WATER SUPPLY REPORT NUMBER THREE

STATE OF MICHIGAN

DEPARTMENT OF CONSERVATION
Gerald E. Eddy, Director

GEOLOGICAL SURVEY DIVISION
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SUMMARY OF GROUND-WATER CONDITIONS IN MICHIGAN

1958

By

P. R. Giroux and Ted Thompson
U. S. Geological Survey

Prepared in cooperation with the
United States Department of the Interior
Geological Survey

CONTENTS

CONTENTS (Continued)

ILLUSTRATIONS AND TABLES

Figures | Page

Figures | Page

Tables

SUMMARY OF GROUND-WATER CONDITIONS IN MICHIGAN 1958

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INTRODUCTION

This report is the third of a series covering ground-water levels and related hydrologic data in the State of Michigan. It summarizes and interprets, in part, the results of the program of measurement of ground-water levels and the collection of other pertinent hydrologic information by the United States Geological Survey. This program is a part of the overall water-resource investigations carried out in cooperation with the Geological Survey Division of the Michigan Department of Conservation.

Cooperative ground-water investigations by the U. S. Geological Survey in Michigan are directed jointly by P. E. LaMoreaux, Chief of the Ground Water Branch, U. S. Geological Survey, Washington, D. C., and W. L. Daoust, State Geologist, Michigan Department of Conservation, Lansing, and are supervised by Morris Deutsch, District Geologist, U. S. Geological Survey, Lansing.

Records and interpretations of water levels and artesian pressures from 1935 through 1955 have been published in the annual series of U. S. Geological Survey Water-Supply Papers entitled "Water Levels and Artesian Pressures in the United States". The following tabulation lists the papers containing water-level data for Michigan:

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

Beginning in 1956, the U. S. Geological Survey discontinued publication of its series of annual reports and is now publishing, at 5-year intervals, a reduced number of water-level records without interpretive text or illustrations. The needs of the State, however, require more detailed and current ground-water information and, as a result, the first of the present series of Water Supply Reports was published by the Department of Conservation in 1957. These reports are designed to supplement data contained in the Federal report and also provide interpretive text and illustrations. By means of these ground-water summaries, basic information concerning ground-water conditions in Michigan are made readily available to the public.

Objectives of the Observation-Well Program

The observation-well program in Michigan is part of a nation-wide program the purpose of which was summarized by Sayre (Water-Supply Paper 1404, 1957) as follows:

"The objectives of the observation-well program are to provide a day-to-day evaluation of available ground-water supplies, to facilitate the prediction of trends in ground-water levels that will indicate the probable status of important ground-water supplies in the future, to delineate present or potential areas of detrimentally high or low ground-water levels, to aid in the prediction of the base flow of streams, to determine the several forces that act on a ground-water body, and to demonstrate the interplay of those forces in the ground-water regimen, to furnish information for use in basic research, and to provide long-term continuous records of fluctuations of water levels in representative wells. These selected records serve as a framework to which many short-term records collected during an intensive investigation may be related."

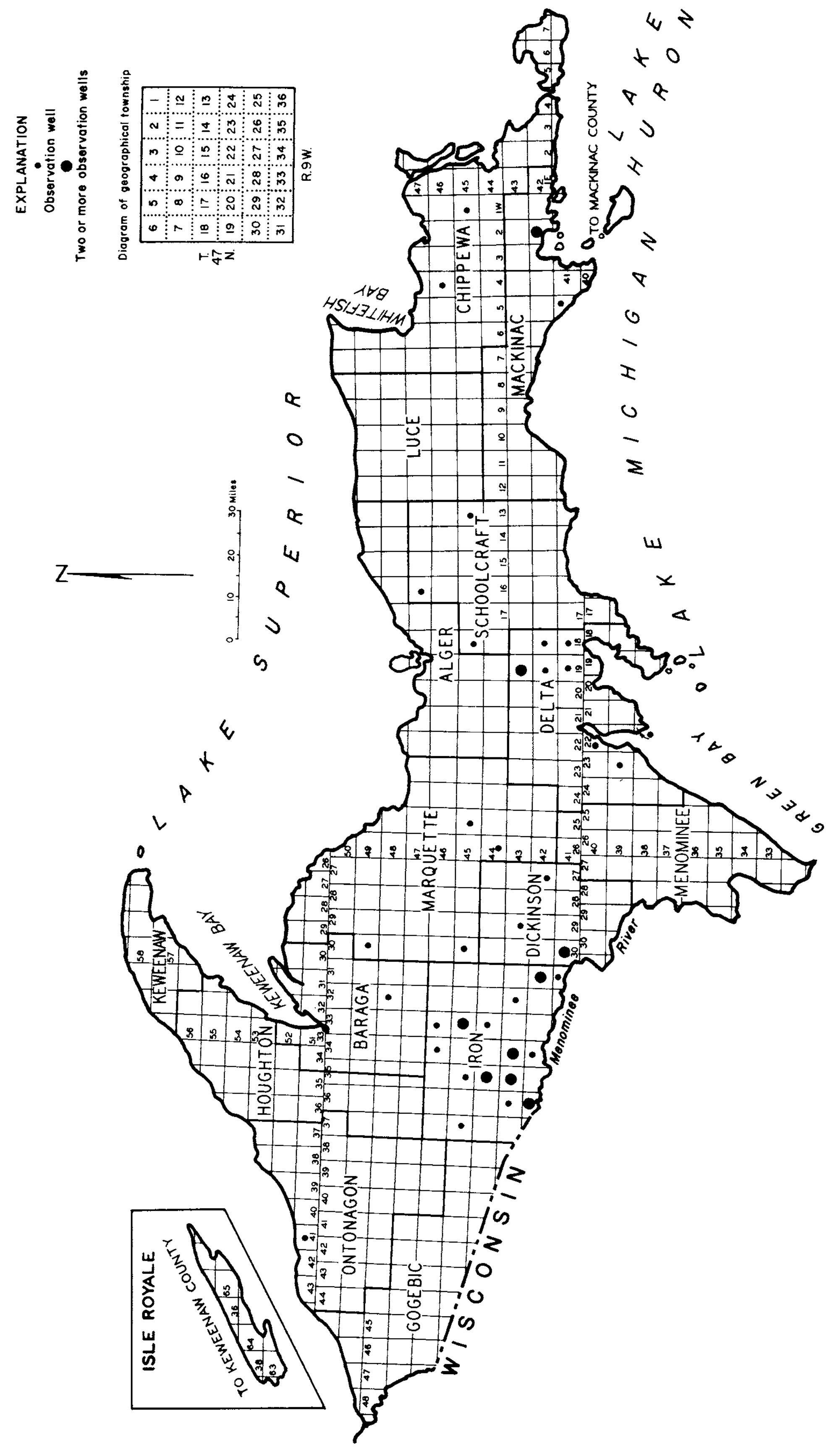
Scope of this Report

This report is based on periodic measurements of water levels made during 1958 in 207 wells of which 33 were equipped with continuous recording gages. Measurements were discontinued at the end of 1957 in a number of observation wells finished in the shallow drift aquifers of the northern half of the Southern Peninsula, as the long period of record permitted selection of representative wells for retention on the basis of areal coverage, usefulness, and length of record. The report summarizes water-level changes observed throughout the State, and analyzes these changes in selected areas. The geographic distribution of wells in which water levels were observed in 1958 is shown in figure 1.

Table 1 lists reported monthly and annual ground-water pumpage for various municipalities, institutions, and industries in the State. Table 2 lists the basic information for each observation well, and the extremes of water-level fluctuations in 1958 and for the period of record. Fluctuations of water levels in representative wells are shown by numerous hydrographs, and in many cases graphic interpretations of the changes in water levels are made by including pertinent climatic or pumpage data.

Open-File Records

Complete tabulations of water-level measurements and hydrographs for each observation well, 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-resources reports are on file for public inspection. They may be examined at the Michigan district office of the U. S. Geological Survey, Ground Water Branch, 407 Capitol Savings and Loan Building, Lansing,


EXPLANATION
Observation well
Two or more observation wells
Diagram of geographical township
T. 47 N.
R.9W.
0 10 20 30 Miles
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
GREEN BAY
WHITEFISH BAY
KEWEENAW BAY
WISCONSIN
Menominee River
ISLE ROYALE
TO KEWEENAW COUNTY
TO MACKINAC COUNTY
KEWEENAW
HOUGHTON
ONTONAGON
GOGEBIC
BARAGA
IRON
MARQUETTE
DICKINSON
MENOMINEE
ALGER
DELTA
SCHOOLCRAFT
LUCE
MACKINAC
CHIPPEWA

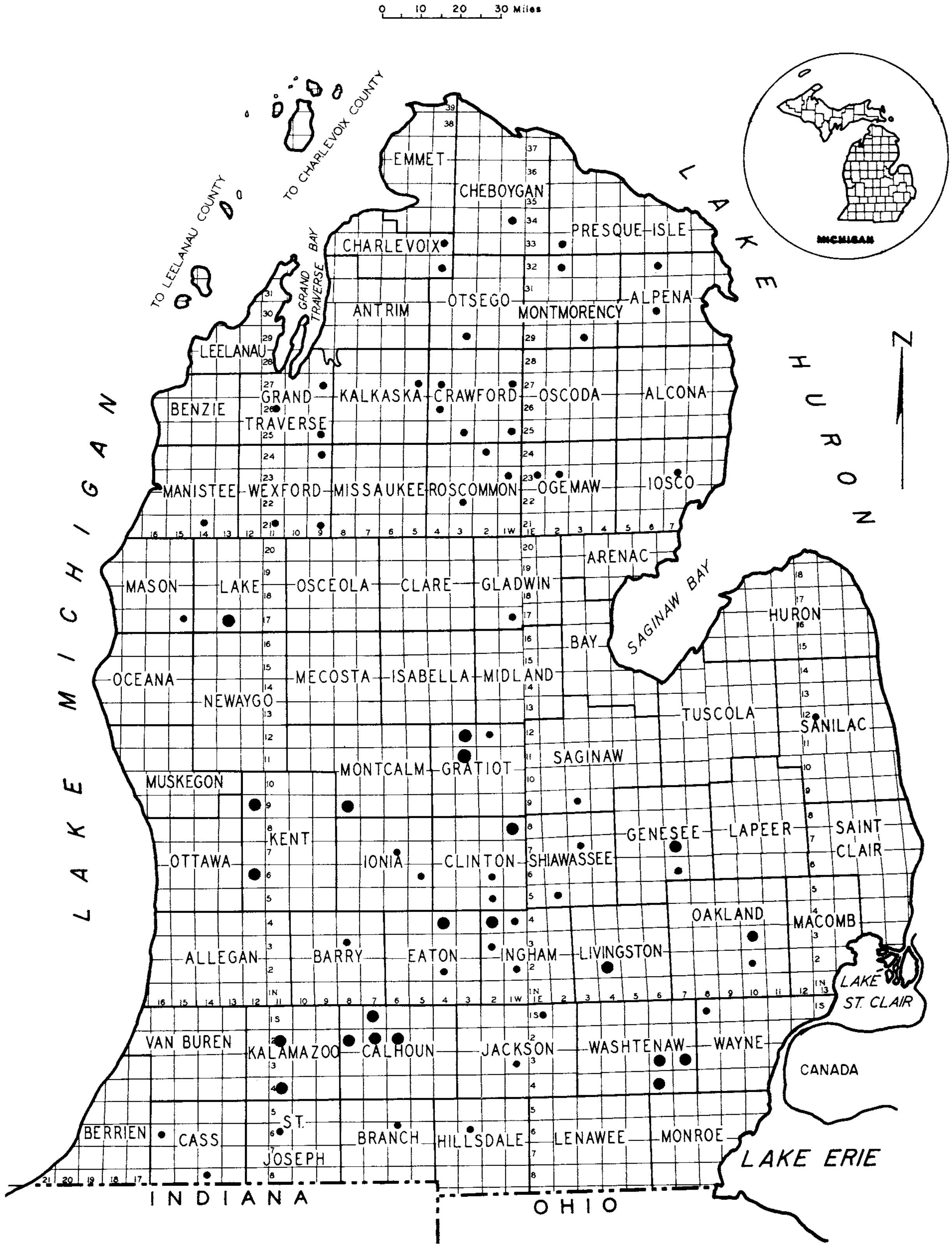


Figure 1. Location of observation wells in Michigan.

or at the Water Resources Section of the Michigan Geological Survey, 4th floor, Mason Building, Lansing. Records for the Northern Peninsula are kept on file also in the office of the Michigan Geological Survey, 203 State Office Building, Escanaba.

U. S. Geological Survey water-supply papers are for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., or can be consulted at the offices listed above or in major university and municipal libraries. The Federal Survey also issues a monthly publication entitled "Water Resources Review" which summarizes ground-water levels and streamflow throughout the United States. The monthly issues plus spring and annual summaries can be obtained free of charge by application to the Director, U. S. Geological Survey, Washington 25, D. C.

Progress reports of cooperative ground-water investigations covering specific areas of the State are published from time to time by the Michigan Department of Conservation. These reports are also available for inspection at the offices listed above. If not out of print, they can be purchased from the Michigan Department of Conservation, Publications Room, Mason Building, Lansing 26, Michigan. A list of publications including prices for each also can be obtained. During 1958 the following Progress Reports were published: No. 17, "Reconnaissance of the ground-water resources of Chippewa County, Michigan"; No. 19, "Reconnaissance of the ground-water resources of Mackinac County, Michigan"; and No. 20, "Summary of ground-water investigations in the Holland area, Michigan".

Well-Numbering System

The well-numbering system now used by the State and Federal Surveys in Michigan indicates the location of wells within the rectangular subdivision of the public lands with reference to the Michigan meridian and base line (fig. 1). The first two segments of a well number designate township and range; the third segment designates both the section and the well within the section. Thus, well number 32N 6E 16-1 is well number 1 in section 16, Township 32 North, Range 6 East. In the several small areas of the State where the rectangular subdivisions have not been made, wells are numbered as above by projection of the rectangular subdivisions to those areas.

Acknowledgments

Acknowledgment is made to personnel of Federal and State agencies, industrial concerns, municipalities, and public utilities who serve as voluntary water-level observers, and whose continuing effort has contributed to the accumulation of the basic data presented in this report.

Appreciation is also extended to Messrs. J. G. Rulison, Chief, Water Resources Section, Lansing, and A. E. Slaughter, Geologist, Escanaba, of the Michigan Geological Survey, for their assistance in the original planning and editing of this report series.

PRECIPITATION AND TEMPERATURE

Total precipitation in Michigan during 1958 was deficient over all the climatological divisions as defined by the U. S. Weather Bureau. Deficiencies ranged from about 1 inch in the western upper division to nearly 9 inches in the southwest and southeast lower divisions of the State, and locally in the Southern Peninsula total annual precipitation was the lowest of record. Widespread deficiencies were recorded by the Weather Bureau during the period January through June and in October and December. Wide variations in total rainfall were observed at stations throughout the State. The lowest annual total of 15.86 inches was recorded at Mt. Clemens Air Force Base in Macomb County, while 40.45 inches fell at Bergland Dam in Ontonagon County, one of the few stations reporting greater than average precipitation.

Mean annual temperatures throughout the State were below average. Winter, spring, and early fall temperatures, however, were warmer than average with most of the below-average temperatures occurring during the summer months. The coldest December of record was recorded at most stations in the State. Both the high and low temperature extremes for the year occurred in the western half of the Northern Peninsula. A low of -41°F. was recorded at the Kenton National Forest Station in Houghton County in February, and a high of 95°F. at the Huron Mountain Station in Marquette County. Below zero temperatures were recorded at every Weather Bureau station in the State during mid-February.

Several illustrations in this report include graphs showing the cumulative departures of annual precipitation from the long-term mean. These graphs were constructed by using the "zero" or "average" line to denote the average precipitation for the period of record preceding the period of the graph.

Starting at this line the excess or deficiency of precipitation for each year is added algebraically to prepare the cumulative departure graph. Thus, for each year, a line sloping downward always indicates below-average precipitation and a line sloping upward, above-average precipitation. In cumulative graphs such as these, the slope of the line is the important part--that is, even where the graph is far below the zero line, if the slope is upward the period is one of above-average precipitation. The end point of the graph thus also gives the total rainfall above or below the average for the entire period of the graph. In addition, some of these illustrations contain bar graphs showing departure from average precipitation for each year.

PRINCIPLES AND SUMMARY OF GROUND-WATER OCCURRENCE

The initial source of most ground water is precipitation, and the average annual precipitation over Michigan is about 30 inches. However, much of this water is lost by evaporation, transpiration, and surface runoff before it can enter the underground reservoirs. The amount of precipitation which becomes ground water in any area is influenced by a number of factors: the duration, intensity, and type of precipitation; the density and types of vegetation; the topography; and the porosity, permeability, and degree of saturation of the soil, subsoil, and underlying rock formations.

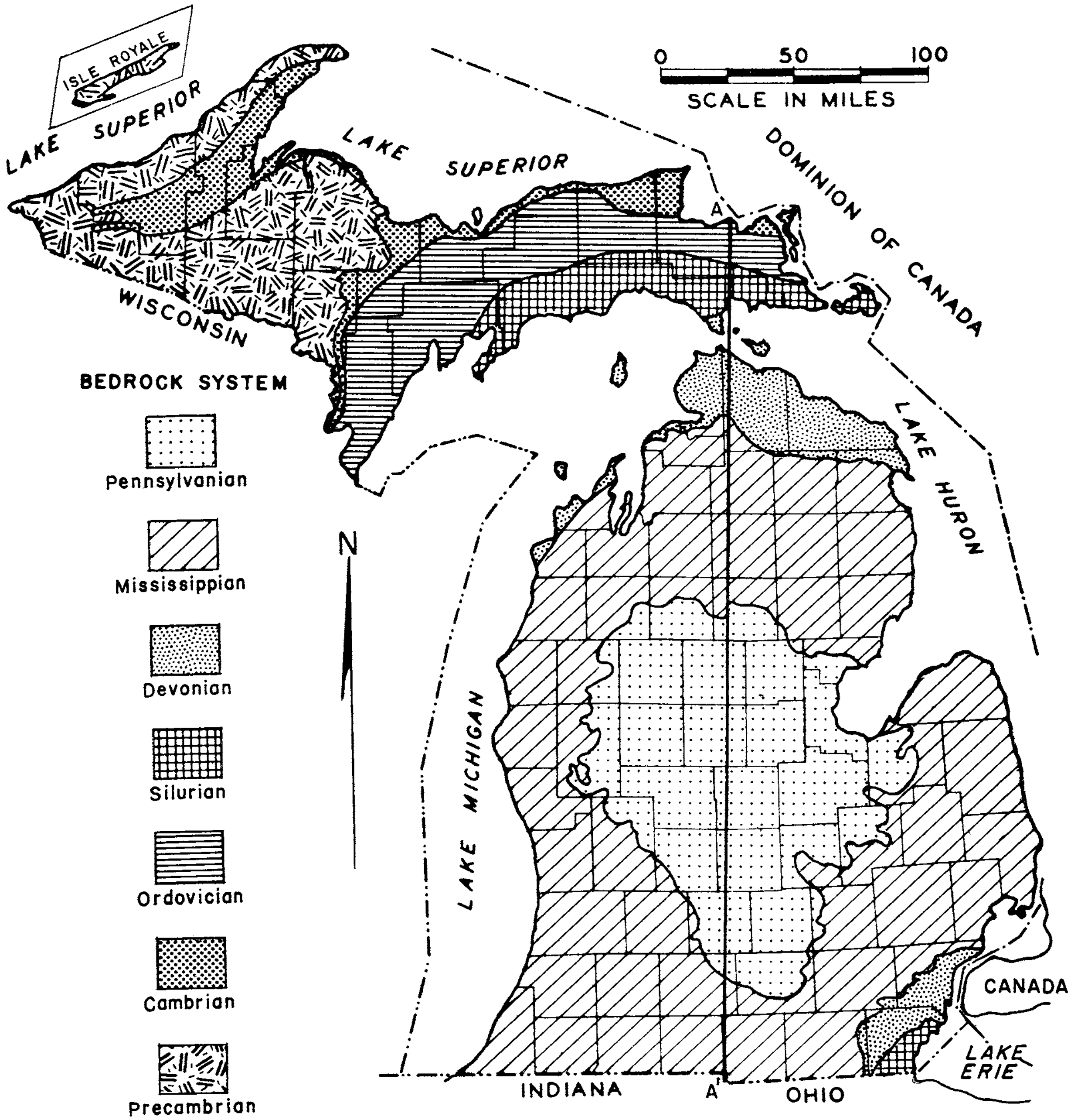
Fresh ground water can be obtained throughout most of Michigan by wells drilled into one or more of the numerous aquifers of the State (table 2). An aquifer is a geologic formation or structure that transmits water in sufficient quantity to supply pumping wells and springs. In some areas of the State, ground water is relatively difficult to obtain, and aquifers yielding only a few gallons per minute of water or less, are of considerable importance. In other areas where aquifers may yield several hundred gallons per minute, formations capable of yielding small amounts may be classed as non-productive.

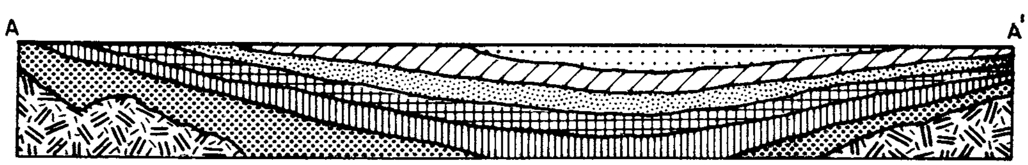
Aquifers may be classified as water table or artesian. In a water-table aquifer ground water is unconfined and the upper surface of the saturated zone is termed the water table. In an artesian aquifer ground water is confined between relatively impermeable strata (strata through which water does not move readily) and is under artesian pressure. The water in a tightly cased well finished in an artesian aquifer will rise above the bottom of the upper confining bed, and, if under sufficient pressure, will flow at or above land surface.

The movement of ground water is somewhat similar to that of surface streams in that the water moves by gravity from high to low levels. Percolation of water through the pores, crevices, and minute interstices between rock particles below the surface generates a large amount of friction and hence is much slower than flow of water upon the surface. Rates of ground-water movement range widely, from a few feet per year to many feet per day. Water may travel great distances underground from recharge areas (areas where precipitation can infiltrate into a ground water reservoir), to areas downgradient where it may once more reach the surface and join the flow of streams, appear as a seep or spring, enter a lake, or escape directly to the atmosphere by means of evaporation and transpiration.

In Michigan, water-bearing rock formations are commonly classified into two broad categories; namely, bedrock and glacial drift aquifers. The bedrock or consolidated rock aquifers include both the igneous and metamorphic rocks of Precambrian age which form the bedrock surface in much of the western half of the Northern Peninsula and the sedimentary rocks of Paleozoic age which overlie the Precambrian rocks elsewhere in the State (fig. 2). Over all but 2 or 3 percent of the area of Michigan the bedrock is mantled by glacial drift or unconsolidated rocks of variable thickness deposited by various processes of glaciation during the Pleistocene epoch or Ice Age.

The Precambrian rocks commonly are very dense, and hence of low permeability. Where the rock is fractured, broken, or creviced, and connected with a source of recharge, water may circulate through these secondary openings, and be intercepted by wells drilled into such zones. Where mine shafts penetrate such permeable zones and are not dewatered, they are essentially large diameter wells.





Schematic geologic cross-section along line A—A'
(Vertical scale greatly exaggerated)

Figure 2. Geologic map of the bedrock systems of Michigan.

In the remainder of the State consolidated sedimentary rocks deposited by shallow seas during the Paleozoic era form the bedrock surface. These consolidated sediments consist of strata of limestone, dolomite, shale, sandstone, and breccia and are commonly interbedded with layers of evaporites such as rock salt or gypsum. Although these rocks were deposited in nearly horizontal layers, gradual subsidence and compaction of the beds produced a bowl-shaped structure (fig. 2). The youngest beds are exposed at the surface in the central part of the structure and the formations crop out in roughly concentric bands.

The chief sedimentary rock aquifers are composed primarily of sandstone, limestone, or dolomite. In a sandstone aquifer water moves through voids between individual sand grains and also along joints, other fractures, and bedding planes. Movement of water in limestone and dolomite aquifers is predominantly through cavities, fractures, and fissures developed by weathering and solution. Layers of shale are of low permeability and yield little water to wells. They are significant in the hydrologic system, however, because they impede vertical movement of ground water, and hence retard solution in underlying soluble rocks, and also act as confining beds in artesian systems.

In general most of the fresh water in the sedimentary rock aquifers is in the portions of the formation where they form the bedrock surface or are close to the surface. Where they are buried at depth beneath younger Paleozoic rock formations the water present is generally saline. For example, the Marshall formation is the principal source of fresh ground water at Battle Creek in Calhoun Co., where it forms the bedrock surface, but in Gratiot Co. where it is overlain by the Saginaw formation it yields saline water. The Trenton and

Black River limestones are a major source of fresh water in Delta County in the Northern Peninsula, but in various areas of the Southern Peninsula, where these formations are present at great depth, they produce gas, oil, and brine.

Glacial drift as great as 1,000 feet in thickness was deposited on the Precambrian and Paleozoic bedrock surface during the Pleistocene epoch following a long period of erosion prior to the glacial age. During the erosional period, which began at the close of the Paleozoic Era and lasted until the Pleistocene, a considerable volume of consolidated rock was removed and some of the major physiographic features of Michigan, including the major valleys which are now part of the Great Lakes, were formed. The glacial drift comprises important aquifers and, in general, are the most accessible aquifers in many areas of the State. The water in these aquifers is contained in the voids between rock particles. The drift material was deposited primarily by ice, meltwater streams, lakes, and wind action during the glacial epoch. The best aquifers consist of water-laid sand and gravel outwash deposits. Till is generally unstratified drift that was deposited directly by the ice, with water playing a minimum part in the process of deposition. Till deposits are not important as aquifers in most of the State as they contain large percentages of silt and clay which fills the voids between the larger rock particles. In the Lake Superior area, however, the till deposits are locally good sources of water as commonly they are composed largely of sand and gravel with little clay and silt. Also included within the glacial drift are large quantities of clay, silt, and fine sand deposited in the waters of the numerous extinct glacial lakes. Most of these deposits comprise rather poor aquifers in Michigan except locally where they are composed chiefly of fine sand and will yield small amounts of water to wells. Extensive dunes composed of well-sorted sand deposited by wind action during late and post-glacial times are present in various areas of the State, especially along the Great Lakes shorelines. Although permeable, they are not important as aquifers as they generally lie above the regional water table.

Causes of Water-Level Fluctuations

Water levels in wells are almost continually changing with movement up or down varying from fractions of an inch per day to many feet in a short time. Water levels are influenced by many factors, including direct recharge from precipitation (fig. 7), pumping from nearby wells (fig. 17), evaporation and transpiration of water by vegetation, and by changes in water levels in nearby streams and drains (figs. 10, 14). In artesian wells, changes in water level or artesian pressure may occur quickly over large areas as the result of pumping or changes in pumping rate (fig. 18). Temporary influences on the levels in artesian wells result from changes in atmospheric pressure, earthquakes, earthtides, and other factors (fig. 15).

Climatic Influences

Water levels fluctuate with seasonal changes in the rate of recharge to, and discharge from the aquifers (fig. 9). During the spring thaw, water levels in wells normally rise in response to recharge from infiltration of rain and melting snow. Summer temperatures cause an increase in evapotranspiration resulting in declines in water levels. Rainfall during the growing season generally has slight effect on the rate of decline as vegetation tends to utilize most of the available moisture.

Water from rains of high intensity and short duration, common in the summer months, tends to run off to surface streams. In the fall, after killing frosts end the growing season and transpiration ceases, precipitation may cause rises in water levels. However, the usual decline in stage during the summer may be accelerated by a deficiency of precipitation (fig. 9) or may be continued into the fall by an early general freeze which tends to impede infiltration.

In much of the State in 1958, conditions were most favorable for ground-water recharge during March, April, and November. Warm temperatures accompanied by thawing of the snow cover in the early spring resulted in some recharge despite deficient precipitation. However, the spring rise of water levels was generally below average and many of the observed levels dipped to below average stages for that time of the year (figs. 3, 4). At the start of the growing season declines began with water levels at already low stages and in most wells levels remained below average for the rest of the year. Cool temperatures during the summer months, however, helped to moderate the seasonal declines. Some recharge occurred in the fall, especially in November, when unseasonably warm weather and above-average precipitation occurred. Due to the record or near-record deficiencies of total annual precipitation, ground-water levels in many wells fell to new lows of record during the latter part of the year.

Pumping Influences

Generally, ground water is a renewable natural resource as it is intermittently or continually being replaced directly or indirectly by precipitation. If an aquifer is to be developed by means of wells so that a long-term yield can be obtained without substantially dewatering the aquifer, then equilibrium must exist between the rate of recharge to and the rate of discharge from the aquifer. Any aquifer in its natural state (before it is tapped by wells) is in approximate dynamic equilibrium. When water is discharged from an aquifer by means of a well, an increase results, at least temporarily, in the rate of total discharge from the aquifer. Pumping causes a cone-shaped depression in the water table or piezometric surface that expands with time around the discharging well. With continued discharge, the cone of depression will continue to expand until the resultant lowering of water levels causes a decrease in discharge from the aquifer, or an increase in recharge to the aquifer, or a combination of both, which restores the aquifer to a state of equilibrium.

Wells within the cone of depression are affected by the lowering of water levels or artesian pressures. Thus, a well tapping an aquifer may be affected by the discharge of other wells that tap the same aquifer. In the case of several or many discharging wells, a composite cone of depression results that may extend over a large area. The result of the lowering of water levels over a large area may cause a considerable increase in the rate of recharge to, or a considerable decrease in the rate of natural discharge from the aquifer. A lowering of the water level, therefore, is necessary in the utilization of an aquifer.

Withdrawals of ground water by some of the municipalities, institutions, and industries in the State are discussed under the various county headings below. Reported monthly and annual pumpage totals are listed in table 1. Many of the wells listed in table 2 were selected for observation because their water levels respond to pumping influences. Graphs to show the effect of pumping on the water levels in nearby observation wells are used in some of the illustrations. Municipal pumping was very high in May probably due to increases in lawn sprinkling as soil moisture was deficient following an unusually dry winter and early spring. Increases in urban populations combined with deficient precipitation during the year resulted in increased withdrawals of ground water and some communities reported record-high pumpage. In most areas demands for water during the summer were reduced somewhat because of cool and wet weather.

Table 1.--Reported ground-water pumpage by some Michigan municipalities, institutions, and industries.-
(in millions of gallons)

Owner	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	1958 Total
Alger County													
Burt Township (Grand Marais)	1.1	1.1	1.3	1.4	1.4	1.4	1.5	1.6	1.4	1.3	1.1	1.1	15.7
Branch County													
City of Coldwater	33	30	32	34	53	46	48	50	44	38	35	34	477
Calhoun County													
City of Battle Creek	237	204	230	268	365	307	387	402	337	313	280	281	3,611
Battle Creek Township	24	20	25	30	52	35	46	44	27	30	26	20	379
City of Marshall	24	28	28	27	27	34	41	42	35	33	35	30	384
Cass County													
City of Dowagiac	13	15	18	13	24	28	23	27	12	9	10	16	208
Clinton County													
Village of Elsie													148
Crawford County													
City of Grayling	5.1	5.7	7.9	12.9	11.9	8.9	11.5	13.1	8.7	7.8	6.8	6.8	107.1
Eaton County													
City of Grand Ledge	11	13	13	13	17	16	16	18	15	14	13	14	173
City of Charlotte	26	25	26	27	34	31	30	36	31	30	27	20	343

					Genesee County								
Beecher Metropolitan District	17	16	17	16	20	19	21	21	18	18	17	19	219
Burton Township	4.5	8.8	9.2	11.1	15.2	13.3	15.3	15.3	12.7	12.9	12.2	11.9	142.4
City of Davison	6.1	7.2	9.2	8.4	11.1	8.1	11.9	13.6	9.7	8.3	6.2	7.2	107.0
Village of Flushing	6.5	5.5	6.5	7.0	9.8	8.0	8.7	9.0	7.2	6.5	5.6	5.9	86.2
Grand Blanc Fisher Body Plant	4.1	4.0	4.2	4.5	4.7	4.9	5.1	5.0	4.5	3.7	4.4	5.2	54.3
City of Mt. Morris	5.9	5.4	5.9	5.7	6.5	6.1	6.3	6.9	6.0	6.0	5.8	6.1	72.6
Village of Otisville	1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.0	0.9	0.7	0.8	0.8	11.3
					Gladwin County								
City of Beaverton	2.7	2.5	2.6	3.1	2.5	2.3	3.1	2.1	3.1	2.2	1.7	2.2	30.1
					Gogebic County								
City of Bessemer	11.2	9.9	11.1	10.5	10.9	11.1	11.6	11.9	11.3	13.3	11.0	13.1	136.9
					Gratiot County								
City of Alma	45	42	61	45	55	55	66	68	58	59	53	44	651
Village of Ithaca	3	3	4	4	4	5	7	8	7	6	4	3	58
City of St. Louis	28	27	28	24	27	27	29	30	26	23	23	23	315
					Hillsdale County								
a/City of Hillsdale	-	-	-	-	5	33	35	35	19	-	-	-	117
					Ingham County								
City of Lansing	495	456	486	469	575	515	560	546	507	460	476	505	6,050
City of East Lansing	31	28	30	36	52	31	40	38	31	36	32	31	416
Lansing Township	36	34	35	30	64	32	30	39	28	25	33	42	428
Meridian Township													e/100
City of Mason	10.0	9.4	10.6	10.4	13.7	12.0	11.5	13.3	11.6	11.2	9.4	10.9	134.0
Michigan State University	73	74	73	72	85	71	71	60	58	75	65	58	835

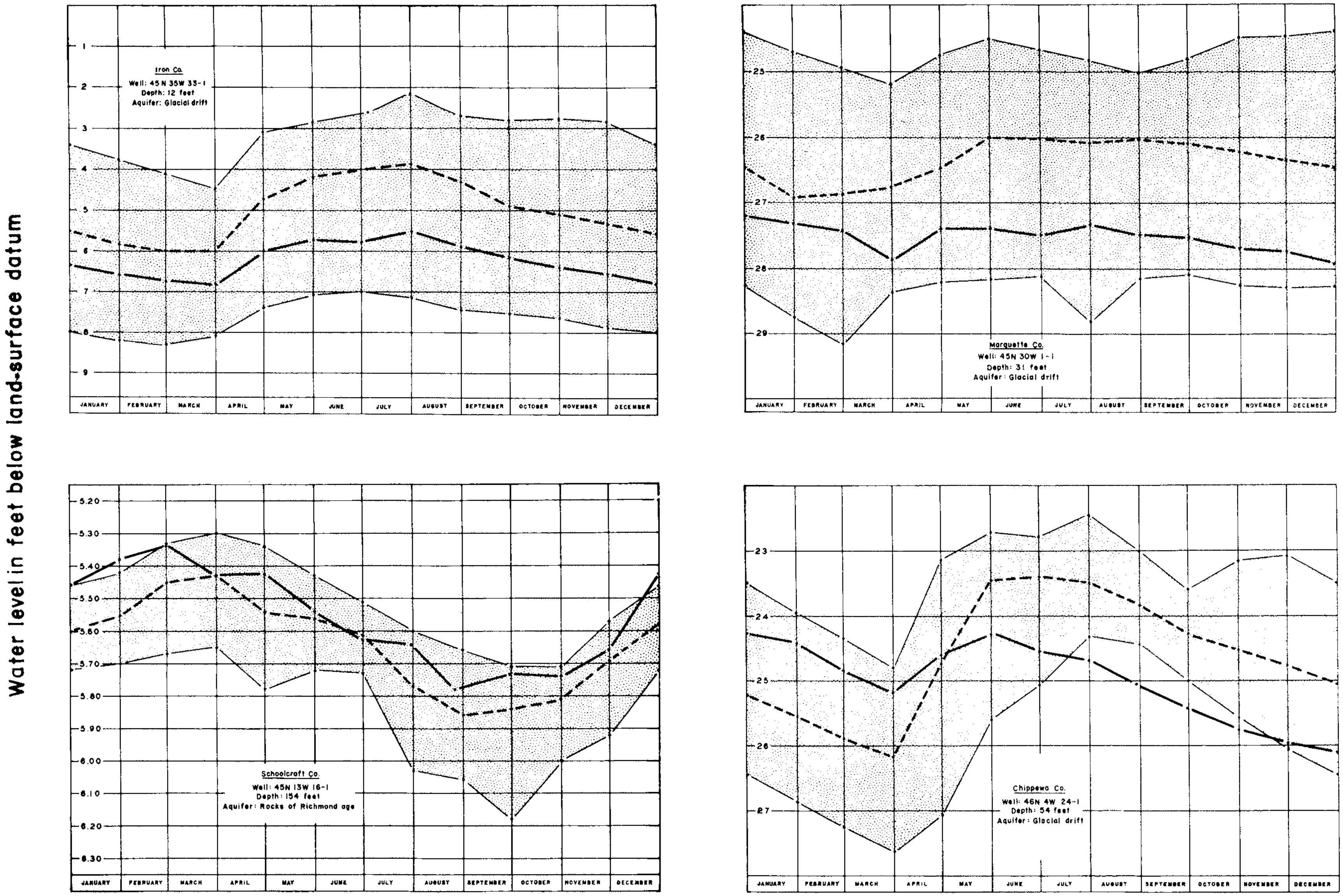
Table 1.--Reported ground-water pumpage by some Michigan municipalities, institutions, and industries. (in millions of gallons)--(Cont'd.)

Owner	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	1958 Total
Ionia County													
City of Ionia	31	28	27	25	31	27	31	35	30	32	31	31	359
City of Portland	8.3	7.8	8.8	8.3	11.4	9.4	11.0	12.5	9.6	9.1	7.6	8.1	111.9
Iron County													
City of Stambaugh	7.0	6.5	7.2	7.1	7.4	7.0	7.8	8.5	7.8	7.9	7.9	7.6	89.7
Jackson County													
City of Jackson	307	272	295	296	351	325	379	368	331	343	299	323	3,889
Kalamazoo County													
City of Kalamazoo	346	293	323	363	512	418	465	462	402	379	335	342	4,640
Kalamazoo State Hospital	19	17	17	17	19	18	19	20	18	e/17	e/17	e/17	e/215
Kent County													
Jervis Corp. at Grandville	8	8	4	6	4	3	8	7	7	12	12	13	92
Village of Sparta	10.8	9.9	12.5	9.0	9.9	11.3	15.0	13.2	10.8	9.7	9.7	11.1	132.9
Livingston County													
City of Howell	19	16	19	23	20	19	20	19	19	19	19	20	232
State TB San.	3.4	2.9	4.1	6.0	8.7	5.5	7.6	6.3	3.8	3.6	3.4	5.5	60.8
Montcalm County													
City of Greenville	41	28	34	36	45	40	56	59	43	58	59	30	529

Oakland County													
Cranbrook School	8	8	6	8	16	15	15	17	15	14	14	10	146
City of Pontiac	283	253	272	267	329	284	322	321	282	245	272	305	3,435
Ontonagon County													
Village of Ontonagon	4.9	5.3	4.8	3.9	5.0	4.7	4.9	5.3	4.8	4.9	5.0	5.8	59.3
Shiawassee County													
City of Owosso	62	59	64	69	94	74	83	88	72	70	65	66	865
Village of Perry	1.4	1.4	1.4	1.0	2.4	1.9	1.8	2.0	1.7	1.7	1.4	1.4	19.5
Washtenaw County													
a/City of Ann Arbor	49	45	61	50	80	69	133	124	98	91	86	74	960
Ypsilanti State Hospital	23	21	22	20	21	21	23	21	21	22	18	20	253
Ypsilanti Township	146	135	143	132	154	150	166	154	131	110	143	144	1,708

a/ Use surface water with supplemental ground-water supply.

e/ Estimated in part.



EXPLANATION

Levels in 1958

Average for period of record through 1957

Extremes for period of record through 1957

Figure 3. Month-end water levels in key observation wells in the Northern Peninsula.

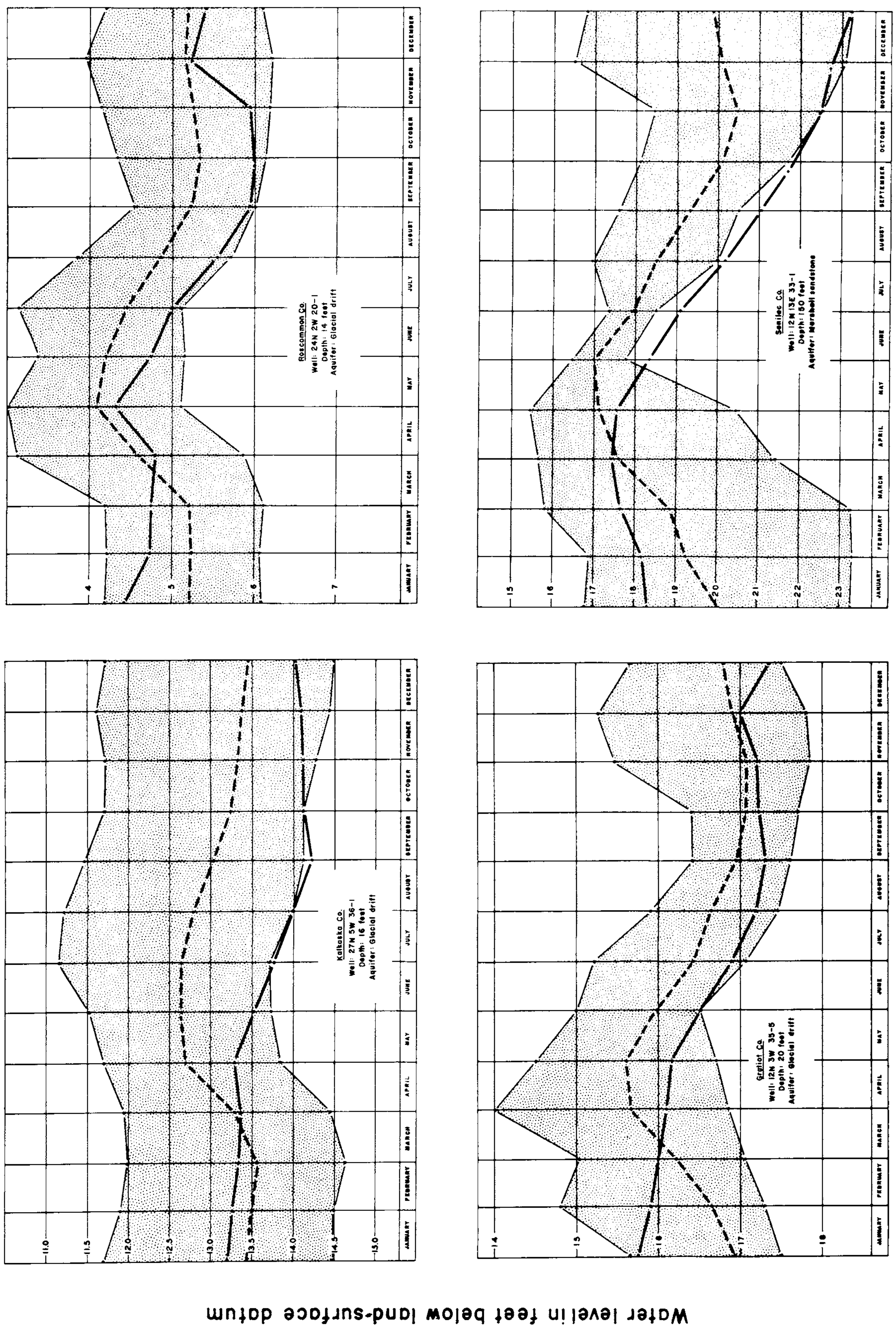
SUMMARY OF GROUND-WATER CONDITIONS

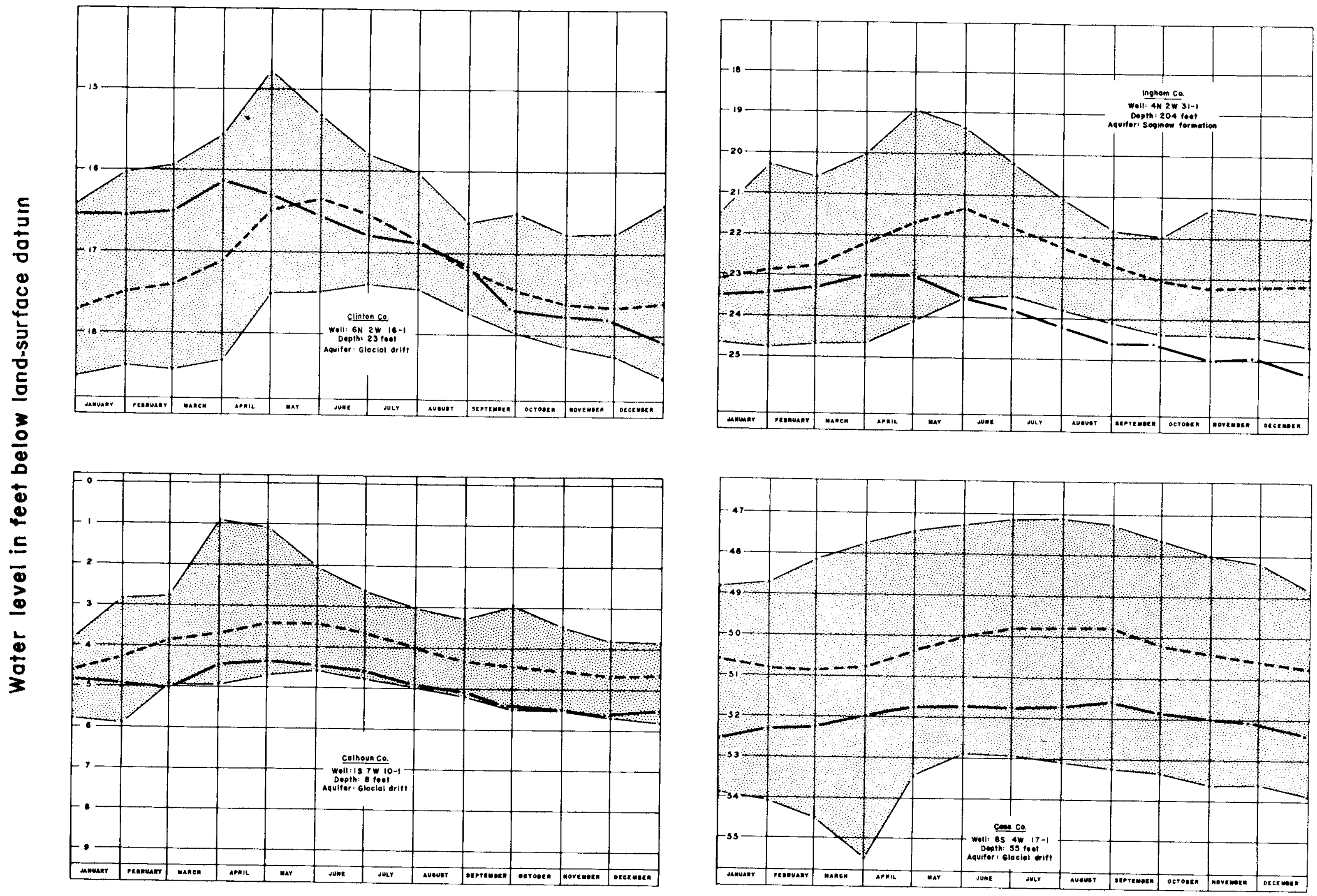
Statewide Changes in Natural Storage

Figures 3 and 4 show the hydrographs of month-end levels in 1958 and the extremes and average of month-end levels for the past record in selected observation wells in the State. These wells are located in areas of little or no pumping effect and reflect changes in aquifer storage primarily in response to natural climatic conditions. Records of ground-water levels that reflect natural climatic conditions serve as a basis for comparison with records of levels that are affected by pumping withdrawals.

In the Northern Peninsula water levels in key wells in the western portion (Iron and Marquette Counties, fig. 3) were at below-average stages throughout the year. In the eastern portion, high stages were recorded through April in the Chippewa County well, but during the rest of the year, stages were far below average. The record lows recorded during the period July through October are not especially significant, however, as the period of record for this well is relatively short (table 2). High stages prevailed throughout the year in the well in Schoolcraft County in contrast to those observed in key observation wells elsewhere.

In much of the Southern Peninsula above-average water levels were common during the winter, although in the southern and southwestern portions stages were below average. By early spring, however, water levels in all of the representative wells (fig. 4) were below average and remained at low stages for the rest of the year. The only exception occurred during August when the water levels in the Clinton County well attained an about-average stage. Record low stages prevailed during the latter half of the year in the Sanilac and Ingham County wells.


Roscommon Co.
Well: 24N 2W 20-1
Depth: 14 feet
Aquifer: Glacial drift
Kalkaska Co.
Well: 27N 5W 36-1
Depth: 16 feet
Aquifer: Glacial drift
Sanilac Co.
Well: 12N 13E 33-1
Depth: 150 feet
Aquifer: Marshall sandstone
Gratiot Co.
Well: 12N 3W 35-5
Depth: 20 feet
Aquifer: Glacial drift
JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
Water level in feet below land-surface datum



EXPLANATION

Levels in 1958

Average for period of record through 1957

Extremes for period of record through 1957

Figure 4. Month-end water levels in key observation wells in the Southern Peninsula.

Northern Peninsula

Western Half

Most of the wells presently observed in the western half of the Northern Peninsula are those maintained by the Wisconsin-Michigan Power Co. to evaluate ground-water storage and to aid in the prediction of stream flows in the Menominee River Basin. These wells are finished at shallow depth in glacial-drift deposits of Pleistocene age and reflect changes in natural storage in the water-table reservoirs.

Generally, water levels in the Menominee River Basin were above average at the beginning of the year and during the winter. Although precipitation was deficient during the winter, water levels did not decline at a greater than average rate owing to frequent thaws during the period. Spring rises in April were less than average, however, as precipitation continued to be deficient and little recharge occurred from snowmelt as the thawing in the winter period reduced the snow cover gradually. As a result of the small spring rises, water levels were at below-average stages in mid-April. Precipitation in May was near normal but most of the rain fell late in the month and was absorbed by the soil and transpired by vegetation and hence did not result in increases in ground-water storage. Heavy rains in late June and early July moderated the usual summer decline so that near average water levels prevailed in July. In August and September deficient precipitation resulted in a resumption of the summer declines and levels again fell to below-average stages. Precipitation in October and November was mostly in the form of rain and thus some recharge to the aquifer resulted. December was one of the coldest months of record and the freezing temperatures precluded any further appreciable recharge. Year-end levels were somewhat lower than at the end of 1957.

Figure 3 shows month-end water levels in 1958, with extremes and the average for the period of the past record for wells 45N 30W 1-1 and 45N 35W 33-1 in Marquette and Iron Counties, respectively. In these wells, however, the water levels were below average during the entire year.

Eastern Half

Chippewa County

Well 46N 4W 24-1 near Raco is finished in glacial drift, and reflects natural climatic conditions. The well is equipped with a continuous recording gage.

Figure 5 shows the hydrograph of month-end levels and monthly precipitation for the period of record. The hydrograph illustrates that peak stages of the annual cycle occur late in the spring or early summer, after which levels generally decline until early in the following spring. At that time spring rains and recharge from snowmelt result in the annual rise of water level. The long-term hydrograph shows that a slight declining trend occurred during the 1952 to 1956 period, and a rising trend in the period 1956 to 1958. However, in 1958 a new decline resulted from deficient precipitation. Figure 6 shows the daily plot of water levels from this well and weekly totals of precipitation during 1958. As a result of the less than usual spring rise year-end levels were nearly 2 feet below those observed at the beginning of the year.

A graph showing the month-end levels in 1958, as compared to the extremes, and average of month-end levels of the past record for this well is included in figure 3. The hydrograph shows that month-end levels dipped to below average in May and reached new lows of record during late summer and early fall.

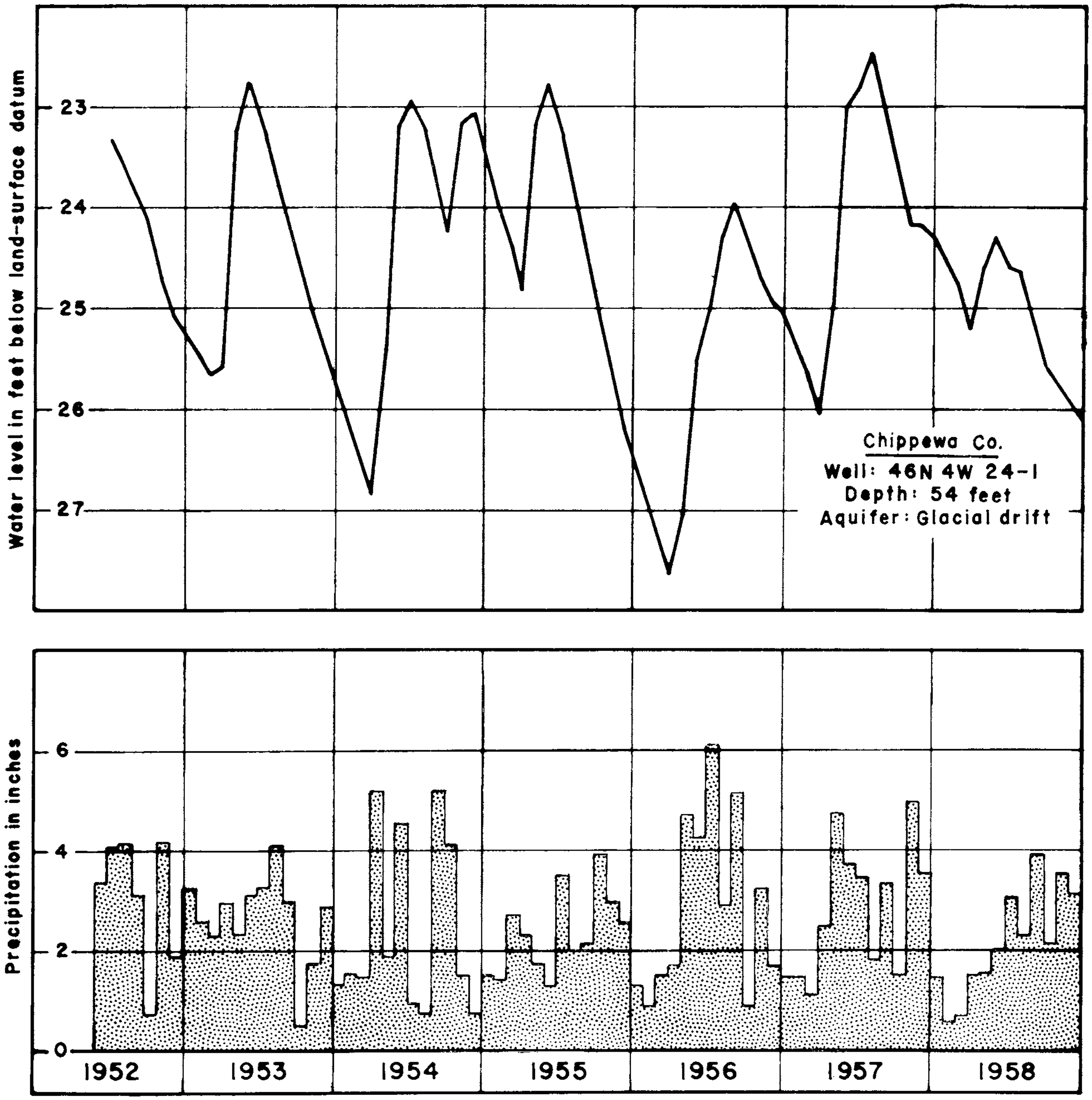


Figure 5. Hydrograph of month-end levels from recording gage on well 46N 4W 24-1 and monthly totals of precipitation at Sault Ste. Marie, 1952-58.

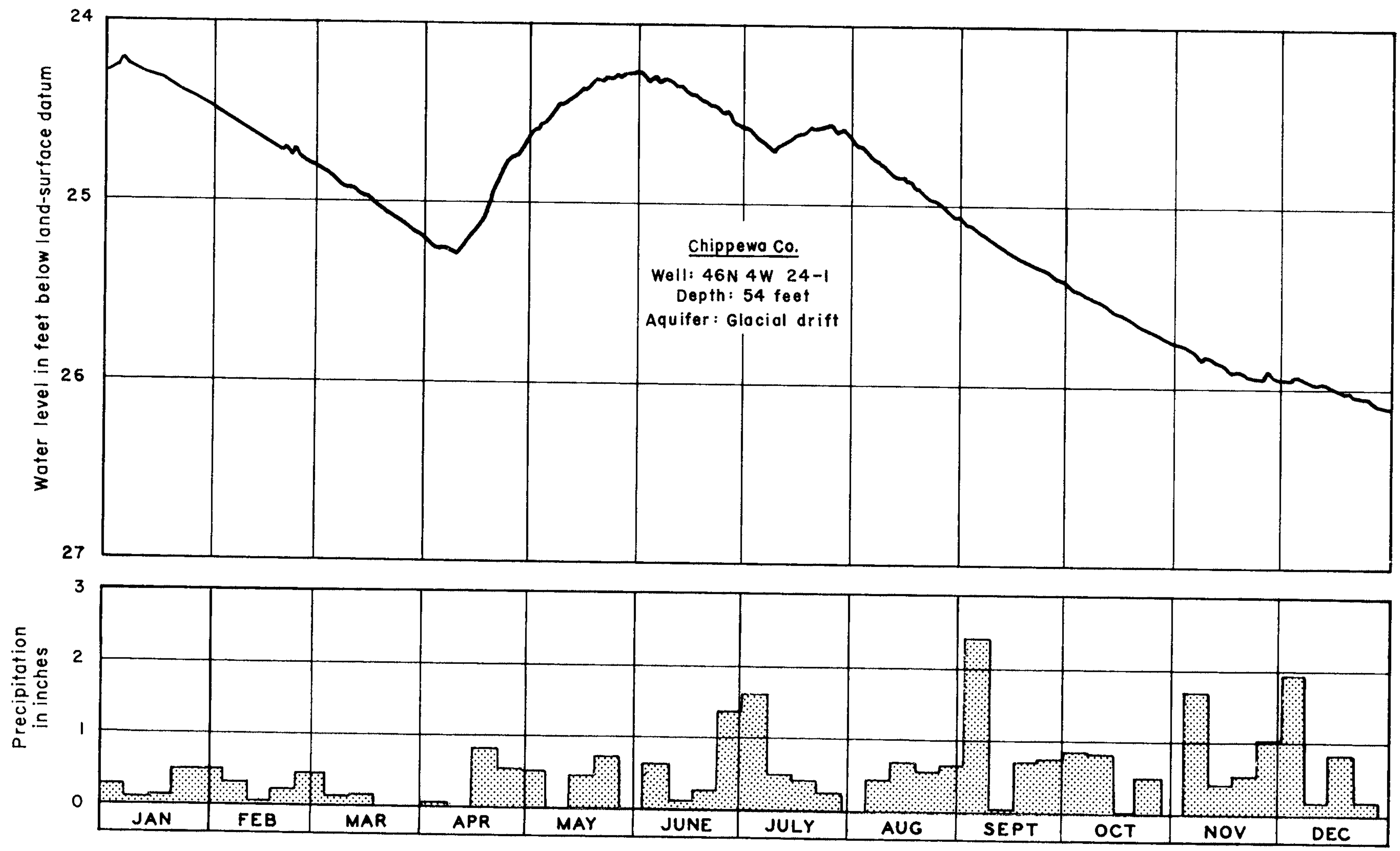


Figure 6. Hydrograph of daily levels at 2:00 a.m. from recording gage on well 46N 4W 24-1 and weekly totals of precipitation at Sault Ste. Marie, 1958.

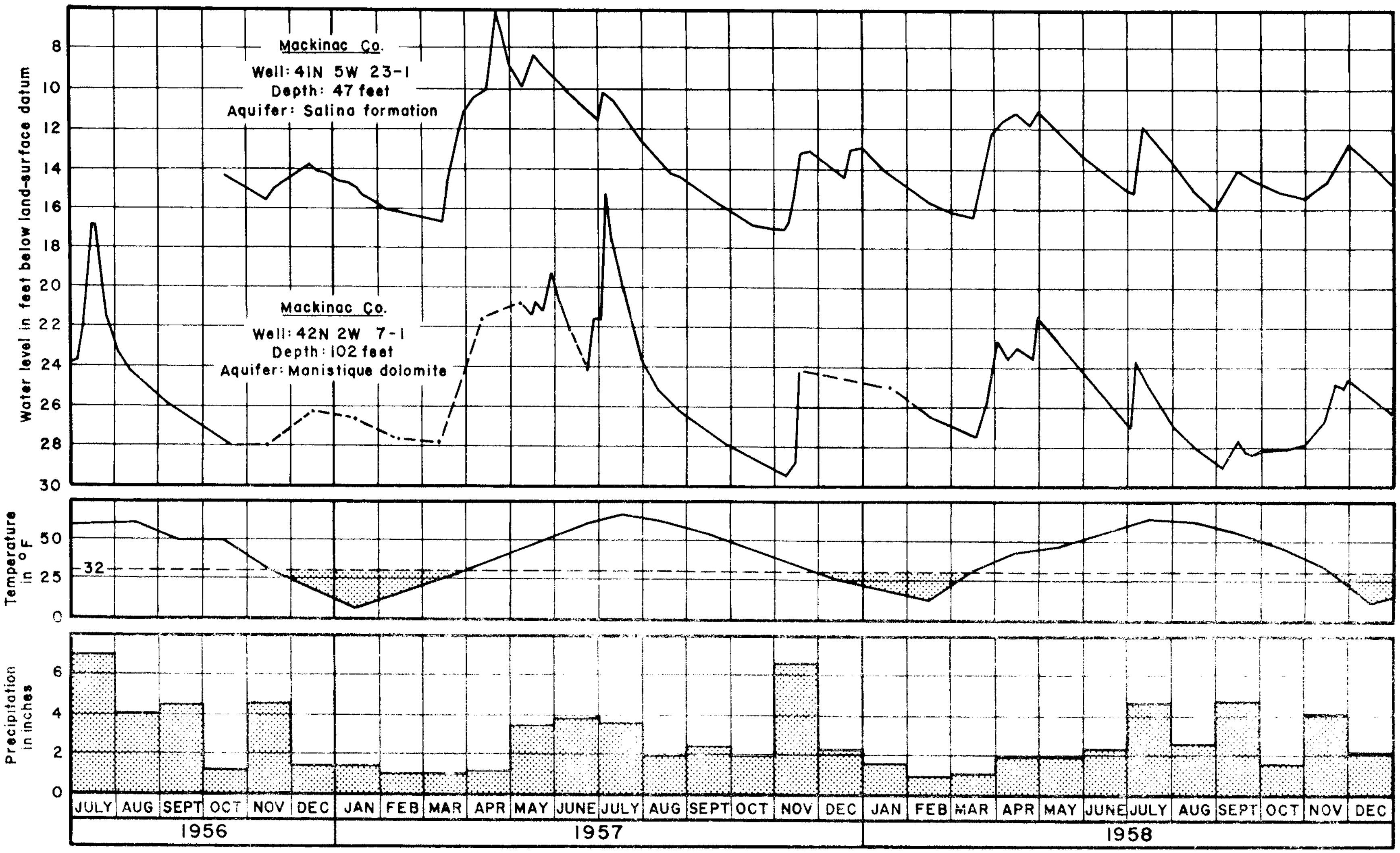


Figure 7. Hydrographs from recording gages on 2 wells in Mackinac County, monthly totals of precipitation, and monthly mean temperatures at Kinross, 1956-58.

Delta County

Observation of water levels was begun in a number of wells throughout Delta County during the summer of 1958 (table 2) as part of a ground-water reconnaissance investigation. Three wells were equipped with continuous recording gages. The water levels in these wells reflected changes in artesian pressure in various rock aquifers underlying the county. In other wells where water levels reflect water-table conditions periodic measurements were made and the lowest levels for the short period of record were observed at the end of the year.

Mackinac County

During 1958, observations of water levels were continued in three wells in this county, two of which were equipped with continuous recording gages. The hydrographs of wells 42N 2W 7-1 and 41N 5W 23-1 (fig. 7), show that water levels in these wells respond generally to climatic conditions.

Well 42N 2W 7-1 at Pontchartrain Shores taps the Manistique dolomite of Middle Silurian age. As in 1957, the water level declined during the winter until mid-March, when recharge from snowmelt resulted in rising levels. As in previous years the summer decline was temporarily reversed by recharge from heavy precipitation in July. More than 4 inches of precipitation in September and again in November effectively recharged the aquifer. In December below-freezing temperatures precluded any further appreciable recharge.

Well 41N 5W 23-1 at Round Lake is finished in the Salina formation of Late Silurian age. The fluctuations of water level in this well illustrate that stages in the Salina formation respond to the same climatic conditions affecting the Manistique dolomite at Pontchartrain Shores (fig. 7).

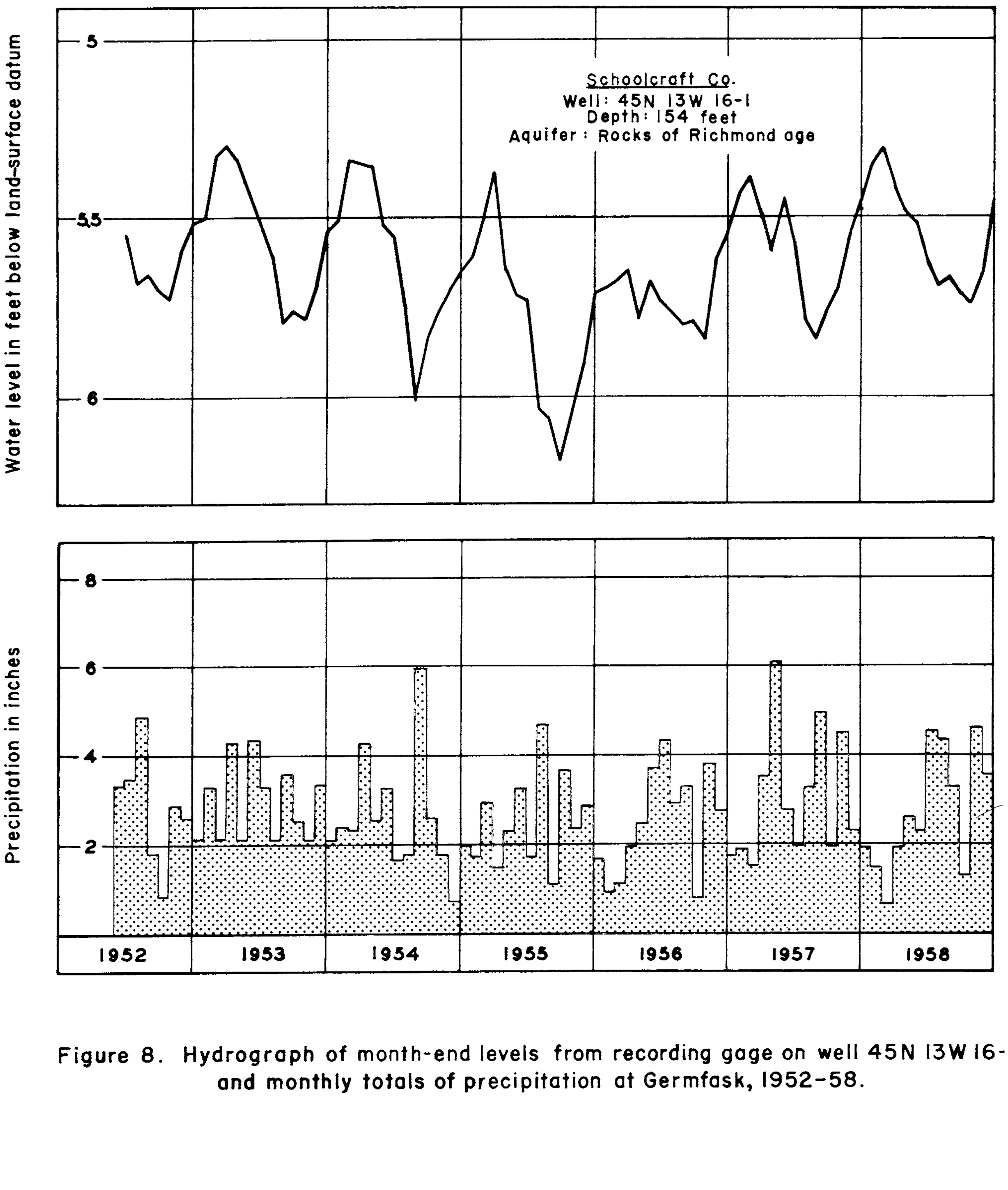


Figure 8. Hydrograph of month-end levels from recording gage on well 45N 13W 16-1 and monthly totals of precipitation at Germfask, 1952–58.

Schoolcraft County

Well 45N 13W 16-1 is located at the Seney Wildlife Refuge near Germfask. The water levels in this well reflect changes in artesian pressure in limestones of Richmond age.

Unlike well 46N 4W 24-1 in Chippewa County in which peak stages are reached in late spring or early summer, the peaks in the Schoolcraft County well occur early in the spring. The annual lows occur in the fall (fig. 8). The hydrograph also shows that a declining trend occurred during the period 1952 through 1955, followed by a rising trend since 1955. Precipitation in the Germfask area was about average in 1958, and, as a result, the year-end water level was about the same as at the end of 1957.

A graph showing the month-end levels in 1958, as compared to the extremes and average of month-end levels of the past record is included in figure 3. Month-end levels were higher than average and some were the highest for the 1952-58 period of record.

Southern Peninsula

Northern Half

In the northern half of the Southern Peninsula many record-low water levels (table 2) were observed during the latter part of the year in observation wells finished at shallow depth in the glacial drift aquifers.

In observation wells finished at greater depth water levels in most wells, while not at record-low levels, were generally below average. The low water levels during 1958 can be attributed to large deficiencies of precipitation, especially during the spring, when conditions are usually most favorable for ground-water recharge. Year-end levels were generally below those observed at the end of 1957.

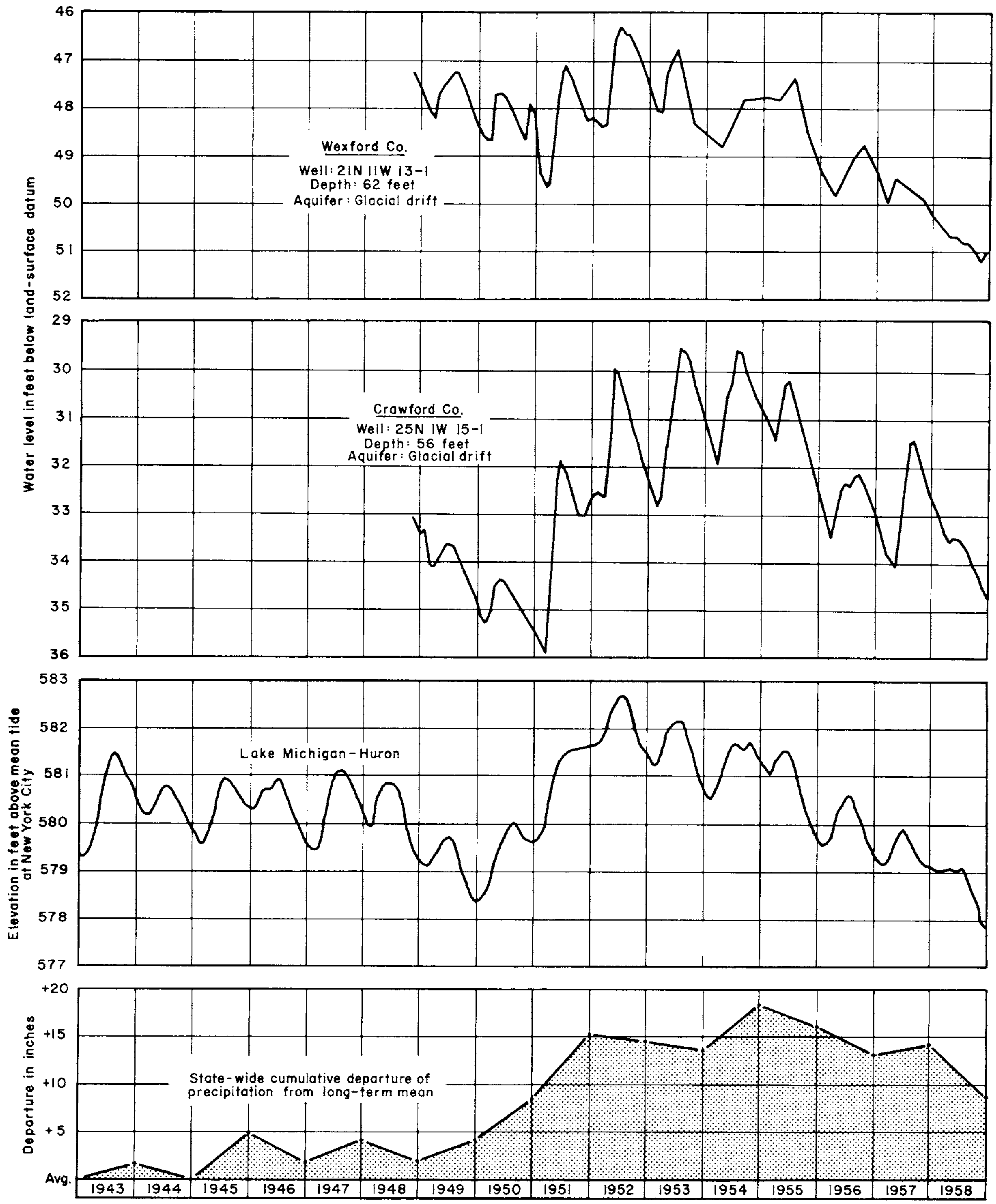


Figure 9. Hydrographs of two wells in Crawford and Wexford Counties, Lake Michigan-Huron levels, and cumulative departure of precipitation from the State-wide long-term mean, 1943-58.

Crawford County

Water levels in well 25N 1W 15-1 (fig. 9) tapping the glacial drift declined almost continually throughout the year except during a relatively short period in late spring when recharge exceeded discharge. Water levels in this well have tended to decline since 1954, apparently in response to a deficiency of about 8 inches of precipitation during that period. Despite the long-term decline, however, water levels at the end of 1958 were still more than 1 foot above the record low observed in 1951.

Figure 9 shows also fluctuations in levels of Lakes Michigan and Huron. The similarity in fluctuations in levels of those lakes and the Crawford County well provide evidence that water levels in the drift aquifers of the area and the lake levels each respond primarily to the same general climatic conditions, especially cumulative precipitation.

Kalkaska County

Well 27N 5W 36-1 followed much the same general trend in water levels as the key well at Roscommon (fig. 4) except that sharp rises did not occur in the spring and fall. The unseasonal spring decline in the Kalkaska well resulted in record-low water levels by early summer. Record-low stages for the 20-year period of measurement persisted in July, August, and September. Some recovery occurred in the fall but the levels remained below average, and, at the end of the year were about 1 foot lower than at the end of 1957.

Roscommon County

Well 24N 2W 20-1 near Roscommon is used as an index of trends of ground-water levels in the shallow drift aquifers of the northern half of the Southern Peninsula. A graph showing month-end levels in 1958, and extremes and average for the period of record is included in figure 4. The water level was above average at the beginning of the year but fell to below average by the end of March as the result of accumulated deficiencies of precipitation. The usual sharp March rise in water levels failed to occur in 1958. Moisture from snowmelt by late March followed by precipitation resulted in an average rate of rise in April. However, the start of the growing season and continuing deficiencies of precipitation caused water levels to decline at a sharp rate in May and the decline continued through September. The end of the growing season, and precipitation, resulted in a small rise in water levels in October. In mid-November a sharp rise of about 0.7 foot resulted from 1.6 inches of rain that fell during a period of a few days. Below-freezing temperatures that prevailed for the remainder of November and in December halted any further effective recharge causing the water levels to fall slightly during December. Year-end levels were below average and lower than those observed in 1957.

Wexford County

A general decline in the water levels in well 21N 11W 13-1 (fig. 9) was observed during the year except in the last two months when a rise of 0.14 foot was recorded. A declining trend in stage has been noted since 1952.

A general similarity may be noted also in the water-level fluctuations in this well and in Lakes Michigan and Huron (fig. 9). Differences in fluctuations in stages in glacial-drift aquifers in Crawford County, Wexford County, and other parts of the northern half of the Southern Peninsula with levels of the Great Lakes may be attributed to 2 major factors: precipitation locally, as compared to average precipitation over the entire Lake Michigan-Huron Basin, may vary considerably; and recharge and discharge characteristics of the drift aquifers at various places are not identical.

Southern Half

Ground-water levels observed in areas of the southern half of the Southern Peninsula (fig. 4) where little or no pumping occurs, were generally higher at the start of 1958 than at the beginning of 1957. The year was one of the driest of record. Precipitation in the area was most deficient at times when effective recharge to the ground-water aquifers usually occurs. Stages did not follow the normal pattern in the spring and in some months levels declined unseasonally. Thus at the beginning of the summer the water levels were at far below-average stages. The ensuing summer decline resulted in record and near-record low stages. Very little recharge occurred in the fall and levels continued low. At the end of the year stages were below average and much lower than at the end of 1957.

Branch County

Observation well 6S 6W 22-1 is finished in glacial drift, and located at the municipal well field in Coldwater. The water levels are affected by pumping of municipal wells tapping the same aquifer.

The water levels were higher at the start of 1958 than at the beginning of 1957. The summer decline was reversed in July and again in September by recharge from heavy precipitation. Thus, despite a total deficiency of precipitation of nearly 5 inches for the year and record-high municipal pumping of 477 million gallons (table 1), a net decline in water levels of only 1 foot was recorded for the year.

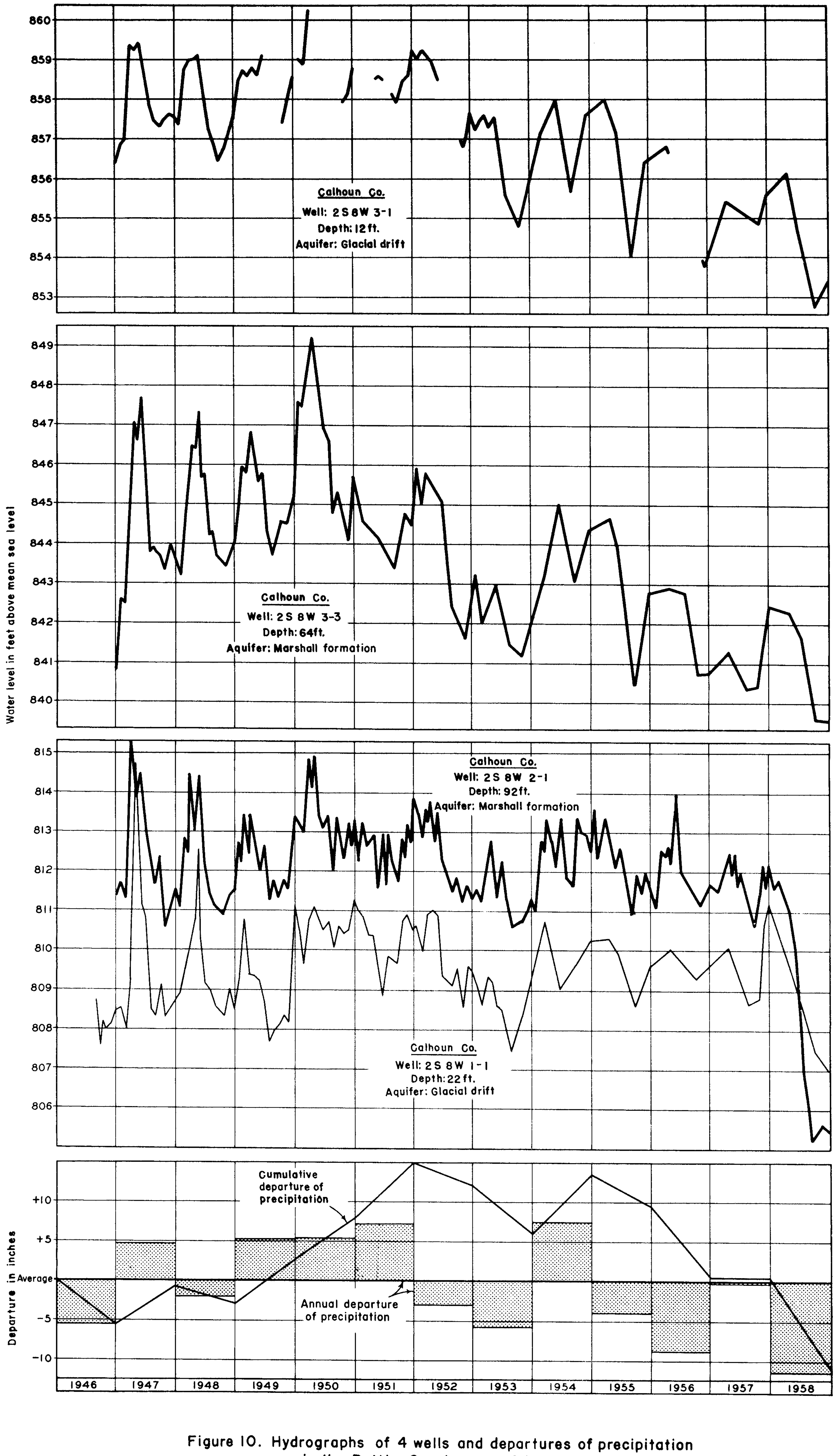


Figure 10. Hydrographs of 4 wells and departures of precipitation in the Battle Creek area, 1946-58.

Calhoun County

Battle Creek metropolitan area.--Most observation wells and municipal and industrial wells in the Battle Creek area are finished in the Marshall formation of Mississippian age. A few are finished in the overlying glacial drift.

Water levels fell in all of the observation wells in this area with declines for the year ranging from less than 1 foot to more than 6 feet. The lesser declines were primarily due to deficient precipitation, as a total of only 21.9 inches was recorded for the year at Battle Creek, the lowest since 1879.

In the central and northwest part of the area large declines occurred as the result of the deepening and straightening of the Kalamazoo River below its confluence with the Battle Creek River. This flood control work by the U. S. Army Engineers resulted in a lower base level for the Kalamazoo River and caused ground-water levels to decline sharply in 1958 (fig. 10) as the gradient of ground-water flow was steepened and a new base level for the underflow was being created. The decline in ground-water levels was largest in wells nearest the river.

In the northeast part of the area large declines in water levels resulted from increased pumping by the City from the Verona well field. The water levels in observation well 1S 7W 32-1 at the Verona Station (fig. 11) rose in response to decreased municipal pumping during the winter months, but fell to record-low levels during the summer as the result of increased municipal pumping and deficiencies of precipitation. Municipal pumpage increased by nearly 600 million gallons for the second consecutive year. The increased pumpage and a cumulative deficiency of precipitation of about 24 inches since the end of 1954 resulted in a net decline in water levels of about 6 feet in the observation well.

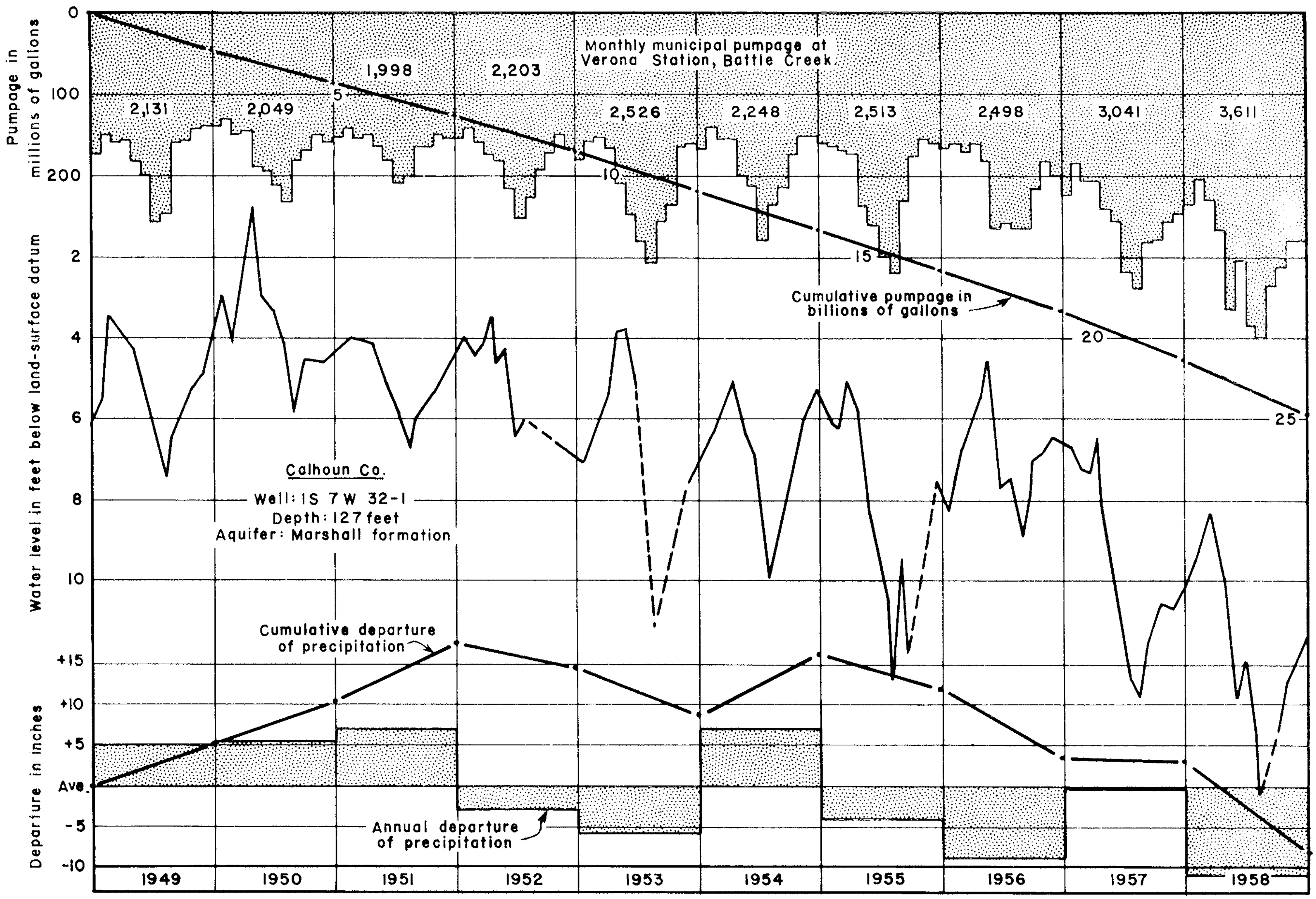


Figure 11. Hydrograph of well 1S 7W 32-1, municipal pumpage, and departures of precipitation at Battle Creek, 1949-58.

Total municipal pumpage reported by the city of Battle Creek was a record 3.6 billion gallons in 1958. This was an average of nearly 10 million gallons per day (mgd) and ranged from 7.3 mgd in February to 13.0 mgd in August. A 45-percent increase in pumping has occurred since 1956.

City of Marshall.--The three observation wells in the city of Marshall tap the Marshall formation and reflect municipal and industrial withdrawals of ground water from that aquifer.

The levels in the three observation wells declined slightly for the year principally because of deficient precipitation. Municipal withdrawals of ground water were 384 million gallons for the year, about the same as was pumped in 1957.

Cass County

Observation well 6S 16W 1-1, in the city of Dowagiac, is finished in glacial sand and gravel deposits and is affected by pumping of nearby municipal wells tapping the same aquifer. The water levels in the observation well neither rose as high nor fell as low as during 1957 but the year-end stages were about the same as at the end of 1957. This was probably due to a decrease in pumpage of about 8 percent or 17 million gallons for the year offsetting a deficiency of 8 inches of precipitation. Total municipal pumpage for the year was 208 million gallons as compared to the 224 million gallons reported in 1957.

Clinton County

At the village of Elsie the water levels in observation well 8N 1W 13-1 finished in the Saginaw formation, and in observation well 8N 1W 13-3 finished in glacial drift are affected by municipal pumping from wells tapping these aquifers.

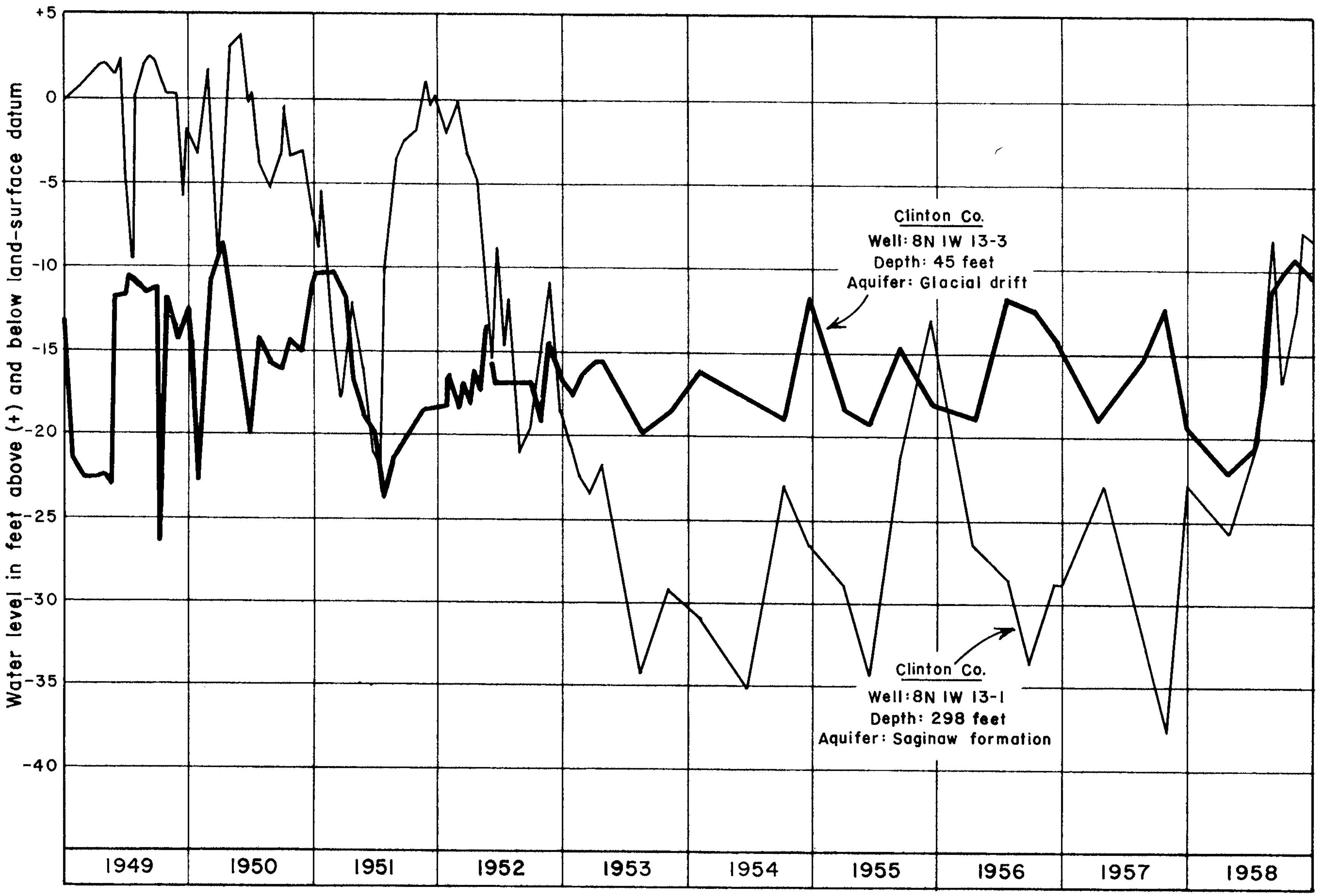


Figure 12. Hydrographs of 2 wells at the municipal well field at Elsie, 1949-58.

As shown by the long-term hydrographs (fig. 12) the water levels in the drift aquifer have remained relatively stable during the past ten years. However, in the rock aquifer a large drawdown occurred after 1950 owing to increased municipal pumping from that aquifer.

In 1958, a local industry largely discontinued the use of municipal water resulting in a substantial decrease in pumping of ground water by the Village. The decreased withdrawals resulted in a recovery of water levels of about 15 feet in the observation well tapping the Saginaw formation. Total pumpage of 148 million gallons was reported for the year by the village of Elsie.

Water levels in other observation wells in southern Clinton County are included in the discussion in the section headed "Ingham County, Lansing metropolitan area."

Eaton County

City of Charlotte.--Observation well 2N 4W 19-1, and public-supply wells at the Municipal Park in Charlotte are finished in the glacial drift. The water levels in the observation well are affected by municipal pumping and also reflect natural conditions of recharge and discharge.

The stage in the observation well fell to a new low for the period of record (1947-58) in early fall, principally as the result of a deficiency of more than 7 inches of precipitation during the year. The year-end water level was about $1\frac{1}{2}$ feet lower than that observed at the end of 1957. Municipal withdrawals of ground water by the city of Charlotte were reported as 343 million gallons (mg) for the year, an increase of 18 mg over 1957.

City of Grand Ledge.--Observation well 4N 4W 2-1 and the municipal wells in Grand Ledge are finished in the Saginaw formation. The water levels

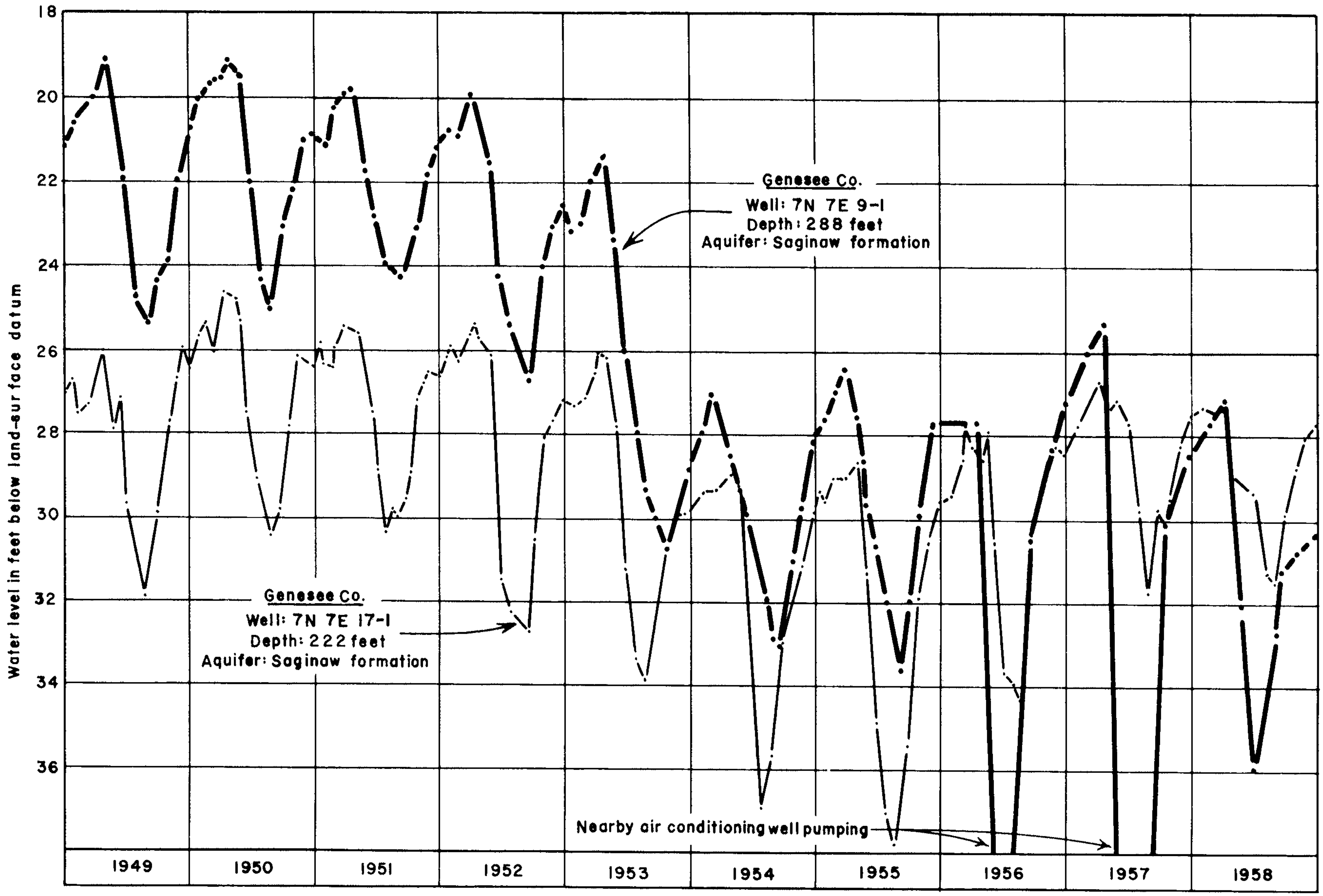


Figure 13. Hydrographs of 2 wells tapping the Saginaw formation at Flint, 1949-58.

in the observation well fell during the spring and fall mostly as a result of deficient precipitation. A small rise in stage occurred during the summer when more than 13 inches of rainfall was recorded. Year-end levels were about 1/2 foot below those observed at the end of 1957.

Total municipal pumpage of ground water at Grand Ledge in 1958 was reported as 173 million gallons, which was slightly more than was pumped in 1957.

Other observation wells in Eaton County are located near Lansing and are included in the discussion under the heading "Ingham County, Lansing metropolitan area."

Genesee County

The city of Flint obtains its municipal water supply from the Flint River. However, Burton Township, south of Flint, Beecher Metropolitan Water District to the north, and many industries in the Flint area obtain water from the Saginaw formation and from the overlying glacial drift. Observation wells in the Flint area reflect changes in water levels in the Saginaw formation, deep glacial-drift aquifers, and the shallow drift deposits.

Observed water levels were generally lower at the end of the year because of the more than 10 inches of deficiency of precipitation for the year. An overall decline of water levels has been observed for the past decade in observation wells in the Flint area finished in the Saginaw formation (fig. 13) and in the deeper glacial drift. This decline is mostly the result of withdrawals of ground water from these aquifers.

Figure 14 shows the long-term hydrograph of two wells finished at shallow depth in the surficial glacial drift aquifer in Burton Township. The

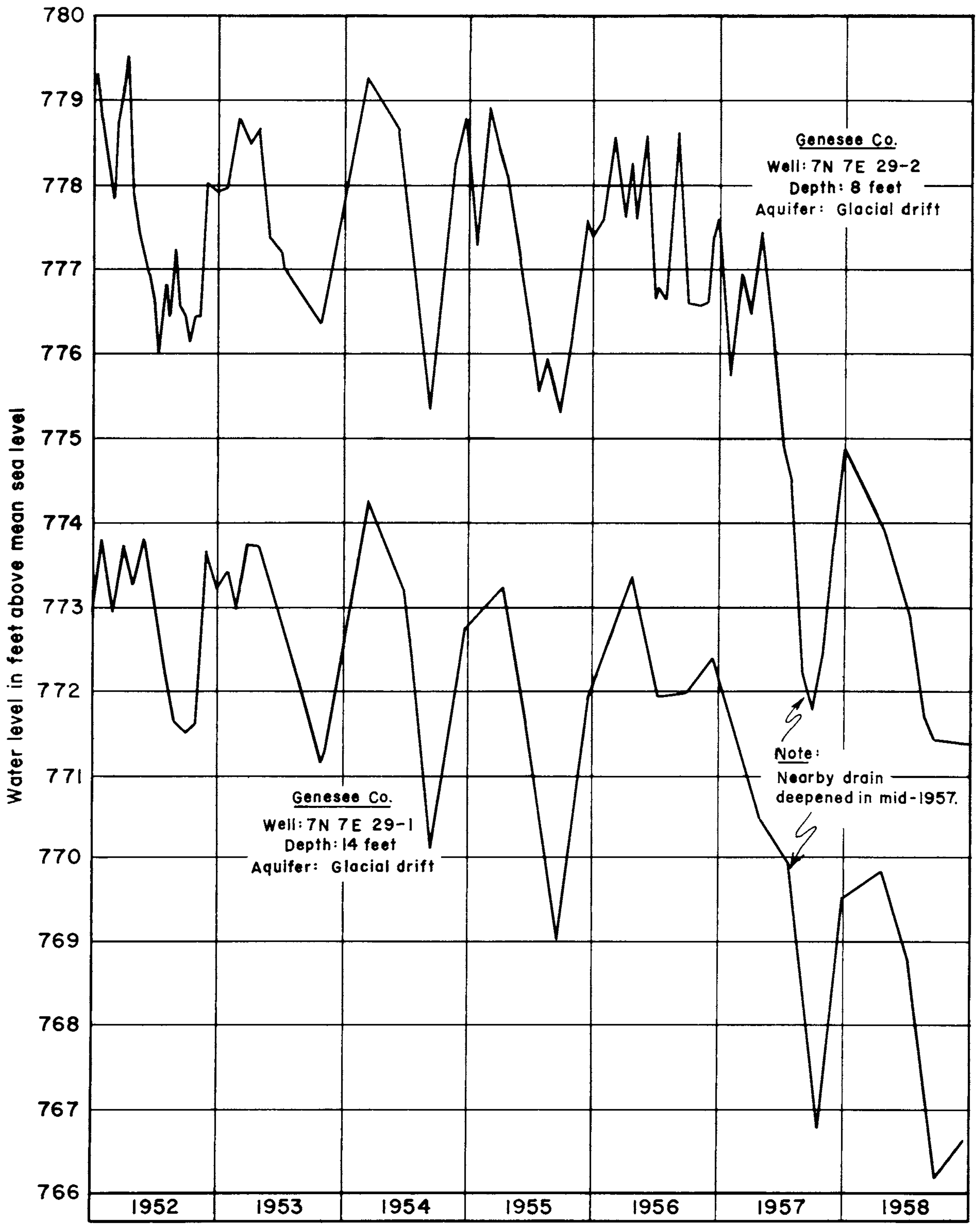


Figure 14. Hydrographs of 2 wells tapping shallow glacial drift at Burton Township near Flint, 1952-58.

sharp decline of the past two years resulted from deepening of a nearby County drain in mid-1957, which caused a lowered water table in the aquifer in the vicinity of the drain.

Figure 15 shows the effect of changes in barometric pressure on artesian pressures in well 7N 7E 17-1, tapping the Saginaw formation. (Note that barometric pressure is plotted inversely.) Water levels in artesian wells such as this are subject to water-level changes as the barometric pressure changes. As the pressure increases the water level in the well casing tends to be depressed and vice versa. In shallow water-table wells an equal effect is exerted on the soil column and on the water in the well and thus no change in water level is observed. The tiny vertical fluctuations in the hydrograph are the effect of the increased load on the formation caused by passing railroad trains, while the mound-like diurnal variations are the result of earth tide effects caused by the gravitational pull of the sun and moon. When the water level changes rapidly as in the case of infiltration from precipitation and or large barometric changes, the earth tide effects are masked by the movement of the water in the well.

Figure 16 shows the effect of pumping and precipitation on observation well 6N 7E 9-1 near Grand Blanc. Since 1955, when the rate of pumping at the Fisher Body plant was curtailed somewhat, no persistent decline in water levels has occurred. The net decline of about 5 feet in the observation well during 1958 may be attributed to the large deficiency of precipitation rather than to nearby pumping.

Municipal withdrawals of ground water from the Saginaw formation and the glacial drift in 1958 were 219 million gallons (mg) by the Beecher Metropolitan District, and 142 mg for Burton Township. The Grand Blanc plant, General Motors Corporation, reported a pumpage of 54 mg for the year from the Saginaw formation.

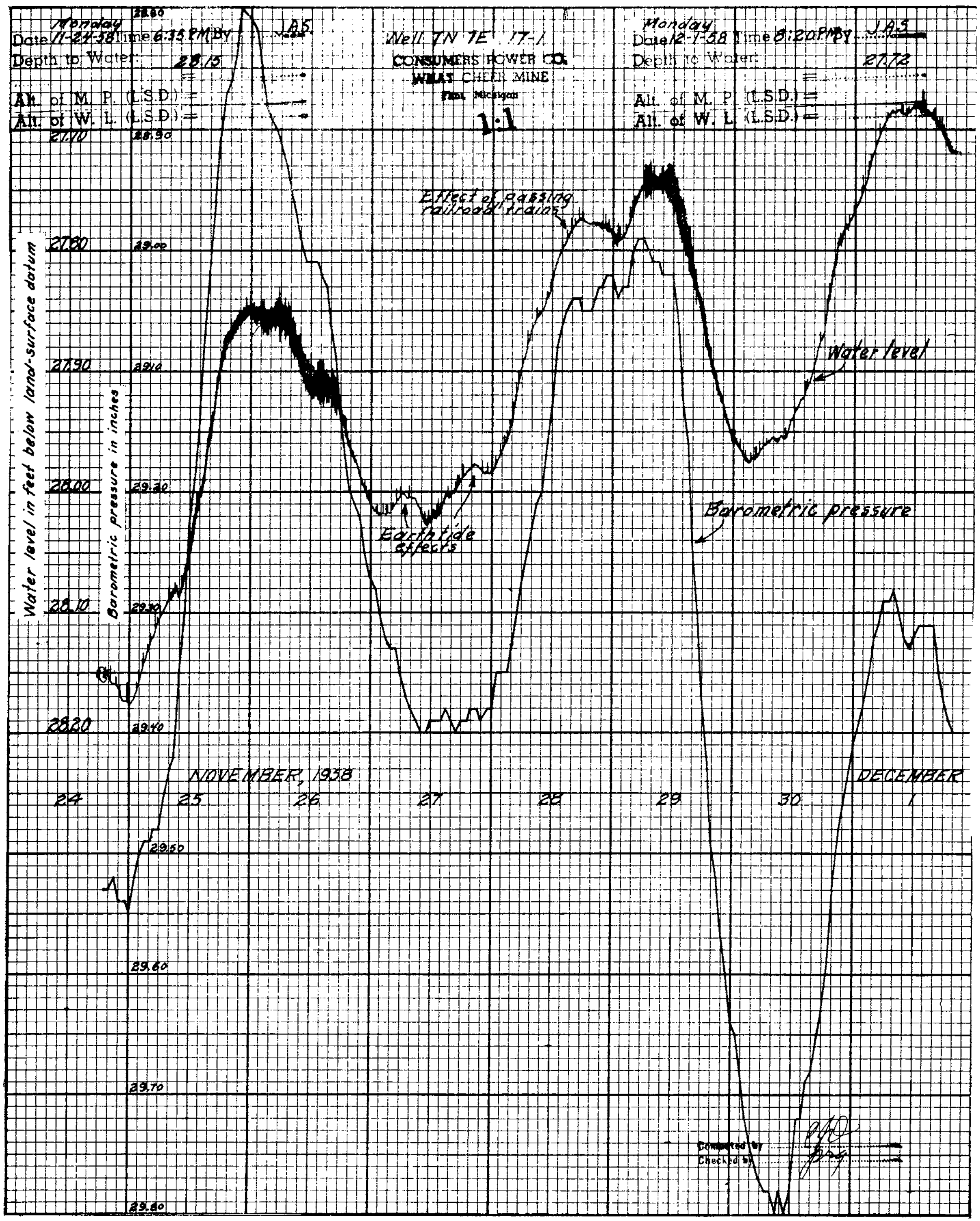


Figure 15. Hydrograph from continuous recording gage in operation on well 7N 7E 17-1 and inverse plot of hourly barometric pressure readings at Flint for week ending December 1, 1958.

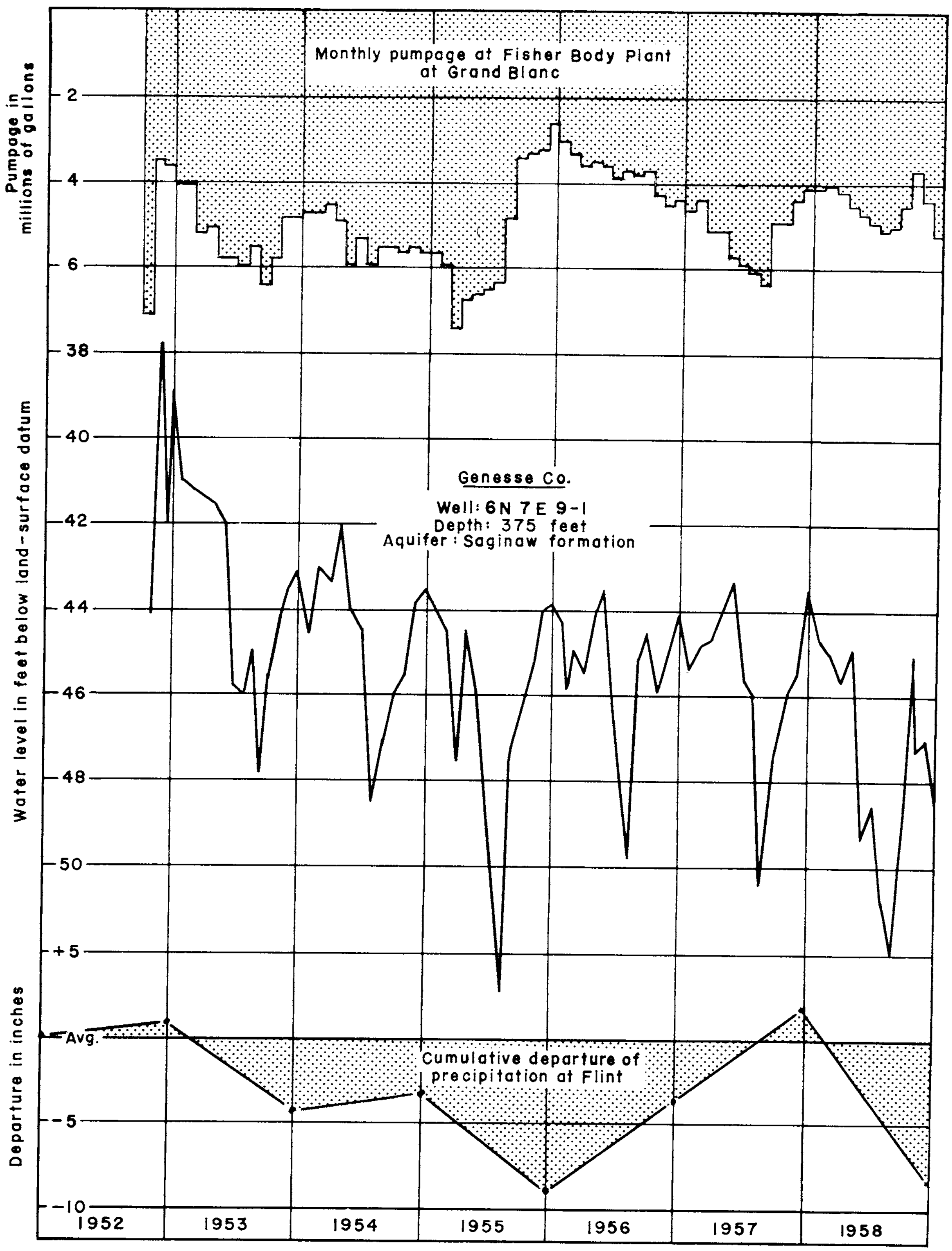


Figure 16. Hydrograph of well 6N 7E 9-1 near Grand Blanc, pumpage, and cumulative departure of precipitation, 1952-58.

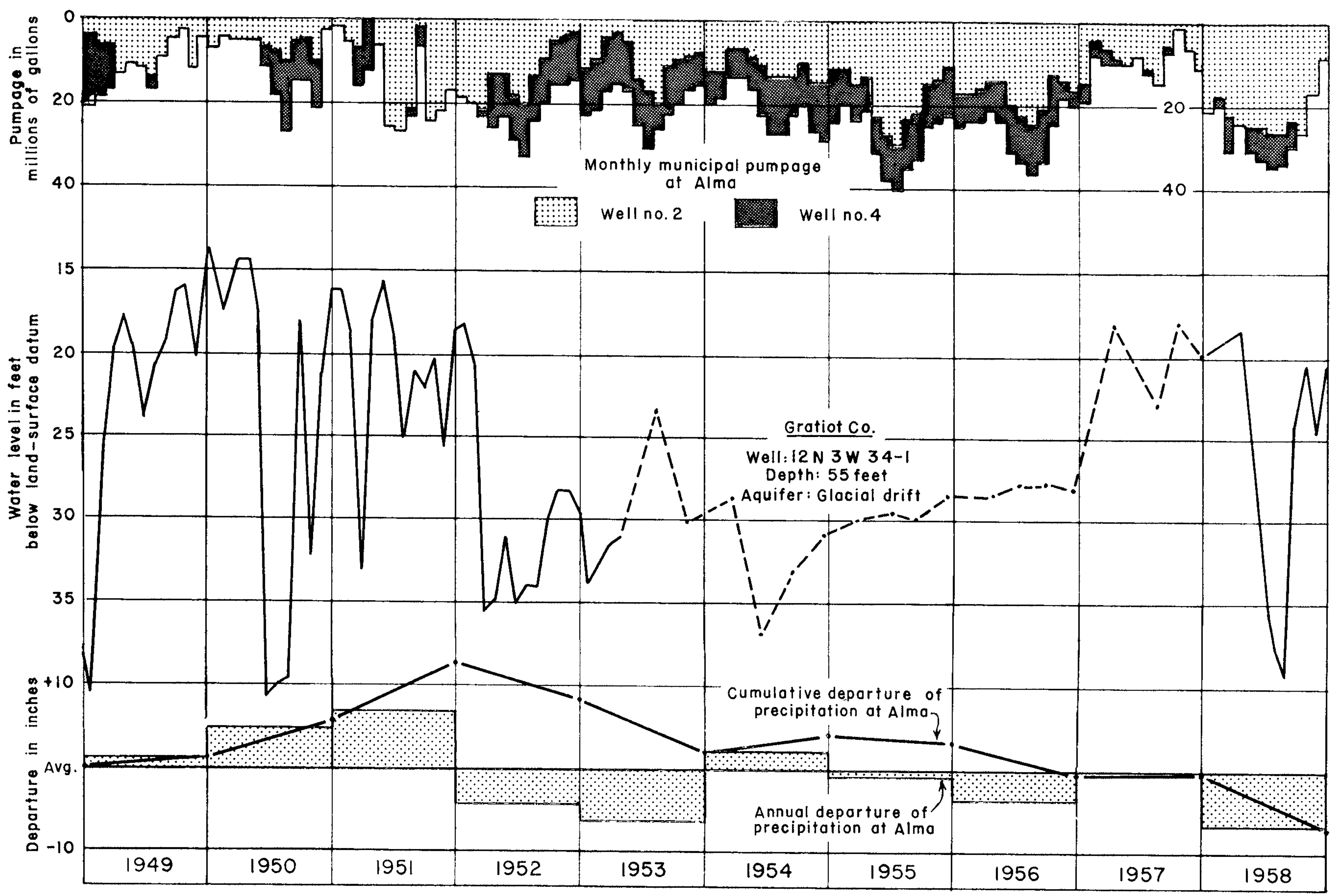


Figure 17. Hydrograph of well 12N 3N 34-1, municipal pumpage, and departures of precipitation at Alma, 1949-58.

Gratiot County

Observation wells in the Alma area are finished in the surficial drift deposits or in deeply-buried sand and gravel outwash deposits. Municipal and industrial wells tap the buried outwash. One deep municipal well taps the Saginaw formation but is seldom used as the water is of objectionable quality. The artesian pressure in the buried outwash is affected by municipal and industrial pumping (fig. 17), but the water levels in the surficial drift primarily reflect climatic conditions (fig. 4).

Year-end water levels in observation wells in the Alma area (table 2) were lower due to deficient precipitation and increased pumping. Declines ranged from $1\frac{1}{2}$ feet in the surficial drift to as much as 13 feet in the deeper buried outwash. Increased municipal pumping in the center of the City resulted in lower levels in that area. Figure 17 shows the effect on observation well 12N 3W 34-1 of changes in pumping rate in municipal wells 2 and 4 over the past decade. Increased pumping by these municipal wells and deficient precipitation resulted in the lowest observed levels in many years by late summer. Well no. 4 is closer and hence has a greater effect on water levels in the observation well than does well no. 2, when both are pumping.

Municipal withdrawals of ground water totaled 651 million gallons (mg) for the year, a sizeable increase over the 554 mg reported in 1957.

Ingham County

Lansing metropolitan area.--The Saginaw formation is the principal source of water for municipal, industrial, and domestic wells in the area, although a few wells obtain water from the overlying glacial drift. Most of the observation wells in the area are finished in the Saginaw formation and reflect changes in pattern and rate of pumping from the aquifer. A few including those finished in the glacial drift principally reflect climatic conditions (fig. 4).

Generally, in the heavily-pumped areas, long-term declines of water levels continued, and many record-low stages were observed during the year. The declines were the result of withdrawals of ground water from the Saginaw formation in the area and were aggravated by weather conditions. The year was the driest since 1930 with a precipitation deficiency of more than 9 inches, and warm dry weather in the spring and fall reduced the normal amount of ground-water recharge to the aquifer. In suburban areas, where effects of pumping are not as great, levels in observation wells reached new lows for the period of record (table 2) chiefly as the result of the deficient precipitation. In observation well 4N 2W 31-1 (fig. 4) which is at some distance south of the heavily-pumped portion of the Saginaw formation, the water level fell to record-low stages from June to the end of the year. West of Lansing in Eaton County water levels in well 4N 3W 12-1 were not appreciably affected by pumping of nearby Lansing Township wells. However, further west in the County, well 4N 3W 10-1 has shown a small but persistent decline amounting to a total of about 6 feet for the 15-year record, probably due to an extension of the cone of depression in the metropolitan area. To the east, water levels in well 4N 2W 24-1 at Michigan State University continued a general decline that has persisted since the start of record in 1945. Water levels in observation well 4N 1W 18-1, at Marble School in East Lansing, continued to decline as the result of pumping from nearby municipal wells. Here, a decline of about 10 feet has occurred since the start of record in 1953. North of Lansing in Clinton County, water

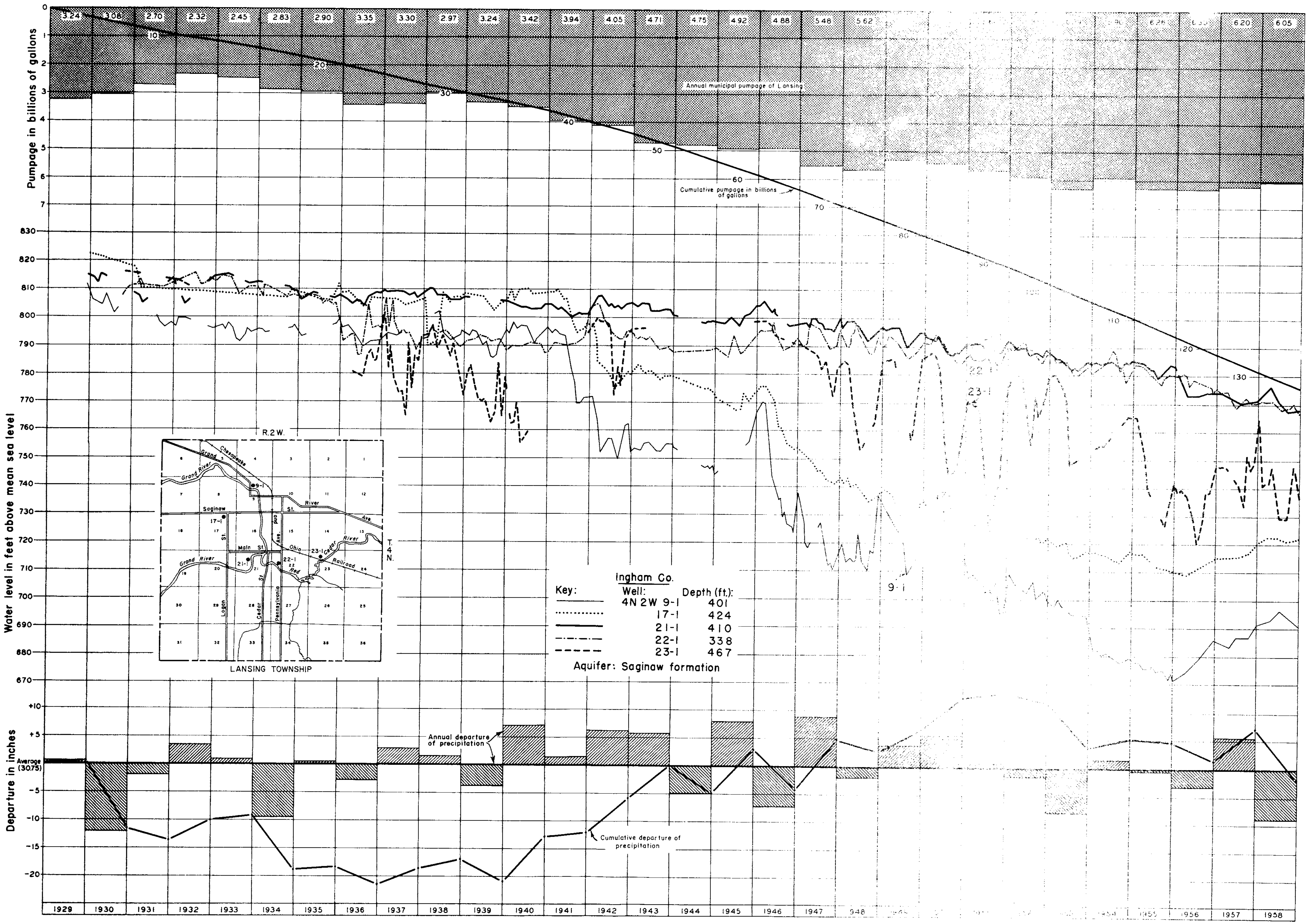


Figure 18. Hydrographs of 5 wells tapping the Saginaw formation, municipal pumpage, and departures of precipitation at Lansing, 1929–58.

levels in observation well 5N 2W 32-1 have declined more than 30 feet during the 15-year period of record. Water levels in observation well 6N 2W 16-1 finished at shallow depth in glacial drift, 10 miles north of Lansing in Clinton County, fell to below average in May and continued below average for the remainder of the year because of the adverse climatic conditions (fig. 4).

Figure 18 presents records since 1929 of 5 observation wells in the heavily-pumped areas of Lansing, along with total Lansing municipal pumping and the precipitation departures. The rise in water levels in observation wells 4N 2W 9-1 and 17-1 in the northwest section and the declines observed in wells 21-1 and 22-1 in the southeast were caused by changes in pumping patterns and rates in those areas since 1955. A net increase in stage of almost 20 feet was observed during the past 3 years in well 4N 2W 9-1. South and east of the center of the city, levels have declined more than 10 feet from the effects of increased pumping in that area. Precipitation trends seem to have had little effect on the water levels in the heavily-pumped area.

The average daily withdrawals of ground water for municipal use by Lansing, East Lansing, Lansing Township, Meridian Township, and Michigan State University was about 21.5 million gallons during 1958. The total pumpage of 7.8 billion gallons for 1958 was less than in recent years, probably owing to decreased industrial activity and also to the cool wet summer with attendant decreases in normal hot weather uses for air conditioning and lawn sprinkling.

City of Mason.--Observation well 2N 1W 5-1 in Mason is finished in the Saginaw formation. The water levels in the well are affected chiefly by industrial pumping, as the municipal supply is obtained from wells tapping glacial sands and gravels. The water levels in the observation well were generally lower throughout the year because of large deficiencies of precipitation during favorable periods of recharge in the spring and fall. The year-end level was about 2 feet below that observed at the end of 1957. Total municipal pumpage for the year was reported as 134 million gallons or an average of about 367,000 gallons per day.

Kalamazoo County

Wells in and near the city of Kalamazoo tap only glacial drift aquifers. Stages in many of the observation wells fell to record lows for the second consecutive year as precipitation in 1958 totaled only 24.64 inches or 10.25 inches below average. The normal spring and fall recharge to the ground-water aquifers was much less because most of the deficiency of rainfall occurred during those seasons. Declines of water levels for the year ranged from 0.8 foot to as much as 3.0 feet.

Figure 19 shows the effect of pumping and precipitation trends on wells 2S 11W 22-6 and 22-102 located in the Axtell Creek area. It is evident from the illustration that no persistent decline for the 13-year record can be directly attributed to municipal withdrawals of ground water from the Axtell Creek area well fields. The fluctuations of water level in the observation well reflect mainly precipitation trends and the pumping appears to be in good balance with the recharge to the aquifer by precipitation and infiltration of surface water. As additional water is needed, it is being drawn from other stations as the city has limited pumping in the Axtell Creek area to an amount which will cause no serious dewatering of the aquifer in that vicinity.

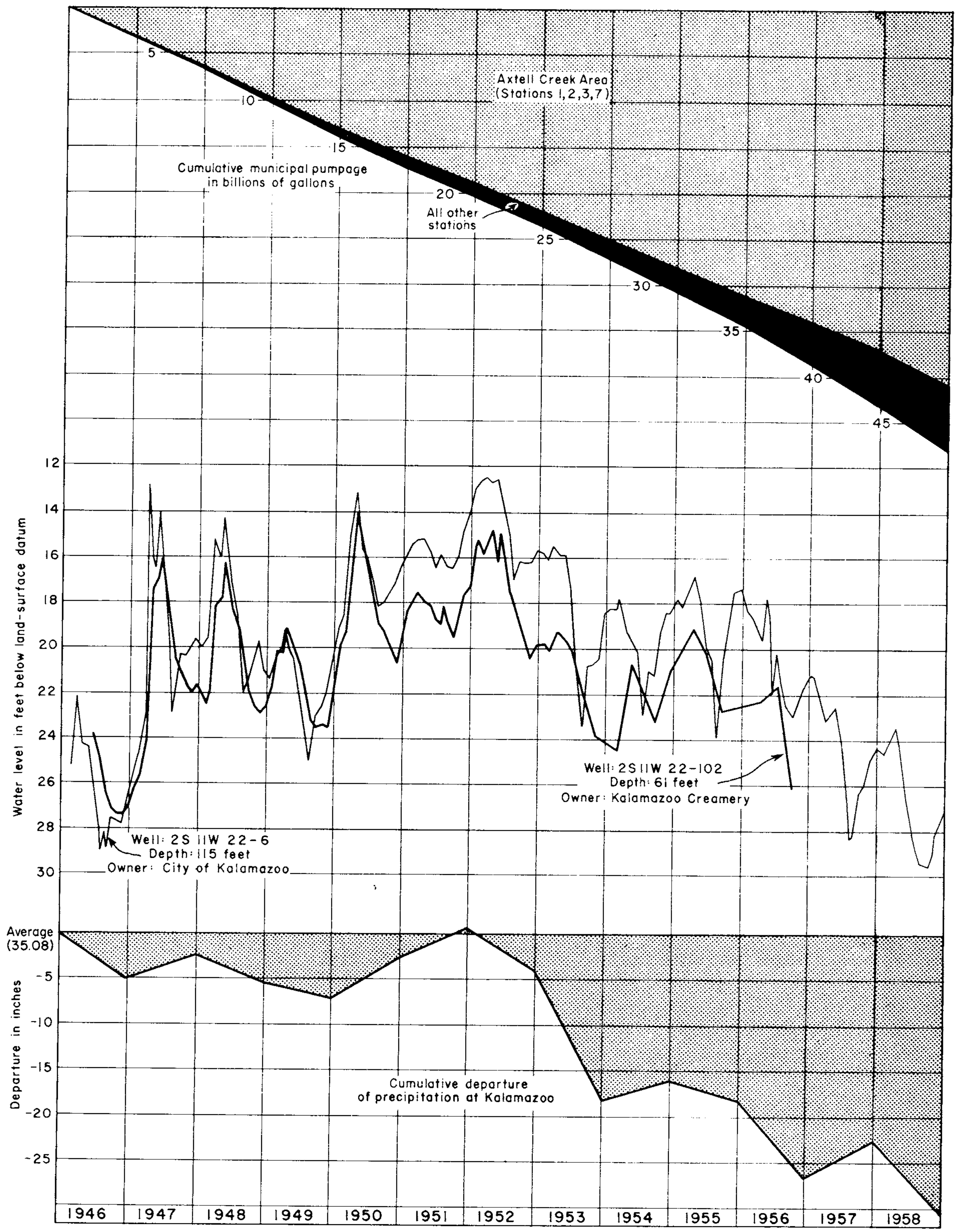


Figure 19. Hydrographs of 2 wells tapping the glacial drift, cumulative municipal pumpage, and cumulative departure of precipitation at Kalamazoo, 1946-58.

The total municipal pumpage for the year was reported as a record 4.64 billion gallons, slightly more than in 1956. Pumpage averaged 12.7 million gallons per day (mgd) and ranged from 10.4 mgd in March to 16.5 mgd in May.

Montcalm County

At the city of Greenville municipal wells are finished in glacial drift as are the observation wells. Observation well 9N 8W 15-1, at the municipal well field in the southeast part of the City reflects pumping from nearby municipal wells. Water-level measurements made since 1950 indicate no persistent decline in the stage due to municipal withdrawals of ground water. The observed levels more generally follow annual climatic variations. Stages were highest during the early part of the record when precipitation was far above normal and have been lower during the last few years as the result of deficiencies in precipitation. However, the range in fluctuation has only been about 6 feet during the 9 years of record. Despite deficient precipitation and increased municipal pumping, the water levels in this observation well were only slightly lower during the year than in 1957.

Observation well 9N 8W 10-1 in the northeast part of the City reflects industrial pumping of ground water, but declines in levels during the year probably were due mostly to climatic conditions.

Municipal pumpage of ground water in 1958 was reported as 529 million gallons or an increase of about 20 percent over 1957.

Oakland County

The observation wells in Pontiac are finished in glacial-drift aquifers, as are the municipal and most of the industrial wells in the area.

Precipitation of only 21 inches for the year was about 10 inches below normal and the least since 1934, when only 19 inches were reported. Despite the dryness, the rising trend of water levels in the two observation wells in Pontiac continued (wells 3N 10E 31-1 and 32-1, table 2). This was due to decreased pumping in the vicinity of the observation wells owing to a change in the City's pumping pattern since 1955.

Figure 20 shows the hydrograph of well 3N 10E 32-1 for the last 10 years based on records from a continuous recording gage. During the period 1939-55, water levels in this well declined about 70 feet. Since mid-1955 when the lowest level of record was recorded, a recovery of about 20 feet has been observed.

Municipal withdrawals of ground water from the glacial-drift aquifer in 1958 were reported as 3.4 billion gallons averaging 9.4 million gallons per day. This was a slight increase over 1957. In addition, however, large amounts of ground water are pumped by private industry.

Washtenaw County

All observation wells presently maintained in this County are finished in glacial drift and reflect withdrawals of ground water from drift aquifers by municipal or institutional well fields.

City of Ann Arbor.--The City obtains its water supply from the Huron River and supplements this supply by pumping water from wells tapping the glacial-drift aquifer at the Steere Farm well field south of the City.

Figure 21 shows the hydrograph of observation well 3S 6E 16-1 for the 1954-58 period. The declining trend in water levels of the past 3 years is mostly the result of increased municipal withdrawals of ground water as total

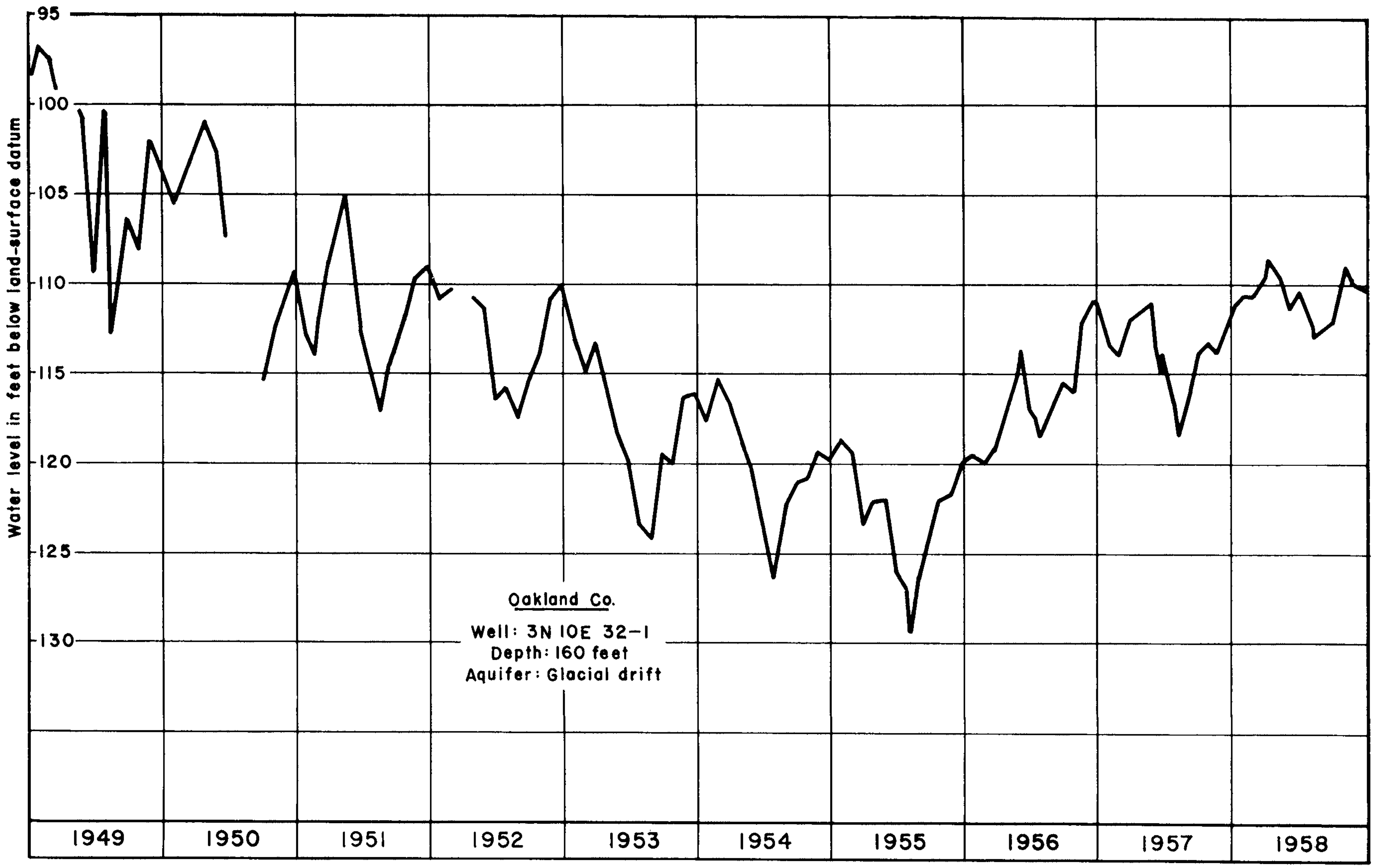


Figure 20. Hydrograph of well 3N 10E 32-1 tapping the glacial drift at Pontiac, 1949-58.

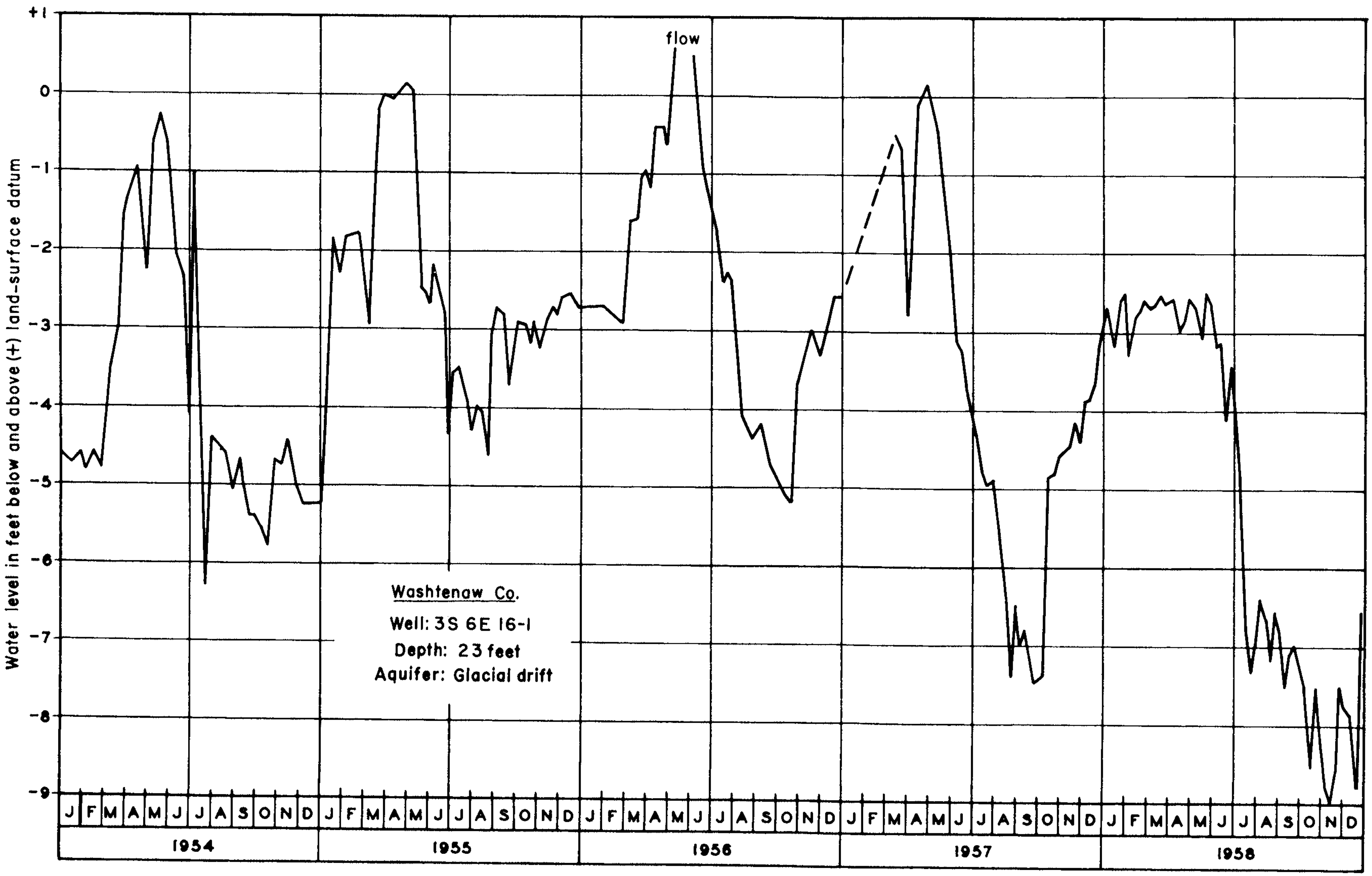


Figure 21. Hydrograph of well 3S 6E 16-1 tapping the glacial drift at the Ann Arbor municipal well field, 1954-58.

precipitation for this period was about normal. The water levels during 1958, however, showed the effect of reduced recharge because of precipitation deficiencies in the spring and fall of the year, resulting in less than the usual seasonal rises. Year-end levels were about 4 feet lower than at the end of 1957.

Total municipal pumpage of ground water was reported as 960 million gallons (mg) for the year, ranging from 45 in February to 133 mg in July.

Ypsilanti State Hospital.--Water levels in the two observation wells at Ypsilanti State Hospital reflect climatic changes and withdrawals of ground water by the institutional well field.

In observation well 4S 6E 9-1 (fig. 22), which is more than a mile from the pumped wells, the water level failed to rise appreciably in the spring because of deficient precipitation. Decreased pumping during the summer and increased precipitation precluded the usual seasonal decline and the stage in the well rose somewhat during the summer months. Precipitation and mild weather in November resulted in effective recharge in late fall and by the end of the year the water level in the well was about 1½ feet higher than at the end of 1957.

In observation well 4S 6E 10-1, which is closer to the pumped wells, levels were several feet higher at the end of the year probably as the result of decreased pumping for the year. Total institutional pumpage from the drift was reported as 253 million gallons (mg) for the year as compared to 274 mg in 1957.

Ypsilanti Township.--The water levels in observation wells (fig. 23) at the Township well field remained relatively stable as decreased pumping was offset by a large deficiency of precipitation during the year which halted the

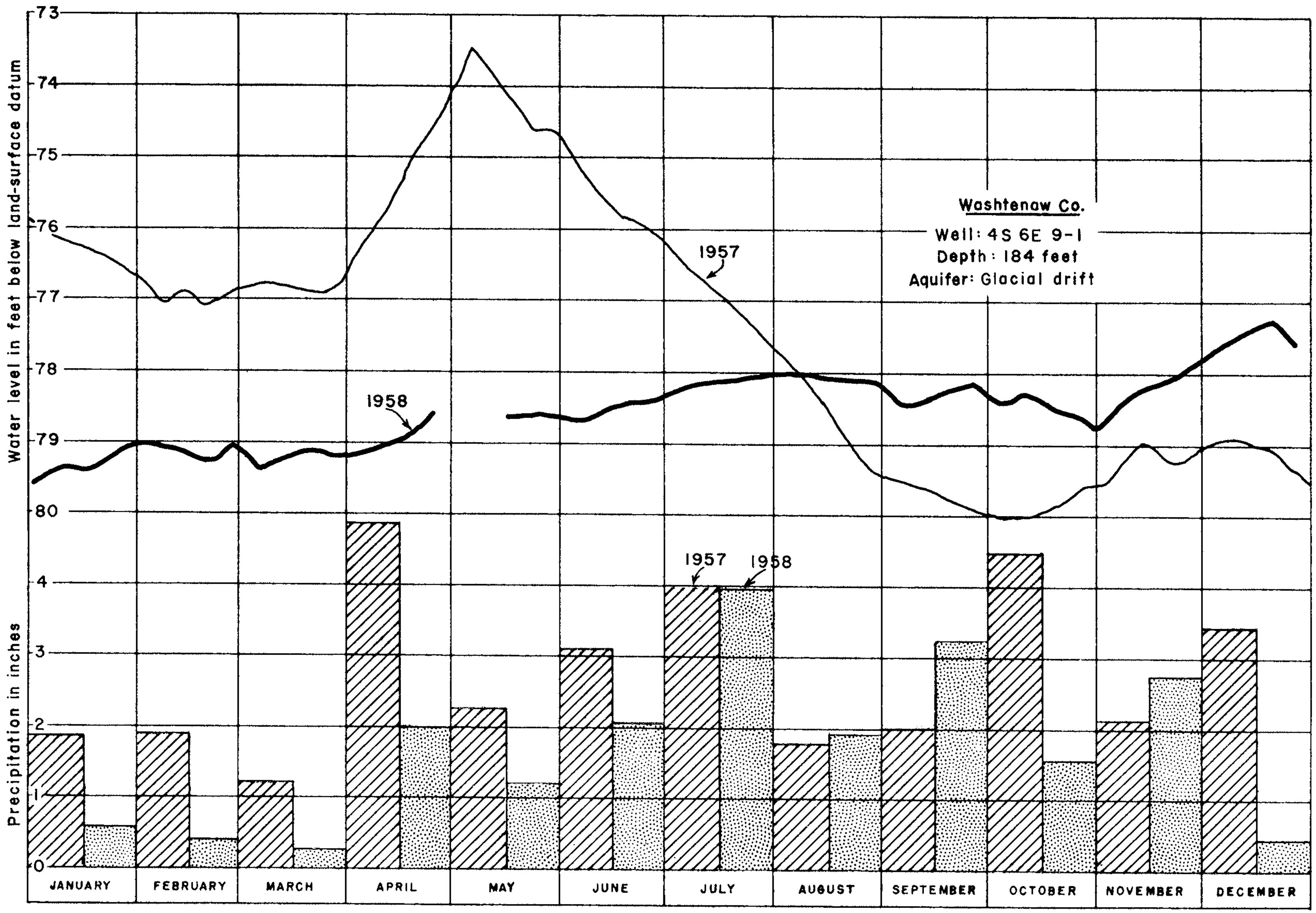


Figure 22. Hydrograph of well 4S 6E 9-1 tapping the glacial drift at Ypsilanti State Hospital and monthly precipitation at Willow Run Airport, 1957-58.

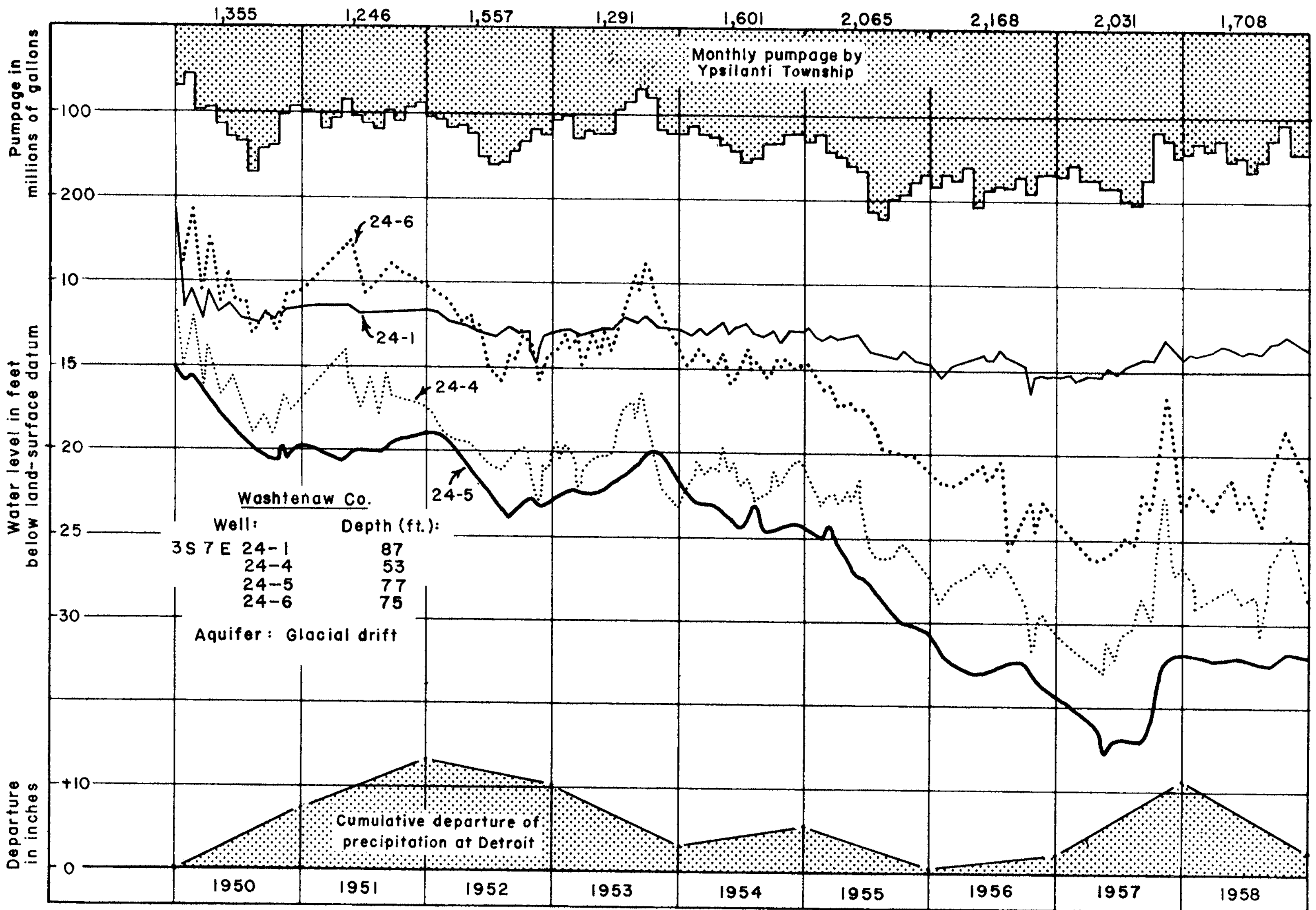


Figure 23. Hydrographs of four wells tapping the glacial drift, municipal pumpage by Ypsilanti Township, and cumulative departure of precipitation, 1950-58.

recovery of water levels that occurred during the last part of 1957. Well 3S 7E 24-1 is least affected by pumping as it is the farthest from the pumped wells. The total pumpage of about 1.7 billion gallons was the least since 1954 and may have been a reflection of decreased business activity. Average daily pumpage was 4.68 million gallons as compared to 5.56 and 5.91 in 1957 and 1956, respectively.

Table 2.--Records of Michigan observation wells and extremes in water levels observed in 1958 and for the period of record.

Owner: MDC - Mich. Dept. of Conservation; WMP - Wisconsin-Michigan Power Co.; MSHD - Mich. State Highway Dept.; USFS - U. S. Forest Service.

Chief Aquifer:

Qgd - Glacial drift deposits of Pleistocene (Quaternary) age
Ps - Saginaw formation of Pennsylvanian age
Mb - Bayport limestone of Mississippian age
Mm - Marshall formation of Mississippian age
Dtb - Thunder Bay limestone of Middle Devonian age
Ss - Salina formation of Late Silurian age
Sm - Manistique dolomite of Middle Silurian age
Or - Limestones of Richmond age (Late Ordovician)
Otb - Trenton and Black River limestones of Ordovician age
Oat - Au Train formation of Ordovician age (previously designated as Hermansville limestone)
€m - Munising sandstone of Cambrian age
p€ - Rocks of Precambrian age (undifferentiated)
p€f - Freda sandstone of Keweenawan age (Precambrian)

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

F - 58 - Frequency of measurement in 1958: R - Continuous recorder; D - Daily; W - Weekly; M - Monthly; Q - Quarterly; S - Semiannual; A - Annual.

Observed water-level extremes: 1958 measurements underscored are new extremes for entire period of record (in feet below or above (+) land surface).

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

Well number	Location in section ¼ ¼	Owner	Depth (ft.)	Dia. (in)	Chief Aquifer	Altitude	Years of record	F 58	Observed water level extremes: Through 1957 Highest	Date	Lowest	Date	In 1958 Highest	Date	Lowest	Date	Remarks
								Alpena County									
32N 6E 16-1	NW SW	Harlo Mellon	53	6	Dtb	-	1948-58	M	5.46	4-15-55	16.67	11-12-48	7.99	4-22	12.29	9-2	
30N 6E 6-1	NW NE	R. E. James	19	18	Qgd	785	1948-58	Q	0.90	4-13-52	9.52	12-11-49	4.85	4-22	10.12	12-2	
								Baraga County									
48N 32W 12-1	SE SE	MSHD (WMP 14)	10	1¼	Qgd	-	1948-58	M	4.19	5- 3-51	6.72	3-15-49	4.91	6-30	5.96	2-27	
								Barry County									
3N 8W 18-1	SE NE	City of Hastings	33	6	Qgd	-	1958	R	-	-	-	-	3.55	8-27	5.32	10-7	P, record started 8-26-58.
								Branch County									
6S 6W 22-1	NE SW	City of Coldwater(3)	130	6	Qgd	-	1949-58	W	10.08	4- 8-50	16.67	1-15-54	13.12	1-10	15.59	11-15	P, Meas. by owner.
								Calhoun County									
1S 7W 10-1	NW NW	K. N. Sabin	8	15	Qgd	907.99	1946-58	W	0.89	3-28-50	5.90	1-27-54	4.35	4-23	5.71	12-10	
31-1	NE SW	City of Battle Creek (TW 1)	140	2	Mm	838.92	1945-58	Q	+0.08	5-23-50	5.79	10-18-57	4.89	4-16	6.75	10-6	
32-1	NE SE	do. (Verona 22)	127	8	Mm	830.79	1939-58	D	0.7	4-26-50	13.04	8-12-57	6.57	1-2	15.35	8-5	P, Meas. by owner.
32-2	NE NW	Mrs. Harriet Rice	43	2	Mm	842.88	1946-58	Q	8.98	4-25-50	17.11	10-18-57	15.96	4-16	18.10	10-6	
2S 8W 1-1	SW SE	Sherman Mfg. Co.	22	2	Qgd	825.19	1946-58	Q	10.49	4-11-47	17.74	8-21-53	15.50	4-16	18.15	12-17	

2S 8W 2-1	NW SE	Post Products Co.	92	10	Mm	819.99	1946-58	R	4.75	4- 9-47	9.60	10-15-57	7.60	1-1	14.90	12-12	P, Meas. by Battle Creek.
3-1	SE SE	Dominic Conto	12	2	Qgd	862.02	1946-58	Q	1.75	4-28-50	8.25	12-19-56	5.91	4-16	9.24	10-6	
3-2	SE NE	Eaton Mfg. Co.	80	10	Mm	833.39	1946-58	Q	13.43	4-25-50	22.78	12-19-56	20.41	4-16	24.73	10-6	P
3-3	NE SE	P. E. Slayton	64	4	Mm	849.51	1945-58	Q	0.26	4-25-50	9.39	8- 2-46	7.23	4-16	10.00	12-17	P
14-1	NE SE	City of Battle Creek (TW 3)	62	2	Qgd	916.05	1939-58	Q	9.10	5-31-52	32.76	3-26-41	12.44	7-9	12.83	10-6	P
14-2	SE SE	do. (TW 1)	89	26	Qgd	914.97	1945-58	Q	6.22	5-29-50	12.86	10-18-46	9.40	7-9	9.97	12-16	P
2S 7W 7-1	SW NE	Oliver Farm Implement Co.	74	6	Mm	834.30	1946-58	Q	15.00	4-11-47	23.86	9-19-55	19.12	4-16	22.23	10-6	P
10-1	NW SW	Fred Frey	90	6	Mm	884.94	1946-58	Q	11.42	5-29-50	15.67	4-18-57	15.06	4-16	16.37	12-17	P
17-1	NW SW	City of Battle Creek	87	2	Mm	841.78	1945-58	Q	6.57	4-25-50	11.23	11- 6-53	9.87	4-16	11.31	10-6	P
18-1	SW SW	do.	87	2	Mm	832.49	1945-58	Q	+0.50	4-25-50	3.24	9-21-49	1.54	4-16	2.83	10-6	P
2S 6W 25-1	NE NE	City of Marshall-(Ferguson)	59	6	Mm	904.85	1950-58	M	5.46	5- 9-50	9.43	10-17-57	8.85	4-16	9.59	10-6	P, Meas. by owner.
25-2	SE NW	do.(Egeler)	67	6	Mm	901.15	1950-51, 56-58	Q	6.50	9-14-50	9.00	8-14-57	8.38	4-16	8.96	10-6	P
25-3	SW SE	do.(Filkin)	82	4	Mm	914.15	1950-58	Q	19.71	5- 3-50	26.32	12-19-56	23.97	4-16	24.76	12-17	P
								Cass County									
6S 16W 1-1	SW NE	City of Dowagiac	159	10	Qgd	750.19	1949-58	W	+4.20	11-30-51	5.97	7-24-53	+3.61	5-9	1.55	8-22	P, Meas. by owner.
8S 14W 17-1	NE NW	Ted Little	55	28	Qgd	-	1945-58	W	46.20	7-16-50	55.03	3-10-47	51.60	8-17	52.46	1-5	
								Charlevoix County									
33N 4W 2-1	SW NE	MDC	94	6	Qgd	-	1948-58	Q	70.85	7-19-52	75.85	4-16-56	73.30	4-22	73.83	10-7	
32N 4W 10-1	NE SE	MDC (33)	17	2	Qgd	-	1934-41, 48-58	M	1.19	3-30-58	6.11	10- 8-57	5.58	4-22	7.02	10-7	
								Cheboygan County									
34N 1W 1-1	NW SW	MDC (7)	11	2	Qgd	-	1938-41, 48-52, 55-58	Q	2.75	3-28-38	5.55	10-13-55	4.15	4-22	4.34	11-11	
								Chippewa County									
46N 4W 24-1	NE SE	USFS	54	6	Qgd	-	1952-58	R	e22.45	7-25-57	27.77	4-12-56	24.14	1-4	26.11	12-31	
45N 1W 28-3	SW SW	MDC	28	1¼	Qgd	-	1958	M	-	-	-	-	25.74	11-7	25.97	12-30	Record started 11-7-58.
								Clinton County									
8N 1W 13-1	SW NW	Village of Elsie	298	12	IPs	699.68	1947-58	M	+3.78	6- 3-50	37.55	10-15-57	7.72	11-21	25.78	4-21	P
13-3	SW NW	do. (3)	45	12	Qgd	706.17	1947-58	M	8.3	4- 5-50	26.4	10-11-49	9.58	11-3	22.36	4-21	P
6N 2W 16-1	SE SE	MSHD	23	14	Qgd	803.32	1948-58	M	14.59	4-19-52	18.53	12-29-53	16.14	3-31	18.09	12-31	
5N 2W 32-1	SW SE	Mich. Health Dept.	135	4	IPs	849.21	1944-58	M	42.02	9-14-44	77.62	4-22-57	74.52	11-26	78.47	8-28	P
								Crawford County									
27N 4W 2-1	NE NW	MDC (42)	13	2	Qgd	1194.18	1934-58	Q	3.84	4-17-47	7.08	3-14-51	6.68	4-21	7.30	7-31	Record stopped 7-31-58.
27N 1W 22-1	NE NE	MDC (27)	12	2	Qgd	-	1934-58	Q	3.51	4-18-52	6.38	1-27-56	5.52	4-22	6.14	10-3	
26N 4W 11-1	NW SW	MDC	12	15	Qgd	1147.59	1942-58	R	4.03	6- 1-43	9.83	10- 3-55	7.04	4-11	9.85	9-3	
25N 3W 28-1	SW SW	MDC (8)	13	1¼	Qgd	1175.14	1934-37, 39-58	Q	8.70	6-15-43	10.85	1- 7-57	10.58	4-21	11.28	10-22	
25N 1W 15-1	SE SE	USFS	56	6	Qgd	-	1948-58	R	29.44	8- 4-53	35.97	4- 4-51	32.55	1-1	34.74	12-30	
								Delta County									
43N 19W 24-3	NW NW	Harry Clarage	405	4	Otb	-	1958	R	-	-	-	-	79.27	10-10	79.64	12-29	Record started 9-30-58.
24-2	SW NW	Floyd Dickman	67	1¼	Qgd	-	1958	M	-	-	-	-	56.02	9-30	56.27	11-24	Record started 9-30-58.

Table 2.--Records of Michigan observation wells and extremes in water levels observed in 1958 and for the period of record.--Continued

Well number	Location in section ¼ ¼	Owner	Depth (ft)	Dia. (in)	Chief Aquifer	Altitude	Years of record	F 58	Through 1957 Highest	Through 1957 Date	Through 1957 Lowest	Through 1957 Date	In 1958 Highest	In 1958 Date	In 1958 Lowest	In 1958 Date	Remarks
Delta County (Continued)																	
42N 19W 20-3	NE NE	USFS	134	6	Or	-	1958	M	-	-	-	-	25.42	7-23	25.84	8-27	Record started 7-23-58.
42N 18W 17-2	SW NE	USFS	60	6	Qgd	-	1958	M	-	-	-	-	23.77	7-22	24.62	11-28	Record started 7-22-58.
41N 19W 17-1	NE SW	USFS	58	6	Or	-	1958	M	-	-	-	-	1.75	11-28	3.62	8-27	Record started 7-23-58.
41N 18W 31-2	SE SW	Charles Thompson	250	4	Or	-	1958	R	-	-	-	-	4.08	9-6	5.65	12-17	Record started 8-19-58.
40N 22W 4-2	NE NW	USFS	40	5	Qgd	-	1958	M	-	-	-	-	22.86	8-6	23.19	11-24	Record started 8-6-58.
39N 23W 28-3	SW NE	Marshall and Sherman Blake	530	5	Єm	-	1958	R	-	-	-	-	2.08	7-10	3.86	9-28	Record started 8-58.
38N 22W 24-1	NW SE	USFS (3)	36	6	Or	-	1958	M	-	-	-	-	2.91	7-24	5.53	10-27	Record started 7-24-58.
Dickinson County																	
43N 29W 32-1	NW NE	Dickinson Co.(WMP 11)	12	1¼	Qgd	-	1948-58	M	5.12	4-18-51	dry	10-12-48	7.77	4-30	dry	10-1	Meas. by WMP.
42N 27W 33-1	NE NW	E.W. La Freniere (WMP 10)	12	36	Qgd	-	1945-46, 48-58	M	3.08	4-29-54	10.75	10- 3-55	4.47	4-30	9.26	9-2	Do.
41N 30W 25-1	NE SW	Dickinson Co.(WMP 1)	20	1¼	Qgd	-	1948-58	M	3.51	10-30-51	dry	10- 3-55	7.95	4-30	dry	1-31	Do.
25-2	NW SE	Wm. Carrolo (WMP 2)	16	36	Qgd	-	1945-46, 48-58	M	2.61	10-30-51	14.40	3-29-56	4.99	4-30	10.94	2-27	Do.
25-3	SE NE	Oscar Martinson (WMP 3)	12	48	Qgd	-	1945-46, 48-58	M	1.73	7- 6-53	dry	11- -48	3.59	4-30	9.71	2-27	Do.
Eaton County																	
4N 4W 2-1	SW SW	City of Grand Ledge	376	12	IPs	846.59	1948-58	W	21.34	5- 5-50	28.79	12- 3-49	25.76	1-6	27.22	12-28	P, Meas. by owner.
4N 3W 10-1	SE NE	John Schneeberger	121	3	IPs	855.99	1944-58	M	31.28	5-27-48	37.90	4-29-57	36.80	2-28	38.41	12-30	
12-1	SE SW	Mrs. Harold Worden	381	6	IPs	861.91	1953-58	R	67.51	11-23-53	78.10	8-19-55	69.2	4-7	74.2	5-16	P
24-1	SE SE	J. R. McLaughlin	22	12	Qgd	851.96	1944-58	Q	0.14	4-24-50	dry	12-12-55	1.36	4-12	dry	9-24	Often dry.
2N 4W 19-1	NW SW	City of Charlotte	25	240	Qgd	889.44	1947-58	Q	8.04	4- 7-47	15.77	1- 2-48	14.37	4-16	15.90	10-6	P
Genesee County																	
7N 7E 9-1	SE SW	Consumers Power Co.	288	12	IPs	761.83	1946-58	Q	17.50	4-11-48	45.48	7-20-57	25.12	4-15	34.20	7-8	P
17-1	SE NE	do.	222	12	IPs	757.83	1946-58	R	24.23	2-12-50	37.99	8-24-55	27.05	4-6	32.17	8-15	P
20-2	SW SW	City of Flint	169	2	Qgd	749.48	1947-58	Q	1.09	4-26-50	9.07	9-15-55	5.25	12-15	7.60	8-21	
29-1	SE SW	C. F. Crain	14	1¼	Qgd	776.63	1946-58	Q	1.69	12-22-49	9.90	10-17-57	6.82	4-15	10.46	9-23	
29-2	SW SE	Jack Palmer	8	18	Qgd	779.86	1946-58	Q	+0.20	6-29-48	8.10	9-29-57	5.92	4-15	8.50	12-15	
32-1	SW SW	A. W. Arndt	140	2	Qgd	792.27	1946-58	Q	18.51	6- 2-47	30.35	9-15-55	27.42	4-15	32.66	12-15	
6N 7E 9-1	SW SE	Grand Blanc Tank Plant (6)	375	6	IPs	841.71	1952-58	R	37.79	11-24-52	52.9	8- 3-55	42.9	1-2	52.0	8-30	P
Gladwin County																	
17N 1W 7-1	SW NW	City of Beaverton	93	12	Qgd	721.50	1950-58	D	28.90	5-14-56	49.35	6-26-50	30.04	8-28	47.79	10-9	P, Meas. by owner.
Grand Traverse County																	
27N 9W 4-1	NW NE	MDC (18)	15	2	Qgd	687.01	1934-37, 41-44, 48-52, 55-58	M	0.91	9-20-44	2.54	7-26-35	1.44	11-10	2.28	7-31	
26N 11W 27-1	NW SW	MDC (2)	14	2	Qgd	914.25	1935-37, 41-44, 48-58	Q	1.32	10-30-51	4.02	8-18-36	2.65	4-23	3.29	10-23	

25N	9W	34-1	NW NW	MDC (27)	17	2	Qgd	1025.34	1934-37, 41-44, 48-58	M	10.86	8- 6-43	14.81	4-30-57	14.65	5-2	15.05	12-17	
				Gratiot County															
12N	3W	33-1	NE SE	E. E. Peterson	19	1¼	Qgd	756.10	1947-58	Q	8.88	6-10-47	13.63	11-28-49	11.00	4-21	12.30	7-11	Record stopped 7-11-58.
		34-1	SW SE	S. J. Brown	55	2	Qgd	727.12	1947-58	M	6.08	4-26-48	40.87	6-28-50	18.43	4-21	38.98	8-27	P
		34-3	SW SE	S. H. Ball	76	2	Qgd	727.19	1946-52, 54-58	Q	5.17	4-26-48	31.05	6-28-50	16.74	4-21	29.11	7-11	P, Do.
		34-4	SE NE	Oris Martin	55	2	Qgd	744.03	1950-58	Q	21.41	4-28-50	dry	2- -50	24.20	4-21	27.56	7-11	P, Do.
		34-5	NW NE	City of Alma (5)	90	18	Qgd	-	1944, 47-50, 55-58	Q	19.94	5- 6-50	42.73	9-15-48		(23.41,	4-21)		P, Record stopped 4-21-58.
		35-3	NW SW	Walter Stone	26	2	Qgd	732.62	1947-58	M	10.07	5- 3-48	21.64	6-24-52	17.39	12-31	24.30	8.27	P
		35-5	SW NW	Reed Excavating Co.	20	36	Qgd	738.78	1950-58	M	13.74	4- 7-50	17.91	11-12-53	16.14	4-21	17.40	8-27	
12N	2W	18-1	NE NW	Mich. Chemical Co.	1350	5½	Mm	-	1957-58	R	260.4	12-31-57	267.7	8-30-57	242.3	12-31	260.8	1-3	
11N	3W	2-2	NW NE	Layne Water Co.(2)	130	8	Qgd	744.15	1947-58	M	25.0	4-29-48	72.5	8-26-50	58.16	4-21	71.20	12-1	P
		2-4	NW NW	C. D. Peet	15	1¼	Qgd	750.24	1947-58	Q	7.69	6-10-47	11.37	11-28-49	9.66	4-21	9.90	7-11	Record stopped 7-11-58.
		3-2	SW NW	City of Alma (TW 1)	160	8	Qgd	733.51	1955-58	Q	18.70	12-30-57	73.55	12-17-56	18.04	4-21	26.63	7-11	P, Do.
		3-5	NE NE	Thomas Thompson	59	2	Qgd	743.27	1947-58	Q	24.35	4-26-48	45.79	9-14-55	34.17	4-21	41.54	7-11	P, Do.
		3-6	NW NW	E. H. Waber	49	2	Qgd	733.20	1946-58	M	7.64	2-27-51	32.98	12-16-55	20.70	4-21	32.09	8-27	P
		4-1	SW NE	City of Alma (TW 6)	165	8	Qgd	732.31	1955-58	Q	12.06	6-14-55	21.38	10-15-57	15.72	4-21	17.26	7-11	P, Do.
		4-2	SW NE	do. (TW 10)	167	8	Qgd	734.43	1955-58	A	9.24	6-14-55	53.49	8-13-57		(34.18,	7-11)		P, Do.
		5-1	SE NE	John Pfarr	162	4	Qgd	740.97	1955-58	M	11.01	7-10-56	16.45	8-13-57	12.29	4-21	15.30	11-3	P
		36-1	SE SE	Village of Ithaca	785	8	IPs	804.50	1947-58	M	78.25	1-22-52	83.96	9- 4-49	79.17	4-17	80.71	11-21	
				Hillsdale County															
6S	3W	23-2	NW NW	City of Hillsdale (TW 6)	26	6	Qgd	-	1957-58	W	2.24	4-12-57	12.96	9-18-57	2.40	1-6	10.68	9-8	P
				Ingham County															
4N	2W	4-1	NW SW	C&O R.R. (East 1)	38	12	Qgd	842.19	1953-58	R	25.98	3- 3-53	32.75	11-10-57	32.02	1-6	33.57	12-30	P, Recorder removed 8-27-58.
		7-1	SE NW	Tank Bros.	107	3	IPs	866.01	1944-58	Q	53.94	11- 2-44	80.15	9-26-57	79.63	3-31	80.49	7-9	P
		9-1	SE NW	City of Lansing (Seymour 1)	401	14	IPs	828.81	1929-58	Q	15.63	3-26-31	154.77	4-10-56	132.60	7-9	138.70	12-16	P
		9-2	SW NW	Consumers Power Co.	370	12	IPs	820.69	1945-58	Q	61.26	3-23-46	143.27	12-12-55	124.24	7-9	126.51	9-24	P
		16-1	NE SE	City of Lansing (Cedar)	417	12	IPs	829.11	1945-58	Q	42.01	3-11-46	67.0	8-22-49	57.20	12-30	59.10	4-25	P
		17-1	NW NE	City of Lansing (Logan)	424	20	IPs	858.72	1929, 31, 33-58	Q	34.34	12- -29	149.64	4-11-56	135.75	4-12	137.30	9-24	P
		17-2	NW NW	Olds Drop Forge(4)	417	12	IPs	872.55	1946-58	Q	104.86	12-10-46	148.47	4-10-56	136.47	4-12	140.63	9-24	P
		19-1	SW SW	Waverly Hills Assoc.	87	2	IPs	833.94	1947-58	Q	0.00	3-29-50	5.08	4-22-57	4.88	7-9	5.77	12-30	P
		21-1	NE NW	City of Lansing (Townsend)	410	14	IPs	834.10	1906, 19, 1929-58	Q	2.0	5- 9-06	63.64	7-30-57	57.38	4-12	63.64	9-26	P
		22-1	SW NW	City of Lansing (P-5)	338	12	IPs	823.64	1930-58	M	7.1	7- -32	53.05	12-23-57	52.41	4-25	57.62	12-30	P
		23-1	NE NW	City of Lansing (RS-7)	467	12	IPs	824.86	1930-32, 36-58	M	7.55	11-17-30	105.28	7-17-56	76.95	10-31	96.28	8-31	P, Meas. by owner.
		24-1	NE SW	Mich. State Univ.	453	10	IPs	853.45	1945-58	R	25.47	3-25-46	71.7	8-16-57	50.2	12-29	78.4	5-30	P
		28-1	NE NW	Atlas Drop Forge(2)	425	8	IPs	849.20	1944-45, 48-58	Q	30.28	4-23-48	54.40	8-19-48	45.99	7-9	49.70	12-30	P
		31-1	SW SW	C. A. Weber	204	3	IPs	880.15	1944-58	M	18.92	4-26-52	24.77	5-29-57	22.97	3-31	25.35	12-30	
4N	1W	18-1	SE NE	Marble School	175	3	IPs	847.85	1952-58	M	20.09	4-27-53	29.64	4-24-57	31.23	4-25	32.56	10-30	P
3N	2W	8-1	NW NW	F. H. Kraus	72	3	IPs	876.67	1950-58	M	10.43	5- 1-50	15.22	11-24-53	13.56	4-12	15.70	12-30	
2N	1W	5-1	SE SE	City of Mason(old 2)	150	6	IPs	-	1948-58	W	0.08	6-29-49	7.37	9-17-55	1.69	3-1	7.28	9-13	P, Meas. by owner.
				Ionia County															
7N	6W	19-1	NE NE	City of Ionia (8)	143	12	Qgd	-	1957-58	R	46.77	11-18-57	49.27	11- 9-57	46.29	4-5	48.90	2-14	P
6N	5W	33-1	- NE	Barley-Earhart Co.	15	180	Qgd	-	1957-58	R	8.32	12-19-57	10.02	10- 7-57	7.23	3-1	10.16	8-18	

Table 2.--Records of Michigan observation wells and extremes in water levels observed in 1958 and for the period of record.--Continued

Well number	Location in section ¼ ¼	Owner	Depth (ft)	Dia. (in)	Chief Aquifer	Altitude	Years of record	F 58	Through 1957 Highest	Date	Lowest	Date	In 1958 Highest	Date	Lowest	Date	Remarks
								Iosco County									
23N 7E 7-1	NE SE	USFS	341	6	Qgd	-	1948-58	S	25.13	8- 3-52	27.94	1- 3-50	27.18	4-21	27.92	12-22	
								Iron County									
46N 34W 14-1	NE NW	Oliver Iron Mining Co. (WMP 18)	12	1¼	Qgd	-	1945-58	M	3.65	6- 2-54	8.60	3-15-49	5.93	8-1	7.85	4-1	Meas. by WMP.
46N 33W 18-1	SW NW	MSHD (WMP 7)	12	1¼	Qgd	-	1948-58	M	2.80	4-18-49	dry	2-28-56	5.24	8-1	7.72	1-31	Do.
45N 37W 23-1	SW NE	USFS (WMP 28)	8	1¼	Qgd	-	1948-58	M	0.75	8-31-51	4.72	9-11-48	1.06	6-30	3.07	10-1	Do.
45N 35W 33-1	SE NW	MSHD (WMP 34)	12	1¼	Qgd	-	1948-58	M	1.93	7- 6-53	8.44	3-15-49	5.53	8-1	6.85	4-1	Do.
45N 33W 8-1	SW SW	Basilo Prandi (WMP 20)	33	36	Qgd	-	1945-58	M	23.39	10-30-51	32.16	3-15-49	27.00	8-1	30.19	2-27	Do.
10-1	SE NW	Bonifas Lumber Co. (WMP 19)	7	1¼	Qgd	-	1948-58	M	2.01	9-28-51	4.23	3-12-49	2.56	6-30	3.20	5-31	Do. Record stopped 8-1-58.
44N 35W 6-1	SW SW	USFS (Paint R. 1)	6	1¼	Qgd	1468.15	1948-58	M	+0.10	5- 2-51	2.26	11-15-48	1.37	4-30	2.06	10-30	Meas. by WMP.
6-2	SW SW	USFS (do. 2)	13	1¼	Qgd	1475.14	1948-58	M	5.08	7- 6-53	8.92	11-15-48	7.67	4-30	8.68	10-1	Do.
6-3	NW SW	USFS (do. 3)	12	1¼	Qgd	1476.35	1948-58	M	4.03	7- 6-53	9.20	11-15-48	7.56	4-30	8.87	10-1	Do.
7-1	NW NW	USFS (do. 4)	4	1¼	Qgd	1469.28	1948-58	M	1.12	5- 2-51	3.73	8- 1-47	2.77	4-30	3.39	10-30	Do.
7-2	NW NW	USFS (do. 5)	13	1¼	Qgd	1471.25	1948-58	M	2.50	7- 6-53	9.44	10-26-48	4.63	4-30	5.42	10-2	Do.
7-3	NW NW	USFS (do. 6)	17	1¼	Qgd	1475.83	1948-58	M	8.48	5- 2-51	13.40	10-26-48	12.04	4-30	13.03	10-30	Do.
44N 33W 10-1	SW SW	Iron Co. (WMP 21)	8	1¼	Qgd	-	1948-58	M	1.95	4-29-54	7.94	1-12-51	2.57	6-30	5.85	10-1	Do.
43N 36W 1-1	SW NE	do. (WMP 27)	9	1¼	Qgd	-	1948-58	M	6.67	4-29-54	9.02	6-30-52	8.15	4-30	8.54	2-27	P, Do.
43N 35W 11-1	SE NE	J. J. Javoroski (WMP 23)	47	36	Qgd	-	1945-58	M	39.33	1-11-52	47.08	8-15-49	43.18	12-1	43.90	5-31	P, Do.
13-1	SW SE	F. V. Gendzwill(5)	65	36	pC	-	1945-58	A	47.90	9-11-46	63.68	11-30-46	(54.62, 10-10)				Mine drainage study.
13-2	SW SE	Boyington (hole 4-44)	?	?	?	-	1945, 47-58	A	66.39	1-14-52	71.56	3-24-49	(69.26, 10-10)				Do.
20-1	SW SE	Mrs. B. Henriksen (WMP 25)	48	1¼	Qgd	-	1945-58	M	41.66	6-20-53	48.29	8-15-49	45.47	4-30	46.22	12-30	Federal Key Well.
24-1	SE NE	Spies-Johnson No. 73 (7)	?	3	Qgd?	-	1945-58	A	70.42	11-20-56	86.05	1-19-49	(71.34, 10-10)				Mine drainage study.
26-1	SW NE	City of Iron River (1)	130	2	Qgd	-	1945-58	A	25.30	9-24-45	44.58	3-24-50	(22.48, 10-10)				P
43N 34W 19-1	NW SW	Spies-Johnson No. 3004 (8)	?	3	Qgd?	-	1945-58	A	63.37	12-20-56	89.5	10-20-45	(64.22, 10-10)				Mine drainage study.
19-2	NE SW	Spies-Johnson No. 3c (9)	?	3	Qgd?	-	1945-58	A	69.35	12-20-56	84.10	12-21-48	(70.33, 10-10)				Do.
29-1	SW NE	Rogers Mine (11)	?	48	Qgd	-	1947-53, 56-58	A	10.31	8-15-53	20.69	3-24-50	(17.70, 10-10)				Do.
43N 32W 26-2	NE SW	Caya Mine (17)	?	?	Qgd?	-	1952-58	A	1.04	5-12-55	86.03	3-18-53	(9.68, 10-10)				Do.
42N 36W 15-1	NE SW	MSHD (Brule R. 1)	6	1¼	Qgd	1543.92	1948-58	M	0.81	4-29-54	3.17	10-26-48	1.88	2-27	2.93	10-1	Meas. by WMP.
15-2	NE SW	MSHD (do. 2)	7	1¼	Qgd	1545.60	1948-58	M	0.46	7- 6-53	3.10	10-26-48	1.09	6-30	2.64	10-1	Do.
15-3	NW SW	W. Young Estate (Brule R. 3)	14	1¼	Qgd	1554.36	1948-58	M	3.67	4-29-54	8.29	10-26-48	5.84	4-30	7.58	2-27	Do.
42N 34W 7-1	SW NE	Zimmerman No. 1(13)	171	12	Qgd	1165.32	1945-58	A	132.24	8-23-56	153.27	4-21-50	(131.46, 10-10)				Mine drainage study.
42N 31W 33-1	NW SE	Iron Co. (WMP 7)	11	1¼	Qgd	-	1948-58	M	+0.03	7- 3-56	6.28	10-13-48	0.38	4-30	3.98	12-30	Meas. by WMP.
33-2	NW SE	Joseph Giachino (WMP 8)	12	15	Qgd	-	1945-58	M	1.89	10-30-51	12.22	2-25-53	5.48	5-31	10.94	12-30	Do.
41N 31W 10-1	SW NE	Iron Co. (WMP 5)	17	1¼	Qgd	-	1948-58	M	8.47	1- 3-52	dry	12-15-48	12.07	8-1	15.52	4-1	Do.
								Jackson County									
1S 1E 36-9	SE SE	MDC (9)	9	1¼	Qgd	920.28	1956-58	W	0.42	5-10-56	5.75	11-16-56	1.25	4-11	6.80	12-30	
3S 1W 11-2	NE NE	City of Jackson (4a)	360	6	IPs	-	1957-58	D	21.1	7- 7-57	71.5	8-14-57	26.2	5-4	85.7	8-13	P, Meas. by owner.

								Kalamazoo County										
2S 11W 3-37	NE NE	KVP Co. (TW 6)	25	2	Qgd	766.93	1946-58	Q	9.49	4-18-50	14.96	10-18-57	13.16	3-25	14.74	10-2	P
3-60	NE NE	do. (61)	36	6	Qgd	763.18	1956-58	W	10.21	5-27-57	12.05	10-14-57	10.05	3-10	11.98	9-15	P, Meas. by owner.
15-18	NE SE	Consumers Power Co.	64	12	Qgd	766.17	1946-58	Q	9.20	3-28-50	15.97	10-18-57	14.96	3-26	17.29	12-17	P
15-31	NW SW	Wigginton Co.	68	6	Qgd	781.37	1946-58	Q	18.55	5-22-50	26.05	10-18-57	25.33	3-26	27.03	12-18	P
15-33	NE SW	Columbia Hotel	65	5	Qgd	769.46	1946-58	Q	13.64	4-18-50	21.51	10-18-57	20.15	3-26	22.81	12-18	P
20-7	SW SE	Western Mich. Univ.	78	8	Qgd	868.68	1946-58	Q	33.44	6-19-50	36.90	10-18-57	36.30	3-26	37.40	12-18	
22-6	NE SW	City of Kalamazoo	115	6	Qgd	777.45	1946-58	R	11.22	3-11-52	29.36	8- 9-46	23.43	4-14	29.77	10-10	P, Meas. by owner.
26-3	NE NE	Reed Land Co.	41	6	Qgd	773.71	1947-58	S	3.63	4-26-50	11.14	11- 6-53	8.24	3-26	9.59	12-18	P
27-52	NE NE	Bryant Paper Co.(7)	113	12	Qgd	802.59	1946-58	R	34.46	5- 5-50	64.37	9- 1-46	44.20	4-7	48.10	10-17	P, Meas. by Kalamazoo.
29-3	SW SE	Oakwood, Inc.	47	2	Qgd	880.72	1946-58	Q	26.12	8- 1-52	29.88	8- 6-53	29.58	3-26	30.26	12-18	
4S 11W 13-2	NE SW	Lee Paper Co.(7A)	48	12	Qgd	838.18	1946-58	A	+0.55	7- 8-50	9.72	9-14-46		(6.78, 7-10)			P
21-2	NW SW	Willis Chamberlain	19	1¼	Qgd	-	1957-58	W	14.07	12-28-57	14.62	11-14-57	13.25	4-19	14.88	12-29	
27-1	SE NW	H. E. Stiver	19	1¼	Qgd	854.64	1953-58	A	12.94	7-12-56	15.22	1-20-54		(14.73, 7-10)			
								Kalkaska County										
27N 5W 36-1	SE NW	MDC (100)	16	1¼	Qgd	-	1939-58	W	11.12	7-11-43	14.69	3-12-40	13.29	5-1	14.39	10-3	
								Kent County										
9N 12W 22-1	SE NE	Village of Sparta (3)	90	12	Qgd	-	1957-58	W	35.60	9- 6-57	44.3	10-29-57	33.2	2-8	42.3	6-23	P, Meas. by owner.
23-1	SE NW	Carnation Co.(6)	280	10	Mb?	-	1957-58	R	0.13	12-28-57	7.9	10- 6-57	+0.70	1-25	7.0	5-28	P
6N 12W 17-1	SE NE	Jervis Corp. (1)	30	12	Qgd	-	1950-58	M	6.88	6- 8-56	16.45	2-12-54	9.78	4-9	12.38	12-2	P, Do.
17-2	SE NE	do.	26	6	Qgd	606.05	1950-58	M	7.34	6- 1-56	16.32	2-12-54	9.70	4-9	12.22	12-2	P, Do.
								Lake County										
17N 13W 3-1	SW NW	C and O RR. (East Well)	28	10	Qgd	-	1957-58	A	19.94	7-18-57	21.28	12-31-57		(20.82, 4-23)			
4-1	SE NE	C and O RR (West Well)	83	8	Qgd	-	1957-58	S	19.34	7-18-57	20.34	11- 4-57	19.69	12-9	20.36	5-23	
								Livingston County										
2N 4E 3-1	NW SW	Howell State Sanitarium	148	8	IPs	-	1958	R	-	-	-	-	11.1	7-9	27.8	12-13	P, Record started 4-28-58. Meas. by owner.
9-1	NW NE	Howell State Sanitarium(TW 3)	280	6	IPs	-	1958	R	-	-	-	-	110.6	7-12	115.2	5-23	P, Do.
								Mackinac County										
42N 2W 7-1	NE NE	USFS (Pontchartrain)	102	6	Sm	-	1956-58	R	15.15	7- 5-57	29.35	11- 5-57	21.40	4-29	29.19	9-5	
9-1	NE NW	Kenneth Kerr	84	2	Sm	-	1956, 58	M	+1.0	6- 7-56	+0.43	8- 8-56	2.97	10-28	3.83	8-28	Not meas. in winter.
41N 5W 23-1	SW NW	MDC (Round Lake)	47	6	Ss	-	1956-58	R	5.80	4-13-57	17.09	11- 8-57	11.02	4-29	16.58	3-18	
								Manistee County										
21N 14W 13-1	NE NE	MDC	63	6	Qgd	-	1949-54, 58	M	12.54	5- 8-51	16.12	12-19-49	15.74	12-9	16.45	10-7	Record resumed 5-7-58. Formerly MsNr 1.
								Marquette County										
49N 30W 22-1	SW NE	Marquette Co. (WMP 13)	17	1¼	Qgd	-	1948-58	M	0.64	5- 3-51	13.32	9- 2-48	8.89	6-30	10.72	10-1	Meas. by WMP
45N 30W 1-1	SW NW	Arnold Janofski (WMP 4)	31	36	Qgd	-	1945-58	M	25.38	12-13-56	29.28	3-15-49	27.33	1-31	27.92	12-30	Do.
45N 25W 28-1	NE NW	MDC (Gwinn CCC)	18	6	Qgd?	-	1958	M	-	-	-	-	4.10	8-5	4.72	8-27	Not meas. in winter.
44N 26W 28-1	NE SE	MDC (Escanaba R. CCC)	31	6	Qgd	-	1953-58	M	2.05	5-10-54	2.83	8-30-57	2.21	5-20	2.71	8-27	

Table 2.--Records of Michigan observation wells and extremes in water levels observed in 1958 and for the period of record.--Continued

Well number	Location in section ¼ ¼	Owner	Depth (ft)	Dia. (in)	Chief Aquifer	Altitude	Years of record	F 58	Through 1957 Highest	Date	Through 1957 Lowest	Date	In 1958 Highest	Date	In 1958 Lowest	Date	Remarks
Mason County																	
17N 15W 3-1	SE SW	USFS	32	6	Qgd	737.37	1948-58	M	14.44	5-15-52	19.30	12-31-57	17.90	12-22	19.45	8-24	
Montcalm County																	
9N 8W 10-1	SW NW	City of Greenville (1)	29	12	Qgd	-	1957-58	R	3.35	11-17-57	7.05	10-11-57	4.60	3-3	7.76	6-13	P
15-1	SW NW	do. (9)	65	12	Qgd	-	1950-58	M	11.40	4- 1-50	17.36	8- 3-55	13.30	12-1	17.40	8-1	P
Montmorency County																	
32N 2E 34-1	NW NE	MDC	24	2	Qgd	-	1948-58	Q	17.41	5-15-52	20.97	8-17-49	20.48	4-22	21.12	12-3	
29N 3E 21-1	NW NE	MDC (32)	14	2	Qgd	-	1945-58	Q	2.63	5-15-52	5.91	1-27-56	4.81	4-22	5.90	12-2	
Oakland County																	
3N 10E 31-1	NE SW	City of Pontiac (Orchard L.)	173	12	Qgd	-	1952-58	R	109.2	1- 5-53	128.0	8- 6-55	107.5	11-4	115.6	8-5	P, Meas. by owner.
32-1	SE NW	City of Pontiac(6)	160	8	Qgd	921.88	1939-58	R	59.55	4-22-40	129.5	8- 5-55	107.7	10-27	115.0	8-5	P, Do.
2N 10E 22-1	NE NW	Cranbrook School (3)	65	6	Qgd	-	1950-58	W	11.00	4-30-56	17.60	9-26-55	11.75	3-24	16.96	10-6	P, Do.
Ogemaw County																	
23N 1E 4-1	SE NE	MDC (15)	21	4	Qgd	-	1934, 55-58	Q	1.73	7-15-57	4.26	10-10-55	1.85	4-1	4.17	10-22	
23N 2E 2-1	NE NW	Charles Hudson	7	36	Qgd	-	1951-58	R	0.37	5- 5-52	4.05	3- 1-56	1.90	6-1	4.16	11-5	
Ontonagon County																	
51N 41W 8-1	SE NW	Mich. Corrections Dept.	100	6	p€f	620±	1958	R	-	-	-	-	9.90	12-27	11.87	10-18	Record started 10-18-58.
Otsego County																	
29N 3W 29-1	SW SE	MDC (106)	15	2	Qgd	-	1933-58	Q	5.56	5-14-47	9.68	9-16-41	8.59	7-9	9.74	10-7	
Presque Isle County																	
33N 2E 30-1	NE SE	MDC (19)	14	2	Qgd	-	1934-44, 48-58	Q	1.80	5-23-38	5.69	1-27-56	3.70	4-22	4.39	10-9	
Roscommon County																	
24N 2W 20-1	NE NW	MDC (1)	14	8	Qgd	1145.30	1934-58	R	2.78	5- 3-51	6.23	12- 6-49	4.28	4-17	6.04	10-8	Federal Key Well.
23N 1W 3-1	SE SE	MDC (50)	12	2	Qgd	1188.95	1939-58	Q	1.62	6-15-43	7.31	12-14-49	3.60	4-21	6.33	10-22	
22N 3W 22-1	SE NE	MDC (7)	14	2	Qgd	1170.58	1934-58	Q	3.25	4-17-52	8.25	12-13-49	4.69	4-21	7.14	10-22	
Saginaw County																	
9N 3E 16-2	SE NW	Ray Ellis	129	3	IPs	-	1958	W	-	-	-	-	40.15	4-15	52.27	8-3	P, Record started 4-15-58.
St. Joseph County																	
6S 11W 18-1	SW SE	City of Three Rivers (7)	59	6	Qgd	790.92	1939-58	W	+2.90	5-22-53	5.70	9-27-47	+0.20	3-7	2.30	7-11	P, Well destroyed. Record stopped 8-29-58.

								Sanilac County									
12N 13E 33-1	SE SE	MSHD	150	3	Mm	-	1948-58	W	15.45	4-25-51	23.42	2- 1-56	17.30	4-16	23.23	12-31	
								Schoolcraft County									
47N 16W 30-1	NW NW	MDC (Cusino)	57	6	Oat	-	1957-58	R	13.88	9-25-57	15.51	11- 7-57	10.71	5-16	15.17	11-6	
45N 18W 31-1	NE SW	USFS	229	5	Otb	-	1958	M	-	-	-	-	16.11	8-25	16.54	12-29	Record started 8-25-58.
45N 13W 16-1	SW SW	U.S. Fish and Wildlife Serv.	154	4	Or	-	1952-58	R	5.09	4-12-54	6.28	9-26-55	5.30	2-28	5.87	8-23	
								Shiawassee County									
7N 3E 19-1	SE NW	City of Owosso	55	16	Qgd	-	1958	R	-	-	-	-	28.90	9-10	32.09	12-31	P, Record started 9-10-58.
5N 2E 16-1	NE SE	A. B. Cobb	26	1½	Qgd	896.00	1948-58	M	17.28	5- 3-50	21.10	10-30-53	19.42	4-15	22.11	12-15	
								Washtenaw County									
3S 6E 16-1	SW NW	City of Ann Arbor	23	2	Qgd	817.43	1920-58	W	e+2.5	2- -30	e10.0	11- -27	2.50	5-21	9.01	11-12	P, Meas. by owner.
16-2	SE NW	do.	23	192	Qgd	-	1948-58	W	+2.00	6-30-51	15.50	8-21-57	3.74	2-26	12.10	11-5	P, Do.
3S 7E 24-1	NE SW	Ford Motor Co.(104)	87	4	Qgd	665.56	1943-45, 49-58	M	5.79	1- 5-50	16.43	10-16-56	13.08	10-21	14.20	1-28	P, Meas. by Ypsilanti Twp.
24-2	NE SW	do. (106)	53	4	Qgd	664.51	1943-45, 49-58	M	11.81	7-13-43	31.57	5-10-57	23.82	10-21	28.73	8-6	P, Do.
24-4	NE SW	do. (107)	53	4	Qgd	664.05	1943-45, 49-58	M	11.55	1- 5-50	33.0	5-10-57	24.76	10-21	30.68	8-6	P, Do.
24-5	NW SW	do. (109)	77	4	Qgd	665.56	1943-45, 49-58	M	15.15	6- 6-45	37.76	5-22-57	31.78	10-21	32.54	8-6	P, Do.
24-6	SW SW	Federal Works Agency (117)	75	6	Qgd	657.83	1944-45, 49-58	M	5.69	2-15-50	26.22	5-10-57	18.25	10-21	24.38	8-6	P, Do.
24-7	- SW	Ford Motor Co.(124)	90	24	Qgd	686.5	1955-58	M	23.47	12-29-55	36.05	10-16-56	33.78	10-21	35.04	6-6	P, Do.
4S 6E 9-1	NW NW	Ypsilanti State Hosp. (TW 20)	184	6	Qgd	-	1946-58	W	51.22	5-15-48	88.14	6-17-49	77.31	12-19	79.83	10-30	P, Meas. by owner.
10-1	SW NW	do. (TW 22)	173	6	Qgd	-	1946-58	W	61.48	6-12-53	88.27	7- 8-55	64.63	11-11	82.26	3-28	P, Do.
								Wayne County									
1S 8E 16-1	NE NE	Plymouth State School (TW 9)	105	6	Qgd	-	1958	R	-	-	-	-	55.23	4-6	58.78	12-24	Do.
								Wexford County									
24N 9W 19-1	SW NW	MDC (38)	11	2	Qgd	944.16	1935-37, 41-44, 49-58	Q	0.94	4-10-51	3.74	8-19-36	1.33	12-17	2.15	7-28	
21N 11W 13-1	NW NE	USFS	62	6	Qgd	-	1948-58	M	46.28	6- 5-52	50.16	12-31-57	50.65	4-23	51.13	11-1	
21N 9W 4-1	NW NE	City of Cadillac	277	6	Qgd	-	1949-58	Q	19.99	7- 6-53	23.24	2-14-51	23.21	7-14	23.83	10-6	P

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