TEXAS WATER COMMISSION

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GROUND-WATER AVAILABILITY AT WHITNEY, HILL COUNTY, TEXAS

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GROUND-WATER AVAILABILITY AT WHITNEY, HILL COUNTY, TEXAS

ABSTRACT

The city of Whitney, Hill County, Texas, obtains water from a single well completed in sands of the Travis Peak Formation, at a depth of about 1,200 feet. Coefficient of transmissibility was calculated to be about 2,830 gpd/ft., and coefficient of storage was estimated to be about 2.83×10^{-5}.

It is estimated that about 250,000 gpd of ground water is obtainable at Whitney on a perennial basis.

GROUND-WATER AVAILABILITY AT
WHITNEY, HILL COUNTY, TEXAS

INTRODUCTION

This report presents a compilation of basic data pertaining to the ground-water resources in the vicinity of Whitney, Hill County, Texas (see Figure 1) and a brief discussion of the ground water available. The report was made subsequent to a request for assistance by Mayor O. E. Carroll on April 15, 1963. The city was interested in obtaining quantitative information concerning their ground-water resources not only to establish the adequacy of the supply but also to provide a basis for additional ground-water development.

The Texas Water Commission agreed to make a special study for the city which would consist of a review of available data and collection of additional data in the field. The information obtained would be compiled and analyzed in a memorandum-type report which would be presented the city for their use.

Review of available data consisted of obtaining well-completion information on the city's wells, drillers' logs, electrical logs, depth-to-water records, chemical analyses of water, and municipal pumpage. Collection of data in the field consisted of conducting pumping tests on the city's water wells, determining altitudes of water wells by leveling, and measuring distances between wells. Pumping tests provided information on well performances and aquifer coefficients. Aquifer coefficients were then used to evaluate the amount of ground water available for development in the vicinity of Whitney and to estimate future water-level drawdowns in the vicinity of a pumped well.

Data obtained from the study are presented in tables at the end of this report.

GEOLOGY AND OCCURRENCE OF GROUND WATER

Geologic rock units of Cretaceous age appear at the surface in the Whitney area and occur in the subsurface to depths greater than 1,200 feet (See Table 1). The only structural feature exhibited by the rocks is a gentle regional dip to the southeast.

The most important water-bearing unit, or aquifer, in the Whitney area is a sequence of sands at the base of the Cretaceous known as the Travis Peak Formation or "lower Trinity sand." The top of the aquifer occurs at a depth of 1,128 feet in well 40-06-501 according to the driller's log presented in Table 2. The aquifer outcrops at the surface and receives its recharge about 50 miles northwest of Whitney.

Water obtained from the aquifer at Whitney is a sodium bicarbonate type, soft, and suitable for public supply. As shown by chemical analyses presented in Table 3, the concentration of dissolved solids is about 800 parts per million, and concentrations of individual constituents have exhibited little change since 1943.

Water levels have declined considerably since the first Travis Peak well was drilled in the late 1800's. Available water-level data on the city's wells (Table 4) show that water levels have declined from above the land surface (flowing conditions) to the present depth of about 80 to 90 feet below land surface. This decline in water level is due to pumpage from the city's wells and to withdrawals from the aquifer in the surrounding area.

UTILIZATION AND DEVELOPMENT

Ground-water development from the Travis Peak sands at Whitney is principally from one well, 40-06-501, which supplies the city and is situated within the city limits. The locations of this well and two other wells owned by the city, 40-06-502 and 40-06-503, are shown on Figure 2. Well 40-06-502 is used as a standby well, but is equipped with a pump of rather small capacity to be of much benefit in emergencies. It is suggested that the city investigate replacing the present jet pump in this well with a larger-capacity turbine pump, possibly the one which the city now has in storage. Well 40-06-503 was never equipped with a pump and was used until the natural flow of water from the well ceased. Technical data on the city's wells are presented in Table 4.

At present, well 40-06-501 is adequate to supply the city's water demand. Its annual pumpage since 1959 has been as follows:

1959	26,280,000 gallons
1960	30,789,200 gallons
1961	30,695,900 gallons
1962	35,671,900 gallons

The greatest monthly pumpage was in August 1962 in which 5,252,600 gallons was pumped. The peak daily pumpage during this month probably exceeded 170,000 gallons.

PUMPING TEST OF WELL 40-06-501

Personnel of the Texas Water Commission conducted a pumping test of well 40-06-501 on May 15, 1963. The test consisted of pumping the well at a constant rate for 8 hours and recording measurements of depths to water. After pumping for 8 hours the pump was stopped and water-level observations were continued for 4 more hours. The pumping rate, which averaged 300 gpm (gallons per minute), was measured with a Cox flowmeter inserted in the 6-inch pipeline leading from the well. Data from the test are presented in Table 5 and illustrated on Figure 3. It was desired to obtain water-level measurements in one or both of the other city wells which are located nearby. However, well 40-06-502 was sealed at the surface, and the water-bearing strata in well 40-06-503 were clogged or plugged.

Results from the test were used to compute the specific capacity of well 40-06-501 and the coefficient of transmissibility of the sand interval screened by the well. The specific capacity of a well is defined as the gallons per minute the well will yield for each foot of water-level drawdown that has occurred at the end of a period of time during which the well has been pumped at a constant rate. Specific capacity values indicate the water-bearing characteristics of the producing aquifer and the thoroughness of well development. The 1-hour specific capacity of well 40-06-501 was found to be about 1.8 gpm/ft. for a pumping rate of 297 gpm.

The coefficient of transmissibility is an index of an aquifer's ability to transmit water and is computed by the use of certain formulas. It is defined as the amount of water in gpd (gallons per day) which will pass through a vertical strip of the aquifer one foot wide under a hydraulic gradient of one foot per foot. On the basis of data obtained from the pumping test of well 40-06-501, the coefficient of transmissibility for the Travis Peak is 2,830 gpd/ft., which is considerably less than values obtained in neighboring cities of Waco and Waxahachie.

Another important aquifer property is coefficient of storage, which is defined as the amount of water in cubic feet that will be released from or taken into storage by a vertical column of the aquifer having a base one foot square when the water level or hydrostatic pressure is lowered or raised one foot. The coefficient of storage can be determined from pumping-test data only if data are available from an observation well. Because observation well data were not obtainable at Whitney the coefficient of storage could not be calculated. However, an estimated coefficient of storage of 2.83×10^{-5} is considered a reasonable value for the purposes of this report. The estimate is based on the assumption that the ratio of coefficient of storage to coefficient of transmissibility in the Travis Peak sands is about 10^{-8} ft./gpd, as determined from pumping-test data in Waxahachie and Waco.

Values of coefficients of transmissibility and storage can be used to calculate the effects that pumping from a well will have on water levels in the aquifer at various times and at various distances from the pumped well. Figure 4 shows a theoretical time-distance-drawdown relationship for a well completed in the Travis Peak at Whitney and pumping at a constant rate of 100 gpm, assuming there is no recharge to the aquifer. Each curve of the graph shows the cone of depression or the drawdown that should occur at various distances from the pumped well at a given time after pumping began. For example, after 10 days of pumping at 100 gpm about 8 feet of drawdown occurs 2,000 feet from the pumped well, and after 1,000 days about 27 feet of drawdown occurs 2,000 feet from the pumped well. Since drawdown is proportional to rate of pumping, drawdowns resulting from pumping rates other than 100 gpm can be easily computed. For example if after 10 days of pumping 100 gpm 8 feet of drawdown occurs 2,000 feet from the pumped well, a pumping rate of 200 gpm would have caused 16 feet of drawdown. When the cone of depression of one well is overlapped by the cone of another, interference or additional lowering of water levels occurs as a result of superposition of one cone of depression upon another. For example, assume two wells 1,000 feet apart each pumping 100 gpm for 100 days. According to Figure 4, 23 feet of additional drawdown would occur in each well due to the overlapping of the cones of depression. Hence the information shown on Figure 4 can be useful in selecting an optimum spacing between wells.

Coefficients of transmissibility and storage can also be used in computing the quantity of water that will flow through an aquifer and in estimating the availability of water from storage.

GROUND WATER AVAILABLE FOR DEVELOPMENT

An estimate of the ground water available within 5 miles of the city of Whitney was made based on the value of the coefficient of transmissibility obtained from the pumping test of well 40-06-501 and several idealized assumptions. It is estimated that an average pumpage of 250,000 gallons per day is available on a perennial basis without causing water levels to be lower than 400 feet below land surface. Moreover, on the basis of the assumed coefficient of storage, about 2 billion gallons of water should be obtainable from storage during the period of time the water levels are being lowered to a depth of 400 feet.

The coefficient of transmissibility value of the Travis Peak sand obtained at Whitney is considerably lower than values obtained in nearby cities, which suggests that the Whitney well is not utilizing the full potential of the Travis Peak. If this is true, then more water would be available perennially in the Whitney area than is estimated herein.

RECOMMENDATIONS

To assure orderly and efficient development of additional ground-water supplies, it is suggested that the city obtain the services of a qualified ground-water hydrologist to select locations of additional wells, determine details of well construction, select pumps, establish pumping rates, and recommend other procedures for water-supply development. It is further recommended that the city maintain records of accurately measured water levels in their producing wells at least on a monthly basis.

REFERENCE

Sundstrom, R. W., and Rowley, J. H., 1943, Public water supplies in Hill County, Texas: U. S. Geol. Survey open-file report [available at Austin, Texas].

Table 1.--Cretaceous rock units and their water-bearing characteristics at Whitney

Group	Stratigraphic unit	Approximate thickness (feet)	Character of rocks	Water-bearing properties
Washita	Georgetown Limestone	145	Nodular limestone and gray clay.	Yields small amounts of water to domestic and livestock wells.
Fredericksburg	Edwards Limestone	30	Hard massive limestone.	Not known to yield water.
	Comanche Peak Limestone	150	Nodular limestone and clay.	Do.
	Walnut Clay	130	Clay with thin beds of limestone and sand.	Yields no water.
	Paluxy Sand	35	Sand with thin clay beds.	Probably yields small amounts of water.
Trinity	Glen Rose Limestone	640	Bedded limestone and clay.	Not known to yield water.
	Travis Peak Formation	140+	Fine to coarse sand, and clay.	Yields large amounts of water for municipal purposes.

Table 2.--Driller's log of well 40-06-501

	Thickness (feet)	Depth (feet)		Thickness (feet)	Depth (feet)	
Black soil-------------	5	5	Blue shale-------------	25	835	
Gravel-----------------	15	20	Lime-------------------	25	860	
Chalk------------------	10	30	Sandy lime-------------	35	895	
Shale and shell--------	50	80	Sandy shale------------	70	965	
Lime, gray-------------	45	125	Sand-------------------	15	980	
Shale------------------	15	140	Shell, hard------------	7	987	
White lime-------------	70	210	Sand-------------------	3	990	
Shale, gray------------	50	260	Lime, sandy------------	8	998	
Lime, gray-------------	60	320	Sand-------------------	15	1,013	
Blue gumbo-------------	10	330	Shale------------------	4	1,017	
Lime, gray-------------	5	335	Red rock---------------	3	1,020	
Blue shale-------------	40	375	Shale------------------	10	1,030	
Lime, gray-------------	10	385	Sandy lime-------------	10	1,040	
Lime rock--------------	20	405	Lime-------------------	40	1,080	
Lime and flint---------	15	420	Lime, hard-------------	14	1,094	
Blue shale-------------	30	450	Shale------------------	22	1,116	
Sand-------------------	36	486	Red shale--------------	7	1,123	
White lime-------------	114	500	Sandy lime-------------	5	1,128	1128
Lime-------------------	135	635	Sand-------------------	142	1,270	
Shale, blue------------	15	650	Sand, red--------------	5	1,275	
Lime, white------------	105	755	Red sandy lime---------	5	1,280	
Lime-------------------	55	810	Lime-------------------	2	1,282	1282

Table 3.--Chemical analyses of water from city of Whitney's water wells

Date of collection	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium and Potassium (Na + K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved Solids (sum)	Total Hardness as $CaCO_3$	Specific Conductance (Micromhos at 25° C.)	pH
1-13-43	10	0.03	3.6	1.6	232	394	129	37	0.3	1.5	--	809	16	--	8.4
3-22-49	14	.11	2.6	1.4	227	398	115	41	.8	1.2	0.32	801	12	972	8.3
11- -59	--	.02	3	1.0	212	--	112	29	.4	.7	--	--	11	925	8.6
7-12-62	--	.02	3	1.0	236	390	56	46	.4	<.4	--	--	12	1,100	8.2

Table 4.--Records of city of Whitney's water wells

Well	Driller	Date completed	Depth of well (ft.)	Casing: Diameter (in.)	Casing: Depth (ft.)	Altitude of land surface (ft.)	Water Level: Above (+) or below land-surface datum (ft.)	Water Level: Date of measurement	Remarks
40-06-501	Layne-Texas	1942	1,282	8-5/8 6-5/8	0-1,128 1,109-1,282	575.6	+ 0 53 87.0	1942 1949 1958 5-15-63	City of Whitney's well no. 3. Well No. 116 of Sundstrom (1943). Electric motor, 40-hp. Turbine pump, set at 350 ft. Pumping capacity 335 gpm. Casing perforated 1,128-1,282 ft. Flowed 65 gpm when drilled. Water temperature, 87° F.
40-06-502	Layne-Texas	1925	1,280	6	--	580.2	+29 0	1940 1949	City of Whitney's well no. 2. Well no. 115 of Sundstrom (1943). Electric motor, 15-hp. Jet pump, set at 150 ft. Pumping capacity 26 gpm. Flowed 40 gpm when drilled.
40-06-503	--	before 1900	1,575	6	--	579.5	+40 56.5	before 1900 5-15-63	City of Whitney's well no. 1. Well no. 114 of Sundstrom (1943). Not used, not equipped with pump. Well flowed 140 gpm when drilled and flowed 20 gpm in 1940. Water-bearing intervals presently clogged or plugged.

Table 5.--Pumping-test data for well 40-06-501

Date	Time	Depth to water below measuring point (ft.)	Pumping rate (gpm)	Remarks
5-14-63	11:34 p. m.	96.31		Measuring point: lower edge of opening in pump housing, which is 1.57 ft. above land surface. Pumping stopped at 9 p.m., 5-14-63.
5-15-63	2:48 a. m.	91.49		
Do.	5:32	89.42		
Do.	6:33	88.57		
Do.	7:00	--		Pumping started. Pumping rates measured with Cox flowmeter.
Do.	7:10	150.23		
Do.	7:22	238.48		
Do.	7:30	231.65	297	
Do.	7:40	233.42	297	
Do.	7:50	238.58		
Do.	7:55	237.35	300	
Do.	8:00	238.00		
Do.	8:30	241.21	300	
Do.	9:00	243.31	297	
Do.	9:30	244.81	297	
Do.	10:00	245.91	292	
Do.	10:30	249.16	300	
Do.	11:00	250.00	300	
Do.	11:30	250.88	274	
Do.	12:00	257.93	300	
Do.	12:30 p. m.	258.39	303	
Do.	1:00	259.45	308	
Do.	2:00	260.47	308	
Do.	3:00	--	308	
Do.	3:10	--		Pumping stopped
Do.	3:15	135.75		
Do.	3:17	133.89		
Do.	3:19	131.90		
Do.	3:20	130.41		
Do.	3:22	128.29		
Do.	3:24	127.12		
Do.	3:26	125.81		
Do.	3:28	124.09		
Do.	3:30	122.94		
Do.	3:35	120.08		
Do.	3:40	118.15		
Do.	3:45	116.36		

(Continued on next page)

Table 5.--Pumping-test data for well 40-06-501--Continued

Date	Time	Depth to water below measuring point (ft.)	Pumping rate (gpm)	Remarks
5-15-63	3:50 p. m.	114.97		
Do.	3:55	113.68		
Do.	4:00	112.55		
Do.	4:15	109.68		
Do.	4:30	107.54		
Do.	4:45	105.75		
Do.	5:00	104.33		
Do.	5:30	101.99		
Do.	6:00	100.20		
Do.	6:30	98.74		
Do.	7:10	97.25		

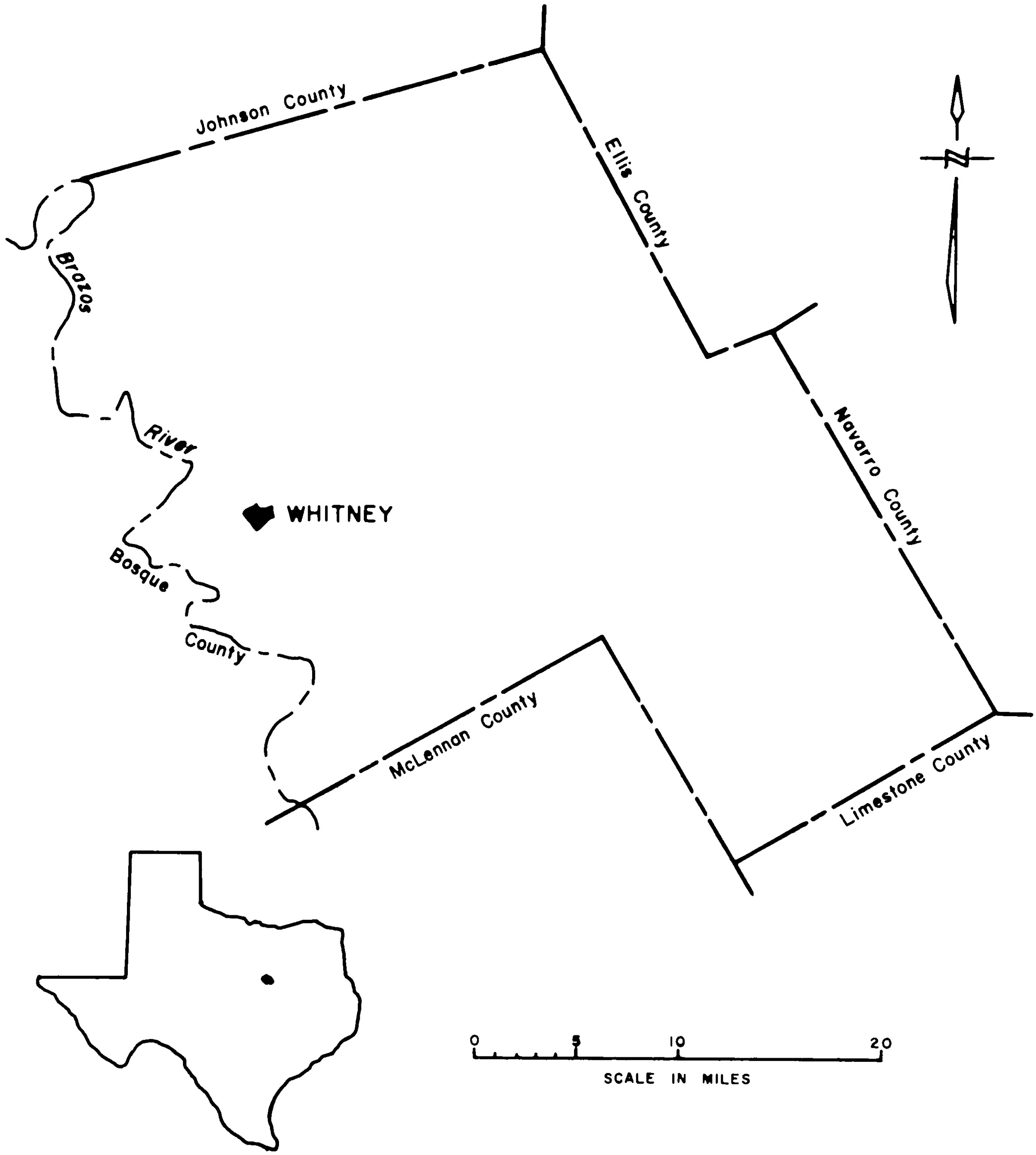

Figure I
Map Showing Location of Whitney, Hill County, Texas
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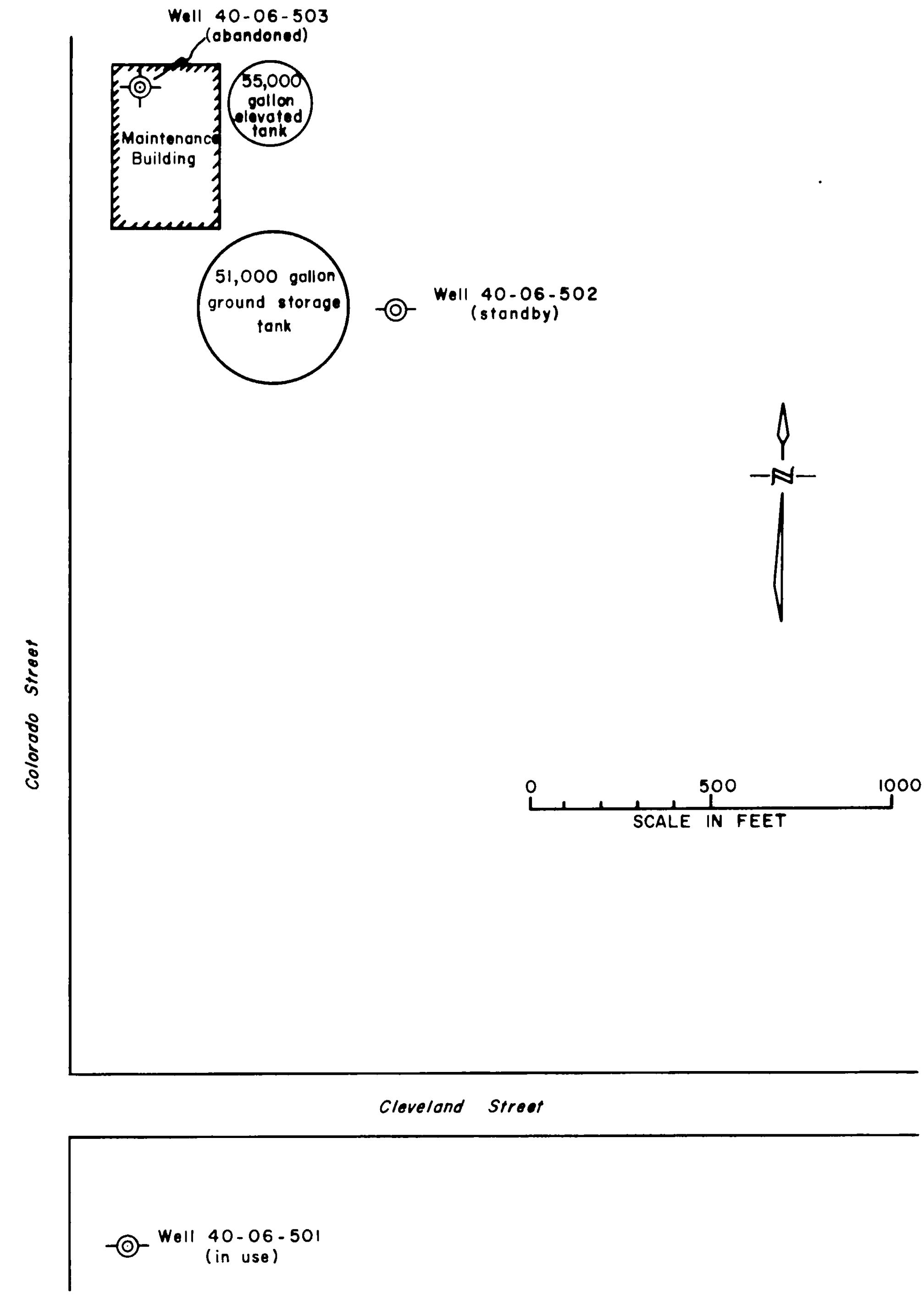

Figure 2

Locations of City of Whitney's Water Wells

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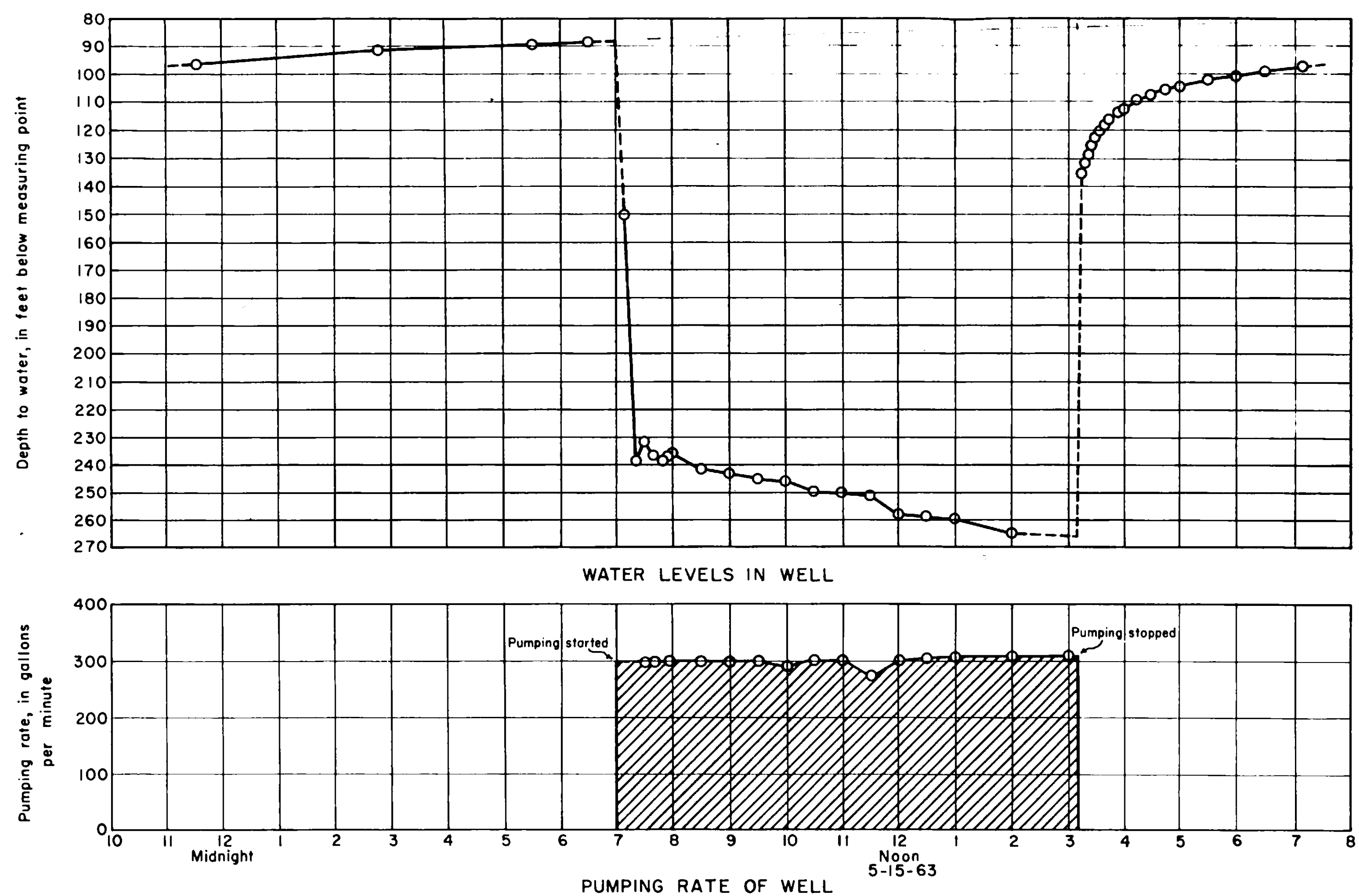

Figure 3

Pumping Test of Well 40-06-501

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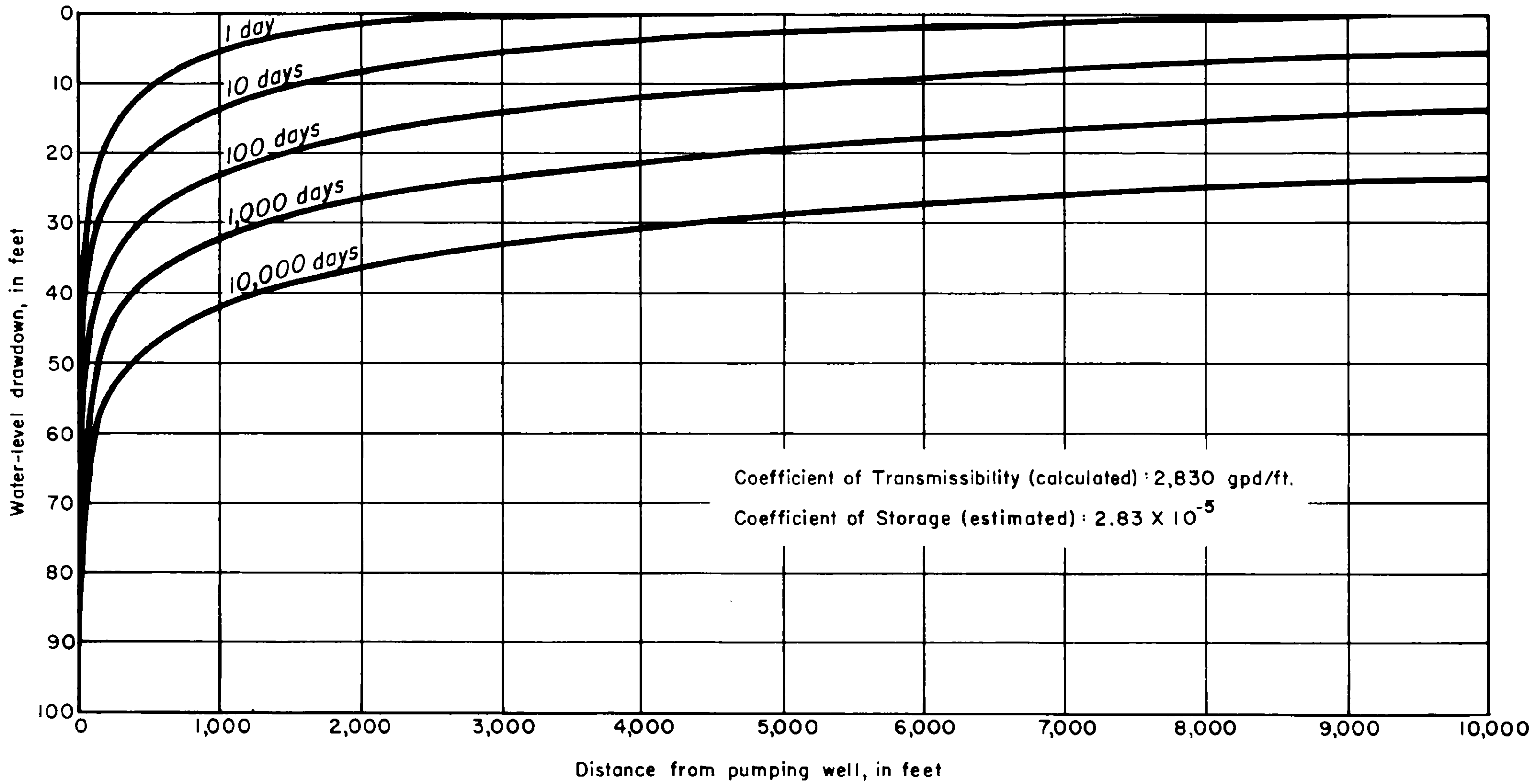

Figure 4

Theoretical Water-Level Drawdown Caused by a Well Pumping 100 Gallons per Minute From an Areally Extensive Aquifer

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