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WATER-SUPPLY PAPER ____

AN APPRAISAL OF GROUND-WATER RESOURCES IN THE SOUTHWESTERN PART OF THE LOUISVILLE AREA, KENTUCKY

By

William H. Walker

Prepared in cooperation with the

DEPARTMENT OF ECONOMIC DEVELOPMENT
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AN AQUIFER TEST IN THE SOUTHWESTERN PART OF THE LOUISVILLE AREA, KENTUCKY

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ABSTRACT

The unconsolidated sand and gravel deposits along the Ohio River at Louisville, Ky. contain a large quantity of ground water. Parts of the aquifer have been overdeveloped in recent years, however, and at the present time great emphasis is being placed on proper location, development, and use of ground-water supplies. The present trend of industrial growth is to the southwest of the city in the undeveloped area along the Ohio River, where the yields to individual wells are higher and relatively large supplies can be developed. The average coefficient of permeability and storage coefficient of the aquifer here are 1,500 gallons per day per square foot and 0.22, respectively.

These values are used in this report to estimate the natural discharge from the aquifer to the river; the natural recharge to the aquifer from flow through the valley wall; and release of ground-water storage in the aquifer. In the undeveloped area southwest of the city the outflow of ground water to the Ohio River during 1952 was about 1.6 million gallons a day per mile of river channel. A large percentage of the ground water now being lost to the stream could be salvaged by the proper location of well fields close to the river. Furthermore, by locating wells near the riverbank large quantities of additional ground water may be obtained by induced infiltration of river water, thereby greatly increasing the total ground-water yield of the aquifer.

The growth of the city of Louisville depends upon a systematic plan of industrial development; therefore, analyses presented in this report are intended as an aid for a part of this plan --- the future development of the ground-water resources of the area.

INTRODUCTION

During World War II the great demand for cool water of good quality caused a temporary overdevelopment of the ground-water resources in some of the heavily industrialized sections of Louisville, Ky. As the situation became critical, investigations were started to find areas where ground water could be obtained to meet the additional needs. In the spring of 1944, a detailed study of the ground-water resources in the southwestern part of Louisville was begun. A report of this investigation released by the United States Geological Survey (Rorabaugh, 1946), indicated that additional ground water could be obtained in the area covered by the study. Although quantitative information of the general area was presented in this report, the amount of ground water obtainable at any one site was not determined, and until recently, little information of this nature was available.

In August 1953, an aquifer test was made in a well field in this area. The data gathered during this test provided valuable information on the hydraulic properties of the aquifer here which should serve as an important supplement to the 1946 report. ~~A~~ Determinations of the coefficients of transmissibility, permeability, and storage for the aquifer, which were obtained from an analysis of the data gathered during the 1953 aquifer test, are included in the present report. Recharge to the aquifer and the occurrence of natural boundaries within the area are also discussed.

The present investigation was conducted by the Ground Water Branch of the U.S. Geological Survey, in cooperation with the Agricultural and Industrial Development Board of Kentucky (superseded by Department of Economic Development of Kentucky, in July 1956). The work was under the administrative direction of A.N. Sayre, chief, Ground Water Branch, U.S. Geological Survey, and under the direct supervision of M.I. Rorabaugh, district engineer in charge of ground-water investigations in Kentucky.

Much of the field data were gathered by R.W. Kellogg assisted by E.A. Bell and W.H. Walker. Other data were furnished by the Diehl Pump and Supply Co. Special acknowledgment is due the officials of the Stauffer Chemical Co. for their cooperation in permitting the use of their wells and equipment and in granting permission to publish the data.

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LOCATION OF AREA

The area covered by this report lies near the southwestern edge of the Rubbertown industrial area and is bounded by Bramer Lane, Cane Run Road, Lees Lane, and the Ohio River. A map showing the location of the test wells and nearby areas of heavy ground-water withdrawal is shown in figure 1.

Figure 1.--Map of the southwestern part of the Louisville area, Kentucky, showing location of wells used in the investigation; nearby areas of heavy pumpage; and the glacial outwash boundaries.

WELL-NUMBERING SYSTEM

The Louisville area lies between 85° and 86° west longitude and 38° and 39° north latitude. The area has been subdivided by a grid of 1-minute meridians of longitude and 1-minute parallels of latitude. A well is designated by a composite of three numbers: the first indicates the minutes of longitude, the second indicates the minutes of latitude, and the third the number of the well in that quadrangle. Thus well 52-11-1 is the first well inventoried in the 1-minute quadrangle west of longitude 85°52' W. and north of latitude 38°11' N.

GEOLOGY

The geology of the Louisville area is described in the "Progress report on the ground-water resources of the Louisville area, Kentucky," by W.F. Guyton, W.T. Stuart, and G.B. Maxey, March 1944. The following paragraphs are quoted from that report:

> The greater part of the Louisville area lies in the Ohio River valley on unconsolidated glacial outwash and other river deposits of Pleistocene and Recent age. The valley was cut in limestone, shale, and tightly-cemented sandstone of Silurian, Devonian, and Mississippian age, and is bounded on both sides by hills made of those rocks. The formations composed by these consolidated rocks are relatively uniform in structure and dip gently to the west.
>
> The Pleistocene glacial outwash sand and gravel overlying the bedrock in general vary inversely in thickness with the elevation of the bedrock surface, the thickness ranging from a featheredge in the marginal areas of the valley to over 125 feet in the main channel in the bedrock. Examination of over 100 logs of wells and borings * * * drilled in the area show that the outwash deposits are principally gravel and coarse-, medium-, and fine-grained sand. Usually the gravel and sand are mixed, with gravel or coarse sand predominating, and make up interbedded lenses of different mixtures which vary in thickness from 5 to 20 feet. Occasionally lenses of well-sorted medium- or fine-grained sand occur. Well-sorted lenses of gravel are extremely rare. The lenses contain varying small quantities of finer material but are not clay- or silt-bound. Clay and silt lenses are seldom present, and when present are thin. The gravel varies from granule- to cobble-size, and the particles are well rounded and worn. Occasional boulders encountered by well drillers were probably rafted down the valley with fragments of ice from the melting ice sheet. Quartzitic, granitic, and limestone particles predominate in gravels, whereas the sand is nearly all quartz with infrequent heavy mineral and limestone particles.

Thus, the geologic setting in the Louisville area consists of a rather deep channel which was cut into the bedrock prior to the Pleistocene epoch; Pleistocene glacial outwash sand and gravel which fill the channel to an average thickness of 60 feet; and a blanket of Recent alluvial clay, silt, and sand which ~~varies~~ ranges in thickness from 10 to 70 feet.

The preglacial channel is about 5 miles wide between Kramers and Lees Lanes. In the central part of the channel along Cane Run Road there is a well defined bedrock ridge nearly a mile wide that parallels the river. The elevation of the greater part of this ridge is between 370 and 380 feet above mean sea level. The elevations of the bedrock surface are shown by contour lines in figure 2.

Figure 2.--~~Bedrock~~ map showing contours on the bedrock surface of the southwestern part of the Louisville area, Kentucky, from (MacCary, 1955).

The bedrock surface is also shown on cross sections in figures 3 and 4. The cross sections in figure 3 show that alluvial deposits fill

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Figure 3.--Sections of the Ohio River flood plain in the southwestern part of the Louisville area, Kentucky. (For location see fig. 2).

Figure 4.--A cross section of the alluvial material ~~at~~ near Lees Lane in the southwestern part of the Louisville area, Kentucky. (For location of wells, see fig. 1).

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the bedrock channel to an average elevation of 450 feet above mean sea level. The term "alluvial sand, gravel, and silt" is used to indicate the channel fill (fig. 3) because sufficient data are not available to determine the contact between the Recent alluvium and the glacial outwash in most places. Figure 4 is a more detailed section based on logs for the indicated wells or boring showing the heterogeneous character of the fill material overlying bedrock at Lees Lane. The material here varies considerably over short distances, and mixtures of silt, sand, and gravel are common. This is characteristic of the alluvial deposits underlying the entire area. Although the material is highly heterogeneous, aquifer tests indicate that it functions as a homogeneous unit if the aquifer is pumped long enough to dissipate the slow drainage of water from the fine material in the upper part of the aquifer.

AQUIFER TEST

Theory

The water table or piezometric surface near a pumping well is drawn down in all directions from the well and, if not affected by other pumping wells, is shaped somewhat like an inverted cone. The drawdown is greatest at the pumped well and becomes infinitely small at some distance from the point of withdrawal. The shape and size of the cone of influence depend primarily upon the pumping rate and the transmission and storage properties of the water bearing formation. From measurements made at two or more observation points on the cone of influence at a given time, or from measurements of the rate of decline of the water surface in nearby observation wells, it is possible to determine the hydraulic characteristics of a water-bearing formation in the vicinity of a discharging well. These characteristics are commonly expressed as the coefficients of permeability, transmissibility, and storage.

The Geological Survey commonly defines the coefficient of permeability (P) as the rate of flow of water, in gallons per day, through a cross-sectional area of 1 square foot of the water-bearing material under a hydraulic gradient of 100 percent. This may be simply expressed in equation form as

$$P = \frac{Q}{IA} \qquad (1)$$

where Q is the rate of flow; I is the hydraulic gradient; and A is the cross-sectional area through which the flow occurs. The coefficient is given local field significance, as opposed to its use in laboratory measurements, by specifying that it is computed for the naturally prevailing water temperature.

The coefficient of transmissibility (T) may be defined as the number of gallons of water that will move in 1 day through a vertical strip of the aquifer 1 foot wide, having a height equal to the full thickness of the aquifer, under an hydraulic gradient of 100 percent. Thus, the coefficient of transmissibility differs from the coefficient of permeability only by the term "aquifer thickness", and therefore

$$T = Pm \quad \text{.........................}(2)$$

where m is the saturated thickness of the water-bearing formation.

In ground-water work the hydraulic gradient ~~and cross-sectional area~~ used in the~~se~~ foregoing definitions ~~are~~ is often expressed in terms of feet per mile in order to simplify field computations. It should be pointed out, however, that the field coefficient of permeability for a homogeneous formation is a constant factor, whereas the coefficient of transmissibility varies according to the thickness of the saturated part of the formation.

The coefficient of storage of an aquifer may be defined as the volume of water it releases from or takes into storage per unit surface area of the aquifer per unit change in the component of head normal to that surface. For a water-table case the yield of water by gravity from a saturated volume of material will range from about 5 to 30 percent of the total volume of the material. Thus, if the water level in an aquifer having a storage coefficient of 0.3 is raised or lowered 1 foot, the gain or loss of water from each cubic foot of the material that is newly saturated or dewatered will be approximately 0.3 cubic foot, or 2.2 gallons.

The nonequilibrium formula developed by Theis (1935, p. 519-524) is used in this report to determine the transmissibility and storage characteristics of the aquifer. In the units customarily used by the Geological Survey this formula is expressed as:

$$s = \frac{114.6Q}{T}\int_{u}^{\infty} \frac{e^{-u}}{u}\,du \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

where

- s = drawdown of water level in observation well, in feet
- Q = discharge of pumped well, in gallons per minute
- r = distance of observation well from pumped well, in feet
- t = time well has been pumped, in days
- S = coefficient of storage as a ratio or decimal fraction
- T = coefficient of transmissibility in gallons per day per foot, under unit hydraulic gradient
- $u = \frac{1.87r^2S}{Tt}$

A more convenient expression of this formula is:

$$T = \frac{114.6Q}{s} W(u) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

$$S = \frac{u\,Tt}{1.87r^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

in which W(u), the "well function of u", replaces the integral expression. The value of the integral is given by the series

$$W(u) = -0.577216 - \log_e u + u - \frac{u^2}{2 \cdot 2!} + \frac{u^3}{3 \cdot 3!} - \frac{u^4}{4 \cdot 4!} \quad \ldots\ldots \quad (6)$$

The nonequilibrium formula is based on the following assumptions: (1) the aquifer is homogeneous and isotropic, (2) the aquifer has an infinite areal extent, (3) the discharge well penetrates the entire thickness of the aquifer, (4) the coefficient of transmissibility is constant at all places and all times, (5) the discharging well has an infinitesimal diameter, and (6) water is released from storage instantaneously with the decline in head.

A type curve that simplifies the computations involved is given in figure 12. This type curve is a plot on logarithmic coordinates of the values of $W(u)$ against values of $\frac{1}{u}$. If values of drawdown are plotted against t/r^2 to the same scale as the type curve a similar curve is developed. By overlaying this plot on the type curve a position of the curves can be found where most of the plotted points match the type curve. With the graphs in this position, the coordinates of any common point on the graphs will give values for s, t/r^2, $\frac{1}{u}$, and $W(u)$. By substituting these values in equations (4) and (5) values of T and S for the aquifer can be computed.

A shortcut method of determining T, (Jacob, 1946, p. 635-636) may be used after t becomes large and a semilog plot of drawdown versus the log of time, for a selected observation well, produces a straight line. The modified version of equation (4) used in this computation is:

$$T = \frac{264Q \log_{10} t_2/t_1}{s_2 - s_1} \quad \dots\dots\dots\dots\dots\dots (7)$$

where t_1 and t_2 are two selected times since pumping started, and s_1 and s_2 are the respective drawdowns, in feet, at these times. The solution is simplified further by selecting t_1 and t_2 so that they are one log cycle apart (on the semilog plot) and $\log_{10} \frac{t_2}{t_1}$ is unity. Equation (7) can then be given as:

$$T = \frac{264Q}{\Delta s} \quad \dots\dots\dots\dots\dots\dots\dots\dots (8)$$

where Δs is the difference in drawdown over one log cycle of time.

Presentation of Data

Wells used in an aquifer test made at the Stauffer Chemical Co. plant in August 1953, are shown in figures 1 and 5. ~~The discharging~~

Figure 5.--Location and summary of well information used in aquifer test.

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well 52-12-17 was pumped at 609 gpm (gallons per minute) throughout the 10-day test. In order to obtain measurements of the water-level decline in the test site area, the wells shown in figure 5 were equipped with electric tapes or automatic water-level recorders, and readings of depth to water in each well were recorded periodically during the 10-day period of pumping. The water-level measurements made during the test, and corrections applied to them, are given in tables 1 through 6. The Ohio

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Table 1.--Drawdown of water level in pumped well, 52-12-17.

Table 2.--Drawdown of water level in well 52-12-16 caused by pumping well 52-12-17.

Table 3.--Drawdown of water level in well 52-12-15 caused by pumping well 52-12-17.

Table 4.--Drawdown of water level in well 52-12-18 caused by pumping well 52-12-17.

Table 5.--Drawdown of water level in well 52-12-2 caused by pumping well 52-12-17.

Table 1.—Drawdown of water [illegible] in pumped well, 52-12-17

Date 1953	Watch time	Pump time (min)	Depth to water below measuring point (ft)	Corrected water level (ft)	Corrected drawdown (ft)
June 9	8:41 a. m.	-	57.88	-	-
10	9:51 a. m.	-	57.91	-	-
11	11:00 a. m.	-	58.02	-	-
12	8:00 a. m.	-	58.08	-	-
15	8:15 a. m.	-	58.47	-	-
16	8:34 a. m.	-	58.58	-	-
18	8:19 a. m.	-	59.05	-	-
19	8:24 a. m.	-	59.15	-	-
26	10:00 a. m.	-	59.91	-	-
30	3:04 p. m.	-	60.20	-	-
July 20	8:44 a. m.	-	61.54	-	-
Aug. 5	9:06 a. m.	-	62.34	-	-
6	8:15 a. m.	-	62.36	-	-
7	10:10 a. m.	-	62.40	-	-
8	3:15 p. m.	-	62.37	-	-
9	4:07 p. m.	-	62.43	-	-
10	8:53 a. m.	-	62.50	-	-
10	9:42 a. m.	-	62.50	-	-
10	10:55 a. m.	-	62.48	-	-
10	11:10 a. m.	-	62.48	-	-
10	11:11 a. m.	1	84.63	-	-
10	11:12 a. m.	2	84.72	-	-
10	11:13 a. m.	3	84.74	-	-
10	11:14 a. m.	4	84.74	-	-
10	11:15 a. m.	5	84.73	-	-
10	11:16 a. m.	6	84.72	-	-
10	11:17 a. m.	7	84.72	-	-
10	11:18 a. m.	8	84.68	-	-
10	11:19 a. m.	9	84.60	-	-
10	11:20 a. m.	10	-	-	-
10	11:21 a. m.	11	-	-	-
10	11:22 a. m.	12	65.10	-	-
10	11:26 a. m.	16	65.50	-	-
10	11:28 a. m.	18	65.75	-	-
10	11:30 a. m.	20	65.75	-	-
10	11:32 a. m.	22	70.00	-	-
10	11:34 a. m.	24	72.80	-	-
10	11:35 a. m.	25	72.77	-	-
10	11:36 a. m.	26	72.77	-	-
10	11:37 a. m.	27	72.88	-	-
10	11:38 a. m.	28	73.54	-	-
10	11:39 a. m.	29	74.12	-	-
10	11:40 a. m.	30	74.15	-	-
10	11:41 a. m.	31	76.60	-	-
10	11:42 a. m.	32	77.16	-	-
10	11:43 a. m.	33	79.50	-	-
10	11:44 a. m.	34	79.60	-	-
10	11:45 a. m.	35	79.63	-	-
10	11:47 a. m.	37	79.66	-	-
10	11:48 a. m.	38	79.66	-	-
10	11:50 a. m.	40	79.70	-	-
10	11:52 a. m.	42	79.69	-	-
10	11:54 a. m.	44	79.69	-	-
10	11:56 a. m.	46	79.70	-	-
10	11:58 a. m.	48	79.72	-	-
10	12:00 m.	50	79.72	-	-
10	12:03 p. m.	53	79.73	-	-
10	12:07 p. m.	57	79.73	-	-
10	12:10 p. m.	60	79.73	-	-

Date 1953	Watch time	Pump time (min)	Depth to water below measuring point (ft)	Corrected water level (ft)	Corrected drawdown (ft)
Aug. 10	12:15 p. m.	65	79.80	-	-
10	12:20 p. m.	70	79.78	-	-
10	12:25 p. m.	75	79.80	-	-
10	12:30 p. m.	80	79.83	-	-
10	12:35 p. m.	85	79.83	-	-
10	12:40 p. m.	90	79.85	-	-
10	12:45 p. m.	95	79.87	-	-
10	12:50 p. m.	100	79.88	-	-
10	12:55 p. m.	105	79.88	-	-
10	1:00 p. m.	110	79.90	-	-
10	1:05 p. m.	115	79.91	-	-
10	1:18 p. m.	128	79.91	-	-
10	1:20 p. m.	130	79.75	-	-
10	1:30 p. m.	140	79.98	-	-
10	1:44 p. m.	154	77.74	-	-
10	1:57 p. m.	167	77.77	-	-
10	2:08 p. m.	178	78.27	-	-
10	2:11 p. m.	181	78.28	-	-
10	2:30 p. m.	200	78.40	-	-
10	2:40 p. m.	210	78.37	-	-
10	2:50 p. m.	220	78.40	-	-
10	3:00 p. m.	230	78.42	-	-
10	3:10 p. m.	240	78.44	-	-
10	3:40 p. m.	270	78.49	-	-
10	4:10 p. m.	300	78.56	-	-
10	4:20 p. m.	310	78.56	-	-
10	4:40 p. m.	330	78.59	-	-
10	5:21 p. m.	371	78.66	-	-
10	5:50 p. m.	400	78.69	-	-
10	6:30 p. m.	440	78.74	-	-
10	7:05 p. m.	475	78.81	-	-
10	8:02 p. m.	532	78.89	-	-
10	8:44 p. m.	574	78.93	78.72	16.24
10	9:46 p. m.	636	78.98	78.75	16.27
10	9:47 p. m.	637	79.00	-	-
10	11:14 p. m.	724	79.06	78.88	16.40
11	12:16 a. m.	786	79.15	78.98	16.50
11	1:05 a. m.	835	79.17	79.00	16.52
11	2:25 a. m.	915	79.21	-	-
11	3:45 a. m.	995	79.31	79.15	16.67
11	5:28 a. m.	1,095	79.42	79.23	16.75
11	6:48 a. m.	1,178	79.50	79.32	16.84
11	8:48 a. m.	1,278	79.56	79.36	16.88
11	9:50 a. m.	1,360	79.62	79.44	16.96
11	11:19 a. m.	1,449	79.65	79.47	16.99
11	12:51 p. m.	1,541	79.68	79.54	17.06
11	3:45 p. m.	1,715	79.75	-	-
11	4:30 p. m.	1,760	79.78	79.63	17.15
11	6:03 p. m.	1,853	79.80	79.64	17.16
11	8:04 p. m.	1,974	79.91	79.73	17.25
11	8:40 p. m.	2,010	79.85	-	-
11	10:18 p. m.	2,108	79.95	79.74	17.26
11	11:55 p. m.	2,205	80.09	79.90	17.42
12	1:58 a. m.	2,328	80.11	79.92	17.44
12	4:04 a. m.	2,454	80.11	79.92	17.44
12	4:57 a. m.	2,507	80.14	-	-
12	6:27 a. m.	2,597	80.20	79.96	17.48
12	9:56 a. m.	2,806	80.15	-	-

Date 1953	Watch time	Pump time (min)	Depth to water below measuring point (ft)	Corrected water level (ft)	Corrected drawdown (ft)
Aug. 12	10:55 a. m.	2,865	80.20	-	-
12	12:28 p. m.	2,958	80.22	80.02	17.54
12	1:43 p. m.	3,033	80.24	-	-
12	3:16 p. m.	3,126	80.26	80.09	17.61
12	6:07 p. m.	3,297	80.32	80.15	17.67
12	9:12 p. m.	3,482	80.40	80.17	17.69
13	12:03 a. m.	3,653	80.48	80.21	17.73
13	3:02 a. m.	3,834	80.55	80.25	17.77
13	6:02 a. m.	4,012	80.64	80.28	17.80
13	9:10 a. m.	4,200	80.73	80.33	17.85
13	12:17 p. m.	4,387	80.76	80.36	17.88
13	3:20 p. m.	4,570	80.77	80.39	17.91
13	6:10 p. m.	4,740	80.86	80.43	17.95
13	9:16 p. m.	4,926	81.00	80.45	17.97
13	10:57 p. m.	5,027	81.15	80.48	18.00
13	11:21 p. m.	5,056	80.70	-	-
13	11:36 p. m.	5,066	81.04	-	-
14	12:11 p. m.	5,821	81.21	80.63	18.15
14	3:05 p. m.	5,995	81.26	-	-
14	6:14 p. m.	6,184	81.36	80.64	18.16
14	9:01 p. m.	6,351	81.42	80.68	18.20
15	12:07 a. m.	6,537	81.44	80.70	18.22
15	6:25 a. m.	6,915	81.46	80.75	18.27
15	6:32 a. m.	6,922	81.45	-	-
15	9:24 a. m.	7,094	81.46	80.76	18.28
15	12:20 p. m.	7,270	81.44	80.78	18.30
15	3:18 p. m.	7,448	81.43	80.83	18.35
15	6:30 p. m.	7,640	81.50	80.84	18.36
15	9:20 p. m.	7,810	81.55	80.86	18.38
16	1:16 a. m.	8,046	81.61	80.88	18.40
16	6:21 a. m.	8,351	81.69	80.92	18.44
16	9:20 a. m.	8,530	81.70	80.94	18.46
16	1:22 p. m.	8,710	81.69	80.94	18.46
16	3:20 p. m.	8,900	81.67	81.00	18.52
16	6:12 p. m.	9,062	81.78	81.01	18.53
16	9:19 p. m.	9,249	81.79	81.00	18.52
17	12:01 a. m.	9,411	81.83	81.01	18.53
17	3:00 a. m.	9,590	81.85	81.02	18.54
17	6:00 a. m.	9,770	81.89	81.05	18.57
17	9:29 a. m.	9,979	81.87	81.06	18.58
17	12:44 p. m.	10,174	81.87	81.08	18.60
17	4:43 p. m.	10,413	81.83	81.07	18.59
18	9:23 a. m.	11,413	81.93	81.18	18.70
18	10:19 a. m.	11,469	81.93	-	-
18	8:58 p. m.	12,048	82.00	81.26	18.78
18	9:01 p. m.	12,051	82.03	-	-
18	9:07 p. m.	12,057	82.02	-	-
19	9:34 a. m.	12,864	82.10	81.29	18.81
19	9:37 a. m.	12,867	82.11	-	-
19	9:41 a. m.	12,871	82.10	-	-
19	9:23 p. m.	13,573	82.18	81.38	18.90
19	9:27 p. m.	13,577	82.19	-	-
20	7:30 a. m.	14,180	82.24	81.43	18.95
20	7:35 a. m.	14,185	82.24	-	-
20	8:34 a. m.	14,244	82.26	-	-
20	9:06 a. m.	14,276	82.98	-	-
20	9:22 a. m.	14,292	82.86	-	-
20	9:30 a. m.	14,300	82.86	-	-

Table 2.—Drawdown of water level in well 52-12-16 caused by pumping well 52-12-17

Date 1953	Watch time	Pump time (min)	Depth to water below measuring point (ft)	Corrected water level (ft)	Corrected drawdown (ft)	t/r^2 $\left(\frac{min}{ft^2}\right)$	t/r^2 $\left(\frac{day}{ft^2}\right)$
June 9	8:35 a. m.	-	56.44	-	-	-	-
10	9:30 a. m.	-	56.44	-	-	-	-
11	11:03 a. m.	-	56.66	-	-	-	-
12	8:07 a. m.	-	56.76	-	-	-	-
12	9:32 a. m.	-	56.74	-	-	-	-
15	8:48 a. m.	-	57.27	-	-	-	-
16	8:10 a. m.	-	57.44	-	-	-	-
18	8:15 a. m.	-	58.05	-	-	-	-
19	8:28 a. m.	-	58.12	-	-	-	-
26	9:30 a. m.	-	58.96	-	-	-	-
30	3:08 p. m.	-	59.30	-	-	-	-
July 20	2:10 p. m.	-	60.93	-	-	-	-
20	2:50 p. m.	-	60.85	-	-	-	-
20	2:55 p. m.	-	60.84	-	-	-	-
20	3:16 p. m.	-	60.82	-	-	-	-
21	1:25 p. m.	-	60.72	-	-	-	-
Aug. 5	9:01 a. m.	-	61.45	-	-	-	-
6	8:11 a. m.	-	61.47	-	-	-	-
7	9:59 a. m.	-	61.52	-	-	-	-
8	3:10 p. m.	-	61.49	-	-	-	-
9	4:04 p. m.	-	61.54	-	-	-	-
10	8:35 a. m.	-	61.60	-	-	-	-
10	10:10 a. m.	-	61.58	-	-	-	-
10	11:10 a. m.	0	61.58	61.59	0.00	-	-
10	11:13 a. m.	3	61.62	-	-	-	-
10	11:15 a. m.	5	61.63	-	-	-	-
10	11:26 a. m.	16	61.61	-	-	-	-
10	11:28 a. m.	18	61.61	-	-	-	-
10	11:30 a. m.	20	61.61	61.62	.03	1.54×10^{-4}	1.07×10^{-7}
10	11:35 a. m.	25	61.65	-	-	-	-
10	11:37 a. m.	27	61.64	-	-	-	-
10	11:40 a. m.	30	61.63	-	-	-	-
10	11:45 a. m.	35	61.64	-	-	-	-
10	11:50 a. m.	40	61.65	-	-	-	-
10	11:54 a. m.	44	61.66	-	-	-	-
10	12:00 m.	50	61.66	61.66	.07	3.84 x 10[illegible]	[illegible] $\times 10^{-7}$
10	12:07 p. m.	57	61.65	-	-	-	-
10	12:14 p. m.	64	61.66	-	-	-	-
10	12:20 p. m.	70	61.65	-	-	-	-
10	12:31 p. m.	81	61.66	61.67	.08	6.2×10^{-4}	4.3×10^{-7}
10	12:41 p. m.	91	61.66	-	-	-	-
10	12:54 p. m.	104	61.67	-	-	-	-
10	1:01 p. m.	111	61.68	61.69	.10	8.5×10^{-4}	5.9×10^{-7}
10	1:26 p. m.	136	61.69	-	-	-	-
10	1:33 p. m.	143	61.70	61.71	.12	1.1×10^{-3}	7.63×10^{-7}
10	1:58 p. m.	168	61.69	61.71	.12	1.38×10^{-3}	9.58×10^{-7}
10	2:10 p. m.	180	61.68	-	-	-	-
10	2:16 p. m.	186	61.68	-	-	-	-
10	2:45 p. m.	215	61.70	-	-	-	-
10	2:59 p. m.	229	61.70	61.71	.12	1.75×10^{-3}	1.22×10^{-6}
10	3:15 p. m.	245	61.71	-	-	-	-
10	3:20 p. m.	250	61.70	61.71	.12	1.93×10^{-3}	1.34×10^{-6}
10	3:48 p. m.	278	61.71	-	-	-	-
10	4:13 p. m.	303	61.72	-	-	-	-
10	4:18 p. m.	308	61.72	61.74	.15	2.38×10^{-3}	1.64×10^{-6}
10	4:42 p. m.	332	61.73	-	-	-	-
10	5:23 p. m.	373	61.75	61.76	.17	2.86×10^{-3}	1.99×10^{-6}
10	5:53 p. m.	403	61.75	61.76	.17	3.1×10^{-3}	2.16×10^{-6}
10	6:37 p. m.	447	61.78	61.78	.19	3.42×10^{-3}	2.38×10^{-6}
10	7:07 p. m.	477	61.80	61.79	.20	3.66×10^{-3}	2.54×10^{-6}
10	8:00 p. m.	530	61.83	61.79	.20	4.06×10^{-3}	2.82×10^{-6}
10	8:40 p. m.	570	61.85	61.81	.22	4.37×10^{-3}	3.03×10^{-6}
10	9:43 p. m.	633	61.86	61.81	.22	4.86×10^{-3}	3.37×10^{-6}
10	10:00 p. m.	650	61.89	61.84	.25	4.98×10^{-3}	3.45×10^{-6}
10	11:10 p. m.	720	61.90	61.86	.27	5.52×10^{-3}	3.83×10^{-6}
11	12:10 a. m.	780	61.92	61.89	.30	5.98×10^{-3}	4.15×10^{-6}

Date 1953	Watch time	Pump time (min)	Depth to water below measuring point (ft)	Corrected water level (ft)	Corrected drawdown (ft)	t/r^2 $\left(\frac{min}{ft^2}\right)$	t/r^2 $\left(\frac{day}{ft^2}\right)$
Aug. 11	1:02 a. m.	832	61.92	61.89	0.30	6.38×10^{-3}	4.43×10^{-6}
11	2:05 a. m.	895	61.94	61.92	.33	6.85×10^{-3}	4.76×10^{-6}
11	3:42 a. m.	992	61.98	61.96	.37	7.6×10^{-3}	5.27×10^{-6}
11	5:26 a. m.	1,096	62.03	61.97	.38	8.4×10^{-3}	5.83×10^{-6}
11	6:39 a. m.	1,169	62.06	61.99	.40	8.96×10^{-3}	6.22×10^{-6}
11	8:15 a. m.	1,265	62.11	62.04	.45	9.70×10^{-3}	6.73×10^{-6}
11	9:42 a. m.	1,352	62.10	62.06	.47	1.04×10^{-2}	7.20×10^{-6}
11	11:15 a. m.	1,445	62.10	62.06	.47	1.11×10^{-2}	7.70×10^{-6}
11	12:48 p. m.	1,538	62.10	62.09	.50	1.18×10^{-2}	8.20×10^{-6}
11	3:20 p. m.	1,690	62.14	62.13	.54	1.30×10^{-2}	9.00×10^{-6}
11	4:33 p. m.	1,763	62.16	62.15	.56	1.35×10^{-2}	9.38×10^{-6}
11	5:59 p. m.	1,849	62.19	62.17	.58	1.42×10^{-2}	9.87×10^{-6}
11	8:00 p. m.	1,970	62.25	62.20	.61	1.51×10^{-2}	1.05×10^{-5}
11	10:12 p. m.	2,102	62.30	62.23	.64	1.61×10^{-2}	1.12×10^{-5}
11	12:00 p. m.	2,210	62.31	62.26	.67	1.70×10^{-2}	1.18×10^{-5}
12	2:02 a. m.	2,332	62.33	62.27	.68	1.79×10^{-2}	1.24×10^{-5}
12	4:10 a. m.	2,460	62.38	62.32	.73	1.89×10^{-2}	1.31×10^{-5}
12	6:07 a. m.	2,577	62.42	62.32	.73	1.98×10^{-2}	1.37×10^{-5}
12	8:56 a. m.	2,746	62.44	62.34	.75	2.10×10^{-2}	1.46×10^{-5}
12	12:25 p. m.	2,955	62.46	62.40	.81	2.25×10^{-2}	1.57×10^{-5}
12	3:14 p. m.	3,124	62.48	62.45	.86	2.40×10^{-2}	1.67×10^{-5}
12	6:03 p. m.	3,293	62.53	62.49	.90	2.53×10^{-2}	1.76×10^{-5}
12	9:04 p. m.	3,474	62.58	62.49	.90	2.66×10^{-2}	1.85×10^{-5}
13	12:07 a. m.	3,657	62.61	62.51	.92	2.80×10^{-2}	1.95×10^{-5}
13	3:06 a. m.	3,836	62.63	62.55	.96	2.94×10^{-2}	2.04×10^{-5}
13	6:08 a. m.	4,018	62.69	62.58	.99	3.08×10^{-2}	2.15×10^{-5}
13	9:16 a. m.	4,206	62.70	62.59	1.00	3.22×10^{-2}	2.24×10^{-5}
13	12:03 p. m.	4,373	62.70	62.62	1.03	3.36×10^{-2}	2.33×10^{-5}
13	3:06 p. m.	4,556	62.70	62.64	1.05	3.49×10^{-2}	2.42×10^{-5}
13	5:57 p. m.	4,727	62.75	62.67	1.08	3.62×10^{-2}	2.51×10^{-5}
13	9:09 p. m.	4.919	62.82	62.70	1.11	3.77×10^{-2}	2.62×10^{-5}
13	11:06 p. m.	5,036	62.83	62.71	1.12	3.86×10^{-2}	2.67×10^{-5}
14	3:17 a. m.	5,287	62.88	62.77	1.18	4.05×10^{-2}	2.81×10^{-5}
14	6:12 a. m.	5,462	62.91	62.75	1.16	4.18×10^{-2}	2.90×10^{-5}
14	9:35 a. m.	5,665	62.93	62.79	1.20	4.35×10^{-2}	3.02×10^{-5}
14	12:05 p. m.	5,815	62.93	62.81	1.22	4.45×10^{-2}	3.09×10^{-5}
14	3:44 p. m.	6,034	62.93	62.82	1.23	4.62×10^{-2}	3.20×10^{-5}
14	6:20 p. m.	6,190	62.98	62.86	1.27	4.75×10^{-2}	3.30×10^{-5}
14	9:11 p. m.	6,361	63.04	62.87	1.28	4.87×10^{-2}	3.38×10^{-5}
15	12:14 a. m.	6,544	63.06	62.90	1.31	5.00×10^{-2}	3.47×10^{-5}
15	6:16 a. m.	6,906	63.12	62.95	1.36	5.29×10^{-2}	3.68×10^{-5}
15	9:14 a. m.	7,084	63.14	62.96	1.37	5.44×10^{-2}	3.78×10^{-5}
15	12:11 p. m.	7,261	63.13	62.98	1.39	5.56×10^{-2}	3.86×10^{-5}
15	3:12 p. m.	7,442	63.13	63.00	1.41	5.71×10^{-2}	3.97×10^{-5}
15	6:18 p. m.	7,628	63.18	63.01	1.42	5.85×10^{-2}	4.06×10^{-5}
15	9:15 p. m.	7,805	63.24	63.03	1.44	5.97×10^{-2}	4.15 x 10[illegible]
16	1:10 a. m.	8,040	63.24	63.05	1.46	6.16×10^{-2}	4.28×10^{-5}
16	6:16 a. m.	8,346	63.29	63.09	1.50	6.38×10^{-2}	4.43×10^{-5}
16	9:12 a. m.	8,522	63.31	63.09	1.50	6.53×10^{-2}	4.53×10^{-5}
16	12:12 p. m.	8,702	63.30	63.12	1.53	6.66×10^{-2}	4.63×10^{-5}
16	3:12 p. m.	8,882	63.30	63.13	1.54	6.80×10^{-2}	4.72×10^{-5}
16	6:10 p. m.	9,060	63.38	63.16	1.57	6.95×10^{-2}	4.83×10^{-5}
16	9:15 p. m.	9,245	63.40	63.16	1.57	7.09×10^{-2}	4.92×10^{-5}
17	12:08 a. m.	9,428	63.40	63.17	1.58	7.22×10^{-2}	5.01×10^{-5}
17	3:07 a. m.	9,597	63.43	63.20	1.61	7.36×10^{-2}	5.12×10^{-5}
17	6:07 a. m.	9,777	63.46	63.19	1.60	7.50×10^{-2}	5.21×10^{-5}
17	9:22 a. m.	9,972	63.48	63.21	1.62	7.64×10^{-2}	5.30×10^{-5}
17	12:41 p. m.	10,171	63.47	63.24	1.65	7.80×10^{-2}	5.42×10^{-5}
17	4:40 p. m.	10,410	63.48	63.27	1.68	8.00×10^{-2}	5.55×10^{-5}
18	9:17 a. m.	11,407	63.62	63.35	1.76	8.75×10^{-2}	6.06×10^{-5}
18	8:54 p. m.	12,104	63.69	63.39	1.80	9.28×10^{-2}	6.44×10^{-5}
19	9:32 a. m.	12,862	63.75	63.44	1.85	9.86×10^{-2}	6.85×10^{-5}
19	9:19 p. m.	13,569	63.82	63.47	1.88	1.04×10^{-1}	7.22×10^{-5}
20	7:26 a. m.	14,176	63.88	63.52	1.93	1.09×10^{-1}	7.55×10^{-5}
20	8:32 a. m.	14,240	63.89	-	-	-	-
20	9:19 a. m.	14,289	63.89	63.56	1.97	1.10×10^{-1}	7.60×10^{-5}

Table 3.--Drawdown of water level in well 52-12-15 caused by pumping well 52-12-17

Date 1953	Watch time	Pump time (min)	Depth to water below measuring point (ft)	Corrected water level (ft)	Corrected drawdown (ft)	t/r² (min/ft²)	t/r² (day/ft²)
June 9	8:23 a.m.	-	57.19	-	-	-	-
10	9:17 a.m.	-	57.26	-	-	-	-
11	11:00 a.m.	-	57.39	-	-	-	-
12	8:02 a.m.	-	57.51	-	-	-	-
15	8:53 a.m.	-	58.06	-	-	-	-
16	7:59 a.m.	-	58.25	-	-	-	-
18	8:11 a.m.	-	58.80	-	-	-	-
19	8:20 a.m.	-	58.96	-	-	-	-
26	9:48 a.m.	-	59.85	-	-	-	-
30	3:12 p.m.	-	60.26	-	-	-	-
July 21	1:19 p.m.	-	61.64	-	-	-	-
Aug. 5	8:56 a.m.	-	62.34	-	-	-	-
6	8:07 a.m.	-	62.37	-	-	-	-
7	9:30 a.m.	-	62.39	-	-	-	-
8	3:02 p.m.	-	62.37	-	-	-	-
9	3:50 p.m.	-	62.42	-	-	-	-
10	9:19 a.m.	-	62.45	-	-	-	-
10	10:13 a.m.	-	62.46	-	-	-	-
10	11:10 a.m.	0	62.45	62.45	0.0	-	-
10	11:32 a.m.	22	62.44	62.45	.0	4.2×10^{-5}	2.92×10^{-8}
10	11:42 a.m.	32	62.44	-	-	-	-
10	11:57 a.m.	47	62.44	-	-	-	-
10	12:05 p.m.	55	62.44	62.45	.0	1.05×10^{-4}	7.3×10^{-8}
10	12:15 p.m.	65	62.45	-	-	-	-
10	12:19 p.m.	69	62.45	-	-	-	-
10	12:34 p.m.	84	62.45	62.46	.01	1.6×10^{-4}	1.11×10^{-7}
10	12:37 p.m.	87	62.45	-	-	-	-
10	12:56 p.m.	106	62.45	62.46	.01	2.0×10^{-4}	1.39×10^{-7}
10	1:27 p.m.	137	62.45	-	-	-	-
10	1:31 p.m.	141	62.45	62.46	.01	2.7×10^{-4}	1.87×10^{-7}
10	2:12 p.m.	182	62.44	-	-	-	-
10	2:50 p.m.	220	62.44	-	-	-	-
10	2:57 p.m.	227	62.44	62.46	.01	4.30×10^{-4}	2.99×10^{-7}
10	3:17 p.m.	247	62.44	62.45	.0	4.70×10^{-4}	3.26×10^{-7}
10	3:46 p.m.	276	62.44	62.45	.0	5.20×10^{-4}	3.61×10^{-7}
10	4:15 p.m.	305	62.44	62.46	.01	5.80×10^{-4}	4.02×10^{-7}
10	4:43 p.m.	333	62.45	-	-	-	-
10	5:25 p.m.	375	62.45	-	-	-	-
10	5:55 p.m.	405	62.45	62.46	.01	7.70×10^{-4}	5.35×10^{-7}
10	6:39 p.m.	449	62.47	62.47	.02	8.50×10^{-4}	5.90×10^{-7}
10	7:10 p.m.	480	62.49	-	-	-	-
10	7:55 p.m.	525	62.49	62.46	.01	1.00×10^{-3}	6.94×10^{-7}
10	8:38 p.m.	568	62.50	62.46	.01	1.08×10^{-3}	7.50×10^{-7}
10	9:40 p.m.	630	62.50	62.45	.0	1.20×10^{-3}	8.33×10^{-7}
10	11:07 p.m.	717	62.52	62.48	.03	1.36×10^{-3}	9.44×10^{-7}
10	11:14 p.m.	724	62.52	62.48	.03	-	-
11	12:07 a.m.	777	62.51	62.48	.03	1.48×10^{-3}	1.03×10^{-6}
11	1:00 a.m.	830	62.50	62.47	.02	1.58×10^{-3}	1.10×10^{-6}
11	2:03 a.m.	893	62.50	62.48	.03	1.70×10^{-3}	1.18×10^{-6}
11	3:40 a.m.	990	62.52	62.50	.05	1.88×10^{-3}	1.31×10^{-6}
11	5:24 a.m.	1,094	62.54	62.48	.03	2.08×10^{-3}	1.44×10^{-6}
11	6:36 a.m.	1,166	62.55	62.51	.06	2.20×10^{-3}	1.53×10^{-6}
11	8:09 a.m.	1,259	62.57	62.51	.06	2.40×10^{-3}	1.67×10^{-6}
11	9:38 a.m.	1,348	62.55	62.50	.05	2.56×10^{-3}	1.78×10^{-6}
11	11:10 a.m.	1,440	62.54	62.52	.07	2.74×10^{-3}	1.90×10^{-6}
11	12:43 p.m.	1,533	62.54	62.53	.08	2.90×10^{-3}	2.01×10^{-6}
Aug. 11	3:17 p.m.	1,687	62.53	62.52	0.07	3.20×10^{-3}	2.22×10^{-6}
11	5:55 p.m.	1,845	62.55	62.53	.08	3.60×10^{-3}	2.50×10^{-6}
11	7:55 p.m.	1,965	62.58	62.53	.08	3.74×10^{-3}	2.60×10^{-6}
11	10:09 p.m.	2,099	62.61	62.54	.09	4.00×10^{-3}	2.78×10^{-6}
12	12:05 a.m.	2,215	62.61	62.56	.11	4.20×10^{-3}	2.92×10^{-6}
12	2:04 a.m.	2,334	62.61	62.57	.12	4.40×10^{-3}	3.05×10^{-6}
12	4:12 a.m.	2,462	62.64	62.59	.14	4.70×10^{-3}	3.26×10^{-6}
12	6:10 a.m.	2,580	62.67	62.57	.12	4.90×10^{-3}	3.40×10^{-6}
12	9:01 a.m.	2,751	62.68	62.60	.15	5.20×10^{-3}	3.61×10^{-6}
12	12:22 p.m.	2,952	62.67	62.61	.16	5.60×10^{-3}	3.89×10^{-6}
12	3:10 p.m.	3,120	62.66	62.63	.18	5.90×10^{-3}	4.10×10^{-6}
12	6:00 p.m.	3,290	62.69	62.65	.20	6.25×10^{-3}	4.34×10^{-6}
12	9:01 p.m.	3,471	62.74	62.65	.20	6.60×10^{-3}	4.58×10^{-6}
13	12:08 a.m.	3,658	62.75	62.65	.20	6.95×10^{-3}	4.82×10^{-6}
13	3:08 a.m.	3,838	62.76	62.68	.23	7.30×10^{-3}	5.07×10^{-6}
13	6:10 a.m.	4,020	62.80	62.68	.23	7.65×10^{-3}	5.31×10^{-6}
13	9:19 a.m.	4,209	62.81	62.71	.26	8.00×10^{-3}	5.55×10^{-6}
13	11:59 a.m.	4,369	62.79	62.71	.26	8.30×10^{-3}	5.76×10^{-6}
13	3:03 p.m.	4,553	62.78	62.72	.27	8.65×10^{-3}	6.01×10^{-6}
13	5:54 p.m.	4,724	62.82	62.74	.29	9.00×10^{-3}	6.25×10^{-6}
13	9:06 p.m.	4,916	62.87	62.74	.29	9.35×10^{-3}	6.49×10^{-6}
13	11:08 p.m.	5,038	62.88	62.76	.31	9.55×10^{-3}	6.63×10^{-6}
14	3:20 a.m.	5,290	62.99	62.78	.33	1.00×10^{-2}	6.94×10^{-6}
14	6:14 a.m.	5,464	62.93	62.78	.33	1.04×10^{-2}	7.22×10^{-6}
14	9:40 a.m.	5,670	62.94	62.80	.35	1.07×10^{-2}	7.43×10^{-6}
14	11:58 a.m.	5,808	62.93	62.81	.36	1.10×10^{-2}	7.64×10^{-6}
14	3:42 p.m.	6,032	62.93	62.82	.37	1.14×10^{-2}	7.91×10^{-6}
14	6:25 p.m.	6,195	62.96	62.84	.39	1.17×10^{-2}	8.12×10^{-6}
14	9:17 p.m.	6,367	63.01	62.84	.39	1.21×10^{-2}	8.40×10^{-6}
15	12:16 a.m.	6,546	63.02	62.86	.41	1.24×10^{-2}	8.62×10^{-6}
15	6:10 a.m.	6,900	63.05	62.87	.42	1.30×10^{-2}	9.02×10^{-6}
15	9:09 a.m.	7,079	62.08	62.89	.44	1.34×10^{-2}	9.30×10^{-6}
15	12:08 p.m.	7,258	63.06	62.90	.45	1.38×10^{-2}	9.58×10^{-6}
15	3:08 p.m.	7,438	63.06	62.93	.48	1.41×10^{-2}	9.80×10^{-6}
15	6:13 p.m.	7,623	63.11	62.94	.49	1.45×10^{-2}	1.01×10^{-5}
15	9:12 p.m.	7,802	63.15	62.94	.49	1.48×10^{-2}	1.03×10^{-5}
16	1:06 a.m.	8,036	63.15	62.96	.51	1.52×10^{-2}	1.06×10^{-5}
16	6:11 a.m.	8,341	63.19	62.99	.54	1.58×10^{-2}	1.10×10^{-5}
16	9:08 a.m.	8,518	63.21	62.99	.54	1.62×10^{-2}	1.13×10^{-5}
16	12:09 p.m.	8,699	63.19	63.01	.56	1.65×10^{-2}	1.15×10^{-5}
16	3:10 p.m.	8,880	63.18	63.01	.56	1.69×10^{-2}	1.17×10^{-5}
16	6:07 p.m.	9,057	63.25	63.03	.58	1.72×10^{-2}	1.20×10^{-5}
16	9:12 p.m.	9,242	63.27	63.03	.58	1.75×10^{-2}	1.22×10^{-5}
17	12:10 a.m.	9,420	63.26	63.03	.58	1.79×10^{-2}	1.24×10^{-5}
17	3:09 a.m.	9,599	63.29	63.05	.60	1.82×10^{-2}	1.26×10^{-5}
17	6:08 a.m.	9,778	63.32	63.05	.60	1.85×10^{-2}	1.29×10^{-5}
17	9:19 a.m.	9,969	63.33	63.06	.61	1.89×10^{-2}	1.31×10^{-5}
17	12:37 p.m.	10,167	63.31	63.08	.63	1.93×10^{-2}	1.34×10^{-5}
17	4:38 p.m.	10,408	63.31	63.10	.65	1.98×10^{-2}	1.38×10^{-5}
18	9:14 a.m.	11,404	63.43	63.15	.70	2.16×10^{-2}	1.50×10^{-5}
18	8:51 p.m.	12,101	63.49	63.19	.74	2.30×10^{-2}	1.60×10^{-5}
19	9:28 a.m.	12,858	63.54	63.23	.78	2.44×10^{-2}	1.70×10^{-5}
19	9:16 p.m.	13,566	63.59	63.26	.81	2.58×10^{-2}	1.79×10^{-5}
20	7:22 a.m.	14,172	63.65	63.29	.84	2.70×10^{-2}	1.87×10^{-5}
20	8:29 a.m.	14,239	63.65	-	-	2.70×10^{-2}	1.87×10^{-5}
20	9:24 a.m.	14,294	63.65	63.31	.86	2.71×10^{-2}	1.88×10^{-5}

Table 4.—Drawdown of water level in well 52-12-18 caused by pumping well 52-12-17

Date 1953	Watch time	Pump time (min)	Depth to water below measuring point (ft)	Corrected water level (ft)	Corrected drawdown (ft)	t/r^2 $\left(\frac{min}{ft^2}\right)$	t/r^2 $\left(\frac{day}{ft^2}\right)$
June 9	8:16 a. m.	-	51.99	-	-	-	-
10	9:10 a. m.	-	51.98	-	-	-	-
11	10:20 a. m.	-	52.05	-	-	-	-
12	7:55 a. m.	-	52.07	-	-	-	-
15	8:59 a. m.	-	52.27	-	-	-	-
16	8:41 a. m.	-	52.30	-	-	-	-
18	8:10 a. m.	-	52.54	-	-	-	-
19	8:15 a. m.	-	52.65	-	-	-	-
26	9:00 a. m.	-	53.32	-	-	-	-
30	3:16 p. m.	-	53.55	-	-	-	-
July 21	3:15 p. m.	-	69.77	-	-	-	-
22	7:43 a. m.	-	54.86	-	-	-	-
22	8:18 a. m.	-	55.04	-	-	-	-
Aug. 5	9:12 a. m.	-	55.50	-	-	-	-
5	9:21 a. m.	-	69.21	-	-	-	-
6	8:00 a. m.	-	55.54	-	-	-	-
7	9:45 a. m.	-	55.87	-	-	-	-
8	3:20 p. m.	-	55.53	-	-	-	-
9	4:11 p. m.	-	55.61	-	-	-	-
10	8:09 a. m.	-	55.66	-	-	-	-
10	9:38 a. m.	-	55.65	-	-	-	-
10	10:17 a. m.	-	55.66	-	-	-	-
10	12:04 p. m.	54	55.65	55.66	0.01	8.21 x 10^{-5}	5.70 x 10^{-8}
10	12:17 p. m.	67	55.65	55.66	.01	1.04 x 10^{-4}	7.20 x 10^{-8}
10	12:36 p. m.	86	55.65	55.66	.01	1.31 x 10^{-4}	9.10 x 10^{-8}
10	12:58 p. m.	108	55.65	55.66	.01	1.64 x 10^{-4}	1.14 x 10^{-7}
10	1:29 p. m.	139	55.64	55.66	.01	2.11 x 10^{-4}	1.47 x 10^{-7}
10	2:13 p. m.	183	55.64	55.66	.01	2.78 x 10^{-4}	1.93 x 10^{-7}
10	2:54 p. m.	224	55.64	55.66	.01	3.41 x 10^{-4}	2.37 x 10^{-7}
10	3:19 p. m.	249	55.63	55.66	.01	3.79 x 10^{-4}	2.63 x 10^{-7}
10	4:16 p. m.	306	55.63	55.66	.01	4.65 x 10^{-4}	3.23 x 10^{-7}
10	4:46 p. m.	336	55.63	55.66	.01	5.11 x 10^{-4}	3.55 x 10^{-7}
10	5:58 p. m.	408	55.65	55.66	.01	6.20 x 10^{-4}	4.30 x 10^{-7}
10	6:42 p. m.	452	55.65	-	-	-	-
10	7:15 p. m.	485	55.67	55.66	.01	7.37 x 10^{-4}	5.12 x 10^{-7}
10	7:53 p. m.	523	55.68	55.66	.01	7.95 x 10^{-4}	5.59 x 10^{-7}
10	8:35 p. m.	565	55.69	55.66	.01	7.80 x 10^{-4}	7.97 x 10^{-7}
10	9:37 p. m.	627	55.69	-	-	-	-
10	11:11 p. m.	721	55.71	55.67	.02	1.10 x 10^{-3}	7.60 x 10^{-7}
11	12:04 a. m.	774	55.69	55.67	.02	1.18 x 10^{-3}	8.20 x 10^{-7}
11	12:56 a. m.	826	55.68	55.67	.02	1.26 x 10^{-3}	8.70 x 10^{-7}
11	2:00 a. m.	890	55.68	55.67	.02	1.35 x 10^{-3}	9.38 x 10^{-7}
11	3:37 a. m.	987	55.69	55.67	.02	1.50 x 10^{-3}	1.04 x 10^{-6}
11	5:21 a. m.	1,091	55.72	55.67	.02	1.67 x 10^{-3}	1.16 x 10^{-6}
11	6:31 a. m.	1,161	55.73	55.67	.02	1.77 x 10^{-3}	1.23 x 10^{-6}
11	8:00 a. m.	1,250	55.74	55.68	.03	1.90 x 10^{-3}	1.32 x 10^{-6}
11	9:33 a. m.	1,343	55.73	55.69	.04	2.04 x 10^{-3}	1.42 x 10^{-6}
11	11:02 a. m.	1,432	55.71	55.69	.04	2.18 x 10^{-3}	1.51 x 10^{-6}
11	12:39 p. m.	1,529	55.69	55.69	.04	2.32 x 10^{-3}	1.61 x 10^{-6}
11	3:14 p. m.	1,684	55.69	55.69	.04	2.56 x 10^{-3}	1.78 x 10^{-6}
11	5:53 p. m.	1,843	55.70	55.69	.04	2.80 x 10^{-3}	1.94 x 10^{-6}
11	7:52 p. m.	1,962	55.73	55.70	.05	2.98 x 10^{-3}	2.07 x 10^{-6}
11	10:06 p. m.	2,096	55.76	55.70	.05	3.19 x 10^{-3}	2.22 x 10^{-6}
Aug. 12	12:09 a. m.	2,219	55.76	55.72	0.07	3.37 x 10^{-3}	2.34 x 10^{-6}
12	2:07 a. m.	2,337	55.75	55.73	.08	3.56 x 10^{-3}	2.47 x 10^{-6}
12	4:15 a. m.	2,465	55.78	55.73	.08	3.75 x 10^{-3}	2.60 x 10^{-6}
12	6:15 a. m.	2,585	55.81	55.73	.08	3.93 x 10^{-3}	2.73 x 10^{-6}
12	9:04 a. m.	2,754	55.81	55.74	.09	4.17 x 10^{-3}	2.90 x 10^{-6}
12	12:18 p. m.	2,948	55.79	55.74	.09	4.48 x 10^{-3}	3.11 x 10^{-6}
12	3:08 p. m.	3,118	55.77	55.75	.10	4.75 x 10^{-3}	3.30 x 10^{-6}
12	5:57 p. m.	3,287	55.80	55.76	.11	5.00 x 10^{-3}	3.47 x 10^{-6}
12	8:59 p. m.	3,469	55.84	55.78	.13	5.27 x 10^{-3}	3.66 x 10^{-6}
13	12:11 a. m.	3,661	55.85	55.79	.14	5.57 x 10^{-3}	3.87 x 10^{-6}
13	3:11 a. m.	3,841	55.86	55.81	.16	5.85 x 10^{-3}	4.06 x 10^{-6}
13	6:11 a. m.	4,021	55.90	55.82	.17	6.12 x 10^{-3}	4.25 x 10^{-6}
13	9:22 a. m.	4,212	55.90	55.83	.18	6.40 x 10^{-3}	4.40 x 10^{-6}
13	11:55 a. m.	4,365	55.88	55.84	.19	6.63 x 10^{-3}	4.60 x 10^{-6}
13	3:00 p. m.	4,550	55.83	55.84	.19	6.92 x 10^{-3}	4.80 x 10^{-6}
13	5:51 p. m.	4,721	55.88	55.85	.20	7.17 x 10^{-3}	4.97 x 10^{-6}
13	9:02 m.	4,912	55.94	55.87	.22	7.48 x 10^{-3}	5.20 x 10^{-6}
13	11:10 p. m.	5,040	55.95	55.88	.23	7.66 x 10^{-3}	5.32 x 10^{-6}
14	3:02 a. m.	5,272	55.96	55.89	.24	8.00 x 10^{-3}	5.55 x 10^{-6}
14	6:16 a. m.	5,466	56.01	55.90	.25	8.31 x 10^{-3}	5.77 x 10^{-6}
14	9:50 a. m.	5,680	56.00	55.92	.27	8.65 x 10^{-3}	6.00 x 10^{-6}
14	11:53 a. m.	5,803	55.99	55.93	.28	8.82 x 10^{-3}	6.12 x 10^{-6}
14	3:40 p. m.	6,030	55.98	55.93	.28	9.18 x 10^{-3}	6.37 x 10^{-6}
14	6:27 p. m.	6,197	56.01	55.94	.29	9.42 x 10^{-3}	6.54 x 10^{-6}
14	9:22 p. m.	6,372	56.06	55.95	.30	9.70 x 10^{-3}	6.73 x 10^{-6}
15	12:18 a. m.	6,548	56.07	55.97	.32	9.95 x 10^{-3}	6.90 x 10^{-6}
15	6:06 a. m.	6,896	56.10	55.99	.34	1.05 x 10^{-2}	7.28 x 10^{-6}
15	9:05 a. m.	7,075	56.12	56.00	.35	1.08 x 10^{-2}	7.47 x 10^{-6}
15	12:02 p. m.	7,252	56.10	56.01	.36	1.10 x 10^{-2}	7.64 x 10^{-6}
15	3:05 p. m.	7,435	56.08	56.01	.36	1.13 x 10^{-2}	7.85 x 10^{-6}
15	6:11 p. m.	7,621	56.12	56.02	.37	1.16 x 10^{-2}	8.05 x 10^{-6}
15	9:09 p. m.	7,799	56.16	56.02	.37	1.19 x 10^{-2}	8.23 x 10^{-6}
16	1:03 a. m.	8,033	56.16	56.04	.39	1.22 x 10^{-2}	8.48 x 10^{-6}
16	6:05 a. m.	8,335	56.19	56.06	.41	1.27 x 10^{-2}	8.80 x 10^{-6}
16	9:02 a. m.	8,512	56.21	56.07	.42	1.29 x 10^{-2}	9.00 x 10^{-6}
16	12:07 p. m.	8,697	56.18	56.08	.43	1.32 x 10^{-2}	9.17 x 10^{-6}
16	3:07 p. m.	8,877	56.17	56.08	.43	1.35 x 10^{-2}	9.38 x 10^{-6}
16	6:05 p. m.	9,055	56.27	56.12	.47	1.38 x 10^{-2}	9.55 x 10^{-6}
16	9:10 p. m.	9,240	56.26	56.09	.44	1.40 x 10^{-2}	9.72 x 10^{-6}
17	12:13 a. m.	9,423	56.25	56.10	.45	1.43 x 10^{-2}	9.93 x 10^{-6}
17	3:13 a. m.	9,603	56.28	56.13	.48	1.46 x 10^{-2}	1.01 x 10^{-5}
17	6:11 a. m.	9,781	56.30	56.12	.47	1.49 x 10^{-2}	1.03 x 10^{-5}
17	9:16 a. m.	9,966	56.32	56.14	.49	1.52 x 10^{-2}	1.05 x 10^{-5}
17	12:34 p. m.	10,164	56.28	56.14	.49	1.55 x 10^{-2}	1.07 x 10^{-5}
17	4:36 p. m.	10,406	56.27	56.15	.50	1.58 x 10^{-2}	1.10 x 10^{-5}
18	9:11 a. m.	11,401	56.39	56.20	.55	1.73 x 10^{-2}	1.20 x 10^{-5}
18	8:48 p. m.	12,098	56.46	56.26	.61	1.84 x 10^{-2}	1.28 x 10^{-5}
19	9:22 a. m.	12,852	56.46	56.26	.61	1.95 x 10^{-2}	1.35 x 10^{-5}
19	9:13 p. m.	13,563	56.50	56.28	.63	2.04 x 10^{-2}	1.42 x 10^{-5}
20	7:19 a. m.	14,169	56.56	56.33	.68	2.06 x 10^{-2}	1.43 x 10^{-5}
20	8:27 a. m.	14,237	56.56	56.33	.68	2.16 x 10^{-2}	1.50 x 10^{-5}
20	9:34 a. m.	14,304	56.55	56.33	.68	2.18 x 10^{-2}	1.51 x 10^{-5}

Table 5.—Drawdown of water level in well 52-12-2 caused by pumping well 52-12-17

Date 1953	Watch time	Pump time (min)	Depth to water below measuring point 1/ (ft)	Date 1953	Watch time	Pump time (min)	Depth to water below measuring point 1/ (ft)	Date 1953	Watch time	Pump time (min)	Depth to water below measuring point 1/ (ft)	Date 1953	Watch time	Pump time (min)	Depth to water below measuring point 1/ (ft)
Aug. 1	2:00 a. m.	-	49.85	Aug. 6	2:00 a. m.	-	49.83	Aug. 11	2:00 a. m.	890	49.93	Aug. 16	2:00 a. m.	8,090	50.18
1	4:00 a. m.	-	49.83	6	4:00 a. m.	-	49.83	11	4:00 a. m.	1,010	49.94	16	4:00 a. m.	8,210	50.18
1	6:00 a. m.	-	49.85	6	6:00 a. m.	-	49.85	11	6:00 a. m.	1,130	49.96	16	6:00 a. m.	8,330	50.18
1	8:00 a. m.	-	49.87	6	8:00 a. m.	-	49.89	11	8:00 a. m.	1,250	49.96	16	8:00 a. m.	8,450	50.19
1	10:00 a. m.	-	49.89	6	10:00 a. m.	-	49.89	11	10:00 a. m.	1,370	49.94	16	10:00 a. m.	8,570	50.18
1	12:00 m.	-	49.90	6	12:00 m.	-	49.87	11	12:00 m.	1,490	49.92	16	12:00 m	8,690	50.18
1	2:00 p. m.	-	49.90	6	2:00 p. m.	-	49.85	11	2:00 p. m.	1,610	49.92	16	2:00 p. m.	8,810	50.18
1	4:00 p. m.	-	49.92	6	4:00 p. m.	-	49.83	11	4:00 p. m.	1,730	49.91	16	4:00 p. m.	8,930	50.18
1	6:00 p. m.	-	49.91	6	6:00 p. m.	-	49.81	11	6:00 p. m.	1,850	49.90	16	6:00 p. m.	9,050	50.19
1	8:00 p. m.	-	49.92	6	8:00 p. m.	-	49.81	11	8:00 p. m.	1,970	49.90	16	8:00 p. m.	9,170	50.20
1	10:00 p. m.	-	49.93	6	10:00 p. m.	-	49.81	11	10:00 p. m.	2,090	49.90	16	10:00 p. m.	9,290	50.20
1	12:00 p. m.	-	49.92	6	12:00 p. m.	-	49.82	11	12:00 p. m.	2,210	49.89	16	12:00 p. m.	9,410	50.20
2	2:00 a. m.	-	49.92	7	2:00 a. m.	-	49.83	12	2:00 a. m.	2,330	49.89	17	2:00 a. m.	9,530	50.22
2	4:00 a. m.	-	49.90	7	4:00 a. m.	-	49.86	12	4:00 a. m.	2,450	49.88	17	4:00 a. m.	9,650	50.24
2	6:00 a. m.	-	49.87	7	6:00 a. m.	-	49.88	12	6:00 a. m.	2,570	49.89	17	6:00 a. m.	9,770	50.25
2	8:00 a. m.	-	49.86	7	8:00 a. m.	-	49.90	12	8:00 a. m.	2,690	49.88	17	8:00 a. m.	9,890	50.27
2	10:00 a. m.	-	49.85	7	10:00 a. m.	-	49.90	12	10:00 a. m.	2,810	49.88	17	10:00 a. m.	10,010	50.26
2	12:00 m.	-	49.84	7	12:00 m.	-	49.89	12	12:00 m.	2,930	49.86	17	12:00 m.	10,130	50.26
2	2:00 p. m.	-	49.83	7	2:00 p. m.	-	49.87	12	2:00 p. m.	3,050	49.86	17	2:00 p. m.	10,250	50.26
2	4:00 p. m.	-	49.82	7	4:00 p. m.	-	49.86	12	4:00 p. m.	3,170	49.85	17	4:00 p. m.	10,370	50.27
2	6:00 p. m.	-	49.82	7	6:00 p. m.	-	49.87	12	6:00 p. m.	3,290	49.85	17	6:00 p. m.	10,490	50.28
2	8:00 p. m.	-	49.82	7	8:00 p. m.	-	49.87	12	8:00 p. m.	3,410	49.85	17	8:00 p. m.	10,610	50.29
2	10:00 p. m.	-	49.83	7	10:00 p. m.	-	49.87	12	10:00 p. m.	3,530	49.86	17	10:00 p. m.	10,730	50.30
2	12:00 p. m.	-	49.85	7	12:00 p. m.	-	49.89	12	12:00 p. m.	3,650	49.86	17	12:00 p. m.	10,850	50.30
3	2:00 a. m.	-	49.88	8	2:00 a. m.	-	49.89	13	2:00 a. m.	3,770	49.85	18	2:00 a. m.	10,970	50.30
3	4:00 a. m.	-	49.90	8	4:00 a. m.	-	49.89	13	4:00 a. m.	3,890	49.86	18	4:00 a. m.	11,090	50.32
3	6:00 a. m.	-	49.92	8	6:00 a. m.	-	49.90	13	6:00 a. m.	4,010	48.87	18	6:00 a. m.	11,210	50.33
3	8:00 a. m.	-	49.93	8	8:00 a. m.	-	49.91	13	8:00 a. m.	4,130	49.88	18	8:00 a. m.	11,330	50.34
3	10:00 a. m.	-	49.93	8	10:00 a. m.	-	49.91	13	10:00 a. m.	4,250	49.90	18	10:00 a. m.	11,450	50.32
3	12:00 m.	-	49.89	8	12:00 m.	-	49.88	13	12:00 m.	4,370	49.91	18	12:00 m.	11,570	50.32
3	2:00 p. m.	-	49.87	8	2:00 p. m.	-	49.85	13	2:00 p. m.	4,490	49.92	18	2:00 p. m.	11,690	50.31
3	4:00 p. m.	-	49.87	8	4:00 p. m.	-	49.86	13	4:00 p. m.	4,610	49.93	18	4:00 p. m.	11,810	50.30
3	6:00 p. m.	-	49.87	8	6:00 p. m.	-	49.87	13	6:00 p. m.	4,730	49.94	18	6:00 p. m.	11,930	50.33
3	8:00 p. m.	-	49.87	8	8:00 p. m.	-	49.87	13	8:00 p. m.	4,850	49.95	18	8:00 p. m.	12,050	50.35
3	10:00 p. m.	-	49.87	8	10:00 p. m.	-	49.89	13	10:00 p. m.	4,970	49.96	18	10:00 p. m.	12,170	50.37
3	12:00 p. m.	-	49.87	8	12:00 p. m.	-	49.89	13	12:00 p. m.	5,090	49.96	18	12:00 p. m.	12,290	50.38
4	2:00 a. m.	-	49.86	9	2:00 a. m.	-	49.89	14	2:00 a. m.	5,210	49.96	19	2:00 a. m.	12,410	50.39
4	4:00 a. m.	-	49.86	9	4:00 a. m.	-	49.89	14	4:00 a. m.	5,330	49.96	19	4:00 a. m.	12,530	50.40
4	6:00 a. m.	-	49.88	9	6:00 a. m.	-	49.91	14	6:00 a. m.	5,450	49.98	19	6:00 a. m.	12,650	50.41
4	8:00 a. m.	-	49.88	9	8:00 a. m.	-	49.92	14	8:00 a. m.	5,570	49.98	19	8:00 a. m.	12,770	50.42
4	10:00 a. m.	-	49.85	9	10:00 a. m.	-	49.92	14	10:00 a. m.	5,690	49.98	19	10:00 a. m.	12,890	50.43
4	12:00 m.	-	49.82	9	12:00 m.	-	49.92	14	12:00 m.	5,810	49.98	19	12:00 m.	13,010	50.43
4	2:00 p. m.	-	49.80	9	2:00 p. m.	-	49.92	14	2:00 p. m.	5,930	49.99	19	2:00 p. m.	13,130	50.43
4	4:00 p. m.	-	49.79	9	4:00 p. m.	a-1,150	49.92	14	4:00 p. m.	6,050	50.00	19	4:00 p. m.	13,250	50.43
4	6:00 p. m.	-	49.80	9	6:00 p. m.	a-1,030	49.92	14	6:00 p. m.	6,170	50.02	19	6:00 p. m.	13,370	50.43
4	8:00 p. m.	-	49.80	9	8:00 p. m.	a-910	49.92	14	8:00 p. m.	6,290	50.05	19	8:00 p. m.	13,490	50.44
4	10:00 p. m.	-	49.82	9	10:00 p. m.	a-790	49.92	14	10:00 p. m.	6,410	50.06	19	10:00 p. m.	13,610	50.44
4	12:00 p. m.	-	49.82	9	12:00 p. m.	a-670	49.93	14	12:00 p. m.	6,530	50.08	19	12:00 p. m.	13,730	50.44
5	2:00 a. m.	-	49.82	10	2:00 a. m.	a-550	49.93	15	2:00 a. m.	6,650	50.10	20	2:00 a. m.	13,850	50.44
5	4:00 a. m.	-	49.86	10	4:00 a. m.	a-430	49.93	15	4:00 a. m.	6,770	50.11	20	4:00 a. m.	13,970	50.45
5	6:00 a. m.	-	49.91	10	6:00 a. m.	a-310	49.93	15	6:00 a. m.	6,890	50.13	20	6:00 a. m.	14,090	50.46
5	8:00 a. m.	-	49.93	10	8:00 a. m.	a-190	49.93	15	8:00 a. m.	7,010	50.15	20	8:00 a. m.	14,210	50.46
5	10:00 a. m.	-	49.90	10	10:00 a. m.	a-70	49.94	15	10:00 a. m	5,130	50.15	20	10:00 a. m.	14,330	50.46
5	12:00 m.	-	49.89	10	12:00 m.	50	49.93	15	12:00 m.	7,250	50.15	20	12:00 m.	14,450	50.44
5	2:00 p. m.	-	49.86	10	2:00 p. m.	170	49.93	15	2:00 p. m.	7,320	50.15	20	2:00 p. m.	14,570	50.43
5	4:00 p. m.	-	49.84	10	4:00 p. m.	290	49.92	15	4:00 p. m.	7,490	50.15	20	4:00 p. m.	14,690	50.44
5	6:00 p. m.	-	49.84	10	6:00 p. m.	410	49.91	15	6:00 p. m.	7,610	50.16	20	6:00 p. m.	14,810	50.44
5	8:00 p. m.	-	49.84	10	8:00 p. m.	530	49.91	15	8:00 p. m.	7,730	50.17	20	8:00 p. m.	14,930	50.44
5	10:00 p. m.	-	49.84	10	10:00 p. m.	650	49.92	15	10:00 p. m.	7,850	50.18	20	10:00 p. m.	15,050	50.44
5	12:00 p. m.	-	49.84	10	12:00 p. m.	770	49.93	15	12:00 p. m.	7,970	50.18	20	12:00 p. m.	15,170	50.45

1/ Measuring point elevation is 347.08 ft above msl.
a Minus signs denote measurements made before start of test.

Table 6.—Drawdown of water level in well 52-12-9 caused by pumping well 52-12-17

Date 1953	Watch time	Pump time (min)	Depth to water below measuring point 1/ (ft)	Date 1953	Watch time	Pump time (min)	Depth to water below measuring point 1/ (ft)	Date 1953	Watch time	Pump time (min)	Depth to water below measuring point 1/ (ft)	Date 1953	Watch time	Pump time (min)	Depth to water below measuring point 1/ (ft)
Aug. 1	2:00 a. m.	-	21.15	Aug. 6	2:00 a. m.	-	21.13	Aug. 11	2:00 a. m.	890	21.40	Aug. 16	2:00 a. m.	8,090	21.99
1	4:00 a. m.	-	21.14	6	4:00 a. m.	-	21.16	11	4:00 a. m.	1,010	21.46	16	4:00 a. m.	8,210	21.98
1	6:00 a. m.	-	21.27	6	6:00 a. m.	-	21.33	11	6:00 a. m.	1,130	21.46	16	6:00 a. m.	8,330	21.96
1	8:00 a. m.	-	21.40	6	8:00 a. m.	-	21.37	11	8:00 a. m.	1,250	21.35	16	8:00 m.	8,450	21.96
1	10:00 a. m.	-	21.48	6	10:00 a. m.	-	21.30	11	10:00 a. m.	1,370	21.33	16	10:00 a. m.	8,570	21.94
1	12:00 m.	-	21.58	6	12:00 m.	-	21.20	11	12:00 m.	1,490	21.31	16	12:00 m.	8,690	21.93
1	2:00 p. m.	-	21.57	6	2:00 p. m.	-	21.12	11	2:00 p. m.	1,610	21.28	16	2:00 p. m.	8,810	21.[illegible]
1	4:00 p. m.	-	21.52	6	4:00 p. m.	-	21.02	11	4:00 p. m.	1,730	21.27	16	4:00 p. m.	8,930	21.93
1	6:00 p. m.	-	21.48	6	6:00 p. m.	-	20.99	11	6:00 p. m.	1,850	21.25	16	6:00 p. m.	9,050	21.93
1	8:00 p. m.	-	21.46	6	8:00 p. m.	-	21.03	11	8:00 p. m.	1,970	21.23	16	8:00 p. m.	9,170	21.94
1	10:00 p. m.	-	21.47	6	10:00 p. m.	-	21.10	11	10:00 p. m.	2,090	21.24	16	10:00 p. m.	9,290	21.93
1	12:00 p. m.	-	21.40	6	12:00 p. m.	-	21.17	11	12:00 p. m.	2,210	21.22	16	12:00 p. m.	9,410	21.98
2	2:00 a. m.	-	21.34	7	2:00 a. m.	-	21.27	12	2:00 a. m.	2,330	21.21	17	2:00 a. m.	9,530	22.06
2	4:00 a. m.	-	21.20	7	4:00 a. m.	-	21.35	12	4:00 a. m.	2,450	21.21	17	4:00 a. m.	9,650	22.12
2	6:00 a. m.	-	21.10	7	6:00 a. m.	-	21.39	12	6:00 a. m.	2,570	21.24	17	6:00 a. m.	9,770	22.22
2	8:00 a. m.	-	21.11	7	8:00 a. m.	-	21.45	12	8:00 a. m.	2,690	21.20	17	8:00 a. m.	9,890	22.28
2	10:00 a. m.	-	21.10	7	10:00 a. m.	-	21.36	12	10:00 a. m.	2,810	21.20	17	10:00 a. m.	10,010	22.10
2	12:00 m.	-	21.08	7	12:00 m.	-	21.30	12	12:00 m.	2,930	21.20	17	12:00 m.	10,130	22.1[illegible]
2	2:00 p. m.	-	21.07	7	2:00 p. m.	-	21.25	12	2:00 p. m.	3,050	21.20	17	2:00 p. m.	10,250	22.13
2	4:00 p. m.	-	21.06	7	4:00 p. m.	-	21.20	12	4:00 p. m.	3,170	21.20	17	4:00 p. m.	10,370	22.22
2	6:00 p. m.	-	21.06	7	6:00 p. m.	-	21.22	12	6:00 p. m.	3,290	21.22	17	6:00 p. m.	10,490	22.12
2	8:00 p. m.	-	21.06	7	8:00 p. m.	-	21.23	12	8:00 p. m.	3,410	21.24	17	8:00 p. m.	10,610	22.11
2	10:00 p. m.	-	21.11	7	10:00 p. m.	-	21.25	12	10:00 p. m.	3,530	21.25	17	10:00 p. m.	10,730	22.11
2	12:00 p. m.	-	21.29	7	12:00 p. m.	-	21.31	12	12:00 p. m.	3,650	21.27	17	12:00 p. m.	10,850	22.17
3	2:00 a. m.	-	21.40	8	2:00 a. m.	-	21.34	13	2:00 a. m.	3,770	21.29	18	2:00 a. m.	10,970	22.19
3	4:00 a. m.	-	21.40	8	4:00 a. m.	-	21.36	13	4:00 a. m.	3,890	21.29	18	4:00 a. m.	11,090	22.27
3	6:00 a. m.	-	21.47	8	6:00 a. m.	-	21.44	13	6:00 a. m.	4,010	21.31	18	6:00 a. m.	11,210	22.33
3	8:00 a. m.	-	21.48	8	8:00 a. m.	-	21.43	13	8:00 a. m.	4,130	21.40	18	8:00 a. m.	11,330	22.28
3	10:00 a. m.	-	21.42	8	10:00 a. m.	-	21.36	13	10:00 a. m.	4,250	21.49	18	10:00 a. m.	11,450	22.08
3	12:00 m.	-	21.27	8	12:00 m.	-	21.14	13	12:00 m.	4,370	21.57	18	12:00 m.	11,570	22.08
3	2:00 p. m.	-	21.23	8	2:00 p. m.	-	21.11	13	2:00 p. m.	4,490	21.62	18	2:00 p. m.	11,690	22.05
3	4:00 p. m.	-	21.20	8	4:00 p. m.	-	21.20	13	4:00 p. m.	4,610	21.59	18	4:00 p. m.	11,810	22.05
3	6:00 p. m.	-	21.21	8	6:00 p. m.	-	21.20	13	6:00 p. m.	4,730	21.55	18	6:00 p. m.	11,930	22.18
3	8:00 p. m.	-	21.18	8	8:00 p. m.	-	21.20	13	8:00 p. m.	4,850	21.56	18	8:00 p. m.	12,050	22.26
3	10:00 p. m.	-	21.22	8	10:00 p. m.	-	21.27	13	10:00 p. m.	4,970	21.54	18	10:00 p. m.	12,170	22.41
3	12:00 p. m.	-	21.21	8	12:00 p. m.	-	21.30	13	12:00 p. m.	5,090	21.58	18	12:00 p. m.	12,290	22.47
4	2:00 a. m.	-	21.25	9	2:00 a. m.	-	21.28	14	2:00 a. m.	5,210	21.55	19	2:00 a. m.	12,410	22.48
4	4:00 a. m.	-	21.25	9	4:00 a. m.	-	21.28	14	4:00 a. m.	5,330	21.55	19	4:00 a. m.	12,530	22.52
4	6:00 a. m.	-	21.31	9	6:00 a. m.	-	21.32	14	6:00 a. m.	5,450	21.60	19	6:00 a. m.	12,650	22.56
4	8:00 a. m.	-	21.18	9	8:00 a. m.	-	21.35	14	8:00 a. m.	5,570	21.64	19	8:00 a. m.	12,770	22.56
4	10:00 a. m.	-	21.10	9	10:00 a. m.	-	21.38	14	10:00 a. m.	5,690	21.61	19	10:00 a. m.	12,890	22.54
4	12:00 m.	-	21.04	9	12:00 m.	-	21.36	14	12:00 m.	5,810	21.64	19	12:00 m.	13,010	22.54
4	2:00 p. m.	-	21.02	9	2:00 p. m.	-	21.35	14	2:00 p. m.	5,930	21.72	19	2:00 p. m.	13,130	22.47
4	4:00 p. m.	-	21.02	9	4:00 p. m.	a-1,150	21.34	14	4:00 p. m.	6,050	21.74	19	4:00 p. m.	13,250	22.42
4	6:00 p. m.	-	21.09	9	6:00 p. m.	a-1,030	21.34	14	6:00 p. m.	6,170	21.89	19	6:00 p. m.	13,370	22.35
4	8:00 p. m.	-	21.12	9	8:00 p. m.	a-910	21.34	14	8:00 p. m.	6,290	21.94	19	8:00 p. m.	13,490	22.31
4	10:00 p. m.	-	21.12	9	10:00 p. m.	a-790	21.34	14	10:00 p. m.	6,410	21.96	19	10:00 p. m.	13,610	22.30
4	12:00 p. m.	-	21.13	9	12:00 p. m.	a-670	21.35	14	12:00 p. m.	6,530	22.02	19	12:00 p. m.	13,730	22.31
5	2:00 a. m.	-	21.26	10	2:00 a. m.	a-550	21.34	15	2:00 a. m.	6,650	22.08	20	2:00 a. m.	13,850	22.33
5	4:00 a. m.	-	21.47	10	4:00 a. m.	a-430	21.35	15	4:00 a. m.	6,770	22.14	20	4:00 a. m.	13,970	22.33
5	6:00 a. m.	-	21.53	10	6:00 a. m.	a-310	21.35	15	6:00 a. m.	6,890	22.18	20	6:00 a. m.	14,090	22.35
5	8:00 a. m.	-	21.57	10	8:00 a. m.	a-190	21.35	15	8:00 a. m.	7,010	22.18	20	8:00 a. m.	14,210	22.30
5	10:00 a. m.	-	21.38	10	10:00 a. m.	a-70	21.32	15	10:00 a. m.	7,130	22.12	20	10:00 a. m.	14,330	22.27
5	12:00 m.	-	21.21	10	12:00 m.	50	21.33	15	12:00 m.	7,250	22.09	20	12:00 m.	14,450	22.19
5	2:00 p. m.	-	21.10	10	2:00 p. m.	170	21.33	15	2:00 p. m.	7,370	22.03	20	2:00 p. m.	14,570	22.15
5	4:00 p. m.	-	21.07	10	4:00 p. m.	290	21.25	15	4:00 p. m.	7,490	22.02	20	4:00 p. m.	14,690	22.21
5	6:00 p. m.	-	21.10	10	6:00 p. m.	410	21.15	15	6:00 p. m.	7,610	22.05	20	6:00 p. m.	14,810	22.13
5	8:00 p. m.	-	21.14	10	8:00 p. m.	530	21.25	15	8:00 p. m.	7,730	22.07	20	8:00 p. m.	14,930	22.11
5	10:00 p. m.	-	21.15	10	10:00 p. m.	650	21.31	15	10:00 p. m.	7,850	22.06	20	10:00 p. m.	15,050	22.12
5	12:00 p. m.	-	21.12	10	12:00 p. m.	770	21.37	15	12:00 p. m.	7,970	22.01	20	12:00 p. m.	15,170	22.12

1/ Measuring point elevation is 408.68 ft above msl.

a Minus signs denote measurements made before start of test.

Table 6. --Drawdown of water level in well 52-12-9 caused by pumping well 52-12-17.

River levels and the atmospheric pressure changes during the period of the test are included in tables 7 and 8. The observed fluctuations

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Table 7. --Ohio River stage adjacent to the aquifer test site, August 1-20, 1953.

Table 8. --Atmospheric pressure at Louisville, Ky., August 10-21, 1953.

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of water level in each well, of stage changes of the Ohio River, and of atmospheric pressure changes during the aquifer test are shown in figure 6.

Figure 6. --Fluctuations of water levels in wells, of Ohio River stage, and of atmospheric pressure, observed during aquifer test.

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stage

Table 7.—Ohio River ~~level~~ adjacent to the aquifer test site, August 1-20, 1953

Date 1953	Watch time	River level above lower gage at dam 41 1/ (ft)	Date 1953	Watch time	River level above lower gage at dam 41 1/ (ft)	Date 1953	Watch time	River level above lower gage at dam 41 1/ (ft)	Date 1953	Watch time	River level above lower gage at dam 41 1/ (ft)
Aug. 1	2:00 a. m.	9.60	Aug. 6	4:00 a. m.	9.95	Aug. 11	4:00 a. m.	10.27	Aug. 16	4:00 a. m	9.50
1	4:00 a. m.	9.60	6	6:00 a. m.	9.66	11	6:00 a. m.	10.23	16	6:00 a. m.	9.57
1	6:00 a. m.	9.30	6	8:00 a. m.	9.60	11	8:00 a. m.	10.33	16	8:00 a. m.	9.57
1	8:00 a. m.	9.10	6	10:00 a. m.	9.73	11	10:00 a. m.	10.40	16	10:00 a. m.	9.70
1	10:00 a. m.	8.90	6	12:00 m.	9.80	11	12:00 m.	10.50	16	12:00 m.	9.8
1	12:00 m.	8.95	6	2:00 p. m.	10.03	11	2:00 p. m.	10.50	16	2:00 p. m.	9.85
1	2:00 p. m.	8.80	6	4:00 p. m.	10.40	11	4:00 p. m.	10.54	16	4:00 p. m.	9.80
1	4:00 p. m.	8.97	6	6:00 p. m.	10.30	11	6:00 p. m.	10.54	16	6:00 p. m.	9.94
1	6:00 p. m.	9.00	6	8:00 p. m.	10.30	11	8:00 p. m.	10.62	16	8:00 p. m.	9.96
1	8:00 p. m.	9.05	6	10:00 p. m.	10.14	11	10:00 p. m.	10.62	16	10:00 p. m.	10.03
1	10:00 p. m.	8.95	6	12:00 p. m.	10.00	11	12:00 p. m.	10.70	16	12:00 p. m.	9.83
1	12:00 p. m.	9.26	7	2:00 a. m.	9.70	12	2:00 a. m.	10.80	17	2:00 a. m.	9.65
2	2:00 a. m.	9.50	7	4:00 a. m.	9.60	12	4:00 a. m.	10.80	17	4:00 a. m.	9.47
2	4:00 a. m.	9.83	7	6:00 a. m.	9.40	12	6:00 a. m.	10.80	17	6:00 a. m.	9.20
2	6:00 a. m.	10.00	7	8:00 a. m.	9.35	12	8:00 a. m.	10.80	17	8:00 a. m.	9.35
2	8:00 a. m.	10.06	7	10:00 a. m.	9.53	12	10:00 a. m.	10.86	17	10:00 a. m.	9.67
2	10:00 a. m.	10.06	7	12:00 m.	9.63	12	12:00 m.	10.90	17	12:00 m.	9.67
2	12:00 m.	10.15	7	2:00 p. m.	9.74	12	2:00 p. m.	10.90	17	2:00 p. m.	9.55
2	2:00 p. m.	10.15	7	4:00 p. m.	9.76	12	4:00 p. m.	10.90	17	4:00 p. m.	9.33
2	4:00 p. m.	10.15	7	6:00 p. m.	9.80	12	6:00 p. m.	10.83	17	6:00 p. m.	9.33
2	6:00 p. m.	10.15	7	8:00 p. m.	9.76	12	8:00 p. m.	10.83	17	8:00 p. m.	9.33
2	8:00 p. m.	10.15	7	10:00 p. m.	9.70	12	10:00 p. m.	10.83	17	10:00 p. m.	9.40
2	10:00 p. m.	9.80	7	12:00 p. m.	9.54	12	12:00 p. m.	10.83	17	12:00 p. m.	9.33
2	12:00 p. m.	9.46	8	2:00 a. m.	9.42	13	2:00 a. m.	10.83	18	2:00 a. m.	9.33
3	2:00 a. m.	8.65	8	4:00 a. m.	9.40	13	4:00 a. m.	10.76	18	4:00 a. m.	9.30
3	4:00 a. m.	8.90	8	6:00 a. m.	9.09	13	6:00 a. m.	10.70	18	6:00 a. m.	9.10
3	6:00 a. m.	8.94	8	8:00 a. m.	9.26	13	8:00 a. m.	10.40	18	8:00 a. m.	9.25
3	8:00 a. m.	9.20	8	10:00 a. m.	9.56	13	10:00 a. m.	10.25	18	10:00 a. m.	9.75
3	10:00 a. m.	9.46	8	12:00 m.	10.13	13	12:00 m.	10.17	18	12:00 m.	9.90
3	12:00 m.	9.56	8	2:00 p. m.	10.36	13	2:00 p. m.	10.10	18	2:00 p. m.	9.93
3	2:00 p. m.	9.60	8	4:00 p. m.	10.25	13	4:00 p. m.	10.20	18	4:00 p. m.	9.80
3	4:00 p. m.	9.60	8	6:00 p. m.	10.50	13	6:00 p. m.	10.20	18	6:00 p. m.	9.65
3	6:00 p. m.	9.64	8	8:00 p. m.	10.42	13	8:00 p. m.	10.24	18	8:00 p. m.	9.36
3	8:00 p. m.	9.76	8	10:00 p. m.	9.94	13	10:00 p. m.	10.10	18	10:00 p. m.	8.95
3	10:00 p. m.	9.67	8	12:00 m.	9.94	13	12:00 p. m.	10.17	18	12:00 p. m.	8.85
3	12:00 p. m.	9.68	9	2:00 a. m.	10.03	14	2:00 a. m.	10.23	19	2:00 a. m.	8.83
4	2:00 a. m.	9.54	9	4:00 a. m.	10.03	14	4:00 a. m.	10.27	19	4:00 a. m.	8.80
4	4:00 a. m.	9.46	9	6:00 a. m.	9.98	14	6:00 a. m.	10.20	19	6:00 a. m.	8.80
4	6:00 a. m.	9.63	9	8:00 a. m.	9.95	14	8:00 a. m.	10.20	19	8:00 a. m.	8.75
4	8:00 a. m.	9.96	9	10:00 a. m.	10.03	14	10:00 a. m.	10.20	19	10:00 a. m.	8.80
4	10:00 a. m.	10.35	9	12:00 m.	10.03	14	12:00 m.	10.03	19	12:00 m.	8.87
4	12:00 m.	10.43	9	2:00 p. m.	10.03	14	2:00 p. m.	10.03	19	2:00 p. m.	8.87
4	2:00 p. m.	10.50	9	4:00 p. m.	10.03	14	4:00 p. m.	9.84	19	4:00 p. m.	9.05
4	4:00 p. m.	10.46	9	6:00 p. m.	10.03	14	6:00 p. m.	9.55	19	6:00 p. m.	9.13
4	6:00 p. m.	10.36	9	8:00 p. m.	10.03	14	8:00 p. m.	9.43	19	8:00 p. m.	9.25
4	8:00 p. m.	10.33	9	10:00 p. m.	10.03	14	10:00 p. m.	9.27	19	10:00 p. m.	9.26
4	10:00 p. m.	10.25	9	12:00 p. m.	10.03	14	12:00 p. m.	9.16	19	12:00 p. m.	9.26
5	2:00 a. m.	9.76	10	2:00 a. m.	10.03	15	2:00 a. m.	9.00	20	2:00 a. m.	9.26
5	4:00 a. m.	9.21	10	4:00 a. m.	10.03	15	4:00 a. m.	8.93	20	4:00 a. m.	9.26
5	6:00 a. m.	9.06	10	6:00 a. m.	10.03	15	6:00 a. m.	9.06	20	6:00 a. m.	9.26
5	8:00 a. m.	9.13	10	8:00 a. m.	10.03	15	8:00 a. m.	9.00	20	8:00 a. m.	9.40
5	10:00 a. m.	9.80	10	10:00 a. m.	10.15	15	10:00 a. m.	9.07	20	10:00 a. m.	9.43
5	12:00 m.	9.87	10	12:00 m.	10.15	15	12:00 m.	9.05	20	12:00 m.	9.59
5	2:00 p. m.	10.34	10	2:00 p. m.	10.06	15	2:00 p. m.	9.15	20	2:00 p. m.	9.43
5	4:00 p. m.	10.47	10	4:00 p. m.	10.40	15	4:00 p. m.	9.30	20	4:00 p. m.	9.47
5	6:00 p. m.	10.44	10	6:00 p. m.	10.50	15	6:00 p. m.	9.16	20	6:00 p. m.	9.47
5	8:00 p. m.	10.36	10	8:00 p. m.	10.50	15	8:00 p. m.	9.20	20	8:00 p. m.	9.60
5	10:00 p. m.	10.30	10	10:00 p. m.	10.39	15	10:00 p. m.	9.40	20	10:00 p. m.	9.57
5	12:00 p. m.	10.36	10	12:00 p. m.	10.33	15	12:00 p. m.	9.40	20	12:00 p. m.	9.64
6	2:00 a. m.	10.36	11	2:00 a. m.	10.30	16	2:00 a. m.	9.50			

1/ Dam 41 lower gage elevation is 383.3 ft above msl.

Table 8.--~~Barometric~~ Atmosphere pressure at Louisville, Ky., August 10-21, 1953

Time	Aug. 10	Aug. 11	Aug. 12	Aug. 13	Aug. 14	Aug. 15	Aug. 16	Aug. 17	Aug. 18	Aug. 19	Aug. 20	Aug. 21
1:00 a. m.	-	29.26	29.26	29.25	29.17	29.16	29.18	29.20	29.27	29.24	29.22	29.26
2:00 a. m.	-	29.26	29.25	29.24	29.17	29.16	29.17	29.21	29.27	29.24	29.22	29.26
3:00 a. m.	-	29.26	29.25	29.24	29.17	29.16	29.16	29.21	29.28	29.24	29.23	29.27
4:00 a. m.	-	29.26	29.25	29.24	29.18	29.17	29.17	29.22	29.28	29.24	29.24	29.28
5:00 a. m.	-	29.28	29.27	29.26	29.19	29.18	29.17	29.24	29.28	29.26	29.25	29.29
6:00 a. m.	-	29.30	29.29	29.27	29.20	29.18	29.18	29.26	29.30	29.27	29.26	29.31
7:00 a. m.	29.26	29.30	29.29	29.27	29.21	29.18	29.19	29.26	29.30	29.28	29.26	29.32
8:00 a. m.	29.26	29.32	29.29	29.27	29.21	29.19	29.20	29.27	29.31	29.28	29.27	29.33
9:00 a. m.	29.26	29.31	29.30	29.27	29.21	29.20	29.20	29.28	29.31	29.28	29.27	29.33
10:00 a. m.	29.26	29.31	29.31	29.26	29.20	29.20	29.20	29.28	29.31	29.27	29.26	29.32
11:00 a. m.	29.25	29.30	29.31	29.25	29.19	29.18	29.19	29.27	29.30	29.26	29.25	29.31
12:00 m.	29.25	29.28	29.29	29.24	29.18	29.18	29.18	29.27	29.29	29.25	29.24	29.30
1:00 p. m.	29.24	29.28	29.29	29.22	29.17	29.17	29.17	29.25	29.26	29.23	29.23	29.28
2:00 p. m.	29.23	29.26	29.27	29.20	29.16	29.15	29.16	29.23	29.24	29.22	29.22	29.27
3:00 p. m.	29.23	29.26	29.25	29.19	29.15	29.14	29.14	29.22	29.23	29.20	29.21	29.27
4:00 p. m.	29.22	29.25	29.24	29.18	29.14	29.13	29.14	29.21	29.22	29.20	29.21	29.26
5:00 p. m.	29.21	29.24	29.22	29.17	29.13	29.13	29.14	29.21	29.22	29.19	29.21	29.26
6:00 p. m.	29.21	29.24	29.23	29.17	29.13	29.14	29.16	29.22	29.22	29.19	29.22	29.26
7:00 p. m.	29.22	29.24	29.23	29.17	29.14	29.15	29.18	29.23	29.22	29.12 (.19)	29.23	29.28
8:00 p. m.	29.24	29.25	29.24	29.18	29.15	29.16	29.18	29.24	29.24	29.20	29.24	29.29
9:00 p. m.	29.25	29.26	29.25	29.19	29.16	29.17	29.19	29.26	29.24	29.21	29.21	29.29
10:00 p. m.	29.26	29.27	29.25	29.18	29.16	29.18	29.20	29.27	29.24	29.21	29.26	29.30
11:00 p. m.	29.26	29.27	29.26	29.18	29.16	29.18	29.20	29.27	29.24	29.22	29.26	29.30
12:00 p. m.	29.26	29.26	29.25	29.18	29.16	29.18	29.20	29.27	29.24	29.22	29.26	29.30

Corrections Applied

The water-level measurements in wells 52-12-15,-16,-17, and-18 were used in the computation of T and S in this report. Before the observed drawdowns were used, however, they were corrected for the effect of changes in atmospheric pressure and for the seasonal recession of the water table that occurred throughout the test period. An additional correction for a changing thickness of oil overlying the water surface in the pumped well had to be applied before these data could be used. In using the Theis graphical method under water-table conditions the drawdowns should be adjusted for unwatering if the water-level decline is a large fraction of the original aquifer thickness and if the observation wells are relatively close to the pumping well. This correction was not necessary for the data used in this report, however, because the drawdowns in the observation wells during the aquifer test were small. Graphs of the observed and corrected water levels in each well are shown in figures 7 through 10.

Figure 7.--Observed and corrected water-levels, well 52-12-17.

Figure 8.--Observed and corrected water-levels, well 52-12-16.

Figure 9.--Observed and corrected water-levels, well 52-12-15.

Figure 10.--Observed and corrected water-levels, well 52-12-18.

Analysis of Data

A logarithmic graph of the corrected drawdowns in wells 52-12-15, -16, and-18 is shown in figure 11. A transition from artesian to

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Figure 11.--Logarithmic graph of corrected drawdowns of water level in wells 52-12-15,-16, and-18 caused by pumping well 52-12-17.

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water-table conditions near the pumping well and the effects of slow drainage from the silty material in the upper part of the aquifer caused excessive drawdown in each observation well during the early part of the test. Near the end of the test, however, the drawdowns in each well reflect the true T and S of the aquifer, and the latter points of each plot ~~fall on~~ define a single smooth curve. The type curve (fig. 12) was overlain on this portion of ~~each~~ the combined plot ~~(fig. 12)~~ and a match point was selected. The values for

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Figure 12.--Logarithmic graph of the exponential-integral type curve.

$\frac{1}{u}$, W(u), s, and t/r^2 obtained from the match point, when substituted in~~to~~ equations (4) and (5), gave a coefficient of transmissibility of about 80,000 gallons per day per foot and a storage coefficient of about 0.2.

It is evident from figure 6 that the water level in wells 52-12-2 and -9 were affected by the pumped well. A solution of T and S using these data checked reasonably close with the values obtained from drawdowns of wells 52-12-15, -16, -17, and -18. The computations of this analysis are not included in this report.

The water-level decline of 1.93 feet per log cycle in the pumped well (fig. 7), when substituted in equation (8), gives a value for T of a little more than 80,000 gallons per day per foot which checks the value obtained by the type-curve solution. A further check was made by comparing the results of this analysis with that of an aquifer test made in the northeastern part of the Louisville area (Rorabaugh, 1948). The coefficient of transmissibility divided by the aquifer thickness indicates a field coefficient of permeability of 1,500 gallons per day per square foot --- a value identical with the one obtained from the analysis discussed in the present report.

This value has been used in the discussion which follows to compute the volume of water moving through the aquifer in the southwestern part of the Louisville area.

AVAILABLE GROUND WATER

In the unpumped area downriver from the Rubbertown area practically all the water entering the aquifer is eventually discharged to the river. Salvage of this water is therefore of paramount importance in the development and utilization of the ground-water resources of the area.

Ground-water outflow from the aquifer in this area is supported by downward percolation of local precipitation, ground water emerging from the valley wall and entering the aquifer, and ground water released from storage.

To determine the relative magnitude of these three sources of water which supports the ground-water outflow from the unpumped area, a rectangular strip of the area 1 mile wide and 4 miles long will be considered. The shorter sides of the rectangle are the valley wall, east of Dixie Highway, and the Ohio River.

Outflow from the area can be computed if the field coefficient of permeability, aquifer thickness, and hydraulic gradient of the water table are known. Water-level records for wells near the river at Lees Lane indicate that during 1952 the hydraulic gradient averaged about 20 feet per mile. Assuming an aquifer thickness of 52 feet and a field coefficient of permeability of 1,500 gpd/ft^2, it follows from equation (1) that

$$Q_{(outflow)} = PIA = 1500 \times 20 \times 52 = 1{,}600{,}000 \text{ gpd/mile of river channel.}$$

Inflow to the aquifer, from the limestone and shale strata along the edge of the flood plain, can be estimated in a like manner. During 1952 the hydraulic gradient near the valley wall averaged about 2 feet per mile, and the saturated aquifer was approximately 45 feet thick. Therefore

$$Q_{(\text{valley-wall inflow})} = 1500 \times 2 \times 45 = 140{,}000 \text{ gpd/mile of valley wall.}$$

The release of ground water from storage in the unpumped area for the same period can be computed by multiplying the net decline of water levels in the area by the storage coefficient of the water-bearing material. During 1952 the average net water-level decline over a 1-mile width of the aquifer which extends from the Ohio River at Lees Lane eastward to the valley wall, approximately 4 miles away, was 1.1 feet. Thus the total volume of water released from storage in this 4-square-mile area is given by

$$Q_{(\text{storage loss})} = \frac{4 \times 5,280^2 \times 1.1 \times 7.48 \times .2}{365} = 500,000 \text{ gpd}$$

or an average removal from storage of about 125,000 gpd per square mile.

Net recharge from rainfall, the only ground-water inflow factor yet undetermined, is evidently obtained by subtracting from the outflow the sum of the quantity released from storage and the quantity entering the aquifer through the valley wall. Thus, for the 4-square-mile unpumped area

$$Q_{(\text{rainfall recharge})} = Q_{(\text{outflow})} - \left[Q_{(\text{storage loss})} + Q_{(\text{valley-wall inflow})} \right]$$

$$= 1,600,000 - (500,000 + 140,000)$$

$$= 1,000,000 \text{ gpd (approximately)}$$

This amounts to about 250,000 gpd per square mile or, converting to the equivalent precipitation over the area, it would represent about 5 inches for 1952.

Precipitation during 1952, as reported by the U. S. Weather Bureau, was 37.58 inches or 91 percent of normal. Precipitation during the winter recharge period, however, was 19.19 inches or 105 percent of normal.

Theoretically, in an infinite aquifer, when a well is pumped its cone of influence will continue indefinitely to expand and deepen. Practically, however, where the aquifer has finite dimensions, the cone will expand and deepen until one or more of the boundaries is intercepted. Subsequent expansion and deepening of the cone will be influenced by the nature of the boundary or boundaries. If the cone intercepts a surface-water source, infiltration from this source is induced in direct proportion to the difference that is developed between river stage and adjacent ground-water level.

In the Rubbertown area, where a constant rate of withdrawal has been maintained for several years, it is estimated that almost one-half of all the water pumped is derived from induced infiltration from the Ohio River.

The approximate boundaries of a major cone in this area are shown by water-level contours in figure 13. The catchment area of

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Figure 13.--~~Water-level~~ map of the southwestern part the Louisville area, Kentucky, showing contours on the water table, December 1952.

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the cone is approximately 8 square miles. During 1952, about 6.9 million gallons a day was pumped from the aquifer beneath this catchment area. Net recharge from precipitation on the catchment area and inflow to the aquifer through the valley wall contributed about 2.2 mgd. The remainder, 4.7 mgd, had to come from storage and from the river by induced infiltration. The average net decline of water levels in this catchment area was 1.4 feet during 1952, which represents a yield from ground-water storage of about 1.3 mgd. Therefore, the average amount of induced river infiltration was approximately 3.4 mgd.

The total amount of water available to a well field from sources other than the Ohio River (by infiltration) is relatively constant from point to point in the undeveloped parts of the aquifer. The amount of recharge by river infiltration to a well field varies inversely with the distance from the well field to the river; that is, the less the distance, the greater the recharge. In the developed areas, however, the creation of a new cone of influence is restricted by existing cones.

SUMMARY AND CONCLUSIONS

The area covered by this report lies near the southwestern edge of the Rubbertown industrial area and is bounded by Bramer Lane, Cane Run Road, Lees Lane, and the Ohio River. It is underlain by unconsolidated alluvial deposits which have a maximum thickness of about 70 feet. The saturated thickness of these deposits ranges from about 25 to 70 feet. Although the water-bearing materials are highly heterogeneous, aquifer tests show that they act as homogeneous units if the cone of influence, around a pumped well, develops until it includes a large part of the aquifer.

The analysis of data from this test indicates that about 80,000 gallons of water a day will move through a 1-mile width of the aquifer under a gradient of 1 foot per mile, and that the aquifer will yield 0.2 cubic foot of water for each cubic foot of aquifer unwatered.

The four wells for which analyses of drawdown data are given (fig. 11) are screened in the lower 40 percent of a water-table aquifer which is 52 feet thick.

The presence of natural barriers in the area are clearly indicated in figures 1, 2, 3, and 4. The sides of the bedrock channel, the rock ridge along Cane Run Road, and the restricted zone along the river will all be effective with time, but their ultimate effect is not known. River infiltration, outflow from the valley wall and various other factors could conceivably dampen or cancel the barrier effects so that they could not be recognized. Therefore, before an analysis can include the barrier effects, aquifer tests of long duration will have to be made on wells at strategic locations in the area to evaluate the net effect of each barrier.

Recharge to the sand and gravel deposits comes from rainfall which seeps through the ground from the surface, from the consolidated rocks along the walls of the valley, and from infiltration of water from the Ohio River through its bed and banks. The average recharge to the aquifer has been estimated by M. I. Rorabaugh (1946, p. 35) to be about 200,000 gpd per square mile by rainfall, and 100,000 gpd per mile of valley wall by outflow from the valley wall to the alluvium. The rainfall recharge during 1952, a year with above-average rainfall during the winter recharge period, was about 250,000 gpd per square mile and the inflow from the valley wall was about 140,000 gpd per mile of valley wall. Recharge by river infiltration varies inversely with the distance between the river and the well field and will be greater if the well field is adjacent to the river. It is therefore of paramount importance to locate future well fields properly with respect to the river and other well fields in order to insure the maximum utilization of the ground-water potential of the area.

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