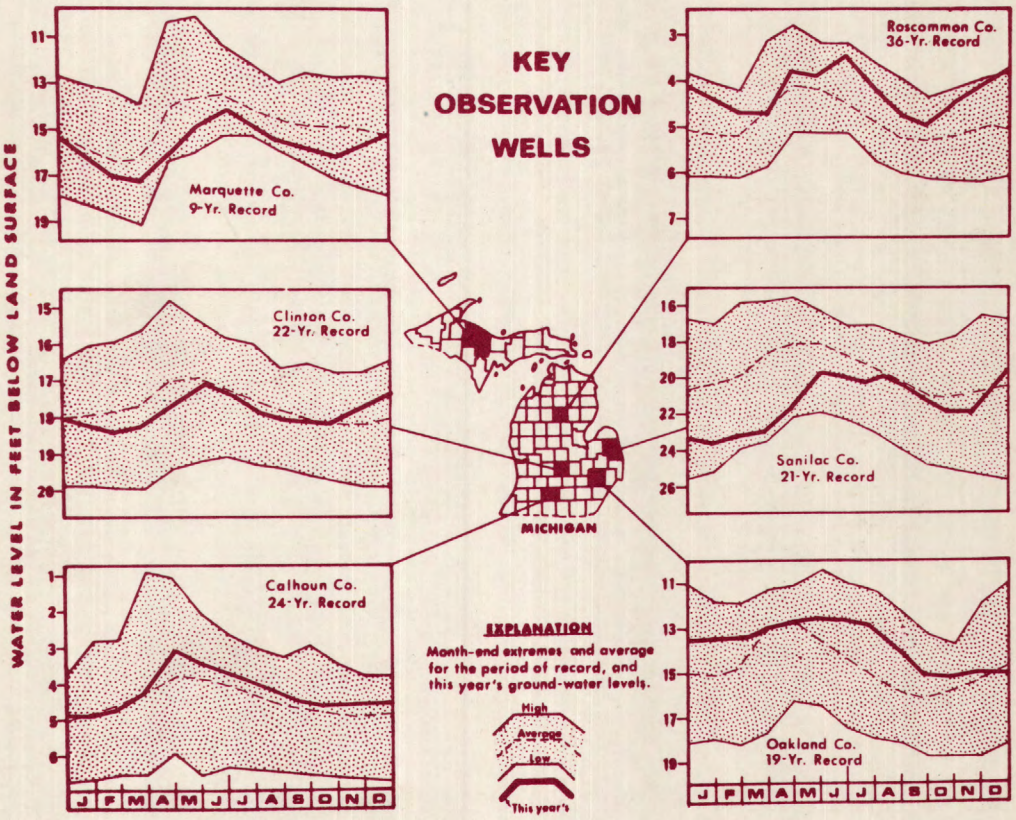
SUMMARY
OF
GROUND-WATER HYDROLOGICAL DATA
IN
MICHIGAN
IN
1970

BY

G. C. HUFFMAN AND T. THOMPSON

U. S. GEOLOGICAL SURVEY



PREPARED IN COOPERATION WITH THE
MICHIGAN DEPARTMENT OF NATURAL RESOURCES
GEOLOGICAL SURVEY DIVISION

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OF

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G. C. HUFFMAN AND T. THOMPSON

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

Prepared by the U. S. Geological Survey
in cooperation with
State of Michigan
Department of Natural Resources
R. A. MacMullan, Director
Geological Survey Division
A. E. Slaughter, State Geologist

1971

PREFACE

The program of ground-water investigations in Michigan is conducted in cooperation with the Michigan Department of Natural Resources, R. A. MacMullan, Director, through the Geological Survey Division, A. E. Slaughter, State Geologist, and under an overall agreement for water-resources investigations in Michigan with the State Bureau of Water Management, 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, Coldwater, Dowagiac, Grand Ledge, Hillsdale, Holland, Ironwood, Jackson, Kalamazoo, Lansing, Marshall, Mason, Plymouth, Portage, St. Johns, St. Louis, Wyoming, and Ypsilanti; the townships of Battle Creek, Pinconning, Waterford, and Ypsilanti; Counties of Branch, Van Buren, and Kalamazoo; U. S. Army Engineers; 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.

Acknowledgement 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.

Previous Investigations

In addition to this series of water-level reports, records and interpretations of water levels in Michigan have been published annually in 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

Beginning in 1956, annual publication of Water-Supply Papers was discontinued. A new series was adopted in which fewer water-level records were published and the interpretative text was eliminated. Subsequent reports were published for the years 1956-57 and 1958-62 and are being published at 5 year intervals, currently.

To supplement the new report series, publication of annual reports entitled "Summary of Ground-Water Conditions in Michigan" was begun for Michigan in 1956. The first seven of these reports, for the years 1956-62, were published by the Michigan Department of Natural Resources. Subsequent reports are open-file publications. Beginning in 1967, the title of the reports was changed to "Summary of Ground-Water Hydrological Data in Michigan."

Many 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 Geological Survey Division, 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 State and Federal Geological Survey offices, State Office Building, Escanaba, Michigan 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 most major university and municipal libraries.

The U. S. Geological Survey 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 4 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 Hydrological Data in Michigan" are free on application. 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 also are available for inspection and sale at the offices listed above.

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By G. C. Huffman and T. Thompson

INTRODUCTION

Purpose of this report

The purpose of this report is to make available the records of ground-water levels in principal aquifers of the State through 1970 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, well locations, depths, elevations, aquifers which they tap, and the extremes of water level for the past record and in 1970. Table 2 contains records of ground-water pumpage in 1970 of most major ground-water users in the State.

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

Shown in summary form in the text, are supplementary data on the yield of wells, pumpage, storage facilities, treatment, quality of water and trends of ground-water levels for 1970 and for part of the previous record.

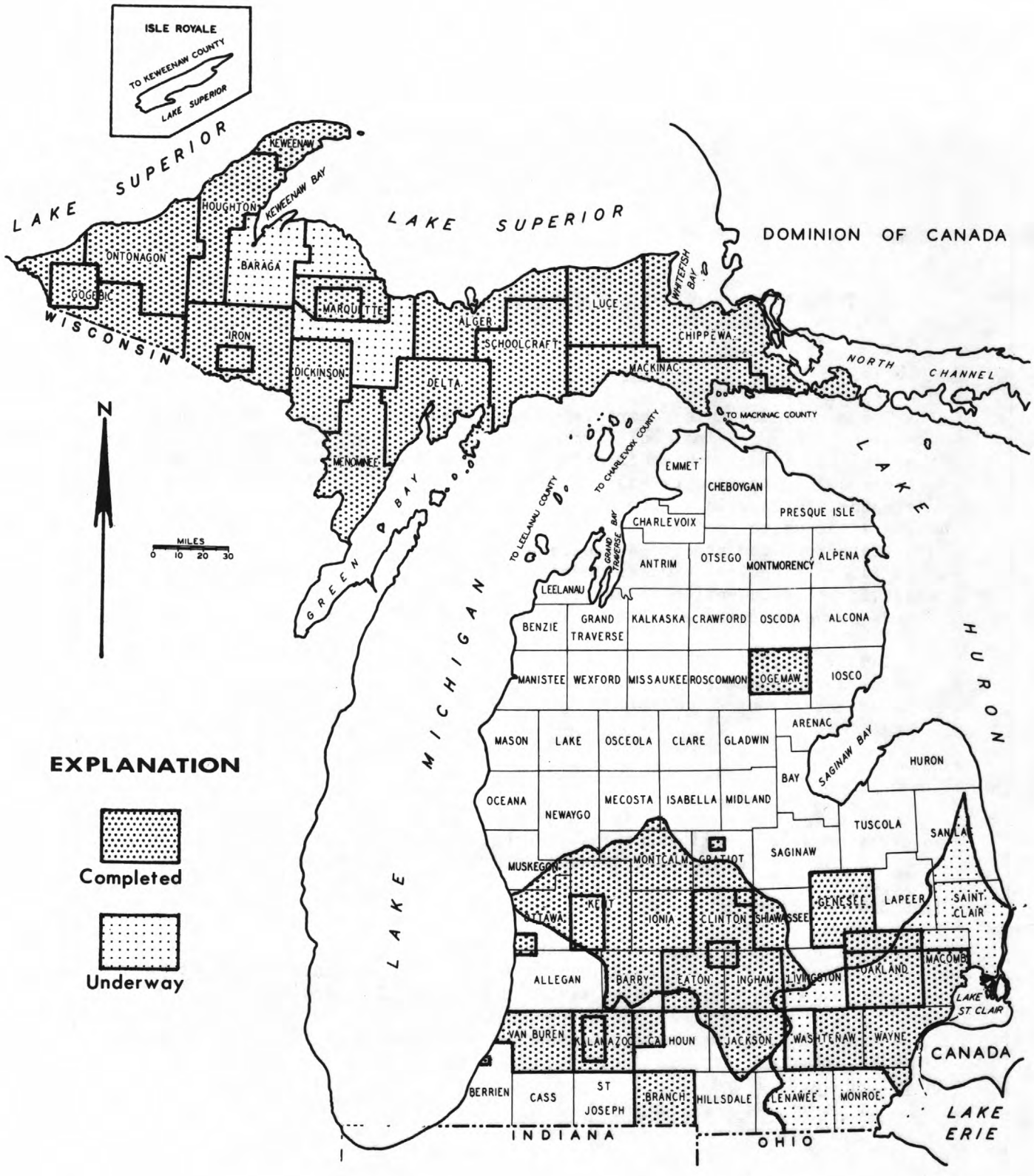


Figure 1.--Areas where water-resources investigations containing groundwater data are completed or underway (completed reports or those in press are listed under References).

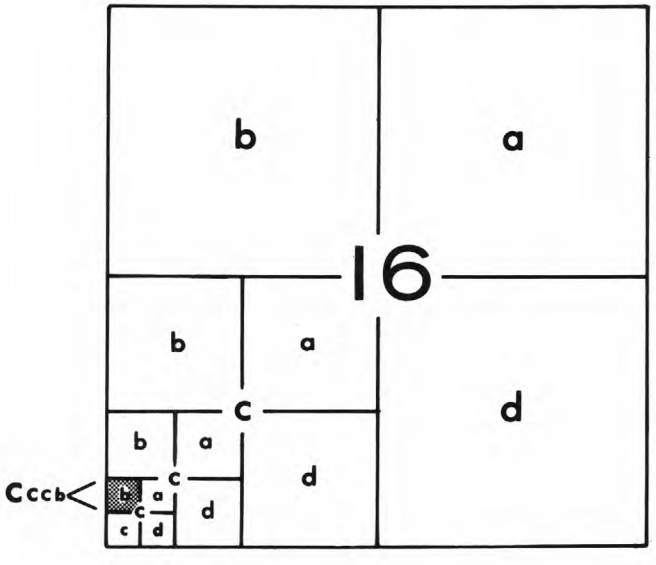
The yield of wells is shown specifically or as a range of production in gallons per minute (gpm). The specific capacity (gallons per minute per foot of drawdown) is also given as a range, or specifically for each well. Yield and specific capacity data are as reported by water departments and consultants.

Progress of areal water-resources investigations containing groundwater data for Michigan through 1970 are shown in figure 1. Reports for areas completed are listed in references at the end of this report. Some investigations encompass areas previously studied or more intensively investigated.

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

Well numbering system

The well-numbering system for Michigan indicates the location of wells within the rectangular subdivision of the land with reference to the Michigan meridian and base line. The first two segments of the well number designate township and range, the third segment of the number gives the section and an a, b, c, d, breakdown of the section as illustrated below. Thus, a well designated as 32N 6E 16-cccb would be located to the nearest 2.5-acres as pinpointed by the hachured area in section 16 below.



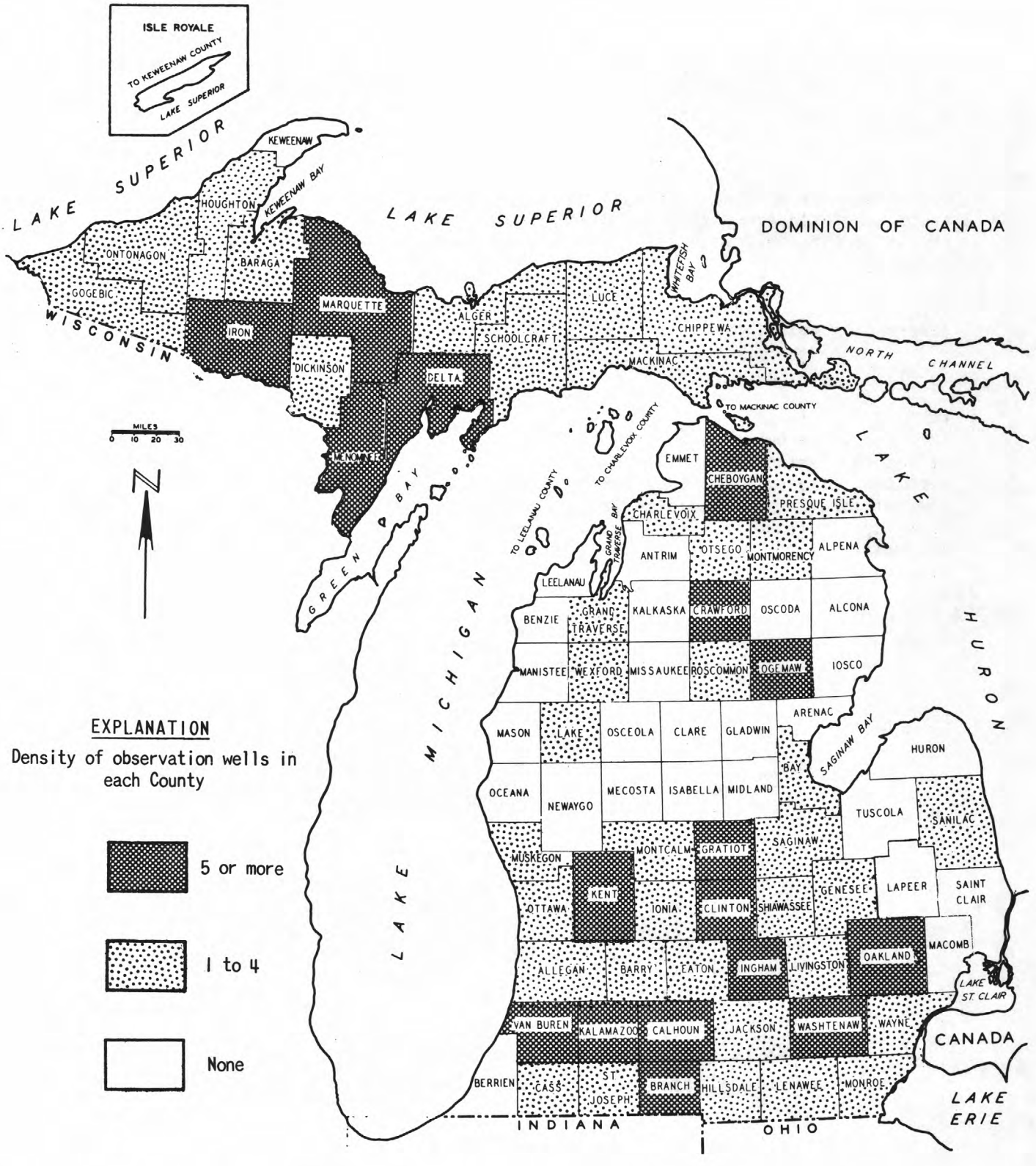


Figure 2.-- In 1970, measurements of water levels were made in 241 observation wells of which 82 were continuous recording stations.

For this report well locations are only broken down to 1/4, 1/4 sections--i.e. 16-cc. In the event that two or more wells are located in the same 40-acre tract, a number designation follows 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.

Uses of data in this report

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 recorders. These water-level records 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 spacing 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 pumping, a projection of future water levels should be made. 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 account for 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 2 to 3 feet annually and about 5 feet over a period of years (figs. 4, 5). 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 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.

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 by computer. Well data for Washtenaw County are also being prepared for computer processing. 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 rapid way of updating and retrieving of records.

GROUND-WATER LEVELS IN 1970

Water levels in most wells declined during the first half of 1970 as precipitation during that period was generally below normal. However, above normal precipitation during the latter part of the year resulted in levels rising to higher stages than at the start of the year (figs. 4, 5). During 1970 record high levels were observed in only 25 wells, about 60 percent less than in 1969, whereas record lows remained about the same at 27 (table 1) The fewer record high levels can be attributed to the deficient precipitation early in the year as most recharge to ground-water aquifers occurs during that time.

Precipitation in 1970 was below normal in the southeastern part of the lower peninsula and in the western part of the upper peninsula (fig. 3). The total precipitation for the 1966-70 period has been well above normal. As a result, water levels, in areas affected principally by natural influences, have in general been rising (figs. 4, 5).

In 1970, 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.

Although precipitation is one of the major climatic factors affecting ground-water levels, 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 soil conditions, time, duration, and intensity of precipitation, nature of underlying rocks, slope of land surface, etc.

Hydrographs of natural fluctuations of water levels in wells (figs. 4, 5, 7, 31, 34, 36), show that spring is the season when water levels are highest. 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 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 rainfall is evaporated, is transpired by vegetation, or runs off overland when precipitation occurs as heavy showers. In the fall, evapotranspiration (return of water to the atmosphere as a vapor from water surfaces, from soil, and from living plants) is reduced by cold weather. Thus, substantial rises in water levels usually follow fall rains. During the winter, frozen ground impedes the infiltration of water.

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

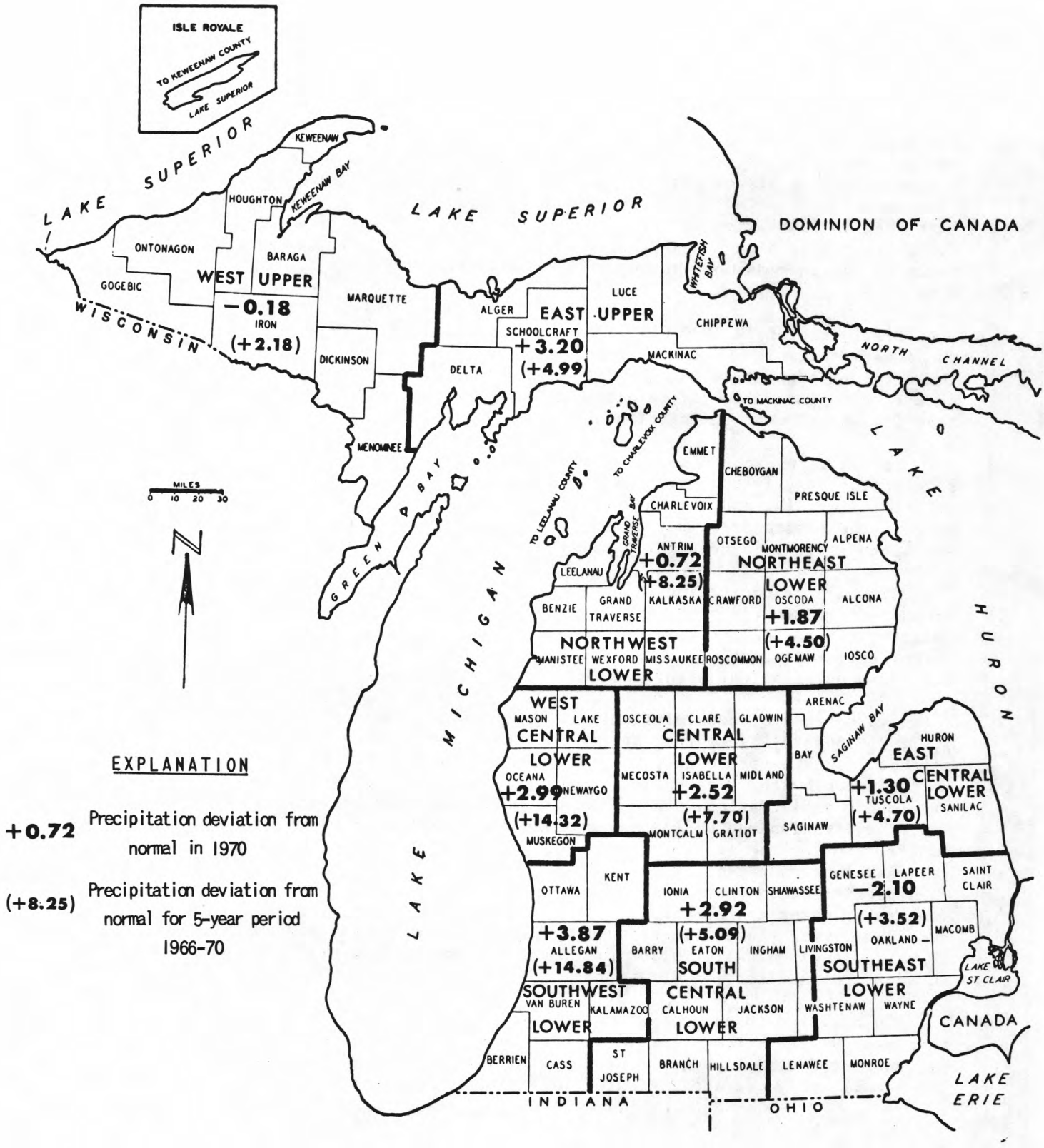


Figure 3.--In 1970, precipitation was above normal in all but two of the ten climatological divisions. For the five year period, 1966-70, cumulative departure of precipitation was above normal for all divisions.

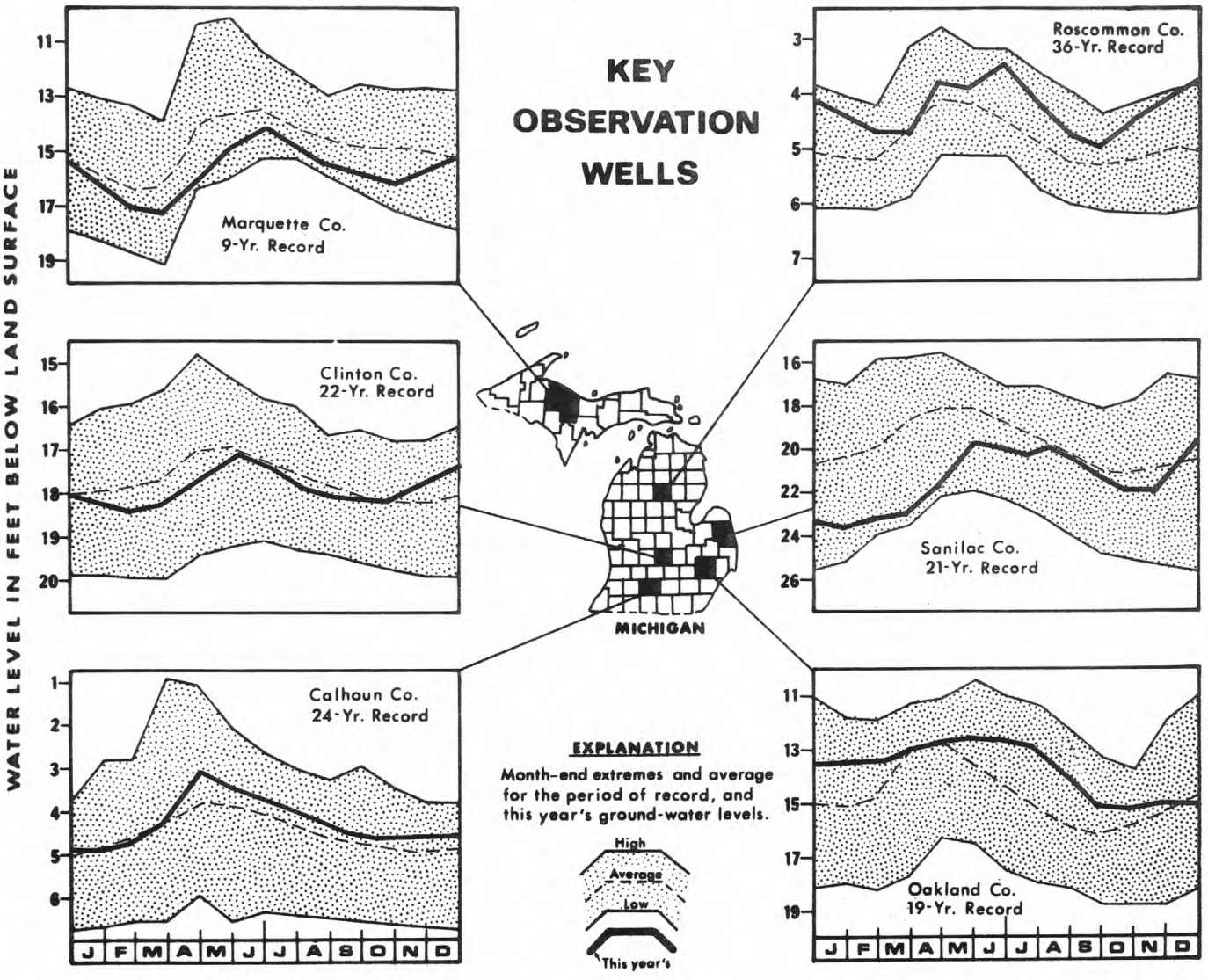


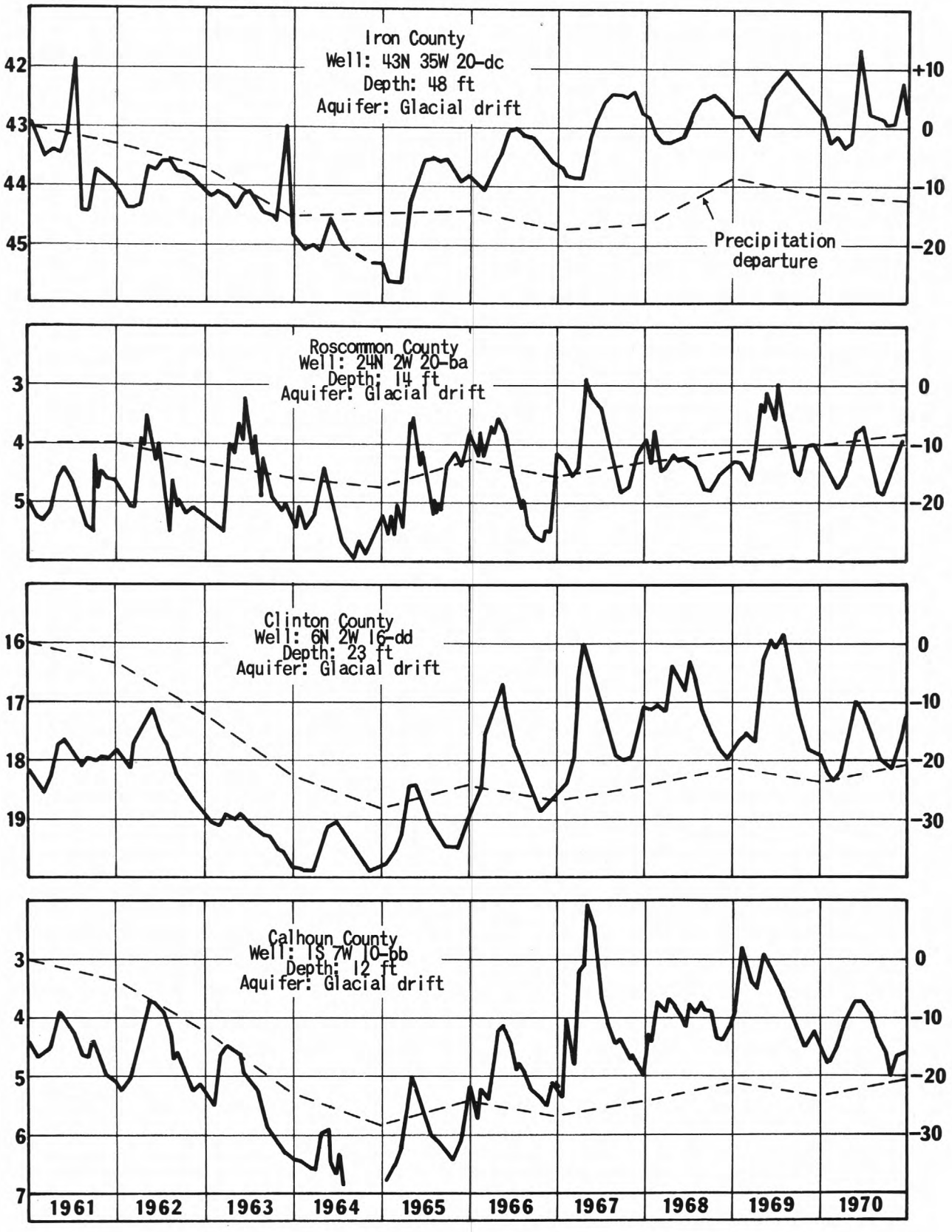
Figure 4.--In 1970, water levels had risen to above average in most key observation wells by year end. The Roscommon well reached a record high December level during 1970.

AREA GROUND-WATER LEVELS

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

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

Figure 5.--Long-term records of water levels in four wells whose levels respond principally to natural climatic conditions. Precipitation departures (dashed lines) are cumulative totals for the climatological divisions in which the wells are located.



WATER LEVELS, IN FEET BELOW LAND SURFACE

CUMULATIVE DEPARTURE OF PRECIPITATION, IN INCHES

WATER SUPPLY AND SOURCE -- Water is obtained from Saginaw Bay and, if necessary, is supplemented by a 110-foot deep well tapping sandstones of the Saginaw Formation.

YIELD OF WELLS (in gpm*) -- 70.

SPECIFIC CAPACITY OF WELLS (in gpm per ft of drawdown) -- 1.1.

PUMPAGE IN 1970 -- Pumpage from city well was discontinued in 1968. Est. 80 million gallons from Saginaw Bay.

STORAGE FACILITIES -- 75,000 gallons elevated.

QUALITY OF WATER -- Saginaw Bay:

Hardness	125 mg/1
Iron	0 mg/1
Chloride	25 mg/1

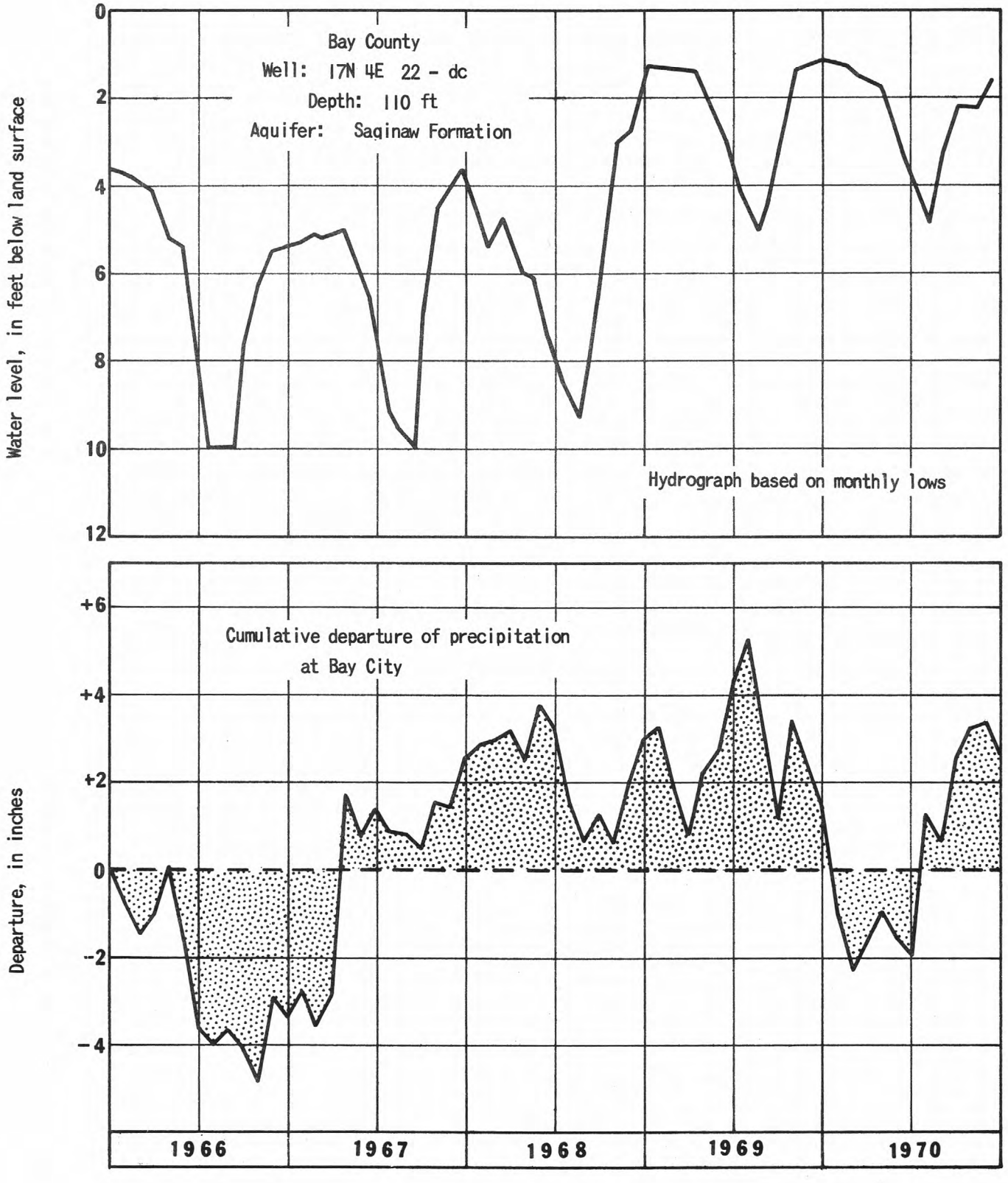
Well water:

Hardness	650 mg/1
Chloride	60-106 mg/1

TREATMENT -- Standard filtration.

Figure 6.--In Pinconning Township, ground-water levels in the observation well have remained high for the second consecutive year. However, as indicated by the sharp summer declines, some pumping is still being done in the area.

* gpm = gallons per minute


Bay County
Well: 17N 4E 22 - dc
Depth: 110 ft
Aquifer: Saginaw Formation
Hydrograph based on monthly lows
Water level, in feet below land surface
0
2
4
6
8
10
12
Cumulative departure of precipitation
at Bay City
Departure, in inches
+6
+4
+2
0
-2
-4
1966
1967
1968
1969
1970

Below normal precipitation during the first half of 1970 resulted in the lowest spring levels in most wells for the past 5 years (fig. 8). However, above normal precipitation during the latter part of the year resulted in rising ground-water levels by years end.

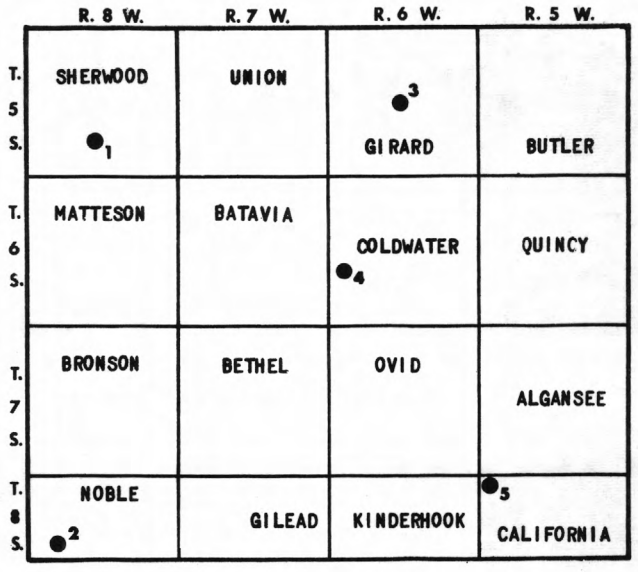
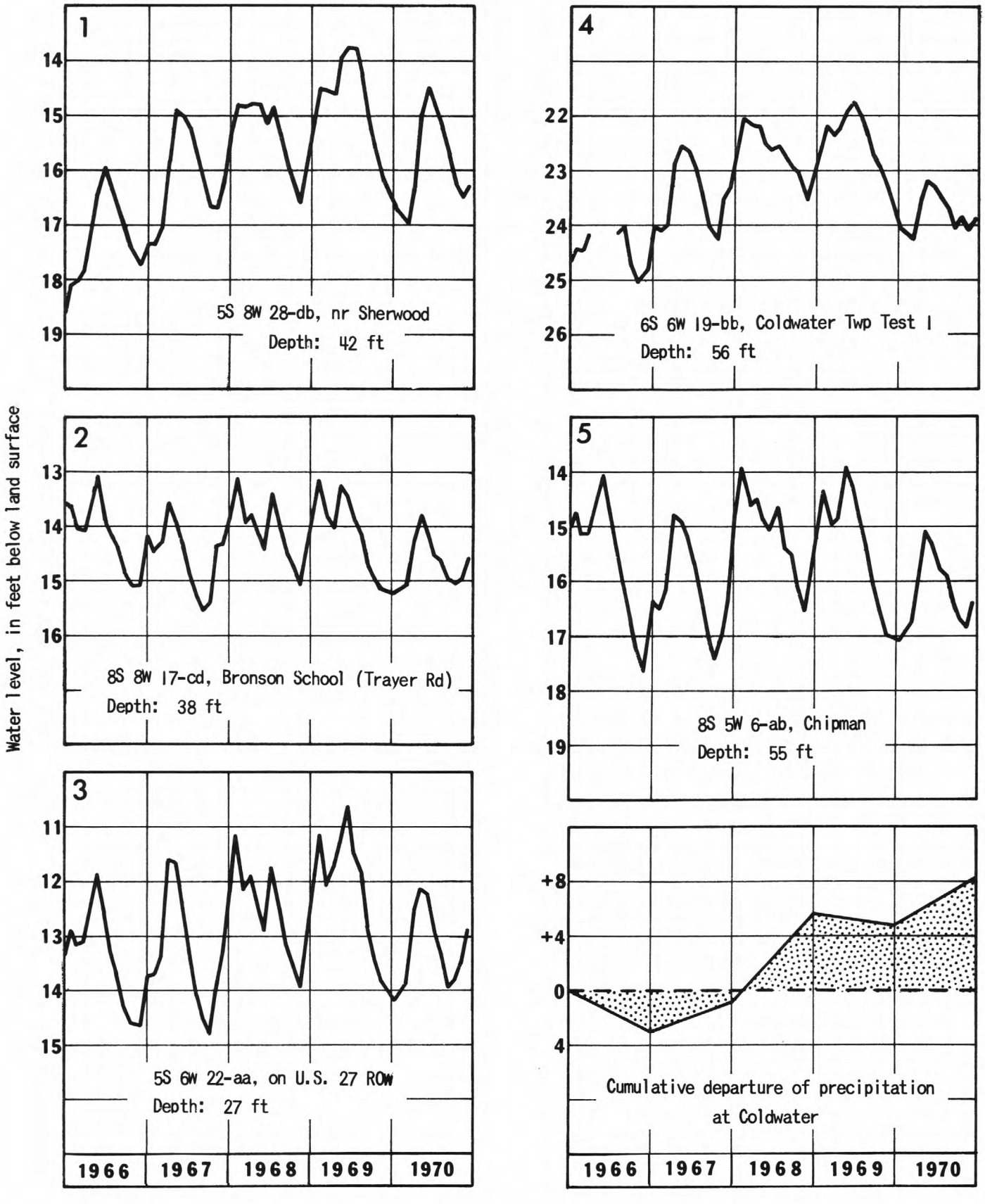


Figure 7.--Location of observation wells in Branch County.

Figure 8.--In Branch County, water levels in most wells respond principally to variations in precipitation.


Water level, in feet below land surface
1
14
15
16
17
18
19
5S 8W 28-db, nr Sherwood
Depth: 42 ft
2
13
14
15
16
8S 8W 17-cd, Bronson School (Trayer Rd)
Depth: 38 ft
3
11
12
13
14
15
5S 6W 22-aa, on U.S. 27 ROW
Depth: 27 ft
1966
1967
1968
1969
1970
4
22
23
24
25
26
6S 6W 19-bb, Coldwater Twp Test 1
Depth: 56 ft
5
14
15
16
17
18
19
8S 5W 6-ab, Chipman
Depth: 55 ft
+8
+4
0
4
Cumulative departure of precipitation
at Coldwater
1966
1967
1968
1969
1970

WATER SUPPLY AND SOURCE -- 4 wells, 121 to 132 feet deep, tap the glacial drift.

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

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

PUMPAGE IN 1970 -- 851 million gallons.

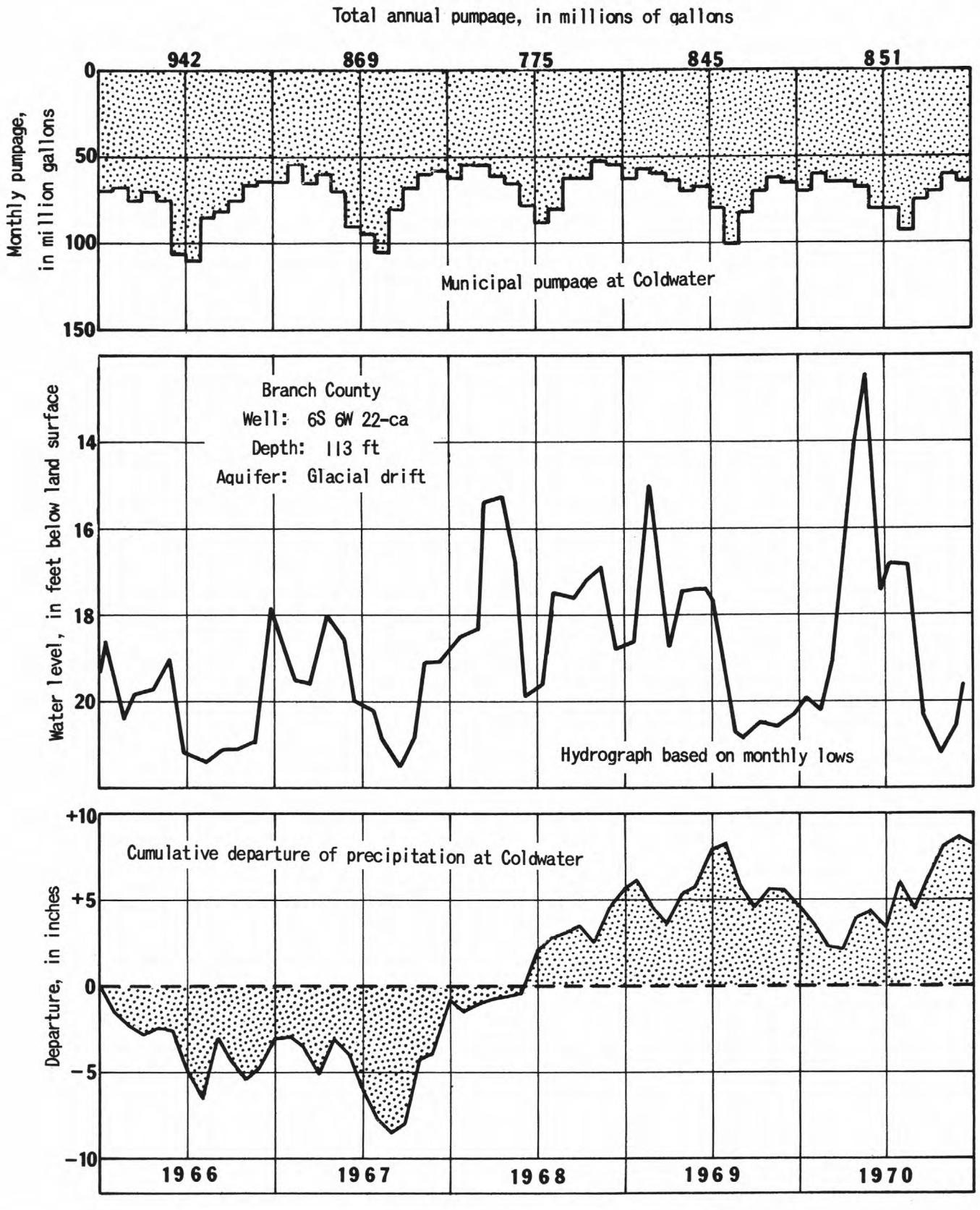
MAXIMUM DAY -- 5.74 million gallons.

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

QUALITY OF WATER -- Hardness 175-310 mg/1
Iron 0.3-1.5 mg/1

TREATMENT -- None.

Figure 9.--At Coldwater, a slight gain in water levels at years end resulted from above normal precipitation. The sharp rise in water levels during the spring was caused by one of the nearby supply wells being shut down for repairs.


Total annual pumpage, in millions of gallons
942
869
775
845
851
Monthly pumpage, in million gallons
0
50
100
150
Municipal pumpage at Coldwater
Branch County
Well: 6S 6W 22-ca
Depth: 113 ft
Aquifer: Glacial drift
Water level, in feet below land surface
14
16
18
20
Hydrograph based on monthly lows
Cumulative departure of precipitation at Coldwater
Departure, in inches
+10
+5
0
-5
-10
1966
1967
1968
1969
1970

CALHOUN COUNTY - CITY OF BATTLE CREEK

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

YIELD OF WELLS (in gpm) -- 300 to 1,000.

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

PUMPAGE IN 1970 -- 2,799 million gallons.

MAXIMUM DAY -- 17.48 million gallons.

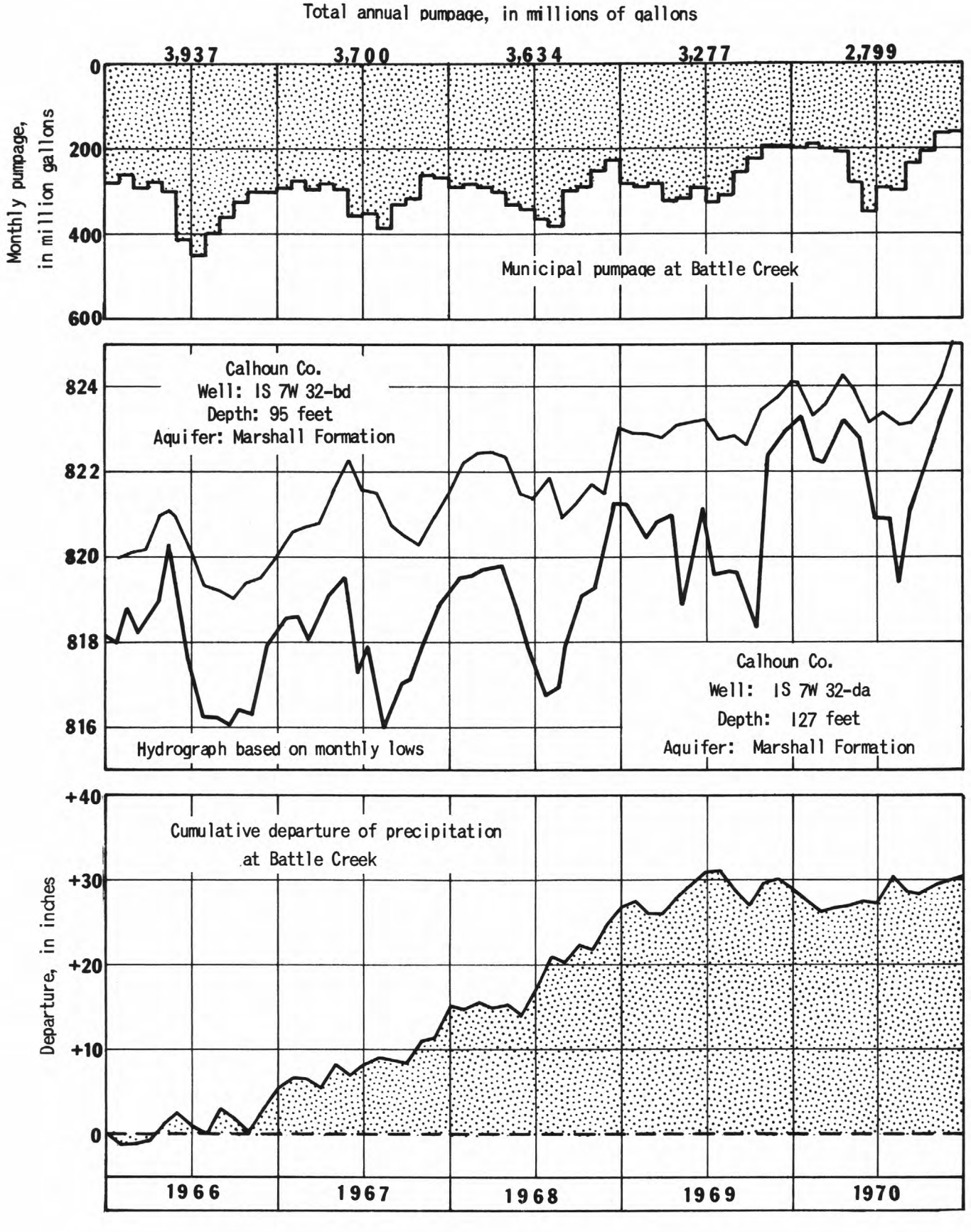
STORAGE FACILITIES -- 2,000,000 gallons at plant; and 4,000,000 gallons elevated.

QUALITY OF WATER -- Composites of Verona wells -- Hardness 240-285 mg/l
Iron 0.05-5.0 mg/l

TREATMENT -- Chlorination, fluoridation, hexamethaphosphate.

REMARKS -- Water levels in the Hopkins St. well, about a half mile from the Verona observation well, were the highest of record for the 7 year period of record.

Figure 10.--At Battle Creek, above average precipitation and decreased pumpage during the 1966-70 period has resulted in rising water levels at the City's Verona well field.


Total annual pumpage, in millions of gallons
3,937
3,700
3,634
3,277
2,799
Monthly pumpage, in million gallons
0
200
400
600
Municipal pumpage at Battle Creek
Calhoun Co.
Well: 1S 7W 32-bd
Depth: 95 feet
Aquifer: Marshall Formation
824
822
820
818
816
Hydrograph based on monthly lows
Calhoun Co.
Well: 1S 7W 32-da
Depth: 127 feet
Aquifer: Marshall Formation
Cumulative departure of precipitation at Battle Creek
Departure, in inches
+40
+30
+20
+10
0
1966
1967
1968
1969
1970

WATER SUPPLY AND SOURCE -- 6 wells, 143 to 165 feet deep, tap sandstones of the Marshall Formation. Two of the wells are located at the West Columbia Avenue well field.

YIELD OF WELLS (in gpm) -- 950 to 1,200.

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

PUMPAGE IN 1970 -- 515 million gallons; 227 at West Columbia Avenue well field.

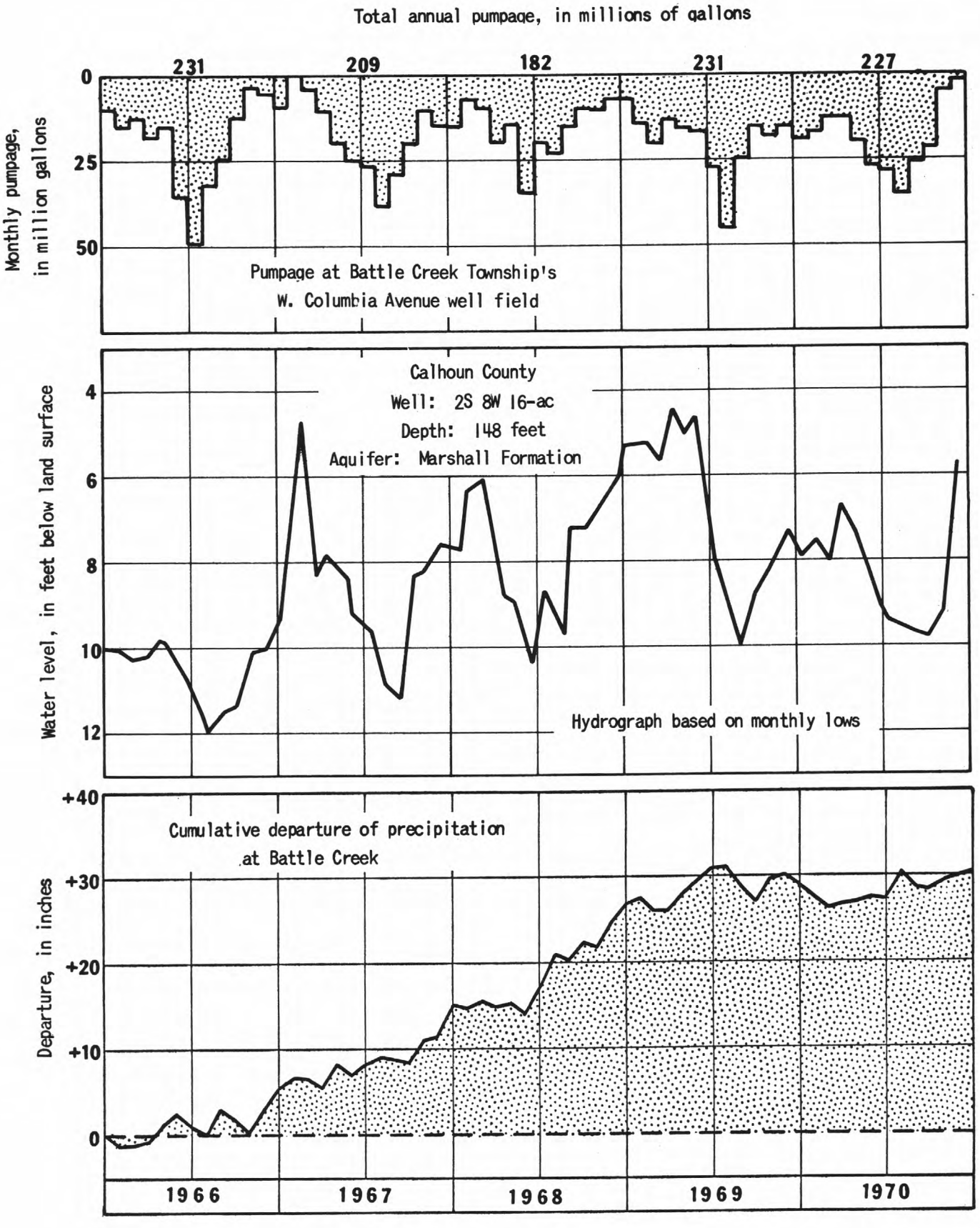
MAXIMUM DAY -- 3.51 million gallons.

STORAGE FACILITIES -- 400,000 gallons elevated.

QUALITY OF WATER -- Hardness 270-350 mg/1
Iron 0.5-1.2 mg/1

TREATMENT -- Chlorination.

Figure 11.--At Battle Creek Township, the water level in the observation well shows a definite response to pumpage. The overall rising trend in water level in 1970 is attributed to above average precipitation during the 1969-70 period.


Total annual pumpage, in millions of gallons
231
209
182
231
227
Monthly pumpage, in million gallons
0
25
50
Pumpage at Battle Creek Township's W. Columbia Avenue well field
Calhoun County
Well: 2S 8W 16-ac
Depth: 148 feet
Aquifer: Marshall Formation
Water level, in feet below land surface
4
6
8
10
12
Hydrograph based on monthly lows
Cumulative departure of precipitation at Battle Creek
Departure, in inches
+40
+30
+20
+10
0
1966
1967
1968
1969
1970

WATER SUPPLY AND SOURCE -- 7 wells, about 500 feet deep, tap sandstones of the Saginaw Formation.

YIELD OF WELLS (in gpm) -- 250 to 500.

SPECIFIC CAPACITY OF WELLS (in gpm per ft of drawdown) -- 3 to 12.

PUMPAGE IN 1970 -- 520 million gallons.

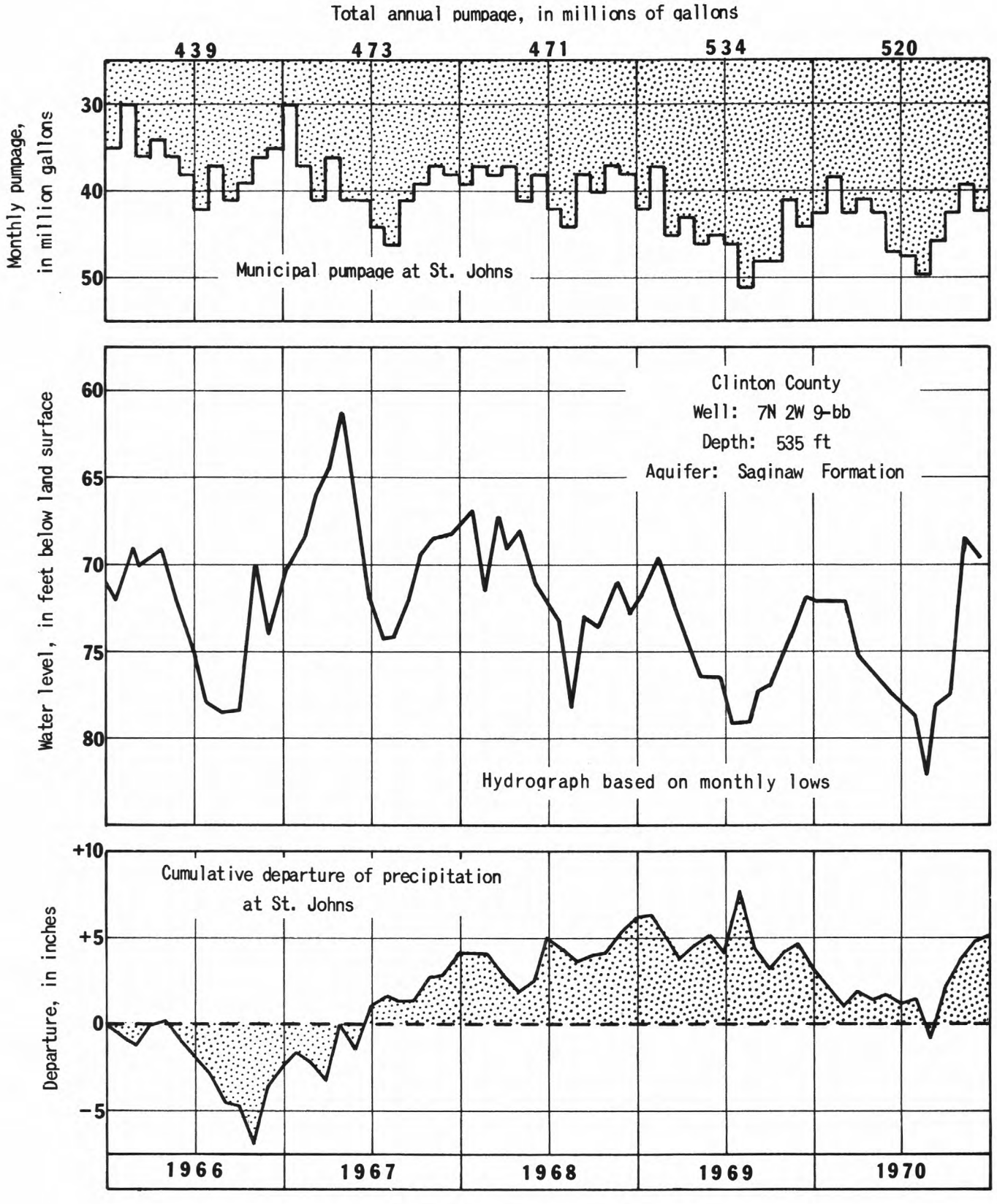
MAXIMUM DAY -- 1.96 million gallons.

STORAGE FACILITIES -- 500,000 gallons elevated and 400,000 gallons ground storage.

QUALITY OF WATER -- Hardness 280-295 mg/l
Iron 0.2-1.8 mg/l
Chlorides 10-80 mg/l

TREATMENT -- Lime softening, chlorination, fluoridation, and filtration for iron removal.

Figure 12.--At St. Johns, water levels in the observation well declined to a record low during the year (table 1, Clinton Co.). However, above average precipitation and decreased pumpage during the latter part of the year resulted in rising water levels at years end.


Total annual pumpage, in millions of gallons
439
473
471
534
520
Monthly pumpage, in million gallons
30
40
50
Municipal pumpage at St. Johns
Water level, in feet below land surface
60
65
70
75
80
Clinton County
Well: 7N 2W 9-bb
Depth: 535 ft
Aquifer: Saginaw Formation
Hydrograph based on monthly lows
Departure, in inches
+10
+5
0
-5
Cumulative departure of precipitation at St. Johns
1966
1967
1968
1969
1970

WATER SUPPLY AND SOURCE -- 3 wells, 241 to 400 feet deep, tap sandstones of the Saginaw Formation.

YIELD OF WELLS (in gpm) -- 300 to 525.

SPECIFIC CAPACITY OF WELLS (in gpm per ft of drawdown) -- 3.5 to 10.

PUMPAGE IN 1970 -- 187 million gallons.

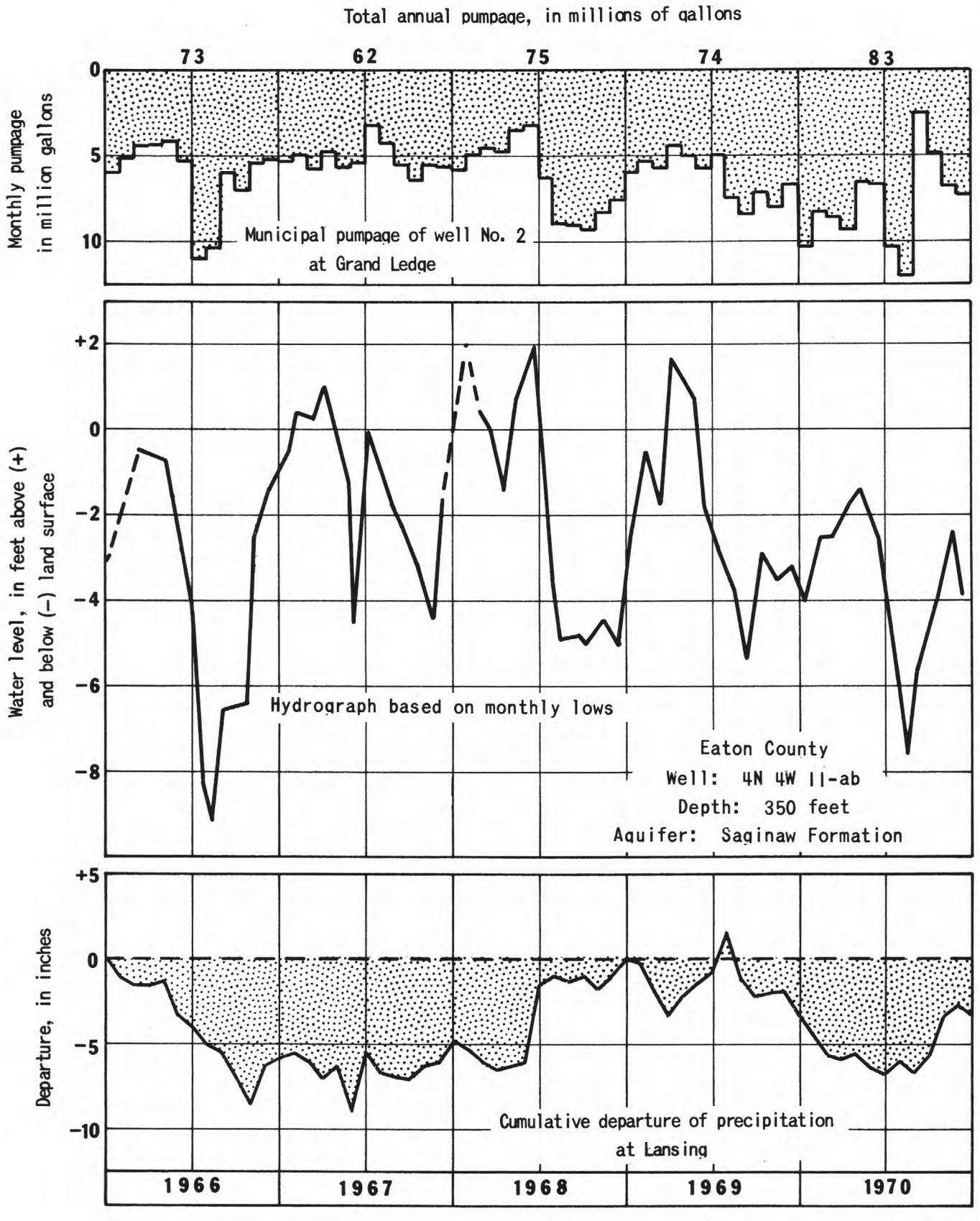
MAXIMUM DAY -- .88 million gallons.

STORAGE FACILITIES -- 100,000 gallons elevated.

QUALITY OF WATER -- Hardness 364-405 mg/l
Iron 0.5-2.0 mg/l
Fluoride 0.2-0.3 mg/l

TREATMENT -- Chlorination, phosphate.

Figure 13.--At Grand Ledge water levels in the Park well declined to their lowest level since 1967 principally as a result of below normal precipitation and increased pumpage during the first part of the year. However, with above normal precipitation and decreased pumpage during the latter part of the year levels recovered and by the end of 1970 showed no appreciable loss.


Total annual pumpage, in millions of gallons
73
62
75
74
83
Monthly pumpage in million gallons
0
5
10
Municipal pumpage of well No. 2 at Grand Ledge
Water level, in feet above (+) and below (-) land surface
+2
0
-2
-4
-6
-8
Hydrograph based on monthly lows
Eaton County
Well: 4N 4W 11-ab
Depth: 350 feet
Aquifer: Saginaw Formation
Departure, in inches
+5
0
-5
-10
Cumulative departure of precipitation at Lansing
1966
1967
1968
1969
1970

EATON COUNTY
DELTA CHARTER TOWNSHIP WATER SYSTEM (not illustrated)

WATER SUPPLY AND SOURCE -- 4 wells, 370 to 450 feet deep, tap the Saginaw Formation.

YIELD OF WELLS (in gpm) -- 160 to 700.

PUMPAGE IN 1970 -- 356 million gallons.

STORAGE FACILITIES -- 500,000 gallons elevated.

QUALITY OF WATER --

Hardness	260-365	mg/1
Iron	0.4-0.6	mg/1
Chlorides	0.5	mg/1
Fluorides	0.2-0.3	mg/1

TREATMENT -- Chlorination and phosphate.

REMARKS -- Increased population and commercial development in Delta Township has resulted in an increase in water use and a lowering of the water levels in the Saginaw Formation in this area. For example, water levels in the Robins Road observation well have fallen 36 feet since the beginning of measurements in 1953 (table 1, Eaton Co.) or about 2 feet per year. However, despite an increase of 37 percent in pumpage during 1970, the ground-water level in the Robins Road observation well did not fall to a new low as it had during the past 8 years (table 1, Eaton Co.). A new well was added to the system in 1970 and production from one of the older wells was discontinued.

GENESEE COUNTY
FISHER BODY, GMC, AT GRAND BLANC

WATER SUPPLY AND SOURCE -- 4 wells, 200 to 275 feet deep, tap sandstones of the Saginaw Formation. Three of the 4 Fisher Body Plant wells have been added to the city of Grand Blanc water system since 1968.

YIELD OF WELLS (in gpm) -- 250 to 300.

SPECIFIC CAPACITY OF WELLS (in gpm per ft of drawdown) -- 3 1/2 to 6 2/3.

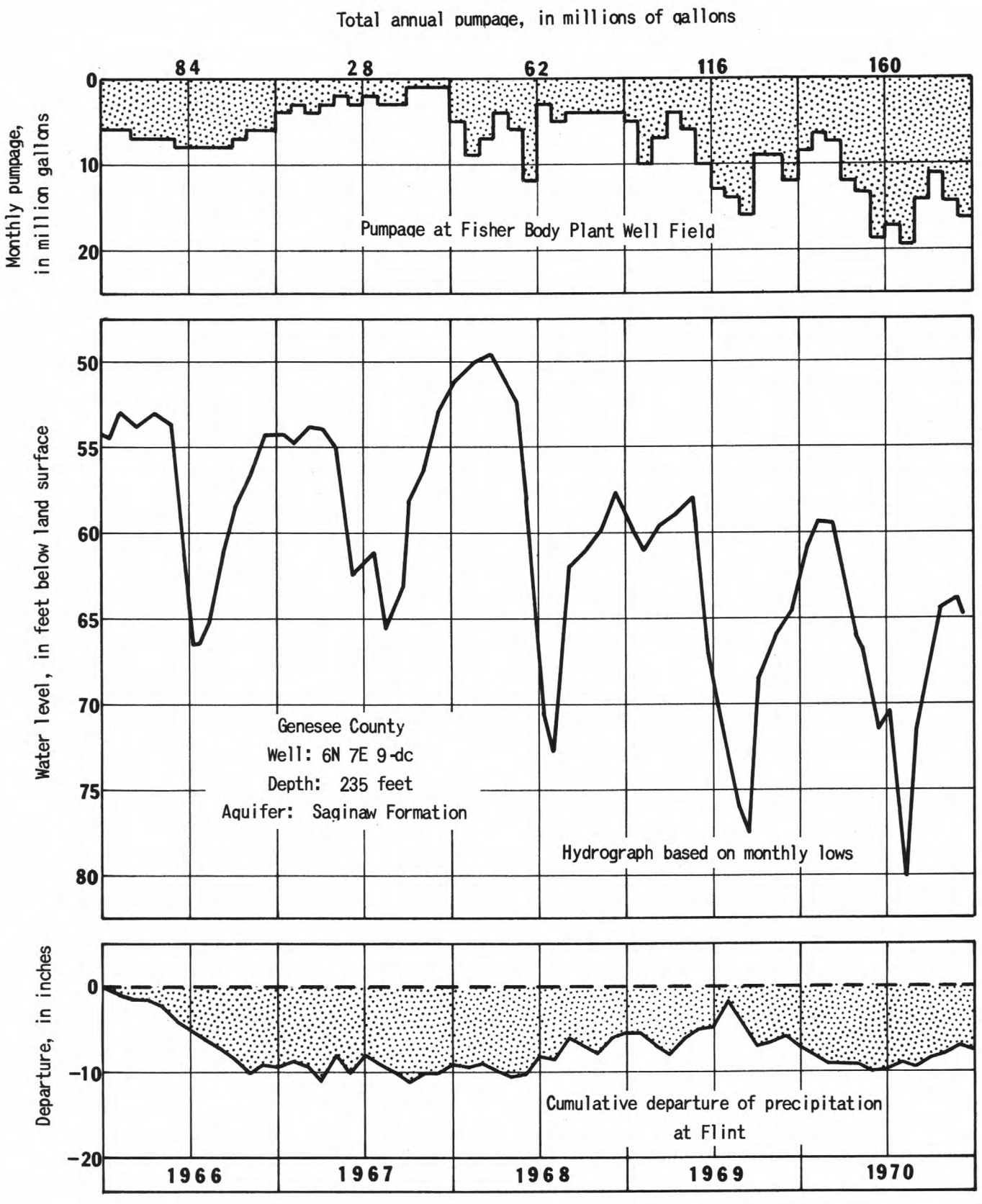
PUMPAGE IN 1970 -- 160 million gallons. Of the 160 million gallons withdrawn in 1970, 10 million gallons were pumped directly by the Fisher Body plant from their one remaining well.

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

QUALITY OF WATER -- Hardness 255-344 mg/l
Iron 0.4-1.0 mg/l
Chloride 72-120 mg/l

TREATMENT -- Phosphate and chlorination.

Figure 14.--At the Fisher Body well field, the water level has declined to a record low for the third consecutive year.


Total annual pumpage, in millions of gallons
84
28
62
116
160
Monthly pumpage, in million gallons
0
10
20
Pumpage at Fisher Body Plant Well Field
Water level, in feet below land surface
50
55
60
65
70
75
80
Genesee County
Well: 6N 7E 9-dc
Depth: 235 feet
Aquifer: Saginaw Formation
Hydrograph based on monthly lows
Departure, in inches
0
-10
-20
Cumulative departure of precipitation at Flint
1966
1967
1968
1969
1970

WATER SUPPLY AND SOURCE -- 5 wells, 41 to 118 feet deep, tap the glacial drift.

YIELD OF WELLS (in gpm) -- No. 1 - 380; no. 2 - 135; no. 3 - 360; no. 4 - 200; no. 5 - 240.

SPECIFIC CAPACITY OF WELLS (in gpm per ft of drawdown) -- No. 1 - 47; no. 3 - 21; no. 4 - 6; no. 5 - 27.

PUMPAGE in 1970 -- 454 million gallons.

MAXIMUM DAY -- 1.82 million gallons.

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

QUALITY OF WATER --

Hardness	63-186	mg/l
Iron	0.0-0.1	mg/l
Chloride	4-63	mg/l

TREATMENT -- Chlorination.

Figure 15.--At Ironwoods Big Spring well field water level in the observation well declined to its lowest level during the 8 year record despite a decrease in pumpage during 1970. The decline is attributed mainly to a net loss of about 13 inches of precipitation during the 1969-70 period.

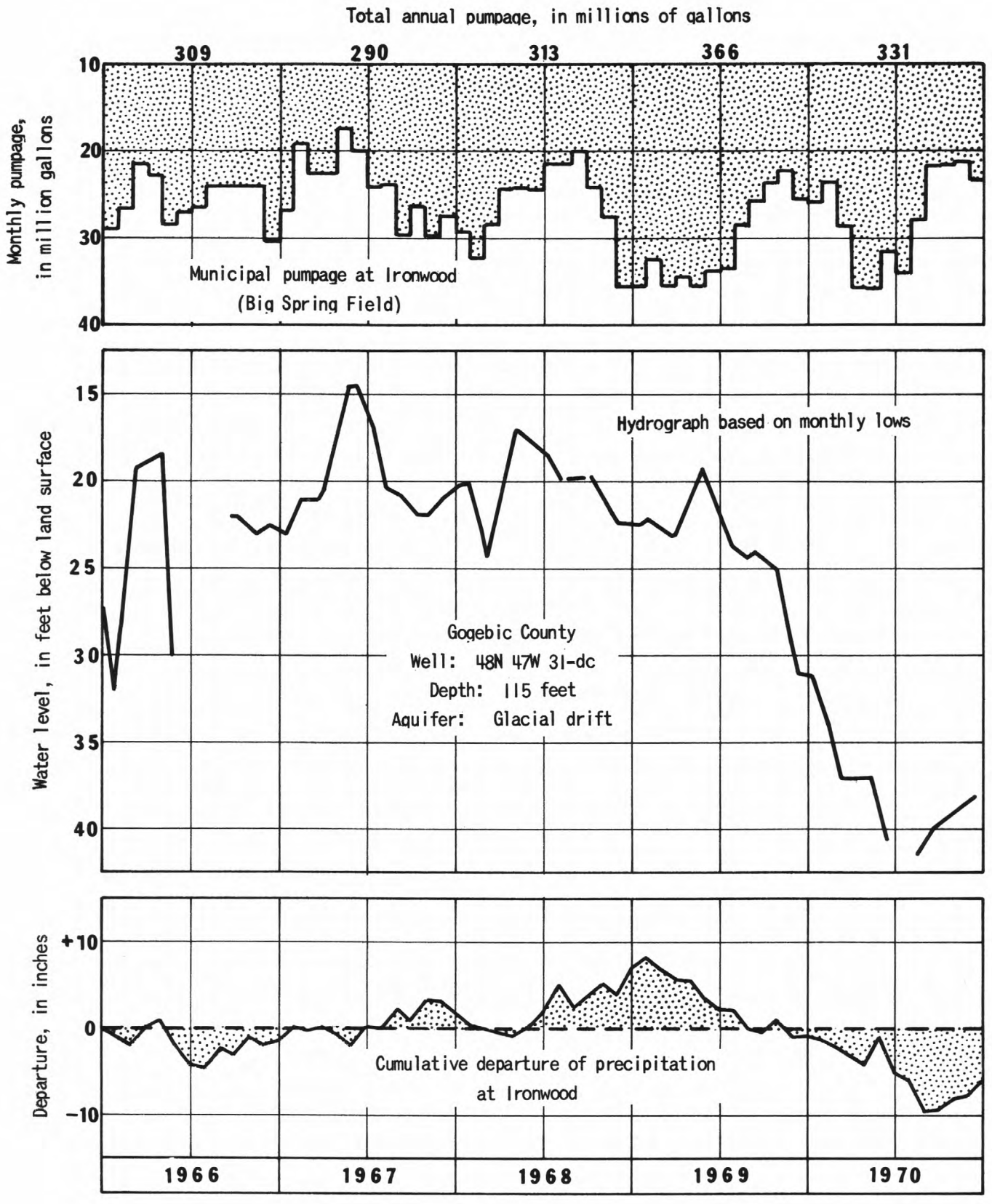
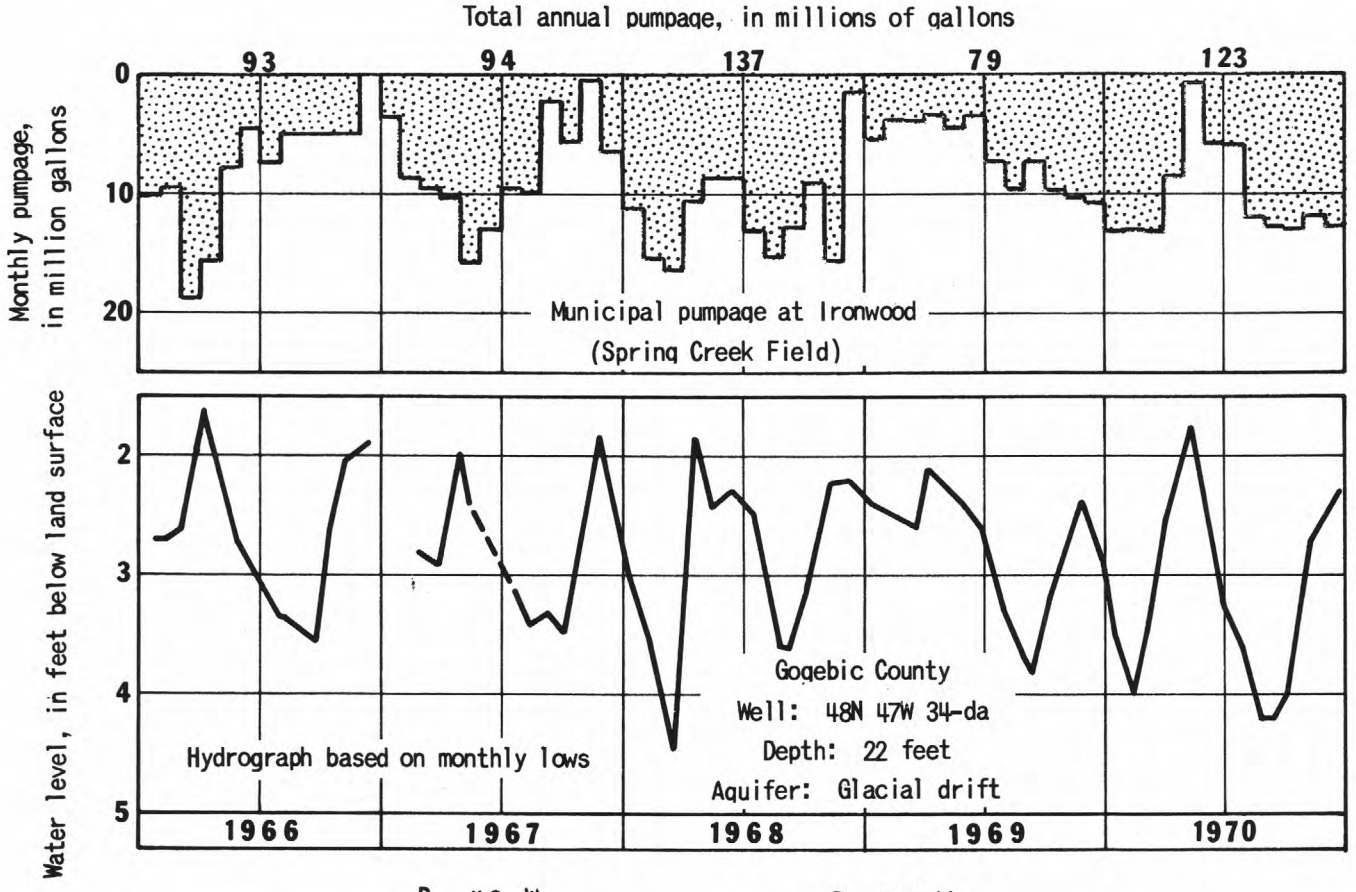
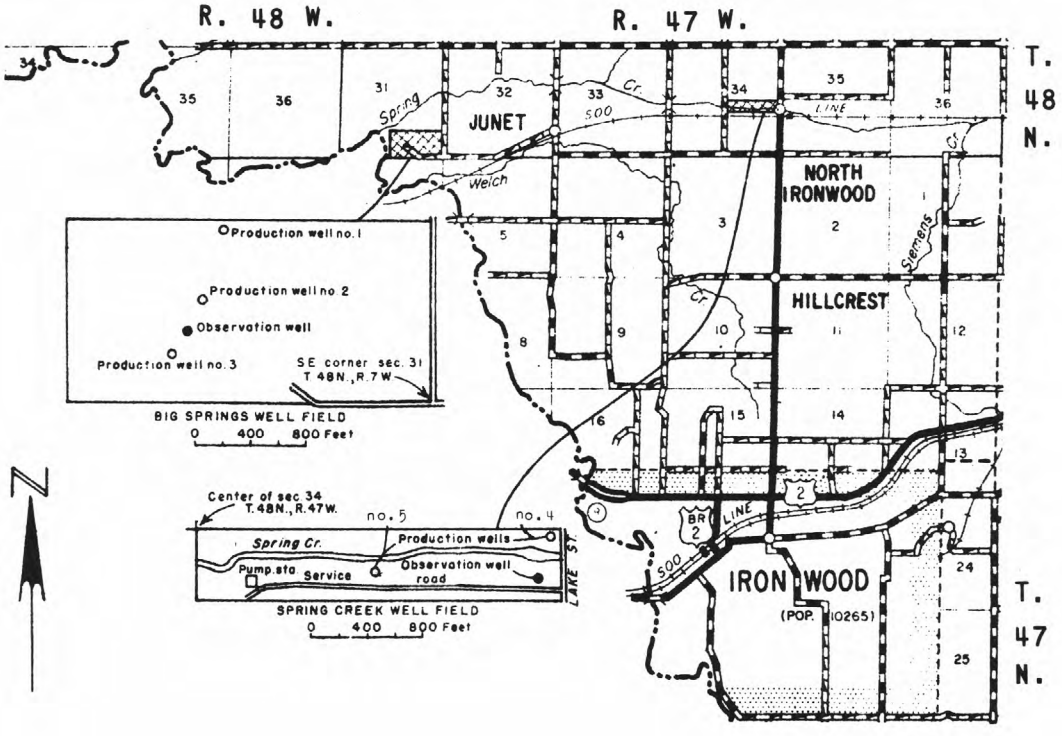

Total annual pumpage, in millions of gallons
309
290
313
366
331
Monthly pumpage, in million gallons
10
20
30
40
Municipal pumpage at Ironwood
(Big Spring Field)
Water level, in feet below land surface
15
20
25
30
35
40
Hydrograph based on monthly lows
Gogebic County
Well: 48N 47W 31-dc
Depth: 115 feet
Aquifer: Glacial drift
Departure, in inches
+10
0
-10
Cumulative departure of precipitation
at Ironwood
1966
1967
1968
1969
1970

Figure 16.--At Ironwood's Spring Creek Field, water levels in the observation well showed no major declines even though pumpage increased and precipitation was below normal. This was due principally to the fact that the aquifer received considerable recharge from Spring Creek.


Total annual pumpage, in millions of gallons
93
94
137
79
123
Monthly pumpage, in million gallons
0
10
20
Municipal pumpage at Ironwood
(Spring Creek Field)
Water level, in feet below land surface
2
3
4
5
Gogebic County
Well: 48N 47W 34-da
Depth: 22 feet
Aquifer: Glacial drift
Hydrograph based on monthly lows
1966
1967
1968
1969
1970


R. 48 W.
R. 47 W.
T. 48 N.
T. 47 N.
JUNET
NORTH IRONWOOD
HILLCREST
IRON WOOD
(POP. 10265)
Spring Cr.
Welch Cr.
Siemens Cr.
500 LINE
Production well no. 1
Production well no. 2
Observation well
Production well no. 3
SE corner sec. 31 T. 48N., R. 7W.
BIG SPRINGS WELL FIELD
0 400 800 Feet
Center of sec. 34 T. 48N., R. 47W.
no. 5
no. 4
Spring Cr.
Production wells
Pump sta.
Service road
Observation well
LAKE ST.
SPRING CREEK WELL FIELD
0 400 800 Feet
N

WATER SUPPLY AND SOURCE -- 5 wells, 82 to 155 feet deep, tap outwash deposits in glacial drift. Standby well, 550 feet deep, taps sandstone of the Saginaw Formation. Since 1965, most water for municipal use has been obtained from the Pine River.

YIELD OF WELLS (in gpm) -- 175 to 875.

SPECIFIC CAPACITY OF WELLS (in gpm per ft of drawdown) -- Glacial drift 12 to 25; Saginaw Formation - 2 1/2.

PUMPAGE IN 1970 -- 171 million gallons, also 651 million gallons of river water. Total 822 million gallons. Ground-water wells are used during the summer months to augment the surface supply from the Pine River when flow is low.

MAXIMUM DAY -- 3.08 million gallons.

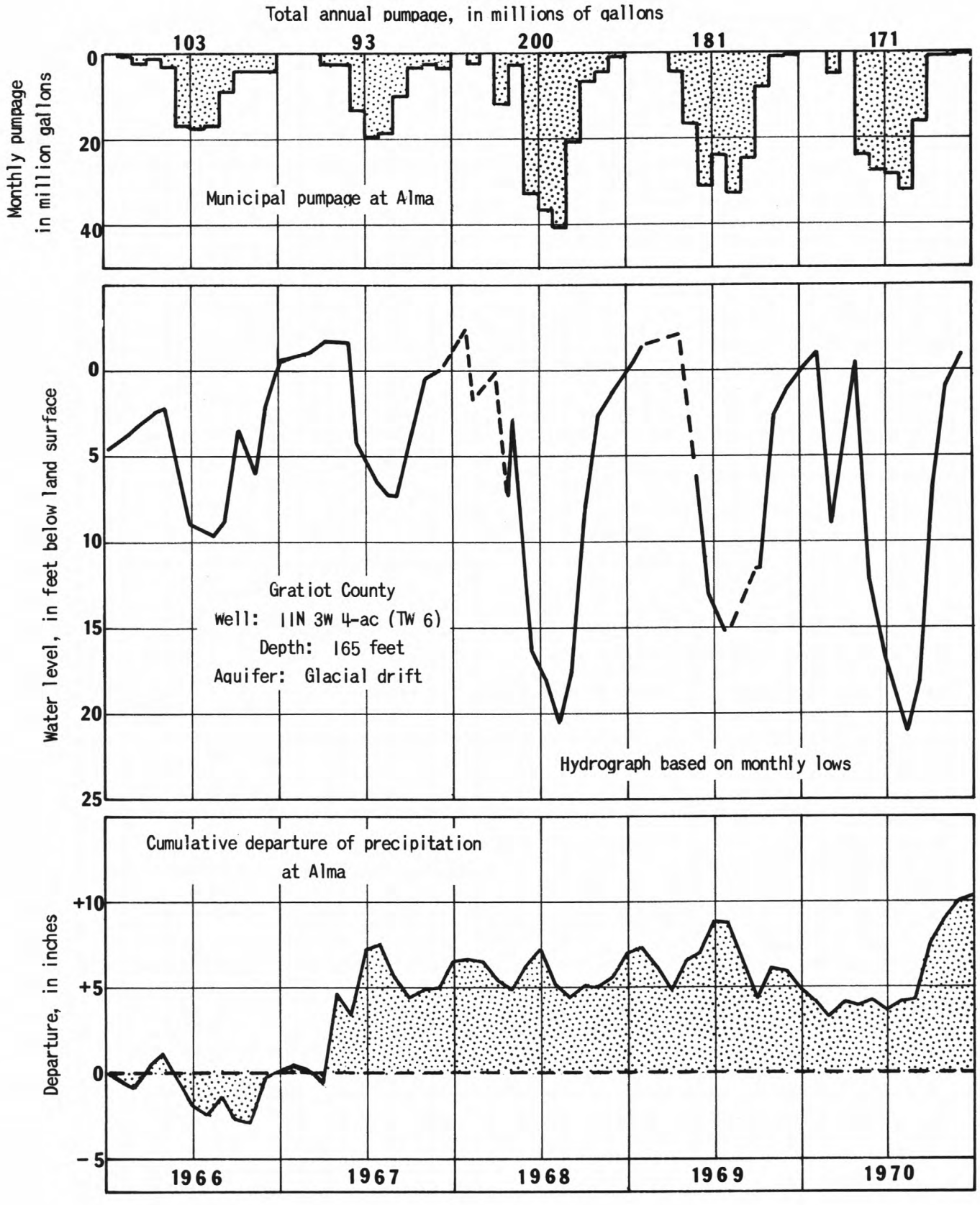
STORAGE FACILITIES -- 1,000,000 gallons ground level for treated water, 500,000 gallons elevated for treated water; 200,000 gallons on industrial water.

QUALITY OF WATER --

Drift:		Saginaw:	
Hardness	350-451 mg/l	Hardness	250 mg/l
Iron	1.4-1.7 mg/l	Iron	1.1 mg/l
Fluoride	0.1-0.2 mg/l	Fluoride	0.1 mg/l

TREATMENT -- None for ground water.

Figure 17.--Water levels in the observation well show the effects of the pumpage withdrawal during summer months.


Total annual pumpage, in millions of gallons
103
93
200
181
171
Monthly pumpage in million gallons
0
20
40
Municipal pumpage at Alma
Water level, in feet below land surface
0
5
10
15
20
25
Gratiot County
Well: 11N 3W 4-ac (TW 6)
Depth: 165 feet
Aquifer: Glacial drift
Hydrograph based on monthly lows
Cumulative departure of precipitation at Alma
Departure, in inches
+10
+5
0
-5
1966
1967
1968
1969
1970

WATER SUPPLY AND SOURCE -- 6 wells, 136 to 223 feet deep, tap buried outwash deposits in glacial drift.

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

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

PUMPAGE IN 1970 - 571 million gallons.

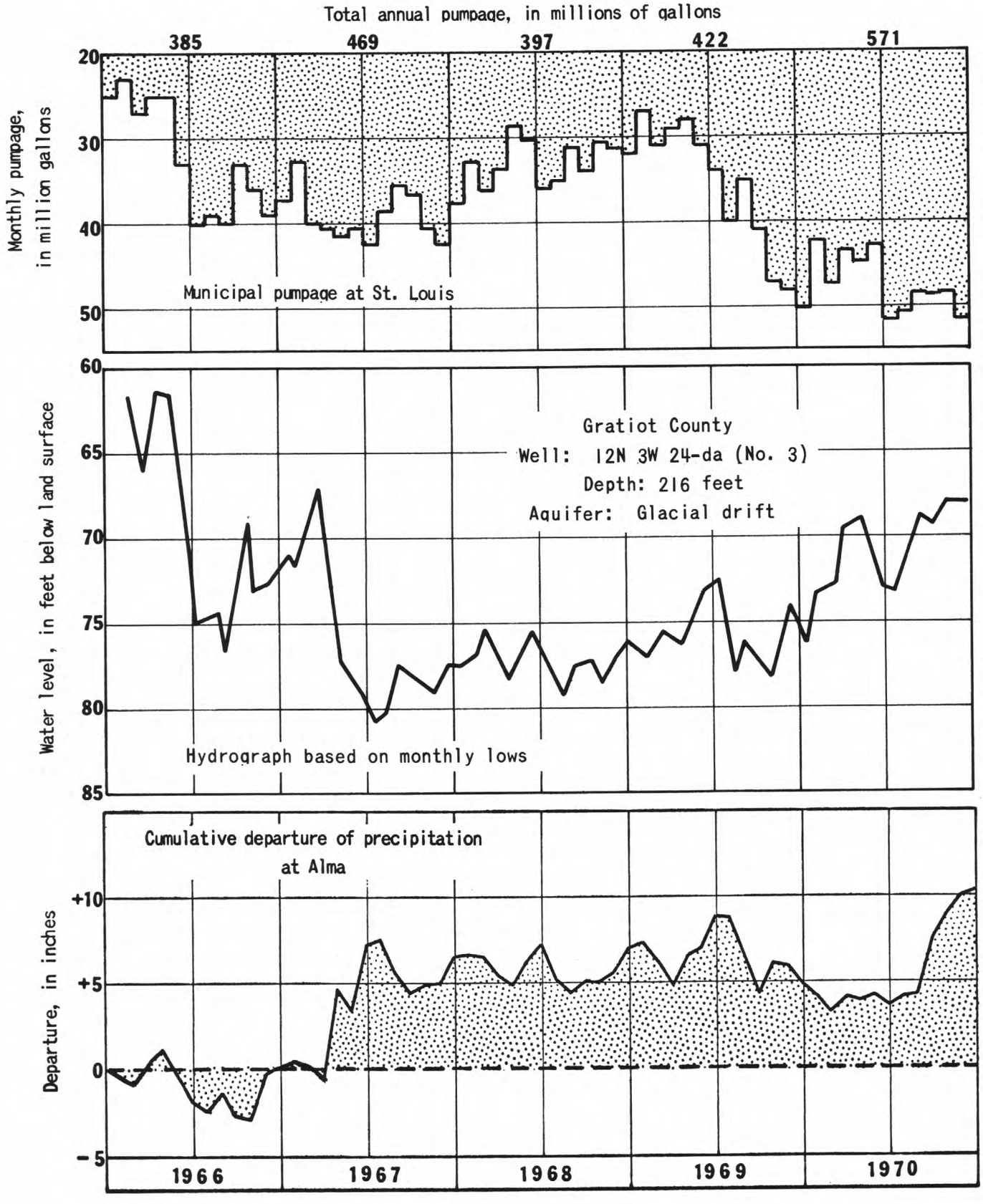
MAXIMUM DAY -- 2.15 million gallons.

STORAGE FACILITIES -- 500,000 gallons elevated.

QUALITY OF WATER -- Hardness 260-325 mg/l
Iron 0.5-1.0 mg/l
Fluoride 0.1-0.4 mg/l

TREATMENT -- None.

Figure 18.--At St. Louis, water levels in the observation well continued an upward trend as an increase in precipitation offset a 26-percent increase in pumpage.


Total annual pumpage, in millions of gallons
385
469
397
422
571
Monthly pumpage, in million gallons
20
30
40
50
Municipal pumpage at St. Louis
Water level, in feet below land surface
60
65
70
75
80
85
Gratiot County
Well: 12N 3W 24-da (No. 3)
Depth: 216 feet
Aquifer: Glacial drift
Hydrograph based on monthly lows
Cumulative departure of precipitation at Alma
Departure, in inches
+10
+5
0
-5
1966
1967
1968
1969
1970

INGHAM COUNTY
CITY OF EAST LANSING (not illustrated)

WATER SUPPLY AND SOURCE -- 10 wells, 385 to 400 feet deep, tap sandstones of the Saginaw Formation.

YIELD OF WELLS (in gpm) -- 275 to 825.

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

PUMPAGE IN 1970 -- 1,286 million gallons.

MAXIMUM DAY -- 5.60 million gallons.

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

QUALITY OF WATER -- Hardness 325-565 mg/1
Iron 0.8-3.0 mg/1
Chloride 3-34 mg/1

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

REMARKS -- Water levels in the "Marble School" observation well (table 1, Ingham Co.) have been declining since the start of record in 1953. The new low of record, about 65 feet below land surface or 45 feet below levels recorded in 1953, was established in 1970.

INGHAM COUNTY
LANSING TOWNSHIP (not illustrated)

WATER SUPPLY AND SOURCE -- 7 wells, 399 to 417 feet deep, tap sandstones of the Saginaw Formation.

YIELD OF WELLS (in gpm) -- 260 to 500.

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

PUMPAGE IN 1970 -- 528 million gallons.

STORAGE FACILITIES -- 200,000 gallons elevated, and 2,000,000 underground storage tank.

QUALITY OF WATER --

Hardness	290-350	mg/l
Iron	0.4-1.0	mg/l
Fluoride	0.4	mg/l

TREATMENT -- Chlorination, and phosphate for iron control.

REMARKS -- About two-thirds of Lansing township's water supply is supplied to industry. As a result, the township pumped about 221 million gallons less in 1970 than in 1969 primarily because of the strikes at General Motors plants.

WATER SUPPLY AND SOURCE -- 125 wells, 400 to 425 feet deep, tap sandstone of the Saginaw Formation; 3 wells, 85 to 105 feet deep, tap sands in glacial drift.

YIELD OF WELLS (in gpm) -- 100 to 700 (sandstone).
790 to 1,200 (glacial drift).

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

PUMPAGE IN 1970 -- 7,946 million gallons.

MAXIMUM DAY -- 33.1 million gallons.

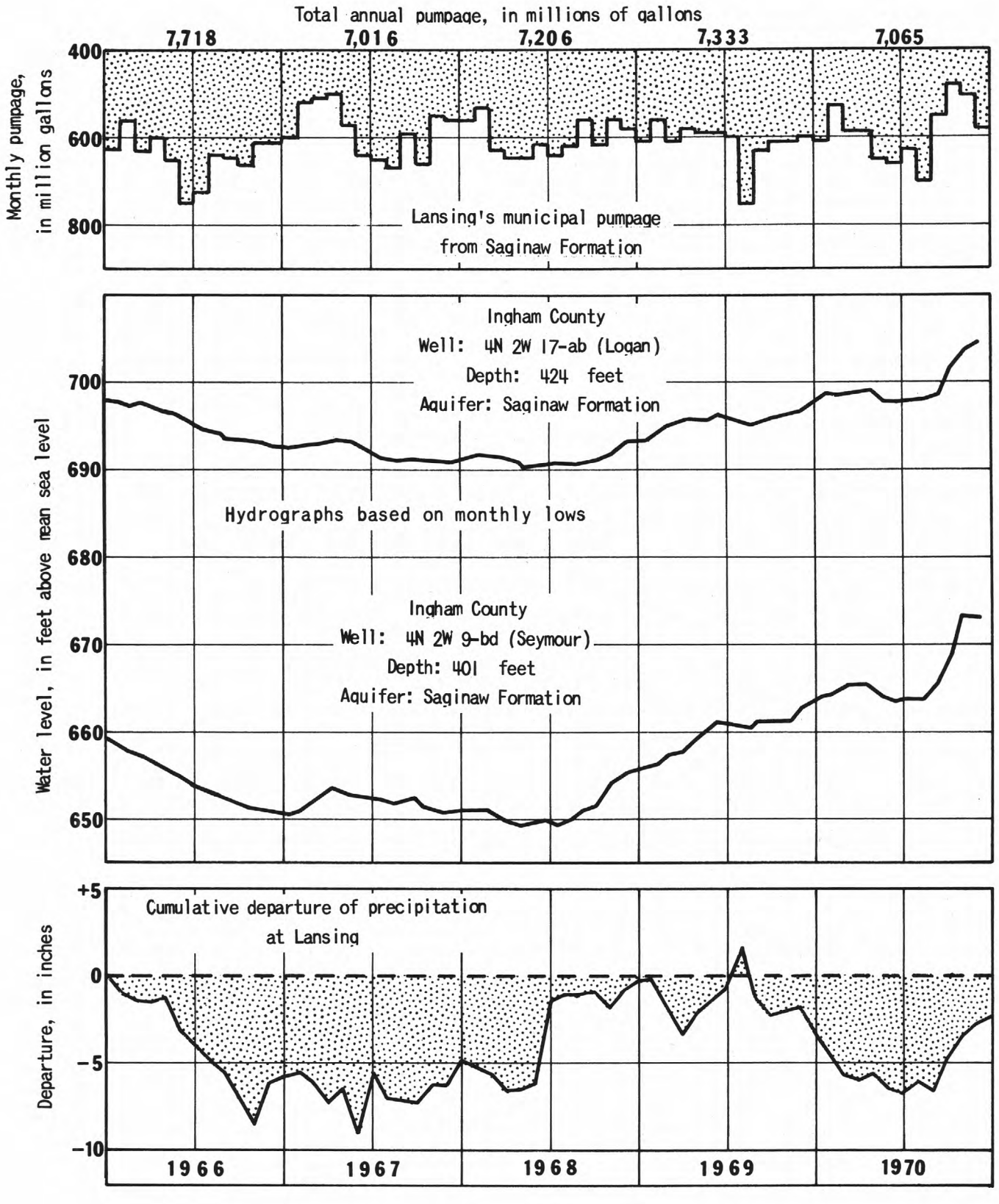
STORAGE FACILITIES -- Ground storage of 22,000,000 gallons.

QUALITY OF WATER --

	Saginaw sandstone:	Glacial drift:
Hardness	200-600 mg/l	348 mg/l
Iron	0.03-4.0 mg/l	0.0 mg/l

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

Figure 19.--In the Lansing area, water levels in some observation wells finished in the Saginaw Formation continue to show recovery. These recoveries reflect the effects of the new Stiefel Field, which obtains its water from the glacial drift, and the addition of 9 new wells located in the southeastern part of the city. Some pumping is being shifted from areas that have carried the peak load allowing water levels to recover.


Total annual pumpage, in millions of gallons
7,718
7,016
7,206
7,333
7,065
Monthly pumpage, in million gallons
400
600
800
Lansing's municipal pumpage from Saginaw Formation
Ingham County
Well: 4N 2W 17-ab (Logan)
Depth: 424 feet
Aquifer: Saginaw Formation
Hydrographs based on monthly lows
Ingham County
Well: 4N 2W 9-bd (Seymour)
Depth: 401 feet
Aquifer: Saginaw Formation
Water level, in feet above mean sea level
700
690
680
670
660
650
Cumulative departure of precipitation at Lansing
Departure, in inches
+5
0
-5
-10
1966
1967
1968
1969
1970

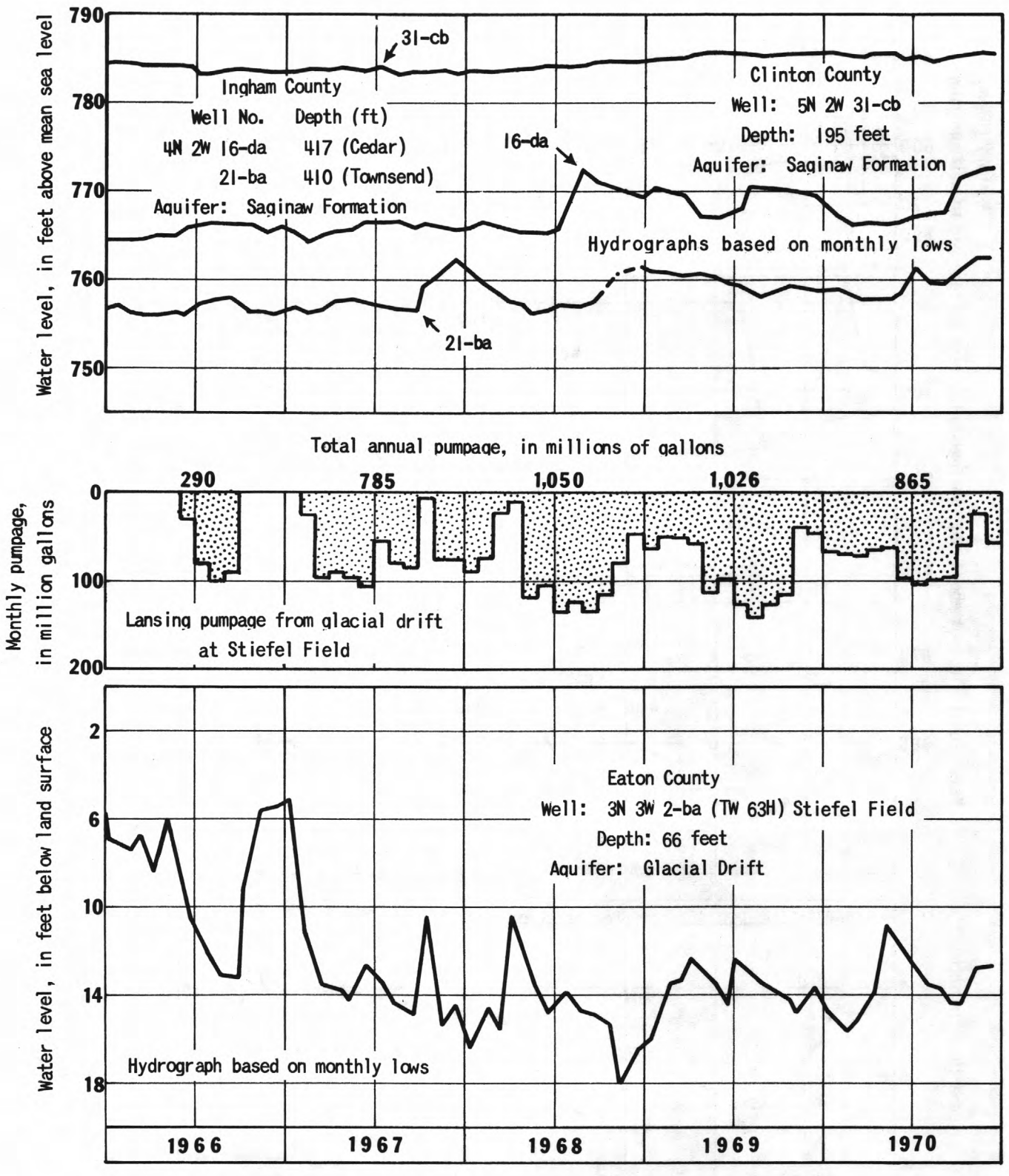


Figure 20.--In the Lansing metropolitan area water levels in these observation wells showed a net gain during 1970.

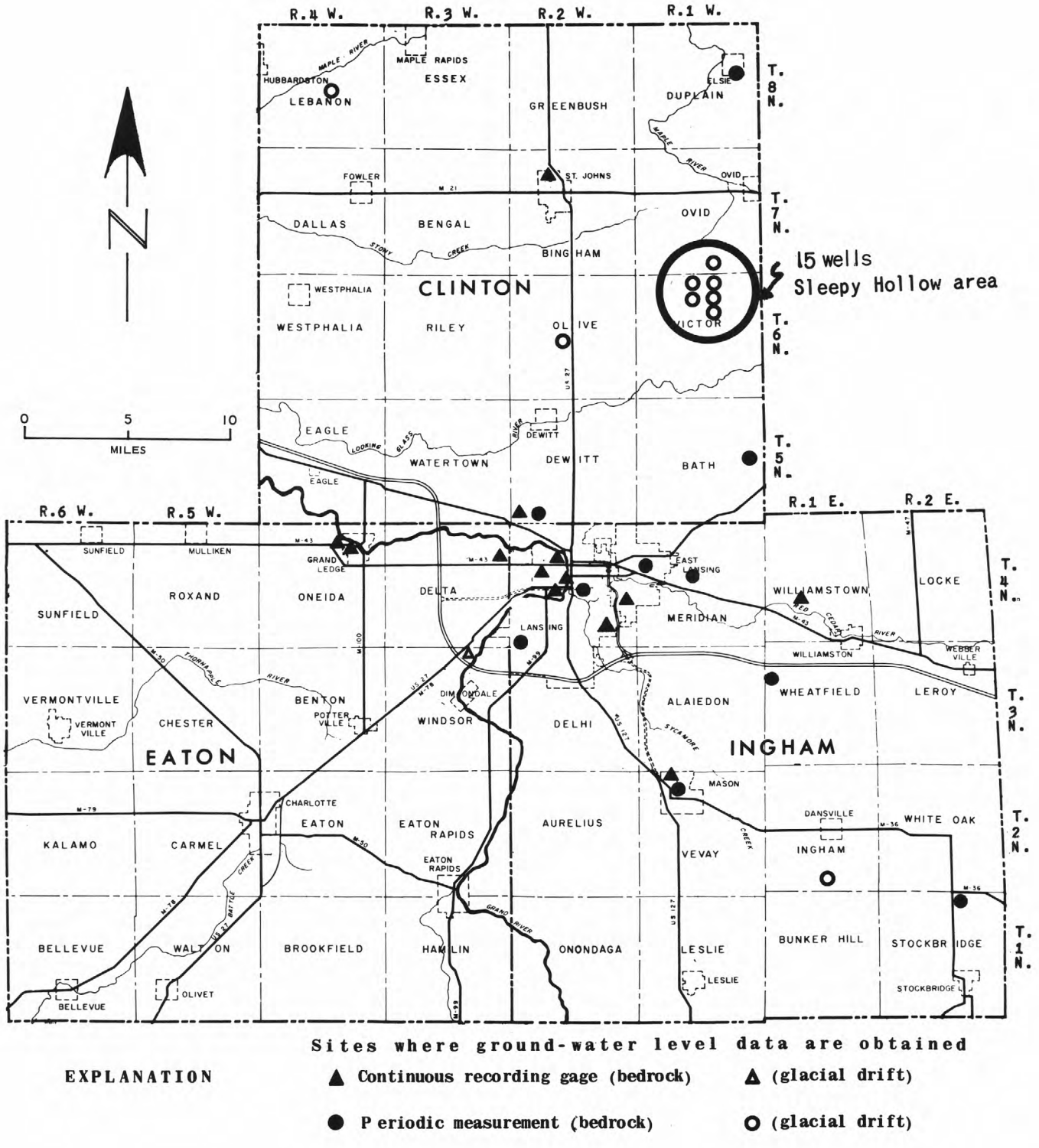


Figure 21.--Location of observation wells in the Tri-County area. The wells in the Sleepy Hollow area are being monitored to ascertain ground-water conditions in the glacial drift prior to development of an impoundment to create an artificial lake.

WATER SUPPLY AND SOURCE -- 1 well, about 50 feet deep, taps the glacial drift; one well, 223 feet deep, taps sandstones of the Saginaw Formation.

YIELD OF WELLS (in gpm) -- 675 to 700.

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

PUMPAGE IN 1970 -- 186 million gallons

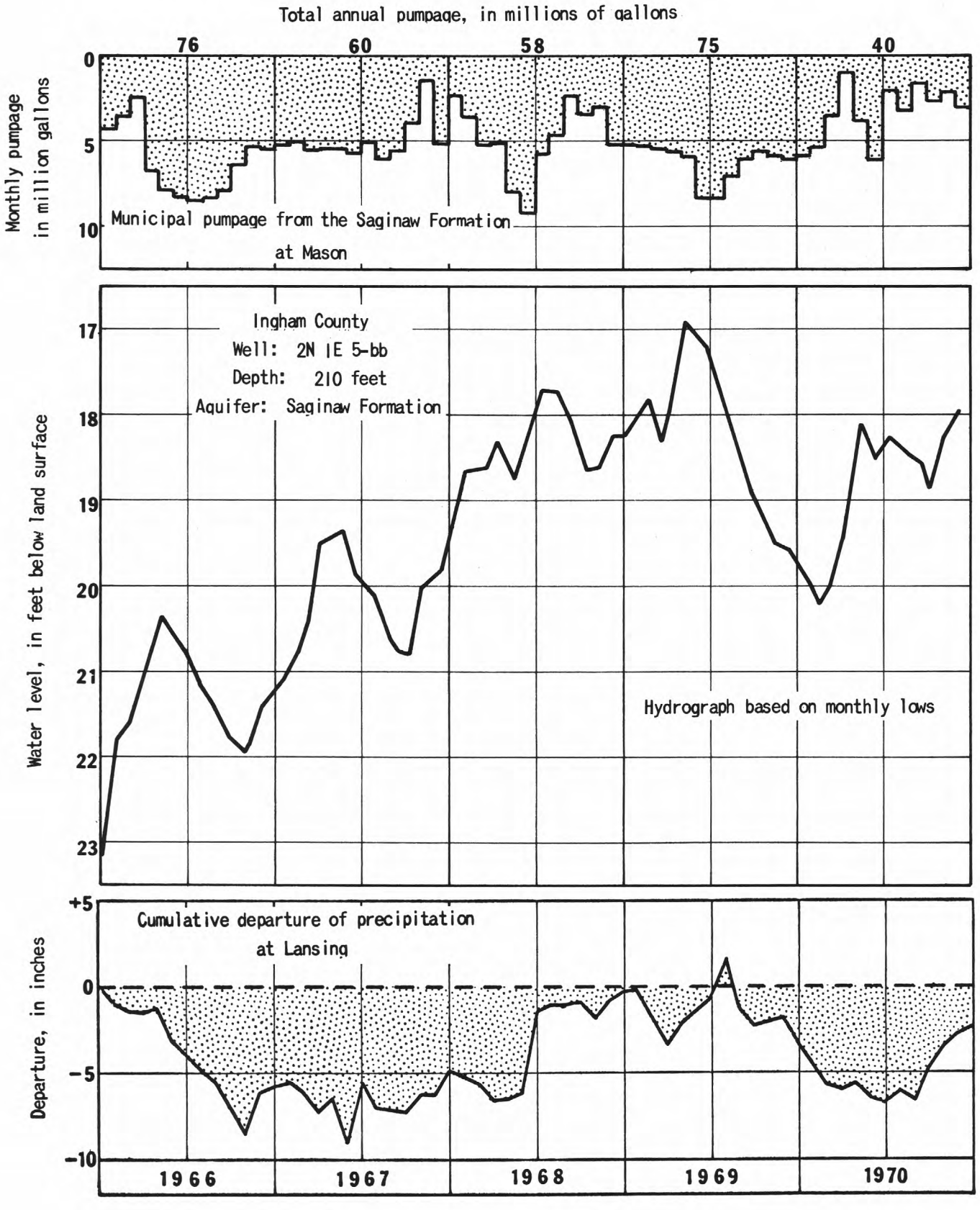
STORAGE FACILITIES -- 360,000 elevated.

QUALITY OF WATER --

Hardness	310-400	mg/l
Iron	0.3	mg/l
Fluoride	0-0.2	mg/l
Chloride	8-44	mg/l

TREATMENT -- Chlorination and fluoride.

Figure 22.--At Mason, water levels in February 1970 declined to their lowest level since 1967. However, a decrease in pumpage from the Saginaw Formation and above normal precipitation during the latter part of 1970 resulted in the highest year end levels of record.


Total annual pumpage, in millions of gallons
76
60
58
75
40
Monthly pumpage in million gallons
0
5
10
Municipal pumpage from the Saginaw Formation at Mason
Ingham County
Well: 2N 1E 5-bb
Depth: 210 feet
Aquifer: Saginaw Formation
Water level, in feet below land surface
17
18
19
20
21
22
23
Hydrograph based on monthly lows
Cumulative departure of precipitation at Lansing
Departure, in inches
+5
0
-5
-10
1966
1967
1968
1969
1970

INGHAM COUNTY
MERIDIAN TOWNSHIP (not illustrated)

WATER SUPPLY AND SOURCE -- 16 wells, 295 to 422 feet deep, tap the Saginaw Formation.

YIELD OF WELLS (in gpm) -- About 200 to 500.

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

PUMPAGE IN 1970 -- 211 million gallons. About 100 million gallons of water is purchased from East Lansing to supply the Township's Water District No. 1.

STORAGE FACILITIES -- 580,000 gallons.

QUALITY OF WATER -- Hardness 235-395 mg/l
Iron 0.9-4.5 mg/l
Fluoride 0.15-0.5 mg/l

TREATMENT -- None.

REMARKS -- During 1970, the township increased its areal supply of water to residents by extending its main water trunk through the Haslett and Okemos areas. A new water treatment plant is planned for the area.

INGHAM COUNTY
MICHIGAN STATE UNIVERSITY (not illustrated)

WATER SUPPLY AND SOURCE -- 17 wells, 353 to 435 feet deep, tap sandstones of the Saginaw Formation. Two of these wells are on a standby basis only.

YIELD OF WELLS (in gpm) -- 147 to 654.

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

PUMPAGE IN 1970 -- 1,806 million gallons.

MAXIMUM DAY -- 7.03 million gallons.

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

QUALITY OF WATER -- Composite: Average, raw water

Hardness	324 mg/l
Iron	0.3 mg/l
Fluoride	0.4 mg/l

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

REMARKS -- Despite a decrease in pumpage for the second consecutive year at Michigan State University, water levels in observation well 4N 2W 24-ca (Ingham County, table 1) fell to a record low for the ninth consecutive year.

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

YIELD OF WELLS (in gpm) -- 1,000 to 2,800.

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

PUMPAGE IN 1970 -- 4,337 million gallons.

MAXIMUM DAY -- 19.83 million gallons.

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

QUALITY OF WATER -- Hardness 340-390 mg/l
Iron 0.3-1.0 mg/l
Chloride 13-88 mg/l

TREATMENT -- Chlorination and fluoridation.

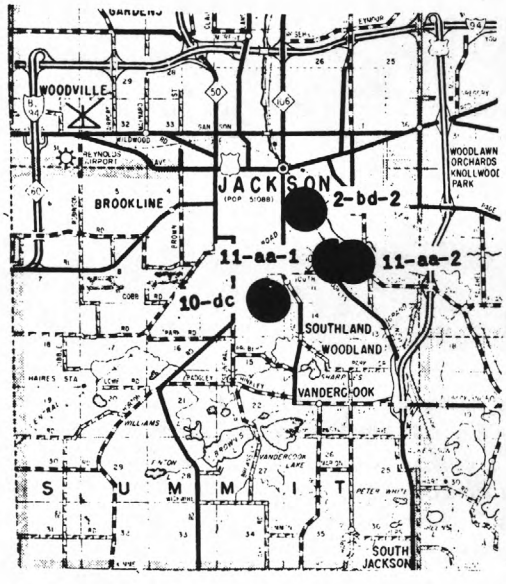
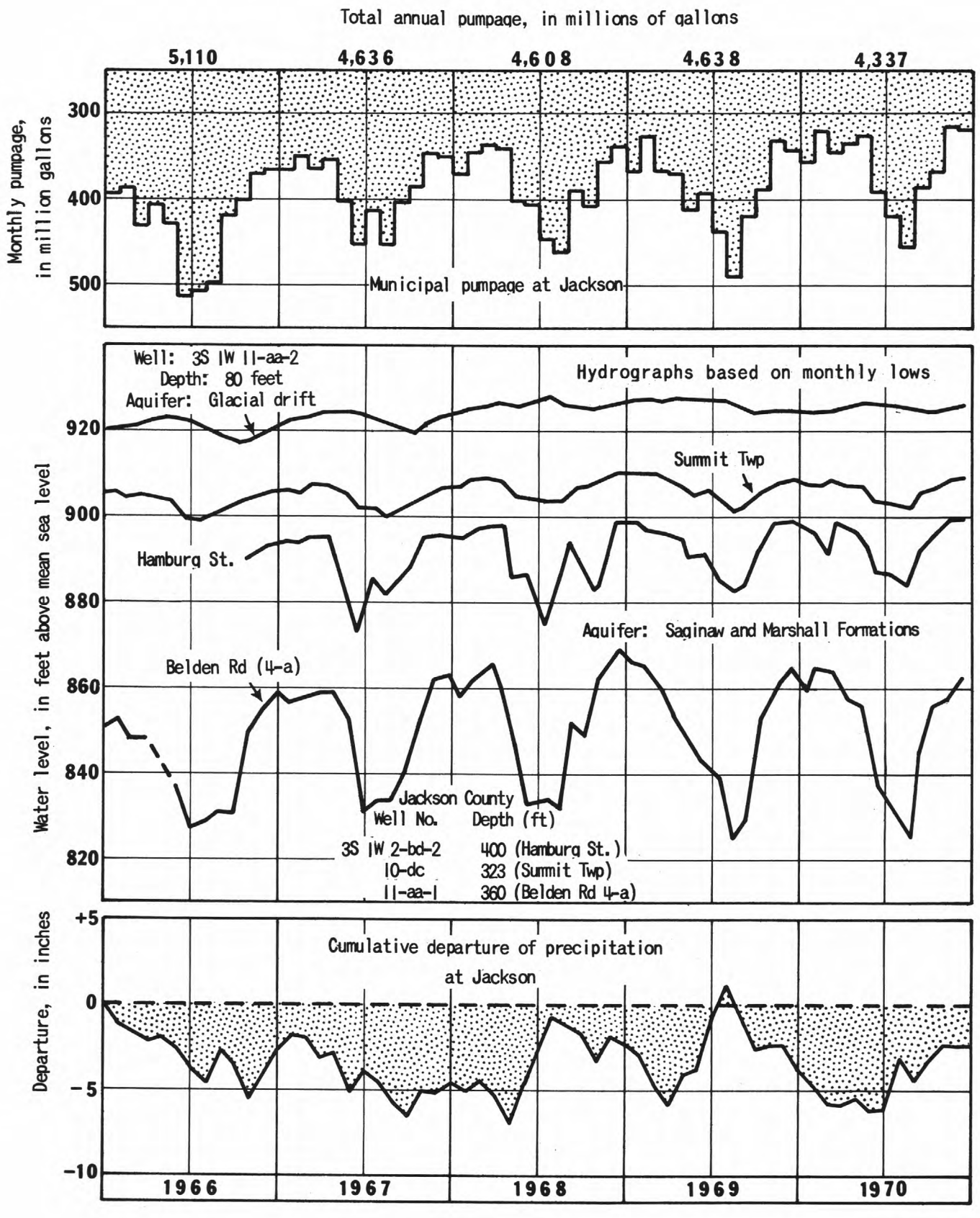


Figure 23.--Location of observation wells.

Figure 24.--At Jackson, the December water levels were about the same as the January levels. The two rock wells, Summit Twp. and Hamburg St., showed slight rises principally due to the decrease in pumpage. However, the Belden Rd. (4-a) well equaled the record low of 1969.


Total annual pumpage, in millions of gallons
5,110
4,636
4,608
4,638
4,337
Monthly pumpage, in million gallons
300
400
500
Municipal pumpage at Jackson
Well: 3S 1W 11-aa-2
Depth: 80 feet
Aquifer: Glacial drift
Hydrographs based on monthly lows
Summit Twp
Hamburg St.
Aquifer: Saginaw and Marshall Formations
Belden Rd (4-a)
Water level, in feet above mean sea level
920
900
880
860
840
820
Jackson County
Well No. Depth (ft)
3S 1W 2-bd-2 400 (Hamburg St.)
10-dc 323 (Summit Twp)
11-aa-1 360 (Belden Rd 4-a)
Departure, in inches
+5
0
-5
-10
Cumulative departure of precipitation at Jackson
1966
1967
1968
1969
1970

WATER SUPPLY AND SOURCE -- 84 wells, 130 to 254 feet deep, tap the glacial drift.

YIELD OF WELLS (in gpm) -- 200 to 2,000.

SPECIFIC CAPACITY OF WELLS (in gpm per ft of drawdown) -- 7 to 100.

PUMPAGE IN 1970 -- 6,481 million gallons.

MAXIMUM DAY -- 38.81 million gallons.

STORAGE FACILITIES -- 15,150,000 gallons elevated.

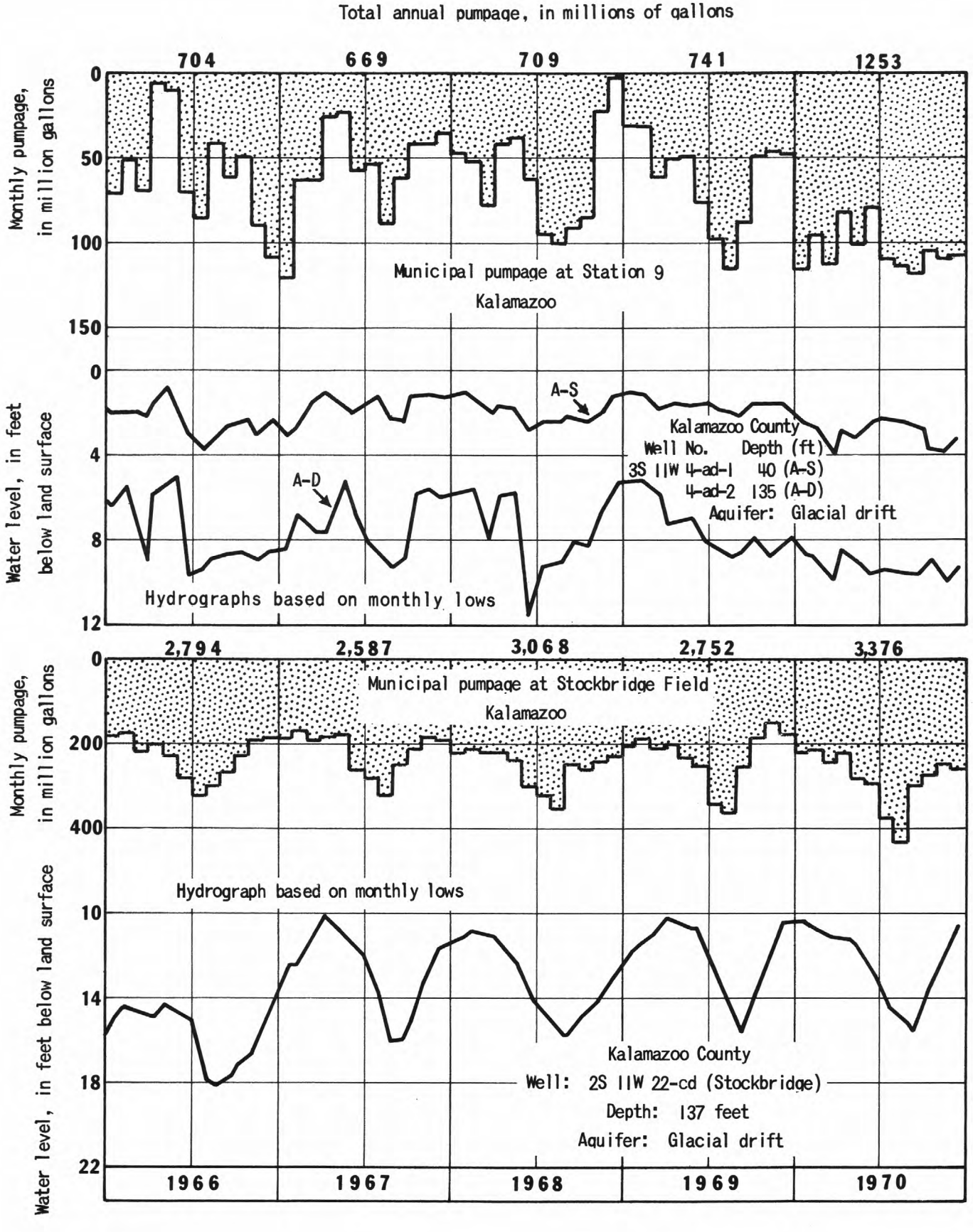
QUALITY OF WATER --

Hardness	312-350	mg/l
Chloride	2-18	mg/l
Iron	0.25-0.75	mg/l

TREATMENT -- Chlorination, fluoridation, hexametaphosphate.

REMARKS -- Of the 20 observation wells in Kalamazoo County (table 1, Kalamazoo County), 10 wells reached record highs or lows during 1970. All of these wells have short records of 4 years or less.

Figure 25.--Water levels and pumpage at the city of Kalamazoo's two main well fields. The Stockbridge field shows levels to be stable while the Station 9 field indicates only a slight decline even though pumpage was increased by about 70 percent in 1970.


Total annual pumpage, in millions of gallons
704
669
709
741
1253
Monthly pumpage, in million gallons
0
50
100
150
Municipal pumpage at Station 9
Kalamazoo
Water level, in feet below land surface
0
4
8
12
A-S
A-D
Kalamazoo County
Well No. Depth (ft)
3S 11W 4-ad-1 40 (A-S)
4-ad-2 135 (A-D)
Aquifer: Glacial drift
Hydrographs based on monthly lows
2,794
2,587
3,068
2,752
3,376
Monthly pumpage, in million gallons
0
200
400
Municipal pumpage at Stockbridge Field
Kalamazoo
Hydrograph based on monthly lows
Water level, in feet below land surface
10
14
18
22
Kalamazoo County
Well: 2S 11W 22-cd (Stockbridge)
Depth: 137 feet
Aquifer: Glacial drift
1966
1967
1968
1969
1970

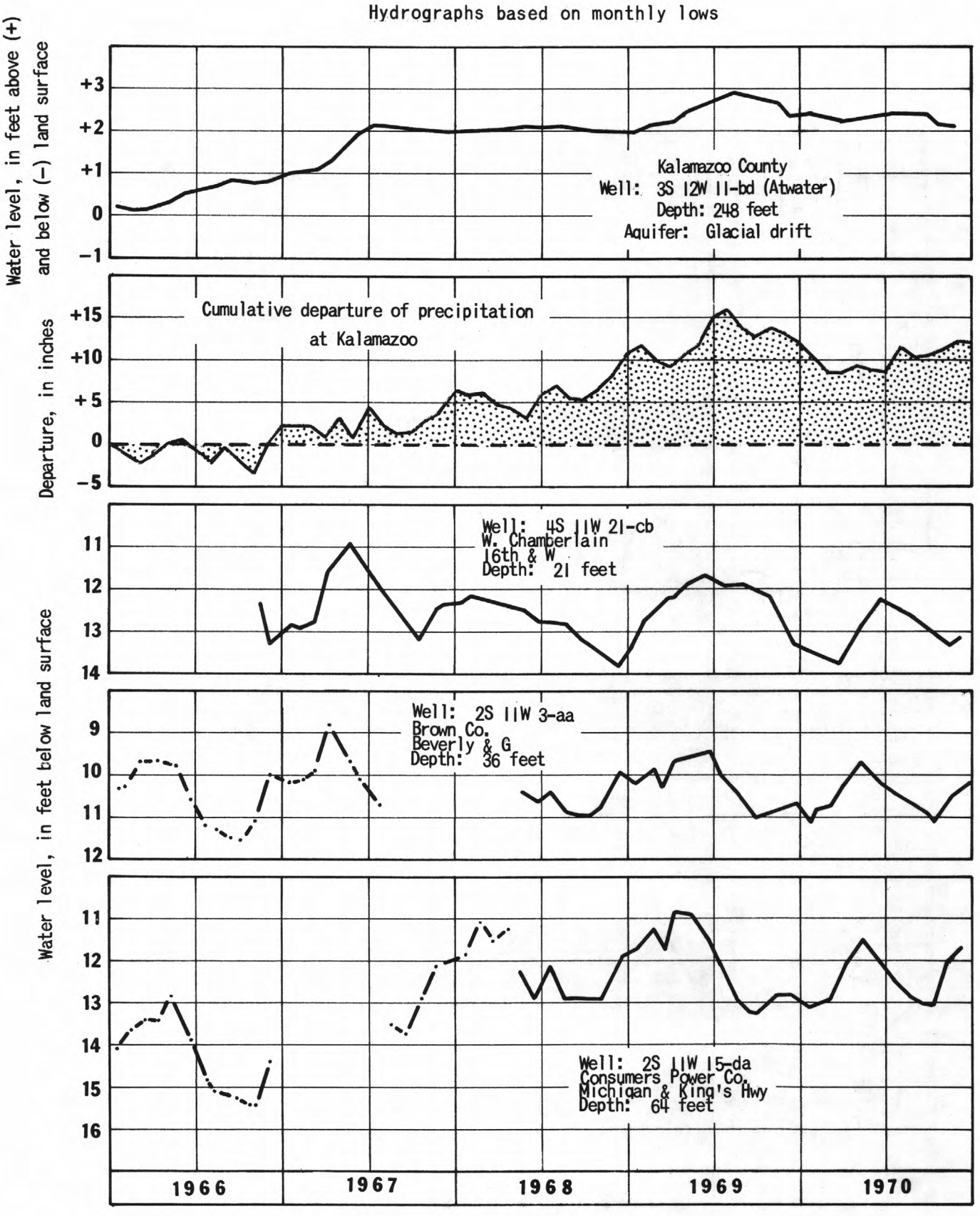


Figure 26.--In the Kalamazoo Area these wells showed a net gain in water levels at the end of 1970.

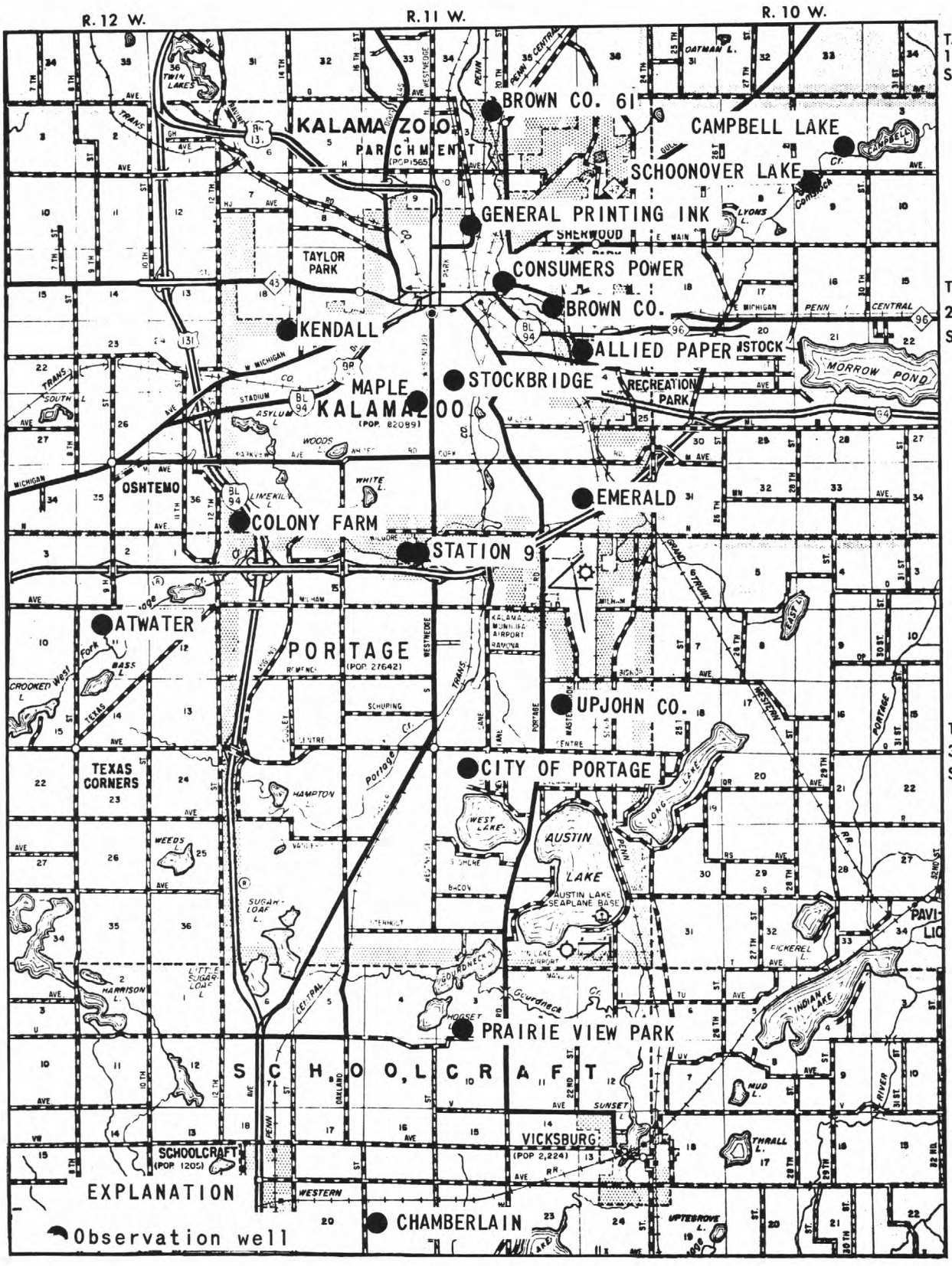


Figure 27.--Location of observation wells in Kalamazoo County. The Atwater, Chamberlain, and Prairie View Park wells are in areas where their water levels are affected principally by natural influences. The remainder of the wells are in areas of heavy ground-water withdrawals.

WATER SUPPLY AND SOURCE -- 15 wells, 95 to 185 feet deep, tap the glacial drift.

YIELD OF WELLS (in gpm) -- 300 to 1,000.

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

PUMPAGE IN 1970 -- 421 million gallons.

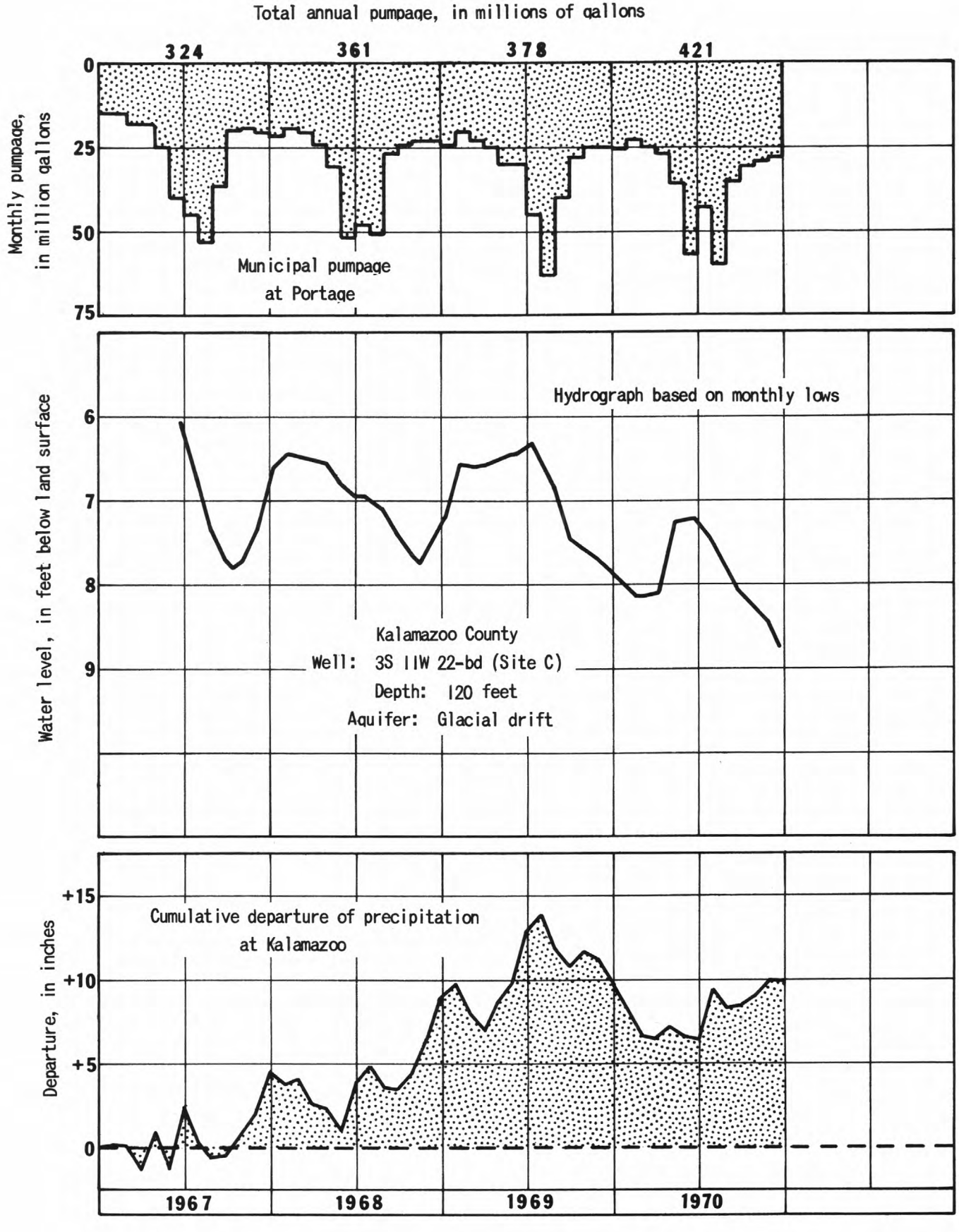
MAXIMUM DAY -- 3.57 million gallons.

STORAGE FACILITIES -- 150,000 gallons elevated.

QUALITY OF WATER -- Iron 0.03 to 0.3 mg/1
Hardness 181 mg/1

TREATMENT -- Chlorination and phosphate.

Figure 28.--During 1970 a net lowering of about one foot in water level occurred in the Portage observation well as compared to the previous 3-year low. Pumpage that previously had been increasing about 17 million gallons per year increased 43 million gallons during 1970.


Total annual pumpage, in millions of gallons
324
361
378
421
Monthly pumpage, in million gallons
0
25
50
75
Municipal pumpage at Portage
Water level, in feet below land surface
Hydrograph based on monthly lows
6
7
8
9
Kalamazoo County
Well: 3S 11W 22-bd (Site C)
Depth: 120 feet
Aquifer: Glacial drift
Departure, in inches
+15
+10
+5
0
Cumulative departure of precipitation at Kalamazoo
1967
1968
1969
1970

WATER SUPPLY AND SOURCE -- 3 wells, 180 to 203 feet deep, tap the glacial drift.

YIELD OF WELLS (in gpm) -- 100 to 360.

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

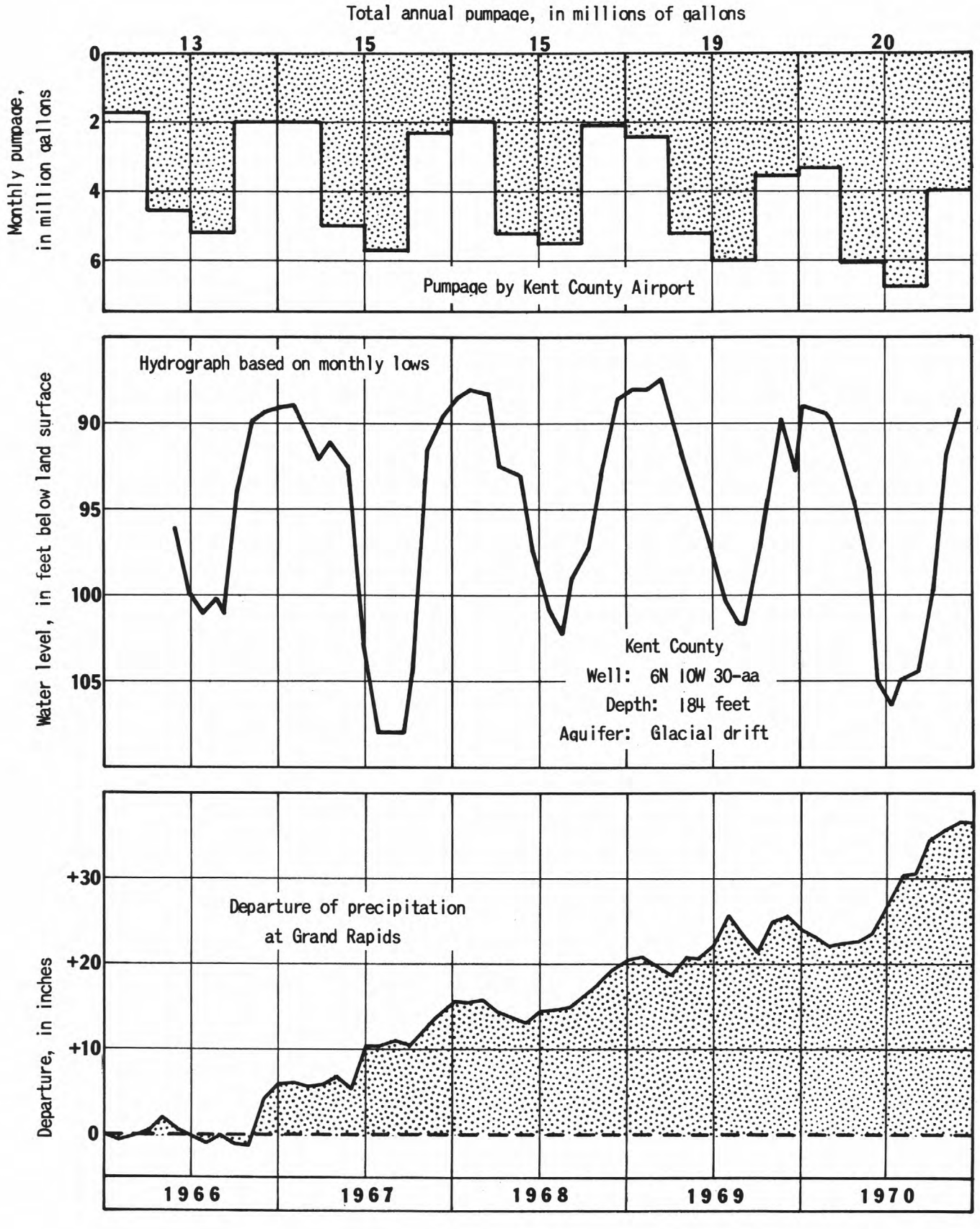
PUMPAGE IN 1970 -- 20.0 million gallons. As of December 1970, water for domestic use by the airport is being supplied by the city of Grand Rapids. The airport wells will be used only to supply water for air conditioning.

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

QUALITY OF WATER -- Hardness 435-460 mg/l
3-4 mg/l

TREATMENT -- Iron removal, phosphates, and chlorination.

Figure 29.--At Kent County Airport, above normal precipitation, about 36 inches over the past five years, has kept water levels relatively stable. Sharp summer declines occur as pumpage is doubled to supply water for air conditioning.


Total annual pumpage, in millions of gallons
13
15
15
19
20
Monthly pumpage, in million gallons
0
2
4
6
Pumpage by Kent County Airport
Hydrograph based on monthly lows
Water level, in feet below land surface
90
95
100
105
Kent County
Well: 6N 10W 30-aa
Depth: 184 feet
Aquifer: Glacial drift
Departure of precipitation at Grand Rapids
Departure, in inches
+30
+20
+10
0
1966
1967
1968
1969
1970

LENAWEE COUNTY
FISHER BODY, GMC, NEAR TECUMSEH

WATER SUPPLY AND SOURCE -- 3 wells, 76 to 89 feet deep, tap the glacial drift.

YIELD OF WELLS (in gpm) -- About 500.

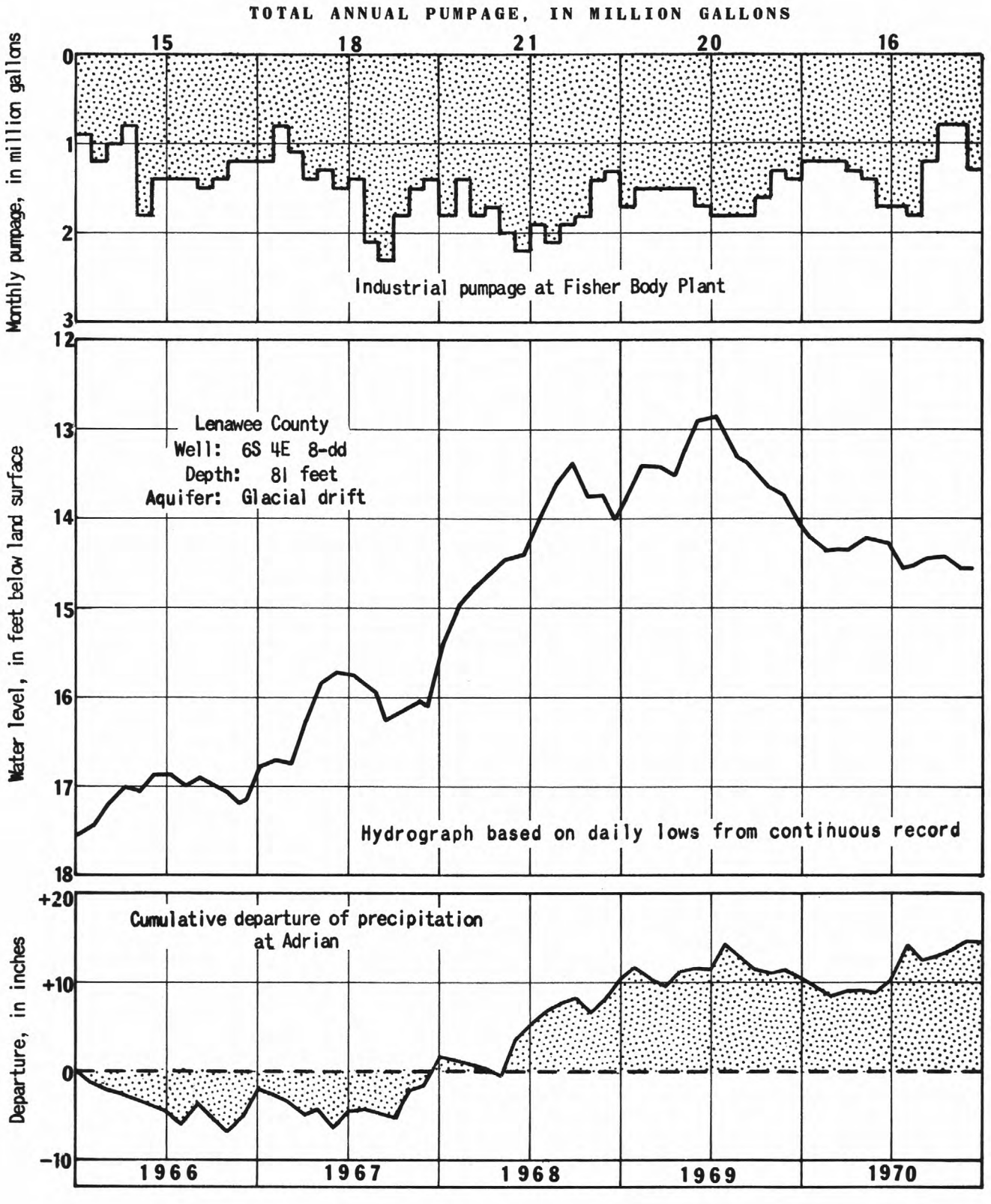
SPECIFIC CAPACITY OF WELLS (in gpm per ft of drawdown) -- No. 2 and 3 - 25; no. 4 - 30.

PUMPAGE IN 1970 -- 16.1 million gallons.

MAXIMUM DAY -- 0.10 million gallons.

QUALITY OF WATER -- Hardness 415-525 mg/1
Iron 2.2-4.2 mg/1
Fluoride 0.2 mg/1

Figure 30.--At the Fisher Body well field near Tecumseh, water levels in the observation well continued a declining trend that started in mid 1969. Until that time, levels had been rising since monitoring began in 1965.


TOTAL ANNUAL PUMPAGE, IN MILLION GALLONS
15
18
21
20
16
Monthly pumpage, in million gallons
0
1
2
3
Industrial pumpage at Fisher Body Plant
Water level, in feet below land surface
12
13
14
15
16
17
18
Lenawee County
Well: 6S 4E 8-dd
Depth: 81 feet
Aquifer: Glacial drift
Hydrograph based on daily lows from continuous record
Departure, in inches
+20
+10
0
-10
Cumulative departure of precipitation at Adrian
1966
1967
1968
1969
1970

In the Marquette Iron Range, ground water levels in the glacial drift aquifer (fig. 33) respond principally to natural climatic conditions. Although precipitation was near normal (fig. 31), record high levels were recorded in two wells (Humboldt and Gentian) and one record low in the short term Rock Lake well.

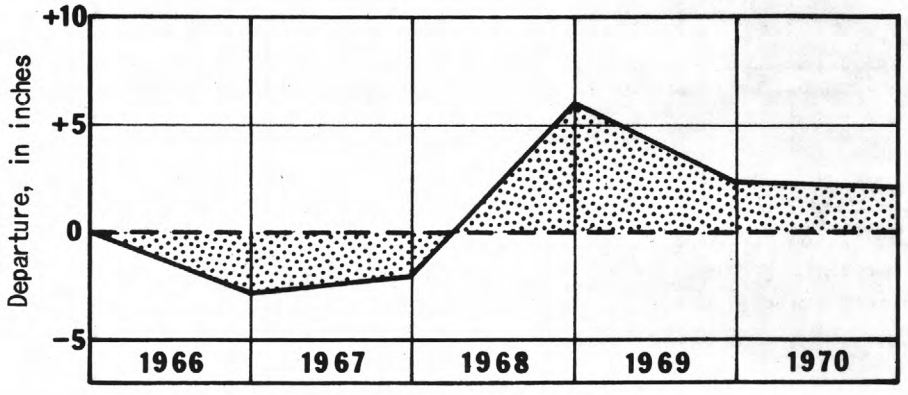


Figure 31.--Cumulative departure of precipitation from normal in West Upper Climatological Division of Michigan.

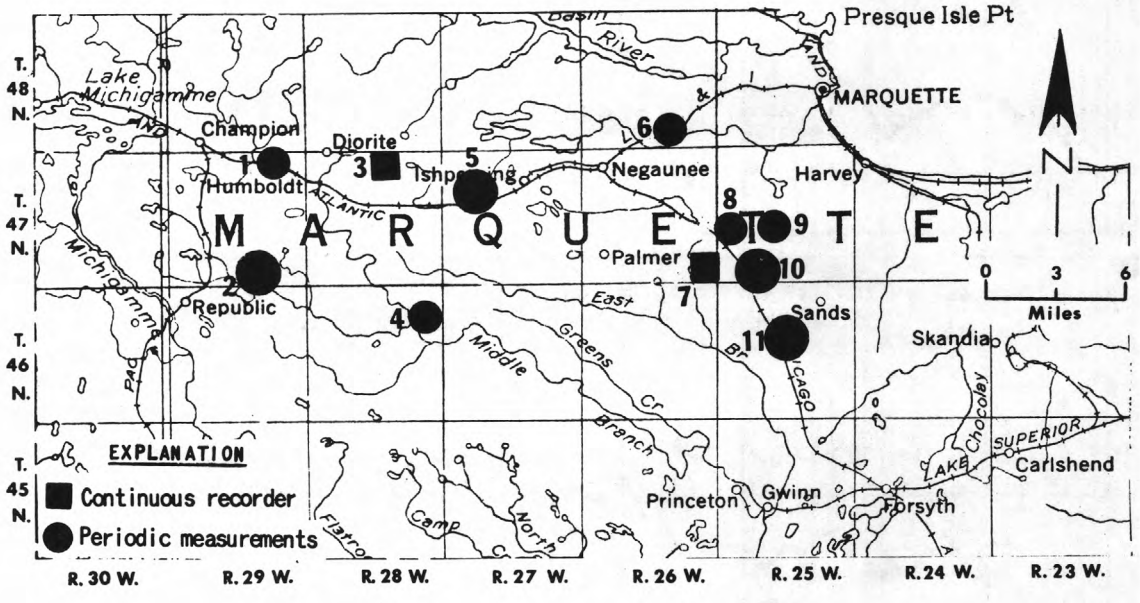


Figure 32.--Location of observation wells in the Marquette Iron Range area.

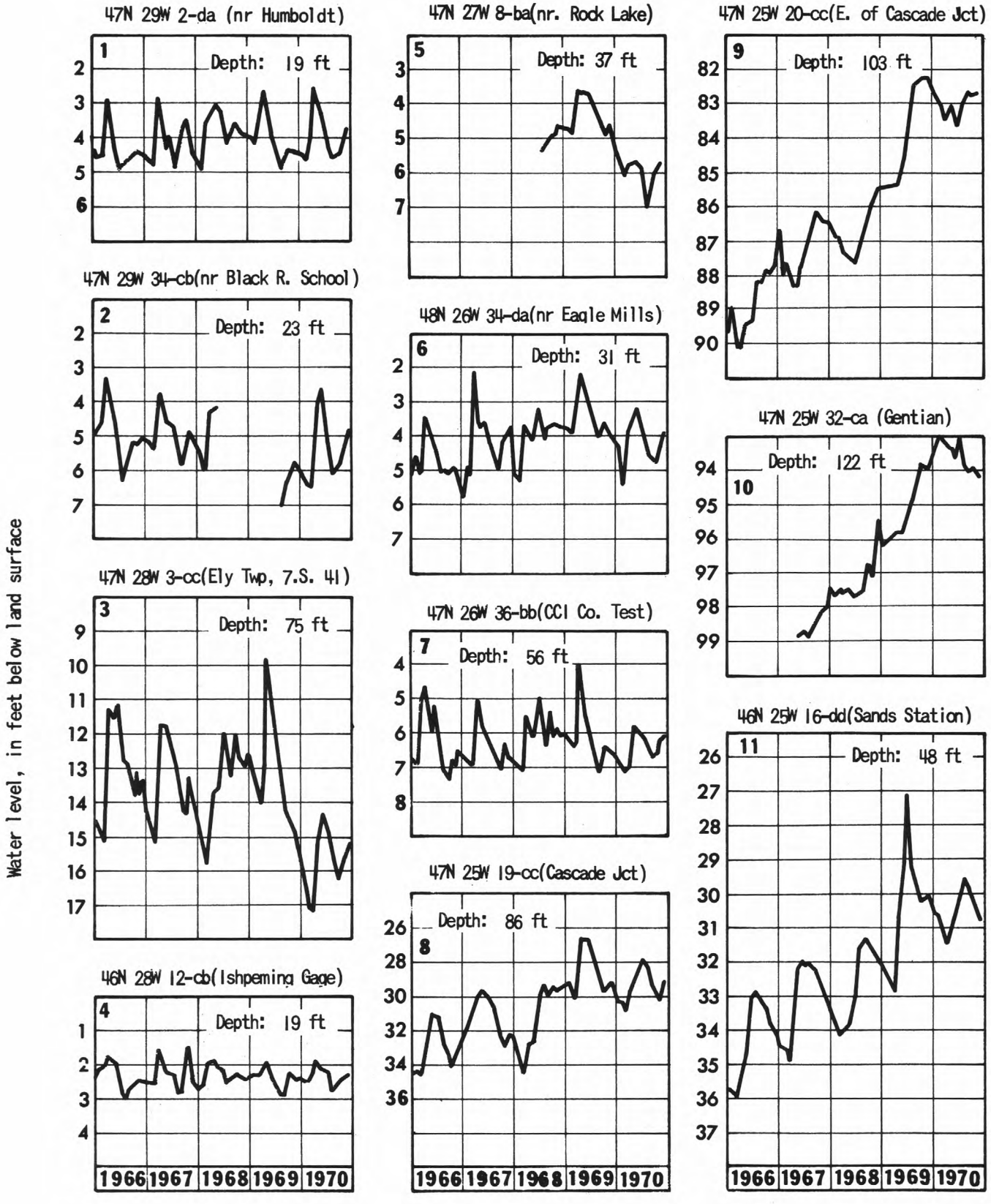


Figure 33.--In the Marquette County Iron Range area, water levels are being monitored in both shallow and deep glacial drift aquifers.

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

YIELD OF WELLS (in gpm) -- 300 to 1,750.

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

PUMPAGE IN 1970 -- 920 million gallons. Pumpage in Waterford Township in 1970 was the largest amount withdrawn since the beginning of the water-supply system.

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

QUALITY OF WATER -- Hardness 283-300 mg/l
Iron 1.4-2.3 mg/l

TREATMENT -- Phosphate and chlorination

Figure 34.--At Waterford Township, water levels continued to rise in the observation well during 1970. The rise in 1970 occurred despite increased township pumping and a decrease in precipitation. Water levels have been recovering in this area since 1963 when the city of Pontiac discontinued the use of wells and began using water from the Detroit system. Water levels have risen about 32 feet in the Josephine well since pumpage was discontinued.

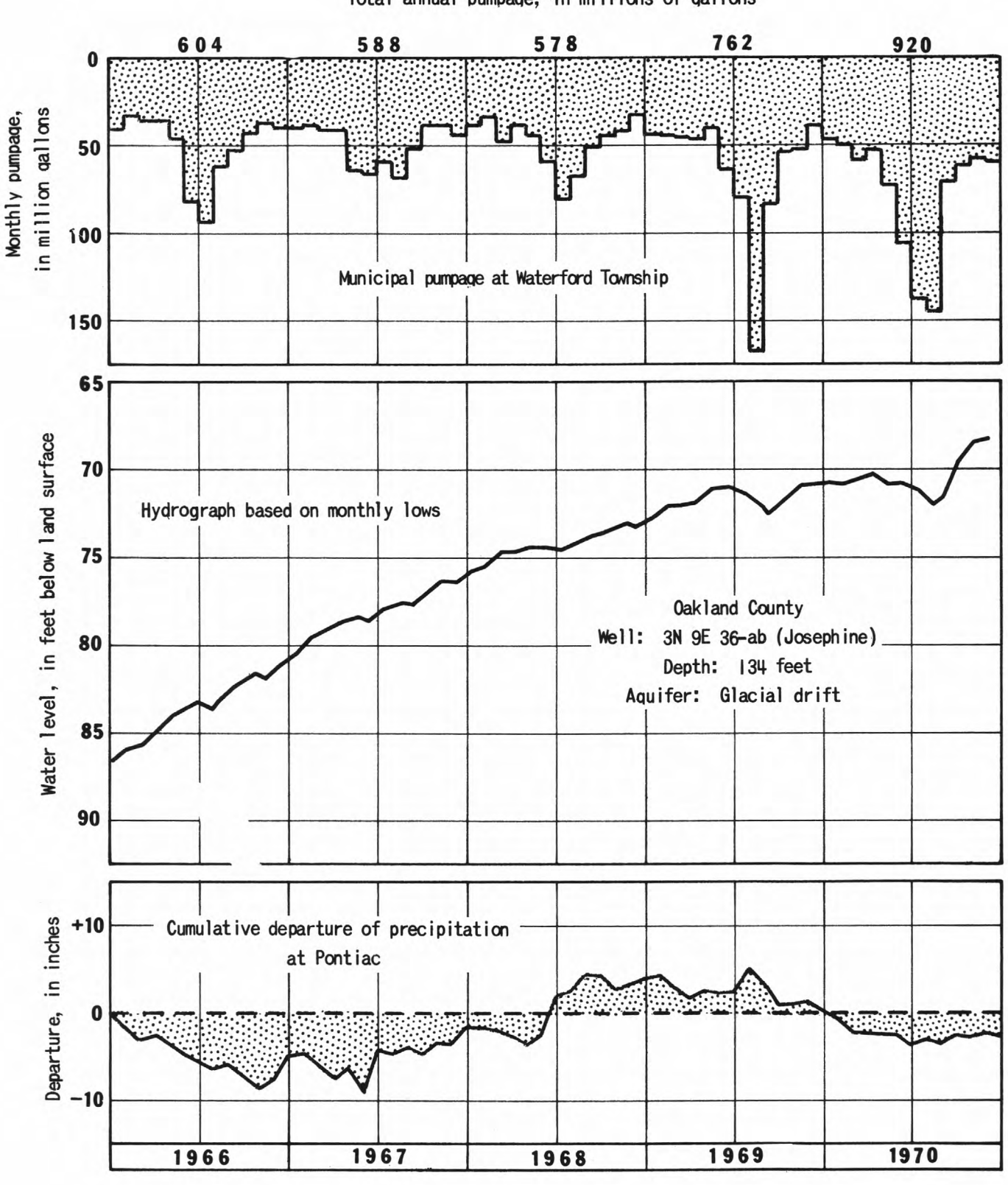
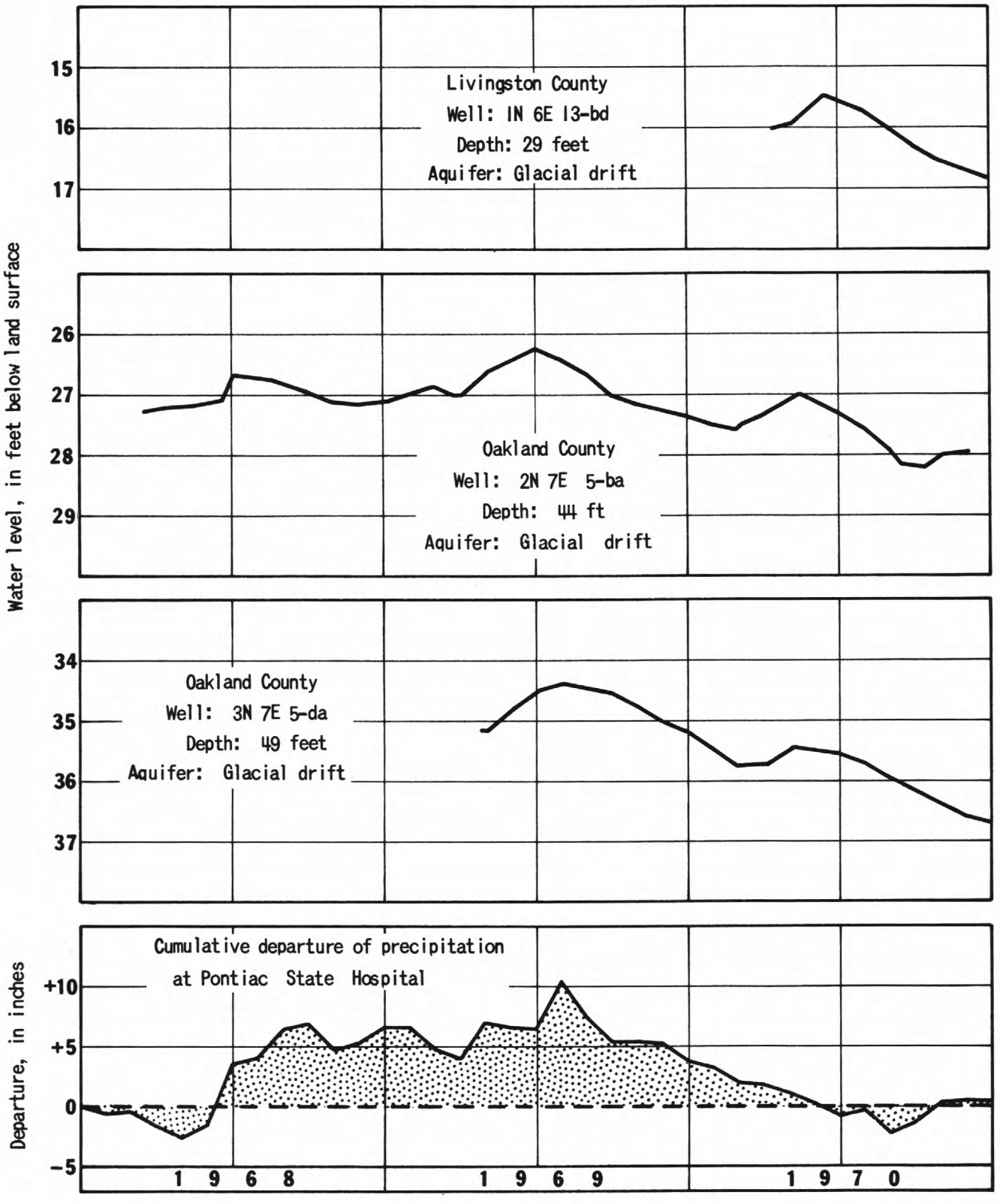

Total annual pumpage, in millions of gallons
604
588
578
762
920
Monthly pumpage, in million gallons
0
50
100
150
Municipal pumpage at Waterford Township
Water level, in feet below land surface
65
70
75
80
85
90
Hydrograph based on monthly lows
Oakland County
Well: 3N 9E 36-ab (Josephine)
Depth: 134 feet
Aquifer: Glacial drift
Departure, in inches
+10
0
-10
Cumulative departure of precipitation at Pontiac
1966
1967
1968
1969
1970

Figure 35.--The water level in the American Aggregate Corporation observation well 2N-7E-5ba showed an overall decline during 1970. This well is typical of the Corporation's 3 observation wells on their property in Oakland and Livingston County near the mutual County line. The water levels in these wells respond to natural climatic conditions. Thus, in 1970 when precipitation was below normal, the water levels declined.

Hydrographs based on monthly lows



In Van Buren County, little overall change in water levels occurred in most wells during 1970--records from observation wells, as shown in figure 37, indicate that water levels at the beginning and the end of the year were similar. However, wells "2" and "5" equaled or surpassed, respectively, record high levels of previous years. Water levels in wells "1" and "2" are affected by nearby pumping.

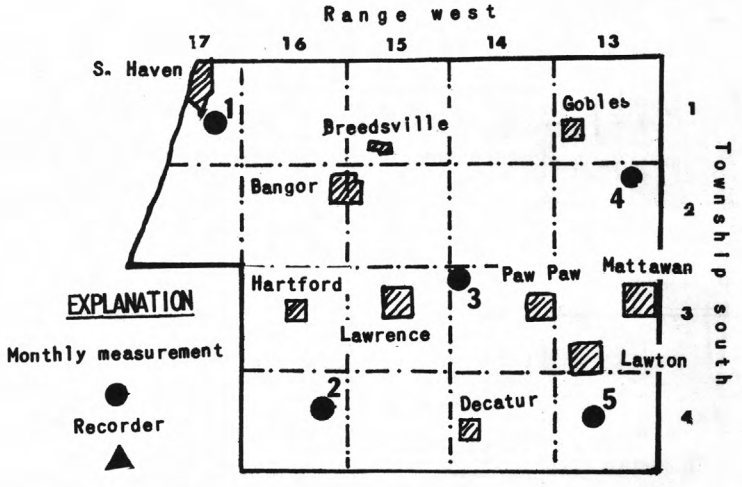
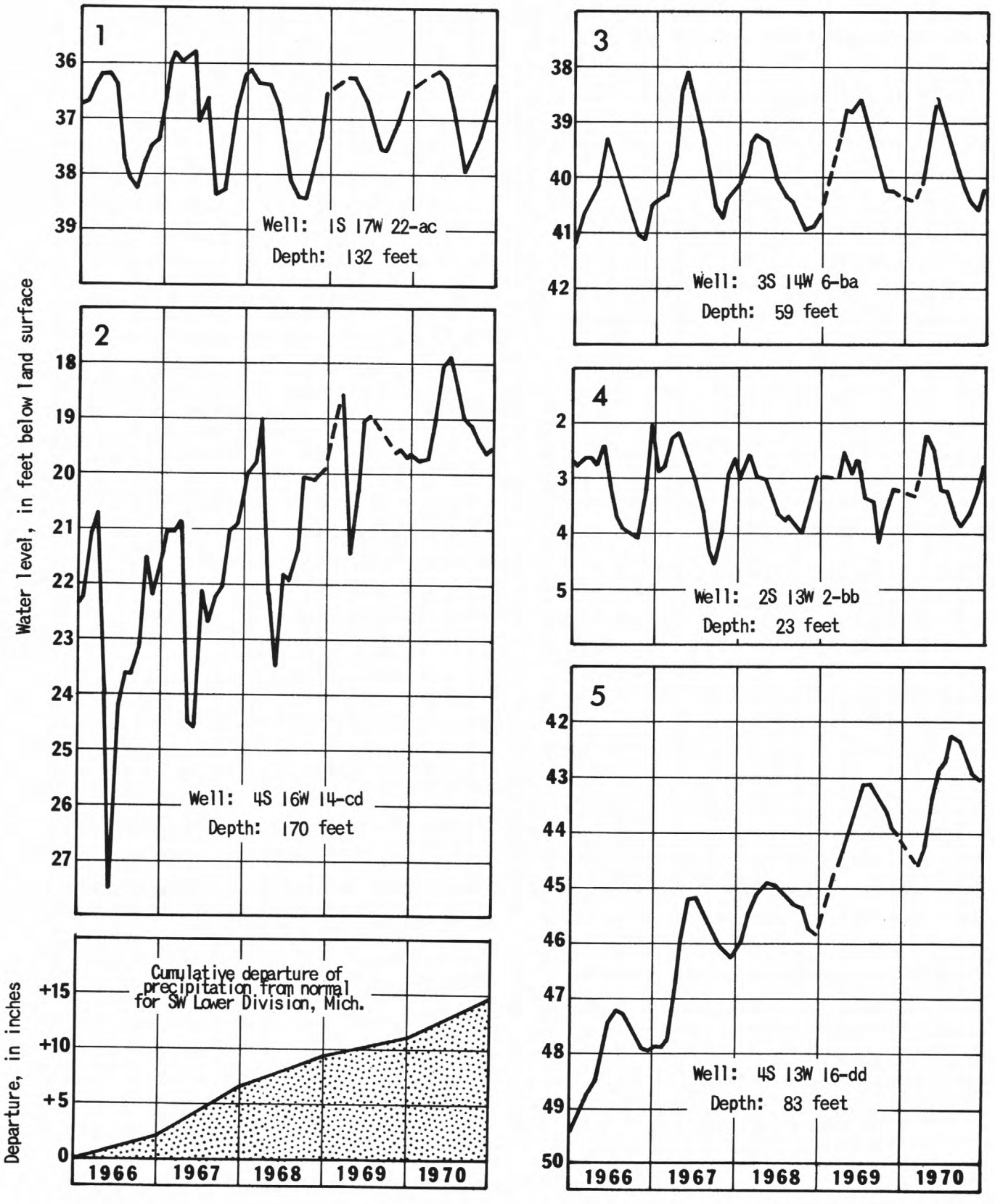


Figure 36.--Location of observation wells in Van Buren County.

Figure 37.--Water levels in the glacial drift in Van Buren County.


1
Well: 1S 17W 22-ac
Depth: 132 feet
2
Well: 4S 16W 14-cd
Depth: 170 feet
3
Well: 3S 14W 6-ba
Depth: 59 feet
4
Well: 2S 13W 2-bb
Depth: 23 feet
5
Well: 4S 13W 16-dd
Depth: 83 feet
Water level, in feet below land surface
Cumulative departure of precipitation from normal for SW Lower Division, Mich.
Departure, in inches
+15
+10
+5
0
1966
1967
1968
1969
1970

WATER SUPPLY AND SOURCE -- 3 wells, 91 to 196 feet deep, tap the glacial drift; most water is pumped from the Huron River.

YIELD OF WELLS (in gpm) -- 1,050 to 4,860.

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

PUMPAGE IN 1970 -- Total 5,426 million gallons--surface water and ground water. (800 million gallons ground water)

MAXIMUM DAY -- 26.9 million gallons.

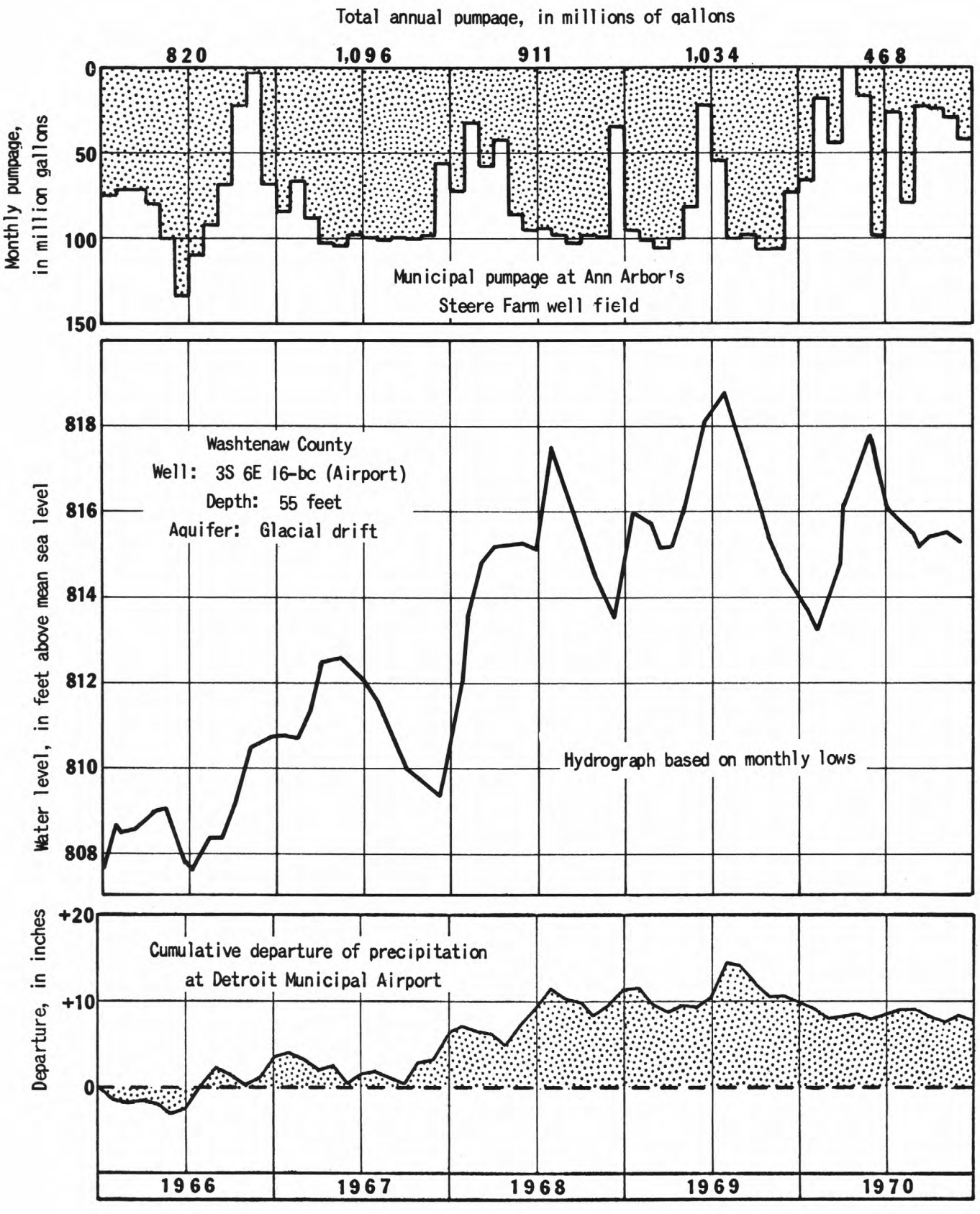
STORAGE FACILITIES -- Treatment plant: 6,057,000 gallons
Ground level: 6,200,000 gallons
Elevated storage: 1,000,000 gallons

QUALITY OF WATER -- Ground water:

Hardness	355-585 mg/1
Iron	0.25-2.4 mg/1

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

Figure 38.--At Ann Arbor, pumpage at the Steere Farm well field decreased by about 55 percent. Despite this decrease the water level in the observation well did not reach the record highs of last year. The slow recovery is the result of below average precipitation during the past two years.


Total annual pumpage, in millions of gallons
820
1,096
911
1,034
468
Monthly pumpage, in million gallons
0
50
100
150
Municipal pumpage at Ann Arbor's Steere Farm well field
Water level, in feet above mean sea level
818
816
814
812
810
808
Washtenaw County
Well: 3S 6E 16-bc (Airport)
Depth: 55 feet
Aquifer: Glacial drift
Hydrograph based on monthly lows
Departure, in inches
+20
+10
0
Cumulative departure of precipitation at Detroit Municipal Airport
1966
1967
1968
1969
1970

WATER SUPPLY AND SOURCE -- 7 wells, 87 to 102 feet deep, tap the glacial drift.

YIELD OF WELLS (in gpm) -- 450 average for 5 wells--wells are not metered individually.

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

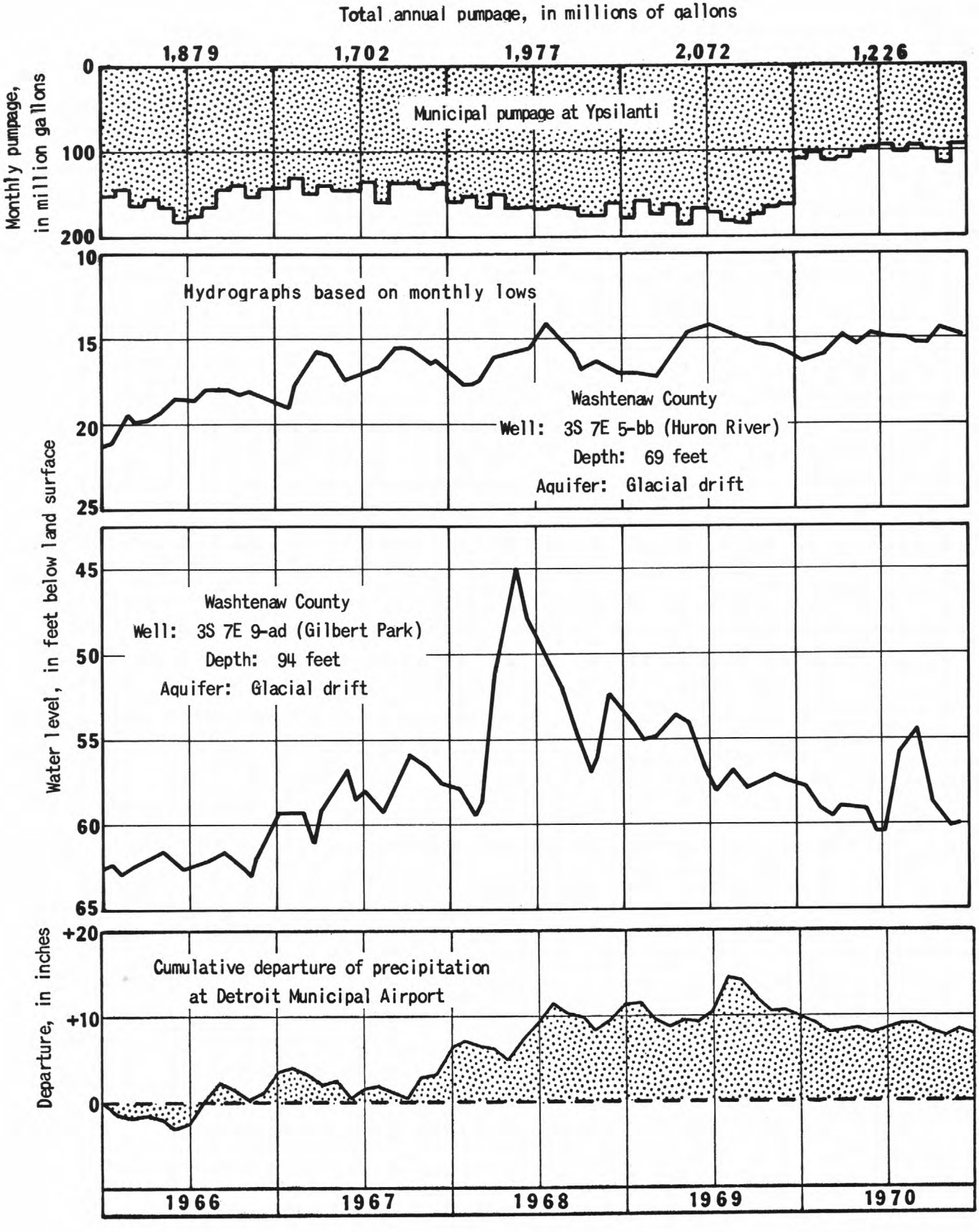
PUMPAGE IN 1970 -- 1,226 million gallons.

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

QUALITY OF WATER -- Hardness 305-320 mg/1
Iron 1.2-1.6 mg/1
Fluoride 0.3 mg/1

TREATMENT -- Lime softening, and iron removal.

Figure 39.--At Ypsilanti, the outlying Huron River well continued a rising trend while the centrally located Gilbert Park well continued to decline.


Total annual pumpage, in millions of gallons
1,879
1,702
1,977
2,072
1,226
Monthly pumpage, in million gallons
0
100
200
Municipal pumpage at Ypsilanti
Hydrographs based on monthly lows
Washtenaw County
Well: 3S 7E 5-bb (Huron River)
Depth: 69 feet
Aquifer: Glacial drift
Water level, in feet below land surface
10
15
20
25
Washtenaw County
Well: 3S 7E 9-ad (Gilbert Park)
Depth: 94 feet
Aquifer: Glacial drift
45
50
55
60
65
Departure, in inches
+20
+10
0
Cumulative departure of precipitation
at Detroit Municipal Airport
1966
1967
1968
1969
1970

WATER SUPPLY AND SOURCE -- 8 wells, 50 to 95 feet deep, tap the glacial drift.

YIELD OF WELLS (in gpm) -- 700 to 3,500.

PUMPAGE IN 1970 -- 2,806 million gallons.

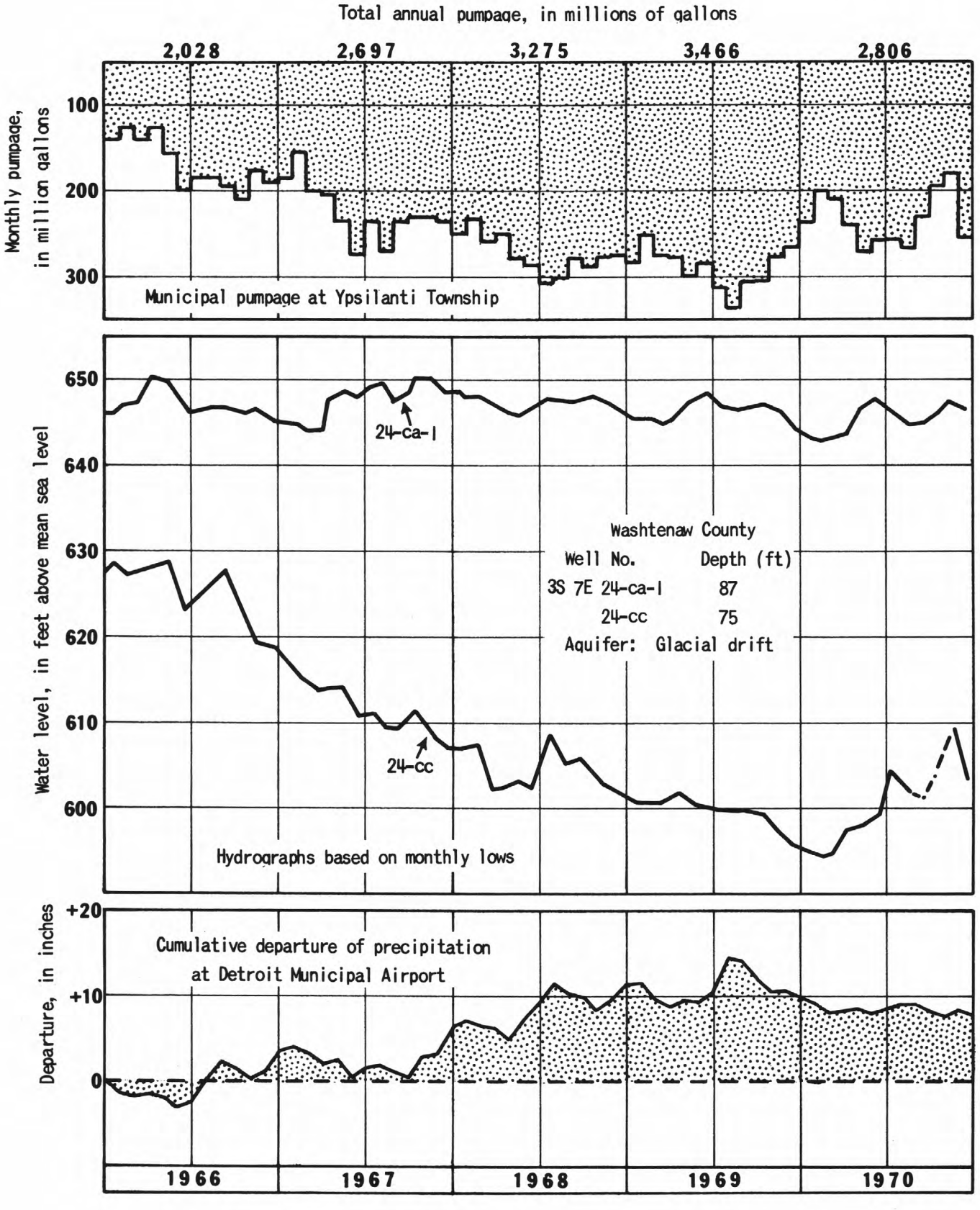
MAXIMUM DAY -- 14.15 million gallons.

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

QUALITY OF WATER -- Hardness 280-355 mg/l
Iron 0.3-1.8 mg/l
Fluoride 0.1-0.6 mg/l

TREATMENT -- Lime softening, chlorination.

Figure 40.--At Ypsilanti Township's well field, water levels declined to record low levels in all three observation wells (see table 1 - Washtenaw County). However, by 1970 year-end levels had recovered to their highest level since the end of 1967, the result of decreased pumpage.


Total annual pumpage, in millions of gallons
2,028
2,697
3,275
3,466
2,806
Monthly pumpage, in million gallons
100
200
300
Municipal pumpage at Ypsilanti Township
Water level, in feet above mean sea level
650
640
630
620
610
600
24-ca-1
24-cc
Washtenaw County
Well No. Depth (ft)
3S 7E 24-ca-1 87
24-cc 75
Aquifer: Glacial drift
Hydrographs based on monthly lows
Departure, in inches
+20
+10
0
Cumulative departure of precipitation at Detroit Municipal Airport
1966
1967
1968
1969
1970

WATER SUPPLY AND SOURCE -- 6 wells, 20 to 110 feet deep, tap the glacial drift.

YIELD OF WELLS (in gpm) -- 500 to 2,400.

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

PUMPAGE IN 1970 -- 1,139 million gallons.

MAXIMUM DAY -- 4.87 million gallons.

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

QUALITY OF WATER --

Hardness	325-395 mg/l
Iron	0.1-1.1 mg/l
Fluoride	0.2-0.4 mg/l
Chloride	31-59 mg/l

TREATMENT -- Chlorination, fluoridation, phosphate.

Figure 41.--At Plymouth, water levels in the observation well at 6-Mile Road field are heavily influenced by pumping on a day-to-day basis, but long-term trends also follow precipitation trends. Although pumpage has tripled at the field since 1962 no appreciable lowering of water levels has occurred.

Water levels in the observation well at the Beck Road field have closely followed trends in precipitation since the discontinuance of pumping at this field.

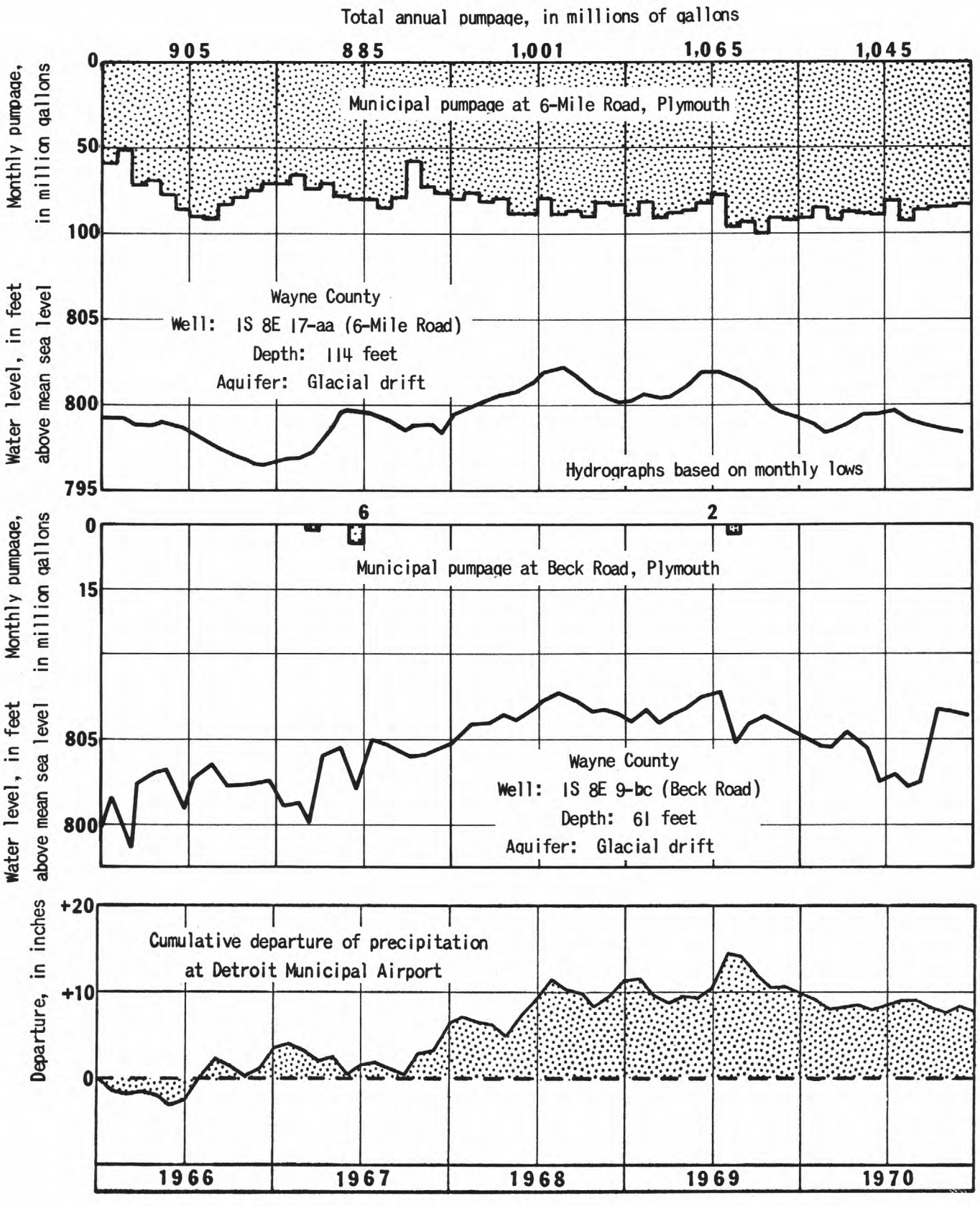

Total annual pumpage, in millions of gallons
905
885
1,001
1,065
1,045
Monthly pumpage, in million gallons
0
50
100
Municipal pumpage at 6-Mile Road, Plymouth
Water level, in feet above mean sea level
805
800
795
Wayne County
Well: 1S 8E 17-aa (6-Mile Road)
Depth: 114 feet
Aquifer: Glacial drift
Hydrographs based on monthly lows
6
2
Monthly pumpage, in million gallons
0
15
Municipal pumpage at Beck Road, Plymouth
Water level, in feet above mean sea level
805
800
Wayne County
Well: 1S 8E 9-bc (Beck Road)
Depth: 61 feet
Aquifer: Glacial drift
Departure, in inches
+20
+10
0
Cumulative departure of precipitation at Detroit Municipal Airport
1966
1967
1968
1969
1970

TABLE 1. RECORDS OF MICHIGAN OBSERVATION WELLS.

COUNTY AND WELL NUMBER: For explanation of well numbers see text under - Introduction "Well numbering system":
OWNER: MDNR - Mich. Dept. of Natural Resources; 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; LCRC - Luce 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)
€m - Munising Sandstone of Cambrian age
€LSj - Jacobsville Sandstone of Cambrian age
p€f - 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: In feet below or above (+) land surface. 1970 measurements underscored are extremes for entire record.
FREQUENCY OF MEASUREMENT: R - Continuous recorder; D - Daily; W - Weekly; M - Monthly; Q - Quarterly; S - Semiannually; A - Annually; I - Intermittent.
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 TWP., RANGE, SECTION	OWNER OR OTHER DESIGNATION	DEPTH (ft)	DIAMETER (in)	AQUIFER	ALTITUDE	YEARS OF RECORD	FREQUENCY OF MEAS., 1970	OBSERVED WATER-LEVEL EXTREMES				REMARKS
								THROUGH 1969		IN 1970		
								MAXIMUM	MINIMUM	MAXIMUM	MINIMUM	
ALGER COUNTY												
45N 19W 25-bd	USFS (former CCC camp)	66	6	Qgd	850	12	Q	6.4 June 1960	14.2 Apr 1964	11.3 May	12.1 Aug	
ALLEGAN COUNTY												
3N 14 W 23-dd	Allegan State Game Area	41	1	Qgd	700	5	M	9.5 Dec 1965	13.5 Nov 1969	11.1 July	12.8 Jan	
BARAGA COUNTY												
49N 33W 18-ca	Mich. Tech. Univ.	12	16	Qgd	1,320	10	R	4.9 Apr 1960	9.4 Feb 1959	7.1 Apr	9.4 Feb	
48N 32W 12-dd	MSHD (WMP 14)	10	1	Qgd	1,630	23	M	3.3 Apr 1965	8.1 Sept 1969	5.9 June	7.9 Aug.	
BARRY COUNTY												
3N 10W 3-da	MDNR (Shaw L. Rd)	53	2	Qgd	760	7	Q	35.1 Aug 1967	36.4 Jan 1965	35.3 July	35.7 Jan	
4N 9W 5-da	MDNR (Solomon Rd)	131	2	Qgd	860	7	Q	119.3 Jan 1964	122.0 Mar 1965	120.3 July	120.6 Oct	
BAY COUNTY												
17N 4E 15-dc	Pinconning Twp. (Twp. Hall)	61	2	Ps	610	9	Q	+1.1 Apr 1967	5.0 Aug 1962	+.43 Apr	0.4 Oct	
22-ad	Sterling Tube Co. (Horn Rd)	170	6	Ps	620	9	M	5.4 Jan 1969	13.0 Sept 1962	5.4 Jan	7.0 Aug	Well destroyed 12-70
22-dc	Pinconning Twp. (2nd St)	110	6	Ps	620	9	R	0.7 Dec 1969	10.5 Aug 1963	0.6 Apr	4.8 Aug	P
BRANCH COUNTY												
5S 6W 22-aa	MSHD (U. S. 27)	27	1	Qgd	950	7	M	10.6 June 1969	16.3 Nov 1964	12.1 May	14.2 Jan	
8W 28-db	BCRC (Sherwood)	42	1	Qgd	880	6	M	13.8 June 1969	18.9 Nov 1965	14.5 June	17.0 Mar	
6S 6W 19-bb	Coldwater Twp. (Test 1)	56	6	Qgd	950	7	M	21.0 July 1969	28.3 July 1964	23.2 May	24.3 Mar	
22-ca	City of Coldwater (test for No. 4)	113	6	Qgd	970	7	R	10.0 May 1967	24.1 Aug 1964	10.7 Apr	21.1 Oct	P
8S 5W 6-ab	Chipman (Calif. No. 2 School)	55	4	Qgd	1,032	7	M	13.9 Feb 1968	19.4 Dec 1964	15.1 May	17.1 Jan	
8W 17-cd	Bronson School (Trayer Rd)	38	1	Qgd	917	7	M	13.1 May 1966	16.3 Nov 1964	13.8 May	15.2 Jan	
CALHOUN COUNTY												
1S 7W 10-bb	K Sabin (M 78)	12	15	Qgd	907.99	25	W	0.9 Mar 1950	7.2 Dec 1964	2.9 Apr	5.0 Oct	Meas. by owner
32-bd	Penfield Twp. (Hopkins St)	95	6	Mm	845	7	R	19.6 Dec 1969	27.0 Aug 1964	18.8 Dec	21.9 Aug	P
32-da	City of Battle Creek (Verona 22)	127	8	Mm	830.79	32	D	0.7 Apr 1950	16.8 July 1959	5.3 Dec	11.4 Aug	P, Meas. by owner
2S 6W 25-aa	City of Marshall (Ferguson)	59	6	Mm	904.85	21	M	5.5 May 1950	9.7 Aug 1964	7.5 May	8.4 Mar	P, Meas. by owner
8W 2-db	Oliver Elec. Mfg. Co. (Angell St)	92	10	Mm	819.99	25	Q	4.8 Apr 1947	15.6 Mar 1964	13.7 July	15.2 Jan	P
16-ac	Battle Creek Twp. (Territorial Rd)	148	8	Mm	917	7	R	+0.7 May 1969	12.0 Aug 1966	0.6 June	9.8 Oct	P
CASS COUNTY												
8S 14W 17-ba	T. Little (Starbrick Rd)	55	28	Qgd	840	26	W	46.2 July 1950	55.0 Mar 1957	48.8 Aug	50.0 Dec	

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

COUNTY AND WELL NUMBER TWP., RANGE, SECTION	OWNER OR OTHER DESIGNATION	DEPTH (ft)	DIAMETER (in)	AQUIFER	ALTITUDE	YEARS OF RECORD	FREQUENCY OF MEAS., 1970	OBSERVED WATER-LEVEL EXTREMES				REMARKS
								THROUGH 1969		IN 1970		
								MAXIMUM	MINIMUM	MAXIMUM	MINIMUM	
CHARLEVOIX COUNTY												
32N 4W 10-da	MDNR (33) (Thumb Lake)	17	2	Qgd	1,060	31	M	1.2 Mar 1958	7.4 Feb 1959	1.6 Apr	3.3 Aug	
33N 4W 2-ac	MDNR (Wolverine CCC)	94	6	Qgd	970	23	Q	69.5 July 1960	75.8 Apr 1956	73.0 Dec	73.1 Apr	
CHEBOYGAN COUNTY												
33N 1W 22-cd	MDNR (Cornwall Lake impoundment) No. 4	15	1	Qgd	863	5	M	1.5 Apr 1967	6.2 Oct 1966	2.0 Apr	5.2 Aug	
22-dc	Do No. 5	19	1	Qgd	866	5	M	2.5 Apr 1967	8.3 Oct 1966	4.5 Dec	6.8 Aug	
26-bb	Do No. 1-B	42	1	Qgd	915	5	M	31.0 Aug 1967	34.8 Mar 1967	32.1 Jan	33.4 Dec	
26-da	Do Pigeon R. CCC	164	6	Qgd	933	5	R	57.1 May 1968	61.8 Nov 1966	57.8 Jan	58.7 Dec	
27-ab	Do No. 6	20	1	Qgd	862.22	5	M	4.0 Apr 1969	18.1 Nov 1966	4.0 Apr	5.2 Aug	Water levels affected by reservoir filling.
27-ba	Do No. 11	82	1	Qgd	863.8	5	M	9.3 Jan 1966	13.3 Dec 1967	9.8 Jan	10.2 Nov	
27-cb	Do No. 7	32	1	Qgd	853.5	5	M	18.6 Apr 1967	21.0 Nov 1966	19.2 Jan	20.3 Sept	
27-cc	Do No. 8	37	1	Qgd	886	5	M	24.0 Aug 1967	27.4 Mar 1966	24.8 July	25.6 Dec	
27-db	Do No. 9	32	1	Qgd	881.5	5	M	18.5 July 1967	23.0 Jan 1967	19.2 May	20.3 Dec	
27-dc	Do No. 10	32	1	Qgd	879.5	5	M	16.0 Aug 1967	19.4 Feb 1966	16.6 June	17.4 Nov	
34-aa	Do No. 12	22	1	Qgd	850	5	M	7.6 Dec 1967	9.9 Oct 1966	8.2 Apr	9.5 Feb	
34N 1W 1-cb	MDNR (7) (M-68)	11	2	Qgd	780	25	Q	2.8 Mar 1938	5.6 Oct 1955	3.8 Apr	4.2 Oct	
CHIPPEWA COUNTY												
46N 4W 24-da	USFS (Raco CCC camp)	54	6	Qgd	850	16	R	20.7 July 1960	28.4 Apr 1964	20.7 Dec	22.5 May	Record resumed 11-10-69
CLINTON COUNTY												
5N 1W 24-bd	MDNR (Rose Lake)	40	2	Qgd	870	7	Q	29.3 July 1969	32.2 Sept 1964	29.8 Apr	30.5 Jan	
2W 31-cb	Mich. Dept. of Aeronautics (Airport)	195	6	Ps	850	13	R	45.0 Mar 1949	66.4 Jan 1967	63.2 Apr	65.1 Aug	P
32-dc	Mich. Health Dept. (Quarantine Farm)	135	4	Ps	849.21	27	M	42.0 Sept 1944	99.2 May 1966	97.0 Nov	97.8 Aug	P
6N 1W 3-bb-1	MDNR (Sleepy Hollow impoundment) No. 6	42	1	Qgd	784.77	5	I	7.7 May 1969	12.8 Nov 1966	8.3 Apr	10.8 Sept	
3-bb-2	Do No. 5	62	1	Qgd	814.05	5	I	40.8 May 1969	43.3 Nov 1966	41.2 May	42.1 Sept	
4-da	Do No. 4	57	1	Qgd	817.74	5	I	38.7 Sept 1969	41.7 Jan 1966	39.1 Mar	40.0 Oct	
9-dc	Do No. 14	32	1	Qgd	797	5	I	0.7 Apr 1969	6.5 Sept 1967	1.1 May	5.8 Sept	
9-dd	Do No. 1	22	1	Qgd	789.15	5	I	3.0 Apr 1969	5.2 Sept 1966	2.4 May	4.4 Sept	
10-ad	Do No. 12	37	1	Qgd	802.98	5	I	4.8 Apr 1969	11.8 Nov 1966	5.1 May	9.0 Sept	
10-ba	Do No. 3	42	1	Qgd	792.48	5	I	4.3 Apr 1969	11.6 Nov 1966	4.8 May	9.6 Mar	
10-bc	Do No. 2	32	1	Qgd	801.38	5	I	16.4 May 1969	19.8 Nov 1966	17.0 May	18.4 Sept	
10-dd	Do No. 13	32	1	Qgd	815	5	I	12.3 May 1969	18.4 Aug 1966	13.5 May	17.0 Sept	
15-cc	Do No. 15	17	1	Qgd	805	5	I	1.8 May 1969	5.4 Aug 1966	2.0 May	3.6 Sept	
6N 2W 16-dd	MSHD (U. S. 27)	23	14	Qgd	803.32	23	M	14.6 Apr 1952	19.9 Feb 1964	17.0 May	18.3 Feb	Fed key well
7N 1W 34-ca	MDNR (Sleepy Hollow impoundment) No. 9	39	1	Qgd	793.84	5	I	14.9 May 1969	21.7 Dec 1966	16.1 May	18.5 Mar	
34-cb	Do No. 10	62	1	Qgd	787.22	5	I	20.6 May 1969	23.2 Nov 1966	21.0 May	22.4 Sept	
34-cc	Do No. 7	32	1	Qgd	785.34	5	I	17.7 May 1969	20.0 Nov 1966	18.1 May	19.4 Sept	
34-cd	Do No. 8	28	1	Qgd	783.39	5	I	15.4 May 1969	18.9 July 1967	15.8 May	17.4 Sept	
2W 9-bb	City of St. Johns (6" test)	535	6	Ps	743.36	7	R	52.2 May 1967	79.1 July 1969	55.3 Nov	82.0 Aug	P
8N 1W 13-bc	Village of Elsie (12" test)	298	12	Ps	699.68	24	Q	+4.2* May 1965	37.6 Oct 1957	+1.4 Jan	12.0 Oct	P, *well flowing
4W 22-bd	MDNR (Maple R. Game Area)	90	2	Qgd	680	7	Q	65.2 Aug 1967	70.8 Jan 1965	67.9 Jan	68.8 Oct	

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

COUNTY-AND WELL NUMBER TWP., RANGE, SECTION	OWNER OR OTHER DESIGNATION	DEPTH (ft)	DIAMETER (in)	AQUIFER	ALTITUDE	YEARS OF RECORD	FREQUENCY OF MEAS., 1970	OBSERVED WATER-LEVEL EXTREMES				REMARKS
								THROUGH 1969		IN 1970		
								MAXIMUM	MINIMUM	MAXIMUM	MINIMUM	
CRAWFORD COUNTY												
25N 1W 15-dd	USFS (Eldorado)	56	6	Qgd	1,190	23	R	28.9 Aug 1969	36.0 Apr 1951	29.0 Aug	30.7 Apr	
3W 28-cc	MDNR (8) (M-76)	13	1	Qgd	1,175.14	36	Q	8.6 July 1960	11.3 Oct 1958	10.1 Apr	10.5 Oct	Well destroyed 12-70
26N 4W 11-cb	MDNR (Game Refuge)	12	15	Qgd	1,147.59	29	R	4.0 June 1943	9.8 Sept 1958	5.8 June	9.2 Sept	
27N 1W 20-cc	MDNR (22) (N. Down River Rd)	15	2	Qgd	1,140	35	Q	1.6 July 1943	5.9 Oct 1955	3.8 Apr	4.4 July	
4W 23-aa	MDNR (51) (U. S. 27)	17	2	Qgd	1,180	31	Q	10.9 July 1943	15.6 Dec 1964	12.5 Apr	13.2 July	
DELTA COUNTY												
38N 22W 24-db	USFS (3) (Peninsula Point)	36	6	Or	585	13	Q	0.3 May 1964	5.5 Oct 1958	2.4 May	4.5 Aug	
39N 23W 28-ab	M & S. Blake (Schemmel)	530	5	Gm	680	13	R	1.3 May 1960	5.1 Dec 1966	2.9 Apr	4.7 Sept	
41N 18W 31-cd	C. Thompson (Isabella)	250	4	Or	615	13	Q	3.6 June 1968	6.3 Feb 1961	3.8 Apr	5.2 Aug	
19W 17-ca	USFS (Morman Cr. CCC camp)	58	6	Or	635	13	Q	0.0 May 1967	4.5 Nov 1963	1.4 May	3.8 Aug	
42N 18W 17-ac	USFS (Cooks CCC camp)	60	6	Qgd	770	13	Q	21.2 May 1960	28.4 Mar 1966	25.0 May	25.8 Dec	
19W 20-aa	USFS (Pollack CCC camp)	134	6	Or	730	13	Q	23.8 Mar 1960	28.0 Mar 1966	25.5 Aug	26.0 Jan	
43N 19W 24-bb	H. Clarage (FFHwy-13)	405	4	Otb	860	13	Q	77.0 July 1960	88.8 Oct 1966	79.1 July	79.4 May	
DICKINSON COUNTY												
42N 27W 33-ba	E. LaFreniere (WMP 10)	12	36	Qgd	1,060	17	M	2.7 May 1960	10.8 Oct 1955	2.9 June	10.4 Aug	Meas. by WMP
43N 28W 32-ad	MDNR (Felch)	1	29	Qgd	1,160	5	Q	13.6 May 1967	16.8 May 1968	15.1 June	16.4 Oct	
EATON COUNTY												
3N 3W 2-ba	City of Lansing (TW 63H) (Stiefel Farm)	66	1	Qgd	839	7	R	3.1 Mar 1965	18.0 Nov 1968	4.8 Dec	15.6 Feb	P
4N 3W 12-cd	F. Wheeler (Robins Rd)	381	6	Ps	861.91	18	R	67.5 Nov 1953	103.6 Aug 1969	89.3 Nov	102.9 Aug	P
4W 2-cc	City of Grand Ledge (Chair Co.)	376	12	Ps	846.59	23	R	19.7 July 1968	30.1 Aug 1964	22.2 Nov	25.3 Feb	P
11-ab	City of Grand Ledge (Park)	350	8	Ps	788.9	11	R	*+4.6 Mar 1967	9.1 Aug 1966	+4.2 Sept	7.7 Aug	P *well flowing
GENESEE COUNTY												
6N 7E 9-dc	Fisher Body Div., GMC (Grand Blanc)	235	6	Ps	841.71	19	R	37.8 Nov 1952	77.5 Sept 1969	54.5 Mar	80.1 Aug	P
GOGEBIC COUNTY												
48N 47W 31-dc	City of Ironwood (Big Springs)	115	1	Qgd	1,170	8	R	12.6 June 1966	33.0 Jan 1966	19.4 June	41.5 Aug	P
34-da	City of Ironwood (Spring Creek Gp 3)	22	6	Qgd	1,190	10	R	+0.7 Apr 1969	4.5 Mar 1968	0.0 Mar	4.2 Aug	P
GRAND TRAVERSE COUNTY												
26N 9W 13-cc	MDNR (2) (6 roads)	13	2	Qgd	961.78	31	M	4.4 Apr 1967	7.9 Oct 1949	4.9 Apr	7.0 Aug	
11W 27-cb	MDNR (2) (Mill Rd)	14	2	Qgd	914.25	30	Q	1.1 Apr 1962	4.0 Aug 1936	2.1 Apr	2.1 July	
27N 9W 4-ab	MDNR (18) (Williamsburg)	15	2	Qgd	687.01	29	M	0.2 Feb 1966	2.5 July 1935	1.0 Mar	1.7 July	
GRATIOT COUNTY												
9N 3W 33-ad	MDNR (Maple Rd)	55	3	Qgd	658	7	Q	11.1 Mar 1965	16.6 July 1965	12.3 Apr	15.1 Jan	
11N 3W 3-bb	E. Waber (Prospect St.)	49	2	Qgd	733.20	25	M	+0.9 July 1969	36.3 Oct. 1964	3.2 July	10.6 Sept	P
4-ac	City of Alma (TW 6) (Pine River)	165	8	Qgd	733.31	15	R	+2.5 Mar 1969	31.0 July 1965	+2.8 Apr	21.1 Aug	P
12N 2W 18-ba	Mich. Chemical Co. (Riverside Dr.)	1,216	5	Mm	720	14	M	117.6 Dec 1969	267.7 Aug 1957	111.3 Dec	117.3 Jan	
3W 24-da	City of St. Louis (3)	261	16	Qgd	730	11	R	37.9 Jan 1964	80.7 July 1967	62.2 Apr	76.3 Jan	P
35-bc	Reed Excavating Co. (Bridge St)	20	36	Qgd	738.78	21	M	12.7 Apr 1967	17.9 Feb 1963	15.1 Nov	17.2 Jan	

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

COUNTY AND WELL NUMBER (TWP., RANGE, SECTION)	OWNER OR OTHER DESIGNATION	DEPTH (ft)	DIAMETER (in)	AQUIFER	ALTITUDE	YEARS OF RECORD	FREQUENCY OF MEAS., 1970	OBSERVED WATER-LEVEL EXTREMES				REMARKS
								THROUGH 1969		IN 1970		
								MAXIMUM	MINIMUM	MAXIMUM	MINIMUM	
HILLSDALE COUNTY												
6S 3W 23-bb	City of Hillsdale (TW 6)	26	6	Qgd	1,070	13	W	1.0 May 1969	13.0 Sept 1957	2.1 Oct	7.2 Mar	P, Meas. by owner
7S 2W 10-ca	Pittsford State Game Area	20	1	Qgd	1,070	5	M	7.7 May 1969	11.1 Sept 1967	8.0 May	10.2 Jan	
HOUGHTON COUNTY												
54N 33W 32-ca	Jerome Soumis (Chassell)	228	4	CLSj	650	2	I	20.3 Apr 1969	21.8 Sept 1969	21.2	Oct	
INGHAM COUNTY												
1N 2E 3-ab	MSHD (M-36 & M-52)	320	5	Ps	960	3	M	26.2 June 1969	28.5 Sept 1969	26.5 May	27.9 Aug	Well destroyed
2N 1E 34-db	MDNR (Williamston Rd)	87	2	Qgd	980	7	Q	22.9 Apr 1969	29.3 Oct 1964	23.6 Apr	24.7 Jan	
3N 1E 7-cd	M. Lotte (windmill)	184	3	Ps	900	7	M	+0.7 Apr 1969	7.0 Nov 1964	+0.3 Dec	3.9 Jan	
4N 1E 21-cd	Duncan Lumber Co. (Sherwood)	265	8	Ps	890	8	R	20.1 May 1967	23.2 Aug 1965	21.5 Apr	23.4 Aug	P
2N 1W 5-bb	City of Mason (Gravel Pit)	210	8	Ps	890	7	R	16.4 May 1969	23.8 Nov 1964	16.8 Dec	20.2 Feb	P
5-dd	Do (old No. 2)	150	6	Ps	890	23	W	0.1 June 1949	10.7 Aug 1964	4.0 Apr	6.3 Jan	P, Meas. by owner
4N 1W 6-da	Meridian Twp. (4" test)	398	4	Ps	841.16	3	M	6.7 Dec 1968	11.3 Aug 1969	6.8 Dec	11.3 Aug	P
18-ad	Marble School (Hagadorn Rd.)	175	3	Ps	847.85	19	M	20.1 Apr 1953	61.4 Nov 1969	61.3 Jan	65.5 Aug	P
4N 2W 9-bd	City of Lansing (Seymour 1)	401	14	Ps	828.81	42	R	15.6 Mar 1931	179.4 Apr 1968	152.1 Nov	165.2 June	P
16-da	City of Lansing (Cedar)	417	12	Ps	829.11	26	R	42.0 Mar 1946	67.0 Aug 1949	55.3 Nov	62.4 Mar	P
17-ab	City of Lansing (Logan)	424	20	Ps	858.72	40	R	34.3 Dec 1929	168.3 May 1968	152.8 Nov	160.9 May	P
21-ba	City of Lansing (Townsend)	410	14	Ps	834.10	44	R	2.0 May 1906	78.2 June 1966	68.7 Oct	76.1 Mar	P
22-bc	City of Lansing (P-5)	338	12	Ps	823.64	41	M	7.1 July 1932	76.8 Dec 1969	70.1 Oct	80.5 Feb	P
24-ca	Michigan State Univ. (Spartan Village)	453	10	Ps	853.45	26	R	25.5 Mar 1946	100.2 Aug 1969	84.1 Jan	100.5 Oct	P
27-bb	Fenner Arboretum Park	215	6	Ps	835	3	R	52.0 July 1968	61.8 Apr 1969	60.3 May	77.4 Nov	P
31-cc	C. Weber (Maybel St.)	204	3	Ps	880.15	27	M	18.9 Apr 1952	37.4 Nov 1969	29.3 Nov	40.4 Sept	P
IONIA COUNTY												
6N 5W 33-aa	Barley-Erhart Co.	15	180	Qgd	715	14	Q	4.6 Apr 1960	10.7 Aug 1965	8.5 Apr	9.9 Oct	
7N 7W 23-bb	Mich. Tng. Unit at Ionia	127	6	Qgd	741.65	11	R	28.0 Feb 1968	34.1 Oct 1961	29.2 Apr	31.8 July	P
25-ac	Ionia State Hospital	23	6	Qgd	635.76	11	R	1.2 Mar 1962	15.3 Oct 1963	4.3 Apr	13.9 Sept	P
IRON COUNTY												
42N 31W 33-ab	Iron Co. (WMP 7)	11	1	Qgd	1,275	23	M	+0.2 May 1960	6.3 Oct 1948	0.6 June	5.3 Mar	Meas. by WMP
43N 32W 26-ac	Cayia Mine (shaft)	200+	4		1,420	12	Q	29.8 May 1960	39.7 Jan 1964	34.2 Dec	37.2 Feb	Mine drainage study
35W 11-ad	J. Javoroski (WMP 23)	47	36	Qgd	1,565	26	M	37.8 July 1969	47.1 Aug 1949	38.9 Jan	41.5 June	Meas. by WMP
20-dc	B. Henricksen (WMP 25)	48	1	Qgd	1,560	26	M	41.7 June 1953	48.3 Aug 1949	41.7 June	43.4 Apr	Do
33-bd	MSHD (WMP 34)	12	1	Qgd	1,520	23	M	1.9 July 1953	8.4 Mar 1949	3.8 June	5.7 Apr	Do
44N 33W 10-cc	Iron County (WMP 21)	8	1	Qgd	1,540	23	M	2.0 Apr 1954	8.0 Feb 1964	2.7 June	6.9 Sept	Do
37W 14-bb	USFS (Former CCC camp)	102	6	Qgd	1,720	12	Q	93.4 Dec 1969	96.2 Sept 1964	93.4 Feb	93.7 Apr	
45N 37W 23-ac	USFS (WMP 28)	8	1	Qgd	1,610	23	M	0.7 Apr 1965	4.7 Sept 1948	1.0 May	3.9 Sept	Meas. by WMP
46N 33W 18-bc	MSHD (WMP 17)	12	1	Qgd	1,560	23	M	2.8 Apr 1949	dry Feb 1956	5.2 June	7.9 Mar	Do
JACKSON COUNTY												
3S 1W 2-bd	City of Jackson (Hamburg St.)	400	12	Ps, Mn	935	5	R	21.0 Dec 1968	62.3 June 1967	17.4 Dec	50.6 Aug	P
10-dc	Summit Twp. (Francis St.)	323	12	Ps, Mn	935	11	R	14.3 Jan 1961	36.2 July 1965	16.1 Dec	33.1 Aug	P
11-aa-1	City of Jackson (4a) (Belden Rd.)	360	6	Ps, Mn	935	14	D	18.6 Jan 1961	110.0 Aug 1969	25.7 Dec	110.0 Aug	P, Meas. by owner
11-aa-2	City of Jackson (Belden Rd)	36	3	Qgd	928.82	9	R	+1.5 July 1968	18.2 Nov 1964	1.4 Apr	4.2 Sept	

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

COUNTY AND WELL NUMBER- TWP., RANGE, SECTION	OWNER OR OTHER DESIGNATION	DEPTH (ft)	DIAMETER (in)	AQUIFER	ALTITUDE	YEARS OF RECORD	FREQUENCY OF MEAS., 1970	OBSERVED WATER-LEVEL EXTREMES				REMARKS
								THROUGH 1969		IN 1970		
								MAXIMUM	MINIMUM	MAXIMUM	MINIMUM	
KALAMAZOO COUNTY												
2S 10W 4-d	City of Kalamazoo (Campbell Lake)	13	4	Qgd	836.5	2	R	2.4 June 1969	3.0 Mar 1969	2.7 Apr	3.3 Sept	
9-b	City of Kalamazoo (Schoonover Lake)	21	6	Qgd	828	2	R	+0.5 June 1969	0.0 Sept 1969	+0.4 Apr	0.2 Sept	
11W 3-aa	Brown Co. (61)	36	6	Qgd	763.18	15	R	8.3 May 1967	14.0 Aug 1967	8.8 Apr	11.1 Jan	P
10-db	General Printing	49	10	Qgd	761	3	R	12.4 July 1968	16.8 Oct 1968	12.5 Apr	17.2 Dec	P
14-dc	Brown Co.	100	12	Qgd	780	3	R	10.4 Dec 1968	24.7 Oct 1969	9.4 Apr	21.9 Jan	P
15-da	Consumers Power Co. (steam plant)	64	12	Qgd	766.17	25	R	9.2 Mar 1950	19.4 Sept 1964	9.9 Apr	13.1 Jan	P
20-bb-2	City of Kalamazoo Kendall (Deep)	106	4	Qgd	880	3	R	19.6 Aug 1969	47.1 July 1968	20.1 Jan	45.8 July	P
22-cd	City of Kalamazoo (Stockbridge)	137	4	Qgd	764.7	11	R	6.0 Apr 1969	31.1 Aug 1961	8.9 Jan	15.6 Sept	P
23-ad	Allied Paper Co.	43	12	Qgd	760	3	R	3.8 July 1968	20.2 Dec 1969	7.6 May	22.0 Feb	P
28-aa	City of Kalamazoo (Maple Station)	245	4	Qgd	820	2	R	36.5 Dec 1969	53.1 Aug 1969	36.5 Jan	54.3 Nov	P
31-cd	City of Kalamazoo (Colony Farm Station)	226	4	Qgd	910	2	R	54.9 Dec 1969	66.1 Aug 1969	53.0 Nov	65.8 Mar	P
36-cb	City of Kalamazoo (Emerald Station)	226	4	Qgd	860	2	R	30.0 Dec 1969	47.0 Aug 1969	28.8 May	47.0 July	P
3S 11W 4-ad-1	City of Kalamazoo (A-D)	135	3	Qgd	854.03	12	R	0.5 May 1967	12.9 July 1964	1.8 Jan	9.9 Mar	P
4-ad-2	City of Kalamazoo (A-S)	40	3	Qgd	854.01	12	R	0.0 Oct 1961	9.1 Nov 1959	0.6 July	4.0 Mar	P
14-aa	UpJohn Co. (28)	233	16	Qgd	870	4	R	27.5 Feb 1968	45.0 May 1967	28.5 Feb	44.8 July	P
22-bd	City of Portage (site C)	120	8	Qgd	865	4	R	5.9 June 1967	7.8 Nov 1967	6.8 June	8.8 Dec	P
12W 11-bd	City of Kalamazoo (Atwater)	248	3	Qgd	880	10	R	+3.0 Aug 1969	0.3 Jan 1965	+2.8 Jan	+2.1 Oct	
11-cb	City of Kalamazoo (scout camp)	259	6	Qgd	921.25	1	R			37.8 Sept	38.1 Dec	Record started 9-25
4S 11W 3-cd	Prarie View Co. Park	190	4	Qgd	870	2	R	19.2 Aug 1969	20.0 Dec 1969	19.0 May	20.2 Jan	
21-cb	W. Chamberlain (16th St.)	21	1	Qgd	863	5	W	10.5 Oct 1969	13.8 Dec 1968	12.2 June	13.8 Mar	
KENT COUNTY												
5N 12W 4-dc	City of Wyoming (Wobma)	86	6	Qgd	685.97	9	R	9.7 Apr 1967	12.9 Aug 1964	9.5 June	11.0 Jan	
6N 10W 30-aa	Kent Co. Airport	184	10	Qgd	800	5	R	85.7 Mar 1969	108.0 Sept 1967	85.8 Apr	106.6 July	P
12W 17-ad-1	Jervis Corp. (30th St.)	30	12	Qgd	606	21	M	6.8 Apr 1965	16.4 Feb 1954	9.4 Apr	13.3 July	P, Meas. by owner
17-ad-2	Jervis Corp. (30th St.)	26	6	Qgd	606.05	21	M	6.8 Apr 1965	16.3 Feb 1954	9.5 Apr	13.4 July	P, Meas. by owner
27-bb	City of Wyoming (44th St.)	265	14	Mm	707.24	9	R	48.4 May 1969	56.0 Aug 1964	48.6 Dec	50.1 Aug	P
10N 12W 13-dd	Rogue R. State Game Area	30	1	Qgd	785	5	M	4.6 May 1967	9.2 Oct 1969	4.4 Oct	8.9 Feb	
LAKE COUNTY												
17N 13W 4-ad	C & O R.R. (West Well)	83	8	Qgd	840	14	Q	15.2 July 1969	20.4 May 1958	17.1 July	18.1 Oct	
LENAWEE COUNTY												
5S 1E 12-dd	Onsted State Game Area	39	1	Qgd	1,000	5	M	16.6 May 1969	18.8 Sept 1967	16.8 May	18.2 Sept	
6S 4E 8-dd	Fisher Body Div. (GMC) (Tecumseh Plant)	81	8	Qgd	800	6	R	12.6 June 1969	18.4 Feb 1965	13.9 Jan	14.6 Dec	P
LIVINGSTON COUNTY												
1N 3E 11-ad	MDNR (Roche Rd.)	78	2	Qgd	980	7	Q	50.5 July 1969	55.3 Jan 1965	51.2 Jan	51.8 Oct	
6E 13-bd	American Aggregate Corp.	29	2	Qgd	930	1	R			15.4 June	16.8 Dec	Record started 4-10
2N 4E 3-cb	Howell State Hospital (Deer Lake)	375	8	Ps, Mm, Mb	916.13	13	R	10.0 May 1964	27.8 Dec 1958	13.2 Apr	19.8 Sept	P

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

COUNTY AND WELL NUMBER TWP., RANGE, SECTION	OWNER OR OTHER DESIGNATION	DEPTH (ft)	DIAMETER (in)	AQUIFER	ALTITUDE	YEARS OF RECORD	FREQUENCY OF MEAS., 1970	OBSERVED WATER-LEVEL EXTREMES				REMARKS
								THROUGH 1969		IN 1970		
								MAXIMUM	MINIMUM	MAXIMUM	MINIMUM	
LUCE COUNTY												
47N 10W 7-aa	LCRC (CR 407)	14	2	Qgd	900	4	Q	1.6 Apr 1969	4.9 Oct 1967	2.3 Dec	4.5 Jan	
49N 11W 2-ab	State (5) (Muskallunge L.)	7	1	Qgd	630	12	Q	+0.4 May 1960	6.6 Dec 1963	+0.1 May	2.6 Dec	Lake Hydr. Study
MACKINAC COUNTY												
41N 5W 23-bc	MDNR (Round L. CCC camp)	47	6	Ss	610	15	Q	4.3 May 1959	17.5 Mar 1959	7.3 Apr	14.4 Mar	
42N 2W 7-aa	USFS (Pontchartrain CCC)	102	6	Sm	650	15	R	13.1 May 1960	32.2 Nov 1963	15.3 June	27.3 Mar	
9-ba	K. Kerr (Nuns Creek School)	84	2	Sm	650	13	Q	*+3.5 Apr 1969	6.1 Oct 1966	+2.7 Apr	2.3 Jan	Meas. disc. 6-70 * well flowing
MARQUETTE COUNTY												
44N 26W 28-da	MDNR (Escanaba River CCC)	31	6	Qgd	1,120	17	S	1.9 May 1960	2.8 Aug 1957	2.3 Oct	2.6 Sept	
46N 25W 16-dd	G. Johnson (Sands sta.)	48	1	Qgd	1,198.43	8	M	27.1 July 1969	37.7 May 1964	30.6 Aug	32.5 Apr	
28W 12-cb	Mrs. S. Hill (Ishpeming gage)	19	1	Qgd	1,410	9	M	1.4 Oct 1967	3.0 Aug 1963	1.9 Apr	2.8 Aug	
47N 25W 19-cc	MDNR (Cascade Jct.)	86	1	Qgd	1,223.11	8	M	26.4 May 1969	39.0 Feb 1965	27.8 July	30.8 Mar	
20-cc	MDNR (E. of Cascade Jct.)	103	1	Qgd	1,229.78	8	M	82.2 Dec 1969	90.6 June 1965	82.6 Oct	83.7 July	
32-ca	MDNR (Gentian)	122	1	Qgd	1,239.17	6	M	93.8 Oct 1969	100.0 Oct 1964	93.0 Feb	94.1 Dec	
26W 27-bc	A. E. Laitala	31	1	Qgd		3	M	2.4 Aug 1969	10.1 Oct 1969	+0.5 June	6.6 Mar	
36-bb	Cleveland Cliffs Iron Co. (test)	56	8	Qgd	1,210	6	R	3.6 Apr 1969	7.5 Sept 1965	4.0 June	7.1 Mar	
27W 8-ba	Cleveland Cliffs Iron Co. (near Rock Lake)	37	1	Qgd	1,430	3	M	3.6 May 1969	5.3 Aug 1968	5.4 Jan	7.1 Aug	
28W 3-cc	Ely Twp. (U. S. 41)	75	8	Qgd	1,571.99	10	R	9.9 May 1969	19.3 Apr 1964	13.7 June	17.2 Apr	Feb. key well
28-cb	Bell Creek	18	1	Qgd	1,484.79	4	M	1.2 May 1964	3.9 Aug 1963	0.2 June	3.5 Aug	
35-cb	Triangle Intersection	52	1	Qgd	1,484.85	3	M	36.6 Dec 1964	37.9 June 1964	34.8 Aug	36.7 Apr	
29W 2-da	Marquette Co. Rd. Comm. (near Humboldt)	19	1	Qgd	1,527.32	8	M	2.8 May 1965	5.5 Aug 1963	2.6 Apr	4.7 Feb	
34-cb	Do (near Black River School)	23	1	Qgd	1,494.34	9	M	2.0 Apr 1966	7.1 Sept 1969	3.7 June	6.5 Apr	
48N 26W 34-da	Do (near Eagle Mills)	31	1	Qgd	1,282.99	8	M	2.0 Apr 1967	7.0 Apr 1964	3.2 June	4.8 Oct	
29W 30-cc	Van Riper State Park	78	6	Qgd	1,560	2	M	11.0 June 1969	13.9 Nov 1969	12.2 June	14.7 Mar	
49N 30W 22-ac	Marquette Co. Rd. Comm. (WMP 13)	17	1	Qgd	1,680	23	M	0.6 May 1951	13.3 Sept 1948	6.8 Apr	10.8 Aug	Meas. by WMP
MENOMINEE COUNTY												
37N 26W 19-da	MSHD (Carney)	16	4	Otb	800	12	M	3.7 May 1960	7.7 July 1967	3.9 June	7.5 Aug	
41N 25W 34-ad-1	Hanna Mining Company (LB 69-7 Lower)					2	M	+10.5 May 1969	+6.9 Oct 1969	+9.0 Nov	+6.9 Feb	
34-ad-2	Do (LB 69-7 Upper)					2	M	+1.5 May 1969	+0.3 Oct 1969	+1.2 Nov	+0.3 Feb	
34-ad-3	Do (LB 68-1)					3	I	+7.1 May 1969	+4.3 Oct 1969	+4.45 Nov		
34 da-1	Do (LB 67-1)					3	M	+10.2 May 1969	+5.7 Sept 1969	+9.1 May	+5.5 Aug	
34 da-2	Do (Auger 68-2)		1	Qgd	920	2	M	4.3 July 1969	7.4 Sept 1969	4.4 May	7.3 Aug	
34 da-3	Do (Auger 68-1)		1	Qgd	920	2	R	2.3 Apr 1969	8.0 Sept 1969	4.7 Nov	7.5 Aug	
34 da-4	Do (LB 68-4)					2	M	1.5 May 1969	2.4 Aug 1969	1.9 Nov	3.1 Feb	
35-ba	Do (LB 69-4)					2	I	+0.9 July 1969	0.6 Aug 1969	+0.1 Nov		
35-bb	Do (LB 69-5)					2	M	3.3 May 1969	4.7 Aug 1969	3.8 Nov	4.5 Feb	
35-bc	Do (LB 69-1)					2	I	0.4 May 1969	2.0 Aug 1969	4.8 Nov		
MONROE COUNTY												
7S 6E 15-ad	Petersburg State Game Area	17	1	Qgd	675	5	M	3.0 Feb 1966	6.4 Sept 1967	4.4 May	5.7 Oct	

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

COUNTY AND WELL NUMBER TWP., RANGE, SECTION	OWNER OR OTHER DESIGNATION	DEPTH (ft)	DIAMETER (in)	AQUIFER	ALTITUDE	YEARS OF RECORD	FREQUENCY OF MEAS., 1970	OBSERVED WATER-LEVEL EXTREMES				REMARKS
								THROUGH 1969		IN 1970		
								MAXIMUM	MINIMUM	MAXIMUM	MINIMUM	
MONTCALM COUNTY												
10N 8W 17-bb	L. Packard (Colby Rd.)	28	2	Qgd	865	7	Q	19.2 Aug 1967	23.5 Mar 1964	21.1 July	22.4 Jan	
MONTMORENCY COUNTY												
29N 3E 21-ab	MDNR (32) (Co. Rd. 612)	14	2	Qgd	900	26	Q	2.5 July 1960	5.9 Jan 1956	4.0 July	5.0 Dec	
MUSKEGON COUNTY												
11N 15W 34-da	Muskegon State Game Area	31	1	Qgd	595	5	M	0.4 Feb 1966	4.0 Oct 1966	0.5 Feb	3.4 Sept	
OAKLAND COUNTY												
2N 7E 5-ba	American Aggregates (Honeywell Lake Rd)	44	2	Qgd	1,020	3	R	26.1 June 1969	27.4 Dec 1969	26.9 May	28.2 Oct	
8E 18-da	Proud Lake State Park	45	6	Qgd	910	2	R	3.7 July 1969	5.3 Dec 1969	4.4 May	5.8 Dec	P
10E 22-ba	Cranbrook School (3)	65	6	Qgd	788	21	R	10.4 May 1963	18.9 Dec 1964	12.5 June	15.1 Nov	
3N 7E 5-da	American Aggregates (Fish Lake Rd.)	49	2	Qgd	1,055	2	R	34.3 Aug 1969	35.2 Apr 1969	35.2 Jan	36.7 Dec	
8E 36-ab	Waterford Twp. (Josephine Street)	134	12	Qgd	976.70	11	R	69.7 Dec 1969	100.5 Aug 1963	67.2 Nov	72.0 Aug	P
10E 13-ac	Oakland Univ.	183	6	Qgd	940	10	R	63.9 Dec 1969	93.5 July 1963	62.1 Dec	64.2 Jan	P
32-ab	City of Pontiac (LS 6) (Hayes-Jones Rec. Ctr.)	184	12	Qgd	923.13	8	R	36.4 Dec 1969	99.4 Oct 1963	29.7 Nov	38.7 Aug	
5N 8E 8-ac	Holly State Recreation Area	42	1	Qgd	930	5	M	23.6 June 1969	26.5 Sept 1966	24.7 May	25.6 Sept	
OGEMAW COUNTY												
23N 1E 2-ba-1	Ogemaw Co. Rd. Comm. (Rose City Rd.)	105	1	Qgd	1,265	3	Q	77.2 Oct 1968	78.2 Apr 1969	76.5 Dec	77.0 Jan	
2-ba-2	Do (Rose City Rd.)	20	1	Qgd	1,265	3	Q	8.7 July 1969	11.6 Oct 1968	9.6 July	10.8 Oct	
4-ad	MDNR (Fire suppression well #15)	21	4	Qgd	1,230	17	Q	1.1 Apr	4.4 Oct 1964	1.3 Apr	2.6 Oct	
2E 6-aa	Ogemaw Co. Rd. Comm. (Fairview Rd.)	133	1	Qgd	1,270	3	Q	102.8 Oct 1969	103.6 Apr 1969	102.4 Dec	102.5 July	
24N 2E 35-cd	Jim Kelley	70	1	Qgd	1,130	3	Q	9.7 Nov 1968	12.7 Feb 1969	7.2 Dec	9.2 Feb	
3E 8-bb	Ogemaw Co. Rd. Comm. (Beechwood Rd.)	89	1	Qgd	1,215	3	Q	86.8 Oct 1969	87.8 Apr 1969	86.4 July	86.6 Jan	
ONTONAGON COUNTY												
46N 38W 30-ad	USFS	65	1	Qgd	1,530	4	M	16.6 May 1969	18.4 Dec 1969	17.8 June	19.1 Apr	
51N 41W 8-bd	Mich. Corrections Dept. (Silver City)	100	6	p6f	620	13	Q	8.2 Apr 1959	18.9 Oct 1963	9.6 June	17.8 Oct	
OTSEGO COUNTY												
29N 3W 29-dc	MDNR (106) (Waters)	15	2	Qgd	1,260	38	Q	5.1 Apr 1967	9.7 Oct 1958	7.3 Apr	7.9 Oct	
OTTAWA COUNTY												
5N 15W 27-cc	City of Holland (Waverly Rd.)	102	1	Qgd	640	24	M	40.8 June 1969	dry July 1953	39.5 Dec	41.2 Mar	Meas. by owner
PRESQUE ISLE COUNTY												
33N 2E 30-da	MDNR (19) (Truck trail)	14	2	Qgd	800	34	Q	0.6 July 1960	5.7 Jan 1956	2.8 Dec	3.4 Apr	
6E 8-bb	A. Styma (farm)	61	6	Dt	800	12	Q	5.4 Apr 1967	18.8 Mar 1963	6.1 Apr	11.5 Oct	
21-aa	M. Ardycan (M-65)	43	5	Dt	790	12	Q	1.1 Apr 1963	7.6 Oct 1966	1.1 Dec	6.2 July	
ROSCOMMON COUNTY												
22N 3W 22-ad	MDNR (7) (Fox farm)	14	2	Qgd	1,170.58	37	Q	2.3 July 1969	7.5 Oct 1964	3.3 Apr	4.6 Oct	
23N 1W 3-dd	MDNR (50) (M-76)	12	2	Qgd	1,188.95	32	Q	1.6 June 1943	7.3 Dec 1949	3.1 Apr	5.2 Oct	
24N 2W 20-ba	MDNR (1) (Exp. sta.)	14	8	Qgd	1,145.30	37	R	2.7 May 1967	6.2 Dec 1949	3.1 June	4.8 Sept	Fed. key well

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

COUNTY AND WELL NUMBER TWP., RANGE, SECTION	OWNER OR OTHER DESIGNATION	DEPTH (ft)	DIAMETER (in)	AQUIFER	ALTITUDE	YEARS OF RECORD	FREQUENCY OF MEAS., 1970	OBSERVED WATER-LEVEL EXTREMES				REMARKS
								THROUGH 1969		IN 1970		
								MAXIMUM	MINIMUM	MAXIMUM	MINIMUM	
SAGINAW COUNTY												
9N 3E 16-bd	R. Ellis (Liberty St.)	129	3	Ps	643	13	W	25.8 Nov 1969	53.8 Sept 1959	25.9 Jan	28.1 Feb	P, Meas. by owner
SANILAC COUNTY												
12N 13E 33-dd	MSHD (at Elmer)	150	3	Mm	800	23	W	15.4 Apr 1951	25.6 Jan 1965	19.0 Dec	23.7 Feb	
SCHOOLCRAFT COUNTY												
45N 13W 16-cc	U. S. Fish and Wildlife (Seney)	154	4	Or	710	19	R	4.8 May 1960	6.5 Oct 1963	5.1 Dec	5.8 Aug	
47N 16W 30-bb	MDNR (Cusino CCC)	57	6	Op	900	14	R	5.7 May 1960	16.3 Oct 1963	8.9 Apr	15.8 Mar	
SHIAWASSEE COUNTY												
5N 2E 16-da	A. Cobb (at Perry)	26	1	Qgd	896.00	23	Q	17.3 May 1950	23.2* Jan 1964	19.8 July	22.7 Oct	*W/L below obstruction in pipe
VAN BUREN COUNTY												
1S 17W 22-ad	Stevie Bros. (M-140)	132	4	Qgd	640	8	M	35.6 May 1967	e39.15 Aug 1964	36.1 Apr	37.9 Aug	P
2S 13W 2-bb	Co. Road Commission (8) (24th St.)	23	1	Qgd	740	8	M	2.0 Dec 1966	5.1 Sept 1964	2.2 Apr	3.9 Sept	
3S 14W 6-ba	R. Martin (3) 48th St.	59	1	Qgd	740	8	M	38.1 May 1967	43.3 Nov 1964	38.6 May	40.6 Nov	
4S 16W 14-cd	O. Klett (Keeler)	170	14	Qgd	800	8	M	17.9 June 1969	27.6 Aug 1964	17.9 June	19.7 Mar	P
13W 16-dd	Porter Twp. (1) (Twp. Hall)	83	1	Qgd	930	8	M	43.1 July 1969	50.4 Oct 1964	42.4 Sept	44.6 Mar	
WASHTENAW COUNTY												
2S 3E 9-da	Waterloo State Park	48	6	Qgd	970	2	R	4.4 July 1969	6.1 Nov 1969	4.6 May	6.0 Jan	P
3S 6E 16-bc	City of Ann Arbor (Airport)	55	10	Qgd	821.50	8	R	2.3 July 1969	15.9 Oct 1964	2.4 May	8.2 Feb	P
7E 5-bb	City of Ypsilanti (Huron River)	69	8	Qgd	720	9	R	1.8 Feb 1965	21.4 Dec 1965	10.5 Dec	16.2 Jan	P
9-ac	City of Ypsilanti (NR) (River St.)	50	6	Qgd	710	20	M	27.6 July 1968	51.6 Nov 1964	35.9 May	39.0 Dec	P
9-ad	City of Ypsilanti (GP) (Gilbert Park)	94	6	Qgd	710	20	R	29.1 Nov 1945	70.4 Oct 1964	53.7 Sept	60.4 June	P
24-ca-1	Ypsilanti Twp. (104) (Water Works)	87	4	Qgd	665.56	25	R	5.8 Jan 1950	21.4 Feb 1967	15.8 Nov	22.6 Feb	P
24-cb	Do (109)	77	4	Qgd	665.56	25	M	15.2 June 1945	57.2 Dec 1969	55.6 Nov	58.2 Apr	P
24-cc	Do (117)	75	6	Qgd	657.83	24	R	5.7 Feb 1950	62.0 Dec 1969	41.2 Nov	63.2 Feb	P
4S 6E 9-bb	Ypsi. State Hosp. (TW 20) (Moon Rd.)	184	6	Qgd	800	25	W	51.2 May 1948	88.1 June 1949	71.9 Nov	83.1 Jan	P, Meas. by owner
10-bc	Ypsi. State Hosp. (TW 22) (Warner Rd.)	173	6	Qgd	794	25	W	56.6 Oct 1962	88.3 July 1955	75.1 Jan	78.2 Sept	P, Do
WAYNE COUNTY												
1S 8E 9-bc	City of Plymouth (Beck Rd.)	61	6	Qgd	820	10	R	9.3 Aug 1968	21.3 Feb 1966	12.0 June	17.7 Aug	P
17-aa	Do (6-Mile Rd.)	114	6	Qgd	856	9	R	50.4 Apr 1963	59.6 Dec 1966	55.3 July	58.1 Dec	P
WEXFORD COUNTY												
21N 9W 4-ab	City of Cadillac (Lakeside)	277	6	Qgd	1,291.10	22	Q	20.0 July 1953	27.6 June 1964	21.9 Dec	22.2 Apr	P
22N 12W 13-ba	Harrietta State Fish Hatchery	141	4	Qgd	1,060	10	R	+13.6 Feb 1961	+1.5 Jan 1966	+13.8 Mar	+7.6 Feb	P
24N 9W 19-bc	MDNR (38) (No. 37 Rd.)	11	2	Qgd	994.16	29	Q	0.5 Apr 1959	3.7 Aug 1936	1.2 Dec	3.2 Apr	

TABLE 2. REPORTED GROUND-WATER PUMPAGE, IN 1970. (IN MILLIONS OF GALLONS)

WATER USER	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	1970 TOTAL	MAX DAY	MIN DAY
ALCONA COUNTY															
City of Harrisville	1.6	1.6	1.6	1.2	1.3	1.7	2.1	2.3	1.4	1.2	1.2	1.1	18.3	.096	.029
ALGER COUNTY															
Township of Burt	1.8	1.7	2.0	2.1	2.3	2.8	2.8	3.2	2.1	1.9	1.9	2.2	26.8	—	—
ALLEGAN COUNTY															
City of Allegan	22.2	25.2	23.3	25.4	27.9	34.5	36.2	40.9	39.1	32.8	31.2	29.7	368.4	1.779	.458
City of Plainwell	11.8	9.9	10.4	12.4	13.5	16.1	17.6	18.4	12.9	10.8	10.1	10.5	154.4	.798	.262
City of Otsego	19.6	18.3	20.8	21.9	24.0	30.1	27.9	30.0	24.0	22.2	20.6	18.2	277.6	1.172	.447
ANTRIM COUNTY															
Village of Mancelona	17.3	14.3	17.7	16.7	18.7	22.8	18.5	22.4	18.0	19.4	17.6	16.4	219.8	.820	—
BARRY COUNTY															
City of Hastings	33.0	33.9	35.5	38.0	39.2	42.8	46.1	47.0	38.1	39.4	35.4	36.2	464.6	2.000	.720
Village of Middleville	11.4	11.5	12.9	13.0	14.8	13.7	13.6	17.4	13.5	14.9	10.8	12.0	159.5	1.834	.187
BENZIE COUNTY															
City of Frankfort	5.2	4.7	5.6	5.9	8.9	6.5	9.4	10.1	6.0	10.7	5.1	5.8	83.9	.569	.147
BERRIEN COUNTY															
Village of Berrien Springs	8.6	8.2	8.6	9.1	11.3	12.7	17.1	15.6	12.9	10.7	8.7	9.0	132.5	.735	.188
City of Buchanan	68.7	70.3	71.3	72.2	80.8	84.2	95.2	97.4	77.2	69.6	62.0	65.3	914.2	3.994	1.169
City of Coloma	7.1	6.5	7.3	7.6	8.9	10.3	11.1	11.8	9.6	9.3	9.1	8.5	107.1	—	—
City of Niles	93.0	81.7	84.1	87.3	90.3	102.0	97.4	108.6	94.2	89.8	77.9	78.8	1,085.1	5.210	1.520
BRANCH COUNTY															
City of Bronson	18.6	15.9	16.5	15.4	15.3	16.3	16.7	17.7	17.6	16.8	13.2	15.9	195.9	.774	.167
City of Coldwater	70.3	60.5	63.9	63.7	67.8	80.8	81.3	92.4	74.7	69.6	60.9	65.2	851.1	5.742	.901
State Home and Training School at Coldwater	15.1	13.9	14.8	14.2	15.8	17.6	19.0	18.4	16.8	17.9	17.5	17.2	198.2	—	—
Village of Quincy	5.1	5.1	5.1	5.1	5.5	5.5	5.5	3.4	3.4	3.4	23.4	23.4	93.9		
CALHOUN COUNTY															
City of Albion	133.7	122.1	138.3	143.4	153.5	159.9	141.4	161.1	150.7	142.6	132.7	133.2	1,712.6	6.297	2.824
American Legion Hospital at Battle Creek	.3	.3	.4	.3	.3	.3	.2	.2	.3	.3	.2	.2	3.3	—	—
Village of Athens	2.6	2.1	2.4	2.8	3.4	4.6	3.4	3.6	3.6	3.5	2.5	2.4	36.9	.178	.048
City of Battle Creek	200.9	190.6	200.9	207.1	280.7	351.5	295.4	300.9	236.6	207.0	165.7	161.8	2,799.1	17.480	3.980
Township of Battle Creek	34.6	32.0	33.7	34.8	43.4	59.4	53.2	64.1	47.1	40.7	39.0	32.7	514.7	3.508	.869
City of Marshall	37.8	35.6	41.1	39.3	42.2	44.4	43.2	42.7	41.8	41.8	39.2	39.1		1.914	.821
CASS COUNTY															
City of Dowagiac	21.8	20.7	20.6	20.4	23.5	27.0	27.4	27.8	24.6	21.4	19.1	18.4	272.7	1.411	.407
CHARLEVOIX COUNTY															
City of East Jordan	15.4	13.6	15.7	14.1	16.6	19.1	20.2	19.1	19.6	13.7	12.0	12.3	191.4	1.180	.250
CHEBOYGAN COUNTY															
City of Cheboygan	27.1	20.4	26.6	23.2	24.0	22.7	23.5	21.2	29.6	18.2	27.6	29.0	293.1	.807	.657
Village of Mackinac City	3.5	3.4	3.9	4.5	6.4	6.4	10.4	10.6	7.1	5.7	3.9	3.6	69.4	.439	.087
CHIPPEWA COUNTY															
Kincheloe Air Force Base near Kinross	29.5	28.8	31.9	31.9	30.1	52.7	38.6	38.9	27.1	28.0	26.2	28.6	392.3	2.548	.792
CLARE COUNTY															
City of Clare	21.4	27.7	23.3	21.0	24.6	32.9	39.5	46.2	25.6	23.6	20.5	19.8	326.1	2.086	.454
City of Harrison	5.1	5.7	6.0	4.5	4.3	5.1	5.9	6.5	3.7	3.1	3.1	3.2	56.2	.329	.060
CLINTON COUNTY															
Village of Ovid	5.2	4.3	4.5	3.9	3.9	4.0	4.0	4.3	3.8	3.6	3.4	3.6	48.5	.189	.093
City of St. Johns	42.6	38.3	42.4	40.9	42.4	47.0	47.5	49.7	45.8	42.5	39.2	42.2	520.5	1.960	.580
EATON COUNTY															
Delta Charter Twp.													356.0		
City of Charlotte	55.1	48.3	52.6	54.3	55.6	57.3	58.5	50.1	52.9	51.9	45.5	50.5	632.6	2.463	.824
City of Eaton Rapids	25.9	21.4	20.7	27.7	23.0	30.3	35.9	34.2	26.1	29.1	20.9	25.1	320.3	1.598	.381
City of Grand Ledge	16.6	14.8	15.8	15.9	16.2	19.0	19.5	20.3	16.1	16.0	15.5	16.3	202.0	.883	.346
Village of Bellevue	3.8	3.8	4.1	4.1	4.1	4.9	4.1	3.9	3.8	3.2	3.2	2.6	45.6	.175	.075
City of Olivet													c50.0		
Olds Parts Warehouse near Lansing	1.7	2.1	2.1	2.1	2.1	2.1	4.2	2.9	3.4	1.6	1.8	2.5	28.6	—	—
EMMET COUNTY															
City of Harbor Springs	12.9	13.9	12.1	11.0	9.9	16.4	24.6	30.7	14.9	12.7	7.6	8.6	176.1	1.617	.244
GENESEE COUNTY															
Beecher Metropolitan District	34.6	31.2	33.1	32.9	37.3	40.0	38.2	46.0	34.5	35.4	32.3	34.4	429.9	2.023	.880
City of Davison	16.9	14.8	14.4	14.1	16.4	18.6	19.6	23.1	15.2	15.2	13.9	14.4	196.6	1.021	.346
City of Fenton	23.2	22.8	26.1	23.6	24.8	26.9	23.6	28.5	23.5	21.8	21.4	22.7	288.9	1.226	.530
Village of Linden	1.3	1.6	2.2	1.3	1.7	2.6	2.9	2.8	2.2	1.8	1.7	1.6	23.7		
Fisher Body Div. at Grand Blanc	.6	.5	.8	.5	.5	3.9	.5	1.4	.6	0	0	0	9.3	.390	.095
City of Grand Blanc	20.9	19.5	24.3	22.7	26.0	39.6	33.8	55.0	23.1	20.0	27.9	22.6	335.4	1.975	.636
City of Mt. Morris	6.8	1.9	6.9	7.6	7.4	7.4	6.7	8.7	8.1	7.1	6.9	7.0	82.5	.566	.127
Village of Otisville	1.2	1.1	1.2	1.1	1.2	1.3	1.3	1.4	1.2	1.3	1.1	1.2	14.6	.068	.029

TABLE 2. REPORTED GROUND-WATER PUMPAGE, IN 1970. (IN MILLIONS OF GALLONS)—Continued

WATER USER	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	1970 TOTAL	MAX DAY	MIN DAY
GLADWIN COUNTY															
City of Beaverton	2.6	2.6	4.1	3.1	2.5	2.3	2.6	3.0	3.0	3.5	2.9	3.1	35.3	.220	.047
GOGEBIC COUNTY															
City of Bessemer	10.0	10.6	11.1	10.8	10.8	11.4	12.9	12.3	10.8	10.9	9.9	9.5	131.0	.550	.256
City of Ironwood	38.9	36.4	41.9	44.4	36.6	37.4	39.9	39.9	34.5	34.5	33.2	36.0	453.5	1.818	.640
City of Wakefield	8.8	8.3	9.4	8.4	8.6	9.1	10.3	10.3	9.5	9.6	9.5	10.2	112.0	—	—
GRATIOT COUNTY															
[f]City of Alma	0.0	0.0	6.5	0.0	29.5	33.7	36.0	40.3	19.8	2.2	1.8	1.3	171.1	—	—
Village of Breckenridge	2.9	2.6	2.8	2.9	3.1	3.5	4.1	4.5	3.8	3.8	3.5	3.4	40.9	.195	.061
City of Ithaca	6.3	5.6	6.1	5.0	5.9	6.0	6.1	6.7	6.0	5.3	5.4	4.2	68.6	.449	.153
City of St. Louis	50.2	42.3	47.2	43.4	44.8	42.9	51.7	50.8	48.5	48.7	48.3	51.6	570.4	2.148	1.053
HILLSDALE COUNTY															
Village of Jonesville	17.7	14.4	13.6	14.2	8.0	9.8	11.1	9.5	6.8	4.0	—	5.1	[d]114.2	1.161	.126
[g]City of Hillsdale	29.0	25.8	27.7	25.5	24.1	26.8	27.5	26.0	.7				213.1	.994	.211
HOUGHTON COUNTY															
City of Houghton	27.9	26.9	28.0	29.4	30.4	26.6	25.9	27.1	24.1	29.0	27.1	26.4	328.8	1.103	.626
Township of Chassell	2.9	2.4	1.8	.9	1.8	2.2	2.6	2.9	2.4	2.0	1.9	2.1	25.9	.181	.019
HURON COUNTY															
Village of Pigeon	4.6	4.3	5.1	5.8	6.3	6.6	8.9	9.1	6.7	7.2	5.7	6.0	[e]76.3	.323	.180
Village of Sebewaing	8.2	7.2	7.4	7.2	8.6	9.8	9.1	10.8	10.7	9.6	9.1	8.7	106.4	—	—
INGHAM COUNTY															
City of East Lansing	102.6	95.9	101.8	108.0	120.8	122.5	124.5	139.8	99.7	97.6	88.3	84.1	1,285.6	5.6	2.3
City of Lansing (Rock Wells)	606.6	528.9	585.6	585.6	649.8	660.6	629.4	700.9	549.1	480.8	505.4	582.0	7,064.7	33.100	15.100
City of Lansing Stiefel Field (Eaton Co.) (Gravel)	67.0	68.9	70.7	64.1	61.1	97.3	103.8	99.4	95.7	59.5	22.7	54.4	864.6	—	—
NW Field (Gravel)	—	—	—	—	4.5	5.2	2.5	2.9	1.9	—	—	—	17.0	—	—
Township of Lansing	54.1	45.1	58.1	47.1	51.4	65.8	[d]5.5	[d]33.6	59.3	44.0	29.3	34.5	527.8	—	—
City of Mason	15.1	14.3	14.4	14.7	16.1	17.1	15.7	17.5	15.8	16.0	14.2	14.7	185.6	—	—
Township of Meridian	15.1	13.2	14.5	15.2	18.1	19.3	20.0	26.1	18.8	16.3	17.2	17.6	211.4	—	—
Michigan State University at East Lansing	158.9	146.6	143.6	163.2	168.9	166.9	150.7	145.5	150.9	154.8	142.7	112.9	1,805.6	5.032	2.300
Oldsmobile Forge #2 at Lansing	10.8	10.9	16.5	13.9	11.3	16.2	9.4	14.3	1.8	0.0	3.8	13.8	122.7	—	—
IONIA COUNTY															
State Hospital at Ionia	7.5	6.9	6.6	6.6	7.4	8.0	5.8	8.5	5.8	5.1	.5	.7	69.3	.376	.134
Michigan Reformatory at Ionia	20.0	21.0	20.0	24.0	20.0	20.0	20.5	19.8	18.2	17.0	20.3	17.6	238.4	.792	.452
Michigan Training Unit at Ionia	2.5	2.1	2.6	2.6	3.7	5.0	7.2	6.0	2.6	3.0	2.9	2.7	42.9	.432	.052
City of Portland	12.0	8.9	12.4	12.6	14.0	15.2	15.1	16.2	13.0	13.9	12.9	13.5	159.7	.925	.226
Village of Saranac	8.7	7.9	8.0	9.3	9.5	9.8	11.0	10.5	10.0	11.0	9.6	10.6	115.9	.547	.096
IOSCO COUNTY															
Wurtsmith Air Force Base near Oscoda	24.2	23.9	29.8	26.4	35.8	48.2	43.2	52.1	35.5	28.0	22.4	29.4	398.9	—	—
IRON COUNTY															
City of Caspian	9.8	9.8	10.1	10.0	10.4	10.9	11.9	11.9	11.8	10.1	9.4	9.3	125.4	.508	.222
City of Crystal Falls	16.6	14.7	14.4	14.6	15.0	18.9	17.9	18.9	15.5	14.0	13.8	14.3	188.6	.812	.245
City of Iron River	10.8	10.5	12.5	11.3	10.5	11.0	12.1	11.7	10.7	9.7	9.6	10.5	130.9	.677	.240
City of Stambaugh	4.7	4.3	4.8	4.8	4.7	4.4	4.7	4.8	4.7	4.4	4.5	4.7	55.5	—	—
Township of Stambaugh	1.7	1.6	2.1	1.7	1.7	2.4	3.4	3.1	2.0	1.9	1.8	1.8	25.2		
ISABELLA COUNTY															
City of Mt. Pleasant	63.3	61.9	65.1	53.6	69.2	71.6	72.9	84.5	79.7	74.3	67.3	62.3	[k]825.7	4.529	1.583
Village of Shepherd	2.4	2.2	2.3	2.5	2.5	2.6	2.6	2.8	2.6	2.5	3.0	2.3	30.3		
JACKSON COUNTY															
[a]Village of Concord	2.1	1.8	2.2	2.2	2.5	3.0	2.9	3.7	3.0	2.9	2.7	2.2	31.2	.237	.048
[a]Village of Grass Lake			6.3			7.2			7.0			6.2	26.7	—	—
City of Jackson	356.4	320.0	345.8	334.3	326.6	392.2	419.9	454.9	385.8	367.0	315.0	318.8	4,336.7	18.630	5.750
State Prison of Southern Michigan at Jackson	33.9	26.5	35.2	34.4	33.0	35.5	34.8	39.9	34.8	31.9	34.2	32.3	406.4	1.599	.804
KALAMAZOO COUNTY															
Village of Augusta	2.1	2.2	1.2	2.0	2.2	3.7	2.7	3.5	2.5	2.4	2.2	2.3	29.0	.120	.037
City of Kalamazoo	450.4	434.1	472.5	493.1	526.3	629.8	693.9	783.1	556.1	534.3	436.0	471.9	6,481.5	38.811	4.550
State Hospital at Kalamazoo	17.5	14.6	20.2	18	19.0	91.1	18.7	18.3	16.0	19.2	17.4	20.3	218.3	.720	.430
City of Portage	25.9	23.0	25.3	26.7	36.1	57.3	43.1	60.5	34.8	31.0	28.9	28.3	420.9	3.574	.601
Village of Vicksburg	7.5	7.5	7.5	7.6	6.7	12.4	9.4	10.2	10.1	9.6	6.8	8.0	103.3	.947	.114
Upjohn Company near Kalamazoo	417.3	365.5	424.8	435.2	500.4	520.5	544.2	536.2	505.6	492.4	391.2	392.2	5,526.2	20.776	9.650
City of Parchment	7.1	6.3	7.8	9.7	9.3	14.0	13.8	13.3	9.1	8.2	7.1	7.0	112.7	1.017	.178
Brown Company Specialties Paper Division	77.5	69.4	73.2	75.1	76.4	74.6	76.1	79.3	72.3	74.1	71.6	73.0	892.6	—	—
Converting Board Division	145.2	141.9	172.3	148.9	167.9	156.8	159.2	166.8	152.4	188.6	199.3	196.7	2,005.0	—	—

TABLE 2. REPORTED GROUND-WATER PUMPAGE, IN 1970. (IN MILLIONS OF GALLONS)—Continued

WATER USER	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	1970 TOTAL	MAX DAY	MIN DAY
KALAMAZOO COUNTY (Continued)															
Simpson-Lee Paper Company at Vicksburg	67.0	60.5	67.0	64.8	47.5	45.7	45.7	56.2	54.0	56.2	56.2	67.0	e/687.8	—	—
City of Galesburg	3.4	3.3	3.2	3.1	4.2	5.0	4.7	5.8	3.6	3.4	2.9	3.2	45.8	.427	.070
KALKASKA COUNTY															
Village of Kalkaska	6.6	6.4	7.2	5.9	7.7	11.6	12.3	11.9	6.9	5.2	4.6	4.8	91.1	.643	.108
KENT COUNTY															
Jervis Corporation	e/3.0	e/3.0	5.0	3.0	3.2	5.8	6.1	6.7	4.5	4.5	e/2.0	1.5	e/48.3		
Kent County Airport near Grand Rapids			3.3			2.7			3.3			b/1.7	11.0		
Kent County Airport near Grand Rapids for Air Conditioning													e/9.0		
City of Lowell	15.3	12.8	13.8	14.4	15.4	17.5	18.7	19.4	15.4	16.2	12.7	13.8	185.4	.889	.095
Village of Sparta	11.6	8.2	8.4	8.1	9.5	12.4	11.5	13.9	11.8	9.2	8.7	9.6	122.9	.683	.211
LAPEER COUNTY															
State Home & Training School at Lapeer	16.8	17.6	18.7	14.8	15.7	14.3	12.3	11.5	11.0	13.7	13.3	12.6	172.3	—	—
LENAWEE COUNTY															
c/Village of Clinton			15.3			18.7			20.2			16.8	71.0	—	—
City of Hudson	9.9	9.1	9.9	9.0	8.4	9.1	8.5	9.5	8.6	7.7	7.0	6.7	103.4	.581	.103
City of Morenci	7.1	6.8	7.4	6.0	7.4	6.5	6.6	6.5	6.2	5.5	5.1	5.4	76.5	.300	.128
City of Tecumseh	37.5	37.4	40.3	36.8	48.7	52.0	54.1	51.4	45.8	40.2	42.0	41.7	527.9	2.538	.636
Fisher Body Div. G.M.C. near Tecumseh	1.2	1.2	1.2	1.3	1.4	1.7	1.7	1.8	1.2	.8	.8	1.3	e/15.6	.103	.015
LIVINGSTON COUNTY															
City of Brighton	12.3	12.0	13.4	13.0	12.1	14.3	15.6	18.2	17.9	14.2	13.1	12.3	168.4	.995	.323
City of Howell	28.5	25.3	27.9	25.2	27.6	28.4	30.0	32.3	27.9	23.9	24.1	26.8	327.9	1.284	.598
State Hospital at Howell	3.7	3.1	3.5	3.3	3.8	4.5	3.9	4.7	3.8	3.7	2.3	3.3	43.6	.304	.065
LUCE COUNTY															
City of Newberry	10.4	10.8	12.8	12.4	9.8	10.9	16.0	14.5	15.6	9.1	10.4	14.7	147.4	—	—
State Hospital at Newberry	6.5	5.4	5.9	6.8	6.0	6.2	6.4	6.1	6.1	5.7	5.6	5.6	72.3	—	—
MACOMB COUNTY															
City of Richmond	10.7	9.2	11.0	8.2	9.8	12.7	11.2	13.0	10.8	9.5	10.0	8.9	125.0	—	—
Village of Romeo	16.3	14.7	15.5	15.8	15.3	15.2	15.1	16.3	16.0	16.1	16.9	14.8		.578	.372
MARQUETTE COUNTY															
State House of Corr. & Br. Prison at Marquette	7.3	6.6	7.1	6.3	6.6	7.5	5.1	7.1	7.4	7.3	6.7	7.6	82.6	.240	—
K. I. Sawyer Air Force Base near Gwinn	30.3	29.2	33.2	32.6	34.1	52.6	41.4	47.7	32.5	32.9	30.7	32.4	429.6	2.561	.997
MONTCALM COUNTY															
City of Carson City	9.9	9.0	9.6	9.4	9.6	9.8	10.0	10.6	10.2	6.3	6.5	6.5	107.4	.493	.134
City of Greenville	46.8	44.6	49.8	55.5	64.1	61.2	62.0	58.3	55.4	58.8	55.4	57.8	669.7	3.193	.467
Village of Sheridan	1.7	1.4	1.5	1.6	2.4	3.8	2.9	2.9	2.1	1.9	1.6	1.8	25.6	—	—
City of Stanton	1.9	1.7	2.0	2.0	1.8	2.5	2.3	2.2	2.2	2.4	2.2	2.5	25.7	—	—
MUSKEGON COUNTY															
City of Montague	5.4	5.4	5.9	5.9	7.2	9.5	8.7	9.9	6.3	4.9	5.2	4.6	78.9	—	—
City of Whitehall	27.4	28.2	26.1	30.9	31.5	42.4	39.1	37.8	34.1	32.2	29.1	31.0	389.8	1.806	.570
OAKLAND COUNTY															
Cranbrook School	9.0	5.6	9.7	6.2	8.5	12.0	6.5	8.5	7.5	7.4	5.4	6.8	93.1	—	—
Village of Oxford													m/48.8		
City of Rochester	50.5	47.3	52.7	56.2	86.4	70.4	72.1	79.8	63.6	58.0	44.9	56.8	738.7	3.147	1.300
City of South Lyon	70.6	60.1	63.0	48.9	50.1	51.3	33.4	56.3	52.2	40.9	41.9	44.7	613.4	2.434	.307
City of Sylvan Lake	6.1	6.1	6.1	5.5	5.5	6.8	6.4	7.6	7.6	4.9	7.3	6.6	e/76.5	—	—
City of Troy	2.3	2.1	2.1	2.2	1.9	2.2	3.1	3.4	3.0	2.7	2.4	2.2	n/29.6	—	—
Township of Waterford	46.9	49.9	58.0	53.2	72.9	105.8	137.4	145.4	71.0	62.4	56.9	60.4	920.2	—	—
OGEMAW COUNTY															
City of West Branch	7.5	7.8	4.3	6.7	7.8	8.8	9.3	9.9	8.4	b/12.4	8.2	7.5	98.6	—	—
OSCEOLA COUNTY															
City of Evart	59.0	52.3	54.6	51.3	50.9	51.9	53.8	63.2	54.1	52.8	44.8	42.6	631.3	2.390	.531

TABLE 2. REPORTED GROUND-WATER PUMPAGE, IN 1970. (IN MILLIONS OF GALLONS) -Continued

WATER USER	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	1970 TOTAL	MAX DAY	MIN DAY
OTSEGO COUNTY															
City of Gaylord	13.0	11.2	13.4	12.8	13.5	17.1	15.6	18.4	15.0	14.8	11.8	12.1	e/168.7	—	—
State Home at Gaylord	.7	.7	.8	.8	.8	.8	1.0	1.0	.9	.8	.8	1.0	10.1	.056	.006
OTTAWA COUNTY															
Village of Spring Lake	11.1	9.8	9.6	11.1	14.0	25.6	24.7	28.5	11.9	10.6	9.8	9.9	176.7	2.088	.084
City of Coopersville	4.5	4.3	5.1	4.4	5.8	5.3	5.3	6.1	4.4	4.9	4.8	4.6	e/59.5	.273	.122
PRESQUE ISLE COUNTY															
City of Onaway															
City of Rogers City	8.0	7.1	8.3	8.2	8.8	12.5	12.6	15.3	8.8	8.9	8.2	9.1	115.8	1.060	.164
SANILAC COUNTY															
City of Croswell	29.1	18.1	14.9	15.0	17.8	24.0	29.0	31.3	22.0	18.4	19.1	21.4	260.1	1.241	.219
City of Sandusky	15.4	15.2	16.1	15.5	14.7	15.5	17.0	21.9	17.5	15.7	13.0	13.5	191.0	.993	.253
SHIAWASSEE COUNTY															
City of Corunna	5.4	4.9	5.4	5.3	5.2	5.3	5.4	6.2	5.5	6.8	5.6	7.8	68.8	.484	.143
City of Durand	11.5	12.3	12.3	12.0	13.7	14.4	14.6	15.2	13.6	12.8	11.4	13.3	157.1	.741	.197
City of Owosso	64.0	56.1	55.0	69.0	84.4	100.6	96.7	107.4	90.3	89.1	79.5	81.5	973.5	4.422	1.248
City of Perry	2.8	2.5	2.7	2.6	3.6	3.2	3.1	3.7	3.8	4.1	3.3	3.1	38.5	—	—
ST. CLAIR COUNTY															
Village of Capac	3.0	2.6	2.9	2.9	3.2	3.2	3.3	5.0	4.1	3.4	2.9	2.9	39.4	.186	.046
City of Yale	4.0	3.5	3.9	5.1	7.1	5.1	5.2	5.1	13.6	5.9	4.5	4.7	67.7	—	—
ST JOSEPH COUNTY															
Village of Constantine															
City of Sturgis	48.2	44.1	48.5	47.5	52.6	56.6	61.6	66.5	55.2	49.3	42.7	45.4	e/618.2	3.114	1.002
City of Three Rivers	30.7	24.7	29.2	28.9	33.0	36.5	37.1	39.4	31.3	30.2	26.1	28.5	375.6	2.030	.329
TUSCOLA COUNTY															
State Hospital at Caro	7.4	6.8	8.1	6.7	e/7.0	e/7.0	7.3	6.9	6.4	5.3	4.9	4.9	e/78.7	.360	.110
Village of Cass City	6.0	6.7	6.4	6.8	e/7.0	e/8.0	8.3	9.0	7.6	7.7	7.2	6.7	e/86.4	.658	.144
VAN BUREN COUNTY															
City of Bangor	12.4	10.1	11.3	11.5	11.3	10.9	13.7	13.9	12.6	12.7	10.6	10.2	141.2	.644	.245
City of Hartford	9.2	9.6	9.0	9.4	9.8	12.6	12.8	12.5	13.7	9.9	7.0	4.8	120.3	.633	.108
Village of Lawton	17.4	13.1	11.7	13.7	14.3	17.3	7.4	19.4	27.4	30.9	14.9	14.3	201.8	1.962	.215
Village of Paw Paw	20.2	18.6	17.1	18.2	20.7	16.3	23.2	21.0	21.9	23.6	19.8	18.3	238.9	1.117	.346
WASHTENAW COUNTY															
City of Ann Arbor	104.6	63.6	76.4	23.3	50.0	103.1	66.9	91.0	60.1	26.6	63.3	71.3	p/800.2	—	—
Boy's Training School at Whitmore Lake	6.5	5.5	6.4	6.0	5.6	5.6	6.0	6.7	6.0	6.2	5.5	5.8	71.8	.567	.123
Cassidy Lake Tech. School	1.2	1.1	1.5	1.3	1.8	1.8	1.7	1.7	1.5	1.8	1.6	1.6	18.6	—	—
Village of Dexter	7.1	6.0	7.0	6.2	7.1	7.1	7.0	6.0	6.5	7.0	6.0	6.1	79.1	—	—
Village of Manchester	8.0	7.8	8.3	9.8	10.2	9.1	10.2	11.3	10.3	11.4	9.4	9.7	115.5	.860	.089
City of Saline	16.0	14.4	15.9	17.1	21.8	24.0	24.0	31.1	27.0	23.4	21.6	17.2	253.5	1.515	.305
City of Ypsilanti	109.0	102.0	111.0	109.0	102.0	96.0	95.0	101.0	94.0	100.0	114.0	93.0	1,226.0		
Township of Ypsilanti	238.2	200.0	209.7	240.6	271.5	259.1	257.0	269.0	230.0	159.8	180.1	255.0	2,806.0	14.153	4.612
State Hospital at Ypsilanti	20.9	18.4	20.8	20.7	22.0	21.7	23.2	25.1	19.5	18.5	18.5	16.8	246.1	.748	.306
WAYNE COUNTY															
State Hospital at Northville	15.8	14.4	16.0	14.9	15.7	15.2	15.8	16.0	15.9	16.3	16.2	18.2	190.4	.748	.312
City of Plymouth	91.7	85.1	92.4	93.5	101.7	106.8	93.5	111.6	99.0	92.0	87.8	83.9	1,139.0	4.870	—
Plymouth State Home & Training School at Northville	10.1	9.7	11.2	8.2	9.2	5.0	— Converted to Plymouth water system						53.4	.260	.046
WEXFORD COUNTY															
City of Cadillac	51.1	47.6	52.4	48.1	65.9	71.7	81.8	87.5	62.7	62.9	41.7	56.1	729.5	5.601	1.612

NOTES

NA) Not available.

a) Quarterly figures.

b) Water lost due to broken main.

c) Estimate for year.

d) All that was metered-more pumped.

e) Wholly or partly estimated.

f) Also pumped 651 million gallons from the Pine River.

g) Also pumped water from Baw Beese Lake.

h) Use of wells discontinued.

k) Use Ranney collector system at Chippewa River site.

m) Annual total based on sales figures.

n) Also used water from Detroit system

p) Also pumped 4,626 million gallons from the 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 "Geological and Water-Supply Reports and Maps--Michigan". Price lists of available publications of the Michigan Geological Survey are available from that agency.

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