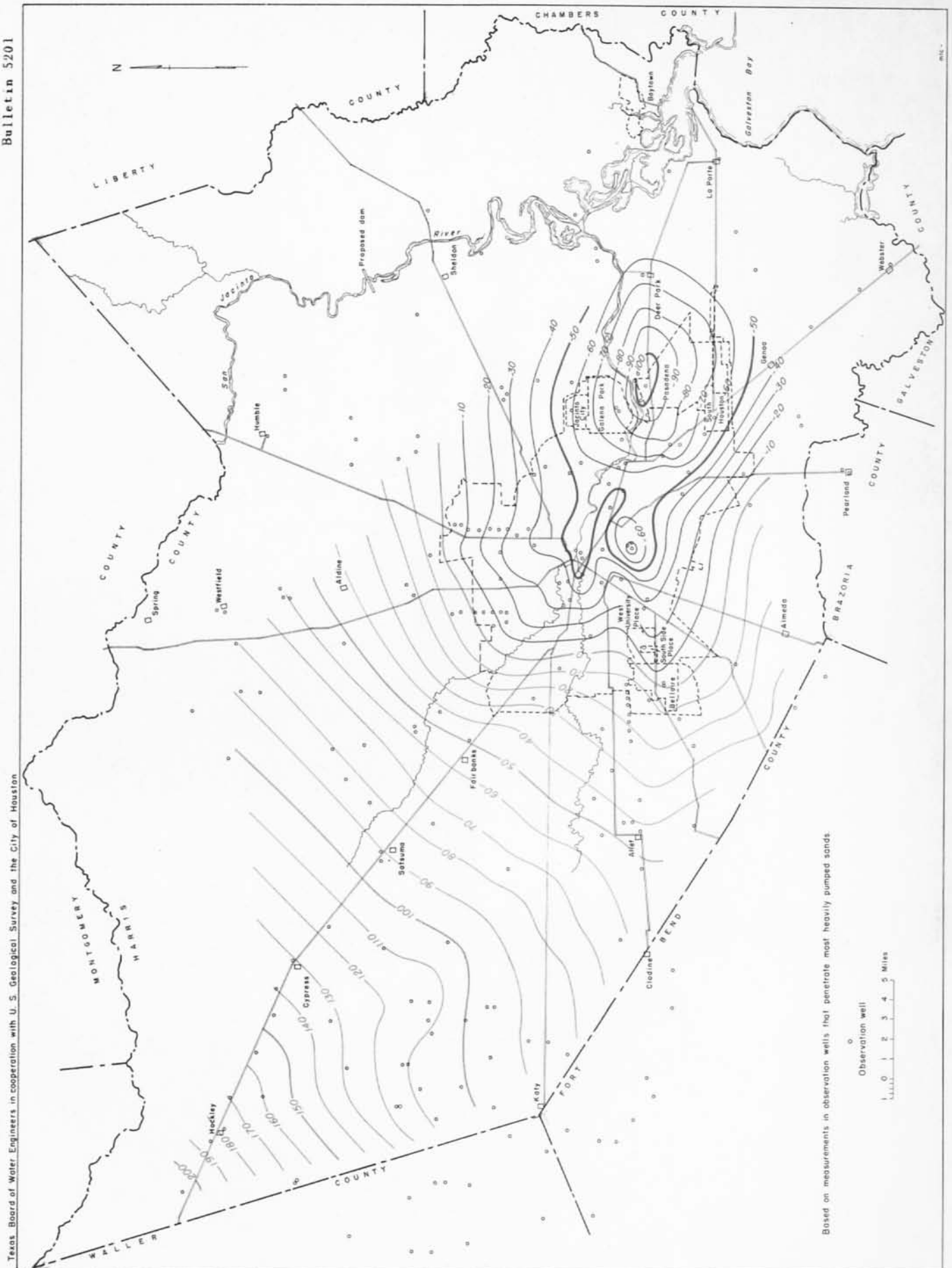


FIGURE 16.-Approximate altitude of water levels, in feet, in wells in Houston district, Tex., January 1941

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Based on measurements in observation wells that penetrate most heavily pumped sands.

Observation well

0 1 2 3 4 5 Miles

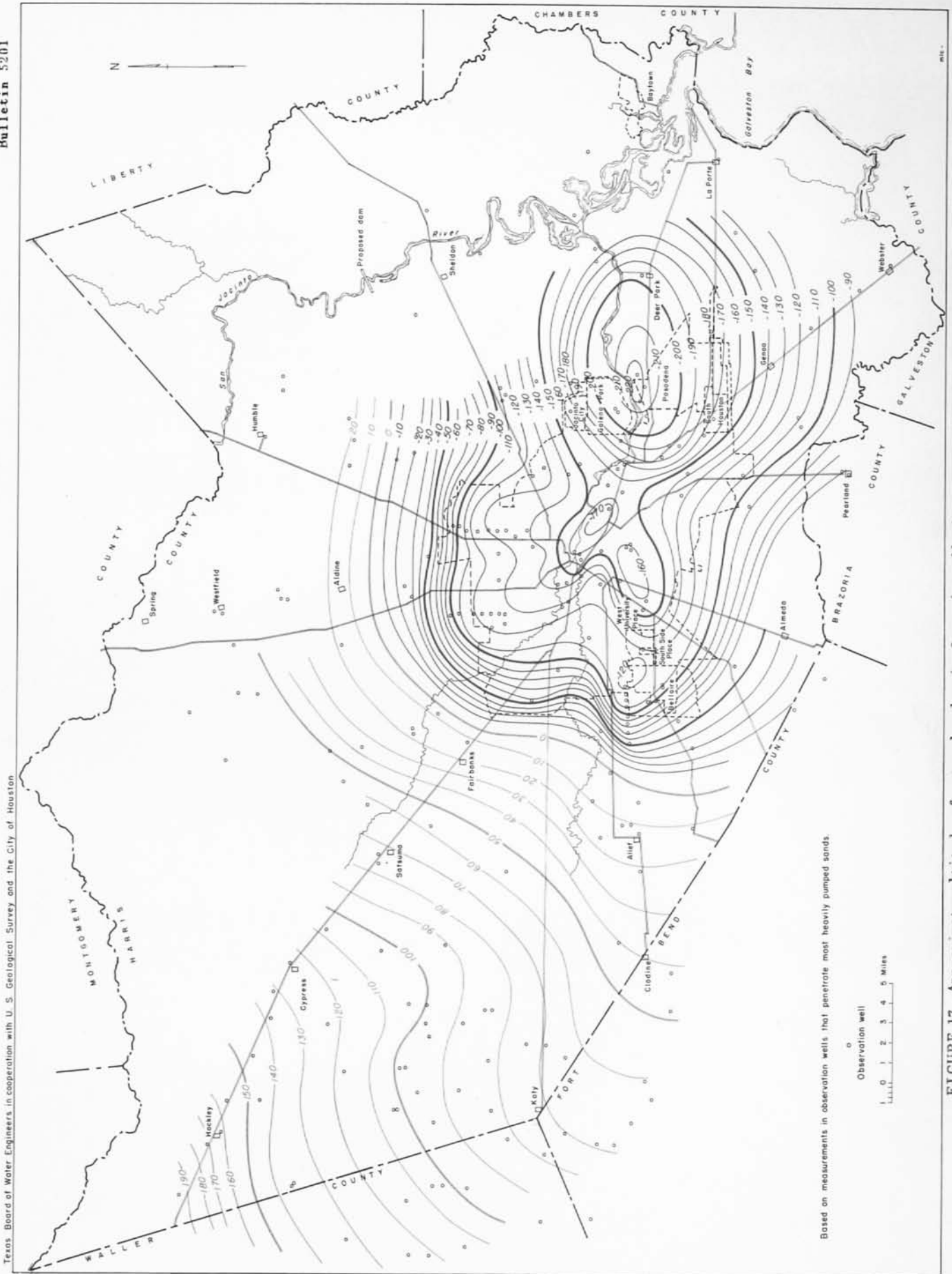


FIGURE 17.-Approximate altitude of water levels, in feet, in wells in Houston district, Tex., March 1951.

Based on measurements in observation wells that penetrate most heavily pumped sands.

Observation well  
0 1 2 3 4 5 Miles

Table 2.- Net declines of artesian pressure, in feet, in Houston municipal wells  
(Based on spring measurements)

Plant	Office no.	City well no.	Date (1950)	Depth to water	Length of shut-down	Date (1951)	Depth to water	Length of shut-down	1950 to 1951	1946 to 1951	1939 to 1951	
Central	617	F-1	Mar. 8	191.0	24 hrs.	Mar. 6	207.0	1 hr.	16.0	-	111.5	
	616	F-5	6	195.19	-	6	213.92	1 hr.	18.7	66.7	118.3	
	618	F-10	6	178.18	Unused	Apr. 12	195.82	Unused	17.6	57.6	109.2	
	625	F-12	6	180.0	-	Mar. 6	202.0	Months	22.0	72.0	118.5	
		D-17	8	181.18	22 hrs.	6	196.71	6 days	15.5	-	109.6	
		C-18	14	181.66	30 min.	13	196.30	30 min.	14.6	66.0	-	
		C-19	14	209.71	35 min.	6	224.26	35 min.	14.6	-	-	
		C-20	6	194.46	-- hrs.	6	217.65	30 min.	23.2	-	-	
	East End	895	1	9	217.40	Unused	6	236.97	Unused	19.6	60.3	138.6
3			6	202.54	-	6	236.47	21 hrs.	34.9	-	-	
4			9	202.27	12 hrs.	6	228.96	3 days	26.7	-	-	
5			6	177.82	-	7	219.31	75 min.	42.5	-	-	
Heights	591	3	Feb. 9	175.49	Unused	Feb. 16	198.37	Unused	22.9	53.8	113.2	
	589	5	June 21	132.73	90 days	Mar. 7	155.33	-	22.6	-	93.3	
	1410	6	Mar. 13	186.55	30 min.	7	183.50	-	+3.0	43.6	105.0	
	1412	7	10	180.20	5 hrs.	7	186.32	-	6.1	42.3	97.0	
	1411	8	13	188.46	30 min.	7	189.92	7 hrs.	1.5	40.1	107.1	
		9	8	139.11	-	14	182.1	20 min.	43.0	-	-	
		10	13	155.0	20 min.	7	176.66	-	21.7	-	-	
		13	Jan. 25	129.78	2 hrs.	14	199.17	20 min.	69.4	-	-	
		14	Mar. 4	134.07	100 min.	14	195.00	15 min.	60.9	-	-	
Northeast	744	1	9	177.17	8 hrs.	Mar. 8	194.72	-	17.6	71.8	144.8	
	1395	2	Feb. 28	181.0	10 min.	12	189.0	-	8.0	56.9	106.9	
		3	Mar. 9	176.09	30 min.	8	195.11	-	19.0	67.2	-	
		4	8	167.8	-	8	192.73	-	24.9	-	-	
		5	8	143.26	-	8	189.90	-	46.6	-	-	
		8	30	145.55	24 hrs.	14	189.56	24 hrs.	44.0	-	-	
		9	Apr. 21	147.22	4 hrs.	8	187.20	-	40.0	-	-	
		10	May 6	148.84	70 min.	8	171.44	-	22.6	-	-	
		11	27	138.63	3 hrs.	8	160.63	-	22.0	-	-	
Scott Street	855	2	Mar. 9	197.48	Unused	Mar. 12	211.44	Unused	14.0	57.6	116.6	
	858	4	10	189.0	30 min.	12	203.65	4 months	14.6	56.0	110.2	
	767	5	10	179.0	30 min.	12	193.0	30 min.	14.0	43.0	95.6	
South End	795	2	6	141.67	1 week	20	165.1	35 min.	23.4	55.8	83.0	
	793	5	15	209.99	30 min.	20	223.63	15 min.	13.6	55.8	109.4	
		7	15	212.78	30 min.	16	215.93	23 hrs.	3.2	62.7	-	
Southwest		1	9	159.80	2 days	13	187.0	80 min.	27.2	-	89.0 <sup>a/</sup>	
		3	9	159.24	17 days	12	184.55	3 hrs.	25.3	-	93.6 <sup>a/</sup>	
		4	9	158.77	2 days	13	181.67	2 hrs.	22.9	63.4	89.3 <sup>a/</sup>	
		7	30	150.54	3 days	12	152.73	3 hrs.	2.2	-	26.3 <sup>b/</sup>	
		8	-	-	-	12	135.22	4 hrs.	-	-	28.6 <sup>b/</sup>	

<sup>a/</sup> 1945 to 1951.

<sup>b/</sup> 1947 to 1951.