WISCONSIN

A Summary of Water-Resources Activities

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

1986

A SUMMARY OF WATER-RESOURCES ACTIVITIES OF THE UNITED STATES DEPARTMENT OF THE INTERIOR GEOLOGICAL SURVEY 1986

PREPARED IN COOPERATION WITH:

Wisconsin Department of Natural Resources
Wisconsin Department of Transportation
Wisconsin Geological and Natural History Survey
Dane County Department of Public Works
Dane County Regional Planning Commission
Southeastern Wisconsin Regional Planning Commission
Madison Metropolitan Sewerage District
Green Bay Metropolitan Sewerage District Green Lake Sanitary District
Delavan Lake Sanitary District
Waukesha Water Utility Commission
Park Lake Management District
City of Middleton
Village of Slinger
Lac La Belle Management District
Fowler Lake Management District
Fox Valley Water Quality Planning Agency
Okauchee Lake Management District
Morris Lake Management District
Wolf Lake Management District
The District of Powers Lake
Menominee Indian Tribe of Wisconsin
Lac du Flambeau Tribal Council
Forest County Potawatomi Community
St. Croix Tribal Council
Bad River Tribal Council
Oneida Tribe of Indians of Wisconsin
Stockbridge-Munsee Tribal Council
National Park Service
National Weather Service
Federal Energy Regulatory Commission
Corps of Engineers, U.S. Army
Federal Emergency Management Agency
Illinois Department of Transportation
City of Madison
City of Beaver Dam
City of Medford
Wood County
City of Waupun
Town of Norway
City of Galena, Ill.
Town of Delavan
City of Thorp

UNITED STATES DEPARTMENT OF THE INTERIOR

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U.S. GEOLOGICAL SURVEY

The mission of the U.S. Geological Survey is to collect, to analyze, and to publish information about the Nation's energy, mineral, land, and water resources; to conduct research to determine the geologic structure of the United States, and to develop an understanding of Earth processes and history. The Director of the U.S. Geological Survey is responsible for the overall direction and supervision of Geological Survey activities. He is assisted by an Associate Director and Assistant Directors for Research, Engineering Geology, Administration, Intergovernmental Affairs, and Information Services. The work of the Geological Survey is accomplished by three principal and two support divisions.

GEOLOGIC DIVISION

The Geologic Division conducts diversified research programs to provide basic information on the character, magnitude, location, and distribution of the mineral, energy, and land resources of the United States and on the principles and processes involved in their formation. This information provides a basis for critical decisions and actions relating to land use, urban planning and development, construction practices, environmental and health hazards, and earthquake, volcanic, and other natural hazards. Special programs include the investigation and evaluation of geothermal energy resources, the maintenance of seismic and geomagnetic observatories, offshore oil and gas resource appraisal, onshore oil and gas investigations, and mineral land assessment.

NATIONAL MAPPING DIVISION

The National Mapping Division prepares, publishes, and revises topographic maps at several standard scales, photoimage maps, State maps, various U.S. base maps, land use-land cover maps, and other special map products as components of the National Mapping Program which covers the United States and its outlying areas, and Antarctica. The Division operates the National Cartographic Information Center, coordinates mapping activities financed by Federal funds, conducts research in topographic surveying and mapping, investigates geography in support of fundamental earth science and land-use data analysis mapping, and conducts studies and maintains an information and records depository for the U.S. Board of Geographic Names.

WATER RESOURCES DIVISION

The Water Resources Division provides the hydrologic information and understanding needed for the best use and management of the Nation's water resources for the benefit of the people of the United States. In cooperation with State and local governments and other Federal agencies the Division collects, on a systematic basis, data needed for the continuing determination and evaluation of the quantity, quality, and use of the Nation's water resources; conducts interpretive studies to describe the occurrence, availability, and biological, chemical, and physical characteristics of surface and ground water; conducts basic and applied research in hydraulics, hydrology, and related scientific fields to improve field investigations and measurement techniques, and to understand hydrologic systems sufficiently to predict quantitatively their response to natural or manmade stresses. The Division disseminates water data and the results of investigations and research through reports, maps, computerized information services, and other public releases; coordinates water-data acquisition activities of other Federal agencies; and provides scientific and technical assistance to other Federal, State, and local agencies, and to international agencies in the field of hydrology.

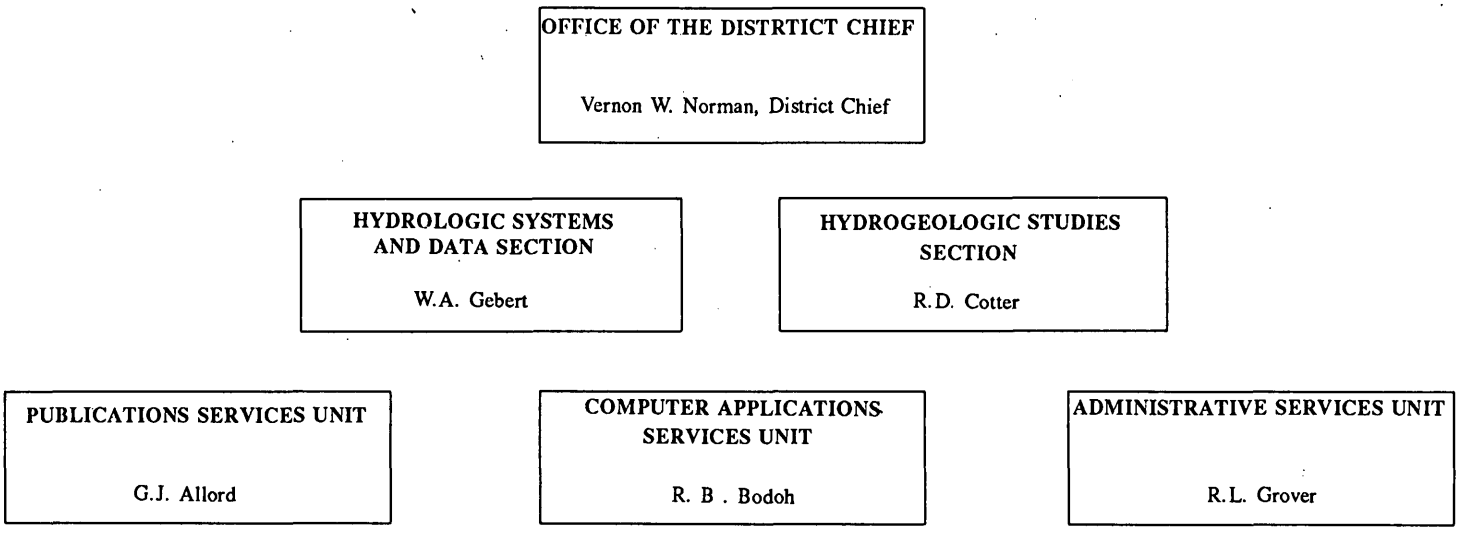
Support for the three principal Divisions is provided by the Administrative and Information Services Divisions.

The Water Resources Division is the only unit with permanent offices located in Wisconsin.

WISCONSIN DISTRICT

Organization

The Wisconsin District of the Water Resources Division consists of two operating sections and three support units. Water-resources projects conducted by the District are assigned to one of the two operating sections with responsibility for a project assigned to a project chief. The Wisconsin District consists of persons based at the District Office and at Field Headquarters in Madison, Merrill, and Rice Lake. The Wisconsin District is assisted and advised by research centers, laboratories, technical consultants, and training centers maintained throughout the United States by the Water Resources Division.



HYDROLOGIC SYSTEMS AND DATA SECTION

The Hydrologic Systems and Data Section studies, analyzes, and interprets hydrologic systems as they relate primarily to the problems of surface-water management and development. The Section collects, analyzes, and prepares for publication the basic data from a statewide network of stations necessary for a continuous inventory of the water resources of the State. Studies are either areal in nature or basic-data oriented and are related to surface-water problems: floods, low flow, water quality, and changing conditions of the resource. Interpretive reports are prepared for areal studies. The Section responds to requests for surface-water related information.

The Section consists of persons experienced in surface-water hydraulics and hydrology, flood frequency and low-flow analysis, digital modeling, water quality, sedimentation, limnology, biology, surface-water hydrology, and surface/ground-water relationships.

HYDROGEOLOGIC STUDIES SECTION

The Hydrogeologic Studies Section studies, analyzes, and interprets hydrologic and geologic systems as they relate primarily to the availability, quantity, quality, and uses of ground water within the State. Areal studies are conducted, resulting in interpretive reports. The Section collects, analyzes, and prepares for publication basic data related to ground-water- level fluctuations. The Section maintains a computerized data base of information on wells and borings throughout the State. The Section responds to requests for ground-water-related information.

The Section consists of persons experienced in hydrogeology, ground-water hydraulics, water quality, digital modeling, geophysical techniques, soils, and ground/surface-water relationships.

PUBLICATION SERVICES UNIT

The Publication Services Unit assists District personnel in the production of interpretive and basic-data reports. This assistance includes: typing, editing, cartographic design and production, and printing. The Unit also coordinates cartographic design and production for a Division-wide series of reports; assists in the use of a prototype geographic information system for digital hydrologic analysis and display of data; and assists in preparing cartographic technical standards for the Water Resources Division.

The Unit consists of persons experienced in various phases of editing and cartography ranging from traditional map design and production to automated digital cartography.

COMPUTER APPLICATIONS SERVICES UNIT

The Computer Applications Services Unit provides automatic data- processing (ADP) services to the District principally through the use of the District's PRIME minicomputer. The Unit is responsible for automatic data processing of water data collected by the District, for developing and maintaining computer files of water-related data and a library of computer programs, for computer programing services, and for answering requests related to the National Water Data Exchange (NAWDEX).

The Unit consists of persons experienced in the application of computer technology to hydrology.

ADMINISTRATIVE SERVICES UNIT

The Administrative Services Unit provides support services in the areas of budgeting, financial management, personnel administration, procurement, and general administrative activities.

FUNDING

Funding for the work of the Wisconsin District of the Water Resources Division is obtained from several sources. Most of our work is cooperative where State and local agency offerings are matched by Federal dollars. Some work is funded entirely by other Federal agencies and some Federal dollars are obtained, unmatched, from Water Resources Division.
The breakdown of funding and funding source is shown on the diagram below. This year the total Federal dollars make up about two-thirds of our budget.

INDIAN TRIBES

Bad River Tribal Council
Lac du Flambeau Band of Lake Superior Chippewa Indians
Oneida Tribe of Indians of Wisconsin
Forest County Potawatomi Community
Menominee Indian Tribe of Wisconsin
St. Croix Council Stockbridge-Munsee Tribal Council

OTHERS

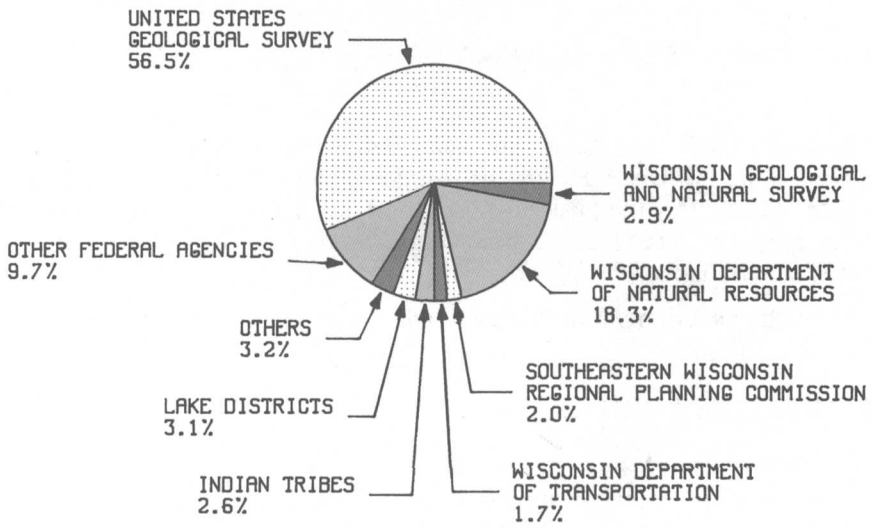
City of Middleton
Dane County Department of Public Works
Fox Valley Water Quality Agency
City of Fond du Lac
Wood County
Green Lake Sanitary District
Village of Slinger
Dane County Regional Planning Commission
Madison Metropolitan Sewerage District
City of Beaver Dam
City of Medford
City of Waupun
Green Bay Metropolitan Sewerage District
Illinois Department of Transportation

LAKE DISTRICTS

Town of Norway
Wolf Lake District
Lake La Belle District
Okauchee Lake District
Delavan Lake Sanitary District
Morris Lake District
Fowler Lake District

OTHER FEDERAL AGENCIES

Federal Power Commission
U.S. Department of Defense- Army Corps of Engineers
Federal Emergency Management Agency
U.S. Department of the Interior- National Park Service
U.S. Department of Commerce- Weather Service



PROPORTION OF FUNDING
FISCAL YEAR 1986

Program

The program of the Water Resources Division for 1986 has been developed to meet some of the Nation's needs for water-resources information.
In Wisconsin, the program includes the collection of basic hydrologic data as well as interpretive studies. The Northern Midwest Regiona Aquifer- System Study is also headquartered in the Wisconsin District, but is administered by the regional office. A description of these projects as of March 31, 1986, follows;

NORTHERN MIDWEST REGIONAL AQUIFER-SYSTEM ANALYSIS

This is one of a series of studies of regional aquifer systems in the United States. They are federally funded, and administered through the Regional Aquifer-Ststem Analysis (RASA) Program, WRD of the U.S. Geological Survey. This project is headquartered in the Wisconsin District of the WRD.

STUDY AREA: Parts of Illinois, Indiana, Iowa, Minnesota, Missouri, and Wisconsin

PROJECT CHIEF: Harley L. Young

PERIOD OF PROJECT: October 1978 to September 1987

OBJECTIVE: The subject of this project is a regional aquifer system composed primarily of sandstone and dolomite rocks of Cambrian and Ordovician ages. They are the lowermost sedimentary rocks throughout much of the Northern Midwest and supply large quantities of ground water for municipal, industrial, and rural uses. The potentiometric head in the aquifer system has declined hundreds of feet in the heavily pumped Chicago-Milwaukee area and, to a somewhat lesser extent, in other heavily pumped areas.

The objectives of this project are to: 1) describe the geologic, hydrologic, and chemical-quality characterics of the Cambrian-Ordovician aquifer system, 2) develop a regional data base and computerized data- management system, 3) define the predevelopment hydrologic system and detail the changes induced by man, 4) determine past and present withdrawals from the aquifer and estimate future needs, 5) develop digital computer models of the aquifer system, and 6) estimate the effects of continued and future stress on the aquifer system.

APPROACH: The study is conducted by a central RASA project staff in Madison, with the close cooperation and participation of WRD District personnel in each of the six States of the study.

The objectives are being met by: 1) compilation and analysis of existing data and collection and analysis of new data where needed, 2) development of computer models of the aquifer system, and 3) evaluation of past and future impacts from development of the aquifer system.

PROGRESS (through February 1986): Hydrologic characteristics and interrelationships of individual rock units within the aquifer system have been studied in some detail, and the overlying aquifers and confining beds have been studied in the detail necessary to understand their relationship with the Cambrian-Ordovician aquifer system. The following products or data were compiled with the assistance of the WRD Districts and certain State agencies:

Regional structure and isopach maps of four aquifer and four confining unit layers and a structure map of the Precambrian surface were compiled from State maps sent from each District office, some being products of the particular State Geological Survey.

Historical pumpage from the aquifer system was compiled, as multiyear averages for 12 periods from 1864 to 1980, for input to the regional ground-water flow model.

Work by the WRD District personnel and through contracts with some State agencies has resulted in several publications, which are described in the later section, "REPORTS":

Illinois - Fassnacht (1982), Nicholas, Sherrill, and Young (in press), and Visocky, Sherrill, and Cartwright (1985).

Iowa - Burkart and Buchmiller (in review).

Minnesota - Delin and Woodward (1984), Horn (1983), Mossler (1983a and 1983b), and Woodward (1984, 1985, and 1986).

Missouri - Imes (1985)

Wisconsin - Emmons (in press)

Field activities included contract drilling of five deep test wells that reached the Precambrian basement: three in Wisconsin and one each in Iowa and Illinois. One deep well and two shallow observation wells were drilled at two sites in Minnesota. Aquifer characteristics were determined from pumping tests and potentiometric head obtained for individual units isolated with inflatable hydraulic packers in these wells and nine other existing wells. Borehole geophysical logs were run on these and an additional 21 wells. The five deep test wells were converted into nests of three or four piezometers individually finished in the Mount Simon, Ironton-Galesville, or St. Peter-Prairie du Chien-Jordan aquifers. These piezometers are now part of the ground-water level monitoring network in each State.

A regional digital-computer model has been developed, as well as more localized models of areas with heavy pumping and large water-level declines. These are: 1) regional model (Mandle and Kontis, in press), 2) northeastern Missouri (Imes, 1985), 3) northeastern Wisconsin (Emmons, in press), and 4) the Jordan aquifer in Iowa (Burkart and Buchmiller, in review). A model of the Cambrian-Ordovician aquifer system in the Chicago-Milwaukee area is in progress and will be reported by H. L. Young and A. J. Mackenzie as USGS PP- 1405E. About 185 ground-water samples were collected and analyzed for all common ions and many trace constituents, and for stable isotopic composition, including carbon-14 age determination on 41 samples. Various aspects of the water chemistry of the Cambrian-Ordovician aquifer system are described by Siegel and Mandle (1984), Siegel (in press), and Franz (1985), in addition to several abstracts of papers given by D. I. Siegel at technical meetings. Interpretation of stable isotope and other water-quality data suggests that the present day water chemistry in confined parts of the Cambrian-Ordovician aquifer system is partly a result of recharge and discharge patterns that were altered by glaciation during the Pleistocene. A study of saline water in the Mount Simon aquifer in northeastern Illinois is concluding and will be described in a report from the Illinois District.

A report on the regional geohydrologic framework and general water quality of the Cambrian-Ordovician aquifer system in the Northern Midwest is near completion and will be published as USGS PP-1405B by H. L. Young and D.I. Siegel.

PLANS: The project is currently scheduled for completion in September 1987. The Chicago-Milwaukee model will be finished and used to simulate future potentiometric heads that would result from the pumping rates that can be predicted from planning agency data and the plans for allocation of Lake Michigan water by the Illinois Department of Transportation.

Two additional interpretive reports by D. I. Siegel will address the relation of the geochemistry of ground water in the aquifer system to paleoflow conditions in Iowa and southeastern Wisconsin.

REPORTS: The following reports are a direct result of the Northern Midwest RASA:

1. Bennett, G. D., Kontis, A. L., and Larson, S. P., 1982, Representation of multiaquifer well effects in three-dimensional ground-water flow simula- tion: Ground Water, v. 20, no. 3, p. 334-341.

2. Burkart, M. R., and Buchmiller, R. C., A quantitative estimate of the effects of pumping on the Jordan aquifer in Iowa: U.S. Geological Survey Water-Supply Paper [in review].

3. Delin, G. N., and Woodward, D. G., 1984, Hydrogeologic setting and poten- tiometric surfaces of regional aquifers in the Hollandale Embayment, southeastern Minnesota: U.S. Geological Survey Water-Supply Paper 2219, 56 p.

4. Emmons, P. J., An evaluation of the bedrock aquifer system in northeastern Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 85-4199 [in press].

5. Fassnacht, T. L., 1982, A seismic reflection study of the Precambrian basement along the Illinois-Wisconsin State line: Northern Illinois University, Master of Science thesis, 103 p.

6. Franz, K. E., 1985, Geochemistry of the sandstone and Silurian aquifers in eastern Wisconsin: Syracuse, New York, Syracuse University M. S. Thesis, 103 p.

7. Horn, M. A., 1983, Ground-water-use trends in the Twin Cities metropolitan area, Minnesota, 1880-1980: U.S. Geological Survey Water-Resources Investigations Report 83-4033, 37 p.

8. Imes, J. L., 1985, The ground-water flow system in northern Missouri, with emphasis on the Cambrian-Ordovician aquifer: U.S. Geological Survey Professional Paper 1305, 61 p.

9. Kontis, A. L., and Mandle, R. J., 1980, Data-base system for Northern Midwest regional aquifer-system analysis: U.S. Geological Survey Water- Resources Investigations Report 80-104, 23 p.

10. Mandle, R. J., and Kontis, A. L., A regional ground-water flow model of the Cambrian-Ordovician aquifer system in the Northern Midwest, United States: U.S. Geological Survey Professional Paper 1405-C [in press].

11. Mossler, J. H., 1983a, Bedrock topography and isopachs of Cretaceous and Quaternary strata, east-central and southeastern Minnesota: Minnesota Geological Survey Miscellaneous Map Series M-52, 2 pls.

12. -----1983b, Paleozoic lithostratigraphy of southeastern Minnesota: Minnesota Geological Survey Miscellaneous Map Series M-51, 8 pls.

13. Nicholas, J. R., Sherrill, M. G., and Young, H. L., 1984, Hydrology of the Cambrian-Ordovician aquifer system at a test well in northeastern Illinois: U.S. Geological Survey Water-Resources Investigations Report 84-4165 [in press].

14. Siegel, D. I., Geochemistry of the Cambrian-Ordovician aquifer system in the Northern Midwest: U.S. Geological Survey Professional Paper 1405-D [in press].

15. Siegel, D. I., and Mandle R. J., 1984, Isotopic evidence for glacial meltwater recharge to the Cambrian-Ordovician aquifer, north-central United States: Quaternary Research: An Interdisciplinary Journal, v. 22, p. 328-335.

16. Steinhilber, W. L., and Young, H. L., 1979, Plan of study for the Northern Midwest regional aquifer-system analysis: U.S. Geological Survey Water- Resources Investigations Report 79-44, 20 p.

17. Visocky, A. P., Sherrill, M. G., and Cartwright, Keros, 1985, Geology, hydrology, and water quality of the Cambrian and Ordovician systems in northern Illinois: Illinois State Geological Survey, Illinois State Water Survey, and U.S. Geological Survey Cooperative Groundwater Report 10, 136 p.

18. Woodward, D. G., 1984, Areal lithologic changes in aquifers in southeastern Minnesota as determined from natural-gamma borehole logs: National Water Well Association Conference on Surface and Borehole Geophysical Methods in Ground Water Investigations, San Antonio, Tex., February 7-9, 1984, Proceedings, p. 788-800.

19. -----1985, Trends in municipal wells and aquifer utilization in southeastern Minnesota, 1880-1980: U.S. Geological Survey Water- Resources Investigations Report 83-4222, 86 p.

20. -----1986, Hydrogeologic framework and properties of regional aquifers in the Hollandale embayment, southeastern Minnesota: U.S. Geological Survey Hydrologic Investigations Atlas 677, 2 sheets.

COLLECTION OF BASIC RECORDS--SURFACE WATER, WI 001

COOPERATORS:

Federal (Regular)
Wisconsin Department of Natural Resources
Southeastern Wisconsin Regional Planning Commission
Dane County Regional Planning Commission
Madison Metropolitan Sewerage District
U.S. Army Corps of Engineers
Federal Energy Regulatory Commission Licensees
National Weather Service
Dane County Department of Public Works
Village of Slinger
Menominee Indian Tribe of Wisconsin
Illinois Department of Transportation
City of Beaver Dam
City of Medford
City of Thorp
City of Waupun

LOCATION: Statewide

PROJECT CHIEF: Barry K. Holmstrom

PERIOD OF PROJECT: July 1913-Continuing

OBJECTIVE: The objectives of this study are to provide continuous discharge of selected rivers at specific sites to supply the needs for: regulation; analytical studies; definition of statistical properties; trends analysis; determination of the occurrence and distribution of water in streams for planning. The project is also designed to determine lake levels and to provide discharge for flood and low-flow conditions and for water-quality investigations. Requests for streamflow data and information relating to streamflow in Wisconsin are answered. Basic data are published annually in Water Resources Data for Wisconsin.

APPROACH: A network of streamflow stations and lake-level stations will be maintained throughout Wisconsin. This includes: operating the equipment at the gaging station to record river or lake stage; making periodic discharge measurements at each streamflow station to establish or verify a stage- discharge rating curve; reducing the periodic stage readings to instantaneous and daily discharges; compilation of monthly and annual discharges, and preparing data for publication in the annual "Water Resources Data for Wisconsin" report.

Requests for streamflow data from other governmental agencies, consult ants, and private parties will be processed.

PROGRESS (July 1913 to March 31, 1986): The first known streamflow measurements in Wisconsin were made shortly after the Civil War by General Gouverneur Warren on the Wisconsin River and its major tributaries. Several years later, the U.S. Geological Survey began collecting streamflow records at four sites: Chippewa River at Chippewa Falls (1888), Fox River at Rapide Croche (1896), Wolf River at New London (1896), and the Fox River at Berlin (1898). In 1913 the cooperative surface-water data program was started with the Wisconsin Rail-road Commission, and included the following stations: Oconto River near Gillett (04071000), Fox River at Berlin (04073500), Wolf River at Keshena Falls near Keshena (04077000), Wolf River at New London (04079000), St. Croix River at St. Croix Falls (05340500), Chippewa River at Bishops Bridge near Winter (05360000), Chippewa River at Chippewa Falls (05365500), Red Cedar River at Menomonie (06369000), Black River at Neillsville (05381000), Wisconsin River at Whirlpool Rapids (05392000), and Wisconsin River at Merrill (05395000). The number of gaging stations increased steadily to 58 in 1938, and reached a maximum of 135 in 1979, before decreasing to the present level.

During the current fiscal year, continuous streamflow data were collected at 29 sites for the Wisconsin Department of Natural Resources, 15 sites for the Corps of Engineers, 14 sites for the Southeastern Wisconsin Regional

Planning Commission, 10 sites for the Federal program, 5 sites for Federal Energy Commission Licensees, 2 for the Dane County Regional Planning Commission, 3 for the Madison Metropolitan Sewerage District, and 1 site each for the village of Slinger, the Menominee Indian Tribe of Wisconsin, and the cities of Beaver Dam, Medford, Thorp, and Waupun. Streamflow data were also collected at eight sites for agencies working jointly. Lake-level data were collected at two sites for the Dane County Department of Public Works and at two sites for the Corps of Engineers.

Computation of streamflow and lake-level records for network stations for the 1985 water year was completed. More than 70 requests for streamflow information were answered.

PLANS (April 1 to June 30, 1986): The U.S. Geological Survey will continue the collection of continuous streamflow data at 89 stations (see the following list) and lake levels at 4 stations, compute and publish streamflow and lake- level records for the 1986 water year, and respond to requests for streamflow information.

SURFACE-WATER GAGING STATIONS EXPECTED TO BE OPERATED IN 1987 FY

Station no.	Name and location	Period of record (water year)	Cooperator
04024430	Nemadji River - South Superior	1974 -	Fed.
04025500	Bois Brule River - Brule	1943 - 81, 1984 -	Fed.
04027000	Bad River - Odanah	1914 - 23, 1948	Fed.
04027500	White River - Ashland	1948 -	C of E,Detroit
04063700	Popple River - Fence	1964 -	Fed.
04066003	Menominee River - Pembine	1950 -	DNR
04067500	Menominee River - McAllister	1945 - 61, 1980 -	Fed.
04069500	Peshtigo River - Peshtigo	1953 -	Fed.
04071000	Oconto River - Gillett	1906 - 09, 1914 -	Fed.
04071858	Pensaukee River - Pensaukee	1973 -	DNR
04073500	Fox River - Berlin	1898 -	C of E,Detroit
04074538	Swamp Creek - Mole Lake	1977 - 83, 1985 -	DNR
04074950	Wolf River - Langlade	1966 - 79, 1981 -	Menominee Indian Tribe of Wis.
04077000	Wolf River - Keshena Falls	1907 - 09, 1911 -	FERC
04979000	Wolf River - New London	1896 -	C of E,Detroit
04084500	Fox River - Wrightstown	1896 -	DNR
04085200	Kewaunee River - Kewaunee	1964 -	DNR
04085281	East Twin River - Mishicot	1972 -	DNR
04085247	Manitowoc River - Manitowoc	1972 -	DNR
04086000	Sheboygan River - Sheboygan	1916 - 24, 1951 -	DNR
04086500	Cedar Creek - Cedarburg	1930 - 70,1973 - 81, 1983 -	Slinger
04086600	Milwaukee River - Pioneer Road	1982 -	SEWRPC
04087000	Milwaukee River - Milwaukee	1914 -	SEWRPC
04087030	Menomonee River - Menomonee Falls	1975 - 77, 1979 -	SEWRPC
04087088	Underwood Creek - Wauwatosa	1975 -	SEWRPC
04087120	Menomonee River - Wauwatosa	1962 -	SEWRPC
04087160	Kinnickinnic River - Milwaukee	1976 -	SEWRPC
0408704	Oak Creek - South Milwaukee	1964 -	SEWRPC
04087220	Root River - Franklin	1964 -	SEWRPC
04087233	Root River Canal - Franklin	1964 -	SEWRPC
04087240	Root River - Racine	1963 -	SEWRPC
04087257	Pike River - Racine	1972 -	SEWRPC
05333500	St. Croix River -Danbury	1914 - 81, 1985 -	DNR
05340500	St. Croix River - St. Croix Falls	1902 -	Fed.

SURFACE-WATER GAGING STATIONS EXPECTED TO BE OPERATED IN 1987 FY--CONTINUED

Station no.	Name and location	Period of record (water year)	Cooperator
05356000	Chippewa River - Winter	1912 -	DNR
05356500	Chippewa River - Bruce	1914 -	FERC
05360500	Flambeau River - Bruce	1951 -	FERC
05362000	Jump River - Sheldon	1915 -	DNR
05365707	North Fork Eau Claire River - Thorp	1986	City of Thorp
05368000	Hay River - Wheeler	1951 -	Fed.
05369000	Red Cedar River - Menomonie	1907 - 08, 1913 -	FERC
05369500	Chippewa River - Durand	1928 -	C of E,St.Paul,DNR
05370000	Eau Galle River - Spring Valley	1944 -	C of E,St.Paul
05379500	Trempealeau River - Dodge	1914 - 19, 1934	C of E,St.Paul,DNR
05380806	Black River - Medford	1985 -	City of Medford
05381000	Black River - Neillsville	1905 - 09, 1914 -	DNR
05382000	Black River - Galesville	1932 -	C of E, St. Paul, DNR
05391000	Wisconsin River - Lake Tomahawk	1936 -	DNR
05393500	Spirit River - Spirit Falls	1942 -	DNR
05394500	Prairie River - Merrill	1914 - 31, 1939 -	DNR
05395000	Wisconsin River - Merrill	1903 -	DNR
05397500	Eau Claire River - Kelly	1914 - 27, 1939 -	DNR
05398000	Wisconsin River - Rothschild	1945 -	DNR
05399500	Big Eau Pleine River - Stratford	1914 - 26, 1937 -	DNR
05400650	Little Plover River - Plover	1959 -	DNR
05400800	Wisconsin River - Wisconsin Rapids	1914 - 50, 1958 -	FERC
05402000	Yellow River - Babcock	1944 -	DNR
05403500	Lemonweir River - New Lisbon	1944 -	DNR
05404000	Wisconsin River - Wisconsin Dells	1935 -	DNR
05405000	Baraboo River - Baraboo	1914 - 22, 1943 -	Fed.
05406500	Black Earth Creek - Black Earth	1954 -	DNR
05407000	Wisconsin River - Muscoda	1903 -04, 1914 -	C of E,St.Paul, DNR
05408000	Kickapoo River - LaFarge	1939 -	DNR, NWS
05410500	Kickapoo River - Steuben	1933 -	C of E,St. Paul, DNR
05413500	Grant River - Burton	1935 -	C of E, R. Island, DNR
05414000	Platte River - Rockville	1935 -	C of E,R. Island, DNR
05415000	Galena River - Buncombe	1939 -	City of Galena
05423500	S. Br. Rock River - Waupun	1948 - 69, 1986	City of Waupun

SURFACE-WATER GAGING STATIONS EXPECTED TO BE OPERATED IN 1987 FY--CONTINUED

Station no.	Name and location	Period of Record (water year)	Cooperator
05425500	Rock River - Watertown	1931 - 70, 1977 -	C of E, R. Island, DNR
0545912	Beaverdam River - Beaver Dam	1984 -	City of Beaver Dam
05426000	Crawfish River - Milford	1931 -	C of E, R. Island, DNR
05426031	Rock River - Jefferson	1978 -	C of E, R. Island, DNR
05426250	Bark River - Rome	1980 -	SEWRPC
05427570	Rock River - Indianford	1975 -	DNR
05427948	Pheasant Branch - Middleton	1974 -	DCRPC
05427965	Spring Harbor Storm Sewer - Madison	1976 -	DCRPC
05429500	Yahara River - McFarland	1930 -	DNR, DCDPW
05430095	Badfish Creek - Stoughton	1986	MMSD
05430150	Badfish Creek - Cooksville	1977 -	MMSD
05430175	Yahara River - Fulton	1977	MMSD
05430500	Rock River - Afton	1914 -	DNR
05431500	Turtle Creek - Clinton	1939 -	C of E, R. Island
05432500	Pecatonica River - Darlington	1939 -	C of E, R. Island
05433000	E. Br. Pecatonica River - Blanchardville	1939 -	C of E, R. Island
05434500	Pecatonica River - Martintown	1940 -	C of E, R. Island
05436500	Sugar River - Brodhead	1914 -	DNR
05543830	Fox River - Waukesha	1963 -	SEWRPC
05544200	Mukwonago River - Mukwonago	1973 -	SEWRPC
05546500	Fox River - Wilmot	1940 -	C of E, Chicago, and Il. DOT
	LAKES		
04082500	Lake Winnebago - Oshkosh	1882 -	C of E, Detroit
04084255	Lake Winnebago - Stockbridge	1983 -	C of E, Detroit
05428000	Lake Mendota - Madison	1903, 1916 -	DCDPW
05429000	Lake Monona - Madison	1915 -	DCDPW

DNR -- Department of Natural Resources
C of E,Chicago -- Corps of Engineers, Chicago, Illinois
C of E, Detroit -- Corps of Engineers, Detroit, Michigan
C of E,R.Island -- Corps of Engineers, Rock Island, Illinois
C of E,St. Paul -- Corps of Engineers, St. Paul, Minnesota
SEWRPC -- Southeastern Wisconsin Regional Planning Commission
Fed. -- USGS Federal Program
FERC -- Federal Energy Regulatory Commission Licensees
MMSD -- Madison Metropolitan Sewerage District
DCRPC -- Dane County Regional Planning Commission
DCDPW -- Dane County Department of Public Works
Il.DOT -- Illinois Department of Transportation

1986 STREAMFLOW AND LAKE-LEVEL STATIONS

DATA FILES FOR WISCONSIN WELL RECORDS, WI 00201

COOPERATOR: Wisconsin Geological and Natural History Survey

LOCATION: Statewide

PROJECT CHIEF AND DATA BASE ADMINISTRATOR: William G. Batten

PERIOD OF PROJECT: March 1981-continuing

OBJECTIVE: The objective of this project is to create and maintain a computerized data base of well records including well location, well construction, geologic, and water-level information. The data base will provide a central repository of valuable records available from State and Federal agencies. These data can then be used to generate hydrologic and geologic maps, tables, and graphs.

APPROACH: The National Ground-Water Site Inventory (GWSI) data base management system will be used to store well records. Two prompt programs that automatically set required spacing and length of components, and check syntax, are used to enter data into the data base on the District PRIME computer. The programs that enter data into the PRIME data base also create formatted files that are then used to update the national data base on the U.S. Geological Survey AMDAHL computer in Reston, Va.

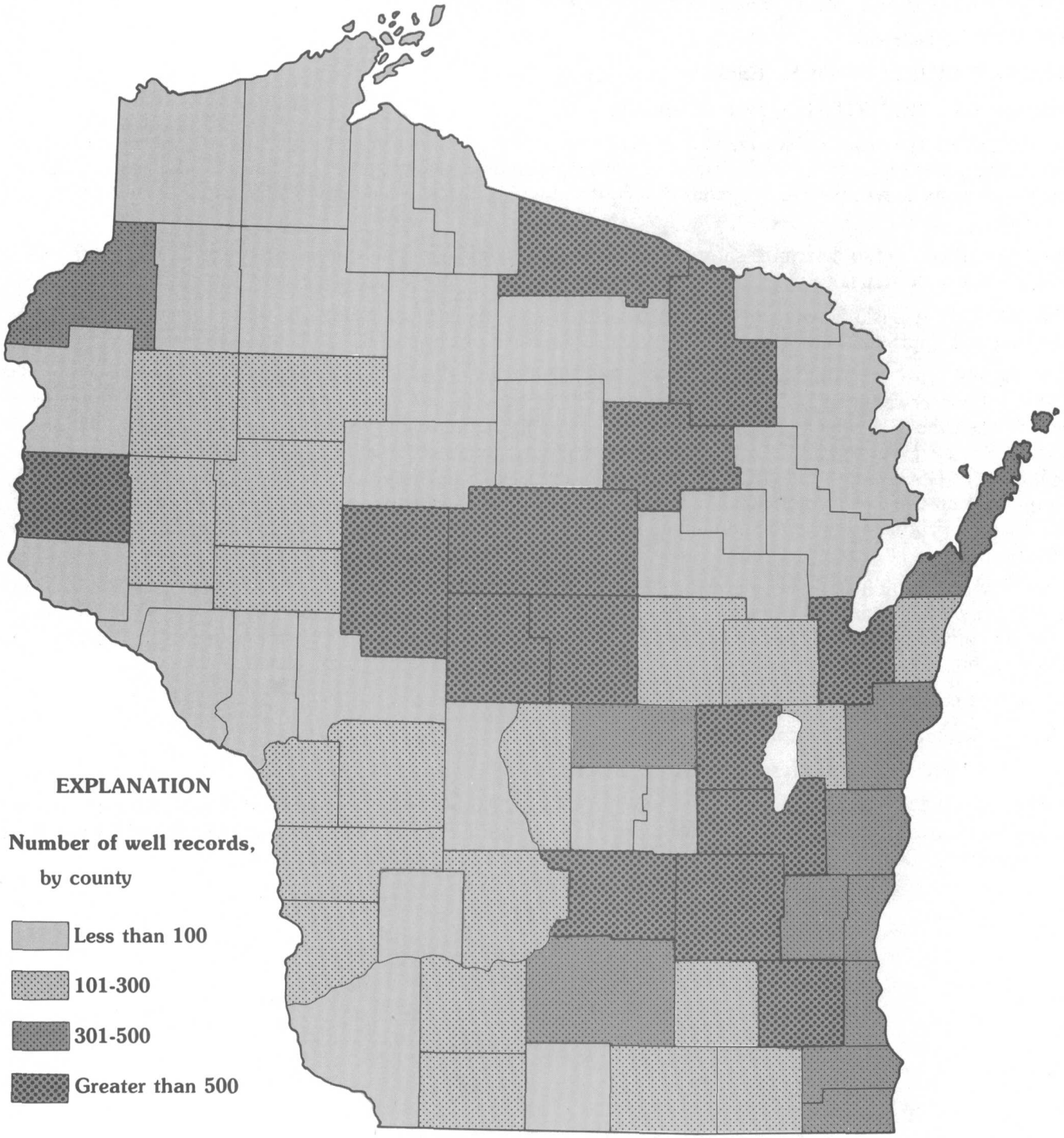
A user-friendly retrieval/tabling program is available to retrieve, interactively or in batch, data files from the PRIME. These files can then be printed in table format or can be used as input to programs for statistical analysis or programs that produce maps at various scales.

PROGRESS (March 1981 to March 1986): Site records were continually added to the GWSI data base on the Reston AMDAHL since March 1981. These data were for wells in ongoing project areas, new WG&NHS logs, and for wells in completed project areas that had not previously been entered. The data base and input/retrieval programs were downloaded to the District PRIME computer in July 1985. Since then, District personnel have spent much time learning to use the new data base and identifying problems in the new system. Some minor problems in both input and retrieval procedures have been identified. Some of these problems have been corrected and others should be corrected in the near future. Interactive retrieval programs are currently being used by authorized staff of the USGS and WG&NHS. These programs are user-friendly so that data retrieval is possible for anyone. Well data can now be used efficiently for information requests and daily project work. The data-base administrator is available to answer questions regarding retrieval procedures.

The total number of sites in the District data base is now 19,782. This is an increase of 193 wells since March 1985.

PLANS (April 1986 to June 1986): The immediate goal is to identify and correct all problems with the new system.

PLANS (July 1986 to June 1987): Data from ongoing projects will continue to be entered into the data base as dictated by project and cooperator activities. Data will be retrieved when requested by District and cooperator personnel.



1986 GROUND-WATER SITE INVENTORY (GWSI)

COLLECTION OF BASIC RECORDS--GROUND WATER, WI 00202

COOPERATOR: Wisconsin Geological and Natural History Survey

LOCATION: Statewide

PROJECT CHIEF: Robert M. Erickson

PERIOD OF PROJECT: July 1946-Continuing

OBJECTIVE: The project objective is to maintain records of ground-water-level fluctuations from a network of observation wells representative of Wisconsin's principal aquifers. A subnetwork of key wells is included in this network. Key wells will have long periods of record and will be measured weekly or be equipped with continuous recorders.

The data will be used to determine short-term changes and long-range trends in ground-water levels, and to relate these changes and trends to natural or man-induced changes in storage in the ground-water reservoirs.

APPROACH: A basic network of about 226 wells is now being maintained. The network will be constantly modified and improved to provide the best possible coverage of our ground-water resource.

PROGRESS (July 1946 to March 31, 1986): Periodic measurements of ground-water levels began on June 15, 1934, on 13 observation wells. The number grew to 23 wells by 1937. In 1946 observation wells began to increase rapidly when the U.S. Geological Survey (USGS), in cooperation with the Wisconsin Geological and Natural History Survey (WG&NHS) initiated a Statewide ground-water observation well network. In April 1980 a committee of USGS and WG&NHS personnel was formed to evaluate the well network and to recommend how it might be improved. A memorandum report on the history of the network and the progress of the committee was submitted in February 1982. The committee's plan was approved and work began to set up the recommended network.

Three new observation wells were established during 1985. A continuous recorder was installed on one well in Rusk County. As of March 1986, 60 of the proposed 63 key wells are being monitored. Ninety-one county resource agents and private individuals have been trained as local observers for measuring ground-water levels. Data for the annual report, "Water Resources Data for Wisconsin, Water Year 1985", is completed.

The current network:

Recording observation wells - - 27

Nonrecording observation wells - - 199

PLANS (April 1, 1986-June 30, 1986): We will continue field location of recommended wells for inclusion in the key well network and will hire local observers. We will continue contacting county resource agents for possible local observers. Quality-assurance review will be made of the work of local observers.

1986 GROUND-WATER OBSERVATION WELLS

COLLECTION OF BASIC RECORDS--WATER QUALITY, WI 003

COOPERATOR: Federal Program, Dane County Regional Planning Commission

LOCATION: Statewide

PROJECT CHIEF: Phil A. Kammerer

PERIOD OF PROJECT: July 1964-Continuing

OBJECTIVE: The Federal program consists of the National Stream Quality Accounting Network (NASQAN) and the Hydrologic Benchmark Network (HBMN). The objectives of the NASQAN program are to: (1) account for the quantity and quality of water moving within and from the United States, (2) depict areal water-quality variability, and (3) detect changes in stream quality with time. The objective of the HBMN program is to monitor hydrologic characteristics at sites that are relatively unaffected by man's activities and will remain unaffected for the foreseeable future. The objective of the Dane County Regional Planning Commission (DCRPC)--U.S. Geological Survey cooperative program is to monitor water quality in selected urban streams in Dane County.

APPROACH: Chemical, bacteriological, and physical water-quality data will be systematically collected at fixed time intervals and stations for NASQAN.

Data, similar to that for the NASQAN program, will be collected for HBMN.

For the DCRPC--USGS program, data will be collected to evaluate stream - channel stabilization measures and sediment input to Lake Mendota.

PROGRESS (through March 1986): Water-quality records collected for this project include monitoring at NASQAN stations (beginning in 1974), the HBMN station (beginning in 1964), and other shorter term ground-water and surface- water quality monitoring, such as the present DCRPC program. Under the NASQAN program concentration data for fecal coliform and streptococci bacteria, dissolved oxygen, nutrients, common ions, trace elements, and suspended sediment, and measurements of water temperature, specific conductance, and pH are collected bimonthly at stations on the Nemadji, Bad, Menominee, Chippewa, Black, and Wisconsin Rivers; and quarterly on the Fox, Manitowoc, Milwaukee, and St. Croix Rivers. Radiochemical data are collected semiannually on the Chippewa River. Under the HBMN program, data are collected quarterly at a station on the Popple River. Water samples for laboratory analysis were collected during periods of runoff from precipitation and snowmelt at the two stations for the DCRPC-USGS program. Automatic, stage-activated samplers are used to collect water-sediment samples for analyses of nutrient and suspended-sediment concentrations from Pheasant Branch Creek and suspended-sediment concentrations from the Spring Harbor storm sewer. All USGS ground- and surface-water-quality data collected during the 1985 water year were processed for publication in the annual data release "Water Resources Data for Wisconsin, Water Year 1985".

PLANS (April 1, 1986-continuing):

The USGS is undertaking a nationwide review of the NASQAN program in 1986. This review is expected to result in a change of emphasis in the program and a net reduction, nationally, in the number of stations in the network. The original accounting objectives of the program will be retained only for a reduced number of stations that account for the quality of water leaving the continent or entering the Great Lakes. Six of Wisconsin's 10 NASQAN stations are on tributaries to the Great Lakes; they are candidates for inclusion in the revised network.

Increased emphasis will be placed on trend detection and transport of dissolved and suspended materials at these remaining accounting stations and any other stations retained in the network. Other stations retained in the network will be selected based on hypotheses concerning the causes of existing or potential trends that the station is intended to identify. This new emphasis will require more intensive sampling (event-related and fixed- frequency sampling) and more chemical analyses of suspended materials, thus increasing per station costs. These increased costs will be met by the reduction in network size rather than by increased funding of the program.

1986 SURFACE-WATER QUALITY STATIONS

COLLECTION OF BASIC RECORDS--SEDIMENT, WI 004

COOPERATORS: U.S. Army Corps of Engineers; Dane County Regional Planning Commission

LOCATION: Statewide

PROJECT CHIEF: William J. Rose

PERIOD OF PROJECT: March 1968-Continuing

OBJECTIVE: This project will provide sediment data for use in specific planning and action programs and will develop a data base for determining sediment discharge and yield trends. Streams will be characterized according to range of concentration and particle size of suspended sediment.

APPROACH: Sediment-monitoring stations will be operated at selected stream sites areally distributed throughout the State, or located at sites of specific interest to cooperating agencies.

Extent of monitoring at a given site will depend on the characteristics of the basin and the needs of the cooperating agency. Some sites will be sampled manually at infrequent intervals; other sites, where flow responds rapidly to precipitation, will be sampled by automatic samplers.

At sites where bedload or unmeasured sediment discharge may be a significant part of the total sediment discharge, suspended- and bed-sediment particle size will be determined from samples collected concurrently with hydraulic data. These data will be used to estimate total sediment discharge using one of several techniques such as the modified Einstein procedure.

PROGRESS (March 1968 through March 31, 1986): Sediment data have been collected at more than 200 stream sites in Wisconsin since 1968. The sampling intensity and length of sampling period varies considerably from site to site. At some sites only a few samples a year were collected at irregular intervals for concentration analysis; at other sites hundreds of samples per year were collected with stage-activated automatic samplers. Suspended and bed material particle-size data are available for many of the sites. Except for data collected as part of the National Stream Quality Accounting Network program, data collection at most sites has been of relatively short (less than 4 years) duration. Most sediment data collection has been in the southern one-third of the State and associated with local special problem studies except for about a 5-year period in the early 1970's when there was a Statewide network of sediment monitoring stations. All data have been published annually in the data report, "Water Resources Data for Wisconsin".

The 1986 monitoring program is as follows:

CORPS OF ENGINEERS--Suspended sediment was sampled at the Sugar River near Brodhead and the Grant River at Burton. Monthly and selected storm loads are being determined from these data.

USGS HYDROLOGIC INSTRUMENTATION FACILIY (HIF)--The Wisconsin District continued field testing of the "Dynatrol", a device that automatically monitors suspended-sediment concentration. The dynatrol's performance at Pheasant Branch at Century Avenue at Middleton was evaluated during several storm-runoff events. Many refinements were incorporated in the unit, resulting in a much improved performance.

DANE COUNTY--Intermittent storm-runoff samples were collected at the Spring Harbor Storm Sewer at Madison and at Pheasant Branch Creek at Middleton.

Progress was made at analyzing and interpreting 1975-83 sediment data that were collected at the Black River near Galesville; Chippewa River near Caryville, at Durand, and near Pepin. A preliminary report on sediment transport at the Chippewa River near Pepin was submitted to the Corps of Engineers.

PLANS (April 1 to June 30, 1986):

CORPS OF ENGINEERS--Operation of the Grant River monitoring stations will continue. The monitoring station on the Sugar River near Brodhead will be discontinued after September 1986. Data collected at the Black River near Galesville; Chippewa River near Caryville, at Durand, and near Pepin; and the Wisconsin River at Muscoda from 1975-83 will be further analyzed, interpreted and summarized in a report.

PLANS (April to December 1986):

DANE COUNTY--Continue the collection of suspended-sediment concentration data as scheduled. Daily sediment levels will be computed for Pheasant Branch Creek at Middleton.

PLANS (July 1, 1986 to June 30, 1987): The Corps of Engineers plans to continue funding the Grant River sediment-monitoring stations. Because very little information is available on sediment trends in Wisconsin, cooperating agencies will be encouraged to fund all or part of a network of long-term sediment-monitoring stations.

1986 STREAM-SEDIMENT STATIONS

FEMA FLOOD-INSURANCE STUDY, WI 006

COOPERATOR: Federal Emergency Management Agency

LOCATION: Statewide

PROJECT CHIEF: Peter E. Hughes

PERIOD OF PROJECT: March 1984 to June 1987

OBJECTIVE: Hydrologic and hydraulic analyses will be performed in order to complete flood-insurance studies at communities selected by FEMA.

APPROACH: Flood-discharge frequency relationships will be determined from local historical information, gaging station records, or other applicable information. Water-surface profiles will be produced by using step-backwater models or by other acceptable methods and the results will be published in reports prepared according to FEMA specifications.

PROGRESS (April 1984 through March 31, 1986): Eighty-eight cities, villages, and counties were evaluated to determine if the existing flood potential warranted a limited-detail flood-insurance study. FEMA selected 51 communities for study by the U.S. Geological Survey from July 1985 through June 1987. Work on 27 of these communities has been completed and the profiles, maps, and reports are undergoing office review.

PLANS (April 1, 1986 to June 1987): The present schedule requires completion of all field surveys by December 1986, and final hydrology and hydraulic analyses and report writing to be completed by June 1987.

1986 FLOOD-INSURANCE STUDIES

WISCONSIN WATER-USE DATA FILE, WI 007

COOPERATOR: Wisconsin Department of Natural Resources

LOCATION: Statewide

PROJECT CHIEF: James T. Krohelski

PERIOD OF PROJECT: March 1978-Continuing

OBJECTIVE: The purpose of this project is to collect accurate and complete data on Wisconsin's water use, to store data in the State Water-Use Data System (SWUDS) and the National Water-Use Data System (NWUDS), and to prepare periodic reports on water use in the State.

APPROACH: Sources of water-use information will be evaluated. The best available data will be entered into the State Water-Use Data System (SWUDS). Efforts will be made to upgrade the accuracy of water-use data.

PROGRESS (March 1978 to March 1, 1986):

1. All sources of water-use information were evaluated. Data being collected by State agencies suitable for entry into a data base were identified.

2. The State water-use data base (SWUDS) was installed on the USGS PRIME computer. Reformatting programs were written to input historic and current water-use information, that was compiled and stored on magnetic tape by DNR, into SWUDS.

3. These data include private industrial, commercial, and irrigation pumpage for 1978-84.

4. Public-supply water-use data was input to SWUDS. This includes information on location of wells, depth, aquifer, and amount of water pumped for 1979 and 1984.

5. Municipal return-flow data has also been entered into SWUDS for 1979 and 1984.

6. A detailed report "Water Use in Wisconsin, 1979", the first of its kind, summarizing all types of water use in Wisconsin, was published.

7. Water-use data were prepared for the Wisconsin's contribution to the 5-year report "Estimated Use of Water in the United States in 1980".

8. Aquifers from which municipal wells withdraw water were identified, coded, and data entered in the State data base. A report including these data "Public-Supply Pumpage in Wisconsin, by Aquifer" was published.

9. Irrigation pumpage at selected wells was measured and compared with pumpage reported by State growers. This information was used to establish a more accurate estimate of Wisconsin's irrigation water use. The report "Estimated Use of Ground Water for Irrigation" will be published in 1986.

10. Currently we are preparing the Wisconsin portion of the 1985 "Estimated Use of Water in the United States". The report will contain estimates of surface- and ground-water withdrawals, and some return flows for calendar year 1985.

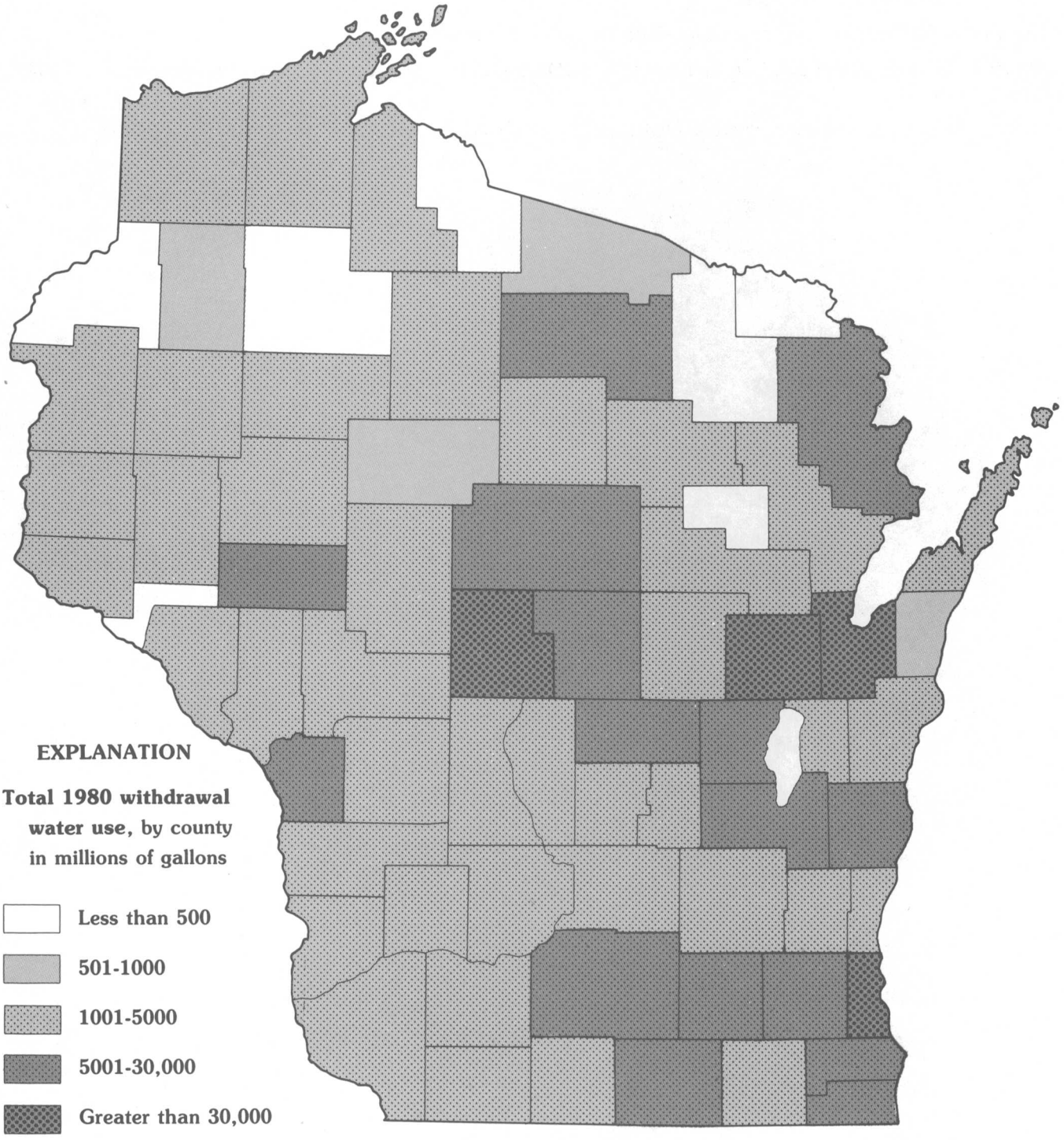
11. We are cooperating with Wisconsin DNR on the Great Lakes water-use project. Meetings have been held with DNR to describe SWUDS and after assistance in compiling water-use data for the Wisconsin part of the Great Lakes basin.

PLANS (April 1 to June 30, 1986):

1. The use of SWUDS will be demonstrated to interested State agencies.

2. Available 1984 water-use data will be input in SWUDS and the publication of Statewide water-use data in 1985 will be prepared.

3. A computer program to ease data retrieval from SWUDS will be written.



1980 WITHDRAWAL WATER USE

LOW FLOW AT OUTFALL SITES, WI 035

COOPERATOR: Wisconsin Department of Natural Resources

LOCATION: Selected sites throughout Wisconsin

PROJECT CHIEF: Barry K. Holmstrom

PERIOD OF PROJECT: April 1972 to June 1987

OBJECTIVE: The purpose of this study is to determine the following low-flow characteristics:

1. The annual 7-day mean low flow (Q7,10) for receiving streams at sewage-treatment plants and industrial plants discharging wastes.

2. The annual 7-day mean low flow (Q7,2) for selected streams.

3. The 10-year low mean monthly flows for October, November, April, and May for sites at fill-and-draw wastewater-treatment lagoons or waste- stabilization ponds.

APPROACH: Low-flow characteristics of selected streams will be determined by: drainage area - discharge relationships, graphical regression methods,regression equations, Log-Pearson Type III frequency analysis, and other statistical and graphical methods.

PROGRESS (April 1972 to March 31, 1986): Preliminary estimates of Q7,2 and Q7,10 were made for approximately 600 streams at sewage-treatment and industrial plants by June 1973. These estimates were based on drainage area- discharge relationships. The second phase confirmed or revised estimates at about 450 of the original sites by July 1974. These estimates were based on graphical-regression analyses relating measured discharge at sites of interest to discharge at nearby gaging stations. The low-flow characteristics at the gaging stations were transferred through the regression lines to determine Q7,2 and Q7,10 values at sites of interest. Additional discharge measurements were made at some of the original sites and at about 116 additional sites for the third phase of the study. A report, "Low-Flow Characteristics of Wisconsin Streams at Sewage-Treatment Plants and Industrial Plants", was published in March 1979 updating low-flow characteristics at about 556 sites. Low-flow characteristics have been provided for additional sites requested by DNR since 1979.

To date this year, low-flow estimates were determined at approximately 24 sites in response to requests for information from DNR.

PLANS (April 1 to June 30, 1986): Low-flow characteristics at approximately 8 sites will be determined in response to DNR requests for information. The low-flow characteristics, in most instances, will be determined by drainage area-discharge relationships or by regression equations.

PLANS (July 1, 1986 to June 30, 1987): Low-flow characteristics at approximately 25 sites will be determined in response to DNR requests for information. The low-flow characteristics, in most instances, will be determined by drainage area-discharge relationships or by regression equations.

STAGE FLUCTUATIONS OF WISCONSIN LAKES, WI 062

COOPERATOR: Wisconsin Geological and Natural History Survey

LOCATION: Statewide

PROJECT CHIEF: Leo B. House

PERIOD OF PROJECT: October 1979 to September 1986

OBJECTIVE: The objectives of this study are to summarize and analyze stage fluctuations of Wisconsin lakes, and to develop methods of estimating the average annual stage fluctuation of ungaged lakes.

APPROACH: Wisconsin lakes will be classified according to hydrographic and topographic scheme. These lake classes will be analyzed statistically by groups to determine fluctuation characteristics. Regression analysis will be used to determine equations to estimate the annual average lake-stage fluctuation according to lake class and geographic zone within the State.

PROGRESS (October 1979 to March 1986): Stage records for 83 Wisconsin lakes were analyzed for maximum, minimum, and average annual stage fluctuations. The mean average lake stage was determined for each lake, along with a probability distribution of lake stage values where sufficient data existed. Lakes were classified as either Ground-Water Flow-Through, Surface-Water Drainage, or Surface-Water Flow-Through; based on a hydrologic-topographic scheme. Separate statistical analysis was performed on data for each lake class to determine characteristic stage fluctuations by lake class.

Stage-frequency analysis was performed for 32 lakes that have long-term records. The analysis results include the annual stage fluctuations for the 2-, 5-, 10-, 20-, 50-, and 100-year recurrence intervals.

Equations were developed to estimate the average annual stage fluctuation at ungaged lakes. These equations were developed using multiple-regression methods that relate stage-fluctuation data to lake and drainage-basin characteristics. Equations were determined for four separate geographic zones within Wisconsin. A report has been published as Wisconsin Geological and Natural History Survey Information Circular No. 49, 1985, titled "Stage Fluctuations of Wisconsin Lakes", by Leo B. House. Interested parties can obtain copies of the report from the WG&NHS.

PLANS: None. The project is completed.

ST. CROIX RIVER NATIONAL SCENIC RIVERWAY, WI 067

COOPERATOR: National Park Service, U.S. Department of the Interior

LOCATION: Northwestern Wisconsin

PROJECT CHIEF: Peter E. Hughes

PERIOD OF PROJECT: April 1975-Continuing

OBJECTIVE: Flood elevations for various frequencies at selected sites within the St. Croix River National Scenic Riverway will be determined. The 100-year flood will be designated on a map. River-water quality will be monitored at selected sites to aid site development and identify possible future changes.

APPROACH: The flood plain will be delineated at specific sites using a slope- conveyance analysis. Estimates of floods of differing magnitude will be based on records from nearby gaging stations or on regional flood-frequency characteristics. The water-quality study will include semiannual general reconnaissance at all the selected sites and periodic monitoring for specific purposes at five sites. Various sediment, chemical, and biologic analyses will be made available.

PROGRESS (April 1975 through March 31, 1986): Flood elevations and delineations for the 29 requested sites are now complete; progress reports were submitted to the National Park Service. A Water-Resources Investigations report titled "Water Quality in the St. Croix National Scenic Riverway" has been approved for publication.

Special-purpose water-quality investigations were made at two sites on the Namekagon River and five sites on the lower St. Croix River. They were undertaken to monitor the possible effects of sewage effluent at the former site and pesticides at the latter site. Water and bottom-material samples on the Namekagon did not show any pesticide contamination above the detection limit.

Water-quality samples were collected during August 1985 at the Namekagon River near Hayward and near Trego, the St. Croix River near Danbury, the Kettle River near Cloverdale, Minn., and the Snake River near Pine City, Minn. Chemical analyses of the samples showed no significant difference from the data published in the above-mentioned water-quality report.

PLANS (April 1, 1986 to June 1987): A continuing program of annual water- quality sampling in the St. Croix National Scenic Riverway will be maintained with the National Park Service. Sampling will occur on an alterating schedule of spring high-flow and low-flow periods. Data will be submitted to the National Park Service in progress reports.

HYDROGEOLOGY AND GROUND-WATER QUALITY OF LANNON-SUSSEX AREA, NORTHEASTERN WAUKESHA COUNTY, WISCONSIN, WI 079

COOPERATOR: Wisconsin Geological and Natural History Survey and Wisconsin Department of Natural Resources

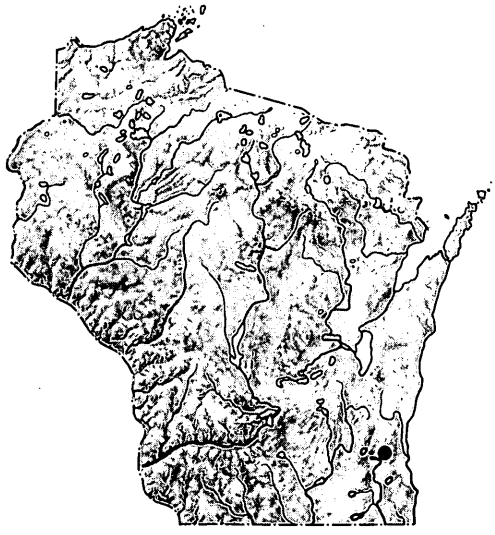
LOCATION: Northeastern Waukesha County, southeastern Wisconsin

PROJECT CHIEF: Ralph D. Cotter

PERIOD OF PROJECT: July 1976 to June 1980

OBJECTIVE: The objectives of this project are to describe hydrogeology and water quality in the Lannon-Sussex area and to determine the direction of movement of ground water with special attention to the effect of septic-tank systems on water quality.

APPROACH: The study uses knowledge gained in the Door County study ("Geology and Ground Water in Door County, Wisconsin, with Emphasis on Contamination Potential in the Silurian Dolomite") and the eastern Wisconsin dolomite study ("Contamination Potential in the Silurian Dolomite Aquifer, Eastern Wisconsin"). Water-table maps will be constructed to determine shallow ground-water movement.



In this small area of individual wells and individual septic systems, water levels will be measured and samples taken from domestic wells to seek a relationship between direction of ground-water flow and water quality.

PROGRESS (July 1976 to October 1984): Three hundred and forty four wells were scheduled for monitoring in the 40-square-mile project area; about 250 of these are in the 4-square-mile subproject area. Well completion depth and well logs are used to map confining layers. Water quality was determined for 181 of these wells. Nine wells were monitored monthly for water level, specific conductance, and chloride concentration. These data were analyzed and a report titled "Hydrogeology and Ground-Water Quality of Lannon-Sussex Area, Northeastern Waukesha County, Wisconsin" was written.

PROGRESS (through March 31, 1986): The report has been approved by the Director and released as a Water-Resources Investigations Report.

PLANS: None. Project completed.

CHANNEL MORPHOLOGY AND SEDIMENTATION IN PHEASANT BRANCH NEAR MIDDLETON, WI 084

COOPERATORS: Wisconsin Geological and Natural History Survey City of Middleton City of Madison Dane County Regional Planning Commission U.S. Army Corps of Engineers

LOCATION: Near Madison, Wisconsin

PROJECT CHIEF: William R. Krug

PERIOD OF PROJECT: December 1976 to June 1982, January 1984 to December 1988

OBJECTIVE: The objectives of this project are to:

1. Document and evaluate sediment transport, streamflow characteristics, and stream-channel morphology.

2. Relate these hydrologic characteristics to land-use practices.

3. Evaluate the effect that future changes in land use will have on Pheasant Branch.

4. Estimate flood peaks for present and fully urbanized conditions at 18 subbasins in the watershed.

5. Monitor changes in channel morphology in areas affected by urbanization and channel modifications.

6. Measure peak flood discharges in tributary channels affected by urbanization.

APPROACH: Streamflow, stream-channel cross-section changes, and sediment load were monitored at five gaging stations through 1982. Channel geometry and sediment transport will be related to discharge to estimate how present and projected land use affect these processes. Since 1984, stream-channel cross-section changes have been monitored in the reach through the urbanized section of Middleton, and in the reach of the South Fork draining the developing area on Madison's west side. Three crest-stage gages will be maintained to monitor flood peaks in the same channels. A rainfall-runoff computer model was used to determine the effects that actual and projected land use have on flood flows. The model was used to estimate flood peaks at 18 subbasins in the watershed for present and fully developed conditions for the 2-, 5-, 10-, and 25-year recurrence interval.

PROGRESS (December 1976 to March 1985): From 1977 through 1982 stream- channel cross sections were resurveyed annually. In 1984, additional cross sections were added in an urbanizing reach farther upstream. All of the cross sections have been resurveyed annually. A preliminary analysis of the data collected in 1977 was presented in "Channel Erosion and Sediment Transport in Pheasant Branch Basin near Middleton, Wisconsin--A Preliminary Report" by R. S. Grant and Gerald Goddard. Analysis of the survey data through 1982 is presented in the final report of the first phase of the project.

Streamflow and sediment data were collected from 1977 through 1982 at five sites on Pheasant Branch. These data were used to calibrate and verify a rainfall-runoff model of the basin. This model was used to predict the increases in flood peaks that would result from urbanization of the basin.

In 1984 three crest-stage gages were installed on the South Fork to monitor flood peaks from the area subject to the most urban development.

As of March 31, 1986, the final report of the first phase, December 1976 to June 1982, of the study is being printed. Hydrographs for the approximate 2-, 5-, 10-, and 25-year floods for both present and fully developed conditions in each of the 18 subbasins were included in this report.

The crest-stage gages have been in operation for 2 years.

PLANS (April to June 1986): The cross sections will be resurveyed before vegetation hinders surveying. Streamflow measurements will be made at the crest-stage gage sites. Peak flood discharges will be determined at the crest-stage gage sites.

PLANS (July 1986 to December 1988): The cross sections will be resurveyed annually and peak flood discharges will be determined at the crest-stage gage sites. A final report summarizing the observed channel changes and the recorded flood peaks will be published at the end of the study.

NONPOINT-SOURCE POLLUTION IN THE RIVER, COUNTY, WISCONSIN, WI 090

COOPERATOR: Green Lake Sanitary District

LOCATION: Green Lake County, south-central Wisconsin

PROJECT CHIEF: Stephen J. Field

PERIOD OF PROJECT: October 1977 to December 1986

OBJECTIVE: The objective of this project is to define the water quality in relation to streamflow in stream basins where nonpoint-source pollution exists.

APPROACH: Streamflow will be monitored continuously. Water-sediment samples will be collected by automatic samplers during storm runoff for determination of suspended-sediment and nutrient concentrations. Daily, monthly, and annual mean suspended-sediment and nutrient loads will be computed.

PROGRESS (October 1977 to March 31, 1986): During the initial phases of this project, several basins were studied in cooperation with the Wisconsin Department of Natural Resources. Streamflow, specific conductance, and water temperature were monitored continuously and precipitation and dissolved-oxygen data were collected intermittently.

Studies were completed for Steiner Branch, Onion River, Elk Creek, and Galena Rivers. The published report are:

"Water Quality Assessment of Steiner Branch Basin, Lafayette County, Wisconsin"

"An Assessment of Nonpoint-Source Discharges, Streamflow, and Water Quality in Onion River, Wisconsin"

"Nonpoint-Source Discharges and Water Quality of the Elk Creek Basin, West-Central Wisconsin

"Relations Between Precipitation, Streamflow, and Water Quality in the Galena River Basin, Wisconsin" (in press)

Work with the Green Lake Sanitary District includes monitoring at White Creek. During the 1982 water year, streamflow ranged from a minimum of 0.6 to 220 cubic feet per second; in the 1983 water year, the range was from 0.4 to 222 cubic feet per second., and in the 1984 water year the range was from 1.5 to 29 cubic feet per second. The suspended sediment and phosphorus yields for the 1982 water year were 983 tons per square mile and 710 pounds per square mile; for the 1983 water year they were 316 tons per square mile and 458 pounds per square mile; and in the 1984 water year they were 503 tons per square mile and 356 pounds per square mile. The 1985 water year loads are being computed.

PLANS (April 1 to June 30, 1986): The U.S. Geological Survey will publish the Galena River report. Data for the 1985 water year will be compiled for White Creek and published in 1985 "Water Resources Data for Wisconsin". Continue monitoring at White Creek as scheduled.

PLANS (July 1, 1986 to June 30, 1987): Water-sediment samples from storm runoff for determining suspended-sediment and nutrient concentrations will be collected at Green Lake. Sediment and nutrient loads will be computed and transmitted to the cooperator.

GROUND-WATER-QUALITY APPRAISAL OF WISCONSIN'S AQUIFERS, WI 093

COOPERATOR:

Wisconsin Department of Natural Resources

LOCATION: Statewide

PROJECT CHIEF: Phil A. Kammerer

PERIOD OF PROJECT: June 1978 to September 1985

OBJECTIVE: The objectives of this project are to delineate and evaluate areas with known ground-water-quality problems and to define the quality of Wisconsin's ground water by aquifer and relate the quality to the hydrogeologic environment.

APPROACH: The objectives of the project will be met through two complementary and concurrent studies:

STUDY 1 (conducted by DNR)--DNR will describe the water resources of the State, summarize water-quality problems, and recommend a ground-water management policy.

STUDY 2 (conducted by USGS)--USGS will provide a study of the quality of water from Wisconsin's principal aquifers and present it in two reports.

PROGRESS (June 1989 through March 1986): Work in Study 2 was divided into two phases. During the first phase, profiles showing geology, direction of ground-water movement, and dissolved-solids concentrations in ground water were constructed along 15 cross sections traversing the State to show general hydrogeologic and water-quality relationships between aquifers. The report describing the results of this phase of the project is in review.

During the second phase of the study, ground-water quality and movement in shallow aquifers were investigated. The shallow aquifer, a composite of unconsolidated materials and shallow underlying bedrock, is the aquifer most commonly utilized for water supplies and is the aquifer most susceptible to contamination. A report describing ground-water quality and movement in the shallow aquifer is in the final stages of preparation.

PLANS (April 1, 1986-June 30, 1986): Complete preparation and review of reports and request approval for publication.

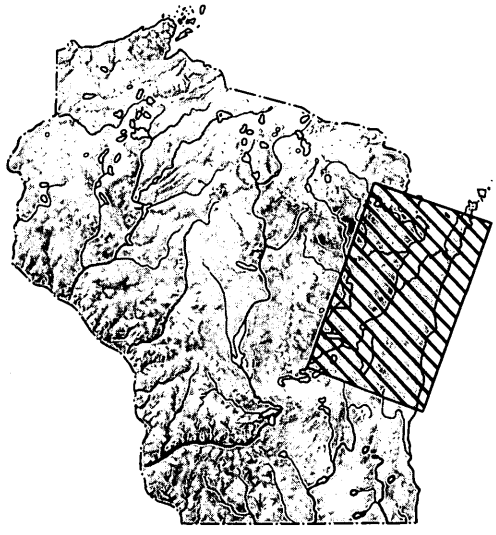
HYDROLOGY OF THE NORTHERN MIDWEST REGIONAL AQUIFER SYSTEM IN WISCONSIN, WI 097

COOPERATOR: Regional Aquifer System Analysis Program, WRD, U.S. Geological Survey

LOCATION: Statewide

PROJECT CHIEF: Patrick J. Emmons

PERIOD OF PROJECT: October 1978 to October 1982



OBJECTIVE: The findings of this study will improve our understanding of the aquifers in the Paleozoic strata in Wisconsin by (1) providing a better definition of the hydrologic, stratigraphic, and water-quality characteristics of the aquifers, and (2) simulation of the aquifer system by development of a subregional digital model of the Lake Winnebago-Green Bay area. The data generated during the study will also be used by the Northern Midwest Regional Aquifer System Analysis (RASA) study group to describe the regional hydrology of the Cambrian-Ordovician aquifer system.

APPROACH: All existing hydrologic and geologic data for the aquifers were collated. Preliminary stratigraphic and hydrologic maps were prepared for the RASA study group to use to evaluate the regional aquifer system and for development of digital-computer simulation models. Where data were insufficient, field work included checking well locations, water-level measurements, water use, pumping, water-quality sampling, aquifer testing using inflatable packers, borehole geophysical logging, and surface geophysical surveys. A ground-water flow model was prepared to simulate flow in northeast Wisconsin.

PROGRESS (October 1978 to March 31, 1986): Water table, potentiometric, and geologic maps were prepared from existing data. Three deep test wells were drilled and tested in southwestern Wisconsin. A three-dimensional ground- water flow model of the lower Fox River valley area was developed and the report "An Evaluation of the Bedrock Aquifer System in Northeastern Wisconsin" documenting the model, was prepared. The report data are being used by the RASA study group to improve the understanding of this regional aquifer system, to refine the regional computer simulation models, and to prepare comprehensive reports. The ground-water model report was approved by the Director in August 1985. Preparation of final illustrations is nearly complete.

PLANS (April 1 to June 30, 1986): Publish the report.

WATER-RESOURCES APPRAISAL OF APOSTLE ISLANDS NATIONAL LAKESHORE, WI 100

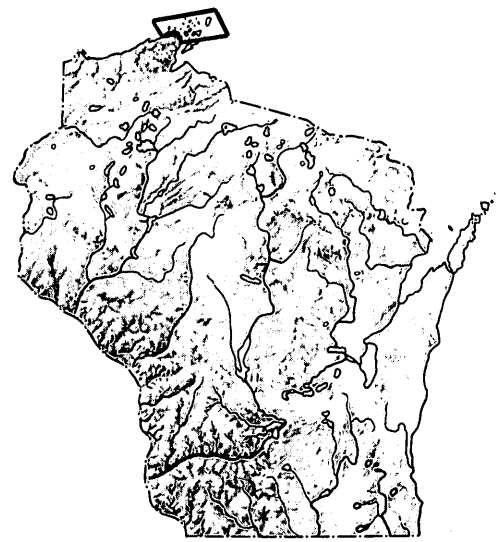
COOPERATOR: National Park Service, U.S. Department of the Interior

LOCATION: Ashland and Bayfield Counties, northwest Wisconsin

PROJECT CHIEF: William J. Rose

PERIOD OF PROJECT: March 1979 to September 1985

OBJECTIVE: The objectives of the project are to appraise the water resources of the Apostle Islands National Lakeshore and to provide information to assist the National Park Service in managing them.



APPROACH: Ground-water availability and quality will be evaluated by analyzing available data and new data will be obtained by testing and sampling new wells. Streamflow and water-quality characteristics will be determined by detailed monitoring at one site, intermittent monitoring at many sites, and correlation and regionalization techniques. Lake Superior circulation patterns will be evaluated by analyzing available data and Landsat imagery. The character of Lake Superior water quality, sediment, and benthos will be determined by evaluating data from a network of deep- and shallow-water sampling stations. A final report will be prepared at the end of the project.

PROGRESS (March 1979 to March 31, 1986): Baseline data needed to characterize the flow and water quality of selected mainland and island streams were collected. Four "deep-water" monitoring sites in Lake Superior were established and sampled to characterize the water, sediment chemistry, and the benthic macroinvertebrates. Nine sites were established and sampled in each of two shallow-water, heavy-use areas of Lake Superior. Water, sediment, and benthic organism samples from these sites were sampled and analyzed. Two lagoons, one on Michigan Island and the other on Outer Island, were studied; measurements were made to determine their physical, hydrologic, and chemical characteristics. About a dozen water-supply wells were logged during their construction and subsequently sampled for chemical analysis. Data collected during the study have been summarized and interpreted. A draft copy of a final summary report is in preparation.

PLANS (April 1 to June 30, 1986): The final report will be completed.

IMPROVING STREAMFLOW ESTIMATES IN WISCONSIN THROUGH THE USE OF LANDSAT, WI 105

COOPERATOR: Land Information and Analysis Office, U.S. Geological Survey

LOCATION: Southwest Wisconsin and Lake Michigan basin

PROJECT CHIEF: Gregory J. Allord

PERIOD OF PROJECT: October 1979 through September 1980

OBJECTIVE: To test the extent of possible improvement in estimating various streamflow characteristics. Regression analyses include drainage- basin characteristics that have been quantified by computer processing of Landsat data.

APPROACH: Landsat scenes covering the central Wisconsin and Lake Michigan basins will be purchased. The land cover will be determined by the use of computer classification and digital-training sets. Subbasin boundaries will be digitized and converted to Landsat coordinates. Basin land-cover percentages will be entered in multiple-regression equations to determine if the standard error of estimate improves for various streamflow characteristics as compared to determining the standard error of estimate from traditional map sources.

PROGRESS (October 1979 to March 31, 1986): Landsat images were classified first at the EROS Data Center in Sioux Falls and later on the University of Wisconsin Univac 1100 series computer using programs developed by the University of Wisconsin Environmental Monitoring Program. Basin boundaries were digitized for subbasins that had long-term streamflow data. Low-flow regressions were done for both the Lower Wisconsin and Lake Michigan basins. Improvements in the standard error of estimate (SE) were achieved for the Lower Wisconsin basin while the SE for the Lake Michigan basin was not improved. The SE for the 100-year flood was improved by 50 percent. A report was written and reviewed by outside colleagues as well as District staff. The report received colleague review and is being prepared for submittal to Region for final approval.

PLANS (April 1 to June 30, 1986): The report will be submitted to Headquarters for final review and approval.

PLANS (July 1, 1986 to June 30, 1987): The report will be published.

MAGNITUDE AND FREQUENCY OF GROUND-WATER-LEVEL FLUCTUATIONS, WI 107

COOPERATOR: Wisconsin Geological and Natural History Survey

LOCATION: Statewide

PROJECT CHIEF: Gary L. Patterson

PERIOD OF PROJECT: May 1980 to June 1983

OBJECTIVE: The objective of the study is to determine the frequency, duration, magnitude, and range of historical ground-water-level fluctuations. These fluctuations will be related to season and precipitation, as well as to other factors that affect levels in each individual well.

APPROACH: Water-level data from 104 observation wells with at least 20 years of record will be analyzed by using statistical methods to assign occurrence frequencies to high /low water levels. Precipitation data from approximately 100 stations will be used to prepare hydrographs, cumulative departure-from- normal plots, and 3-year running mean plots. These will be correlated with ground-water-level hydrographs.

Various statistical methods will be tested for applicability in correlating precipitation with water levels.

PROGRESS (May 1980 through March 31, 1986): Precipitation and water-level data were analyzed by using cumulative departure from normal, 3-year running mean, precipitation and stage-duration analyses, and Pearson Type III frequency analyses.

Physical characteristics of each well were described and, together with numerical data from the statistical analyses, used in multiple-regression analyses to correlate wells of similar character.

A lay reader report, "Ground-Water Level Fluctuations in Wisconsin", describes the fluctuations in 11 wells. It has been approved for publication and given to the cooperator for printing.

A technical report, "Analysis of Water-Level Fluctuations in Wisconsin Wells", covers all of the 104 wells. It has been submitted for Director's approval.

PLANS (April 1, 1986 to June 30, 1986): The technical report will be approved for publication and turned over to the cooperator for printing.

HYDROGEOLOGY OF THE LOWER FOX RIVER VALLEY, WI 108

COOPERATORS: Brown County Planning Commission (BCPC) and Wisconsin Geological and Natural History Survey (WG&NHS)

LOCATION: Brown County and adjacent area, northeastern Wisconsin

PROJECT CHIEF: James T. Krohelski

PERIOD OF PROJECT: January 1980 to December 1982

OBJECTIVE: The objective of this study was to define the availability, use, and quality of ground water in Brown County and to provide a digital ground- water flow model as a tool for predicting aquifer response to pumping.

APPROACH: Several hundred well records will be collected, ground-water levels will be measured, water-use data will be collected, water samples will be collected and analyzed, glacial geology will be mapped, and stream base flow will be measured. These data will be analyzed and an interpretive report written to describe the ground-water hydrology of Brown County. A digital- flow model will be prepared for the Brown County area, to better describe the effects of pumping high-capacity wells.

PROGRESS (January 1980 through March 31, 1986): The geology and hydraulic characteristics of the rocks in Brown County were defined by using drillers' cuttings and logs from 65 deep wells (analyzed by WG&NHS), drillers' logs from 797 wells (inventoried by BCPC), selective formation packer tests, and values found in the literature.

A quasi three-dimensional digital-computer model of three aquifers and two confining beds was developed, calibrated, and verified.

Recharge and recharge areas were estimated using surficial-deposit mapping (WG&NHS), data from five shallow observation wells, and model output. Losing reaches on Duck Creek and the Suamico River were defined with seepage runs.

Water samples from 64 wells and 10 surface-water sites were analyzed to define the chemical character of Brown County waters. Water-use data were collected.

The report "Hydrogeology and Ground-Water Use and Quality, Brown County, Wisconsin" was written, reviewed, and approved for publication as a Wisconsin Geological and Natural History Survey Information Circular.

REGIONAL FLOOD-FREQUENCY STUDY FOR URBAN AND RURAL STREAMS IN WISCONSIN, WI 109

COOPERATOR: Wisconsin Department of Transportation - Highways

LOCATION: Statewide

PROJECT CHIEF: Duane H. Conger

PERIOD OF PROJECT: October 1980 to September 1986

OBJECTIVE: The objectives of this project are to:

1. Develop a method to estimate flood-frequency characteristics for ungaged streams in urban areas of Wisconsin.

2. Refine presently developed flood-frequency relationships so that floods up to a 100-year recurrence interval can be estimated for streams with various drainage area sizes.

APPROACH: This study will include urban and rural basins throughout Wisconsin. Crest-stage gages will be operated at 97 locations for the rural part of the study. The urban part of the study will use streamflow and rainfall data from 25 urban basins to develop the relationship between urbanization and flood dischages. Long-term flood discharges will be determined by the USGS Distributed Routing Rainfall-Runoff Model. Multiple- regression techniques will be used to develop equations that estimate flood discharges at ungaged sites for various degrees of urbanization.

PROGRESS (October 1980 through March 1986): Multiple-regression techniques were used to develop equations for estimating flood frequencies at ungaged urban sites. The flood-frequency equations are based on data from 33 urban gaging stations, including 20 crest-stage gages and 13 rainfall-runoff gaging stations. The USGS Distributed Routing Rainfall-Runoff Model--Version II was used to extend records by synthesis for the 13 rainfall-runoff urban stations. The second phase of the study was started; it includes a special flood- frequency study in the Driftless Area of Wisconsin.

As part of this project Ken Potter and Ellen Baldwin of the University of Wisconsin studied the effect that generalized least squares has on regressions. They also studied the effect of time-area histograms on peaks in the Driftless Area. Unfortunately, neither proved to be significant. The Environmental Remote Sensing Center (ERSC) of the University of Wisconsin are using Landsat satellite imagery to provide up-to-date land-cover information for the entire Wisconsin Driftless Area to assist in the refinement of the flood-frequency models for this region. Work on this phase started on January 1, 1986. About 50 percent of the drainage-basin outlines have been transferred from 15-minute quad sheets to 7 1/2 minute quad sheets and have been digitized.

Annual flood discharges were determined for the 97 crest-stage gage stations. Numerous flood-frequency requests were processed for the Department of Transportation and other agencies.

PLANS (April 1986 to June 1986): A report, "Estimating Magnitude and Frequency of Floods for Wisconsin Urban Streams" will be published. Basin characteristics will be determined for the Driftless Area.

PLANS (July 1986 to July 1989): Data will be collected at 97 crest-stage gages. Landsat imagery will be used to determine basin characteristics in the Driftless Area. Improved regression equations will be developed for the Driftless Area and the entire State.

Flood characteristics for streams in the Driftless Area will be studied in an effort to determine why they differ from those in streams elsewhere in Wisconsin. Areal factor boundaries will be examined in the Marathon County area to delineate if a better agreement between observed and estimated flood peaks can be obtained.

EFFECTS OF ACID PRECIPITATION ON LAKES, WI 110; LONG-TERM EFFECTS OF ACID PRECIPITATION ON LAKES IN NORTHERN WISCONSIN, WI 129

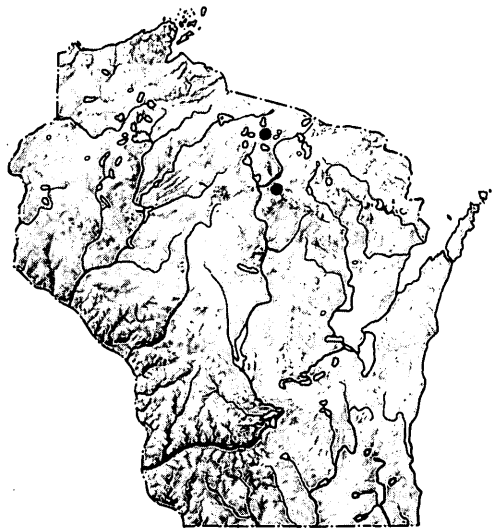
COOPERATORS: Wisconsin Department of Natural Resources (WI 110) WRD, U.S. Geological Survey (WI 129)

LOCATION: Lincoln and Vilas Counties, north-central Wisconsin

PROJECT CHIEF: Dennis A. Wentz

PERIOD OF PROJECT: August 1980-September 1990

OBJECTIVE: Determine hydrologic and chemical budgets for Vandercook Lake and Lake Clara in northern Wisconsin to provide information regarding mechanisms of acid assimilation and long-term changes of acid loadings to these lakes.



APPROACH: Lake inflows from precipitation, overland flow, and ground-water discharge, and lake outflows from evaporation, streamflow, and ground-water recharge will be quantified. Concentrations of major cations and anions, nutrients, and trace elements in selected flow paths will be measured. The lakes will be evaluated for their potential for acidification.

PROGRESS (August 1980 through March 1986): Wisconsin DNR personnel made monthly water-level measurements in 35 piezometers and five surrounding lakes near Vandercook Lake, and in 37 piezometers and three surrounding lakes near Lake Clara. Daily precipitation and pan evaporation were measured by local observers at each site. USGS personnel obtained continuous measurements of lake stage, ground-water levels, and precipitation using recording instrumentation. Air temperature, relative humidity, wind speed, and lake- surface temperature were measured continuously during the open-water period at Lake Clara to allow estimation of evaporation using the mass-transfer technique. Similar data, collected at Vandercook Lake through October 1983 and at Little Rock Lake since April 1984, were used to estimate evaporation at Vandercook Lake. Snowpack on the ice at each site was determined monthly during periods of snow cover. At Lake Clara, intermittent overland flow was monitored using recording instrumentation at one site, and miscellaneous measurements at three additional sites; the intermittent outlet was montitored continuously using a stage recorder. Wisconsin DNR personnel sampled bulk precipitation, lake water, and ground water on a monthly basis at both sites for chemical analysis. At Lake Clara, samples of overland flow and the lake outlet were collected periodically. Approximately 10 percent of the samples were duplicates, collected for quality assurance.

Hydrologic budgets were determined for the 1981 through 1983 water years. Chemical budgets were determined for only the 1982 and 1983 water years, because chemical data were incomplete during the 1981 water year. A draft report describing the results of the study during the 1981 through 1983 water years was written and submitted to the Wisconsin DNR.

PLANS (April 1, 1986 through June 30, 1986): Continue hydrologic and water- quality data collection. Present results to the American Geophysical Union meeting in Baltimore during May.

PLANS (July 1, 1986 through September 30, 1990): Continue hydrologic and water-quality data collection. Prepare monthly hydrologic and chemical budgets for the period beginning October 1983. Prepare a journal article describing results through the 1983 water year. Prepare a report describing hydrologic and chemical budgets for the period 1980-90.

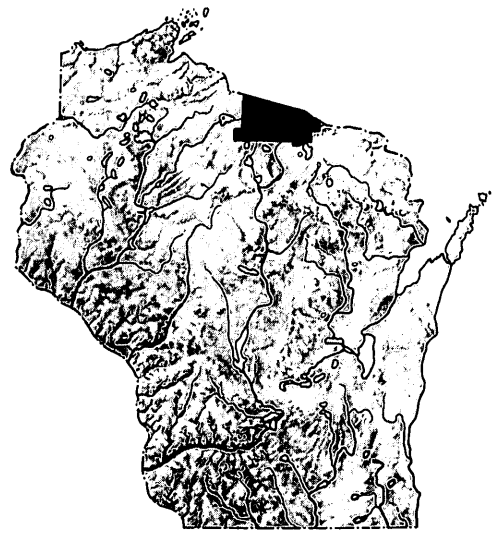
GROUND-WATER RESOURCES AND GEOLOGY OF VILAS COUNTY, WISCONSIN, WI 112

COOPERATORS: Wisconsin Geological and Natural History Survey (WG&NHS) and Vilas County Board of Commissioners

LOCATION: North-central Wisconsin

PROJECT CHIEF: Gary L. Patterson

PERIOD OF PROJECT: January 1981 to December 1983



OBJECTIVE: The objective of the study is to describe the water resources of Vilas County, including ground-water quality, movement, availability, and use; ground-water/surface-water relationships; classification of lakes; and geology.

APPROACH: Well records will be reviewed to verify the accuracy of the infor mation. Selected wells will be field located and water levels measured where possible. This information will then be entered into the GWSI (Ground-Water Site Inventory) data base. Sites where data are lacking will be selected, after data review, for the installation of monitoring wells. Water levels will be measured monthly from a network of wells and slug tests will be performed to determine values of hydrualic conductivity. All water-level data will be entered into GWSI and computer-generated contour maps of water levels will be produced.

Seepage runs will be performed on selected streams to determine the relationship between surface and ground water.

Water samples will be collected from about 60 wells and analyzed for common inorganic chemical constituents. Water from about 30 wells will be analyzed for minor constituents.

Lake data collected and tabulated by the Department of Natural Resources (DNR), and supplemented where necessary by USGS, will be used to classify lakes. If possible, lakes will also be classified by their susceptibility to pollution from acid precipitation.

Ground-water temperature will be measured at various times of the year to determine the feasibility of using ground-water heat pumps as an alternative source of energy. The glacial geology of the county will be mapped by the Wisconsin Geological and Natural History Survey.

PROGRESS (January 1981 through March 31, 1986): About 80 test holes were drilled and 70 of them were converted to test wells. Water levels were measured monthly in these 70 wells until December 1982. Water samples were obtained from 51 wells and analyzed for the common ions and nutrients. Thirty-one of the samples were analyzed for trace metals and dissolved organic carbon. Slug tests were done on 50 wells and four sets of temperature measurements were taken on 70 wells. Lake water-quality data were obtained from the DNR and will be used to assign relative susceptibility to harm from acid deposition. Surface-water altitudes and locations were digitized at about 12,000 points and merged with ground-water data from about 500 wells to produce a water-table contour map. Ten short seismic lines were run to supplement existing data on depth to Precambrian bedrock. Glacial geology was mapped by the WG&NHS. A seepage run was made and streamflow was measured at 40 sites on three streams. Records on 613 wells and borings were entered into computer storage (GWSI). About 150 of these were field located by county personnel. The data were analyzed and the final report partially written.

PLANS (April 1, 1986 to June 30, 1986): The final report will be completed and submitted for review.

PLANS (July 1, 1986 to June 30, 1987): The report will be approved for publication and turned over the the WG&NHS for printing.

A GUIDE TO WISCONSIN'S GROUND-WATER RESOURCES, WI 113

COOPERATOR: Information Transfer Program, WRD, U.S. Geological Survey

LOCATION: Statewide

PROJECT CHIEF: Gregory J. Allord

PERIOD OF PROJECT: March 1981 to September 1983

OBJECTIVE: The objective of this project is to prepare a report on ground- water in Wisconsin. This report will include data needed for planning purposes.

APPROACH: A report will be prepared from existing information and data gathered for numerous State and Federal studies. The report will describe the general aspects of ground-water hydrology as well as Wisconsin's aquifers, water quality, and water use. It will also list additional sources of infor mation and give examples of how the report information can be used to approach ground-water problems. All information will be written in a style that will be understandable by the general public. All material is being prepared in the Sequential Thematic Organization of Publications (STOP) format, which places the text for each topic on a single page and a supporting map or graph on a facing page.

PROGRESS (March 1981 to March 31, 1986): Individual text sections were assigned to appropriate staff members of the U.S. Geological Survey and Wisconsin Geological and Natural History Survey for preparation. Topics were researched and outlines prepared. A storyboard conference was held and the outlines reviewed and revised. The text sections were drafted.

In November 1985, an editorial staff of three was assigned to review the sections and expedite completion of the report.

PLANS (April 1 to June 30, 1986): The report will be completed.

PLANS (July 1, 1986 to June 30, 1987): The report will be reviewed, approved for publication, and printed as a U.S. Geological Survey Water-Supply Paper.

EFFECTS OF ACID PRECIPITATION ON LAKES IN NORTHWESTERN WISCONSIN, WI 116

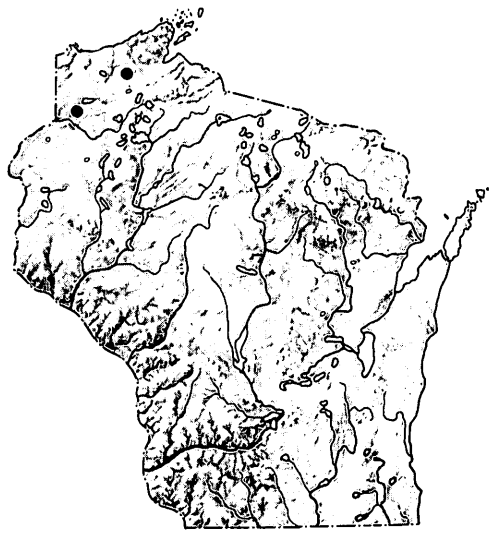
COOPERATORS: Wisconsin Department of Natural Resources

LOCATION: Douglas and Bayfield Counties, northwest Wisconsin

PROJECT CHIEF: Dennis A. Wentz

PERIOD OF PROJECT: July 1981-September 1987

OBJECTIVE: Determine hydrologic and chemical budgets for Round and East Eightmile Lakes in northwestern Wisconsin to provide information regarding mechanisms of acid assimilation in these lakes and to assist modification and calibration of the Integrated Lake Watershed Acidification Study (ILWAS) ecosystem model to this area.



APPROACH: Lake inflows from precipitation and ground-water discharge, and lake outflows from evaporation and ground-water recharge will be quantified. Alkalinity, pH, concentrations of major cations and anions, nutrients, and trace elements (including aluminum, lead, and mercury) in selected flowpaths will be measured. The lakes will be evaluated for their potential for acidification.

PROGRESS (July 1981 through March 1986): During the first phase of the study (ending August 1983), monthly water-level measurements were made in 39 piezometers and seven surrounding lakes near Round Lake and in 46 piezometers and four surrounding lakes near East Eightmile Lake. Daily precipitation and pan evaporation were measured by local observers at each site. Continuous measurements of lake stage, ground-water levels, and precipitation were obtained using recording instrumentation. Air temperature, relative humidity, wind speed, and lake-surface temperature were measured continuously during the open-water period to allow estimation of evaporation using the mass-transfer technique. Snowpack at each site was determined monthly during periods of snow cover. Ground water was sampled on a monthly basis at both sites for chemical analysis. Hydrologic budgets for the first 2 years of the study (September 1981 through August 1983) were constructed for both study lakes. Draft reports covering (1) hydrologic budgets for the two lakes and (2) chemical input-output budgets for the two lakes have been prepared and submitted to the DNR.

The period from September 1983 through August 1984 was a period of reduced funding between the first and second phases of the study. During this interim period, the data-collection effort was reduced in both frequency and in total number of measurements during a given month.

During the second phase of the study (beginning September 1984), 43 additional piezometers were installed upgradient from Round Lake and 30 additional piezometers were installed upgradient from East Eightmile Lake. Thirteen piezometers were installed downgradient from Round Lake and five piezometers installed downgradient from East Eightmile Lakes. Monthly water- quality samples have been collected from many of the upgradient piezometers in an attempt to determine how ground-water quality changes along a flowpath from the recharge area to the lake. Aquifer samples were collected from the augered holes for mineralogic analysis. The USGS two-dimensional ground-water model has been applied to cross sections at both sites to help refine ground- water flow to and from the lakes. Instrumentation for measuring short-wave and long-wave radiation was installed to allow calculation of evaporation by the energy-budget procedure.

PLANS (April 1 to June 30, 1986): Continue hydrologic and water-quality data collection.

PLANS (July 1, 1986 to June 30, 1987): Hydrologic and water-quality data collection will continue until September, 1976. Aquifer samples will be analyzed for mineralogic content. The USGS chemical-equlibrium models WATEQF and BALANCE will be applied to assist in determining chemical reactions occurring in the ground- water basins upgradient from the lakes. Hydrologic and chemical budgets will be determined for the period September 1983 through August 1986, and the final report will be written.

WATER RESOURCES AND GEOLOGY OF LANGLADE COUNTY, WISCONSIN, WI 118

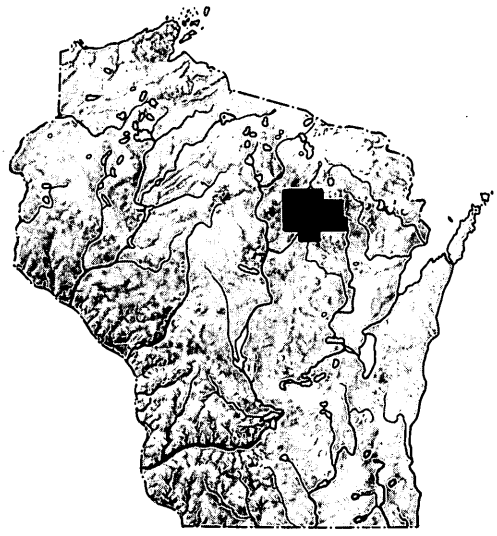
COOPERATOR: Wisconsin Geological and Natural History Survey

LOCATION: North-central Wisconsin

PROJECT CHIEF: William G. Batten

PERIOD OF PROJECT: July 1981 to December 1984

OBJECTIVE: The objective of the study is to describe ground-water movement, quality, availability, and use in Langlade County. The study will also evaluate stream and lake-water quality, and the relationship between surface water and ground water in the county. The geology of the county will be mapped and described.



APPROACH: Water levels, geologic logs, and other construction data will be collected for about 900 wells throughout Langlade County. Aquifer-test data will be analyzed to determine aquifer characteristics. Information on water use and pumpage will be collected. The Wisconsin Geological and Natural History Survey will map the glacial geology of the county. Water-table observation wells equipped with continuous water-level recorders and rain gages will be installed to show the precipitation/ground-water recharge relation. Seepage measurements will be made of selected streams to show the ground-water/surface-water relationship. Ground-water samples will be collected throughout the county and analyzed for common inorganic constituents. Water from selected streams will be analyzed for specific water-quality characteristics.

PROGRESS (through March 31, 1986): The report, "Water Resources of Langlade County, Wisconsin", has been reviewed and approved by the Director of the U.S. Geological Survey for publication as an Information Circular by the Wisconsin Geological and Natural History Survey.

PLANS (April 1 to June 30, 1986): Report will be prepared for publication.

PLANS (July 1, 1986 to June 30, 1987): The final report "Water Resources of Langlade County, Wisconsin" will be published by the Wisconsin Geological and Natural History Survey.

EFFECTS OF URBANIZATION ON FLOODS IN THE MILWAUKEE METROPOLITAN AREA, WI 121

COOPERATORS: Milwaukee Metropolitan Sewerage District Southeastern Wisconsin Regional Planning Commission

LOCATION: Milwaukee, Wisconsin

PROJECT CHIEF: Duane H. Conger

PERIOD OF PROJECT: July 1981 to September 1985

OBJECTIVE:

1. To determine flood-frequency discharge values for a network of 25 crest-stage gages that are operated by the Milwaukee Metropolitan Sewerage District.

2. To develop a method to estimate flood frequencies up to a 100-year flood for ungaged urban streams in the Milwaukee area.

APPROACH: This study will include urban basins throughout the Milwaukee area. Crest-stage gage stations and records will be inspected to determine which stations should be included in the project. Stage-discharge ratings will be developed for each station by discharge measurements or step-backwater analysis. Basin characteristics will be determined for each station. Multiple-regression techniques will be used to relate flood-frequency characteristics for each basin with drainage-area and other typical drainage- basin characteristics. Equations will be developed to estimate flood discharges at ungaged sites for various degrees of urbanization.

PROGRESS (October 1981 to March 30, 1986): Peak data were compiled for 20 crest-stage gages and 2 rainfall-runoff gaging stations in the Milwaukee area. The USGS Rainfall-Runoff Model was used to generate peak discharges for the rainfall-runoff stations. Stage-discharge ratings were developed for all the gages. Log-Pearson Type III computations were used to determine flood discharges (Q2-Q100). Multiple-regression techniques were used to develop equations for estimating flood frequencies at ungaged urban sites. An urban flood-frequency report titled "Estimating Magnitude and Frequency of Floods for Wisconsin Urban Streams" has been prepared and approved for publication.

PLANS (April 1 to June 30, 1986): The report will be processed and prepared for printing.

WATER RESOURCES OF WISCONSIN INDIAN RESERVATIONS, WI 123

COOPERATORS: Bad River Tribal Council Forest County Potawatomi Community Lac du Flambeau Band of Lake Superior Chippewa Indians Menominee Indian Tribe of Wisconsin Oneida Tribe of Indians of Wisconsin St. Croix Council Stockbridge-Munsee Tribal Council

LOCATION: Northern Wisconsin

PROJECT CHIEF: Robert A. Lidwin

PERIOD OF PROJECT: August 1977-Continuing

OBJECTIVE: The purpose of these studies is to describe the hydrology and ground- and surface-water quality of Wisconsin Indian reservations. The resultant reports will be used by the individual tribes as planning tools and guides to possible resource development. Particular problems or concerns on individual reservations will be considered and the study approaches modified as needed.

APPROACH: These studies will evaluate the water resources of Indian lands with special emphasis on specific problem areas. The problem areas will be defined in consultation with individual tribes. In general, the approach will be as follows:

Wells will be inventoried. Ground-water levels will be measured and water-level recorders installed. Additional piezometers will be installed where necessary for good areal coverage. Water samples will be collected from wells and analyzed for selected constituents. Aquifer tests will be conducted to determine the physical characteristics of the major aquifer. Bedrock topography will be defined using seismic surveys in areas lacking adequate drill-hole data.

Discharge measurements will be made on selected streams; in some cases, gaging stations will be established. Low-flow gain-and-loss studies will be performed to help define ground-water/surface-water relationships.

In some areas, wild rice surveys will be made; in other areas stream biota will be examined to document present stream "health".

Stream, lake, and precipitation samples will be collected for analysis of selected chemical constituents.

Maps showing bedrock topography, water table, saturated thickness, and discernible areal patterns of ground-water chemical constituents will be prepared.

Reports describing the water resources and addressing water-resources problems on specific reservations will be prepared for each reservation. These reports will be either in Water-Resources Investigations report format or in map report format, as appropriate.

PROGRESS (August 1977 to March 31, 1986): The Mole Lake Indian Reservation was studied initially. An assessment of the existing hydrologic and water-quality conditions was made. Potential impacts of future nearby mining activity were also assessed. A report was written and provided to the tribe. A study of the water resources of the Lac Courte Oreilles Indian Reservation was undertaken for 1 year, but terminated by request of the tribal council. Data collection for similar studies on the Forest County Potawatomi Indian Reservation, the Lac du Flambeau Indian Reservation, and the Menominee Indian Reservation was completed in 1985. The first draft of the final report for the Forest County Potawatomi Indian Reservation was completed and is in review. The final reports for the other two reserva tions have been begun.

Appraisals of the existing conditions of the water resources of the Bad River Indian Reservation, the St. Croix Indian Reservation, and the Stockbridge-Munsee Indian Reservation are presently being undertaken. Existing

Indian Reservation, and the Stockbridge-Munsee Indian Reservation are presently being undertaken. Existing domestic reservation wells were inventoried, located, and measured. Water samples from some of these wells, as well as piezometers installed earlier, were analyzed for a number of constituents. Lakes have been sampled on the St. Croix and Potawatomi Reservations. Stream sampling has been done on the Menominee, Bad River and Forest County Potawatomi Reservations. Gaging stations were maintained on the Wolf River. Some followup seismic work was performed on the Bad River Reservation.

Monitoring of a paper mill sludge pond complex adjacent to tribal land of the Oneida Indian Reservation is also being performed. Observation wells were installed, developed, and sampled. An electromagnetic survey was begun in the same area to locate a contaminant plume in the ground water. A continuous recorder was installed on one of the monitoring wells.

PLANS (April 1, 1986 to September 30, 1986): Additional existing wells will be inventoried and measured on all reservations in the data-collection phases of the studies. Additional lakes and streams will be sampled. Wells will be sampled or resampled and the water analyzed for selected constituents as needed.

Additional observation wells will be installed, developed, and sampled on the Oneida Reservation. Geophysical techniques will be used to collect information to aid in preparing water-table and bedrock-surface maps and the electromagnetic survey of the Oneida site will be completed.

A streamflow gaging station on the Wolf River will be maintained. Lake levels will continue to be monitored on selected lakes.

The reports for the Menominee and Lac du Flambeau Reservation will be completed.

Work will begin on the Stockbridge-Munsee Reservation. Existing well records will be reviewed. Wells will be located, inventoried, and measured. Observation wells will be installed where needed. A seismic survey will be performed on the reservation. Selected wells and streams will be sampled.

MILWAUKEE HARBOR STUDY, WI 125

COOPERATOR: Southeastern Wisconsin Regional Planning Commission

LOCATION: Milwaukee

PROJECT CHIEF: Leo B. House

PERIOD OF PROJECT: April 1982 to September 1986

OBJECTIVE: The objectives of this study are to provide stage, discharge, suspended-sediment loads, and water-quality data for use in the Milwaukee Harbor Estuary Comprehensive Water Resources Planning Program.

APPROACH: Discharge data and suspended-sediment loads were determined at seven gaging stations on the Milwaukee, Menomonee, and Kinnickinnick Rivers. Water levels were monitored at four locations in the inner harbor estuary, and at two locations in the outer harbor. Shoreland storage yards next to the estuary will be investigated to determine the extent of runoff pollutants. Water-quality samples will be taken at 16 sites throughout the estuary at scheduled intervals and during selected storm events. These data will be used to calibrate and verify hydraulic and water-quality simulation models used by the USGS, the cooperator, and the cooperator's consultants.

PROGRESS (April 1982 to March 31, 1986):

The U.S. Geological Survey's Branch Network Model was used to compute discharges within the estuary for selected storm-related time periods when intensive water-quality sampling efforts were also made in the estuary. The model was required to estimate unsteady-state discharge conditions where conventional gaging-station methods could not be applied. Input to the model consists of upstream tributary discharge, continuous stage records at the Jones Island channel, and channel geometry data for the estuary. The model was used to simulate the upstream flow that periodically occurs in the estuary.

Ten materials-storage sites adjacent to the inner harbor estuary were sampled for water-quality analysis of runoff. The samples collected were analyzed for organo-chlorides, phenols, and toxic metals. Contaminant loads to the estuary were estimated using a modified Hydrologic Simulation Program model.

Chemical-quality and suspended-sediment samples were collected at scheduled intervals at 16 sites. These same sites were intensively sampled during selected storm events. These samples were delivered to the cooperator for chemical analysis and load computations.

A report describing the USGS Branch Network Discharge model study has been written and approved for publication by the USGS Director's office as Water-Resources Investigations Report 86-4050. The title of this report is "Simulation of Unsteady Flow in the Milwaukee Harbor Estuary at Milwaukee, Wisconsin".

PLANS (March 31 to September 1986): The report describing the discharge model will be published. Technical assistance will be provided at the cooperator's study meetings as required until the final report by SEWRPC is completed.

REGIONAL REAERATION COEFFICIENTS, WI 126

COOPERATOR: Wisconsin Department of Natural Resources

LOCATION: Selected streams in Wisconsin

PROJECT CHIEF: David J. Graczyk

PERIOD OF PROJECT: July 1981-continuing

OBJECTIVE: The objective of this project is to determine the reaeration coefficents of small Wisconsin streams to aid in the design and operation of sewage-treatment plants.

APPROACH: The reaeration coefficients will be determined for 10 to 20 streams during the project by the steady-state propane-tracer technique. The coefficients will be regionalized for a statewide data base.

PROGRESS (July 1981 to March 31, 1986): Reaeration coefficients were determined for nine streams by using the steady-state propane-tracer method. Coefficients were reported to the DNR by letter. Reaeration coefficients have been determined at 12 additional sites by other methods. These coefficients will be utilized in the regionalization process.

PLANS (April 1 to June 30, 1986): A meeting will be held with DNR personnel to select the sites to be studied during the summer of 1986.

PLANS (July 1, 1986 to June 30, 1987): Reaeration coefficients will be determined for three streams during low-flow conditions in the summer of 1986. A meeting will be held in the fall of 1986 to determine if the data base is adequate to conduct a regional analysis or if additional streams should be measured. If additional data are required, it will be collected in subsequent years. After data collection a multiple-regression analysis will be performed relating reaeration coefficients to basin characteristics and stream characteristics.

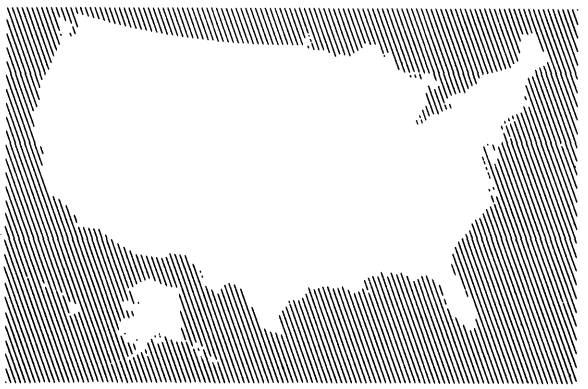
GEOGRAPHIC INFORMATION SYSTEMS AND NATIONAL WATER SUMMARY

COOPERATOR: Office of National Water Summary and Long-Range Planning

LOCATION: Nationwide plus Puerto Rico, Virgin Islands, and Pacific Trust Territories

PROJECT CHIEF: Gregory J. Allord

PERIOD OF PROJECT: January 1983-continuing



OBJECTIVE: The objective of this project is to assist in the cartographic preparation of the annual publication "National Water Summary". This publication is released as a U.S. Geological Survey Water-Supply Paper and includes a topical discussion for each state in addition to thematic articles in the first half of the paper that relate to significant hydrologic events that occurred within the year.

APPROACH: The Wisconsin District, one of the three Water Resources Division Federal Series Reports Units, assists Division in preparing publications for printing. This project is funded with a two-fold purpose: to explore Geographic Information Systems capability and application to WRD mapping activities, and to assist in preparing maps and graphs for final publication. The Wisconsin District cartography section is responsible for using ARC/INFO software to build new and modify existing cartographic data bases for preparing maps that can be printed by conventional printing methods while maintaining quality standards.

PROGRESS (January 1983 to March 31, 1986): This project was originally created to assist the National Center to prepare a proof-of-concept test of a Geographic Information System (GIS). The study area chosen was the Fox-Wolf River basin and a report (WRIR 83-4142) was prepared by the EROS Data Center staff. Since that time, Wisconsin District cartographers have assisted in selecting a GIS and testing cartographic production capability for several special projects.

The ARC/INFO system was installed on the Wisconsin District Prime 750 during November 1985. Since that time, work has concentrated on manipulating the 1:2,000,000 Digital Line Graph data base released by National Mapping Division. This data base covers all 50 states and is representative of maps printed in the "Atlas of the United States". Data files for all states have been checked and stored for all states and are: streams, water bodies, counties, state outlines, and hydrologic unit boundaries. This project has also served as the nucleus of interest in ARC/INFO within the District and is serving as a base on which to build applications of a Geographic Information System to hydrologic studies.

PLANS (April 1, 1986-continuing): During the next quarter the 1985 National Water Summary will be completed and sent to the printer. This report, that emphasizes surface-water resources, will have 5 maps and an average of 11 hydrographs for each of the 50 states, Puerto Rico, the Virgin Islands, and the Pacific Trust Territories. Data for reservoirs, precipitation, runoff, and base maps will all be prepared using ARC/INFO software. In addition, approximately 500 pages of text will be prepared using the District photo typesetting equipment.

Emphasis during the next year will be on differentiating the needs in data bases for cartographic analysis and cartographic presentation. While preparing maps for publication using digital data bases, Wisconsin District personnel have determined shortcomings in data that are acceptable for analysis but not for publication. These differences will be documented in a U.S. Geological Survey open-file report.

HYDROLOGY OF THE CRANDON AREA, WI 132 Ground-Water Flow Model for the Area of a Proposed Mine near Crandon

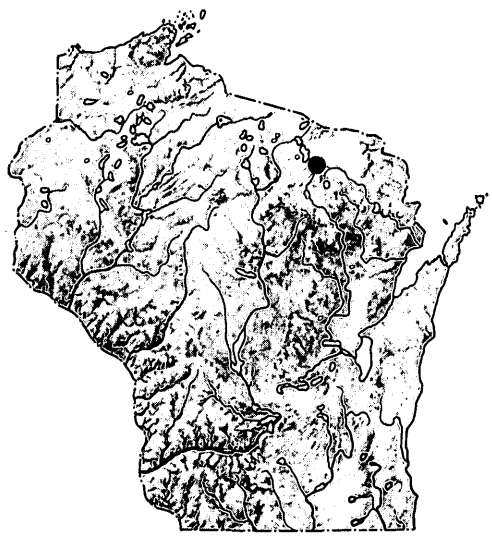
COOPERATOR: Wisconsin Department of Natural Resources

LOCATION: An area of 22 square miles south of Crandon, Wis.

PROJECT CHIEF: James T. Krohelski

PERIOD OF PROJECT: April 1983 to July 1986

OBJECTIVE: The objective of the study is to better understand the hydrology of the area and the possible impact of mining on the hydrology of the area.



APPROACH: Phases of the study will include:

1. Review of parameters such as hydraulic conductivity and stratigraphy provided to the DNR by Exxon Minerals Company.

2. Request further data collection from Exxon Minerals Company if needed.

3. Develop a ground-water flow model and determine if additional data are required.

4. Refine the model and run sensitivity analysis on parameters and boundary conditions.

5. Develop a contaminant-transport model using results of flow modeling as input.

6. Conduct special applications of the models.

7. Complete a report describing general hydrology, results of sensitivity analysis, basis of parameter estimation, contaminant movement, and documentation of the models.

PROGRESS (April 1, 1983 to March 31, 1986): The Environmental Impact Statement was reviewed and additional information in hydrologic parameters was requested to better define areal hydrology. Cross-sectional flow and contaminant-transport models were developed. The cross-sectional flow model simulates steady-state premining flow through Rice Lake, Hemlock and Swamp Creeks, and the ore body and mine-waste disposal facility. The contaminant- transport model simulates contaminant movement along a portion of the same cross section used for the flow model. The contaminant-transport model simulates varying seepage rates of a conservative contaminant emanating from the mine-waste disposal facility and moving towards Swamp Creek.

A draft report was written and reviewed by DNR and Exxon Minerals Company. The report describes the hydrology along the cross section, sensitivity analyses, and the effect of varying seepage from the mine-waste disposal facility, and dispersivity ratios.

PLANS (April 1 to June 30, 1986): DNR has requested several more scenarios to be simulated with the contaminant-transport model. These runs will be made and incorporated into the report. The report will be submitted to DNR for final review in June 1986.

HYDROLOGY OF THE CRANDON AREA, WI 132 Surface-Water Evaluation-Crandon

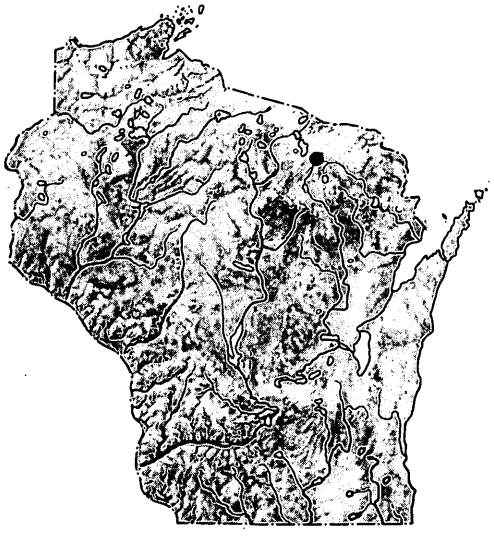
COOPERATOR: Wisconsin Department of Natural Resources

LOCATION: Northeastern Wisconsin, near Crandon

PROJECT CHIEF: William R. Krug

PERIOD OF PROJECT: April 1984 to June 1987

OBJECTIVE: The objectives of this project are to:



1. Review EXXON'S Environmental Impact Report (EIR) pertaining to stream, lake, and wetland hydrology; and analyze the effects of the proposed waste- water discharge on the streamflow and channel morphology of Swamp Creek. Recommend to joint committee concerning EXXON'S methods, means of verifying the data, inadequacies, and additional data required. (By June 30, 1984)

2. Apply two computer simulation models of surface water to verify EXXON'S results:

a. Develop a lake water budget model for five lakes in the project area and use the model to estimate effects of the mine on lake levels, outflow, and seepage to ground water. (By June 30, 1986)

b. Use a rainfall-runoff model to simulate the runoff from the area of the tailings ponds during construction and use, and after reclamation. (By June 30, 1985)

3. Review EXXON'S Environmental Impact Report (EIR) pertaining to surface- and ground-water hydrology relating to ground-water-supported wetlands, streams, and lakes to be affected by the proposed facility. Recommend to the joint committee concerning any inadequacies in EXXON'S methods and any additional data required. (By June 30, 1985)

4. Conduct seepage/low-flow measurements at selected sites in the project area. Determine Q7,2; Q7,10; and the lower half of the flow-duration curve at each site for which there is sufficient data. Assist DNR staff in locating representative cross sections and determining stage-discharge relations. (By December 1, 1984)

5. Continue streamflow data collection at 04074538 Swamp Creek above Rice Lake at Mole Lake, Wis.

6. Establish lake gaging stations on six lakes in the project area. Also assist DNR reconnaissance of spring areas in lakes in the project area. (By June 30, 1985)

APPROACH: The adequacy of the methods employed to collect and analyze surface-water data in the vicinity of the Crandon Project will be analyzed, and methods of improving the data suggested.

Low-flow discharge measurements will be made at selected sites in the project area. Low-flow characteristics will be estimated from these data by correlation with nearby gaging stations. The 7-day, 2-year and 10-year low flow will be estimated; the lower half of the duration curve will also be estimated.

The gaging station on Swamp Creek above Rice Lake will be operated. A lake water budget model will be developed and used to estimate effects on area lakes.

Staff gages will be established on six lakes in the project area.

PROGRESS (through March 31, 1986): Portions of the Environmental Impact Report (EIR) regarding surface water have been reviewed. Comments and suggested improvements have been furnished to the cooperator.

A lake-budget model has been developed to simulate Duck, Deephole, Little Sand, Skunk, and Oak Lakes. The model has been calibrated with data collected in the area during the period 1977-85. The model is used to estimate long- term changes in the water balance due to mine dewatering.

PLANS: (April to June 1986): The lake budget modeling will be finished; summaries will be provided to DNR.

PLANS: (July 1986 to June 1987): Additional summaries will be prepared as required by the cooperator to prepare for hearings on mine permit applications. An open-file report will be written to document the lake-budget model and present the predictions of the model.

LAKE WATER-QUALITY MONITORING, WI 133 Statewide Lake-Stage and Seicchi-Disc Monitoring

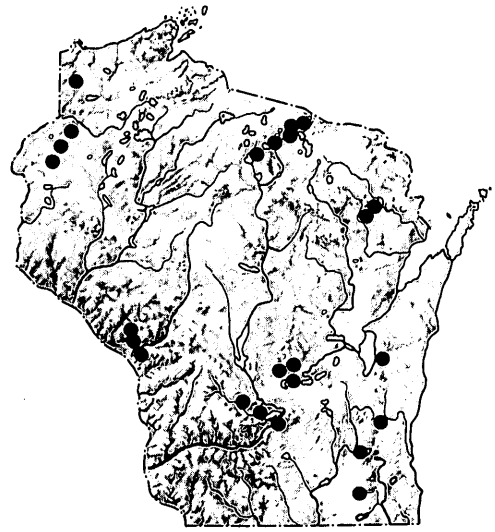
COOPERATOR: Wisconsin Department of Natural Resources

LOCATION: Statewide

PROJECT CHIEF: Stephen J. Field

PERIOD OF PROJECT: October 1984 to June 30, 1987

OBJECTIVE: The objectives are to determine lake stage and water transparency at selected lakes throughout Wisconsin and, through a continuous monitoring program, provide the data that will document lake-stage fluctuations and detect water-quality changes that may take place.



APPROACH: Staff gages will be installed at each selected lake to monitor stage fluctuations. Reference marks will be established and levels run at each lake. Stage readings will be made weekly during the open-water period, and monthly during the winter by Lake District personnel. Stage data will be entered into the USGS computer data-base storage file. They will be retained as part of the permanent data record of the water resources of Wisconsin.

Secchi-disk readings will be made by Lake District personnel weekly during ice-free periods in the deepest part of the lake. Secchi-disc readings will be entered into the USGS computer data-base storage file.

PROGRESS (October 1984 to March 31, 1986): Lake-stage and Secchi-disc data were compiled on 24 lakes. Data have been formatted for inclusion into the 1985 water year "Water Resources Data for Wisconsin" publication.

PLANS (April 1 to June 30, 1986): Data collection and compilation will be continued.

PLANS: (July 1, 1986 to June 30, 1987): Data will be collected, compiled, and entered into computer storage. Data will be published.

LAKE-WATER QUALITY MONITORING WI 133 Chemical and Biological Monitoring of Selected Lakes

COOPERATORS: Morris, Wolf, Lac La Belle, Okauchee, Oconomowoc, Powers, and Park Lake Districts; Town of Norway (Wind Lake)

LOCATION: Selected lakes in Wisconsin

PROJECT CHIEF: Stephen J. Field

PERIOD OF PROJECT: June 1983-continuing

OBJECTIVE: The objective of this project is to determine lake stage and water quality at selected lakes throughout Wisconsin and, through a continuous monitoring program, provide data to detect chemical or biological changes that may take place.

APPROACH: Water quality at each lake will be monitored in February, April, June, July, and August. Depth profiles of dissolved-oxygen concentration, temperature, pH, and specific conductance will be determined. In April, the lakes will be sampled at the top and bottom for analysis of the major anions and cations, nitrogen, and dissolved phosphorus. Secchi-disk readings will be made for all months (except February), and total phosphorus and chlorophyll a samples will be collected and analyzed. Weekly stage readings of the lake level will be obtained by a local observer.

PROGRESS (June 1983 through March 31, 1986): Total phosphorus, chlorophyll a, dissolved oxygen, and Secchi depth data were collected and analyzed at Lac La Belle, Wolf, Morris, Okauchee, and Wind Lakes. These data are summarized in the following table:

Lake	Monitoring period	Maximum lake depth (feet)	Minimum depth for summer anoxia (feet)
Wolf Lake	4/84 - 8/85	47	21
Lac La Belle	4/84 - 8/85	46	24
Okauchee Lake	4/84 - 8/85	92	78
Wind Lake	4/84 - 8/85	52	21
Morris Lake	6/83 - 8/85	43	18

	Surface total phosphorus range (mg/L)	Surface chlorophyll a range (ug/L)	Secchi disc depth range (meter)
Wolf Lake	<0.010 - 0.040	1.20 - 60	1.6 - 3.2
Lac La Belle	<0.001 - 0.100	<0.1 - 8.00	1.2 - 3.5
Okauchee Lake	<0.010 - 0.016	<0.1 - 5.80	1,8 - 4.2
Wind Lake	<0.036 - 0.061	1.8 - 22	0.6 - 1.2
Morris Lake	0.007 - 0.110	1.1 - 11	2.2 - 4.6

In February 1986, a letter evaluating the water quality of each lake was sent to the respective Lake District.

PLANS (April 1 to June 30, 1986): Lake-water quality at the eight lakes (Lac La Belle discontinued) in the program will be monitored.

PLANS (July 1, 1986 to June 30, 1987): Monitoring will be continued as scheduled for the eight lakes in the program and for additional lakes as they join the program. We will compile data and submit it to the cooperator after August monitoring. We will prepare data for publication in the annual resources data publication for the 1985 water year.

HYDROLOGIC CONSIDERATIONS ASSOCIATED WITH THE ARTIFICIAL ACIDIFICATION OF LITTLE ROCK LAKE IN VILAS COUNTY, WI 134

COOPERATOR: Wisconsin Department of Natural Resources

LOCATION: Vilas County, north-central Wisconsin

PROJECT CHIEF: William J. Rose

PERIOD OF PROJECT: August 1983 to September 1990

OBJECTIVE: The goal of this project is to determine monthly water budgets for Little Rock Lake, define ground-water flow paths, and monitor ground-water quality.

APPROACH: Inflow to the lake from precipitation, overland flow, and ground- water discharge, and outflow from the lake from evaporation and ground-water recharge will be determined. Ground-water gradients determined from a piezometer network will be evaluated to define flow paths of ground water discharging to and recharging from the lake. Ground water discharging to and recharging from the lake will be sampled from piezometers situated in the appropriate flow paths. Concentrations of major chemical constituents, including hydrogen ion and alkalinity, nutrients, and trace elements, including aluminum and lead, will be determined. Monthly water budgets will be calculated.

PROGRESS (August 1983 to March 1986): Instrumentation for hydrologic data monitorng was installed within a 4-square mile area surrounding the lake. Fifty-eight piezometers were installed at 44 sites and their water levels were measured monthly. Five of the sites consist of nests of two or more piezometers finished at different depths. Lake stage, water level in one piezometer, and precipitation were measured continuously with automatic recording equipment. Data that are used for calculating lake evaporation (which include class A pan evaporation, wind speed, air and lake-surface temperature, and relative humidity) were measured during nonfreezing periods. Slug tests were done on 50 piezometers to obtain estimates of aquifer hydraulic conductivity. Ground water was sampled monthly at selected piezometers for chemical analysis. Water-table contour maps were plotted and ground-water flow paths defined. Routine monitoring of hydrologic variables needed for water budget determination continued during the period since April 1, 1985, with little change in number of monitoring sites or frequency of measurements.

A marine reflection survey was done in June 1, 1985. The primary purpose of the survey was to determine the presence and thickness of organic sediment. A preliminary sediment thickness map from these data has been constructed. The sediment thickness information is needed for ground-water flow modeling.

Preliminary monthly water budgets for the 1984 and 1985 water years were compiled. In these budgets, net ground-water flow to and from the lake was calculated as the residual of the other budget terms.

PLANS (April 1 to June 30, 1986): Routine hydrologic and ground-water-quality monitoring will continue. Computation of preliminary monthly water budgets for the 1985 water year will be completed.

Ground-water-quality monitoring will be reduced because of reduced funding.

PLANS (July 1, 1986 to September 30, 1990): Routine hydrologic and ground- water-quality monitoring will continue. Monthly water budgets will be computed and previously computed budgets will be refined and revised on the basis of new data as it becomes available. A report will be prepared summarizing the hydrology of Little Rock Lake.

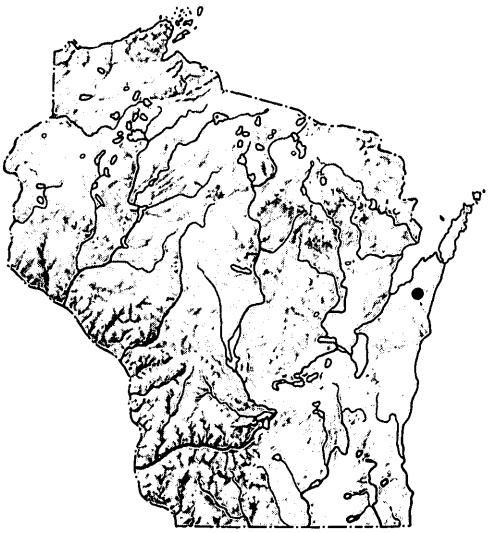
EVALUATION OF SEDIMENT YIELD HYDROLOGIC MODELING USING GEOGRAPHIC INFORMATION SYSTEMS, WI 135

COOPERATOR: Wisconsin Department of Natural Resources

LOCATION: Southwestern and northeastern Wisconsin

PROJECT CHIEF: Peter E. Hughes

PERIOD OF PROJECT: April 1983-continuing



OBJECTIVE: The original objective of this project was to coordinate an analysis of the capability of the EPA ANSWERS model by the EROS Data Center and the Wisconsin Department of Natural Resources. The ANSWERS model uses land cover, topographic, and hydrologic data to predict nonpoint source sediment and water quality stream loads for rural basins. These agencies planned to use different techniques of data input to calibrate the model on hydrologic and water-quality data available for two basins in the Galena River watershed. The project objectives were broadened in 1985 to provide discharge and precipitation monitoring and automatic storm-event sampling at one selected site. Monitoring would be continuous for 6 months to 1 year at a given site. (A second phase added to the project is data collection from small basins in Wisconsin to provide calibration data for basins different from the Galena area. A third phase added to the project concerned estimating Q7,2 values at approximately 40 sites in 4 nonpoint-source priority watersheds.

APPROACH: This will be a cooperative study with the Wisconsin Department of Natural Resources (DNR) and the Applications Branch of the EROS Data Center. DNR and EROS will compile and test the ANSWERS model on their respective computers. DNR will calibrate the ANSWERS model on two basins in the Galena River watershed by using manually compiled data. EROS will calibrate the model on the same basins by using the Geographic Information Systems (GIS) approach to input data to the model. The U.S. Geological Survey will provide the hydrologic and water-quality data from monitored runoff events and will evaluate the results of the modeling by both the DNR and EROS. Data from additional sites will be collected to assist in model development.

The Q7,2 estimates will be determined by making a base-flow discharge measurement at the site of interest and determining the Q7,2 by using low-flow regression equations for the basin. The Q7,2 values will be determined by drainage area-discharge relationships, cfsm analyses, and regression equation if base-flow discharge measurements cannot be made in a basin.

PROGRESS (April 1983 to March 31, 1986): A monitoring station was established and maintained on a 3.14 square mile basin in the Kewaunee River watershed in northeastern Wisconsin. The station was operated from April through September 1984 and equipped to obtain discharge, rainfall, temperature, dissolved oxygen, and automatic storm-runoff sampler. All data was recorded on a solid- state data logger that was connected to the U.S. Geological Survey host computer in Madison. Data were supplied to the DNR on magnetic tape, paper printouts, and plots. Two remote rain gages were also installed. These data will be used to calibrate the ANSWERS model.

The ANSWERS model has been compiled on the DNR and EROS computers. Compilation of input data is complete and calibration runs were attempted by DNR. Calibration of the model by EROS was never completed. Calibration of the ANSWERS model has been discontinued due to unsatisfactory results and the Wisconsin Department of Natural Resources is attempting to develop a nonpoint- source model that can be used in Wisconsin.

A gaging station was established and maintained for a 125-acre basin in the upper Milwaukee River watershed. The station was started in June 1985 and operation is continuing. Discharge rainfall and storm-sampling data have been provided to the Wisconsin Department of Natural Resources.

Q7,2 estimates for about 40 nonpoint sites in 5 basins were transmitted to Wisconsin Department of Natural Resources on November 27, 1985.

PLANS (April 1 to June 30, 1986): The monitoring station on the small basin in the upper Milwaukee River watershed will be operated until June 30, 1986.

PLANS (July 1986-continuing): The data will be summarized in a letter format for DNR. It is expected that the monitoring instrumentation will be relocated to another small basin site during July 1986 and monitoring will continue at that site for the rest of the year. Base-flow discharge measurements will be obtained at approximately 40 sites for nonpoint-source priority watersheds and Q7,2 estimates will be determined for these sites.

ASSESSMENT OF THE HYDROLOGY, WATER QUALITY, AND BIOLOGY OF DELAVAN LAKE, WI 136

COOPERATOR: Delavan Lake Sanitary District

LOCATION: Walworth County, southeast Wisconsin

PROJECT CHIEF: Stephen J. Field

PERIOD OF PROJECT: August 1983 to September 1986

OBJECTIVE: The objectives of the project are to determine:

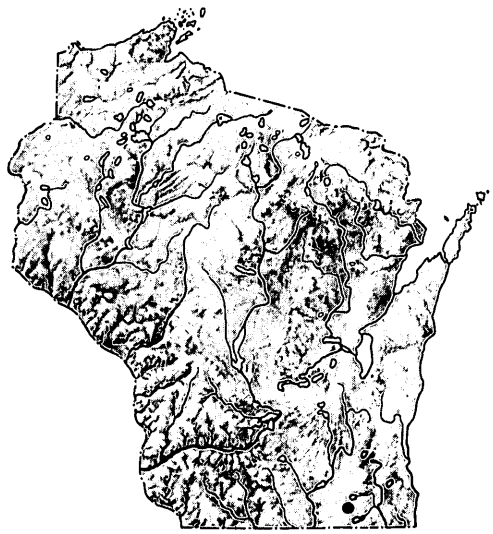
1. Nutrient discharge into the lake from surface water, ground water, and precipitation. Suspended-sediment discharge into the lake will also be determined.

2. Internal recycling of nutrients.

3. Chemical characteristics of the water, bottom sediments of the lake, and other physical characteristics.

4. The phytoplankton, zooplankton, macroinvertebrates, and rooted aquatic macrophytes present.

5. Nutrient discharges from the lake to surface and ground water. Suspended-sediment discharge from the lake will also be determined.



APPROACH: Streamflow into and out of Delavan Lake will be monitored, and stream sediment samples will be collected. Lake and stream samples will be collected and analyzed for nutrients and diagnostic biota. Ground-water levels will be monitored and water samples collected and analyzed. Wells will be installed if existing domestic wells are unavailable or inadequate. Precipitation will be monitored; lake bottom sediments will be studied. Water, nutrient, and sediment budgets will be prepared. An interpretive report will be written.

PROGRESS (August 1983 to March 31, 1986): Streamflow was monitored continuously at three inflow sites and at one outflow site from Delavan Lake. Water-sediment samples were collected weekly by Delavan Lake Sanitary District personnel. During storm runoff samples were collected by an automatic sampler. Water samples were analyzed for total phosphorus, total nitrite plus nitrate nitrogen, and total organic plus ammonia nitrogen. Miscellaneous discharge measurements were made and water-quality samples were collected at three miscellaneous inflow sites to characterize the loading from the drainage basin. The water levels in 12 piezometers installed for this project at the lake's edge, and in 50 existing wells, were measured quarterly. Six of the piezometers at the lake's edge were sampled quarterly for dissolved nitrite plus nitrate, dissolved phosphorus, and dissolved ammonia plus organic nitrogen. Seasonal ground-water inflow was determined by flow-net analysis. Recording rain gages, installed in the central part of the drainage basin, that monitor inflow to the lake were operated during ice-free periods. The U.S. Weather Service station 5 miles southeast of Delavan Lake was used to supplement the records and provide the precipitation water-quality data. Three sites within the lake were monitored to determine the physio-chemical characteristics of the water. The bottom sediments at the deepest part in the lake were analyzed for chemical content. A 2-mile long inlet to the lake was probed to determine the depth of soft sediment, and the sediments were analyzed for chemical content. Phytoplankton, zooplankton, macro- invertebrates, and rooted aquatic macrophytes were identified through a sampling program. A water, nutrient, and sediment budget for the lake was prepared by using streamflow, ground-water, precipitation, and in-lake data. This information was compiled by using a mass-balance approach.

In October 1985 the monitoring was reduced significantly. Streamflow will be monitored continuously at two inflow sites, Jackson Creek tributary and Delavan Lake inlet, and at Delavan Lake outlet. Water samples will be collected during storm runoff with an automatic sampler at Jackson Creek tributary and manual EWI samples obtained by the Delavan Lake Sanitary District personnel at the inlet and outlet. Only total phosphorus will be analyzed. Total phosphorus loads will be computed at these three sites. Three sites within the lake will be monitored to determine depth profiles of dissolved oxygen, water temperature, pH, and specific conductance. Only total phosphorus and dissolved orthophosphate phosphorus will be analyzed in the water column. Phytoplankton and zooplankton will be identified in June, July, and August. A water and phosphorus budget for the lake will be prepared by using streamflow, precipitation, in-lake data, and estimates of the remaining components for these budgets based on the data collected in the 1984 and 1985 water years. This will then be compiled using a mass-balance approach.

PLANS (April 1 to June 30, 1986): Continue monitoring as rescheduled.

PLANS (July 1, 1986 to June 30, 1987): Continue monitoring as rescheduled. Complete report on 1984 and 1985 water year data.

RESOURCE MAPS FOR EVALUATING GROUND-WATER CONTAMINATION POTENTIAL IN WISCONSIN, WI 137

COOPERATOR: Wisconsin Department of Natural Resources

LOCATION: Statewide

PROJECT CHIEF: Lee Trotta

PERIOD OF PROJECT: October 1983 to June 1985

OBJECTIVE: The objective of the project is to produce a map that shows the relative susceptibility of different areas of the State to ground-water contamination.

APPROACH: The objective of the project will be met in two concurrent phases:

Phase 1: Five State resource maps at a scale of 1:500,000 will be prepared during Phase I. Most of the Phase I data analysis will be conducted by the U.S. Geological Survey (USGS); the Wisconsin Department of Natural Resources (DNR) will digitize the data. The maps will illustrate the depth-to-water table, depth-to-bedrock, bedrock type, permeability of unconsolidated materials, and soil permeability.

Phase 2: A rating system for combining the map components delineated in Phase 1 will be developed to aid production of a contamination-potential map. This phase of the project will be conducted by an Advisory Committee composed of USGS, WG&NHS, UW, and DNR specialists. The committee will assign values to map areas, and the maps will be analyzed to evaluate the cumulative effect of mapped characteristics on susceptibility to ground- water contamination from an aqueous contaminant applied at the land surface. Maps will be digitized by Wisconsin DNR's Bureau of Information Management (BIM). Compositing will be done by a computer system to produce a contamination-potential map.

PROGRESS (October 1, 1983 to March 31, 1986): A group of scientists familiar with Wisconsin's water resources was asked to serve on the technical advisory committee. A series of meetings of the committee was held to define parameters that control movement of contaminants to the water table, and are mappable, statewide, at a scale of 1:500,000 or 1:250,000. The committee also formulated a rating scheme to derive numerical ratings for contamination potential on the composite map.

The USGS utilized available data to prepare depth to bedrock, depth to water, and permeability of subsurface unconsolidated deposits maps. The Wisconsin Geological and Natural History Survey map of bedrock geology of 1982 was used. Francis Hole's soil association map of 1968 was used. These maps were digitized by the Wisconsin DNR.

Upon later evaluation, the permeability of subsurface unconsolidated deposits map was found to be unsatisfactory and was replaced by a surficial geology map, and the soil association map definitions and values were revised.

A final composite map of contamination potential has been produced and paper proofs have been prepared by DNR. The technical advisory committee met and discussed the map. DNR decided to make one final change in the rating scheme and to then print the resultant map.

PLANS (April 1986 to June 1986): The final map will be evaluated by the technical committee.

LAKE ASSESSMENT--FOWLER LAKE, WI 138

COOPERATOR: Fowler Lake Management District

LOCATION: City of Oconomowoc, Waukesha County, southeast Wisconsin

PROJECT CHIEF: Peter E. Hughes

PERIOD OF PROJECT: January 1984 to March 1985

OBJECTIVE: The objectives of this project are to identify the sources of nutrient enrichment to Fowler Lake; compare the nutrient and suspended- sediment discharge to the Oconomowoc River and contributing urban area, and from the lake; monitor chemical and physical characteristics of the lake water; and estimate internal recycling of nutrients.

APPROACH:

Stream Monitoring:

Streamflow and water quality will be monitored from February through November 1984 on the Oconomowoc River upstream of Fowler Lake. Discharge and nutrient inflow from the directly connected urban area of the city of Oconomowoc for the same period will be estimated using the Wisconsin Urban Runoff Model (WURM).

Lake Monitoring:

Inlake water quality will be sampled once monthly from January to March and every 2 weeks during the open-water period. Dissolved oxygen, temperature conductivity, and pH will be measured at 3-foot depth intervals at the deepest point of the lake. Nutrient samples from this site will be obtained at three depths: near the surface, the center of the thermocline, and 3 feet above the bottom. Temperature and conductivity profiles will be taken at 11 additional locations to determine the mixing of the river inflow with the lake water. The water level will be recorded weekly during ice cover and daily during open-water conditions. Secchi-disk transparency measurements will be taken at the same time as other water-quality sampling. Rooted aquatic plants will be identified and mapped in June prior to the start of mechanical or chemical control programs.
Ground-Water Monitoring:

Two wells will be installed at an abandoned dump site located on the southeast shore of the lake. Water-levels in these wells will be measured quarterly at which time samples will be collected for analysis of conductivity, pH, chloride, sulfate, and total and dissolved phosphorus. The data will be analyzed to determine the potential for leachate from the abandoned dump site to reach the lake.

Water, Nutrient, Sediment Budget:

Monthly budgets will be prepared using the data collected. Nutrient recycling in the lake will be estimated using a mass balance approach. A final report summarizing the collected data will be published.

PROGRESS (January 1984 to March 31, 1986): The stream gage on the Oconomowoc River was installed on February 8, 1984. Water-quality sampling of both the lake and the river began in January. By March 1985, all field data-collection activities have been completed and laboratory analyses received. Data analyses show that the lake water quality generally reflects that of the influent Oconomowoc River. Data collection and analyses showed that the lake- water quality generally reflects that of the influent Oconomowoc River. With the river contributing 98 percent of the inflow and 86 percent of the phosphorus load.

Water-quality loadings to the lake from the river and the urban drainage were computed and a summary report written. The report is in the review process.

PLANS (April through September 1986): Publish the Water-Resources Investigation Report, "The Hydrology and Water Quality of Fowler Lake, Wisconsin".

WISCONSIN DISTRICT FEDERAL SERIES CARTOGRAPHIC CENTER, WI 139

COOPERATOR: Office of Scientific Information Management

LOCATION: Nationwide

PROJECT CHIEF: Gregory J. Allord

PERIOD OF PROJECT: October 1, 1985-continuing

OBJECTIVE: Both the time from approval of formal-series USGS reports until publication and the number of reports waiting for printing have been steadily increasing. The Geologic Division has primary responsibility for preparing reports that are to be released in the formal series. Due to an increased volume of work and decreasing number of employees, the Water Resources Division has set a goal of producing reports available for printing within 9 months of approval by the Director's Office.

PROGRESS (October 1, 1983 to March 31, 1986): Since the beginning of this project, numerous WRD Professional Papers, Water-Supply Papers, and Circulars have been prepared for publication. This has included assisting authors throughout the county in report design and preparation in addition to traditional thematic cartographic efforts.

The Wisconsin District Federal Series Reports Units (FSRU) has been established and supplied with cartographic equipment to accomplish this goal. Within the past year, this center has obtained large-format contact frames, platemakers, a Compugraphic phototypesetting system, geographic information-system software, color and monochrome graphic-display terminals, a digitizing table, laser printers, and plotters. This equipment allows the staff to use conventional photo-mechanical techniques for preparing thematic maps for printing. In addition, of the three FSRU centers, the Wisconsin District is specializing in determining when digital cartographic methods can best be merged with traditional methods.

This unit, during this fiscal year, has been assigned special priority publications including Regional Aquifer Systems Analysis Professional Papers, a Regional Aquifer Systems Analysis Summary (Circular 1002), and a two-volume special edition publication for the Office of Surface Mining.

PLANS (April 1, 1981-continuing): The Wisconsin Federal Series Reports Unit will continue to concentrate on Regional Aquifer reports to be released in the U.S. Geological Survey Professional Paper series. This unit has also been requested to explore new methods of preparing maps for publication and expanding on an integrated publishing system of merging text and graphics.

HYDROLOGIC CONCERNS INVOLVED IN LANDFILL SITING, OPERATION, AND MONITORING, WI 140

COOPERATOR: Information Transfer Program, WRD, U.S. Geological Survey

LOCATION: Regional

PROJECT CHIEF: Gary Patterson

PERIOD OF PROJECT: June 1984 to October 1985

OBJECTIVE: The project objective is to describe, in simple nontechnical terms, how landfills can affect nearby surface water and ground water.

APPROACH: A small pamphlet describing, in general terms, how leachate is produced and how it moves to wells and streams will be written by the project chief and a member of the Wisconsin Department of Natural Resources technical staff. Preventative methods such as proper siting and design, adequate monitoring, and advanced engineering techniques will also be discussed.

PROGRESS (June 1984 to March 31, 1985): A detailed outline is completed and has been approved at the regional level. The outline has been annotated. The Wisconsin DNR project member withdrew from the project.

PLANS (April 1 to June 30, 1986): Complete report writing.

PLANS (July 1 to September 30, 1986): Complete report review and submit for approval for publication.

ASSESSMENT OF THE HYDROLOGY AND WATER QUALITY OF THE BLACK EARTH CREEK WATERSHED, WI 141

COOPERATOR: Wisconsin Department of Natural Resources

LOCATION: Western Dane County, south-central Wisconsin

PROJECT CHIEFS: Stephen J. Field and David J. Graczyk

PERIOD OF PROJECT: October 1, 1984 to September 30, 1987

OBJECTIVE: The objectives of the study are to:

1. Determine streamflow characteristics of Black Earth Creek and its tributaries.

2. Determine water-quality characteristics and dissolved-oxygen profiles of Black Earth Creek.

3. Identify reaches, tributaries, or sources in the watershed that are contributing nutrient and sediment loads.

APPROACH: Continuous-record gaging stations will be operated at two sites on Black Earth Creek and on Brewery Creek and Garfoot Creek and partial-record stations will be established on five tributaries. Periodic discharge measurements and water-quality samples will be collected at these stations during selected low-flow and high-flow events. Automatic water-quality samplers will be operated at the continuous-record gaging stations. Water- quality samples will be collected during low-flow and selected high-flow events. Continuous dissolved-oxygen monitors will be operated on three sites on Black Earth Creek: one at County Trunk P in Cross Plains, another downstream of the sewage-treatment plant in Cross Plains, and a third at the most downstream gaging station.

Low-flow water-quality samples will be collected at 15 miscellaneous sites throughout the basin. Daily and annual loads of sediment, phosphorus, and nitrogen will be calculated. Continuous-record water temperature recorders also will be operated at the four continuous gaging stations.

PROGRESS (October 1, 1984 to March 31, 1986): Streamflow data were collected at the four gaging stations and streamflow records of the four stations for the 1985 water year were prepared. Water-quality samples were collected four times during low flow and selected events and were used to calculate daily and annual loads for selected constituents. Records of water temperature (four sites) and dissolved oxygen (two sites) were prepared for the 1985 water year and were transmitted to the DNR. An additional continuous dissolved-oxygen monitor was installed on Black Earth Creek below the sewage-treatment plant and the dissolved-oxygen monitor from Garfoot Creek was removed and installed at Black Earth Creek at Black Earth.

PLANS (April 1 to June 30, 1986): Streamflow monitoring and water-quality data collection will be continued. Another low-flow sampling trip will be made.

PLANS (July 1, 1986 to September 30, 1987): Streamflow and water-quality data will be collected until September 30, 1986, when all data collection will be terminated. Records for all gaging stations will be prepared. All existing data will be analyzed and a report will be prepared.

GROUND-WATER RESOURCES AND GEOLOGY OF WOOD COUNTY, WISCONSIN, WI 142

COOPERATOR: Wisconsin Geological and Natural History Survey, and Wood County

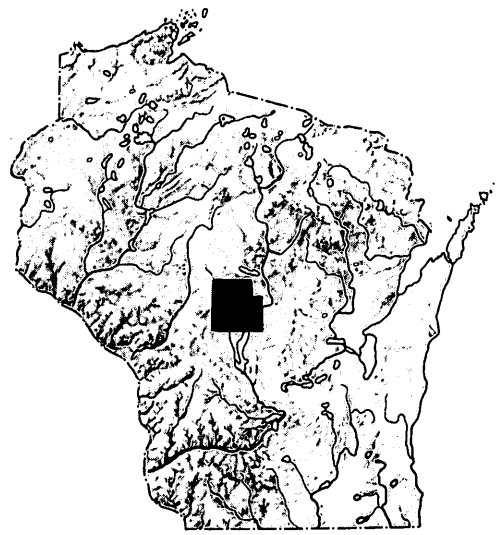
LOCATION: Central Wisconsin

PROJECT CHIEF: William G. Batten

PERIOD OF RECORD: October 1984 to September 1987

OBJECTIVE: This study will describe ground-water availability, movement, use, and quality in Wood County. Emphasis will be placed on determining the presence of ground-water contamination due to solid-waste disposal and agricultural practices.

The results of this study will be used by local planning and zoning officials to determine land-use practices that best utilize and protect the water resources of the county.



APPROACH: Available geologic, water-level, and water-use data from existing wells will be reviewed. About 400 to 500 wells with construction report information will be field located. These well data and additional geologic data from test holes drilled during the study will be used to describe the geology. The glacial geology will be mapped in detail by the Wisconsin Geological and Natural History Survey. The Wisconsin Geological and Natural History Survey will also relate soil type to contamination potential.

Well drillers' specific-capacity data and slug-test data (collected from test holes drilled during this study) will be analyzed to estimate the hydraulic properties of the Precambrian rock aquifer and the glacial sand-and-gravel aquifer.

About 30 wells will be sampled and the water analyzed for major ions and physical properties to define the general ground-water quality in the county. Ground water from wells adjacent to landfills will be sampled and analyzed to determine the possible presence and amount of contamination, if any, by landfill leachate. Wells and streams in areas of heavy agriculture will also be sampled and the water analyzed for contamination by agricultural chemicals.

Historical and present land use will be discussed regarding their potential impact on water quality. This information can then be used as a basis for future water-quality monitoring.

PROGRESS (October 1984 to March 31, 1986): Existing data have been reviewed. Well-construction data from all available construction reports were entered into a computer file. Preliminary statistical analysis of these data has been completed. About 700 well-construction reports were selected for field inventory. Wood County personnel located these wells. Data from these wells have been entered into the ground-water computer data base.

A field reconnaissance of all landfill sites in the county was completed. Ten monitoring sites were selected and electromagnetic surveys were conducted at each of these 10 sites. Observation/sampling wells were installed around each site.

Twenty domestic wells were sampled to help identify general ground-water quality throughout the county.

An initial draft of a water-table map has been completed. A contour map of the thickness of glacial deposits has been started. The locations of wells with high specific-capacity data were plotted on a map and compared with locations of fracture traces to see if there might be a correlation between high well production and fractured bedrock areas.

PLANS (April 1 to June 30, 1986): The glacial thickness map will be completed. Ground water from landfill sites will be sampled and analyzed to determine the amount, if any, of contamination by landfill leachate. About 300 wells will be sampled for constituents indicative of contamination; analyses will test for total dissolved solids, chloride, and nitrogen species.

PLANS (July 1986 to June 1987): Ground water and surface water will be sampled and analyzed in areas where municipal sludge is applied to farm fields to determine the effects, if any, of this practice. All water-quality and ground-water data will be analyzed and report illustrations completed. The initial draft of an interpretive report will be completed.

GROUND-WATER LEVELS AT CREX MEADOWS WILDLIFE AREA, BURNETT COUNTY, WISCONSIN, WI 143

COOPERATOR: Wisconsin Department of Natural Resources

LOCATION: Burnett County

PROJECT CHIEF: Gary Patterson

PERIOD OF PROJECT: October 1984-September 1987

OBJECTIVE: The project objectives are to describe the shallow ground-water system near Crex Meadows and to determine the relationships between the ground- and surface-water systems. High water levels have been a problem in recent years. This project will include an assessment of the influences of the impounded areas within Crex Meadows and of precipitation on water-level fluctuations within the system.

APPROACH: Historical records of wells, test holes, water quality, water levels, streamflow, and precipitation in the vicinity of Crex Meadows will be carefully reviewed. A pre-impoundment water-table map will be prepared using late 1930's boring records. Existing domestic wells in the vicinity of the site will be inventoried and water levels will be measured if possible. Some of these wells will be monitored regularly. After inventory of existing data and wells, approximately 10 monitoring wells will be installed within each of four problem areas. The exact number of wells will be based on the number required to define the hydraulic head gradient. Some of these wells will be installed as piezometer nests to determine vertical gradients in the area. Because the DNR plans to lower the level of Phantom Flowage for dike repair, the wells will be installed there first to determine changes in water levels during the lowering and subsequent refilling of the flowage.

PROGRESS: (October 1984 to March 31, 1986): Fifty-two shallow monitoring wells were installed; some in November 1984 and some in June 1985. Monthly and biweekly water-level measurements have been made since installation of the wells. Water samples were collected for water-quality analysis from 20 wells in August 1985 and analyzed for common inorganics and metals.

Surface-water gaging stations were established at four sites in August 1985, two on the North Fork of the Wood River, one on Hay Creek, and one on Whiskey Creek. Daily stage observations were made through the summer of 1985, and monthly discharge measurements have been made since August 1985.

Water levels from CCC logs made in the 1930's have been plotted and an estimated 1930 water-table map has been prepared.

PLANS (April 1 to June 30, 1986): Water-level monitoring and preparation of current water-table maps will continue. The feasibility of preparing a three- dimensional flow model of the site will be determined.

PLANS (July 1, 1986 to June 1987): Because of delays in the repair and refilling of Phantom Flowage, it is anticipated that the data-collection phase of the project will be extended 1 year.

EAST RIVER WATER-QUALITY ASSESSMENT STUDY, WI 144

COOPERATOR: Fox Valley Water Quality Planning Agency

LOCATION: City of Green Bay and Brown County, northeast Wisconsin

PROJECT CHIEF: Peter E. Hughes

PERIOD OF PROJECT: January 1985 to December 1986

OBJECTIVE: The streamflow characteristics of the East River near its mouth and of a small tributary watershed will be determined. The baseline and storm water quality for the same sites will be monitored. The baseline water quality for the East River upstream of the estuary influence will be determined. Dissolved oxygen and temperature at the gaging stations will be monitored. The application of an accoustic velocity meter (AVM) for determining streamflow in an estuary-affected river reach and the utility of telecommunications data retrieval will be demonstrated.

APPROACH: An AVM gaging station will be established near the mouth of the East River. A gaging station will be established on a 5-square mile drainage area tributary to the East River to provide data for a model that will be used to extrapolate information to other tributary source areas. Dissolved oxygen and temperature monitoring and storm event water-quality sampling will be supplemented by bimonthly baseline sampling. The transport of phosphorus and sediment both upstream and downstream in the East River estuary reach will be evaluated.

PROGRESS (January 1985 through March 1986): Gaging stations have been established near the mouth of the East River and on Bower Creek. The East River site utilizes an accoustic velocity meter because this reach is seiche affected and therefore does not have a stable stage-discharge relationship. Discharge records for the East River site and the Bower Creek site have been completed for the period March 1985 through November 1985. These data were used to calculate the total phosphorus and suspended-sediment loads transported past the gage sites.

PLANS (April 1 to December 1986): The basic data-collection activities will be continued and summaries for discharge, rainfall, and water-quality analyses will be prepared as the data becomes available. It is expected that event sampling will occur for each major increase in discharge (resulting from precipitation) and that samples will be collected for chemical analyses during 10 of those events. Field work will be coordinated with the activities of the Green Bay Metropolitan Sewerage District and the University of Wisconsin-Green Bay. After the completion of the data collection and analyses, a Water-Resources Investigations report will be written to present the findings of the study.

SEDIMENT AND ASSOCIATED PCB TRANSPORT OUT OF LITTLE LAKE BUTTE DES MORTES, LOWER FOX RIVER, WISCONSIN, WI 145

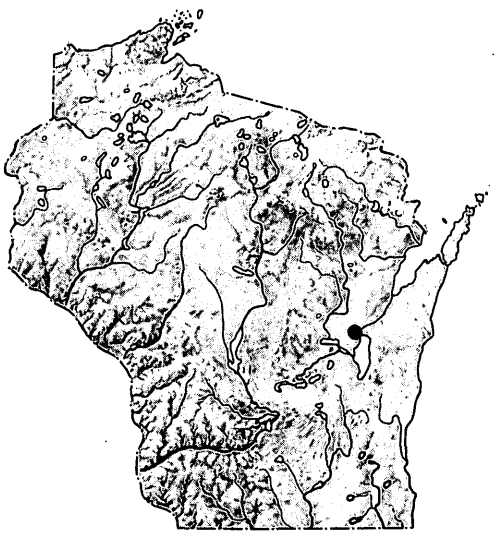
COOPERATOR: Wisconsin Department of Natural Resources

LOCATION: Neenah-Menasha, Appleton area in northeast Wisconsin

PROJECT CHIEF: Leo B. House

PROJECT PERIOD: July 1985 to September 1990

OBJECTIVE: The objectives of this study are to estimate the total mass of PCB's present in the Little Lake Butte Des Mortes bottom sediments, to determine the average annual sediment and PCB transport out of the lake, to determine what relationships exist between sediment and PCB transport, and to estimate the time required for the lake's PCB-contaminated bottom sediments to be scoured from the lake.



APPROACH: River discharge and sediment transport will be monitored for 3 years at the lake outlet. Suspended-sediment samples will be analyzed for PCB concentration. The relationship between suspended-sediment concentration and PCB concentration will be used to estimate the total PCB transport load leaving the lake.

The total mass of PCB's present in the lake bottom sediments will be estimated using sediment core data collected at approximately 50 sites, in conjunction with bathymetric mapping of unconsolidated sediment thickness.

Preliminary investigation indicates that wind and wave action may be significant in resuspension and transport of PCB-contaminated bottom sediments. Special attention and monitoring of these effects will be included as part of the study. Suspended-sediment samples will be collected every eight hours in conjunction with hourly windspeed and direction data at the lake outlet. An acoustic-path velocity meter installation will be used to provide instantaneous real-time discharge information. Such an installation is required because the lake level is controlled by a dam and fluctuates very little. Standard stream-gaging methods that relate discharge to stage would be inadequate for this gage site.

PROGRESS (July 1985 to March 31, 1986): Equipment has been ordered and gage site locations have been selected. Project workplans for equipment installation and data collection have been developed.

PLANS (April 1 to June 1986): The acoustical velocity stream-gaging equipment, suspended sediment, and windspeed monitoring equipment will be installed

PLANS (July 1, 1986 through end of project): Sediment cores will be extracted from the study area by the Wisconsin DNR and analyzed for PCB concentration and total organic carbon content. The unconsolidated sediment thickness within the study area will be mapped by using sonic or seismic reflection methods. Water samples collected at the downstream gage site will be analyzed for suspended-sediment and PCB concentration. Past and present discharge, windspeed, suspended-sediment, and PCB concentration data will be analyzed to determine what relationships exist. The average annual PCB load leaving the study area will be determined and compared to the total mass of PCB in the bottom sediments of the lake and the PCB inflow to estimate the time required for the PCB load leaving the study area to drop to background levels.

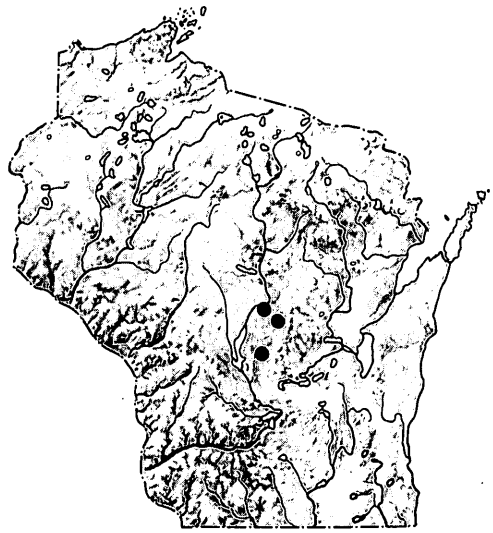
IRRIGATION AND WATER QUALITY, WI 146

COOPERATOR: Wisconsin Department of Natural Resources

LOCATION: Portage and Adams Counties, Wisconsin

PROJECT CHIEF: Phil A. Kammerer

PERIOD OF PROJECT: October 1985 to September 1986



OBJECTIVE: This project continues a ground-water-quality monitoring program, begun in 1979, that provides long-term fixed-site ground-water-quality data for the central sand plain. A proposal for extending the scope and length of this project in order to investigate the relationship between ground-water quality, farming practices, and hydrogeology will be prepared.

APPROACH: The long-term ground-water quality monitoring program that began in 1979 with the Wisconsin Geological and Natural History Survey as project WI-00351 will be resumed. Water samples for chemical analysis will be collected from all irrigation wells and piezometers at the beginning and end of the irrigation season; water-level measurements and field measurements of water temperature, pH, and specific conductance will be made at the time of sample collection. A summary of previously collected data (ground-water quality, ground-water level, chemical and water application, crop type, and precipitation quantity) and recommendations for continued investigation beyond the end of the current fiscal year will be prepared.

PROGRESS (through March 31, 1986): Ground-water quality monitoring began at four sites in 1979-80 as part of the previous project; each site is a 160-acre field irrigated by a central pivot sprinkler system. Piezometer nests were installed around the perimeter of each site (approximately 10 wells per site) for collection of water samples and measurement of ground-water gradients. Some preliminary conclusions may be drawn from data collected at the beginnng and end of each irrigation season through 1884. There are no readily apparent long-term changes with time in water quality occurring at sites that were under irrigation when monitoring began, but there are apparent increases in the concentrations of some constituents in water from the irrigation well on a field that was not brought into cultivation until after the start of the monitoring program. Considerable areal variation in water quality occurs at all sites. Seasonal water-quality changes occur consistently at some wells, especially the irrigation wells.

Water-quality samples were collected and water-level and field water-quality measurements were made at the irrigation and observation wells at the four field sites at the end of the 1985 irrigation season. A draft progress report containing summaries of data collected since the beginning of the monitoring program in 1979 and alternate recommendations for continuing the investigation was submitted to the cooperator.

PLANS (April 1 to June 30, 1986): Water-quality samples will be collected and water-level and water-quality field measurements will be made at irrigation and observation wells at the four field sites at the beginning of the 1986 irrigation season. Plans for continuing this investigation beyond the current fiscal year will be finished and a formal proposal for extending the project into 1987 will be developed.

NATIONAL RUNOFF MAPPING, WI 147

COOPERATOR: WRD, U.S. Geological Survey

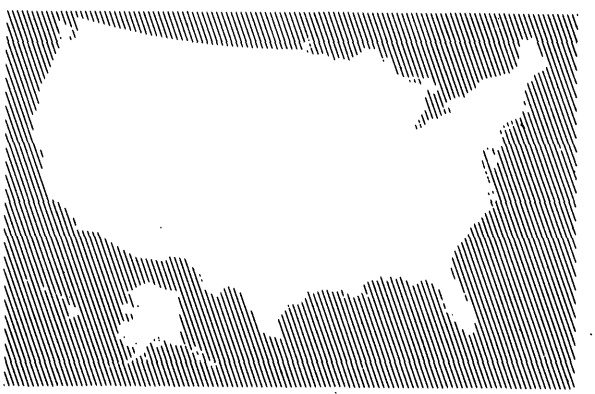
LOCATION: Nationwide

PROJECT CHIEF: David J. Graczyk

PERIOD OF PROJECT: October 1985 to September 1987

OBJECTIVE: To prepare a map of average annual runoff for the United States.

APPROACH: Streamflow data will be used to compute annual runoff for the period 1951-80 for all gaging stations in the country. If streamflow data are not available for the 30-year period, the runoff will be estimated based on correlations with streamflow data from nearby gaging stations. For areas that have no streamflow data available, the average runoff will be estimated based on average runoff values from adjacent units. The average annual runoff values calculated in inches will be plotted in the centroid of the drainage basin. Runoff contours will be drawn based on these values along with topographic variations.



PROGRESS (October 1985 to March 31, 1986): Runoff maps at 1:2,000,000 scale were prepared for use in the National Water Summary for 1985 for all states, including Puerto Rico.

An open-file report "Average Annual Runoff in the United States, 1951-80" by Warren A. Gebert, David J. Graczyk, and William R. Krug was prepared and approved for publication. Streamflow from the 21 water-resource regions in the United States was determined and the open-file report "A History of Annual Streamflows from the 21 Water-Resource Regions in the United States, 1951-83" by David J. Graczyk, William R. Krug, and Warren A. Gebert was prepared. This report has been sent out for colleague review.

PLANS (April 1 to September 1987): An open-file report that documents the methods used to prepare the runoff maps will be produced. Outflow values for use in regional water balances for the 1987 water summary will also be prepared. Statistical streamflow characteristics representing present flow conditions for hydrologic accounting units will be developed.

DEFINITION OF THE SAND-AND-GRAVEL AQUIFER IN SOUTH-CENTRAL WAUKESHA COUNTY, WISCONSIN, WI 148

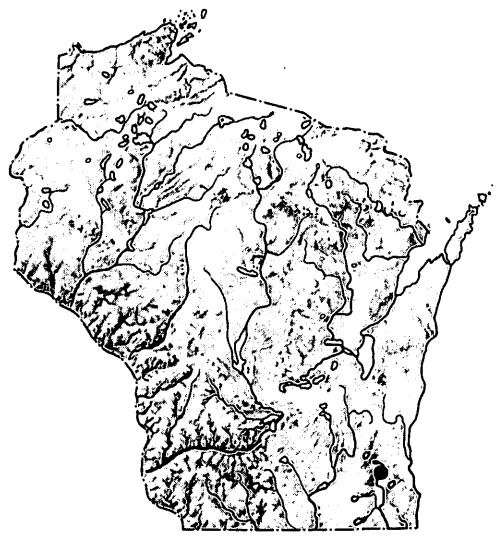
COOPERATOR: Waukesha Water Utility

LOCATION: South-central Waukesha County

PROJECT CHIEF: William G. Batten

PERIOD OF PROJECT: October 1985 to September 1986

OBJECTIVE: The results of this project will better define the extent and thickness of glacial deposits within a preglacial bedrock valley system in southern Waukesha County. Sand and gravel deposits capable of yielding large quantities (500 to 1,000 gallons per minute) of water will be mapped.



APPROACH: Existing geologic, water-level, and pumping-test data will be assembled and reviewed. New data from about 1,500 well-construction reports will be added to the existing data to draw geologic cross sections, a water- table map, and a map of saturated sand and gravel deposits of the study area. Seismic refraction surveys will be conducted to better define the shape of the preglacial valley and the extent of saturated sand and gravel deposits.

PROGRESS (October 1, 1985 to March 31, 1986): All well data have been assembled and well locations plotted on work maps. Cross sections across the bedrock valley have been mapped to determine the existence of any continuous sand and gravel deposits.

PLANS (April 1, 1986 to June 30, 1986): Because of a lack of well information within the bedrock valley, it is planned to drill a few test holes in the study area. During this period the cross sections will be updated and seismic surveys planned.

PLANS (July 1, 1986 to September 30, 1986): All maps and seismic refraction surveys will be completed by August 1986. A summary report will be written and presented to the cooperator in September 1986.

REPORTS UPDATE

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Holmstrom, B. K., Kammerer, P. A., Jr., and Erickson, R. M., 1985, Water resources data--Wisconsin, water year 1984: U.S. Geological Survey Water-Data Report WI-84-1, 373 p., 7 figs.

House, L. B., 1986, Stage fluctuations of Wisconsin Lakes: Wisconsin Geological and Natural History Survey Information Circular No. 49.

Zaporozec, Alexander, and Cotter, R. D., 1985, Major ground-water units of Wisconsin: Wisconsin Geological and Natural History Survey Educational Series No. 28, 20 p.

REPORTS APPROVED AND IN PREPARATION FOR PRINTING:

Batten, W. G., Water resources of Langlade County, Wisconsin: Wisconsin Geological and Natural History Survey Information Circular.

Conger, D. H., Estimating magnitude and frequency of floods for Wisconsin urban streams: U.S. Geological Survey Water-Resources Investigations Report 86-4005.

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Field, S. J., Relations between precipitation, streamflow, and water quality in the Galena River basin, Wisconsin: U.S. Geological Survey Water- Resources Investigations Report 85-4214.

Gebert, W. A., Graczyk, D. J., and Krug, W. R., Average annual runoff in the United States, 1951-80: U.S. Geological Survey Open-File Report 85-627. Graczyk, D. J., Water quality in the St. Croix National Scenic Riverway, Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 85-4319.

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Krohelski, J. T., Ellefson, B. R., and Storlie, C. A., Estimated use of ground water for irrigation in Wisconsin, 1984: U.S. Geological Survey Water- Resources Investigations Report 86-4079.

Krug, W. R., and Goddard, G. L., Effects of urbanization on streamflow, sediment loads, and channel morphology in Pheasant Branch basin near Middleton, Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 85-4068.

Patterson, G. L., and Zaporozec, Alexander, Water-level fluctuations in Wisconsin wells: Wisconsin Geological and Natural History Survey Circular.

Patterson, G. L., and Zaporozec, Alexander, Analysis of water-level fluctuations in Wisconsin wells: Wisconsin Geological and Natural History Survey Circular.

REPORTS WRITTEN AND IN REVIEW:

Allord, G. J., Determining land-use values for hydrologic studies: U.S. Geological Survey Open-File Report.

Allord, G. J., Cotter, R. D., and Zaporozec, Alexander, A guide to Wisconsin's ground-water resources: U.S. Geological Survey Water-Supply Paper.

Graczyk, D. J., Krug, W. R., and Gebert, W. A., A history of annual streamflows from the 21 water-resource regions in the United States and Puerto Rico, 1951-83: U.S. Geological Survey Open-File Report 86-128.

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