GROUND-WATER DATA FOR MICHIGAN 1987

by G. C. Huffman and C. R. Whited

U.S. GEOLOGICAL SURVEY

Open-File Report 88-704

Prepared in cooperation with the

MICHIGAN DEPARTMENT OF NATURAL RESOURCES
GEOLOGICAL SURVEY DIVISION

Lansing, Michigan
1988

UNITED STATES DEPARTMENT OF THE INTERIOR

DONALD PAUL HODEL, Secretary

GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information
write to:

District Chief
U.S. Geological Survey
6520 Mercantile Way, Suite 5
Lansing, MI 48911

Copies of this report can
be purchased from:

U. S. Geological Survey
Books and Open-File Reports
Box 25425, Federal Center
Denver, CO 80225

CONTENTS

FIGURES

TABLES

CONVERSION FACTORS AND ABBREVIATIONS

For the convenience of readers who may prefer to use metric (International System) units rather than the inch-pound units used in this report, values may be converted by using the following factors:

Multiply inch-pound units	by	To obtain metric units
inch (in.)	25.4	millimeter (mm)
feet (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
acre	0.4047	hectare
gallon (gal)	3.785	liter (L)
gallon per minute (gal/min)	0.06308	liter per second (L/s)
million gallons (Mgal)	3,785	cubic meters (m^3)
gallon per minute per foot [(gal/min)/ft]	0.2070	liter per second per meter [(L/s)/m]

Temperature in degrees Fahrenheit (°F) as follows:

$$°F = 1.8 \times °C + 32$$

GROUND-WATER DATA FOR MICHIGAN

1987

by G. C. Huffman and C. R. Whited

ABSTRACT

Water levels, locations, depths, and aquifers tapped are given for 112 observation wells. Tabulated data include extremes of water levels for calendar year 1987 and for the period of record, pumpage of most major ground-water users in the State, and water-quality data from selected wells. The largest municipal user of ground water, the city of Lansing, pumped 7.8 billion gallons from the Saginaw Formation and glacial deposits in 1987.

INTRODUCTION

Purpose and Scope

This report provides records of water levels and related data collected during 1987 for the principal aquifers of Michigan. Data on yield of wells, pumpage, quality of water, and hydrographs of ground-water levels for the past 5 years are shown in the text. Yearly hydrographs are included to illustrate seasonal changes in water levels. Records of water levels in observation wells, records of pumpage by most major ground-water users, and water-quality data from selected wells sampled during 1987 are given in tables 2, 3, and 4. Distribution of observation wells is shown in figure 1. Location of wells sampled for water-quality data and years sampled are shown in figure 2.

Use of Ground-Water Data

The quantity of water available from an aquifer can be determined by analysis of records of water levels and pumpage. Water-level records showing long-term effects of pumping can be used to estimate the capacity of aquifers to meet present and future demands for water and to determine whether expansion of present supply systems for ground water is practicable.

Water levels normally fluctuate annually and may exhibit long-term trends over a period of years. A knowledge of fluctuations is important when planning constructions that require excavation. For example, when construction is made after several years of drought, the allowance for rising water levels should be greater. Test drilling may be needed at some sites to determine water levels. In an area where the water level is declining because of pumping, projection of future water levels indicates the depth below which well intakes should be installed.

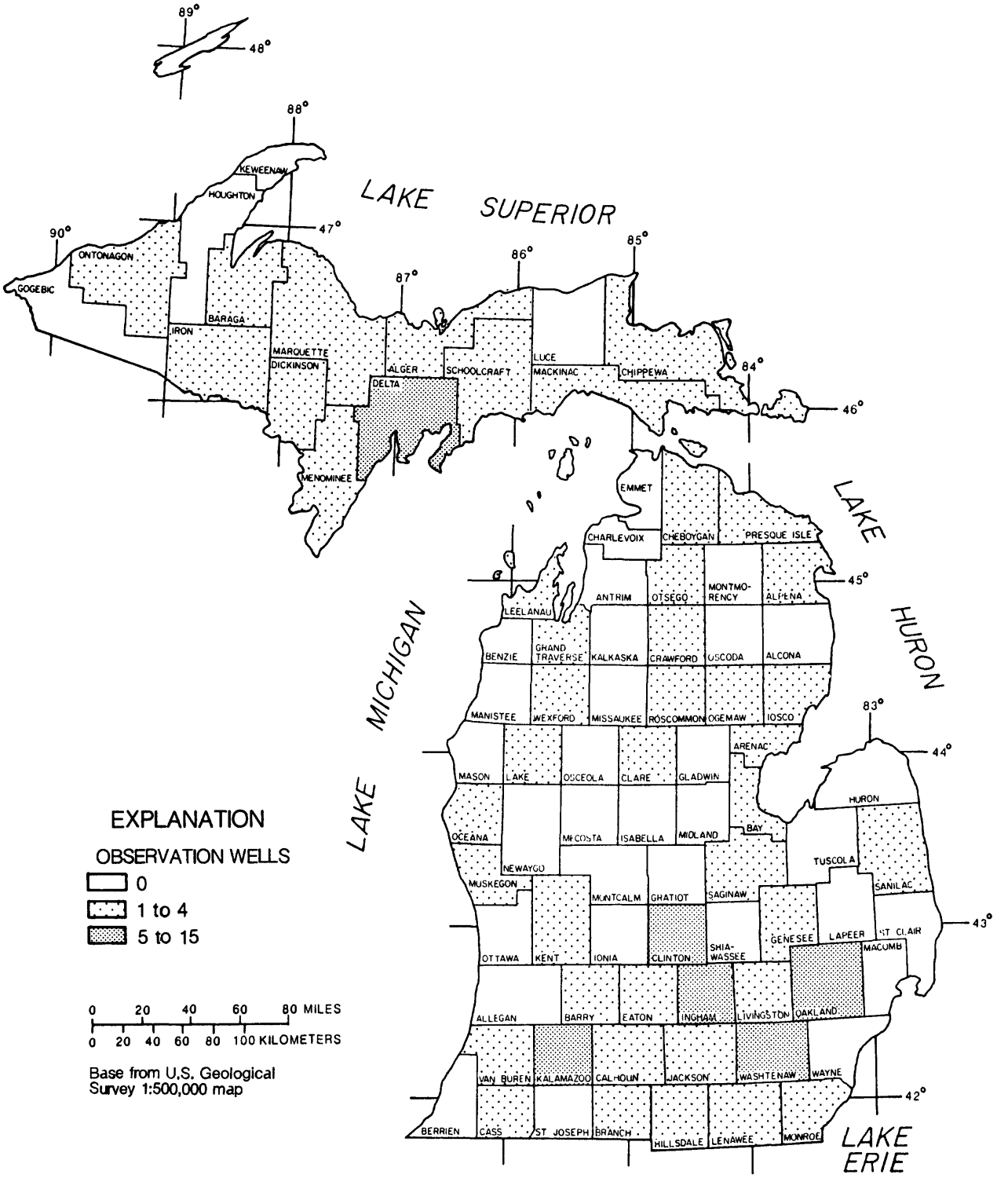


Figure 1.--Distribution of observation wells. (Water levels were monitored in 112 wells in 1987.)

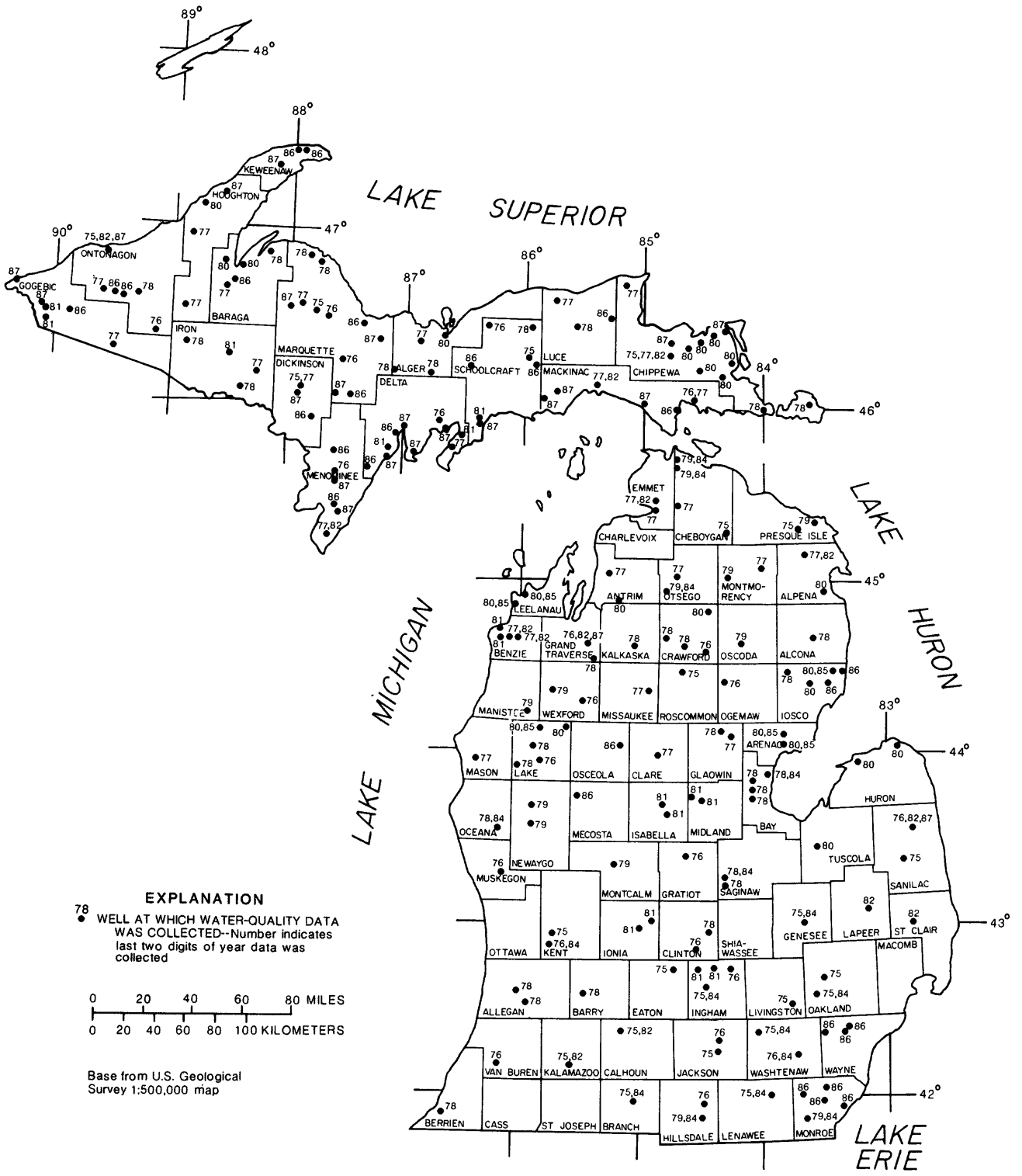


Figure 2.--Water-quality sampling sites and year sample collected. (Water-quality data are given in the Michigan annual ground-water report for year in which sample was collected. Data for the years 1975-76 are in the annual report for 1977.)

Ground-Water Records and Reports

Tabulations of water-level measurements, hydrographs of observation wells, chemical analyses, water-temperature measurements, well records and logs, aquifer tests, records of pumping for public and industrial supplies, and water resources reports are on file for public inspection. They may be examined at the office of the Geological Survey Division, Michigan Department of Natural Resources, 735 E. Hazel Street, Lansing, Michigan 48912, or at the office of the U.S. Geological Survey, Water Resources Division, 6520 Mercantile Way, Suite 5, Lansing, Michigan 48911. Records for the Upper Peninsula of Michigan are also on file at the U.S. Geological Survey Office, State Office Building, Escanaba, Michigan 49829.

Ground-water levels from 1935-1974 are reported in U.S. Geological Survey Water-Supply Papers. Records since 1975 are in U.S. Geological Survey Water-Data Reports. Annual reports, titled "Summary of Ground-Water Conditions in Michigan," were begun in 1956 to supplement the Water-Supply Paper and Water-Data Report series. The title of the report was changed to "Summary of Ground-Water Hydrological Data in Michigan" in 1967, and to "Ground-Water Data for Michigan" in 1973.

Areas covered by reports that describe ground water in Michigan are shown in figure 3 and listed in table 1. In addition, many publications dealing with ground water are listed in the references at the end of this report.

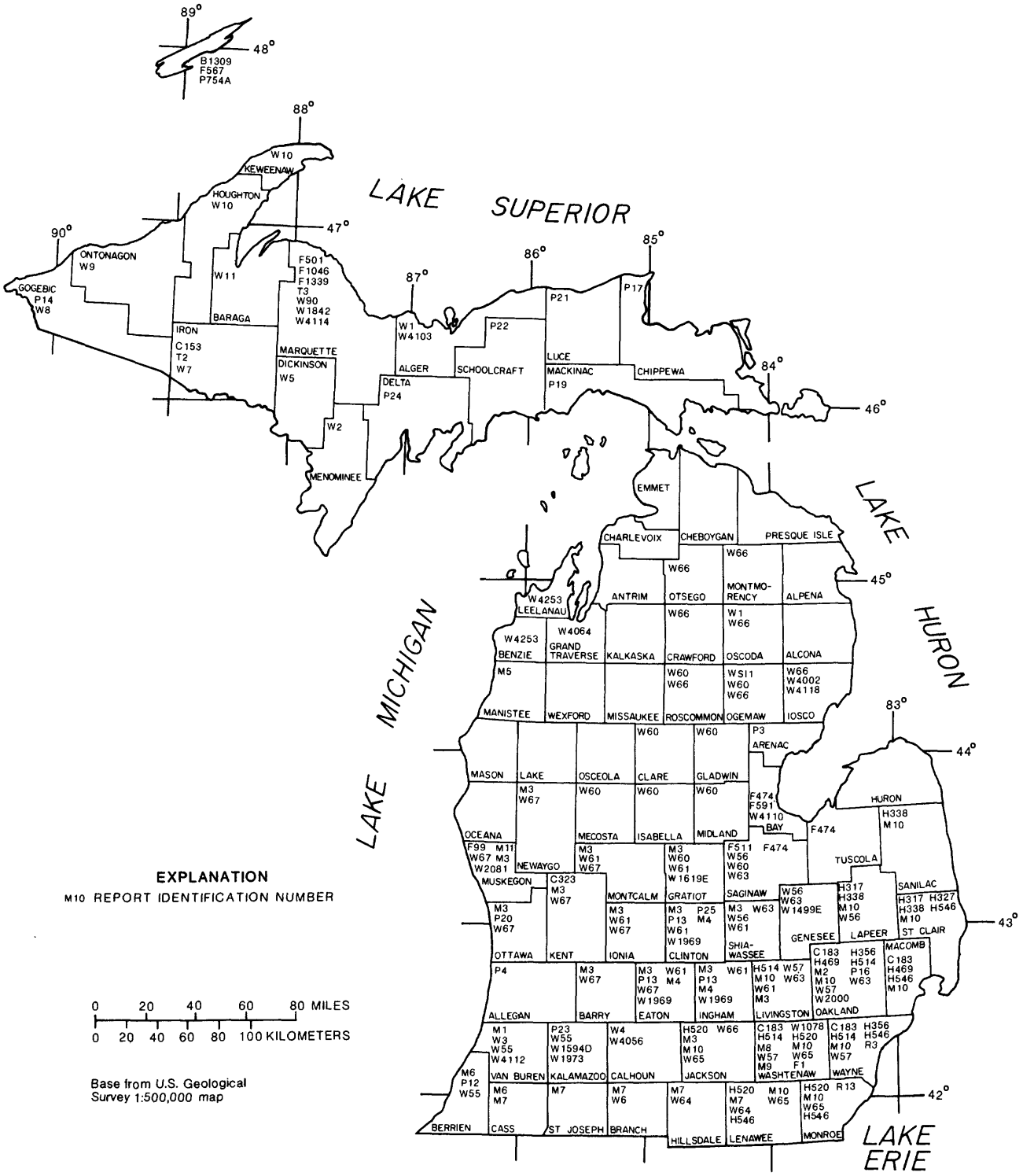


Figure 3.--Ground-water reports in Michigan.
(See table 1 for report title)

Table 1.--Published reports on ground water in Michigan

B1309 -- Huber, N. K., 1975, The geologic story of Isle Royale National Park: U.S. Geological Survey Bulletin 1309.

C153 -- Pettijohn, F. J., 1952, Geology of the northern Crystal Falls area, Iron County, Michigan: U.S. Geological Survey Circular 153.

C183 -- Wisler, C.O., Stramel, G. J., and Laird, L. B., 1952, Water resources of the Detroit area, Michigan: U.S. Geological Survey Circular 183.

C323 -- Stramel, G. J., Wisler, C. O., and Laird, L. B., 1954, Water resources of the Grand Rapids area, Michigan: U.S. Geological Survey Circular 323.

F1 -- Fleck, W. B., 1980, Geology and hydrology for environmental planning in Washtenaw County, Michigan: U.S. Geological Survey Open-File Report unnumbered.

F99 -- McDonald, M. G., and Fleck, W. B., 1978, Model analysis of the impact on ground-water conditions of the Muskegon County wastewater disposal system, Michigan: U.S. Geological Survey Open-File Report 78-99.

F474 -- Mandle, R. J., and Westjohn, D. B., 1987, Preliminary interpretation of vertical electrical-resistivity soundings in the Saginaw Valley, Michigan: U.S. Geological Survey Open-File Report 87-474.

F501 -- Doonan, C. J., and VanAlstine, J. L., 1982, Ground water and geology of Marquette County, Michigan: U.S. Geological Survey Open-File Report 82-501.

F511 -- Handy, A. H., 1982, Water quality of coal deposits and abandoned mines, Saginaw County, Michigan: U.S. Geological Survey Open-File Report 82-511.

F567 -- Grannemann, N. G., and Twenter, F. R., 1982, Ground water for public supply at Windigo, Isle Royale National Park, Michigan: U.S. Geological Survey Open-File Report 82-567.

F591 -- Stark, J. R., and McDonald, M. G., 1980, Ground water of coal deposits, Bay County, Michigan: U.S. Geological Survey Open-File Report 80-591.

F1046 -- Grannemann, N. G., 1978, Water supply potential of the Lake Sally system, Marquette County, Michigan: U.S. Geological Survey Open-File Report 78-1046.

F1339 -- ____, 1979, Water resources of the Marquette Iron Range area, Marquette County, Michigan: U.S. Geological Survey Open-File Report 79-1339.

H317 -- Knutilla, R. L., 1969, Water resources of the Belle River basin, southeastern Michigan: U.S. Geological Survey Hydrological Investigation Altas HA-317.

H327 -- ____, 1969, Water resources of the Pine River basin, southeastern Michigan: U.S. Geological Survey Hydrological Investigation Atlas HA-327.

H338 -- ____, 1970, Water resources of the Black River basin, southeastern Michigan: U.S. Geological Survey Hydrological Investigation Atlas HA-338.

H356 -- ____, 1971, Water resources of the River Rouge basin, southeastern Michigan: U.S. Geological Survey Hydrological Investigation Atlas HA-356.

H469 -- Nowlin, J. O., 1973, Water resources of the Clinton River basin, southeastern Michigan: U.S. Geological Survey Hydrological Investigation Atlas HA-469.

H514 -- Larson, R. W., Allen, W. B., and Hanson, S. D., 1975, Water resources of the Huron River basin, southeastern Michigan: U.S. Geological Survey Hydrological Investigation Atlas HA-514.

H520 -- Knutilla, R. L., and Allen, W. B., 1975, Water resources of the River Raisin basin, southeastern Michigan: U.S. Geological Survey Hydrological Investigation Atlas HA-520.

H546 -- Twenter, F. R., Knutilla, R. L., Cummings, T. R., 1975, Water resources of basins for minor streams draining into St. Clair River, Lake St. Clair, Detroit River, and Lake Erie, southeastern Michigan: U.S. Geological Survey Hydrological Investigation Atlas HA-546.

M1 -- Terwilliger, F. W., 1954, The glacial geology and ground-water resources of Van Buren County, Michigan, pt. 1 of Occasional papers for 1954 on the geology of Michigan: Michigan Geological Survey Publication 48.

M2 -- Mozola, A. J., 1954, A survey of ground-water resources in Oakland County, Michigan, pt. 2 of Occasional papers for 1954 on the geology of Michigan: Michigan Geological Survey Publication 48.

M3 -- Vanlier, K. E., 1968, Comprehensive planning study of the Grand River basin, Michigan, Appendix E, Ground-water resources and geology of the Grand River basin, Michigan: U.S. Army Engineers District, Detroit, Michigan.

M4 -- Vanlier, K. E., and Wheeler, M. L., 1968, Analog simulation of ground-water development of the Saginaw Formation, Lansing metropolitan area, Michigan: Tri-County Planning Commission, Lansing Ground-Water Report.

M5 -- Childs, K. E., 1970, History of the salt, brine, and paper industries and their probable effect on the ground-water quality in the Manistee Lake area, Michigan: Michigan Department of Natural Resources.

Table 1.--Published reports on ground water in Michigan--Continued

M6 -- Schneider, A. F., and Keller, S. J., 1970, Indiana Geological Survey regional geological map number 4: Indiana Department of Natural Resources.

M7 -- Johnson, G. H., and Keller, S. J., 1972, Indiana Geological Survey regional geologial map number 8: Indiana Department of Natural Resources.

M8 -- Twenter, F. R., Knutilla, R. L., and Nowlin, J. O., 1976, Water resources of Washtenaw County, Michigan: Washtenaw County Metropolitan Planning Commission.

M9 -- Borton, T. E., 1974, Planning perspectives on water resources, Washtenaw County, Michigan: Washtenaw County Metropolitan Planning Commission.

M10 -- Twenter, F. R., 1975, Ground water and geology -- southeastern Michigan: U.S. Army Corps of Engineers.

M11 -- Fleck, W. B., and McDonald, M. G., 1978, Three-dimensional finite-difference model of ground-water system underlying the Muskegon County wastewater disposal system, Michigan: U.S. Geological Survey Journal of Research, volume 6, number 3.

P3 -- Pringle, G. H., 1937, Geology of Arenac County, Michigan: Michigan Geological Survey Progress Report 3.

P4 -- Riggs, C. H., 1938, Geology of Allegan County, Michigan: Michigan Geological Survey Progress Report 4.

P12 -- Stuart, W. T., and Stallman, R. W., 1945, Ground-water resources of the Benton Harbor area, Michigan: Michigan Geological Survey Progress Report 12.

P13 -- Stuart, W. T., 1945, Ground-water resources of the Lansing area, Michigan: Michigan Geological Survey Progress Report 13.

P14 -- Brown, E. A., and Stuart, W. T., 1951, Ground-water resources of the glacial deposits in the Bessemer area, Michigan: Michigan Geological Survey Progress Report 14.

P16 -- Ferris, J. G., and others, 1954, Ground-water resources of southeastern Oakland County, Michigan: Michigan Geological Survey Progress Report 16.

P17 -- Vanlier, K. E., and Deutsch, Morris, 1958, Reconnaissance of the ground-water resources of Chippewa County, Michigan: Michigan Geological Survey Progress Report 17.

P19 -- ____, 1958, Reconnaissance of the ground-water resources of Mackinac County, Michigan: Michigan Geological Survey Progress Report 19.

P20 -- Deutsch, Morris, Burt, E. M., and Vanlier, K. E., 1958, Summary of ground-water investigations in the Holland area, Michigan: Michigan Geological Survey Progress Report 20.

P21 -- Vanlier, K. E., 1959, Reconnaissance of the ground-water resources of Luce County, Michigan: Michigan Geological Survey Progress Report 21.

P22 -- Sinclair, W. C., 1959, Reconnaissance of the ground-water resources of Schoolcraft County, Michigan: Michigan Geological Survey Progress Report 22.

P23 -- Deutsch, Morris, Vanlier, K. E., and Giroux, P. R., 1960, Ground-water hydrology and glacial geology of the Kalamazoo area, Michigan: Michigan Geological Survey Progress Report 23.

P24 -- ____, 1960, Reconnaissance of the ground-water resources of Delta County, Michigan: Michigan Geological Survey Progress Report 24.

P25 -- Vanlier, K. E., 1962, Summary of ground-water investigations in the Elsie area, Michigan: Michigan Geological Survey Progress Report 25.

P754A -- Huber, N. K., 1973, Glacial and postglacial geologic history of Isle Royale National Park, Michigan: U.S. Geological Survey Professional Paper 754-A.

R3 -- Mozola, A. J., 1969, Geology for land and ground-water development in Wayne County, Michigan: Michigan Geological Survey Report Investigation 3.

R13 -- ____, 1970, Geology for environmental planning in Monroe County, Michigan: Michigan Geological Survey Report Investigation 13.

T2 -- Stuart, W. T., Theis, C. V., and Stanley, G. M., 1948, Ground-water problems in the Iron River district, Michigan: Michigan Geological Survey Technical Report 2.

T3 -- Stuart, W. T. Brown, E. A., and Rhodehamel, E. C., 1954, Ground-water investigations of the Marquette iron-mining district, Michigan: Michigan Geological Survey Technical Report 3.

W1 -- Vanlier, K. E., 1963, Reconnaissance of the ground-water resources in Alger County, Michigan: Michigan Geological Survey Water Investigation 1.

W2 -- ____, 1963, Ground water in Menominee County: Michigan Geological Survey Water Investigation 2.

W3 -- Giroux, P. R., Hendrickson, G. E., Stoimenoff, L. E., and Whetstone, G. W., 1964, Water resources of Van Buren County, Michigan: Michigan Geological Survey Investigation 3.

Table 1.--Published reports on ground water in Michigan--Continued

W4 -- Vanlier, K. E., 1966, Ground-water resources of the Battle Creek area, Michigan: Michigan Geological Survey Water Investigation 4.

W5 -- Hendrickson, G. E., and Doonan, C. J., 1966, Ground-water resources of Dickinson County, Michigan: Michigan Geological Survey Water Investigation 5.

W6 -- Giroux, P. R., Stoimenoff, L. E., Nowlin, J. O., and Skinner, E. L., 1966, Water resources of Branch County, Michigan: Michigan Geological Survey Water Investigation 6.

W7 -- Doonan, C. J., Hendrickson, G. E., 1967, Ground water in Iron County, Michigan: Michigan Geological Survey Water Investigation 7.

W8 -- ____, 1968, Ground water in Gogebic County, Michigan: Michigan Geological Survey Water Investigation 8.

W9 -- ____, 1969, Ground water in Ontonagon County, Michigan: Michigan Geological Survey Water Investigation 9

W10 -- Doonan, C. J., Hendrickson, G. E.,and Byerlay, J. R., 1970, Ground water and geology of Keweenaw Peninsula, Michigan: Michigan Geological Survey Water Investigation 10.

W11 -- Doonan, C. J., and Byerlay, J. R., 1973, Ground water and geology of Baraga County, Michigan: Michigan Geological Survey Water Investigation 11.

W55 -- Water resource conditions and uses in the Paw Paw River Basin, 1955, (revised report in 1964): Michigan Water Resources Commission Report.

W56 -- Water resource conditions and uses in the Flint River Basin, 1956: Michigan Water Resources Commission Report.

W57 -- Water resource conditions and uses in the Huron River Basin, 1957: Michigan Water Resources Commission Report.

W60 -- Water resource conditions and uses in the Tittabawassee River Basin, 1960: Michigan Water Resources Commission Report.

W61 -- Water resource conditions and uses in the Upper Grand River Basin, 1961: Michigan Water Resources Commission Report.

W63 -- Water resource conditions and uses in the Shiawassee River Basin, 1963: Michigan Water Resources Commission Report.

W64 -- Water resource conditions and uses in the Maumee River Basin, 1964: Michigan Water Resources Commission Report.

W65 -- Water resource conditions and uses in the River Raisin Basin, 1965: Michigan Water Resources Commission Report.

W66 -- Water resource conditions and uses in the Au Sable River Basin, 1966: Michigan Water Resources Commission Report.

W67 -- Water resource conditions and uses in the Lower Grand River Basin, 1967, (open file): Michigan Water Resources Commission Report.

W90 -- Twenter, F. R., 1981, Geology and hydrology for environmental planning in Marquette County, Michigan: U.S. Geological Survey Water Resources Investigations, 80-90.

W1078 -- McGuinness, C. L., Poindexter, O. F., and Otton, E. G., 1949, Ground-water supplies of the Ypsilanti area, Michigan: U.S. Geological Survey Water-Supply Paper 1078.

W1499E -- Wiitala, S. W., Vanlier, K. E., and Krieger, R. A., 1963, Water resources of the Flint area, Michigan: U.S. Geological Survey Water-Supply Paper 1499-E.

W1594D -- Reed, J. E., Deutsch, Morris, and Wiitala, S. W., 1966, Induced recharge of an artesian glacial-drift aquifer at Kalamazoo, Michigan: U.S. Geological Survey Water-Supply Paper 1594-D.

W1619E -- Vanlier, K. E., 1963, Ground-water resources of the Alma area, Michigan: U.S. Geological Survey Water-Supply Paper 1619-E.

W1842 -- Wiitala, S. W., Newport, T. G., and Skinner, E. L., 1967, Water Resources of the Marquette Iron Range area, Michigan: U.S. Geological Survey Water-Supply Paper 1842.

W1969 -- Vanlier, K. E., Wood, W. W., and Brunett, J. O., 1973, Water-supply development and management alternatives for Clinton, Eaton, and Ingham Counties, Michigan: U.S. Geological Survey Water-Supply Paper 1969.

W1973 -- Allen, W. B., Miller, J. B., and Wood, W. W., 1972, Availability of water in Kalamazoo County, Michigan: U.S. Geological Survey Water-Supply Paper 1973.

W2000 -- Twenter, F. R., and Knutilla, R. L., 1972, Water for a rapidly growing urban community -- Oakland County, Michigan: U.S. Geological Survey Water-Supply paper 2000.

W2081 -- McDonald, M. G., 1980, Hydraulic characteristics of an underdrained irrigation circle, Muskegon County wastewater disposal system, Michigan: U.S. Geological Survey Water-Supply Paper 2081.

Table 1.--Published reports on ground water in Michigan--Continued

W4002 -- Stark, J. R., Cummings, T. R., and Twenter, F. R., 1983, Ground-water contamination at Wurtsmith Air Force Base, Michigan: U.S. Geological Survey Water Resources Investigations Report 83-4002.

W4056 -- Grannemann, N. G., and Twenter, F. R., 1985, Geohydrology and ground-water flow at Verona Well Field, Battle Creek, Michigan: U.S. Geological Survey Water Resources Investigations Report 85-4056.

W4064 -- Twenter, F. R., Cummings, T. R., and Grannemann, N. G., 1983, Ground-water contamination in East Bay Township, Michigan: U.S. Geological Survey Water-Resources Investigations Report 85-4064.

W4103 -- Handy, A. H., and Twenter, F. R., Water Resources of Pictured Rocks National Lakeshore, Michigan, 1985, U.S. Geological Survey Water Resources Investigations Report 85-4103.

W4110 -- Twenter, F. R., and Cummings, T. R, 1985, Quality of ground water in Monitor and Williams Townships, Bay County, Michigan: U.S. Geological Survey Water Resources Investigations Report 85-4110.

W4112 -- Cummings, T. R., Twenter, F. R., and Holtschlag, D. J., 1984, Hydrology and land use in Van Buren County, Michigan: U.S. Geological Survey Water Resources Investigations Report 84-4112.

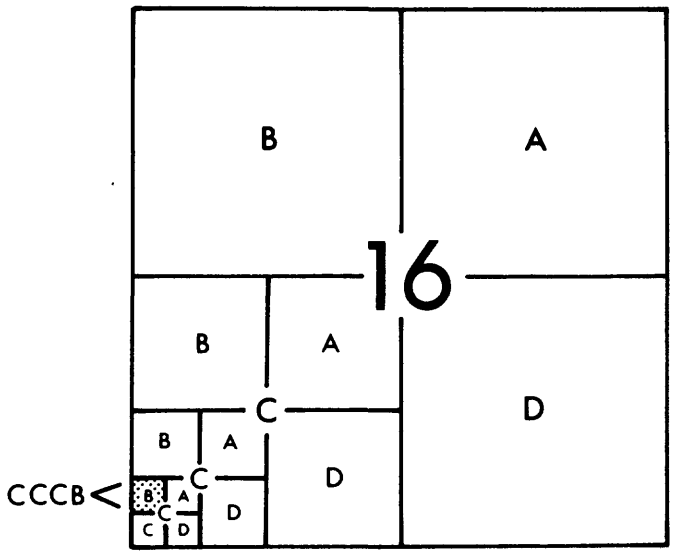
W4114 -- Grannemann, N. G., 1984, Hydrogeology and effects of tailing basins on the hydrology of Sands Plain, Marquette County, Michigan, U.S. Geological Survey Water-Resources Investigations Report 84-4114.

W4253 -- Handy, A. H., and Stark, J. R., 1984, Water resources of Sleeping Bear Dunes National Lakeshore, Michigan: U.S. Geological Survey Water Resources Investigations Report 83-4253.

W1S1 -- Knutilla, R. L., Twenter, F. R., and Larson, R. W., 1971, Upper Rifle River Basin -- An Evaluation of its Water Resources and Hydrologic Environment: Michigan Geological Survey Water Information Series Report 1.

Well-Numbering System

The well-numbering system for Michigan indicates the location of wells within a rectangular subdivision of land with reference to the Michigan meridian and base line. The first two segments of the well number designate township and range, the third segment of the number designates the section, and the letters A through D designate successively smaller subdivisions of the section, as shown below. Thus, a well designated as 32N 6E 16CCCB is located to the nearest 2.5 acres and is within the shaded area in section 16.



For many wells in this report, locations are only given to the nearest 40-acre tract, for example, 16CC. In the event that two or more wells are in the same tract, sequential number designation is added--for example, 16CCCB1, 16CCCB2, etc. The Michigan Geological Survey uses a similar system except that numbers are used instead of letters.

Acknowledgments

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

GROUND-WATER LEVELS

Water levels, measured in 112 observation wells throughout the State (fig. 1 and table 2) in 1987, generally follow precipitation trends. Rising levels usually occur where precipitation has been above normal and declining levels where precipitation has been below normal. Hydrographs (fig. 4) show that water levels are generally highest in spring. During the spring, snowmelt and rain constitutes most of the annual recharge to ground-water reservoirs. However, if ice cover or frost in the ground persists during snowmelt, recharge will be impeded by decreased infiltration and increased overland flow. Generally, recharge is relatively smaller during the summer when most rainfall is evaporated, transpired, or flows overland, depending on rainfall intensity and duration. In the autumn, when evapotranspiration is minor, significant amounts of precipitation may cause water levels to rise. Little or no recharge occurs during winter due to persistent below-freezing temperatures and frost conditions.

Although quantity of precipitation is a major factor affecting ground-water levels, many other natural factors, such as soil condition, composition of underlying rock, and slope of the land surface affect the levels. Minor fluctuation in levels are caused by earth tides and variation in barometric pressure. Evapotranspiration causes small daily declines in water levels in some shallow wells. Pumping withdrawals can lower water levels appreciably. If withdrawals are greater than recharge, long-term water-level declines will occur.

Uniform pumping rates throughout the year may allow levels to follow precipitation trends.

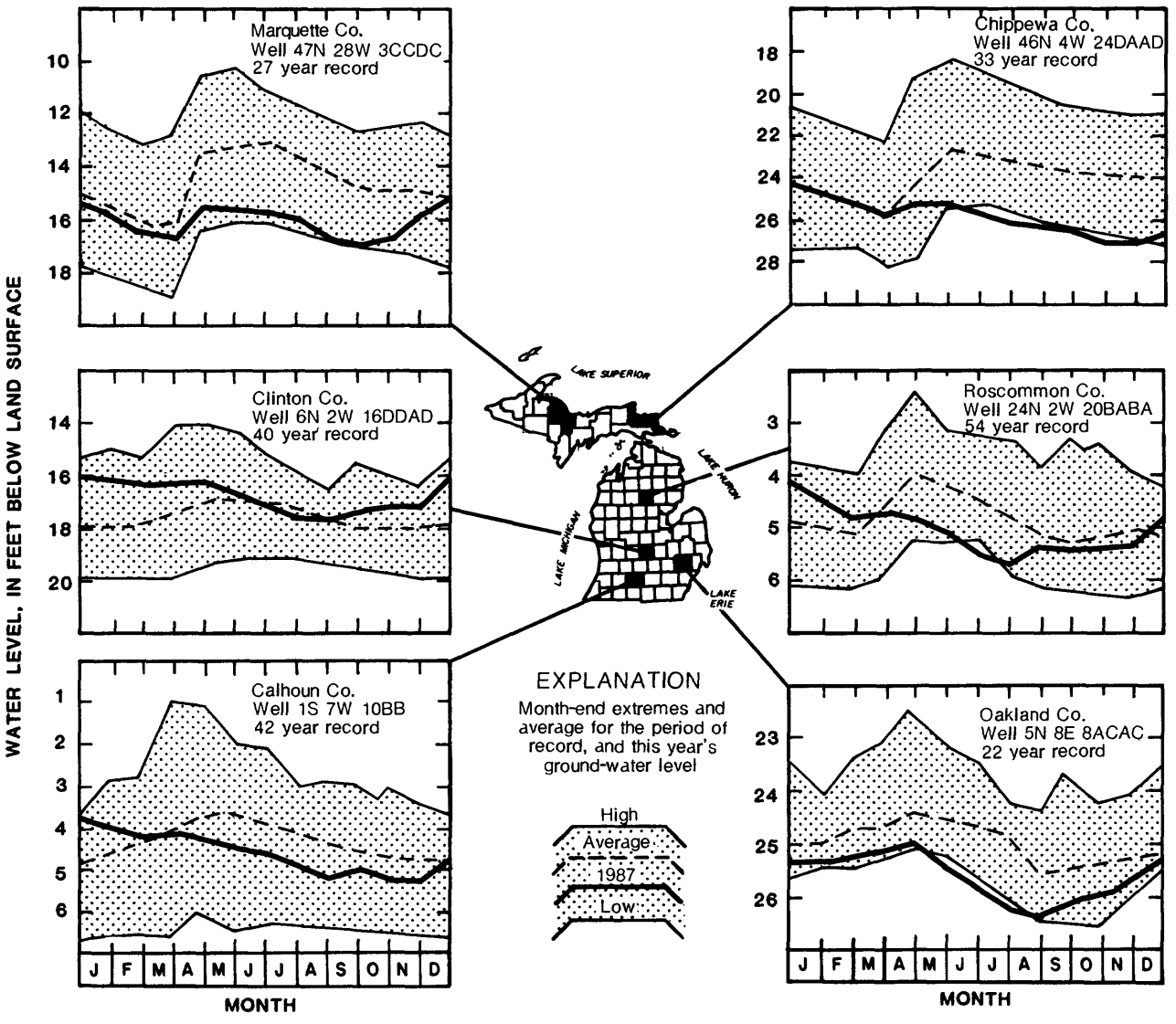
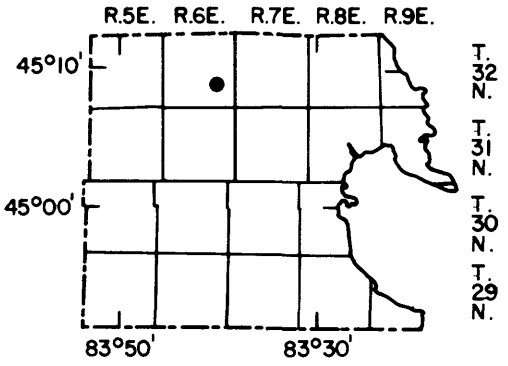


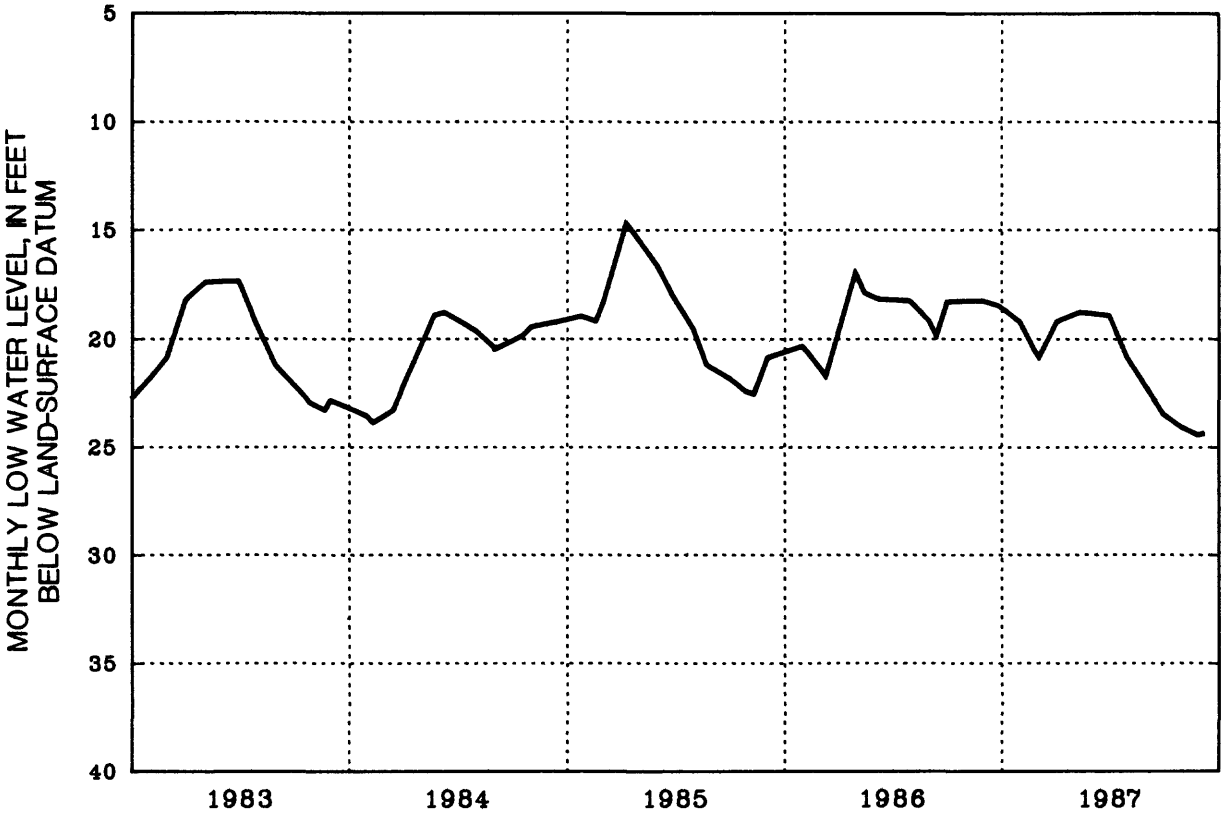
Figure 4.--Water levels in selected wells.

GROUND-WATER DATA

Variation of water levels and descriptions of some ground-water supplies in Michigan follow alphabetically, by county. Yield of wells and pumpage data are those reported by municipal water departments.

ALPENA COUNTY





Water levels in well 32N 6E 23DDDA1. Well is 88 feet deep and in sand. Water-quality data in ground-water reports for 1977 and 1982 (Huffman, 1979, 1983).

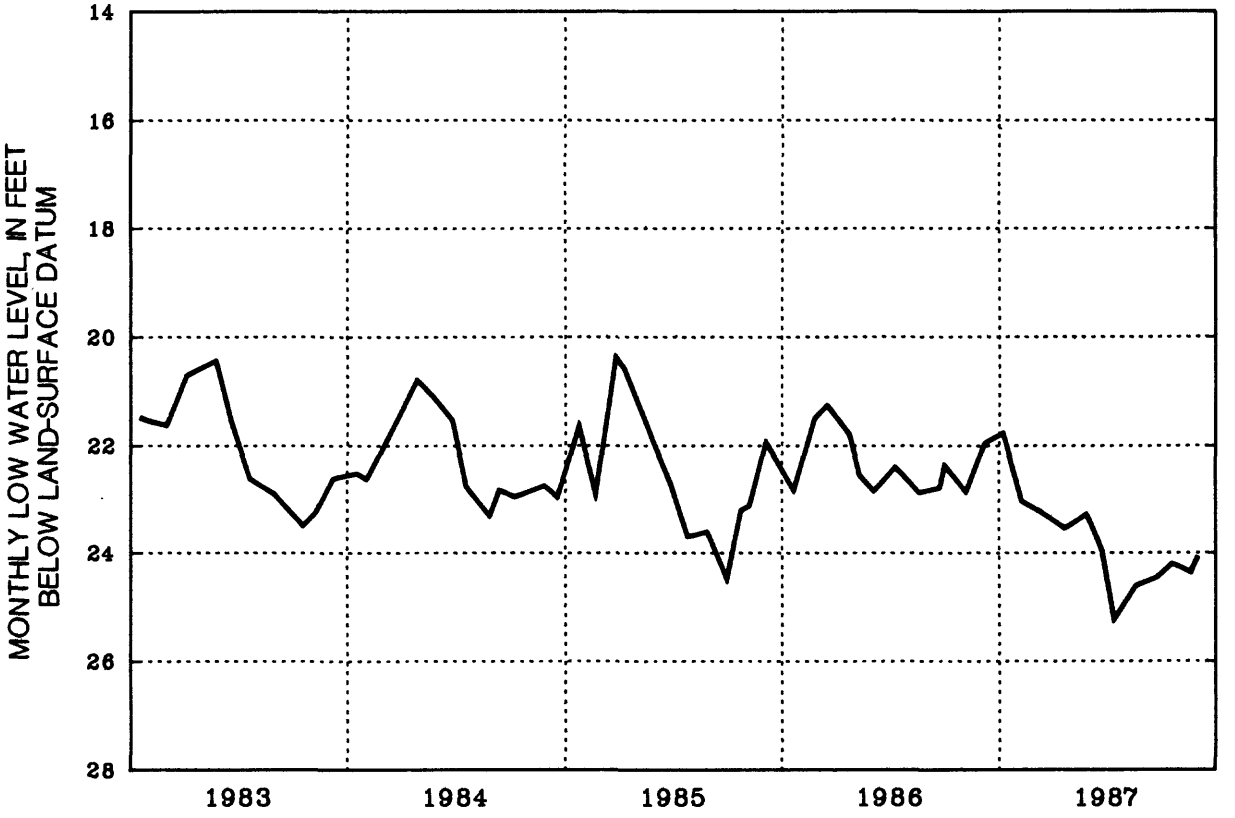
BRANCH COUNTY - CITY OF COLDWATER

SUPPLY AND SOURCE -- 4 wells, 117 to 129 feet deep, tap glacial deposits.

YIELD OF WELLS -- 1,200 to 2,850 gal/min; specific capacity -- 80 to 190 gal/min/ft of drawdown.

PUMPAGE -- Total annual pumpage, in million gallons, for past 5 years.

1987 - 1,078
1986 - 1,183
1985 - 1,168
1984 - 1,115
1983 - 1,308



Water levels in well 6S 6W 22CABA1. Well is 113 feet deep and in glacial deposits.

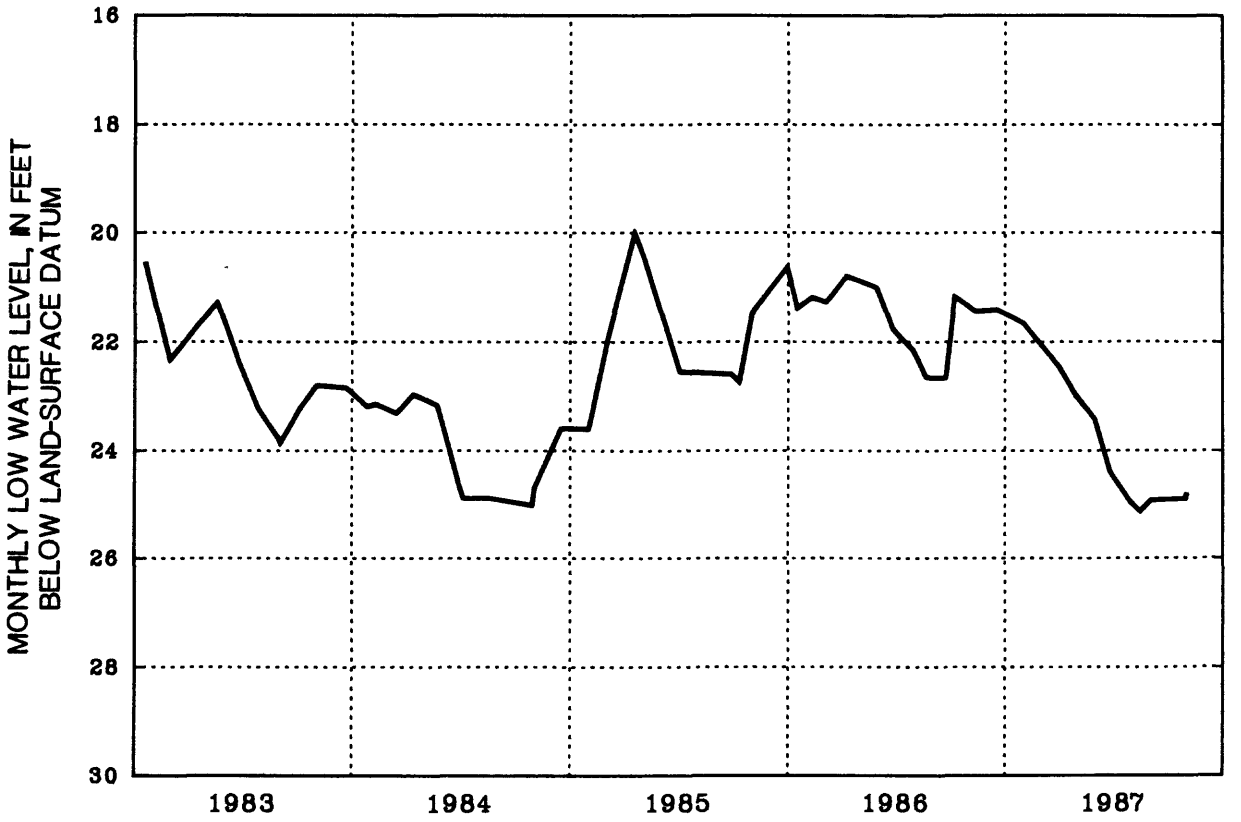
CALHOUN COUNTY - CITY OF BATTLE CREEK

SUPPLY AND SOURCE -- 38 wells, 110 to 180 feet deep, tap sandstones of Marshall Formation.

YIELD OF WELLS -- 300 to 1,000 gal/min; specific capacity -- 50 to 650 gal/min/ft of drawdown.

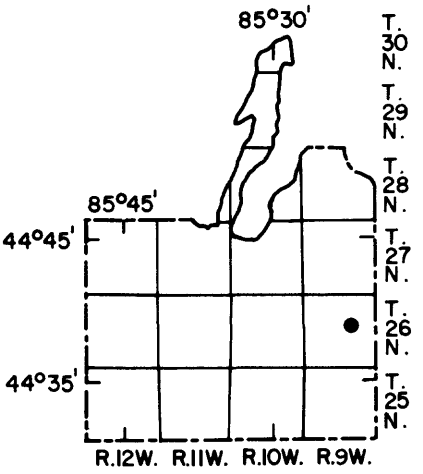
PUMPAGE -- Total annual pumpage, in million gallons, for past 5 years.

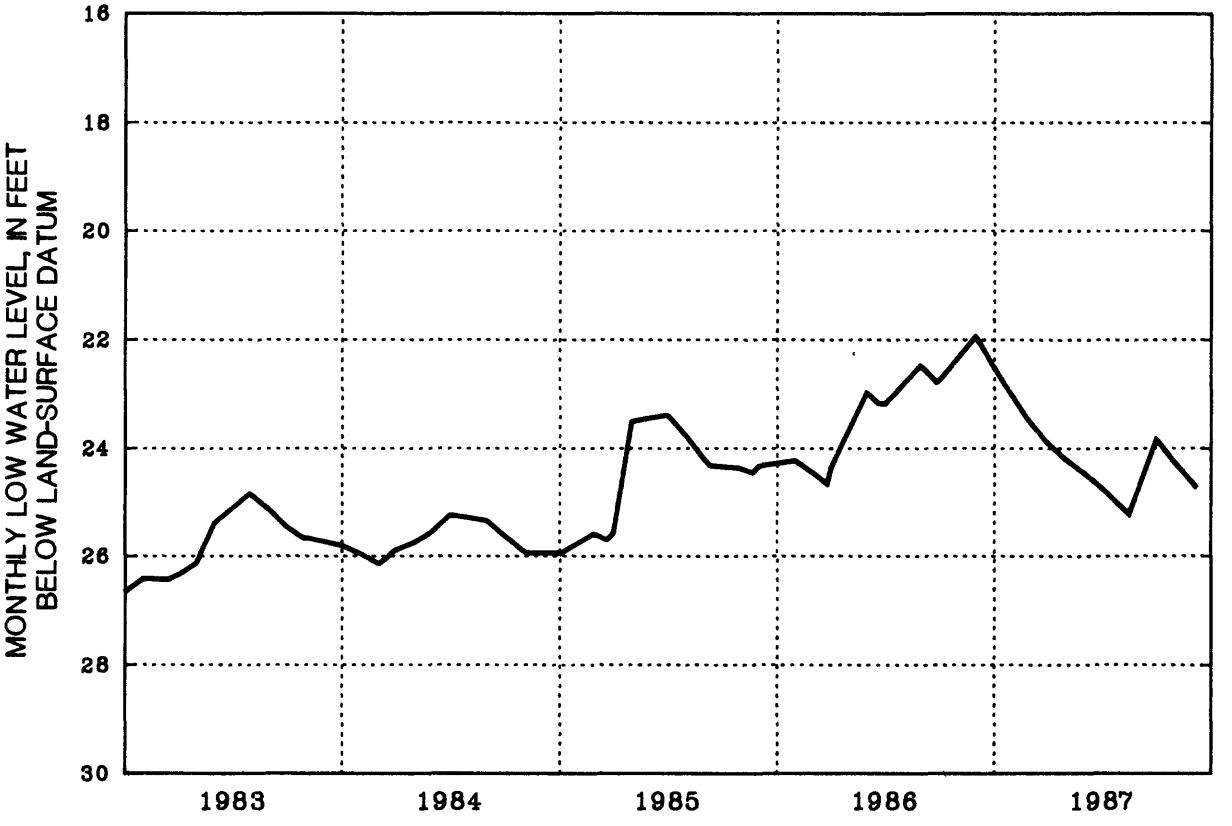
1987 - 3,697
1986 - 3,518
1985 - 2,950
1984 - 3,083
1983 - 3,495



Water levels in well 1S 7W 32BDCC1. Well is 95 feet deep and in Marshall Formation. Water-quality data in ground-water reports for 1977 and 1982 (Huffman, 1979, 1983).

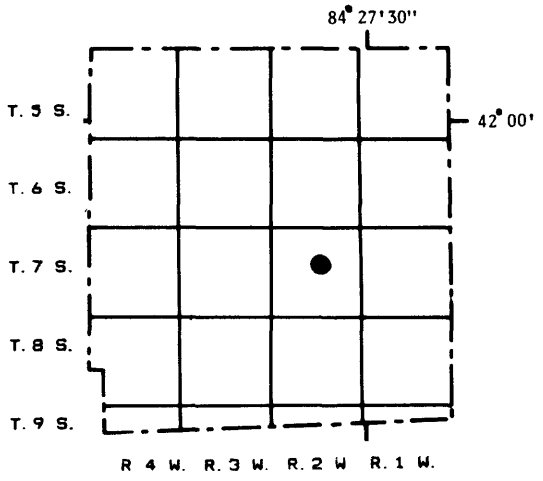
GRAND TRAVERSE COUNTY

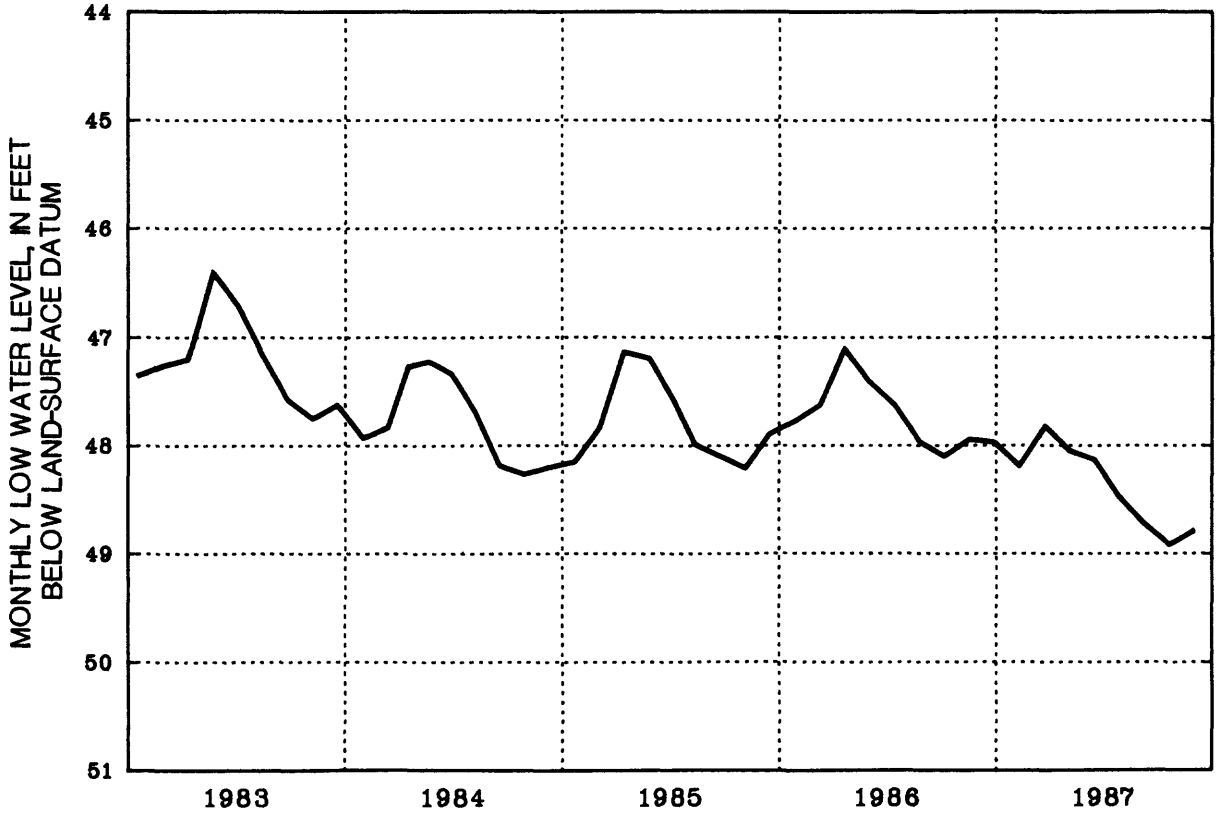




Water levels in well 26N 9W 14ABAA1. Well is 80 feet deep and in sand. Water-quality data in ground-water reports for 1977 and 1982 (Huffman, 1979, 1983).

HILLSDALE COUNTY





Water levels in well 7S 2W 15BCBA1. Well is 150 feet deep and in glacial outwash. Water-quality data in ground-water reports for 1979 and 1984 (Huffman, 1980, 1985).

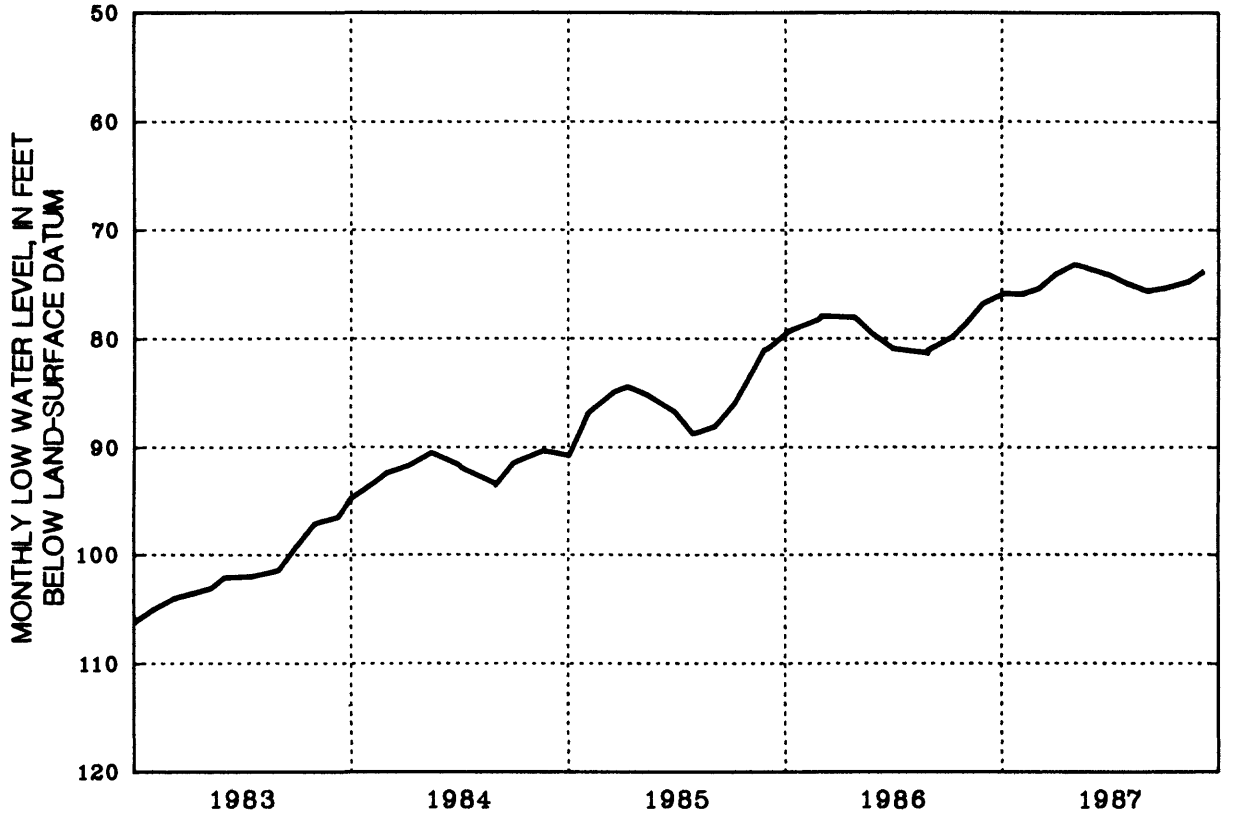
INGHAM COUNTY - CITY OF LANSING

SUPPLY AND SOURCE -- 125 wells, 400 to 425 feet deep, tap sandstones of Saginaw Formation; 3 wells, 85 to 105 feet deep, tap sand beds in glacial deposits.

YIELD OF WELLS -- Sandstone - 100 to 700 gal/min; specific capacity -- 3 to 10 gal/min/ft of drawdown.
-- Glacial deposits - 790 to 1,200 gal/min, specific capacity - - 12 to 80 gal/min/ft of drawdown.

PUMPAGE -- Total annual pumpage, in million gallons, for past 5 years.

1987 - 7,838
1986 - 7,690
1985 - 7,945
1984 - 8,249
1983 - 8,105



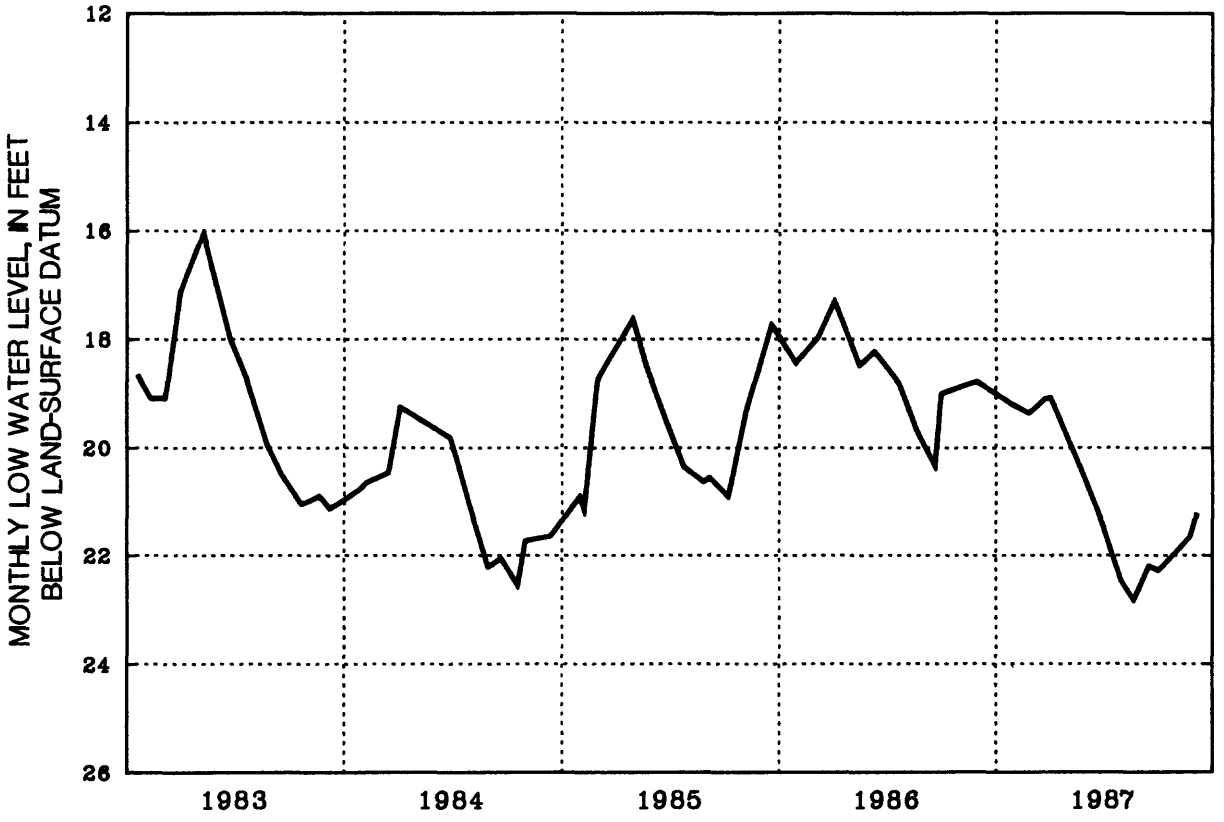
Water levels in well 4N 2W 17. Well is 424 feet deep and in Saginaw Formation.

SUPPLY AND SOURCE -- 1 well, about 50 feet deep, taps glacial deposits; 2 wells, 218, 223 feet deep, tap sandstones of Saginaw Formation.

YIELD OF WELLS -- 675 to 700 gal/min; specific capacity -- No. 3 yields 30 gal/min/ft of drawdown from the glacial deposits.

PUMPAGE -- Total annual pumpage, in million gallons, for past 5 years.

1987 - 256
1986 - 232
1985 - 240
1984 - 240
1983 - 232



Water levels in well 2N 1W 5BCAB1. Well is 210 feet deep and in Saginaw Formation. Water-quality data in ground-water reports for 1977 and 1984 (Huffman, 1979, 1985).

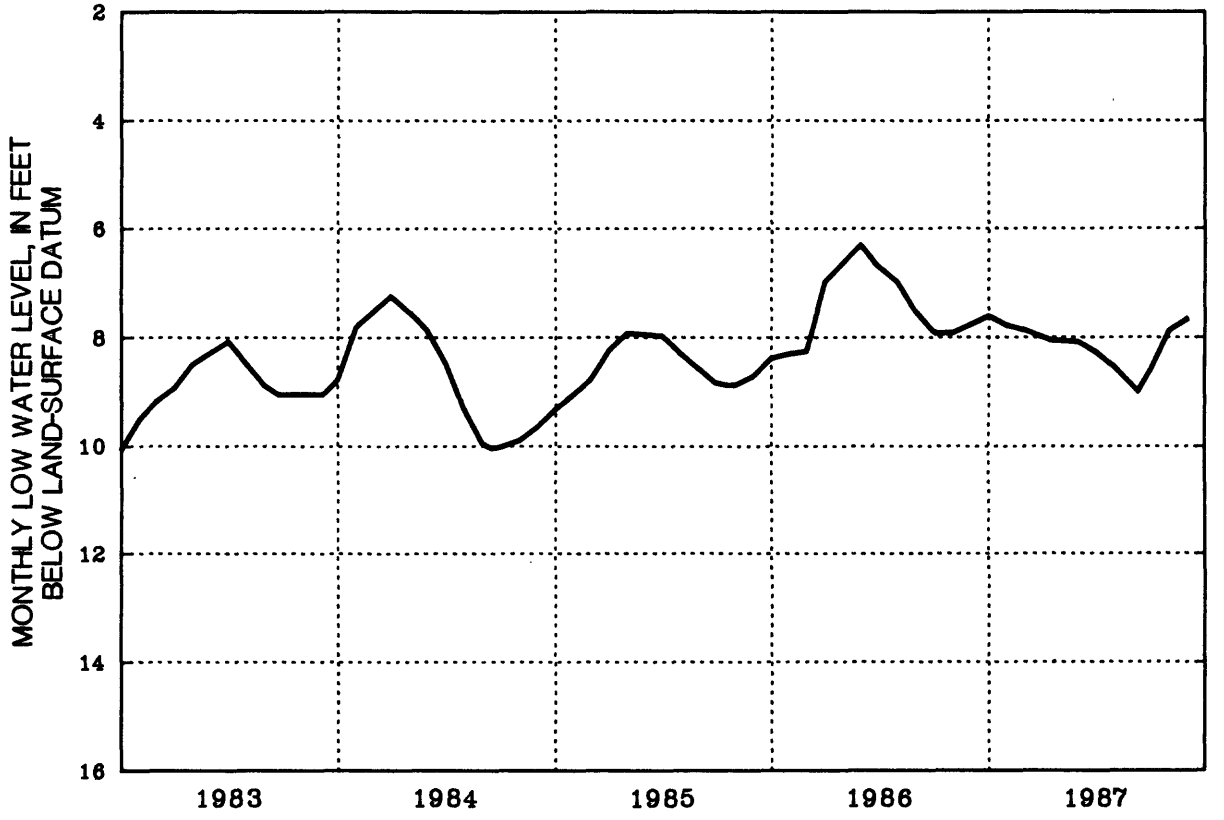
KALAMAZOO COUNTY - CITY OF KALAMAZOO

SUPPLY AND SOURCE -- 84 wells, 130 to 254 feet deep, tap glacial deposits.

YIELD OF WELLS -- 200 to 2,000 gal/min; specific capacity -- 7 to 100 gal/min/ft of drawdown.

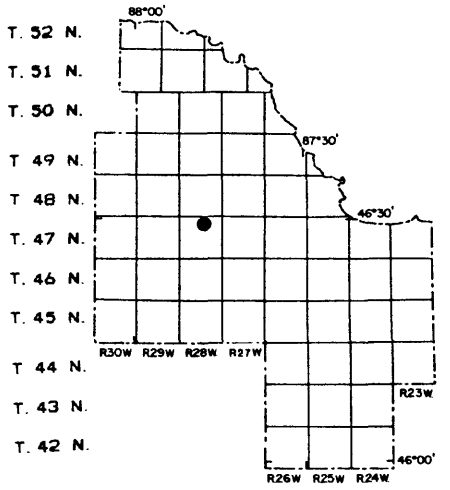
PUMPAGE -- Total annual pumpage, in million gallons, for past 5 years.

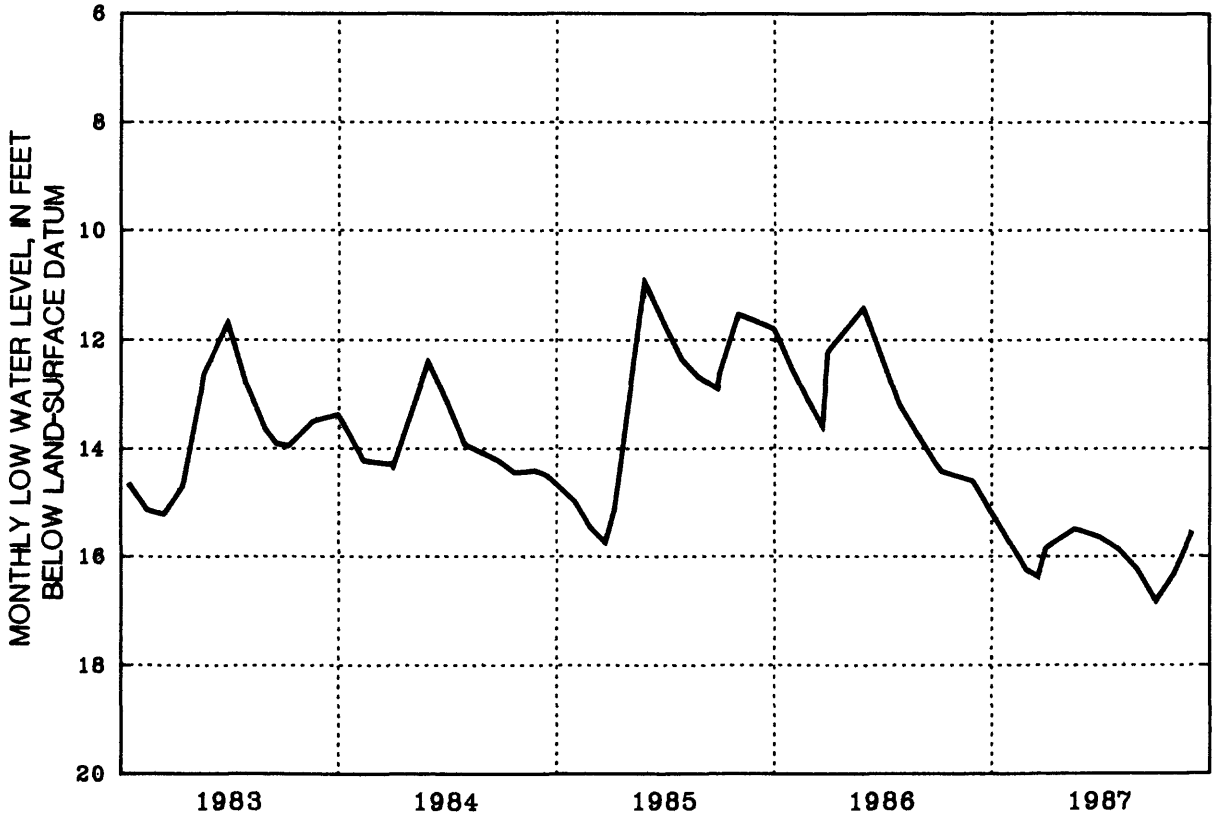
1987 - 6,450
1986 - 6,638
1985 - 6,736
1984 - 7,275
1983 - 7,204



Water levels in well 2S 11W 22CD. Well is 137 feet deep and in outwash.

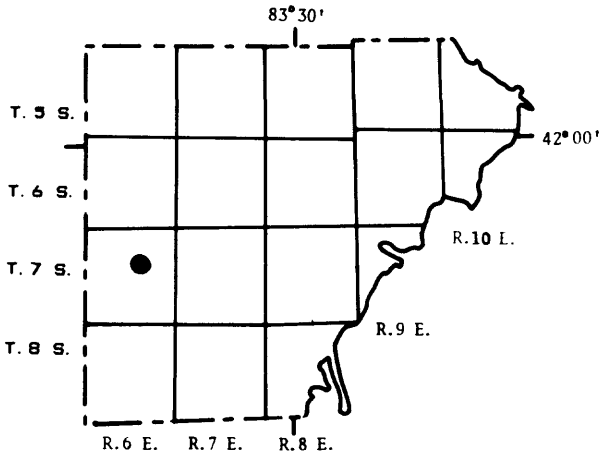
MARQUETTE COUNTY - IRON RANGE AREA

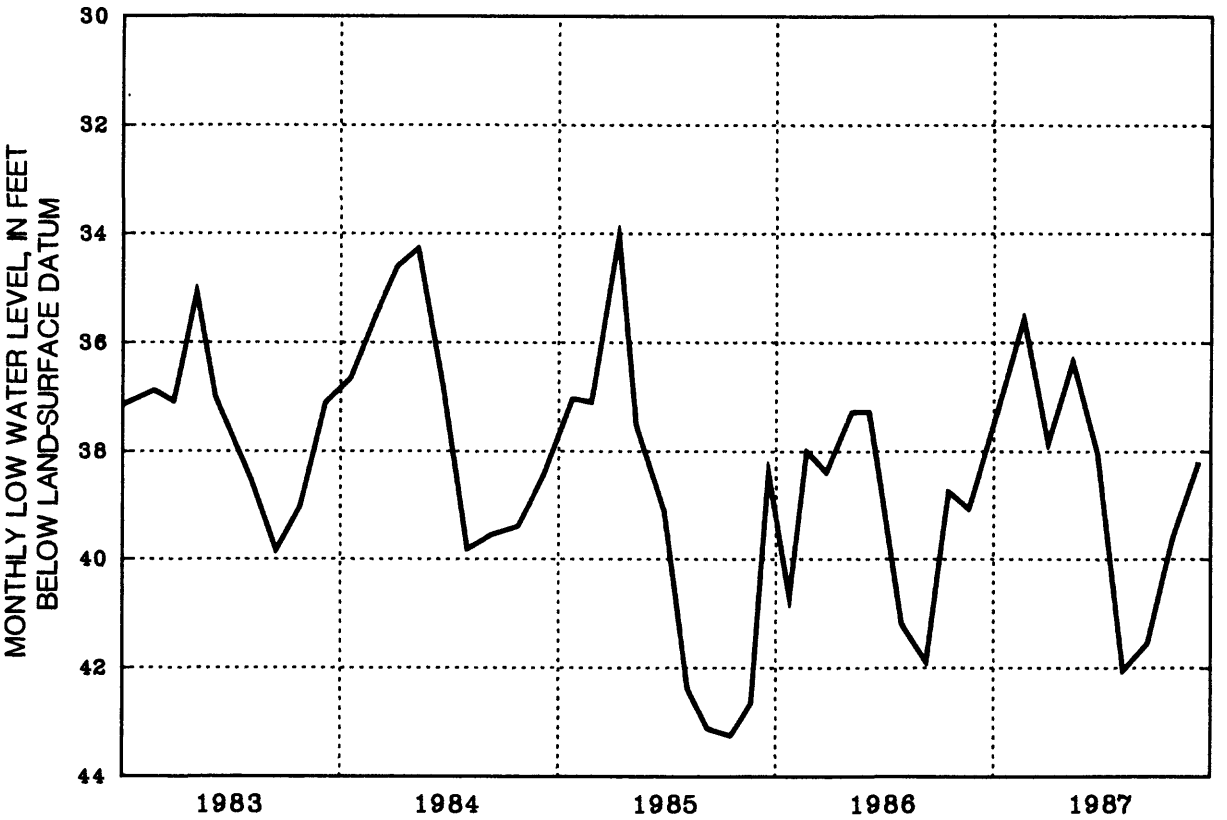




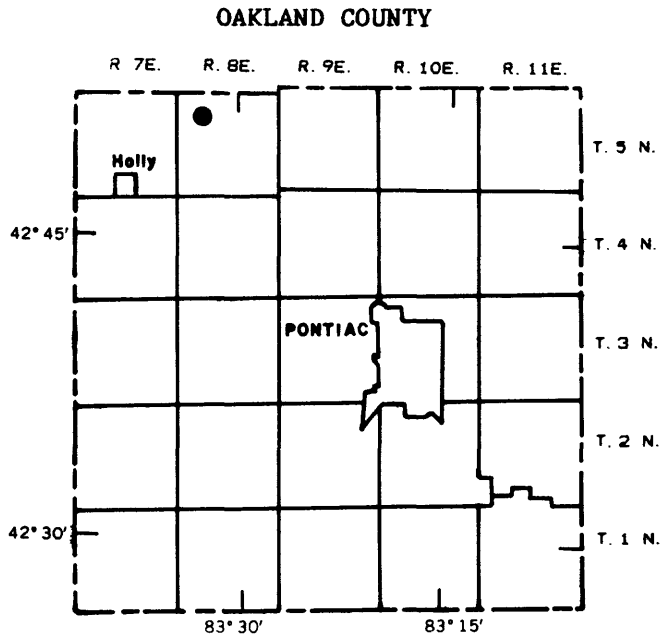
Water levels in well 47N 28W 3CCDC1. Well is 75 feet deep and in outwash. Levels are typical of observation wells in Marquette Iron Range. Water-quality data in ground-water report for 1977 (Huffman, 1979).

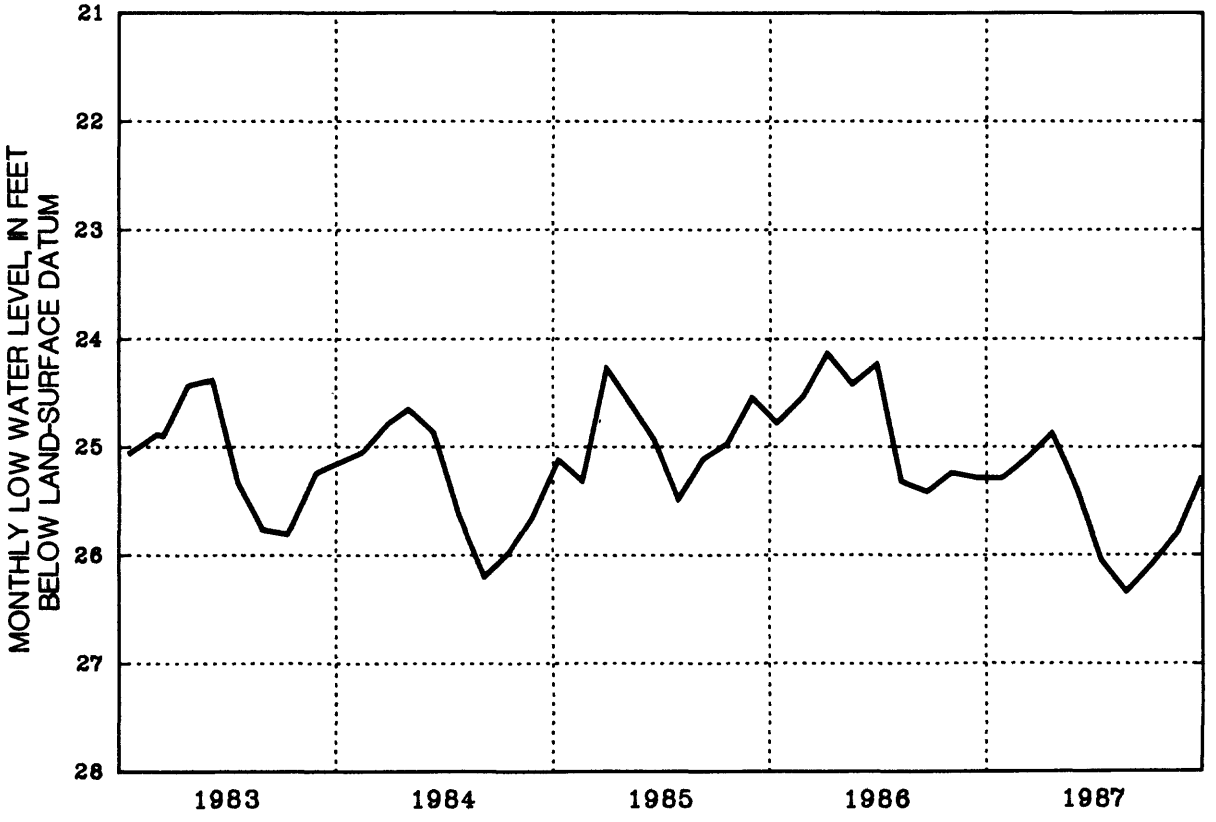
MONROE COUNTY





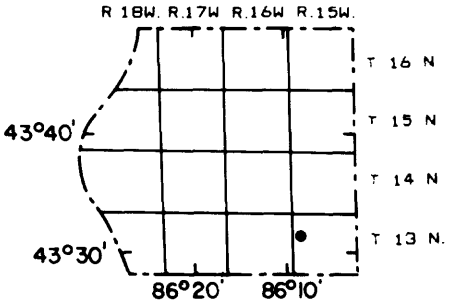
Water levels in well 7S 6E 15ACAA1. Well is 73 feet deep and in the Detroit River Group. Water-quality data in ground-water reports for 1979 and 1984 (Huffman, 1980, 1985).

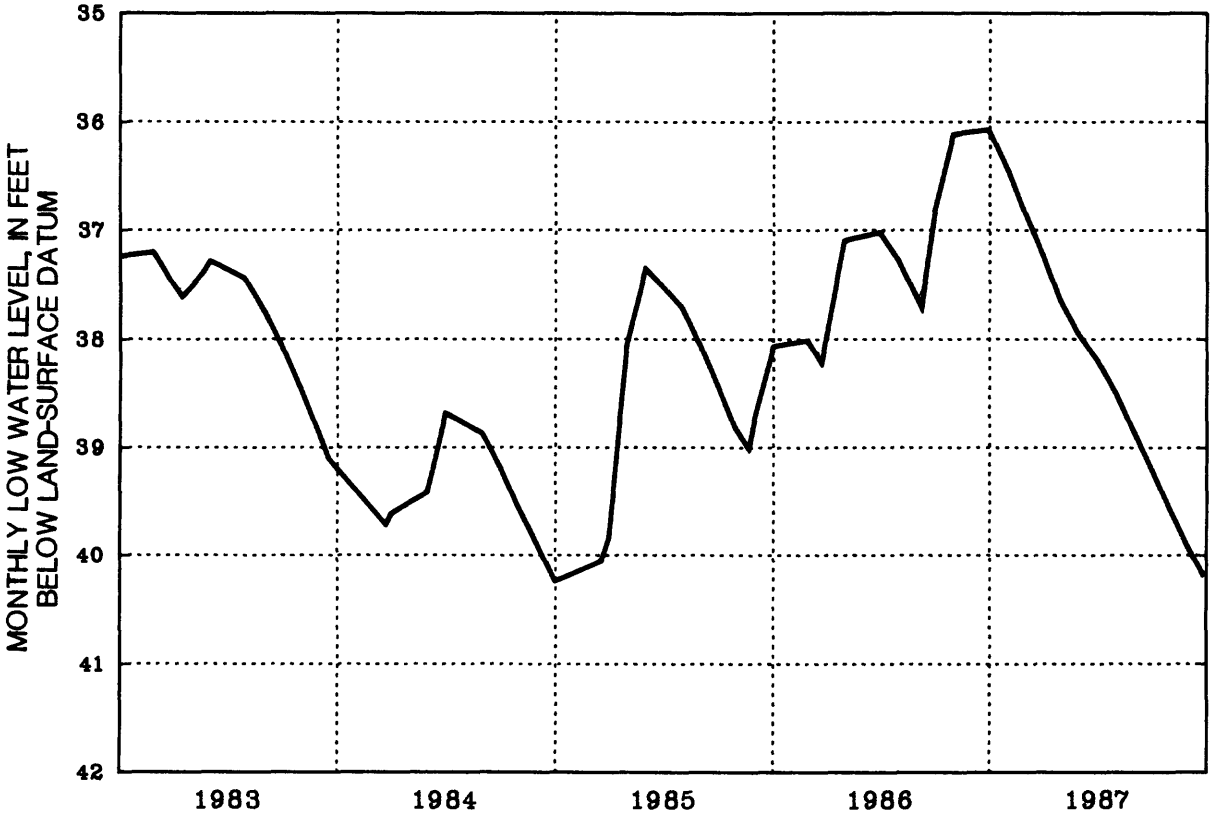




Water levels in well 5N 8E 8ACAC1. Well is 42 feet deep and in glacial deposits.

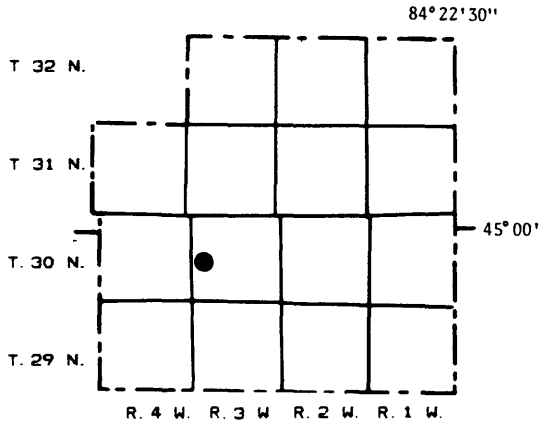
OCEANA COUNTY

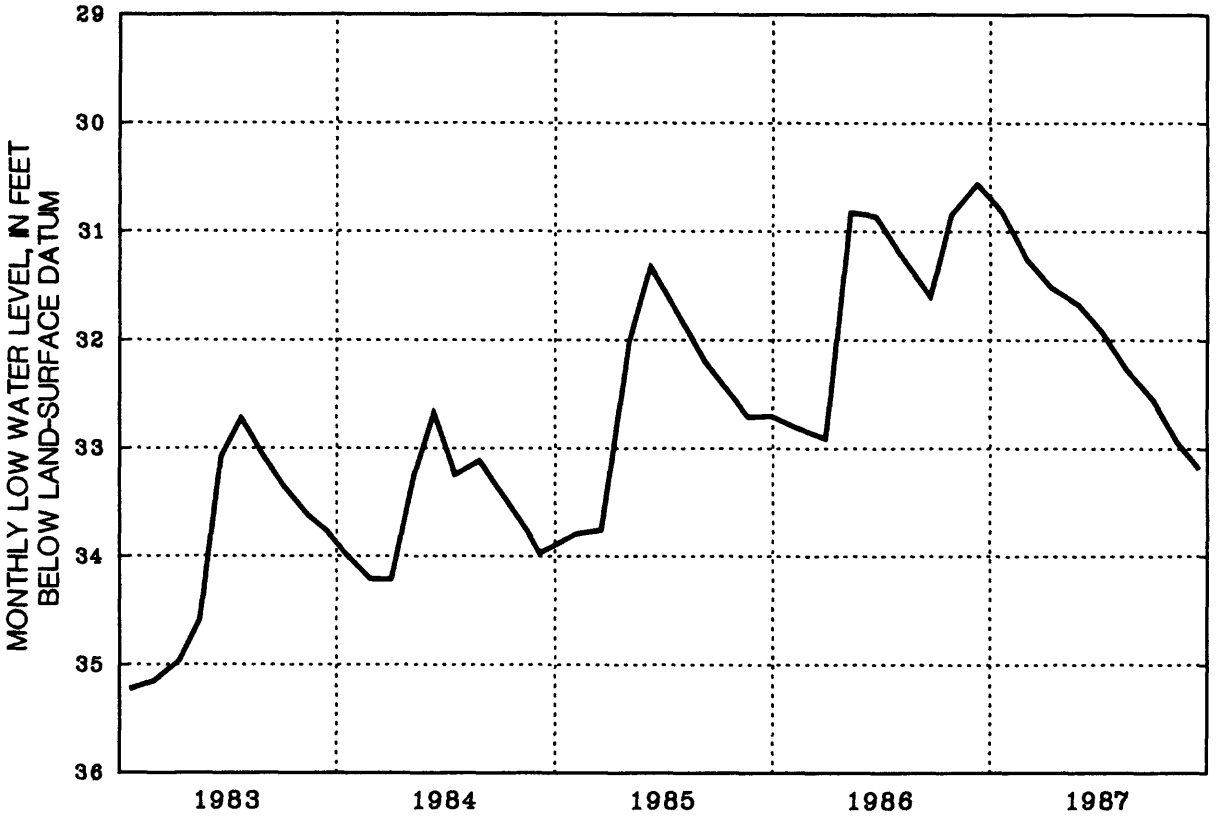




Water levels in well 13N 15W 18AAAA1. Well is 79 feet deep and in outwash. Water-quality data in ground-water reports for 1978 and 1984 (Huffman, 1979, 1985).

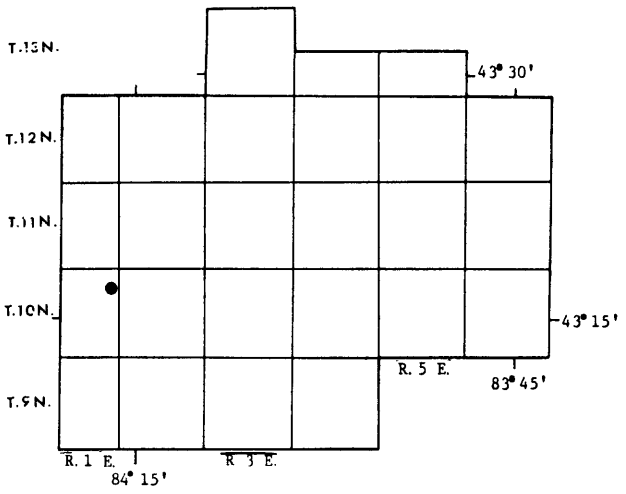
OTSEGO COUNTY

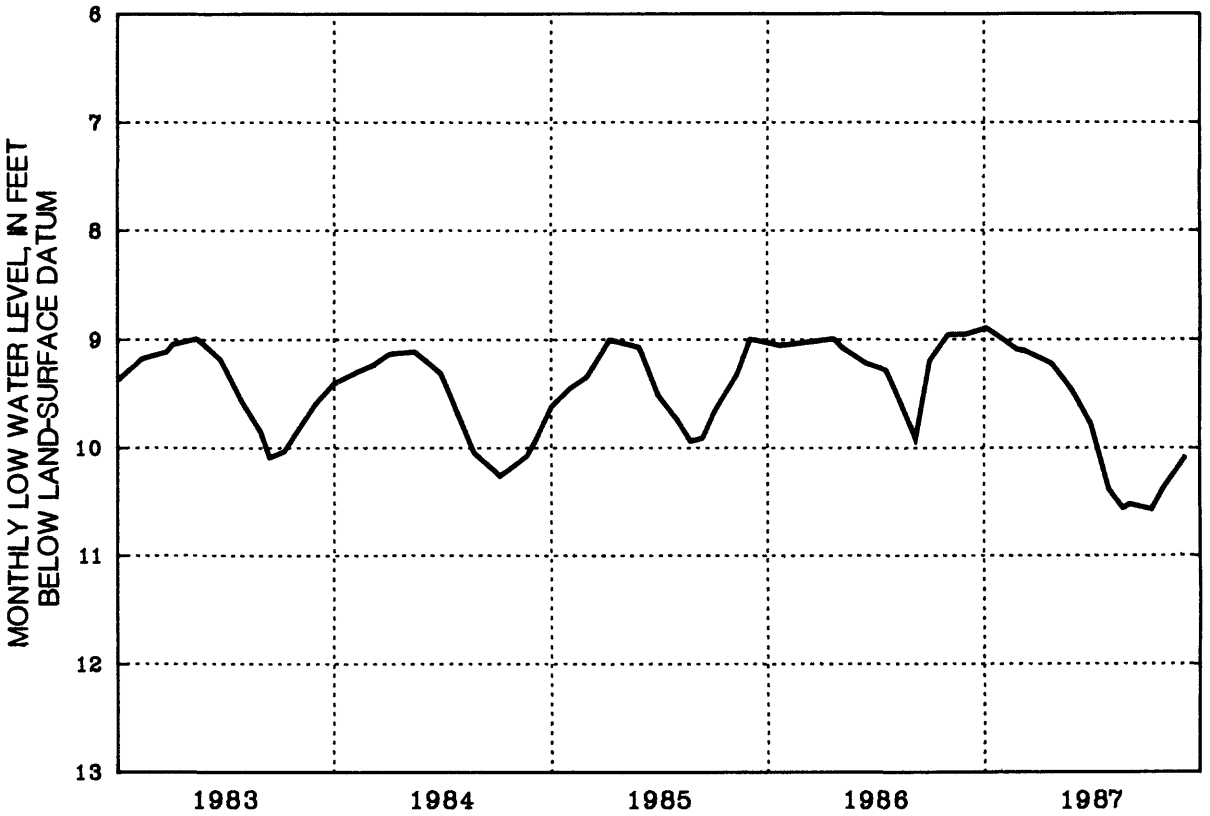




Water levels in well 30N 3W 19ABBB1. Well is 90 feet deep and in glacial outwash. Water-quality data in ground-water reports for 1979 and 1984 (Huffman, 1980, 1985).

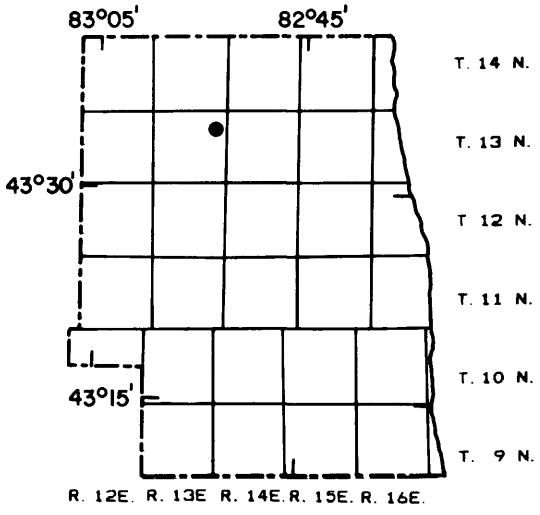
SAGINAW COUNTY

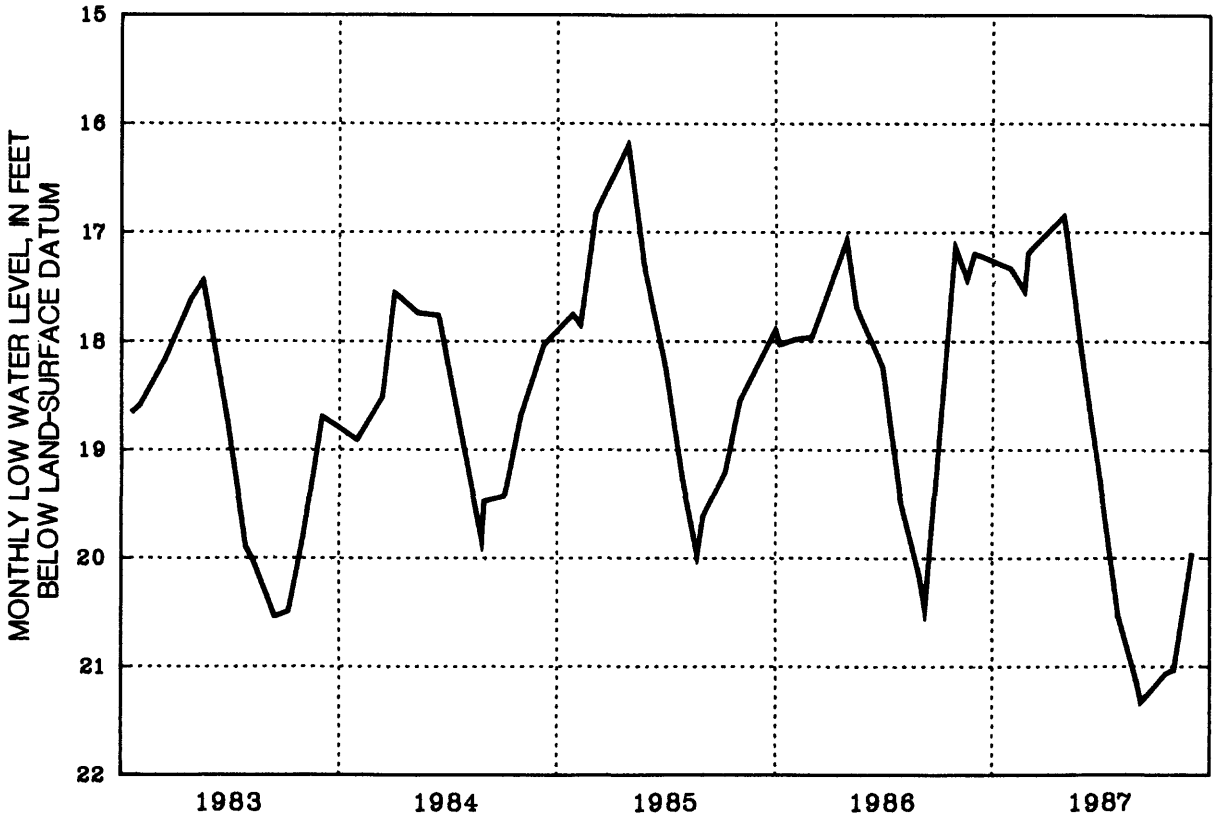




Water levels in well 10N 1E 22DADA1. Well is 210 feet deep and in Saginaw Formation. Water-quality data in ground-water reports for 1977 and 1984.

SANILAC COUNTY





Water levels in well 13N 13E 12ADAA1. Well is 130 feet deep and in the Marshall Formation. Water-quality data in ground-water reports for 1977 and 1982 (Huffman, 1979, 1983).

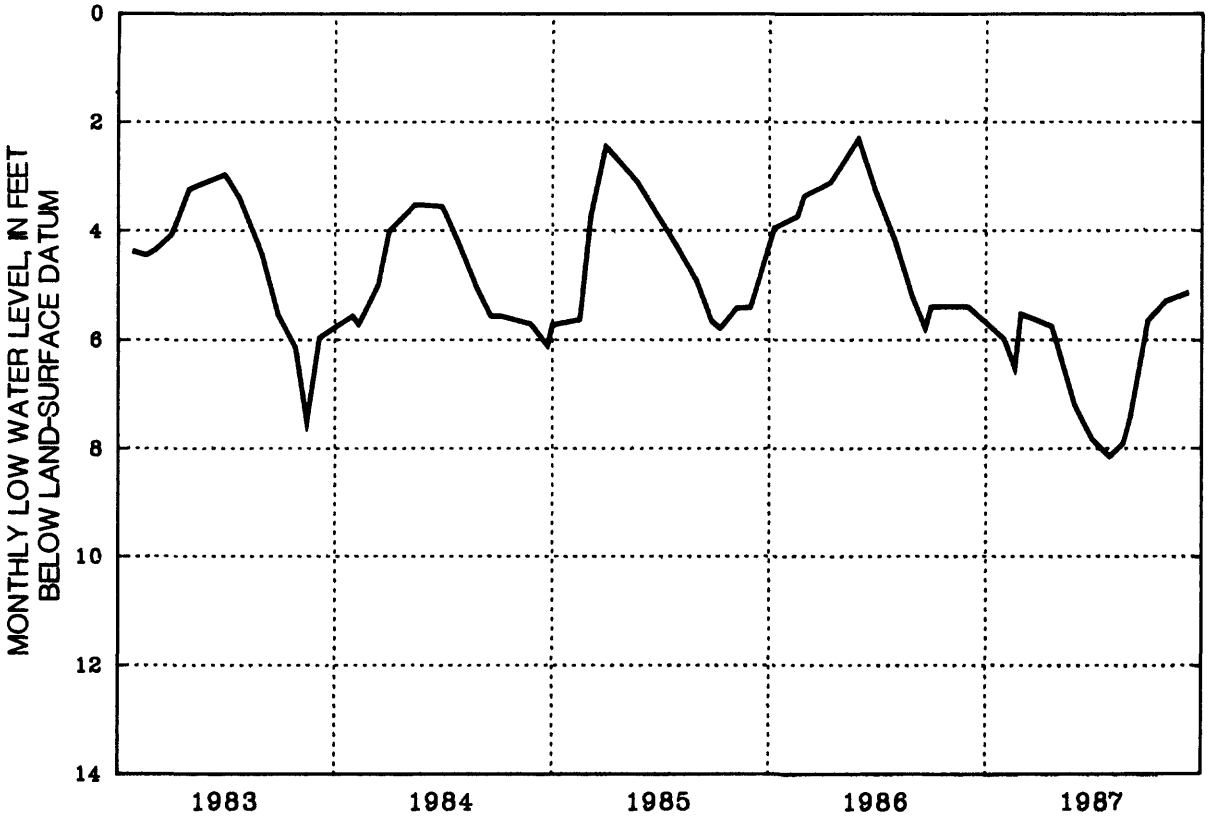
WASHTENAW COUNTY - CITY OF ANN ARBOR

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

YIELD OF WELLS -- 1,050 to 4,860 gal/min; specific capacity -- 20 to 600 gal/min/ft of drawdown.

PUMPAGE -- Total annual ground-water pumpage, in million gallons, for past 5 years (ground water is used to augment supply from Huron River).

1987 - 957
1986 - 1,044
1985 - 1,177
1984 - 1,192
1983 - 810



Water levels in well 3S 6E 16BCCD1. Well is 55 feet deep and in glacial deposits. Water-quality data in ground-water reports 1977 and 1984 (Huffman, 1979, 1985).

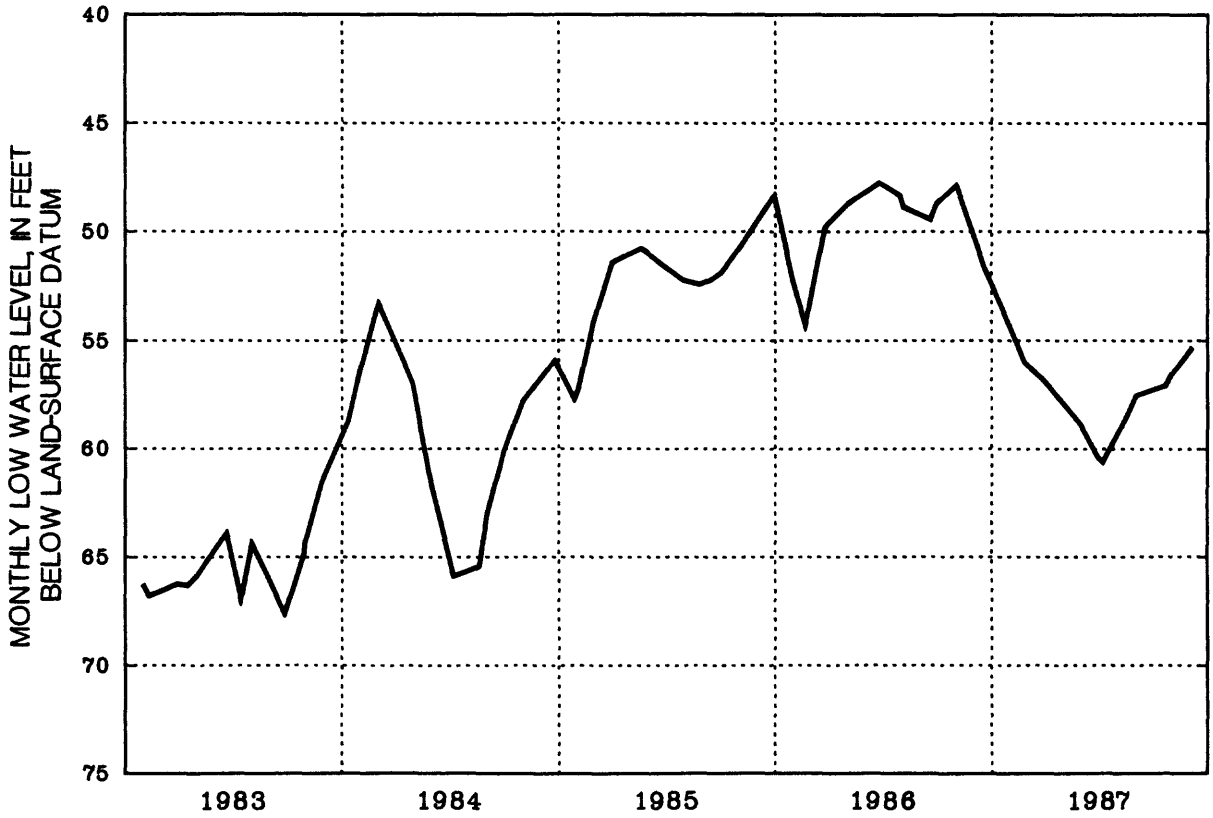
WASHTENAW COUNTY - CITY OF YPSILANTI

SUPPLY AND SOURCE -- 6 wells, 87 to 102 feet deep, tap glacial deposits.

YIELD OF WELLS -- Average 450 gal/min; specific capacity -- 25 to 180 gal/min/ft of drawdown.

PUMPAGE -- Total annual pumpage, in million gallons, for past 5 years.

1987 - 1,220
1986 - 925
1985 - 906
1984 - 1,155
1983 - 1,112



Water levels in well 3S 7E 9ADBC1. Well is 94 feet deep and in glacial deposits.

Table 2.--Records of observation wells in Michigan

COUNTY AND WELL NUMBER: See section in text entitled "Well-numbering system".

NAME: CCC - Civilian Conservation Corp.; MDNR - Michigan Department of Natural Resources; MDOT - Michigan Department of Transportation; Twsp - Township; USFS - U.S. Forest Service; WEP - Wisconsin Electric Power Company.

AQUIFER:

112GLCL	Glacial deposits	337MRSL	Marshall Formation	361ODVCU	Ordovician, Upper
112GRVL	Gravel	341TRVR	Traverse Group	365TBRV	Trenton-Black River Group
112OTSH	Outwash	344DUND	Dundee Formation	368PRDC	Prairie du Chien Group
112SAND	Sand	348DRRV	Detroit River Group	372MNSG	Munising Sandstone
112SDGV	Sand and Gravel	355SLINH	Salina Formation	42DFRED	Freda Sandstone
324SGNW	Saginaw Formation	355MNSQ	Manistique Dolomite		

ELEVATION: Land-surface datum in feet above National Geodetic Vertical Datum of 1929.

MEASUREMENTS FREQUENCY: R - Continuous recorder, D - Daily, W - Weekly, M - Monthly, Q - Quarterly, S - Semiannually, A - Annually, I - Intermittent.

OBSERVED WATER-LEVEL EXTREMES: Data for calendar years. In feet below or above (+) land surface. 1987 measurements underscored are extremes for period of record.

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

County and well number (Twsp,range,section)	Name	Depth (feet)	Diam. (inches)	Aquifer	Elev.	Yrs. record	Meas. freq.	Observed water-level extremes: Through 1986 Highest	Through 1986 Lowest	1987 Highest	1987 Lowest
ALGER											
45N 19W 25BDCD1	CCC	66	6	112GLCL	850	29	Q	6.4 Jun 1960	14.2 Apr 1964	11.8 Aug	12.7 Dec
ALPENA											
32N 6E 23DDDA1	Alpena State Forest	88	6	112SAND	713	11	R	13.6 May 1983	30.0 Mar 1982	18.1 Jan	24.4 Nov
ARENAC											
19N 5E 7DABA1	Omer, D	185	6	324SGNW	667	8	M	8.3 Jul 1980	10.9 Oct 1984	9.7 Jan	11.4 Oct
7DABA2	Omer, S	21	6	112GLCL	667	8	M	2.3 May 1983	6.9 Aug 1980	3.8 Mar	7.0 Oct
BARAGA											
48N 32W 12DD	[1] WEP14	10	1	112GLCL	1,630	40	M	3.3 Apr 1965	8.1 Sep 1969	6.9 Nov.	9.9 Jan
BARRY											
4N 9W 5DA	Solomon Road	131	2	112GLCL	860	24	Q	111.5 Mar 1978	122.0 Mar 1965	115.1 Apr	116.0 Nov
BAY											
17N 4E 22DCAA1	Pinconning Twsp	110	6	324SGNW	620	26	M	0.0 Mar 1976	10.5 Aug 1963	1.6 Jan	4.8 Sep
BRANCH											
6S 6W 18CCCD1	[2] Coldwater Twsp	56	6	112OTSH	950	24	M	18.3 Mar 1976	28.3 Jul 1964	23.8 May	25.7 Oct
22CABA1	Coldwater Test 4	113	6	112GLCL	970	24	R	9.0 May 1975	25.9 May 1977	11.8 Dec	25.2 Jul
CALHOUN											
1S 7W 10BB	[3] Sabin	12	1	112GLCL	908	42	W	0.9 Mar 1950	7.2 Dec 1964	3.8 Jan	5.2 Oct
32BDCC1	[2] Penfield Twsp	95	6	337MRSL	845	24	R	15.6 Apr 1974	27.0 Aug 1964	19.6 Jan	25.1 Aug
32DABD	[2,3] Battle Creek	127	8	337MRSL	830.8	49	D	0.7 Apr 1950	16.8 Jul 1959	6.4 Jan	12.6 Aug
2S 6W 25AA	[2,3] Marshall	59	6	337MRSL	904.8	38	M	5.5 May 1950	9.7 Aug 1964	6.8 Jan	8.5 Aug
CASS											
8S 14W 17BA	[3] Little	55	28	112GLCL	840	43	M	46.2 Jul 1950	55.0 Mar 1957	50.3 Feb	51.7 Dec

Table 2.--Records of observation wells in Michigan--Continued

County and well number (Twsp,range,section)	Name	Depth (feet)	Diam. (inches)	Aquifer	Elev.	Yrs. record	Meas. freq.	Observed water-level extremes Through 1986 Highest	Through 1986 Lowest	1987 Highest	1987 Lowest
CHEBOYGAN											
33N 1W 26DABA1	Pigeon River CCC	164	6	112SAND	933	22	R	55.2 May 1985	60.2 Jul 1982	57.9 Jan	59.8 Dec
39N 3W 29CBCB1	Mackinaw, D	125	6	344DUND	705	9	M	4.7 Apr 1986	11.7 Feb 1981	6.3 Apr	10.6 Oct
29CBC82	Mackinaw, S	55	6	112SDGV	705	9	M	1.8 Apr 1986	6.5 Feb 1981	2.6 Apr	5.9 Oct
CHIPPEWA											
46N 4W 24DAAD1	Raco	54	6	112OTSH	850	33	R	18.4 Jun 1971	28.4 Apr 1964	24.4 Jan	27.3 Dec
CLARE											
17N 4W 34DCAD	Clare	91	4	112GLCL	850	13	R	7.9 Mar 1976	24.9 May 1977	10.5 Jan	20.1 Dec
CLINTON											
5N 2W 31CBBA1	[2] Capital City Airport	195	6	324SGNW	850	30	R	45.0 Mar 1949	66.4 Jan 1967	50.5 Dec	53.3 Jul
32DC	[2] Quarantine Farm	135	4	324SGNW	849.2	44	M	42.0 Sep 1944	99.2 May 1966	68.1 Dec	76.1 Aug
6N 1W 3BB2	Sleepy Hollow 5	62	1	112GLCL	814.0	18	I	37.6 Apr 1983	43.5 Nov 1966	37.8 Apr	
2W 16DDAD1	[4] MDOT, U.S. 27	23	14	112GLCL	803.3	40	M	13.8 Apr 1974	19.9 Feb 1964	16.2 Dec	17.9 Aug
7N 1W 34CC	Sleepy Hollow 7	32	1	112OTSH	785.3	21	A	16.5 Apr 1983	20.3 Oct 1973	17.2 Apr	
CRAWFORD											
25N 1W 15DDCD1	Eldorado	56	6	112GLCL	1,190	40	R	25.6 Nov 1986	36.0 Apr 1951	26.1 Jan	28.8 Dec
DELTA											
39N 23W 28AC	Schemmel	530	5	372MNSG	680	30	R	1.3 May 1960	8.6 Feb 1977	5.1 Jun	8.0 Jun
41N 18W 31CD	Isabella	250	5	361ODVCU	615	30	M	3.3 Sep 1979	6.4 Feb 1977	4.3 Apr	6.9 Jul
42N 19W 20AA	Pollack CCC	134	6	112GLCL	740	30	Q	23.4 Jul 1982	28.1 Feb 1977	25.6 Jan	26.2 Dec
43N 19W 24BB	Clarage	405	4	365TBRV	860	30	Q	77.0 Jul 1960	88.8 Oct 1966	79.6 Jan	80.4 Dec
DICKINSON											
43N 28W 32ADAB1	Felch	31	1	112SAND	1,160	22	M	13.0 Apr 1986	16.8 May 1968	14.8 Jul	15.3 Jun
EATON											
3N 3W 2BA	[2] Lansing, Stiefel	66	1	112GLCL	839	24	R	3.0 Jun 1986	18.0 Nov 1968	5.1 Oct	9.8 Sep
4N 3W 12CD	[2] Robins Road	381	6	324SGNW	861.9	35	R	67.5 Nov 1953	103.6 Aug 1969	66.8 Dec	88.9 Jun
GENESEE											
6N 7E 9DCCC1	[2] Fisher Body No. 2	385	10	324SGNW	837.0	15	R	52.3 Dec 1975	87.0 Jun 1977	61.0 Nov.	79.1 Aug
GRAND TRAVERSE											
26N 9W 14ABAA1	Fife Lake State Forest	80	6	112SAND	960	11	R	21.3 Oct 1986	28.0 Mar 1982	22.5 Jan.	25.2 Aug
HILLSDALE											
7S 2W 10BDDD1	Pittsford Game Area	20	1	112SAND	1,070	22	M	5.8 Apr 1982	11.1 Sep 1967	8.1 May	9.1 Sep
2W 15BCBA1	Osseo	150	6	112OTSH	1,095	9	M	46.1 Apr 1982	49.0 Dec 1979	47.8 Mar	48.9 Oct

Table 2.--Records of observation wells in Michigan--Continued

County and well number (twsp,range,section)	Name	Depth (feet)	Diam. (inches)	Aquifer	Elev.	Yrs. record	Meas. freq.	Observed water-level extremes: Through 1986 Highest	Through 1986 Lowest	1987 Highest	1987 Lowest
INGHAM											
2N 1E 34DB	Dansville Game Area	87	2	112GLCL	930	24	Q	22.4 Apr 1974	29.3 Oct 1964	23.6 Mar	25.4 Sep
1W 5BCAB1 [2]	Mason	210	8	324SGNW	890	24	R	14.7 Mar 1973	23.8 Nov 1964	18.1 Jan	22.8 Aug
3N 1E 7DDCA1 [2]	Lotte	184	3	324SGNW	900	24	M	+2.4 Apr 1974	7.0 Nov 1964	0.0 Mar	3.9 Oct
2W 23BCBD [2]	Holt	188	8	324SGNW	895	6	R	18.3 May 1983	25.5 Oct 1985	20.3 Jan	24.0 Nov
4N 1W 16DA [2]	Meridian Twsp	398	4	324SGNW	841.2	20	M	6.3 Mar 1976	18.6 Jul 1984	15.4 Mar	23.4 Jul
28BCAD1 [2]	Okemos	125	4	324SGNW	865	12	R	17.6 Apr 1985	24.2 Sep 1978	19.2 Jan	22.8 Jul
2W 9BD [2]	Lansing, Seymour	401	14	324SGNW	828.8	54	R	15.6 Mar 1931	179.4 Apr 1968	43.8 May	61.0 Jul
16DA [2]	Lansing, Cedar	417	12	324SGNW	829.1	43	R	30.3 Dec 1986	67.0 Aug 1949	28.3 Apr	35.4 Aug
17AB [2]	Lansing, Logan	424	20	324SGNW	858.7	57	R	34.3 Dec 1929	168.3 May 1968	71.7 May	76.0 Feb
21BA3 [2]	Lansing, Scott Park	400	4	324SGNW	835	9	R	27.3 Dec 1986	58.8 Jun 1979	24.3 Feb	31.8 Jan
22BC [2]	Lansing, P-5	338	12	324SGNW	823.6	58	M	7.1 Jul 1932	80.5 Feb 1979	25.1 Jan	30.5 Aug
24CA [2]	Spartan Village	453	10	324SGNW	853.4	43	R	25.5 Mar 1946	105.5 May 1972	56.9 Jan	82.6 May
27BB [2]	Fenner Arboretum	215	6	324SGNW	835	20	R	35.9 May 1986	89.5 Oct 1972	36.9 Jan	60.9 Jul
31CC [2]	Maybel Street	204	3	324SGNW	880.2	44	M	18.9 Apr 1952	45.9 Jul 1980	36.8 Jul	39.6 Jun
IOSCO											
24N 7E 13ADAD1	Oscoda	69	6	112SAND	760	8	M	27.3 Nov 1986	32.7 Mar 1982	27.7 Jan	29.6 Dec
IRON											
43N 35W 11AD [1]	WEP 23	47	36	112GLCL	1,565	43	M	35.3 Aug 1983	47.1 Aug 1949	39.0 Jan	40.5 Aug
20DC [1]	WEP 25	48	1	112GLCL	1,560	43	M	40.7 Jun 1973	48.3 Aug 1949	43.3 Jan	44.3 Oct
44N 37W 14BB	CCC Camp	102	6	112GLCL	1,730	29	Q	90.6 Sep 1986	97.1 Aug 1982	90.8 Jan	91.8 Sep
JACKSON											
3S 1W 11AA1 [2,3,5]	Jackson, 4a Belden	360	6	324SGNW, 337MRSL	935	30	D	18.6 Jan 1961	119.1 Jun 1971	40.1 Dec	71.9 Feb
KALAMAZOO											
2S 10W 4D [2,6]	Kalamazoo, Campbell	13	4	112OTSH	836.5	19	R	1.9 Apr 1974	6.4 Sep 1984	3.2 Jan	5.1 Nov
9B [2]	Kalamazoo, Schoonover	21	6	112OTSH	828	19	R	+1.0 Apr 1975	4.3 Oct 1984	1.4 Mar	3.6 Jun
26BBCC [2]	Kalamazoo, Morrow	46	4	112OTSH	790	1	R			6.3 Dec	8.1 Jul
11W 20BB2 [2]	Kalamazoo, Kendall	106	4	112OTSH	880	20	R	12.5 Feb 1976	48.4 Jun 1971	16.8 Mar	37.4 Jun
22CD [2]	Kalamazoo, Stockbridge	137	4	112OTSH	764.7	28	R	4.8 Feb 1975	31.1 Aug 1961	7.5 Dec	13.5 Aug
28AA [2]	Kalamazoo, Maple	245	4	112OTSH	820	19	R	32.9 Jan 1979	73.1 Jul 1985	29.8 Dec	50.9 Jun
31CD [2]	Kalamazoo, Colony	226	4	112OTSH	910	19	R	41.4 Sep 1982	71.8 May 1978	51.2 Jan	64.7 Apr
36CB [2]	Kalamazoo, Emerald	226	4	112OTSH	860	19	R	25.4 Apr 1985	50.4 Jun 1971	27.2 Jan	45.0 Jun
3S 11W 4AD1 [2]	Kalamazoo, A-D	135	3	112OTSH	854.0	29	R	0.5 May 1967	12.9 Jul 1964	2.3 Apr	11.9 Jul
4AD2 [2]	Kalamazoo, A-S	40	3	112OTSH	854.0	29	R	+0.2 Sep 1975	9.1 Nov 1959	0.2 Apr	3.6 Aug
14AA [2]	Upjohn 28	233	16	112OTSH	870	21	R	23.5 Aug 1982	45.2 Jul 1977	30.3 Jan	41.3 Jul

Table 2.--Records of observation wells in Michigan--Continued

County and well number (Twsp,range,section)	Name	Depth (feet)	Diam. (inches)	Aquifer	Elev.	Yrs. record	Meas. freq.	Observed water-level extremes Through 1986 Highest	Through 1986 Lowest	1987 Highest	1987 Lowest
KALAMAZOO--Continued											
3S 11W 22BBCD	[2] Portage	102	12	112GLCL	877	6	R	24.8 Apr 1985	27.9 Nov 1984	26.3 Jan	28.1 Aug
12W 11BD	[2] Kalamazoo, Atwater	248	3	112OTSH	880	27	R	+3.0 Sep 1969	1.0 Aug 1977	+0.6 Feb	0.8 Aug
11AD1	[2] Kalamazoo, Sabo-D	300	4	112OTSH	877	15	R	4.5 Jul 1973	16.6 Jul 1984	7.0 Dec	17.3 Aug
11AD2	[2] Kalamazoo, Sabo-S	38	6	112OTSH	877	15	R	9.1 Aug 1975	12.8 Aug 1984	10.8 Mar	12.7 Aug
4S 11W 3CDDA1	[2] Prairie View Park	190	4	112OTSH	870	19	R	18.0 Apr 1985	20.6 Dec 1977	19.1 Jan	20.2 Aug
KENT											
5N 12W 4DCCD1	Wyoming, Wobma	86	6	112GRVL	868.0	26	M	7.8 Oct 1978	12.9 Aug 1964	9.5 Jan	11.3 Jul
10N 12W 13DD	Rogue River Game Area	30	1	112GLCL	785	22	Q	0.8 Jan 1975	9.2 Oct 1969	5.4 Jan	7.3 Oct
LAKE											
20N 13W 13ACAC1	Irons	57	6	112OTSH	945	8	M	9.1 Oct 1986	18.0 Mar 1982	10.2 Jan	12.0 Nov
LEELANAU											
28N 14W 8DDCA1	Sleeping Bear,D	128	6	112SAND	750	8	M	111.6 Dec 1986	114.5 Jun 1984	111.2 Apr	111.8 Oct
18BABB1	Sleeping Bear,S	60	6	112SAND	625	8	R	20.8 Oct 1986	24.9 Nov 1982	22.0 Jan	23.4 Nov
LENAWEE											
5S 1E 12DDBD1	Onsted Game Area	39	1	112GLCL	1,000	22	M	15.9 Mar 1982	19.3 Sep 1971	16.6 Apr	18.4 Aug
6S 4E 8DDBA1	Fisher Body	81	8	112OTSH	800	23	R	9.9 Apr 1982	18.4 Feb 1965	14.0 Jan	15.3 Dec
LIVINGSTON											
1N 6E 13DBAB1	American Aggregate	29	2	112OTSH	930	18	R	12.1 Apr 1974	21.6 Oct 1979	15.8 Jan	16.9 Dec
MACKINAC											
41N 5W 23BC	Round Lake CCC	47	6	355SLIMH	610	32	Q	2.9 Apr 1985	17.8 Feb 1981	10.1 Mar	15.0 Oct
42N 2W 7AABB1	Pontchartrain CCC	102	6	355MNSQ	680	32	R	12.5 Apr 1985	32.3 Feb 1977	20.7 Apr	30.2 Sep
MARQUETTE											
47N 28W 3CCDC1	[4] Ely Twsp	75	8	112OTSH	1,572.0	27	R	9.4 Apr 1985	19.3 Apr 1964	15.0 Dec	16.8 Oct
49N 30W 22AC	[1] WEP 13	17	1	112GLCL	1,680	40	M	0.6 May 1951	13.3 Sep 1948	8.4 Jun	10.1 Feb
MENOMINEE											
37N 26W 19DADA1	Carney	17	4	365TBRV	800	29	Q	3.3 Mar 1986	8.6 Jan 1977	4.4 Dec	5.6 Sep
MONROE											
7S 6E 15ACAA1	Petersburg, Rock	73	6	348DRRV	860	9	M	32.3 Mar 1982	43.2 Oct 1985	35.6 Feb	42.0 Aug
15ADBB1	Petersburg Game Area	17	1	112GLCL	675	22	M	3.0 Feb 1966	7.4 Oct 1985	5.6 Jan	6.9 Oct
MUSKEGON											
11N 15W 34ADDD1	[7] Muskegon Game Area	31	1	112SAND	595	22	Q	+0.2 Apr 1978	4.7 Sep 1972	0.7 Mar	

Table 2.--Records of observation wells in Michigan--Continued

County and well number (Twsp,range,section)	Name	Depth (feet)	Diam. (inches)	Aquifer	Elev.	Yrs. record	Meas. freq.	Observed water-level extremes: Through 1986 Highest	Through 1986 Lowest	1987 Highest	1987 Lowest
OAKLAND											
2N 7E 5BA	Honeywell Lake Road	44	2	112GLCL	1,020	20	R	23.9 Apr 1976	28.9 Dec 1971	26.5 Apr	27.7 Oct
8E 18DBAD1	[2] Proud Lake Park	45	6	1120TSH	910	19	R	2.8 May 1974	6.4 Sep 1971	4.5 Apr	5.5 Sep
3N 7E 5DA	Fish Lake Road	49	2	112GLCL	1,055	19	R	29.5 Jun 1976	38.7 Dec 1972	33.4 May	34.9 Dec
10E 13AC	Oakland University	183	6	112GLCL	940	7	R	56.2 Apr 1984	93.5 Jul 1963	55.4 Apr	57.0 Jun
5N 8E 8ACAC1	Holly Recreation Area	42	1	112GLCL	930	22	M	22.3 Apr 1974	26.5 Sep 1966	24.9 Apr	26.3 Aug
OCEANA											
13N 15W 18AAAA1	Hesperia	79	6	1120TSH	703	10	R	35.8 Dec 1986	41.0 Mar 1982	36.0 Jan	40.2 Dec
OGEMAW											
23N 1E 2BAAA1	Rose City Road, D	105	1	112GLCL	1,265	20	Q	73.6 Oct 1976	78.2 Apr 1969	73.3 Apr	74.3 Jan
2BAAA2	Rose City Road, S	20	1	112SAND	1,265	20	Q	7.6 Apr 1976	13.6 Dec 1972	10.0 Apr	11.9 Oct
ONTONAGON											
51N 41W 8BDBC1	Silver City	100	6	420FRED	620	30	Q	8.2 Apr 1959	21.8 Dec 1976	9.3 Jun	12.4 Sep
OTSEGO											
30N 3W 19ABBB1	Gaylord	90	6	1120TSH	1,308	9	M	30.6 Dec 1986	35.8 Apr 1982	30.8 Jan	33.2 Dec
PRESQUE ISLE											
33N 6E 8BBB81	Styma	61	6	341TRVR	800	29	Q	4.8 Mar 1984	18.8 Mar 1963	8.8 Mar	12.7 Jul
ROSCOMMON											
24N 2W 20BABA1	[4] Exp. Station	14	8	1120TSH	1,145.3	54	R	2.1 Apr 1976	6.2 Dec 1949	4.2 Jan	5.9 Aug
SAGINAW											
10N 1E 22DADA1	Marion Springs, D	210	6	324SGNW	657	10	R	7.9 Feb 1981	10.3 Oct 1984	8.6 Jan	10.6 Oct
SANILAC											
13N 13E 12ADAA1	Minden Game Area	130	6	337MRSL	805	11	R	15.5 Apr 1985	22.7 Oct 1979	16.3 Apr	21.5 Oct
SCHOOLCRAFT											
45N 13W 16CCCB1	Seney	154	4	361ODVCU	710	36	R	4.6 Apr 1971	6.5 Oct 1963	5.3 Apr	6.0 Sep
47N 16W 30B8BB1	Cusino CCC	57	6	368PRDC	900	31	R	5.6 Apr 1985	16.4 Feb 1977	10.3 Apr	15.4 Sep
VAN BUREN											
2S 13W 28BCB1	Almena, D	108	4	112GLCL	737	7	M	4.7 Oct 1986	10.7 Aug 1981	6.8 May	8.1 Jul
28BCB2	Almena, S	44	4	112GLCL	737	7	M	8.4 Oct 1986	12.6 Sep 1984	10.5 May	12.2 Jul
WASHTENAW											
2S 3E 9DAAB2	[2] Waterloo Park	48	6	112SDGV	970	19	R	4.1 May 1974	7.0 Aug 1971	4.7 Apr	6.9 Aug
3S 6E 16BCCD1	[2] Ann Arbor	55	10	112GLCL	821.5	25	R	0.7 Mar 1974	15.9 Oct 1964	4.4 Dec	8.2 Jul

Table 2.--Records of observation wells in Michigan--Continued

County and well number (Twsp,range,section)	Name	Depth (feet)	Diam. (inches)	Aquifer	Elev.	Yrs. record	Meas. freq.	Observed water-level extremes: Through 1986 Highest	Through 1986 Lowest	1987 Highest	1987 Lowest
WASHTENAW--Continued											
3S 7E 588	[2] Ypsilanti, Superior	69	8	112GLCL	720	26	R	1.8 Feb 1965	21.4 Dec 1965	3.0 Jun	7.5 Jan
9AD8C1	[2] Ypsilanti, Gilbert	94	6	112GLCL	710	37	R	29.1 Nov 1945	78.8 Oct 1974	48.5 Jan	60.6 Jul
24CA1	[2] Ypsilanti Twsp, 104	87	4	112GLCL	665.6	42	R	5.8 Jan 1950	22.7 Feb 1971	14.7 Dec	19.5 Jun
24CD	[2] Ypsilanti Twsp, 117	75	6	112GLCL	657.8	41	R	4.7 Oct 1981	63.2 Feb 1970	12.2 Jan	38.5 Sep
WEXFORD											
22N 12W 138A	[2] Harrietta Fish	141	4	112GLCL	1,060	27	R	+13.8 Mar 1970	1.6 Jan 1981	+7.9 Jun	+3.0 Jan

FOOTNOTES

[1] Measured by WEP.

[2] Water levels affected by pumping.

[3] Measured by owner.

[4] Federal key well.

[5] No measurements made from March to middle of October.

[6] Changed datum by 2.0 ft, Feb. 20, 1987.

[7] Destroyed.

Table 3.--Reported ground-water pumpage in 1987

(in millions of gallons)

County and water user	Total	Maximum day	Minimum day
ALCONA			
Harrisville	23.8	0.125	0.038
ALGER			
Burt Township	38.6	.233	.045
Chatham	10.3	.186	.012
ALLEGAN			
Allegan	381.7	2.303	.572
Fennville	239.2	[a]--	--
Otsego	368.2	1.760	.687
Plainwell	235.3	1.593	.300
Saugatuck	191.9	--	--
ANTRIM			
Bellaire	75.3	.440	.149
Central Lake	74.2	.326	.141
Mancelona	95.7	.733	--
BENZIE			
Beulah	17.4	.133	.024
Frankfort	99.5	--	--
BERRIEN			
Berrien Springs	158.2	.969	.279
Buchanan	276.1	1.717	.302
Coloma	108.3	.544	.200
Niles	1,023.8	4.500	1.850
Niles Township	90.1	.759	.075
Watervliet	94.9	.400	.000
BRANCH			
Bronson	140.0	.720	.095
Coldwater	1,078.4	6.220	1.556
Coldwater Regional Center	90.1	.336	.118
Quincy	82.6	.664	--
CALHOUN			
Albion	836.7	3.890	1.147
Athens	37.9	.374	.023
Battle Creek	3,696.6	17.150	4.510
Battle Creek Township	779.8	5.520	1.460
Homer	71.6	.575	.111
Marshall	607.5	2.909	.848
CASS			
Cassopolis	89.4	.428	.167
Dowagiac	355.6	2.043	.477
CHARLEVOIX			
Boyne City	370.9	1.836	.507
East Jordan	250.9	1.170	.410
CHEBOYGAN			
Mackinaw City	81.9	.847	.068
CHIPPEWA			
Kinross Township	114.4	.573	.120
CLARE			
Clare	264.5	1.315	.410
Farwell	52.2	--	--
Harrison	76.6	.517	.129
CLINTON			
Fowler	26.6	0.237	0.026
Maple Rapids	25.9	--	--
Ovid	89.5	.420	.127
St. Johns	66.2	2.269	.772
Westphalia	21.5	.212	.041
CRAWFORD			
Grayling	254.6	1.207	.516
DICKINSON			
Breitung Township	43.6	--	--
EATON			
Bellevue	66.5	.370	.075
Charlotte	394.5	1.857	.670
Delta Township	1,081.3	5.423	--
Eaton Rapids	277.5	1.664	.406
Grand Ledge	260.6	1.564	.382
Sunfield	29.2	--	--
EMMET			
Harbor Springs	185.4	1.660	.270
Petosky	692.0	3.187	1.332
GENESEE			
Beecher Metro District	543.6	2.224	1.132
Burton	277.7	1.774	.244
Davison	243.9	3.870	.114
Fenton	335.7	1.566	.619
Grand Blanc	483.7	2.411	.811
Grand Blanc Township	176.1	--	--
Linden	84.6	.438	.081
GLADWIN			
Beaverton	48.0	--	--
GOGEBIC			
Ironwood	483.2	--	--
Marenisco Township	58.4	.233	.122
Wakefield	167.2	.648	.342
GRAND TRAVERSE			
Kingsley	39.0	--	--
GRATIOT			
Breckenridge	42.4	.199	.032
Ithaca	108.3	--	--
St. Louis	257.0	1.326	.330
HILLSDALE			
Hillsdale	389.2	1.919	.526
Jonesville	170.9	.757	.217
Litchfield	58.1	.340	.103
HOUGHTON			
Adams Township - South Range Water Authority	396.5	--	--
Chassell Township	49.2	--	--
Houghton	382.4	1.562	.624
[b]Northern Michigan Water	390.8	1.509	.788
HURON			
Elkton	37.5	--	--
Pigeon	59.9	0.339	0.026

Table 3.--Reported ground-water pumpage in 1987--Continued

(in millions of gallons)

County and water user	Total	Maximum day	Minimum day
INGHAM			
East Lansing-Meridian Township	2,393.9	12.600	4.320
Lansing	7,838.3	35.113	15.452
Lansing Township	309.9	--	--
Mason	256.5	--	--
Michigan State University	1,517.8	4.399	1.361
Stockbridge	43.1	--	--
Webberville	59.9	0.402	0.114
Williamston	99.3	.560	.108
IONIA			
Belding	667.9	--	--
Ionia	620.4	2.488	1.151
Michigan Training Unit, Ionia	59.0	.346	--
[c]Muir	52.4	.418	.091
Pewamo	25.3	--	--
Portland	171.0	--	--
Saranac	56.6	.360	.008
IOSCO			
Oscoda Township	304.2	--	--
IRON			
Alpha	10.6	--	--
Caspian	89.4	.344	.169
Crystal Falls	160.3	.887	.348
Crystal Falls Township	58.2	--	--
Iron River	125.5	.631	.123
Stambaugh	61.2	.479	.032
ISABELLA			
Mt. Pleasant	960.2	5.279	1.114
JACKSON			
Concord	65.2	.442	.010
Grass Lake	24.6	.199	.033
Jackson	3,322.0	14.530	4.740
Springport	51.9	--	--
State Prison, Jackson	588.7	--	--
KALAMAZOO			
Augusta	30.4	.429	.040
Galesburg	75.9	.473	.143
Kalamazoo	6,450.3	39.742	10.854
Parchment	167.1	1.614	.161
Portage	1,373.7	12.736	1.733
Upjohn Company	8,235.7	29.940	12.180
Vicksburg	112.7	.979	.140
KALKASKA			
Kalkaska	228.2	1.662	.261
KENT			
Alloytek, Incorporated	79.8	--	--
Cedar Springs	147.9	.801	.116
Lowell	247.7	1.531	.163
Plainfield Township	868.3	6.940	1.210
LAPEER			
Columbiaville	31.6	.172	.057
Dryden	16.7	.105	.024
North Branch	35.8	.207	.069
LEELANAU			
Northport	30.2	.295	.022
LENAWEE			
Britton	19.7	0.109	0.009
Clinton	119.5	--	--
Hudson	128.8	.548	.212
Morenci	82.7	.547	.003
Onsted	37.1	.298	.053
Tecumseh	379.3	1.986	.499
Inland Division, Tecumseh	4.8	.081	.000
LIVINGSTON			
Brighton	330.0	1.780	.051
Fowlerville	109.4	.571	.232
Green Oak Township	37.0	--	--
Howell	507.9	2.706	.807
LUCE			
Newberry	142.6	1.556	.127
Newberry Health Center	16.9	--	--
MACOMB			
Armada	36.3	--	--
Romeo	104.6	--	--
Richmond	131.3	--	--
MANISTEE			
Filer Township	62.1	.536	.046
Manistee	408.3	2.133	.767
MARQUETTE			
Ishpeming Township	143.2	--	--
K.I. Sawyer AFB	449.4	2.391	.796
Powell Township	14.2	.102	.010
MENOMINEE			
Stephenson	39.5	.225	.066
MISSAUKEE			
Lake City	62.8	.524	.096
MONROE			
Petersburg	47.8	.238	.052
MONTCALM			
Carson City	75.4	.430	.111
Edmore	69.6	.875	.053
Greenville	972.8	5.131	1.269
Howard City	42.9	--	--
Sheridan	37.9	--	--
MUSKEGON			
Montague	101.6	.905	.094
NEWAYGO			
Freemont	502.2	3.214	.404
Hesperia	24.7	--	--
Newaygo	71.4	.360	.100
White Cloud	61.7	.458	.090
OAKLAND			
Holly	182.5	1.003	.376
Independence Township	245.4	--	--

Table 3.--Reported ground-water pumpage in 1987--Continued

(in millions of gallons)

County and water user	Total	Maximum day	Minimum day
OAKLAND (Continued)			
Milford	254.4	1.395	.411
Orion Township	268.2	1.447	.497
Oxford	195.6	1.036	.196
Rochester	692.4	3.737	1.171
South Lyon	705.0	--	0.221
Southfield	5.2	--	--
Sylvan Lake	67.8	--	--
Walled Lake	304.5	--	--
Waterford Township	2,310.8	--	--
Wolverine Lake	72.3	--	--
OCEANA			
Shelby	136.8	--	--
OGEMAW			
West Branch	105.5	0.628	.000
ONTONAGON			
Bergland Township	[d]10.4	--	--
Rockland Township	12.3	.049	.016
OSCEOLA			
Evart	800.2	3.600	.530
Reed City	138.5	--	--
OTSEGO			
Gaylord	275.2	--	--
OTTAWA			
Spring Lake	166.5	1.304	.082
PRESQUE ISLE			
Onaway	86.3	.756	.127
Rogers City	155.0	.978	.299
ROSCOMMON			
Roscommon	61.3	--	--
ST. CLAIR			
Capac	40.0	.200	.037
Yale	80.1	--	--
ST. JOSEPH			
Constantine	153.5	.446	.131
Sturgis	812.5	4.258	1.389
SAGINAW			
Chesaning	112.3	0.500	0.108
SANILAC			
Croswell	194.4	1.116	.220
Deckerville	56.5	.380	.015
Marlette	97.7	.560	.160
Peck	19.5	--	--
Port Sanilac	42.7	--	--
SHIAWASSEE			
Bancroft	17.0	--	--
Byron	23.7	--	--
Corunna	95.0	--	--
Durand	151.0	.628	.266
Owosso	848.8	4.258	1.536
Perry	67.9	.386	.116
TUSCOLA			
Akron	2.5	--	--
Caro	218.4	1.077	.225
Cass City	100.7	.758	.174
Kingston	14.6	--	--
Mayville	32.8	--	--
State Hospital, Caro	55.6	.370	.050
Vassar	189.5	1.078	.301
VAN BUREN			
Bangor	66.3	.618	.008
Decatur	98.7	--	--
Gobles	44.3	--	--
Hartford	91.5	.471	.104
Lawrence	27.8	--	--
Lawton	304.1	1.864	.460
Paw Paw	210.6	1.311	.334
WASHTENAW			
Ann Arbor	[e]957.2	--	--
Chelsea	203.3	.985	.349
Dexter	99.9	.384	.115
Milan	329.3	1.594	.482
Saline	410.6	2.758	.650
Webster Township	49.0	--	--
Ypsilanti	1,220.2	6.344	1.520
Ypsilanti Township	1,820.8	10.130	.167
WEXFORD			
Cadillac	776.0	3.981	1.251
Manton	66.2	.311	.076

FOOTNOTES

[a] Indicates data not available.

[b] Amount pumped to supply Calumet, Calumet Township, Copper City, Lake Linden, Laurium, Osceola Township, Torch Lake Township, Ahmeek, and Allouez Township.

[c] Supplies water to Lyons.

[d] Wholly or partly estimated.

[e] Also pumped 5,355 million gallons from Huron River.

Table 4.--Water-quality data

[Analyses by U.S. Geological Survey]

LOCAL IDENTIFIER: See section in text entitled "Well-numbering system", also includes abbreviated spelling of county name.

GEOLOGIC UNIT:

112OTSH	Outwash	368PCTP	Prairie Du Chien-Trempealeau Formations
112SAND	Sand	372TPMG	Trempealeau-Munising Formations
337MRSL	Marshall Formation	372MNSG	Munising Sandstone
355BBLF	Burnt Bluff Group	420FRED	Freda Sandstone
355ENGD	Engadine Dolomite	420JCBV	Jacobsville Sandstone
355MNSQ	Manistique Series	420KWNW	Keweenawan Supergroup
365TRNNL	Trenton Limestone	420PGLK	Portage Lake Volcanics
368HMVL	Hermansville Limestone	430MCGM	Michigamme Slate
368PRDC	Prairie Du Chien Group	430RDVL	Randville Dolomite

UNITS: Turbidity is reported in Ftu = Formazin turbidity units: mg/L = Milligrams per liter µg/L = Micrograms per liter; Pci/L = Picocuries per liter.

Local identifier		Date	Geologic unit	Depth of well, total (feet)	Alkalinity, lab (mg/L as CaCO3)	Aluminum, total recoverable (µg/L as Al)	Arsenic, total (µg/L as As)	Barium, total recoverable (µg/L as Ba)	Beryllium, total recoverable (µg/L as Be)
46N 04W 24DAAD01	CHIPWA	08-26-87	112OTSH	53.90	13	<10	<1	<100	<10
47N 01E 31CDBA01	CHIPWA	08-27-87	420JCBV	99.00	113	<10	<1	<100	<10
38N 21W 08DBDB01	DELTA	09-04-87	368PCTP	720.00	138	380	<1	<100	<10
38N 23W 15CDBB01	DELTA	08-11-87	368PCTP	665.00	113	<10	<1	<100	<10
40N 19W 28BBBB01	DELTA	08-10-87	368PCTP	1290.00	123	<10	<1	100	<10
41N 21W 20CDBC01	DELTA	08-11-87	368PRDC	303.00	188	<10	<1	100	<10
43N 28W 31CCCA01	DCKNSN	08-12-87	430RDVL	100.00	157	<10	<1	<100	<10
47N 46W 04DBBA01	GOGEBC	08-21-87	420KWNW	230.00	125	<10	<1	<100	<10
49N 48W 32ABBA01	GOGEBC	08-20-87	420FRED	75.00	80	<10	<1	<100	<10
26N 09W 14ABAA01	GR TRV	09-01-87	112SAND	80.00	96	<10	14	<100	<10
55N 33W 06DDDD01	HOGHTN	08-27-87	420PGLK	92.00	90	<10	<1	<100	<10
57N 30W 08BABA01	KEWENW	08-26-87	420JCBV	342.00	128	<10	<1	<100	<10
42N 06W 23DDDD01	MACKNC	08-26-87	355ENGD	139.00	74	350	8	<100	<10
42N 12W 06DCAA01	MACKNC	08-27-87	355BBLF	185.00	182	<10	2	<100	<10
43N 11W 28BCBB01	MACKNC	08-31-87	355MNSQ	118.00	212	<10	<1	<100	<10
42N 26W 05ACCC01	MARQTE	09-02-87	368HMVL	38.00	198	<10	<1	<100	<10
46N 23W 29CBBA01	MARQTE	09-01-87	372MNSG	133.00	113	<10	4	<100	<10
48N 29W 31DADA01	MARQTE	09-02-87	430MCGM	303.00	87	<10	9	<100	<10
35N 27W 26BAAD01	MENOME	08-13-87	365TRNNL	75.00	216	2000	<1	<100	<10
37N 26W 17CDCD01	MENOME	08-28-87	372TPMG	483.00	241	<10	1	<100	<10
51N 41W 08BDBC01	ONTNGN	08-19-87	420FRED	100.00	160	1400	2	<100	<10
13N 13E 12ADAA01	SANLAC	06-11-87	337MRSL	130.00	167	<10	1	<100	<10
41N 16W 29BCBD01	SCHCFT	09-03-87	355MNSQ	90.00	168	<10	1	<100	<10

Table 4.--Water-quality data--Continued

Local identifier			Boron, total recoverable (µg/L as B)	Cadmium, total recoverable (µg/L as Cd)	Calcium, dissolved (mg/L as Ca)	Carbon, organic dissolved (mg/L as C)	Chloride, dissolved (mg/L as Cl)	Chromium, total recoverable (µg/L as Cr)	Cobalt, total recoverable (µg/L as Co)	Color (platinum-cobalt units)
46N 04W 24DAAD01	CHIPWA		<10	<1	4.5	1.5	0.50	<10	<1	1
47N 01E 31CDBA01	CHIPWA		30	<1	32	2.7	12	<10	1	1
38N 21W 08DBDB01	DELTA		220	<1	120	0.5	470	10	1	1
38N 23W 15CDBB01	DELTA		470	<1	30	.7	24	10	<1	4
40N 19W 28BBBB01	DELTA		160	<1	120	2.0	430	<10	<1	2
41N 21W 20CDBC01	DELTA		200	<1	51	1.0	30	<10	<1	2
43N 28W 31CCCA01	DCKNSN		30	<1	38	2.7	.80	10	2	1
47N 46W 04DBBA01	GOGEBC		140	<1	25	3.7	8.9	30	1	2
49N 48W 32ABBA01	GOGEBC		180	<1	22	4.0	7.8	20	<1	2
26N 09W 14ABAA01	GR TRV		<10	<1	31	1.6	.60	20	2	2
55N 33W 06DDDD01	HOGHTN		280	<1	10	3.0	1.9	10	1	2
57N 30W 08BABA01	KEWENW		110	<1	39	1.1	4.7	20	1	1
42N 06W 23DDDD01	MACKNC		140	<1	220	1.9	1.1	10	1	2
42N 12W 06DCAA01	MACKNC		20	<1	50	2.5	1.2	40	1	2
43N 11W 28BCBB01	MACKNC		<10	<1	67	3.5	5.4	<10	<1	3
42N 26W 05ACCC01	MARQTE		<10	<1	52	6.0	.60	30	<1	13
46N 23W 29CBBA01	MARQTE		<10	<1	33	1.2	.50	10	50	2
48N 29W 31DADA01	MARQTE		20	<1	29	1.0	17	30	4	6
35N 27W 26BAAD01	MENOME		210	1	44	1.3	9.6	30	2	2
37N 26W 17CDCD01	MENOME		30	<1	57	1.3	4.0	20	1	1
51N 41W 08BDBC01	ONTNGN		1100	<1	35	1.5	15	<10	2	4
13N 13E 12ADAA01	SANLAC		<10	<1	47	1.6	5.4	10	<1	3
41N 16W 29BCBD01	SCHCFT		<10	<1	39	1.6	2.3	10	<1	3

Local identifier			Copper, total recoverable (µg/L as Cu)	Cyanide, total (mg/L as Cn)	Fluoride, dissolved (mg/L as F)	Hardness, total (mg/L as CaCO3)	Hardness, noncarbonate mg/L as CaCO3	Iron, dissolved (µg/L as Fe)	Iron, total recoverable (µg/L as Fe)	Lead, total recoverable (µg/L as Pb)
46N 04W 24DAAD01	CHIPWA		1000	<0.010	0.10	15	2	100	3500	18
47N 01E 31CDBA01	CHIPWA		12	<.010	.10	130	12	10	<10	5
38N 21W 08DBDB01	DELTA		9	<.010	.50	520	380	53	810	16
38N 23W 15CDBB01	DELTA		6	<.010	.80	130	20	11	960	<5
40N 19W 28BBBB01	DELTA		6	<.010	.40	510	390	430	1800	5
41N 21W 20CDBC01	DELTA		8	<.010	.30	230	38	280	2100	5
43N 28W 31CCCA01	DCKNSN		11	<.010	.20	170	12	5	7100	<5
47N 46W 04DBBA01	GOGEBC		8	<.010	.10	87	0	7	<10	<5
49N 48W 32ABBA01	GOGEBC		48	<.010	.20	83	3	19	<10	<5
26N 09W 14ABAA01	GR TRV		<1	<.010	.10	110	9	<3	<10	<5
55N 33W 06DDDD01	HOGHTN		17	<.010	.10	29	0	47	90	<5
57N 30W 08BABA01	KEWENW		9	<.010	.10	130	4	3	40	<5
42N 06W 23DDDD01	MACKNC		22	<.010	1.4	870	800	73	3400	6
42N 12W 06DCAA01	MACKNC		6	<.010	.80	200	21	210	980	<5
43N 11W 28BCBB01	MACKNC		3	<.010	.20	230	22	8	490	16
42N 26W 05ACCC01	MARQTE		19	<.010	.10	240	43	520	550	<5
46N 23W 29CBBA01	MARQTE		6	<.010	.10	130	19	27	180	<5
48N 29W 31DADA01	MARQTE		5	<.010	.50	150	60	310	1000	<5
35N 27W 26BAAD01	MENOME		41	--	.20	220	1	56	3200	<5
37N 26W 17CDCD01	MENOME		4	<.010	.10	240	0	48	240	<5
51N 41W 08BDBC01	ONTNGN		48	<.010	.60	120	0	13	2300	<5
13N 13E 12ADAA01	SANLAC		2	<.010	.10	190	21	270	570	<5
41N 16W 29BCBD01	SCHCFT		7	<.010	.40	170	4	7	90	7

Table 4.--Water-quality data--Continued

Local identifier		Lithium, total recoverable (µg/L as Li)	Manganese, dissolved (µg/L as Mn)	Manganese, total recoverable (µg/L as Mn)	Magnesium, dissolved (mg/L as Mg)	Mercury, total recoverable (µg/L as Hg)	Molybdenum, total recoverable (µg/L as Mo)	Nickel, total recoverable (µg/L as Ni)	Nitrogen, ammonia total (mg/L as N)
46N 04W 24DAAD01	CHIPWA	<10	8	<10	0.84	0.20	<1	<1	<0.010
47N 01E 31CDBA01	CHIPWA	10	<1	<10	11	.30	<1	1	.010
38N 21W 08DBDB01	DELTA	70	17	30	53	.10	2	<1	.090
38N 23W 15CDBB01	DELTA	30	18	20	14	.20	5	1	.050
40N 19W 28BBBB01	DELTA	60	70	60	52	.20	4	<1	.120
41N 21W 20CDBC01	DELTA	20	32	30	24	.20	<1	1	.060
43N 28W 31CCCA01	DCKNSN	<10	25	60	18	.10	2	3	.020
47N 46W 04DBBA01	GOGEBC	<10	<1	<10	5.9	<.10	1	2	.010
49N 48W 32ABBA01	GOGEBC	30	<1	<10	6.8	.10	<1	1	<.010
26N 09W 14ABAA01	GR TRV	<10	<1	<10	6.7	.40	1	<1	<.010
55N 33W 06DDDD01	HOGHTN	<10	5	<10	.87	.20	<1	<1	<.010
57N 30W 08BABA01	KEWENW	<10	<1	<10	8.4	.20	<1	<1	<.010
42N 06W 23DDDD01	MACKNC	50	63	80	78	.10	9	<1	.210
42N 12W 06DCAA01	MACKNC	40	7	10	19	.10	1	<1	.080
43N 11W 28BCBB01	MACKNC	<10	<1	<10	16	<.10	<1	<1	.020
42N 26W 05ACCC01	MARQTE	<10	16	20	27	<.10	1	<1	.140
46N 23W 29CBBA01	MARQTE	<10	55	50	12	<.10	33	41	.010
48N 29W 31DADA01	MARQTE	10	470	450	18	<.10	18	<1	.060
35N 27W 26BAAD01	MENOME	10	9	90	26	.20	<1	3	.110
37N 26W 17CDCD01	MENOME	<10	18	20	24	.20	1	<1	.150
51N 41W 08BDBC01	ONTNGN	80	3	70	7.6	.30	3	5	.010
13N 13E 12ADAA01	SANLAC	<10	39	50	17	.20	1	4	.020
41N 16W 29BCBD01	SCHCFT	<10	2	<10	18	<.10	<1	<1	<.010

Local identifier		Nitrogen, nitrite total (mg/L as N)	Nitrogen, NO2+NO3 total (mg/L as N)	Nitrogen, organic total (mg/L as N)	pH (standard units)	Phenols, total (µg/L)	Phosphorous, total (mg/L as P)	Phosphorus, ortho, total (mg/L as P)	Potassium, dissolved (mg/L as K)
46N 04W 24DAAD01	CHIPWA	<0.010	0.200	--	6.25	7	0.020	<0.010	1.7
47N 01E 31CDBA01	CHIPWA	<.010	.500	0.39	7.20	3	<.010	<.010	1.9
38N 21W 08DBDB01	DELTA	<.010	<.100	--	7.75	3	.020	<.010	8.8
38N 23W 15CDBB01	DELTA	<.010	<.100	.35	--	2	.010	<.010	4.1
40N 19W 28BBBB01	DELTA	<.010	<.100	.38	7.65	3	.060	<.010	9.7
41N 21W 20CDBC01	DELTA	<.010	<.100	.44	7.70	3	<.010	<.010	4.3
43N 28W 31CCCA01	DCKNSN	<.010	<.100	.38	8.10	2	.030	<.010	1.3
47N 46W 04DBBA01	GOGEBC	<.010	<.100	.29	7.70	<1	--	<.010	.50
49N 48W 32ABBA01	GOGEBC	<.010	1.20	--	6.45	<1	.070	.060	1.8
26N 09W 14ABAA01	GR TRV	<.010	<.100	--	8.06	5	<.010	<.010	.70
55N 33W 06DDDD01	HOGHTN	<.010	<.100	--	8.80	3	<.010	.010	.10
57N 30W 08BABA01	KEWENW	<.010	.100	--	8.25	5	<.010	.010	.50
42N 06W 23DDDD01	MACKNC	<.010	<.100	.49	7.90	3	.030	<.010	3.2
42N 12W 06DCAA01	MACKNC	<.010	<.100	--	7.80	3	.010	.040	1.4
43N 11W 28BCBB01	MACKNC	<.010	<.100	--	7.80	3	<.010	<.010	.80
42N 26W 05ACCC01	MARQTE	<.010	<.100	.56	7.80	3	<.010	<.010	1.5
46N 23W 29CBBA01	MARQTE	<.010	<.100	--	7.95	2	.010	.010	1.2
48N 29W 31DADA01	MARQTE	<.010	.100	--	7.40	2	<.010	<.010	1.3
35N 27W 26BAAD01	MENOME	<.010	.100	--	7.80	3	.090	<.010	2.7
37N 26W 17CDCD01	MENOME	<.010	<.100	--	8.00	2	<.010	.010	2.0
51N 41W 08BDBC01	ONTNGN	<.010	.100	.19	7.90	5	.090	.020	6.4
13N 13E 12ADAA01	SANLAC	<.010	<.100	.58	7.40	5	.050	.020	3.4
41N 16W 29BCBD01	SCHCFT	<.010	<.100	--	7.90	3	.020	.010	.80

Table 4.--Water-quality data--Continued

Local identifier			Selenium, total (µg/L as Se)	Silica, dissolved (mg/L as SiO2)	Silver, total recoverable (µg/L as Ag)	Sodium, dissolved (mg/L as Na)	Solids, residue at 180 deg. C, dissolved (mg/L)	Solid, sum of constituents, dissolved (mg/L)	Specific conductance (µs/cm)	Strontium, total recoverable (µg/L as Sr)
46N 04W 24DAAD01	CHIPWA		<1	6.4	<1	0.90	30	34	46	80
47N 01E 31CDBA01	CHIPWA		<1	22	<1	8.3	165	173	281	230
38N 21W 08DBDB01	DELTA		<1	8.0	1	110	977	918	1580	2600
38N 23W 15CDBB01	DELTA		<1	6.6	<1	34	236	236	--	860
40N 19W 28BBBB01	DELTA		<1	7.6	<1	110	984	843	1660	640
41N 21W 20CDBC01	DELTA		<1	7.1	<1	18	268	278	500	110
43N 28W 31CCCA01	DCKNSN		<1	5.7	<1	1.3	170	168	327	2600
47N 46W 04DBBA01	GOGEBC		<1	18	<1	22	161	163	262	100
49N 48W 32ABBA01	GOGEBC		<1	24	<1	7.6	127	129	207	170
26N 09W 14ABAA01	GR TRV		<1	7.1	<1	.50	115	114	212	50
55N 33W 06DDDD01	HOGHTN		<1	15	<1	30	109	118	171	50
57N 30W 08BABA01	KEWENW		<1	13	<1	5.6	150	154	276	80
42N 06W 23DDDD01	MACKNC		<1	11	<1	36	1400	1310	1590	10000
42N 12W 06DCAA01	MACKNC		<1	8.7	<1	1.3	211	199	371	180
43N 11W 28BCBB01	MACKNC		<1	5.8	<1	3.2	245	238	413	100
42N 26W 05ACCC01	MARQTE		<1	17	<1	2.3	249	227	416	120
46N 23W 29CBBA01	MARQTE		<1	9.9	<1	1.6	155	153	254	100
48N 29W 31DADA01	MARQTE		2	14	<1	3.3	190	180	326	130
35N 27W 26BAAD01	MENOME		<1	19	<1	8.4	253	257	434	100
37N 26W 17CDCD01	MENOME		<1	12	1	3.6	262	263	471	180
51N 41W 08BDBC01	ONTNGN		<1	11	<1	52	272	237	466	630
13N 13E 12ADAA01	SANLAC		<1	7.9	<1	2.0	212	212	394	40
41N 16W 29BCBD01	SCHCFT		1	7.1	<1	1.9	171	181	310	80

Local identifier			Sulfate, dissolved (mg/L as SO4)	Temperature water (Deg C)	Tritium, total (Pci/L)	Turbidity (Ftu)	Uranium, natural dissolved (µg/L as U)	Vanadium, dissolved (µg/L as V)	Zinc, total recoverable (µg/L as Zn)
46N 04W 24DAAD01	CHIPWA		11	9.0	<110	12	--	3	330
47N 01E 31CDBA01	CHIPWA		18	11.0	<190	0.20	--	3	<10
38N 21W 08DBDB01	DELTA		65	12.5	<120	12	--	8	20
38N 23W 15CDBB01	DELTA		55	10.5	35	2.9	0.08	<1	<10
40N 19W 28BBBB01	DELTA		39	15.0	<10	12	--	9	<10
41N 21W 20CDBC01	DELTA		30	10.5	<10	20	.01	<1	150
43N 28W 31CCCA01	DCKNSN		9.0	7.0	32	3.3	--	1	680
47N 46W 04DBBA01	GOGEBC		7.3	10.0	77	.20	--	4	<10
49N 48W 32ABBA01	GOGEBC		11	10.5	96	.30	--	6	20
26N 09W 14ABAA01	GR TRV		10	8.5	<200	.10	.12	2	<10
55N 33W 06DDDD01	HOGHTN		6.5	8.0	<26	1.8	--	4	170
57N 30W 08BABA01	KEWENW		6.1	8.0	<150	1.9	--	5	20
42N 06W 23DDDD01	MACKNC		910	8.5	<26	22	--	<1	1200
42N 12W 06DCAA01	MACKNC		7.2	11.0	<26	2.3	--	<1	260
43N 11W 28BCBB01	MACKNC		12	8.0	<110	.30	.57	<1	40
42N 26W 05ACCC01	MARQTE		7.5	8.5	<26	.70	.03	2	<10
46N 23W 29CBBA01	MARQTE		27	9.0	<170	.60	1.1	<1	100
48N 29W 31DADA01	MARQTE		44	9.0	<26	5.7	2.7	1	3300
35N 27W 26BAAD01	MENOME		18	7.5	110	56	.04	<1	2200
37N 26W 17CDCD01	MENOME		16	8.0	<26	.50	--	<1	<10
51N 41W 08BDBC01	ONTNGN		13	6.0	<26	43	--	9	50
13N 13E 12ADAA01	SANLAC		29	9.5	<190	2.6	--	<1	10
41N 16W 29BCBD01	SCHCFT		11	11.0	<130	.40	.27	2	60

Table 4.--Water-quality data--Continued

Local identifier		2,4-D, Total (µg/L)	2,4,5-T, Total (µg/L)	2, 4-DP, Total (µg/L)	Silvex, total (µg/L)
46N 04W 24DAAD01	CHIPWA	<0.01	<0.01	<0.01	<0.01
47N 01E 31CDBA01	CHIPWA	<.01	<.01	<.01	<.01
38N 21W 08DBDB01	DELTA	<.01	<.01	<.01	<.01
38N 23W 15CDBB01	DELTA	<.01	<.01	<.01	<.01
40N 19W 28BBBB01	DELTA	.05	<.01	<.01	<.01
41N 21W 20CDBC01	DELTA	.06	<.01	<.01	<.01
43N 28W 31CCCA01	DCKNSN	<.01	<.01	<.01	<.01
47N 46W 04DBBA01	GOGEBC	<.01	<.01	<.01	<.01
49N 48W 32ABBA01	GOGEBC	<.01	<.01	<.01	<.01
26N 09W 14ABAA01	GR TRV	<.01	<.01	<.01	<.01
55N 33W 06DDDD01	HOGHTN	<.01	<.01	<.01	<.01
57N 30W 08BABA01	KEWENW	<.01	<.01	<.01	<.01
42N 06W 23DDDD01	MACKNC	<.01	<.01	<.01	<.01
42N 12W 06DCAA01	MACKNC	<.01	<.01	<.01	<.01
43N 11W 28BCBB01	MACKNC	<.01	<.01	<.01	<.01
42N 26W 05ACCC01	MARQTE	<.01	<.01	<.01	<.01
46N 23W 29CBBA01	MARQTE	<.01	<.01	<.01	<.01
48N 29W 31DADA01	MARQTE	<.01	<.01	<.01	<.01
35N 27W 26BAAD01	MENOME	<.01	<.01	<.01	<.01
37N 26W 17CDCD01	MENOME	<.01	<.01	<.01	<.01
51N 41W 08BDBC01	ONTNGN	<.01	<.01	<.01	<.01
13N 13E 12ADAA01	SANLAC	<.01	<.01	<.01	<.01
41N 16W 29BCBD01	SCHCFT	<.01	<.01	<.01	<.01

REFERENCES

Allen, W. B., 1977, Flowing wells in Michigan, 1974: Michigan Geological Survey Water Information Series Report 2, 27 p., 5 figs., 2 pls., 16 refs.

Allen, W. B., Miller J. B., and Wood, W. W., 1972, Availability of water in Kalamazoo County, Michigan: U.S. Geological Survey Water-Supply Paper 1973, 129 p., 36 figs., 9 pls.

Bedell, D. J., 1982, Municipal water withdrawals in Michigan: Michigan Department of Natural Resources, Water Management Division, 43 p., 14 figs., 2 tables.

Bedell, D. J., and Van Til, R. L., 1979, Irrigation in Michigan, 1977: Michigan Department of Natural Resources, Water Management Division, 44 p., 10 figs., 5 tables, 13 refs.

Borton, T. E., 1974, Planning perspectives on water resources, Washtenaw County, Michigan: Washtenaw County Metropolitan Planning Commission, 69 p.

Brown, E. A., and Stuart, W. T., 1951, Ground-water resources of the glacial deposits in the Bessemer area, Michigan, 1950: Michigan Geological Survey Progress Report 14, 68 p., 27 figs.

Cummings, T. R., 1980, Chemical and physical characteristics of natural ground waters in Michigan--a preliminary report: U.S. Geological Survey Open-File Report 80-953, 34 p., 12 figs., 5 tables, 13 refs.

Cummings, T. R., Twenter, F. R., and Holtschlag, D. J., 1984, Hydrology and land use in Van Buren County, Michigan: U.S. Geological Survey Water-Resources Investigations Report 84-4112, 124 p., 31 figs., 2 pls., 4 tables, 25 refs.

Cummings, T. R., and Twenter, F. R., 1986, Assessment of ground-water contamination at Wurtsmith Air Force Base, Michigan, 1982-85: U.S. Geological Survey Water-Resources Investigations Report 86-4118, 110 p., 3 pls., 55 figs., 16 tables, 10 refs.

Deutsch, Morris, 1956, Effects of dissemination of radioactive materials on water resources conservation--with special references to Michigan: Michigan State University Agricultural Experiment Station Water Bulletin 2.

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

----- 1961b, Incidents of chromium contamination of ground water in Michigan: U.S. Public Health Service Technical Report W61-5, p. 98-104.

Deutsch, Morris, 1962a, Controlled induced-recharge tests at Kalamazoo, Michigan: Journal of American Water Works Association, v. 54, no. 2, p. 181-196.

----- 1962b, Phenol contamination of an artesian aquifer at Alma, Michigan: Proceedings of the Society for Water Treatment and Examination, v. 11, p. 94-100, 2 figs.

----- 1963, Ground-water contamination and legal controls in Michigan: U.S. Geological Survey Water-Supply Paper 1691, 79 p., 23 figs.

Deutsch, Morris, Burt, E. M., and Vanlier, K. E., 1958, Summary of ground-water investigations in the Holland area, Michigan: Michigan Geological Survey Progress Report 20, 87 p., 16 figs.

Deutsch, Morris, Vanlier, K. E., and Giroux, P. R., 1960, Ground-water hydrology and glacial geology of the Kalamazoo area, Michigan: Michigan Geological Survey Progress Report 23, 122 p., 21 figs.

Deutsch, Morris, and Vanlier, K. E., 1961, Ground water for Michigan's future: U.S. Geological Survey Open-File Report, unnumbered.

Doonan, C. J., and Byerlay, J. R., 1973, Ground water and geology of Baraga County, Michigan: Michigan Geological Survey Water Investigation 11, 26 p., 2 figs., 2 pls.

Doonan, C. J., and Hendrickson, G. E., 1967, Ground water in Iron County, Michigan: Michigan Geological Survey Water Investigation 7, 61 p., 3 figs., 2 pls.

----- 1968, Ground water in Gogebic County, Michigan: Michigan Geological Survey Water Investigation 8, 22 p., 5 figs., 2 pls.

----- 1969, Ground water in Ontonagon County, Michigan: Michigan Geological Survey Water Investigation 9, 29 p., 5 figs., 1 pl.

Doonan, C. J., Hendrickson, G. E., and Byerlay, J. R., 1970, Ground water and geology of Keweenaw Peninsula, Michigan: Michigan Geological Survey Water Investigation 10, 41 p., 1 fig., 2 pls.

Doonan, C. J., and VanAlstine, J. L., 1982, Ground water and geology in Marquette County, Michigan: U.S. Geological Survey Open-File Report 82-501, 46 p., 6 figs., 1 pl., 20 refs.

Ferris, J. G., and others, 1954, Ground-water resources of southeastern Oakland County, Michigan: Michigan Geological Survey Progress Report 16, 158 p., 44 figs., 6 pls.

Fleck, W. B., 1980, Geology and hydrology for environmental planning in Washtenaw County, Michigan: U.S. Geological Survey Open-File Report, unnumbered, 23 p., 21 figs., 14 refs.

Fleck, W. B., and McDonald, M. G., 1978, Three-dimensional finite-difference model of ground-water systems underlying the Muskegon County wastewater disposal system, Michigan: U.S. Geological Survey Journal of Research, v. 6, no. 3, p. 307-318, 16 figs., 14 refs.

Giroux, P. R., Hendrickson, G. E., Stoimenoff, L. E., and Whetstone, G. W., 1964, Water resources of Van Buren County, Michigan: Michigan Geological Survey Water Investigation 3, 144 p., 45 figs.

Giroux, P. R., Stoimenoff, L. E., Nowlin, J. O., and Skinner, E. L., 1966, Water resources of Branch County, Michigan: Michigan Geological Survey Water Investigation 6, 158 p., 34 figs., 2 pls.

Grannemann, N. G., 1978, Water supply potential of the Lake Sally System, Marquette County, Michigan: U.S. Geological Survey Open-File Report 78-1046, 14 p., 6 figs., 1 table, 12 refs.

----- 1979, Water resources of the Marquette Iron Range area Marquette County, Michigan: U.S. Geological Survey Open-File Report 79-1339, 77 p., 34 figs., 20 tables, 23 refs.

----- 1984, Hydrogeology and effects of tailing basins on the hydrology of Sands Plain, Marquette County, Michigan: U.S. Geological Survey Water-Resources Investigations Report 84-4114, 98 p., 1 pl., 30 figs., 21 tables.

Grannemann, N. G., and Twenter, F. R., 1982, Ground water for public supply at Windigo, Isle Royale National Park, Michigan: U. S. Geological Survey Open-File Report 82-567, 16 p., 4 figs., 3 tables, 5 refs.

Grannemann, N. G., and Twenter, F. R., 1985, Geohydrology and ground-water flow at Verona Well Field, Battle Creek, Michigan: U.S. Geological Survey Water Resources Investigations Report 85-4056, 54 p., 31 figs., 7 tables.

Grannemann, N. G., Twenter, F. R., Huffman, G. C., and Cummings, T. R., 1984, Michigan ground-water resources in National Water Summary 1984: U.S. Geological Survey Water-Supply Paper 2275, pgs. 255-260, 2 figs., 2 tables.

Great Lakes Basin Commission, 1975, Appendix 3, Geology and ground water: Great Lakes Basin Framework Study, 152 p., 15 tables, 60 figs.

Handy, A. H., 1982, Water quality of coal deposits and abandoned mines, Saginaw County, Michigan: U.S. Geological Survey Open-File Report 82-511, 35 p., 7 figs., 5 tables, 13 refs.

Handy, A. H., and Stark, J. R., 1984, Water resources of Sleeping Bear Dunes National Lakeshore, Michigan: U.S. Geological Survey Water-Resources Investigations Report 83-4253, 39 p., 16 figs., 7 tables, 13 refs.

Handy, A. H., and Twenter, F. R., 1985, Water Resources of Pictured Rocks National Lakeshore, Michigan: U.S. Geological Survey Water-Resources Investigations Report 85-4103, 41 p., 13 figs., 13 tables, 11 refs.

Hendrickson, G. E., 1966, Michigan's Au Sable River--Today and tomorrow: Michigan Geological Survey Bulletin 3, 80 p., 29 figs., 11 photos.

Hendrickson, G. E., and Doonan, C. J., 1966, Ground-water resources of Dickinson County, Michigan: Michigan Geological Survey Water Investigation 5, 49 p., 5 figs., 3 pls.

Huber, N. K., 1973, Glacial and post glacial geological history of Isle Royale National Park, Michigan: U.S. Geological Survey Professional Paper 754-A,15 p., 19 figs., 1 plate, 26 refs.

Huber, N. K., 1973, Geologic map of Isle Royale National Park, Keweenaw County, Michigan: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-796, 1 sheet (scale 1:62,500), 11 refs.

----- 1975, The geological story of Isle Royale National Park, Keweenaw County, Michigan: U.S. Geological Survey Bulletin 1309, 66 p., 76 figs., 22 refs.

Huffman, G. C., 1979, Ground-water data for Michigan--1977: U.S. Geological Survey Open-File Report 79-332, 75 p., 5 figs., 3 tables.

----- 1979, Ground-water data for Michigan--1978: U.S. Geological Survey Open-File Report 80-002, 61 p., 5 figs., 3 tables.

----- 1980, Ground-water data for Michigan--1979: U.S. Geological Survey Open-File Report 80-1212, 56 p., 4 figs., 3 tables.

----- 1981, Ground-water data for Michigan--1980: U.S. Geological Survey Open-File Report 81-811, 57 p., 4 figs., 3 tables.

----- 1982, Ground-water data for Michigan--1981: U.S. Geological Survey Open-File Report 82-754, 55 p., 4 figs., 3 tables.

----- 1983, Ground-water data for Michigan--1982: U.S. Geological Survey Open-File Report 83-753, 54 p., 5 figs., 3 tables.

----- 1984, Ground-water data for Michigan--1983: U.S. Geological Survey Open-File Report 84-623, 47 p., 5 figs., 2 tables.

----- 1985, Ground-water data for Michigan--1984: U.S. Geological Survey Open-File Report 85-420, 50 p., 5 figs., 3 tables.

Huffman, G. C., 1986, Ground-water data for Michigan--1985: U.S. Geological Survey Open-File Report 86-417W, 50 p., 5 figs., 3 tables.

----- 1988, Ground-water data for Michigan--1986: U.S. Geological Survey Open-File Report 88-87, 52 p., 5 figs., 3 tables.

Knutilla, R. L., Twenter, F. R., and Larson, R. W., 1971, Upper Rifle River Basin--An evaluation of its water resources and hydrologic environment: Michigan Geological Survey Water Information Series Report 1, 66 p., 64 figs.

McDonald, M. G., 1981, Hydraulic characteristics of an under-drained irrigation circle, Muskegon County wastewater disposal system, Michigan: U.S. Geological Survey Water-Supply Paper 2081, 14 p., 9 figs., 9 refs.

McDonald, M. G., and Fleck, W. B., 1978, Model analysis of the impact on ground-water conditions of the Muskegon County wastewater disposal system, Michigan: U.S. Geological Survey Open-File Report 78-99, 63 p., 17 figs., 14 refs.

McGuinness, C. L., Poindexter, O. P., and Otton, E. G., 1949, Ground-water supplies of the Ypsilanti area, Michigan: U.S. Geological Survey Water-Supply Paper 1078, 105 p., 7 figs., 5 pls.

Mandle, R. J., 1986, Plan of study for the regional aquifer systems analysis of the Michigan basin: U.S. Geological Survey Open-File Report 86-494, 23 p., 6 figs., 26 refs.

Mandle, R. J., and Westjohn, D. B., 1987, Preliminary interpretation of vertical electrical-resistivity soundings in the Saginaw Valley, Michigan: U.S. Geological Survey Open-File Report 87-474, 43 p., 6 figs., 18 refs.

Michigan Department of Health, 1961, Data on public water supplies in Michigan: Michigan Department of Health Engineering Bulletin 4, 57 p.

Michigan Water Resources Commission, 1953, Water resources of the Clinton River Basin, 55 p., 9 figs.

----- 1956, Water resource conditions and uses in the Flint River Basin, 75 p., 14 figs.

----- 1957, Water resource conditions and uses in the Huron River Basin, 149 p., 27 figs., 2 pls.

----- 1960, Water resource conditions and uses in the Tittabawassee River Basin, 117 p., 19 figs.

----- 1961, Water resource conditions and uses in the Upper Grand River Basin, 137 p., 19 figs.

Michigan Water Resources Commission, 1963, Water resource conditions and uses in the Shiawassee River Basin, 113 p., 32 figs., 1 pl.

----- 1964, Water resource conditions and uses in the Paw Paw River Basin, (revised from 1955 edition), 56 p., 6 figs.

----- 1964, Water resource conditions and uses in the Michigan portion of the Maumee River Basin, 67 p., 18 figs.

----- 1965, Water resource conditions and uses in the River Raisin Basin, 105 p., 38 figs.

----- 1966, Water resource conditions and uses in the Au Sable River Basin, 116 p., 30 figs.

----- 1968, Water resource conditions and uses in the Lower Grand River Basin, 133 p., 38 figs.

----- 1968, The water resource of southeastern Michigan, 162 p., 61 figs.

----- 1968, The water resources of the lower Lake Huron Drainage Basin, 189 p., 64 figs.

----- 1968, The water resources of the lower Lake Michigan Drainage Basin, 172 p., 54 figs.

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

Mozola, A. J., 1954, A survey of ground-water resources in Oakland County, Michigan, pt. 2 of Occasional papers for 1954 on the geology of Michigan: Michigan Geological Survey Publication 48, p. 96-348, 31 figs.

----- 1969, Geology for land and ground-water development in Wayne County, Michigan: Michigan Geological Survey Report of Investigation 3, 25 p., 9 figs., 4 pls.

----- 1970, Geology for environmental planning in Monroe County, Michigan: Michigan Geological Survey Report of Investigation 13, 34 p., 18 figs., 6 pls.

Pettijohn, F. J., 1952, Geology of the northern Crystal Falls area, Iron County, Michigan: U.S. Geological Survey Circular 153, 17 p., 1 fig., 3 tables, 8 pls., 14 refs.

Reed, J. E., Deutsch, Morris, and Wiitala, S. W., 1966, Induced recharge of an artesian glacial-drift aquifer at Kalamazoo, Michigan: U.S. Geological Survey Water-Supply 1594-D, 62 p., 36 figs., 2 pls.

Sinclair, W. C., 1959, Reconnaissance of the ground-water resources of Schoolcraft County, Michigan: Michigan Geological Survey Progress Report 22, 84 p., 14 figs.

----- 1960, Reconnaissance of the ground-water resources of Delta County, Michigan: Michigan Geological Survey Progress Report 24, 93 p., 13 figs.

Solley, W. B., Chase, E. B., Mann, W. B., IV, 1983, Estimated use of water in the United States, 1980: U.S. Geological Survey Circular 1001, 56 p., 13 figs., 22 tables, 18 refs.

Stark, J. R., and McDonald, M. G., 1980, Ground water of coal deposits, Bay County, Michigan: U.S. Geological Survey Open-File Report 80-591, 36 p., 22 figs., 1 table, 13 refs.

Stark, J. R., Cummings, T. R., and Twenter, F. R., 1983, Ground-water contamination at Wurtsmith Air Force Base, Michigan: U.S. Geological Survey Water-Resources Investigation Report 83-4002, 93 p., 43 figs., 1 pl., 4 tables, 22 refs.

Stramel, G. J., Wisler, C. O., and Laird, L. B., 1954, Water resources of the Grand Rapids area, Michigan: U.S. Geological Survey Circular 323, 40 p., 29 figs., 3 pls.

Stuart, W. T., 1945, Ground-water resources of the Lansing area, Michigan: Michigan Geological Survey Progress Report 13, 35 p., 11 figs.

Stuart, W. T., Brown, E. A., and Rhodehamel, E. C., 1954, Ground-water investigations of the Marquette iron-mining district, Michigan: Michigan Geological Survey Technical Report 3, 92 p., 8 figs.

Stuart, W. T., and Stallman, R. W., 1945, Ground-water resources of the Benton Harbor area, Michigan: Michigan Geological Survey Progress Report 12, 15 p., 4 figs.

Stuart, W. T., Theis, C. V., and Stanley, G. M., 1948, Ground-water problems in the Iron River district, Michigan: Michigan Geological Survey Technical Report 2, 59 p., 16 figs.

Terwilliger, F. W., 1954, The glacial geology and ground-water resources of Van Buren County, Michigan, pt. 1 of Occasional papers of 1954 on the geology of Michigan: Michigan Geological Survey Publication 48, p. 1-95, 24 figs. 1 pl.

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

Twenter, F. R., 1966b, General availability of ground water in the glacial deposits in Michigan: State Resources Planning Division, Michigan Department of Commerce and Michigan Water Resources Commission, map (color).

----- 1975, Ground water and geology--Southeastern Michigan: U.S. Army Corps of Engineers, Detroit, Michigan, 143 p., 31 figs., 36 tables, 46 refs.

----- 1981, Geology and hydrology for environmental planning in Marquette County, Michigan: U.S. Geological Survey Water-Resources Investigations Report 80-90, 44 p., 16 figs., 21 refs.

Twenter, F. R., and Knutilla, R. L., 1972, Water for a rapidly growing urban community--Oakland County, Michigan: U.S. Geological Survey Water-Supply Paper 2000, 150 p., 90 figs.

Twenter, F. R., Knutilla, R. L., and Nowlin, J. O., 1976, Water resources of Washtenaw County, Michigan: Washtenaw County Planning Commission, 143 p., 43 figs., 18 tables, 25 refs.

Twenter, F. R., Cummings, T. R., and Grannemann, N. G., 1983, Ground-water contamination in East Bay Township, Michigan: U.S. Geological Survey Water-Resources Investigations Report 85-4064, 63 p., 25 figs., 5 pls., 20 refs.

Twenter, F. R., and Cummings, T. R., 1985, Quality of ground water in Monitor and Williams Townships, Bay County, Michigan: U.S. Geological Survey Water-Resources Investigations Report 85-4110, 39 p., 16 figs.

Use designation areas for Michigan's intrastate water quality standards, March 1969.

Vanlier, K. E., 1959, Reconnaissance of the ground-water resources of Luce County, Michigan: Michigan Geological Survey Progress Report 21, 76 p., 11 figs., 3 pls.

----- 1962, Summary of ground-water investigations in the Elsie area, Michigan: Michigan Geological Survey Progress Report 25, 35 p., 7 figs.

----- 1963a, Ground water in Alger County, Michigan: Michigan Geological Survey Water Investigation 1, 55 p., 13 figs.

----- 1963b, Ground water in Menominee County, Michigan: Michigan Geological Survey Water Investigation 2, 42 p., 11 figs.

----- 1963c, Ground-water resources of the Alma area, Michigan: U.S. Geological Survey Water-Supply Paper 1619-E, 66 p., 20 figs., 2 pls.

Vanlier, K. E., 1966, Ground water resources of the Battle Creek area, Michigan: Michigan Geological Survey Water Investigation 4, 52 p., 19 figs.

----- 1968, Appendix E of the report on the Grand River Comprehensive Basin Study: U.S. Army Engineers District, Detroit, Michigan, 82 p., 2 figs.

Vanlier, K. E., and Deutsch, Morris, 1958a, Reconnaissance of the ground-water resources of Chippewa County, Michigan: Michigan Geological Survey Progress Report 17, 56 p., 7 figs., 7 pls.

----- 1958b, Reconnaissance of the ground-water resources of Mackinac County, Michigan: Michigan Geological Survey Progress Report 19, 82 p., 8 figs., 6 pls.

Vanlier, K. E., and Wheeler, M. L., 1968, Analog simulation of ground-water development of the Saginaw Formation, Lansing Metropolitan area, Michigan: Tri-County Planning Commission, Lansing Ground-Water Report, 40 p., 23 figs.

Vanlier, K. E., Wood, W. W., and Brunett, J. O., 1973, Water-supply development and management alternatives for Clinton, Eaton, and Ingham Counties, Michigan: U.S. Geological Survey Water-Supply Paper 1969, 111 p., 35 figs., 3 pls.

Weist, W. G., 1978, Summary appraisals of the nations ground-water resources--Great Lakes Region: U.S. Geological Survey Professional Paper 813-J, 30 p., 14 figs., 5 tables, 35 refs.

Western Michigan University, 1981, Hydrologic atlas of Michigan: Department of Geology, 35 plates (87 sheets 25 x 38 inches, some in color).

Wiitala, S. W., Newport, T. G., and Skinner, E. L., 1967, Water resources of the Marquette Iron Range area, Michigan: U.S. Geological Survey Water-Supply Paper 1842, 142 p., 40 figs., 4 pls.

Wiitala, S. W., Vanlier, K. E., and Krieger, R. A., 1963, Water resources of the Flint area, Michigan: U.S. Geological Survey Water-Supply Paper 1499-E, 86 p., 32 figs., 6 pls.

Wisler, C. O., Stramel, G. J., and Laird, L. B., 1952, Water resources of the Detroit area, Michigan: U.S. Geological Survey Circular 183, 36 p., 30 figs., 4 pls.

U.S. Geological Survey Water-Supply Papers (contain ground-water data for Michigan)

Year	WSP Number	Year	WSP Number	Year	WSP Number
1935	777	1944	1016	1953	1265
1936	817	1945	1023	1954	1321
1937	840	1946	1071	1955	1404
1938	845	1947	1096	1956-57	1537
1939	886	1948	1126	1958-62	1782
1940	906	1949	1156	1963-67	1977
1941	936	1950	1165	1968-72	2140
1942	944	1951	1191	1973-74	2164
1943	986	1952	1221		

U.S. Geological Survey Water-Data Reports:

Year	WDR Number
1975	MI-75-1
1976	MI-76-1
1977	MI-77-1
1978	MI-78-1
1979	MI-79-1
1980	MI-80-1
1981	MI-81-1
1982	MI-82-1
1983	MI-83-1
1984	MI-84-1
1985	MI-85-1
1986	MI-86-1
1987	MI-87-1

☆U.S. GOVERNMENT PRINTING OFFICE: 1989-643-834/82034