GROUND-WATER DATA FOR MICHIGAN 1984

by G. C. Huffman

U.S. GEOLOGICAL SURVEY

Open-File Report 85-420

Prepared in cooperation with the

MICHIGAN DEPARTMENT OF NATURAL RESOURCES

Lansing, Michigan
1985

UNITED STATES DEPARTMENT OF THE INTERIOR

WILLIAM P. CLARK, Secretary

GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information write to:

District Chief
U.S. Geological Survey
6520 Mercantile Way, Suite 5
Lansing, Michigan 48910

Copies of this report can be purchased from:

Open-File Services Section
Western Distribution Branch
U.S. Geological Survey
Box 25425, Federal Center
Denver, Colorado 80225
(Telephone: (303) 236-7476)

CONTENTS

FIGURES

TABLES

GROUND-WATER DATA FOR MICHIGAN

1984

by

G. C. Huffman

ABSTRACT

Water levels, locations, depths, and aquifers tapped are given for 114 observation wells. Tabulated data include extremes of water levels for 1984 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 reported user of ground-water, the city of Lansing, pumped 8.2 billion gallons from the Saginaw Formation and glacial deposits.

INTRODUCTION

Purpose and Scope

This report makes available, through 1984, the records of water levels and related data for the principal aquifers of the State. Data on yield of wells, pumpage, quality of water, and trends of ground-water levels for the past 5 years are shown in the text. Many hydrographs are included to illustrate 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 1984 are given in tables 1, 2, and 3. 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 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.

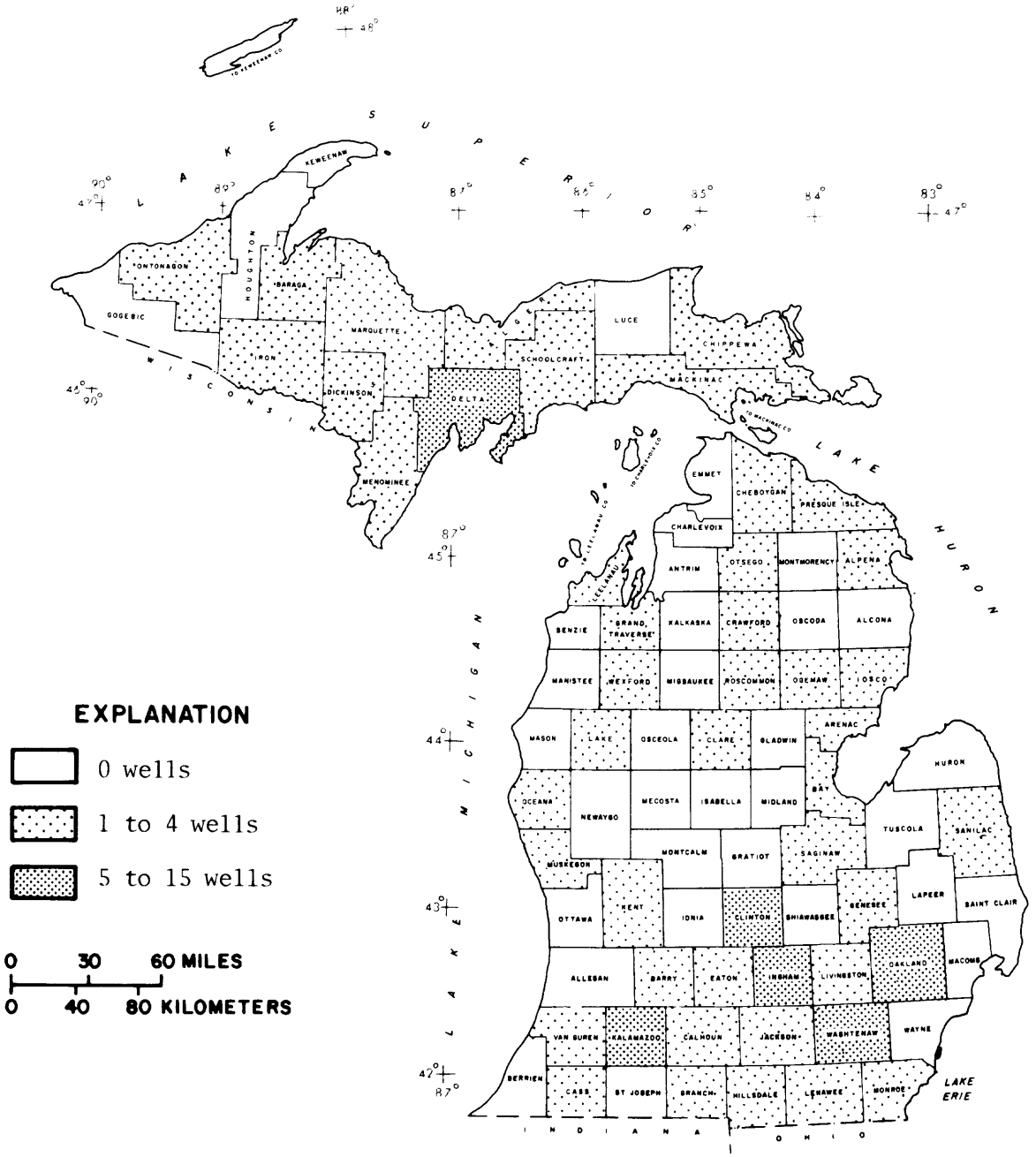


Figure 1.--Distribution of observation wells. Water levels were monitored in 114 wells in 1984.

Normally, the water levels fluctuate 2 to 3 ft annually and about 5 ft over a period of years. If an excavation for a basement or septic tank is made when the levels are low, good construction practices would allow for probable higher levels in the spring. If construction is made after several years of drought, the allowance for rising water levels should be greater. If a site is at all questionable, the depth to water can be determined by test borings. 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.

Ground-water records and reports

Tabulations of water-level measurements, hydrographs for observation wells, records of chemical quality, 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 Geological Survey Division, Michigan Department of Natural Resources, Mason Building, Lansing, Michigan 48933; or at the U.S. Geological Survey, 6520 Mercantile Way, Suite 5, Lansing, Michigan 48910. Records for the Upper Peninsula are also kept on file in the State and Federal Geological Survey Offices, State Office Building, Escanaba, Michigan 48929.

Records of ground-water levels from 1935 to 1974 are in U.S. Geological Survey Water-Supply Papers (WSP). Records since 1975 are in U.S. Geological Survey Water-Data Reports (WDR). 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 figures 3 and 4. In addition, many publications dealing with ground water are listed in the selected references at the end of this report.

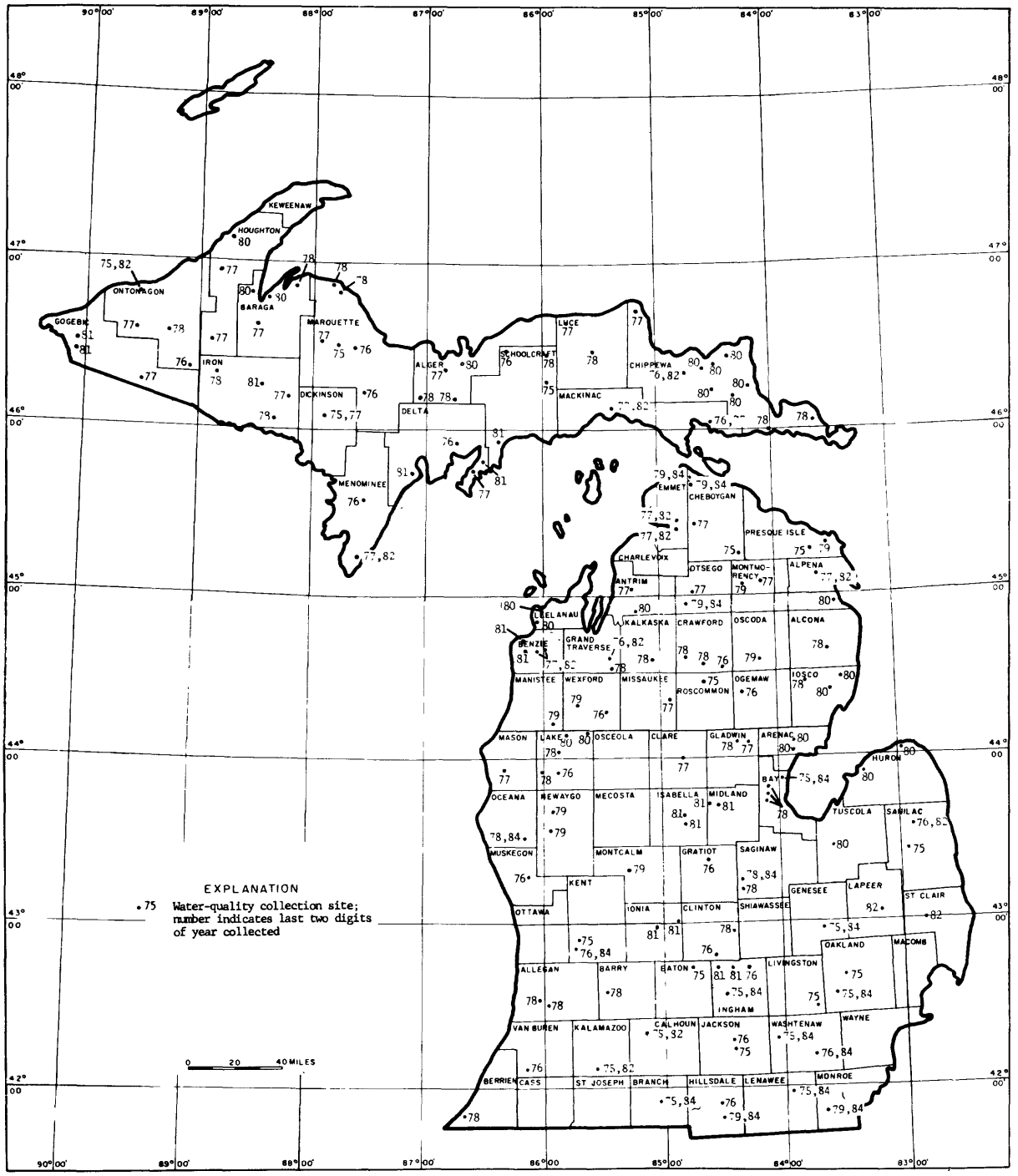
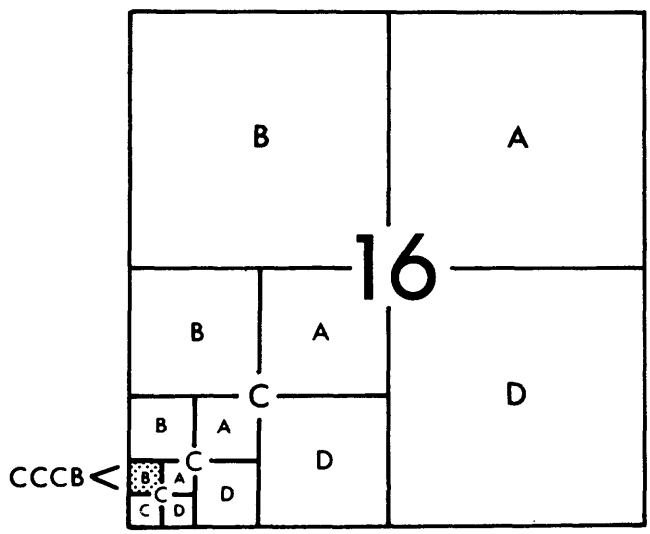


Figure 2.--Water-quality collection sites and year sample collected. (Water-quality data are given in the annual ground-water report for year in which sample was collected except data for the years 1975-76 which are in the annual report for 1977. Analyses by U.S. Geological Survey.)

Well-numbering system

The well-numbering system for Michigan indicates the location of wells within the rectangular subdivision of the land with reference to the Michigan meridian and base line. The first two segments of the well number designate township and range, the third segment of the number 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 have not been possible.

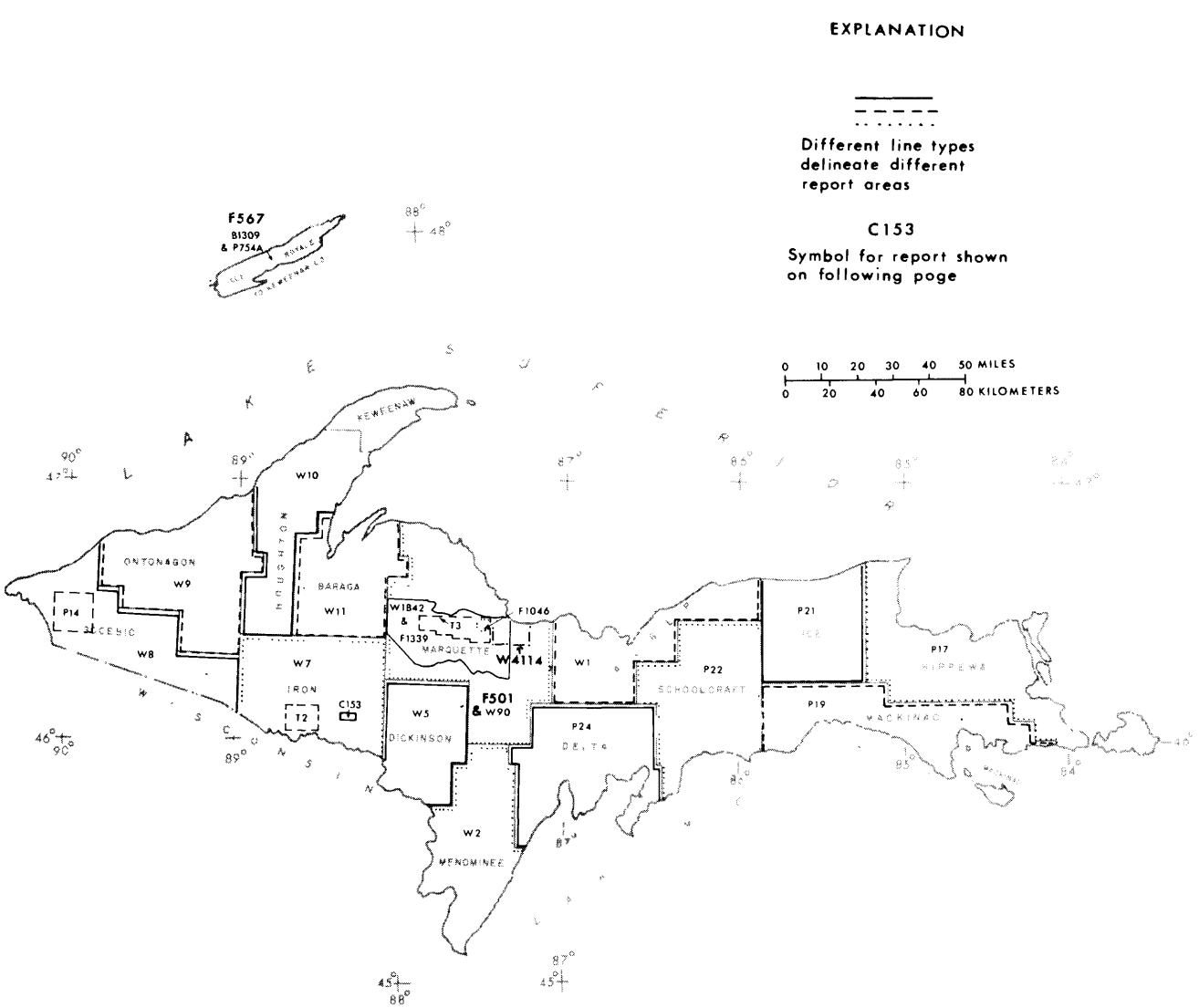


Figure 3.--Areas in the Upper Peninsula where ground-water conditions are described in published reports.

PUBLISHED REPORTS

Upper Peninsula

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.

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

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.

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.

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.

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.

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.

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

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

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.

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

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.

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

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.

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.

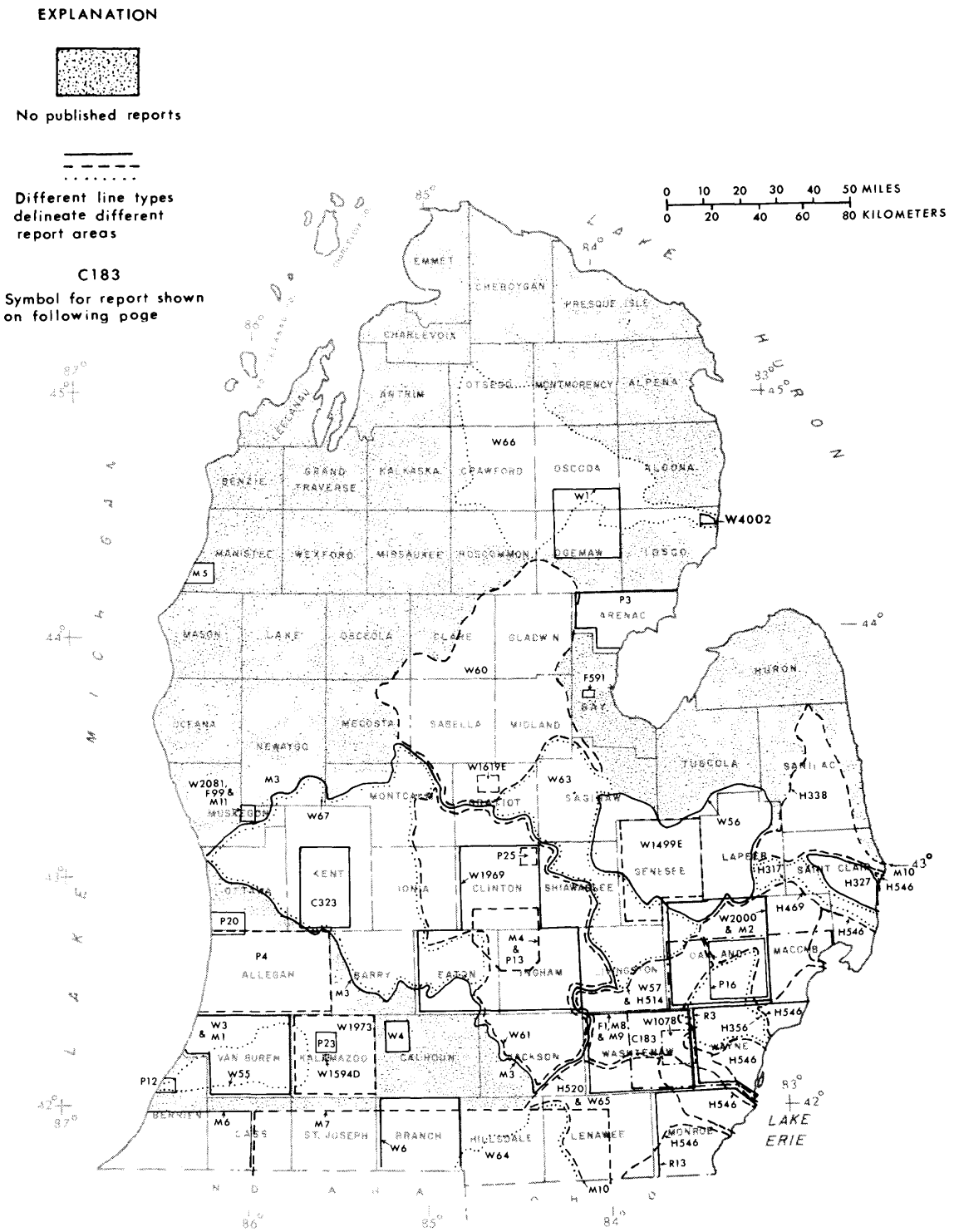


Figure 4.--Areas in the Lower Peninsula where ground-water conditions are described in published reports.

PUBLISHED REPORTS

Lower Peninsula

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.

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.

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

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 geological 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.

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

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.

PUBLISHED REPORTS--Continued

Lower Peninsula

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.

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

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.

W1 -- 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.

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 Water Investigation 3.

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

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.

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.

W1078 -- McGuinness, C. L., Poindexter, O. F., and Otten, 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.

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.

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 Investigation Report 83-4002.

GROUND-WATER LEVELS

Water levels, measured in 114 observation wells throughout the State (fig. 1 and table 1) in 1984, generally follow precipitation trends. Rising levels usually occur where precipitation has been above normal and declining levels where precipitation has been below normal. Although quantity of precipitation is a major factor affecting ground-water levels, many other natural factors, such as soil condition, nature of underlying rock, and slope of the land surface affect the levels.

Hydrographs of water levels in wells (fig. 5) show that levels are highest in the spring. At this time, snowmelt and rain normally result in large additions to ground-water reservoirs. However, ice cover or frost in the ground can impede infiltration. Under these conditions, most water from snowmelt and precipitation runs off rapidly and little goes to recharge the ground-water reservoirs. Recharge is small during the growing season, as most rainfall is evaporated, transpired by vegetation, or runs off overland after heavy showers. In the fall, when evapotranspiration is reduced, heavy rains may cause water levels to rise. Frozen ground impedes infiltration of water during winter.

In addition to changes in water levels from precipitation, temporary changes in levels may be caused by earth tides and variation in barometric pressure. Evapotranspiration causes small daily declines in water levels in some wells. Pumping withdrawals can have a major effect on water levels. 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.

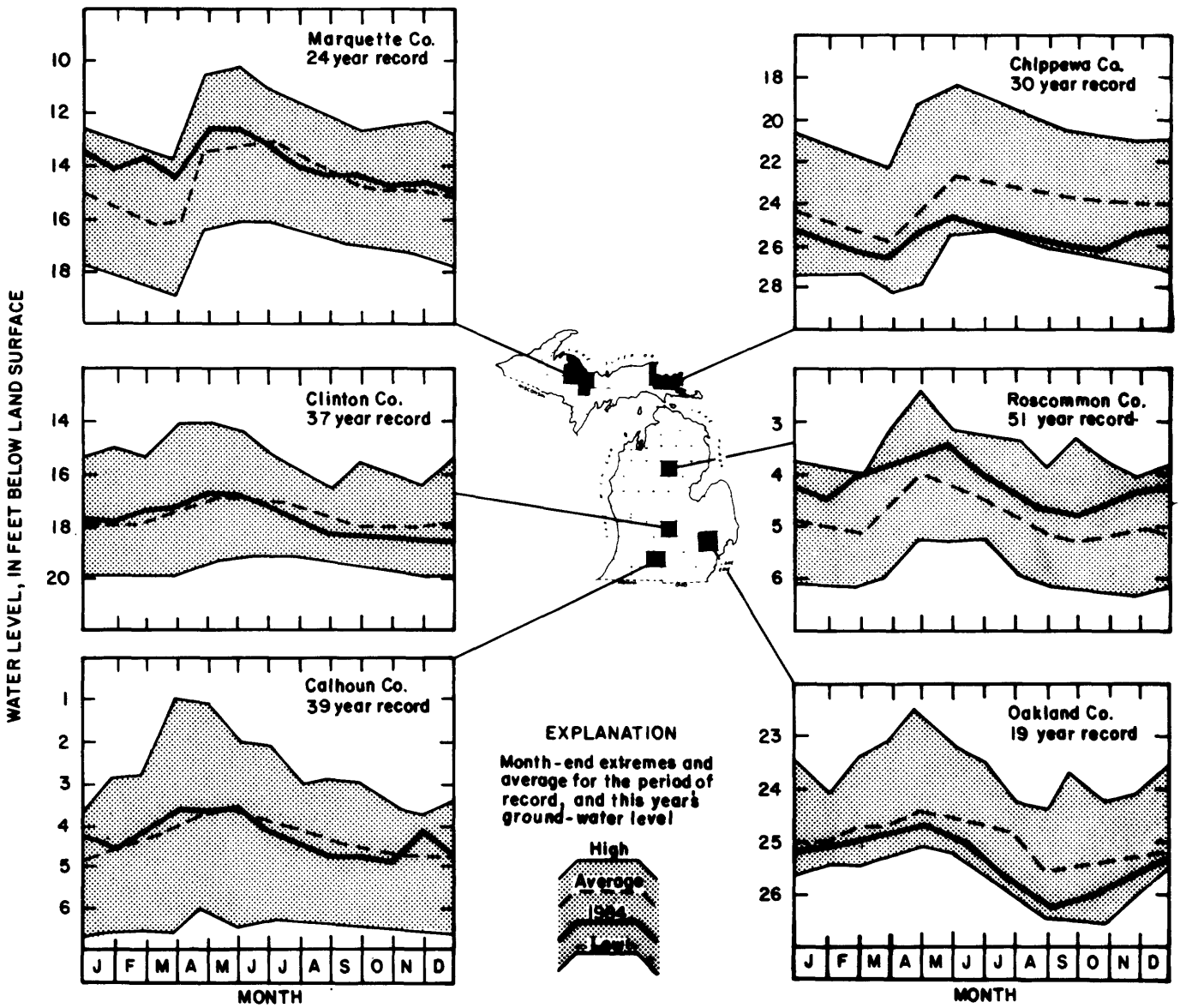
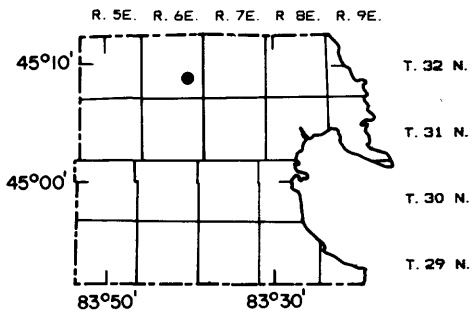
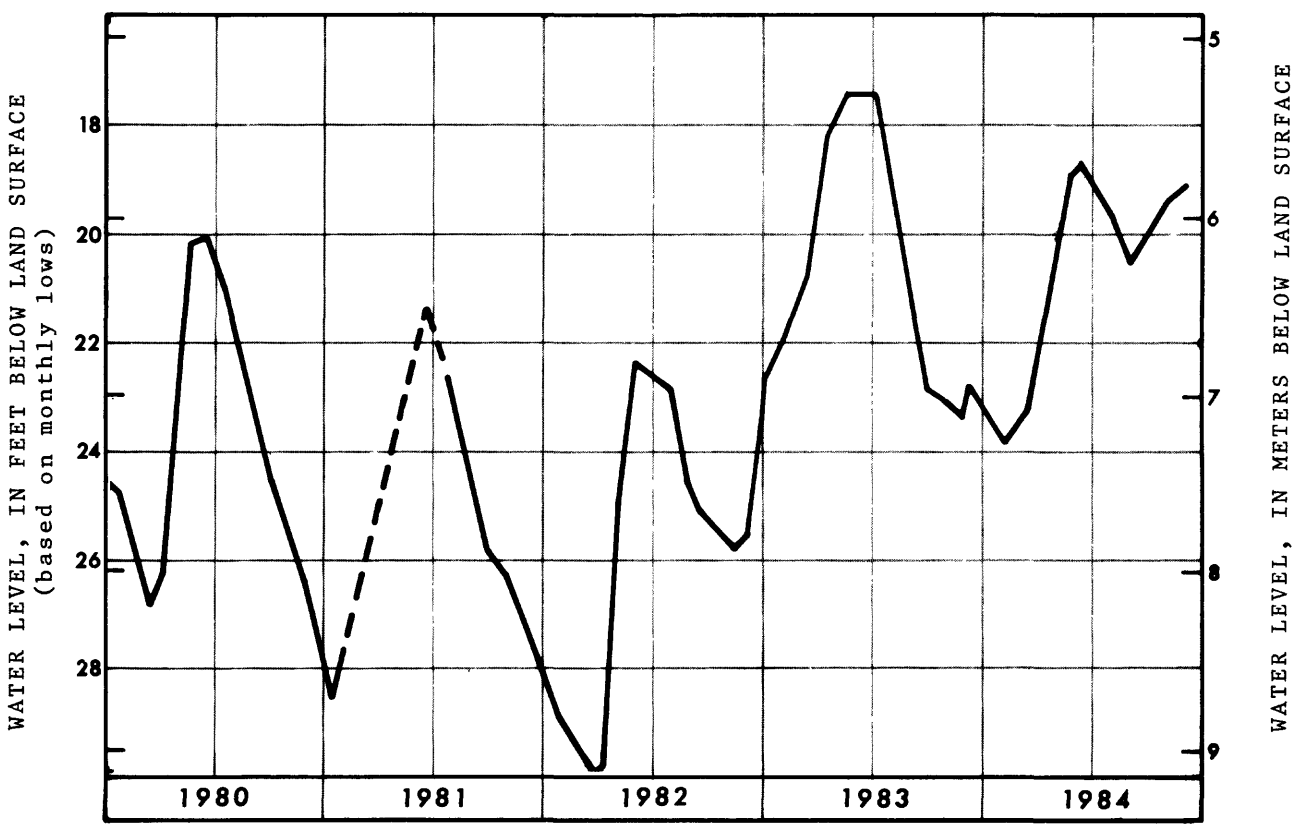


Figure 5.--Water levels in selected wells.

AREA GROUND-WATER DATA

Trends of water levels and descriptions of some ground-water supplies in Michigan follow alphabetically, by county. Yield of wells and pumpage data are given as reported by water departments and consultants.





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).

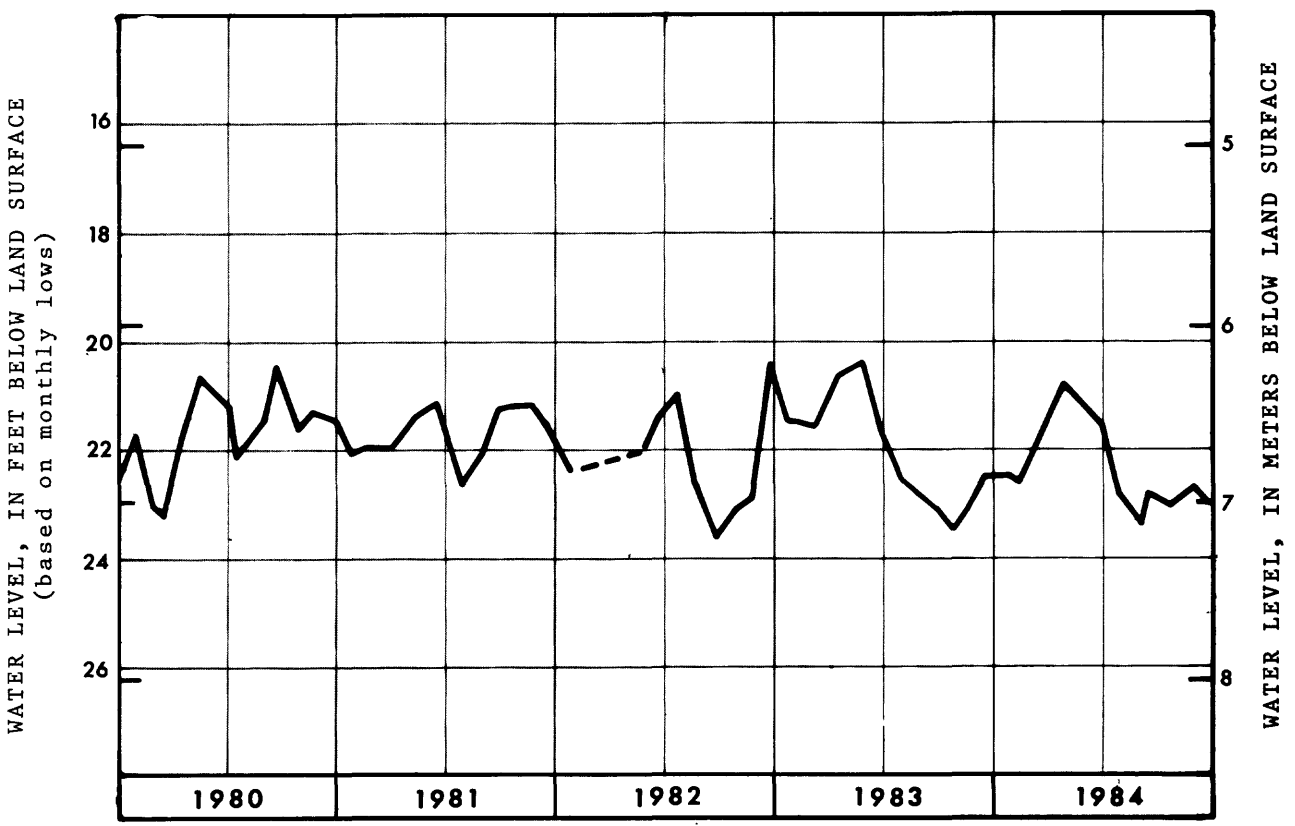
BRANCH COUNTY - CITY OF COLDWATER

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.

1984 - 1,115
1983 - 1,308
1982 - 1,123
1981 - 1,122
1980 - 1,169



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

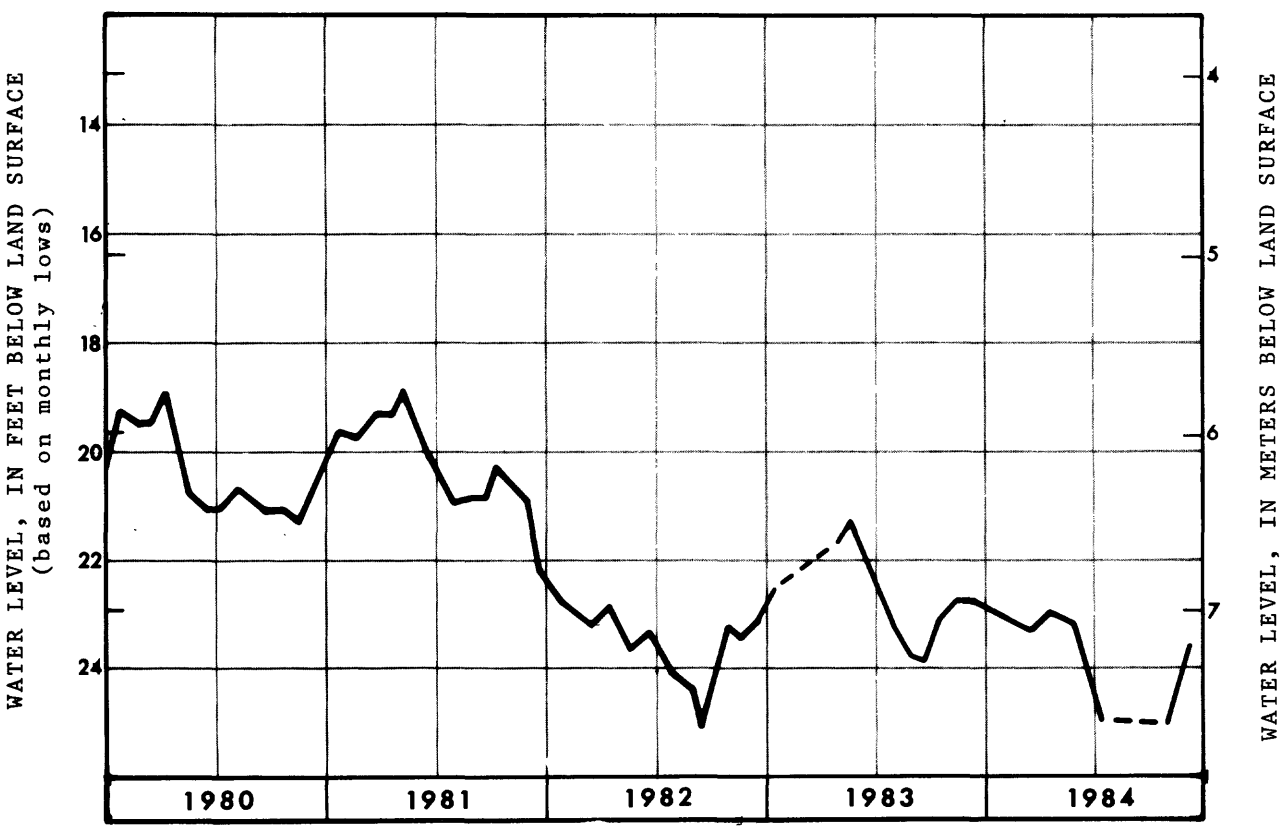
CALHOUN COUNTY - CITY OF BATTLE CREEK

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

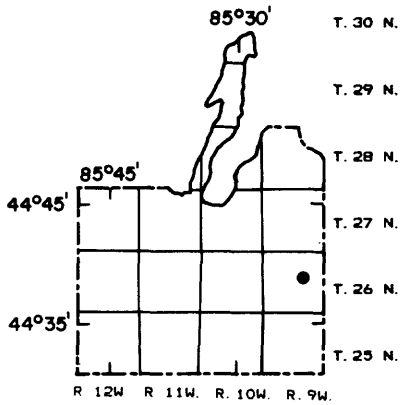
YIELD OF WELLS -- 300 to 1,000 gal/min; specific capacity -- 50 to 650 gal/min/ft of drawdown.

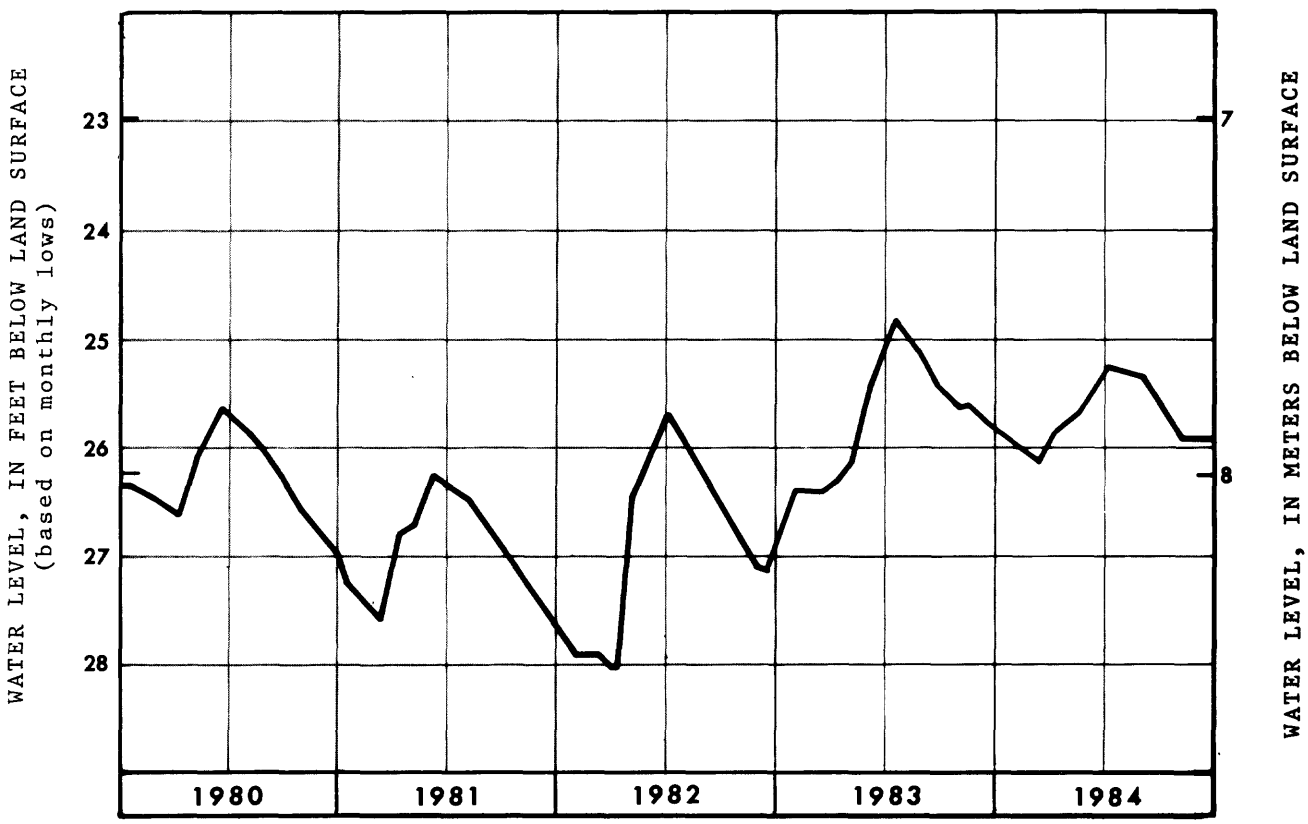
PUMPAGE -- Total annual pumpage, in million gallons, for past 5 years.

1984 - 3,083
1983 - 3,495
1982 - 3,590
1981 - 2,742
1980 - 2,836

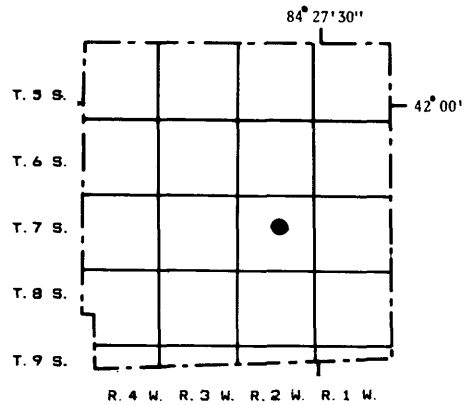


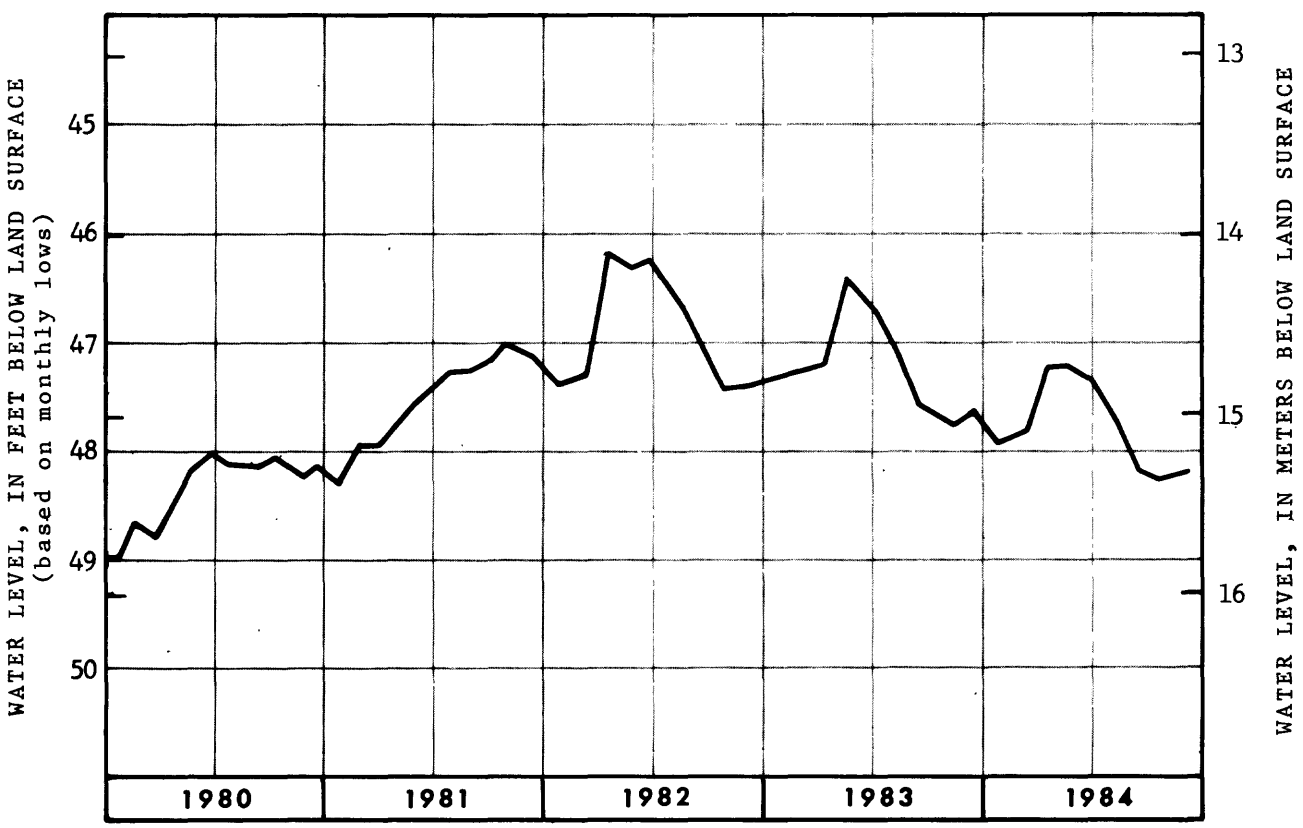
Water levels in well 1S 7W 32BDCC1. Well is 95 feet deep and in Marshall Formation. Water-quality data in ground-water reports for 1977 and 1982 (Huffman, 1979, 1983).





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).





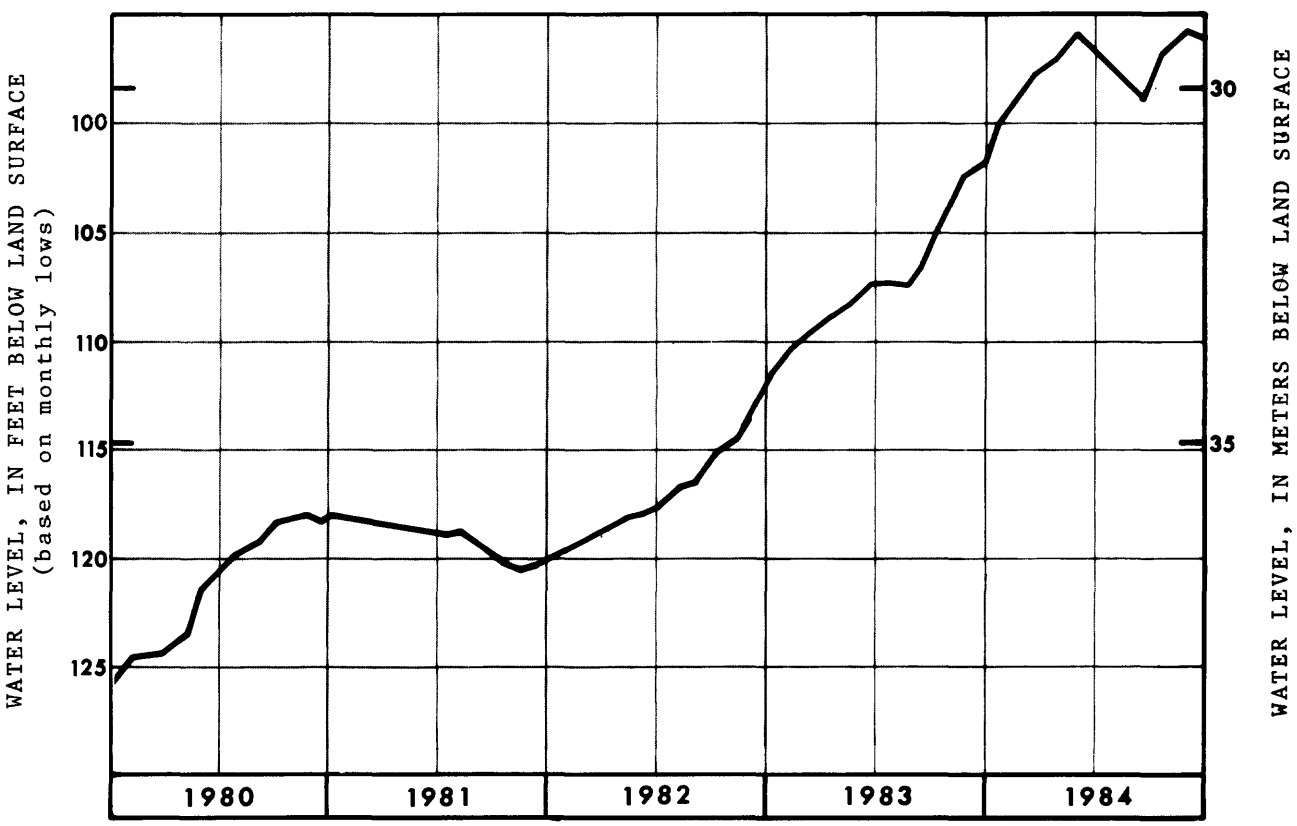
Water levels in well 7S 2W 15BCBA1. Well is 150 feet deep and in glacial outwash. Water-quality data in ground-water reports for 1979 and 1984 (Huffman, 1980, 1985).

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.

1984 - 8,249
1983 - 8,105
1982 - 8,182
1981 - 8,607
1980 - 8,592



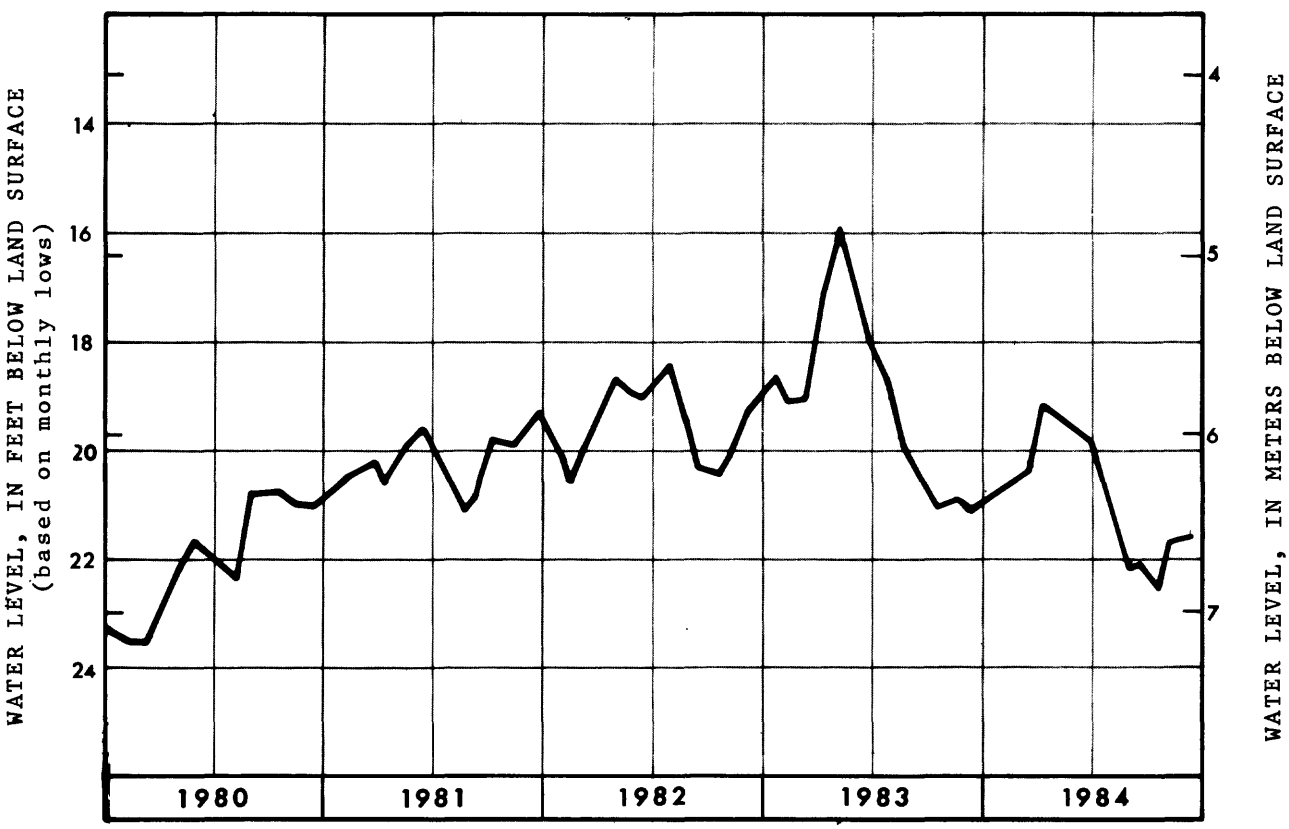
Water levels in well 4N 2W 17AB. Well is 424 feet deep and in Saginaw Formation.

SUPPLY AND SOURCE -- 1 well, about 50 feet deep, taps glacial deposits; 2 wells, 218, 223 feet deep, taps 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 drift.

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

1984 - 240
1983 - 232
1982 - 228
1981 - 233
1980 - 217



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).

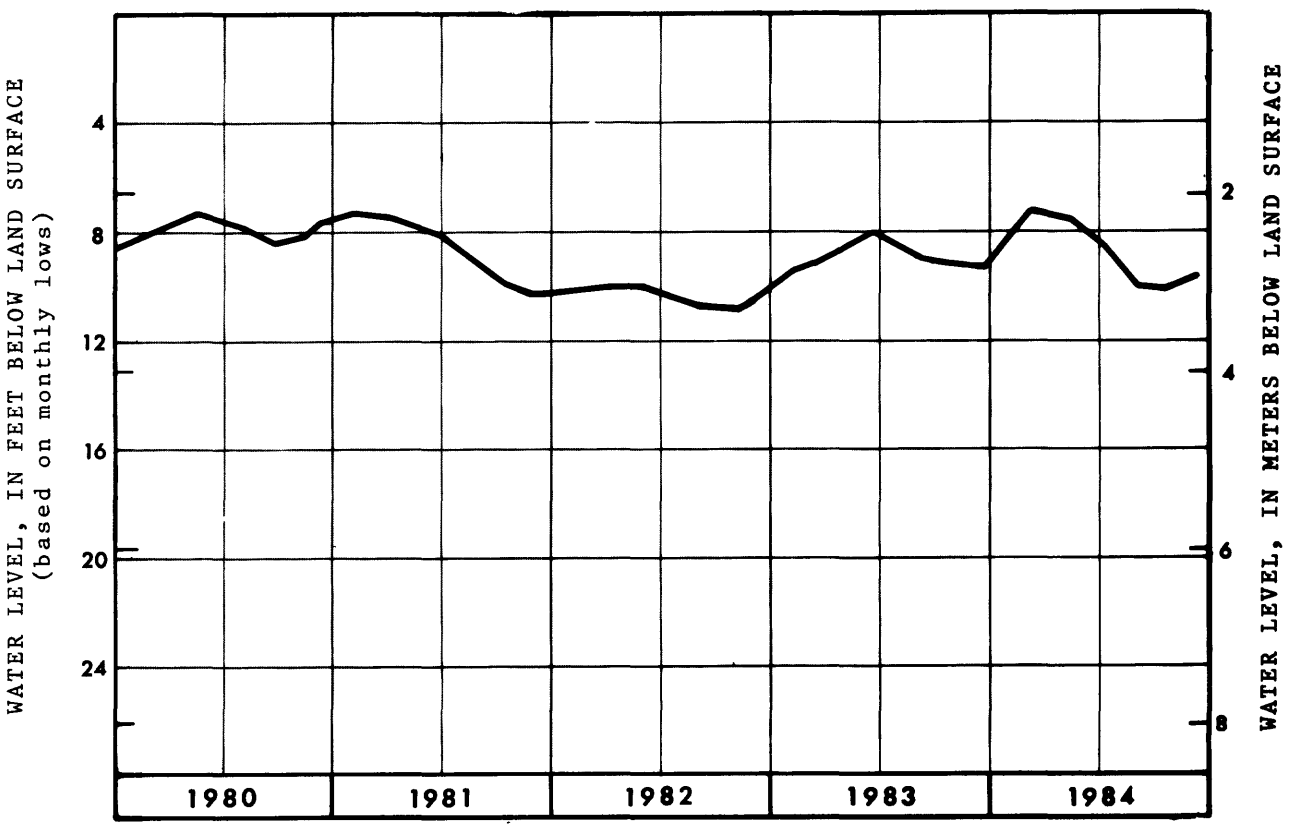
KALAMAZOO COUNTY - CITY OF KALAMAZOO

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

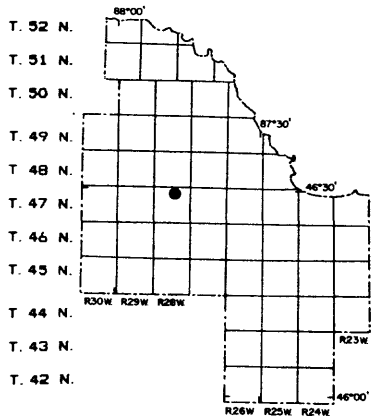
YIELD OF WELLS -- 200 to 2,000 gal/min; specific capacity -- 7 to 100 gal/min/ft of drawdown.

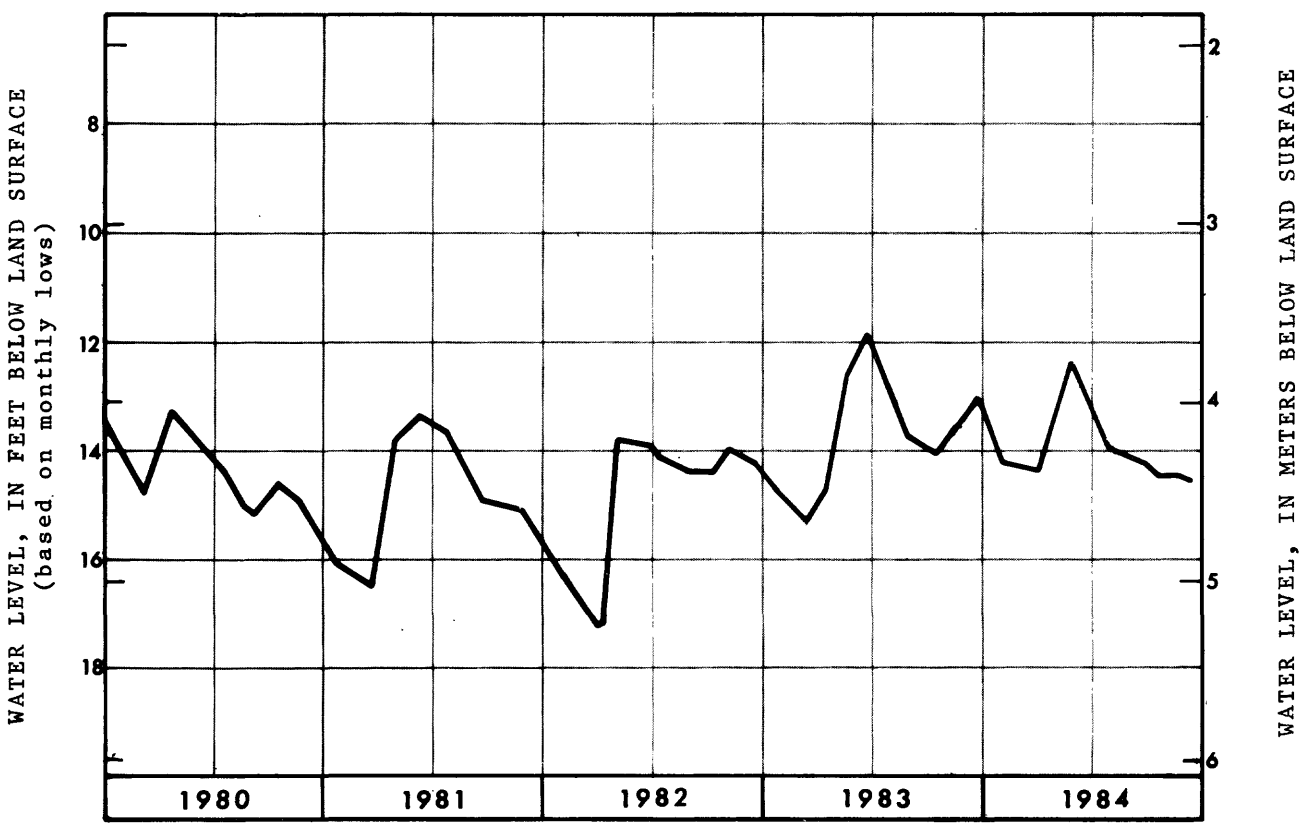
PUMPAGE -- Total annual pumpage, in million gallons, for past 5 years.

1984 - 7,275
1983 - 7,204
1982 - 5,772
1981 - 6,393
1980 - 5,774

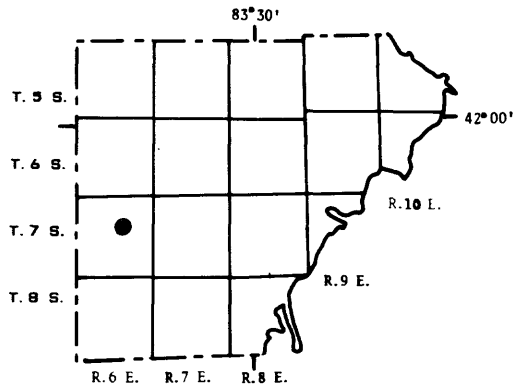


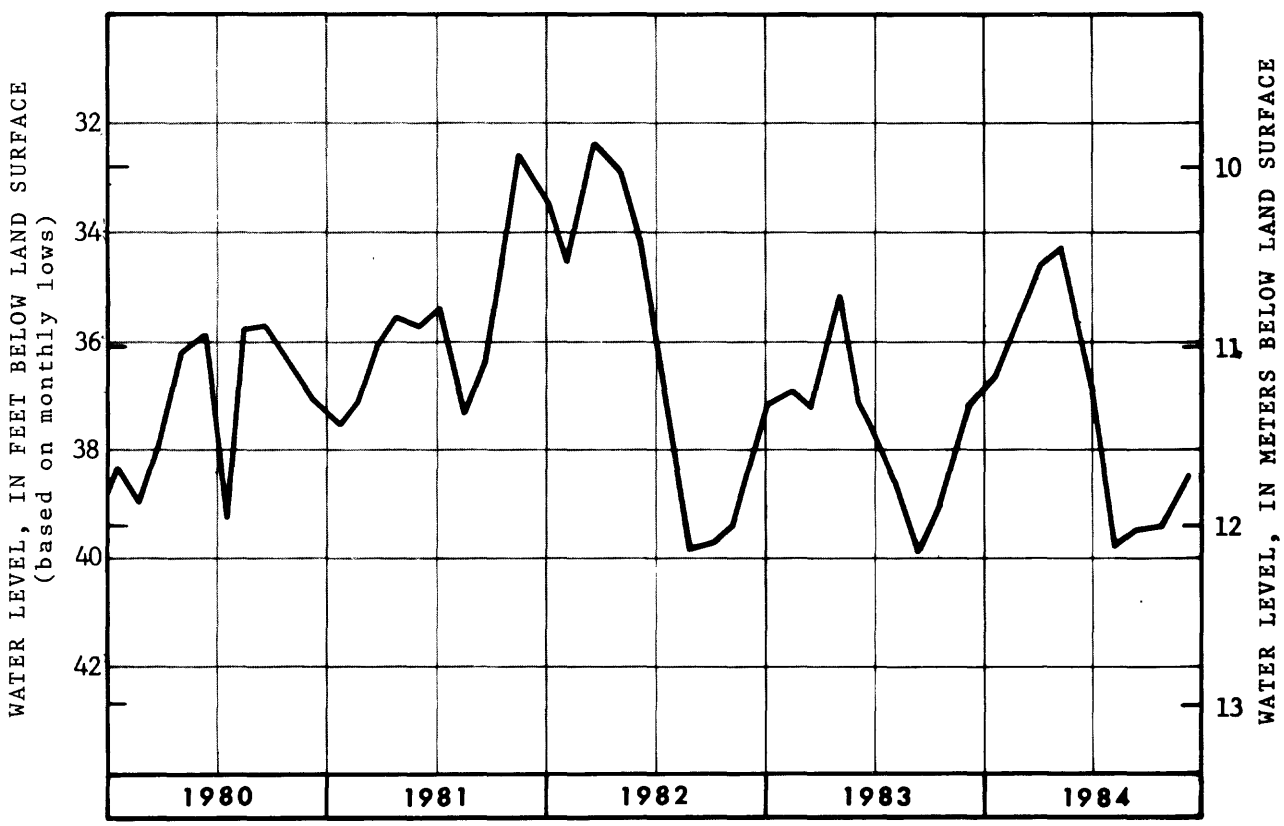
Water levels in well 2S 11W 22CD. Well is 137 feet deep and in outwash.



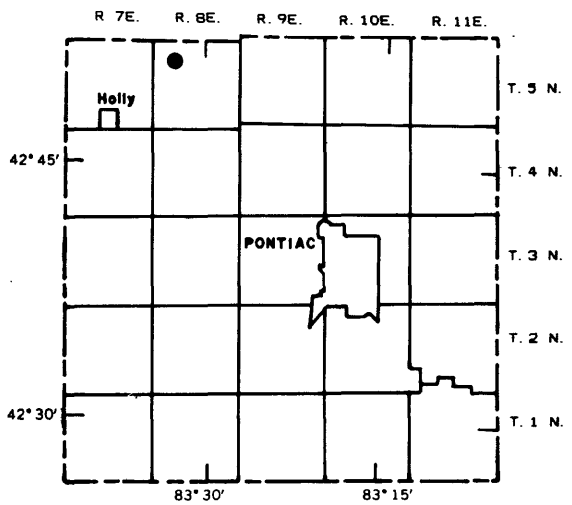


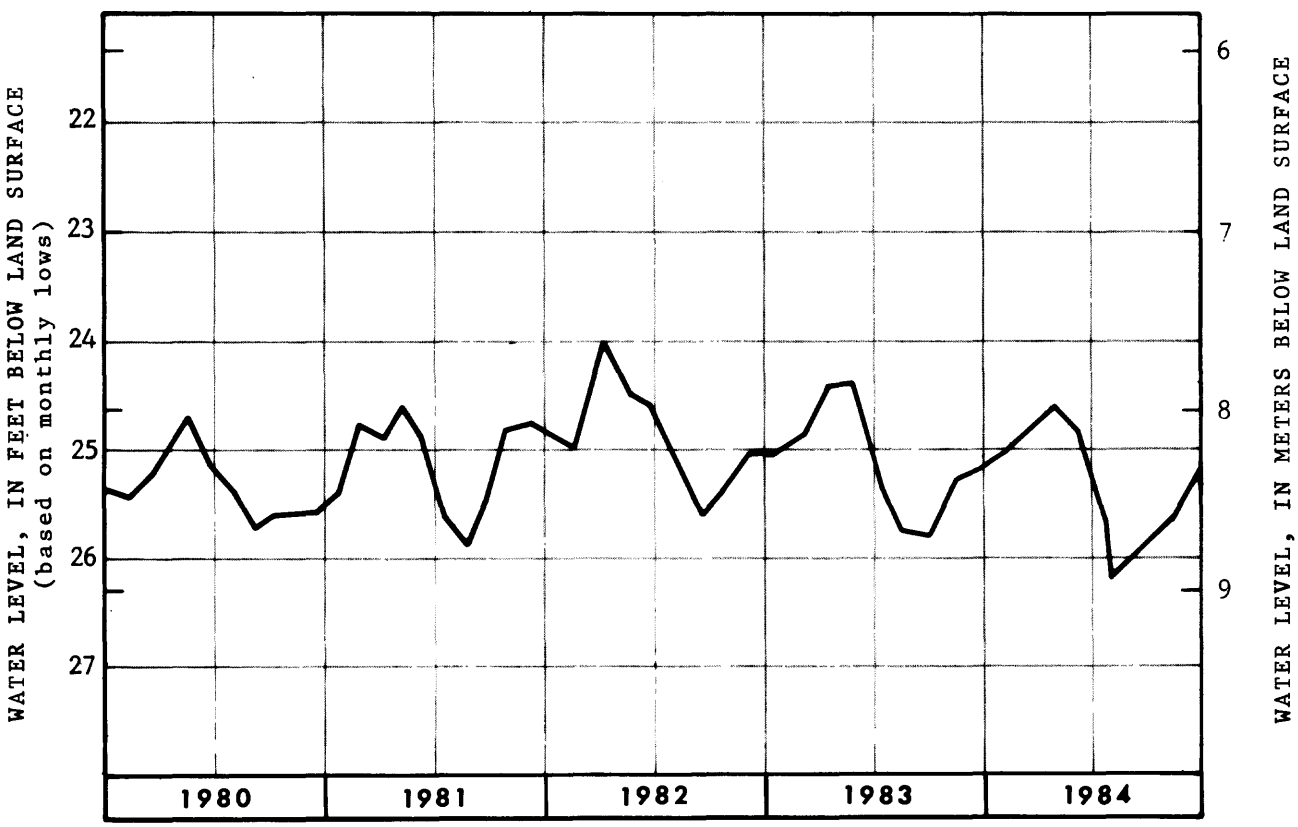
Water levels in well 47N 28W 3CCDC1. Well is 75 feet deep and in outwash. Levels are typical of observation wells in Marquette Iron Range. Water-quality data in ground-water report for 1977 (Huffman, 1979).



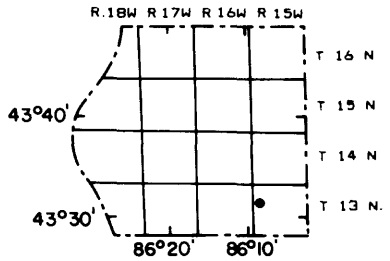


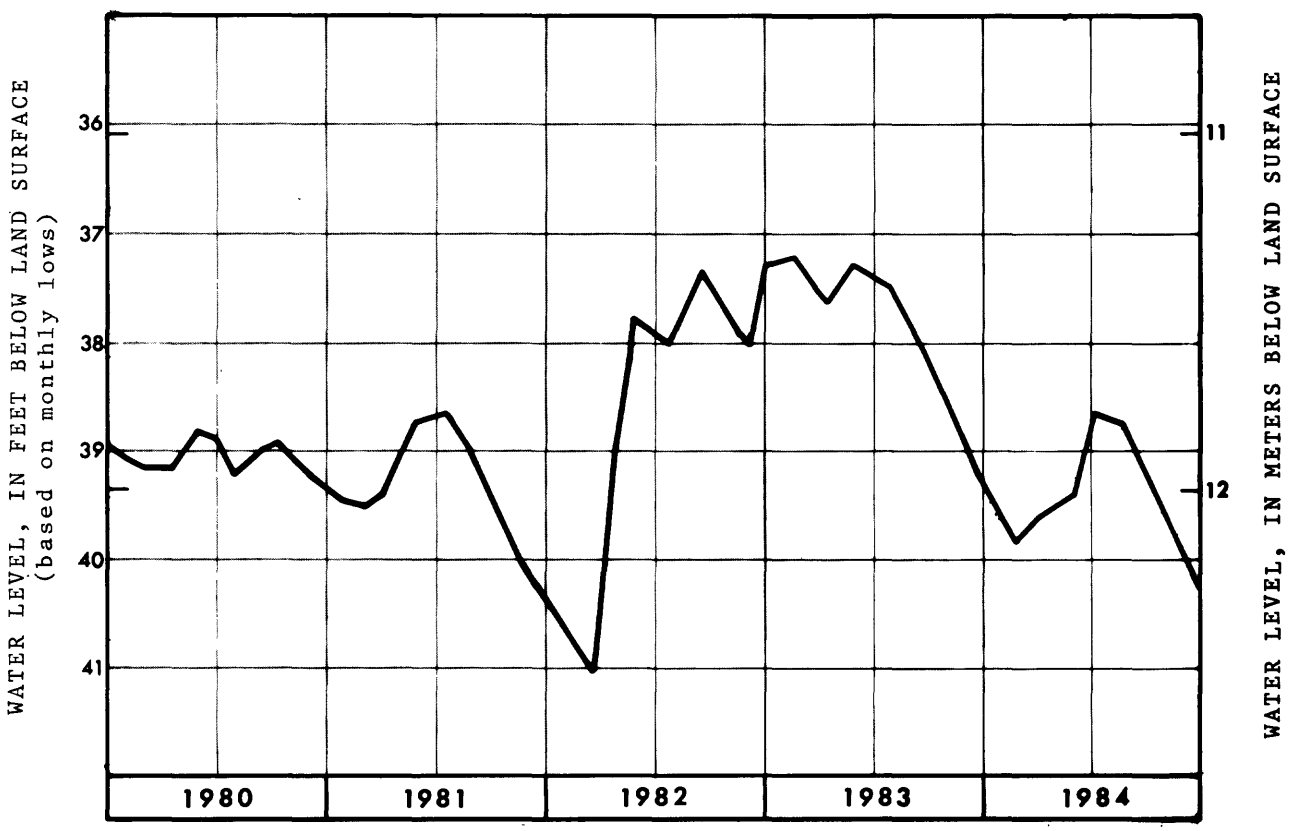
Water levels in well 7S 6E 15ACAA1. Well is 73 feet deep and in the Detroit River Group. Water-quality data in ground-water reports for 1979 and 1984 (Huffman, 1980, 1985).



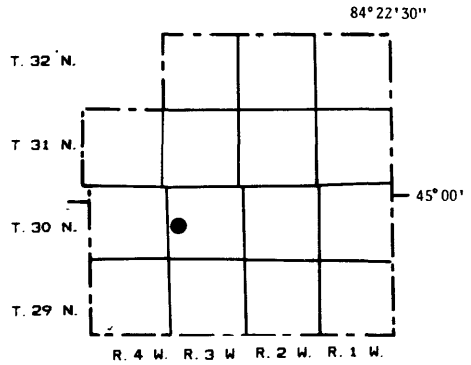


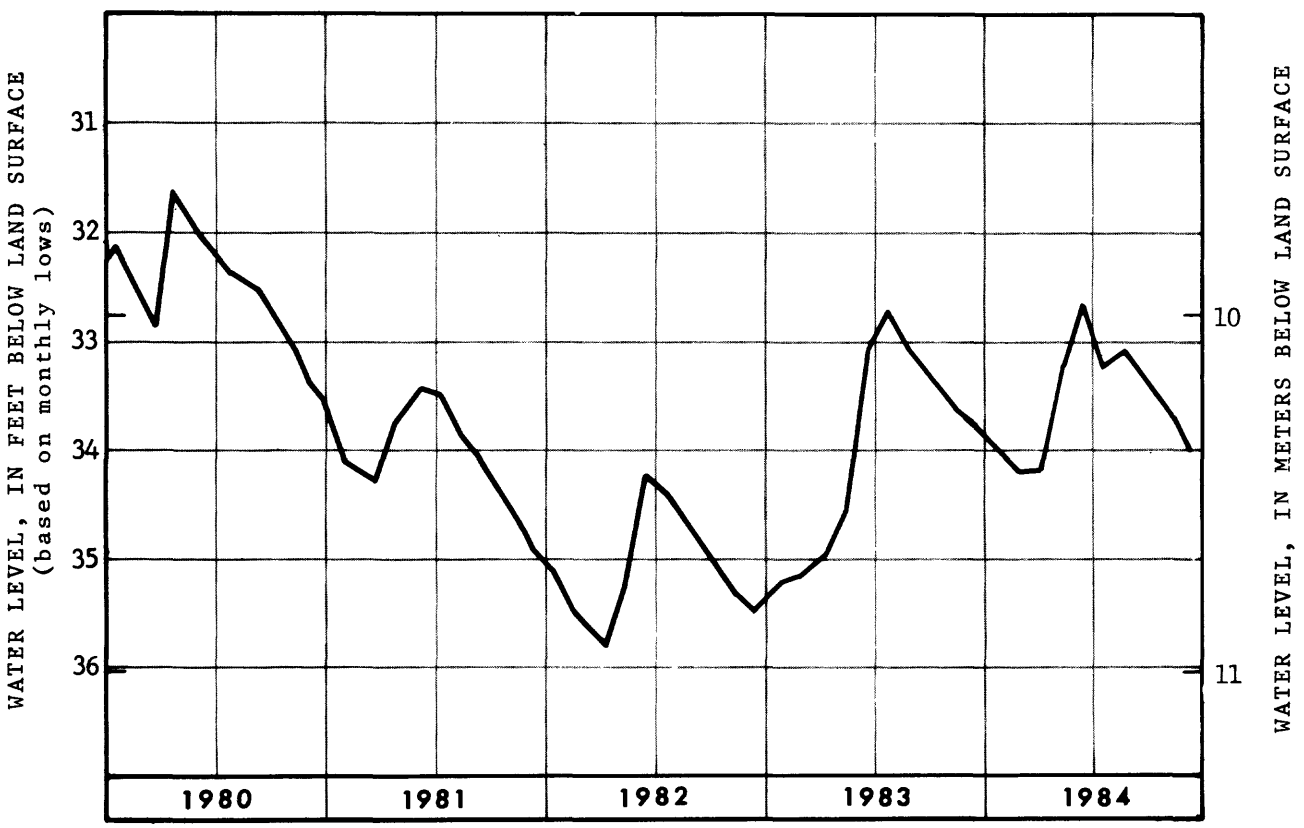
Water levels in well 5N 8E 8ACAC1. Well is 42 feet deep and in glacial deposits.



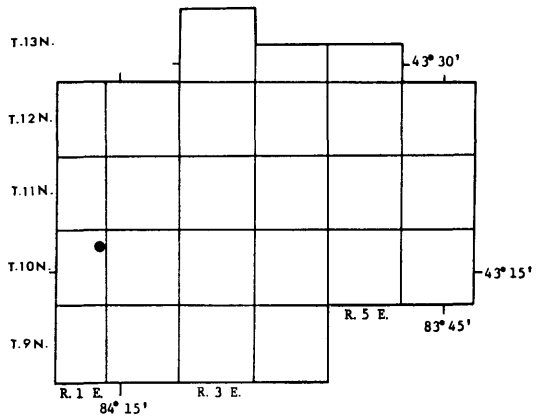


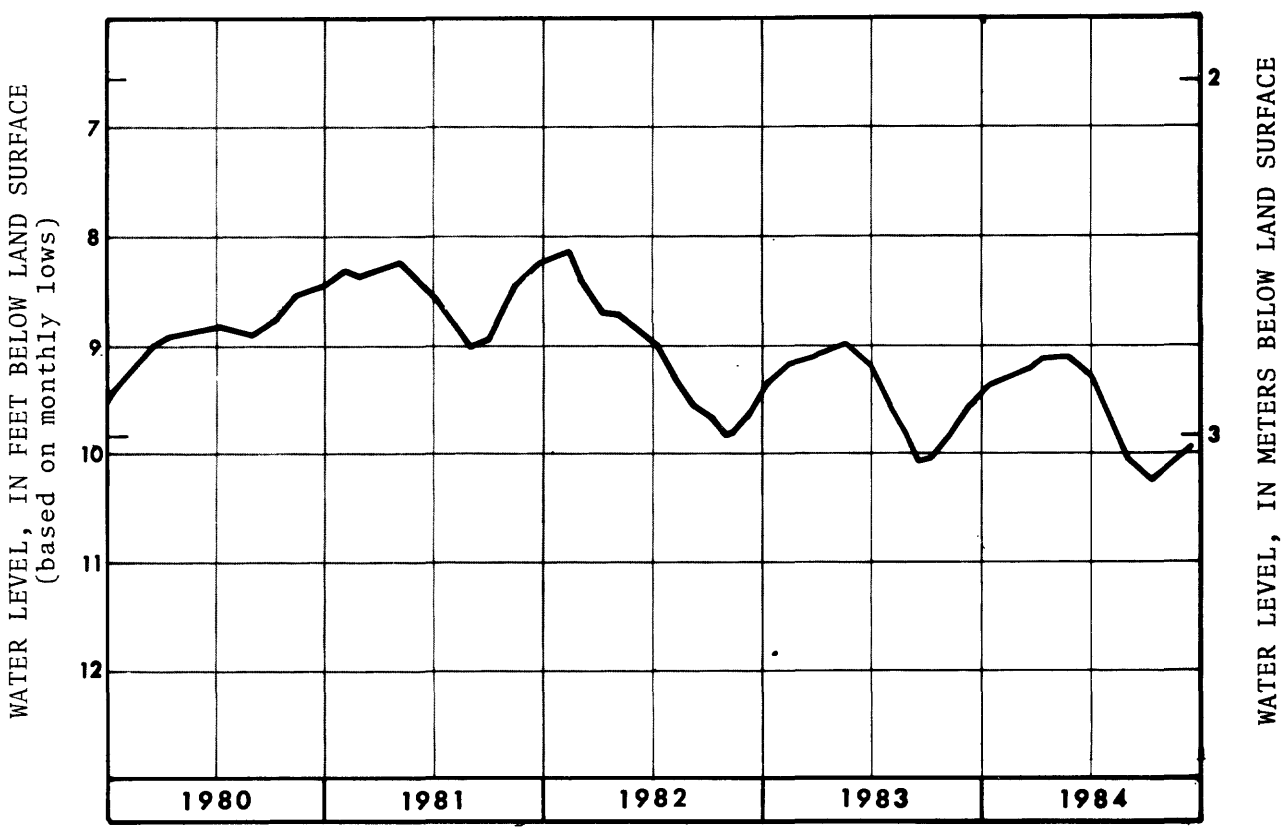
Water levels in well 13N 15W 18AAAA1. Well is 79 feet deep and in outwash. Water-quality data in ground-water reports for 1978 and 1984 (Huffman, 1979, 1985).



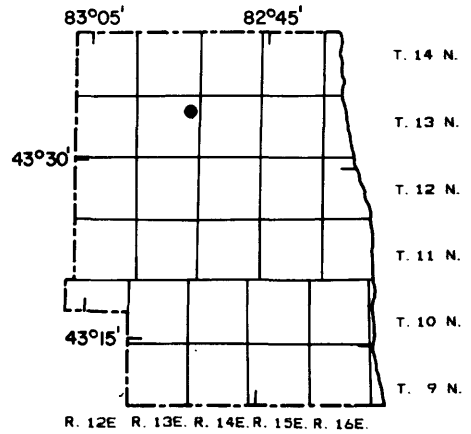


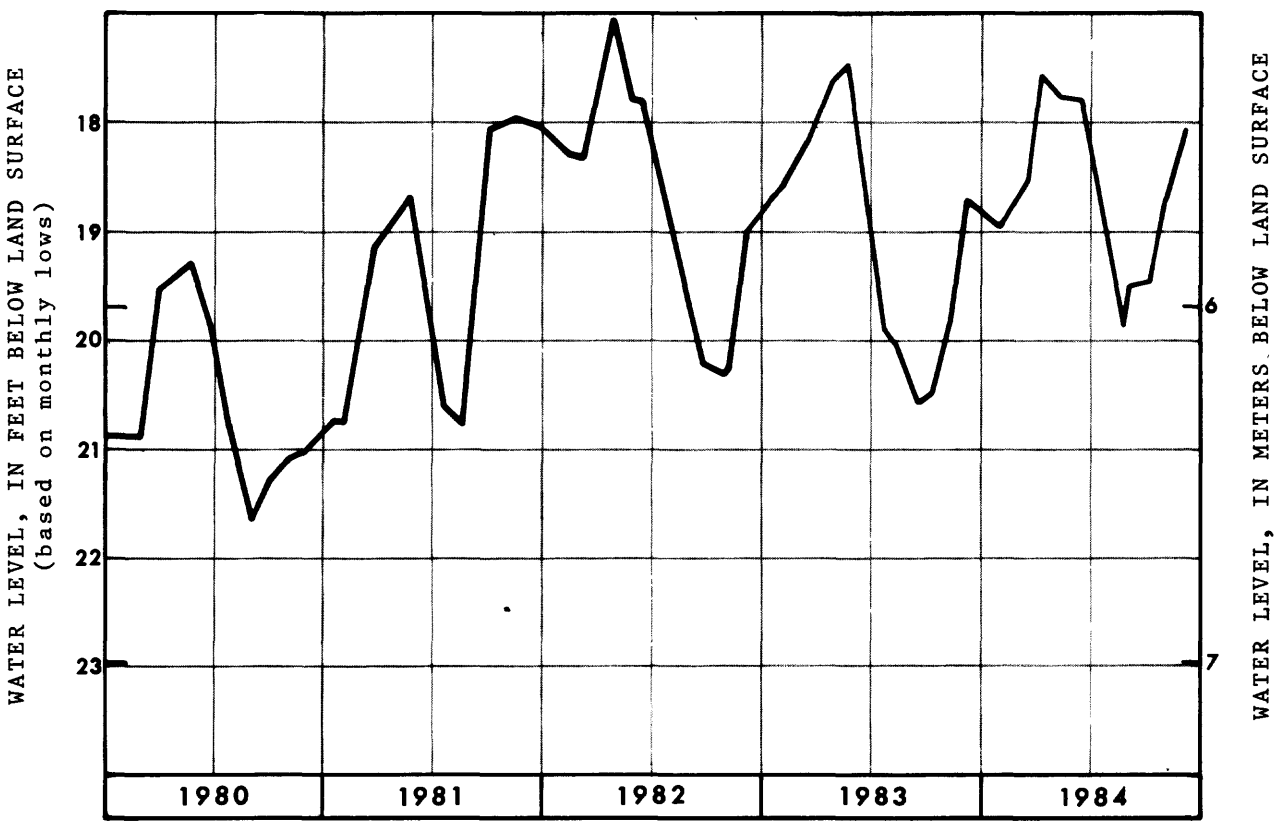
Water levels in well 30N 3W 19ABBB1. Well is 90 feet deep and in glacial outwash. Water-quality data in ground-water reports for 1979 and 1984 (Huffman, 1980, 1985).





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 (Huffman, 1979, 1985).





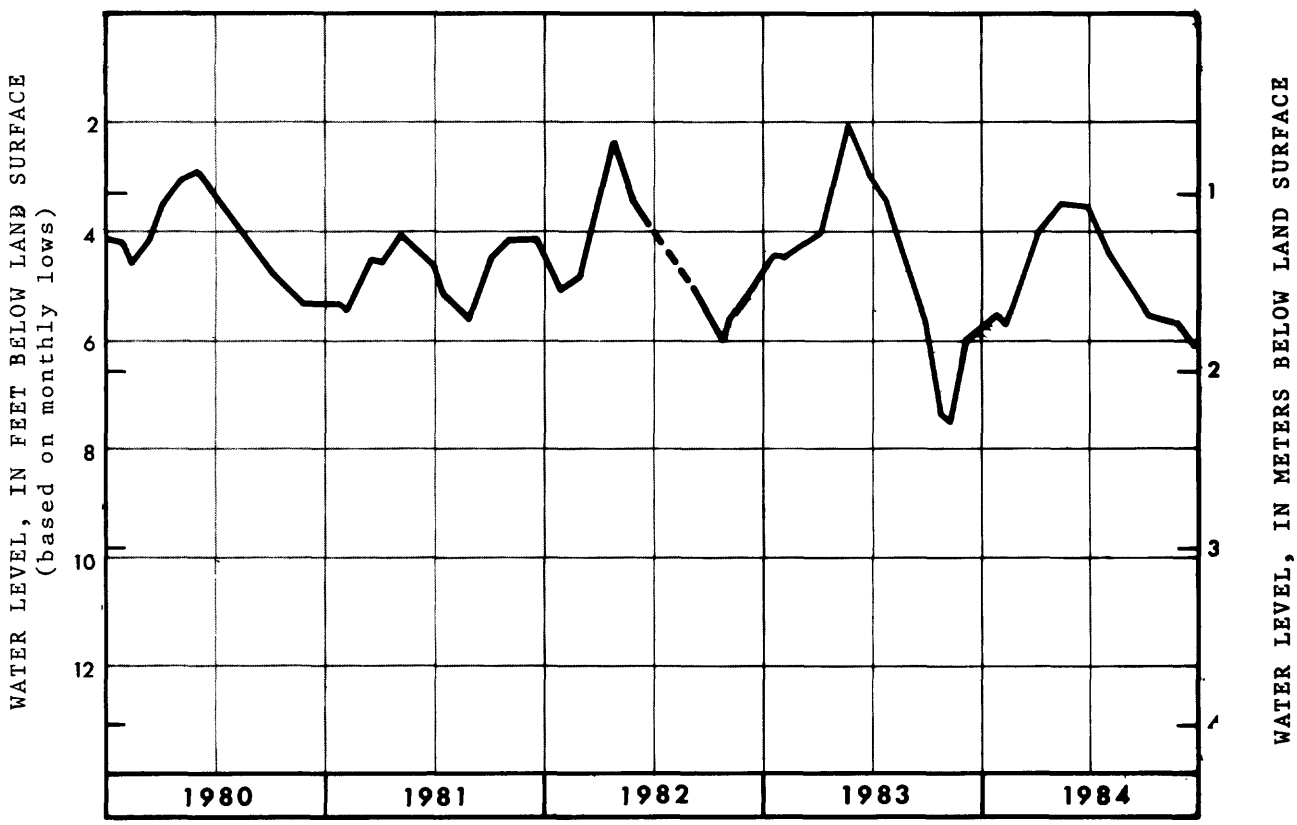
Water levels in well 13N 13E 12ADAA1. Well is 130 feet deep and in the Marshall Formation. Water-quality data in ground-water reports for 1977 and 1982 (Huffman, 1979, 1983).

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).

1984 -	1,192
1983 -	810
1982 -	720
1981 -	787
1980 -	742



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).

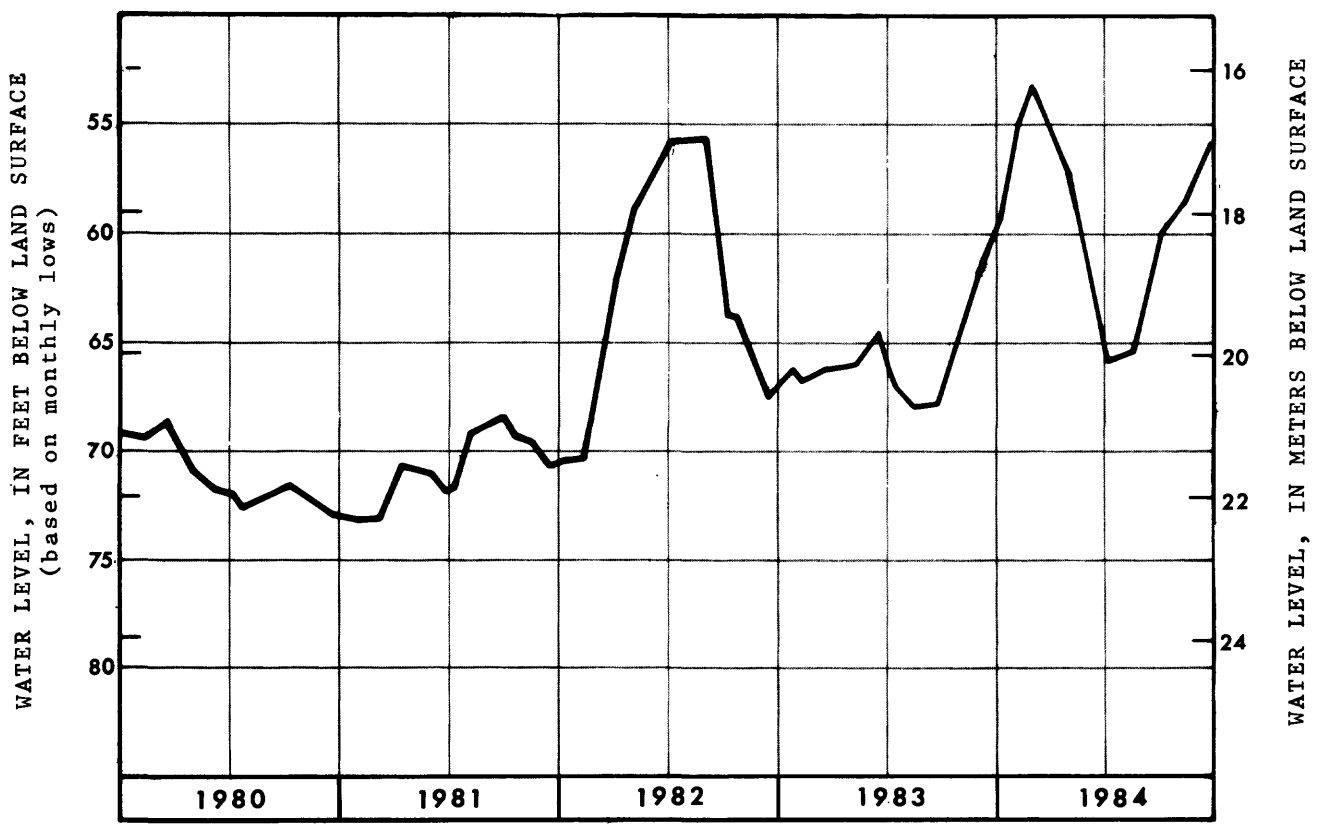
WASHTENAW COUNTY - CITY OF YPSILANTI

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.

1984 - 1,155
1983 - 1,112
1982 - 1,196
1981 - 1,385
1980 - 1,288



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

TABLES

Table 1.--Records of Michigan observation wells

COUNTY AND WELL NUMBER: See section in text entitled "Well-numbering system".
NAME: MDNR - Michigan Department of Natural Resources; WEP - Wisconsin Electric Power Company; MSHD - Michigan State Highway Department; USFS - U.S. Forest Service.
AQUIFER:

112GLCL	Glacial deposits	337MRSL	Marshall Formation		
112GRVL	Gravel	341TRVR	Traverse Group	361ODVCU	Ordovician, Upper
112OTSH	Outwash	344DUND	Dundee Formation	365TBRV	Trenton-Black River Group
112SAND	Sand	348DRRV	Detroit River Group	368PRDC	Prairie du Chien Group
112SDGV	Sand and Gravel	355SLINH	Salina Formation	372MNSG	Munising Sandstone
324SGNW	Saginaw Formation	355MNSQ	Manistique Dolomite	420FRED	Freda Sandstone

ALTITUDE: Land-surface datum in feet above sea level.
MEASUREMENTS, 1984 (frequency); R - Continuous recorder; D - Daily; W - Weekly; M - Monthly; Q - Quarterly; S - Semiannually; A - Annually; I - Intermittent.
OBSERVED WATER-LEVEL EXTREMES: In feet below or above (+) land surface. 1984 measurements underscored are extremes for entire record.
REMARKS: P - Water levels affected by pumping. Water-level measurements are made by the U.S. Geological Survey unless otherwise noted.

COUNTY AND WELL NUMBER	NAME	DEPTH (FT)	DIAMETER (IN)	AQUIFER	ALTITUDE	YRS. RECORD	MEAS. 1984	OBSERVED WATER-LEVEL EXTREMES				REMARKS
								THROUGH 1983		IN 1984		
TWP, RANGE, SECT								MAXIMUM	MINIMUM	MAXIMUM	MINIMUM	
ALGER												
45N 19W 25BDCD1	CCC	66	6	112GLCL	850	26	Q	6.4 Jun 1960	14.2 Apr 1964	10.6 Apr	11.3 Oct	
ALPENA												
32N 6E 23DDDA1	Alpena State Forest	88	6	112SAND	713	8	R	13.6 May 1983	30.0 Mar 1982	17.0 Apr	23.9 Feb	
ARENAC												
19N 5E 7DABA1	Omer, D	185	6	324SGNW	667	5	M	8.3 Jul 1980	10.1 Aug 1980	9.7 Apr	10.9 Oct	
7DABA2	Omer, S	21	6	112GLCL	667	5	M	2.3 May 1983	6.9 Aug 1980	2.6 Jun	6.7 Oct	
BARAGA												
48N 32W 12DD	WEP 14	10	1	112GLCL	1,630	37	M	3.3 Apr 1965	8.1 Sep 1969	5.3 May	6.9 Apr	Meas. by WEP
BARRY												
4N 9W 5DA	Solomon Road	131	2	112GLCL	860	21	Q	111.5 Mar 1978	122.0 Mar 1965	116.5 Jan	117.0 Oct	
BAY												
17N 4E 22DCAA1	Pinconning Twsp.	110	6	324SGNW	620	23	M	0.0 Mar 1976	10.5 Aug 1963	1.7 Apr	5.4 Sep	
BRANCH												
6S 6W 18CCCD1	Coldwater Twsp.	56	6	112OTSH	950	21	M	18.3 Mar 1976	28.3 Jul 1964	23.0 Jun	24.9 Dec	
22CABA1	Coldwater Test 4	113	6	112GLCL	970	21	R	9.0 May 1975	25.9 May 1977	10.4 Jun	23.3 Aug	P
CALHOUN												
1S 7W 10BB	Sabin	12	15	112GLCL	908	39	W	0.9 Mar 1950	7.2 Dec 1964	3.5 May	4.8 Oct	Meas. by owner
32BDCC1	Penfield Twsp.	95	6	337MRSL	845	21	R	15.6 Apr 1974	27.0 Aug 1964	21.7 Jan	25.0 Oct	P
32DABD	Battle Creek	127	8	337MRSL	830.8	46	D	0.7 Apr 1950	16.8 Jul 1959	6.0 Apr	11.4 Jul	P, Meas. by owner
2S 6W 25AA	Marshall	59	6	337MRSL	904.8	35	M	5.5 May 1950	9.7 Aug 1964	7.5 Jun	8.5 Sep	P, Meas. by owner
CASS												
8S 14W 17BA	Little	55	28	112GLCL	840	40	M	46.2 Jul 1950	55.0 Mar 1957	48.6 Jan	50.0 Feb	
CHEBOYGAN												
33N 1W 26DABA1	Pigeon River CCC	164	6	112SAND	933	19	R	56.1 Jun 1979	60.2 Jul 1982	56.3 Jun	57.9 Dec	
39N 3W 29CBCB1	Mackinaw, D	125	6	344DUND	705	6	M	5.2 May 1979	11.7 Feb 1981	5.7 Apr	9.6 Aug	
29CBCB2	Mackinaw, S	55	6	112SDGV	705	6	M	2.1 May 1979	6.5 Feb 1981	2.0 Apr	5.0 Aug	
CHIPPEWA												
46N 4W 24DAAD1	Raco	54	6	112OTSH	850	32	R	18.4 Jun 1971	28.4 Apr 1964	24.6 Jun	26.4 Apr	
CLARE												
17N 4W 34DCAD	Clare	91	4	112GLCL	850	10	R	7.9 Mar 1976	24.9 May 1977	11.7 Jun	18.1 Aug	

Table 1.--Records of Michigan observation wells--Continued

COUNTY AND WELL NUMBER TWP, RANGE, SECT	NAME	DEPTH (FT)	DIAMETER (IN)	AQUIFER	ALTITUDE	YRS. RECORD	MEAS. 1984	OBSERVED WATER-LEVEL EXTREMES THROUGH 1983 MAXIMUM	THROUGH 1983 MINIMUM	IN 1984 MAXIMUM	IN 1984 MINIMUM	REMARKS
CLINTON												
5N 2W 31CBBA1	Capital City Airport	195	6	324SGNW	850	27	R	45.0 Mar 1949	66.4 Jan 1967	52.6 Dec	55.7 Aug	P
32DC	Quarantine Farm	135	4	324SGNW	849.2	41	M	42.0 Sep 1944	99.2 May 1966	73.2 May	79.2 Aug	P
6N 1W 3BB2	Sleepy Hollow 5	62	1	112GLCL	814.0	15	I	37.6 Apr 1983	43.5 Nov 1966	38.3 Apr		
6N 2W 16DDAD1	MSHD, U.S. 27	23	14	112GLCL	803.3	37	M	13.8 Apr 1974	19.9 Feb 1964	16.7 Apr	18.5 Dec	Federal key well
7N 1W 34CC	Sleepy Hollow 7	32	1	112OTSH	785.3	18	A	16.5 Apr 1983	20.3 Oct 1973	17.1 Apr		
2W 9BBCD	St. Johns	535	6	324SGNW	743.4	21	R	52.2 May 1967	93.7 May 1977	44.0 Jun	89.3 Oct	P, Disc., 11-84
CRAWFORD												
25N 1W 15DDCD1	Eldorado	56	6	112GLCL	1,190	37	R	25.7 May 1976	36.0 Apr 1951	28.4 Jul	29.5 Dec	
DELTA												
39N 23W 28AC	Schemmel	530	5	372MNSG	680	27	R	1.3 May 1960	8.6 Feb.1977	4.9 Apr	6.6 Aug	
41N 18W 31CD	Isabella	250	5	361ODVCU	615	27	M	3.3 Sep 1979	6.4 Feb 1977	3.9 Sep	5.3 Jan	
42N 18W 17ABBD	Cooks CCC	60	6	112GLCL	760	23	Q	21.2 May 1960	28.4 Mar 1966	23.2 Oct	24.3 Jun	
42N 19W 20AA	Pollack CCC	134	6	112GLCL	740	27	Q	23.4 Jul 1982	28.1 Feb 1977	25.1 Jun	25.5 Oct	
43N 19W 24BB	Clarage	405	4	365TBRV	860	27	Q	77.0 Jul 1960	88.8 Oct 1966	79.3 Aug	79.8 Apr	
DICKINSON												
43N 28W 32ADAB1	Felch	31	1	112SAND	1,160	19	M	13.1 May 1972	16.8 May 1968	14.0 Apr	14.7 Mar	
EATON												
3N 3W 2BA	Lansing, Stiefel	66	1	112GLCL	839	21	R	3.1 Mar 1965	18.0 Nov 1968	7.6 May	11.2 Feb	P
4N 3W 12CD	Robins Road	381	6	324SGNW	861.9	32	R	67.5 Nov.1953	103.6 Aug 1969	72.0 Dec	96.2 Aug	P
GENESEE												
6N 7E 9DCCC1	Fisher Body No. 2	385	10	324SGNW	837.0	12	R	52.3 Dec 1975	87.0 Jun 1977	57.1 May	80.5 Jul	P
GRAND TRAVERSE												
26N 9W 14ABAA1	Fife Lake State Forest	80	6	112SAND	960	8	R	24.3 Sep 1976	28.0 Mar 1982	25.0 Jul	26.1 Mar	
HILLSDALE												
7S 2W 10BDDD1	Pittsford Game Area	20	1	112SAND	1,070	19	M	5.8 Apr 1982	11.1 Sep 1967	7.3 Apr	8.6 Sep	
2W 15BCBA1	Osseo	150	6	112OTSH	1,095	6	M	46.1 Apr 1982	49.0 Dec 1979	47.2 May	48.3 Oct	
INGHAM												
2N 1E 34DB	Dansville Game Area	87	2	112GLCL	930	21	Q	22.4 Apr 1974	29.3 Oct 1964	23.8 Apr	25.8 Sep	
2N 1W 5BCAB1	Mason	210	8	324SGNW	890	21	R	14.7 Mar 1973	23.8 Nov 1964	17.4 May	22.6 Oct	P
3N 1E 7DDCA1	Lotte	184	3	324SGNW	900	21	M	+2.4 Apr 1974	7.0 Nov 1964	+0.7 Apr	4.1 Oct	
2W 23BCBD	Holt	188	8	324SGNW	895	3	R	18.3 May 1983	23.6 Oct 1983	20.9 Jun	24.2 Oct	P
4N 1W 16DA	Meridian Twsp.	398	4	342SGNW	841.2	17	M	6.3 Mar 1976	17.4 Jul 1983	12.9 Feb	18.6 Jul	P
28BCAD1	Okemos	125	4	324SGNW	865	9	R	18.1 May 1976	24.2 Sep 1978	19.6 May	22.8 Aug	P
4N 2W 16DA	Lansing, Cedar	417	12	324SGNW	829.1	40	R	41.0 Dec 1983	67.0 Aug 1949	38.8 Jun	43.2 Feb	P
17AB	Lansing, Logan	424	20	324SGNW	858.7	54	R	34.3 Dev 1929	168.3 May 1968	89.0 Nov	94.7 Jan	P
21BA3	Lansing, Scott Park	400	4	324SGNW	835	6	R	38.6 Dec 1983	58.8 Jun 1979	33.6 Sep	41.5 Jan	P
22BC	Lansing, P-5	338	12	324SGNW	823.6	55	M	7.1 Jul 1932	80.5 Feb 1979	35.0 May	42.3 Nov	P
24CA	Spartan Village	453	10	324SGNW	853.4	40	R	25.5 Mar 1946	105.5 May 1972	70.0 Dec	87.2 Jul	P
27BB	Fenner Arboretum	215	6	324SGNW	835	17	R	47.8 Jun 1983	89.5 Oct 1972	50.5 May	64.9 Mar	P
31CC	Maybel Street	204	3	324SGNW	880.2	41	M	18.9 Apr 1952	45.9 Jul 1980	39.3 Nov	45.4 Apr	P

Table 1.--Records of Michigan observation wells--Continued

COUNTY AND WELL NUMBER / TWP, RANGE, SECT	NAME	DEPTH (FT)	DIAMETER (IN)	AQUIFER	ALTITUDE	YRS. RECORD	MEAS. 1984	OBSERVED WATER-LEVEL EXTREMES THROUGH 1983 MAXIMUM	THROUGH 1983 MINIMUM	IN 1984 MAXIMUM	IN 1984 MINIMUM	REMARKS
IOSCO												
24N 7E 13ADAD1	Oscoda	69	6	112SAND	760	5	M	29.9 Jul 1983	32.7 Mar 1982	28.9 Jul	30.9 Mar	
IRON												
43N 35W 11AD	WEP 23	47	36	112GLCL	1,565	40	M	35.3 Aug 1983	47.1 Aug 1949	37.0 Jan	38.6 Dec	Meas. by WEP
20DC	WEP 25	48	1	112GLCL	1,560	40	M	40.7 Jun 1973	48.3 Aug 1949	41.8 Jun	42.9 Dec	Do.
44N 37W 14BB	CCC Camp	102	6	112GLCL	1,730	26	Q	91.4 Nov 1983	97.1 Aug 1982	91.3 Jun	91.5 Mar	
JACKSON												
3S 1W 11AA1	Jackson, 4a Belden	360	6	324SGNW, 337MRSL	935	27	D	18.6 Jan 1961	119.1 Jun 1971	45.7 Jan	94.4 Jun	P, Meas. by owner
KALAMAZOO												
2S 10W 4D	Kalamazoo, Campbell	13	4	112OTSH	836.5	16	R	1.9 Apr 1974	7.7 Oct 1982	6.4 May	8.4 Sep	P
9B	Kalamazoo, Schoonover	21	6	112OTSH	828	16	R	+1.0 Apr 1975	4.0 Sep 1981	2.0 May	4.3 Oct	P
11W 20BB2	Kalamazoo, Kendall	106	4	112OTSH	880	17	R	12.5 Feb 1976	48.4 Jun 1971	17.8 Apr	44.1 Jun	P
22CD	Kalamazoo, Stockbridge	137	4	112OTSH	764.7	25	R	4.8 Feb 1975	31.1 Aug 1961	7.2 Mar	10.1 Sep	P
28AA	Kalamazoo, Maple	245	4	112OTSH	820	16	R	32.9 Jan 1979	61.6 Jun 1973	35.8 Aug	56.3 Aug	P
31CD	Kalamazoo, Colony	226	4	112OTSH	910	16	R	41.4 Sep 1982	71.8 May 1978	51.7 May	64.7 Jun	P
36CB	Kalamazoo, Emerald	226	4	112OTSH	860	16	R	25.7 May 1976	50.4 Jun 1971	27.4 May	44.6 Jul	P
3S 11W 4AD1	Kalamazoo, A-D	135	3	112OTSH	854.0	26	R	0.5 May 1967	12.9 Jul 1964	2.6 Dec	12.0 Sep	P
4AD2	Kalamazoo, A-S	40	3	112OTSH	854.0	26	R	+0.2 Sep 1975	9.1 Nov 1959	0.8 Feb	3.6 Aug	P
14AA	Upjohn 28	233	16	112OTSH	870	18	R	23.5 Aug 1982	45.2 Jul 1977	32.5 Feb	44.2 May	P
22BBCD	Portage	102	12	112GLCL	877	3	R	25.5 Jun 1982	27.9 Nov 1984	26.5 Jun	27.8 Sep	P
12W 11BD	Kalamazoo, Atwater	248	3	112OTSH	880	24	R	+3.0 Sep 1969	1.0 Aug 1977	+1.2 Jan	1.0 Aug	P
11AD1	Kalamazoo, Sabo-D	300	4	112OTSH	877	12	R	4.5 Jul 1973	16.4 Jul 1977	6.9 May	16.6 Jul	P
11AD2	Kalamazoo, Sabo-S	38	6	112OTSH	877	12	R	9.1 Aug 1975	12.7 Aug 1977	9.7 Jan	12.8 Aug	P
4S 11W 3CDDA1	Prairie View Park	190	4	112OTSH	870	16	R	18.1 Apr 1982	20.6 Dec 1977	18.9 Jun	20.1 Feb	
KENT												
5N 12W 4DCCD1	Wyoming, Wohma	86	6	112GRVL	868.0	23	M	7.8 Oct 1978	12.9 Aug 1964	9.6 Feb	11.3 Oct	
10N 12W 13DD	Rogue River Game Area	30	1	112GLCL	785	19	Q	0.8 Jan 1975	9.2 Oct 1969	6.0 Mar	8.7 Oct	
LAKE												
20N 13W 13ACAC1	Irons	57	6	112OTSH	945	5	M	14.7 Jul 1980	18.0 Mar 1982	15.1 Jul	16.6 Feb	
LEELANAU												
28N 14W 8DDCA1	Sleeping Bear, D	138	6	112SAND	750	5	M	113.1 Mar 1980	114.5 Jun 1984	114.0 Jan	114.3 Nov	
28N 14W 18RABB1	Sleeping Bear, S	60	6	112SAND	625	5	R	22.9 Apr 1982	24.9 Nov 1982	23.3 Feb	24.2 Feb	
LENAWEE												
5S 1E 12DDBD1	Onsted Game Area	39	1	112GLCL	1,000	19	M	15.9 Mar 1982	19.3 Sep 1971	16.4 Apr	17.7 Aug	
6S 4E 8DDBA1	Fisher Body	81	8	112OTSH	800	20	R	9.9 Apr 1982	18.4 Feb 1965	11.6 May	13.5 Dec	

Table 1.--Records of Michigan observation wells--Continued

COUNTY AND WELL NUMBER / TWP, RANGE, SECT	NAME	DEPTH (FT)	DIAMETER (IN)	AQUIFER	ALTITUDE	YRS. RECORD	MEAS. 1984	OBSERVED WATER-LEVEL EXTREMES THROUGH 1983 MAXIMUM	THROUGH 1983 MINIMUM	IN 1984 MAXIMUM	IN 1984 MINIMUM	REMARKS
LIVINGSTON												
1N 6E 13DBAB1	American Aggregate	29	2	112OTSH	930	15	R	12.1 Apr 1974	21.6 Oct 1979	15.5 May	17.0 Dec	
2N 6E 31BA2	Brighton	83	10	112GLCL	935	11	R	27.2 Sep 1975	58.6 Jul 1978	29.2 May	57.5 Jun	P
MACKINAC												
41N 5W 23BC	Round Lake CCC	47	6	355SLINH	610	29	Q	4.3 May 1959	17.8 Feb 1981	7.0 Apr	13.5 Jan	
42N 2W 7AABB1	Pontchartrain CCC	102	6	35SMNSQ	680	29	R	13.1 May 1960	32.3 Feb 1977	18.5 Apr	28.9 Sep	
MARQUETTE												
47N 28W 3CCDC1	Ely Twsp.	75	8	112OTSH	1,572.0	24	R	9.7 May 1973	19.3 Apr 1964	12.0 May	14.5 Dec	Federal key well
48N 29W 30CC	Van Riper Park	78	6	112GLCL	1,560	16	M	9.6 May 1973	15.7 Feb 1977	11.7 May	13.2 Apr	Disc., 6-84
49N 30W 22AC	WEP 13	17	1	112GLCL	1,680	37	M	0.6 May 1951	13.3 Sep 1948	5.9 May	10.5 Aug	Meas. by WEP
MENOMINEE												
37N 26W 19DADA1	Carney	17	4	365TBRV	800	26	Q	3.5 Apr 1979	8.6 Jan 1977	4.2 Nov	5.1 May	
MONROE												
7S 6E 15ACAA1	Petersburg, rock	73	6	348DRRV	860	6	M	32.3 Mar 1982	40.2 Nov 1979	34.3 May	39.8 Aug	
15ADBB1	Petersburg Game Area	17	1	112GLCL	675	19	M	3.0 Feb 1966	6.8 Nov 1978	4.6 Apr	6.0 Oct	
MUSKEGON												
11N 15W 34ADD01	Muskegon Game Area	31	1	112SAND	595	19	Q	+0.2 Apr 1978	4.7 Sep 1972	0.4 Jan	2.9 Oct	
OAKLAND												
2N 7E 5BA	Honeywell Lake Road	44	2	112GLCL	1,020	17	R	23.9 Apr 1976	28.9 Dec 1971	26.5 May	27.9 Sep	
8E 18DBAD1	Proud Lake Park	45	6	112OTSH	910	16	R	2.8 May 1974	6.4 Sep 1971	4.6 May	6.1 Sep	P
3N 7E 5DA	Fish Lake Road	49	2	112GLCL	1,055	16	R	29.5 Jun 1976	38.7 Dec 1972	34.2 Mar	35.6 Dec	
10E 13AC	Oakland University	183	6	112GLCL	940	4	R	56.3 May 1983	93.5 Jul 1963	56.2 Apr	59.2 Nov	
5N 8E 8ACAC1	Holly Recreation Area	42	1	112GLCL	930	19	M	22.3 Apr 1974	26.5 Sep 1966	24.6 May	26.2 Sep	
OCEANA												
13N 15W 18AAAA1	Hesperia	79	6	112OTSH	703	7	R	36.6 Jun 1979	41.0 Mar 1982	38.5 Jul	40.2 Dec	
OGEMAW												
23N 1E 2BAAA1	Rose City Road, D	105	1	112GLCL	1,265	17	Q	73.6 Oct 1976	78.2 Apr 1969	75.8 Jan	76.2 Apr	
2BAAA2	Rose City Road, S	20	1	112SAND	1,265	17	Q	7.6 Apr 1976	13.6 Dec 1972	10.4 Apr	11.6 Jan	
ONTONAGON												
51N 41W 8BDBC1	Silver City	100	6	420FRED	620	27	Q	8.2 Apr 1959	21.8 Dec 1976	10.2 Mar	15.4 Sep	
OTSEGO												
30N 3W 19ABBB1	Gaylord	90	6	112OTSH	1,308	6	M	30.7 Jul 1979	35.8 Apr 1982	32.7 Jun	34.2 Feb	

Table 1.--Records of Michigan observation wells--Continued

COUNTY AND WELL NUMBER TWP, RANGE, SECT	NAME	DEPTH (FT)	DIAMETER (IN)	AQUIFER	ALTITUDE	YRS. RECORD	MEAS. 1984	OBSERVED WATER-LEVEL EXTREMES THROUGH 1983 MAXIMUM	THROUGH 1983 MINIMUM	IN 1984 MAXIMUM	IN 1984 MINIMUM	REMARKS
PRESQUE ISLE												
33N 6E 8BBBB1	Styma	61	6	341TRVR	800	26	Q	5.1 Mar 1979	18.8 Mar 1963	4.8 Mar	12.9 Jul	
ROSCOMMON												
24N 2W 20BABA1	Exp. Station	14	8	112OTSH	1,145.3	51	R	2.1 Apr 1976	6.2 Dec 1949	3.4 May	4.8 Oct	Federal key well
SAGINAW												
10N 1E 22DADA1	Marion Springs, D	210	6	324SGNW	657	7	R	7.9 Feb 1981	10.1 Sep 1983	8.6 Apr	10.3 Oct	
SANILAC												
13N 13E 12ADAA1	Minden Game Area	130	6	337MRSL	805	8	R	16.4 Apr 1982	22.7 Oct 1979	16.6 May	19.8 Aug	
SCHOOLCRAFT												
45N 13W 16CCCB1	Seney	154	4	361ODVCU	710	33	R	4.6 Apr 1971	6.5 Oct 1963	5.3 Mar	6.0 Aug	
47N 16W 30BBBB1	Cusino CCC	57	6	368PRDC	900	28	R	5.7 May 1960	16.4 Feb 1977	8.2 Apr	14.9 Sep	
VAN BUREN												
2S 13W 2BBCD1	Almena, D	108	4	112GLCL	737	4	M	8.3 Feb 1981	10.7 Aug 1981	7.4 Apr	9.2 Sep	
2BBCE2	Almena, S	44	4	112GLCL	737	4	M	9.0 Oct 1982	12.0 Sep 1981	10.4 Apr	12.6 Sep	
WASHTENAW												
2S 3E 9DAAB2	Waterloo Park	48	6	112SDGV	970	16	R	4.1 May 1974	7.0 Aug 1971	4.5 Mar	6.9 Oct	P
3S 6E 16BCCD1	Ann Arbor	55	10	112GLCL	821.5	22	R	0.7 Mar 1974	15.9 Oct 1964	2.7 Jun	6.1 Dec	P
7E 5BB	Ypsilanti, Superior	69	8	112GLCL	720	23	R	1.8 Feb 1965	21.4 Dec 1965	2.4 Nov	11.4 Jan	P
9ADBC1	Ypsilanti, Gilbert	94	6	112GLCL	710	34	R	29.1 Nov 1945	78.8 Oct 1974	50.0 Apr	65.9 Jul	P
24CA1	Ypsilanti Twsp. 104	87	4	112GLCL	665.6	39	R	5.8 Jan 1950	22.7 Feb 1971	13.3 Nov	15.7 Jan	P
24CD	Ypsilanti Twsp. 117	75	6	112GLCL	657.8	38	R	4.7 Oct 1981	63.2 Feb 1970	7.0 May	20.8 Aug	P
WEXFORD												
22N 12W 13BA	Harrietta Fish Hatchery	141	4	112GLCL	1,060	24	R	+13.8 Mar 1970	1.6 Jan 1981	+9.6 Jun	+3.6 Jan	P

Table 2.--Reported ground-water pumpage
(in millions of gallons)

COUNTY AND WATER USER	1984 TOTAL	MAX DAY	MIN DAY
ALCONA			
Harrisville	20.4	.095	.030
ALGER			
Burt Twp.	50.4	--	--
Chatham	9.2	.177	.011
ALLEGAN			
Allegan	430.0	--	--
Douglas	106.3	--	--
Fennville	244.1	--	--
Otsego	392.6	1.632	.652
Plainwell	194.0	1.153	.298
Saugatuck	103.5	--	--
ANTRIM			
Bellaire	58.2	.355	.111
Central Lake	35.6	.305	.110
Mancelona	156.4	.724	.173
BARRY			
Hastings	286.7	1.830	.519
Middleville	89.5	--	--
Nashville	50.4	.455	.078
BENZIE			
Beulah	17.4	--	--
Frankfort	78.9	--	--
BERRIEN			
Berrien Springs	179.2	1.054	.228
Buchanan	e)233.3	1.150	.242
Coloma	127.3	.806	.195
Niles	970.1	4.260	1.460
Niles Twp.	59.3	1.211	.025
Watervliet	89.8	.847	.000
BRANCH			
Bronson	210.9	--	--
Coldwater	1,114.7	5.813	1.742
Quincy	95.5	--	--
Reg. Center Dev. Disab.	48.1	.212	.066
CALHOUN			
Albion	1,045.2	4.041	1.991
Athens	37.4	.313	.070
Battle Creek	3,083.2	12.990	4.750
Battle Creek Twp.	696.4	4.840	1.000
Homer	66.4	.284	.095
Marshall	438.2	2.397	.551
CASS			
Cassopolis	86.1	.595	.148
Dowagiac	334.2	1.764	.324
CHARLEVOIX			
Boyne City	204.9	.830	.269
Boyne Falls	144.2	--	--
East Jordan	227.8	1.180	.375
CHEBOYGAN			
Mackinaw City	88.9	.579	.065
CHIPPEWA			
Kinross Twp.	128.0	.856	.182
CLARE			
Clare	224.5	1.031	.411
Farwell	41.0	.160	.070
Harrison	78.8	.475	.160

COUNTY AND WATER USER	1984 TOTAL	MAX DAY	MIN DAY
CLINTON			
Fowler	23.9	.260	.029
Maple Rapids	23.9	--	--
Ovid	66.1	.336	.059
St. Johns	470.1	2.223	.700
Westphalia	19.9	.083	.028
CRAWFORD			
Grayling	228.9	.915	.402
DICKINSON			
Breitung Twp.	51.1	--	--
EATON			
Bellevue	47.7	.240	.055
Charlotte	423.9	2.527	.685
Delta Twp.	958.9	--	--
Eaton Rapids	273.4	1.506	.384
Grand Ledge	248.1	1.051	.342
Sunfield	29.6	--	--
EMMET			
Harbor Springs	158.8	1.280	.250
Petosky	510.4	2.281	1.060
GENESEE			
Burton	271.8	1.704	.389
Davison	231.3	1.522	.000
Fenton	283.6	1.313	.511
Grand Blanc	409.7	2.725	.621
Grand Blanc Twp.	135.6	--	--
Linden	65.6	.344	.036
Otisville	20.3	.091	.037
GLADWIN			
Beaverton	68.3	--	--
GOGEBIC			
Ironwood	501.6	--	--
Marenisco Twp.	52.0	.238	.090
Wakefield	143.3	.805	.291
GRAND TRAVERSE			
Kingsley	24.8	--	--
GRATIOT			
Alma	0.1	--	--
Breckenridge	41.5	.198	.041
Ithaca	115.2	--	--
St. Louis	183.0	1.351	.300
HILLSDALE			
Hillsdale	447.2	1.930	.780
Jonesville	168.0	1.080	.022
Litchfield	48.5	.287	.049
Waldron	26.7	.126	.042
HOUGHTON			
a)Adams Twp. - S. Range Water Auth.	351.3	--	--
b)Adams Twp. - S. Range Water Auth.	94.4	--	--
c)N. Michigan Water Co.	357.5	1.200	.574
HURON			
Pigeon	51.5	--	--
Sebewaing	179.4	.794	.187

Table 2.--Reported ground-water pumpage--Continued
(in millions of gallons)

COUNTY AND WATER USER	1984 TOTAL	MAX DAY	MIN DAY
INGHAM			
E. Lansing-Meridian Twp.	2,221.5	10.700	3.460
Lansing	8,249.2	33.158	17.100
Lansing Twp.	389.4	--	--
Leslie	110.2	--	--
Mason	240.1	--	--
Michigan State Univ.	1,646.5	--	--
Stockbridge	54.4	.270	.088
Webberville	68.2	--	--
IONIA			
Belding	593.0	--	--
Ionia	332.1	1.425	.495
Riverside Facility, Ionia	47.4	.222	.060
Mich. Reformatory, Ionia	195.0	--	--
Mich. Training Unit, Ionia	44.2	.483	.009
d)Muir	47.9	.807	.098
Pewamo	20.5	--	--
Portland	151.6	--	--
Saranac	193.8	1.100	.080
IOSCO			
Oscoda Twp.	274.0	--	--
Wurtsmith AFB	235.6	--	--
IRON			
Caspian	112.1	.454	.160
Crystal Falls	146.1	.773	.241
Crystal Falls Twp.	88.7	.396	--
Iron River	132.4	.513	.226
Iron Piver Twp.	140.4	1.940	.030
Stambaugh	76.9	.341	.000
Stambaugh Twp.	55.1	--	--
ISABELLA			
f)Mt. Pleasant	925.2	4.048	1.132
JACKSON			
Concord	66.6	2.445	.000
Grass Lake	251.9	2.155	.293
Jackson	3,035.0	14.470	4.110
Springport	49.3	--	--
State Prison, Jackson	570.3	--	--
KALAMAZOO			
Augusta	28.3	.425	--
Galesburg	90.8	.666	.127
Kalamazoo	7,275.3	41.536	11.604
Parchment	103.3	1.071	.098
Portage	1,192.5	9.557	1.271
Upjohn Co.	6,560.3	24.486	7.902
Vicksburg	120.7	.780	.208
KALKASKA			
Kalkaska	162.6	.706	.220
KENT			
Alloytek, Inc.	84.6	--	--
Cedar Springs	132.4	1.536	.119
Kent County Airport	e)12.0	--	--
Lowell	242.1	1.427	.303
Plainfield Twp.	748.1	6.300	.979
Sparta	169.5	.720	.282
LAKE			
Baldwin	82.0	.603	.107
LAPEER			
Columbiaville	31.9	.153	.055
Dryden	14.9	.122	.016
LEELANAU			
Northport	26.1	.269	.003
LENAWEE			
Britton	20.2	.103	.023
Clinton	95.0	--	--
Hudson	120.8	.528	.175
Morenci	87.8	.472	.001
Onsted	41.3	.226	.074
Tecumseh	361.6	1.941	.358
Inland Div., Tecumseh	9.1	.076	--
LIVINGSTON			
Fowlerville	119.3	.520	.190
Howell	445.7	2.118	.794
Maxey Boys School	45.7	.287	.046
LUCE			
Newberry	99.1	--	--
Newberry Health Center	21.0	--	--
MACOMB			
Armada	36.1	.193	.052
Richmond	135.0	--	--
Romeo	227.0	--	--
MANISTEE			
Filer Twp.	55.0	.586	.000
Manistee	388.8	1.950	.781
MARQUETTE			
K.I. Sawyer AFB	453.1	2.162	.702
Richmond Twp.	e)46.5	--	--
MENOMINEE			
Stephenson	36.5	.184	.075
MISSAUKEE			
Lake City	51.6	.371	.080
MONROE			
Milan	360.2	--	--
Petersburg	43.1	.192	.052
MONTCALM			
Carson City	58.8	.350	.110
Edmore	62.9	.665	.051
Greenville	951.5	4.270	1.086
Howard City	26.0	.140	.040
Sheridan	33.1	--	--
Stanton	121.2	--	--
MUSKEGON			
Montague	92.5	.750	.093
NEWAYGO			
Freemont	452.7	2.748	.120
Hesperia	20.6	--	--
Newaygo	65.1	.369	.070
White Cloud	102.4	.532	.116

Table 2.--Reported ground-water pumpage--Continued
(in millions of gallons)

COUNTY AND WATER USER	1984 TOTAL	MAX DAY	MIN DAY
OAKLAND			
Holly	162.8	.718	.326
Independence Twp.	155.8	--	--
Milford	243.1	1.321	.359
Orion Twp.	243.5	1.587	.402
Oxford	161.1	.819	.196
Rochester	625.4	3.340	.957
Southfield	4.9	--	--
South Lyon	645.4	--	.107
Sylvan Lake	70.0	--	--
Walled Lake	309.2	--	--
Waterford Twp.	2,059.9	--	--
Wolverine Lake	67.8	--	--
OCEANA			
Hart	278.9	--	--
Shelby	17.5	--	--
OGEMAW			
West Branch	109.1	.635	.000
ONTONAGON			
Bergland Twp.	e)9.9	--	--
OSCEOLA			
Evart	796.0	3.799	.596
Marion	40.4	.163	.087
Reed City	129.3	--	--
OTSEGO			
Gaylord	199.6	--	--
OTTAWA			
Spring Lake	148.7	--	--
PRESQUE ISLE			
Onaway	65.3	.205	.165
Rogers City	140.9	.874	.192
ROSCOMMON			
Roscommon	78.3	--	---
ST. CLAIR			
Capac	38.1	.883	.015
Yale	74.7	.526	.119
ST. JOSEPH			
Constantine	110.1	.553	.101
Sturgis	e)922.7	4.158	1.235
SANILAC			
Croswell	197.9	.995	.190
Deckerville	45.2	.220	.070
Marlette	100.3	.376	.148
Peck	23.2	.170	.043
Port Sanilac	32.8	--	--
Sandusky	217.7	1.028	.294
SHIAWASSEE			
Bancroft	22.4	--	--
Byron	22.7	--	--
Durand	134.9	.540	.239
Owosso	e)854.0	3.100	1.530
Perry	63.7	--	--
TUSCOLA			
Akron	1.4	--	--
Caro	228.7	--	--
Cass City	114.0	.678	.192
Kingston	15.0	--	--
Mayville	28.7	--	--
State Hosp., Caro	39.7	.024	.070
Vassar	205.9	.927	.467
VAN BUREN			
Bangor	60.7	.365	.055
Decatur	95.9	--	--
Gobles	19.6	--	--
Hartford	102.8	.492	.121
Lawrence	46.3	--	--
Lawton	345.4	2.000	.200
Paw Paw	174.9	1.027	--
WASHTENAW			
Ann Arbor	g)1,192.5	4.780	.000
Chelsea	196.6	.922	.289
Dexter	72.2	--	--
Saline	568.1	2.541	.595
Webster Twp.	48.3	.494	.002
Ypsilanti	1,155.3	6.297	--
Ypsilanti Twp.	1,505.7	10.577	.266
WEXFORD			
Cadillac	738.5	3.351	1.237
Manton	58.3	.369	.064

NOTES

a) Amount pumped to supply Houghton, Hancock, Portage Township, Copper Range Company, and Atlantic Mine.
b) Amount pumped to supply Painesdale, Trimountain, Baltic, and South Range.
c) Amount pumped to supply Calument, Calument Township, Copper City, Lake Linden, Laurin, Osceola Township, Torch Lake Township, Ahmeek, and Allouez Township.
d) Supplies water to Lyons.
e) Wholly or partly estimated.
f) Use Ranney Collector system at Chippewa River site.
g) Also pumped 4,609 million gallons from Huron River.

Table 3.--Water-quality data

LOCAL IDENTIFIER: See section in text entitled "Well-numbering system"; also includes abbreviated spelling of county name.
GEOLOGIC UNIT: 112GLCL Glacial deposits; 112GRVL Gravel; 112OTSH Outwash; 112SAND Sand; 112SDGV Sand and Gravel; 324SGNW Saginaw Formation; 344DUND Dundee Formation; 348DRRV Detroit River Group
UNITS: Units are reported in NTU = Nephelometric Turbidity Units, MG/L = Milligrams per liter; UG/L = Micrograms per liter; PCI/L = Picocuries per liter.

LOCAL IDENTIFIER		DATE OF SAMPLE	GEOLOGIC UNIT	DEPTH OF WELL, TOTAL (FEET)	SPECIFIC CONDUCTANCE (UMHOS)	PH (STANDARD UNITS)	TEMPERATURE (DEG C)	COLOR (PLATINUM-COBALT UNITS)	TURBIDITY (NTU)	HARDNESS (MG/L AS CACO3)	HARDNESS NONCARBONATE (MG/L AS CACO3)
17N 04E 22DCAA01	BAY	84-12-05	324SGNW	110	3280	7.6	10.0	5	100	650	518
06S 06W 18CCCD01	BRANCH	84-12-10	112OTSH	56.	699	7.1	11.5	<1	3.0	410	52
39N 03W 29CBCB01	CHBYGN	84-12-11	344DUND	125	293	7.7	9.0	140	10	160	5
39N 03W 29CBCB02	CHBYGN	84-12-11	112SDGV	55.	243	7.8	9.0	90	.50	110	0
06N 07E 09DCCC01	GENESE	84-11-30	324SGNW	385	502	7.5	11.0	5	1.0	200	0
07S 02W 15BCBA01	HILSDL	84-12-10	112SAND	150	584	7.3	11.0	<1	8.0	320	46
02N 01W 05BCAB01	INGHAM	84-12-03	324SGNW	210	1420	6.6	10.0	500	65	560	153
05N 12W 04DCCD01	KENT	84-12-13	112GRVL	86.	386	7.4	10.5	10	4.5	190	64
06S 04E 08DDBA01	LENAWE	84-12-11	112OTSH	81.	1000	6.8	11.5	10	35	510	123
07S 06E 15ACAA01	MONROE	84-12-11	348DRRV	72.	457	7.5	11.0	<1	1.0	150	0
02N 08E 18DBAD01	OAKLND	84-12-12	112OTSH	45.	642	7.2	10.0	<1	20	300	0
13N 15W 18AAAA01	OCEANA	84-12-07	112OTSH	79.	291	8.0	9.5	5	1.0	160	14
30N 03W 19ABBB01	OTSEGO	84-12-06	112SAND	95.	486	7.8	8.0	5	1.0	180	15
10N 01E 22DADA01	SAGINW	84-11-29	324SGNW	210	1030	6.9	10.0	5	9.0	460	303
02S 03E 09DAAB02	WSHTNW	84-12-11	112SDGV	48.	267	7.7	11.0	<1	15	130	23
03S 06E 16BCCD01	WSHTNW	84-12-12	112GLCL	55.	1130	7.1	11.0	<1	1.5	650	332

LOCAL IDENTIFIER		CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	POTASSIUM, DISSOLVED (MG/L AS K)	ALKALINITY LAB (MG/L AS CACO3)	SULFATE DISSOLVED (MG/L AS SO4)	CHLORIDE, DISSOLVED (MG/L AS CL)	FLUORIDE, DISSOLVED (MG/L AS F)	SILICA, DISSOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DISSOLVED (MG/L)
17N 04E 22DCAA01	BAY	180	48	500	4.4	130	650	690	.30	13	2220
06S 06W 18CCCD01	BRANCH	110	32	6.3	.90	359	33	13	<.10	14	409
39N 03W 29CBCB01	CHBYGN	46	11	1.7	.60	155	<.2	11	<.10	11	207
39N 03W 29CBCB02	CHBYGN	36	5.7	7.1	.70	123	3.4	3.4	<.10	9.9	170
06N 07E 09DCCC01	GENESE	32	28	39	1.9	261	24	3.0	1.4	13	272
07S 02W 15BCBA01	HILSDL	85	25	9.2	1.0	270	35	10	.30	14	273
02N 01W 05BCAB01	INGHAM	150	46	69	1.6	412	89	180	<.10	18	746
05N 12W 04DCCD01	KENT	54	13	4.5	.60	125	70	3.1	.20	14	251
06S 04E 08DDBA01	LENAWE	140	40	29	1.4	392	140	46	.60	15	499
07S 06E 15ACAA01	MONROE	32	18	24	1.2	202	45	1.1	1.4	14	305
02N 08E 18DBAD01	OAKLND	78	25	23	1.3	306	8.5	26	.50	18	317
13N 15W 18AAAA01	OCEANA	39	15	1.4	.40	145	15	1.3	<.10	6.1	148
30N 03W 19ABBB01	OTSEGO	59	7.5	2.8	.70	164	12	4.2	<.10	6.3	182
10N 01E 22DADA01	SAGINW	130	33	47	1.4	158	360	27	.20	11	684
02S 03E 09DAAB02	WSHTNW	39	9.0	3.9	.70	112	28	2.1	.10	10	156
03S 06E 16BCCD01	WSHTNW	180	48	9.8	4.6	316	280	49	<.10	10	779

LOCAL IDENTIFIER		SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	NITROGEN, NITRITE TOTAL (MG/L AS N)	NITROGEN, AMMONIA TOTAL (MG/L AS N)	NITROGEN, ORGANIC TOTAL (MG/L AS N)	NITROGEN, AMMONIA + ORGANIC TOTAL (MG/L AS N)	NITROGEN, TOTAL (MG/L AS N)	PHOSPHORUS, TOTAL (MG/L AS P)	PHOSPHORUS, ORTHO, TOTAL (MG/L AS P)	ALUMINUM, TOTAL RECOVERABLE (UG/L AS AL)	ARSENIC TOTAL (UG/L AS AS)
17N 04E 22DCAA01	BAY	2200	.010	1.20	.50	1.7	--	<.010	<.010	470	2
06S 06W 18CCCD01	BRANCH	420	<.010	.020	.28	.30	--	<.010	<.010	70	3
39N 03W 29CBCB01	CHBYGN	--	.020	.270	.13	.40	.50	.010	.010	110	4
39N 03W 29CBCB02	CHBYGN	140	<.010	.280	.52	.80	--	<.010	.020	<10	4
06N 07E 09DCCC01	GENESE	300	.010	.420	.08	.50	--	<.010	.010	40	43
07S 02W 15BCBA01	HILSDL	340	.010	.070	.73	.80	--	<.010	<.010	<10	7
02N 01W 05BCAB01	INGHAM	810	.010	.950	.75	1.7	--	.040	.020	30	2
05N 12W 04DCCD01	KENT	240	<.010	.250	.75	1.0	--	.120	.020	10	<1
06S 04E 08DDBA01	LENAWE	650	<.010	.510	.99	1.5	--	<.010	<.010	10	10
07S 06E 15ACAA01	MONROE	260	<.010	.350	.15	.50	--	.010	.020	40	<1
02N 08E 18DBAD01	OAKLND	370	<.010	.320	.08	.40	--	<.010	<.010	10	5
13N 15W 18AAAA01	OCEANA	170	<.010	.030	.67	.70	--	<.010	<.010	70	<1
30N 03W 19ABBB01	OTSEGO	190	<.010	<.010	--	.70	.90	<.010	<.010	70	<1
10N 01E 22DADA01	SAGINW	710	<.010	.410	.39	.80	--	<.010	<.010	60	<1
02S 03E 09DAAB02	WSHTNW	160	<.010	<.010	--	.20	--	<.010	<.010	20	4
03S 06E 16BCCD01	WSHTNW	770	<.010	.350	.25	.60	--	<.010	<.010	10	<1

Table 3.--Water-quality data--Continued

LOCAL IDENTIFIER		BARIUM, TOTAL RECOVERABLE (UG/L AS BA)	BERYLLIUM, TOTAL RECOVERABLE (UG/L AS BE)	BORON, TOTAL RECOVERABLE (UG/L AS B)	CADMIUM TOTAL RECOVERABLE (UG/L AS CD)	CHROMIUM, TOTAL RECOVERABLE (UG/L AS CR)	COBALT, TOTAL RECOVERABLE (UG/L AS CO)	COPPER, TOTAL RECOVERABLE (UG/L AS CU)	IRON, TOTAL RECOVERABLE (UG/L AS FE)	IRON, DISSOLVED (UG/L AS FE)	LEAD, TOTAL RECOVERABLE (UG/L AS PB)
17N 04E 22DCAA01	BAY	<100	<10	160	<1	30	6	25	10000	1300	30
06S 06W 18CCCD01	BRANCH	100	<10	30	<1	<10	2	1	2400	1000	1
39N 03W 29CBCB01	CHBYQN	<100	<10	<20	<1	10	1	8	3700	2900	3
39N 03W 29CBCB02	CHBYQN	<100	<10	<20	<1	<10	2	4	2300	2200	1
06N 07E 09DCCC01	GENESE	<100	<10	270	2	<10	1	1	1500	320	2
07S 02W 15BCBA01	HILSDL	200	<10	40	<1	10	1	1	2300	1200	1
02N 01W 05BCAB01	INGHAM	100	<10	20	<1	10	2	<1	9400	9000	3
05N 12W 04DCCD01	KENT	100	<10	<20	<1	<10	1	1	3000	1300	4
06S 04E 08DDBA01	LENAWE	300	<10	230	<1	10	1	1	3700	3300	3
07S 06E 15ACAA01	MONROE	200	<10	310	<1	20	5	<1	140	110	3
02N 08E 18DBAD01	OAKLND	200	<10	40	<1	10	<1	1	2700	1600	8
13N 15W 18AAAA01	OCEANA	<100	<10	<20	<1	10	1	40	30	<3	<1
30N 03W 19ABBB01	OTSEGO	<100	<10	<20	<1	<10	<1	1	20	6	3
10N 01E 22DADA01	SAGINW	<100	<10	60	2	10	1	5	2500	1600	15
02S 03E 09DAAB02	WSHTNW	<100	<10	<20	<1	10	1	55	3400	370	2
03S 06E 16BCCD01	WSHTNW	<100	<10	40	<1	10	3	3	3400	3000	4

LOCAL IDENTIFIER		LITHIUM TOTAL RECOVERABLE (UG/L AS LI)	MANGANESE, TOTAL RECOVERABLE (UG/L AS MN)	MANGANESE, DISSOLVED (UG/L AS MN)	MERCURY TOTAL RECOVERABLE (UG/L AS HG)	MOLYBDENUM, TOTAL RECOVERABLE (UG/L AS MO)	NICKEL, TOTAL RECOVERABLE (UG/L AS NI)	SELENIUM, TOTAL (UG/L AS SE)	SILVER, TOTAL RECOVERABLE (UG/L AS AG)	STRONTIUM, TOTAL RECOVERABLE (UG/L AS SR)	VANADIUM, DISSOLVED (UG/L AS V)
17N 04E 22DCAA01	BAY	40	250	90	.1	5	10	<1	<1	4400	<1
06S 06W 18CCCD01	BRANCH	<10	110	100	<.1	2	1	<1	<1	250	<1
39N 03W 29CBCB01	CHBYQN	10	90	61	.4	1	2	<1	<1	140	5
39N 03W 29CBCB02	CHBYQN	<10	50	53	.2	1	5	<1	<1	50	5
06N 07E 09DCCC01	GENESE	10	20	21	<.1	23	<1	<1	<1	1100	<1
07S 02W 15BCBA01	HILSDL	<10	40	33	<.1	9	<1	<1	<1	400	<1
02N 01W 05BCAB01	INGHAM	10	250	220	.1	36	<1	<1	<1	170	--
05N 12W 04DCCD01	KENT	<10	100	72	<.1	2	<1	<1	<1	2000	<1
06S 04E 08DDBA01	LENAWE	10	270	240	<.1	22	2	<1	<1	2900	2
07S 06E 15ACAA01	MONROE	10	10	5	.9	2	<1	<1	<1	42000	--
02N 08E 18DBAD01	OAKLND	10	50	45	.1	11	<1	<1	<1	480	<1
13N 15W 18AAAA01	OCEANA	<10	10	<1	<.1	<1	4	<1	<1	40	<1
30N 03W 19ABBB01	OTSEGO	<10	<10	<1	<.1	<1	<1	<1	<1	40	<1
10N 01E 22DADA01	SAGINW	30	40	43	.1	4	2	<1	<1	640	1
02S 03E 09DAAB02	WSHTNW	<10	60	43	.1	3	1	<1	<1	60	<1
03S 06E 16BCCD01	WSHTNW	10	120	110	<.1	2	2	<1	<1	230	<1

LOCAL IDENTIFIER		ZINC, TOTAL RECOVERABLE (UG/L AS ZN)	TRITIUM TOTAL (PCI/L)	URANIUM NATURAL DISSOLVED (UG/L AS U)	CARBON, ORGANIC DISSOLVED (MG/L AS C)	CARBON, ORGANIC SUSPENDED TOTAL (MG/L AS C)	CYANIDE TOTAL (MG/L AS CN)	PHENOLS TOTAL (UG/L)	PCB, TOTAL (UG/L)	ALDRIN, TOTAL (UG/L)	CHLORDANE, TOTAL (UG/L)
17N 04E 22DCAA01	BAY	4400	<200	<.4	5.2	.30	.02	7	<.1	<.010	<.1
06S 06W 18CCCD01	BRANCH	20	<200	.9	3.0	.10	<.01	9	<.1	<.010	<.1
39N 03W 29CBCB01	CHBYQN	20	38	<.4	12	.30	<.01	4	<.1	<.010	<.1
39N 03W 29CBCB02	CHBYQN	10	110	<.4	9.7	--	<.01	10	<.1	<.010	<.1
06N 07E 09DCCC01	GENESE	40	<200	1.8	2.1	.30	<.01	8	<.1	<.010	<.1
07S 02W 15BCBA01	HILSDL	20	<200	.5	1.8	.20	<.01	8	<.1	<.010	<.1
02N 01W 05BCAB01	INGHAM	20	<200	.4	16	.30	<.01	4	<.1	<.010	<.1
05N 12W 04DCCD01	KENT	1200	<200	<.4	3.2	<.10	<.01	8	<.1	<.010	<.1
06S 04E 08DDBA01	LENAWE	<10	<200	<.4	9.9	.20	<.01	12	<.1	<.010	<.1
07S 06E 15ACAA01	MONROE	30	<200	<.4	4.2	.20	<.01	4	<.1	<.010	<.1
02N 08E 18DBAD01	OAKLND	30	<200	.5	3.1	.20	<.01	7	<.1	<.010	<.1
13N 15W 18AAAA01	OCEANA	20	<200	.4	1.5	.20	<.01	8	<.1	<.010	<.1
30N 03W 19ABBB01	OTSEGO	10	<200	<.4	2.3	.20	<.01	6	<.1	<.010	<.1
10N 01E 22DADA01	SAGINW	30	<200	<.4	2.9	<.10	<.01	10	<.1	<.010	<.1
02S 03E 09DAAB02	WSHTNW	20	250	<.4	1.4	.20	<.01	4	<.1	<.010	<.1
03S 06E 16BCCD01	WSHTNW	100	<200	.8	4.2	.10	<.01	6	<.1	<.010	<.1

Table 3.--Water-quality data--Continued

LOCAL IDENTIFIER		DDD, TOTAL (UG/L)	DDE, TOTAL (UG/L)	DDT, TOTAL (UG/L)	DIAZINON, TOTAL (UG/L)	DIELDRIN TOTAL (UG/L)	ENDOSULFAN, TOTAL (UG/L)	ENDRIN, TOTAL (UG/L)	ETHION, TOTAL (UG/L)	HEPTACHLOR, TOTAL (UG/L)	HEPTACHLOR EPOXIDE TOTAL (UG/L)
17N 04E 22DCAA01	BAY	<.010	<.010	<.010	<.01	<.010	<.010	<.010	<.01	<.010	<.010
06S 06W 18CCCD01	BRANCH	<.010	<.010	<.010	<.01	<.010	<.010	<.010	<.01	<.010	<.010
39N 03W 29CBCB01	CHBYGN	<.010	<.010	<.010	<.01	<.010	<.010	<.010	<.01	<.010	<.010
39N 03W 29CBCB02	CHBYGN	<.010	<.010	<.010	<.01	<.010	<.010	<.010	<.01	<.010	<.010
06N 07E 09DCCC01	GENESE	<.010	<.010	<.010	<.01	<.010	<.010	<.010	<.01	<.010	<.010
07S 02W 15BCBA01	HILSDL	<.010	<.010	<.010	<.01	<.010	<.010	<.010	<.01	<.010	<.010
02N 01W 05BCAB01	INGHAM	<.010	<.010	<.010	<.01	<.010	<.010	<.010	<.01	<.010	<.010
05N 12W 04DCCD01	KENT	<.010	<.010	<.010	<.01	<.010	<.010	<.010	<.01	<.010	<.010
06S 04E 08DDBA01	LENAWE	<.010	<.010	<.010	<.01	<.010	<.010	<.010	<.01	<.010	<.010
07S 06E 15ACAA01	MONROE	<.010	<.010	<.010	<.01	<.010	<.010	<.010	<.01	<.010	<.010
02N 08E 18DBAD01	OAKLND	<.010	<.010	<.010	<.01	<.010	<.010	<.010	<.01	<.010	<.010
13N 15W 18AAAA01	OCEANA	<.010	<.010	<.010	<.01	<.010	<.010	<.010	<.01	<.010	<.010
30N 03W 19ABBB01	OTSEGO	<.010	<.010	<.010	<.01	<.010	<.010	<.010	<.01	<.010	<.010
10N 01E 22DADA01	SAGINW	<.010	<.010	<.010	<.01	<.010	<.010	<.010	<.01	<.010	<.010
02S 03E 09DAAB02	WSHTNW	<.010	<.010	<.010	<.01	<.010	<.010	<.010	<.01	<.010	<.010
03S 06E 16BCCD01	WSHTNW	<.010	<.010	<.010	<.01	<.010	<.010	<.010	<.01	<.010	<.010

LOCAL IDENTIFIER		LINDANE TOTAL (UG/L)	MALATHION, TOTAL (UG/L)	METHOXYCHLOR, TOTAL (UG/L)	METHYL PARATHION, TOTAL (UG/L)	METHYL TRITHION, TOTAL (UG/L)	MIREX, TOTAL (UG/L)	NAPHTHALENES, POLYCHLOR. TOTAL (UG/L)	PARATHION, TOTAL (UG/L)	PERTHANE TOTAL (UG/L)	TOXAPHENE, TOTAL (UG/L)
17N 04E 22DCAA01	BAY	<.010	<.01	<.01	<.01	<.01	<.01	<.10	<.01	<.1	<1
06S 06W 18CCCD01	BRANCH	<.010	<.01	<.01	<.01	<.01	<.01	<.10	<.01	<.1	<1
39N 03W 29CBCB01	CHBYGN	<.010	<.01	<.01	<.01	<.01	<.01	<.10	<.01	<.1	<1
39N 03W 29CBCB02	CHBYGN	<.010	<.01	<.01	<.01	<.01	<.01	<.10	<.01	<.1	<1
06N 07E 09DCCC01	GENESE	<.010	<.01	<.01	<.01	<.01	<.01	<.10	<.01	<.1	<1
07S 02W 15BCBA01	HILSDL	<.010	<.01	<.01	<.01	<.01	<.01	<.10	<.01	<.1	<1
02N 01W 05BCAB01	INGHAM	<.010	<.01	<.01	<.01	<.01	<.01	<.10	<.01	<.1	<1
05N 12W 04DCCD01	KENT	<.010	<.01	<.01	<.01	<.01	<.01	<.10	<.01	<.1	<1
06S 04E 08DDBA01	LENAWE	<.010	<.01	<.01	<.01	<.01	<.01	<.10	<.01	<.1	<1
07S 06E 15ACAA01	MONROE	<.010	<.01	<.01	<.01	<.01	<.01	<.10	<.01	<.1	<1
02N 08E 18DBAD01	OAKLND	<.010	<.01	<.01	<.01	<.01	<.01	<.10	<.01	<.1	<1
13N 15W 18AAAA01	OCEANA	<.010	<.01	<.01	<.01	<.01	<.01	<.10	<.01	<.1	<1
30N 03W 19ABBB01	OTSEGO	<.010	<.01	<.01	<.01	<.01	<.01	<.10	<.01	<.1	<1
10N 01E 22DADA01	SAGINW	<.010	<.01	<.01	<.01	<.01	<.01	<.10	<.01	<.1	<1
02S 03E 09DAAB02	WSHTNW	<.010	<.01	<.01	<.01	<.01	<.01	<.10	<.01	<.1	<1
03S 06E 16BCCD01	WSHTNW	<.010	<.01	<.01	<.01	<.01	<.01	<.10	<.01	<.1	<1

LOCAL IDENTIFIER		TOTAL TRITHION (UG/L)	2,4-D, TOTAL (UG/L)	2,4-DP TOTAL (UG/L)	2,4,5-T TOTAL (UG/L)	SILVEX, TOTAL (UG/L)
17N 04E 22DCAA01	BAY	<.01	<.01	<.01	<.01	<.01
06S 06W 18CCCD01	BRANCH	<.01	<.01	<.01	<.01	<.01
39N 03W 29CBCB01	CHBYGN	<.01	<.01	<.01	<.01	<.01
39N 03W 29CBCB02	CHBYGN	<.01	<.01	<.01	<.01	<.01
06N 07E 09DCCC01	GENESE	<.01	<.01	<.01	<.01	<.01
07S 02W 15BCBA01	HILSDL	<.01	<.01	<.01	<.01	<.01
02N 01W 05BCAB01	INGHAM	<.01	<.01	<.01	<.01	<.01
05N 12W 04DCCD01	KENT	<.01	.01	<.01	<.01	<.01
06S 04E 08DDBA01	LENAWE	<.01	<.01	<.01	<.01	<.01
07S 06E 15ACAA01	MONROE	<.01	<.01	<.01	<.01	<.01
02N 08E 18DBAD01	OAKLND	<.01	<.01	<.01	<.01	<.01
13N 15W 18AAAA01	OCEANA	<.01	<.01	<.01	<.01	<.01
30N 03W 19ABBB01	OTSEGO	<.01	<.01	<.01	<.01	<.01
10N 01E 22DADA01	SAGINW	<.01	<.01	<.01	<.01	<.01
02S 03E 09DAAB02	WSHTNW	<.01	<.01	<.01	<.01	<.01
03S 06E 16BCCD01	WSHTNW	<.01	<.01	<.01	<.01	<.01

SELECTED 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.

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.

----- 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 Van Alstine, 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.

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, 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.

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

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.

----- 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.

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 groundwater 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 Otten, 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.

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 rescurce 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.

----- 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 conditiors 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.

Michigan Water Resources Commission, 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 inWayne 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, Michian: 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).

----- 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 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.

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.

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

----- 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.

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.

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		
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