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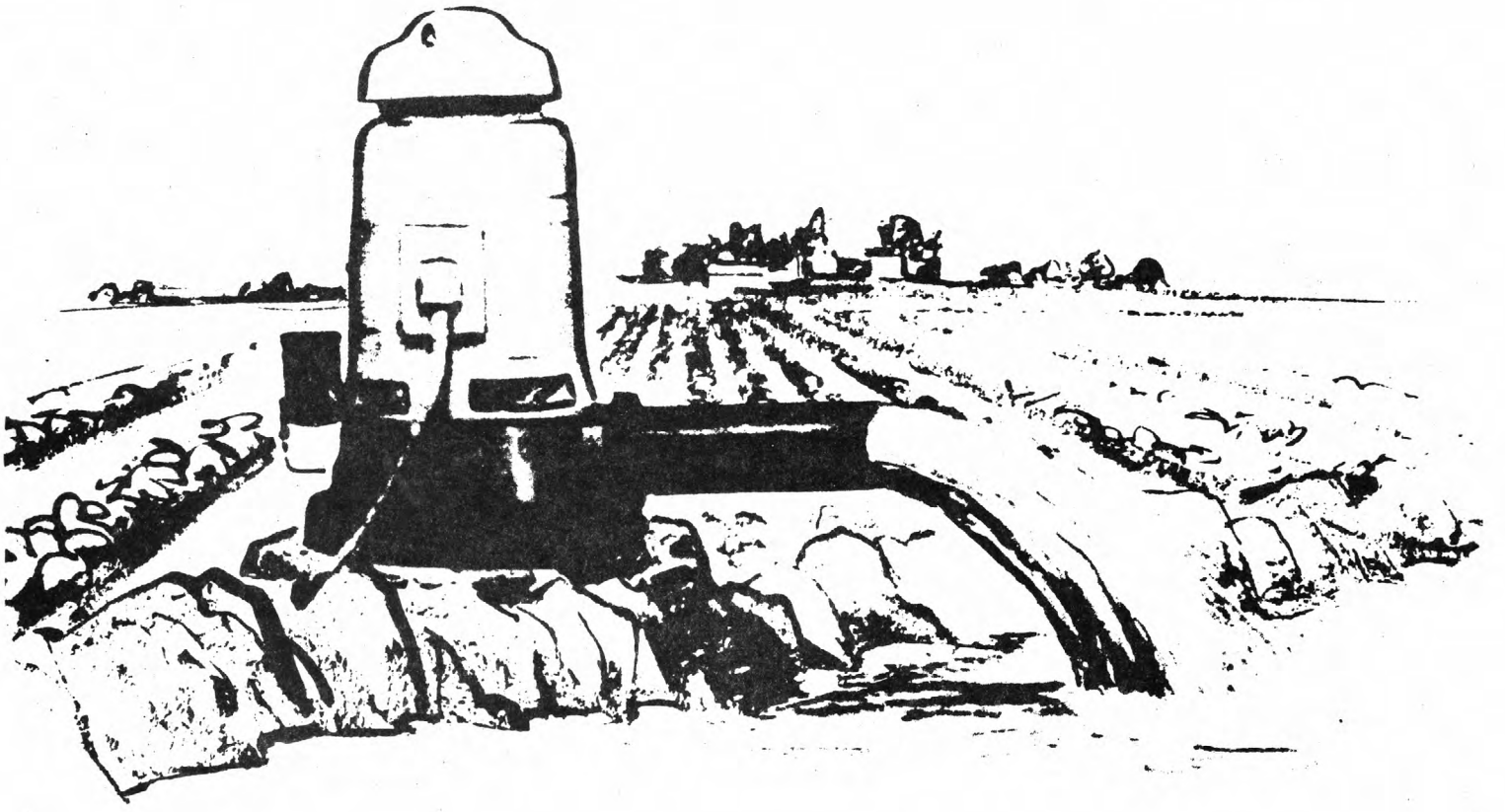
SUMMARY
OF
GROUND-WATER CONDITIONS
IN
MICHIGAN
IN
1964

BY
P. R. GIROUX AND G. C. HUFFMAN
U. S. GEOLOGICAL SURVEY



PREPARED IN COOPERATION WITH THE
STATE OF MICHIGAN
DEPARTMENT OF CONSERVATION
R. A. MacMULLAN, DIRECTOR
GEOLOGICAL SURVEY DIVISION
G. E. EDDY, STATE GEOLOGIST

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PREFACE

Acknowledgment is made to personnel of Federal and State agencies, county and township governments, industrial concerns, well drillers, consultants, municipalities and public utilities without whose cooperation the accumulation of the basic data presented in this report would have not been possible.

The authors are grateful to Messrs. J. G. Rulison and A. E. Slaughter of the Michigan Geological Survey for their help in the editing of this report.

This report summarizes and evaluates records of ground-water levels and related hydrologic information obtained by the U. S. Geological Survey as part of the overall water resources investigation in Michigan carried out in cooperation with the State Geological Survey.

This program of ground-water investigations in Michigan is conducted in cooperation with the Michigan Department of Conservation, R. A. MacMullan, Director, through the Geological Survey Section, G. E. Eddy, State Geologist, and under the overall agreement for water-resources investigations in Michigan with the State Water Resources Commission, L. F. Oeming, Executive Secretary.

The collection of ground-water level records and other related data is also aided by the following municipalities, institutions and private organizations:

Cities and villages of Alma, Ann Arbor, Battle Creek, Beaverton, Cadillac, Coldwater, Dowagiac, Grand Ledge, Greenville, Hastings, Hillsdale, Holland, Ironwood, Jackson, Kalamazoo, Lansing, Lowell, Marshall, Manistee, Mason, Plymouth, Pontiac, Rochester, St. Johns, St. Louis, Wyoming, Ypsilanti; the townships of Battle Creek, Waterford and Ypsilanti; Cranbrook School, Michigan College of Mining and Technology, Oakland University; State institutions at Howell, Ionia, and Ypsilanti; the County of Van Buren; Huron-Clinton Metropolitan Authority; the Fisher Body Division of General Motors Corporation, the Jervis Corporation, KVP-Sutherland Paper Company and the Wisconsin-Michigan Power Company.

Previous Investigations

In addition to this series of water-level reports, records and interpretations of water levels in Michigan have been published annually as U. S. Geological Survey Water Supply Papers entitled "Water Levels and Artesian Pressures in the United States". The following tabulation lists the papers containing water-level data for Michigan:

Year	No.	Year	No.	Year	No.
1935	777	1942	944	1949	1156
1936	817	1943	986	1950	1165
1937	840	1944	1016	1951	1191
1938	845	1945	1023	1952	1221
1939	886	1946	1071	1953	1265
1940	906	1947	1096	1954	1321
1941	936	1948	1126	1955	1404

Beginning in 1956 the annual publication of this series of water-supply papers was discontinued. The series was changed to include a reduced amount of water level records, and the interpretative text was eliminated. The first of this reduced series was published for the two years 1956-57 as Water-Supply Paper No. 1537 and subsequent reports of this series are being published only every 5 years.

To supplement this abbreviated report, a local series of annual reports was begun for Michigan in 1956 and entitled "Summary of Ground-Water Conditions in Michigan". The first seven of these reports were published by the Michigan Department of Conservation for the years 1956-62. The 1963 report and this report are open-file reports.

Selected publications dealing with ground-water conditions in Michigan are listed under REFERENCES at the end of this report.

How open-file data and published records can be obtained

Complete tabulations of water-level measurements and hydrographs for individual observation wells, records of chemical quality of ground-water, water-temperature measurements, well records including logs, aquifer tests, records of pumping for public supply and industrial use, and published and unpublished water-resource reports are on file for public inspection. They may be examined at the office of the Water Resources Section of the Michigan Geological Survey, Fourth Floor, Mason Building, Lansing, or at the Michigan District office of the U. S. Geological Survey, 700 Capitol Savings and Loan Building, Lansing. Records for the Northern Peninsula are also kept on file in the office of the State and Federal Geological Surveys, 203 State Office Building, Escanaba.

U. S. Geological Survey Water-Supply Papers are for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., or can be consulted at the offices listed above and in major university or municipal libraries.

The Federal Survey also issues a monthly publication entitled "Water Resources Review" which briefly summarizes ground-water levels and streamflow throughout the United States. The monthly issues can be obtained free of charge by application to the Director, U. S. Geological Survey, Washington, D. C. 20242.

Copies of annual "Summaries of Ground-Water Conditions in Michigan" are free on application, while other publications of the Michigan Geological Survey can be purchased from the Michigan Department of Conservation, Publications Room, Mason Building, Lansing 26, Michigan.

Reports of cooperative ground-water investigations covering specific areas of the State are also published by the Michigan Geological Survey or the U. S. Geological Survey. These reports are also available for inspection at the offices listed above.

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SUMMARY OF GROUND-WATER CONDITIONS

IN MICHIGAN IN 1964

INTRODUCTION

Purpose of this report

The purpose of this report is to make available records of ground-water level changes in the principal aquifers of the State during 1964 and compile other related data, such as ground-water pumpage, data on municipal, public and industrial water supply facilities, and the effects of precipitation on ground-water levels. Records of water level changes in areas of heavy pumpage and in areas where changes are principally from natural influences are illustrated or tabulated (table 2) to allow comparison between these two types of water-level fluctuations. The water-level and related data provide a day-to-day evaluation of available ground-water supplies. These long-term records serve as a framework to which many short-term records collected during an intensive investigation may be related.

This report is written for those persons, municipalities, industries, institutions, consultants, drillers and hydrologists interested in the ground-water resources of the State.

What this report contains

This report contains the records of measurements of ground-water levels in observation wells in Michigan. These water-level records are listed in Table 2 which also shows the location and depth of well, elevation of land surface, aquifer from which the water is obtained and the extremes of water level for the past record and in the year 1964. Table 3 contains records of ground-water pumpage of most major water users in the State in 1964.

Numerous hydrographs are included in the report to illustrate the changes of water level and most of these illustrations also show the effects of ground-water pumpage and variations of precipitation on water levels in wells.

The text gives supplementary data on the yield of wells, pumpage, storage facilities, treatment, quality of water such as hardness and iron, per capita use and trends of ground-water levels for 1964 and for the period of previous record.

The yield of wells is shown as a range of production in gallons per minute (gpm) for all the wells or specifically for each well. The specific capacity (gallons per minute per foot of drawdown in the well) is also given as a range or specifically for each well. Yield and specific capacity data are reported figures from water departments and consultants.

GROUND WATER LEVELS IN 1964

Ground-water levels fell to record low stages in many parts of the State in 1964 as a result of continued deficiencies of precipitation. In some urban areas increased pumpage also contributed to the decline.

Number and location of wells

In 1964 measurements were made on a total of 334 observation wells, 87 of which were equipped with continuous recording gages, general location of which are shown by figure 1 and by several map inserts in the body of the report. The location map (fig. 1) also shows the rectangular subdivision of the land and the numbering system of the land divisions by use of the base line and north-south meridian. The well-numbering system used by the State and Federal Surveys in Michigan indicates the location of wells within the rectangular subdivision of the land with reference to the Michigan meridian and base line. The first two segments of a well number designate township and range; the third segment designates both the section and the well within the section. Thus, well number 32N 6E 16-1 is well number 1 in section 16, Township 32 North, Range 6 East. Table 2 lists the wells by counties and then by rectangular division.

Effects of precipitation on ground-water levels

Precipitation is the major climatic factor affecting ground-water levels in any area. Hydrographs of natural fluctuations of water in wells (figs. 3-5) show that spring and fall are the seasons when water levels are highest and when most of the ground-water recharge occurs. In the spring before the growing season starts, snowmelt and rain normally result in large additions to the ground-water reservoirs. However, ice cover or frost in the ground can impede infiltration when the first thaws occur. Under these conditions, most of the water from snowmelt and early spring precipitation may be lost by quick surface runoff. During the growing season most of the rainfall either runs off when it occurs as heavy showers or is evaporated or transpired by vegetation. Thus, very little recharge finds its way to the water table. During the winter frozen ground in heavy soil areas impedes the infiltration of water into the ground except when prolonged winter thaws occur. In the fall after the growing season ends, evapotranspiration (water withdrawn by evaporation and by transpiration from plants) is reduced by cold weather. Thus, substantial rises in water levels follow the usual fall rains.


ISLE ROYALE
TO KEWEENAW COUNTY
EXPLANATION
Observation well
Two or more observation wells
R.30W.
T. 49 N.
Diagram of geographical township
N
0 10 20 30 Miles
KEWEENAW
KEWEENAW BAY
HOUGHTON
ONTONAGON
BARAGA
GOGEBIC
IRON
DICKINSON
MARQUETTE
ALGER
SCHOOLCRAFT
LUCE
CHIPPEWA
MACKINAC
DELTA
MENOMINEE
WHITEFISH BAY
TO MACKINAC COUNTY
WISCONSIN
Menominee River
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
GREEN BAY

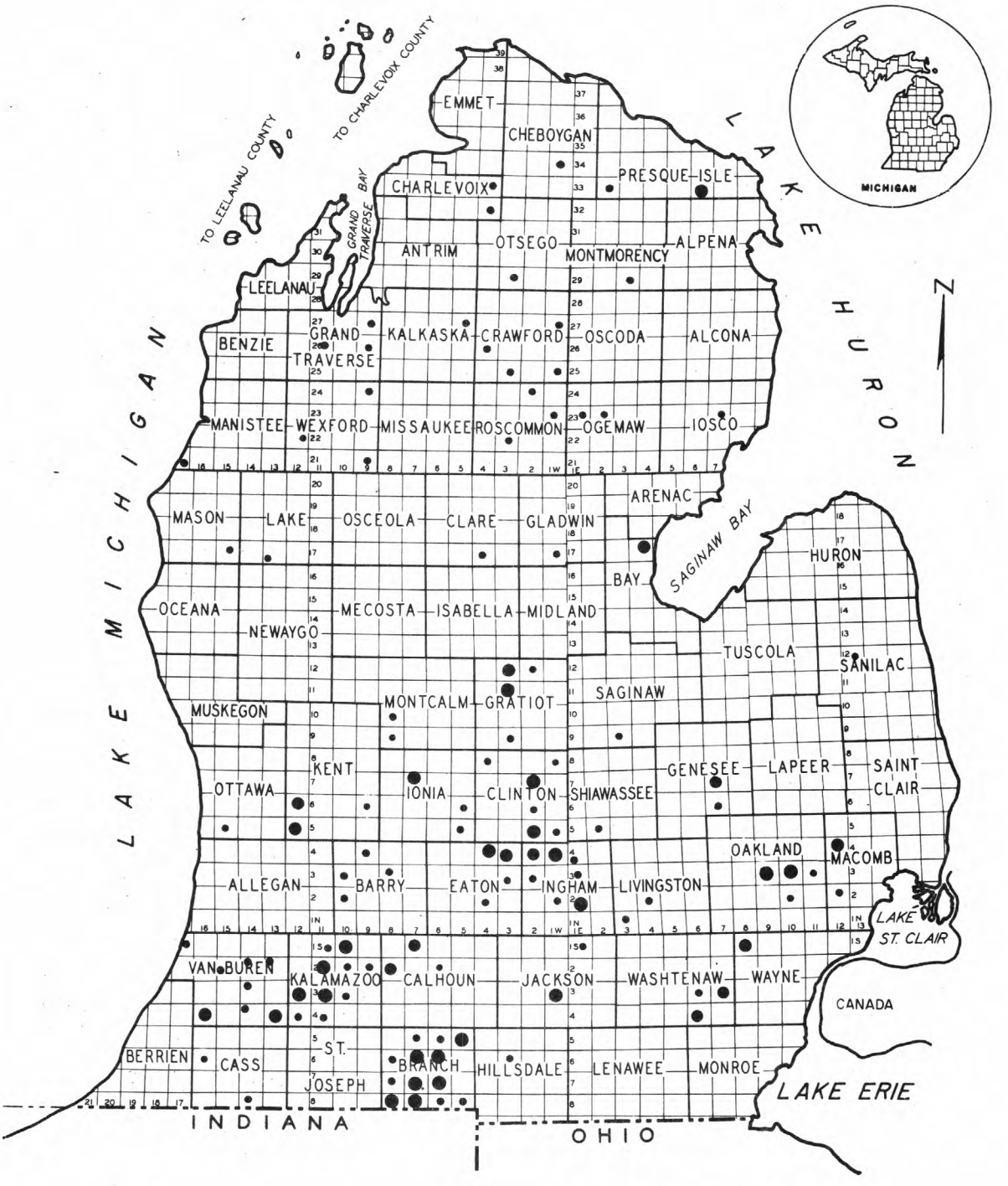

FIGURE 1.--MAP SHOWING LOCATION OF OBSERVATION WELLS IN MICHIGAN, 1964.

Records of water levels were obtained from 334 observation wells, 87 of which were equipped with continuous recording gages. (see Table 2)

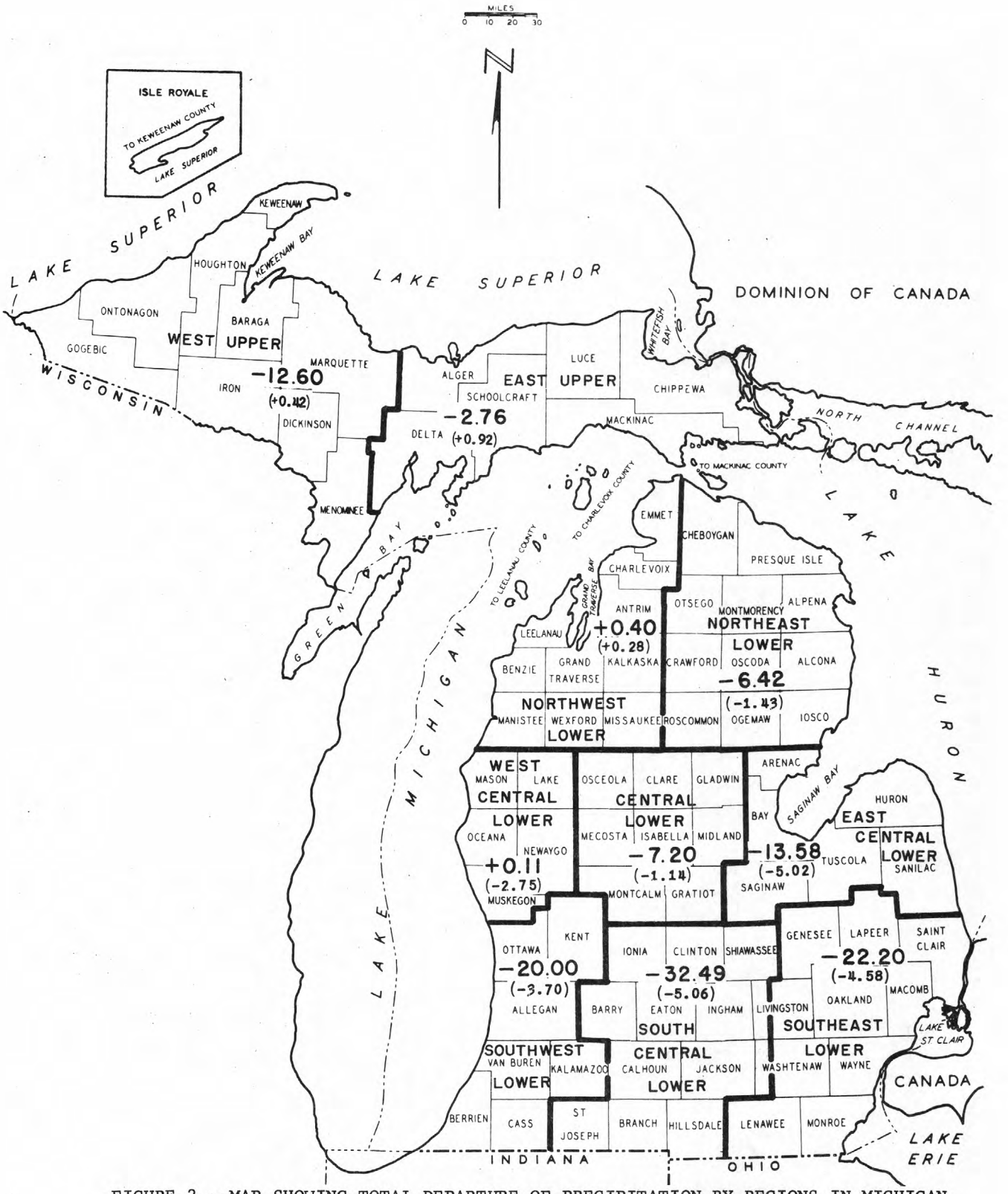

FIGURE 2.--MAP SHOWING TOTAL DEPARTURE OF PRECIPITATION BY REGIONS IN MICHIGAN, 1960-64.

Large deficiencies of precipitation occurred during this five-year period. The figures in parenthesis represent departure for the year 1964.

According to the U. S. Weather Bureau, precipitation in 1964 was below average in 7 of the 10 climatological divisions of the State. Departures ranged from 0.92 inches above in the eastern half of the upper peninsula to 5.06 inches below normal in the south-central part of the lower peninsula (fig. 2). The overall precipitation deficiencies of the past five years (fig. 2) have resulted in record- or near-record low ground-water levels, especially in the "south-central lower" area where precipitation has been very deficient. Many of the illustrations in this report include graphs showing the local cumulative departures of annual precipitation from the long-term mean. These graphs were constructed by using the "zero" or "average" line to denote the average precipitation for the period of record preceding the period of the graph. Starting at this line the excess or deficiency of precipitation for each month or year is added algebraically. Thus, for each time unit, a line sloping downward indicates below-average precipitation, and a line sloping upward indicates above-average precipitation. In cumulative graphs such as these, the slope of the line is the important part -- that is, even where the graph is far below the zero line, if the slope is upward, that part of the period is one of above-average precipitation. The end point thus gives the total rainfall above or below the previous average for the entire period of the graph.

Changes in ground-water storage from natural influences

Water levels in 11 key wells in Michigan continued to be low to record low in 1964 (fig. 3). Stages were especially low in the southern part of the lower peninsula. The low levels were the result of continuing deficiencies of precipitation in much of the State.

Levels in other wells throughout the State reflecting changes in storage from natural influences were also in low to record low stages (table 2).

In Chippewa County water levels in a key well (fig. 4) rose in 1964 in response to above-average precipitation following four years of decline.

A typical spring rise and summer decline of water levels is shown by charts A and B in figure 5.

In addition to changes in water levels in wells from the effects of precipitation, such phenomena as earth tide, barometric pressure variations, evapotranspiration, and earthquakes also cause changes in levels. Evapotranspiration causes small daily losses in water levels in wells, but the others ordinarily cause only temporary changes.

Many earthquakes occurring in various parts of the world are recorded each year in Michigan observation wells as fluctuations in water level of short duration. At 5:36 p.m., Alaskan Standard Time (10:36 p.m. Eastern Standard Time) on Good Friday, March 27, 1964, a great earthquake crippled south-central Alaska. It released at least twice as much energy as the 1906 earthquake which wracked San Francisco, and was felt on land over an area of almost half a million square miles. Fifty of the eighty observation wells equipped with water-stage recorders in Michigan registered fluctuations resulting from the seismic wave caused by this Alaskan quake. Table 1 lists the wells and records of these fluctuations

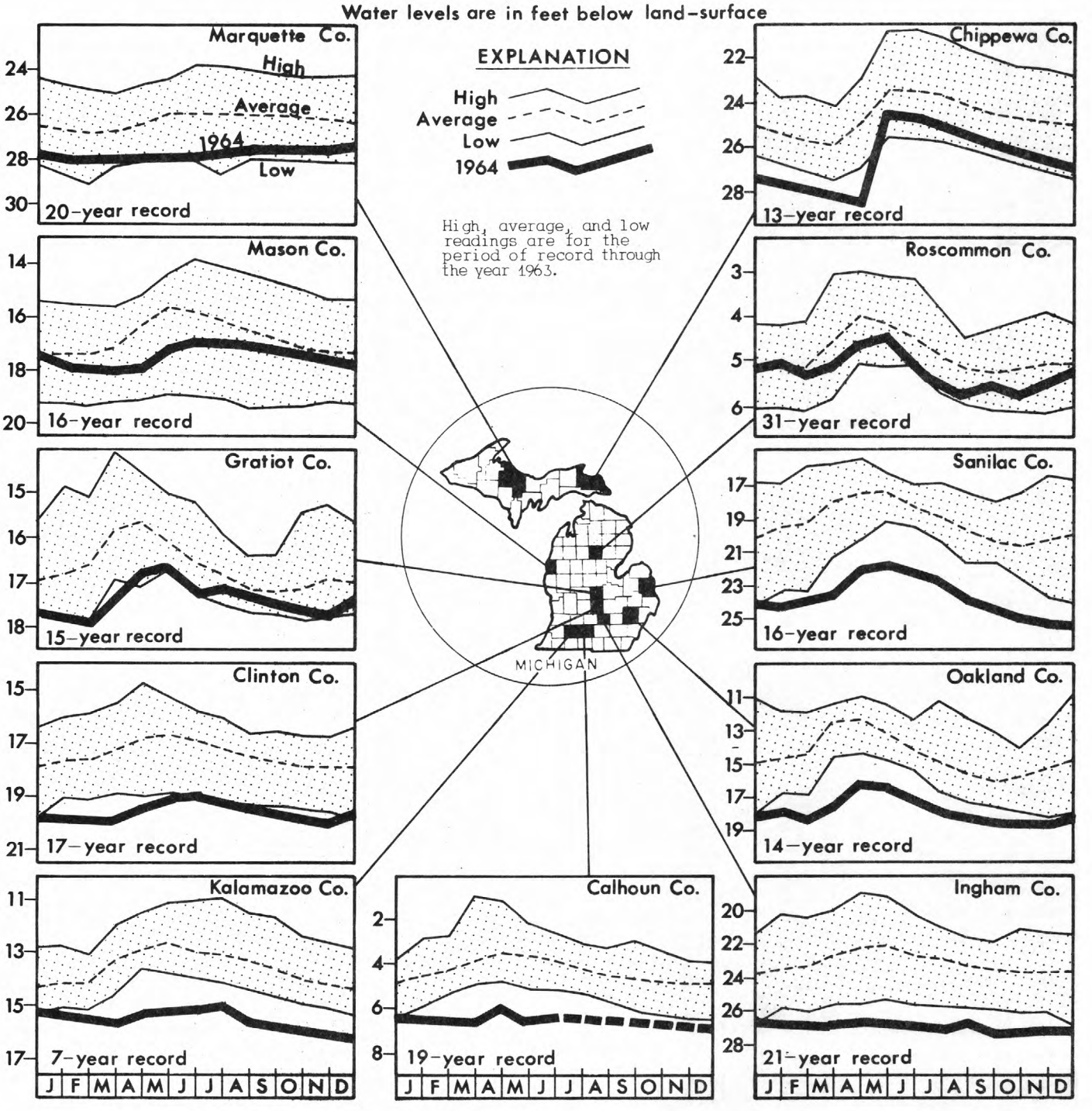

FIGURE 3.--GRAPHS SHOWING MONTH-END LEVELS IN KEY OBSERVATION WELLS IN MICHIGAN, 1964.

Water levels were especially low in the southern half of the Lower Peninsula.

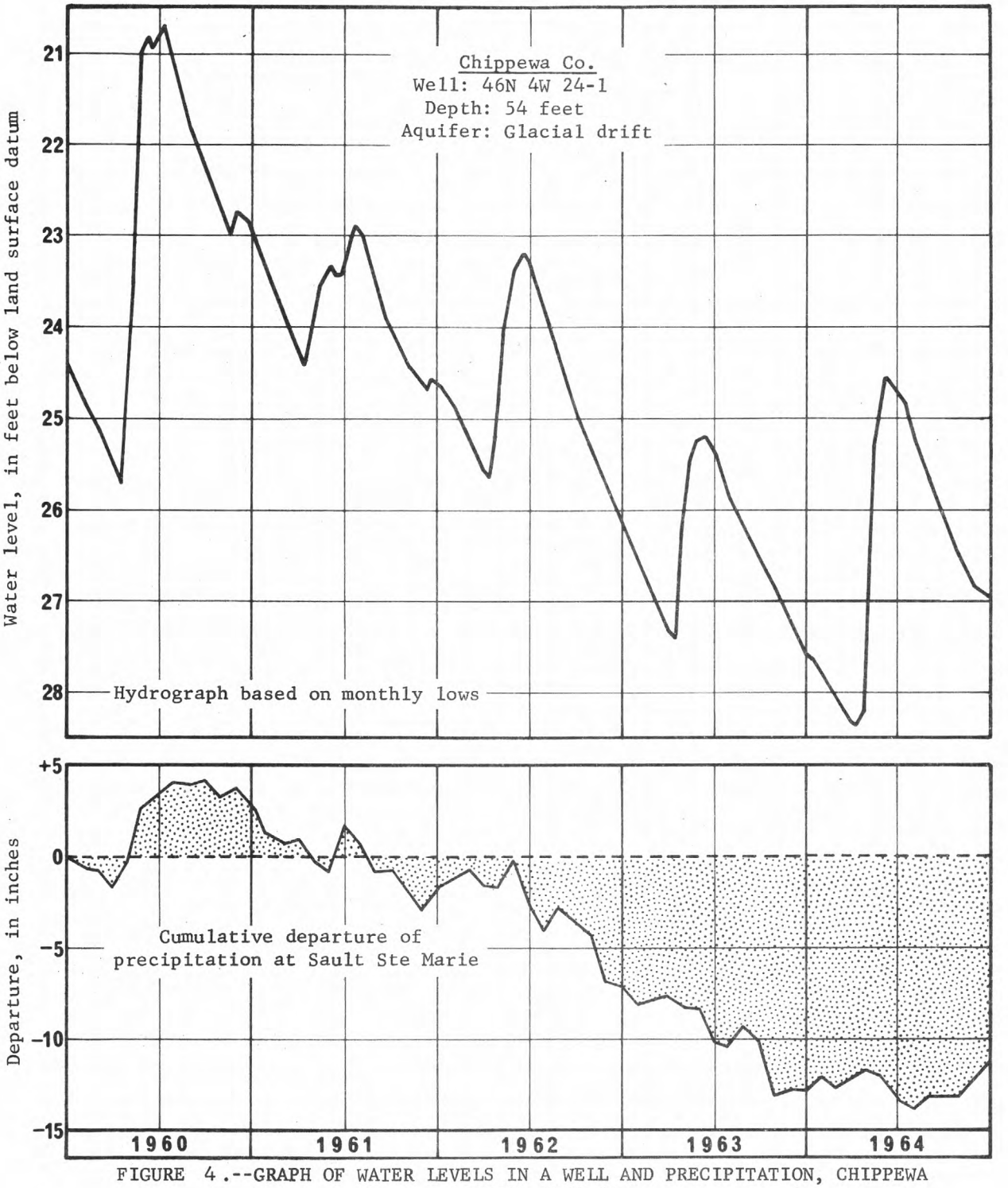

FIGURE 4.--GRAPH OF WATER LEVELS IN A WELL AND PRECIPITATION, CHIPPEWA COUNTY, 1960-64.

This is a striking example of the correlation between precipitation and water levels in a well.

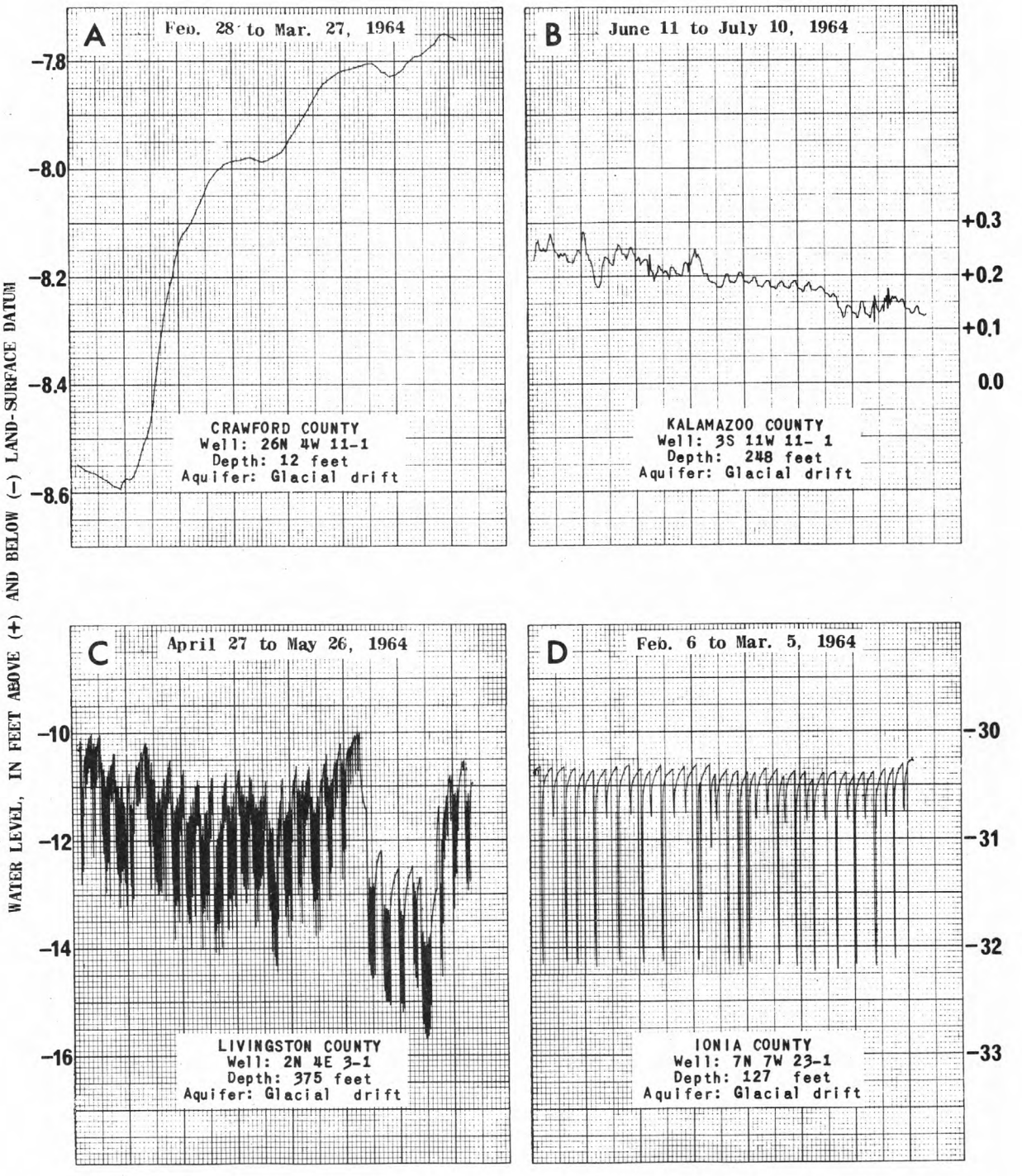

FIGURE 5.--RECORDER CHARTS SHOWING FLUCTUATIONS OF WATER LEVELS IN FOUR WELLS IN THE LOWER PENINSULA.

Chart A shows the annual spring rise of water levels; Chart B shows typical summer decline; Charts C & D show fluctuation of water levels in response to nearby pumping.

Table 1.--Fluctuations of water levels in some Michigan observation wells in response to the great Alaskan earthquake.--Continued.

County and Well No.	Owner	Well Depth (feet)	*Chief aqui-fer	Depth to water below land surface datum, in feet				Total range
				Before	After	High	Low	
Ionia Co.								
7N 7W 25-1	Ionia State Hospital	23	Qgd	16.920	16.915	16.905	16.92	0.015
Jackson Co.								
3S 1W 2-1	City of Jackson	221	Mm	38.50	38.50	36.83	40.56	3.73
3S 1W 10-1	Summit Township	323	Ps, Mm	31.65	31.65	30.92	32.49	1.57
3S 1W 11-3	City of Jackson	46	Qgd	12.00	12.00	11.96	12.04	0.08
Kalamazoo Co.								
2S 11W 20-11	City of Kalamazoo	81	Qgd	17.20	17.20	17.17	17.23	0.06
2S 11W 20-11	Do.	81	Qgd	17.185	17.185	[c]17.165	[c]17.205	[c]0.04
3S 12W 11-1	Do.	248	Qgd	+0.365	+0.365	+0.485	+0.285	0.20
Kent Co.								
6N 12W 27-1	City of Wyoming	265	Mm	52.65	52.65	52.25	53.05	0.80
6N 9W 3-1	City of Lowell	70	Qgd	17.55	17.55	17.53	17.57	0.04
6N 12W 34-1	City of Wyoming	300	Mm	68.21	68.21	[a]65.71	[a]70.71	[a]5.00
5N 12W 4-7	Do.	227	Mm	8.63	8.63	8.44	8.85	0.41
5N 12W 4-3	Do.	86	Qgd	11.77	11.79	11.34	12.12	0.78
Livingston Co.								
2N 4E 3-1	Howell State Hospital	148	Ps	12.75	12.75	10.48	15.02	4.54
Mackinac Co.								
42N 2W 7-1	U. S. Forest Service	102	Sm	25.70	25.70	23.50	28.30	4.80
Manistee Co.								
21N 17W 14-1	City of Manistee	212	Qgd	33.06	33.06	32.93	33.235	0.305
Marquette Co.								
47N 28W 3-1	Ely Township	75	Qgd	19.09	19.10	18.79	19.54	0.75
Oakland Co.								
3N 9E 36-1	Waterford Township	134	Qgd	96.78	96.78	96.75	96.81	0.06
3N 10E 13-2	Oakland Univ.	183	Qgd	86.80	86.80	85.75	87.85	2.10
3N 10E 31-1	City of Pontiac	173	Qgd	78.85	78.85	78.50	79.30	0.80
3N 10E 32-1	Do.	160	Qgd	79.90	79.90	79.10	81.00	1.90
3N 11E 4-1	Village of Rochester	73	Qgd	28.60	28.60	28.35	28.85	0.50

Table 1.--Fluctuations of water levels in some Michigan observation wells in response to the great Alaskan earthquake.

This earthquake occurred in south-central Alaska on Good Friday, March 27, 1964, at 5:36 p.m., Alaskan Standard Time (10:36 Eastern Standard Time). Major fluctuations of water levels occurred between 11:00 and 11:30 p.m., March 27, in Michigan.

County and Well No.	Owner	Well Depth (feet)	*Chief aquifer	Depth to water below land surface datum, in feet				Total range
				Before	After	High	Low	
Bay Co.								
17N 4E 22-1	Pinconning Township	110	Ps	5.35	5.35	5.17	5.53	0.36
Calhoun Co.								
1S 7W 32-3	Penfield Township	95	Mm	25.00	25.00	23.73	26.01	2.28
2S 8W 2-1	Oliver Electric Mfg. Co.	92	Mm	15.25	15.25	14.24	15.81	1.27
Clinton Co.								
5N 2W 31-1	Mich. Dept. of Aeronautics	195	Ps	61.22	61.22	61.06	61.41	0.35
Delta Co.								
39N 23W 28-3	M & S Blake	530	Cm	2.94	2.94	1.82	4.04	2.22
Eaton Co.								
3N 3W 2-1	City of Lansing	66	Qgd	4.04	4.04	3.83	4.19	0.36
4N 4W 11-1	City of Grand Ledge	350	Ps	2.51	2.51	2.35	2.62	0.27
4N 4W 2-1	Do.	376	Ps	29.77	29.77	29.765	29.78	0.015
4N 3W 12-1	F. A. Wheeler	381	Ps	81.88	81.88	81.46	82.34	0.86
Genesee Co.								
7N 7E 17-1	Consumers Power Company	222	Ps	25.68	25.68	[a]24.68	[a]26.68	[a]+2.00
7N 7E 17-1	Do.	222	Ps	25.67	25.67	[b]25.23	[b]26.16	[b] 0.93
Gogebic Co.								
48N 47W 34-2	City of Ironwood	35	Qgd	0.71	0.69	0.0	1.35	1.35
48N 47W 34-3	Do.	22	Qgd	3.04	3.04	2.16	3.78	1.62
48N 47W 31-1	Do.	115	Qgd	22.40	22.40	21.80	22.98	1.18
Ingham Co.								
4N 2W 24-1	Mich. State Univ.	453	Ps	65.10	65.10	64.18	65.92	1.74
4N 1W 27-1	Do.	278	Ps	6.85	6.85	[a]7.35	[a]6.35	[a]+1.00
4N 1W 27-1	Do.	278	Ps	6.86	6.86	[b]6.83	[b]6.88	[b] 0.05
4N 1E 21-1	Duncan Lumber Co.	265	Ps	21.525	21.525	21.47	21.58	0.11
3N 2W 23-2	Delhi Township	268	Ps	7.33	7.33	[a]6.83	[a]7.83	[a]+1.00
2N 1W 5-2	City of Mason	210	Ps	22.50	22.50	22.31	22.685	0.375

Table 1.--Fluctuations of water levels in some Michigan observation wells in response to the great Alaskan earthquake.--Continued

County and Well No.	Owner	Well Depth (feet)	*Chief aquifer	Depth to water below land surface datum, in feet				Total range
				Before	After	High	Low	
Presque Isle Co.								
33N 6E 15-1	H. Ennest	31	Dt	6.90	6.90	6.45	7.35	0.90
Schoolcraft Co.								
47N 16W 30-1	Mich. Dept. of Conservation	57	Op	15.45	15.45	15.38	15.53	0.15
Van Buren Co.								
4S 16W 22-1	Frigid Foods Co.	134	Qgd	27.46	27.46	27.455	27.465	0.01
Washtenaw Co.								
3S 6E 16-3	City of Ann Arbor	55	Qgd	e12.50	e12.50	e12.15	e12.85	e0.70
3S 7E 5-1	City of Ypsilanti	69	Qgd	3.34	3.34	3.28	3.39	0.11
3S 7E 9-3	Do.	94	Qgd	66.34	66.34	66.29	66.41	0.12
3S 7E 24-6	Federal Works Agency	75	Qgd	33.51	33.51	33.20	34.37	1.17
Wayne Co.								
1S 8E 17-1	City of Plymouth	114	Qgd	53.90	53.90	53.32	54.49	1.17
Wexford Co.								
21N 9W 4-1	City of Cadillac	277	Qgd	25.955	25.955	25.775	26.06	0.285

[a] Ink line completely around chart on drum. Full amplitude greater than shown
[b] Aftershock 1/2 hour later
[c] Aftershock 13 hours later
[e] estimated

*Chief Aquifer:
- Qgd - Glacial drift deposits of Pleistocene (Quaternary) age
- Ps - Saginaw Formation of Pennsylvanian age
- Mm - Marshall Formation of Mississippian age
- Dt - Traverse Group of Middle and Late Devonian age
- Sm - Manistique Dolomite of Middle Silurian age
- Op - Prairie du Chien Group of Early Ordovician age (previously designated as Au Train Formation)
- Cm - Munising Sandstone of Cambrian age

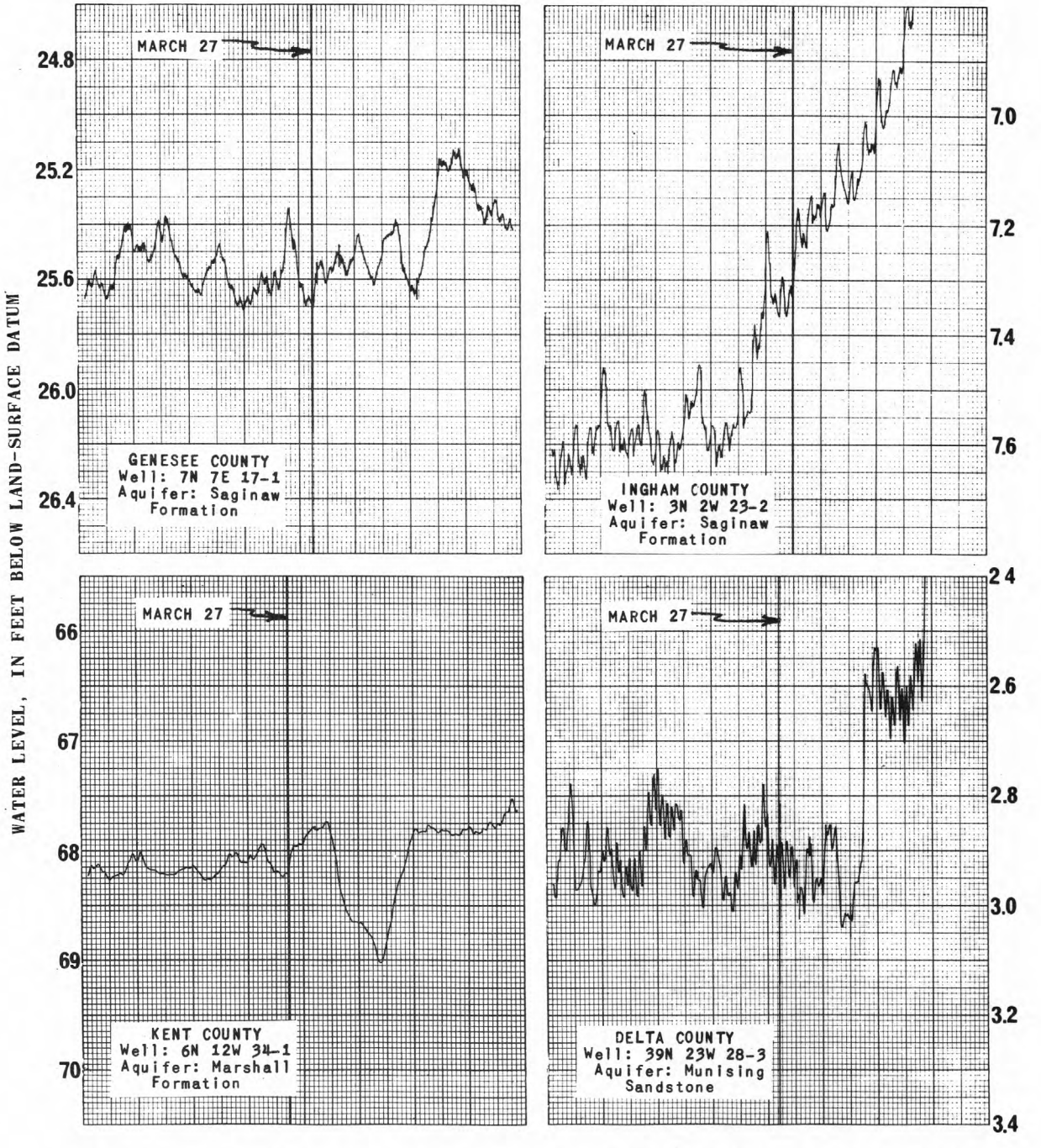

FIGURE 6.--RECORDER CHARTS SHOWING FLUCTUATION OF WATER LEVELS IN FOUR WELLS AS A RESULT OF THE MARCH 27 (GOOD FRIDAY) ALASKAN EARTHQUAKE.

In each of these wells the fluctuations exceeded the total circumference of the chart and ranged from over a foot to more than five feet.

in Michigan. The total vertical double amplitude of fluctuations as recorded ranged from as little as 0.01 of a foot to over 5.00 feet. The apparent time of the fluctuations in Michigan wells was about an hour after the time of occurrence of the earthquake in Alaska. A few wells also recorded aftershocks from this same series of quakes.

The four charts from recording gages (fig. 6) are examples of the fluctuations that occurred as a result of the Alaskan earthquake. The fluctuations exceeded the circumference of the charts on the recording drum so that the exact amount of rise and fall is not known.

Changes in storage from pumping influences

In areas where ground water is used for municipal or industrial supplies, hydrographs of water levels in observation wells show the relation between discharge from wells and natural, induced, and artificial recharge to aquifers. Declines, except as caused by precipitation deficiencies, generally indicate depletion of storage in the aquifers caused by pumping. An effective method of determining the amount of water available from an aquifer is the analysis of long-term records of water levels and pumpage.

Many of the water-level records in pumped areas are obtained by means of continuous recorders. These recording stations provide for the continuous collection of basic water-level data, which serve to indicate both the day-to-day and also the long-term effects of pumping. This information can be used by municipalities, industries, institutions or their consultants to estimate the capacity of aquifers to meet present and future demands for water, to determine the desirable separation between wells, and whether expansion of present ground-water supply systems is practicable.

In 1964 many record and near-record lows of water levels were recorded in the heavily-pumped areas of the State. Large deficiencies of precipitation contributed to these record lows, but some of the decline was caused by increased pumpage in the areas. Increasing population, industrial growth and modern water uses create large additional demands for water. These demands for additional water result in increased pumping and lowered water levels and often in need for expansion of water supply facilities. In one sense, water supply problems are a general symptom of a healthy growing community.

Examples of drawdown effects on water levels of nearby pumping are shown by recorder charts C and D (fig. 5). The vertical lines represent 8-hour time intervals.

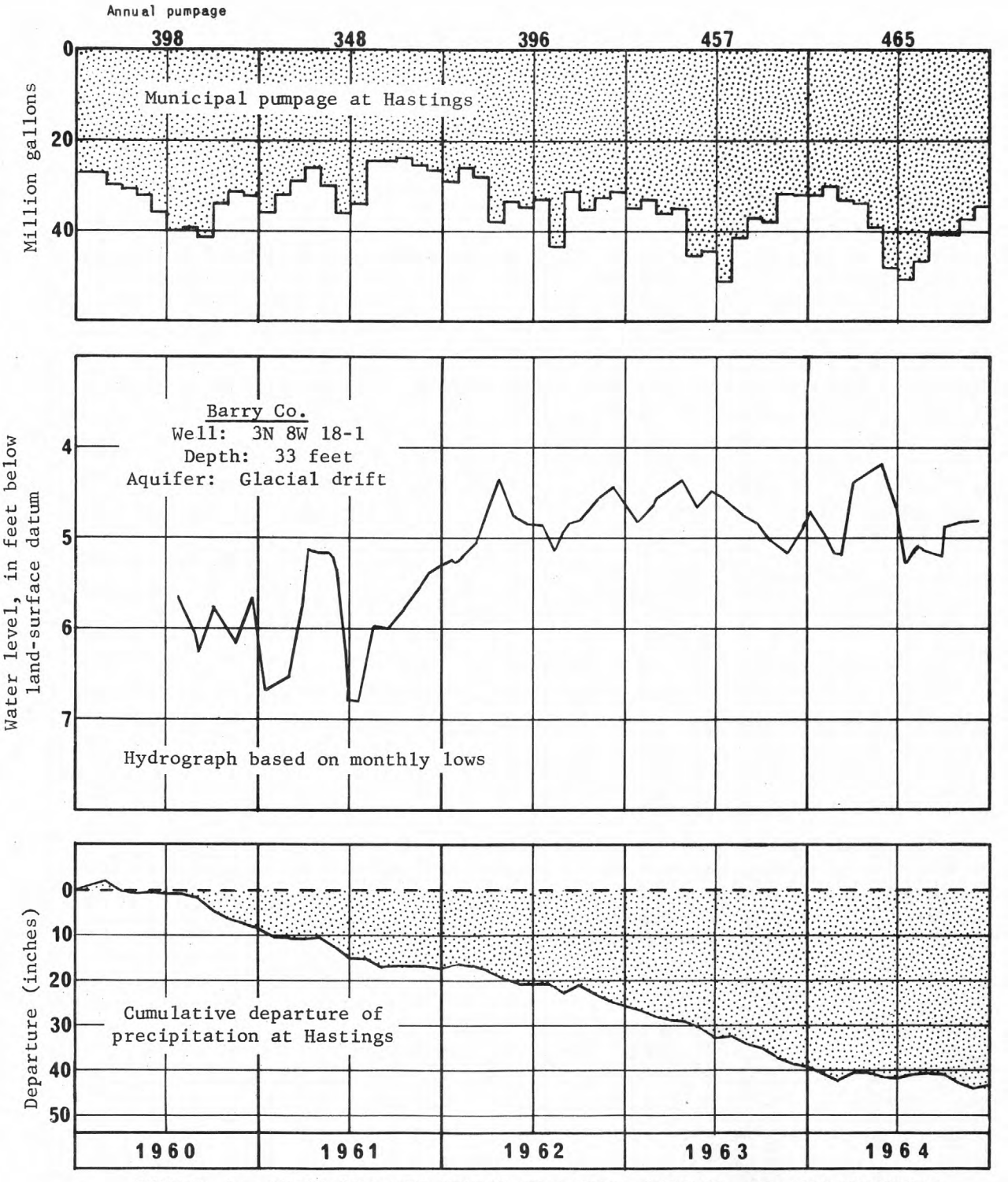

FIGURE 7.--GRAPH OF WATER LEVELS IN A WELL, PUMPAGE, AND PRECIPITATION AT HASTINGS, 1960-64.

Water levels in this well are higher since mid-1961 because of decreased pumpage from the drift aquifer and despite the deficiency of precipitation.

BARRY COUNTY - CITY OF HASTINGS

Water supply -- Four wells -- nos. 2 & 3, about 55 feet deep, are finished in glacial drift; no. 1 is 339 feet and no. 4 is 350 feet deep and tap sandstones of the Marshall Formation.

Yield of wells in gallons per minute -- No. 1 - 1,525; nos. 2 & 3 - 750; no. 4 - 1,725.

Specific capacity of wells in gallons per minute per foot of drawdown -- No. 1 - 25; nos. 2 & 3 - 58; no. 4 - 100.

Pumpage in 1964 -- 465 million gallons.
Maximum day -- 2.56 million gallons.

Storage facilities -- 550,000 gallons elevated (S. Tank - 300,000; N. Tank - 250,000).

Quality of water -- Drift wells have hardness of 325-340 ppm and iron 0.0-0.2 ppm. Rock wells have hardness of 280 ppm and iron 0.4 ppm.

Treatment -- Fluoridation.

Population served -- 6,375.
Per capita use -- 199 gallons per day.

Ground-water conditions -- Water levels in the glacial drift observation well remained high in 1964 despite continued deficiencies of precipitation amounting to over 43 inches for the 1960-64 period (fig. 7). The higher levels in the drift aquifer are the result of large use (90%) of water from the Marshall Formation since 1961 with a corresponding decrease in use of water from the drift. Artesian pressures in the Marshall are above land surface at Hastings. However, no observation well is available at this time to gage the levels or observe the effects of withdrawals of water locally from the Marshall.

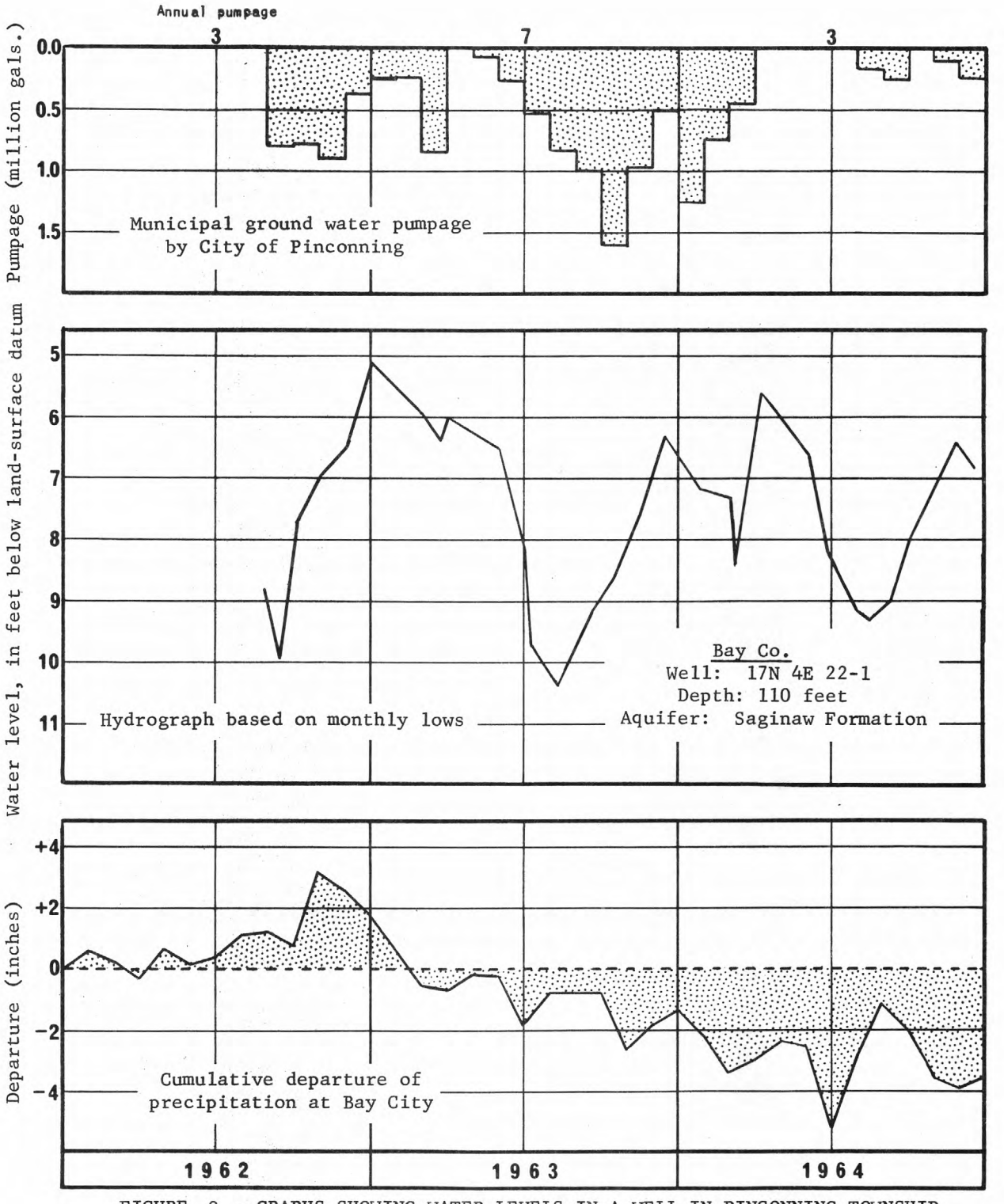

FIGURE 8.--GRAPHS SHOWING WATER LEVELS IN A WELL IN PINCONNING TOWNSHIP, PUMPAGE AT PINCONNING, AND PRECIPITATION, 1962-64.

Precipitation variations influence the water levels more than the small amount of pumpage by the City of Pinconning.

BAY COUNTY - PINCONNING TOWNSHIP

Water supply -- The only public supply in the Township is at the City of Pinconning. Water is obtained from Saginaw Bay, supplemented by a well, 110 feet deep, tapping sandstones of the Saginaw Formation.

Yield of wells in gallons per minute -- 70.

Specific capacity of wells in gallons per minute per foot of drawdown -- 1.1.

Pumpage in 1964 -- 3.15 million gallons from a well.* 76.52 million gallons from the Bay (*About 2% of the Bay water is used for back flushing filters.)

Storage facilities -- 75,000 gallons elevated.

Quality of water -- Saginaw Bay: Hardness 125 ppm, Iron 0 ppm, Chloride 25 ppm. Well water: Hardness 650 ppm, Chloride 60-106 ppm

Treatment -- Standard Filtration.

Population served -- 1,324.
Per capita use -- 162 gallons per day.

Ground-water conditions -- Records of ground-water levels in the area were continued in 1964 by the maintenance of a continuous recorder on a well in Pinconning Township. The light pumpage by the City appears to have less effect on the levels in the observation well than precipitation. Levels were highest at the end of 1962 when precipitation was above average. The subsequent overall deficiency of about 6 inches in the 1963-64 period resulted in a decline of two feet in water level at the end of 1964 as compared to the end of 1962 (fig. 8).

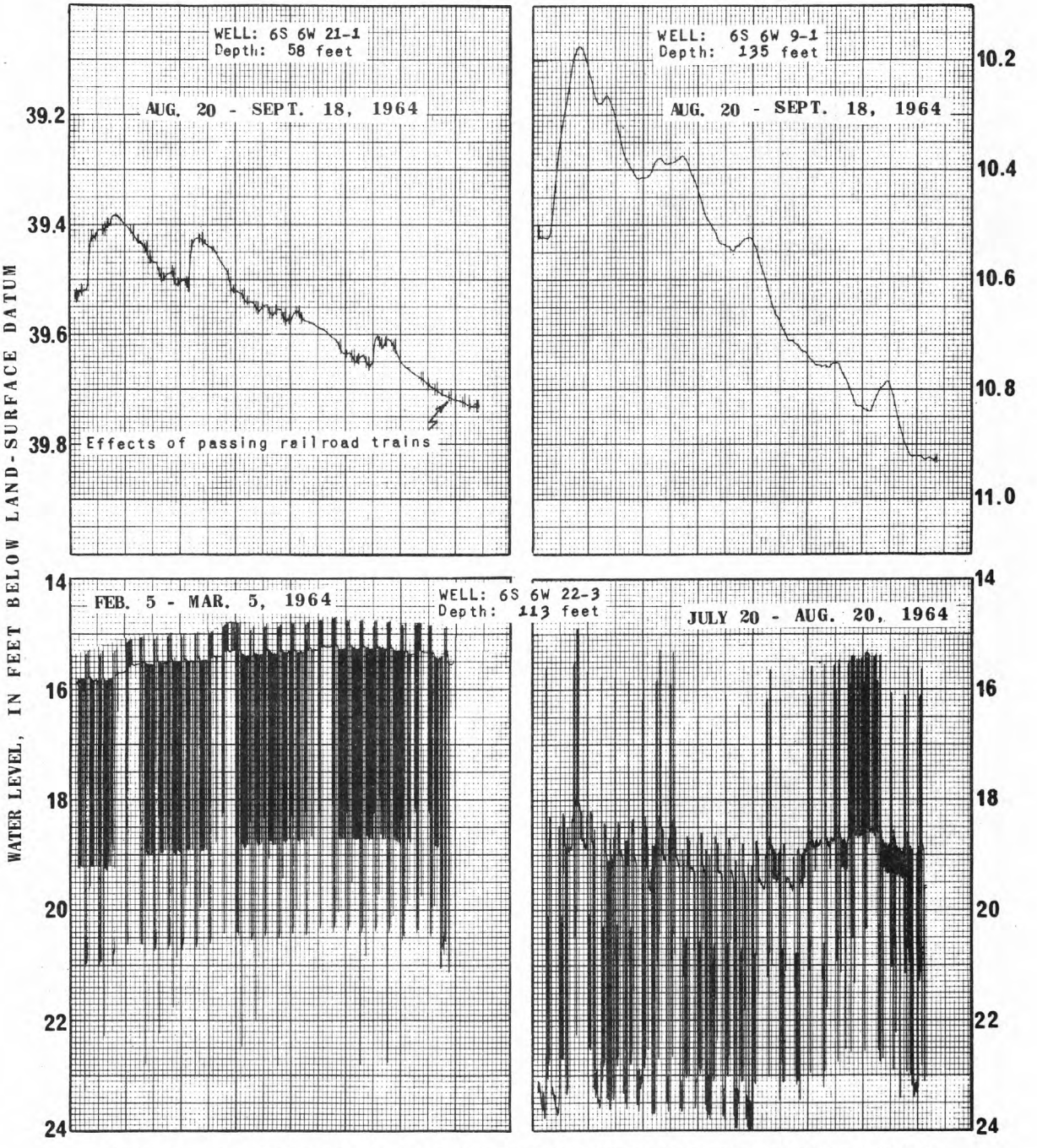

FIGURE 9.--RECORDER CHARTS SHOWING CHANGES IN WATER LEVELS IN THREE WELLS IN AND NEAR COLDWATER IN BRANCH COUNTY.

The upper two charts show the general decline of water levels during the growing season. The lower two charts show the effects of nearby pumping of municipal wells at the Coldwater well field.

BRANCH COUNTY - CITY OF COLDWATER

Water supply -- Three wells in 1964 finished in glacial drift 121-132 feet deep.

Yield of wells in gallons per minute -- No. 3 - 1,200; no. 4 - 1,400; no. 5 - 2,250.

Specific capacity of wells in gallons per minute per foot of drawdown -- No. 3 - 235; no. 4 - 160; no. 5 - 150.

Pumpage in 1964 -- 918 million gallons.
Maximum day -- 5.37 million gallons.

Storage facilities -- 300,000 gallons elevated.

Quality of water -- Hardness 175-295 parts per million
Iron 1.1-1.5 parts per million

Treatment -- Chlorination, calgon and phosphate for iron treatment.

Population served -- estimated 9,000.
Per capita use -- 280 gallons per day.

Ground-water conditions -- A 2-year study of the water resources of Branch County in cooperation with the county and the Michigan Department of Conservation was begun in 1964 with completion due in June, 1966. Some 29 observation wells, 3 of which were equipped with recording gages, were measured in 1964. Four recorder charts (about 1/3 actual size) from these three recording gages are shown in figure 9. The graphs show typical water-level fluctuations in these three wells. The two upper charts show the general summer decline, the effects of distant pumpage on water levels and weekly rises indicating decreased area pumpage during weekends. The small vertical fluctuations in chart of well 21-1 are the results of compressional loading on the aquifer by passing railroad trains. The two lower charts are from the observation well located at the City of Coldwater's well field. Here, the water levels fluctuate sharply from the effects of heavy pumping by three wells varying from about 10 feet to about 500 feet from the observation well. It is interesting to note the effects of pumping of one or combinations of the three pumping wells and also the difference in average pumping level in the summer and winter seasons. The municipal wells are among the highest producers in the State.

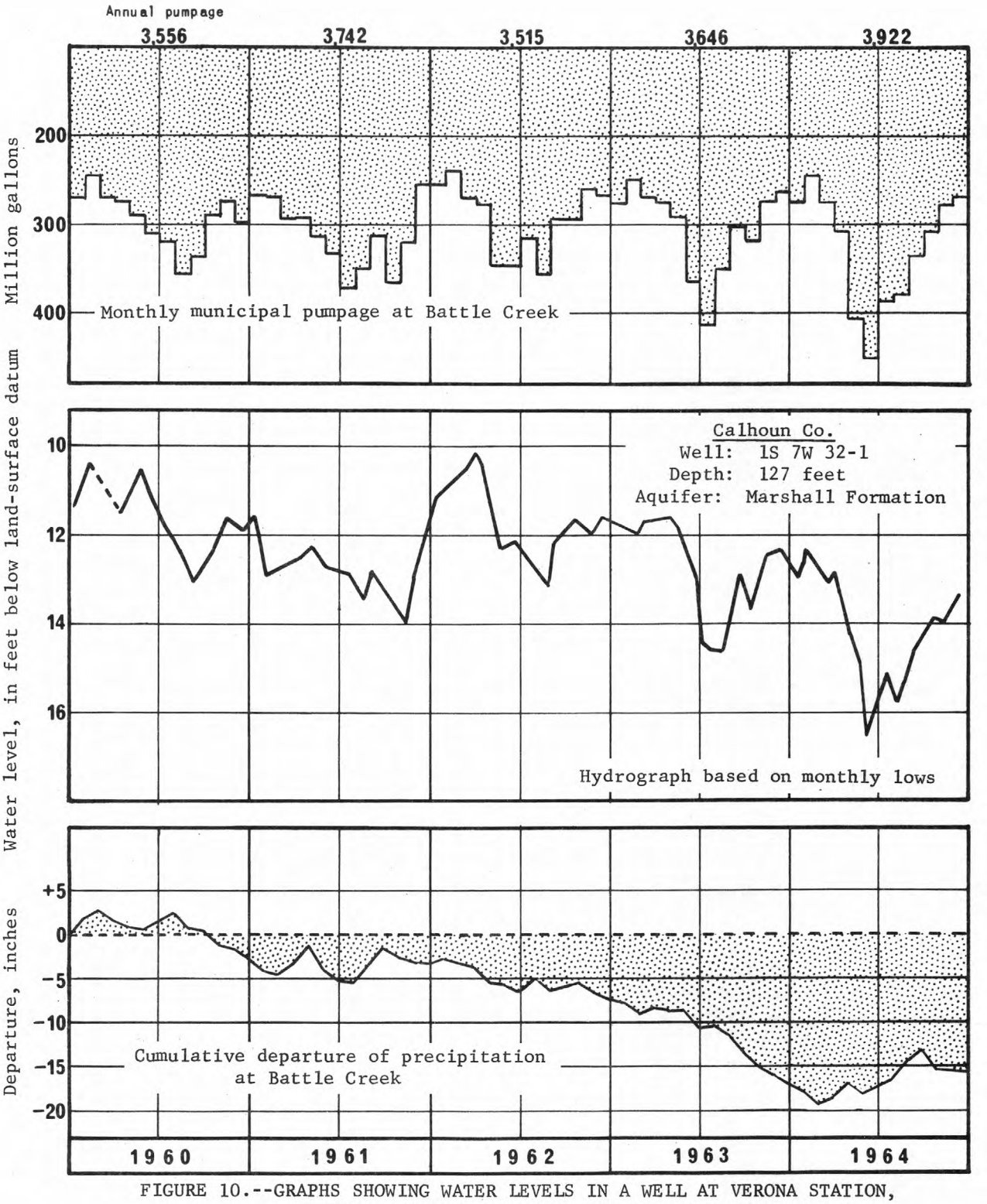

FIGURE 10.--GRAPHS SHOWING WATER LEVELS IN A WELL AT VERONA STATION, PUMPAGE AND PRECIPITATION, AT BATTLE CREEK, 1960-64.

Despite above-average precipitation in 1964 water levels fell as pumpage was increased.

CALHOUN COUNTY - CITY OF BATTLE CREEK

Water supply -- About 29 wells, 120-160 feet deep, are located at the Verona field and tap sandstones of the Marshall Formation. A few standby wells finished in glacial drift at depths of about 82-163 feet are located at the Goguac well field. These wells are seldom used.

Yield of wells in gallons per minute -- 300-1,000.

Specific capacity of wells in gallons per minute per foot of drawdown -- 50-650.

Pumpage in 1964 -- 3,922 million gallons.
Maximum day -- 21.10 million gallons.

Storage facilities -- 200,000 gallons at Plant; 4,100,000 gallons elevated.

Quality of water -- Composites of Verona wells - Hardness 240-285 ppm
Iron 0.05-5.0 ppm

Treatment -- Chlorination, fluoridation.

Population served -- 44,169.
Per capita use -- 243 gallons per day.

Ground-water conditions -- Despite above-normal precipitation in 1964 water levels in the observation well fell to near-record low at mid-year as the result of increased municipal pumpage (fig. 10). The lowest water levels were previously recorded in 1959 when a record 4.37 billion gallons of water were pumped from the Verona field.

Considering the amount of water being pumped, water levels are still high, and no serious dewatering has occurred at this field. The Verona field wells are collectively the most prolific in the State.

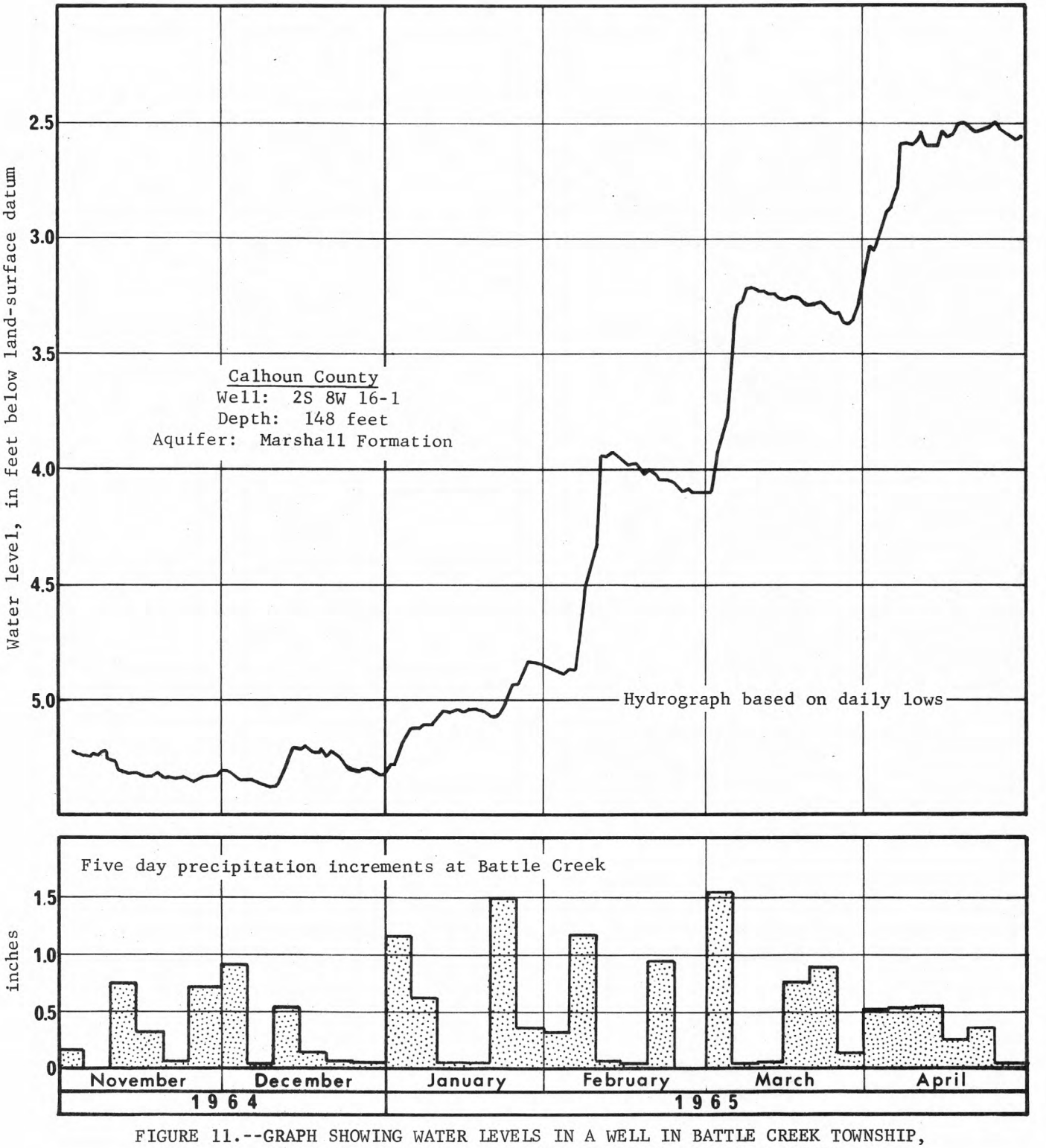

FIGURE 11.--GRAPH SHOWING WATER LEVELS IN A WELL IN BATTLE CREEK TOWNSHIP, AND PRECIPITATION, NOVEMBER 1964 THROUGH APRIL 1965.

The water levels in this observation well show the natural climatic effects prior to the start of pumping in this new Township well field.

CALHOUN COUNTY - BATTLE CREEK TOWNSHIP

Water supply -- Four wells, 143-165 feet deep, tap sandstones of the Marshall Formation.

Yield of wells in gallons per minute -- 950.

Specific capacity of wells in gallons per minute per foot of drawdown -- 10-20.

Pumpage in 1964 -- 375 million gallons.
Maximum day -- 3.06 million gallons.

Storage facilities -- 400,000 gallons elevated storage.

Quality of water -- Hardness 280-350 ppm
Iron 0.5-1.2 ppm

Treatment -- Chlorination.

Population served -- estimated 13,500.
Per capita use -- 76 gallons per day.

Ground-water conditions -- A water-level recording station was established on a well at a new well field for Battle Creek Township in November of 1964. The hydrograph (fig. 11) shows the effects of natural climatic conditions on the water levels. Although two municipal production wells have been installed they are not yet (1964) in operation. Levels are high and the effects of recharge from precipitation and snowmelt in late March and early April are reflected in rises of water levels in the observation well. Pumpage at this field is to begin in early 1965 from two new wells reportedly yielding about 1,000 gpm each.

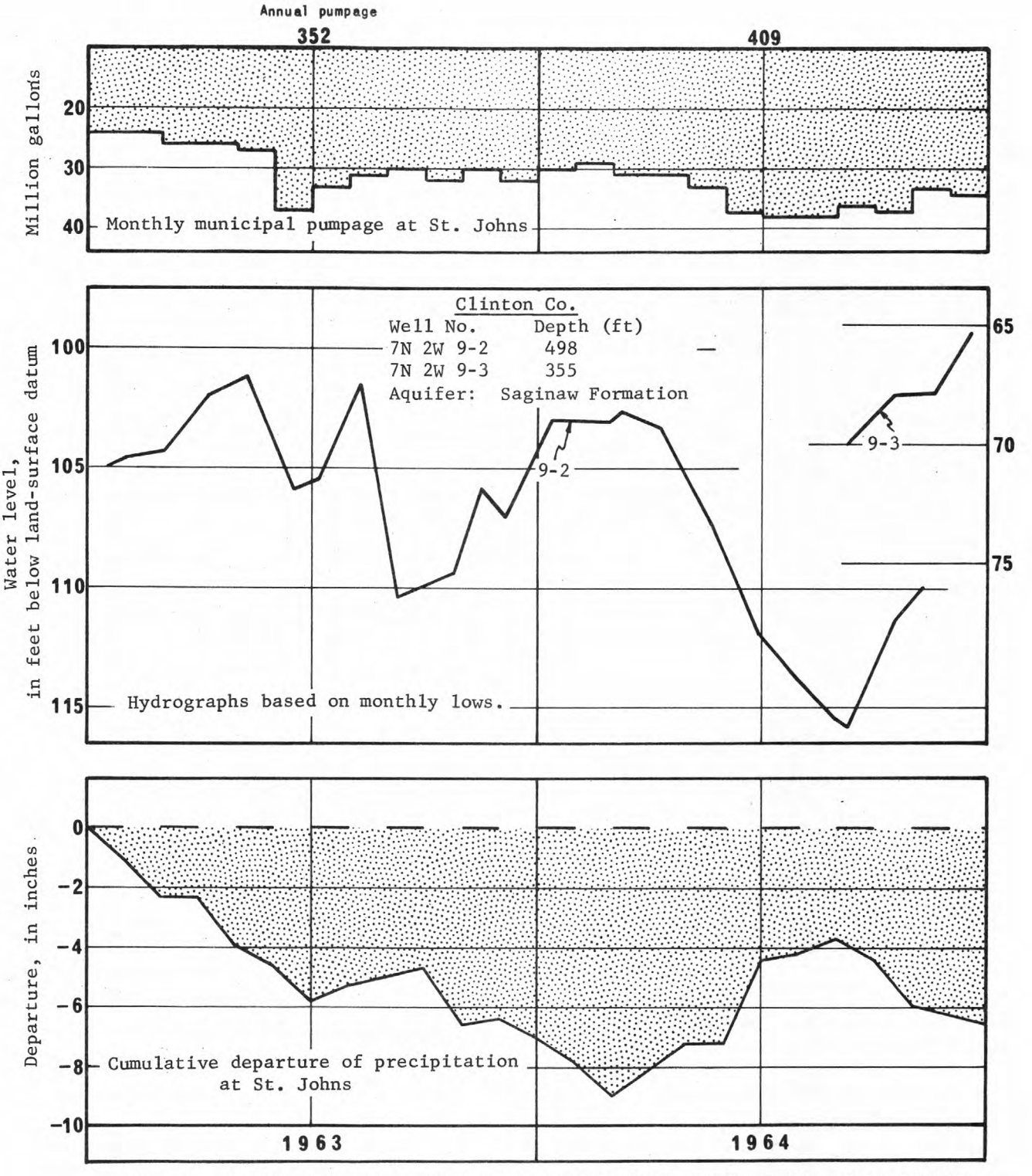

FIGURE 12.--GRAPHS SHOWING WATER LEVELS IN TWO WELLS, PUMPAGE AND PRECIPITATION, ST. JOHNS, 1963-64.

Well 9-3 replaced 9-2 in 1964 because the latter well was too close to pumping wells.

CLINTON COUNTY - CITY OF ST. JOHNS

Water supply -- Four wells, about 500 feet deep, tapping sandstones of the Saginaw Formation.

Yield of wells in gallons per minute -- reportedly average 900.

Specific capacity of wells in gallons per minute per foot of drawdown -- 3-5.

Pumpage in 1964 -- 409 million gallons.
Maximum day -- 1.57 million gallons.

Storage facilities -- 100,000 gallons elevated storage (not used in 1964).

Quality of water -- Hardness 340-359 ppm
Iron 0.2-1.8 ppm
Chlorides 10-80 ppm

Treatment -- None in 1964.

Population served -- 6,000.
Per capita use -- 187 gallons per day.

Ground-water conditions -- Levels in observation well 9-2, located at the City well field, fell in 1964 as the result of a 14% increase in pumpage and despite above-normal precipitation (fig. 12). Because of the large fluctuation range of from about 67 to 115 feet at this site (table 2, Clinton County), the recorder was moved to another well site about one-half mile to the north in late 1964. Here the range of fluctuation was only about 15 feet in late 1964 (table 2).

As the result of a study by a private consultant, 2 test wells were drilled in 1964 and 2 production wells were installed about 1/3 mile from the present well field to take advantage of higher water levels, and less pumping lift, than at the present well field.

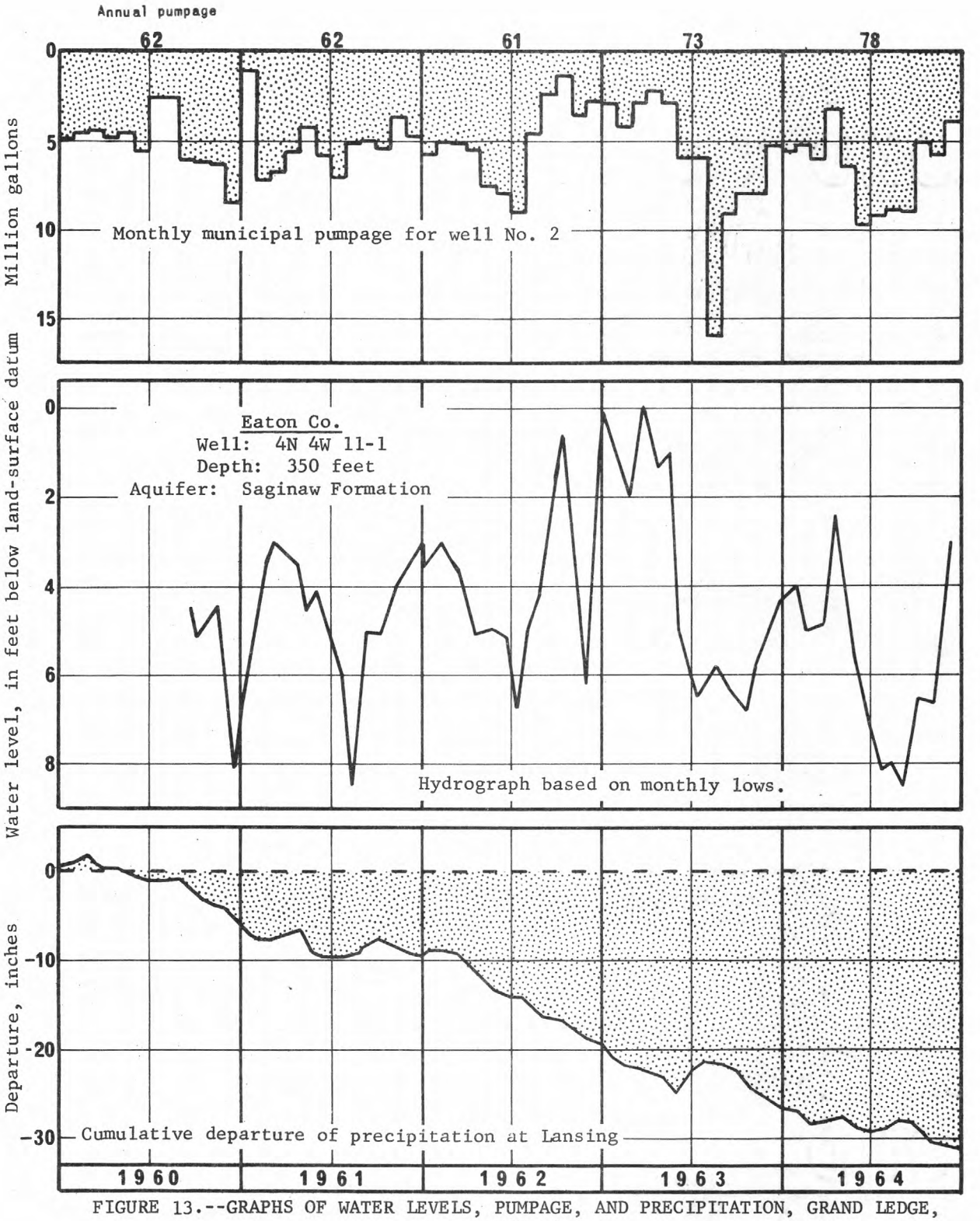

FIGURE 13.--GRAPHS OF WATER LEVELS, PUMPAGE, AND PRECIPITATION, GRAND LEDGE, 1960-64.

No significant decline has occurred despite deficient precipitation.

EATON COUNTY - CITY OF GRAND LEDGE

Water supply -- Three wells, nos. 2, 3, and 4, 241-400 feet deep, in sandstones of the Saginaw Formation.

Yield of wells in gallons per minute -- 300-525.

Specific capacity of wells in gallons per minute per foot of drawdown -- 3.5-10.

Pumpage in 1964 -- 161 million gallons.
Maximum day -- 0.94 million gallons.

Storage facilities -- 100,000 gallons elevated.

Quality of water -- Hardness 364-405 ppm
Iron 0.5-2.0 ppm
Fluoride 0.2-0.3 ppm

Treatment -- Chlorination, phosphate.

Population served -- 5,165.
Per capita use -- 85 gallons per day.

Ground-water conditions -- The observation well, 11-1, mostly reflects pumpage withdrawals by municipal well no. 2 (fig. 13) about 1/3 mile away. The precipitation deficiency shown in the illustration does not seem to affect the levels in this well although a departure of about 31 inches occurred in the 1960-64 period.

The water level in observation well 4N 4W 2-1 (Eaton County - Table 2, Chair Factory Site) about a mile from municipal pumping wells continued to decline in 1964 and fell to a new record low mostly as a result of deficient precipitation.

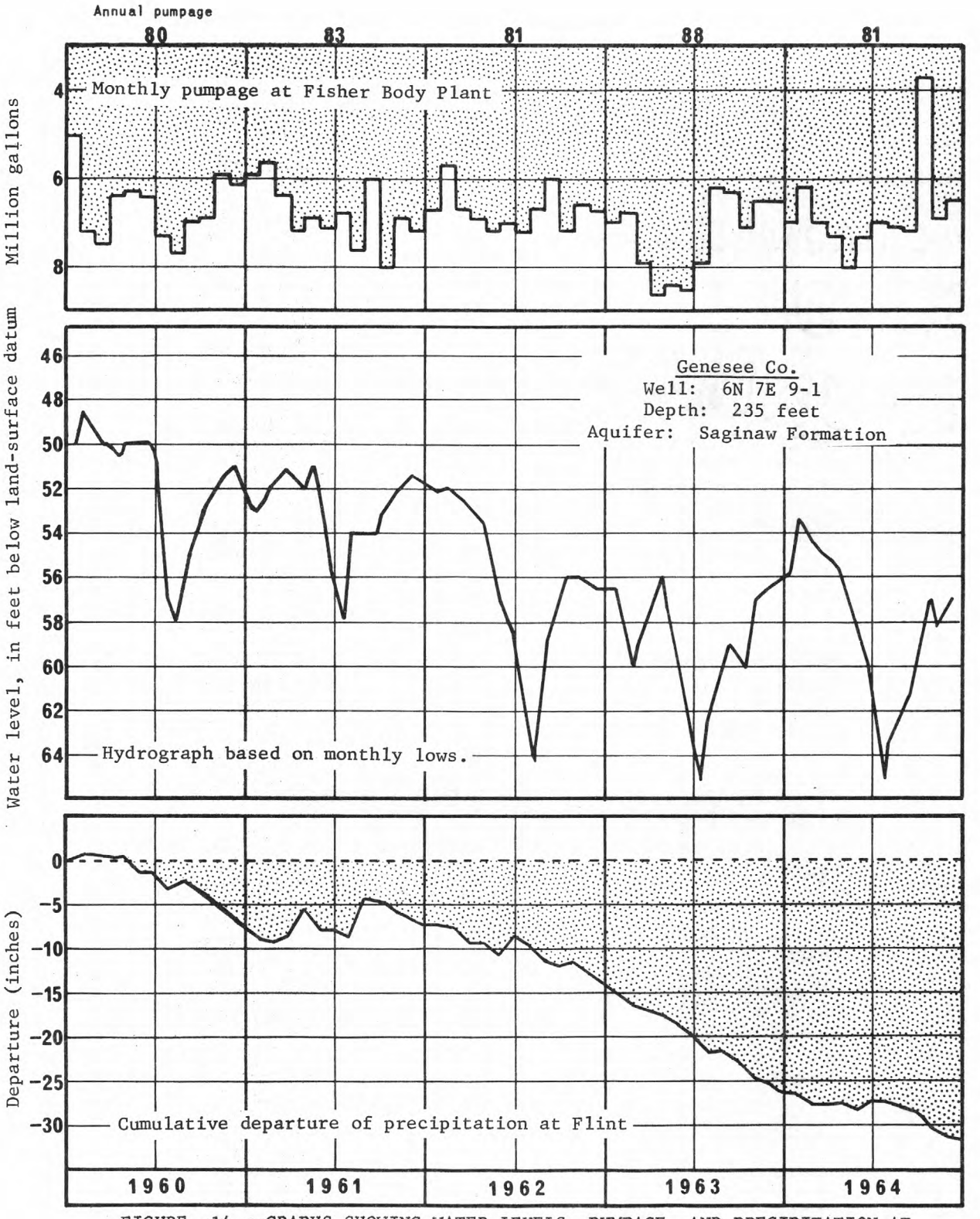

FIGURE 14.--GRAPHS SHOWING WATER LEVELS, PUMPAGE, AND PRECIPITATION AT THE FISHER BODY PLANT NEAR GRAND BLANC, 1960-64.

This area has lost nearly a year's rainfall in this five-year period.

GENESEE COUNTY - FISHER BODY, GMC, AT GRAND BLANC

Water supply -- Three wells, 200 to 275 feet deep, tap sandstones of the Saginaw Formation.

Yield of wells in gallons per minute -- 250-300.

Specific capacity of wells in gallons per minute per foot of drawdown -- 3-1/2 to 6-2/3.

Pumpage in 1964 -- 81.3 million gallons.

Storage facilities -- Ground and elevated: 100,000 plant
650,000 fire protection

Quality of water -- Hardness 255-344 ppm
Iron 0.4-1.0 ppm
Chloride 72-120 ppm

Treatment -- Phosphate and chlorination.

Ground-water conditions -- Despite continued deficiencies of precipitation no significant decline has occurred since mid-1962 and levels have remained relatively steady (fig. 14). Average low levels, however, are more than 20 feet below those recorded at the start of the record in the 1952-53 period.

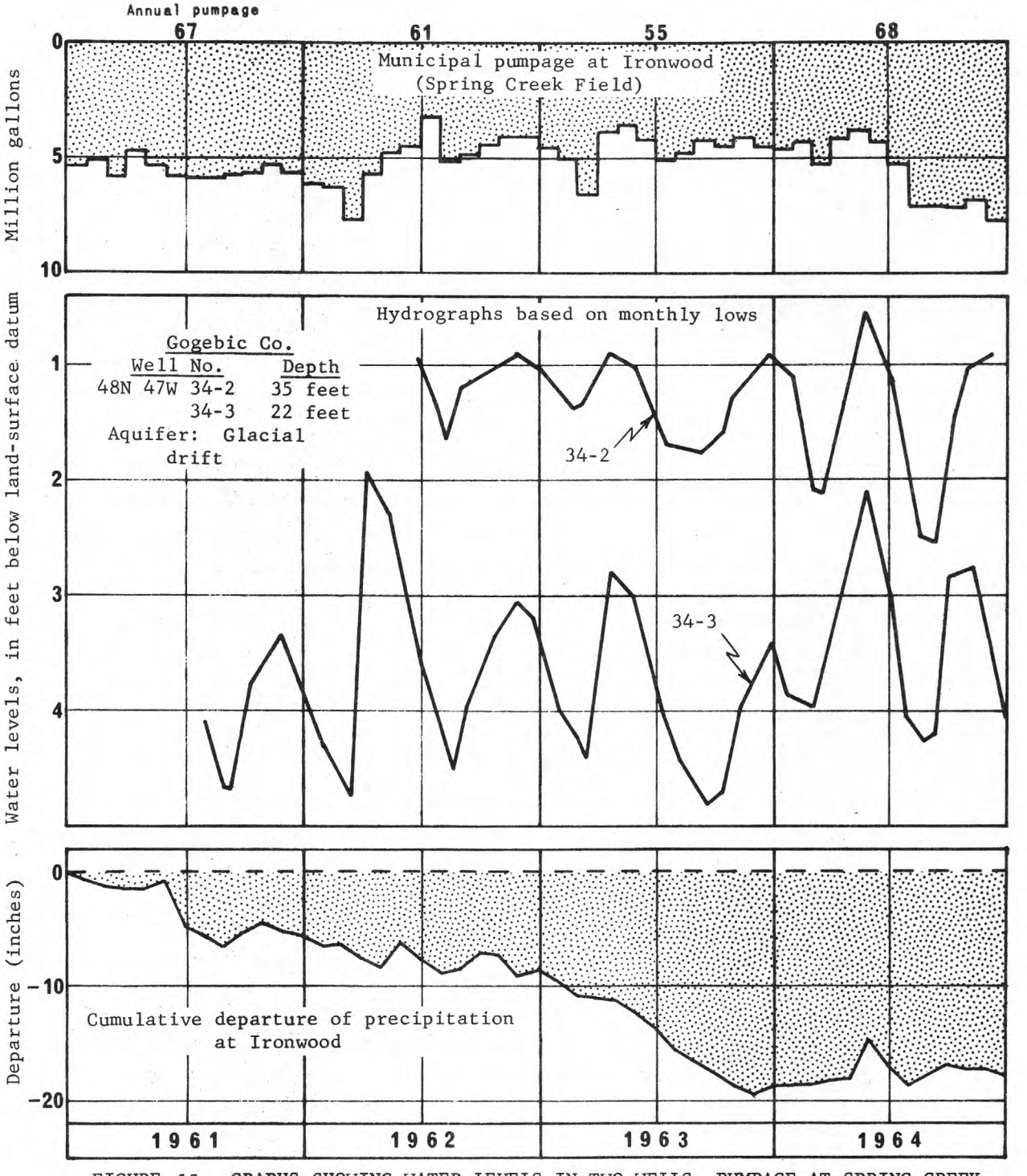

FIGURE 15.--GRAPHS SHOWING WATER LEVELS IN TWO WELLS, PUMPAGE AT SPRING CREEK FIELD, AND PRECIPITATION, IRONWOOD, 1961-64.

Despite deficient precipitation during the 4-year period water levels showed little change.

GOGEBIC COUNTY - CITY OF IRONWOOD

Water supply -- Five wells, 41 to 118 feet deep, finished in glacial drift at Spring Creek and Big Springs fields near Ironwood. No. 1 - 41 feet deep; Nos. 2 and 3 - 118 feet deep; No. 4 - 69 feet deep; and No. 5 - 47 feet deep. Nos. 1, 3 and 4 are 26-inch diameter and nos. 2 and 5 are 12-inch.

Yield of wells in gallons per minute -- No. 1 - 380; no. 2 - 135; no. 3 - 360; no. 4 - 200; no. 5 - 240.

Specific capacity of wells in gallons per minute per foot of drawdown -- No. 1 - 47; no. 2 - ?; no. 3 - 21; no. 4 - 6; no. 5 - 27.

Pumpage in 1964 -- 316 million gallons.
Maximum day -- 1.13 million gallons.

Storage facilities -- 1,000,000 gallons ground level on system, and 2,500,000 gallons elevated storage.

Quality of water -- Hardness 63-186 ppm
Iron 0.0-0.1 ppm
Chloride 4-63 ppm

Treatment -- Chlorination.

Population served -- estimated 11,500.
Per capita use -- 75 gallons per day.

Ground-water conditions -- Levels fell in well 34-2 in response to pumping (fig. 15) by new production well No. 5. An uptrend in levels occurred in well 34-3 as a result of less pumpage by production well No. 4. Water-table elevations at this field are high and about the level of Spring Creek. Despite deficient precipitation during the 4-year period no significant change in water levels has occurred.

At the Big Spring Field levels were higher at the end of 1964 than at the end of the previous year principally as a result of about 13% less pumpage (fig. 16) and the first above-average year of precipitation in 1961-64 period.

Location of well fields, production wells and observation wells is shown in figure 16.

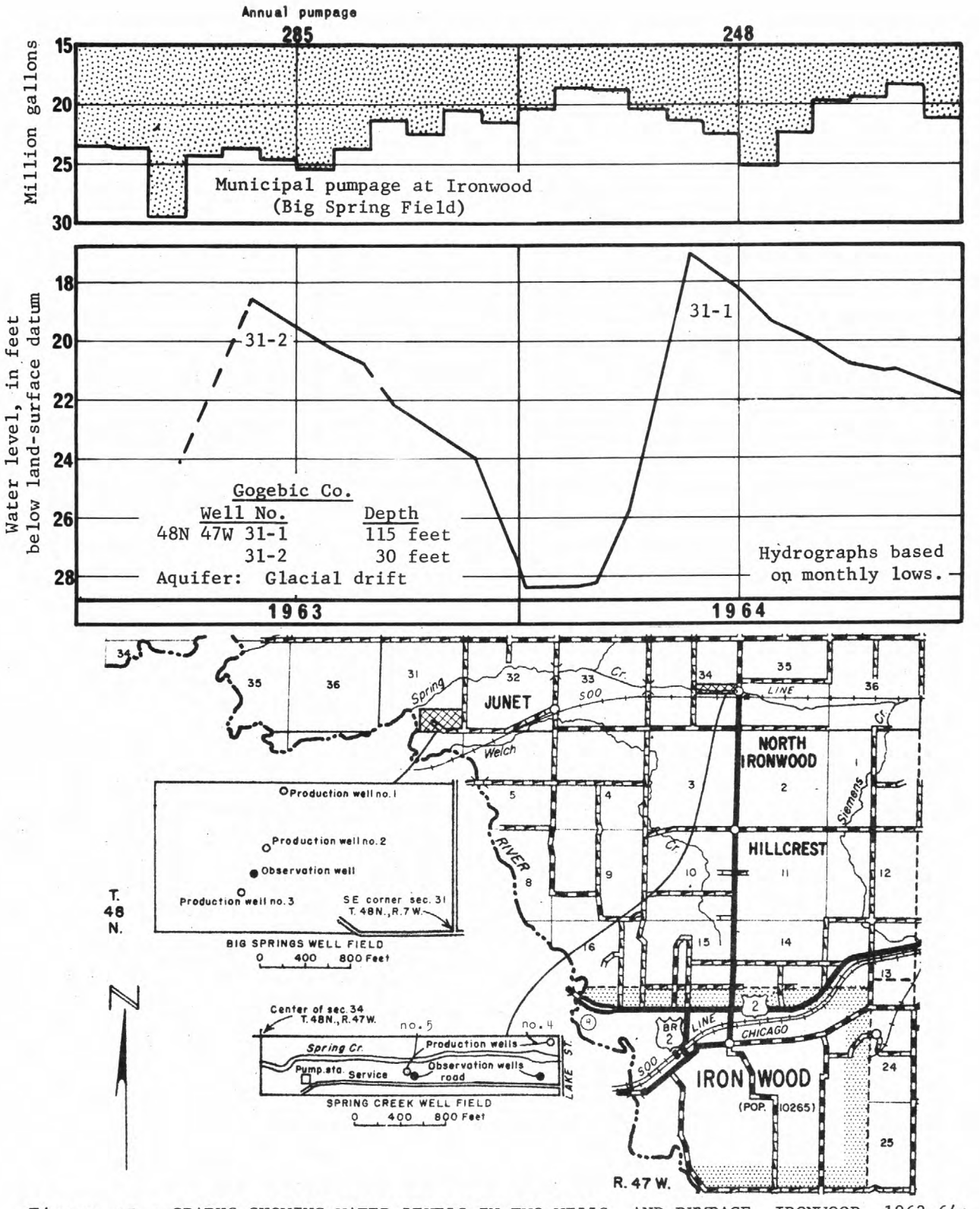

Figure 17.--GRAPHS SHOWING WATER LEVELS IN TWO WELLS, AND PUMPAGE, IRONWOOD, 1963-64; AND MAP SHOWING LOCATION OF OBSERVATION WELLS AND WELL FIELD.

Water levels in the shallow and deep well are the same.

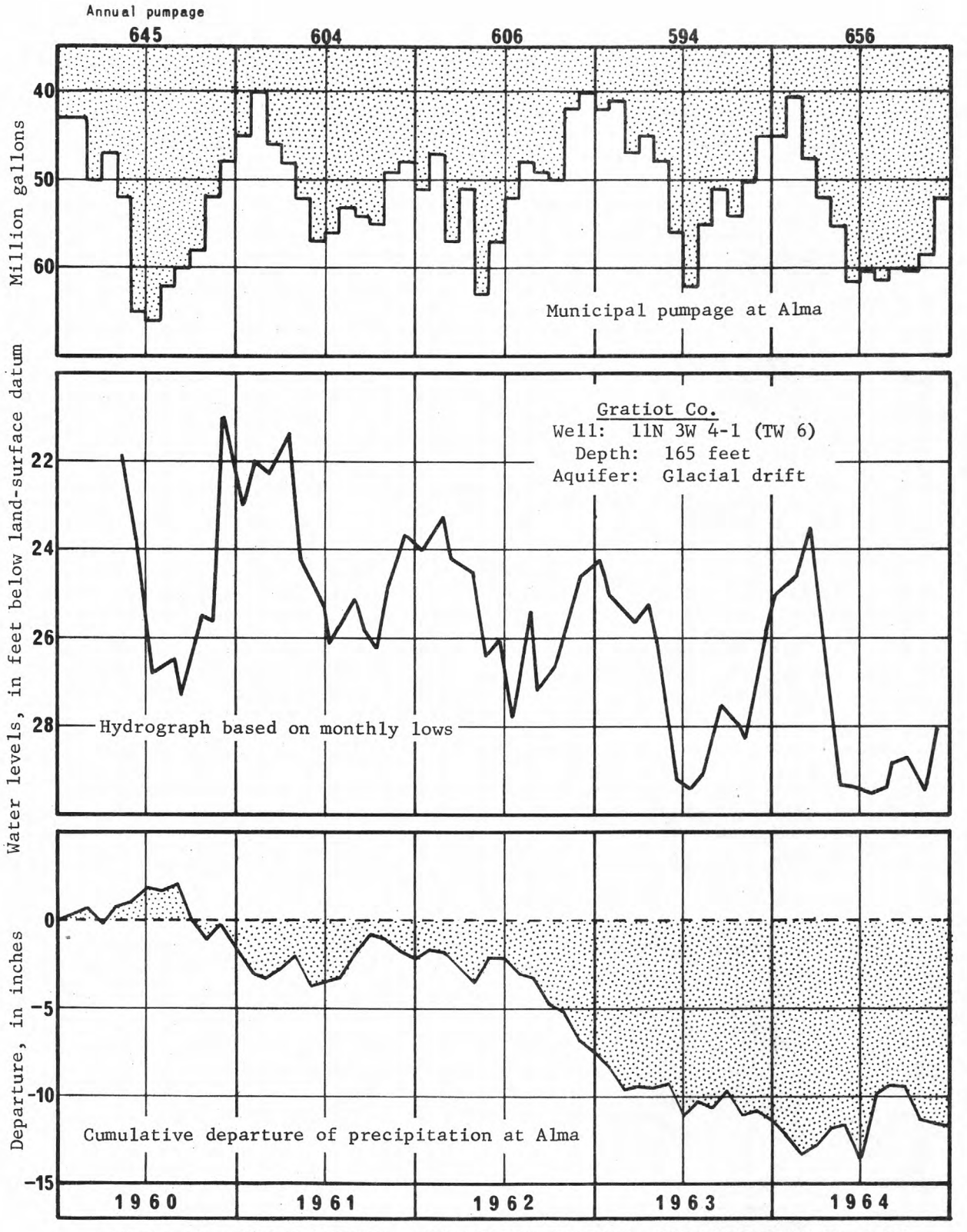

FIGURE 17.--GRAPHS SHOWING WATER LEVELS, PUMPAGE, AND PRECIPITATION, ALMA, 1960-64.

Although pumpage increased in 1964, no further decline occurred as precipitation was not deficient.

GRATIOT COUNTY - CITY OF ALMA

Water supply -- Five wells, 82-155 feet deep, tapping buried outwash deposits of the glacial drift. Standby well, 550 feet deep, tapping sandstone of the Saginaw Formation.

Yield of wells in gallons per minute -- 175-875.

Specific capacity of wells in gallons per minute per foot of drawdown -- drift - 12-25; rock - 2½.

Pumpage in 1964 -- 656 million gallons.
Maximum day -- 2.74 million gallons.

Storage facilities -- 1,000,000 gallons elevated.

Quality of water --	Drift:			Rock well:		
	Hardness	350-451 ppm		Hardness	250 ppm	
	Iron	1.4-1.7 ppm		Iron	1.1 ppm	
	Fluoride	0.1-0.2 ppm		Fluoride	0.1 ppm	

Treatment -- None.

Population served -- 8,978.
Per capita use -- 200 gallons per day.

Ground-water conditions -- Despite above-normal precipitation levels were generally lower in 1964 as pumpage increased 10% over 1963 (fig. 17). The city (1964) is building a treatment plant to allow use of water from the Pine River. However, wells will supplement the river supply -- cooling the warm river water in the summer and warming it in the winter. This plant is due to start operation in 1965. Some of the wells will supply raw water directly to local industries.

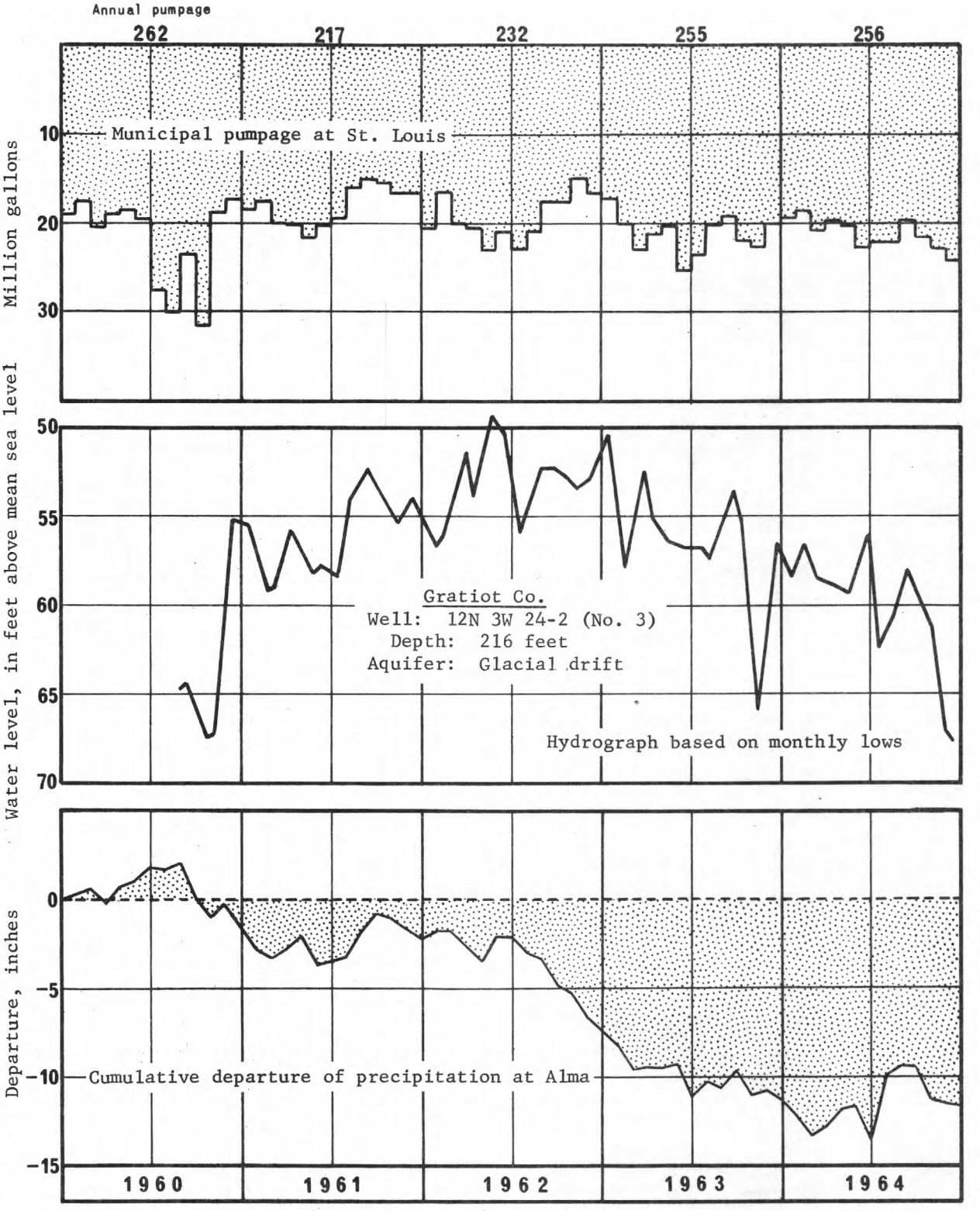

FIGURE 18.--GRAPHS SHOWING WATER LEVELS, PUMPAGE, AND PRECIPITATION, ST. LOUIS, 1960-64.

Deficient precipitation and increased pumpage since 1961 has resulted in a declining trend of water levels.

GRATIOT COUNTY - CITY OF ST. LOUIS

Water supply -- Five wells, 136-223 feet deep, tapping buried outwash deposits of the glacial drift.

Yield of wells in gallons per minute -- 340-540 -- No. 1 - 480; no. 2 - 550; no. 4 - 400; no. 5 - 360; no. 6 - 350.

Specific capacity of wells in gallons per minute per foot of drawdown -- No. 1 - 11; no. 2 - 15; no. 4 - 10; no. 5 - 13; no. 6 - 8.

Pumpage in 1964 -- 256 million gallons.
Maximum day -- 1.21 million gallons.

Storage facilities -- Hydropneumatic storage of 9,800 gallons; 500,000 gallons elevated.

Quality of water --

Hardness	260-325 ppm
Iron	0.5-1.0 ppm
Fluoride	0.1-0.4 ppm

Treatment -- None.

Population served -- 4,000.
Per capita use -- 175 gallons per day.

Ground-water conditions -- Levels in the observation well continued to decline in 1964 despite slightly above-average precipitation in that year (fig. 18). Heavier than average pumpage occurred late in 1964 and levels fell to nearly as low as the previous low that occurred in 1960. In addition to the municipal pumpage, ground water is also withdrawn for industrial use by two wells at the Michigan Chemical Company.

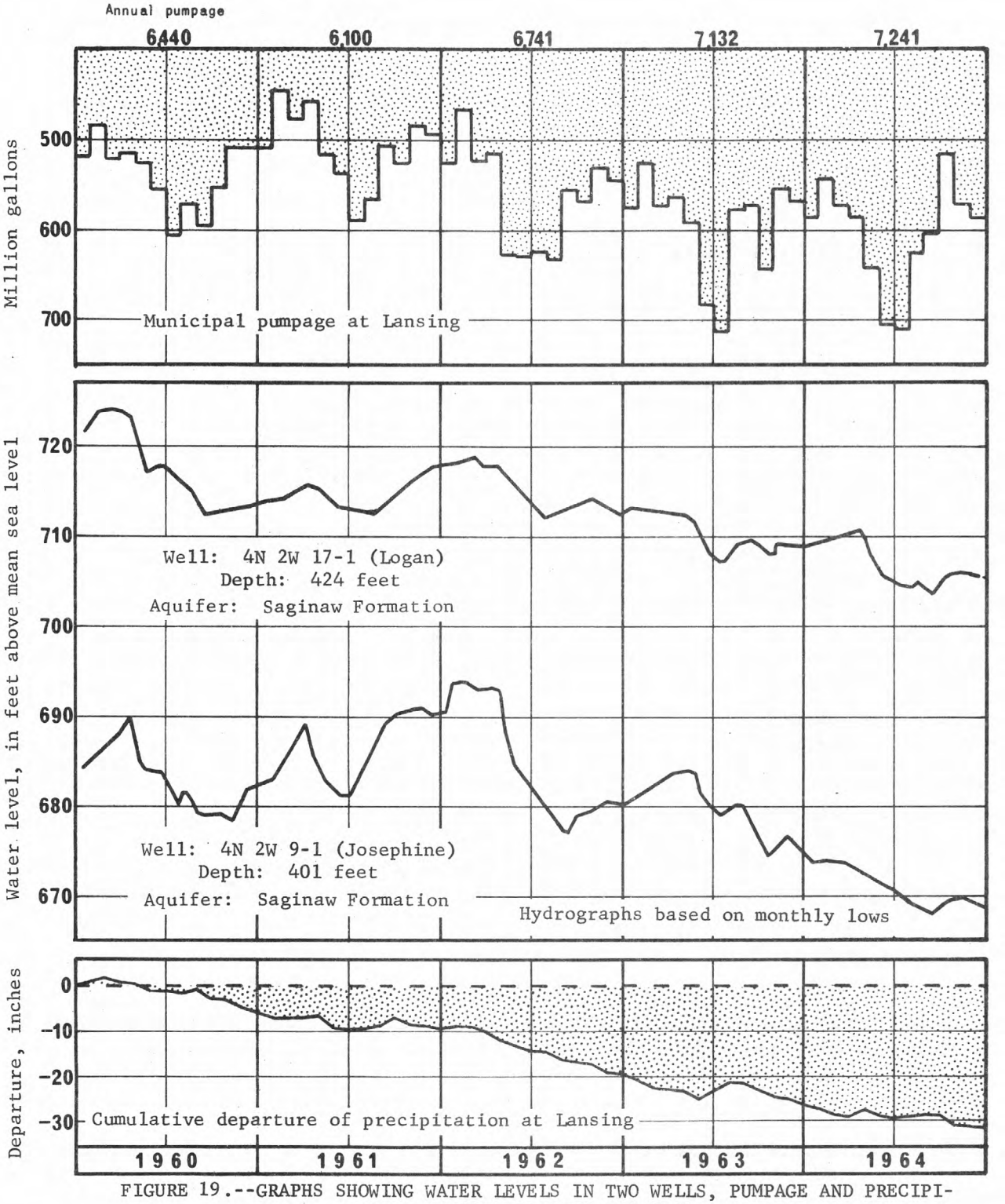

FIGURE 19.--GRAPHS SHOWING WATER LEVELS IN TWO WELLS, PUMPAGE AND PRECIPITATION, LANSING, 1960-64.

The declining trend continued and water levels fell to record lows in 1964.

INGHAM COUNTY - CITY OF LANSING

Water supply -- 115 wells, 400-425 feet deep, tapping sandstones of the Saginaw Formation. 2 wells, 50-60 feet deep, in glacial drift are seldom used.

Yield of wells in gallons per minute -- 100-700.

Specific capacity of wells in gallons per minute per foot of drawdown -- 3-10 reported for rock wells.

Pumpage in 1964 -- 7,247 million gallons.
Maximum day -- 40.99 million gallons.

Storage facilities -- Ground storage of 17,000,000 gallons.

Quality of water -- Treated: Hardness 85 ppm
Raw: Hardness 200-600 ppm
Iron 0.03-4.0 ppm

Treatment -- Fluoridation, chlorination, lime softening and iron removal.

Population served -- 107,807 (1960 census).
Per capita use -- 184 gallons per day.

Ground-water conditions -- Water levels in observation wells in the Lansing area continued to decline (figs. 19 & 20) as the result of continuing deficiencies of precipitation and increasing withdrawals of ground water from the Saginaw Formation. Stages in most of the wells were at or near their lows of record (table 2). While pumpage is contributing to the lowering of water levels, of great concern is the 32 inches of accumulated deficiency of precipitation in the 1960-64 period. This amounts to a years' rainfall lost in the past five years.

A new well field southwest of the City is being developed and will withdraw water from the glacial drift at a proposed rate of about 5 mgd. This field should relieve some of the pumping pressure on the Saginaw Formation. An observation well (TW 63A) located in the well field shows natural conditions and also effects of some of the test pumping on water levels at the new field (fig. 20).

In 1965 a 4-year study of the water resources of the Tri-County area was begun by the U. S. Geological Survey in cooperation with the Tri-County Planning Commission and the Michigan Department of Conservation. The map (fig. 21) shows location of observation wells in this area.

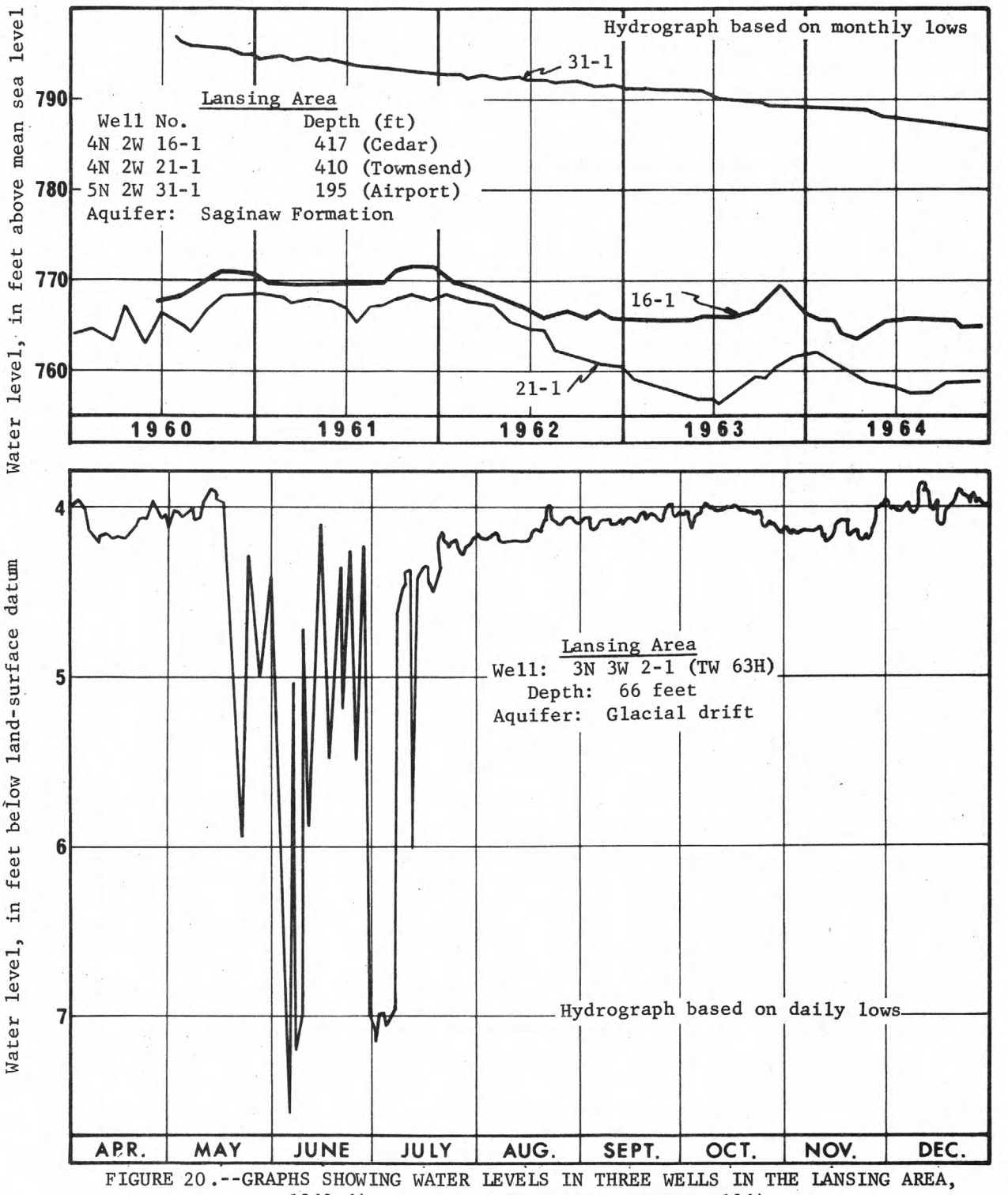

FIGURE 20.--GRAPHS SHOWING WATER LEVELS IN THREE WELLS IN THE LANSING AREA, 1960-64, AND ONE WELL APRIL-DECEMBER, 1964.

The construction of new high-production wells in the glacial drift in the southwest part of the area should alleviate the decline of water levels in the Saginaw Formation.

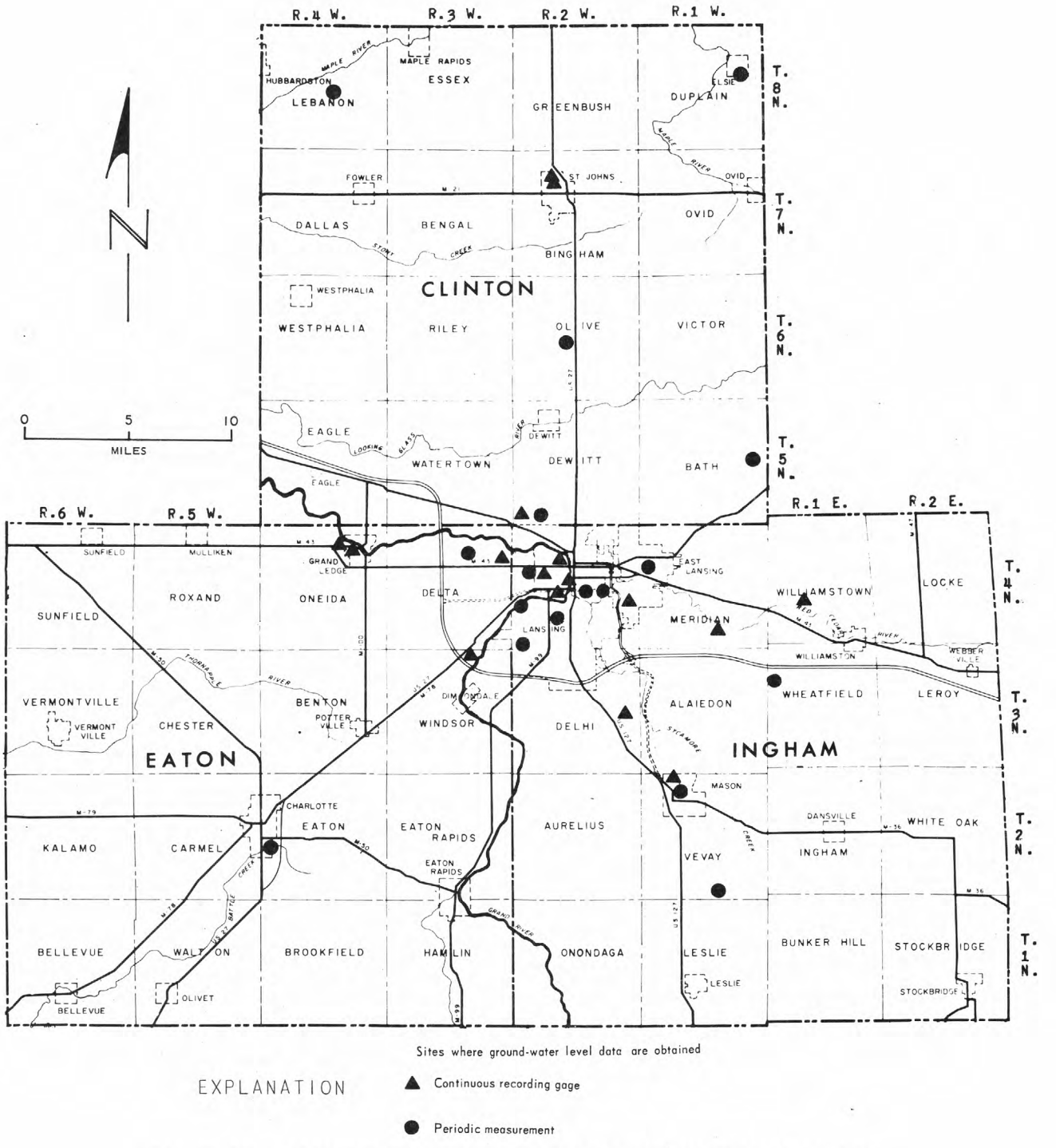

FIGURE 21.--LOCATION MAP OF OBSERVATION WELLS IN THE TRI-COUNTY AREA SURROUNDING LANSING.

This area draws water mainly from sandstones of the Saginaw Formation.

INGHAM COUNTY - CITY OF EAST LANSING

Water supply -- Seven wells, 385-400 feet deep, tapping sandstones of the Saginaw Formation.

Yield of wells in gallons per minute -- 275-900.

Specific capacity of wells in gallons per minute per foot of drawdown -- 3-11.

Pumpage in 1964 -- 781 million gallons.
Maximum day -- 3.96 million gallons.

Storage facilities -- 525,000 gallons elevated.

Quality of water --

Hardness	325-565	ppm
Iron	0.8-7.0	ppm
Chloride	3-34	ppm

Treatment -- Chlorination, softening and iron removal, Fluoride, Phosphate.

Population served -- 22,871.
Per capita use -- 77.5 gallons per day.

INGHAM COUNTY - LANSING TOWNSHIP

Water supply -- Five wells, 399-417 feet deep, tapping sandstones of the Saginaw Formation.

Yield of wells in gallons per minute -- 260-500.

Specific capacity of wells in gallons per minute per foot of drawdown -- 2.6-8.

Pumpage in 1964 -- 527 million gallons.

Storage facilities -- 200,000 gallons elevated.

Quality of water -- Hardness 290-350 ppm
Iron 0.4-1.0 ppm
Fluoride 0.4 ppm

Treatment -- None.

Population served -- 6,100.
*Per capita use -- 236 gallons per day.

* General Motors Forge and Jet Plant use about 40 million gallons monthly.

INGHAM COUNTY - MERIDIAN TOWNSHIP

Water supply -- Water District No. 1 supplied by water purchased from East Lansing. Water Districts Nos. 2-4 supplied by six wells, 311-422 feet deep, tapping sandstones of the Saginaw Formation. Lakeview Heights District #2 - Nos. 1 and 2 wells - 311 feet deep, 10-inch diameter; Forest Hills District No. 3 - No. 1 well - 352 feet by 12-inch, No. 2 - 422 feet by 8-inch; Hillbrooke District No. 4 - No. 1 well - 390 feet by 12-inch, No. 2 - 390 feet by 8-inch.

Yield of wells in gallons per minute -- Lakeview Heights - 300; Forest Hills - 120; Hillbrooke No. 1 - 300, No. 2 - 200.

Specific capacity of wells in gallons per minute per foot of drawdown -- reported 11-30.

Pumpage in 1964 -- 41.5 million gallons.

Storage facilities -- Elevated storage 30,000 and 50,000 gallons.

Treatment -- None.

Population served -- estimated 2,500.
Per capita use -- 45 gallons per day.

INGHAM COUNTY - MICHIGAN STATE UNIVERSITY

Water supply -- Eight wells, 300-450 feet deep, tapping sandstones of the Saginaw Formation.

Average yield of wells in gallons per minute -- 490.

Average specific capacity of wells in gallons per minute per foot of drawdown -- about 5.

Pumpage in 1964 -- 1,255 million gallons.
Maximum day -- 4.89 million gallons.

Storage facilities -- 1,500,000 gallons below-ground storage.

Quality of water -- Composite -- Hardness 360 ppm
Iron 0.8 ppm
Fluoride 0.5 ppm

Treatment -- Chlorination, caustic soda to reduce CO_2, fluoride, polyphosphate.

Population served -- 30,000.
Per capita use -- 115 gallons per day.

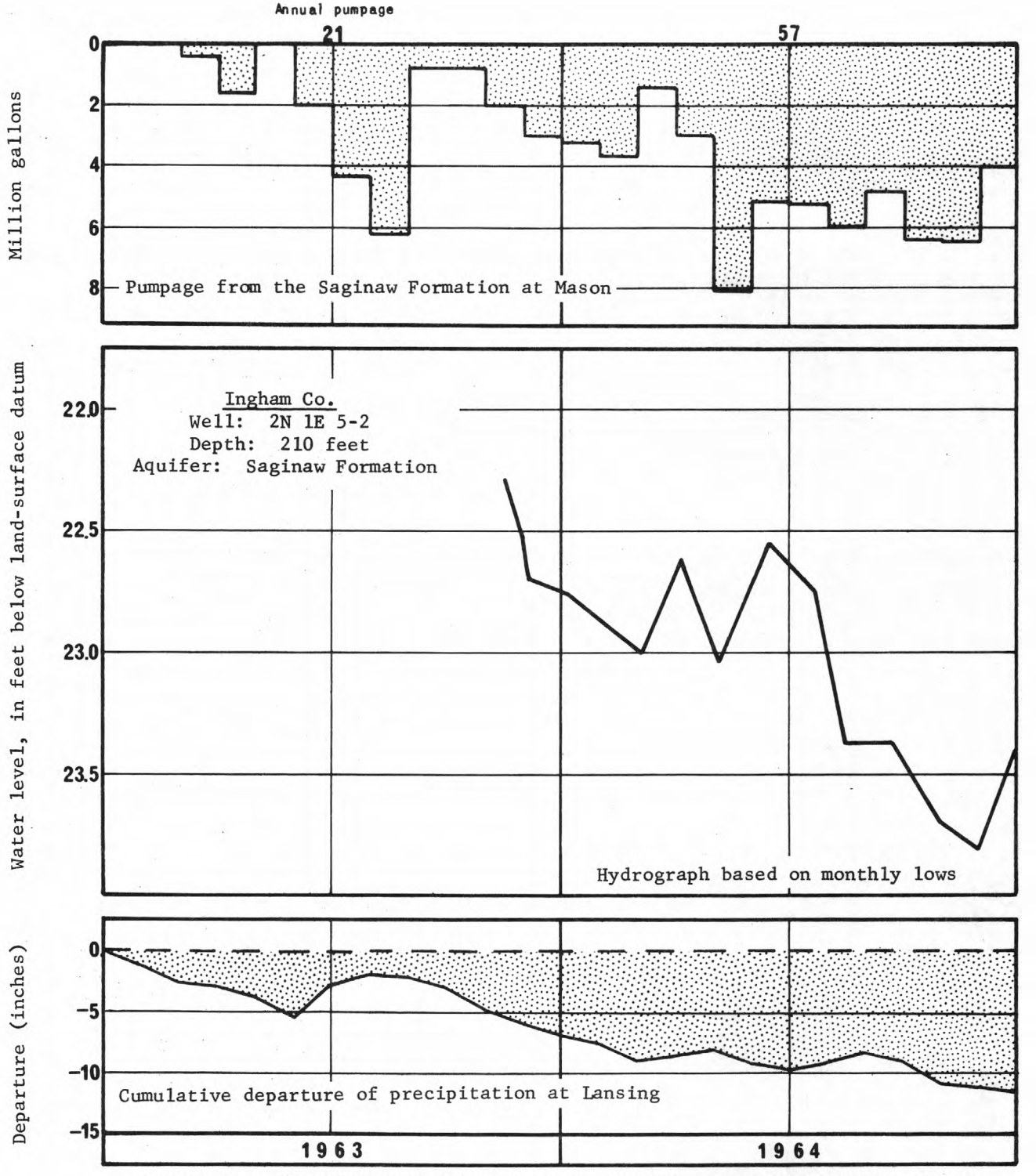

FIGURE 22.--GRAPHS SHOWING WATER LEVELS, PUMPAGE, AND PRECIPITATION, MASON, 1963-64.

Increased municipal pumpage from the Saginaw Formation and deficient precipitation has resulted in a small decline of water levels.

INGHAM COUNTY - CITY OF MASON

Water supply -- Two wells about 50 feet deep finished in glacial drift and one well, 223 feet deep, tapping sandstones of the Saginaw Formation.

Yield of wells in gallons per minute -- 300-550.

Specific capacity of wells in gallons per minute per foot of drawdown -- #3 yields 30 from glacial drift.

Pumpage in 1964 -- 169 million gallons.

Storage facilities -- 250,000 elevated and 100,000 standpipe.

Quality of water --

Hardness	310-400	ppm
Iron	0.3	ppm
Fluoride	0-0.2	ppm
Chloride	8-44	ppm

Treatment -- None.

Population served -- 4,522.
Per capita use -- 102 gallons per day.

Ground-water conditions -- In 1964 municipal pumpage from the Saginaw Formation more than doubled and as a result of the increased pumpage and continued deficiencies of precipitation, the water levels in the observation well continued to decline slightly (fig. 22). Water levels in well 5-1, also finished in the Saginaw Formation (Ingham County, Table 2), fell to record lows of the 17-year period of observation in 1964. No observation wells in the glacial drift are currently being measured. Two-thirds of the municipal water pumped is from wells finished in glacial drift.

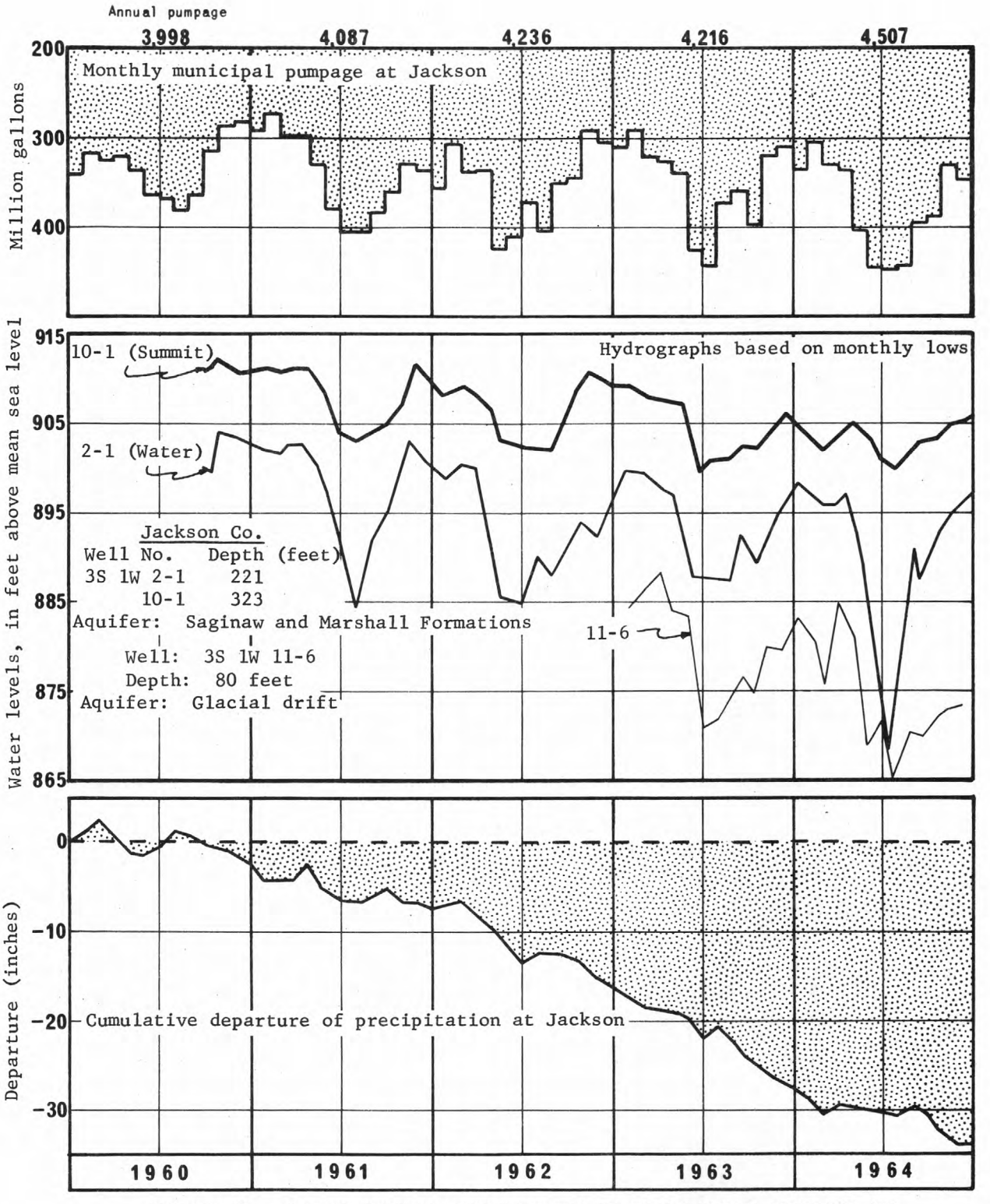

FIGURE 23.--GRAPHS SHOWING WATER LEVELS IN THREE WELLS, PUMPAGE AND PRECIPITATION, JACKSON, 1960-64.

The graph of well 11-6 finished in the glacial drift indicates hydraulic connection with the water levels in the bedrock wells.

JACKSON COUNTY - CITY OF JACKSON

Water supply -- 11 wells, 380-400 feet deep, tapping sandstones of the Saginaw, Parma and Marshall Formations.

Yield of wells in gallons per minute -- No. 12 - 2,000.

Specific capacity of wells in gallons per minute per foot of drawdown -- Reported average 100; specifically #12 well - 56.

Pumpage in 1964 -- 4,507 million gallons.
Maximum day -- 21.76 million gallons.

Storage facilities -- 3,000,000 gallons elevated.

Quality of water -- Hardness 300-360 ppm
Iron 0.3-1.0 ppm
Chloride 13-88 ppm

Treatment -- Chlorination and fluoridation.

Population served -- 52,220.
Per capita use -- 236 gallons per day.

Ground-water conditions -- Water levels in observation wells fell to record and near-record lows in 1964 as pumpage increased and precipitation deficiencies continued (figs. 23 and 24).

Interconnection between levels in the rock and glacial drift aquifers is evident from the graph of well 11-6 (fig. 23) and the graph of wells in figure 24. In the spring levels in the shallow drift wells benefit from high stages in the Grand River. As pumpage increases and levels in the rock are lowered a hydraulic gradient is created and water from the drift feeds into the rock aquifer through a leaky aquiclude. Leakage from River to adjacent glacial drift aquifer apparently decreases greatly during periods of low streamflow.

Well 11-6, finished to the top of the rock in glacial drift (fig. 23), is located at the Belden Road well field where pumpage from the rock is heaviest. As a result water levels in the rock at this field would be lower than at the Summit and Water Street wells which are several miles away from the center of pumping influence (see map, fig. 24). The water levels in this drift well are lower than the levels at the Summit and Water Street wells, but above the water levels in the Belden field rock wells (see observation well 11-2, Jackson County, table 2).

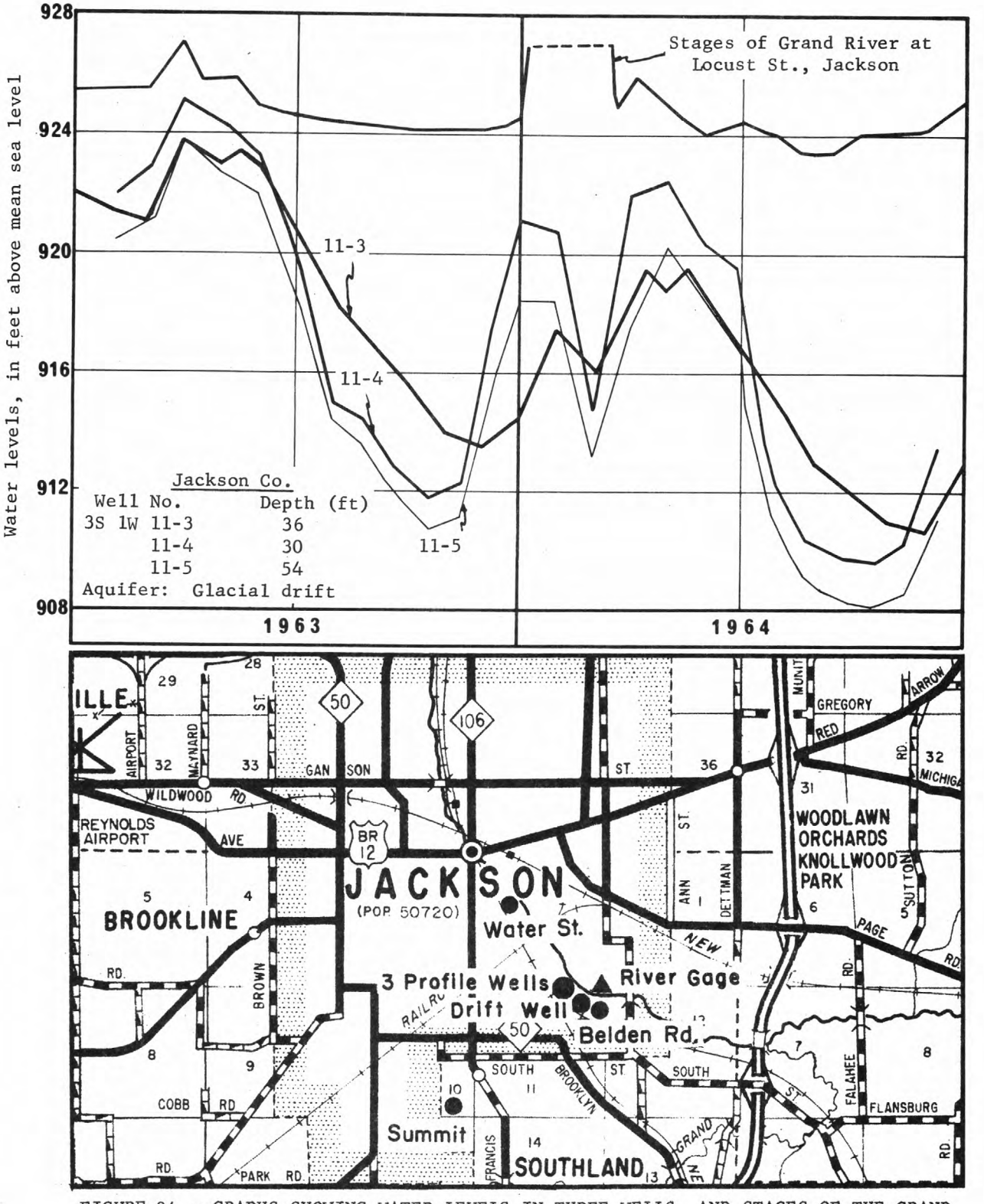

FIGURE 24.--GRAPHS SHOWING WATER LEVELS IN THREE WELLS, AND STAGES OF THE GRAND RIVER, 1963-64, AND LOCATION MAP OF OBSERVATION WELLS, JACKSON.

There seems to be closer correlation of water levels in the drift and water levels in the bedrock than with the Grand River stages.

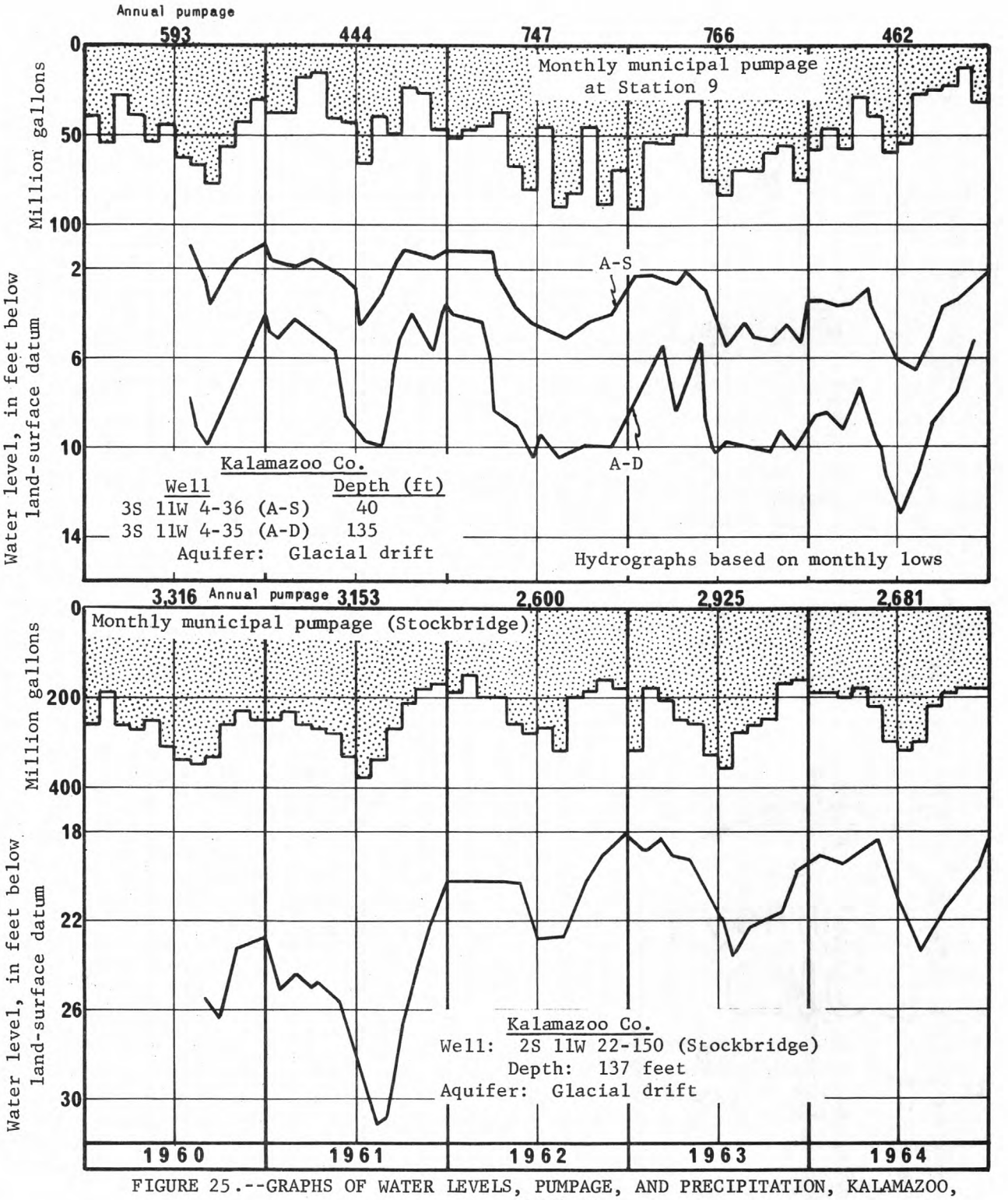

FIGURE 25.--GRAPHS OF WATER LEVELS, PUMPAGE, AND PRECIPITATION, KALAMAZOO, 1960-64.

Large amounts of water are pumped in the Kalamazoo area with no significant declines in water levels.

KALAMAZOO COUNTY - CITY OF KALAMAZOO

Water supply -- About 79 wells, 130-254 feet deep, finished in glacial drift.

Yield of wells in gallons per minute -- 200-750.

Specific capacity of wells in gallons per minute per foot of drawdown -- 7-100.

Pumpage in 1964 -- 5,375 million gallons.
Maximum day -- 29.64 million gallons.

Storage facilities -- 15,150,000 gallons elevated.

Quality of water -- Hardness 312-350 ppm
Chloride 2-18 ppm
Iron 0.25-0.75 ppm

Treatment -- Chlorination, fluoridation.

Population served -- 100,000.
Per capita use -- 148 gallons per day.

Ground-water conditions -- The effectiveness of the recharge pond at Station 9 is shown by the graphs of observation wells A-S and A-D (fig. 25). Production wells pump water from the lower aquifer and the water levels in the upper water-table aquifer shows the good interconnection in the similarity of the graphs.

The Stockbridge observation well (fig. 25) reflects withdrawals of ground water from the Central pumping area of Kalamazoo. Decreased pumpage has resulted in stable levels the past three years.

Levels in the Kendall observation well seem to follow precipitation departures rather than pumpage and the graph resembles that of the Atwater well (fig. 26) whose levels are not affected by pumpage.

The area is well represented by observation well coverage (fig. 27).

Four new municipal production wells were put into operation in 1964, one at Kendall field and three at Station 22.

A 3-year study of the water resources of Kalamazoo County is currently being conducted by the U. S. Geological Survey with completion date in December, 1967.

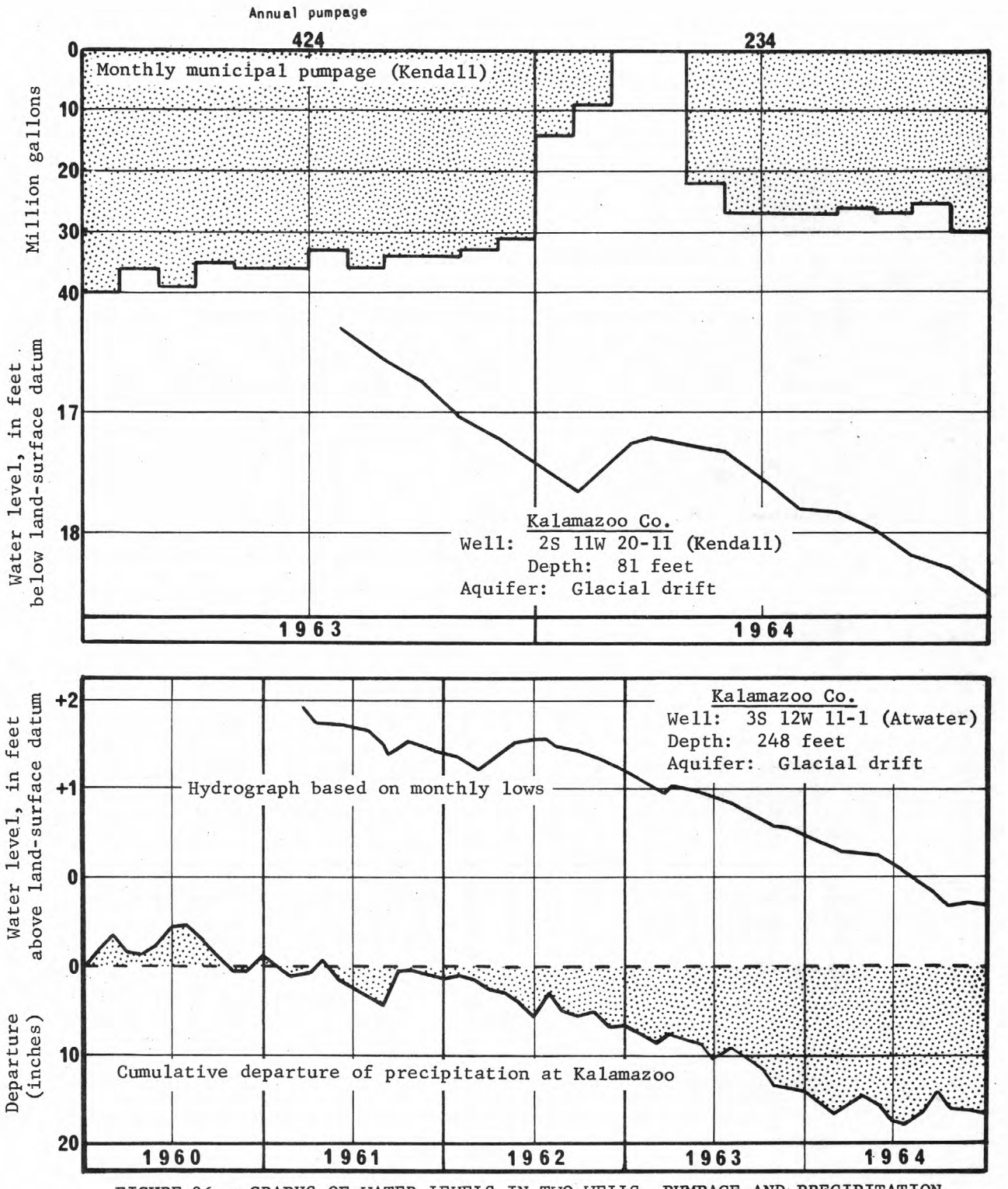

FIGURE 26.--GRAPHS OF WATER LEVELS IN TWO WELLS, PUMPAGE AND PRECIPITATION, KALAMAZOO, 1960-64.

The Atwater well is not near pumping wells and shows mostly the effects of climate.

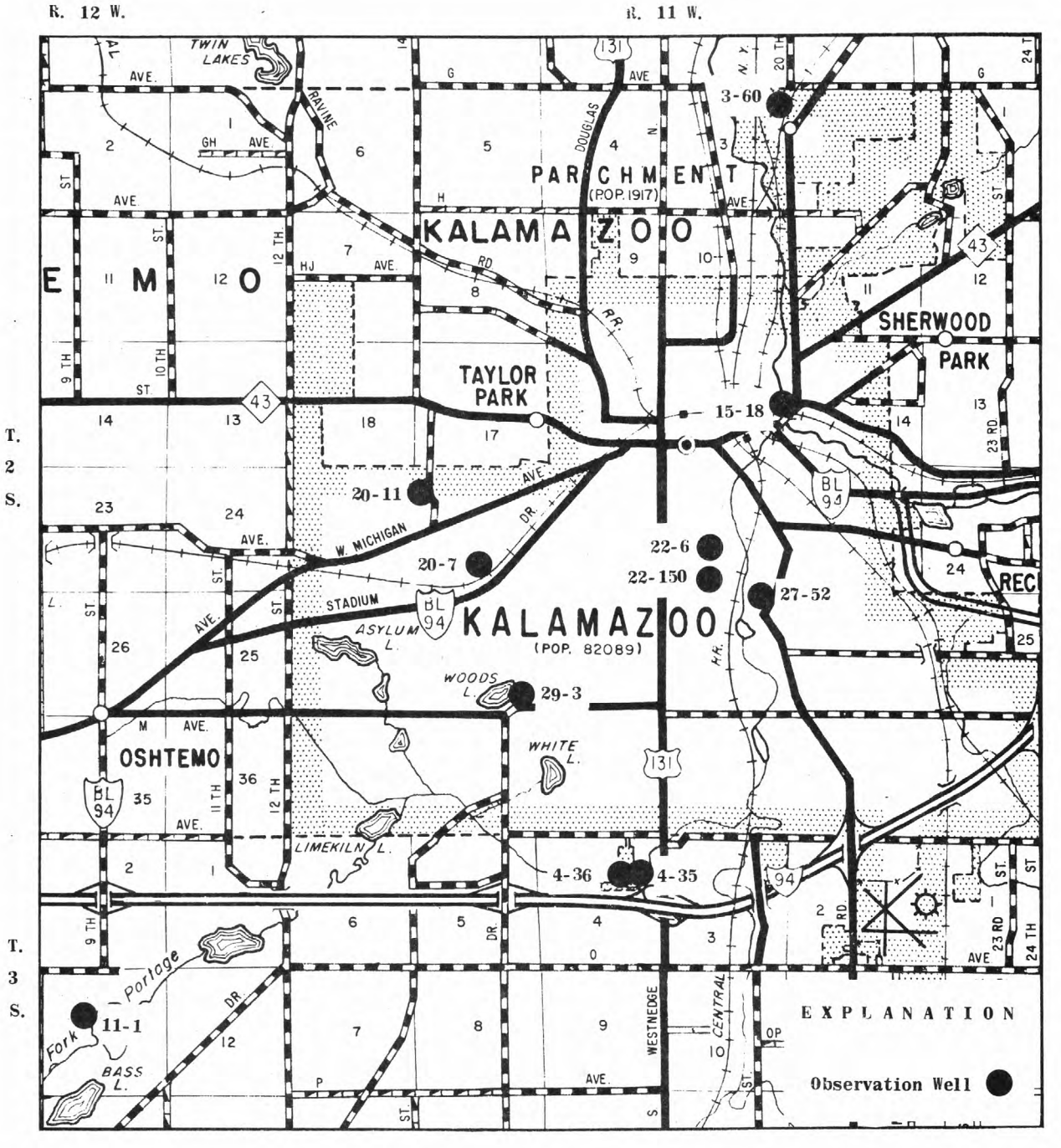

FIGURE 27.--MAP OF KALAMAZOO AREA SHOWING LOCATION OF OBSERVATION WELLS.

11 observation wells are located in the area, of which 5 are equipped with continuous recording gages.

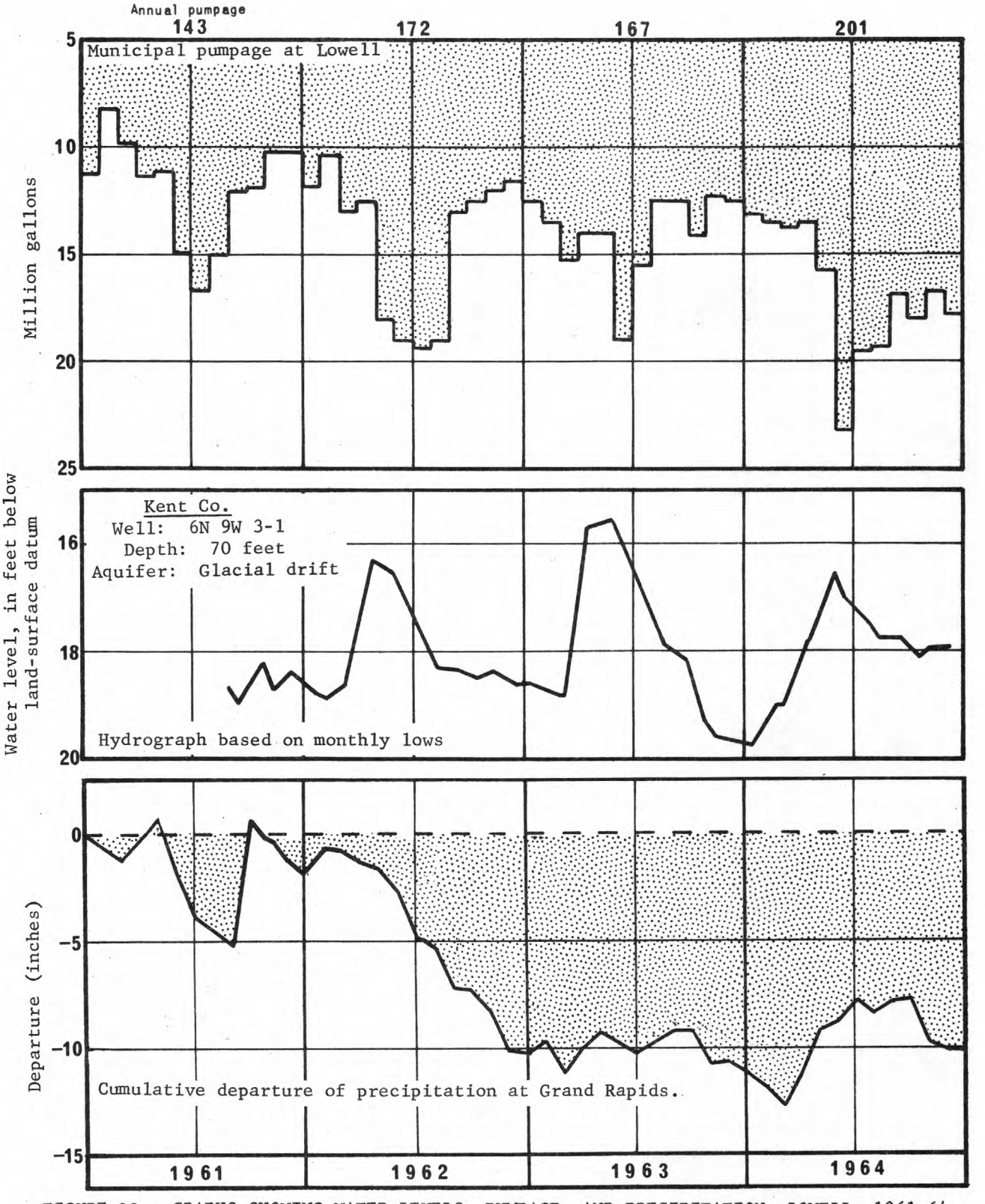

FIGURE 28.--GRAPHS SHOWING WATER LEVELS, PUMPAGE, AND PRECIPITATION, LOWELL, 1961-64.

No decline of water levels is occurring despite overall deficiency of precipitation and increasing pumpage.

KENT COUNTY - CITY OF LOWELL

Water supply -- In 1964 two wells, 47 and 71 feet deep, finished in glacial drift and one well, 107 feet deep, tapping Ionia sandstones of Pennsylvania age.

Yield of wells in gallons per minute -- 350 (Rock); 120-800 (Drift).

Specific capacity of wells in gallons per minute per foot of drawdown -- 4.5 and 80 (Drift) and 13.2 (Rock).

Pumpage in 1964 -- 201 million gallons.

Storage facilities -- 500,000 gallons elevated.

Quality of water -- Hardness 210-352 ppm
Iron 0.3-0.4 ppm

Treatment -- Chlorination and fluoridation.

Population served -- 2,545.
Per capita use -- 215 gallons per day.

Ground-water conditions -- The observation well (fig. 28) is finished in glacial drift and water levels reflect withdrawals from the drift aquifer. Although there was an overall increase of pumpage, precipitation was above normal in 1964 and water levels rose about 2 feet in the observation well above the low at the beginning of the year. The 1964 pumpage was about 41% more than was pumped in 1961.

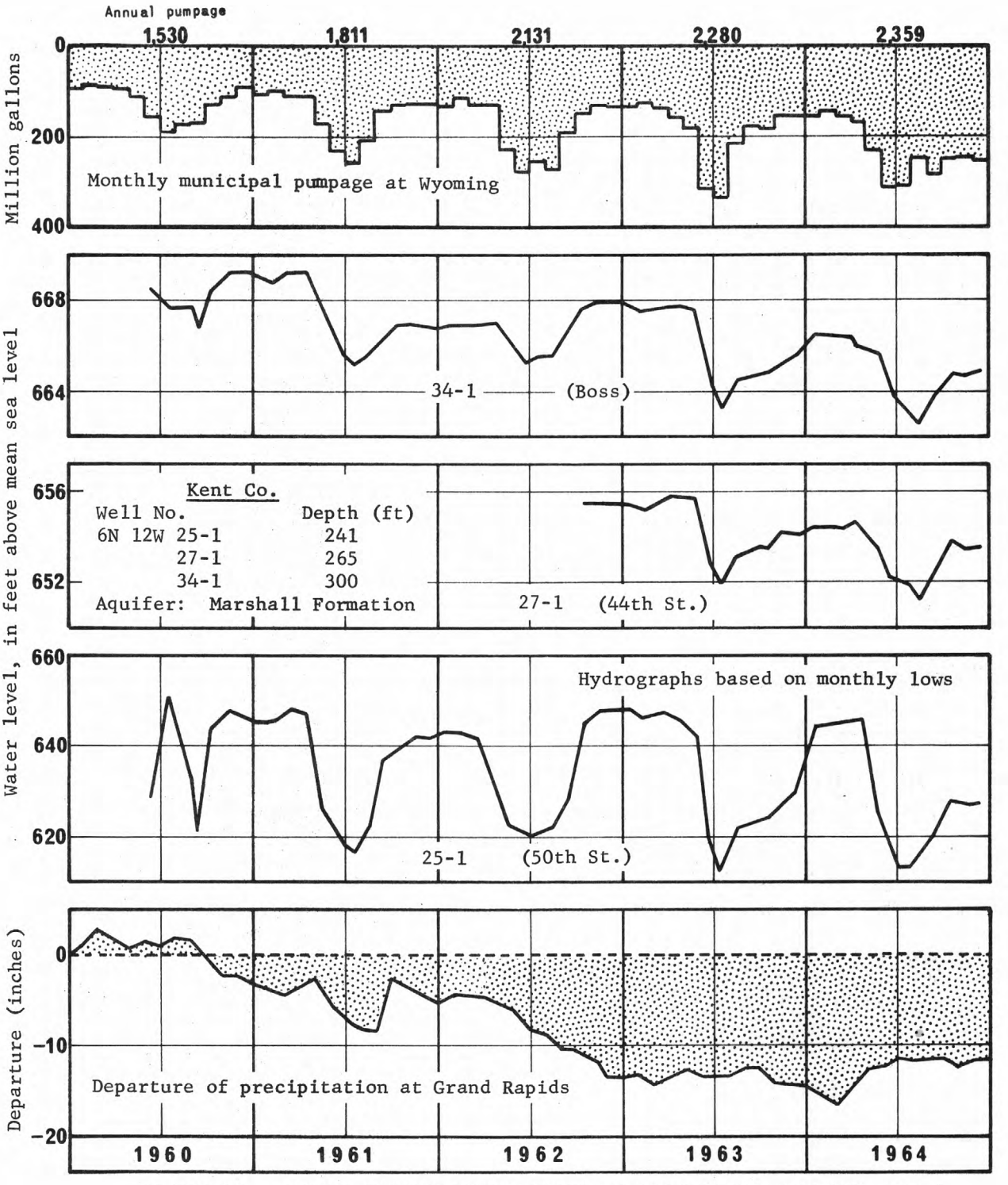

FIGURE 29.--GRAPHS SHOWING WATER LEVELS IN THREE WELLS, PUMPAGE, AND PRECIPITATION, WYOMING, 1960-64.

Despite a large increase in pumpage and deficient precipitation only a slight declining trend has occurred.

KENT COUNTY - CITY OF WYOMING

Water supply -- About 20 wells, 50-298 feet deep, located in seven well fields, are finished in glacial drift or in sandstones of the Marshall Formation.

Yield of wells in gallons per minute -- 250-1,100.

Specific capacity of wells in gallons per minute per foot of drawdown -- 8-10 in sandstone; 14-140 in drift wells.

Pumpage in 1964 -- 2,357 million gallons.
Maximum day -- 16.44 million gallons.

Storage facilities -- 5,000,000 gallons ground storage and 300,000 gallons elevated storage.

Quality of water -- Hardness 285-361 ppm
Chlorides 12-610 ppm
Iron 0-3.5 ppm

Treatment -- Chlorination, fluoridation and calgon.

Population served -- about 35,000.
Per capita use -- 184 gallons per day.

Ground-water conditions -- The declining trend in water levels continued although precipitation was above average in 1964 (figs. 29 and 30). Of the six observation wells five fell to new lows of record (table 2, Kent County).

Observation wells 4-3, 4-7 and 11-3 are 2-3 miles from pumping well fields (see map, fig. 31). The similarity of the hydrographs shows the good hydraulic connection between the glacial drift and the rock aquifer (fig. 30).

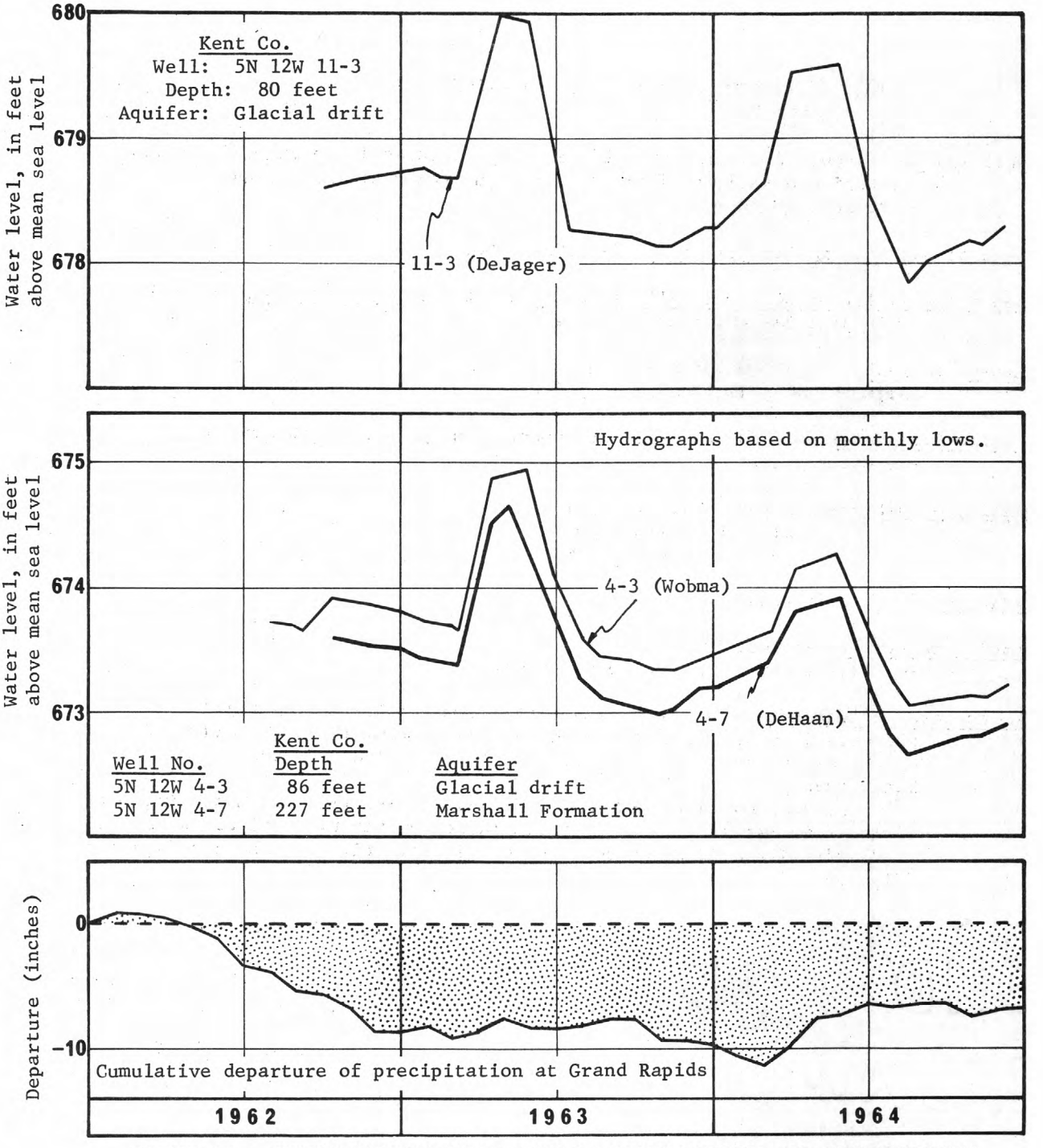

FIGURE 30.--GRAPHS SHOWING WATER LEVELS IN THREE WELLS, AND PRECIPITATION, WYOMING, 1962-64.

The water level in these wells shows good hydraulic connection between the glacial drift and Marshall Formation.

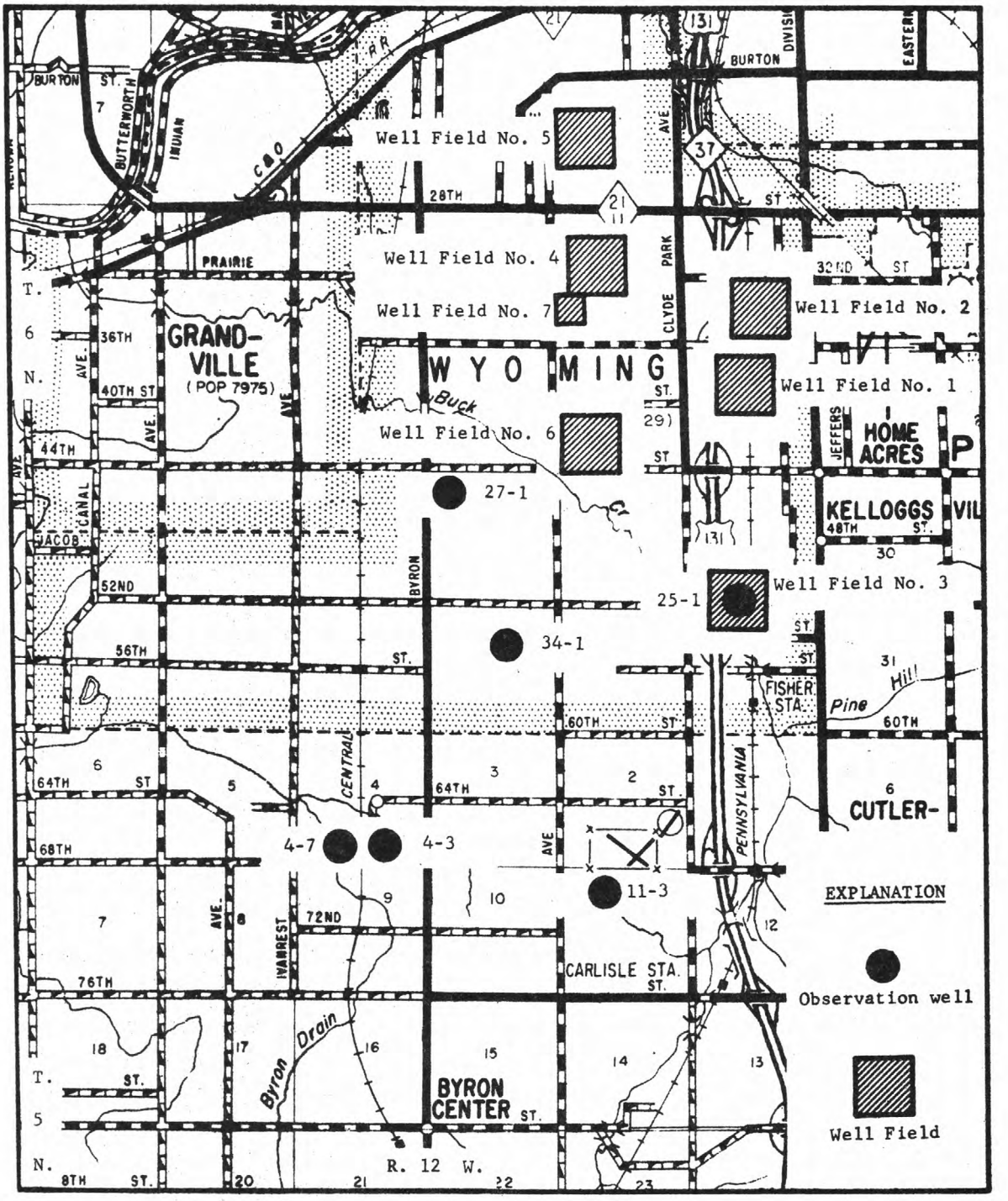

FIGURE 31.--LOCATION MAP OF WELLS AT WYOMING.

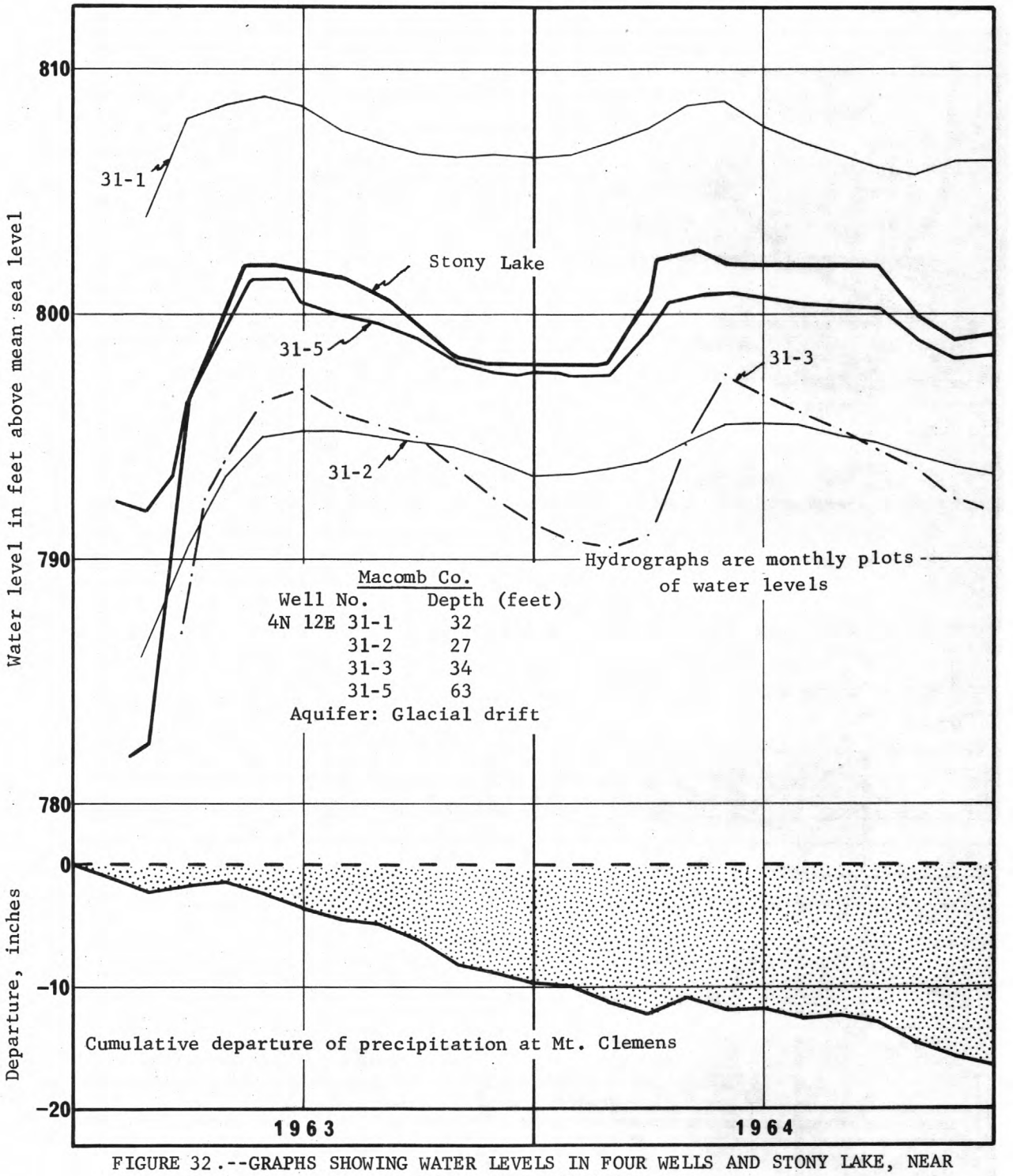

FIGURE 32.--GRAPHS SHOWING WATER LEVELS IN FOUR WELLS AND STONY LAKE, NEAR ROCHESTER, 1963-64.

The lake level is higher than the level in three of the observation wells resulting in some loss to the ground-water table.

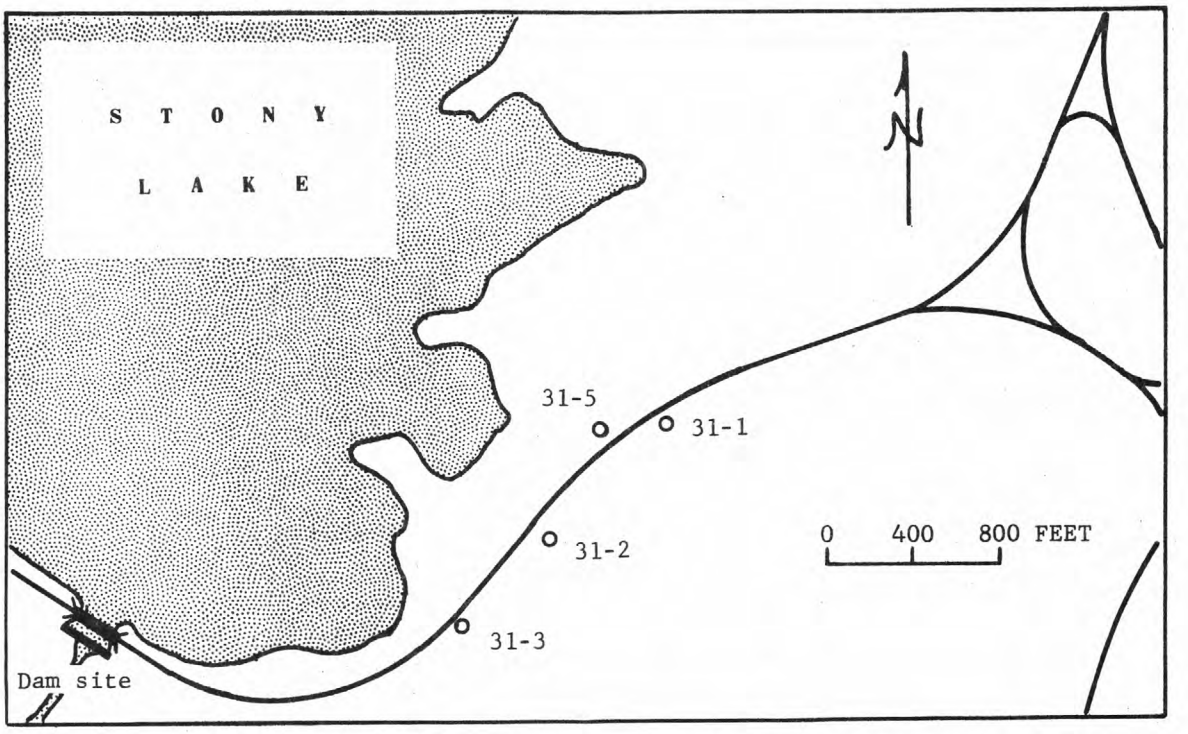

FIGURE 33.--LOCATION OF OBSERVATION WELLS AT STONY CREEK PARK, NEAR ROCHESTER.

MACOMB COUNTY -- Observation wells are maintained at Stony Lake Park, of the Huron-Clinton Metropolitan Authority, to observe the effects of the damming of a creek to create a lake for recreational purposes. The level of the lake (fig. 32) is higher than the surrounding ground-water elevations except for well 31-1 which is deeper and further from the dam site. Some loss of surface water to the water table thus occurs. However, it is possible that ground-water levels are at present low from the accumulated deficiencies of precipitation and that in normal years those ground-water levels may then be higher than the lake and thus reverse the present trend. The location of the wells in relation to the lake are shown above (fig. 33).

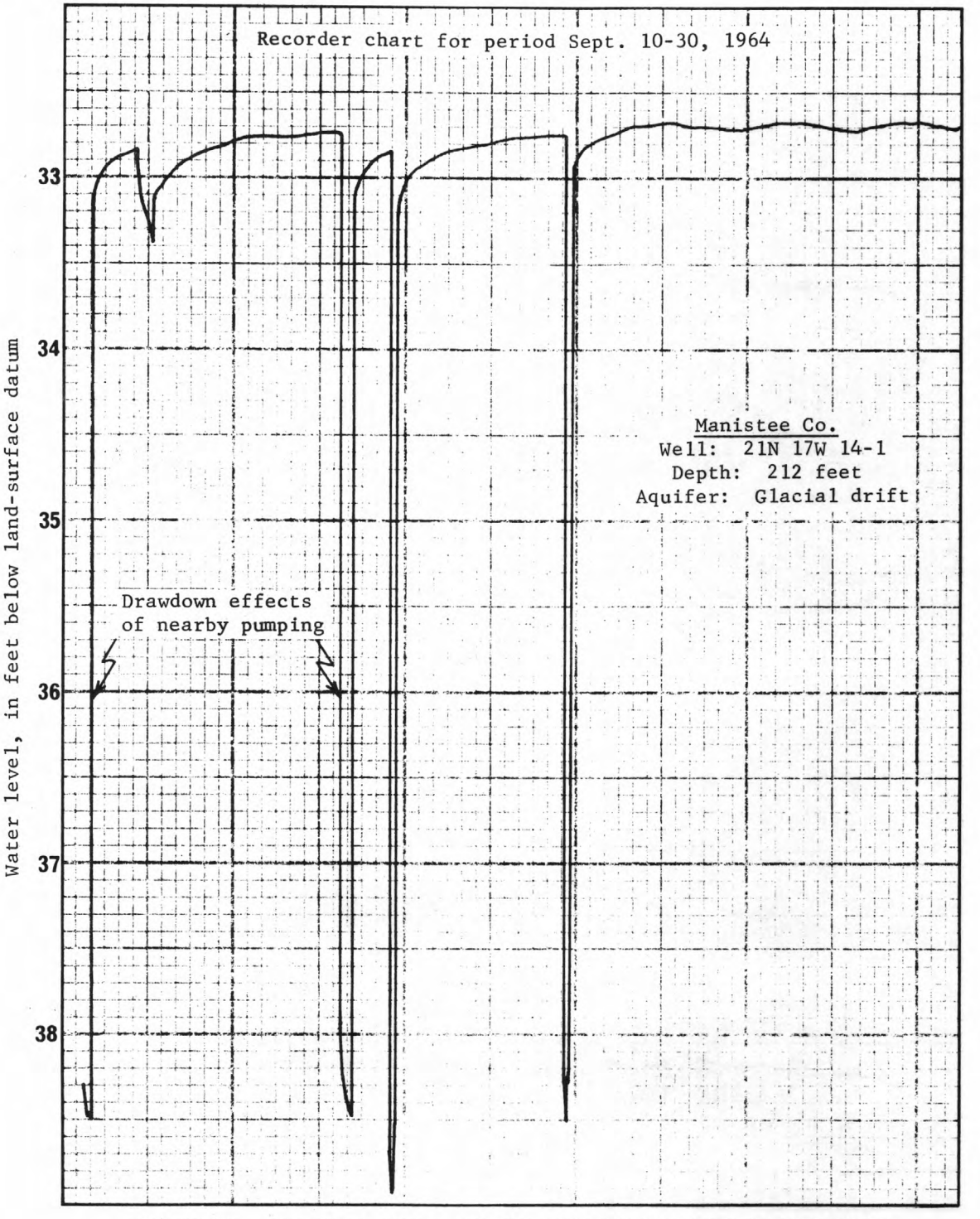

FIGURE 34.--RECORDER CHART SHOWING CHANGES IN WATER LEVELS OWING TO OCCASIONAL PUMPING OF A WELL FIELD AT MANISTEE.

This new well field was pumped occasionally for short periods of time in the fall of 1964.

MANISTEE COUNTY - CITY OF MANISTEE

Water supply -- Five wells, 97 to 205 feet deep, finished in glacial drift.

Yield of wells in gallons per minute -- #3 - 350; #4 - 500; #5 - 350; #6 - 2,000; #7 - 2,000.

Specific capacity of wells in gallons per minute per foot of drawdown -- 25-39.

Pumpage in 1964 -- 463 million gallons.
Maximum day -- 2.98 million gallons.

Storage facilities -- 500,000 gallons elevated.

Quality of water -- Hardness 169-207 ppm
Iron 0.1-0.4 ppm
Chloride 2-75 ppm

Treatment -- None.

Population served -- 8,324.
Per capita use -- 152 gallons per day.

Ground-water conditions -- Water levels in the observation well located at the new well field remained relatively steady during the year. Although several million gallons were pumped in the latter part of 1964 from new wells nearby, static levels declined only about 0.3 of a foot for the year. The effects of pumping of a nearby production well, 10 feet away, on the water levels in the observation well is shown in figure 34.

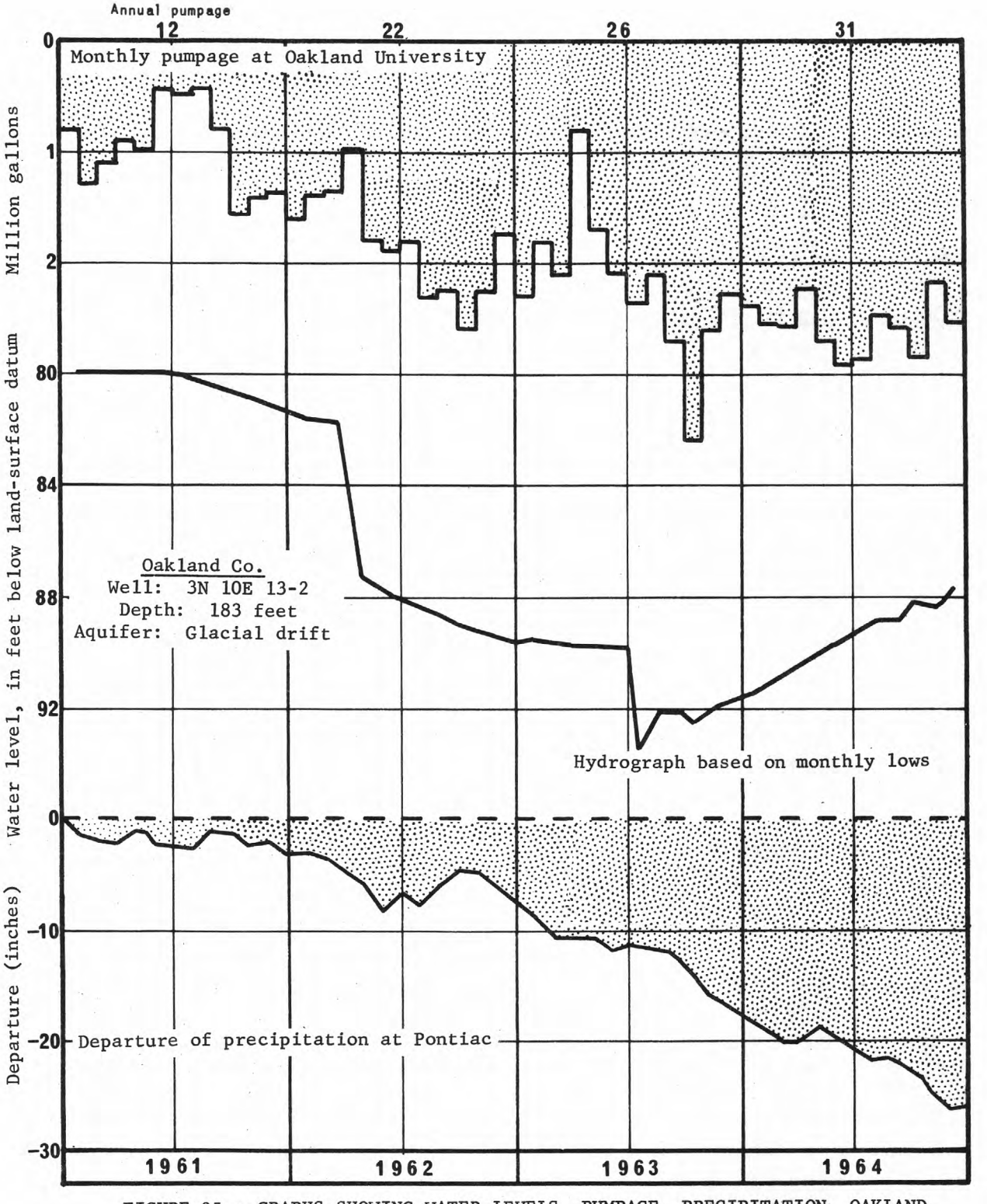

FIGURE 35.--GRAPHS SHOWING WATER LEVELS, PUMPAGE, PRECIPITATION, OAKLAND UNIVERSITY NEAR PONTIAC, 1961-64.

A rise in water levels occurred from mid-1963 because of the discontinuance of municipal pumpage of ground-water in Pontiac.

OAKLAND COUNTY - OAKLAND UNIVERSITY

Water supply -- Two wells, 149 and 184 feet deep, finished in glacial drift.

Yield of wells in gallons per minute -- 600 from 184-foot deep well.

Specific capacity of wells in gallons per minute per foot of drawdown -- 32 from a 6" Test well.

Pumpage in 1964 -- 30.7 million gallons.
Maximum day -- .124 million gallons.

Storage facilities -- 12,900 gallons hydraulic pneumatic storage.

Quality of water -- Hardness 340-555 ppm
Iron 2.3-0.1 ppm
Fluoride 0.0-0.3 ppm

Treatment -- Chlorine, polyphosphate added.

Population served -- estimated 2,000.
Per capita use -- 42 gallons per day.

Ground-water conditions -- Water levels in the observation well (fig. 35) rose nearly 6 feet since August, 1963 principally as the result of the discontinuance of pumping by the City of Pontiac a few miles west. The rise occurred despite increased University pumpage and the continued deficiency of precipitation.

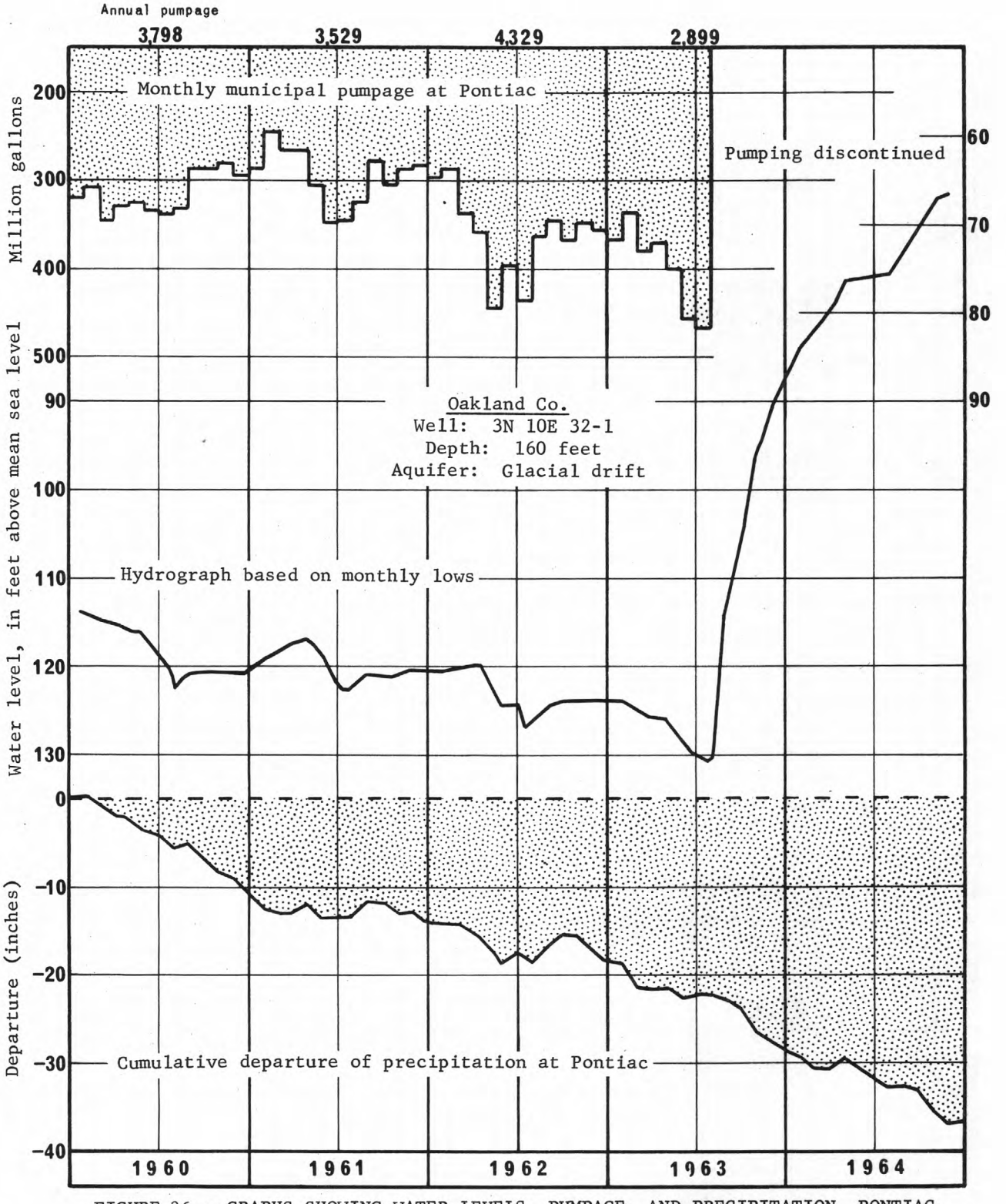

FIGURE 36.--GRAPHS SHOWING WATER LEVELS, PUMPAGE, AND PRECIPITATION, PONTIAC, 1960-64.

Water levels have risen 65 feet since pumpage was discontinued.

OAKLAND COUNTY - CITY OF PONTIAC

Water supply -- From Detroit municipal system. Ground-water system abandoned in August, 1963.

Ground-water conditions -- Levels continued to recover in the two observation wells at Pontiac (Table 2 - Oakland County) in response to the discontinuance of pumping of ground water by the City. A rise of 65 feet occurred in well 32-1 (fig. 36) despite the continued deficiency of precipitation at Pontiac. In the 5-year period a deficiency of about 37 inches has occurred. More than a year's normal rainfall of 31 inches has been lost.

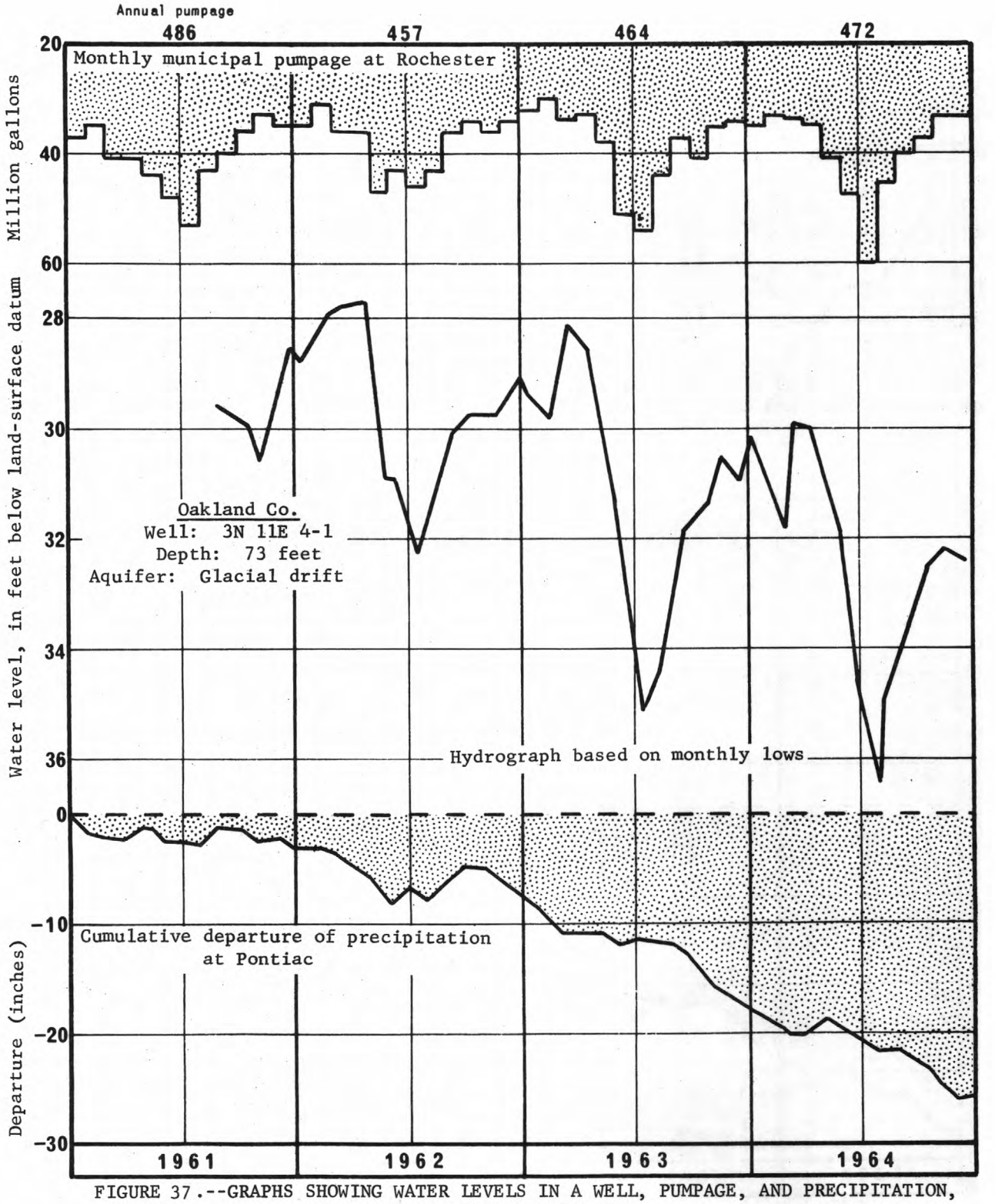

FIGURE 37.--GRAPHS SHOWING WATER LEVELS IN A WELL, PUMPAGE, AND PRECIPITATION, AT ROCHESTER, 1961-64.

Most of the decline in water levels is apparently the result of deficient precipitation as pumpage has not increased significantly.

OAKLAND COUNTY - VILLAGE OF ROCHESTER

Water supply -- Four wells, 65-147 feet deep, finished in glacial drift.

Yield of wells in gallons per minute -- No. 1 - 600; no. 2 - 800; nos. 3 & 4 - 1,000.

Specific capacity of wells in gallons per minute per foot of drawdown -- No. 1 - 22; no. 2 - 27; no. 3 - 110; no. 4 - 56.

Pumpage in 1964 -- 472 million gallons.
Maximum day -- 2.72 million gallons.

Storage facilities -- 750,000 gallons elevated.

Quality of water -- Hardness 305-330 ppm
Iron 1.2-1.4 ppm
Fluoride 0.3 ppm

Treatment -- None.

Population served -- estimated 7,000.
Per capita use -- 145 gallons per day.

Ground-water conditions -- Levels fell to new lows of record for the third consecutive year as precipitation continued to be deficient (fig. 37). No large increase in pumpage has occurred. The effects of the discontinuance of pumping by Pontiac to the west is not apparent in this well field.

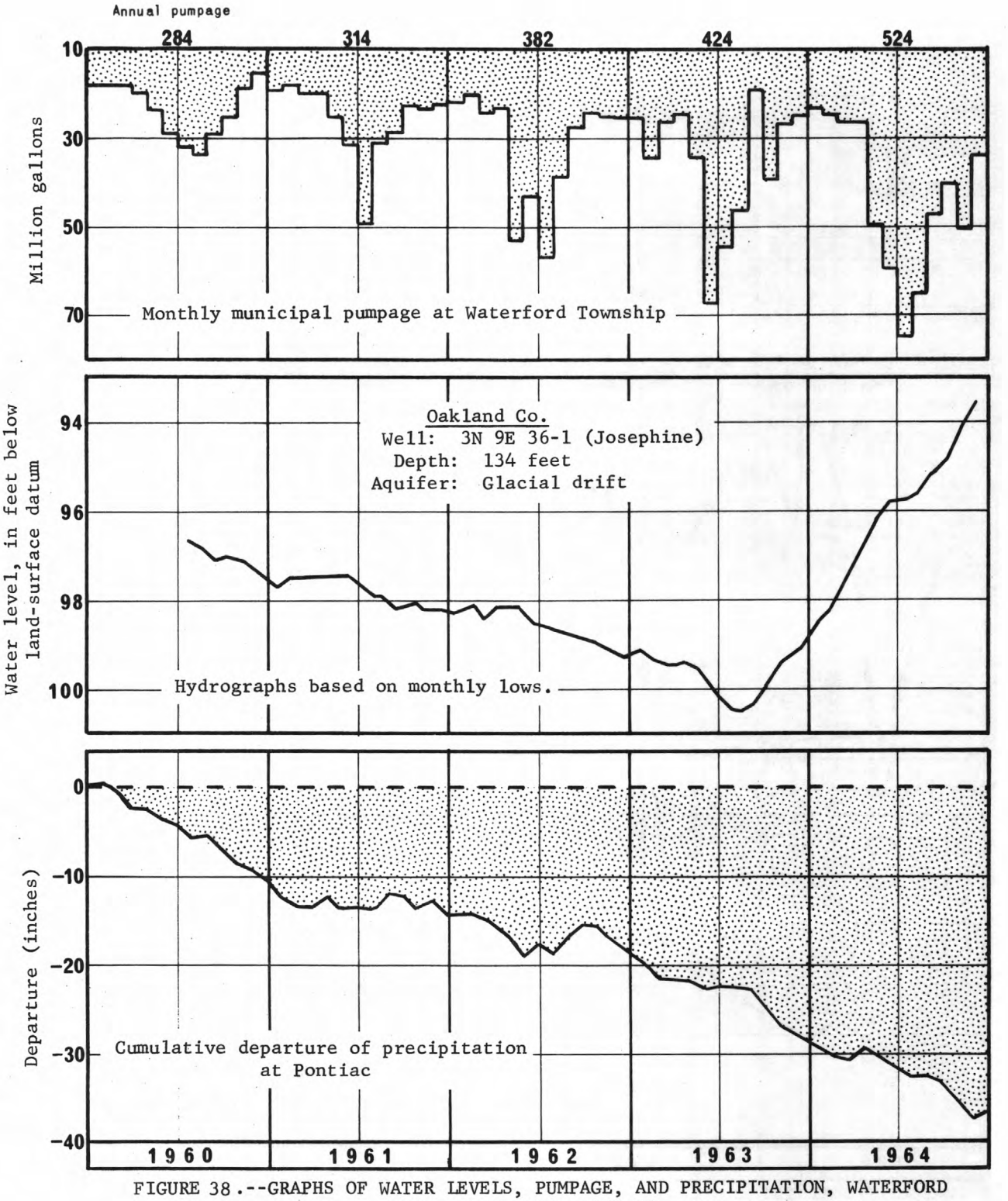

FIGURE 38.--GRAPHS OF WATER LEVELS, PUMPAGE, AND PRECIPITATION, WATERFORD TOWNSHIP, 1960-64.

Despite increased pumpage, and deficient precipitation water levels rose in response to the discontinuance of pumpage by the neighboring city of Pontiac.

OAKLAND COUNTY - WATERFORD TOWNSHIP

Water supply -- 13 wells, 85-327 feet deep, tapping the glacial drift throughout the township.

Yield of wells in gallons per minute -- 300-1,750.

Specific capacity of wells in gallons per minute per foot of drawdown -- 26-88.

Pumpage in 1964 -- 524 million gallons.

Storage facilities -- 50,000 gallons and 75,000 gallons elevated.

Quality of water -- Hardness 283-300 ppm
Iron 1.4-2.3 ppm

Treatment -- Phosphate and chlorination on some individual wells.

Population served -- estimated 18,000.
Per capita use -- 80 gallons per day

Ground-water conditions -- Water levels rose another five feet in the observation well (fig. 38) despite a 100 million gallon increase in pumpage and continued deficiencies of precipitation. The rise since 1963 is the result of the discontinuance of pumping of ground water by the City of Pontiac in 1963.

Work was begun in 1964 to tie into the township water system all subdivision public supplies in the township, and to add additional elevated storage of 1½ million gallons.

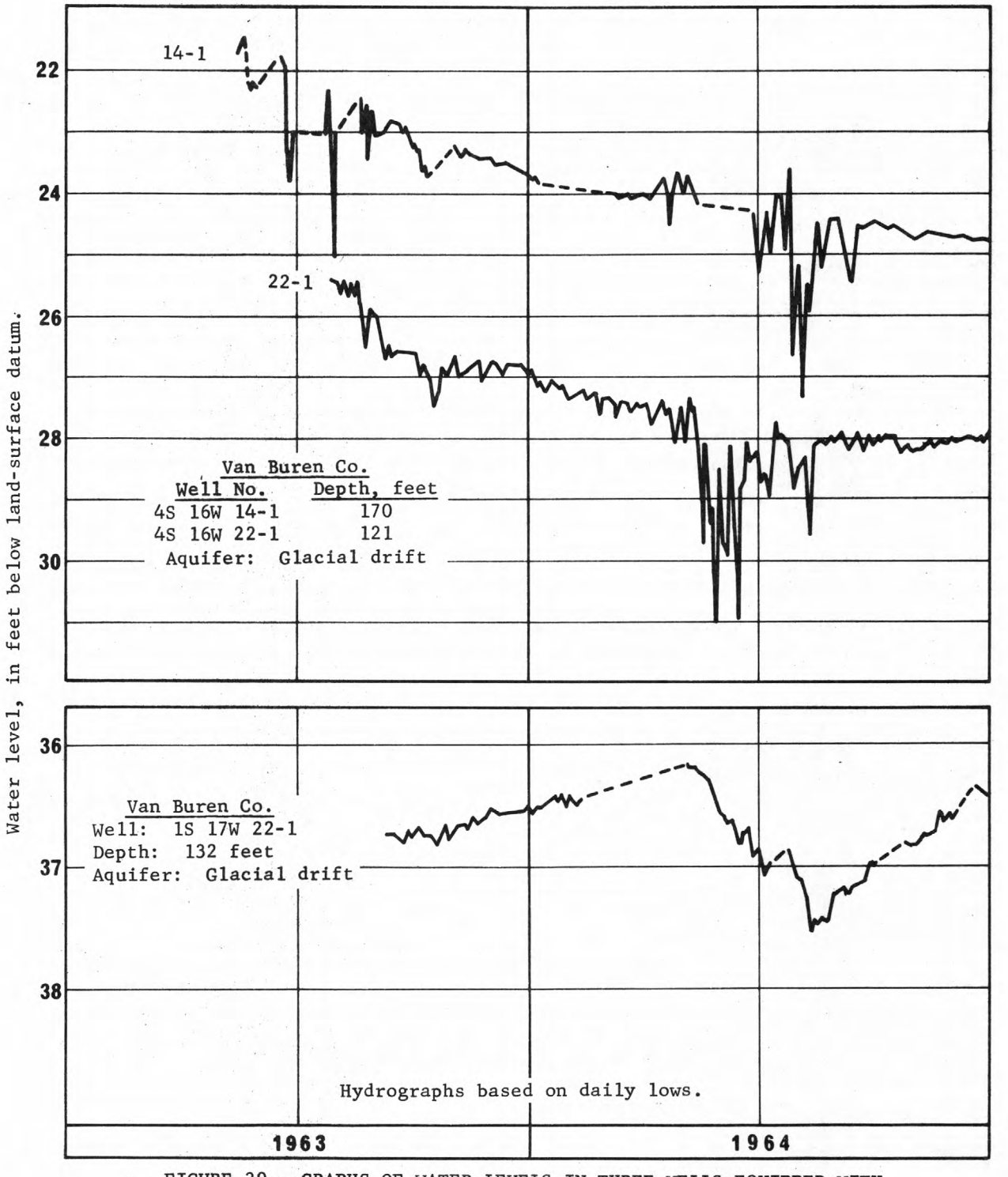

FIGURE 39.--GRAPHS OF WATER LEVELS IN THREE WELLS EQUIPPED WITH RECORDING GAGES, VAN BUREN COUNTY, 1963-64.

The two wells in the upper part of the figure are affected by irrigation and industrial pumpage.

VAN BUREN COUNTY

Most of the public and private water supplies in the County are obtained from wells finished in glacial drift except at South Haven where water is pumped from Lake Michigan. Some irrigation wells yield over 1,000 gallons per minute. The water from wells is generally hard and locally high in iron content, but is otherwise suitable for most uses.

Eight observation wells, three of which are equipped with recording gages, are maintained in the County.

Two of these recording gages (fig. 39) reflect conditions in the heavily irrigated area around Keeler located in the southwest part of the County. The heavy irrigation and also some industrial pumpage causes sharp fluctuations in the water levels. The bottom graph of figure 39 reflects changes in water level owing to natural climatic conditions in the area south of South Haven.

The water level declines in the two wells (14-1 and 22-1) in the Keeler area were mostly the result of large deficiencies of precipitation. In the South Haven area precipitation was about normal and water levels rose somewhat. However, precipitation at Paw Paw and Bloomingdale ranged from 9 to 6 inches below normal in 1964.

Water levels in four out of the five small-diameter wells (fig. 40) measured monthly in the County continued to decline as the result of the general precipitation deficiencies.

For additional information, see report "Water Resources of Van Buren County, Michigan" released in 1964 by the Michigan Department of Conservation as Water Investigation 3.

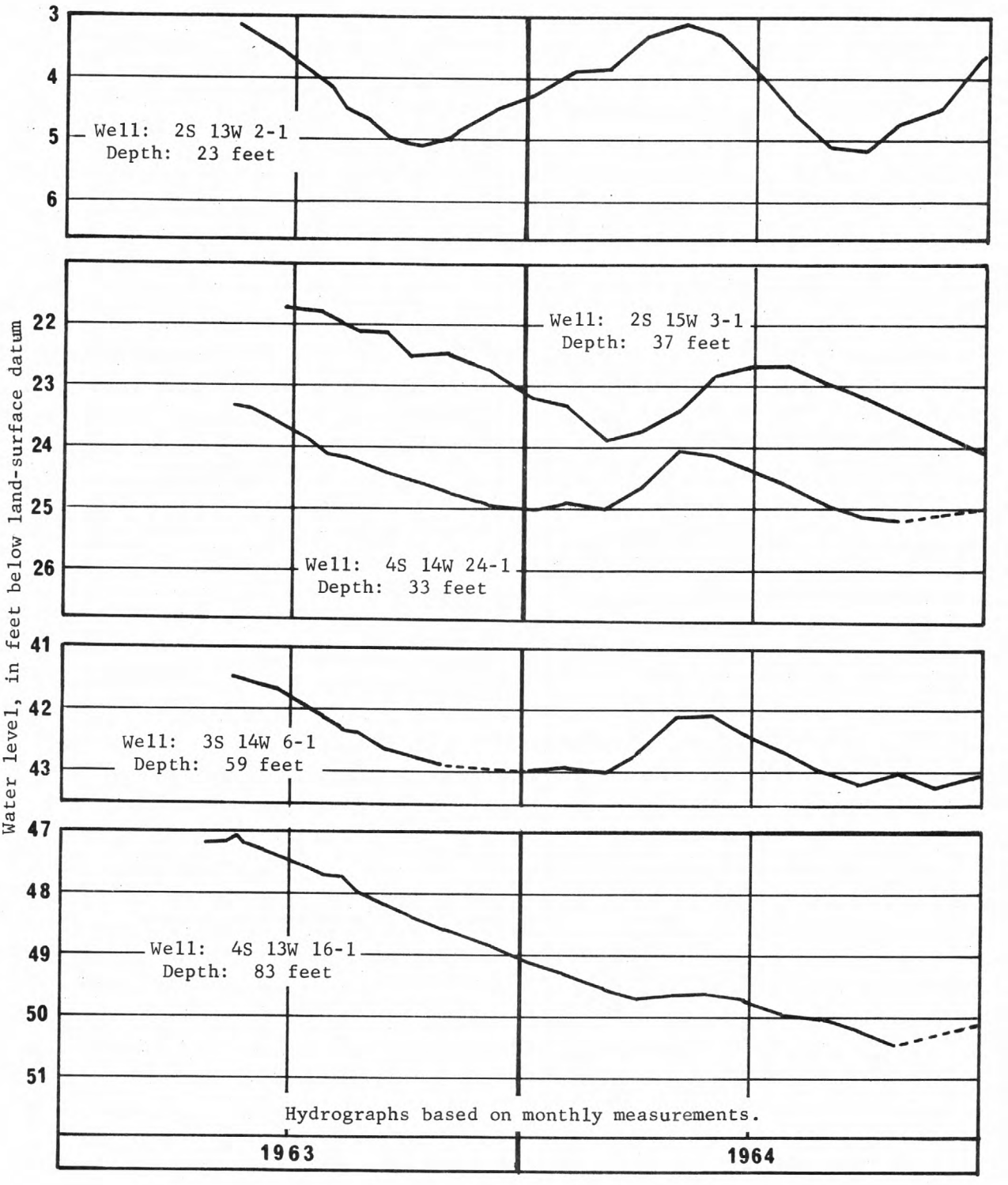

FIGURE 40.--GRAPHS SHOWING WATER LEVELS IN FIVE WELLS TAPPING THE GLACIAL DRIFT IN VAN BUREN COUNTY, 1963-64.

Water levels continued to decline in 1964 as the result of precipitation deficiencies.

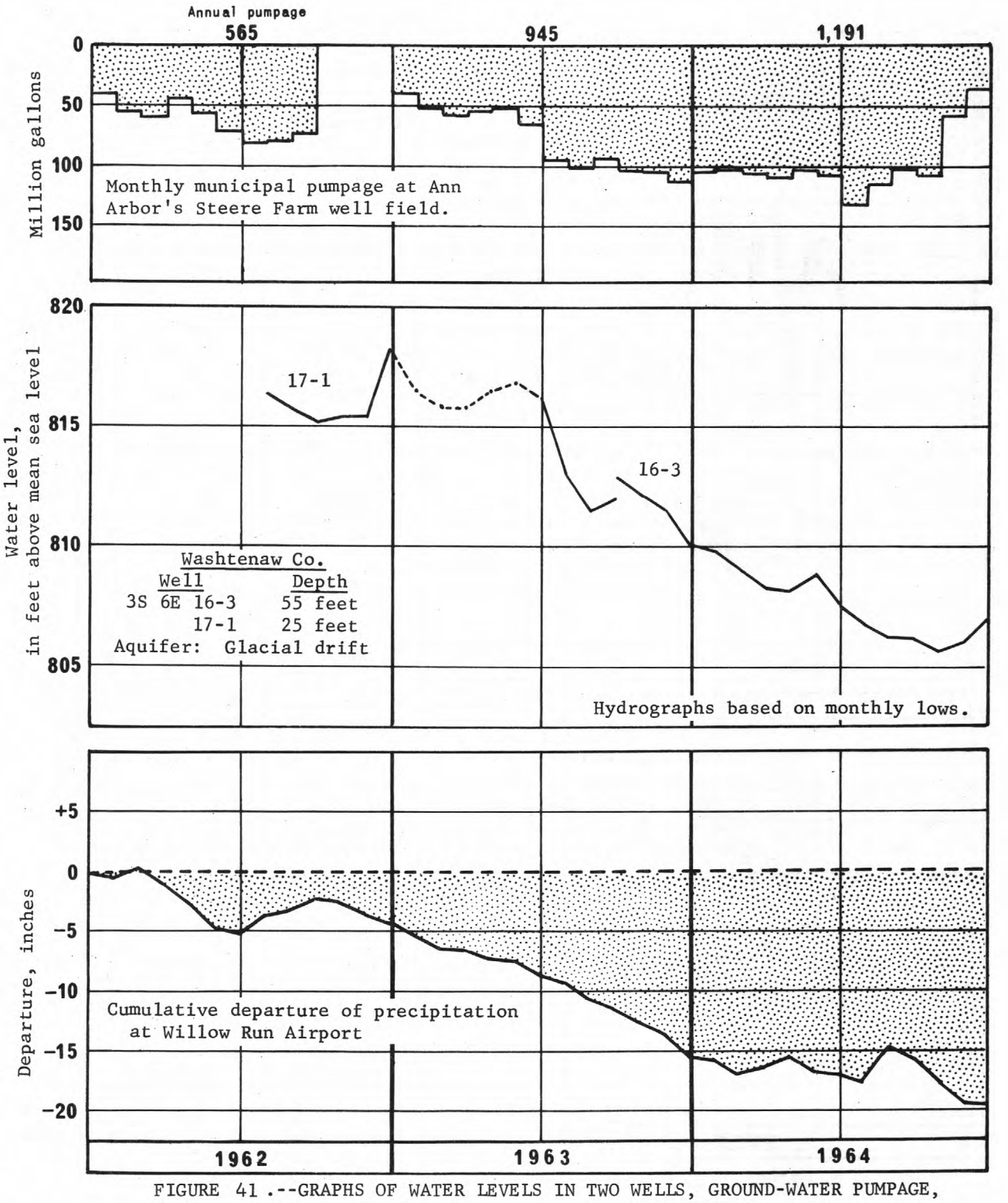

FIGURE 41.--GRAPHS OF WATER LEVELS IN TWO WELLS, GROUND-WATER PUMPAGE, AND PRECIPITATION, ANN ARBOR, 1962-64.

Water levels continued to decline as a result of increased pumpage and precipitation deficiencies.

WASHTENAW COUNTY - CITY OF ANN ARBOR

Water supply -- Four wells, 91-196 feet deep, finished in glacial drift and water from the Huron River.

Yield of wells in gallons per minute -- 2-3,000.

Specific capacity of wells in gallons per minute per foot of drawdown -- about 550-650.

Pumpage in 1964 -- Total 3,974 million gallons - surface water and ground water. (1,430 million gallons ground water).
Maximum day -- 7.65 million gallons of ground water.

Storage facilities -- Treatment plant: 6,057,000 gallons.
Ground level on system: 2,000,000 gallons.
Elevated storage: 1,000,000 gallons.

Quality of water -- Treated water: Hardness 76 ppm; Iron 0.
Ground water: Hardness 370-405 ppm; Iron 0.25-2.4.

Treatment -- Lime and soda ash softening, fluoridation, chlorination and filtration.

Population served -- 67,340.
Per capita use -- *58 gallons per day.
(*For ground water only. 162 gallons per day total surface water and ground water.).

Ground-water conditions -- Water levels in the observation well continued to decline as the result of increased pumpage and continued deficiencies of precipitation. Levels have fallen about 11 feet in the 1963-64 period. The low stages of about 16 feet below land surface occurred in 1964.

Ground-water pumpage at the Steere Farm well field area in 1964 was double the amount pumped in 1962. The observation well water levels and the pumpage shown in figure 41 are for this Steere Farm well field area several miles south of Ann Arbor. Some municipal production wells are located within the city limits. About 64% of the water pumped in 1964 was from the Huron River.

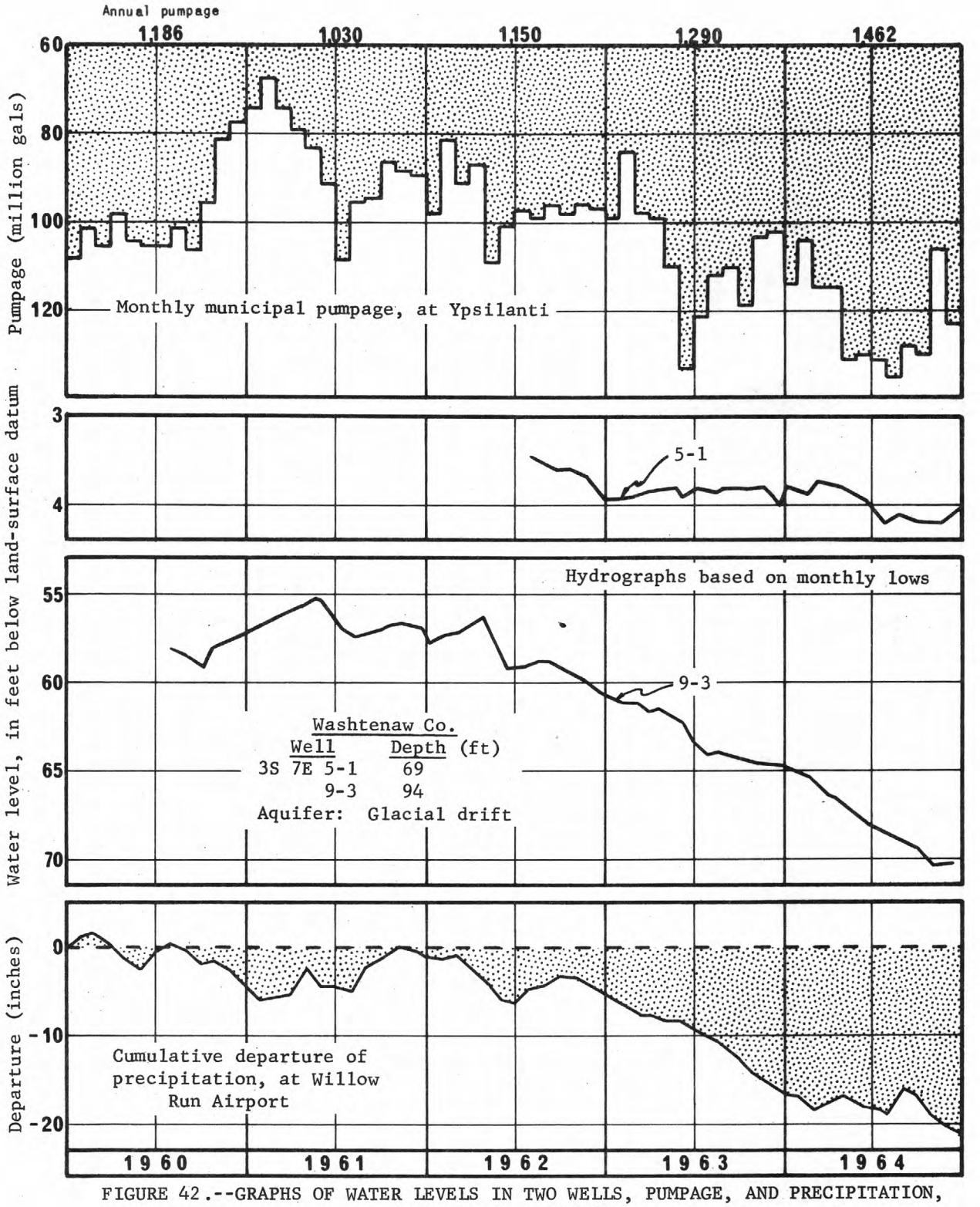

FIGURE 42.--GRAPHS OF WATER LEVELS IN TWO WELLS, PUMPAGE, AND PRECIPITATION, YPSILANTI, 1960-64.

Water levels fell to record-low stages in well 9-3 in 1964 when pumpage increased 13% and precipitation was deficient for the third consecutive year.

WASHTENAW COUNTY - CITY OF YPSILANTI

Water supply -- Water is obtained from five wells, 87-102 feet deep, finished in glacial drift.

Yield of wells in gallons per minute -- 4.5 average for 5 wells -- wells not metered individually.

Specific capacity of wells in gallons per minute per foot of drawdown -- Estimated 25-180.

Pumpage in 1964 -- 1,462 million gallons.
Maximum day -- 4.91 million gallons.

Storage facilities -- Treated water at plant 2,000,000 gallons.
Elevated storage 1,000,000; 250,000.

Quality of water -- Treated water: Hardness 86 ppm; Iron 0.
Raw water: Hardness 305-320 ppm
Iron 1.2-1.6 ppm
Fluoride 0.3 ppm

Treatment -- Lime softening.

Population served -- estimated 28,000 (1964).
Per capita use -- 143 gallons per day.

Ground-water conditions -- Levels continued to decline in 1964 in well 9-3 (fig. 42) as pumpage increased and precipitation deficiencies continued to accumulate. A water-level decline of 41 feet has been recorded since 1945 (table 2) in well 9-3. However, stages remained relatively steady in well 5-1 (fig. 42). This observation well is located over a mile from the City's pumping wells and is close to the Huron River. It is reported that a production well will be drilled at this site in 1965.

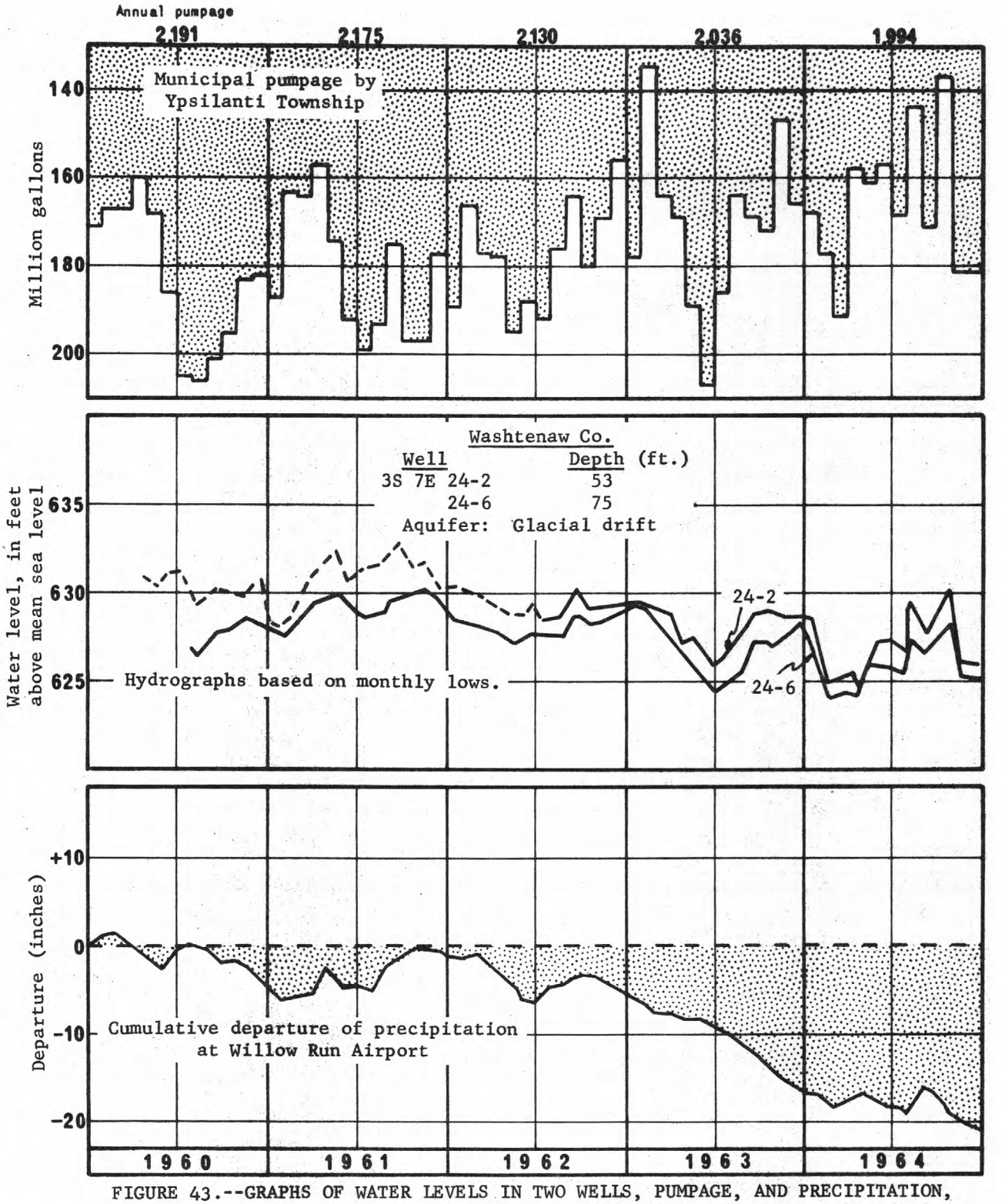

FIGURE 43.--GRAPHS OF WATER LEVELS IN TWO WELLS, PUMPAGE, AND PRECIPITATION, YPSILANTI TOWNSHIP, 1960-64.

Water levels fell to record-low stages in late winter in response to increased pumpage during that period.

WASHTENAW COUNTY - YPSILANTI TOWNSHIP

Water supply -- Five wells, 50-90 feet deep, finished in glacial drift.

Yield of wells in gallons per minute -- 700-1,000.

Pumpage in 1964 -- 1,994 million gallons.

Storage facilities -- Treated water at plant 1,618,000 gallons.
400,000 - 100,000 - 75,000 elevated gallons.

Quality of water -- Treated water: Hardness 88 ppm; Iron 0 ppm; Fluoride 0.1 ppm
Raw water: Hardness 280-355; Iron 0.3-1.8; Fluoride 0.1-0.6

Treatment -- Lime softening, chlorination.

Population served -- estimated 30,000 (1964).
Per capita use -- 181 gallons per day.

Ground-water conditions -- Periods of heavy pumpage caused drops in water levels. In early 1964 water levels fell to new lows of record as a result of the large withdrawals early in the year (fig. 43). However, precipitation deficiencies are also contributing to the decline of water levels. The effect of precipitation is particularly evident in 1961 when water levels showed a net gain for the year as a result of above-average rainfall despite heavy pumpage in that year.

Records of wells 3S 7E 24-1 through 24-6 (Washtenaw County, table 2) show that levels have fallen 15 to 28 feet in these observation wells below the highs observed in the 1943-50 period.

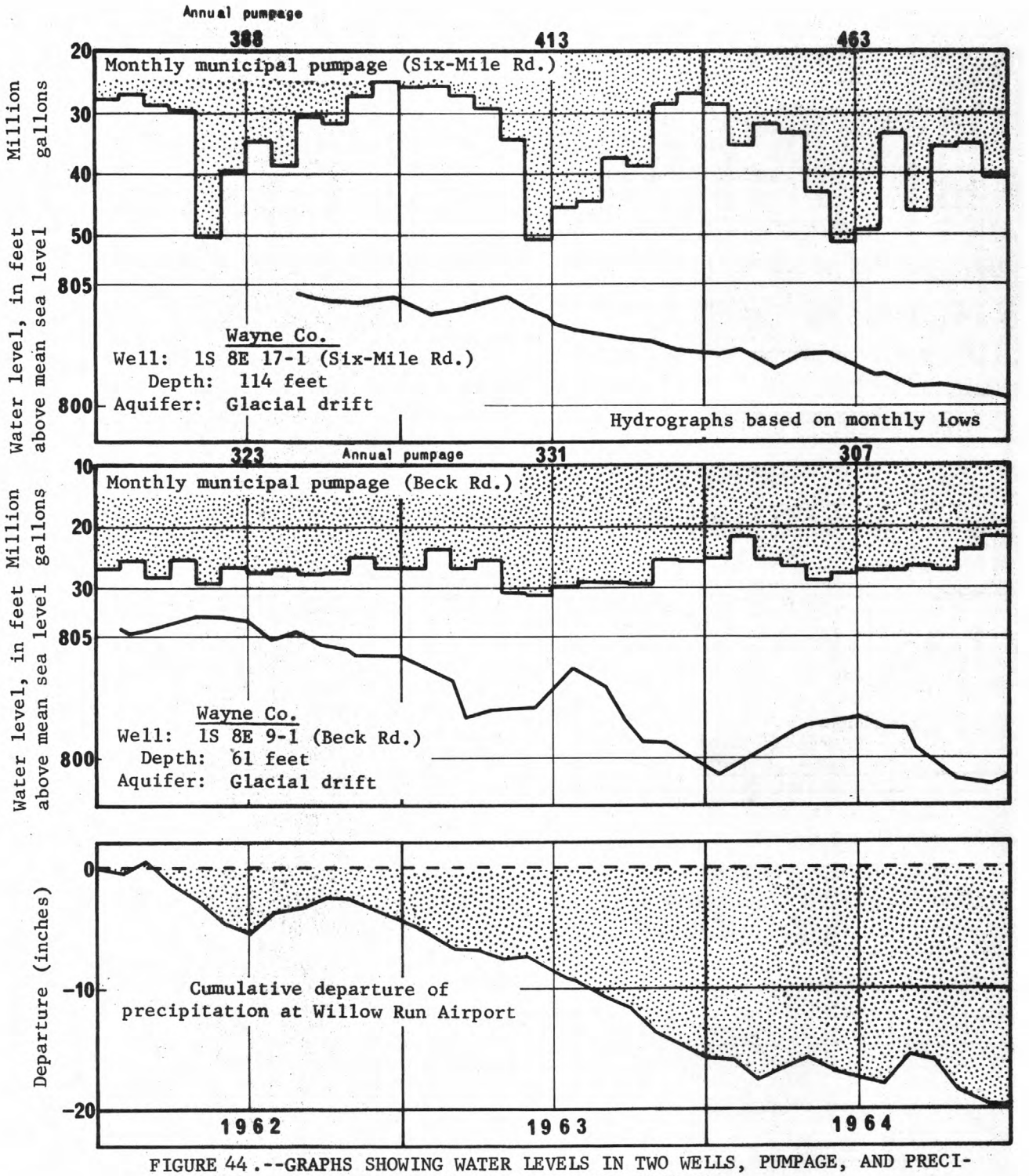

FIGURE 44.--GRAPHS SHOWING WATER LEVELS IN TWO WELLS, PUMPAGE, AND PRECIPITATION, PLYMOUTH, 1962-64.

Much of the declining trend of water levels is the result of deficient precipitation.

WAYNE COUNTY - CITY OF PLYMOUTH

Water supply -- Six wells, 20-110 feet deep, finished in glacial drift and located at three well fields.

Yield of wells in gallons per minute -- 500-2,400.

Specific capacity of wells in gallons per minute per foot of drawdown -- 84-700.

Pumpage in 1964 -- 828 million gallons.
Maximum day -- 4.17 million gallons.

Storage facilities -- 150,000, 250,000 and 1,500,000 gallons elevated storage tanks.

Quality of water --

Hardness	325-395 ppm
Iron	0.1-1.1 ppm
Fluoride	0.2-0.4 ppm
Chloride	31-59 ppm

Treatment -- Chlorination, fluoridation, phosphate.

Population served -- estimated 11,000 (1964).
Per capita use -- 207 gallons per day.

Ground-water conditions -- Ground-water levels continued to decline in 1964 (fig. 44) as precipitation deficiencies continued to accumulate and pumpage increased. The decline was less at the Beck Road field where pumpage decreased and more at 6-Mile Road where pumpage increased by about 12%. The single well at the Six-Mile Road Station pumps over 2,000 gpm when in operation and the monthly pumpage varies considerably. The Beck Road Station pumps about a million gallons daily and the monthly pumpage is relatively steady.

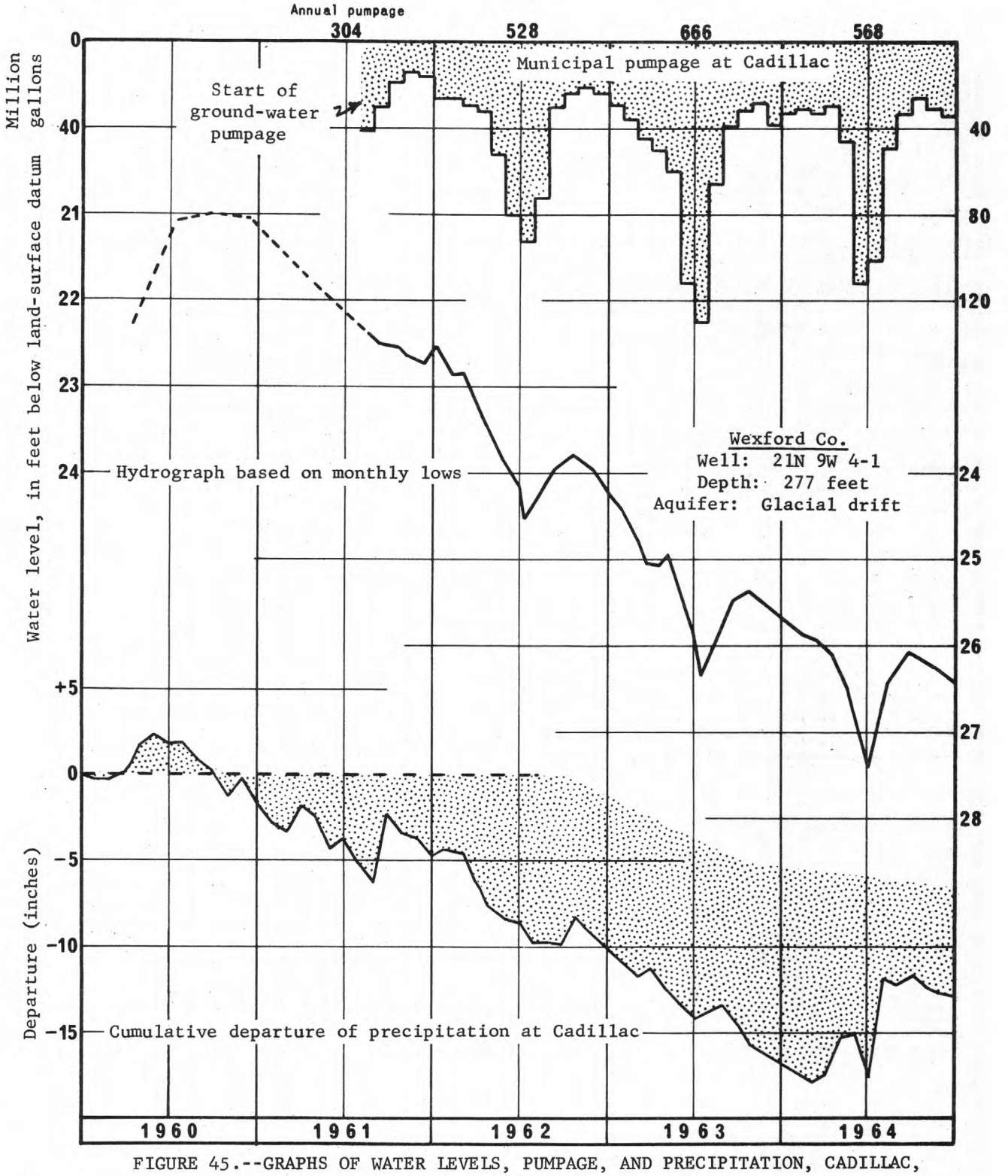

FIGURE 45.--GRAPHS OF WATER LEVELS, PUMPAGE, AND PRECIPITATION, CADILLAC, 1960-64.

Water levels continued to decline in 1964 despite above-average precipitation and reduced pumpage.

WEXFORD COUNTY - CITY OF CADILLAC

Water supply -- Six wells 300 to 382 feet deep obtain water from the glacial drift aquifer.

Yield of wells in gallons per minute -- Nos. 1, 2, 4 and 6 - 1,400; no. 3 - 750; no. 5 - 1,000.

Specific capacity of wells in gallons per minute per foot of drawdown -- No. 1 - 18; no. 2 - 25; no. 3 - 13; no. 4 - 42; no. 5 - 31; no. 6 - 42.

Pumpage in 1964 -- 568 million gallons.
Maximum day -- 7.30 million gallons.

Storage facilities -- 1 million gallons elevated.

Quality of water -- Hardness 108-112 ppm
Iron 0.4 ppm

Treatment -- Chlorination.

Population served -- 10,112.
Per capita use -- 153 gallons per day.

Ground-water conditions -- Cadillac formerly obtained its public supply from Lake Cadillac. Since the start of the ground-water system in mid-1961, ground-water levels in an observation well, located about ½ mile southeast of the city's well field, have fallen about four feet (fig. 45). Much of the decline, however, was the result of deficient precipitation.

In 1964 above-average precipitation and decreased pumpage resulted in only about one-half a foot of decline. The figure of 304 million gallons in 1961 (fig. 45) represents the total pumpage of ground and surface water in that year.

GROUND-WATER RESOURCES INVESTIGATIONS IN MICHIGAN

REPORTS OF INVESTIGATIONS

Selected references on water in Michigan are given below; many of them are available for reference at one of the offices listed in the Preface of this report and at the larger public and university libraries. A more complete listing of Geological Survey reports and their availability is given in a pamphlet "Geologic and Water-Supply Reports and Maps -- Michigan". Price lists of available publications of the Michigan Geological Survey are available from that agency.

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1499-E Water resources of the Flint area, Michigan, by S. W. Wiitala, K. E. Vanlier and R. A. Krieger, 1960.

1619-E Ground-water resources of the Alma area, Michigan, by K. E. Vanlier, 1961.

1691 Ground-water contamination and legal controls in Michigan, by Morris Deutsch, 1961.

1800 The role of ground water in the national water situation, by C. L. McGuinness, p. 412-427, 1963.

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183 Water resources of the Detroit area, Michigan, by C. O. Wisler, G. J. Stramel, and L. B. Laird, 1952.

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Water resource condition and uses in the Shiawassee River Basin, 1963.

Water resource condition and uses in the Maumee River Basin, 1964.

Water resource condition and uses in the River Raisin Basin, 1965.

Table 2.--Records of Michigan observation wells and extremes in water levels observed in 1964 and for the period of record.

Owner: MDC - Mich. Dept. of Conservation; WMP - Wisconsin-Michigan Power Co.; MSHD - Mich. State Highway Department; USFS - U. S. Forest Service; HCMA - Huron-Clinton Metropolitan Authority; BCRC - Branch County Road Commission; KCRC - Kalamazoo County Road Commission

Chief Aquifer:

Qgd - Glacial drift deposits of Pleistocene (Quaternary) age
Ps - Saginaw Formation of Pennsylvanian age
Mb - Bayport Limestone of Mississippian age
Mm - Marshall Formation of Mississippian age
Dt - Traverse Group of Middle and Late Devonian age
Dtb - Thunder Bay Limestone of Middle and Late (?) Devonian age
Ds - Sylvania Sandstone of Middle Devonian age
Ss - Salina Formation of Late Silurian age
Sm - Manistique Dolomite of Middle Silurian age
Or - Limestones of Richmond age (Late Ordovician)
Otb - Black River and Trenton Limestones of Middle Ordovician age
Op - Prairie du Chien Group of Early Ordovician age (previously designated as Au Train Formation)
Cm - Munising Sandstone of Cambrian age
pC - Rocks of Precambrian age (undifferentiated)
pCf - Freda Sandstone of Keweenawan age (Precambrian)

Altitude: Land-surface datum in feet above mean sea level

F - 64: Frequency of measurement in 1964: R - Continuous recorder; D - Daily; W - Weekly; M - Monthly; Q - Quarterly; S - Semiannually; A - Annually

Observed water-level extremes: 1964 measurements underscored are new extremes for entire period of record (in feet below or above (+) land surface).

Remarks: P - Water level affected by pumping. Water-level measurements are made by the U. S. Geological Survey unless otherwise noted.

County and well number	Location in section ¼ ¼	Owner	Depth (ft)	Dia. (in)	Chief aquifer	Altitude	Years of record	F-64	Observed water level extremes								Remarks
									Through 1963				In 1964				
									High	Date	Low	Date	High	Date	Low	Date	
ALGER COUNTY																	
45N 19W 25-1	SW NE	USFS	66	6	Qgd		6	M	6.35	6-60	13.88	12-63	12.80	9-28	14.19	4-3	
BARAGA COUNTY																	
49N 33W 18-1	NE SW	Mich. Col. of Mining and Tech.	12	16	Qgd		7	R	e4.90	4-60	9.40	2-59	5.84	4-24	9.38	2-21	Meas. by owner
48N 32W 12-1	SE SE	MSHD (WMP 14)	10	1¼	Qgd		17	M	4.19	5-51	7.33	2-62	4.80	5-1	7.30	3-30	Meas. by WMP
BARRY COUNTY																	
4N 9W 5-1	NE SE	MDC	131	2	Qgd	e860	1	M					119.27	1-10	121.71	11-13	Record started 11-63
3N 10W 3-1	NE SE	MDC	53	2	Qgd	e760	1	M					36.13	9-7	36.47	1-10	Record started 11-63
3N 8W 18-1	SE NE	City of Hastings	33	6	Qgd		7	R	2.32	4-59	6.81	7-61	2.82	5-20	5.29	7-16	P
2N 10W 1-1	NE NW	MDC	84	2	Qgd	e950	1	M					80.28	1-10	81.89	9-18	Record started 11-63
BAY COUNTY																	
17N 4E 15-1	SW SE	Pinconning Township	61	2	Ps		3	M	+0.80	5-63	5.00	8-62	+0.64	4-6	3.78	9-1	
22-1	SW SE	Pinconning Township	110	6	Ps		3	R	3.75	1-63	10.53	8-63	4.16	1-2	9.26	8-14	P
22-2	SE NE	Sterling Tube Co.	170	6	Ps		3	M	9.00	2-63	12.97	9-62	9.26	1-6	11.80	8-3	
27-1	SW SE	Walter Wolan	72	2	Ps		3	M	1.26	5-63	4.14	9-62	1.36	5-4	4.01	8-7	
BRANCH COUNTY																	
5S 7W 31-1	NW NW	Jake Herman	22	4	Qgd	e905	1	M					7.05	12-18	7.70	9-16	Record started 9-16
5S 6W 22-1	NE NE	MSHD-Auger Site 1	27	1¼	Qgd	e950	1	M					15.71	12-18	16.30	11-3	Do. 10-27
5S 5W 2-1	NE NE	Merrill Wade	169	10		e985	1	M					8.19	12-18	8.57	11-3	Do. 8-14
2-2	NE NE	Do.	45	12	Qgd	e985	1	M					8.44	8-14	8.84	11-3	Do. 8-14
8-1	SW SW	Ernest King	61	4		e990	1	M					10.67	8-14	11.34	11-23	Do. 8-14
6S 8W 27-1	SE NW	H. Herman	29	2	Qgd	e895	1	M					9.19	12-18	9.77	11-23	Do. 9-18
6S 7W 3-1	NW NW	Morrell Barnhart	20	36		e985	1	M					8.67	8-18	9.67	12-18	Do. 9-16
27-1	SW SE	Cleo Crandell	24	1¼	Qgd	e928	1	M					17.91	12-18	18.17	10-22	Do. 9-16
6S 6W 9-1	NE NE	Maple Lawn Hospital	135	6	Qgd	e980	1	R					10.15	8-12	12.08	11-15	Do. 8-10
21-1	SE NW	Robert Kerr	58	12	Qgd	e950	1	R					20.35	12-16	20.91	11-2	Do. 8-12
22-3	NE SW	City of Coldwater	113	6	Qgd		1	R					12.5	5-6	24.1	8-7	Do. 1-22
7S 8W 24-1	NW SW	M & J Adams	39	1¼	Qgd	e916	1	M					8.91	9-15	9.58	11-20	Do. 9-15
7S 7W 1-1	SW SW	Joe Szafanski	49	4	Qgd	e1020	1	M					18.68	9-15	19.71	11-20	Do. 9-15
23-1	NE SE	Bronson School	24	1¼	Qgd	e1015	1	M					20.60	9-15	21.04	12-18	Do. 9-15
31-1	SE NW	Oilo Harbaugh	16	1½	Qgd	e946	1	M					10.90	8-19	11.48	11-20	Do. 8-19
7S 6W 2-1	SW SE	O. Maxson	22	36	Qgd	e1010	1	M					18.60	8-19	21.78	12-18	Do. 8-19
24-1	SW SW	Do.	19	1	Qgd	e1010	1	M					7.62	12-18	8.83	10-22	Do. 8-19

Table 2.--Records of Michigan observation wells and extremes in water levels observed in 1964 and for the period of record.--Continued

County and well number	Location in section ¼ ¼	Owner	Depth (ft)	Dia. (in)	Chief aquifer	Altitude	Years of record	F-64	Observed water level extremes								Remarks
									Through 1963				In 1964				
									High	Date	Low	Date	High	Date	Low	Date	
BRANCH COUNTY (Continued)																	
8S 8W 12-1	NW NE	BCRC-Auger Site 4	17	1¼	Qgd	e945	1	M					7.40	10-29	7.57	11-20	Record started 10-29
17-1	SE SW	Bronson School	38	1¼	Qgd	e917	1	M					15.99	9-15	16.32	11-20	Do. 9-15
8S 7W 5-1	NW NE	BCRC-Auger Site 8	27	1¼	Qgd	e948	1	M					13.18	12-18	13.28	11-20	Do. 11-4
6-1	SW SW	BCRC-Auger Site 3	37	1¼	Qgd	e963	1	M					23.09	10-29	23.38	11-20	Do. 10-29
6-2	NE SE	Olan Martin	28	1¼	Qgd	e955	1	M					18.56	8-19	19.15	12-18	Do. 8-19
6-3	NE NE	H. Bucklin	27	1¼	Qgd	e955	1	M					25.36	9-15	26.00	12-18	Do. 9-15
7-1	SW NE	BCRC-Auger Site 7	47	1¼	Qgd	e975	1	M					30.75	11-4	30.97	12-18	Do. 11-4
7-2	SW NW	BCRC-Auger Site 5	36	1¼	Qgd	e960	1	M					23.90	11-4	24.03	12-18	Do. 11-4
7-3	SE SE	BCRC-Auger Site 6	34	1¼	Qgd	e960	1	M					10.05	11-4	10.21	12-18	Do. 11-4
10-1	NE SE	J. T. Ripley	19	1¼	Qgd	e960	1	M					12.37	12-18	12.62	10-22	Do. 9-16
8S 6W 6-1	NE NE	Robert McCollough	16	1¼	Qgd	e983	1	M					12.80	8-19	13.24	11-23	Do. 8-19
8S 5W 6-1	NW NE	Chipman	55	4	Qgd	e1032	1	M					18.57	9-18	19.42	12-18	Do. 9-18
CALHOUN COUNTY																	
1S 7W 10-1	NW NW	K. N. Sabin	8	15	Qgd	907.99	19	W	0.89	3-50	6.43	12-63	5.91	5-20	dry	7-29	Meas. by owner
32-1	NE SE	City of Battle Creek (22)	127	8	Mn	830.79	26	D	0.7	4-50	16.75	7-59	10.99	2-22	16.60	6-6	P, Meas. by owner
32-2	NE NW	Mrs. Harriett Rice	43	2	Mn	842.88	19	Q	8.98	4-50	18.96	9-63	18.86	4-14	20.28	9-8	P
32-3	SE NW	Penfield Twp.	95	6	Mn	e845	1	R					24.32	4-27	26.98	8-7	Record started 2-64
2S 8W 2-1	NW SE	Oliver Elec. Mfg. Co.	92	10	Mn	819.99	19	R	4.75	4-47	14.95	9-59	14.37	5-31	15.60	3-5	P
3-1	SE SE	Dominic Conto	12	2	Qgd	862.02	19	Q	1.75	4-50	10.45	9-63	9.34	4-14	11.57	9-8	
14-2	SE SE	City of Battle Creek (TW 1)	89	26	Qgd	914.97	20	Q	6.22	5-50	12.86	10-46	9.52	6-30	10.27	9-8	
16-1	SW NE	Battle Creek Twp.	148	8	Mn	917	1	R					5.18	12-16	5.37	12-9	Record started 11-64
2S 6W 25-1	NE NE	City of Marshall (Ferguson)	59	6	Mn	904.85	15	M	5.46	5-50	9.60	11-63	8.95	5-1	9.67	8-1	P, Meas. by owner
CASS COUNTY																	
6S 16W 1-1	SW NE	City of Dowagiac	159	10	Qgd	750.19	16	W	+5.20	2-60	5.97	7-53	1.88	3-6	6.63	8-7	P, Meas. by owner
8S 14W 17-1	NE NW	Ted Little	55	28	Qgd		20	W	46.20	7-50	55.03	3-57	52.53	1-12	54.15	5-3	
CHARLEVOIX COUNTY																	
33N 4W 2-1	SW NE	MDC	94	6	Qgd		17	Q	69.49	7-60	75.85	4-56	72.21	12-23	74.72	4-13	
32N 4W 10-1	NE SE	MDC (33)	17	2	Qgd		25	M	1.19	3-58	7.42	2-59	2.28	5-5	4.89	1-13	
CHEBOYGAN COUNTY																	
34N 1W 1-1	NW SW	MDC (7)	11	2	Qgd		19	Q	2.75	3-38	5.55	10-55	4.59	4-13	5.32	10-5	
CHIPPEWA COUNTY																	
46N 4W 24-1	NE SE	USFS (Raco CCC Camp)	54	6	Qgd		13	R	20.70	7-60	27.77	4-56	24.55	6-19	28.43	4-13	
CLINTON COUNTY																	
8N 4W 22-1	SE NW	MDC	90	2	Qgd		1	M					69.25	7-11	70.40	5-23	Record started 11-63
8N 1W 13-1	SW NW	Village of Elsie	298	12	Pms	699.68	18	M	+3.78	6-50	37.55	10-57	+4.20*	5-25	+1.57	11-27	P, *well flowing
7N 2W 9-2	SW NW	City of St. Johns	498	10	Pms	746.93	3	R	64.7	12-63	112.1	12-62	67.5	3-16	115.8	9-4	P, Record disc. 11-9-64
9-3	NW NW	City of St. Johns	355	6	Pms		1	R					55.9	12-13	70.12	9-11	Record started 9-11-64
6N 2W 16-1	SE SE	MSHD	23	14	Qgd	803.32	17	M	14.59	4-52	19.89	12-63	19.10	6-23	19.93	2-27	Fed. key well
5N 2W 31-1	NW SW	Mich. Dept. of Aeronautics	195	6	Pms	e850	7	R	45.0	3-49	60.94	12-63	59.99	1-2	63.32	12-19	P
32-1	SW SE	Mich. Health Department	135	4	Pms	849.21	21	M	42.02	9-44	95.30	11-63	95.24	4-28	97.81	3-26	P
5N 1W 24-1	SE NW	MDC	40	2	Qgd	e870	1	M					31.30	5-23	32.21	9-17	Record started 11-63

Table 2.--Records of Michigan observation wells and extremes in water levels observed in 1964 and for the period of record.--Continued

County and well number	Location in section ¼ ¼	Owner Owner	Depth (ft)	Dia. (in)		Altitude	Chief aquifer	F-64	Observed water level extremes								Remarks
									Through 1963				In 1964				
									High	Date	Low	Date	High	Date	Low	Date	
CRAWFORD COUNTY																	
27N 1W 20-1	SW SW	MDC (22)	15	2	Qgd		29	Q	1.55	7-43	5.92	10-55	5.01	4-27	5.76	12-23	
26N 4W 11-1	NW SW	MDC	12	15	Qgd	1147.59	23	R	4.03	6-43	9.85	9-58	6.64	5-18	9.81	9-19	
25N 3W 28-1	SW SW	MDC (8)	13	1¼	Qgd	1175.14	30	Q	8.60	7-60	11.28	10-58	10.27	4-10	10.86	12-23	
25N 1W 15-1	SE SE	USFS	56	6	Qgd		17	R	29.36	7-60	35.97	4-51	32.01	1-2	34.21	12-29	
DELTA COUNTY																	
43N 19W 24-3	NW NW	Harry Clarage	405	4	Otb		7	M	77.02	7-60	81.06	11-63	80.84	1-30	81.25	4-29	
42N 19W 20-3	NE NE	USFS	134	6	Or		7	M	23.76	6-60	26.47	11-63	25.08	1-30	26.94	6-30	
42N 18W 17-2	SW NE	USFS	60	6	Qgd		7	M	21.20	5-60	25.38	12-63	24.09	5-25	25.34	9-28	
41N 19W 17-1	NE SW	USFS	58	6	Or	635	7	M	0.30	4-62	4.54	11-63	0.75	5-25	3.39	1-8	
41N 18W 31-2	SE SW	Charles Thompson	250	4	Or		7	R	3.77	5-60	6.31	2-61	3.73	5-9	5.48	6-30	
40N 22W 4-4	NE NW	USFS	34	5	Qgd		6	M	14.87	7-60	17.92	12-36	17.89	6-30	18.35	4-29	
39N 23W 28-3	SW NE	Marshall & Sherman Blake	530	5	€m	680	7	R	1.32	5-60	3.86	9-58	1.65	5-9	3.51	11-?	
38N 22W 24-1	NW SE	USFS (3)	36	6	Or	585	7	R	0.75	4-62	5.53	10-58	0.31	5-8	4.67	7-7	
DICKINSON COUNTY																	
43N 29W 32-1	NW NE	Dickinson Co. (WMP 11)	12	1¼	Qgd		17	M	5.12	4-51	dry	10-48	7.76	6-2	dry	1-2	Meas. by WMP
42N 27W 33-1	NE NW	E.W. LaFreniere (WMP 10)	12	36	Qgd		11	M	2.74	5-60	10.75	10-55	4.74	6-2	10.13	2-27	Do.
41N 30W 25-1	NE SW	Dickinson Co. (WMP 1)	20	1¼	Qgd		17	M	2.66	5-60	dry	10-55	11.66	6-2	dry	1-2	Do.
25-2	NW SE	Wm. Carrola (WMP 2)	16	36	Qgd		19	M	1.69	5-60	dry	1-59	7.41	6-2	dry	1-2	Do.
25-3	SE NE	Oscar Martinson (WMP 3)	12	48	Qgd		19	M	1.57	5-60	dry	11-48	6.79	6-2	dry	1-30	Do.
EATON COUNTY																	
4N 4W 2-1	SW SW	City of Grand Ledge	376	12	Pps	846.59	17	R	21.34	5-50	29.72	9-59	29.20	1-3	30.11	8-6	P
11-1	NW NE	City of Grand Ledge	350	8	Pps	788.9	5	R	+3.9	4-62	-8.3	12-60	+3.5	4-13	-8.5	9-11	P
4N 3W 10-1	SE NE	John Schneeberger	121	3	Pps	855.99	21	M	31.28	5-48	42.14	12-63	41.76	1-29	43.10	11-30	P
12-1	SE SW	F. A. Wheeler	381	6	Pps	861.91	12	R	67.5	11-53	85.7	7-63	80.1	1-27	89.1	7-2	P
3N 3W 2-1	NE NW	City of Lansing (TW 63H)	66	1¼	Qgd	839	1	R					3.61	5-13	7.57	6-6	Record started 1-12
2N 4W 19-1	NW SW	City of Charlotte	25	240	Qgd	889.44	18	Q	8.04	4-47	17.31	12-63	17.27	4-14	17.46	9-8	P
GENESEE COUNTY																	
7N 7E 17-1	SE NE	Consumers Power Co.	222	12	Pps	757.83	19	R	24.23	2-50	37.99	8-55	25.15	4-13	33.35	8-10	P
20-2	SW SW	City of Flint	169	2	Qgd	749.48	18	Q	1.09	4-50	9.10	9-62	6.27	4-15	8.66	9-17	
29-1	SE SW	C. F. Crain	14	1¼	Qgd	776.63	19	Q	1.69	12-49	11.09	9-63	8.24	4-15	11.45	9-17	
32-1	SW SW	A. W. Arndt	140	2	Qgd	792.27	19	Q	18.51	6-47	37.84	12-63	37.06	4-15	39.36	12-10	P
6N 7E 9-1	SW SE	Fisher Body Div., GMC	235	6	Pps	841.71	13	R	37.79	11-52	65.1	7-63	50.1	2-24	65.2	7-31	P
GLADWIN COUNTY																	
17N 1W 7-1	SW NW	City of Beaverton	93	12	Qgd	721.50	15	W	27.94	4-59	49.35	6-50	31.78	6-13	33.73	8-5	P, Meas. by owner
GOGEBIC COUNTY																	
48N 47W 31-1	SW SE	City of Ironwood	115	1½	Qgd		2	R	19.2	9-63	27.2	12-63	14.1	5-10	28.4	1-2	P
31-2	SW SE	City of Ironwood	30	1½	Qgd		2	R	15.56	5-63	24.14	3-63	18.2	10-6	21.2	12-30	P
34-2	NE SE	City of Ironwood (Gp 2)	35	6	Qgd		3	R	e+1.70	3-63	-1.70	7-63	+1.5	4-12	-2.5	8-21	P, Meas. disc. 12-28-64
34-3	NE SE	City of Ironwood (Gp 3)	22	6	Qgd		4	R	+0.14	5-62	-4.8	9-63	-0.5	5-6	-4.3	8-19	P
GRAND TRAVERSE CO.																	
27N 9W 4-1	NW NE	MDC (18)	15	2	Qgd	687.01	23	M	0.74	5-60	2.54	7-35	1.09	4-14	1.68	8-13	
26N 11W 27-1	NW SW	MDC (2)	14	2	Qgd	914.25	24	Q	1.12	4-62	4.02	8-36	1.76	4-10	3.10	10-8	
26N 9W 13-1	SW SW	MDC (2)	14	2	Qgd	961.78	25	M	4.62	5-63	7.87	10-49	6.03	5-14	7.78	9-11	
GRATIOT COUNTY																	
12N 3W 24-2	NE SE	City of St. Louis (3)	216	16	Qgd		5	R	37.9	1-64	67.6	10-60	46.0	6-1	67.5	12-2	P
34-1	SW SE	S. J. Brown	55	2	Qgd	727.12	18	M	6.08	4-48	40.87	6-50	23.86	2-27	31.23	3-27	P
35-3	NW SW	Walter Stone	26	2	Qgd	732.62	18	M	10.07	5-48	24.30	8-58	22.31	1-29	24.39	3-27	P
35-5	SW NW	Reed Excavating Co.	20	36	Qgd	738.78	15	M	13.74	4-50	17.92	2-63	16.61	5-25	17.82	2-27	
12N 2W 18-1	NE NW	Mich. Chemical Company	1350	5½	Mm		8	M	171.83	12-63	267.7	8-57	160.16	12-29	170.94	1-29	
11N 3W 3-6	NW NW	E. H. Waber	49	2	Qgd	733.20	19	M	4.99	2-59	35.52	11-63	30.29	2-27	36.26	10-30	P

Table 2.--Records of Michigan observation wells and extremes in water levels observed in 1964 and for the period of record.--Continued

County and well number	Location in section ¼ ¼	Owner	Depth (ft)	Dia. (in)	Chief aquifer	Altitude	Years of record	F-64	Observed water level extremes								Remarks
									Through 1963				In 1964				
									High	Date	Low	Date	High	Date	Low	Date	
GRATIOT COUNTY (Continued)																	
11N 3W 4-1	SW NE	City of Alma (TW 6)	165	8	Qgd	732.31	9	R	12.06	6-55	29.4	7-63	17.8	1-21	29.4	6-24	P
36-1	SE SE	Village of Ithaca	785	8	Pps	804.50	18	M	78.25	1-52	83.96	9-49	80.61	6-23	81.38	1-29	
9N 3W 33-1	SE NE	MDC	55	3	Qgd	e658	1	M					13.29	4-7	16.47	9-18	Record started 10-63
HILLSDALE COUNTY																	
6S 3W 23-2	NW NW	City of Hillsdale (TW 6)	26	6	Qgd		8	W	1.62	6-60	12.96	9-57	2.40	4-6	12.41	9-14	P
INGHAM COUNTY																	
4N 2W 9-1	SE NW	City of Lansing (Seymour 1)	401	14	Pps	828.81	36	R	15.63	3-31	154.77	4-56	151.2	2-10	161.1	9-11	P
16-1	NE SE	City of Lansing (Cedar)	417	12	Pps	829.11	20	R	42.01	3-46	67.0	8-49	62.28	1-1	65.32	4-13	P
17-1	NW NE	City of Lansing (Logan)	424	20	Pps	858.72	34	R	34.34	12-29	151.9	7-63	146.4	4-13	155.5	9-11	P
17-2	NW NW	Olds Drop Forge (4)	417	12	Pps	872.55	19	Q	104.86	12-46	156.64	6-63	148.67	4-15	155.44	9-28	P
19-1	SW SW	Waverly Hills Assoc.	87	2	Pps	833.94	18	Q	0.00	3-50	8.74	12-60	7.97	4-15	8.26	6-29	P
21-1	NE NW	City of Lansing (Townsend)	410	14	Pps	834.10	38	R	2.0	5-06	77.39	7-63	66.85	1-20	76.47	7-23	P
22-1	SW NW	City of Lansing (P-5)	338	12	Pps	823.64	35	M	7.1	7-32	64.12	10-63	64.60	1-30	67.22	10-12	P
23-1	NE NW	City of Lansing (RS-7)	467	12	Pps	824.86	32	M	7.55	11-30	116.28	7-59	93.83	3-26	98.94	8-25	P
24-1	NE SW	Michigan State Univ.	453	10	Pps	853.45	30	R	25.47	3-46	85.3	6-63	63.3	1-2	85.8	6-6	P
28-1	NE NW	Atlas Drop Forge (2)	425	8	Pps	849.20	19	Q	30.28	4-48	60.75	9-63	57.55	4-15	57.98	6-29	P
31-1	SW SW	C. A. Weber	204	3	Pps	880.15	21	M	18.92	4-52	26.91	12-63	26.85	5-27	27.45	10-29	P
4N 1W 18-1	SE NE	Marble School	175	3	Pps	847.85	13	M	20.09	4-53	42.54	12-63	39.21	4-28	47.03	8-25	P
27-1	SW SE	Mich. State University (Dobie)	278	8	Pps	e860	2	R	6.60	12-63	6.82	12-63	6.14	5-17	8.52	8-8	
4N 1E 21-1	SE SW	Duncan Lumber Co. (Sherwood)	265	8	Pps	e890	2	R	21.20	12-63	21.72	12-63	20.95	5-9	22.61	9-15	
3N 2W 23-2	SE NE	Delhi Township	268	8	Pps	e880	6	R	2.07	3-60	7.83	12-63	6.19	5-16	7.85	1-7	P
3N 1E 7-1	S½	M. Lotte	184	3	Pps	e900	1	M					3.56	5-23	7.00	11-12	Record started 10-63
2N 1W 5-1	SE SE	City of Mason (old 2)	150	6	Pps		17	W	0.08	6-49	9.85	8-63	3.72	6-8	10.67	8-1	P, meas. by owner
2N 1E 5-2	NW	City of Mason	210	8	Pps		2	R	22.21	12-63	22.69	12-63	21.67	6-8	23.82	11-29	P
34-1	NW SE	MDC	87	2	Qgd	980	1	M					27.64	5-25	29.33	10-12	
IONIA COUNTY																	
7N 7W 23-1	NW NW	Mich. Tng. Unit at Ionia	127	6	Qgd	741.65	5	R	28.36	4-61	34.12	10-61	29.60	5-17	33.51	8-21	P
25-1	SW NE	Ionia State Hospital	23	6	Qgd	635.76	5	R	4.23	3-62	18.34	10-63	10.90	5-20	14.82	2-28	P
6N 5W 33-1	NE	Barley-Earhart Co.	15	180	Qgd		8	M	4.55	4-60	10.66	10-63	9.63	5-4	10.64	7-30	
5N 5W 17-1	SE SW	MDC	98	2	Qgd	e830	1	M					88.11	2-4	88.89	11-13	Record started 11-63
IRON COUNTY																	
46N 34W 14-1	NE NW	Oliver Iron Mining Co. (WMP-18)	12	1¼	Qgd		20	M	3.65	6-54	8.60	3-49	6.55	6-2	8.55	3-31	Meas. by WMP
46N 33W 18-1	SW NW	MSHD (WMP 17)	12	1¼	Qgd		17	M	2.80	4-49	dry	2-56	7.66	6-2	9.84	2-28	Do.
45N 37W 23-1	SW NE	USFS (WMP 28)	8	1¼	Qgd		17	M	0.73	8-51	4.72	9-48	1.15	4-30	3.52	7-30	Do.
45N 35W 33-1	SE NW	MSHD (WMP 34)	12	1¼	Qgd		17	M	1.93	7-53	8.44	3-49	6.06	6-2	7.70	3-31	Do.
45N 33W 8-1	SW SW	Basilio Prandi (WMP 20)	33	36	Qgd		20	M	22.71	5-60	32.16	3-49	28.08	6-2	29.71	3-31	Do.
44N 37W 14-1	NW NW	USFS (Former CCC Camp)	102	6	Qgd		6	R	93.8	11-60	95.85	12-63	95.13	1-25	96.20	9-15	
44N 35W 6-1	SW SW	USFS (Paint R. Profile 1)	6	1¼	Qgd	1468.15	17	M	+0.10	5-51	2.32	8-61	1.17	6-2	2.16	10-30	Meas. by WMP
6-2	SW SW	USFS (Paint R. Profile 2)	13	1¼	Qgd	1475.14	17	M	5.08	7-53	8.92	11-48	7.18	6-2	8.85	12-29	Do.
6-3	NW SW	USFS (Paint R. Profile 3)	12	1¼	Qgd	1476.35	17	M	4.03	7-53	9.20	11-48	6.86	6-2	9.01	10-30	Do.
7-1	NW NW	USFS (Paint R. Profile 4)	4	1¼	Qgd	1469.28	17	M	1.12	5-51	3.73	8-47	2.22	6-2	3.36	7-30	Do.
7-2	NW NW	USFS (Paint R. Profile 5)	13	1¼	Qgd	1471.25	17	M	2.30	7-53	9.44	10-48	4.18	6-2	5.41	10-30	Do.

Table 2.--Records of Michigan observation wells and extremes in water levels observed in 1964 and for the period of record.--Continued

County and well number	Location in section ¼ ¼	Owner	Depth (ft)	Dia. (in)	Chief aquifer	Altitude	Years of record	F-64	Observed water level extremes: Through 1963 High	Through 1963 Date	Through 1963 Low	Through 1963 Date	In 1964 High	In 1964 Date	In 1964 Low	In 1964 Date	Remarks
IRON COUNTY (Continued)																	
44N 35W 7-3	NW NW	USFS (Paint R. Profile 6)	17	1¼	Qgd	1475.83	17	M	8.48	5-51	13.40	10-48	11.33	6-2	12.89	7-30	Meas. by WMP
44N 33W 10-1	SW SW	Iron Co. (WMP 21)	8	1¼	Qgd		17	M	1.95	4-54	7.94	1-51	3.09	6-2	8.03	2-28	Do.
43N 35W 11-1	SE NE	J. J. Javoroski (WMP 23)	47	36	Qgd		20	M	38.61	9-60	47.08	8-49	42.33	1-3	43.44	8-31	Do.
13-1	SW SE	F. V. Gendzwill (5)	65	36	pЄ		20	A	47.90	9-46	63.68	11-46		(54.68	5-11)		Mine drainage study
20-1	SW SE	Mrs. B. Hendrikson (WMP 25)	48	1¼	Qgd		20	M	41.66	6-53	48.29	8-49	44.62	6-2	45.31	12-29	Meas. by WMP
24-1	SE NE	Spies-Johnson #73 (7)	?	3	Qgd?		20	A	67.20	10-61	86.05	1-49		(70.03	5-11)		Mine drainage study
26-1	SW NE	City of Iron River (1)	130	2	Qgd		20	A	18.52	5-61	44.58	3-50		(22.67	5-11)		P
43N 34W 19-1	NW SW	Spies-Johnson #3004 (8)	?	3	Qgd?		20	A	59.87	10-61	89.5	10-45		(62.98	5-11)		Mine drainage study
19-2	NE SW	Spies-Johnson #3c (9)	?	3	Qgd?		20	A	66.23	10-61	84.10	12-48		(69.14	5-11)		Do.
29-1	SW NE	Rogers Mine (11)	?	48	Qgd		16	A	10.31	8-53	20.69	3-50		(17.18	5-11)		Do.
43N 32W 26-3	SW NE	Cayia Mine	200+	4	?		6	M	29.79	5-60	38.80	12-63	33.19	5-26	39.67	1-28	Do.
42N 36W 15-1	NE SW	MSHD (Brule R. Profile # 1)	6	1¼	Qgd	1543.92	17	M	0.81	4-54	3.17	10-48	1.68	4-30	3.13	7-30	Meas. by WMP
15-2	NE SW	MSHD (Brule R. Profile # 2)	7	1¼	Qgd	1545.60	17	M	0.30	4-62	3.10	10-48	1.21	4-30	2.95	1-3	Do.
15-3	NW SW	W. Young Est. (Brule R. Profile # 3)	14	1¼	Qgd	1554.36	17	M	3.67	4-54	8.40	10-63	6.29	4-30	8.55	2-28	Do.
42N 31W 33-1	NW SE	Iron Co. (WMP 7)	11	1¼	Qgd		17	M	+0.20	5-60	6.28	10-48	0.54	10-1	5.91	2-28	Do.
33-2	NW SE	Joseph Giachino (WMP 8)	12	15	Qgd		20	M	1.89	10-51	12.22	2-53	3.70	6-2	11.61	5-1	Do.
41N 31W 10-1	SW NE	Iron Co. (WMP 5)	17	1¼	Qgd		17	M	8.47	1-52	dry	12-48	13.40	12-31	dry	1-2	Do.
JACKSON COUNTY																	
1S 1E 36-9	SE SE	MDC (9)	9	1¼	Qgd	920.28	9	W	0.42	5-56	7.80	12-63	1.08	4-10	7.18	3-9	Meas. disc. May 1964
3S 1W 2-1	SE NW	City of Jackson	221	8	Pps,Mm	e935	5	R	17.5	11-60	49.8	6-62	24.1	1-2	65.2	8-7	P
10-1	SW SE	Summit Township	323	12	Pps,Mm	e935	5	R	14.3	1-61	35.4	6-63	19.9	12-27	35.1	8-7	P
11-2	NE NE	City of Jackson (4a)	360	6	Pps,Mm		8	D	18.6	1-61	93.0	8-59	33.5	12-26	99.4	7-28	P, Meas. by owner
11-3	NE NE	City of Jackson	36	3	Qgd	928.82	3	R	3.68	4-62	15.59	12-63	9.10	5-18	18.20	11-25	
11-4	NE NE	City of Jackson	30	3	Qgd		2	M	4.00	4-63	20.85	10-63	10.09	4-29	23.02	10-16	
11-5	NE NE	City of Jackson	54	3	Qgd		2	M	5.25	4-63	21.43	11-63	12.43	4-29	24.52	10-16	
11-6	NE NE	City of Jackson	80	3	Qgd		2	M	35.5	4-63	61.43	6-63	47.45	3-31	68.31	7-23	
KALAMAZOO COUNTY																	
1S 11W 29-1	NE NW	KCRC	69	1¼	Qgd		1	M					54.90	11-4	55.37	10-26	Record started 10-26
1S 10W 7-2	SE SE	KCRC	28	1¼	Qgd		1	M					13.52	12-30	13.86	11-4	Do. 11-4
7-3	NW NW	KCRC	107	1¼	Qgd		1	M					97.70	10-27	97.96	12-30	Do. 10-26
21-1	NE NW	KCRC	47	1¼	Qgd		1	M					37.30	10-27	37.57	12-30	Do. 10-21
2S 11W 3-60	NE NE	KVP Co. (61)	36	6	Qgd	763.18	9	W	9.61	4-60	12.90	7-61	10.65	4-13	12.45	7-20	P
15-18	NE SE	Consumers Power Co.	64	12	Qgd	766.17	19	M	9.20	3-50	18.27	12-63	17.37	5-15	19.36	9-4	P
20-7	SW SE	Western Mich. Univ.	78	8	Qgd	868.68	19	M	33.44	6-50	38.15	9-59	36.97	5-15	37.59	8-7	
20-11	NW NW	City of Kalamazoo (Kendall)	81	5	Qgd		2	R	16.20	7-63	17.22	12-63	16.66	4-27	18.50	12-30	P
22-150	SE SW	City of Kalamazoo (Stockbridge)	137	4	Qgd	764.7	5	R	17.27	12-62	31.08	8-61	16.75	4-27	23.55	8-12	P
29-3	SW SE	Oakwood, Inc.	47	2	Qgd	880.72	19	M	26.12	8-52	31.49	12-63	31.65	5-15	32.27	9-4	Well destroyed 12-2-65
2S 10W 31-1	SW NW	General Motors Corp.	103	8	Qgd		1	M					28.01	12-30	28.64	11-5	Record started 11-5
2S 9W 33-1	SE NE	KCRC	44	1¼	Qgd		1	M					18.87	12-30	19.17	10-27	Do. 10-27
3S 12W 11-1	SE NW	City of Kalamazoo (Atwater)	248	3	Qgd		4	R	+1.96	3-61	+0.47	12-63	+0.60	1-1	-0.29	12-26	

Table 2.--Records of Michigan observation wells and extremes in water levels observed in 1964 and for the period of record.--Continued

County and well number	Location in section ¼ ¼	Owner	Depth (ft)	Dia. (in)	Chief aquifer	Altitude	Years of record	F-64	Observed water level extremes: Through 1963 High	Through 1963 Date	Through 1963 Low	Through 1963 Date	In 1964 High	In 1964 Date	In 1964 Low	In 1964 Date	Remarks
KALAMAZOO COUNTY (Continued)																	
3S 12W 20-1	NE NE	Pretty Lake Boys Camp	46	1¼	Qgd		1	M					32.02	10-27	32.32	12-30	Record started 10-27
3S 11W 4-35	SE NE	City of Kalamazoo (A-D)	135	3	Qgd	854.03	6	R	1.2	1-63	12.89	11-59	2.3	5-19	12.9	7-5	P
4-36	SE NE	City of Kalamazoo (A-S)	40	3	Qgd	854.01	6	R	0.04	10-61	9.12	11-59	1.02	12-13	6.60	8-6	P
10-1	SW SE	R. E. Rinehart	22	1¼	Qgd		1	M					3.60	12-30	4.38	10-27	Record started 10-27
11-1	NW NE	UpJohn Co.	?	2	Qgd		1	M					38.21	12-30	38.43	12-3	Do. 9-25
11-2	NW NE	UpJohn Co.	37	2	Qgd		1	M					-----	-----	dry at 37.05		Do. 10-27
14-1	SE SW	Kal. Co. Drain Comm.	16	1¼	Qgd		1	M					9.71	12-30	9.94	9-30	Do. 9-30
14-2	SE SE	KCRC	22	1¼	Qgd		1	M					11.91	12-30	12.48	10-30	Do. 10-27
15-1	NE SE	KCRC	32	1¼	Qgd		1	M					3.42	12-30	3.86	10-27	Do. 10-27
15-2	NW SE	City of Portage	15	1¼	Qgd		1	M					4.49	12-30	4.63	12-3	Do. 12-3
23-3	NE SE	UpJohn Co.	11	1¼	Qgd		1	M					8.68	12-30	9.10	10-27	Do. 9-25
25-1	NW NE	MDC	22	1¼	Qgd		1	M					4.94	12-30	5.19	10-27	Do. 10-27
3S 10W 18-1	NE NW	KCRC	33	1¼	Qgd		1	M					15.21	10-30	15.58	10-27	Do. 10-27
4S 12W 8-1	SW SE	KCRC	16	1¼	Qgd		1	M					11.21	12-3	11.29	11-17	Do. 11-10
4S 11W 21-2	NW SW	Willis Chamberlain	19	1¼	Qgd		8	W	10.77	7-60	15.24	2-62	14.90	7-28	16.10	12-30	
KALKASKA COUNTY																	
27N 5W 36-1	SE NW	MDC (100)	16	1¼	Qgd		26	W	11.12	7-43	14.84	12-63	13.93	7-3	dry	12-4	
KENT COUNTY																	
6N 12W 17-1	SE NE	Jervis Corp.	30	12	Qgd		15	M	6.88	6-56	16.45	2-54	9.19	6-2	11.44	12-1	P, Meas. by owner
17-2	SE NE	Jervis Corp.	26	6	Qgd	606.05	15	M	6.85	4-62	16.32	2-54	9.13	6-2	11.38	12-1	P, Meas. by owner
25-1	SW SW	City of Wyoming (50th)	241	12	Mm	666.73	5	R	10.0	10-60	54.6	7-63	16.9	4-?	53.8	7-2	P
27-1	NW NW	City of Wyoming (44th)	265	14	Mm	707.24	3	R	51.11	5-63	55.30	7-63	51.67	4-13	56.05	8-8	P
34-1	SE NE	City of Wyoming (Boss)	300	8	Mm	735.42	5	R	64.82	10-60	71.65	7-63	67.52	4-13	72.48	8-8	P
6N 9W 3-1	SW NE	City of Lowell	70	12	Qgd		4	R	11.22	5-62	19.72	12-63	14.06	5-9	19.73	1-15	P
5N 12W 4-3	SW SE	City of Wyoming (Wobma)	86	6	Qgd	685.97	3	R	10.54	5-63	12.63	10-63	11.33	5-?	12.91	8-19	
4-7	SE SW	City of Wyoming (DeHaan)	227	8	Mm	682.56	3	R	7.47	5-63	9.58	10-63	8.21	5-18	9.90	8-19	
11-3	NE NW	City of Wyoming (DeJager)	80	8	Qgd	682.84	3	R	1.86	5-63	4.68	10-63	2.54	5-16	5.02	8-19	
LAKE COUNTY																	
17N 13W 4-1	SE NE	C & O R.R. (West Well)	83	8	Qgd		8	Q	17.17	7-60	20.36	5-58	19.31	7-8	20.09	12-8	
LIVINGSTON COUNTY																	
3E 1N 11-1	SE NE	MDC	78	2	Qgd	e980	1	M	53.34	10-63	53.56	12-63	53.71	1-9	54.88	11-12	Record started 10-63
2N 4E 3-1	NW SW	Howell State Hospital	375	8	Pms,Mb Mm	916.13	7	R	10.2	4-59	27.8	12-58	10.0	5-18	18.5	7-30	P
LUCE COUNTY																	
49N 11W 2-5	NW NE	State (5)	7	1¼	Qgd		6	Q	+0.40	5-60	6.65	12-63	2.66	3-30	5.44	10-1	Lake Hdr. study
49N 10W 6-6	SW SW	State (6)	8	1¼	Qgd		6	Q	1.98	5-60	8.12	9-63	6.45	4-30	dry	10-1	Do.
MACKINAC COUNTY																	
42N 2W 7-1	NE NE	USFS (Pontchartrain)	102	6	Sm		9	R	13.1	5-60	32.2	11-63	15.3	5-1	28.6	10-6	
9-1	NE NW	Kenneth Kerr	84	2	Sm		7	Q	+1.08	5-62	6.01	9-63	+1.60*	5-1	4.75	10-2	*Often flows, freezes in winter
41N 5W 23-1	SW NW	MDC (Round Lake)	47	6	Ss		9	Q	4.30	5-59	17.48	3-59	6.90	5-1	13.52	10-2	
MACOMB COUNTY																	
4N 12E 31-1	NW SE	HCMF # 1	32	2	Qgd	813.67	2	M	4.83	5-63	9.5	2-63	4.93	5-21	8.21	9-3	
31-2	NW SE	HCMF # 2	27	2	Qgd	819.16	2	M	3.5	7-63	13.17	2-63	3.26	7-3	6.06	1-24	
31-3	NW SE	HCMF # 3	34	2	Qgd	804.42	2	M	7.4	7-63	17.67	2-63	7.10	5-21	13.95	1-3	
31-4	NW SE	HCMF # 35	53	4	Qgd	815.54	2	M	13.67	5-63	24.75	3-63	11.09	5-9	15.0	1-1	

Table 2.--Records of Michigan observation wells and extremes in water levels observed in 1964 and for the period of record.--Continued

County and well number	Location in section (¼ ¼)	Owner	Depth (ft)	Dia. (in)	Chief aquifer	Altitude	Years of record	F-64	Observed water level extremes								Remarks
									Through 1963				In 1964				
									High	Date	Low	Date	High	Date	Low	Date	
MACOMB COUNTY (Continued)																	
4N 12E 31-5	NW SE	HCMF # 36	63	4	Qgd	814.53	2	R	13.17	5-63	22.92	3-63	13.40	5-9	17.00	1-8	
2N 12E 1-1	SE NE	B. H. Tolley	29	48	Qgd		6	W	0.50	1-60	9.23	12-63	1.56	4-6	9.21	1-6	
MANISTEE COUNTY																	
21N 17W 14-1	NW	City of Manistee	212	6			2	R	32.43	11-63	32.80	12-63	32.52	4-29	39.3	10-15	P
MARQUETTE COUNTY																	
49N 30W 22-1	SW NE	Marquette Co. (WMP 13)	17	1¼	Qgd		17	M	0.64	5-51	13.32	9-48	7.84	5-1	10.10	1-30	Meas. by WMP
48N 29W 19-1	SW SW	C & NW RR	31	1¼	Qgd	1560.39	2	M			5.60	11-63	3.22	6-18	5.10	1-10	
26-1	SE SW	Do.	32	1¼	Qgd	1553.48	2	M	4.08	6-25	6.56	1-29	4.02	5-13	5.53	7-21	
48N 28W 30-1	NW NW	Marquette Co. Rd. Comm.	20	1¼	Qgd	1566.76	2	M	3.11	5-28	4.62	2-25	2.77	5-13	4.50	2-6	
48N 26W 28-1	NW NW	Marquette Co. Airport	55	6	Qgd	1416.1	3	M	16.25	7-63	18.64	1-63	16.17	10-29	16.70	7-21	
34-1	NE SE	Marquette Co. Rd. Comm.	31	1¼	Qgd	1283.09	2	M			6.10	10-63	5.10	9-30	6.50	4-6	
47N 29W 2-1	NE SE	Do.	19	1¼	Qgd	1531.32	2	M	3.93	4-63	5.49	8-63	3.44	5-13	5.36	7-21	
3-1	NE SW	Bill Koski	28	6	Qgd		3	M	11.82	6-63	13.78	5-63	11.40	5-13	16.06	8-28	
34-1	NW SW	Marquette Co. Rd. Comm.	23	1¼	Qgd		3	M	3.08	5-63	5.27	2-63	2.67	5-14	5.26	2-6	
36-1	NW SW	Do.	19	1¼	Qgd	1498.67	2	M	1.77	5-63	5.52	11-63	1.79	5-14	3.44	7-22	
47N 28W 1-1	NW SE	Inland Steel Co. (Morris # 1)	216	38	Qgd		4	Q	20.59	12-63	70.99	10-61	18.95	10-20	21.08	2-19	P, recovery Recorder removed 12-4-65
3-1	SW SW	Ely Township	75	8	Qgd		4	R	13.60	8-61	18.09	3-63	14.69	10-3	19.26	4-10	
8-1	NW NW	Marquette Co. Rd. Comm.	18	1¼	Qgd	1542.22	2	M			3.02	11-63	0.02	5-13	2.62	2-6	
10-1	NW NW	Clarance Carlson	17	6	Qgd		4	S	8.35	9-61	14.06	2-62	11.48	5-13	14.92	1-10	Record discontinued 6-64
15-1	SW NE	Marquette Co. Rd. Comm.	38	1¼	Qgd	1523.81	2	M			18.40	11-10	17.45	10-29	19.16	5-14	
28-1	NW SW	Do.	16	1¼	Qgd	1484.79	2	M	1.75	5-28	3.89	8-27	1.16	5-14	3.75	7-22	
35-1	NW SW	Do.	52	1¼	Qgd	1481.85	2	M			36.85	12-63	37.86	6-18	36.56	12-1	
47N 26W 24-1	SW NE	Cleveland Cliffs Iron Company	33	1¼	Qgd	1227.44	2	M	22.06	6-63	23.54	4-63	20.56	5-12	25.25	10-28	
25-1	NE NE	MDC	35	1¼	Qgd	1222.39	2	M	17.44	6-63	23.36	11-63	16.93	5-12	20.28	10-28	
25-2	NW SW	Do.	26	1¼	Qgd	1218.02	2	M			16.70	12-63	13.85	6-17	17.02	4-7	
25-3	NW SE	Do.	26	1¼	Qgd	1219.42	1	M					6.17	5-12	8.01	7-21	Record started 5-12
26-1	NW SE	Do.	35	1¼	Qgd	e1220	1	M					1.40	5-12	5.21	7-21	Do. 5-12
36-1	NW NW	Cleveland Cliffs Iron Company	28	1¼	Qgd	1214.44	2	M			7.28	11-63	5.18	5-12	7.73	4-7	
36-5	SE SW	MDC	29	1¼	Qgd	1213.25	2	M			12.86	11-63	11.08	5-12	12.34	7-21	
47N 25W 12-1	NE SW	Marquette Co. Rd. Comm.	35	1¼	Qgd	e695	2	M			4.60	10-63	14.43	5-13	14.74	2-11	
15-1	SW SW	Frank Bollero	245	6	Qgd		3	M	92.09	10-62	99.09	6-62	89.82	5-12	96.64	7-21	
19-1	SW SW	MDC	86	1¼	Qgd	1226.11	2	M			37.10	11-63	31.59	5-12	36.11	10-28	
20-1	SW SW	Do.	103	1¼	Qgd	1244.00	2	M	87.36	5-63	87.76	5-63	89.12	9-23	89.68	10-29	
21-1	SW SW	Do.	161	1¼	Qgd	1242.84	2	M	143.19	5-63	144.99	5-63	144.04	9-29	146.12	9-3	
27-1	SE SW	Do.	86	1¼	Qgd	e1090	2	M			69.23	12-63	70.06	5-5	70.52	10-29	
32-1	NE SW	Do.	125	1¼	Qgd	1243.17	2	M	96.85	5-63	98.10	11-63	98.10	9-29	110.02	10-28	
47N 24W 18-1	SE SW	Charles Shirtz	75	2	Qgd	703	2	M			36.23	11-63	35.92	5-12	37.56	4-6	
28-1	SW SW	Marquette Co. Rd. Comm.	91	1¼	Qgd	709	2	M			25.18	11-30	25.34	6-17	25.52	9-29	
46N 29W 18-2	NE SW	Republic Township	39	1¼	Qgd		3	S	11.36	5-62	14.38	8-63	13.72	4-7	14.02	1-10	Record discontinued 6-64
22-1	NW NE	Marquette Co. Rd. Comm.	35	1¼	Qgd	1507.79	2	M	11.20	6-63	11.87	11-63	11.27	5-12	12.10	2-6	
36-1	SW NE	Do.	30	1¼	Qgd	1484.22	2	M	9.36	2-63	10.87	1-63	9.72	8-28	12.20	2-6	
46N 28W 1-1	SE NW	Clarance Carlson	96	6	Qgd		4	M	35.59	8-61	41.96	7-63	42.57	10-6	42.81	6-18	
8-1	SW NE	Marquette Co. Rd. Comm.	23	1¼	Qgd	1463.63	2	M	6.01	6-63	9.44	11-63	5.30	5-14	7.85	7-21	
12-3	NW SW	Mrs. S. L. Hill	19	1¼	Qgd		3	M	2.21	3-63	3.04	8-63	2.00	10-6	2.89	7-21	

Table 2.--Records of Michigan observation wells and extremes in water levels observed in 1964 and for the period of record.--Continued

County and well number	Location in section ¼ ¼	Owner	Depth (ft)	Dia. (in)	Chief aquifer	Altitude	Years of record	F-64	Observed water level extremes								Remarks
									Through 1963				In 1964				
									High	Date	Low	Date	High	Date	Low	Date	
MARQUETTE COUNTY (Continued)																	
46N 28W 15-1	NE SE	Marquette Co. Rd. Comm.	40	1¼	Qgd	1457	1	M					25.62	8-28	26.63	5-14	Record started 5-14
27-1	NE SE	Do.	72	1¼	Qgd	1447.00	2	M			29.38	11-63	28.82	12-1	30.61	2-6	
32-1	SE SE	Do.	32	1¼	Qgd	1448.31	2	M	7.24	4-63	8.52	8-63	7.50	6-18	8.86	2-6	
46N 27W 17-1	SE SE	USFS	31	1¼	Qgd	e1420	2	M	14.54	7-63	15.87	5-63	15.02	9-3	15.62	10-6	
31-1	SW SW	MDC	71	1¼	Qgd	1471.64	2	M	52.95	5-63	53.73	11-63	54.05	1-10	55.04	10-29	
46N 26W 12-1	SE SE	MDC	24	1¼	Qgd	1194.15	2	M			13.10	11-63	11.94	5-12	12.76	9-29	
31-1	SW SW	MDC	32	1¼	Qgd	1265.36	2	M	22.63	1-63	23.37	8-63	23.08	6-12	24.42	4-6	
46N 25W 9-1	SW NW	MDC	88	1¼	Qgd	1220.68	2	M	68.28	7-63	71.02	11-63	71.26	7-21	71.69	5-12	
16-1	SE SE	G. G. Johnson	48	1¼	Qgd	1198.43	2	M	34.54	5-63	35.02	11-63	34.87	7-21	36.96	8-27	
36-4	SE NW	U. S. Air Force	82	12	Qgd		3	Q	82.10	1-62	84.34	12-63	84.30	1-1	85.23	12-3	Recorder removed 12-4-64
46N 24W 5-1	SW SW	S. Bernard	34	1¼	Qgd	e790	2	M			17.60	11-63	16.82	9-30	17.73	10-29	
45N 30W 1-1	SW NW	Arnold Janofski (WMP 4)	31	36	Qgd		20	R	23.82	7-60	29.28	3-49	26.58	4-6	dry	3-7	Fed. key well, dry at about 28 ft. Well has filled in
45N 28W 3-1	NE SE	Marquette Co. Rd. Comm.	32	1¼	Qgd	1452.31	2	M	21.93	1-63	23.38	11-63	23.66	8-28	24.52	4-7	
45N 26W 8-1	NE NE	Do.	15	1¼	Qgd	1220.00	2	M			6.20	11-63	4.16	5-5	6.53	2-11	
15-1	SW NE	MSHD	18	1¼	Qgd		3	M	1.67	4-63	3.38	8-63	1.50	5-5	3.59	2-12	
45N 25W 11-1	SW NW	Marquette Co. Rd. Comm.	62	1¼	Qgd	1158.04	2	M	46.95	6-63	48.18	4-63	46.62	9-29	48.28	4-6	
23-1	NW SE	Do.	65	1¼	Qgd		3	M	19.20	7-63	20.28	11-63	19.01	6-12	21.17	4-6	
45N 24W 5-1	SW SW	Do.	60	1¼	Qgd	e1160	2	M			41.10	11-63	41.28	1-9	41.88	11-30	
MASON COUNTY																	
17N 15W 3-1	SE SW	USFS	32	6	Qgd	737.37	17	M	13.90	6-60	19.45	8-58	16.95	7-2	18.02	4-1	
MENOMINEE COUNTY																	
37N 26W 19-1	NE SE	MSHD	16	4	Otb		6	Q	3.70	5-60	6.83	8-63	4.57	4-28	6.88	7-64	
MONTCALM COUNTY																	
10N 8W 17-1	NW NW	L. Packard	28	2	Qgd		1	M					22.71	8-13	23.53	3-5	Record started 2-3
9N 8W 15-1	SW NW	City of Greenville (9)	65	12	Qgd		15	M	11.40	4-50	17.40	8-58	14.48	11-1	16.40	12-1	P, Meas. by owner
MONTMORENCY CO.																	
29N 3E 21-1	NW NE	MDC (32)	14	2	Qgd		20	Q	2.54	7-60	5.91	1-56	4.83	7-1	5.63	12-1	
OAKLAND COUNTY																	
3N 9E 7-1	NE SW	Garfield Estates	77	6	Qgd		4	R	+0.31	4-62	-1.70	11-63	-1.55	3-14	-1.82	2-21	Meas. disc. 3-14-64
36-1	NW NE	Waterford Twp. (Josephine Street)	134	12	Qgd		5	R	95.92	4-61	100.51	8-63	91.35	12-24	98.53	1-12	P
3N 10E 13-2	SW NE	Oakland University	183	6	Qgd		4	R	78.84	2-61	93.5	7-63	83.4	12-24	91.5	1-14	P
31-1	NE SW	City of Pontiac (Orchard Lake)	173	12	Qgd	926.4	13	R	86.6	12-63	130.8	7-63	65.4	12-24	86.4	1-1	
32-2	SW NE	City of Pontiac (LS 6)	184	12	Qgd	923.13	2	R	87.8	12-63	99.4	10-63	64.6	12-24	86.6	1-1	
3N 11E 4-1	SE NW	Village of Rochester	73	6	Qgd		4	R	22.8	2-62	35.1	7-63	25.2	2-13	36.5	8-28	P
2N 10E 22-1	NE NW	Cranbrook School (3)	65	6	Qgd		15	W	10.40	5-63	18.23	11-63	15.65	5-11	18.92	12-7	P, Meas. by owner
OGEMAW COUNTY																	
23N 1E 4-1	SE NE	MDC (15)	21	4	Qgd		11	Q	1.14	4-60	4.35	12-63	3.61	4-2	4.44	10-14	
23N 2E 2-1	NE NW	Charles Hudson	7	36	Qgd		14	R	0.37	5-52	4.30	3-59	2.29	6-8	4.17	2-22	
ONTONAGON COUNTY																	
51N 41W 8-1	SE NW	Mich. Corrections Dept.	100	6	pЄf		7	R, Q	8.18	4-59	18.9	10-63	10.7	5-5	16.7	1-3	Recorder removed 10-27-64
OTSEGO COUNTY																	
29N 3W 29-1	SW SE	MDC (106)	15	2	Qgd		32	Q	5.56	5-47	9.74	10-58	8.39	4-29	9.36	10-20	
OTTAWA COUNTY																	
5N 15W 28-71	SE SE	City of Holland	108	1¼	Qgd		18	M	56.44	8-46	dry	9-54	55.53	11-2	58.95	1-31	Meas. by owner

Table 2.--Records of Michigan observation wells and extremes in water levels observed in 1964 and for the period of record.--Continued

County and well number	Location in section ¼ ¼	Owner	Depth (ft)	Dia. (in)	Chief aquifer	Altitude	Years of record	F-64	Observed water level extremes								Remarks
									Through 1963				In 1964				
									High	Date	Low	Date	High	Date	Low	Date	
PRESQUE ISLE COUNTY																	
33N 2E 30-1	NE SE	MDC (19)	14	2	Qgd		28	Q	0.61	7-60	5.69	1-56	4.08	7-13	5.32	12-2	
33N 6E 8-1	NW NW	Albert Styma	61	6	Dt		6	M	5.66	4-60	18.83	3-63	8.38	5-5	16.09	9-2	
15-1	NW NW	Harley Ennest	31	5	Dt		6	R	2.8	5-60	11.6	8-60	4.9	5-9	11.0	9-7	P
21-1	NE NE	Mike Ardycan	43	5	Dt		6	M	1.08	4-63	7.20	8-59	4.82	5-5	7.06	9-2	
ROSCOMMON COUNTY																	
24N 2W 20-1	NE NW	MDC (1)	14	8	Qgd	1145.30	31	R	2.78	5-51	6.23	12-49	4.38	5-16	5.96	9-21	Fed. key well
23N 1W 3-1	SE SE	MDC (50)	12	2	Qgd	1188.95	26	Q	1.62	6-43	7.31	12-49	6.40	12-23	7.08	10-14	
22N 3W 22-1	SE NE	MDC (7)	14	2	Qgd	1170.58	31	Q	2.56	4-60	6.72	12-63	6.59	4-10	7.47	10-12	
SAGINAW COUNTY																	
9N 3E 16-2	SE NW	Ray Ellis	129	3	Pps		7	W	33.13	12-63	53.84	9-59	29.05	7-7	38.40	9-22	
SANILAC COUNTY																	
12N 13E 33-1	SE SE	MSHD	150	3	Mm		17	W	15.45	4-51	24.17	12-63	21.76	5-13	25.58	12-30	
SCHOOLCRAFT CO.																	
47N 16W 30-1	NW NW	MDC (Cusino CCC Camp)	57	6	Op		8	R	5.7	5-60	16.3	10-63	8.7	4-24	16.0	1-23	
45N 18W 31-1	NE SW	USFS	229	5	Otb		7	M	13.71	6-60	17.36	11-63	16.51	9-28	16.76	8-3	
45N 13W 16-1	SW SW	US Fish & Wildlife Service	154	4	Or		13	R	4.80	5-60	6.50	10-63	4.99	5-9	6.15	1-1	
SHIAWASSEE COUNTY																	
5N 2E 16-1	NE SE	A. B. Cobb	26	1½	Qgd	896.00	17	M	17.28	5-50	23.15	12-63	21.91	6-23	23.20*	1-5	*W/L below obstruction in pipe
VAN BUREN COUNTY																	
1S 17W 22-1	SW NE	Stevie Bros.	132	4	Qgd	e640	2	R	36.99	12-63	37.67	9-63	36.35	5-1	e39.15	8-9	
2S 15W 3-1	NW SW	Co. Road Commission	37	1½	Qgd	e680	2	M	21.70	6-63	22.72	12-63	22.61	7-24	23.93	12-22	
2S 14W 35-1	NE NW	Co. Road Commission	12	1½	Qgd	e690	2	M	7.03	4-63	8.30	10-63	7.01	5-1	8.45	9-22	
2S 13W 2-1	NW NW	Co. Road Commission	23	1½	Qgd	e730	2	M	3.14	5-63	5.10	10-63	3.12	5-1	5.14	9-22	
3S 14W 6-1	NE NW	Rex Martin	59	1½	Qgd	e740	2	M	41.43	5-63	42.92	10-63	42.11	5-29	43.28	11-20	
4S 16W 14-1	SE SW	Otis Klett	170	14	Qgd		2	R	21.45	5-63	26.81	7-63	23.53	5-8	27.6	8-5	
22-1	NW NW	Frigid Foods	134	10	Qgd		2	R	25.26	8-63	27.60	10-63	26.93	1-1	31.32	6-1	
4S 14W 24-1	NW NW	Lyle Parker	33	1½	Qgd	e790	2	M	23.28	5-63	24.88	12-63	23.98	4-30	25.14	10-22	
4S 13W 23-1	SE SE	Mike DeMorrow	24	1½	Qgd	e790	2	M	17.75	7-63	19.45	12-63	18.73	5-29	20.52	12-22	
16-1	SE SE	Porter Township	83	1½	Qgd	e940	2	M	47.12	5-63	48.85	12-63	49.14	1-6	50.45	10-22	
WASHTENAW COUNTY																	
3S 6E 16-3	SW NW	City of Ann Arbor	55	10	Qgd	821.50	2	R	7.85	9-63	11.51	12-63	10.88	1-4	15.86	10-18	P
3S 7E 5-1	NW NW	City of Ypsilanti	69	8	Qgd		3	R	2.62	3-63	4.00	12-63	2.97	4-6	4.20	11-22	
9-2	SW NE	City of Ypsilanti (NR)	50	6	Qgd		14	M	29.12	11-45	44.35	12-63	40.49	5-23	51.56	11-21	P
9-3	SE NE	City of Ypsilanti (GP)	94	6	Qgd		14	R	29.12	11-45	64.50	11-63	64.17	1-9	70.42	10-31	P
24-1	NE SW	Ford Motor Co. (104)	87	4	Qgd	665.56	19	M	5.79	1-50	20.55	1-63	15.82	9-26	20.82	3-31	P
24-2	NE SW	Ford Motor Co. (106)	53	4	Qgd	664.51	19	R	11.81	7-43	38.67	6-63	30.68	8-25	39.49	2-22	P
24-4	NE SW	Ford Motor Co. (107)	53	4	Qgd	664.05	19	M	11.55	1-50	39.06	6-63	32.23	10-24	40.40	11-21	P
24-5	NW SW	Ford Motor Co. (109)	77	4	Qgd	665.56	19	M	15.15	6-45	40.70	2-61	40.04	11-21	41.09	4-25	P
24-6	SW SW	Fed. Works Agency (117)	75	6	Qgd	657.83	18	R	5.69	2-50	33.51	6-63	25.57	8-24	33.81	2-22	P
4S 6E 9-1	NW NW	Ypsi. State Hosp. (TW 20	184	6	Qgd		19	W	51.22	5-48	88.14	6-49	63.44	3-16	79.05	2-17	P, Meas. by owner
10-1	SW NW	Ypsi. State Hosp. (TW 22)	173	6	Qgd		19	W	56.64	10-62	88.27	7-55	64.30	1-21	75.81	10-1	P, Do.
WAYNE COUNTY																	
1S 8E 9-1	SW NW	City of Plymouth	61	6	Qgd	820	4	R	10.98	6-62	20.49	12-63	13.20	3-4	21.18	12-?	P
17-1	NE NE	City of Plymouth	114	6	Qgd	856	3	R	50.39	4-63	53.63	12-63	52.67	2-6	55.62	12-31	P
WEXFORD COUNTY																	
24N 9W 19-1	SW NW	MDC (38)	11	2	Qgd	944.16	23	Q	0.49	4-59	3.74	8-36	1.20	4-14	2.27	10-8	
22N 12W 13-1	NW	Harrietta State Fish Hatchery	141	4	Qgd		4	R	+13.55	2-61	+6.75	3-62	+11.70	12-18	+7.75	2-29	P
21N 9W 4-1	NW NE	City of Cadillac	277	6	Qgd		16	R	19.99	7-53	26.34	7-63	25.40	1-4	27.59	6-30	P

e - estimated

Table 3.--Reported ground-water pumpage by some Michigan municipalities, institutions, and industries (in million gallons).

Water User	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1964 Total	Max. Day	Min. Day
ALCONA COUNTY															
City of Harrisville	1.15	1.12	1.03	0.79	1.00	1.75	2.08	1.69	1.17	0.88	0.83	0.99	14.48	0.11	0.02
ALGER COUNTY															
Burt Township	1.67	1.42	1.51	1.62	1.71	1.84	2.15	2.14	1.95	1.54	1.37	1.53	20.45	0.85	0.29
ALLEGAN COUNTY															
City of Allegan	24.6	22.2	23.1	26.8	24.8	34.2	35.2	47.6	27.8	26.9	23.8	22.0	339.0	2.35	0.53
City of Plainwell	9.1	8.3	9.3	10.2	13.6	17.1	18.7	19.1	12.5	10.1	10.3	11.4	149.7	0.94	0.18
City of Otsego	16.2	13.8	14.4	15.3	18.6	27.0	28.4	23.8	17.6	15.7	14.1	14.3	219.2	1.02	0.29
ANTRIM COUNTY															
Village of Mancelona	12.8	12.2	13.2	13.1	13.2	15.3	15.0	14.8	14.0	13.9	12.6	12.5	162.6		
BARRY COUNTY															
City of Hastings	32.3	30.2	33.1	33.5	38.7	47.9	50.3	46.3	40.4	40.4	37.5	34.3	464.9	2.56	0.62
Village of Middleville	7.7	7.9	8.0	8.3	8.6	10.7	11.0	11.3	10.3	9.8	7.6	7.9	109.1	0.66	0.09
BAY COUNTY															
a) City of Pinconning	1.23	0.73	0.46					0.17	0.24		0.10	0.22	3.15		
BENZIE COUNTY															
City of Frankfort	5.5	5.3	4.3	4.6	5.4	10.4	10.1	8.6	6.4	5.3	5.3	5.2	76.4	0.50	0.15
BERRIEN COUNTY															
Village of Berrien Springs	8.8	8.4	9.2	9.0	10.9	11.4	11.5	11.9	11.2	11.0	10.8	8.9	123.0	0.53	0.24
City of Buchanan	53.2	47.3	52.9	52.3	59.5	71.2	69.9	68.5	59.6	57.7	56.9	58.2	707.2	3.21	0.85
e) City of Coloma	4.67	4.18	4.68	4.90	5.18	5.36	5.68	5.85	5.52	5.17	4.68	5.18	61.05		
City of Niles	87	79	84	95	107	119	110	119	99	93	84	87	1163	5.73	1.62
BRANCH COUNTY															
City of Bronson	20.0	20.2	20.2	23.1	22.2	24.0	25.0	26.8	25.5	25.6	20.7	21.6	274.9	1.39	0.88
City of Coldwater	59.9	54.2	60.5	62.7	78.8	99.2	111.7	96.3	81.6	76.9	70.7	65.0	917.5	5.37	1.11
State Home and Training School at Coldwater	12.7	12.4	13.3	12.8	14.1	13.8	15.8	15.3	13.9	13.9	14.2	13.3	165.5	NA	NA
CALHOUN COUNTY															
City of Albion	165	151	164	161	176	182	180	186	178	186	172	161	2062	7.73	
American Legion Hospital at Battle Creek	1.05	0.74	0.92	1.23	0.90	0.85	1.08	1.18	0.80	0.86	1.04	1.04	11.69	0.04	0.02
Village of Athens	2.59	0.46	2.13	3.02	3.08	5.10	6.37	4.75	5.04	6.25	4.98	2.80	46.57	0.23	0.13
City of Battle Creek	275	246	274	307	408	452	388	380	335	309	279	269	3922	21.10	6.12
Battle Creek Township	20.6	19.2	20.2	23.2	37.1	52.1	51.5	45.4	24.5	27.7	27.2	26.0	374.7	3.06	0.42
City of Marshall	30.1	25.9	27.3	28.1	37.7	43.5	48.0	46.0	34.4	31.3	29.5	29.0	410.8	2.26	0.67
CASS COUNTY															
City of Dowagiac	22.0	18.8	21.1	23.6	22.4	33.1	26.8	18.7	32.9	28.4	25.5	23.0	296.3		
Village of Marcellus	1.60	1.46	1.22	1.84	2.02	3.08	3.84	3.50	2.23	1.83	1.58	1.69	25.89	0.39	0.03
CHARLEVOIX COUNTY															
City of East Jordan	9.7	9.8	9.6	9.4	13.4	18.6	23.3	19.4	16.0	17.4	15.1	15.8	177.5		
CHEBOYGAN COUNTY															
City of Cheboygan	12.9	15.9	18.0	16.7	17.7	19.6	22.1	24.7	16.6	16.7	16.8	11.8	209.5	0.83	0.24
Village of Mackinac City	3.95	5.51	5.75	5.54	5.07	5.64	7.59	7.57	5.30	3.49	2.60	1.96	59.97	0.30	0.03
CHIPPEWA COUNTY															
Kincheloe Air Force Base near Kinross	19.1	17.1	17.6	18.5	28.0	32.4	38.4	29.1	25.0	24.7	22.5	23.7	296.1	1.70	0.37
CLARE COUNTY															
City of Clare	11.9	22.0	17.6	18.6	23.5	33.8	32.9	22.9	19.0	17.9	17.8	20.1	258.0	1.68	0.45
City of Harrison	2.39	2.32	3.19	1.01	2.84	5.95	3.62	2.92	2.28	2.55	1.91	2.16	33.14	0.30	0.05
CLINTON COUNTY															
Village of Elsie													e36.0		
Village of Ovid	1.81	1.81	1.93	2.04	2.44	2.26	4.81	2.35	2.36	1.95	1.60	1.81	27.17	0.16	0.04
City of St. Johns	30.0	29.5	30.8	31.2	33.2	36.9	38.1	38.1	36.5	36.9	33.3	34.4	408.9	1.57	0.47
CRAWFORD COUNTY															
City of Grayling	5.7	5.6	5.8	5.6	7.6	10.8	16.4	6.6	7.6	6.0	5.6	6.3	89.6	0.96	0.08
EATON COUNTY															
e)Village of Bellevue	2.00	2.00	2.00	2.00	2.00	2.10	2.50	2.50	2.00	2.00	2.00	2.00	25.10		
City of Olivet													e33.6		
City of Charlotte	34.9	32.9	34.3	31.3	38.3	43.7	45.1	46.8	39.6	41.4	39.6	40.9	468.8	2.12	0.60
City of Eaton Rapids	26.5	23.3	24.4	22.9	25.5	26.3	28.5	31.3	25.3	23.7	21.3	21.1	300.1		
City of Grand Ledge	12.9	10.3	12.2	11.9	14.2	16.3	17.0	16.0	13.7	13.0	11.7	11.7	160.9	0.94	0.19
Oldsmobile Parts Whse.	1.38	1.90	1.52	1.28	0.85	1.05	1.58	1.68	1.70	0.98	2.15	1.25	17.32		
EMMET COUNTY															
City of Harbor Springs	7.1	7.3	6.6	6.5	9.5	16.6	23.9	28.1	14.6	7.4	7.3	6.1	141.0	1.64	0.19
GENESEE COUNTY															
Beecher Metropolitan District	25.3	24.8	26.6	25.5	31.0	34.6	36.4	31.6	29.0	29.1	26.5	31.3	351.7	1.75	0.67
Village of Clio													e51.0	0.20	0.13
City of Davison	9.8	9.3	10.1	10.4	11.7	14.1	15.8	13.7	11.3	11.5	10.4	10.8	138.9	0.80	0.19
City of Fenton	16.8	15.6	15.2	16.6	19.9	21.5	25.6	21.1	19.6	18.5	16.6	17.9	224.9	1.17	0.24
Fisher Body Div. at Grand Blanc	7.01	6.21	6.98	7.31	8.00	7.33	7.01	7.08	7.22	3.70	6.94	6.51	81.30		
Village of Flushing	6.84	6.23	6.84	6.69	7.23	8.05	7.30	6.48	6.79	7.26	f	f	69.71		
Village of Linden	2.86	2.63	2.65	4.00	5.89	6.00	7.99	5.43	5.11	4.66	3.36	3.42	54.00	0.30	0.11
City of Mt. Morris	6.05	5.59	6.21	6.15	7.18	7.51	8.11	7.28	7.19	6.98	6.03	5.71	79.99	0.36	0.15
Village of Otisville	1.21	1.06	1.07	1.06	1.13	1.25	1.19	1.24	1.22	1.16	1.02	1.09	13.70	0.05	0.03

Table 3.--Reported ground-water pumpage by some Michigan municipalities, institutions, and industries (in million gallons).--Continued.

Water User	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1964 Total	Max. Day	Min. Day
GLADWIN COUNTY															
City of Beaverton	2.62	2.18	2.16	2.91	2.89	2.57	1.02	4.51	1.61	1.78	2.16	3.02	29.43		
GOGEBIC COUNTY															
City of Bessemer	10.6	10.5	10.6	10.1	10.7	10.5	11.7	10.5	10.2	9.7	9.1	9.7	123.9	0.47	0.16
City of Ironwood	24.9	22.9	24.1	24.5	25.4	26.8	30.3	29.1	27.0	26.6	25.2	29.1	315.9	1.13	0.39
City of Wakefield	7.58	5.96	6.75	6.38	6.37	6.51	7.44	6.97	6.65	6.30	6.36	6.81	80.08		
GRATIOT COUNTY															
City of Alma	44.6	41.6	47.8	52.1	55.5	61.5	60.5	61.5	60.0	60.5	58.7	52.2	656.5	2.74	0.89
Village of Breckenridge	2.80	2.60	2.90	2.60	3.11	3.47	3.70	3.00	2.80	2.70	2.50	2.60	34.78	0.16	0.07
City of Ithaca	5.91	5.31	5.06	5.32	5.45	6.26	6.75	5.57	4.63	3.91	4.99	3.86	63.02	0.35	0.14
City of St. Louis	19.6	18.7	20.9	19.8	21.1	22.9	22.1	22.1	19.9	21.7	22.9	24.4	256.1	1.21	0.47
HILLSDALE COUNTY															
Village of Jonesville	7.7	6.8	8.4	9.1	9.5	10.8	10.9	9.6	8.5	9.5	8.2	7.1	106.1	0.55	0.20
b) City of Hillsdale						28.0	34.3	35.5	18.8				116.6	1.94	0.74
HOUGHTON COUNTY															
City of Hancock	13.6	12.6	12.3	14.6	14.1	14.1	14.3	17.1	16.2	14.2	15.2	13.5	171.8	0.80	0.34
City of Houghton	27.0	25.5	26.0	24.5	25.8	23.6	31.4	24.7	24.9	25.2	23.9	22.3	304.8	1.25	0.56
Chassell Township	40	64	35	35	75	128	185	140	97	91	77	130	1097	9.29	7.90
HURON COUNTY															
Village of Pigeon	3.52	3.18	3.52	3.89	4.02	4.54	6.70	6.86	4.86	5.02	3.89	4.19	54.19	0.22	0.11
Village of Sebewaing	11.2	10.1	7.6	9.6	8.4	13.3	12.7	11.4	11.6	10.6	9.7	7.2	123.4		
INGHAM COUNTY															
City of East Lansing	52.3	53.9	54.1	57.7	71.3	83.9	86.1	74.6	61.5	66.8	61.5	56.9	780.6	3.96	
City of Lansing	586	542	577	583	641	706	711	627	602	516	570	586	7247	40.99	
Lansing Township	34.6	37.5	57.1	43.9	48.2	64.5	43.7	40.1	47.2	29.0	40.6	40.5	526.9		
Village of Leslie	5.30	3.95	4.16	4.51	5.83	7.30	8.13	8.07	5.14	5.11	4.84	5.29	67.63	0.11	0.48
City of Mason	10.9	11.6	11.7	11.7	17.3	20.7	19.3	16.4	13.6	13.0	11.9	11.2	169.3		
Meridian Township	2.96	2.51	2.64	2.75	3.68	5.20	5.44	4.21	3.07	3.03	2.85	3.16	41.50		
Michigan State University at East Lansing	103	99	110	103	116	101	102	90	86	117	116	112	1255	4.89	1.75
Oldsmobile Forge Plant #2	14.1	14.8	7.6	12.4	13.8	17.9	13.8	16.2	15.1	12.4	13.4	13.1	164.6		
Oldsmobile Main Plant #1 at Lansing	NA	NA	NA	NA	NA	NA	11.4	6.2	5.6	0.5	0.7	0.9	25.30		
IONIA COUNTY															
City of Ionia	28.6	25.7	28.9	29.9	36.0	41.8	35.7	36.0	31.7	25.1	25.8	28.1	373.3	1.70	0.48
State Hospital at Ionia	9.7	8.8	9.0	8.8	9.3	10.1	10.3	9.7	8.9	8.9	8.3	8.9	110.7	0.38	0.25
Michigan Reformatory at Ionia	16.7	15.4	14.4	17.2	16.9	22.7	20.2	23.8	19.2	17.6	17.2	17.3	218.6	0.89	0.50
Michigan Training Unit at Ionia	1.70	1.60	1.65	2.71	1.88	4.77	5.06	5.36	4.59	1.85	1.80	2.30	35.27	0.26	0.04
City of Portland	9.3	8.9	10.1	10.6	12.8	15.6	15.2	12.4	11.5	10.3	9.3	8.9	134.9	0.52	0.29
Village of Saranac	9.61	7.18	7.47	7.63	8.00	8.54	8.94	7.98	7.46	6.75	7.19	7.67	94.42	0.49	.09
IOSCO COUNTY															
Wurtsmith Air Force Base	23.5	20.5	21.9	24.9	38.7	42.9	42.0	43.0	39.5	35.6	31.5	27.0	391.0	1.58	0.41
IRON COUNTY															
City of Caspian	8.11	7.28	8.26	8.14	8.57	5.98	8.14	6.42	7.92	8.83	4.43	6.83	88.91	0.52	0.22
City of Crystal Falls	13.3	12.6	13.3	13.4	14.2	15.5	18.6	15.1	13.1	13.6	12.5	12.8	168.0	0.83	0.38
City of Iron River	12.5	13.2	14.1	12.6	13.1	12.8	14.8	12.2	10.9	11.2	11.1	12.4	150.9	0.78	0.16
City of Stambaugh	5.03	4.89	5.17	5.05	5.68	5.87	5.51	5.24	4.81	5.08	4.85	5.47	62.65	0.25	0.10
Stambaugh Township	1.81	1.75	1.82	2.09	2.04	2.35	3.67	2.52	1.51	1.46	1.37	1.60	23.99		
ISABELLA COUNTY															
g) City of Mt. Pleasant	48.7	50.2	46.9	52.0	53.9	70.2	61.9	48.4	53.1	57.2	52.4	50.5	645.4	3.93	0.94
Village of Shepherd	1.94	1.77	2.17	2.17	1.99	2.30	2.23	2.18	2.65	2.27	2.42	2.66	26.75	0.13	0.04
JACKSON COUNTY															
Village of Concord	1.67	1.67	1.89	1.96	2.21	2.28	2.81	2.74	2.34	2.12	1.96	1.77	25.42	0.14	0.05
e) Village of Grass Lake	1.90	1.80	1.60	1.60	1.90	2.00	2.80	2.90	2.80	2.40	2.00	2.00	25.70		
City of Jackson	336	307	330	338	403	443	444	443	396	390	330	347	4507	21.76	5.61
State Prison of S. Mich. at Jackson	38.1	35.2	41.7	39.1	51.9	55.7	57.2	62.3	45.8	50.1	37.6	39.8	554.5	2.43	1.02
KALAMAZOO COUNTY															
Village of Augusta	1.53	1.53	1.73	1.89	1.74	1.04	1.90	3.52	1.81	1.86	1.82	1.56	21.93	0.14	0.09
City of Kalamazoo	357	333	349	381	484	627	677	567	459	411	369	361	5375	29.64	3.60
State Hospital at Kalamazoo	17.7	16.6	18.3	16.7	17.5	16.8	20.9	17.4	19.1	19.2	18.9	17.5	216.6	0.65	0.51
City of Portage	9.6	9.7	8.6	11.6	20.7	31.8	28.8	22.8	15.8	13.7	12.1	12.3	197.5		
Village of Vicksburg	10.1	9.1	10.9	11.2	13.0	17.2	15.8	14.2	13.2	12.0	11.1	10.1	147.9	0.58	0.28
Upjohn Co. near Kalamazoo	256	261	266	285	308	343	355	336	317	312	280	260	3579	14.38	6.50
KVP-Sutherland Paper Co. at Parchment	103	92	100	109	112	109	111	123	104	112	112	102	1289		
e) Simpson-Lee Paper Co. at Vicksburg	47.0	47.0	47.0	50.0	43.0	43.0	43.0	43.0	43.0	47.0	41.0	45.0	539.0	1.8	0
KALKASKA COUNTY															
e) Village of Kalkaska	4.51	5.70	5.60	4.28	4.94	6.27	5.90	6.20	5.90	5.60	4.56	4.52	63.98		
KENT COUNTY															
City of Grandville	17.8	16.2	16.6	16.5	22.6	47.8	45.0	31.9	22.1	17.5	15.8	16.4	286.2	2.67	0.41
City of Lowell	13.1	13.4	13.7	13.5	15.7	23.2	19.5	19.3	16.8	18.0	16.7	17.8	200.7		
Paris Township	29.6	24.6	26.0	28.4	42.1	61.0	65.2	47.9	38.6	32.4	30.0	29.2	455.0	3.55	0.57
Village of Sparta	9.9	9.0	10.0	10.4	12.3	15.1	15.2	14.9	13.4	13.7	12.4	12.2	148.5	0.79	0.11
City of Wyoming	156	145	157	170	231	313	303	245	183	151	146	157	2357	16.44	2.66
LAPEER COUNTY															
Village of Imlay City	6.6	6.5	8.6	7.7	9.1	12.2	10.7	14.0	8.6	9.5	11.1	8.5	113.1		
City of Lapeer	13.5	12.5	14.3	13.9	15.6	19.0	20.2	17.7	15.4	14.7	13.5	13.7	184.0		

Table 3.--Reported ground-water pumpage by some Michigan municipalities, institutions, and industries (in million gallons).--Continued.

Water User	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1964 Total	Max. Day	Min. Day
LAPEER COUNTY (Continued)															
State Home and Training School at Lapeer	23.7	22.6	42.9	42.2	37.4	33.5	25.0	23.6	24.7	27.1	26.7	27.9	357.3		
LENAWEE COUNTY															
Village of Clinton			13.6			16.9			20.6			16.2	67.30	0.36	0.21
City of Hudson	7.5	6.9	7.2	7.1	9.4	11.3	12.5	11.5	9.8	9.4	8.2	9.1	109.9	0.65	0.13
City of Morenci	6.02	6.11	6.09	6.15	5.90	6.27	6.44	6.19	5.66	5.74	5.20	5.13	70.90	0.28	0.12
City of Tecumseh	66.8	54.8	58.5	58.3	69.5	76.1	84.8	68.7	76.0	70.6	51.2	54.5	789.8	3.77	1.05
LIVINGSTON COUNTY															
City of Brighton	7.4	7.3	8.3	8.9	12.6	12.7	12.2	15.3	13.4	12.6	9.3	9.5	129.5	0.98	0.13
City of Howell	16.0	14.3	15.3	15.3	19.3	19.8	20.0	19.9	18.3	18.6	17.3	17.8	211.9		
State Hosp. at Howell	3.3	2.9	3.2	2.8	6.7	10.9	9.4	6.6	3.3	3.3	3.0	3.1	58.5	0.52	0.06
LUCE COUNTY															
City of Newberry	7.0	7.2	9.0	9.4	9.2	13.8	18.7	10.3	9.0	12.0	11.1	10.6	127.3		
State Hospital at Newberry	10.4	9.9	12.0	10.8	11.5	13.8	15.3	12.3	10.7	10.1	9.5	8.3	134.6	0.63	0.18
MACOMB COUNTY															
Village of Richmond	6.55	6.41	7.99	7.41	7.96	8.08	8.89	8.50	8.32	8.53	6.89	8.06	93.59	0.39	0.19
Village of Romeo	11.9	11.3	12.1	12.9	13.0	14.0	14.9	15.2	14.8	14.2	14.0	12.9	161.2	0.52	0.37
MANISTEE COUNTY															
City of Manistee	35.7	31.7	32.4	34.8	39.9	54.7	49.6	44.1	37.7	36.9	33.0	32.0	462.5	2.98	0.94
MARQUETTE COUNTY															
State House of Corr. and Br. Prison at Marquette	5.62	4.65	6.00	4.22	4.15	6.66	7.23	8.93	7.12	8.00	7.20	5.43	75.21	0.37	0.07
KI Sawyer Air Force Base near Gwinn	29.8	28.0	27.8	30.4	42.8	43.7	54.6	31.3	26.6	31.0	30.0	29.4	405.4	2.87	0.71
MONROE COUNTY															
Village of Carleton	2.83	2.50	2.41	2.43	2.91	3.12	3.86	3.15	3.00	2.60	2.48	2.68	33.97	0.16	0.06
MONTCALM COUNTY															
City of Carson City	9.5	7.0	9.9	9.8	11.2	11.2	12.0	11.6	11.0	10.4	10.1	9.9	123.6	0.48	0.18
City of Greenville	39.4	33.7	36.5	47.4	40.1	46.4	42.6	39.7	40.1	49.1	33.6	32.1	480.7	2.58	0.52
Village of Sheridan	1.61	1.50	1.76	1.55	1.74	3.40	4.09	2.84	1.83	1.81	1.39	1.29	24.81	0.29	0.05
City of Stanton	1.79	1.10	1.15	1.84	1.94	1.76	2.42	1.55	1.59	1.87	1.30	1.72	20.03		
MUSKEGON COUNTY															
City of Montague	7.2	4.6	7.1	6.3	6.5	6.9	11.2	9.9	4.9	4.2	4.4	3.6	76.8		
City of Whitehall	12.1	10.4	10.8	11.3	16.0	24.2	23.2	19.8	13.5	12.7	12.2	11.6	177.8	1.09	0.29
NEWAGO COUNTY															
City of Fremont	13.8	11.8	9.9	15.8	17.8	25.0	25.4	22.7	18.6	15.2	15.4	16.2	207.6	1.51	0.08
OAKLAND COUNTY															
c) City of Birmingham	84.0	81.4	70.4	79.0	68.2	72.8	74.0	72.8	66.0	80.4	76.6	71.0	896.6		
Cranbrook School	7.8	7.4	6.9	7.1	14.1	13.5	14.2	12.5	10.1	6.0	5.0	4.2	108.8		
Oakland University	2.38	2.52	2.54	2.21	2.70	2.91	2.89	2.48	2.58	2.82	2.16	2.52	30.71	0.12	0.05
Village of Oxford	6.41	6.33	6.78	6.42	6.45	7.76	9.68	8.06	6.40	6.44	6.35	9.18	86.26		
Village of Rochester	35.0	33.0	34.1	34.7	40.9	46.6	60.4	44.7	39.8	37.2	32.6	33.0	472.0	2.72	
City of South Lyon	40.6	38.5	46.6	45.2	47.9	50.9	42.6	58.2	50.9	49.3	49.9	49.2	569.8	2.42	0.40
City of Sylvan Lake	3.94	3.87	3.68	4.45	4.30	4.93	6.60	7.81	3.00	4.71	4.19	4.16	55.64		
d) City of Troy	5.37	6.44	5.03	5.56	5.47	8.08	9.41	9.93	7.22	6.42	6.14	5.86	80.93	3.16	0.37
Waterford Township	22.9	24.4	26.7	26.6	49.8	59.4	75.2	65.2	46.8	41.2	51.5	34.4	524.1		
OCEANA COUNTY															
City of Hart	9.0	8.5	16.4	9.1	11.6	18.5	49.1	34.8	20.6	1.3	19.9	29.8	228.6		
OGEMAW COUNTY															
City of West Branch	6.0	5.9	5.7	7.0	7.1	10.2	8.9	7.5	7.5	7.3	6.1	6.0	85.20		
ONTONAGON COUNTY															
Village of Ontonagon	11.5	8.8	10.5	12.2	13.4	13.5	15.8	13.1	13.2	12.6	13.6	14.9	153.1	0.69	0.27
OSCEOLA COUNTY															
e) City of Evart	42.0	42.0	42.0	42.0	42.0	48.0	48.0	48.0	48.0	41.0	41.0	41.0	525.0		
OTSEGO COUNTY															
City of Gaylord	9.6	10.9	12.0	11.5	11.9	9.8	12.8	11.9	11.1	11.2	10.7	10.7	134.1	0.51	0.07
Gaylord State Home	1.43	1.38	1.37	1.31	1.44	1.55	1.52	1.34	1.24	1.30	1.19	1.35	16.42		
OTTAWA COUNTY															
City of Hudsonville	12.0			19.4			30.1			14.8			76.30		
Village of Spring Lake	6.4	5.9	6.0	7.0	11.8	22.3	20.5	16.8	11.0	7.9	6.8	6.7	129.1		
Village of Coopersville	3.81	3.40	3.75	4.43	5.14	5.68	5.18	4.90	5.08	4.36	4.06	4.24	54.03	0.19	0.12
PRESQUE ISLE COUNTY															
City of Onaway	1.50	2.00	1.80	2.00	2.00	2.10	3.50	1.80	2.00	1.50	1.50	1.50	24.70	0.09	0.04
City of Rogers City	4.4	5.9	6.4	6.3	7.9	11.6	12.7	8.4	7.3	7.1	6.4	6.5	90.9	0.27	0.20
SAGINAW COUNTY															
Bridgeport Township	8.4	7.7	7.5	8.1	9.7	11.8	11.4	13.4	10.7	9.2	8.4	8.8	115.1		
Thomas Township	5.57	3.79	4.62	4.83	6.28	7.89	6.83	6.45	5.99	5.94	5.56	5.61	69.36	0.43	0.13
SANILAC COUNTY															
City of Croswell	13.6	10.6	11.8	15.0	18.1	23.0	27.2	31.3	24.3	24.0	21.2	20.2	240.3	1.31	0.14
City of Sandusky	12.0	14.0	15.2	12.6	13.7	13.2	16.7	13.4	11.2	10.7	10.1	12.7	155.5	0.93	0.25
SHIAWASSEE COUNTY															
City of Corunna	5.53	5.06	5.33	4.98	4.80	6.06	6.36	5.56	4.81	4.70	4.35	4.71	62.25	0.43	0.01
City of Durand	10.4	9.8	10.0	11.6	12.5	12.4	13.7	11.6	11.7	11.7	10.7	11.0	137.1	0.63	0.21
City of Owosso	74.2	65.3	70.7	69.7	78.2	85.8	87.1	83.5	77.8	78.2	68.3	71.6	910.4	3.92	1.70
City of Perry	1.92	1.75	1.96	1.96	2.55	2.72	2.45	2.43	2.28	2.10	1.73	1.70	25.55		

Table 3.--Reported ground-water pumpage by some Michigan municipalities, institutions, and industries (in million gallons).--Continued.

Water User	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1964 Total	Max. Day	Min. Day
ST. CLAIR COUNTY															
Village of Capac	1.87	1.90	2.24	3.03	2.78	3.71	3.11	2.79	3.15	3.04	2.47	2.53	32.62		
City of Yale	3.78	3.85	4.27	4.09	6.20	5.32	5.86	6.08	4.95	3.84	3.35	3.40	54.99		
ST. JOSEPH COUNTY															
Village of Constantine	6.59	6.02	7.44	5.44	4.35	3.99	4.81	5.28	6.05	3.67	4.18	6.55	64.37		
City of Sturgis	53.2	48.0	51.1	51.8	60.0	70.0	76.7	72.2	58.1	55.4	51.7	50.9	699.1	4.00	0.87
City of Three Rivers	30.6	28.3	29.4	28.2	35.2	41.1	43.3	41.2	31.4	24.8	24.1	24.4	382.0	2.07	0.52
TUSCOLA COUNTY															
State Hosp. at Caro	8.3	7.9	8.8	9.4	8.7	10.3	10.4	10.3	7.7	7.9	7.6	7.9	105.2	0.48	0.19
Village of Cass City	5.37	4.86	5.07	5.36	6.17	6.35	6.61	6.13	5.43	5.37	4.99	5.14	66.85	0.32	0.12
VAN BUREN COUNTY															
Village of Bangor	10.0	8.7	9.9	9.5	10.8	14.2	13.6	13.1	11.8	9.9	8.9	8.7	129.1	0.86	0.26
Village of Hartford	13.1	5.4	5.8	6.8	8.8	13.0	14.5	13.5	10.6	7.3	7.0	7.8	113.6	0.94	0.10
Village of Lawton	24.4	17.0	26.5	22.3	25.0	29.0	31.9	30.4	40.7	40.9	25.5	23.3	336.9	1.98	0.34
WASHTENAW COUNTY															
City of Ann Arbor	145	146	121	118	113	129	144	131	109	116	86	72	1430	7.65	1.89
Boys Training School at Whitmore Lake	1.29	1.06	1.07	1.12	1.13	1.45	2.07	2.61	1.85	2.12	2.20	1.99	19.96	0.15	0.01
Cassidy Lake Tech. School	1.22	1.30	1.43	1.45	2.16	1.84	1.64	2.52	1.53	1.38	1.40	1.49	19.36		
Village of Dexter	5.01	5.02	4.67	4.20	4.72	4.25	5.79	5.99	5.00	5.07	5.27	4.90	59.89	0.40	0.12
City of Saline	6.9	6.3	7.1	7.2	8.4	10.6	12.4	10.1	8.9	8.2	7.1	7.9	101.1	0.71	0.18
City of Ypsilanti	114	104	115	115	131	130	131	135	128	130	106	123	1462	4.91	1.81
Ypsilanti Township	168	177	191	158	161	157	168	144	171	137	181	181	1994		
State Hosp. at Ypsilanti	14.6	13.7	13.8	15.3	15.5	19.8	20.0	17.6	15.1	13.9	11.3	15.0	185.6	0.86	0.31
a) Village of Manchester	6.75	5.93	6.59	6.11	4.03	4.49	3.82	3.71	3.98	3.54	3.86	4.98	57.79		
WAYNE COUNTY															
State Hosp. at Northville	20.9	19.1	19.9	19.6	16.9	17.0	18.5	18.7	17.7	18.8	17.8	20.5	225.4	0.86	0.39
City of Plymouth	53.6	57.1	57.4	59.3	71.7	81.1	101.3	84.2	72.6	67.8	59.9	62.5	828.5	4.17	1.23
Plymouth State Home and Training School at Northville	4.05	3.52	3.91	4.54	8.21	3.89	6.09	4.76	6.29	4.70	4.39	6.63	60.98	0.23	0.10
WEXFORD COUNTY															
City of Cadillac	33.8	31.8	33.3	30.4	47.7	112.2	102.5	50.5	35.3	e26.4	e29.1	e35.1	e568.1		

a) Only part of total supply
b) Used only in summer months
c) Emergency usage - domestic supply from Detroit system
d) 5.61 leased from Walker Well of Birmingham, Michigan
e) Estimated
f) Now using Flint Surface Water
g) Represents mostly River Recharge Shallow Pumping
NA Not available