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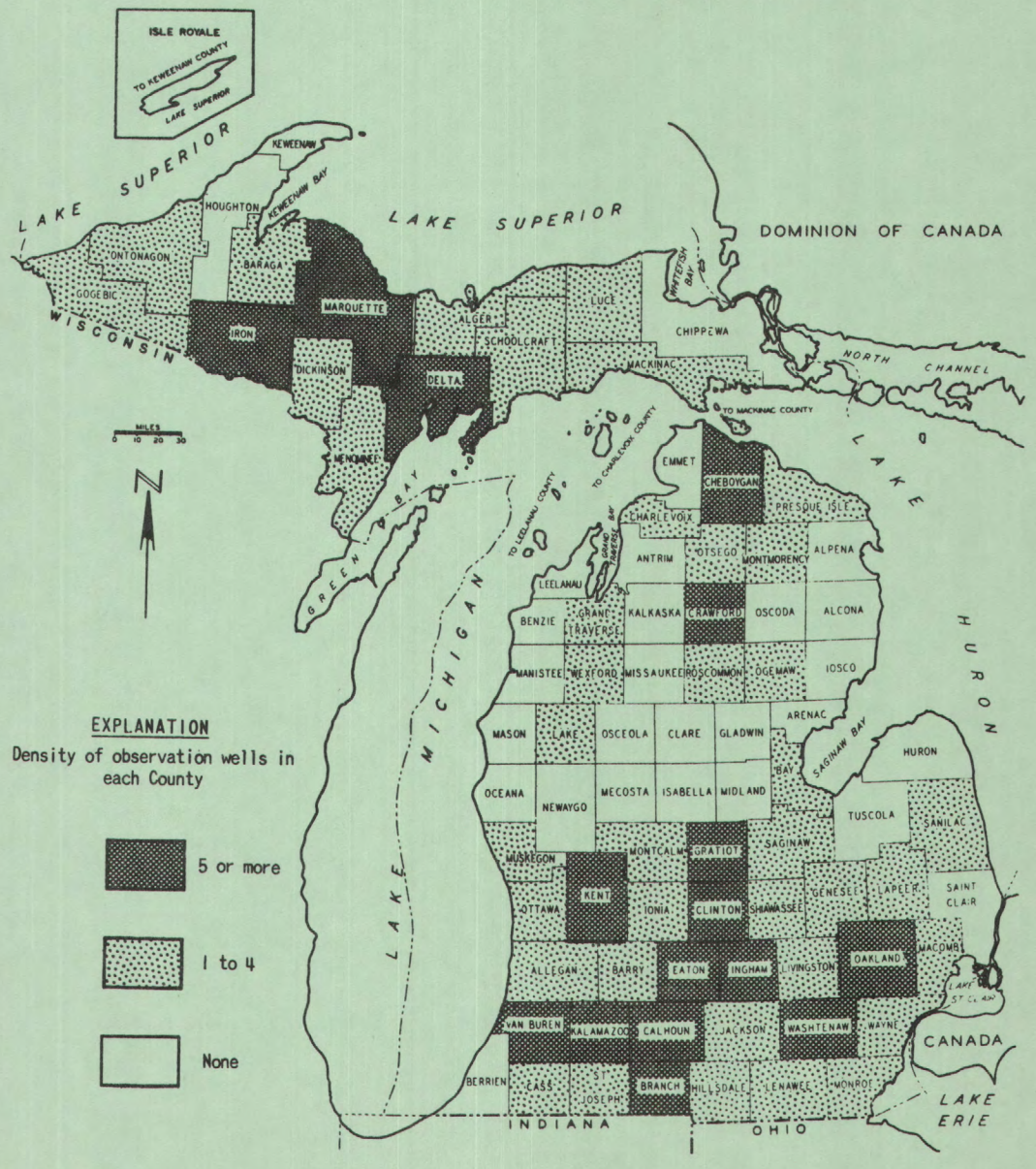
SUMMARY
OF
GROUND-WATER HYDROLOGICAL DATA
IN
MICHIGAN
IN
1968

BY

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



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

SUMMARY

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GROUND - WATER HYDROLOGIC DATA

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U. S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Prepared in cooperation with
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Copies of this report may be obtained from
District Chief, Water Resources Division
U. S. Geological Survey
700 Capitol Savings and Loan Building
Lansing, Michigan 48933

1969

PREFACE

This program of ground-water investigations in Michigan is conducted in cooperation with the Michigan Department of Natural Resources (formerly Michigan Department of Conservation), R. A. MacMullan, Director, through the Geological Survey Division, G. E. Eddy, State Geologist, and under the overall agreement for water-resources investigations in Michigan with the State Water Resources Commission, R. W. Purdy, 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 or villages of Alma, Ann Arbor, Battle Creek, Beaverton, Coldwater, Dowagiac, Grand Ledge, Hillsdale, Holland, Ironwood, Jackson, Kalamazoo, Lansing, Lowell, Marshall, Mason, Plymouth, Portage, St. Johns, St. Louis, Wyoming and Ypsilanti; the townships of Battle Creek, Pinconning, Waterford and Ypsilanti; Cranbrook School; Kent Metropolitan Airport; Michigan Technological University, Oakland University; State institutions at Howell, Ionia, and Ypsilanti; the Huron-Clinton Metropolitan Authority; the Fisher Body Division of General Motors Corporation, the Jervis Corporation, Brown Company, Wisconsin-Michigan Power Company, the Cleveland Cliffs Iron Company, the UpJohn Company, and American Aggregates Corporation; Counties of Branch, Van Buren, Kalamazoo, and Oakland; Tri-County Planning Commission, and the U. S. Army Engineers.

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 Mr. A. E. Slaughter of the Michigan Geological Survey for his assistance in the review of this report.

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 numbers of Water-Supply Papers containing water-level data for Michigan:

Year	No.	Year	No.	Year	No.
1935	777	1943	986	1951	1191
1936	817	1944	1016	1952	1221
1937	840	1945	1023	1953	1265
1938	845	1946	1071	1954	1321
1939	886	1947	1096	1955	1404
1940	906	1948	1126	1956-57	1537
1941	936	1949	1156	1958-62	1782
1942	944	1950	1165	1963-67	1977 (in press)

Beginning in 1956, 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 reports in this series were published for the years 1956-57 and 1958-62. Subsequent reports are to be published every 5 years.

To supplement these abbreviated reports, publication of annual reports was begun for Michigan in 1956 and entitled "Summary of Ground-Water Conditions in Michigan." The first seven of these reports, for the years 1956-62, were published by the Michigan Department of Conservation now Department of Natural Resources. Subsequent reports are open-file publications.

Selected publications dealing with ground-water conditions in Michigan are listed under SELECTED 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 Department of Natural Resources, Mason Building, Lansing, 48926; or at the Michigan District office of the U. S. Geological Survey, 700 Capitol Savings and Loan Building, Lansing 48933. Records for the Northern Peninsula are also kept on file in the office of the State and Federal Geological Survey, 205 State Office Building, Escanaba 49829.

U. S. Geological Survey Water-Supply Papers are for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D.C. 20242, or can be consulted at the offices listed above and in major university or municipal libraries.

The U. S. Geological 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.

The Lansing office of the U. S. Geological Survey also issues monthly a single-page graphical presentation of current ground-water and streamflow conditions in selected Michigan wells and streams. Figure 5 of this report illustrates the ground-water part of this monthly summary. This issue is free upon request.

Copies of annual "Summaries of Ground-Water Conditions in Michigan" are free on application. Other publications of the Michigan Geological Survey can be purchased from the Michigan Department of Natural Resources, Publications Room, Mason Building, Lansing, Michigan 48926.

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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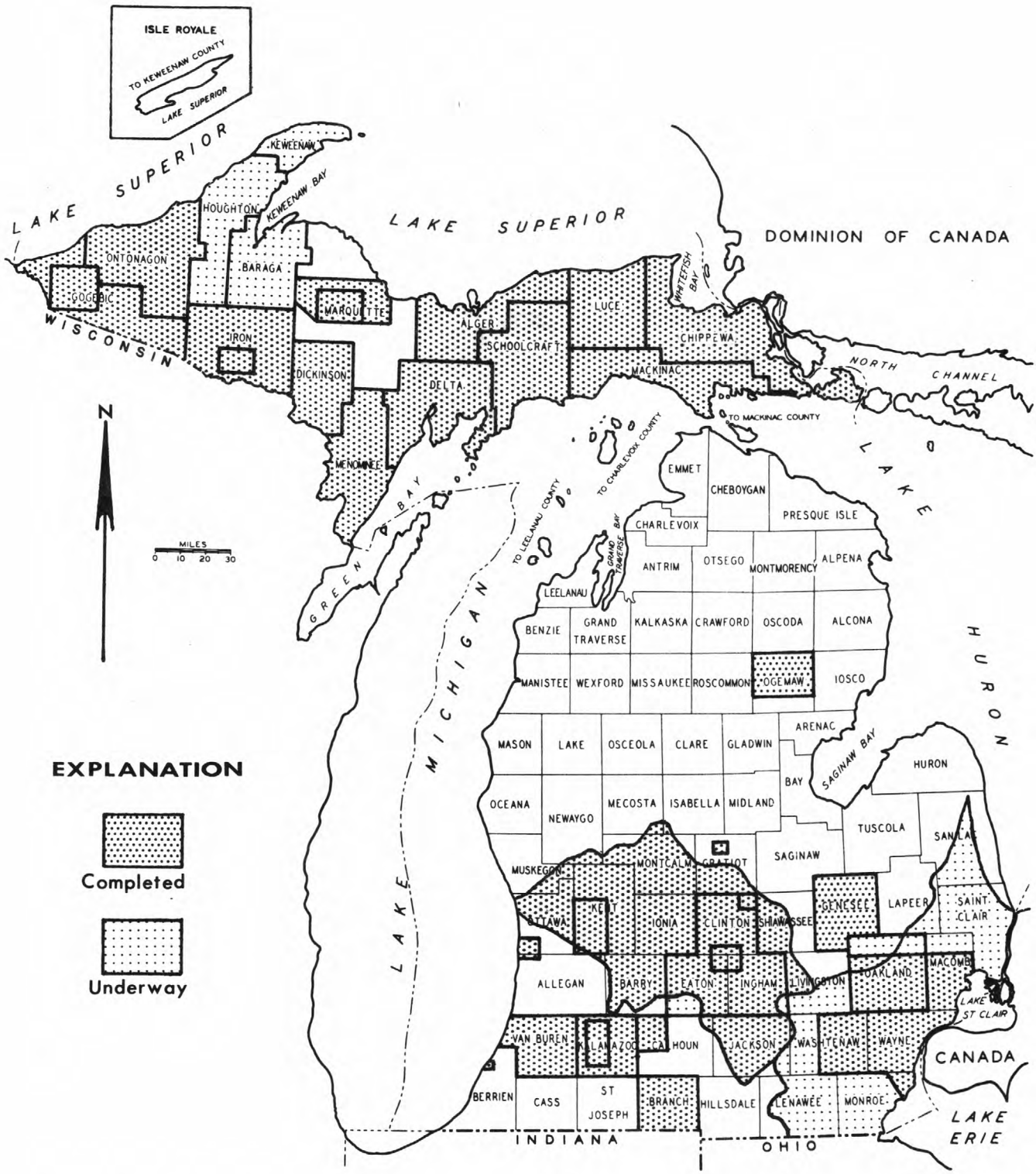


Figure 1.--Areas where water-resources investigations containing some ground-water data are completed or underway.

Completed reports or those in press are listed under REFERENCES.

SUMMARY OF GROUND-WATER CONDITIONS

IN MICHIGAN IN 1968

INTRODUCTION

Purpose of this report

The purpose of this report is to make available the records of ground-water levels in the principal aquifers of the State through 1968 and to compile other related data, such as records of ground-water pumpage, data on municipal, public and industrial water-supply facilities, and the effects of precipitation on ground-water levels. Records of water levels in areas of heavy pumpage and in areas where changes are principally from natural influences are illustrated or tabulated to allow comparison between these types of water-level fluctuations. The water-levels and related data provide a day-to-day record for the evaluation of available ground-water supplies. The long-term records serve as a framework to which short-term records 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

Table 1 contains records of measurements of ground-water levels in observation wells, their location, depth, elevation, aquifer which they tap, and the extremes of water level for the past record and in 1968. Table 2 contains records of ground-water pumpage in 1968 of most major ground-water users in the State.

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

Shown in summary form are supplementary data on the yield of wells, pumpage, storage facilities, treatment, quality of water, per capita use and trends of ground-water levels for 1968 and for part of the previous record.

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

Progress of areal water-resources investigations containing ground-water data for Michigan as of the end of 1968 are shown in figure 1. Reports for areas completed are listed in references at the end of this report. Some of the investigations encompass areas previously studied or more intensively investigated.

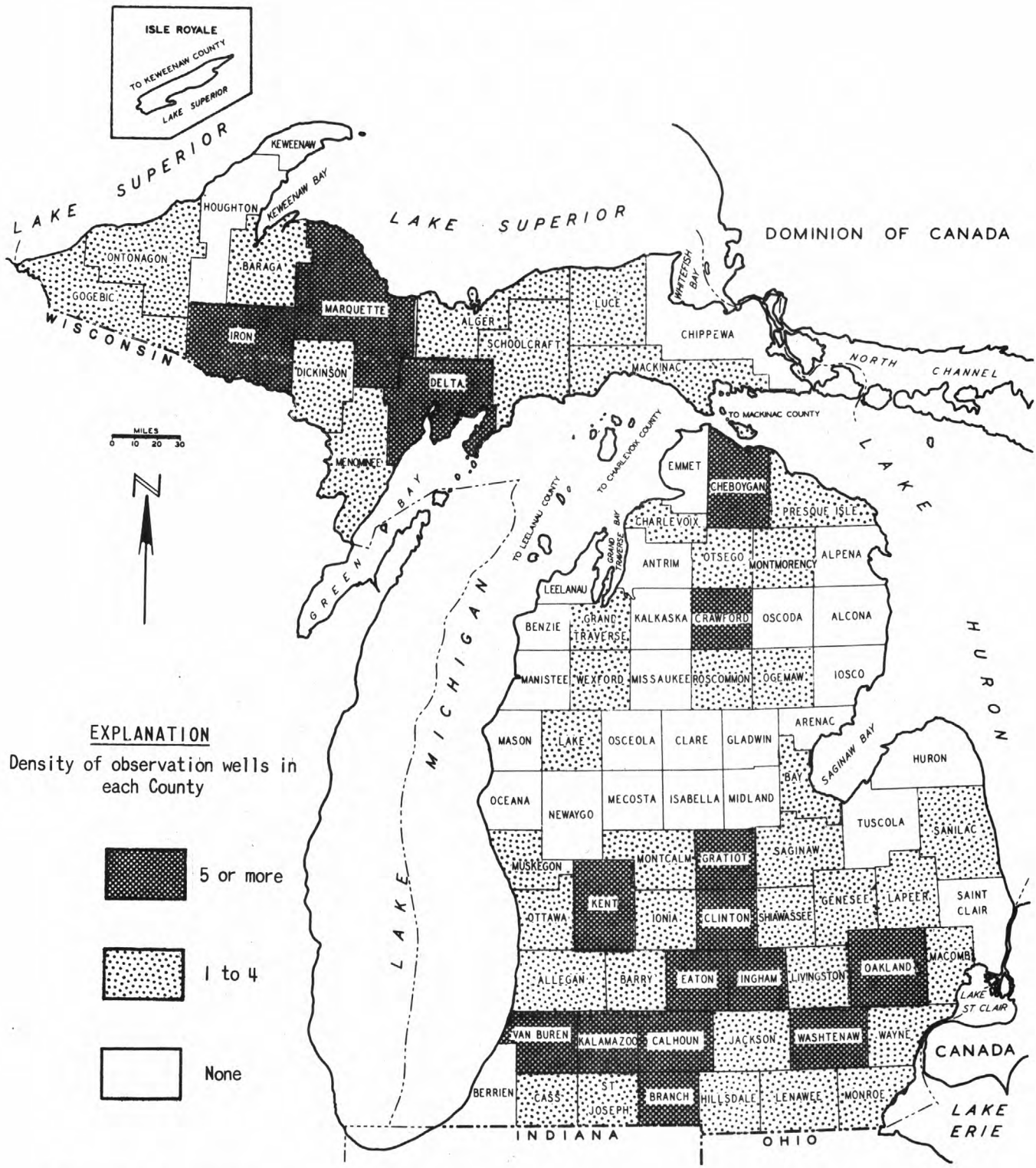


Figure 2.--In 1968, measurements of water levels were made in 306 observation wells in Michigan, of which number, 88 were continuous recordings.

Of the 83 Counties in Michigan, 55 have at least one observation well.

Automatic data processing

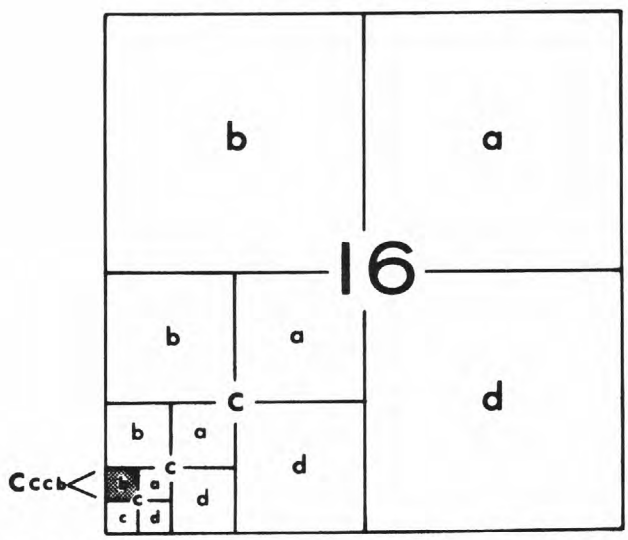
In 1966, a program of automatic data processing (ADP) of ground-water records was begun by the U. S. Geological Survey. The well records used in the study of Oakland County's water resources, recently completed, were coded, punched, and assembled for computerized analysis. Most of the basic records in the Tri-County investigation were also processed.

Records of chemical analyses of ground-water as well as data from a selected number of observation wells, are being automated on a nationwide basis.

The ADP program affords a modern way of updating and retrieval of records.

Well numbering system

The well-numbering system for Michigan was changed in 1966 to facilitate coding. The new system still indicates the location of wells within the rectangular subdivision of the land with reference to the Michigan meridian and base line in that the first two segments of the well number designate township and range. However, the third segment instead of giving the section number and well number within the section--now gives the section number and an a, b, c, d, breakdown of the section as illustrated below. Thus, where a well was formerly designated as number 32N 6E 16-1 it can now be broken down in the section as 32N 6E 16-cccb. This would pinpoint the location to the nearest 2.5-acre part of section 16 (see cut).



For the purpose of this report well locations in sections are only broken down in ¼ ¼ -- i.e. 16-cc. In the event that two or more wells are located in the same 40-acre tract, a number designation can follow the letter designations--i.e. 16-cc-1, 2, 3, 4, etc.

The Michigan Geological Survey uses a similar system except that numbers are used in lieu of letters.

As shown in figure 2, more than half of the counties in Michigan have observation wells.

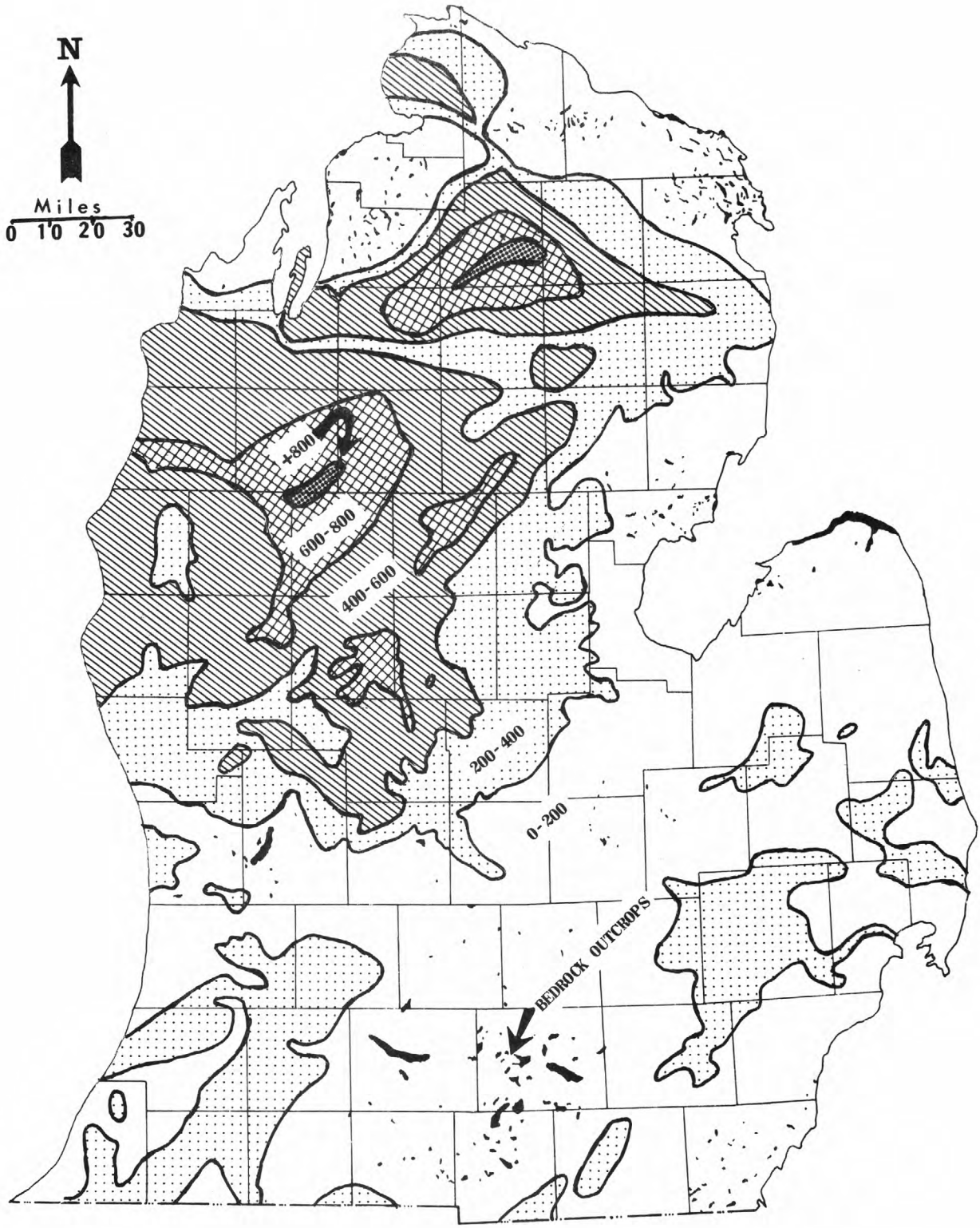


Figure 3.--Generalized drift thickness in feet, and bedrock outcrops in Michigan's Southern Peninsula.

Generalized from Drift Thickness Map of the Southern Peninsula of Michigan, Scale 1/500,000.
Compiled by James Akers, Sept., 1938, Mich. Dept. of Natural Resources.

Availability of water in the glacial drift

The most productive aquifers in Michigan are the glacial drift aquifers in areas where they are of sufficient thickness and contain sand and gravel materials. The thickness of the glacial materials in the southern peninsula of Michigan ranges from zero in the bedrock outcrop areas, to as much as 800 feet in the northwest part of the peninsula (fig. 3). In some areas of the southern peninsula the bedrock underlying the drift consists either of unproductive shales or of bedrock containing saline water. In these areas the glacial drift may be the only source of fresh ground water (Twenter, 1966).

How this report can be used

In areas where ground water is used for municipal or industrial supplies, hydrographs of water levels show the effects of discharge from wells, and natural, induced, and artificial recharge to aquifers. Declines, except those caused by precipitation deficiencies and evapotranspiration, 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 the continuous collection of basic water-level data which serve to indicate both the day-to-day and 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.

When a well is installed in an area of steadily falling water levels caused by heavy municipal or industrial pumping, a projection of future water levels should be made for a reasonable number of years. The well should then be drilled deep enough to take advantage of the full thickness of the aquifer and the suction pipe installed far enough below the water level in the well to provide for the probable lowering of water levels and thereby extend the life of the installation. Much future expense can thus be eliminated.

A factor generally overlooked is the water problem often encountered after a basement or septic tank is constructed for a building or home. The water table fluctuates an average of from 2 to 3 feet annually and about 5 feet over a period of years (figs. 5, 6). Thus, if an excavation is made in the fall when the water table is low, allowances should be made for the probable higher water levels in the spring. If construction is made after several years of drought conditions, a larger allowance should be made for the subsequent rise in water levels. If a site is at all questionable, borings should be made to determine the depth to the water table and allowances for the probable rise in water levels made.

Builders of farm ponds and artificial lakes should also take into account the fluctuations of the water table where these bodies of water depend on the height of the water table for their levels.

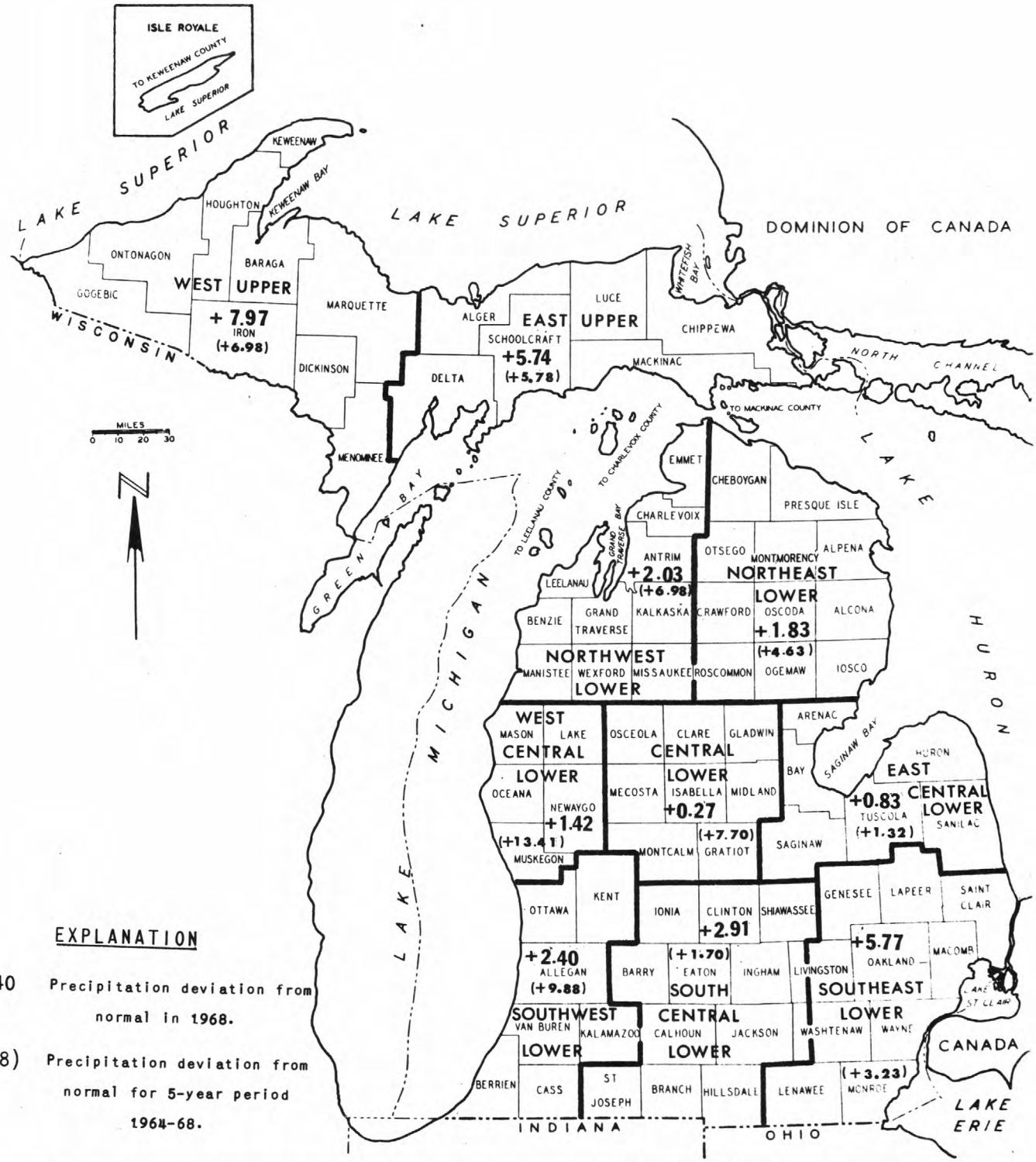


Figure 4.--In 1968, precipitation was above normal in all of the U. S. Weather Bureau's Climatological Divisions.

Precipitation was also also above normal for the 5-year period, 1964-68, the cumulative departure ranging from +1.32 inches in the East Central Lower Division, to +13.41 inches in the West Central Lower Division.

GROUND-WATER LEVELS IN 1968

The rising trend in ground-water levels continued in 1968 benefiting from increased precipitation (fig. 4). Record high levels occurred in 76 observation wells as compared to record low levels in only 18 wells (see table 1). Most of the record lows occurred in heavily pumped urban areas. Declining trends in some heavily pumped areas were halted or reversed as precipitation increased during the 1967-68 period.

Illustrated in this report are 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 normal precipitation as published by the U. S. Weather Bureau. Starting at this line the excess or deficiency of precipitation of 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 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 departure either above or below the average for the period of the graph.

Changes in ground-water storage from natural influences

Water levels in 2 of the 6 key wells, located throughout the State, reached record highs during 1968 (fig. 5) for at least part of the year. The others remained above average.

Long-term graphs for 4 wells (fig. 6) show the seasonal and long-term fluctuations of water levels. The dashed lines indicate the cumulative departure of precipitation based on annual totals and show the relation between precipitation and ground-water levels. Note the relatively minor fluctuation range of water levels and precipitation for the well at Roscommon.

Although precipitation is the major climatic factor affecting ground water levels, the annual total rainfall may not always bear a direct relationship to the amount of recharge received by an aquifer. Many factors affect this relationship, such as time of year, duration, intensity, and the form of precipitation.

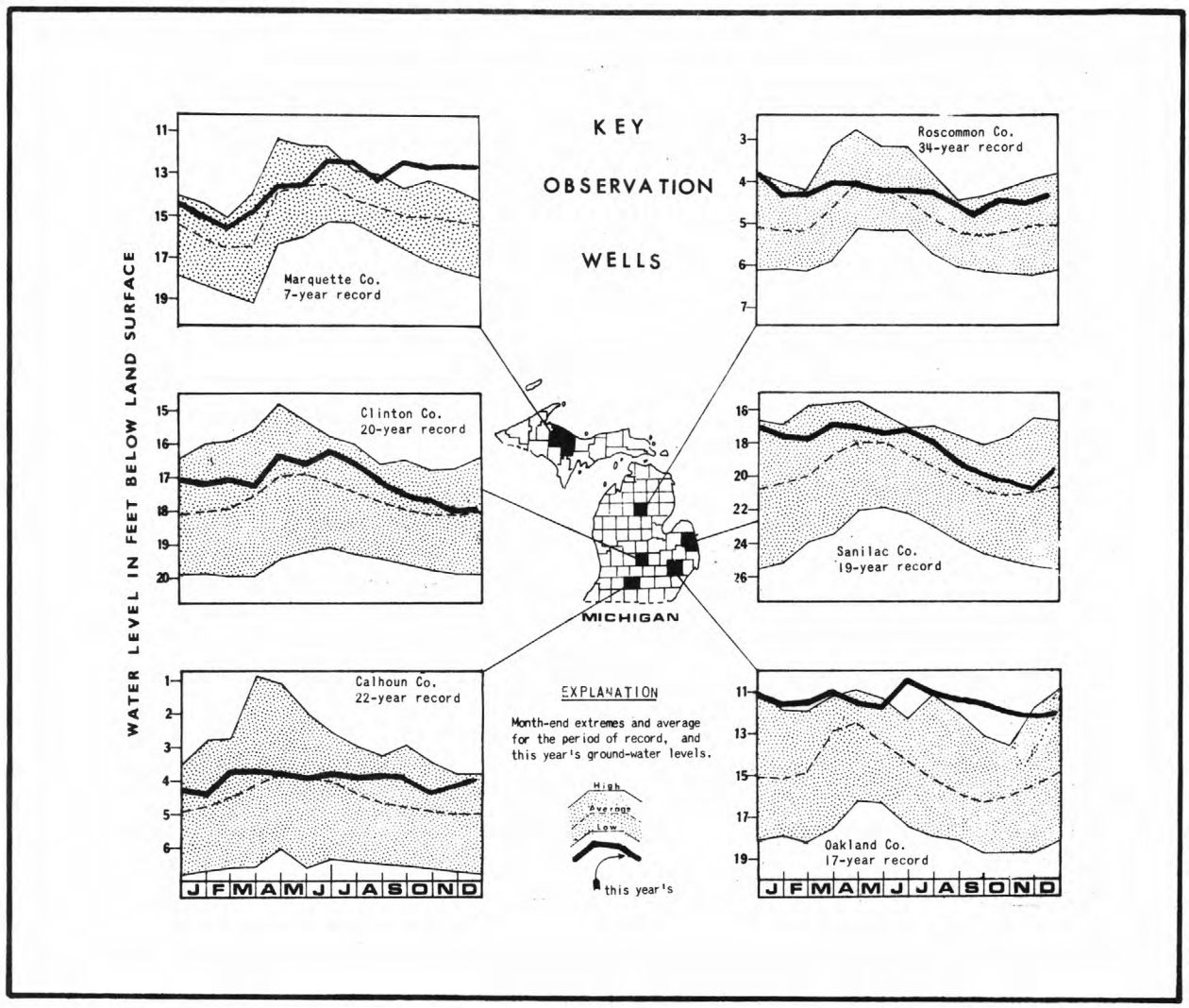


Figure 5.--In 1968, water levels in key wells, wells whose water levels respond principally to precipitation, ranged from above average to record high.

These wells are representative of water-level conditions of aquifers in the areas where the wells are located.

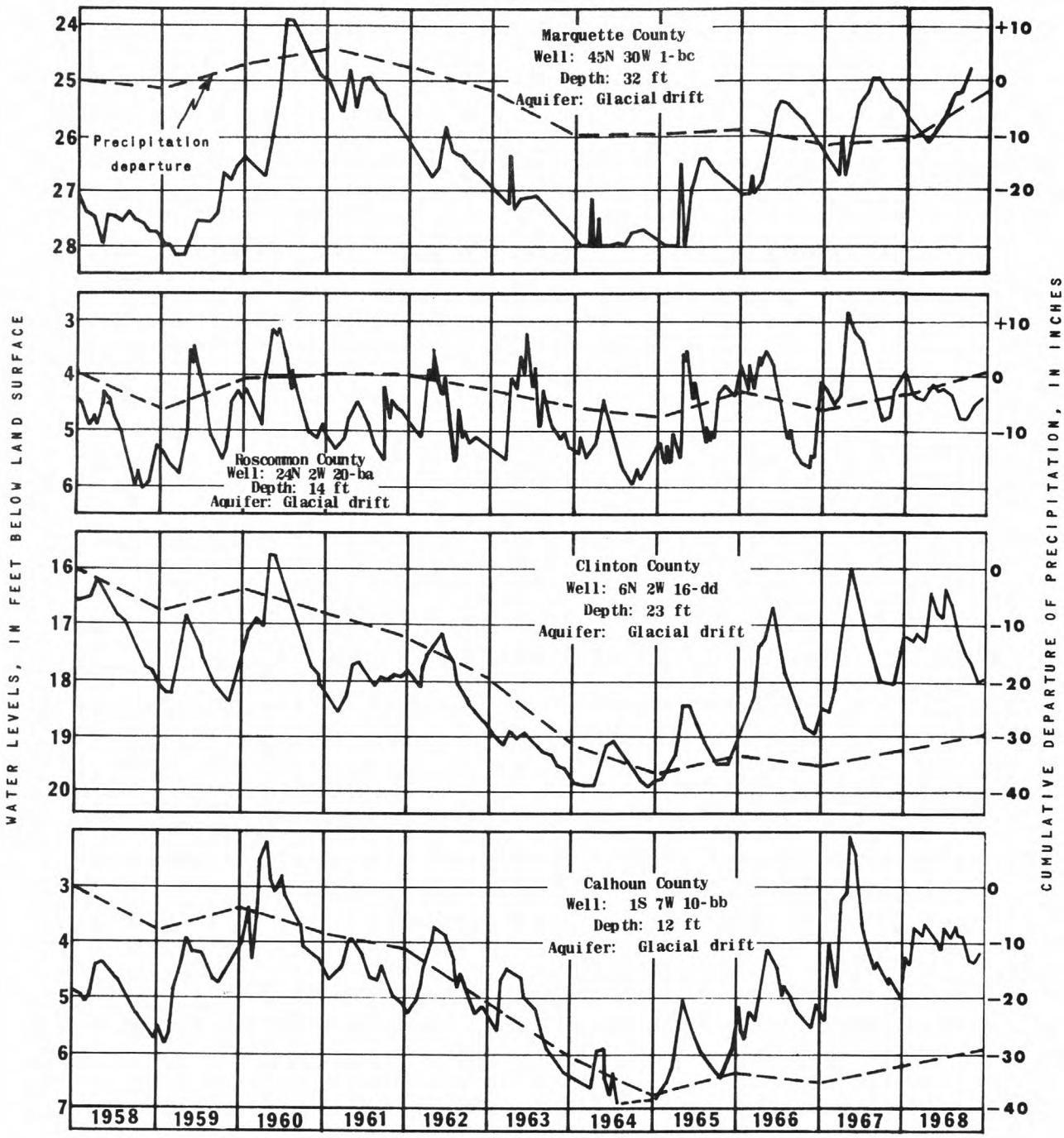


Figure 6.--Long-term records of these four wells, whose levels respond to natural climatic conditions, indicate a rising trend for the past four years principally as a result of increased precipitation.

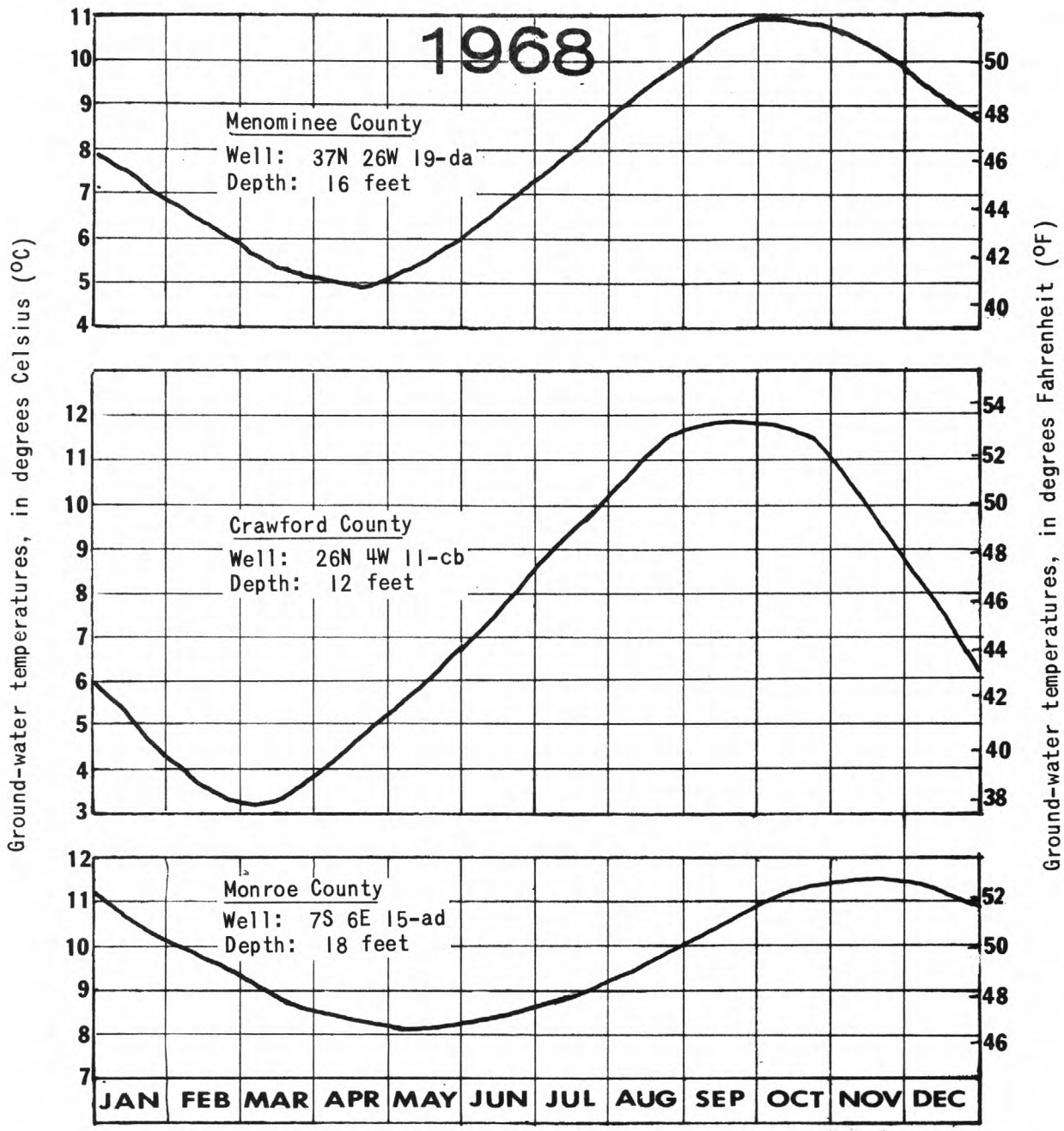


Figure 7.--Generalized graph based on monthly measurements of water temperatures in three Michigan wells in 1968.

These shallow wells are finished in glacial drift.

Hydrographs of natural fluctuations of water levels in wells (figs. 5, 6, 9, 41, and 43), show that spring is the season when water levels are highest and when most of the ground-water recharge occurs. In the spring snowmelt and rain normally result in large additions to the ground-water reservoirs. However, ice cover or frost in the ground can impede infiltration. Under these conditions, most of the water from snowmelt and precipitation may be lost to ground-water reservoirs by quick surface runoff. During the growing season there is very little recharge as most of the rainfall either runs off overland, when it occurs as heavy showers; is evaporated; or is transpired by vegetation. In the fall evapotranspiration (the return of water to the atmosphere as a vapor from water surfaces, from the soil, and from living plants) is reduced by cold weather. Thus, substantial rises in water levels usually follow the usual fall rains. During the winter frozen ground impedes the infiltration of water.

In addition to changes in water levels in wells from the effects of precipitation, such phenomena as earth tide, barometric pressure variations, and earthquakes also cause temporary changes in levels. Also, effects of evapotranspiration show small daily declines in water levels in wells.

Temperature of Ground Water

A series of temperature measurements of ground water was obtained as part of a state-wide water resource investigation. The purpose of the measurements is to determine the natural ground-water temperature at selected points throughout the state. These data can be used to estimate ground-water temperatures at moderate depth at any point in the state. Measurement of temperatures are made by means of "lazy" thermometers (Heath, 1964) which remain in the well except when being read.

Examples of temperatures of ground water in three Michigan wells (fig. 7) show that temperature variations decrease with depth to water.

Changes in storage from pumping influences

In 1968, record and near-record lows of water levels were recorded in some of the heavily-pumped areas of the State (table 1). Increasing population, industrial growth, and modern water uses create large additional demands for water. These demands result in increased pumping and lower water levels, and often indicate a need for expansion of water-supply facilities.

AREA GROUND-WATER LEVELS

Descriptions of some of Michigan's municipal, institutional, industrial, and areal ground-water supplies follow alphabetically by counties. Most of the descriptions are supplemented by illustrations.

The descriptions include chemical quality of water data for a few of the major constituents analyzed. Where more than one well is involved a range in quality of the wells is generally given. The data is the latest available information based mostly on analyses made by the Michigan Department of Health. The unit parts per million (ppm) used in this report can be considered numerically equal to milligrams per liter (mg/l) because of the dilute nature of the waters reported.

Where "population served" figures are given the data is based on the 1960 census unless a later estimate is shown.

Per capita use of water varies greatly because of heavy industrial use in some localities. The per capita use in the following summaries varies from about 80 to 300 gallons per day.

Increased demand for water resulted in additional lowering of ground-water levels in many areas in 1968.

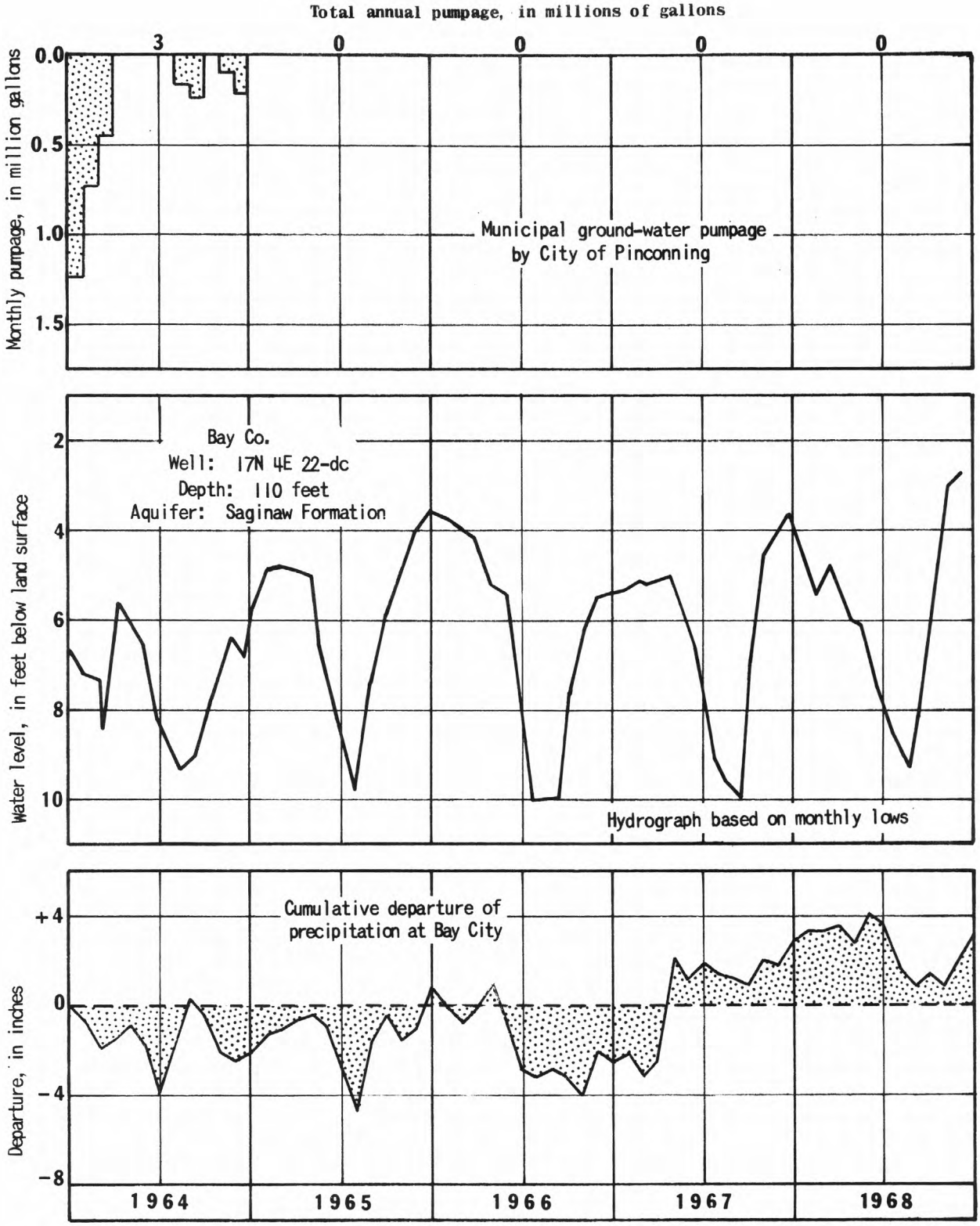


Figure 8.--At Pinconning Township, water levels respond to local changes in artesian pressure in the Saginaw Formation.

Water level changes were principally the result of precipitation variations as little pumping occurred in the area.

BAY COUNTY - PINCONNING TOWNSHIP

WATER SUPPLY AND SOURCE -- 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 ft of drawdown) -- 1.1.

PUMPAGE IN 1968 -- None from city well. 82.9 million gallons from Saginaw Bay.
MAXIMUM DAY -- 478 thousand gallons.

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 -- 1,329.

PER CAPITA USE -- 172 gallons per day.

REMARKS -- Ground-water levels in the observation well at the end of 1968 were the highest of record since 1962 (fig. 8). Record high levels were also observed in the Sterling Tube Co. well (table 1 - Bay Co.). Most changes in water levels were the result of increased precipitation as very little pumping from the ground-water aquifer is occurring. The artesian water surface is just below or slightly above land surface in the area (table 1).

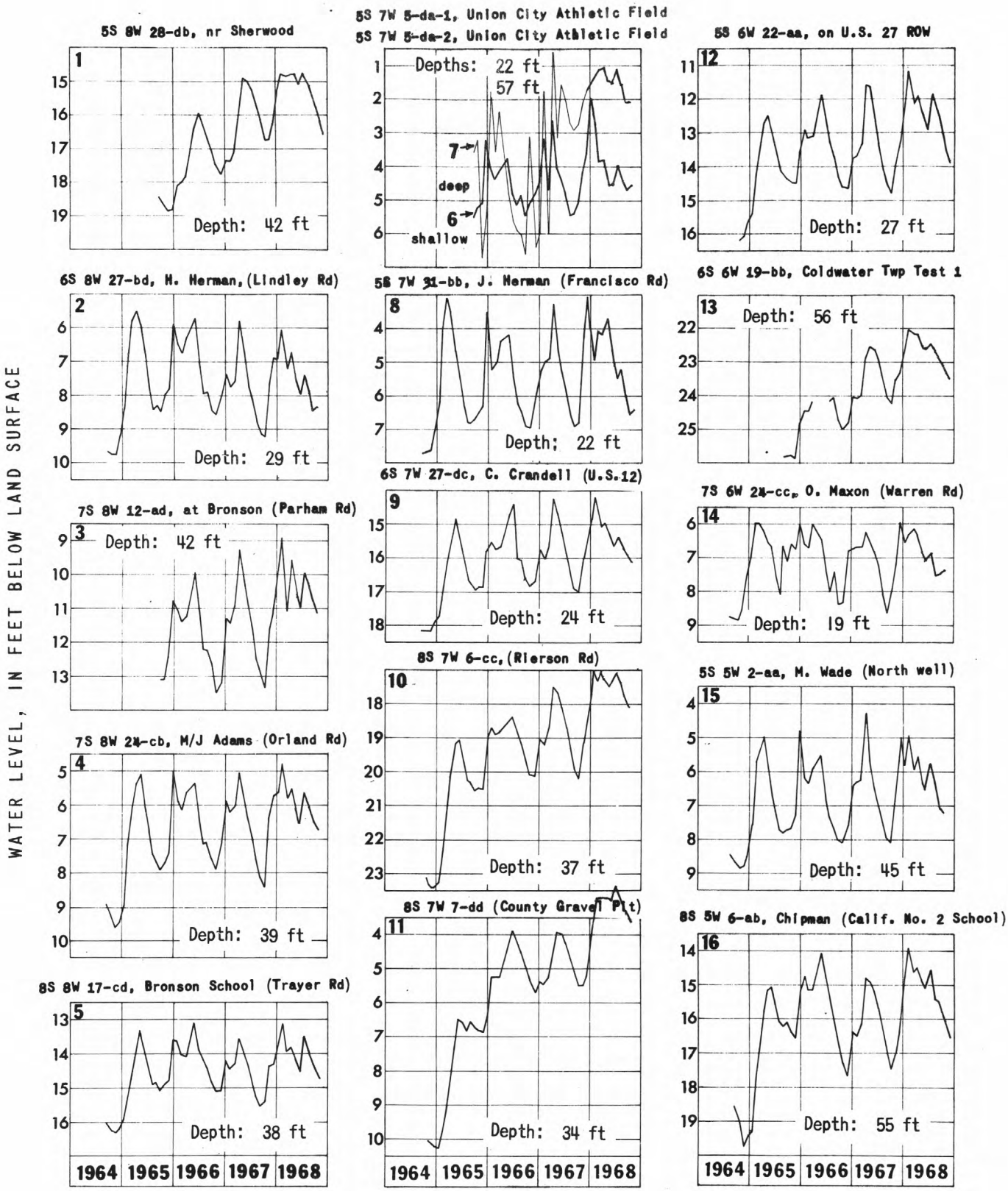


Figure 9.--In 1968, 9 of these 16 observation wells, located in Branch County had record high levels for 1964-68 period. Above-normal precipitation (fig. 10) was the principal reason for the higher levels.

BRANCH COUNTY

In 1968, water levels in 16 observation wells finished in glacial drift were measured monthly until October when the number was reduced to 5. The reduction was made because sufficient record had been accumulated so that observation at a few key wells would permit adequate monitoring of ground-water levels. This allows more time in a continuing program, to measure other water-resource elements, such as the chemical and physical quality of lakes and ground water.

Many new highs of ground-water levels were observed in 1968 (fig. 9) as the result of above-normal precipitation (fig. 10). Fluctuations of ground-water levels are closely related to precipitation departures.

The 16 wells are distributed throughout the county and respond principally to natural conditions (fig. 11). However, wells 3, 6, and 7 are near municipal wells and their water levels are affected by the nearby pumping.

For additional information see report "Water Resources of Branch County, Michigan."

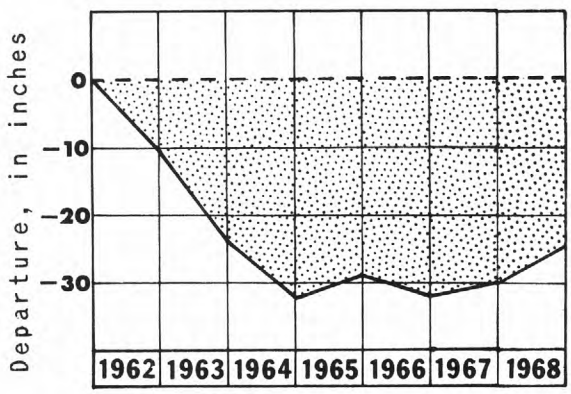


Figure 10.--Cumulative departure of precipitation from normal, at Coldwater.

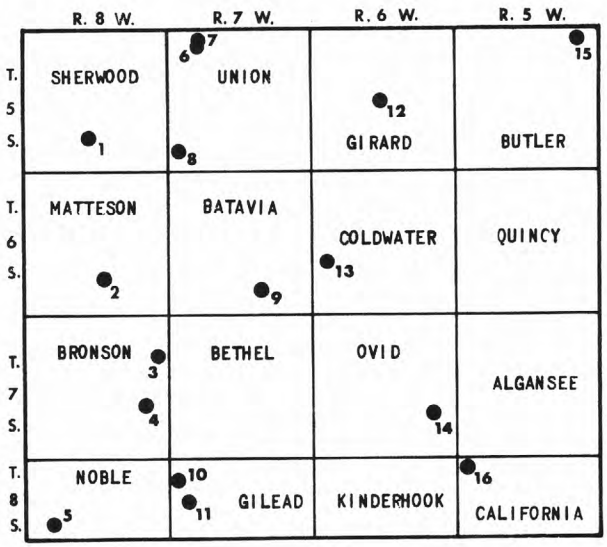


Figure 11.--Location of observation wells in Branch County.

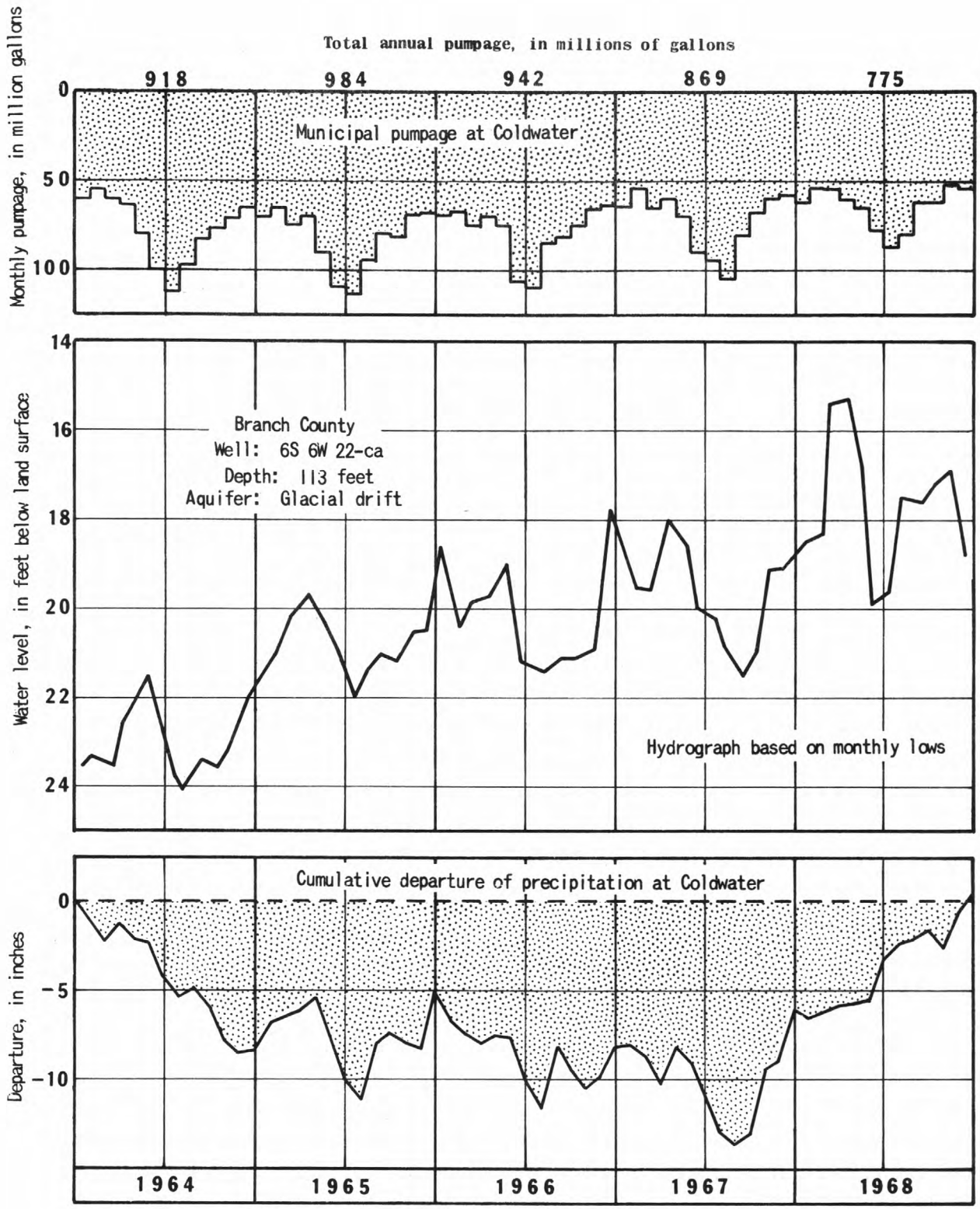


Figure 12.--At Coldwater, water levels in the observation well at the municipal well field, reflect precipitation trends and pumpage.

Several years of dry weather had resulted in low levels by 1964.

BRANCH COUNTY - CITY OF COLDWATER

WATER SUPPLY AND SOURCE -- Four wells, 121 to 132 feet deep, finished in glacial drift.

YIELD OF WELLS (in gallons per minute) -- No. 3 - 1,200; no. 4 - 1,400; no. 5 - 2,250; no. 6 - 2,850.

SPECIFIC CAPACITY OF WELLS (in gallons per minute per ft of drawdown) -- No. 3 - 80; no. 4 - 160; no. 5 - 150; no. 6 - 190.

PUMPAGE IN 1968 -- 775.1 million gallons.

MAXIMUM DAY -- 4.21 million gallons.

STORAGE FACILITIES -- 1,500,000 gallons elevated.

QUALITY OF WATER -- Hardness 175-310 ppm
Iron 0.3-1.5 ppm

TREATMENT -- None.

POPULATION SERVED -- 9,000 estimated.

PER CAPITA USE -- 236 gallons per day.

REMARKS -- A deficiency of about 30 inches of precipitation in the 1962-64 period (fig. 10) had resulted in low water levels in the observation well (fig. 12). However, since then, precipitation and water levels have increased. Part of the recovery of water levels in the aquifer is the result of decreased municipal pumpage which was a record 984 million gallons in 1965.

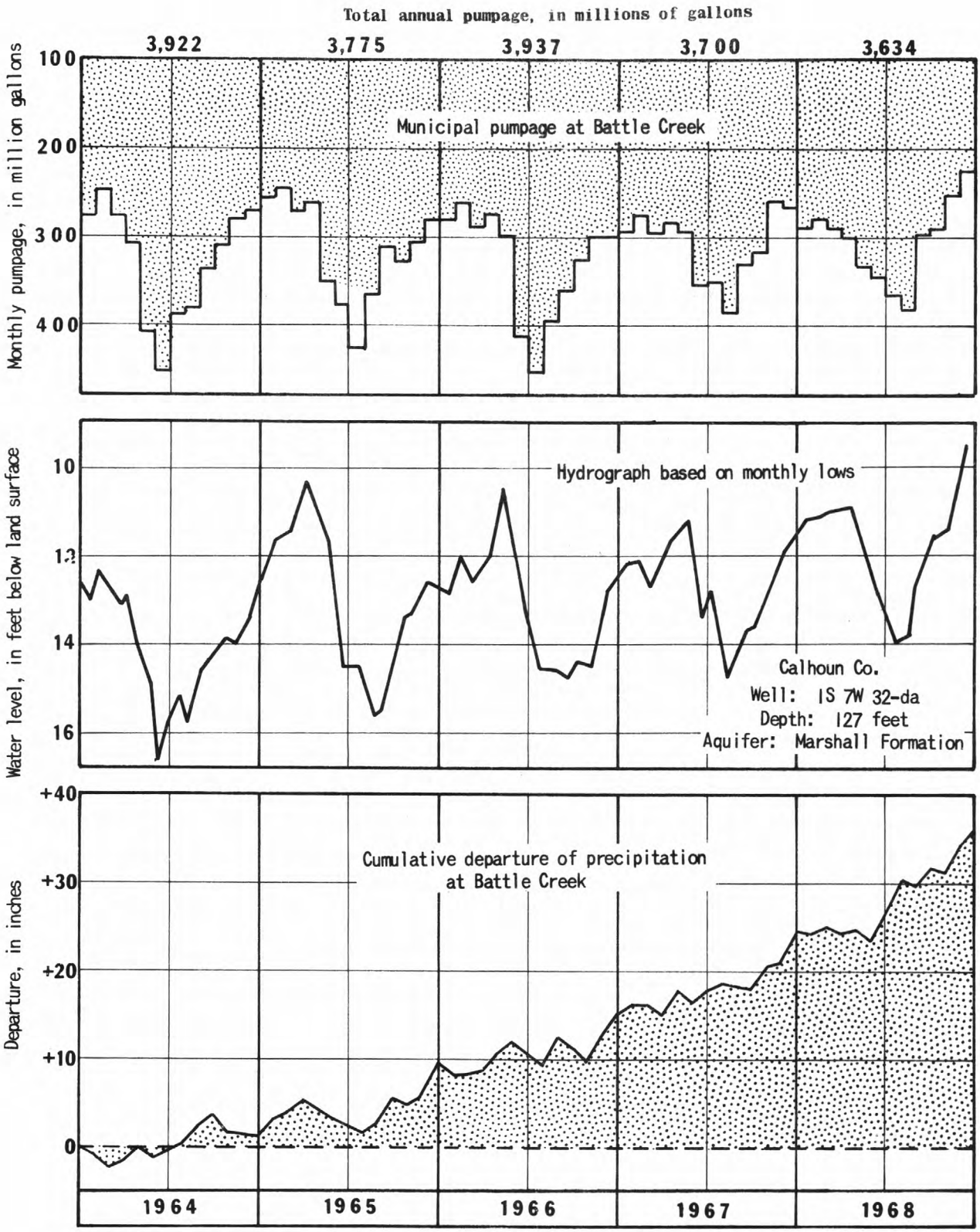


Figure 13.--At Battle Creek, water levels in the observation well are trending upwards as the result of above-normal precipitation, despite heavy municipal withdrawals of water.

Since 1963, the cumulative departure of precipitation has been 36 inches above normal.

CALHOUN COUNTY - CITY OF BATTLE CREEK

WATER SUPPLY AND SOURCE -- About 29 wells, 120 to 160 feet deep. All are located at the Verona Field and tap sandstones of the Marshall Formation.

YIELD OF WELLS (in gallons per minute) -- 300 to 1,000.

SPECIFIC CAPACITY OF WELLS (in gallons per minute per ft of drawdown) -- 50 to 650.

PUMPAGE IN 1968 -- 3,664 million gallons.
MAXIMUM DAY -- 17.40 million gallons.

STORAGE FACILITIES -- 2,000,000 gallons at plant; and 4,000,000 gallons elevated.

QUALITY OF WATER -- Composites of Verona wells -- Hardness 240-285 ppm
Iron 0.05-5.0 ppm

TREATMENT -- Chlorination, fluoridation, hexamethaphosphate.

POPULATION SERVED -- 44,169.
PER CAPITA USE -- 227 gallons per day.

REMARKS -- Water levels in the observation well indicate a rising trend in the annual lows since 1964 (fig. 13). The rising levels are principally the result of increased precipitation which had an accumulated excess of about 36 inches during the 1964-68 period. The range of water levels in the 1939-68 period (table 1) has been from 0.7 ft to 16.8 ft below land surface in April, 1950 and July, 1959, respectively.

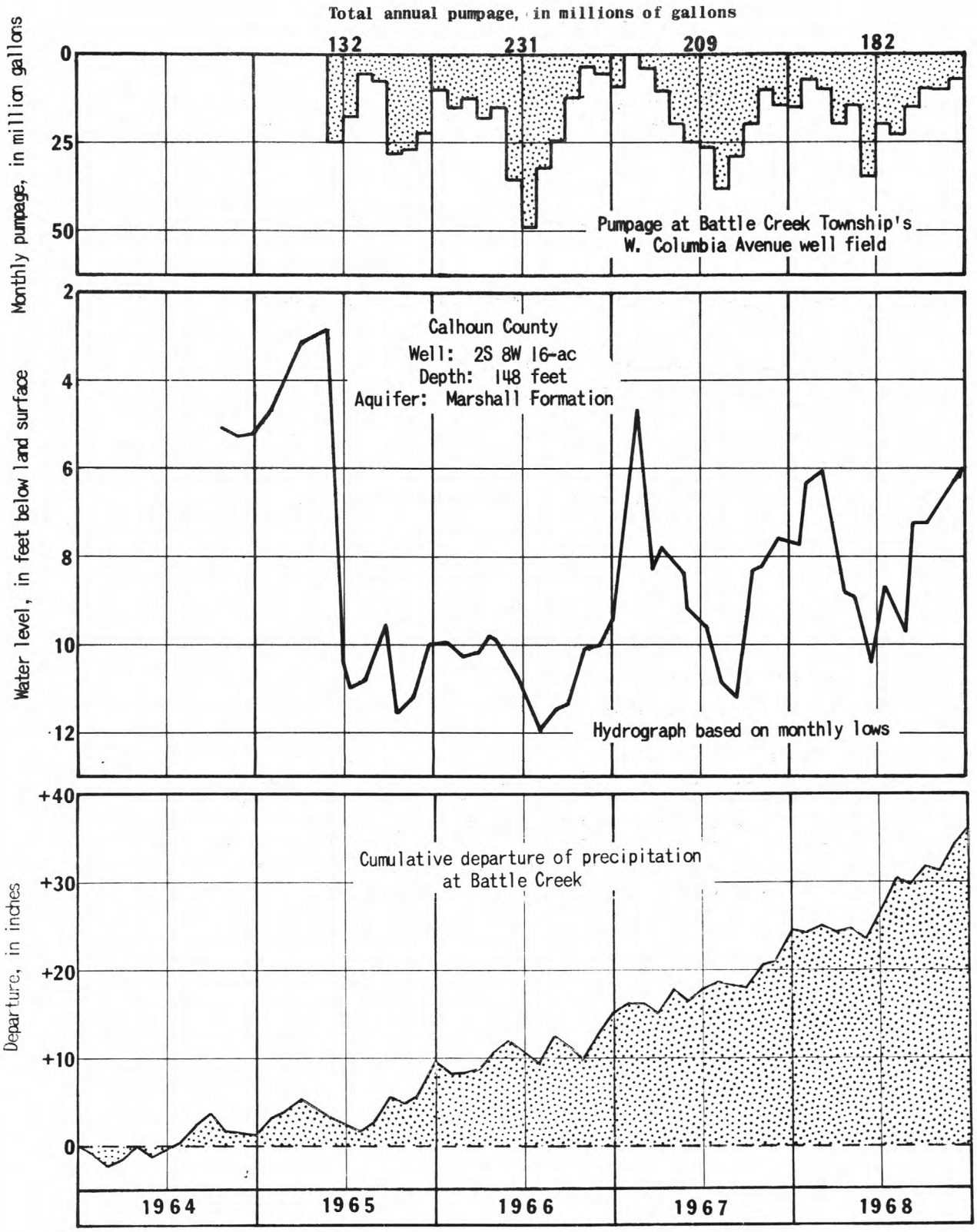


Figure 14.--At Battle Creek Township, water levels have remained high principally as the result of above-normal precipitation.

CALHOUN COUNTY - BATTLE CREEK TOWNSHIP

WATER SUPPLY AND SOURCE -- Six wells 143 to 165 feet deep, tap sandstones of the Marshall Formation.

YIELD OF WELLS (in gallons per minute) -- 950 to 1,200.

SPECIFIC CAPACITY OF WELLS (in gallons per minute per ft of drawdown) -- 10 to 20.

PUMPAGE IN 1968 -- 497 million gallons.
MAXIMUM DAY -- 3.90 million gallons.

STORAGE FACILITIES -- 400,000 gallons elevated.

QUALITY OF WATER -- Hardness 270-350 ppm
Iron 0.5-1.2 ppm

TREATMENT -- Chlorination.

POPULATION SERVED -- 13,500 estimated.

PER CAPITA USE -- 227 gallons per day.

REMARKS -- Prior to the start of pumping in June 1965 a continuous recorder was installed on a test well at the W. Columbia Avenue well field to determine the natural water level conditions, and the trend in water levels due to subsequent pumping. Despite the pumpage, water levels have trended upwards after an initial decline, probably the result of above-normal precipitation since 1964 (fig. 14).

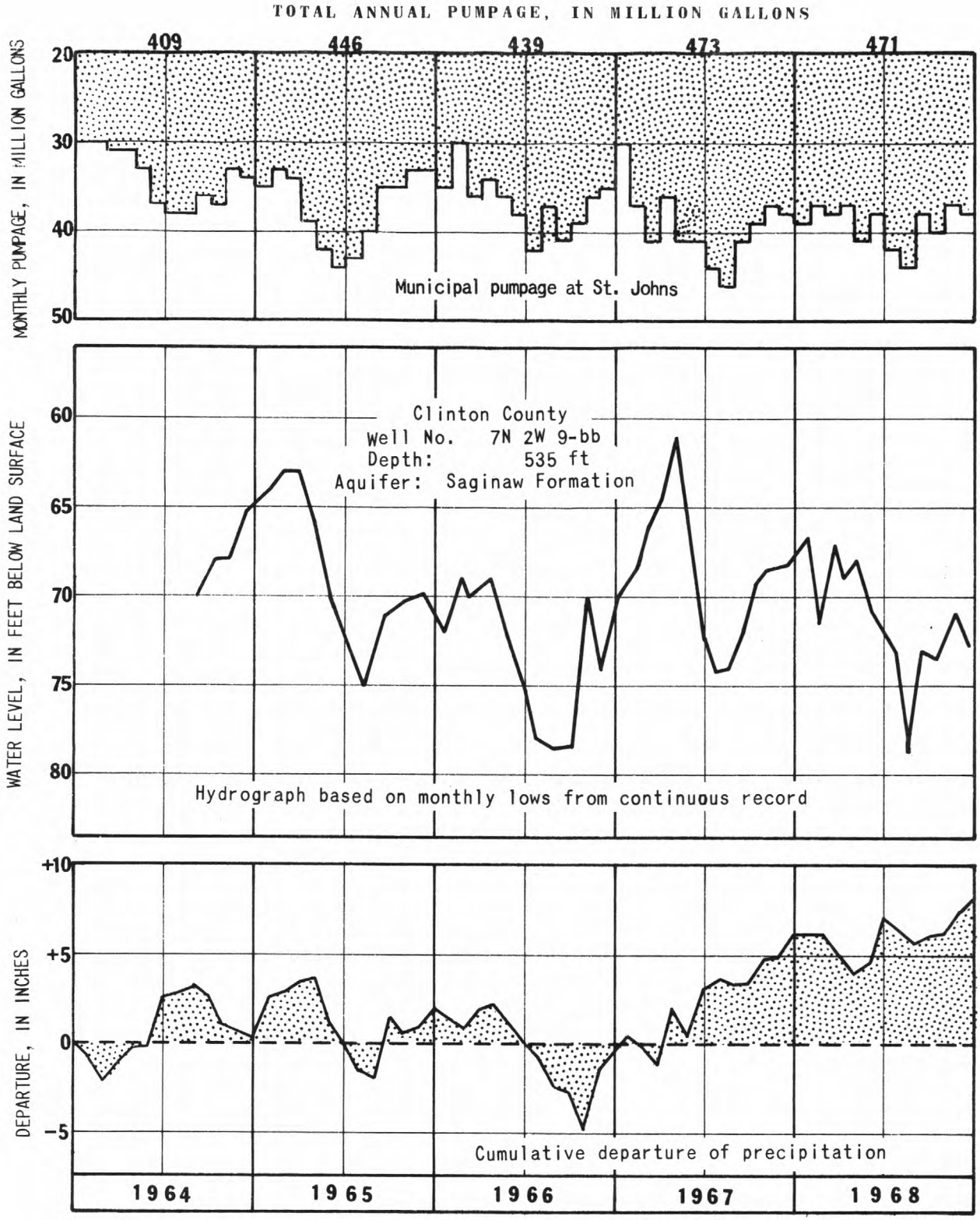


Figure 15.--At St. Johns, water levels in the observation well fell to a new low of record in 1968, as the result of increased pumping and despite increased precipitation.

CLINTON COUNTY - CITY OF ST. JOHNS

WATER SUPPLY AND SOURCE -- Seven wells, about 500 feet deep, tapping sandstones of the Saginaw Formation.

YIELD OF WELLS (in gallons per minute) -- Reportedly average 600 to 900.

SPECIFIC CAPACITY OF WELLS (in gallons per minute per ft of drawdown) -- 3 to 5.

PUMPAGE IN 1968 -- 471 million gallons.

MAXIMUM DAY -- 1.78 million gallons.

STORAGE FACILITIES -- 600,000 gallons elevated and 400,000 gallons ground storage.

QUALITY OF WATER --

Hardness	340-359 ppm
Iron	0.2-1.8 ppm
Chlorides	10-80 ppm

TREATMENT -- None.

POPULATION SERVED -- 6,000 estimated.

PER CAPITA USE -- 215 gallons per day.

REMARKS -- In August, 1968, water levels in the observation well fell to a new low for the 5-year record (fig. 15). The levels during 1968 were lower despite increased precipitation. Although the municipal wells yield 600 to 900 gallons per minute the specific capacity is low; as a result large daily fluctuations of water levels occur in the observation well from municipal pumping about a half mile away.

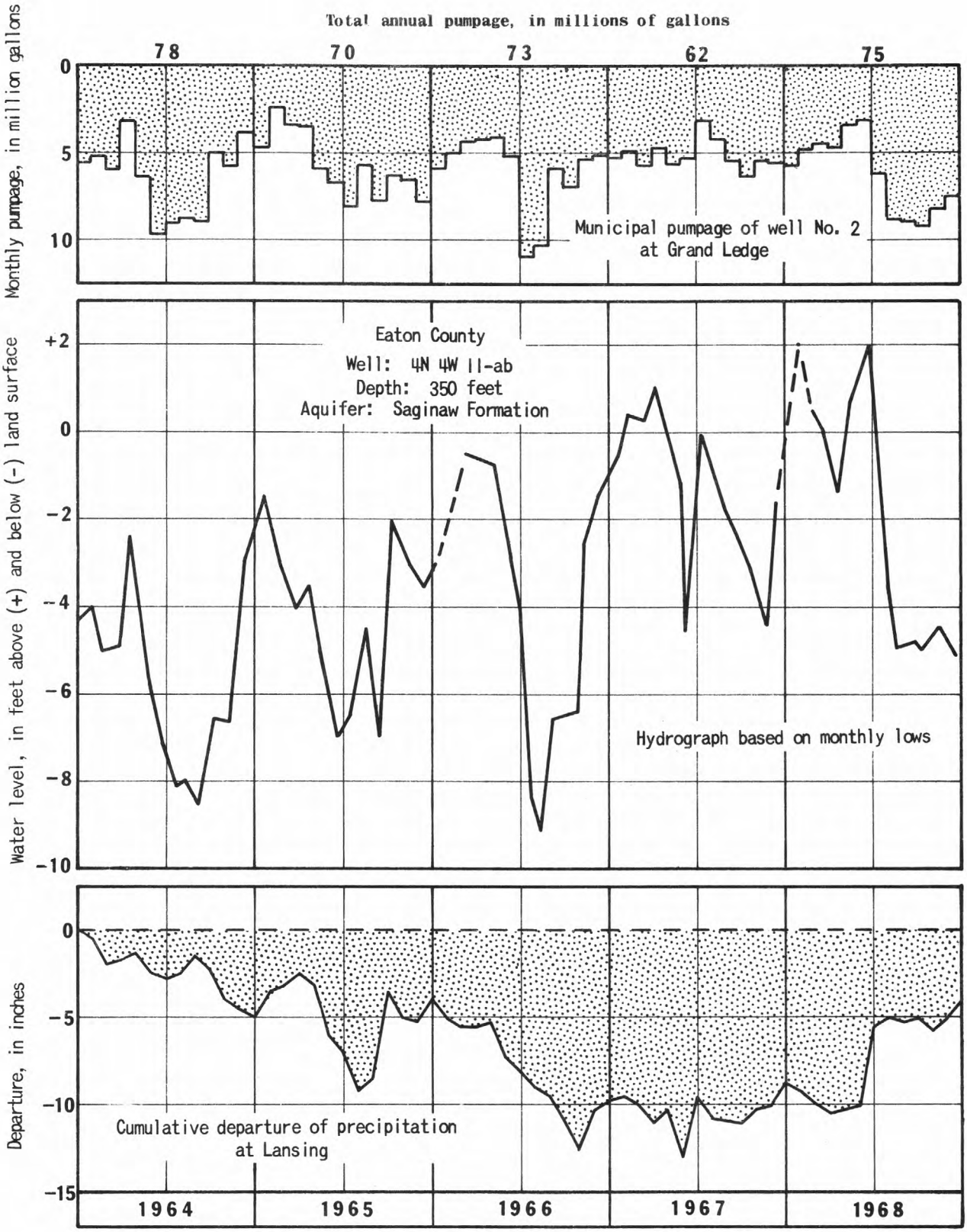


Figure 16.--Water levels in the observation well at Grand Ledge were at higher average levels in the 1967-68 period, as precipitation increased. Heavier pumping from Municipal Well No. 2, in the latter part of 1968, however, resulted in a sharp decline.

EATON COUNTY - CITY OF GRAND LEDGE

WATER SUPPLY AND SOURCE -- Three wells, nos. 2, 3, and 4, ranging from 241-400 feet in depth, in sandstones of the Saginaw Formation.

YIELD OF WELLS (in gallons per minute) -- 300-525.

SPECIFIC CAPACITY OF WELLS (in gallons per minute per ft of drawdown) -- 3.5 - 10.

PUMPAGE IN 1968 -- 175 million gallons.
MAXIMUM DAY -- 983 thousand 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 -- Per capita use -- 93 gallons per day.

REMARKS -- Water levels in the Park observation well (fig. 16) were among the highest of record early in the year but fell considerably when pumpage in the municipal well increased in the latter part of 1968. However, year-end levels were several feet higher than in August 1966, the low of record.

In 1968 a new high for the record since 1949 was observed at the "Chair Factory" well (table 1). Precipitation of about 5 inches above normal in 1968 contributed to the higher levels.

EATON COUNTY
DELTA CHARTER TOWNSHIP WATER SYSTEM (not illustrated)

WATER SUPPLY AND SOURCE -- Five wells, 370 to 450 feet deep tapping the Saginaw Formation.

YIELD OF WELLS (in gallons per minute) -- 300-360.

SPECIFIC CAPACITY OF WELLS (in gallons per minute per ft of drawdown) --

PUMPAGE IN 1968 -- Not available in 1968 (1967 estimated pumpage was 165 million gallons).

MAXIMUM DAY --

STORAGE FACILITIES -- 500,000 gallons elevated.

QUALITY OF WATER --

Hardness	260-365 ppm
Iron	0.4-0.6 ppm
Chlorides	0-5 ppm
Fluorides	0.2-0.3 ppm

TREATMENT -- Chlorination and phosphate.

POPULATION SERVED -- 8,000 estimated.

PER CAPITA USE --

REMARKS -- In 1968 a new well yielding about 600 gpm was added to the system.

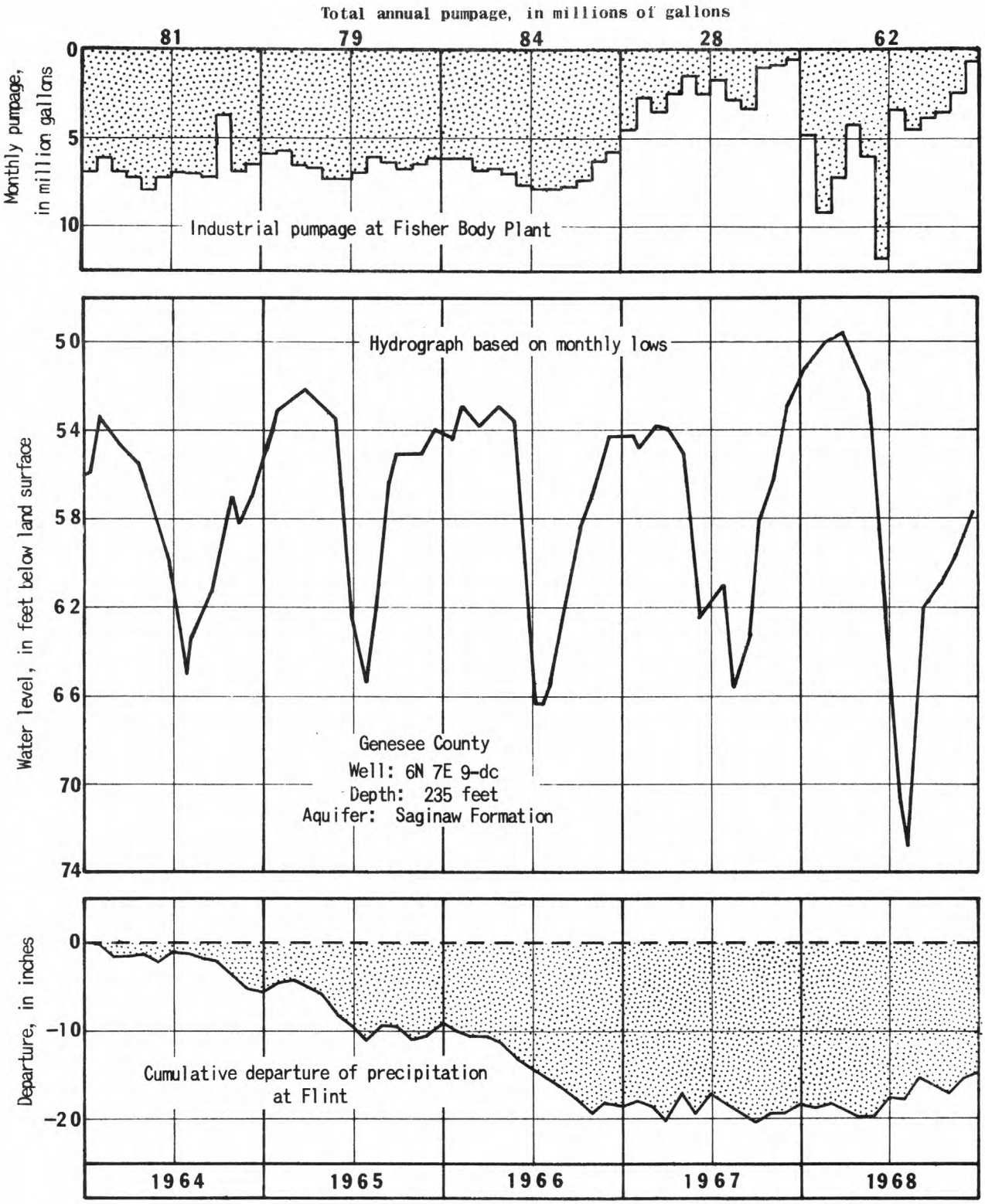


Figure 17.--At Fisher Body's well field near Grand Blanc, water levels, in 1968, fell to record lows for the 17-year period of record.

The record lows resulted when the City of Grand Blanc began using the Plant's wells both to supply Fisher Body and for its municipal supply.

GENESEE COUNTY
FISHER BODY, GMC, AT GRAND BLANC

WATER SUPPLY AND SOURCE -- Four wells, 200-275 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 ft of drawdown) -- 3-1/2 to 6-2/3.

PUMPAGE IN 1968 -- 62 million gallons.

MAXIMUM DAY --

STORAGE FACILITIES -- Ground and elevated: 100,000 plant
650,000 fire protection

QUALITY OF WATER -- Phosphate and chlorination.

TREATMENT --

POPULATION SERVED --

PER CAPITA USE --

REMARKS -- In mid-1968, water levels in the observation well fell to about 6 feet below the previous low of record (fig. 17). The City of Grand Blanc has been using plant wells nos. 2 and 3, and in 1968 pumped a record 55 million gallons from the plant site. As a result water levels fell to new lows for the 17-year record.

Although the nearby plant wells have the greatest effect on the water levels in the observation well, many new heavily pumped municipal and subdivision wells are located within a mile or two and are affecting the observed water levels. It has been reported that several private wells in the general area have gone "dry"--probably as the result of insufficient depth of the well or setting of the drop pipes.

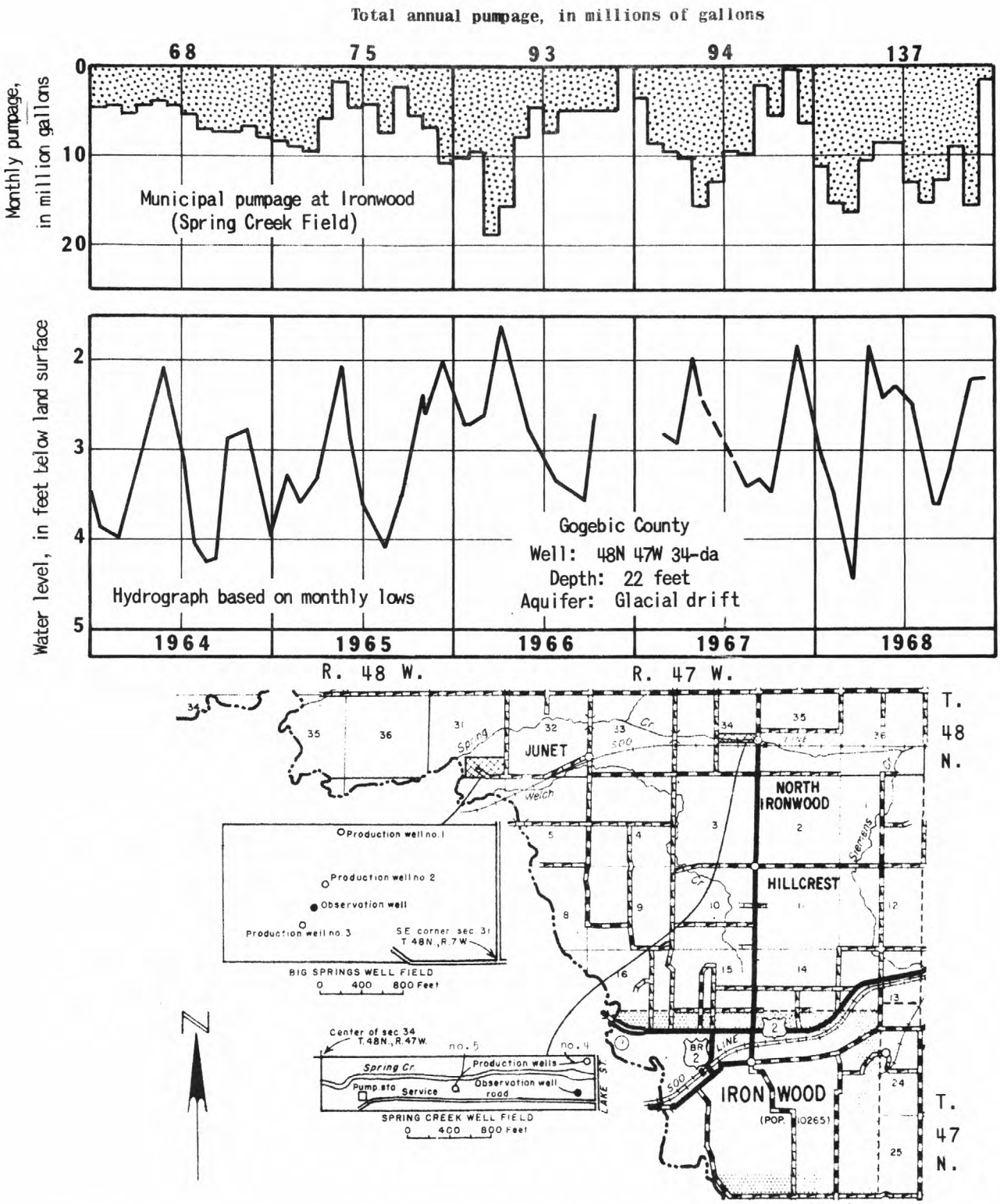


Figure 18.--At Ironwood's Spring Creek well field, water levels in the observation well remained high in 1968, despite a large increase in pumping.

WATER SUPPLY AND SOURCE -- Five wells, 41 to 118 feet deep, finished in glacial drift at Spring Creek and Big Springs field 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 inches in diameter and nos. 2 and 5 are 12 inches.

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 ft of drawdown) -- No. 1 - 47; no. 3 - 21; no. 4 - 6; no. 5 - 27.

PUMPAGE IN 1968 -- 451 million gallons.

MAXIMUM DAY -- 1.85 million gallons.

STORAGE FACILITIES -- 1,000,000 gallons ground level, and 2,500,000 gallons elevated.

QUALITY OF WATER --

Hardness	63-186 ppm
Iron	0.0-0.1 ppm
Chloride	4-63 ppm

TREATMENT -- Chlorination.

POPULATION SERVED -- 11,500 estimated.

PER CAPITA USE -- 107 gallons per day.

REMARKS -- Water levels in the observation well at the Spring Creek field fluctuate in a narrow range of from about land surface to 5 feet below land surface (table 1, Gogebic Co.). Although pumping at Spring Creek field has increased from 55 million gallons in 1963 to 137 mg in 1968, water levels remain high in the observation well (fig. 18).

Water levels in the Big Spring field observation well, however, have fluctuated in a r ange of from about 12 to 33 feet below land surface. At this field pumping has not greatly increased but greater drawdowns occur (fig. 19) than at the Spring Creek field.

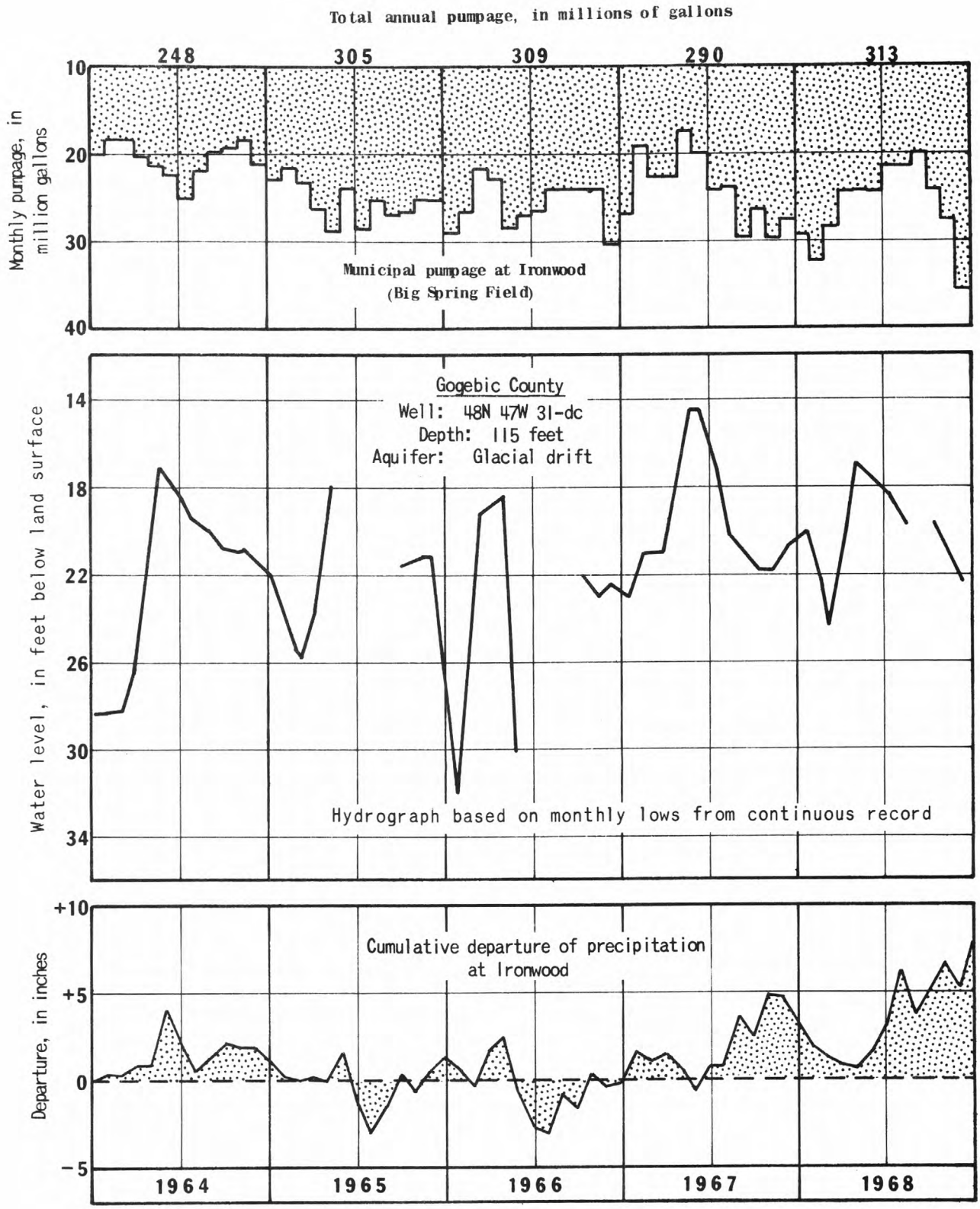


Figure 19.--At Ironwood's Big Spring well field, water levels in the observation well were higher in the 1967-68 period than in 1966, principally as the result of increased precipitation, as pumpage did not increase.

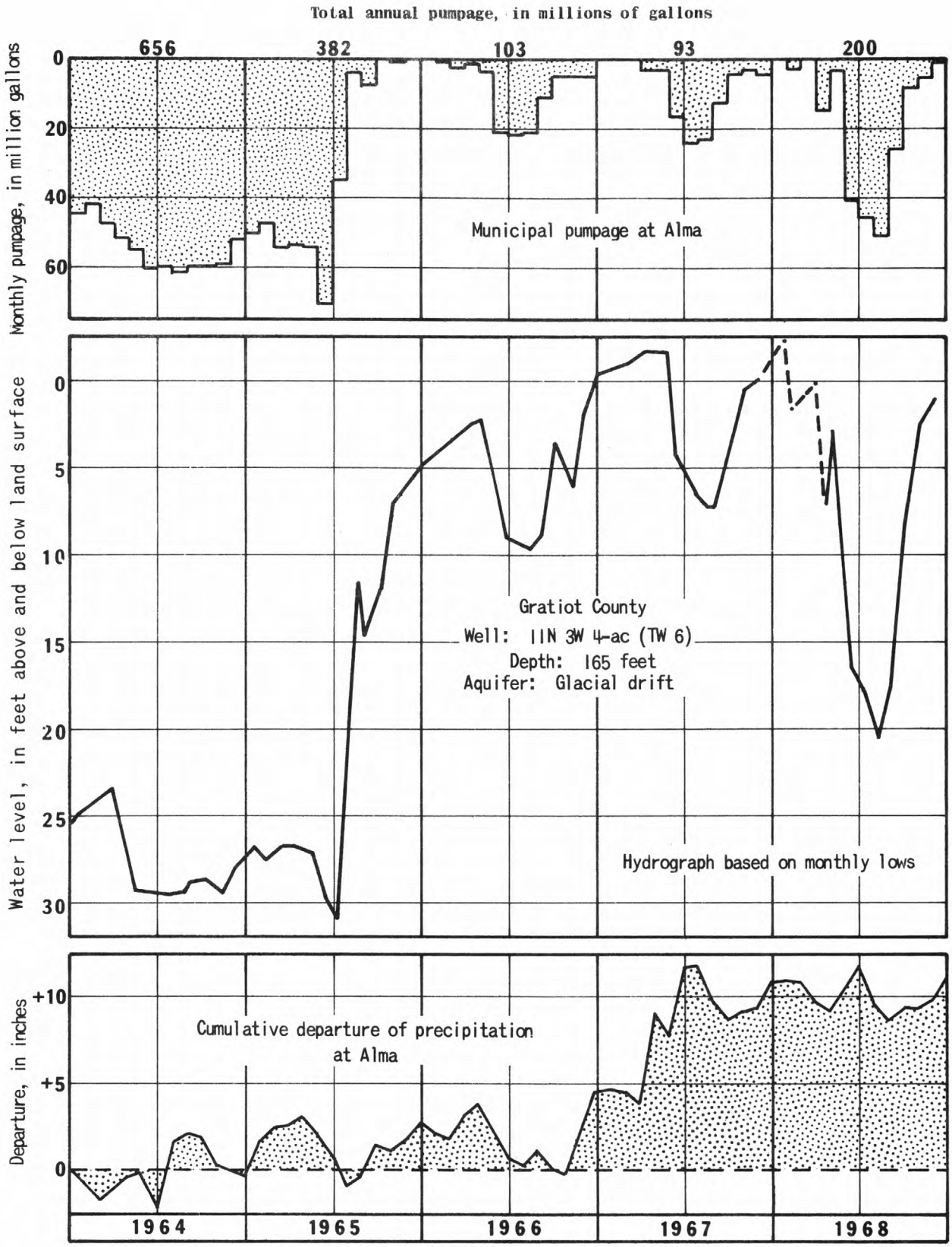


Figure 20.--At Alma, water levels in 1968, declined sharply when pumpage increased.

This was the first year that ground water was used to lower temperatures of Pine River water that is Alma's main source of supply.

GRATIOT COUNTY - CITY OF ALMA

WATER SUPPLY AND SOURCE -- Five wells, 82 to 155 feet deep, tapping buried outwash deposits of glacial drift. Standby well, 550 feet deep, tapping sandstone of the Saginaw Formation. Since 1965, most water for municipal use has been obtained from the Pine River.

YIELD OF WELLS (in gallons per minute) -- 175 - 875.

SPECIFIC CAPACITY OF WELLS (in gallons per minute per ft of drawdown) -- Glacial drift 12-25; Saginaw Formation - 2½.

PUMPAGE IN 1968 -- 200 million gallons, also 558 mg of river water. Total 758 mg.

MAXIMUM DAY -- 2.39 million gallons.

STORAGE FACILITIES -- 1,000,000 gallons ground level for treated water, 500,000 gallons elevated for treated water; 200,000 gallons on industrial water.

QUALITY OF WATER --

Drift:		Saginaw:	
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 for ground water.

POPULATION SERVED -- 8,978.

PER CAPITA USE -- 231 gallons per day (includes surface water).

REMARKS -- Water levels in the observation well rose to a new high of record early in the year but fell to the lowest since 1965 in mid-summer when pumpage increased (fig. 20). Since July 1965, the city has been using water from the Pine River for its principal supply with water from wells used to supply most industrial demands. In 1968, however, ground water was added during the warmer months to the Pine River supply to lower temperatures of the river water.

A few wells, including observation wells, in Alma have had small flows when municipal pumping is stopped.

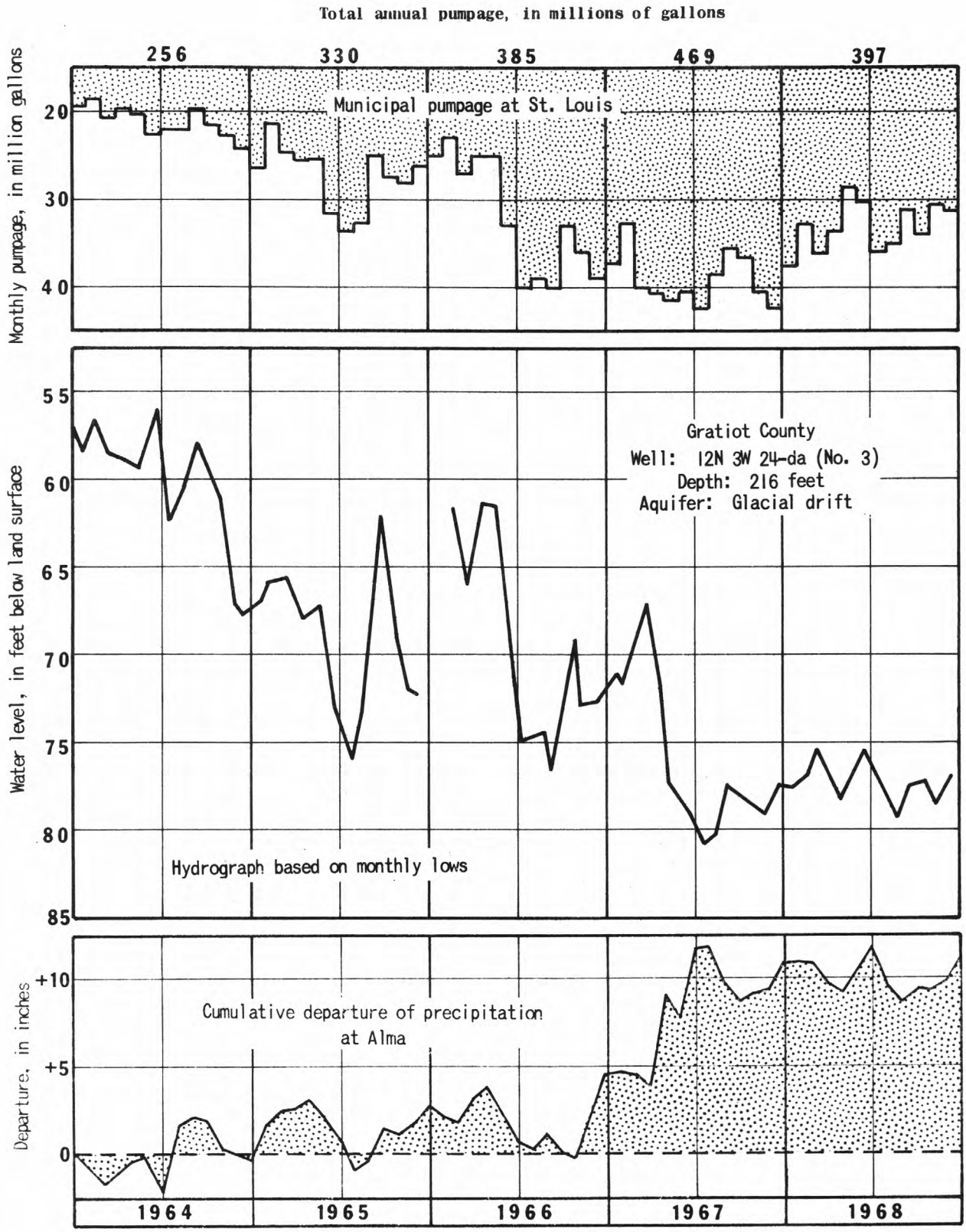


Figure 21.--At St. Louis, the declining trend in water levels in the observation well was halted in 1968. Pumpage decreased and precipitation in the 1967-68 period was above average.

GRATIOT COUNTY - CITY OF ST. LOUIS

WATER SUPPLY AND SOURCE -- Six wells, 136 to 223 feet deep, tapping buried outwash deposits of the glacial drift.

YIELD OF WELLS (in gallons per minute) -- No. 1 - 400; no. 2 - 550; no. 4 - 400; no. 5 - 360; no. 6 - 350; no. 7 - 400.

SPECIFIC CAPACITY OF WELLS (in gallons per minute per ft of drawdown) -- No. 1 - 11; no. 2 - 15; no. 4 - 10; no. 5 - 13; no. 6 - 8.

PUMPAGE IN 1968 -- 397 million gallons.

MAXIMUM DAY -- 1.89 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 -- 4,500 estimated.

PER CAPITA USE -- 242 gallons per day.

REMARKS -- Mid-summer water levels in the observation well were slightly higher in 1968 (fig. 21), principally a result of decreased municipal withdrawals, as precipitation for 1968 was about normal. Levels in the observation well had shown a declining trend since 1962.

INGHAM COUNTY
CITY OF EAST LANSING (not illustrated)

WATER SUPPLY AND SOURCE -- Eight wells, 385 to 400 feet deep, tapping sandstones of the Saginaw Formation.

YIELD OF WELLS (in gallons per minute) -- 275 to 900.

SPECIFIC CAPACITY OF WELLS (in gallons per minute per ft of drawdown) -- 3 to 11.

PUMPAGE IN 1968 -- 1,223 million gallons.
MAXIMUM DAY -- 5.11 million gallons.

STORAGE FACILITIES --525,000 gallons elevated, 1,000,000 ground storage.

QUALITY OF WATER --

Hardness	325-565 ppm
Iron	0.8-5.0 ppm
Chloride	3-34 ppm

TREATMENT -- Chlorination, softening and iron removal, fluoride, phosphate.

POPULATION SERVED -- 30,208.
PER CAPITA USE -- 111 gallons per day.

REMARKS -- Levels in well 4N 1W 18-ad fell to a new record low in 1968 (Ingham Co., table 1) as a result of increased pumpage. The record low was about 37 feet below 1953 levels and a decline of 6 feet from last year's record low. Water levels in the observation well have declined an average of about 2 feet a year since 1953. About 10 percent of the water pumped is furnished to Meridian Townships east side.

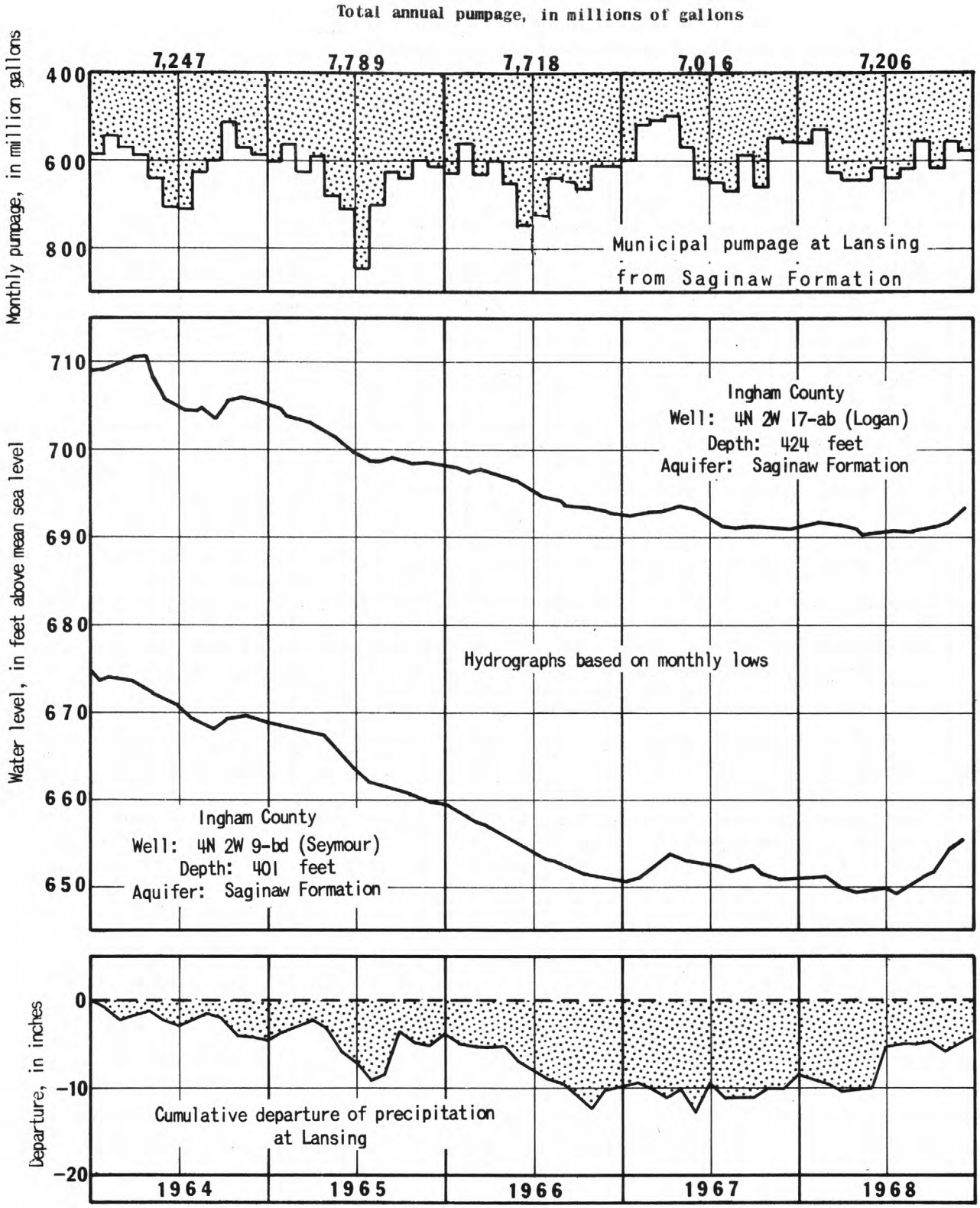


Figure 22.--The declining trend of water levels in these observation wells in Lansing was halted in the 1967-68 period, when pumpage from the Saginaw Formation decreased and precipitation was above normal.

INGHAM COUNTY - CITY OF LANSING

WATER SUPPLY AND SOURCE -- 115 wells, 400-425 feet deep, tapping sandstones of the Saginaw Formation. Two wells, 50 to 60 feet deep are finished in glacial drift, but are seldom used. Three wells, 85 to 105 feet deep, finished in glacial drift are located at Stiefel Field.

YIELD OF WELLS (in gallons per minute) -- 100 to 700 (sandstone).
790 to 1200 (glacial drift).

SPECIFIC CAPACITY OF WELLS (in gallons per minute per ft of drawdown) -- 3 to 10 reported for rock wells, 12 to 80 for glacial drift wells.

PUMPAGE IN 1968 -- 8,256 million gallons.
MAXIMUM DAY -- 35.95 million gallons.

STORAGE FACILITIES -- Ground storage of 22,000,000 gallons.

QUALITY OF WATER --		Saginaw sandstone	Glacial drift
Treated:	Hardness	85 ppm	85 ppm
Raw:	Hardness	200-600 ppm	348 ppm
	Iron	0.03-4.0 ppm	0.0 ppm

TREATMENT -- Fluoridation, chlorination, lime-soda ash softening, iron removal, polyphosphate, sedimentation, coagulation, filtration, and taste and odor control.

POPULATION SERVED -- 31,000 estimated.

PER CAPITA USE -- 171 gallons per day.

REMARKS -- Water levels in the heavily pumped Lansing area continued to decline through the first half of 1968. Many observation wells had record to near record low levels during the first part of the year (table 1, Clinton, Eaton, and Ingham Counties). However, in the latter part of the year levels rose slightly as the result of above-normal precipitation (figs. 22 and 23). An exception was the continuing decline at the Stiefel Field (fig. 23) as withdrawals from the glacial drift continued to increase.

About 12.7 billion gallons of water was pumped from municipal, industrial and institutional wells in the Lansing area, about a 5 percent increase over 1967.

Distribution of observation wells in the Tri-County area is shown on map (fig. 24).

* About 39 million gallons of the total pumpage was used for water treatment.

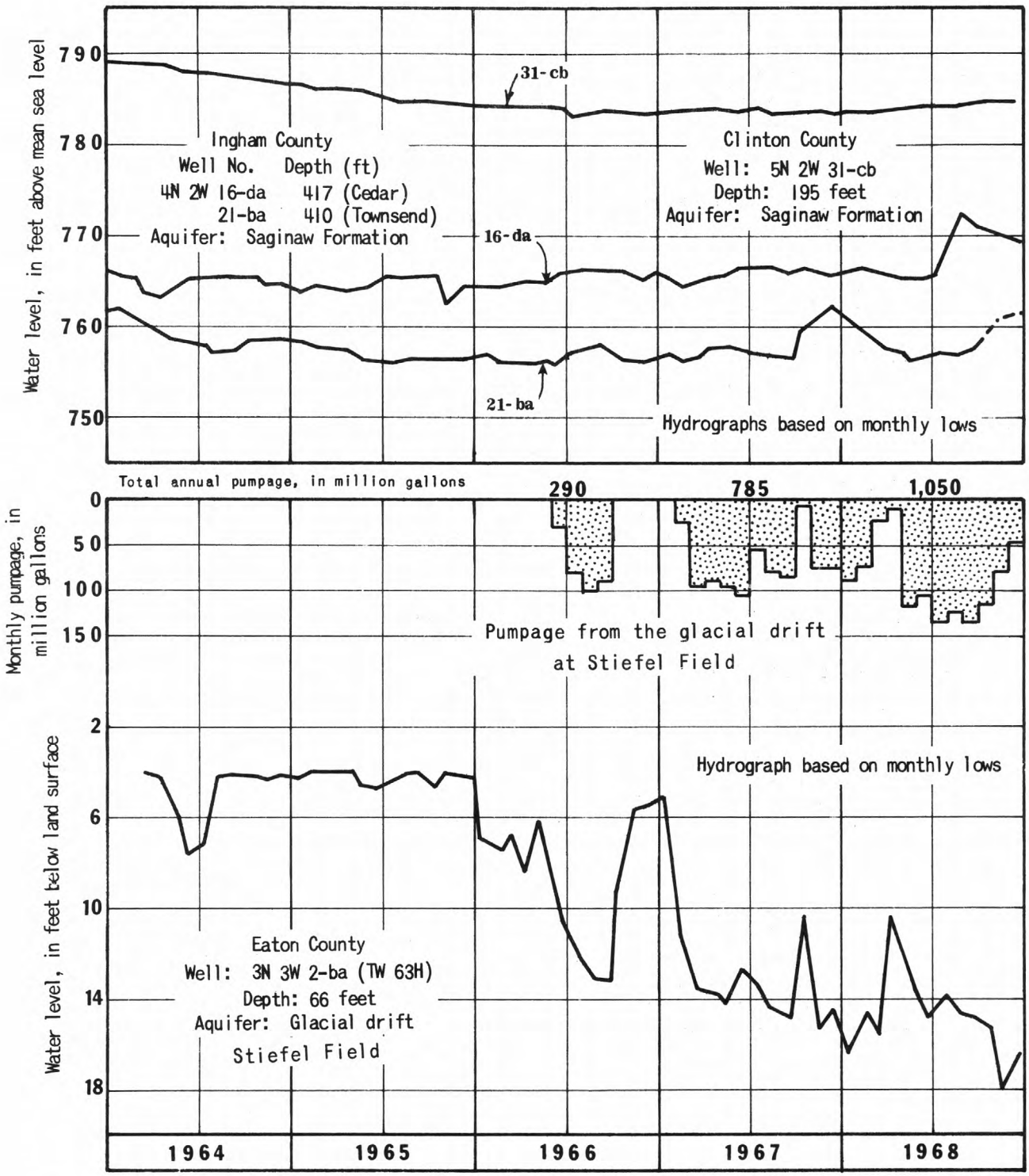
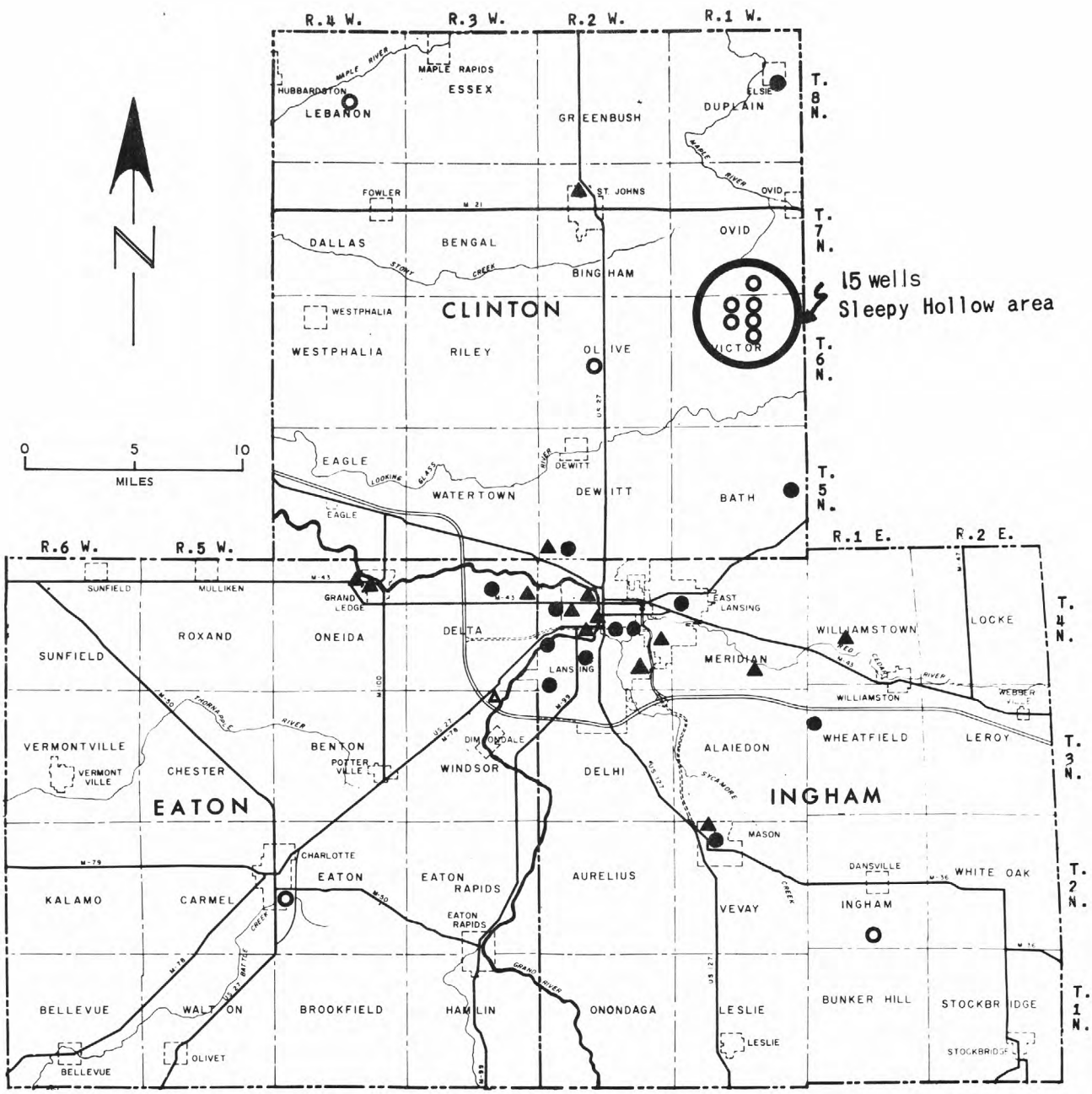


Figure 23.--In the Lansing metropolitan area, the declining trend in water levels in observation wells in the Saginaw Formation, was reversed during the 1967-68 period. A moderate decline of water levels in the glacial drift aquifer at the Stiefel Field continued as pumpage from that field continued to increase.



Sites where ground-water level data are obtained

EXPLANATION

- ▲ **Continuous recording gage (bedrock)**
- △ **(glacial drift)**
- ● **Periodic measurement (bedrock)**
- ○ **(glacial drift)**

Figure 24.--Wells in bedrock and glacial drift aquifers are used to observe both natural conditions and the effects of heavy pumping on water in storage in the aquifers.

A 4-year study of the Tri-County area was completed in 1969. The wells in the Sleepy Hollow area are monitored to observe water levels in the glacial drift prior to a proposed impoundment of water to create an artificial lake.

INGHAM COUNTY
LANSING TOWNSHIP (not illustrated)

WATER SUPPLY AND SOURCE -- *Seven wells, 399 to 417 feet deep, tapping sandstones of the Saginaw Formation.

YIELD OF WELLS (in gallons per minute) -- 260 to 500.

SPECIFIC CAPACITY OF WELLS (in gallons per minute per ft of drawdown) -- 2.6 to 8.

PUMPAGE IN 1968 -- 688 million gallons.

MAXIMUM DAY --

STORAGE FACILITIES -- 200,000 gallons elevated.

QUALITY OF WATER --

Hardness	290-350	ppm
Iron	0.4-1.0	ppm
Fluoride	0.4	ppm

TREATMENT -- Chlorination, and phosphate for iron control.

POPULATION SERVED -- 6,100 estimated.

PER CAPITA USE -- 309 gallons per day.

REMARKS -- Water levels in well 4N 3W 12-cd (table 1, Eaton Co.) continued to decline and fell to new record lows in 1968 in response to continued heavy pumpage from municipal and industrial wells. Water levels in this observation well have declined about 32 feet since 1953. An average decline of two feet a year.

* About two thirds of this amount are used by General Motors Forge and Jet Plant for industrial purposes.

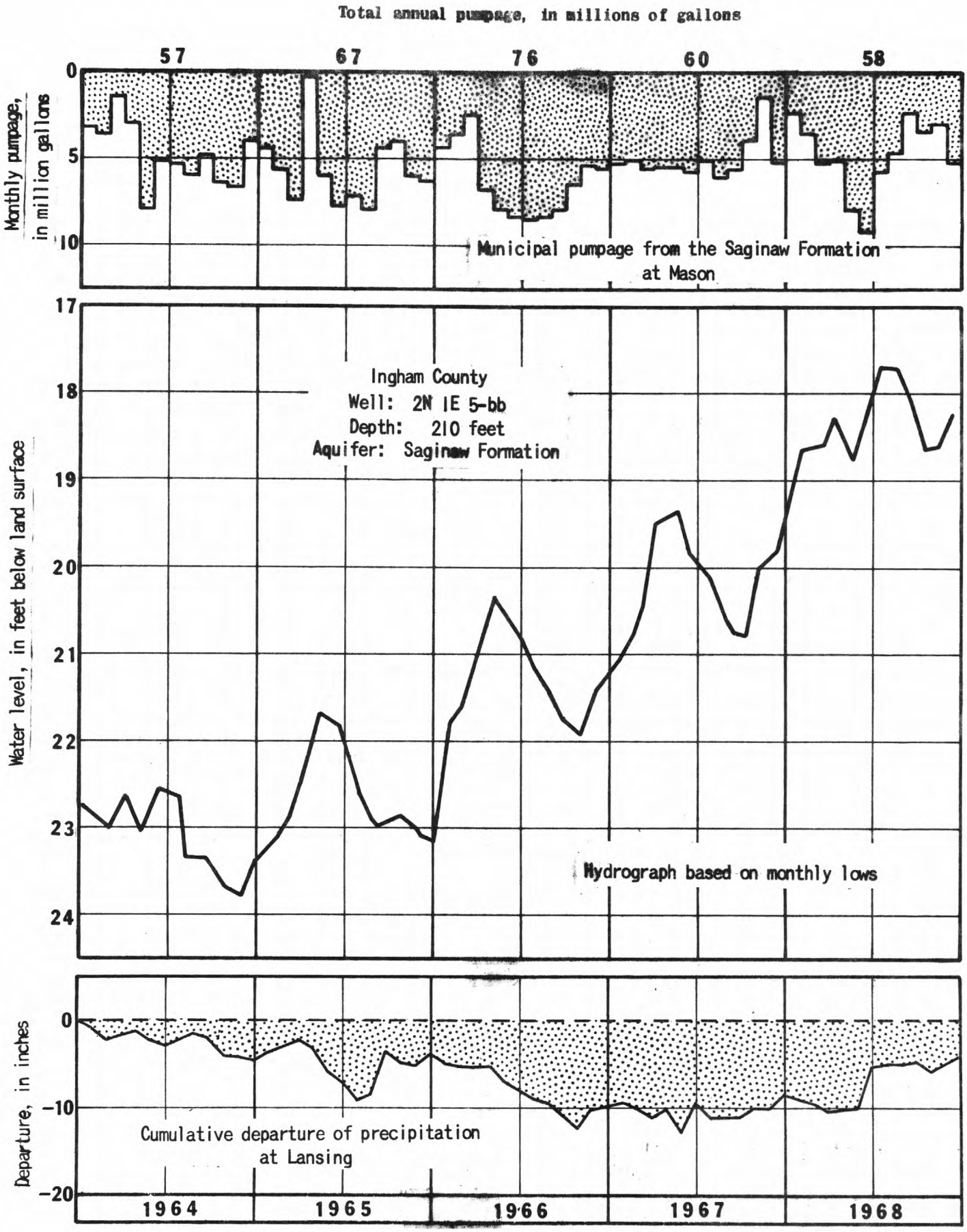


Figure 25.--At Mason, water levels in this observation well have risen about five feet since 1964. The higher levels are principally from a decrease in pumping from the Saginaw Formation and also because of above-normal precipitation.

WATER SUPPLY AND SOURCE -- One well, 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) -- 675-700.

SPECIFIC CAPACITY OF WELLS (in gallons per minute per ft of drawdown) -- No. 3 yields 30 gpm from the glacial drift.

PUMPAGE IN 1968 -- 188 million gallons.

MAXIMUM DAY --

STORAGE FACILITIES -- 360,000 elevated.

QUALITY OF WATER --

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

TREATMENT -- Chlorination and fluoride.

POPULATION SERVED -- 5900 estimated.

PER CAPITA USE -- 87 gallons per day.

REMARKS -- Water levels in the observation well continued to rise for the 4th consecutive year (fig. 25), the result of reduced industrial and municipal pumping and above-normal precipitation.

INGHAM COUNTY
MERIDIAN TOWNSHIP (not illustrated)

WATER SUPPLY AND SOURCE -- Sixteen wells finished in the Saginaw Formation supply water to the township. Wells range in depth from 295 feet to 422 feet. About 100 million gallons of water is purchased from the neighboring city of East Lansing to supply the Township's Water District No. 1.

YIELD OF WELLS (in gallons per minute) -- About 200 to 500.

SPECIFIC CAPACITY OF WELLS (in gallons per minute per ft of drawdown) -- 5 to 25.

PUMPAGE IN 1968 --118 million gallons.

MAXIMUM DAY --

STORAGE FACILITIES -- 580,000 gallons.

QUALITY OF WATER -- Hardness 235-395 ppm
Iron 0.9-4.5 ppm
Fluoride 0.15-0.5 ppm

TREATMENT -- None.

POPULATION SERVED -- 3,050 estimated.

PER CAPITA USE -- 106 gallons per day.

REMARKS -- Use of water has doubled since 1966 in this growing part of the Lansing metropolitan area.

INGHAM COUNTY
MICHIGAN STATE UNIVERSITY (not illustrated)

WATER SUPPLY AND SOURCE -- Sixteen wells, 353-435 feet deep, tapping sandstones of the Saginaw Formation. Two of these wells are on a standby basis only.

YIELD OF WELLS (in gallons per minute) -- 147-654.

SPECIFIC CAPACITY OF WELLS (in gallons per minute per ft of drawdown) -- 1.5 to 11.2.

PUMPAGE IN 1968 -- 2,019 million gallons.
MAXIMUM DAY -- 6.99 million gallons.

STORAGE FACILITIES -- 1,050,000 gallons below-ground storage.

QUALITY OF WATER -- Composite: Average, raw water

Hardness	324 ppm
Iron	0.3 ppm
Fluoride	0.4 ppm

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

POPULATION SERVED -- 40,000 estimated.
PER CAPITA USE -- 138 gallons per day.

REMARKS -- Pumpage of ground water increased in 1968, to a record 2,019 million gallons, an increase of about 7 percent over 1967.

Water levels in observation well 4N 2W 24-ca (Ingham County, table 1) located at Spartan Village fell to a new low for the seventh consecutive year as a result of the increased pumpage.

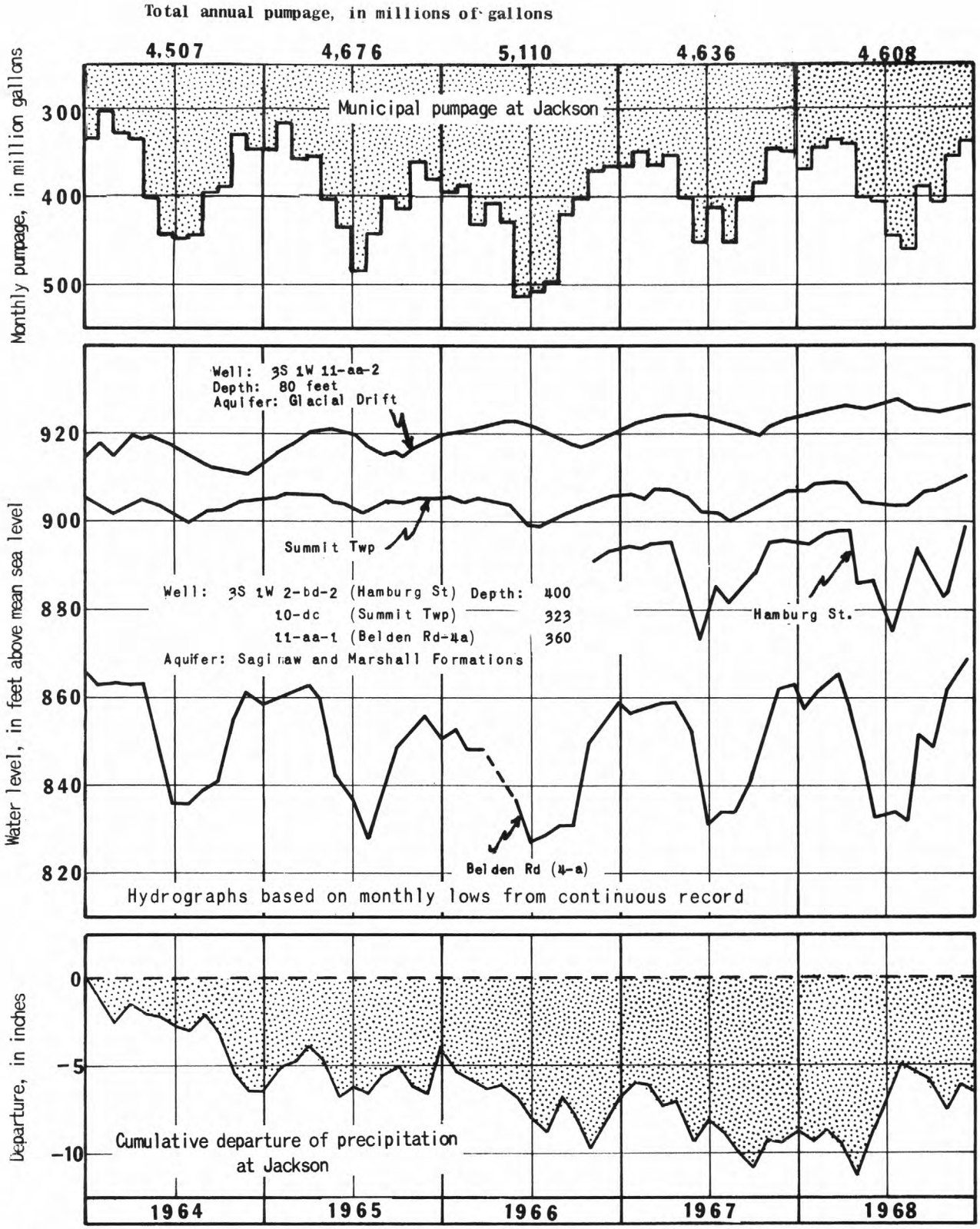


Figure 26.--At Jackson, water levels in the observation well tapping the glacial drift aquifer at the Belden Road Station are about 50 feet above levels in the underlying bedrock aquifers.

JACKSON COUNTY - CITY OF JACKSON

WATER SUPPLY AND SOURCE -- 14 wells, 380 to 400 feet deep, tapping sandstones of the Saginaw, Parma and Marshall Formations.

YIELD OF WELLS (in gallons per minute) -- Range from 1000 to 2800.

SPECIFIC CAPACITY OF WELLS (in gallons per minute per ft of drawdown) -- Reported average, 100; specifically, No. 12 well - 56.

PUMPAGE IN 1968 -- 4,608 million gallons.

MAXIMUM DAY -- 19.72 million gallons.

STORAGE FACILITIES -- 3,000,000 gallons elevated, plus 3,000,000 gallons ground.

QUALITY OF WATER --

Hardness	340-390 ppm
Iron	0.3-1.0 ppm
Chloride	13-88 ppm

TREATMENT -- Chlorination and fluoridation.

POPULATION SERVED -- 52,220 estimated.

PER CAPITA USE -- 242 gallons per day.

REMARKS -- A rising trend of water levels that began in 1967, continued in 1968 as the result of decreased municipal pumpage and above-normal precipitation (fig. 26). In July, 1968, water levels in the glacial drift well at Belden Road were the highest of the 1962-68 record as the level rose to 1.5 feet above land surface (table 1, Jackson County). Location of observation wells are shown in figure 27.

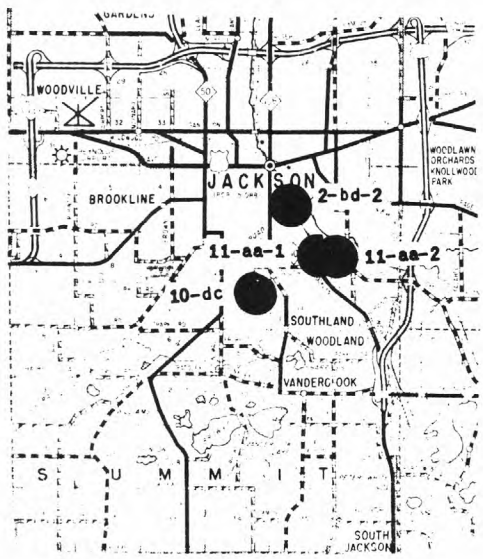


Figure 27.--Location of observation wells.

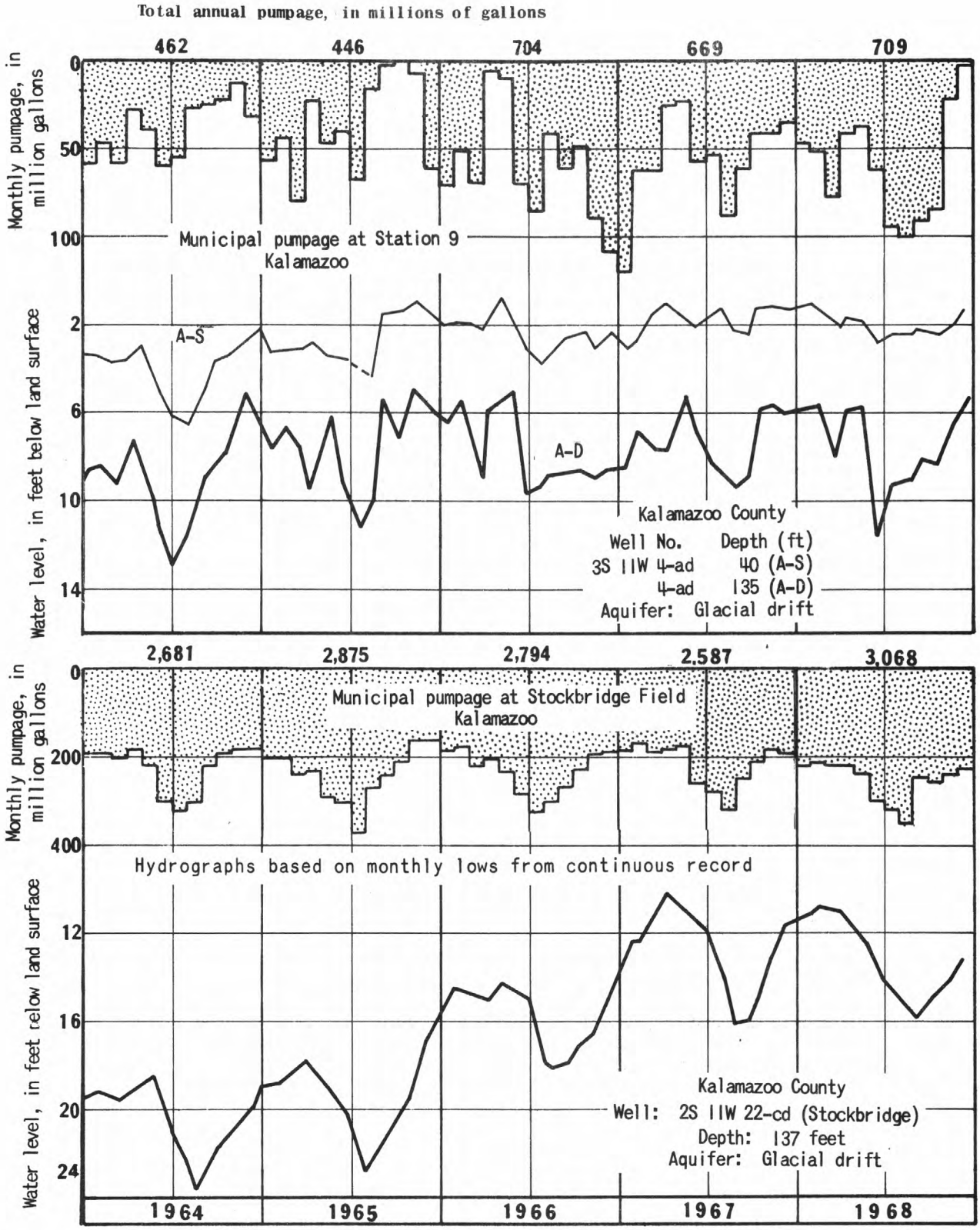


Figure 28.--At Kalamazoo, water levels in these observation wells did not change significantly in 1968, as increased pumpage was countered by increased precipitation.

KALAMAZOO COUNTY - CITY OF KALAMAZOO

WATER SUPPLY AND SOURCE -- About 79 wells, 130 to 254 feet deep, finished in glacial drift.

YIELD OF WELLS (in gallons per minute) -- 200 - 2,000.

SPECIFIC CAPACITY OF WELLS (in gallons per minute per ft of drawdown) -- 7-100.

PUMPAGE IN 1968 -- 6,358 million gallons.
MAXIMUM DAY -- 35.06 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, hexametaphosphate.

POPULATION SERVED -- 115,000 estimated.
PER CAPITA USE -- 141 gallons per day.

REMARKS -- The rising trend in water levels of the past several years, mainly the result of increased precipitation, was blunted in 1968 as municipal pumpage increased by about 450 million gallons (figs. 28 and 29). However, levels remained high and in the Atwater well were above land surface (fig. 29). A new observation well was installed at the Kendall field at a greater depth to better reflect pumping from the nearby municipal wells.

Municipal pumpage has increased rapidly, increasing from, 4.73 billion gallons in 1962 to 6.36 billion gallons in 1968, or a 34 percent increase. Recharge from surface ponds and streams maintain high water levels in the aquifers despite the large increases in pumping.

The distribution of observation wells in the Kalamazoo area is shown in figure 30.

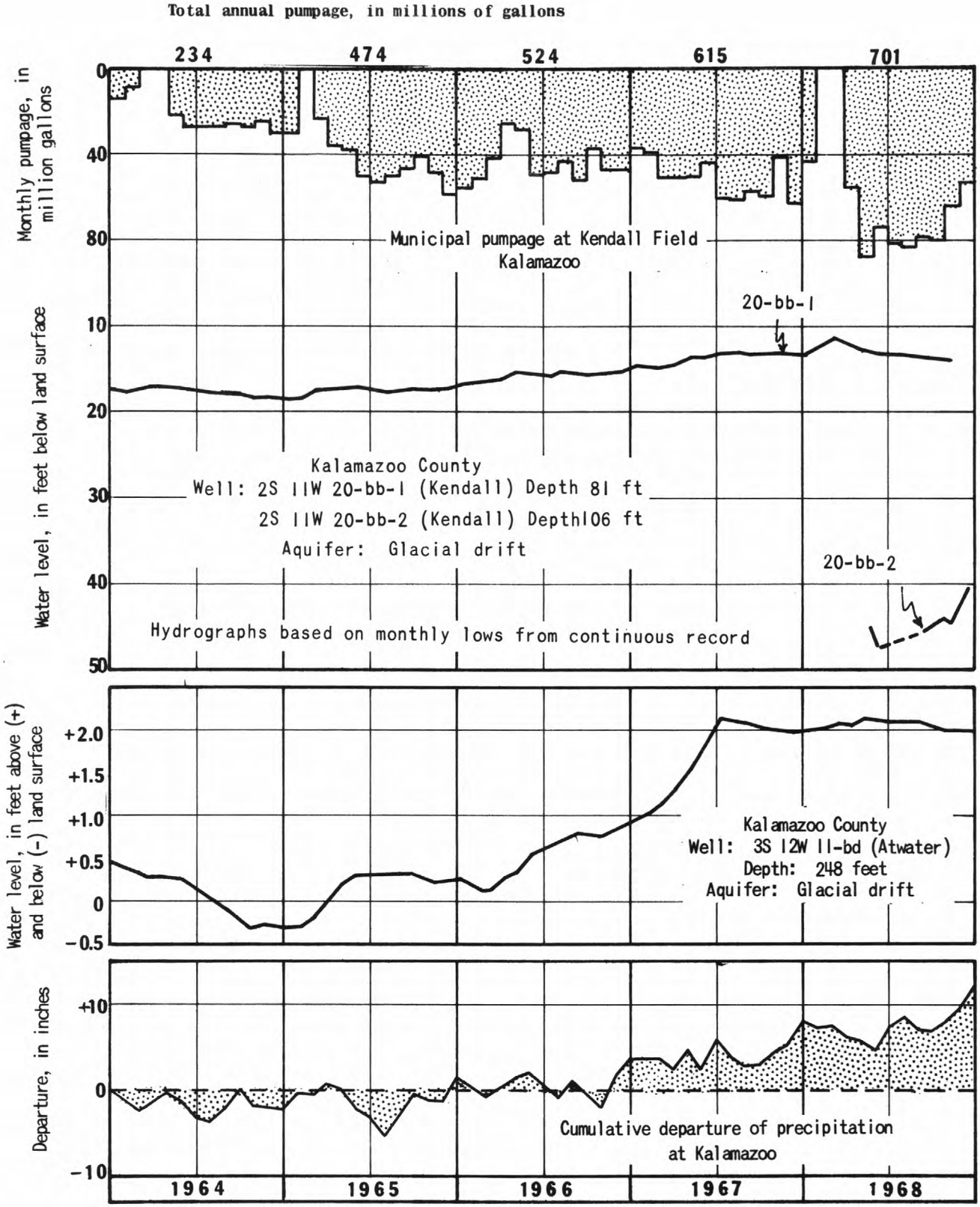
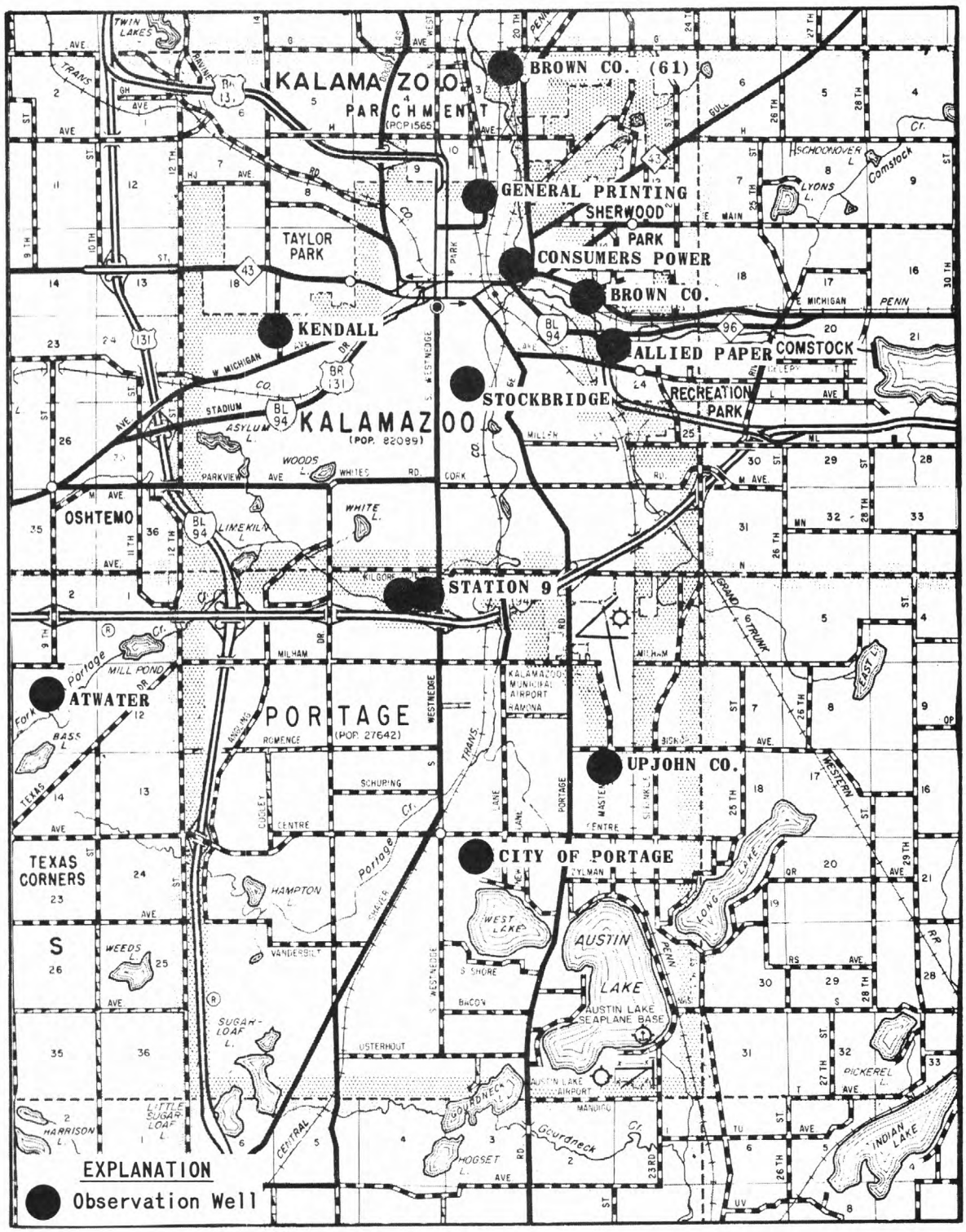


Figure 29.--In 1968, the observation well at Kalamazoo's Kendall field was replaced by a deeper well (20-bb-2) in order to observe the effects of pumping from the lower aquifer. Water levels at the Atwater observation well are not affected by any local pumping and levels remained above land surface.



ure 30.--Location of observation wells in the Kalamazoo area.

Except for the Atwater well, water levels in these observation wells are monitored to reflect municipal and industrial withdrawals of water from the glacial drift aquifers.

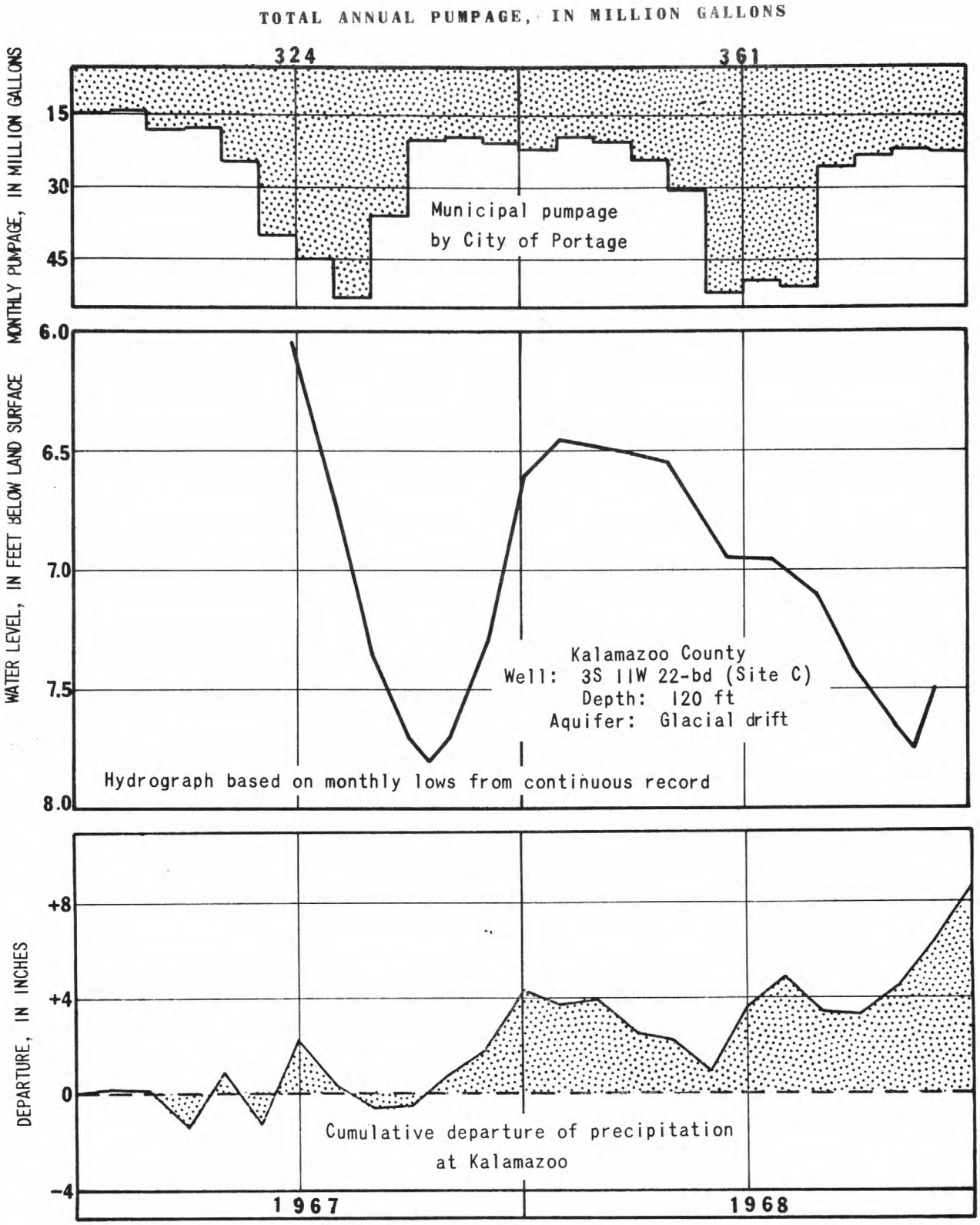


Figure 31.--At Portage, water levels in the observation well declined during 1968, but the low for 1968 was not as low as that for 1967, probably from the benefit of above-normal precipitation.

KALAMAZOO COUNTY - CITY OF PORTAGE

WATER SUPPLY AND SOURCE -- 15 wells finished in glacial drift ranging from 95 to 185 feet in depth.

YIELD OF WELLS (in gallons per minute) -- 300 to 1,000.

SPECIFIC CAPACITY OF WELLS (in gallons per minute per ft of drawdown) -- 25.

PUMPAGE IN 1968 -- 361 million gallons.

MAXIMUM DAY -- 4.43 million gallons.

STORAGE FACILITIES -- 150,000 gallons elevated.

QUALITY OF WATER -- Iron 0.03 to 0.3 ppm
Hardness 181 ppm

TREATMENT -- Chlorination and phosphate.

POPULATION SERVED -- 12,000 estimated

PER CAPITA USE -- 82 gallons per day.

REMARKS -- Despite the increase in pumpage the low water level for the year 1968 was slightly higher than in 1967 indicating some benefit from above-normal precipitation (fig. 31). This observation well is located at sufficient distance from pumping wells to give a general picture of aquifer conditions without interference.

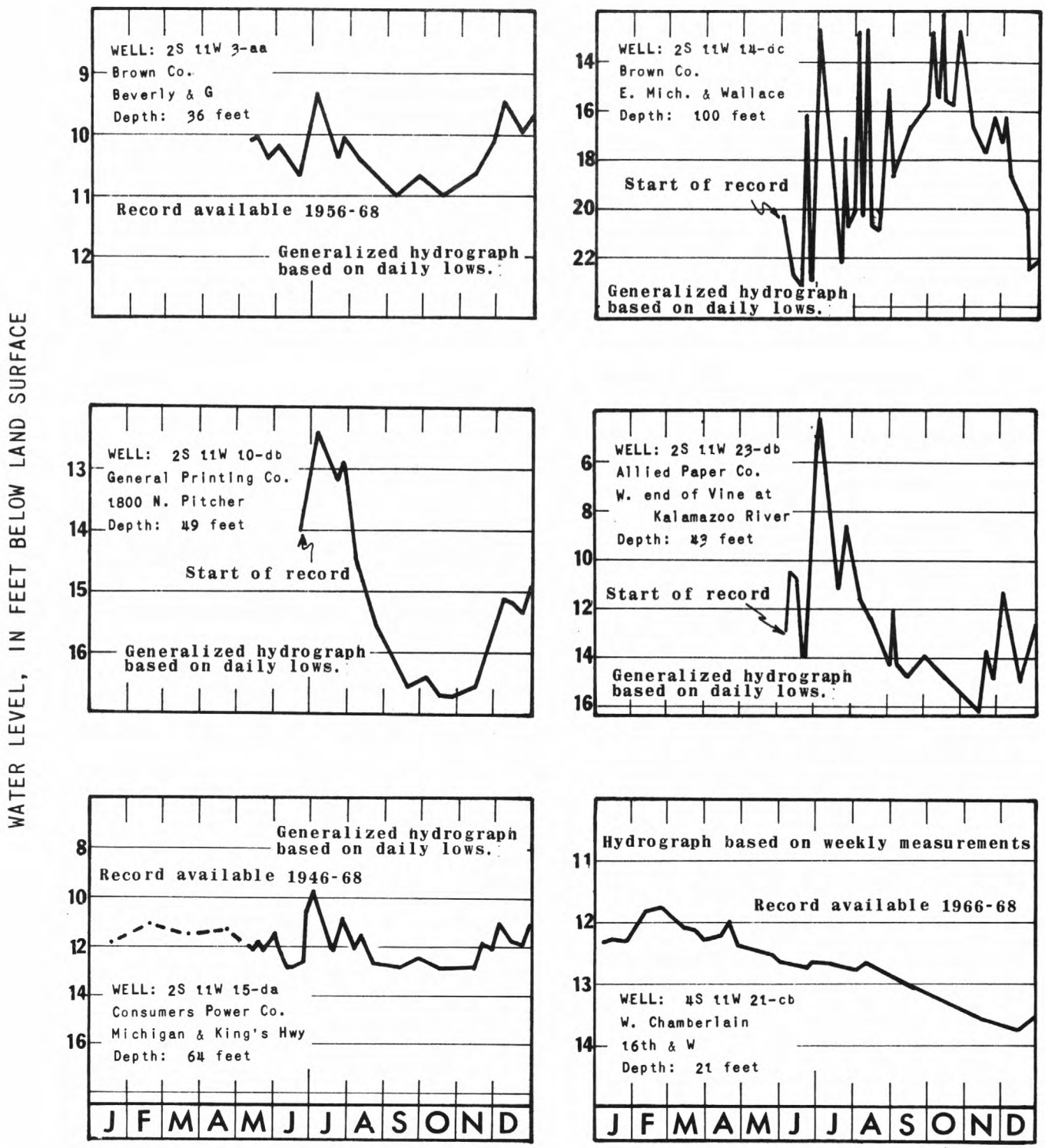


Figure 32.--Hydrographs of six observation wells in Kalamazoo County for the year 1968. All but the Chamberlain well are in heavily pumped areas.

KALAMAZOO COUNTY

Water levels in 5 of the 6 observation wells (fig. 33) show the effects of local and area pumping whereas the Chamberlain well responds mostly to the effects of precipitation and climate.

Observations were started in 3 of the wells in 1968. All of the wells are equipped with continuous recorders with the exception of the Chamberlain well which is measured weekly. The extremes for the past record for those wells having record prior to 1968 can be found in table 1, under Kalamazoo County.

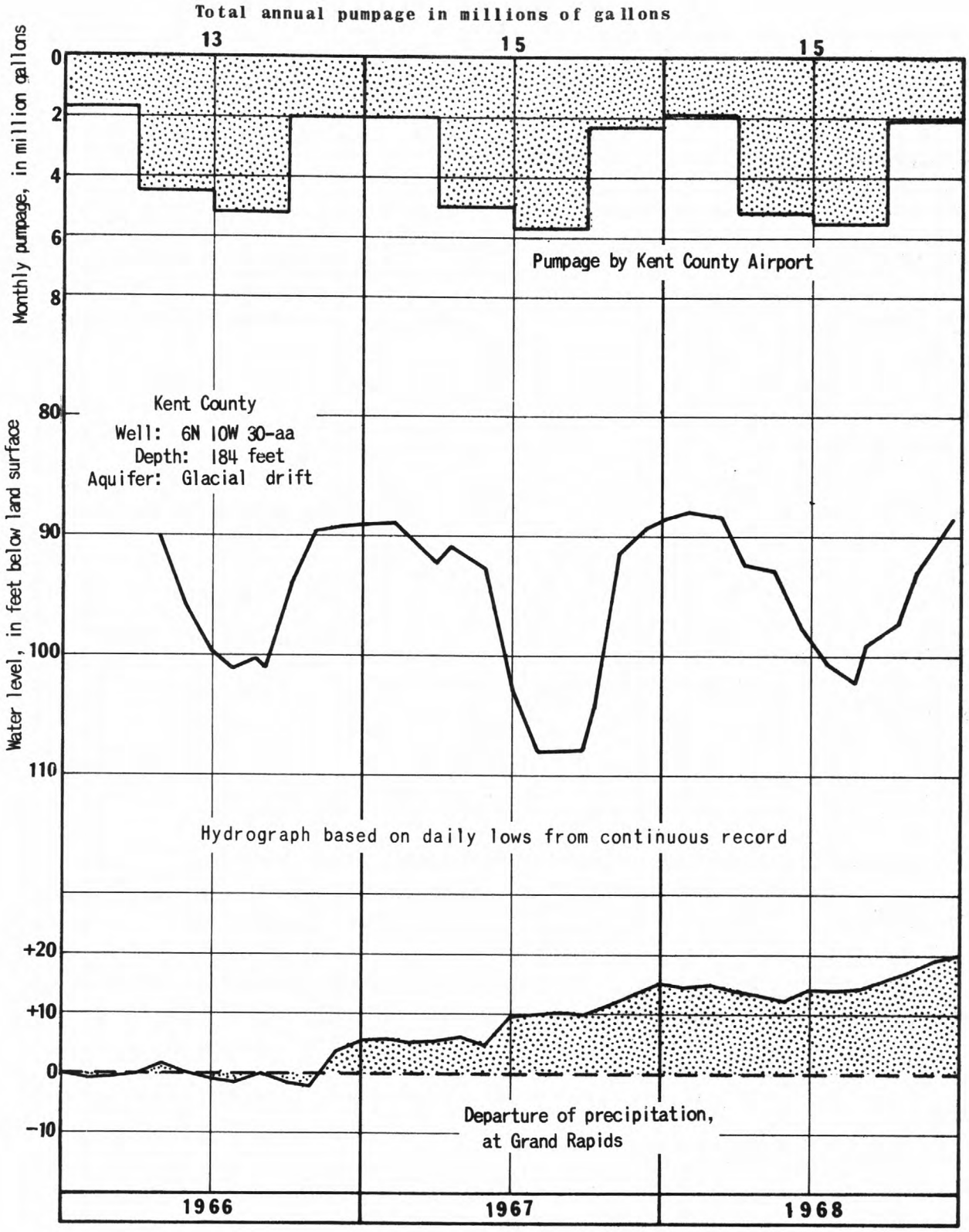


Figure 33.--At Kent County Airport, greater use of water during the summer months for air conditioning results in a seasonal decline in water levels of 10 to 20 feet in the observation well.

KENT COUNTY - KENT COUNTY AIRPORT

WATER SUPPLY AND SOURCE -- Three wells, 180 to 203 feet deep, finished in glacial drift.

YIELD OF WELLS (in gallons per minute) -- 100 to 360.

SPECIFIC CAPACITY OF WELLS (in gallons per minute per ft of drawdown) -- 2.3.

PUMPAGE IN 1968 -- 14.7 million gallons.

MAXIMUM DAY --

STORAGE FACILITIES -- 100,000 gallons ground storage tank.

QUALITY OF WATER -- Hardness 435-460 ppm
3-4 ppm

TREATMENT -- Iron removal, phosphates, and chlorination.

POPULATION SERVED --

PER CAPITA USE --

REMARKS -- As a result of above-normal precipitation, water levels in the observation well were generally higher in 1968 (fig. 34). In March, 1968 a new high of 86.4 feet below land surface was observed (table 1, Kent County). Two of the wells are used for general airport supply throughout the year. During the warmer months an additional well is turned on for air conditioning. However, the total annual use is small and no serious decline should occur at this pumping rate.

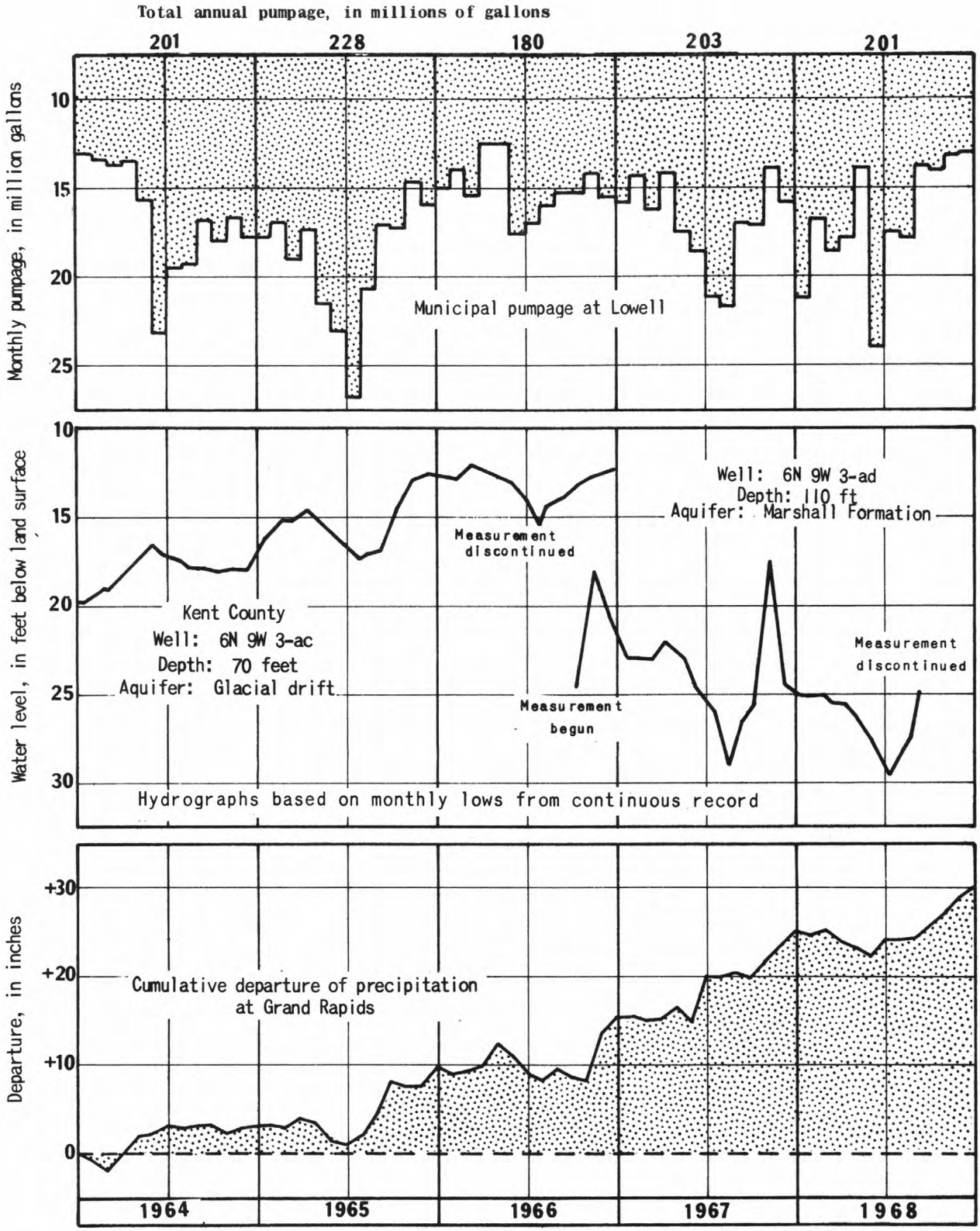


Figure 34.--At Lowell, water levels in the observation well in the glacial drift rose during the 1964-66 period as the result of increased precipitation. In the observation well tapping the Marshall Formation little change in water levels occurred as pumpage from the rock was in equilibrium with recharge from increased precipitation.

KENT COUNTY - CITY OF LOWELL

WATER SUPPLY AND SOURCE -- Two wells, 47 and 71 feet deep, finished in glacial drift and one well, 107 feet deep, tapping Ionia Sandstone, Grand River Group, of Pennsylvanian age.

YIELD OF WELLS (in gallons per minute) -- 120 to 800 (drift); 350 (rock).

SPECIFIC CAPACITY OF WELLS (in gallons per minute per ft of drawdown) -- 4.5 and 80 (drift); 13.2 (rock).

PUMPAGE IN 1968 -- 201 million gallons.

MAXIMUM DAY --

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 -- 216.

REMARKS -- Water-level measurements at Lowell were discontinued in 1968. Water levels were observed from 1961 thru 1966 in the glacial drift aquifer and from 1966 to 1968 in the Ionia Sandstone. During the period 1964 to 1966, levels in the drift trended upwards as the result of increased precipitation (fig. 35). Water levels in the bedrock showed no important change despite increased pumping from the rock, probably owing to the effects of increased precipitation.

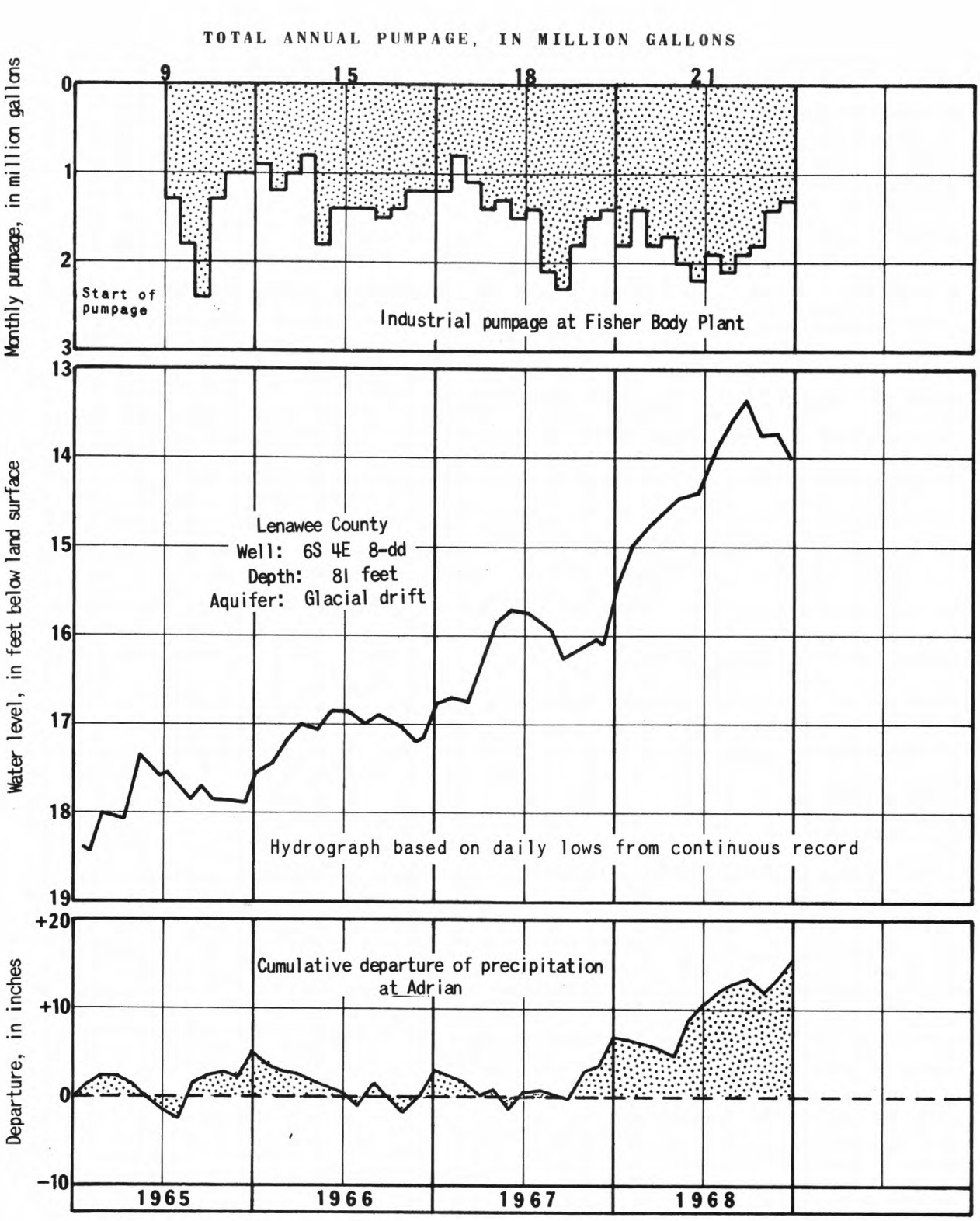


Figure 35.--At the Fisher Body plant's well field near Tecumseh, water levels in the observation well apparently are trending upwards from the effects of increased precipitation.

The small amount of pumpage at this well field has only temporary effects on the water levels in the observation well.

LENAWEE COUNTY
FISHER BODY, GMC, NEAR TECUMSEH

WATER SUPPLY AND SOURCE -- Three 12-inch wells, no. 2 (89 feet deep), no. 3 (85 feet deep), and no. 4 (76 feet deep). Wells have 20 feet of 0.025-inch slot screens.

YIELD OF WELLS (in gallons per minute) -- About 500.

SPECIFIC CAPACITY OF WELLS (in gallons per minute per ft of drawdown) -- No. 2 and 3 - 25; no. 4 - 30.

PUMPAGE IN 1968 -- 21.3 million gallons.
MAXIMUM DAY -- 0.12 million gallons.

STORAGE FACILITIES --

QUALITY OF WATER --

Hardness	415-525 ppm
Iron	2.2-4.2 ppm
Fluoride	0.2 ppm

TREATMENT --

POPULATION SERVED --

PER CAPITA USE --

REMARKS -- The rising trend in water levels as the result of increased precipitation continued in 1968 (fig. 36). Although pumpage at Fisher Body well field has small day-to-day effects, it is not sufficient to counter the natural effects of recharge to the aquifer. Thus, a gain of about 4 feet has been observed since the beginning of water level measurements in 1965.

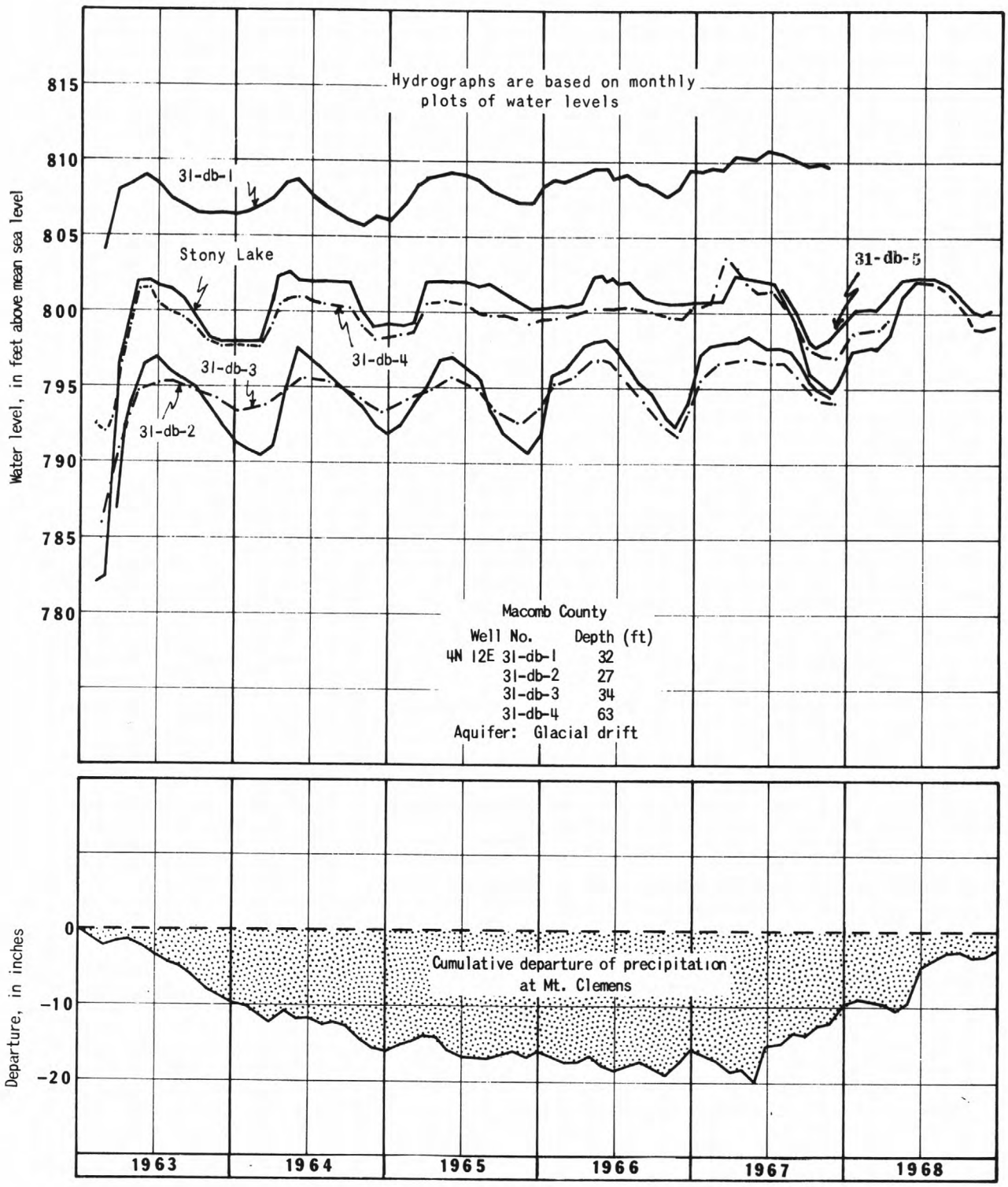


Figure 36.--At Stony Lake Park, observation wells show the effect of the Stony Lake impoundment in relation to ground-water levels.

In 1968, only the lake levels and one observation well were measured as a check on the effects of an impoundment for an artificial lake, on ground-water levels (figs. 37, 38). Sufficient data has been accumulated to discontinue most of the ground-water level observations.

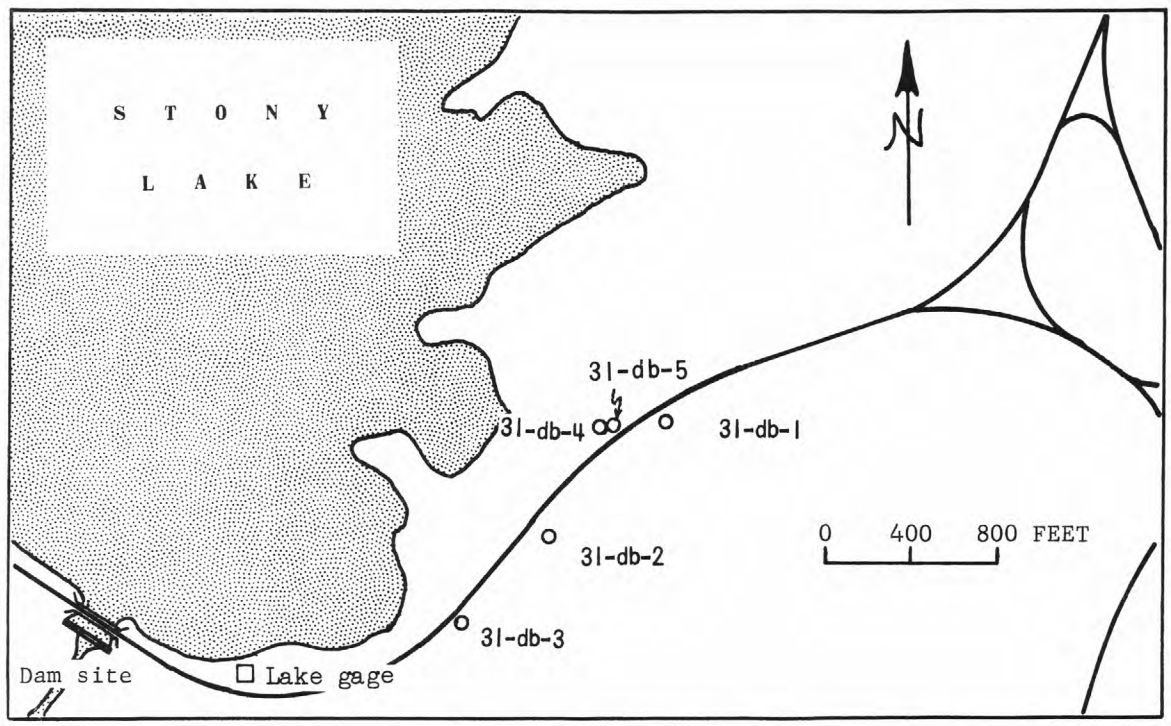


Figure 37.--Location of observation wells and lake gage at Stony Lake Park.

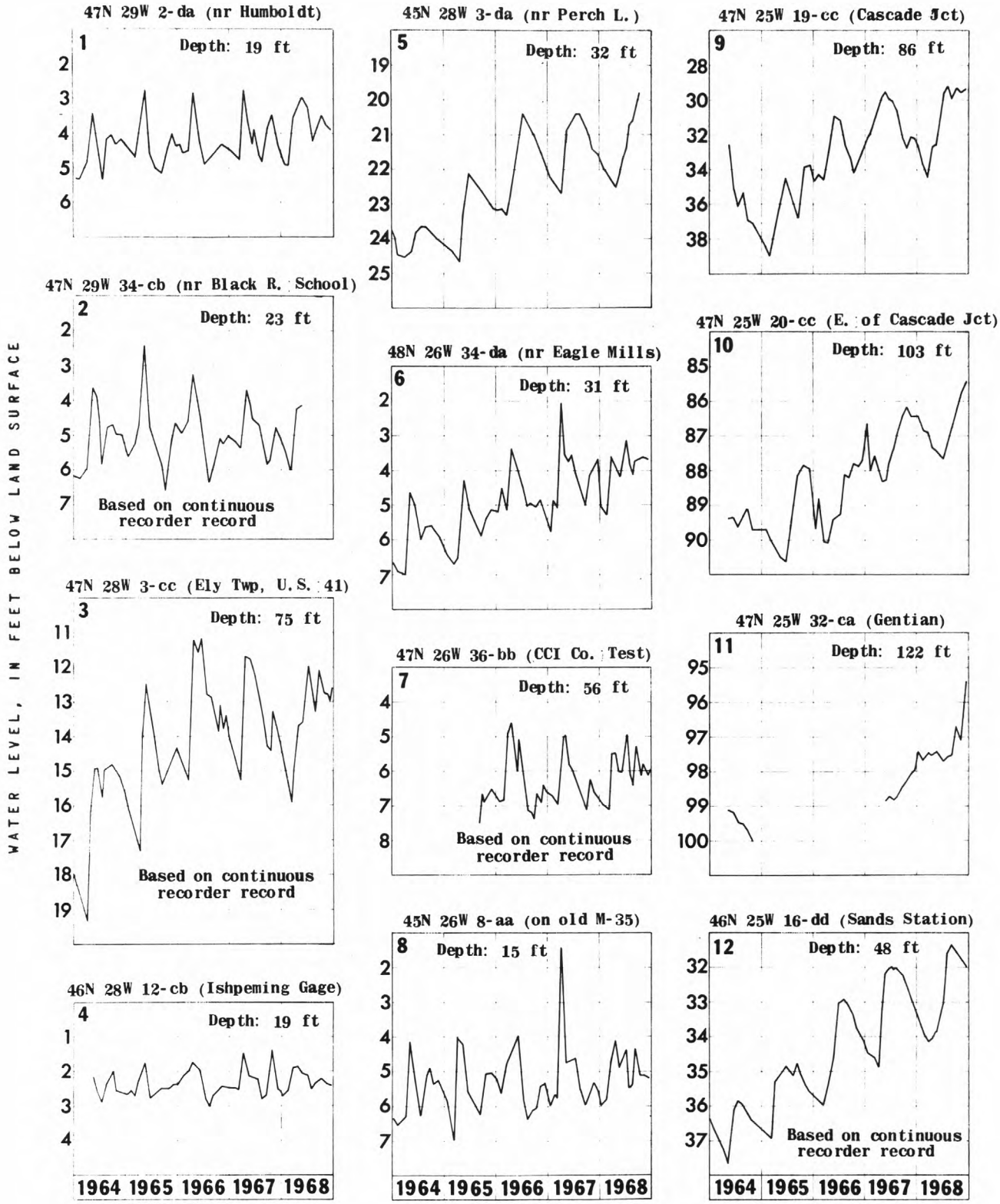


Figure 38.--In part of Marquette County, water levels in observation wells finished in glacial drift are being studied as a basis for comparison with possible effects caused by future industrial development.

MARQUETTE COUNTY - IRON RANGE AREA

Measurement of ground-water levels in the Iron Range area continued in 1968.

The 12 observation wells are finished in glacial drift and their water levels reflect natural effects of precipitation and climate. Depths to water range from about 2 to 90 feet below land surface depending upon depth and location of the wells. Total fluctuation of water levels over the period of record has ranged from about 2 feet in well 4, to 9 feet in well 9 (fig. 39).

The 1964-68 period had a cumulated departure of precipitation of about 7 inches above normal (fig. 40) resulting in a rising trend in water levels in most of the wells.

The wells are located throughout an area of about 350 square miles (fig. 41) to give a regional picture of ground-water conditions.

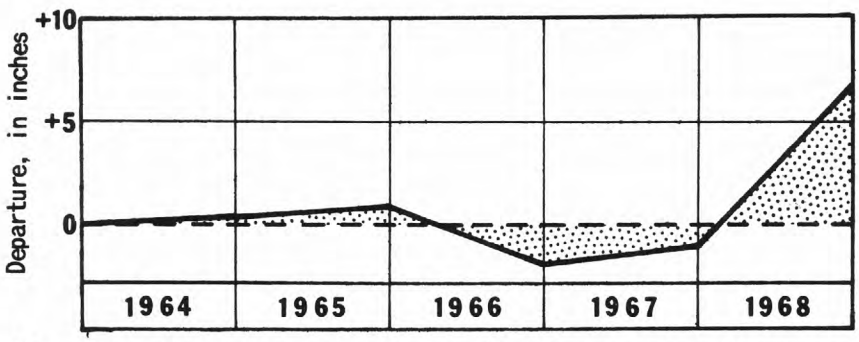


Figure 39.-- Cumulative departure of precipitation from normal in West Upper Division of Michigan.

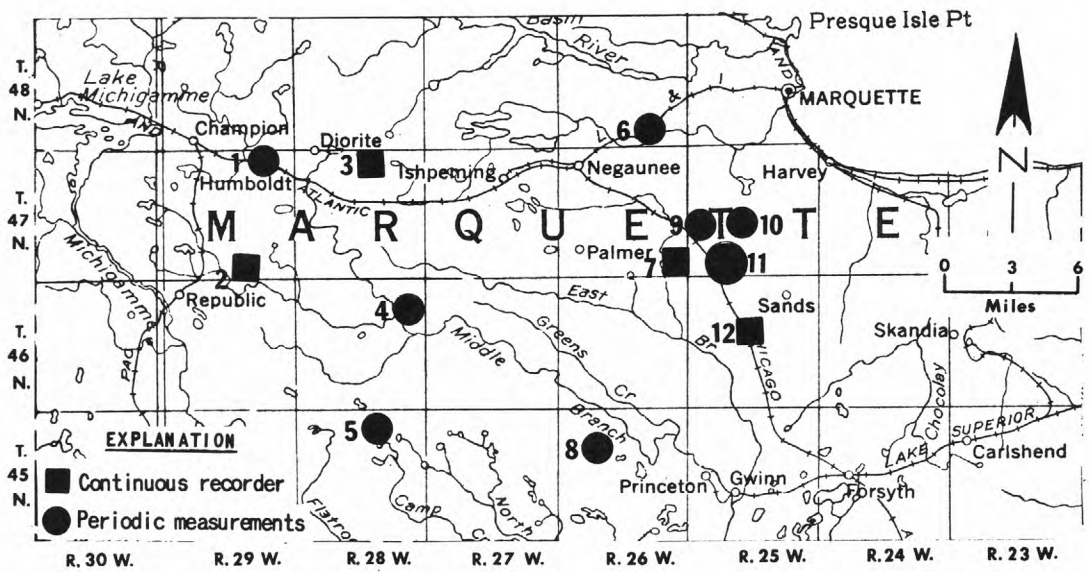


Figure 40.--Location of observation wells in the Marquette Iron Range area.

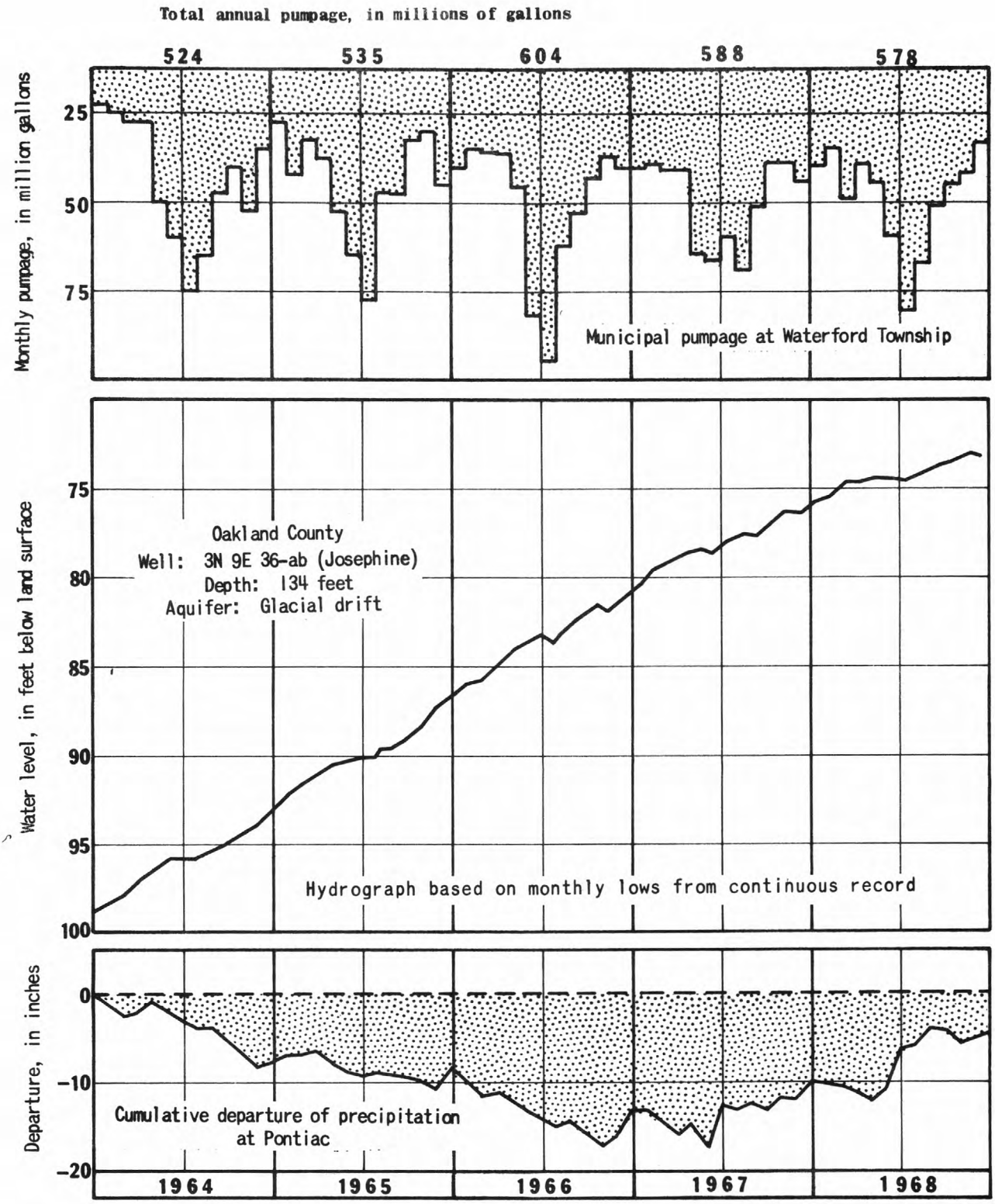


Figure 41.--At Waterford Township, water levels in the observation well continued to rise as a result of the discontinuance of pumping by the neighboring City of Pontiac and increased precipitation since 1967.

OAKLAND COUNTY - WATERFORD TOWNSHIP

WATER SUPPLY AND SOURCE -- 13 wells, 85 to 327 feet deep, tapping the glacial drift.

YIELD OF WELLS (in gallons per minute) -- 300 to 1,750.

SPECIFIC CAPACITY OF WELLS (in gallons per minute per ft of drawdown) -- 26 to 88.

PUMPAGE IN 1968 -- 761 million gallons.

MAXIMUM DAY --

STORAGE FACILITIES -- 8,250,000 gallons elevated.

QUALITY OF WATER -- Hardness 283-300 ppm
Iron 1.4-2.3 ppm

TREATMENT -- Phosphate and chlorination.

POPULATION SERVED -- 18,000 estimated.

PER CAPITA USE -- 116 gallons per day.

REMARKS -- The rise of water levels in the observation well continued in 1968 as the result of the discontinuance of pumping by the City of Pontiac and by increased precipitation in the 1967-68 period (fig. 42).

A 60-foot rise of water levels has occurred in Pontiac's Hayes Recreation area (table 1, Oakland County) since mid-1963.

A water resources study of Oakland County was completed in 1968 and results of this study will be published at a later date.

Other observation wells in Oakland County had record high levels (table 1) as the result of increased precipitation.

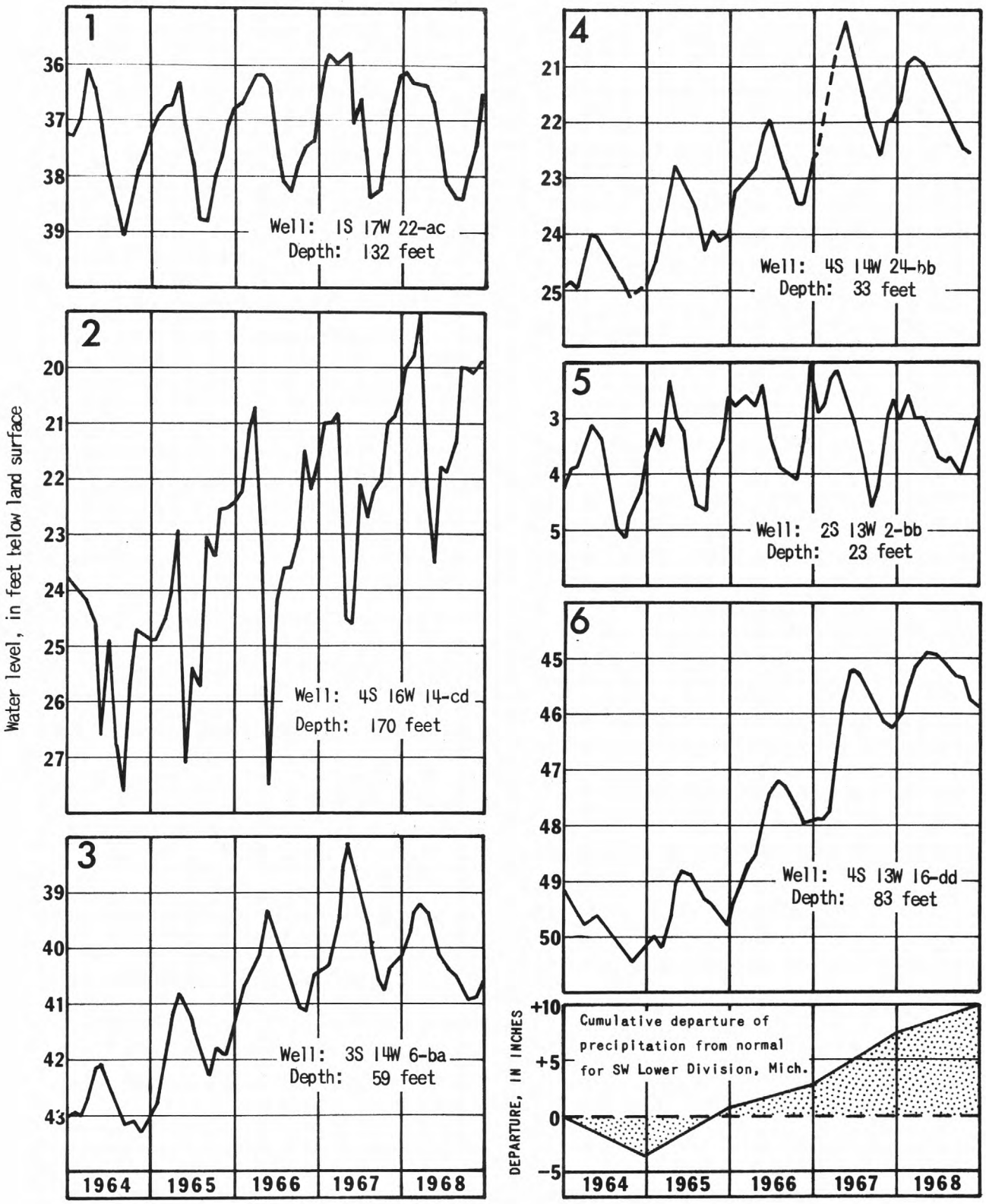


Figure 42.--In Van Buren County, water levels in observation wells tapping the glacial drift reached new highs of record in the 1967-68 period in response to above-normal precipitation.

VAN BUREN COUNTY

In 1968, a study of the ground-water resources, and their quality, and the chemical and physical quality of lakes was continued.

One well, No. 2 in figure 43, is affected by seasonal irrigation and industrial pumping in the area. However, its long term trend in water levels resembles the trends in other wells that are influenced by only natural conditions. Location of wells is shown below (fig. 44).

For further information on the water resources of the county see reports listed under references.

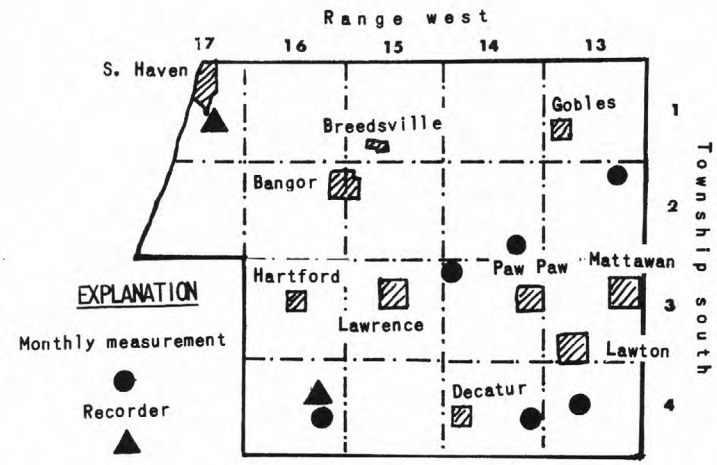


Figure 43.--Location of observation wells in Van Buren County.

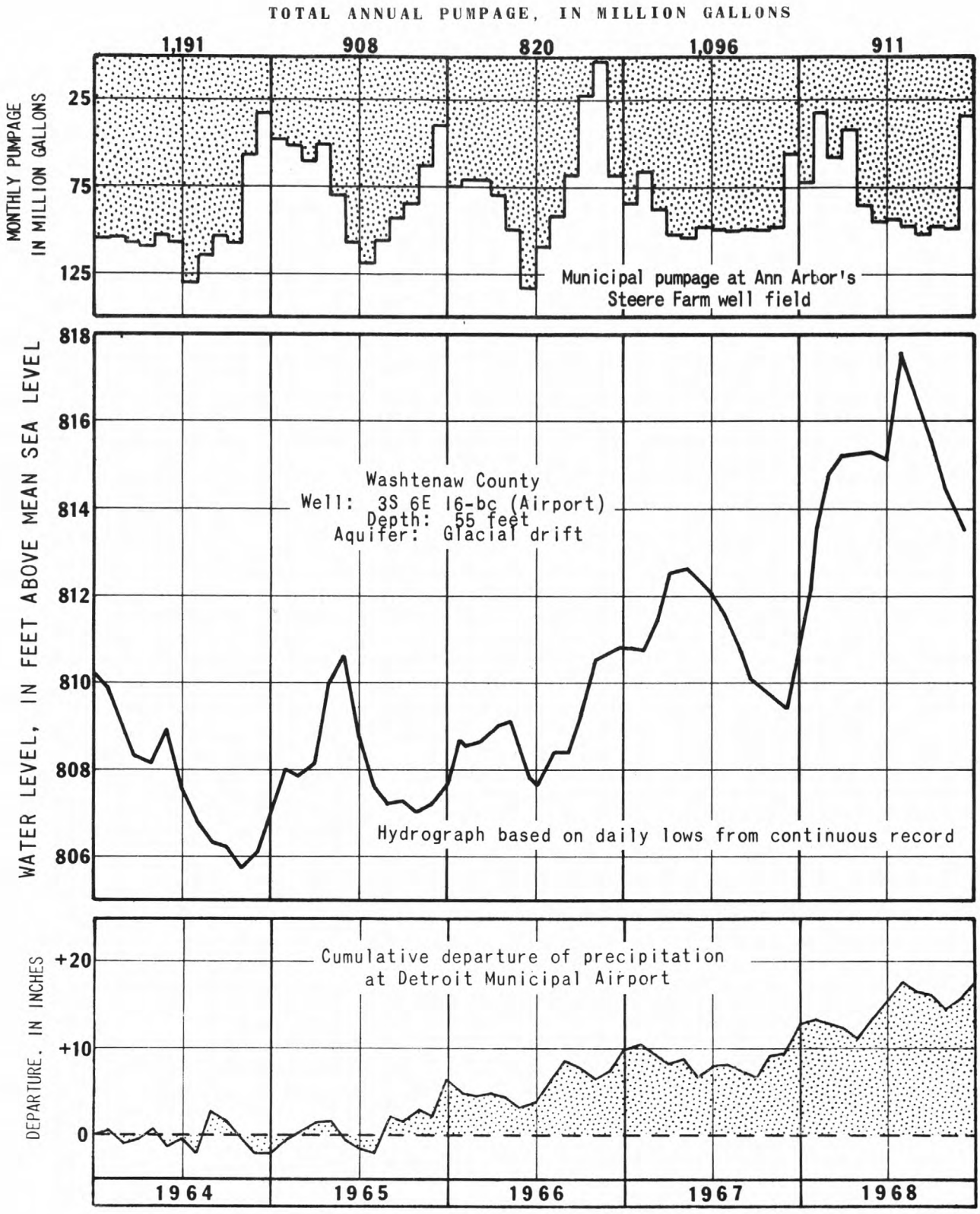


Figure 44.--At Ann Arbor, water levels in the observation well continued to rise resulting in record high levels by mid-1968, principally as the result of increased precipitation.

WASHTENAW COUNTY - CITY OF ANN ARBOR

WATER SUPPLY AND SOURCE -- Four wells, 91 to 196 feet deep, finished in glacial drift; and water from the Huron River.

YIELD OF WELLS (in gallons per minute) -- 1,050 to 4,860.

SPECIFIC CAPACITY OF WELLS (in gallons per minute per ft of drawdown) -- About 20 to 600.

PUMPAGE IN 1968 -- Total 5,012 million gallons - surface water and ground water,
MAXIMUM DAY -- (1,200 million gallons ground water).

STORAGE FACILITIES -- Treatment plant: 6,057,000 gallons.
Ground level on system: 6,200,000 gallons.
Elevated storage: 1,000,000 gallons.

QUALITY OF WATER -- Treated water: Hardness 95 ppm; Iron 0.0
Ground water: Hardness 355-585; Iron 0.25 - 2.4.

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

POPULATION SERVED -- 104,000 estimated.

PER CAPITA USE -- 132 gallons per day total surface and ground water.

REMARKS -- Water levels in the observation well (fig. 45) rose sharply in 1968 continuing an uptrend in water levels of the past few years--the result of decreased pumpage in 1968 and increased precipitation since 1965. The new high of 3.0 feet below land surface was 4.8 feet above the previous high of record on Sept. 1, 1963 (table 1, Washtenaw County). In addition to the pumpage at the Steere Farm well field of 894 million gallons, 306 mg were pumped at the Montgomery well field in Ann Arbor.

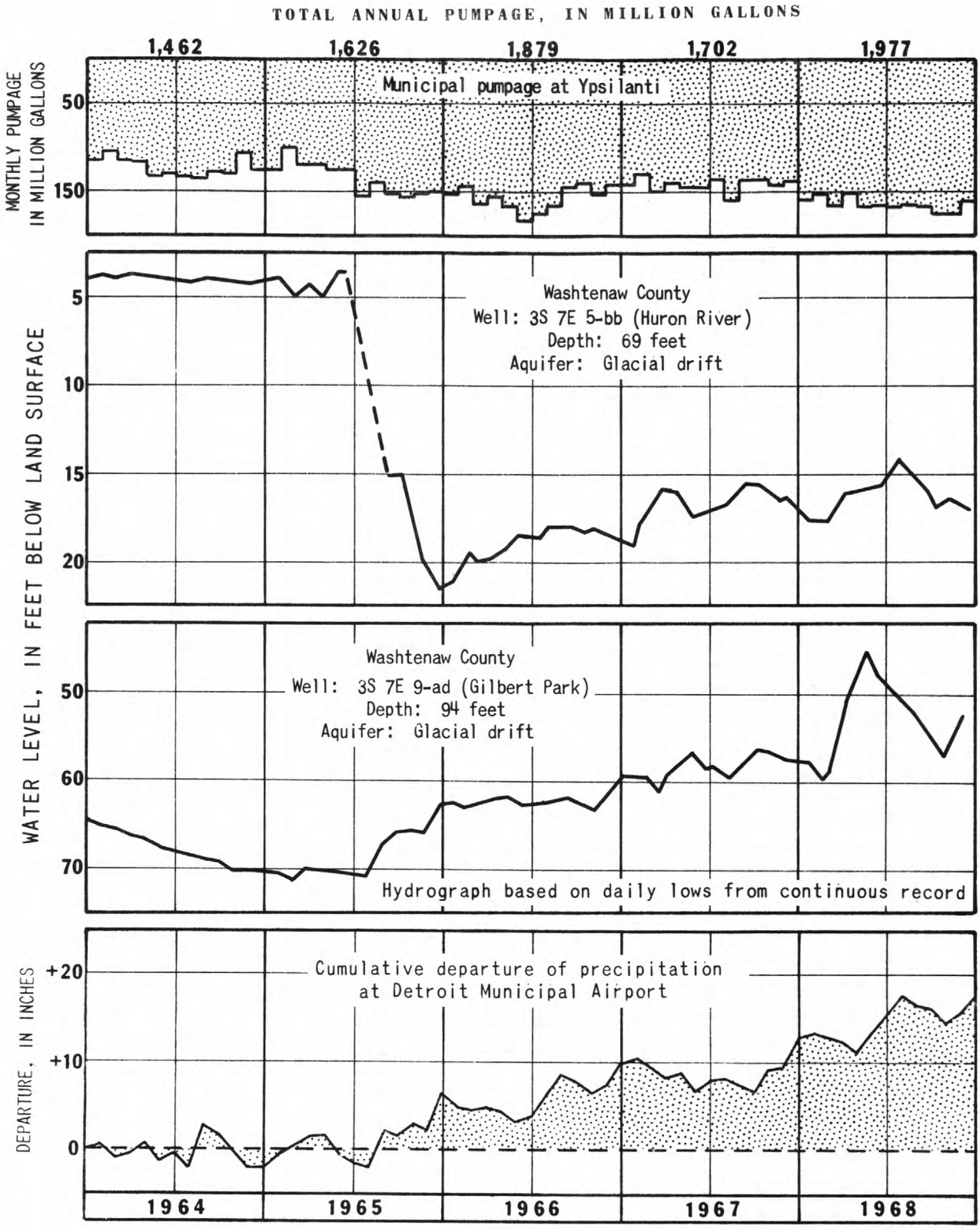


Figure 45.--At Ypsilanti, water levels in the observation wells have been rising since the low levels that occurred in 1965, principally because of above-normal precipitation as pumpage has increased.

WASHTENAW COUNTY - CITY OF YPSILANTI

WATER SUPPLY AND SOURCE -- Obtained from seven wells, 87 to 102 feet deep, finished in glacial drift.

YIELD OF WELLS (in gallons per minute) -- 450 average for 5 of the wells-- wells are not metered individually.

SPECIFIC CAPACITY OF WELLS (in gallons per minute per ft of drawdown) -- 25 to 180, estimated.

PUMPAGE IN 1968 -- 1,997 million gallons.

MAXIMUM DAY -- 6.60 million gallons.

STORAGE FACILITIES -- Treated water at plant 2,000,000 gallons. Elevated storage 1,250,000.

QUALITY OF WATER --

Treated water:	Hardness	86 ppm	Iron 0.0 ppm
Raw water:	Hardness	305-320 ppm	
	Iron	1.2-1.6 ppm	
	Fluoride	0.3 ppm	

TREATMENT -- Lime softening, and iron removal.

POPULATION SERVED -- 28,000 estimated.

PER CAPITA USE -- 195 gallons per day.

REMARKS -- Ground-water levels continued to rise in 1968 (fig. 46) as the result of increased precipitation and despite increased municipal withdrawals. A record high for the 18-year record was observed at the River Street well, (table 1, Washtenaw County) and water levels were the highest of record at the Huron River well (fig. 46) since local pumping began in 1965.

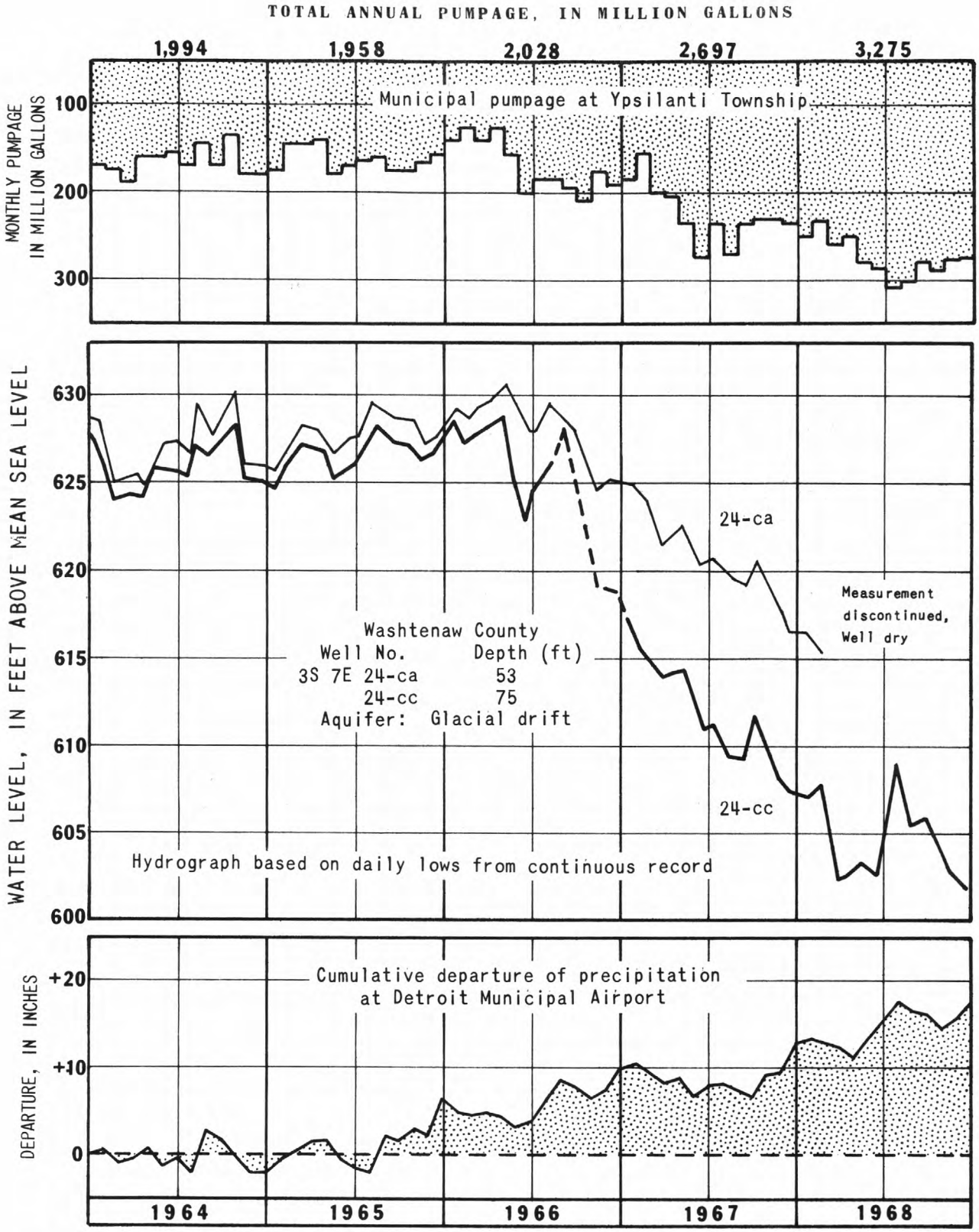


Figure 46.--At Ypsilanti Township's well field, a sharp decline in water levels in observation wells has occurred as a result of the large increase in pumping and despite increased precipitation.

WASHTENAW COUNTY - YPSILANTI TOWNSHIP

WATER SUPPLY AND SOURCE -- Eight wells, 50 to 95 feet deep, finished in glacial drift.

YIELD OF WELLS (in gallons per minute) -- 700 to 3,500.

SPECIFIC CAPACITY OF WELLS (in gallons per minute per ft of drawdown) --

PUMPAGE IN 1968 -- 3,276 million gallons.
MAXIMUM DAY -- 12.94 million gallons.

STORAGE FACILITIES -- 2,000,000 gallons ground storage.

QUALITY OF WATER --

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

TREATMENT -- Lime softening, chlorination.

POPULATION SERVED -- 30,000 estimated.

PER CAPITA USE -- 299 gallons per day.

REMARKS -- Most of the water levels in observation wells at the Ypsilanti Township well field fell to new lows for the 22 to 23 year period of record (table 1, Washtenaw County) as pumpage increased. Measurements in two wells were discontinued when levels fell to below the bottom of the well.

Well 24-cc (fig. 47) is located in close proximity to one of the heavily pumped wells and shows a sharp decline since nearby pumping started in 1966.

Additional municipal wells are being installed at the well field with spacing to provide for less interference between the existing pumping sites.

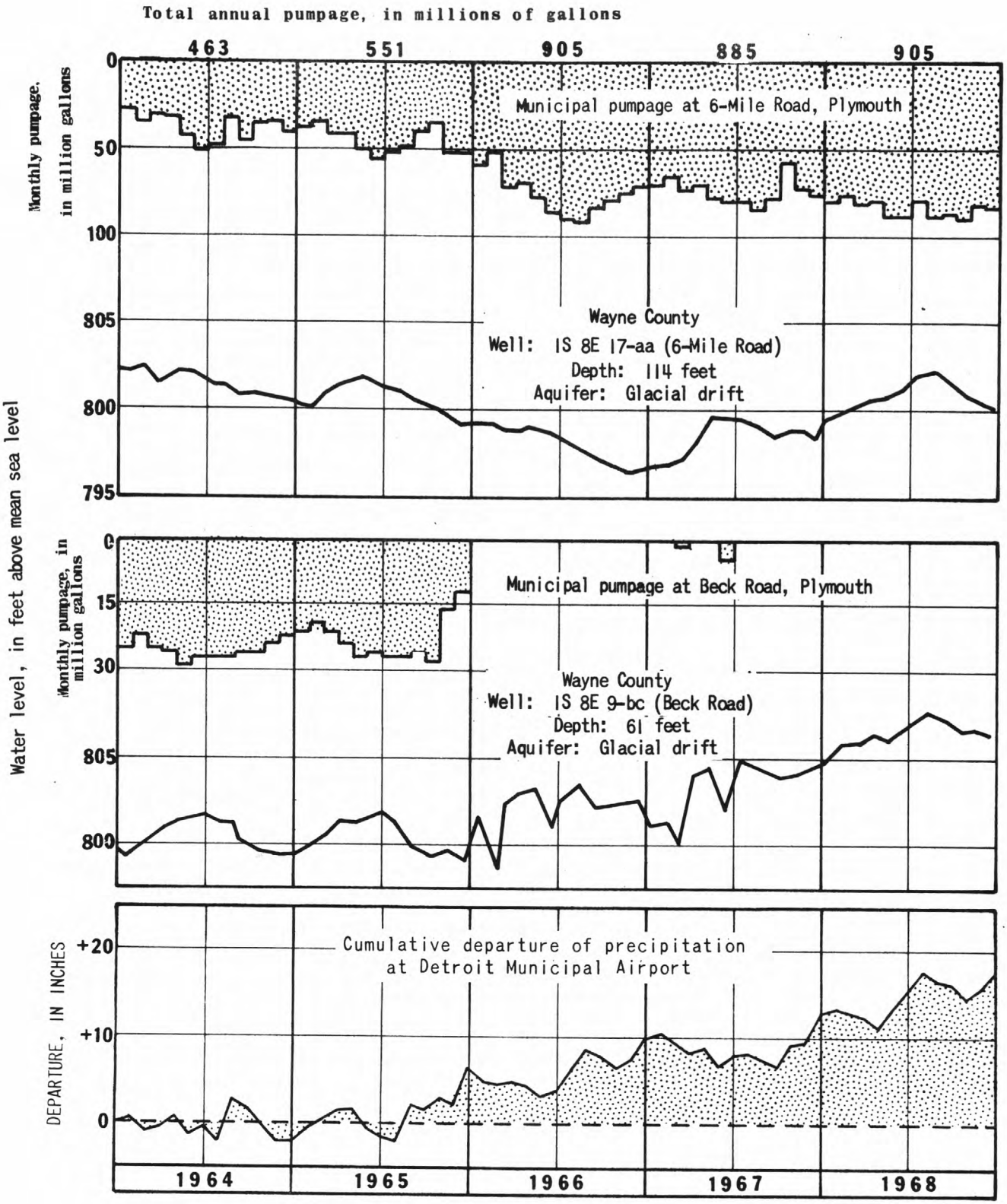


Figure 47.--At Plymouth's 6-Mile Road field, and Beck Road field, water levels in the observation wells continued an upward trend in 1968, despite heavy pumping at the 6-Mile Road field. The higher water levels are primarily the result of above-normal precipitation.

WAYNE COUNTY - CITY OF PLYMOUTH

WATER SUPPLY AND SOURCE -- Six wells, 20 to 110 feet deep, finished in glacial drift and located at three well fields.

YIELD OF WELLS (in gallons per minute) -- 500 to 2,400.

SPECIFIC CAPACITY OF WELLS (in gallons per minute per ft of drawdown) -- 84 to 700.

PUMPAGE IN 1968 -- 1,223 million gallons.
MAXIMUM DAY -- 3.65 million gallons.

STORAGE FACILITIES -- 2,000,000 gallons storage reservoir.

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 -- 11,000 estimated.
PER CAPITA USE -- 263 gallons per day.

REMARKS -- Increased precipitation and the discontinuance of pumping at the Beck Road field has resulted in a rising trend of ground water-levels in the observation wells (fig. 48). In addition to the pumping at the 6-Mile station, some 318 million gallons were pumped from the Mill Street well within the city.

Water levels are shown in mean sea level (fig. 48) to allow for comparison of levels at the two stations. On a basis of water levels below land surface the Beck Road field's levels ranged from 9 to 15 feet whereas the levels at 6-mile field ranged from 52 to 56 feet.

TABLE 1. RECORDS OF MICHIGAN OBSERVATION WELLS.

COUNTY AND WELL NUMBER: For explanation of well numbers see text under - Introduction "Well numbering system".

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

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
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
pCf - Freda Sandstone of Keweenawan age (Precambrian)
Pgr - Grand River Group of Pennsylvanian age

ALTITUDE: Land-surface datum in feet above mean sea level.

OBSERVED WATER-LEVEL EXTREMES: 1968 measurements underscored are new extremes for entire length of record (in feet below or above (+) land surface. Water levels are in feet below land-surface unless otherwise indicated.

FREQUENCY OF MEASUREMENT IN 1968: R - Continuous recorder; D - Daily; W - Weekly; M - Monthly; Q - Quarterly; S - Semiannually; A - Annually.

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

COUNTY AND WELL NUMBER	OWNER	DEPTH (ft)	DIAMETER (in)	AQUIFER	ALTITUDE	YEARS OF RECORD	FREQUENCY OF MEAS., 1968	OBSERVED WATER-LEVEL EXTREMES				REMARKS
								THROUGH 1967		IN 1968		
TWP., RANGE, SEC.	OR OTHER DESIGNATION							HIGHEST DATE	LOWEST DATE	HIGHEST DATE	LOWEST DATE	
ALGER COUNTY												
45N 19W 25-bd	USFS (former CCC camp)	66	6	Qgd	850	10	Q	6.4 June 1960	14.2 Apr 1964	11.0 Oct	12.0 Jan	
ALLEGAN COUNTY												
3N 14W 23-dd	Allegan State Game Area	41	1	Qgd	700	3	M	9.5 Dec 1965	13.3 Nov 1967	10.7 Jan	13.0 Nov	
BARAGA COUNTY												
49N 33W 18-ca	Mich. Tech. Univ.	12	16	Qgd	1,320	8	M	4.9 Apr 1960	9.4 Feb 1959	9.0 Sept	9.2 Oct	Record resumed 9-68
48N 32W 12-dd	MSHD (WMP 14)	10	1	Qgd	1,630	21	M	3.3 Apr 1965	7.6 Oct 1967	6.0 Apr	7.6 Feb	
BARRY COUNTY												
2N 10W 1-ba	MDC (Daggett L.)	84	2	Qgd	950	5	A	80.2 Aug 1967	82.5 Nov 1965	78.8 Apr		Meas. disc. 4-68
3N 10W 3-da	MDC (Shaw L. Rd)	53	2	Qgd	760	5	S	35.1 Aug 1967	36.4 Jan 1965	35.6 Apr	35.9 July	
4N 9W 5-da	MDC (Solomon Rd)	131	2	Qgd	860	5	S	119.3 Jan 1964	122.0 Mar 1965	120.1 Apr	120.3 Oct	
BAY COUNTY												
17N 4E 15-dc	Pinconning Twp. (Twp. Hall)	61	2	Ps	610	7	Q	+1.1 Apr 1967	5.0 Aug 1962	+0.2 Dec	2.4 July	
22-ad	Sterling Tube Co. (Horn Rd)	170	6	Ps	620	7	M	7.4 Dec 1967	13.0 Sept 1962	5.7 Dec	11.1 Sept	
22-dc	Pinconning Twp. (2nd St)	110	6	Ps	620	7	R	2.4 Dec 1967	10.5 Aug 1963	0.9 Dec	9.2 Aug	
BRANCH COUNTY												
5S 5W 2-aa	M. Wade (North Well)	45	12	Qgd	985	5	M	4.3 Apr 1967	8.8 Nov 1964	5.0 Feb	7.3 Oct	Meas. disc. 10-68
6W 22-aa	MSHD (U. S. 27)	27	1	Qgd	950	5	M	11.6 May 1967	16.3 Nov 1964	11.2 Feb	13.9 Nov	
7W 5-da-1	Union City (Athletic Field)	22	1	Qgd	880	4	M	2.6 Apr 1967	5.5 Sept 1965	2.0 Jan	4.7 Sept	Meas. disc. 10-68
5-da-2	Do.	57	1	Qgd	880	4	M	0.6 Apr 1967	6.7 Nov 1965	0.9 Jan	2.2 Oct	P, Do.
31-bb	J. Herman (Francisco Rd)	22	4	Qgd	905	5	M	3.1 Mar 1965	7.7 Sept 1964	3.7 Apr	6.5 Sept	Meas. disc. 10-68
8W 28-db	BCRC (Sherwood)	42	1	Qgd	880	4	M	14.9 May 1967	18.9 Nov 1965	14.8 Feb	16.6 Nov	
6S 6W 19-bb	Coldwater Twp. (Test 1)	56	6	Qgd	950	5	M	22.6 May 1967	28.3 July 1964	22.1 Feb	23.5 Nov	
22-ca	City of Coldwater (test for No. 4)	113	6	Qgd	970	5	R	10.0 May 1967	24.1 Aug 1964	10.0 Feb	19.9 June	P
7W 27-dc	C. Crandell (U. S. 12)	24	1	Qgd	928	5	M	14.3 Apr 1967	18.2 Oct 1964	14.2 Feb	16.1 Oct	Meas. disc. 10-68
8W 27-bd	H. Herman (Lindley Rd)	29	2	Qgd	895	5	M	5.5 Apr 1965	9.8 Nov 1964	6.0 Feb	8.4 Sept	Do.
7S 6W 24-cc	O. Maxon (Warren Rd)	19	1	Qgd	1,010	5	M	6.0 Mar 1965	8.8 Aug 1964	6.1 Mar	7.4 Aug	Do.
8W 12-ad	BCRC (Parham Rd)	42	1	Qgd	915	4	M	9.3 Apr 1967	13.5 Oct 1966	9.6 Apr	11.1 Mar	Do.
24-cb	M & J Adams (Orland Rd)	39	1	Qgd	916	5	M	5.0 Dec 1965	9.6 Nov 1964	4.8 Apr	6.7 Oct	Do.
8S 5W 6-ab	Chipman (Calif. No. 2 School)	55	4	Qgd	1,032	5	M	14.0 May 1966	19.4 Dec 1964	13.9 Feb	16.6 Nov	
7W 6-cc	BCRC (Rierson Rd)	37	1	Qgd	962.71	5	M	17.5 Apr 1967	23.4 Nov 1964	16.9 Feb	18.1 Oct	Meas disc. 10-68
7-dd	BCRC (Gravel pit)	34	1	Qgd	956.54	5	M	3.9 June 1966	10.3 Jan 1965	2.6 July	4.1 Jan	Do.
8W 17-cd	Bronson School (Trayer Rd)	38	1	Qgd	917	5	M	13.1 May 1966	16.3 Nov 1964	13.2 Feb	15.1 Nov	
CALHOUN COUNTY												
1S 7W 10-bb	K. Sabin (M 78)	12	15	Qgd	907.99	23	W	0.9 Mar 1950	7.2 Dec 1964	3.7 Feb	4.4 Jan	Meas. by owner
32-ba	H. Rice (Capital Ave)	43	2	Mm	842.88	23	Q	9.0 Apr 1950	20.3 Sept 1964	16.0 Apr	16.8 Oct	P, Meas. disc. 10-68
32-bd	Penfield Twp. (Hopkins St)	95	6	Mm	845	5	R	21.6 May 1967	27.0 Aug 1964	21.2 Apr	24.0 Aug	P

✱ Michigan Department of Conservation now Michigan Department of Natural Resources

TABLE 1. RECORDS OF MICHIGAN OBSERVATION WELLS. (Continued)

COUNTY AND WELL NUMBER TWP., RANGE, SEC.	OWNER OR OTHER DESIGNATION	DEPTH (ft)	DIAMETER (in)	AQUIFER	ALTITUDE	YEARS OF RECORD	FREQUENCY OF MEAS., 1968	OBSERVED WATER-LEVEL EXTREMES THROUGH 1967 HIGHEST	DATE	LOWEST	DATE	IN 1968 HIGHEST	DATE	LOWEST	DATE	REMARKS
CALHOUN COUNTY (Continued)																
1S 7W 32-da	City of Battle Creek (Verona 22)	127	8	Mm	830.79	30	D	0.7	Apr 1950	16.8	July 1959	7.6	Dec	13.0	July	P, Meas. by owner
2S 6W 25-aa	City of Marshall (Ferguson)	59	6	Mm	904.85	19	M	5.5	May 1950	9.7	Aug 1964	7.8	July	8.3	June	P, Meas. by owner
8W 2-db	Oliver Elec. Mfg. Co. (Angell St)	92	10	Mm	819.99	23	R	4.8	Apr 1947	15.6	Mar 1964	12.3	June	14.4	Nov	P
3-dd	D. Conto (20th St)	12	2	Qgd	862.02	23	Q	1.8	Apr 1950	11.6	Sept 1964	5.2	Jan	6.5	Oct	Meas. disc. 10-68
14-dd	City of Battle Creek (TW 1, Goguac Lake)	89	26	Qgd	914.97	24	Q	6.2	May 1950	12.9	Oct 1946	7.1	July	8.4	Jan	Do.
16-ac	Battle Creek Twp. (Territorial Rd)	148	8	Mm	917	5	R	0.3	May 1967	12.0	Aug 1966	0.7	Dec	10.4	June	P
CASS COUNTY																
6S 16W 1-ac	City of Dowagiac (Water Works)	159	10	Qgd	750.19	20	W	+5.2	Feb 1960	7.9	Aug 1965	+3.3	Apr	7.1	Jun	P, Meas. by owner
8S 14W 17-ba	T. Little (Starbrick Rd)	55	28	Qgd	840	24	W	46.2	July 1950	55.0	Mar 1957	48.6	Aug	50.3	Jan	
CHARLEVOIX COUNTY																
32N 4W 10-da	MDC (33) (Thumb Lake)	17	2	Qgd	1,060	29	M	1.2	Mar 1958	7.4	Feb 1959	1.4	Nov	3.9	Sept	
33N 4W 2-ac	MDC (Wolverine CCC)	94	6	Qgd	970	21	Q	69.5	July 1960	75.8	Apr 1956	72.8	Apr	73.9	Dec	
CHEBOYGAN COUNTY																
33N 1W 22-bd	MDC (Cornwall Lake impoundment) No. 4	15	1	Qgd	890	3	M	1.5	Apr 1967	6.2	Oct 1966	2.1	Apr	4.7	Aug	
22-dc	Do. No. 5	19	1	Qgd	890	3	M	2.5	Apr 1967	8.3	Oct 1966	3.4	Mar	6.4	Aug	
26-bb	Do. No. 1-B	42	1	Qgd	915	3	M	31.0	Aug 1967	34.8	Mar 1967	32.5	Jan	33.5	Dec	
26-da	Do. Pigeon R. CCC	164	6	Qgd	925	3	R	58.7	May 1966	61.8	Nov 1966	57.1	May	58.3	Nov	
27-ac	Do. No. 6	20	1	Qgd	860	3	M	13.4	Apr 1967	18.1	Nov 1966	8.2	June	12.5	Jan	
27-ba	Do. No. 11	82	1	Qgd	860	3	M	9.3	Jan 1966	13.3	Dec 1967	11.7	Dec	13.3	Jan	
27-cb	Do. No. 7	32	1	Qgd	860	3	M	18.6	Apr 1967	21.0	Nov 1966	19.2	Apr	20.4	Apr	
27-cc	Do. No. 8	37	1	Qgd	895	3	M	24.0	Aug 1967	27.4	Mar 1966	24.6	May	25.6	Dec	
27-da	Do. No. 9	32	1	Qgd	870	3	M	18.5	July 1967	23.0	Jan 1967	19.1	July	20.6	Dec	
27-dc	Do. No. 10	32	1	Qgd	895	3	M	16.0	Aug 1967	19.4	Feb 1966	16.5	May	17.4	Dec	
27-dd	Do. No. 12	22	1	Qgd	850	3	M	7.6	Dec 1967	9.9	Oct 1966	8.1	Mar	9.5	Aug	
34N 1W 1-cb	MDC (7) (M-68)	11	2	Qgd	780	23	Q	2.8	Mar 1938	5.6	Oct 1955	3.8	Apr	4.1	Oct	
CLINTON COUNTY																
5N 1W 24-bd	MDC (Rose Lake)	40	2	Qgd	870	5	Q	30.0	June 1966	32.2	Sept 1964	29.6	Apr	30.3	Oct	
2W 31-cb	Mich. Dept. of Aeronautics (Airport)	195	6	Ps	850	11	R	45.0	Mar 1949	66.4	Jan 1967	63.7	Dec	66.4	Jan	P
32-dc	Mich. Health Dept. (Quarantine Farm)	135	4	Ps	849.21	25	M	42.0	Sept 1944	99.2	May 1966	96.2	Oct	97.7	Jan	P
6N 1W 3-bb-1	MDC (Sleepy Hollow impoundment) No. 6	42	1	Qgd	784.77	3	M	8.6	May 1967	12.8	Nov 1966	8.9	Apr	10.8	Oct	
3-bb-2	Do. No. 5	62	1	Qgd	814.05	3	M	41.5	May 1967	43.3	Nov 1966	41.4	Apr	41.8	Sept	
4-da	Do. No. 4	57	1	Qgd	817.74	3	M	39.9	May 1967	41.7	Jan 1966	39.4	Apr	39.8	Mar	
9-dc	Do. No. 14	32	1	Qgd	797	3	M	1.6	Apr 1967	6.5	Sept 1967	1.6	Mar	5.0	Oct	
9-dd	Do. No. 1	22	1	Qgd	789.15	3	M	3.5	Apr 1967	5.2	Sept 1966	3.7	Mar	4.7	Oct	
10-ad	Do. No. 12	37	1	Qgd	802.98	3	M	5.3	May 1967	11.8	Nov 1966	5.0	Apr	9.2	Oct	
10-ba	Do. No. 3	42	1	Qgd	792.48	3	M	6.0	Mar 1966	11.6	Nov 1966	6.2	Mar	10.6	Oct	
10-bc	Do. No. 2	32	1	Qgd	801.38	3	M	17.3	May 1967	19.8	Nov 1966	17.3	Apr	18.3	Oct	
10-dd	Do. No. 13	32	1	Qgd	815	3	M	12.7	May 1967	18.4	Aug 1966	13.0	Apr	15.6	Oct	
15-cc	Do. No. 15	17	1	Qgd	805	3	M	2.9	May 1967	5.4	Aug 1966	2.9	June	3.7	Oct	
6N 2W 16-dd	MSHD (U.S. 27)	23	14	Qgd	803.32	21	M	14.6	Apr 1952	19.9	Feb 1964	16.3	June	18.0	Nov	Fed. key well

TABLE 1. RECORDS OF MICHIGAN OBSERVATION WELLS. (Continued)

COUNTY AND WELL NUMBER (WP., RANGE, SEC.)	OWNER OR OTHER DESIGNATION	DEPTH (ft)	DIAMETER (in)	AQUIFER	ALTITUDE	YEARS OF RECORD	FREQUENCY OF MEAS., 1968	OBSERVED WATER-LEVEL EXTREMES THROUGH 1967 HIGHEST	DATE	LOWEST	DATE	IN 1968 HIGHEST	DATE	LOWEST	DATE	REMARKS
LINTON COUNTY (Continued)																
7N 1W 34-ca	MDC (Sleepy Hollow impoundment) No. 9	39	1	Qgd	793.84	3	M	17.0	May 1967	21.7	Dec 1966	16.4	June	18.6	Oct	
34-cb	Do. No. 10	62	1	Qgd	787.22	3	M	21.0	May 1967	23.2	Nov 1966	21.0	Apr	22.3	Oct	
34-cc	Do. No. 7	32	1	Qgd	785.34	3	M	18.0	May 1967	20.0	Nov 1966	17.9	Apr	19.2	Oct	
34-cd	Do. No. 8	28	1	Qgd	783.39	3	M	15.9	May 1967	18.9	July 1967	15.8	Apr	17.3	Oct	
34-dd	Do. No. 11	32	1	Qgd	788.09	3	M	19.7	July 1967	20.9	Nov 1966	(19.3	Mar)			Well destroyed
2W 9-bb	City of St. Johns (6" test)	535	6	Pe	743.36	5	R	52.2	May 1967	77.8	Aug 1966	54.7	Apr	78.3	Aug	P
8N 1W 13-bc	Village of Elsie (12" test)	298	12	Pe	699.68	22	M	+4.2*	May 1965	37.6	Oct 1957	+4.2*	Jan	5.4	July	P, *well flowing
4W 22-bd	MDC (Maple R. Game Area)	90	2	Qgd	680	5	Q	65.2	Aug 1967	70.8	Jan 1965	66.4	Apr	66.8	Oct	
CRAWFORD COUNTY																
25N 1W 15-dd	USFS (Eldorado)	56	6	Qgd	1,190	21	R	29.4	July 1960	36.0	Apr 1951	30.4	Aug	31.2	Dec	
3W 28-cc	MDC (8) (M-76)	13	1	Qgd	1,175.14	34	Q	8.6	July 1960	11.3	Oct 1958	10.4	Apr	10.7	Oct	
26N 4W 11-cb	MDC (Game Refuge)	12	15	Qgd	1,147.59	27	R	4.0	June 1943	9.8	Sept 1958	6.4	June	8.6	Sept	
27N 1W 20-cc	MDC (22) (N. Down River Rd)	15	2	Qgd	1,140	33	Q	1.6	July 1943	5.9	Oct 1955	3.8	July	4.2	Oct	
4W 23-aa	MDC (51) (U. S. 27)	17	2	Qgd	1,180	29	Q	10.9	July 1943	15.6	Dec 1964	12.6	Apr	13.7	Oct	
DELTA COUNTY																
38N 22W 24-db	USFS (3) (Peninsula Point)	36	6	Or	585	11	Q	0.3	May 1964	5.5	Oct 1958	2.0	June	4.4	Aug	
39N 23W 28-ab	M. & S. Blake (Schemmel)	530	5	Em	680	11	R	1.3	May 1960	5.1	Dec 1966	3.0	June	4.4	Jan	
41N 18W 31-cd	C. Thompson (Isabella)	250	4	Or	615	11	Q	3.7	May 1964	6.3	Feb 1961	3.6	June	5.1	Jan	
19W 17-ca	USFS (Morman Cr. CCC camp)	58	6	Or	635	11	Q	0.0	May 1967	4.5	Nov 1963	1.2	May	3.6	Jan	
42N 18W 17-ac	USFS (Cooks CCC camp)	60	6	Qgd	770	11	Q	21.2	May 1960	28.4	Mar 1966	24.0	May	26.8	Jan	
19W 20-aa	USFS (Pollack CCC camp)	134	6	Or	730	11	Q	23.8	Mar 1960	28.0	Mar 1966	25.1	Aug	27.6	Oct	
43N 19W 24-bb	H. Clarage (FFHwy-13)	405	4	Otb	860	11	Q	77.0	July 1960	88.8	Oct 1966	78.4	Oct	79.7	Jan	
DICKINSON COUNTY																
42N 27W 33-ba	E. LaFreniere (WMP 10)	12	36	Qgd	1,060	15	M	2.7	May 1960	10.8	Oct 1955	2.7	July	9.8	Feb	Meas. by WMP
43N 28W 32-ad	MDC (Felch)	1	29	Qgd	1,160	3	Q	13.6	May 1967	16.6	Oct 1966	14.2	Oct	16.8	May	
EATON COUNTY																
2N 4W 19-cb	City of Charlotte (Water Works Park)	25	240	Qgd	889.44	22	Q	8.0	Apr 1947	17.5	Sept 1964	13.2	July	15.8	Oct	P, Meas. disc. 10-68
3N 3W 2-ba	City of Lansing (TW 63H) (Stiefel Farm)	66	1	Qgd	839	5	R	3.1	Mar 1965	15.3	Nov 1967	4.1	June	18.0	Nov	P
4N 3W 10-ad	J. Schneeberger (Crietz Rd)	121	3	Pe	855.99	25	M	31.3	May 1948	44.6	Nov 1966	43.5	July	44.1	Aug	P, Meas. disc. 10-68
12-cd	F. Wheeler (Robins Rd)	381	6	Pe	861.91	16	R	67.5	Nov 1953	101.6	Aug 1967	89.3	Feb	101.7	July	P
4W 2-cc	City of Grand Ledge (Chair Co.)	376	12	Pe	846.59	21	R	21.1	June 1967	30.1	Aug 1964	19.7	July	23.0	Jan	P
11-ab	City of Grand Ledge (Park)	350	8	Pe	788.9	9	R	+4.6	Mar 1967	9.1	Aug 1966	+4.4	June	5.1	Dec	P
GENESEE COUNTY																
6N 7E 9-dc	Fisher Body Div., GMC (Grand Blanc)	235	6	Pe	841.71	17	R	37.8	Nov 1952	66.5	July 1966	48.7	Mar	72.8	Aug	P
7N 7E 17-ad	Cons. Power Co. (What Cheer Mine)	222	12	Pe	757.83	23	R	24.2	Feb 1950	38.0	Aug 1955	24.4	Feb	30.0	July	P, Meas. disc. 10-68
29-cd	C. Crain (Columbine Rd)	14	1	Qgd	776.63	23	Q	1.7	Dec 1949	11.4	Sept 1964	7.0	Apr	10.0	Oct	Meas. disc. 10-68
32-cc	A. Arndt (Maple Rd)	140	2	Qgd	792.27	23	Q	18.5	June 1947	44.4	Oct 1967	41.9	July	43.1	Oct	P
GOGEBIC COUNTY																
48N 47W 31-dc	City of Ironwood (Big Springs)	115	1	Qgd	1,170	6	R	12.6	June 1966	33.0	Jan 1966	15.0	May	24.3	Mar	P
34-da	City of Ironwood (Spring Creek Gp 3)	22	6	Qgd	1,190	8	R	+0.1	May 1962	4.8	Sept. 1963	1.0	Mar	4.5	Mar	P

TABLE I. RECORDS OF MICHIGAN OBSERVATION WELLS. (Continued)

COUNTY AND WELL NUMBER (TWP., RANGE, SEC.)	OWNER OR OTHER DESIGNATION	DEPTH (ft)	DIAMETER (in)	AQUIFER	ALTITUDE	YEARS OF RECORD	FREQUENCY OF MEAS., 1968	OBSERVED WATER-LEVEL EXTREMES THROUGH 1967 HIGHEST	DATE	LOWEST	DATE	OBSERVED WATER-LEVEL EXTREMES IN 1968 HIGHEST	DATE	LOWEST	DATE	REMARKS
GRAND TRAVERSE COUNTY																
26N 9W 13-cc	MDC (2) (6 roads)	14	2	Qgd	961.78	29	M	4.4	Apr 1967	7.9	Oct 1949	5.2	Mar	7.2	Oct	
11W 27-cb	MDC (2) (Mill Rd)	14	2	Qgd	914.25	28	Q	1.1	Apr 1962	4.0	Aug 1936	2.1	Apr	2.7	Oct	
27N 9W 4-ab	MDC (18) (Williamsburg)	15	2	Qgd	687.01	27	M	0.2	Feb 1966	2.5	July 1935	1.0	Mar	1.7	Oct	
GRATIOT COUNTY																
9N 3W 33-ad	MDC (Maple Rd)	55	3	Qgd	658	5	Q	11.1	Mar 1965	16.6	July 1965	14.3	Apr	15.3	July	
11N 3W 3-bb	E. Waber (Prospect St.)	49	2	Qgd	733.20	23	M	5.0	Feb 1959	36.3	Oct 1964	4.1	May	10.8	June	P
4-ac	City of Alma (TW 6) (Pine River)	165	8	Qgd	733.31	13	R	+2.1	Apr 1967	31.0	July 1965	+2.4	Jan	20.7	Aug	P
12N 2W 18-ba	Mich. Chemical Co. (Riverside Dr.)	1,261	5	Mm	720	12	M	131.7	Dec 1967	267.7	Aug 1957	124.5	Dec	130.9	Jan	
3W 24-da	City of St. Louis (3)	216	16	Qgd	730	9	R	37.9	Jan 1964	80.7	July 1967	69.4	Oct	79.3	Aug	P
34-dc	S. Brown (Court St)	55	2	Qgd	727.12	22	M	+0.5	Mar 1967	40.9	June 1950	0.1	Feb	17.5	Aug	P, Meas. disc. 10-68
35-bc	Reed Excavating Co. (Bridge St.)	20	36	Qgd	738.78	19	M	12.7	Apr 1967	17.9	Feb 1963	15.6	June	17.0	Sept	
HILLSDALE COUNTY																
6S 3W 23-bb	City of Hillsdale TW 6	26	6	Qgd	1,070	11	W	1.6	June 1960	13.0	Sept 1957	1.3	Jan	7.1	Oct	P, Meas. by owner
7S 2W 10-ca	Pittsford State Game Area	20	1	Qgd	1,070	3	M	8.2	Apr 1967	11.1	Sept 1967	8.4	Feb	9.9	Oct	
INGHAM COUNTY																
1N 2E 3-ab	MSHD (M-36 & M-52)	320	5	Ps	960	1	M					27.2	Dec	27.8	Aug	Record started 8-68
2N 1E 34-db	MDC (Williamston Rd)	87	2	Qgd	980	5	Q	23.8	June 1966	29.3	Oct 1964	23.5	Aug	23.9	Oct	
3N 1E 7-cd	M. Lotte (windmill)	184	3	Ps	900	5	M	0.4	Dec 1967	7.0	Nov 1964	+0.3	July	2.8	Nov	
4N 1E 21-cd	Duncan Lumber Co. (Sherwood)	265	8	Ps	890	6	R	20.1	May 1967	23.2	Aug 1965	20.4	Apr	21.9	Sept	
2N 1W 5-bb	City of Mason (Gravel pit)	210	8	Ps	890	5	R	18.6	May 1967	23.8	Nov 1964	16.8	July	19.0	Jan	P
5-dd	Do. (old No. 2)	150	6	Ps	890	21	W	0.1	June 1949	10.7	Aug 1964	4.2	Dec	7.0	Apr	P, Meas. by owner
4N 1W 16-da	Meridian Twp (4" test)	398	4	Ps	841.16	1	M					6.7	Dec	8.7	Oct	Record started 10-68
18-ad	Marble School (Hagadorn Rd)	175	3	Ps	847.85	17	M	20.1	Apr 1953	51.6	Oct 1967	50.7	Mar	57.7	Oct	P
27-dc	Michigan State Univ. (Dobie)	278	8	Ps	860	6	R	5.7	Apr 1965	11.1	Nov 1967	5.7	June	16.0	Aug	P, Meas. disc. 12-68
4N 2W 9-bd	City of Lansing (Seymour 1)	401	14	Ps	828.81	40	R	15.6	Mar 1931	178.0	Jan 1967	169.6	Dec	179.4	Apr	P
16-da	City of Lansing (Cedar)	417	12	Ps	829.11	24	R	42.0	Mar 1946	67.0	Aug 1949	54.5	July	63.7	Apr	P
17-ab	City of Lansing (Logan)	424	20	Ps	858.72	38	R	34.3	Dec 1929	167.7	Dec 1967	163.0	Dec	168.3	May	P
17-bb	Olds Drop Forge (4)	417	12	Ps	872.55	23	Q	104.9	Dec 1946	167.9	Oct 1967	165.0	Jan	167.1	Oct	P, Meas. disc. 10-68
21-ba	City of Lansing (Townsend)	410	14	Ps	834.10	42	R	2.0	May 1906	78.2	June 1966	69.6	Dec	77.9	May	P
22-bc	City of Lansing (P-5)	338	12	Ps	823.64	39	M	7.1	July 1932	69.4	Dec 1966	56.6	July	67.9	Oct	P
23-ba	City of Lansing (RS-7)	467	12	Ps	824.86	36	M	7.6	Nov 1930	125.6	July 1965	97.7	Feb	116.1	July	P, well destroyed 9-68
24-ca	Michigan State Univ. (Spartan Village)	453	10	Ps	853.45	24	R	25.5	Mar 1946	95.6	Aug 1967	77.5	Mar	96.1	Apr	P
26-bb	Fenner Arboretum Park	215	6	Ps	835	1	R					52.0	July	58.9	Dec	Record started 7-68
28-ba	Atlas Drop Forge (2)	425	8	Ps	849.20	23	Q	30.3	Apr 1948	63.0	Mar 1967	57.3	Oct	60.8	Jan	P, Meas. disc. 10-68
31-cc	C. Weber (Maybel St.)	204	3	Ps	880.15	25	M	18.9	Apr 1952	27.6	Jan 1965	24.6	Feb	34.3	Sept	P
IONIA COUNTY																
5N 5W 17-cd	MDC (Morris Rd)	98	2	Qgd	830	5	Q	85.5	Aug 1967	88.9	Nov 1964	85.3	July	85.7	Apr	
6N 5W 33-aa	Barley-Erhart Co.	15	180	Qgd	715	12	M	4.6	Apr 1960	10.7	Aug 1965	5.9	Jan	10.0	Nov	
7N 7W 23-bb	Mich. Tng. Unit at Ionia	127	6	Qgd	741.65	9	R	28.4	Apr 1961	34.1	Oct 1961	28.0	Feb	31.9	Aug	P
25-ac	Ionia State Hospital	23	6	Qgd	635.76	9	R	1.2	Mar 1962	15.3	Oct 1963	2.0	July	13.5	Nov	P

TABLE 1. RECORDS OF MICHIGAN OBSERVATION WELLS. (Continued)

COUNTY AND WELL NUMBER TWP., RANGE, SEC.	OWNER OR OTHER DESIGNATION	DEPTH (ft)	DIAMETER (in)	AQUIFER	ALTITUDE	YEARS OF RECORD	FREQUENCY OF MEAS., 1968	OBSERVED WATER-LEVEL EXTREMES THROUGH 1967 HIGHEST DATE	THROUGH 1967 LOWEST DATE	IN 1968 HIGHEST DATE	IN 1968 LOWEST DATE	REMARKS
IRON COUNTY												
42N 31W 33-db	Iron Co. (WMP 7)	11	1	Qgd	1,275	21	M	+0.2 May 1960	6.3 Oct 1948	0.3 July	4.7 Feb	Meas. by WMP
43N 32W 26-ac	Cayia Mine (shaft)	200+	4		1,420	10	Q	29.8 May 1960	39.7 Jan 1964	31.7 July	36.8 Jan	Mine drainage study
35W 11-ad	J. Javoroski (WMP 23)	47	36	Qgd	1,565	24	M	38.6 Sept 1960	47.1 Aug 1949	38.2 Oct	40.0 May	Meas. by WMP
20-dc	B. Henriksen (WMP 25)	48	1	Qgd	1,560	24	M	41.7 June 1953	48.3 Aug 1949	42.4 Oct	43.3 Apr	Do.
33-bd	MSHD (WMP 34)	12	1	Qgd	1,520	21	M	1.9 July 1953	8.4 Mar 1949	2.4 July	4.9 Mar	Do.
44N 33W 10-cc	Iron County (WMP 21)	8	1	Qgd	1,540	21	M	2.0 Apr 1954	8.0 Feb 1964	2.6 July	6.0 Feb	Do.
37W 14-bb	USFS (Former CCC camp)	102	6	Qgd	1,720	10	Q	93.8 Nov 1960	96.2 Sept 1964	94.2 Oct	94.5 Apr	
25-cd	USFS (Fire tower)	123	8	Qgd	1,690	4	Q	102.1 July 1967	103.3 Dec 1965	102.9 Jan	102.9 Apr	Well destroyed 7-68
45N 37W 23-ac	USFS (WMP 28)	8	1	Qgd	1,610	21	M	0.7 Apr 1965	4.7 Sept 1948	1.2 July	3.1 Aug	Meas. by WMP
46N 33W 18-bc	MSHD (WMP 17)	12	1	Qgd	1,560	21	M	2.8 Apr 1949	dry Feb 1956	4.4 July	7.4 Feb	Do
JACKSON COUNTY												
3S 1W 2-bd	City of Jackson (Hamburg St)	400	12	Pe,Mm	935	3	R	23.2 Jan 1967	54.0 Aug 1967	21.0 Dec	59.6 July	P
10-dc	Summit Twp. (Francis St.)	323	12	Pe,Mm	935	9	R	14.3 Jan 1961	36.2 July 1965	17.3 Dec	31.5 Aug	P
11-aa-1	City of Jackson (4a) (Belden Rd)	360	6	Pe,Mm	935	12	D	18.6 Jan 1961	108.0 June 1966	32.5 Dec	102.6 Aug	P, Meas. by owner
11-aa-2	City of Jackson (Belden Rd)	36	3	Qgd	928.82	7	R	2.6 Apr 1967	18.2 Nov 1964	+1.5 July	4.3 Jan	
KALAMAZOO COUNTY												
2S 9W 33-ad	KCRC (MN Ave.)	44	1	Qgd	935	5	R	15.1 Dec 1967	19.2 Oct 1964	14.7 Feb	15.4 Jan	Meas. disc. 5-68
11W 3-aa	Brown Co. (61)	36	6	Qgd	763.18	13	R	8.3 May 1967	14.0 Aug 1967	9.3 July	11.0 Sept	P
2S 11W 10-db	General Printing	49	10	Qgd	761	1	R			12.4 July	16.8 Oct	Record started 6-68
14-dc	Brown Co.	100	12	Qgd	780	1	R			10.4 Dec	23.3 June	Do.
15-da	Consumers Power Co. (steam plant)	64	12	Qgd	766.17	23	R	9.2 Mar 1950	19.4 Sept 1964	9.6 July	12.9 June	P
20-bb-1	City of Kalamazoo (Kendall)	81	5	Qgd	880	6	R	12.4 Oct 1967	18.7 Jan 1965	11.0 Apr	14.2 Nov	P, Meas. disc. 11-68
20-bb-2	City of Kalamazoo Kendall (Deep)	106	4	Qgd	880	1	R			22.4 Dec	47.1 July	Record started 5-68
22-cd	City of Kalamazoo (Stockbridge)	137	4	Qgd	764.7	9	R	6.7 May 1967	31.1 Aug 1961	9.5 Jan	15.7 Aug	P
23-ad	Allied Paper Co.	43	12	Qgd	760	1	R			3.8 July	16.4 Nov	Record started 6-68
3S 11W 4-ad-1	City of Kalamazoo (A-D)	135	3	Qgd	854.03	10	R	0.5 May 1967	12.9 July 1964	1.0 Jan	11.5 June	P
4-ad-2	City of Kalamazoo (A-S)	40	3	Qgd	854.01	10	R	0.0 Oct 1961	9.1 Nov 1959	0.0 June	2.9 June	P
11-ab	Upjohn Co. (Portage Rd)	106	2	Qgd	878.30	5	R	33.8 May 1967	38.4 Dec 1964	35.8 Mar	37.0 Jan	Meas. disc. 5-68
14-aa	Do. (28)	233	16	Qgd	870	2	R	29.2 Dec 1967	45.0 May 1967	27.5 Feb	42.5 Aug	P
22-bd	City of Portage (site C)	120	8	Qgd	865	2	R	5.9 June 1967	7.8 Nov 1967	6.1 Feb	7.7 Nov	P
12W 11-bd	City of Kalamazoo (Atwater)	248	3	Qgd	880	8	R	+2.3 July 1967	-0.3 Jan 1965	+2.3 Apr	+2.0 Jan	
16-ca	KCRC Eagle L.	31	1	Qgd	905	4	M	15.2 May 1967	20.2 Dec 1965	14.8 Feb	16.2 Oct	Meas. disc. 10-68
4S 11W 21-cb	W. Chamberlain (16th St)	21	1	Qgd	863	3	W	10.6 May 1967	13.3 Dec 1966	11.8 Feb	13.8 Dec	
KENT COUNTY												
5N 12W 4-cd	City of Wyoming (DeHaan)	227	8	Mm	682.56	7	R	6.6 Apr 1967	9.9 Aug 1964	6.6 Feb	8.2 Sept	Meas. disc. 9-68
4-dc	Do. (Wobma)	86	6	Qgd	685.97	7	R	9.7 Apr 1967	12.9 Aug 1964	9.7 Feb	11.4 Sept	
6N 9W 3-ad	City of Lowell	110	6	Pgr	650	3	R	8.7 Jan 1967	27.5 Aug 1967	9.5 Feb	29.6 July	P, Meas. disc. 9-68
10W 30-aa	Kent Co. Airport	184	10	Qgd	800	3	R	86.8 May 1967	108.0 Sept 1967	86.4 Mar	102.2 Aug	P
12W 17-ad-1	Jervis Corp. (30th St.)	30	12	Qgd	606	19	M	6.8 Apr 1965	16.4 Feb 1954	9.5 Feb	12.8 Oct	P, Meas. by owner
17-ad-2	Do.	26	6	Qgd	606.05	19	M	6.8 Apr 1965	16.3 Feb 1954	9.4 Feb	12.0 Dec	P, Do.
12W 25-cc	City of Wyoming (50th St.)	241	12	Mm	666.73	9	R	7.8 Nov 1967	55.3 June 1966	6.5 Dec	20.3 June	P, Meas. disc. 12-68
27-bb	City of Wyoming (44th St.)	265	14	Mm	707.24	7	R	49.0 July 1967	56.0 Aug 1964	48.8 Feb	49.9 June	P
10N 12W 13-dd	Rogue R. State Game Area	30	1	Qgd	785	3	M	4.6 May 1967	9.1 Nov 1966	5.8 Feb	9.1 Oct	

TABLE I. RECORDS OF MICHIGAN OBSERVATION WELLS. (Continued)

COUNTY AND WELL NUMBER TWP., RANGE, SEC.	OWNER OR OTHER DESIGNATION	DEPTH (ft)	DIAMETER (in)	AQUIFER	ALTITUDE	YEARS OF RECORD	FREQUENCY OF MEAS., 1968	OBSERVED WATER-LEVEL EXTREMES THROUGH 1967 HIGHEST DATE	THROUGH 1967 LOWEST DATE	IN 1968 HIGHEST DATE	IN 1968 LOWEST DATE	REMARKS
LAKE COUNTY												
17N 13W 4-ad	C & O R.R. (West Well)	83	8	Qgd	840	12	Q	16.2 July 1967	20.4 May 1958	17.3 July	18.4 Dec	
LAPEER COUNTY												
8N 10E 24-bc	Lapeer State Game Area	24	1	Qgd	845	3	M	6.2 Apr 1967	10.3 Nov 1966	4.4 Apr	9.4 Dec	
LENAWEE COUNTY												
5S 1E 12-dd	Onsted State Game Area	39	1	Qgd	1,000	3	M	16.7 Apr 1967	18.8 Sept 1967	16.7 July	17.5 Oct	
6S 4E 8-dd	Fisher Body Div. (GMC) (Tecumseh Plant)	81	8	Qgd	800	4	R	15.4 Dec 1967	18.4 Feb 1965	13.2 Aug	15.4 Jan	P
LIVINGSTON COUNTY												
1N 3E 11-ad	MDC (Roche Rd)	78	2	Qgd	980	5	Q	53.3 Oct 1963	55.3 Jan 1965	51.6 Oct	53.4 Apr	
2N 4E 3-cb	Howell State Hospital (Deer Lake)	375	8	Ps,Mm Mb	916.13	11	R	10.0 May 1964	27.8 Dec 1958	11.0 July	18.3 May	P
LUCE COUNTY												
47N 10W 7-aa	LCRC (CR407)	14	2	Qgd	900	2	Q	2.5 Jan 1967	4.9 Oct 1967	2.8 May	4.7 Jan	
49N 11W 2-ab	State (5) (Muskallunge L.)	7	1	Qgd	630	10	Q	+0.4 May 1960	6.6 Dec 1963	0.6 May	4.2 Oct	Lake Hydr. study
MACKINAC COUNTY												
41N 5W 23-bc	MDC (Round L. CCC camp)	47	6	Ss	610	13	Q	4.3 May 1959	17.5 Mar 1959	10.3 May	12.8 Jan	
42N 2W 7-aa	USFS (Pontchartrain CCC)	102	6	Sm	650	13	Q	13.1 May 1960	32.2 Nov 1963	21.0 May	24.8 Oct	
9-ba	K. Kerr (Nuns Creek School)	84	2	Sm	650	11	Q	+3.3 Mar 1966	6.1 Oct 1966	+1.2 May	0.4 July	
MACOMB COUNTY												
4N 12E 31-db-4	HCMA#36	63	4	Qgd	814.53	6	R	11.1 Apr 1965	22.9 Mar 1963	13.5 Apr	15.9 Jan	Meas. disc. 4-68
31-db-5	HCMA (Auger Hole)	72	2	Qgd	814.53	2	R	12.3 June 1967	16.5 Oct 1967	11.5 June	14.5 Nov	
MARQUETTE COUNTY												
44N 26W 28-da	MDC (Escanaba River CCC)	31	6	Qgd	1,120	15	M	1.9 May 1960	2.8 Aug 1957	2.3 Aug	2.7 Mar	
45N 26W 8-aa	Marquette Co. Rd Comm. (Old M-35)	15	1	Qgd	1,220	6	M	1.4 Apr 1967	7.0 Mar 1965	4.1 Apr	6.0 Jan	
28W 3-da	Marquette Co. Rd Comm. (nr Perch Lake)	32	1	Qgd	1,448.31	6	M	20.4 July 1967	24.6 Apr 1965	19.8 Oct	22.5 Apr	Disc. 10-8
30W 1-bc	A. Janofski (WMP 4)	28	36	Qgd	1,543.41	24	R	23.8 July 1960	dry Mar 1964	24.6 Oct	26.0 Mar	
46N 25W 16-dd	G. Johnson (Sands sta.)	48	1	Qgd	1,198.43	6	R	32.0 Aug 1967	37.7 May 1964	31.4 Sept	34.2 Mar	
28W 12-cb	Mrs. S. Hill (Ishpeming gage)	19	1	Qgd	1,410	7	M	1.4 Oct 1967	3.0 Aug 1963	1.9 Apr	2.7 Jan	
47N 25W 19-cc	MDC (Cascade Jct.)	86	1	Qgd	1,223.11	6	M	29.5 May 1967	39.0 Feb 1965	29.2 Aug	34.4 Mar	
20-cc	MDC (E. of Cascade Jct.)	103	1	Qgd	1,229.78	6	M	86.2 Oct 1967	90.6 June 1965	85.4 Dec	87.7 July	
32-ca	MDC (Gentian)	122	1	Qgd	1,239.17	4	M	96.8 May 1963	100.0 Oct 1964	95.4 Dec	97.7 Feb	
26W 36-bb	Cleveland Cliffs Iron Co. (test)	56	8	Qgd	1,210	4	R	4.6 Apr 1966	7.5 Sept 1965	4.9 July	7.1 Feb	
27W 8-ba	Cleveland Cliffs Iron Co. (near Rock Lake)	37	1	Qgd	1,430	1	M			4.6 Dec	5.3 Aug	Meas. begun 8-68
28W 3-cc	Ely Twp. (U. S. 41)	75	8	Qgd	1,571.99	8	R	11.2 Apr 1966	19.3 Apr 1964	12.0 July	15.9 Mar	Fed. key well
29W 2-da	Marquette Co. Rd. Comm. (near Humboldt)	19	1	Qgd	1,527.32	6	M	2.8 May 1965	5.5 Aug 1963	3.0 May	4.9 Jan	
34-cb	Do. (near Black River School)	23	1	Qgd	1,494.44	7	R	2.0 Apr 1966	6.4 Aug 1966	3.6 Apr	6.0 Mar	Meas. suspended 5-68
48N 26W 34-da	Do. (near Eagle Mills)	31	1	Qgd	1,282.99	6	M	2.0 Apr 1967	7.0 Apr 1964	3.1 July	5.3 Feb	
49N 30W 22-ac	Do. (WMP 13)	17	1	Qgd	1,680	21	M	0.6 May 1951	13.3 Sept 1948	8.7 Apr	9.9 Jan	Meas. by WMP

TABLE I. RECORDS OF MICHIGAN OBSERVATION WELLS. (Continued)

COUNTY AND WELL NUMBER TWP., RANGE, SEC.	OWNER OR OTHER DESIGNATION	DEPTH (ft)	DIAMETER (in)	AQUIFER	ALTITUDE	YEARS OF RECORD	FREQUENCY OF MEAS., 1968	OBSERVED WATER-LEVEL EXTREMES THROUGH 1967 HIGHEST DATE	THROUGH 1967 LOWEST DATE	IN 1968 HIGHEST DATE	IN 1968 LOWEST DATE	REMARKS
MENOMINEE COUNTY												
37N 26W 19-da	MSHD (Carney)	16	4	Otb	800	10	M	3.7 May 1960	7.7 July 1967	3.8 Aug	6.7 Feb	
MONROE COUNTY												
7S 6E 15-ad	Petersburg State Game Area	17	1	Qgd	675	3	M	3.0 Feb 1966	6.4 Sept 1967	4.3 Apr	5.2 Dec	
MONTCALM COUNTY												
10N 8W 17-bb	L. Packard (Colby Rd)	28	2	Qgd	865	5	Q	19.2 Aug 1967	23.5 Mar 1964	20.4 Apr	21.4 Oct	
MONTMORENCY COUNTY												
29N 3E 21-ab	MDC (32) (Co. Rd 612)	14	2	Qgd	900	24	Q	2.5 July 1960	5.9 Jan 1956	3.8 July	5.0 Dec	
MUSKEGON COUNTY												
11N 15W 34-da	Muskegon State Game Area	31	1	Qgd	595	3	M	0.4 Feb 1966	4.0 Oct 1966	0.7 Feb	3.4 Sept	
OAKLAND COUNTY												
1N 7E 5-dd	USGS Test 51S	28	1	Qgd	940	2	M	17.9 July 1967	18.8 Nov 1967	15.1 July	18.1 Jan	Meas. disc. 7-68
2N 7E 5-ba	American Aggregates (Honeywell Lake Rd)	44	2	Qgd	1,020	1	R			26.4 July	27.3 Mar	Record started 3-68
16-ac	USGS Test 48S	65	1	Qgd	923	2	M	38.9 Aug 1967	39.6 Dec 1967	38.2 July	39.3 Jan	Meas. disc. 7-68
9E 9-bd	Do. 01	42	1	Qgd	955	2	M	19.6 July 1967	21.0 Mar 1967	17.6 July	19.4 Jan	Do.
9-bd	Do. 02	32	1	Qgd	950	2	M	21.0 July 1967	22.3 Mar 1967	18.9 July	20.9 Jan	Do.
10-ac	Do. 04	47	1	Qgd	950	2	M	27.1 Dec 1967	28.0 Sept 1967	25.2 July	26.8 Jan	Do.
11-bd	Do. 05	42	1	Qgd	950	2	M	24.8 Dec 1967	26.0 Mar 1967	22.5 July	24.4 Jan	Do.
11-ca	Do. 06	22	1	Qgd	940	2	M	4.3 Apr 1967	7.1 Sept 1967	3.1 July	5.1 Jan	Do.
13-ca	Do. 07	42	1	Qgd	960	2	M	15.6 May 1967	18.4 Mar 1967	13.0 July	16.5 Jan	Do.
15-da	Do. 08	52	1	Qgd	930	2	M	27.6 July 1967	28.6 Mar 1967	25.1 July	27.5 Jan	Do.
10E 22-ba	Cranbrook School (3)	65	6	Qgd	788	19	R	10.4 May 1963	18.9 Dec 1964	10.5 June	12.4 May	P
3N 7E 1-cd	USGS Test W1	42	1	Qgd	1,050	3	M	22.2 July 1967	25.1 Dec 1966	20.8 Dec	22.0 June	
2-cd	Do. D5	27	1	Qgd	1,033	3	M	19.2 July 1967	22.2 Dec 1966	17.2 July	18.9 Jan	
10-aa	Do. D4	37	1	Qgd	1,035	2	M	26.8 July 1967	28.5 Mar 1967	24.0 Aug	26.2 Jan	
11-ca	Do. D1	22	1	Qgd	1,020	3	M	10.3 Dec 1967	14.0 Dec 1966	9.2 Aug	10.3 Jan	
11-cc	Do. D2	27	1	Qgd	1,025	2	R	15.4 Dec 1967	18.5 Feb 1967	12.7 July	15.4 Jan	
12-db	Do. W2	32	1	Qgd	1,025	3	M	11.8 Dec 1967	14.5 Nov 1966	10.4 Dec	11.4 Jan	
13-bd	Do. W3	42	1	Qgd	1,045	3	M	27.6 July 1967	30.1 Dec 1966	26.0 June	27.6 Jan	
14-da	Do. D6	42	1	Qgd	1,037	3	M	26.4 Dec 1967	28.8 Dec 1966	25.0 July	26.0 Jan	
15-aa	Do. D3	42	1	Qgd	1,043	2	M	31.7 Aug 1967	33.4 Mar 1967	28.4 Aug	31.3 Jan	
36-bd	Do. 42S	30	1	Qgd	980	2	M	14.0 July 1967	15.0 Oct 1967	12.8 July	14.0 Jan	Meas. disc. 7-68
8E 6-cd	Do. W4	42	1	Qgd	1,045	2	M	13.1 July 1967	16.4 Feb 1967	9.6 July	13.1 Jan	
7-ac	Do. W5	47	1	Qgd	1,035	2	R	24.2 July 1967	29.5 Feb 1967	23.0 July	30.1 Sept	
18-ba	Do. W7	32	1	Qgd	1,030	2	M	16.3 July 1967	18.7 Feb 1967	14.8 July	17.2 Sept	Meas. disc. 10-68
18-bc	Do. W8	52	1	Qgd	1,050	2	M	34.9 July 1967	36.9 Feb 1967	33.5 July	35.1 Jan	
9E 27-ad	Do. E4	59	1	Qgd	973	2	M	34.1 May 1967	35.1 Mar 1967	33.1 Feb	34.1 June	Meas. disc. 7-68
27-ca	Do. E3	27	1	Qgd	947	2	M	0.6 Apr 1967	4.2 Sept 1967	1.0 July	2.4 June	Do.
29-bd	Do. E1	47	1	Qgd	953	2	M	7.8 Apr 1967	9.1 Sept 1967	7.4 July	8.1 June	Meas. disc. 7-68
33-da	Do. E5	47	1	Qgd	950	2	M	8.2 July 1967	9.2 Sept 1967	7.2 July	8.0 Jan	Do.
34-da	Do. E6	37	1		960	2	M	27.6 Aug 1967	29.2 Mar 1967	26.0 July	27.6 Jan	Do.
36-ab	Waterford Twp. (Josephine Street)	134	12	Qgd	976.70	9	R	75.0 Dec 1967	100.5 Aug 1963	71.2 Dec	76.1 Jan	P
3N 10E 13-ac	Oakland Univ.	183	6	Qgd	940	8	R	68.2 Dec 1967	93.5 July 1963	65.3 Dec	68.8 Jan	
32-ab	City of Pontiac (LS 6) (Hayes-Jones Recr. Ctr.)	184	12	Qgd	923.13	6	R	40.2 Aug 1967	99.4 Oct 1963	39.6 Dec	44.5 July	
4N 6E 25-ad	USGS Test T4	77	1	Qgd	1,040	2	M	31.7 Aug 1967	34.3 Mar 1967	29.8 July	32.0 Jan	Meas. disc. 7-68

TABLE I. RECORDS OF MICHIGAN OBSERVATION WELLS. (Continued)

COUNTY AND WELL NUMBER	OWNER	DEPTH (ft)	DIAMETER (in)	AQUIFER	ALTITUDE	YEARS OF RECORD	FREQUENCY OF MEAS., 1968	OBSERVED WATER-LEVEL EXTREMES				REMARKS
								THROUGH 1967		IN 1968		
TWP., RANGE, SEC.	OR OTHER DESIGNATION							HIGHEST DATE	LOWEST DATE	HIGHEST DATE	LOWEST DATE	
OAKLAND COUNTY (Continued)												
4N 6E 25-ad	USGS Test T6	27	1	Qgd	1,035	2	M	13.6 July 1967	21.4 Mar 1967	12.2 July	17.5 Jan	Meas. disc. 7-68
25-dd	Do. T5	42	1	Qgd	1,030	2	M	2.1 Apr 1967	6.3 Sept 1967	2.2 Apr	4.0 July	Do.
7E 19-cd	Do. T7	22	1	Qgd	1,025	2	M	6.4 Apr 1967	11.1 Oct 1967	7.5 Apr	8.8 June	Do.
20-cc	Do. T1	87	1	Qgd	1,080	2	M	67.5 Nov 1967	69.8 Mar 1967	66.2 July	67.6 Jan	Do.
30-ab	Do. T3	87	1	Qgd	1,080	2	M	67.4 Aug 1967	70.1 Mar 1967	65.7 July	67.5 Jan	Do.
9E 30-dc	Do. 54S	10	1	Qgd	996	2	M	2.4 Dec 1967	5.8 Sept 1967	2.2 Mar	4.1 June	Do.
10E 7-db	Do. 2S	44	1	Qgd	1,050	2	M	22.0 May 1967	24.5 Dec 1967	22.1 Feb	23.3 Jan	Do.
32-bb	Do. J1	22	1	Qgd	1,020	2	M	12.2 Aug 1967	16.3 Mar 1967	9.8 Apr	11.4 Jan	Meas. disc. 6-68
33-bb	Do. J2	22	1	Qgd	1,000	2	M	4.7 Apr 1967	6.3 Sept 1967	4.8 Feb	5.3 June	Meas. disc. 7-68
34-ba	Do. 4S	22	1	Qgd	1,020	2	M	14.3 May 1967	15.8 Dec 1967	13.7 Apr	14.7 Jan	Do.
5N 7E 2-cd	Do. H5	62	1	Qgd	945	2	M	36.2 Dec 1967	37.9 Mar 1967	36.6 June	37.0 Jan	Do.
5-bd	Do. 24S	62	1	Qgd	900	2	M	32.5 July 1967	33.8 Sept 1967	31.8 Apr	32.8 June	Do.
9-cb	Do. 25S	42	1	Qgd	905	2	M	7.9 July 1967	9.3 Oct 1967	7.3 Apr	8.2 June	Do.
12-db	Do. H4	72	1	Qgd	955	2	M	23.1 Nov 1967	24.3 Mar 1967	22.8 Apr	23.3 Jan	Do.
13-cd	Do. H12	57	1	Qgd	975	2	M	28.2 June 1967	30.9 Mar 1967	28.1 Jan	28.6 Feb	Do.
14-aa	Do. H3	62	1	Qgd	943	2	M	23.1 Apr 1967	24.6 Sept 1967	22.9 Apr	23.6 June	Do.
14-cb	Do. H2	65	1	Qgd	923	2	M	12.4 Apr 1967	13.9 Sept 1967	12.3 Apr	13.2 June	Do.
22-bc	Do. H8	27	1	Qgd	923	2	R	15.1 July 1967	16.6 Mar 1967	14.4 Apr	15.9 Jan	Do.
23-bc	Do. H1	32	1	Qgd	915	2	M	3.5 Dec 1967	5.5 Mar 1967	3.3 Apr	4.5 July	Do.
26-ab	Do. H9	32	1	Qgd	938	2	M	8.4 Apr 1967	9.6 Mar 1967	8.8 Apr	9.2 June	Do.
36-ba	Do. H7	72	1	Qgd	985	2	M	31.4 July 1967	33.5 Mar 1967	31.1 Apr	31.6 Jan	Do.
5N 8E 8-ac	Holly State Recreation Area	42	1	Qgd	930	3	M	23.9 Feb 1967	26.5 Sept 1966	24.4 Apr	25.0 July	
18-cb	USGS Test H6	37	1	Qgd	968	2	M	21.3 July 1967	22.5 Sept 1967	20.7 Mar	21.2 Jan	Meas. disc. 7-68
30-ca	Do. H11	37	1	Qgd	990	2	M	10.3 Aug 1967	13.0 Mar 1967	9.6 Apr	10.6 Jan	Do.
31-ca	Do. H10	87	1	Qgd	991	2	M	19.3 July 1967	21.4 Mar 1967	18.6 July	19.4 Jan	Do.
9E 8-da	Do. 20S	46	1	Qgd	1,070	2	M	42.4 July 1967	45.0 Dec 1967	43.7 May	44.9 Jan	Do.
12-cc	Do. 18S	41	1	Qgd	1,053	2	M	30.2 May 1967	31.2 Oct 1967	29.5 July	30.6 Jan	Do.
24-dc	Do. 17S	87	1	Qgd	1,053	2	M	14.0 July 1967	14.9 Oct 1967	13.3 May	14.3 Jan	Do.
36-db	Do. 14S	11	1	Qgd	1,036	2	M	4.0 Dec 1967	5.4 Sept 1967	3.8 Mar	4.5 June	Do.
11E 1-bb	Do. 11S	57	1	Qgd	1,000	2	M	11.4 July 1967	18.2 Oct 1967	9.6 Apr	13.4 Jan	Do.
OGEMAW COUNTY												
23N 1E 4-ad	MDC (Fire suppression well #15)	21	4	Qgd	1,230	15	Q	1.1 Apr 1960	4.4 Oct 1964	1.6 Apr	2.4 Oct	
2E 2-ba	Charles Hudson	7	36	Qgd	1,230	18	R	0.4 May 1952	4.3 Mar 1959	1.4 June	2.4 Dec	
ONTONAGON COUNTY												
46N 38W 30-ad	USFS	65	1	Qgd	1,530	2	M	18.6 Mar 1967	16.4 July 1967	17.0 July	18.2 Mar	
51N 41W 8-bd	Mich. Corrections Dept. (Silver City)	100	6	pCf	620	11	Q	8.2 Apr 1959	18.9 Oct 1963	9.4 Apr	11.8 Jan	
OTSEGO COUNTY												
29N 3W 29-dc	MDC (106) (Waters)	15	2	Qgd	1,260	36	Q	5.1 Apr 1967	9.7 Oct 1958	7.2 Apr	7.9 July	
OTTAWA COUNTY												
5N 15W 27-cc	City of Holland (Waverly Rd)	102	1	Qgd	640	22	M	44.0 Nov 1967	dry July 1953	42.2 Dec	43.9 Jan	Meas. by owner
PRESQUE ISLE CO.												
33N 2E 30-da	MDC (19) (Truck trail)	14	2	Qgd	800	32	Q	0.6 July 1960	5.7 Jan 1956	3.2 Apr	4.2 Dec	
6E 8-bb	A. Styma (Farm)	61	6	Dt	800	10	Q	5.4 Apr 1967	18.8 Mar 1963	7.7 Apr	12.4 July	
21-aa	M. Ardycan (M-65)	43	5	Dt	790	10	Q	1.1 Apr 1963	7.6 Oct 1966	4.3 Apr	6.2 July	

TABLE 1. RECORDS OF MICHIGAN OBSERVATION WELLS. (Continued)

COUNTY AND WELL NUMBER TWP., RANGE, SEC.	OWNER OR OTHER DESIGNATION	DEPTH (ft)	DIAMETER (in)	AQUIFER	ALTITUDE	YEARS OF RECORD	FREQUENCY OF MEAS., 1968	OBSERVED WATER-LEVEL EXTREMES THROUGH 1967 HIGHEST DATE	THROUGH 1967 LOWEST DATE	IN 1968 HIGHEST DATE	IN 1968 LOWEST DATE	REMARKS
ROSCOMMON COUNTY												
22N 3W 22-ad	MDC (7) (Fox Farm)	14	2	Qgd	1,170.58	35	Q	2.6 Apr 1960	7.5 Oct 1964	4.3 Apr	5.3 Oct	
23N 1W 3-dd	MDC (50) (M-76)	12	2	Qgd	1,188.95	30	Q	1.6 June 1943	7.3 Dec 1949	3.9 Apr	5.2 Oct	
24N 2W 20-ba	MDC (1) (Exp. Sta.)	14	8	Qgd	1,145.30	35	R	2.7 May 1967	6.2 Dec 1949	3.8 Feb	4.8 Sept	Fed. key well
SAGINAW COUNTY												
9N 3E 16-bd	R. Ellis (Liberty St.)	129	3	Ps	643	11	W	26.7 Dec 1966	53.8 Sept 1959	28.2 Dec	35.8 Aug	P, Meas. by owner
ST. JOSEPH COUNTY												
7S 12W 19-ac	Three Rivers State Game Area	21	1	Qgd	805	3	M	+1.0 Mar 1967	1.6 Oct 1966	+0.4 Apr	0.6 Sept	
SANILAC COUNTY												
12N 13E 33-dd	MSHD (at Elmer)	150	3	Mn	800	21	W	15.4 Apr 1951	25.6 Jan 1965	16.7 July	20.7 Nov	
SCHOOLCRAFT COUNTY												
45N 13W 16-cc	U.S. Fish & Wildlife (Seney)	154	4	Or	710	17	R	4.8 May 1960	6.5 Oct 1963	5.2 Dec	5.7 Aug	
47N 16W 30-bb	MDC (Cusino CCC)	57	6	Op	900	12	R	5.7 May 1960	16.3 Oct 1963	8.3 Apr	14.6 Feb	
SHIAWASSEE COUNTY												
5N 2E 16-da	A. Cobb (at Perry)	26	1	Qgd	896.00	21	Q	17.3 May 1950	23.2* Jan 1964	19.6 Jan	20.5 Oct	*W/L below obstruction in pipe
VAN BUREN COUNTY												
1S 17W 22-ad	Stevie Bros. (M-140)	132	4	Qgd	640	6	R	35.6 May 1967	e39.15 Aug 1964	35.8 Feb	38.4 Aug	
2S 14W 35-ab	Co. Road Commission (4) (Fisk Lake Rd)	12	1	Qgd	690	6	M	5.9 Mar 1967	8.4 Sept 1964	6.7 Apr	7.9 Sept	Meas. disc. 10-68
13W 2-bb	Co. Road Commission (8) (24th St.)	23	1	Qgd	740	6	M	2.0 Dec 1966	5.1 Sept 1964	2.5 Feb	4.0 Sept	
3S 14W 6-ba	R. Martin (3) 48th St.	59	1	Qgd	740	6	M	38.1 May 1967	43.3 Nov 1964	39.2 Mar	41.0 Oct	
4S 16W 14-cd	O. Klett (Keeler)	170	14	Qgd	800	6	R	19.1 May 1967	27.6 Aug 1964	18.6 Apr	23.5 May	P
14W 24-bb	L. Parker (2) (Co. Rd 352)	33	1	Qgd	790	6	M	20.2 May 1967	25.1 Oct 1964	20.9 Feb	22.6 Nov	Meas. disc. 11-68
16W 23-dd	M. DeMorrow (Keeler Lake)	24	1	Qgd	790	6	M	15.0 May 1967	20.5 Dec 1964	15.0 Feb	16.2 Oct	Meas. disc. 10-68
4S 13W 16-dd	Porter Twp. (1) (Twp. Hall)	83	1	Qgd	930	6	M	45.2 June 1967	50.4 Oct 1964	44.9 May	46.1 Jan	
WASHTENAW COUNTY												
3S 6E 16-bc	City of Ann Arbor (Airport)	55	10	Qgd	821.50	6	R	7.8 Sept 1963	15.9 Oct 1964	3.0 July	8.8 Jan	P
7E 5-bb	City of Ypsilanti (Huron River)	69	8	Qgd	720	7	R	1.8 Feb 1965	21.4 Dec 1965	7.7 June	18.0 Mar	P
9-ac	City of Ypsilanti (NR) (River St.)	50	6	Qgd	710	18	M	29.1 Nov 1945	51.6 Nov 1964	27.6 July	35.8 Jan	P
9-ad	City of Ypsilanti (GP) (Gilbert Park)	94	6	Qgd	710	18	R	29.1 Nov 1945	70.4 Oct 1964	44.0 May	59.4 Feb	P
24-ca-1	Ypsilanti Twp. (104) (Water Works)	87	4	Qgd	665.56	23	R	5.8 Jan 1950	21.4 Feb 1967	15.4 July	20.1 Apr	P
24-ca-2	Do. (106)	53	4	Qgd	664.51	23	R	11.8 July 1943	48.0 Dec 1967	46.3 Feb	50.6 Mar	P, Meas. disc. 4-68
24-ca-3	Do. (107)	53	4	Qgd	664.05	23	M	11.6 Jan 1950	52.1 Dec 1967	52.0 Mar	52.8 Feb	P, Do.
24-cb	Do. (109)	77	4	Qgd	665.56	23	M	15.2 June 1945	48.5 Dec 1967	47.2 May	53.6 Apr	P
24-cc	Do. (117)	75	6	Qgd	657.83	22	R	5.7 Feb 1950	50.5 Dec 1967	38.1 July	56.1 Dec	P
4S 6E 9-bb	Ypsi. State Hosp. (TW 20) (Moon Rd)	184	6	Qgd	800	23	W	51.2 May 1948	88.1 June 1949	62.8 Mar	79.5 Sept	P, Meas. by owner
10-bc	Ypsi. State Hosp. (TW 22) (Warner Rd)	173	6	Qgd	794	23	W	56.6 Oct 1962	88.3 July 1955	66.2 June	70.5 Aug	P, Do.
WAYNE COUNTY												
1S 8E 9-bc	City of Plymouth (Beck Rd)	61	6	Qgd	820	8	R	11.0 June 1962	21.3 Feb 1966	9.3 Aug	15.0 Jan	P
17-aa	Do. (6-Mile Rd)	114	6	Qgd	856	7	R	50.4 Apr 1963	59.6 Dec 1966	52.6 July	56.5 Jan	P
WEXFORD COUNTY												
21N 9W 4-ab	City of Cadillac (Lakeside)	277	6	Qgd	1,291.10	20	M	20.0 July 1953	27.6 June 1964	22.8 Jan	23.6 Aug	P
22N 12W 13-ba	Harrietta State Fish Hatchery	141	4	Qgd	1,060	8	R	+13.6 Feb 1961	+1.5 Jan 1966	+11.8 Jan	+7.6 Jan	P
24N 9W 19-bc	MDC (38) (No. 37 Rd)	11	2	Qgd	994.16	27	Q	0.5 Apr 1959	3.7 Aug 1936	1.3 Apr	2.6 Oct	

TABLE 2. REPORTED GROUND-WATER PUMPAGE BY MOST MUNICIPALITIES, INSTITUTIONS, AND SOME INDUSTRIES, IN MICHIGAN, 1968. (IN MILLIONS OF GALLONS)

Water User	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1968 Total	Max. Day	Min. Day
ALCONA COUNTY															
City of Harrisville	1.6	1.9	1.6	1.1	1.2	1.5	2.3	2.2	1.2	1.4	1.2	1.2	18.4	0.101	0.032
ALGER COUNTY															
Township of Burt	1.4	1.3	1.5	1.4	1.4	3.0	3.0	2.4	2.0	1.7	1.5	1.6	22.2	--	--
ALLEGAN COUNTY															
City of Allegan	25.3	27.0	23.8	25.0	28.0	36.2	33.4	37.8	33.8	27.6	25.6	20.3	343.8	1.999	.522
City of Plainwell	12.5	10.5	12.0	12.9	15.8	18.1	19.1	16.9	12.6	13.9	11.1	10.4	165.8	1.160	.281
City of Otsego	16.2	14.8	15.0	14.5	17.5	22.5	24.4	24.3	19.7	19.7	17.0	16.7	222.3	1.233	.420
ANTRIM COUNTY															
Village of Mancelona	16.3	17.0	17.0	16.8	19.7	18.5	19.0	20.1	18.5	19.0	17.7	17.2	216.8	0.802	--
BARRY COUNTY															
City of Hastings	34.3	34.1	38.0	37.0	39.4	41.5	45.3	43.6	39.7	37.5	33.6	34.4	458.4	2.210	.690
Village of Middleville	20.3	18.2	13.1	11.3	13.3	15.3	14.7	15.8	12.7	12.9	11.6	12.8	172.0	--	--
BENZIE COUNTY															
City of Frankfort	5.9	5.3	5.5	5.8	5.5	6.0	7.9	7.9	6.3	5.3	5.1	5.3	71.8	0.485	.110
BERRIEN COUNTY															
Village of Berrien Springs	9.0	10.3	10.2	11.4	11.1	15.0	12.8	12.2	8.6	8.0	7.5	6.8	122.9	0.673	.151
City of Buchanan	71.7	66.9	71.9	69.7	76.7	79.0	92.1	91.1	80.7	81.3	79.2	79.8	940.1	3.730	1.520
City of Coloma	6.7	6.6	6.4	6.2	7.1	9.4	9.7	10.7	7.2	8.5	7.0	6.8	92.3	0.560	.105
City of Niles	85.9	82.5	82.0	81.9	91.9	105.5	109.1	106.4	89.8	93.5	84.4	82.9	1,095.8	4.960	1.410
BRANCH COUNTY															
City of Bronson	17.4	14.5	14.6	19.4	20.2	15.6	16.2	16.6	15.3	16.9	16.2	13.9	196.8	0.824	.250
City of Coldwater	63.0	54.5	55.3	60.6	65.6	77.8	87.3	80.2	62.3	62.4	51.9	54.2	775.1	4.214	.962
State Home and Training School at Coldwater	15.5	14.8	15.7	14.7	15.1	14.8	16.7	15.7	15.1	15.4	14.3	14.6	182.6	--	--
[b]/Village of Quincy													62.0		
[g]/Village of Union City			21.2			23.2			26.7			22.3	93.4	--	--
CALHOUN COUNTY															
City of Albion	202.4	175.9	201.2	190.9	192.0	191.0	185.4	190.5	174.0	188.2	171.2	165.4	2,228.1	7.538	3.988
American Legion Hospital at Battle Creek	1.0	0.9	0.9	0.9	0.8	0.9	0.9	0.8	0.9	0.7	0.8	0.6	10.1	--	--
Village of Athens	2.2	1.7	1.8	2.0	2.3	1.6	4.4	4.8	4.8	5.4	4.3	4.4	39.7	.188	.038
City of Battle Creek	288.0	278.8	288.9	299.6	330.9	343.9	363.6	380.3	294.9	289.7	251.8	223.3	3,633.7	17.400	4.330
Township of Battle Creek	31.8	29.1	32.3	34.0	45.4	59.8	57.2	54.0	41.2	38.1	37.4	36.7	497.0	3.900	.750
City of Marshall	55.0	50.9	51.0	52.5	59.1	45.9	58.1	59.6	49.4	49.0	44.3	41.7	616.5	2.463	.976
CASS COUNTY															
City of Dowagiac	23.3	21.5	22.2	22.3	25.6	26.5	27.3	29.8	23.1	22.2	19.4	19.2	282.4	1.319	.430
Village of Marcellus	2.9	3.8	3.1	3.2	3.8	4.3	4.5	5.0	3.6	3.6	3.6	3.6	45.0	.279	.063
CHARLEVOIX COUNTY															
City of East Jordan	14.8	13.6	15.0	14.2	17.3	18.5	20.4	22.1	15.2	15.9	13.9	14.9	195.8	1.130	.220
CHEBOYGAN COUNTY															
City of Cheboygan	23.9	22.3	25.1	25.7	21.4	23.4	23.7	28.1	21.2	21.1	21.7	22.5	285.1	1.129	.636
Village of Mackinac City	2.6	2.5	5.2	5.1	11.4	13.4	17.0	16.4	7.5	6.2	4.5	5.0	96.8	.678	.048
CHIPPEWA COUNTY															
Kincheloe Air Force Base near Kinross	29.1	30.6	33.5	31.5	45.0	43.0	50.0	38.6	37.5	35.7	33.4	30.9	438.8	2.385	.808
CLARE COUNTY															
City of Clare	24.4	22.4	24.8	25.1	27.2	29.5	39.4	40.7	27.9	25.9	23.8	22.7	333.8	1.774	.606
City of Harrison	3.4	3.5	4.9	2.3	3.6	3.5	4.5	4.4	2.8	2.6	2.5	3.2	41.2	.206	.047
CLINTON COUNTY															
Village of Ovid	2.7	2.3	2.5	2.7	2.8	2.8	3.2	3.0	2.7	2.6	2.4	2.7	32.4	.157	.062
City of St. Johns	39.3	36.9	38.6	37.5	40.7	38.1	42.0	43.7	38.5	40.0	37.2	38.1	470.6	1.780	.640
CRAWFORD COUNTY															
City of Grayling	4.4	8.5	5.5	6.0	7.6	9.3	6.1	12.1	6.8	6.3	6.6	6.5	85.7	.548	.135
EATON COUNTY															
City of Charlotte	47.2	40.7	44.6	43.4	44.8	45.9	44.3	48.2	44.5	46.1	41.6	49.5	540.8	3.126	.775
City of Eaton Rapids	21.9	24.1	24.9	21.8	30.4	30.2	43.6	42.1	30.7	26.8	24.1	27.9	348.5	1.869	.053
City of Grand Ledge	14.9	13.1	13.7	13.1	14.6	16.2	19.1	16.0	14.0	14.0	13.0	13.5	175.2	.983	.271
Village of Bellevue	NA	NA	NA	NA	NA	NA	4.1	3.8	4.4	3.4	3.2	3.3	NA	.223	.065
[b]/City of Olivet	--	--	--	--	--	--	--	--	--	--	--	--	48.0	--	--
Olds Parts Warehouse near Lansing	1.3	1.8	1.5	1.5	1.3	1.3	1.3	1.7	1.4	1.6	1.7	1.4	17.8	--	--
EMMET COUNTY															
City of Harbor Springs	8.9	9.0	8.7	12.1	11.0	19.3	20.6	23.7	19.4	15.4	9.5	10.3	167.9	1.698	.273
GENESSEE COUNTY															
City of Grand Blanc	21.5	21.3	20.1	21.4	22.3	28.4	28.4	34.6	31.5	23.0	20.4	20.5	293.5	1.800	.528
Beecner Metropolitan District	34.2	29.4	31.8	30.3	32.8	36.0	42.1	40.2	33.3	32.5	30.4	32.4	405.4	2.029	.759
[b]/Village of Clio													60.0	--	--
City of Davison	16.7	15.6	17.5	14.1	15.3	17.9	19.9	19.9	17.2	16.9	15.1	16.8	202.9	.938	.234
City of Fenton	18.1	18.2	17.7	17.1	20.4	23.4	24.8	21.5	19.3	18.9	18.7	19.9	238.0	1.232	.320
[c]/Fisher Body Div. at Grand Blanc	0.5	0.3	0.5	0.5	0.5	1.5	0.9	1.0	0.4	0.5	0.5	0.2	7.3	--	--
City of Mt. Morris	8.4	7.8	8.2	7.5	7.6	7.8	8.6	8.8	7.8	7.3	6.9	7.3	94.0	.428	.181
Village of Otisville	1.2	1.1	1.2	1.1	1.2	1.2	1.4	1.4	1.2	1.2	1.5	1.1	14.8	.065	.022

TABLE 2. REPORTED GROUND-WATER PUMPAGE BY MOST MUNICIPALITIES, INSTITUTIONS, AND SOME INDUSTRIES, IN MICHIGAN, 1968. (IN MILLIONS OF GALLONS) (Continued)

Water User	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1968 Total	Max. Day	Min. Day
GLADWIN COUNTY															
City of Beaverton	2.9	2.7	2.8	2.5	2.6	2.6	2.9	3.1	2.5	2.8	2.8	2.7	32.9	.137	.043
GOGEBIC COUNTY															
City of Bessemer	13.4	12.7	14.2	13.9	13.6	11.6	11.9	11.5	14.1	11.0	10.6	12.4	150.9	--	--
City of Ironwood	40.3	47.5	44.7	34.8	32.8	33.0	34.6	36.5	32.8	33.2	43.1	37.2	450.5	1.846	.851
City of Wakefield	8.7	8.3	9.4	8.4	8.9	7.9	9.2	9.4	7.9	8.7	8.6	8.8	104.2	2.599	.269
GRATIOT COUNTY															
[d]/City of Alma	0.0	2.9	0.0	14.8	3.2	41.7	45.1	50.7	25.6	8.2	6.5	1.5	200.2	2.390	--
Village of Breckenridge	2.8	2.5	2.8	2.7	3.0	3.2	3.5	3.7	3.2	3.1	2.7	2.8	36.0	.158	.054
City of Ithaca	5.6	4.8	5.5	5.2	6.1	6.5	7.1	8.1	5.5	7.0	6.7	7.1	75.2	.492	.135
City of St. Louis	37.8	32.9	36.2	33.7	28.6	30.2	36.0	35.1	31.0	33.9	30.6	31.2	397.2	1.891	.703
HILLSDALE COUNTY															
Village of Jonesville	13.1	15.1	14.7	14.1	15.0	15.1	14.3	13.4	13.7	13.8	12.6	12.5	167.4	.816	.301
[f]/City of Hillsdale	0.0	0.0	0.0	0.0	0.0	27.7	34.4	34.9	33.0	35.1	0.0	0.0	165.1	2.421	.891
HOUGHTON COUNTY															
City of Hancock	15.0	15.4	17.2	16.5	17.0	16.0	17.4	17.5	15.5	17.1	16.0	16.1	196.7	.812	.339
City of Houghton	31.4	30.1	31.3	31.6	29.6	25.9	27.0	26.7	27.4	31.8	30.3	27.5	350.6	1.312	.664
Township of Chassell	2.9	2.9	3.3	2.7	2.3	2.1	2.2	2.2	2.6	3.1	2.9	3.0	32.2	.131	.053
HURON COUNTY															
Village of Pigeon	4.5	4.1	5.0	5.0	5.5	6.2	8.5	8.7	6.6	6.8	5.1	5.4	71.4	.281	.150
Village of Sebewaing	7.8	8.6	8.0	7.0	6.0	8.2	8.3	15.3	6.1	8.0	9.0	11.1	105.0	--	--
INGHAM COUNTY															
City of East Lansing	107.6	110.6	100.4	91.0	102.9	100.5	114.4	104.2	98.0	107.9	96.8	88.5	1,222.8	5.114	2.288
City of Lansing	559.8	528.2	631.6	644.7	644.1	617.0	638.9	621.3	560.5	617.8	558.2	583.8	7,205.9	36.000	12.600
City of Lansing Stiefel Farm Field (Eaton Co.)	88.6	75.2	22.0	9.8	118.2	104.2	136.6	123.3	133.2	114.0	78.7	46.7	1,050.5	--	--
NW Field (Gravel)	--	--	2.7	2.3	0.8	1.9	0.6	--	--	--	--	--	8.3	--	--
Township of Lansing	58.4	40.3	52.5	62.8	49.9	61.6	65.4	55.4	59.0	67.9	49.8	64.7	687.7	--	--
Village of Leslie	5.7	5.6	5.3	5.2	5.6	6.5	7.3	6.2	5.5	5.3	5.0	5.1	68.3	.370	.129
City of Mason	13.9	13.7	14.8	13.5	15.8	20.1	20.0	18.7	15.5	14.2	13.6	14.2	188.0	--	--
Township of Meridian	7.7	7.0	7.7	7.7	9.8	10.4	14.4	11.8	10.5	10.1	10.2	10.4	117.7	--	--
Michigan State University at East Lansing	169.7	163.6	161.1	176.7	189.4	166.3	172.3	170.0	159.9	184.8	162.1	143.1	2,019.0	6.994	3.497
Oldsmobile Forge #2 at Lansing,	3.6	1.9	7.2	9.9	16.1	11.5	12.4	11.1	15.8	16.7	12.7	12.7	131.6	--	--
Oldsmobile Main Plant #1, at Lansing	1.6	2.1	1.2	1.0	0.2	3.3	4.8	5.0	1.7	2.8	0.8	0.4	24.9	--	--
IONIA COUNTY															
City of Ionia	28.1	27.1	30.7	28.9	30.9	31.9	35.9	37.0	32.4	29.7	37.8	30.2	380.6	1.506	.478
State Hospital at Ionia	9.4	8.9	8.2	6.0	7.8	6.3	7.3	8.8	8.6	9.1	9.6	10.3	100.3	--	--
Michigan Reformatory at Ionia	18.4	20.8	19.2	19.2	18.2	19.0	19.5	20.0	19.6	18.7	18.0	20.8	231.4	.680	.574
Michigan Training Unit at Ionia	2.4	2.4	2.2	2.2	2.4	4.0	6.0	4.9	3.3	2.5	2.3	2.7	37.3	.411	.023
City of Portland	14.5	11.0	11.9	11.1	11.8	13.3	16.0	14.3	14.1	10.9	11.7	12.3	152.9	--	--
Village of Saranac	10.2	9.5	8.6	9.6	9.9	9.9	10.5	10.6	11.5	13.8	12.3	12.5	128.9	--	--
IOSCO COUNTY															
Wurtsmith Air Force Base near Oscoda	24.8	20.5	22.6	30.1	29.8	35.2	46.8	41.5	28.1	24.3	24.6	24.5	352.8	--	--
IRON COUNTY															
City of Caspian	10.9	11.6	10.7	9.6	9.6	9.0	10.0	11.0	9.0	9.2	11.1	9.8	121.5	.372	.298
City of Crystal Falls	14.2	13.3	14.7	13.6	14.6	14.6	15.7	15.4	13.5	14.2	13.2	14.0	171.1	.621	.411
City of Iron River	12.4	12.6	13.3	12.0	11.8	13.0	14.0	14.3	11.7	12.9	10.9	11.2	150.1	.579	.256
City of Stambaugh	4.4	4.4	4.8	4.5	4.5	4.4	5.0	4.8	4.5	5.6	5.3	5.6	57.8	--	--
Township of Stambaugh	1.8	1.6	2.3	1.8	1.8	1.9	2.3	2.5	1.6	1.6	1.6	2.2	23.0	--	--
ISABELLA COUNTY															
[g]/City of Mt. Pleasant	60.9	56.0	62.7	58.0	64.2	63.4	72.3	65.8	60.8	68.5	53.1	54.9	740.6	3.177	1.069
Village of Shepherd	2.4	2.3	2.5	2.6	3.0	2.1	2.4	2.3	2.2	2.2	2.2	2.3	28.3	.134	.052
JACKSON COUNTY															
Village of Concord	2.2	1.8	1.9	2.0	2.6	2.6	2.6	2.8	2.5	2.8	1.2	2.2	27.2	.257	.115
[a]/Village of Grass Lake			4.3			5.9			6.8			6.7	23.7	--	--
City of Jackson	370.3	345.5	337.1	341.3	401.6	405.8	446.2	461.4	389.3	408.5	353.7	347.5	4,608.2	19.720	6.410
State Prison of Southern Michigan at Jackson	34.0	33.2	35.2	34.8	40.5	36.2	37.6	37.0	36.2	31.1	28.5	30.7	415.0	2.106	.881
KALAMAZOO COUNTY															
Village of Augusta	3.2	2.9	3.9	3.1	3.4	2.9	3.1	1.6	2.4	3.8	2.1	2.1	34.5	.122	.053
City of Kalamazoo	439.9	411.6	464.3	464.0	520.5	656.1	710.7	748.3	550.6	504.2	456.9	420.5	6,347.6	35.065	10.095
State Hospital at Kalamazoo	15.6	17.0	17.1	15.5	17.8	15.6	17.4	19.2	15.5	18.2	18.8	19.9	207.6	.720	.510
State Hospital at Kalamazoo Colony Farm	1.6	1.6	1.0	1.6	1.1	1.6	1.3	1.7	1.1	1.7	0.9	1.6	16.8	--	--
City of Portage	21.6	19.3	21.0	23.7	30.8	52.2	47.8	50.9	26.1	23.4	21.9	22.5	361.2	4.427	.327
Village of Vicksburg	10.8	10.1	10.4	11.0	14.0	12.4	20.5	15.4	10.3	11.9	10.8	11.4	149.0	.900	.200
Upjohn Company near Kalamazoo	340.2	316.7	356.4	373.5	399.2	425.1	453.1	475.4	424.6	427.9	415.5	402.7	4,810.3	19.002	8.221
City of Parchment	5.9	5.6	7.2	6.7	8.7	13.2	13.3	12.7	7.3	7.4	5.9	5.8	99.7	1.020	.137
[e]/Brown Company Total														3,269.6	
E. side Plant 12	60.2	19.0	12.3	16.4	18.2	14.0	15.5	10.5	15.1	11.9	4.3	18.2	215.6	--	--
Industrial-Paper Division	62.0	58.0	62.0	60.0	60.0	60.0	50.0	51.0	50.0	47.0	45.0	46.5	651.5	--	--
Industrial-Board Division	54.8	44.6	42.9	50.8	53.3	58.4	63.0	66.5	52.4	59.4	59.3	60.3	665.7	--	--
River-Northfield-Board Div.	88.7	83.3	93.3	108.6	111.2	111.1	124.6	115.2	119.9	110.4	106.5	105.5	1,278.3	--	--
River-Northfield-Paper Div.	31.0	32.7	33.9	32.9	31.1	33.5	36.8	39.1	37.4	39.7	35.9	29.7	413.7	--	--
S. side-Service Products	2.3	2.2	2.6	2.6	3.8	6.0	5.3	6.3	3.8	4.1	3.0	2.8	44.8	--	--

TABLE 2. REPORTED GROUND-WATER PUMPAGE BY MOST MUNICIPALITIES, INSTITUTIONS, AND SOME INDUSTRIES, IN MICHIGAN, 1968. (IN MILLIONS OF GALLONS) (Continued)

Water User	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1968 Total	Max. Day	Min. Day
KALAMAZOO COUNTY (Continued)															
[a] Simpson-Lee Paper Company at Vicksburg	45.0	43.0	47.0	45.0	47.0	72.0	38.0	35.0	36.0	45.0	43.0	38.0	504.0	--	--
[b] City of Schoolcraft													80.0		
City of Galesburg	4.1	4.0	4.4	3.5	3.7	4.8	4.8	4.6	3.7	3.4	3.5	3.7	48.2	--	--
KALKASKA COUNTY															
Village of Kalkaska	4.7	5.4	6.1	3.3	4.2	5.1	6.0	6.9	5.9	4.1	4.6	5.8	62.1	.339	.054
KENT COUNTY															
City of Lowell	21.2	16.8	18.6	17.8	13.8	23.9	17.5	17.9	13.7	13.9	13.1	13.0	201.2	0.974	.201
City of Kentwood	27.0	25.0	28.0	30.0	37.0	24.0	from	June 20	Lake Michigan water				171.0	3.000	.800
Village of Sparta	8.0	7.5	8.0	7.9	8.6	10.8	11.7	12.9	9.9	10.1	8.5	8.7	112.6	.572	.187
[c] Kent County Airport near Grand Rapids			1.9			2.7			3.0			2.1	9.7	--	--
[d] Kent County Airport near Grand Rapids for Air Conditioning								5.0					5.0	--	--
LAPEER COUNTY															
Village of Imlay City	8.6	8.3	8.4	8.7	7.4	5.9	15.9	12.0	11.9	9.8	6.1	12.7	115.7	--	--
City of Lapeer	17.5	17.8	18.5	16.9	17.3	17.6	20.2	19.9	17.7	17.0	15.2	15.7	211.3	1.275	.195
State Home & Training School at Lapeer	16.1	19.6	21.3	13.0	23.6	16.5	17.9	20.0	14.9	17.2	17.9	18.0	216.0	--	--
LENAWEE COUNTY															
Village of Clinton			18.7			17.7			19.3			16.4	72.1	--	--
City of Hudson	10.4	10.2	10.6	10.1	9.4	9.7	10.4	11.5	10.1	10.5	10.0	10.8	123.7	.646	.186
City of Morenci	7.1	6.8	6.3	5.8	5.9	6.3	6.6	6.7	6.2	5.9	6.1	6.0	75.7	.310	.137
City of Tecumseh	42.2	40.2	40.6	39.4	41.2	47.9	52.9	44.2	32.4	38.7	38.9	36.8	495.4	2.165	.775
[e] Fisher Body Div. G.M.C. near Tecumseh	1.8	1.4	1.8	1.7	2.0	2.2	1.9	2.1	1.9	1.8	1.4	1.3	21.3	.124	.028
LIVINGSTON COUNTY															
City of Brighton	14.8	14.0	15.5	15.3	16.7	17.4	20.2	21.6	14.7	12.6	10.6	10.9	184.3	.707	.387
City of Howell	22.5	21.5	22.8	23.1	24.9	25.2	29.4	29.1	31.0	31.4	27.7	30.5	319.1	1.322	.599
State Hospital at Howell	3.2	2.9	3.1	3.0	3.8	4.4	4.9	3.7	3.2	2.7	2.7	1.8	39.4	.212	.041
LUCE COUNTY															
City of Newberry	9.3	15.1	11.6	10.0	16.1	12.3	14.6	16.6	10.8	10.5	10.6	11.8	149.3	--	--
State Hospital at Newberry	6.7	5.2	7.1	7.1	6.9	7.8	8.8	8.5	7.5	7.2	6.6	6.8	86.2	.347	.138
MACOMB COUNTY															
Village of Richmond	7.8	7.7	8.1	7.6	7.9	8.4	8.3	8.2	8.9	7.5	7.2	7.1	94.7	--	--
Village of Romeo															
MANISTEE COUNTY															
City of Manistee															
MARQUETTE COUNTY															
State House of Corr. & Br. Prison at Marquette	3.9	3.9	3.6	5.9	7.8	8.9	8.9	9.1	9.4	9.3	7.4	7.5	85.6	--	--
K. I. Sawyer Air Force Base near Gwinn	30.4	28.6	30.0	29.9	46.0	32.5	47.4	46.2	30.2	32.2	25.9	28.0	407.3	2.447	.765
MONROE COUNTY															
Village of Carleton	3.4	2.9	3.3	3.3	3.5	3.9	3.7	3.8	3.8	3.7	3.0	2.9	41.2	--	--
MONTCALM COUNTY															
City of Carson City	8.7	8.2	8.9	9.3	9.0	9.7	10.7	11.3	11.0	11.2	10.0	10.0	118.0	.441	.174
City of Greenville	45.4	42.5	43.2	39.8	41.8	45.3	50.4	50.0	37.5	35.5	37.4	45.1	513.9	2.515	.598
Village of Sheridan	1.6	1.5	1.6	1.6	1.7	2.6	3.3	4.5	2.2	1.4	1.3	1.3	24.6	--	--
City of Stanton	1.9	1.4	2.7	4.2	2.3	2.3	2.6	2.3	1.9	1.9	2.3	2.9	28.7	--	--
MUSKEGON COUNTY															
City of Montague	5.2	4.8	5.0	4.3	5.2	6.3	8.9	9.0	5.4	5.6	6.1	4.9	70.7	.500	.425
City of Whitehall	26.4	25.3	28.9	31.1	34.1	35.3	34.7	39.3	29.8	31.6	27.1	26.5	370.1	1.798	.594
NEWAYGO COUNTY															
City of Fremont															
OAKLAND COUNTY															
Cranbrook School	6.4	9.2	1.1	0.6	10.2	8.1	7.6	8.6	7.7	7.4	5.4	4.9	77.2		
[f] Village of Holly	11.7	13.9	15.0	14.3	15.6	17.0	16.3	17.7	13.7	13.4	13.9	13.9	176.4	.760	.271
Village of Oxford															
Village of Rochester	44.0	43.1	47.7	47.2	50.3	54.5	57.4	57.5	51.1	54.3	53.6	49.0	609.7	2.539	1.137
City of South Lyon	59.7	57.4	61.0	62.2	66.6	67.7	48.5	70.5	62.9	38.1	59.5	66.8	720.9	2.800	.303
City of Sylvan Lake															
[h] City of Troy	1.9	1.7	2.6	1.2	1.3	1.8	3.5	3.2	3.0	2.9	2.4	2.3	27.8	*1.500	.038
Township of Waterford	38.7	34.2	47.5	38.4	43.5	59.2	80.9	66.8	50.8	43.7	41.6	32.7	578.0		
OCEANNA COUNTY															
[g] City of Hart			17.5			18.4			75.8			36.1	147.8		
OGEMAW COUNTY															
City of West Branch	5.6	5.4	5.8	5.3	5.9	7.6	9.0	9.3	7.0	6.4	5.8	5.7	78.8	--	--
OSCEOLA COUNTY															
[g] City of Evart	40.0	40.0	40.0	40.0	40.0	42.0	50.0	50.0	50.0	40.0	41.8	37.6	511.4		

* Includes water from Detroit

TABLE 2. REPORTED GROUND-WATER PUMPAGE BY MOST MUNICIPALITIES, INSTITUTIONS, AND SOME INDUSTRIES, IN MICHIGAN, 1968. (IN MILLIONS OF GALLONS) (Continued)

Water User	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1968 Total	Max. Day	Min. Day
OTSEGO COUNTY															
City of Gaylord	2.3	1.9	1.6	1.6	2.1	2.5	2.5	2.6	2.5	2.0	3.0	2.0	26.6	--	--
State Home at Gaylord	1.1	1.1	1.1	1.2	1.3	1.1	1.0	1.0	0.8	0.8	0.9	0.9	12.3	.059	.013
OTTAWA COUNTY															
Village of Spring Lake	8.0	7.3	7.7	8.7	12.8	19.1	21.4	23.8	11.9	9.7	7.9	8.5	146.8	2.768	.089
e/City of Coopersville	4.9	4.8	4.4	4.1	5.0	5.1	5.5	5.4	4.9	5.2	4.6	5.2	59.1	.204	.090
PRESQUE ISLE COUNTY															
City of Onaway															
City of Rogers City	8.0	7.4	8.6	8.0	8.8	9.6	12.0	10.1	8.0	9.5	8.8	8.6	107.4	.579	.187
SAGINAW COUNTY															
Township of Thomas	8.4	8.9	10.3	10.3	11.6	13.2	16.0	14.7	16.4	12.6	11.7	11.4	145.5	.864	.247
SANILAC COUNTY															
City of Croswell	17.4	17.4	15.1	17.5	19.9	26.9	28.8	41.4	24.6	25.7	21.1	23.8	279.6	2.202	.229
City of Sandusky	15.7	17.0	17.5	16.3	16.4	16.6	17.3	19.3	15.4	13.7	13.4	15.0	193.6	.886	.246
SHIAWASSEE COUNTY															
City of Corunna	4.6	5.0	5.3	5.0	5.2	5.2	4.5	5.6	4.8	5.1	4.5	5.2	60.0	.403	.049
City of Durand	11.9	11.0	11.0	10.7	11.6	11.7	12.5	11.9	12.4	11.4	10.9	11.7	138.7	.543	.216
e/City of Owosso	74.9	68.0	72.1	69.6	77.0	75.3	82.5	84.4	76.2	75.6	71.1	66.8	893.5	3.770	1.668
City of Perry	2.2	2.1	2.1	2.1	2.5	2.7	3.0	2.7	2.3	2.1	2.0	2.0	27.8	--	--
ST. CLAIR COUNTY															
Village of Capac	2.8	2.6	2.8	2.6	3.3	2.9	3.3	4.6	3.9	3.2	2.9	2.9	37.8		
City of Yale	5.2	4.6	4.8	4.8	4.2	4.6	9.5	12.3	16.0	5.0	4.6	4.5	80.1	--	--
ST. JOSEPH COUNTY															
Village of Constantine	6.0	5.2	5.8	5.4	4.7	5.1	4.6	4.4	3.9	3.8	4.3	5.1	58.3	.297	.081
e/City of Sturgis	54.7	51.2	52.0	55.0	59.5	67.0	67.2	69.9	58.8	61.8	53.8	51.2	702.1	3.178	.808
City of Three Rivers	27.8	26.9	28.7	30.8	31.9	37.2	41.6	39.9	31.0	30.7	27.0	30.1	383.6	1.988	.654
TUSCOLA COUNTY															
State Hospital at Caro	5.3	5.6	6.3	5.9	5.4	6.6	7.2	9.4	8.6	9.9	10.9	11.3	92.4	.483	.117
Village of Cass City	5.4	5.6	5.8	5.7	6.6	6.9	7.5	9.3	7.9	7.4	6.6	6.5	81.3	.379	.084
VAN BUREN COUNTY															
e/City of Bangor	10.7	9.6	10.3	10.7	11.3	11.9	13.0	12.0	11.0	10.6	9.5	10.0	130.6	.727	.221
e/City of Hartford	11.0	9.5	9.6	8.6	9.4	9.0	9.2	9.5	9.3	9.5	8.5	8.1	111.2	--	--
Village of Lawton	15.8	15.3	13.8	15.2	17.2	18.5	17.8	18.4	19.0	34.6	15.4	16.9	217.9	1.840	.192
Village of Paw Paw	16.6	14.5	16.2	14.8	19.2	21.8	21.8	24.3	18.6	18.8	15.1	16.0	217.7	1.751	.324
WASHTENAW COUNTY															
i/City of Ann Arbor	100.1	66.8	78.1	78.7	107.0	116.6	121.7	123.2	127.7	122.2	114.1	68.6	1,224.8	--	--
Boy's Training School at Whitmore Lake	4.0	4.2	4.9	5.0	5.1	5.5	5.7	6.1	5.9	6.6	7.1	6.3	66.4	.855	.052
e/Cassidy Lake Tech. School	1.3	1.3	1.3	1.3	1.3	1.4	1.5	1.6	1.2	1.2	1.2	1.0	15.6	--	--
Village of Dexter	7.1	6.7	6.1	6.6	7.0	7.0	8.0	5.1	7.2	6.9	6.3	6.0	80.0	.420	.121
City of Saline	15.9	15.1	15.0	14.4	16.0	18.0	19.4	18.9	16.7	17.2	15.1	15.0	196.7	.866	.307
City of Ypsilanti	158.9	152.2	165.7	151.3	168.0	166.1	167.7	165.6	167.4	174.8	176.6	162.4	1,976.7	6.603	3.273
Township of Ypsilanti	248.1	230.6	257.2	249.2	278.0	286.7	306.2	299.5	277.8	289.1	277.5	275.5	3,275.4	12.942	4.360
State Hospital at Ypsilanti	12.7	12.9	14.6	13.7	14.6	15.2	18.6	17.5	15.0	14.8	15.4	15.6	180.6	.618	.299
WAYNE COUNTY															
State Hospital at Northville	20.2	16.8	17.2	16.5	15.7	15.5	16.8	18.4	16.7	15.0	15.4	17.2	201.4	.991	.351
City of Plymouth	81.5	76.3	81.9	80.1	88.6	98.5	90.0	102.3	96.9	93.7	82.4	83.3	1,055.5	3.650	1.690
Plymouth State Home & Training School at Northville	9.1	7.8	6.8	8.3	6.7		9.5	8.9	8.4	8.8	8.5	8.5	99.7	.410	.227
WEXFORD COUNTY															
City of Cadillac	45.7	40.0	42.7	43.8	64.2	77.3	111.4	92.4	48.3	40.5	42.2	45.1	693.6	6.980	1.213

NOTES

NA/ Not available
a/ Quarterly readings
b/ Annual estimate
c/ Also used 88 mg purchased from City of Grand Blanc
d/ Also used 557 mg of water from the Pine River
e/ Wholly or partly estimated
f/ Also used 418 mg of water from Baw Beese Lake
g/ Water is from river recharge collector system
h/ Main supply from Detroit system
i/ Also used 3,772 mg from Huron River

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.

SELECTED REFERENCES

Publications of the U.S. Geological Survey

Water-Supply Papers

1078 Ground-water supplies of the Ypsilanti area, Michigan, by C. L. McGuinness, O. F. Poindexter, and E. G. Otten. 1949.

1299 The industrial utility of public water supplies in the United States 1952, pt. 1, States east of the Mississippi River, by E. W. Lohr and S. K. Love. 1954.

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

1594-D Induced recharge of an artesian glacial-drift aquifer at Kalamazoo, Michigan, by J. E. Reed, Morris Deutsch, and S. W. Wiitala. 1966.

1619-E Ground-water resources of the Alma area, Michigan, by K. E. Vanlier. 1963.

1619 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.

1842 Water resources of the Marquette Iron Range area, Michigan, by S. W. Wiitala, T. G. Newport, and E. L. Skinner. 1967.

1973 Availability of water in Kalamazoo County, Michigan: W. B. Allen, J. B. Miller, and W. W. Wood, (in press).

2000 Water for a rapidly growing urban community -- Oakland County, Michigan by F. R. Twenter, and R. L. Knutilla. 1969 (in press).

Circulars

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

323 Water resources of the Grand Rapids area, Michigan, by G. J. Stramel, C. O. Wisler and L. B. Laird. 1954.

456 Estimated use of water in the United States, 1960, by K. A. MacKichan and J. C. Kammerer. 1961.

Professional papers

475-D "Lazy" thermometers and their use in measuring ground-water temperatures. Art. 171. R. C. Heath. 1964.

Open-file reports

Deutsch, Morris, Phenol contamination of an artesian aquifer at Alma, Michigan: 1962.

Deutsch, Morris, and Vanlier, K. E., Ground water for Michigan's future: 1961.

Miscellaneous

A Primer on Water, 1960, by L. E. Leopold, and W. B. Langbein.

A Primer on Ground Water, 1963, by H. L. Baldwin, and C. L. McGuinness.

A Primer on Water Quality, 1965, by H. A. Swenson, and H. L. Baldwin.

Other Publications

Brown, E. A., and Stuart, W. T., 1951, Ground-water resources of the glacial deposits in the Bessemer area, Michigan: Michigan Geol. Survey Prog. Rept. 14.

Clayton, R. N., et al, 1966, The origin of saline formation waters, I, Isotopic composition: Jour. of Geophys. Research, v. 71, no. 16.

Deutsch, Morris, 1956, Effects of dissemination of radioactive materials on water resources conservation--with special references to Michigan: Michigan State Univ. Agr. Expt. Sta. Water Bull. 2.

_____, 1961, Hydrogeologic aspects of ground-water pollution: Water Well Jour., v. 15, no. 9.

Deutsch, Morris, 1961, Incidents of chromium contamination of ground water in Michigan: U. S. Public Health Service Tech. Rept. W61-5, p. 98-104.

_____, 1962, Controlled induced-recharge tests at Kalamazoo, Michigan: Jour. Am. Water Works Assoc., v. 54, no. 2, p. 181-196, Feb.

Deutsch, Morris, Burt, E. M., and Vanlier, K. E., 1958, Summary of ground-water investigations in the Holland area, Michigan: Michigan Geol. Survey Prog. Rept. 20.

Deutsch, Morris, Vanlier, K. E., and Giroux, P. R., 1960, Ground-water hydrology and glacial geology of the Kalamazoo area, Michigan: Michigan Geol. Survey Prog. Rept. 23.

Doonan, C. J., Hendrickson, G. E., 1967, Ground water in Iron County, Michigan: Michigan Geol. Survey Water Inv. Rept. 7.

_____, 1968, Ground-water in Gogebic County, Michigan: Michigan Geol. Survey Water Inv. Rept. 8.

_____, 1968, Ground-water in Ontonagon County, Michigan: Michigan Geol. Survey Water Inv. Rept. 9.

Ferris, J. G., and others, 1954, Ground-water resources of southeastern Oakland County, Michigan: Michigan Geol. Survey Prog. Rept. 16.

Giroux, P. R., 1957, Summary of ground-water conditions in Michigan, 1956: Michigan Geol. Survey Water Supply Rept. 1.

_____, 1958, Summary of ground-water conditions in Michigan, 1957: Michigan Geol. Survey Water Supply Rept. 2.

Giroux, P. R., and Thompson, Ted, 1960, Summary of ground-water conditions in Michigan, 1958: Michigan Geol. Survey Water Supply Rept. 3.

_____, 1960, Summary of ground-water conditions in Michigan, 1959: Michigan Geol. Survey Water Supply Rept. 4.

_____, 1961, Summary of ground-water conditions in Michigan, 1960: Michigan Geol. Survey Water Supply Rept. 5.

Giroux, P. R., 1962, Summary of ground-water conditions in Michigan, 1961: Michigan Geol. Survey Water Supply Rept. 6.

Giroux, P. R., and Huffman, G. C., 1963, Summary of ground-water conditions in Michigan, 1962: Michigan Geol. Survey Water Supply Rept. 7.

Giroux, P. R., and Huffman, G. C., 1964, Summary of ground-water conditions in Michigan, 1963: Open-file report.

_____, 1965, Summary of ground-water conditions in Michigan, 1964: Open-file report.

_____, 1966, Summary of ground-water conditions in Michigan, 1965: Open-file report.

_____, 1967, Summary of ground-water conditions in Michigan, 1966: Open-file report.

_____, 1968, Summary of ground-water hydrologic data in Michigan, 1967: Open-file report.

Giroux, P. R., Hendrickson, G. E., Stoimenoff, L. E., and Whetstone, G. W., 1964, Water resources of Van Buren County, Michigan: Michigan Geol. Survey Water Inv. Rept. 3.

Giroux, P. R., Hendrickson, G. E., Stoimenoff, L. E., Nowlin, J. O., and Skinner, E. L., 1966, Water resources of Branch County, Michigan: Michigan Geol. Survey Water Inv. Rept. 6.

Graf, D. L., et al, 1966, The origin of saline formation waters, III: calcium chloride waters: Illinois State Geol. Survey Cir. 397.

Hendrickson, G. E., and Doonan, C. J., 1966, Ground-water resources of Dickinson County, Michigan: Michigan Geol. Survey Water Inv. Rept. 5.

Hendrickson, G. E., 1966, Michigan's Au Sable River--Today and Tomorrow: Michigan Geol. Survey Bull. 3.

Michigan Department of Health, 1961, Data on Public Water Supplies in Michigan: Michigan Dept. of Health Eng. Bull. 4.

Mozola, A. J., 1953, A survey of ground-water resources in Oakland County, Michigan, pt. 2 of Occasional papers for 1954 on the geology of Michigan: Michigan Geol. Survey Pub. 48.

Sinclair, W. C., 1959, Reconnaissance of the ground-water resources of Schoolcraft County, Michigan: Michigan Geol. Survey Prog. Rept. 22.

_____, 1960, Reconnaissance of the ground-water resources of Delta County, Michigan: Michigan Geol. Survey Prog. Rept. 24.

Stuart, W. T., 1945, Ground-water resources of the Lansing area, Michigan: Michigan Geol. Survey Prog. Rept. 13.

Stuart, W. T., Brown, E. A., and Rhodehamel, E. C., 1954, Ground-water investigations of the Marquette iron-mining district, Michigan: Michigan Geol. Survey Tech. Rept. 3.

Stuart, W. T., and Stallman, R. W., 1945, Ground-water resources of the Benton Harbor area, Michigan: Michigan Geol. Survey Prog. Rept. 12.

Stuart, W. T., Theis, C. V., and Stanley, G. M., 1948, Ground-water problems in the Iron River district, Michigan: Michigan Geol. Survey Tech. Rept. 2.

Terwilliger, F. W., 1954, The glacial geology and ground-water resources of Van Buren County, Michigan, pt. 1 of Occasional papers for 1954 on the geology of Michigan: Michigan Geol. Survey Pub. 48.

Vanlier, K. E., 1959, Reconnaissance of the ground-water resources of Luce County, Michigan: Michigan Geol. Survey Prog. Rept. 21.

Vanlier, K. E., and Deutsch, Morris, 1958, Reconnaissance of the ground-water resources of Chippewa County, Michigan: Michigan Geol. Survey Prog. Rept. 17.

_____, 1958, Reconnaissance of the ground-water resources of Mackinac County, Michigan: Michigan Geol. Survey Prog. Rept. 19.

Vanlier, K. E., 1962, Summary of ground-water investigations in the Elsie area, Michigan: Michigan Geol. Survey Prog. Rept. 25.

_____, 1963, Ground water in Alger County: Michigan Geol. Survey Water Inv. Rept. 1.

_____, 1963, Ground water in Menominee County: Michigan Geol. Survey Water Inv. Rept. 2.

_____, 1966, Ground-water resources of the Battle Creek area, Michigan: Michigan Geol. Survey Water Inv. Rept. 4.

_____, 1968, Appendix E of the report on the Grand River Comprehensive Basin Study: U. S. Army Eng. District, Detroit, Michigan (in press).

Water Resources Commission Reports

Water Resources of the Clinton River Basin, 1953.

Water resource conditions and uses in the Paw Paw River Basin, 1955 (revised report in 1964).

Water Resources Commission Reports (continued)

Water resources conditions and uses in the Flint River Basin, 1956.

_____ in the Huron River Basin, 1957.

_____ in the Tittabawassee River Basin, 1960.

_____ in the Upper Grand River Basin, 1961.

_____ in the Shiawassee River Basin, 1963.

_____ in the Maumee River Basin, 1964.

_____ in the River Raisin Basin, 1965.

_____ in the Au Sable River Basin, 1966.

_____ in the Lower Grand River Basin, 1967 (open file).

Water resources of southeastern Michigan, Feb., 1968

Water resources of the lower Lake Huron drainage basin, May, 1968.

Water quality standards for Michigan intrastate waters, Jan., 1968.

Water quality standards for Michigan waters, Appendix A (interstate and international waters) June, 1967.

Water resource uses, present and prospective, and water-quality standards and plan of implementation (revised June, 1967) for . . . . . .

Lake Superior and the St. Mary's River

Lake Huron

The Menominee and Montreal River basins in Michigan and the other Michigan-Wisconsin interstate boundary waters.

St. Clair River, Lake St. Clair, Detroit River, Lake Erie, and Maumee River basin.

Lake Michigan

St. Joseph River basin

Maps

Twenter, F. R., 1966, Map (color) general availability and quality of ground water in the bedrock deposits in Michigan: State Resources Planning Division, Michigan Dept. of Commerce and Michigan Water Resources Commission.

_____, 1966 Map (color) general availability of ground water in the glacial deposits in Michigan: State Resources Planning Division, Michigan Dept. of Commerce and Michigan Water Resources Commission.