CURRENT WATER-RESOURCES ACTIVITIES IN OHIO, 1991

Compiled by S.M. Hindall and Linda D. Camp

U.S. GEOLOGICAL SURVEY

Open-File Report 91-96

Columbus, Ohio

1991

U.S. DEPARTMENT OF THE INTERIOR

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U.S. GEOLOGICAL SURVEY

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FOREWORD

The U.S. Geological Survey, Water Resources Division, has been active in water-resources investigations in Ohio for more than 70 years. During that time, volumes of data have been collected, numerous investigations have been completed, and more than 150 reports have been published on various aspects of Ohio's water resources. Many changes have taken place in the Geological Survey and the Water Resources Division since its formation in 1879, but our mission remains firm--"to provide the hydrologic information and understanding needed for the optimum utilization and management of the Nation's water resources for the overall benefit of the people of the United States." As the water resources of Ohio become increasingly important to its economy and quality of life, the Ohio District's role as an unbiased water-resources investigation and data-collection agency also becomes increasingly important.

Over the years, the District's programs have reflected the needs of the people and priority issues of the times. We have evolved from the early days of hydrologic data collection and ground-water and surface-water reconnaissance studies into flood and low-flow studies, projects associated with energy production, and, finally, into studies relating to hazardous-waste disposal and ground-water contamination. The District continues to move into new areas of water resources previously unstudied by our scientists. Those areas are: agricultural contamination of ground water and surface water, bridge scour, and microbiological and bacterial research and assessments. Through all of this, the District has continued to expend a considerable amount of its resources in collecting and disseminating basic data on surface water, ground water, water quality, and sediment.

Our present program centers on four areas: basic hydrologic data collection, surface-water modeling, ground-water assessment, and ground-water contamination. Of the four areas, basic hydrologic data collection is the largest in terms of employees involved and funds expended; however, the largest number of projects are in the two ground-water categories. In all of the above areas, chemical quality of the resource is an important factor. In fact, I believe that water quality will become the overriding concern in all water-resources investigations well into the 1990's and beyond. The use of computers and digital modeling will continue to be an integral part of all investigations.

Within the next few years, the growth of new projects will be in the area of water quality and aquatic biology and microbiology as it relates to ground-water and surface-water systems. To meet this need, the District will correspondingly increase its technical expertise in the fields of geochemistry, organic chemistry, and microbiology. I look forward to the U.S. Geological Survey's active role in these activities and a continuing relationship with State, county, local, and other Federal agencies in studying the water-resources issues of Ohio.

Nationally, the Water Resources Division is embarking on two very important and far-reaching activities. The first is the implementation of the full-scale National Water-Quality Assessment program (NAWQA). The goals of the NAWQA program are to: provide a nationally consistent description of current water-quality conditions for a large part of the Nation's water resources; define long-term trends (or lack of trends) in water quality; and identify, describe, and explain the major factors that affect observed water-quality conditions and trends. Of the 60 proposed study units, 20 are to begin in Federal fiscal year 1991, and an additional 20 will follow on a 3-year rotational basis. Two basins in Ohio, the Great and Little Miami River basins, and the western Lake Erie basin have been selected for study.

The Water Resources Division is also beginning a division-wide reorganization designed to increase Districts' abilities to meet the needs of cooperating agencies and respond to changing water-resources issues. A major component of the reorganization is the formation of four regions into 19 program areas. Boundaries of the four regions also will change. At this time, there are no plans to change the individual District structure or the way in which Districts deal with cooperating agencies. The subregional concept will allow Districts to share services and technical expertise, and will increase the efficiency of operation and improve the quality of technical programs.

Steven M. Hindall,
District Chief

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ABSTRACT

The mission of the U.S. Geological Survey's Water Resources Division is to provide the hydrologic information and understanding needed for the optimum utilization and management of the Nation's water resources for the overall benefit of the United States. This report summarizes the Division's program in Ohio in 1991.

The work of the Ohio District is carried out through the District office in Columbus and a field office in New Philadelphia. Collection of basic data needed for continuing determination and evaluation of the quantity, quality, and use of Ohio's water resources is the responsibility of the District's Hydrologic Surveillance and Information Management Section. The Hydrologic Investigation and Program Development Section conducts analytical and interpretive water-resources appraisals describing the occurrence, availability, physical, chemical, and biological characteristics of surface water, ground water, and precipitation.

In addition to introductory material describing the structure of the Ohio District, information is presented on current projects, sites at which basic surface-water and ground-water data are collected, and reports on Ohio's water resources published by the U.S. Geological Survey and cooperating agencies.

INTRODUCTION

The U.S. Geological Survey was established by an act of Congress on March 3, 1879, to provide a permanent Federal agency to conduct the systematic and scientific "classification of the public lands, and examination of the geological structure, mineral resources, and products of national domain." An integral part of that original mission includes publishing and disseminating the earth-science information needed to understand, to plan the use of, and to manage the Nation's energy, land, mineral, and water resources.

Since 1879, the research and fact-finding role of the Survey has grown and been modified to meet the changing needs of the Nation it serves. As part of that evolution, the Survey has become the Federal Government's largest earth-science research agency, the Nation's largest civilian mapmaking agency, the primary source of data on the Nation's surface-water and ground-water resources, and the employer of the largest number of professional earth scientists. Today's programs serve a diversity of needs and users. Programs include:

- Conducting detailed assessments of the energy and mineral potential of the Nation's land and offshore areas.
- Investigating and issuing warnings of earthquakes, volcanic eruptions, landslides, and other geologic and hydrologic hazards.
- Conducting research on the geologic structure of the Nation.
- Studying the geologic features, structure, processes, and history of the other planets of our solar system.
- Conducting topographic surveys of the Nation and preparing topographic and thematic maps and related cartographic products.
- Developing and producing digital cartographic data bases and products.
- Collecting data on a routine basis to determine the quantity, quality, and use of surface water and ground water.
- Conducting water-resources appraisals to describe the consequences of alternative plans for developing land and water resources.
- Conducting research in hydraulics and hydrology, and coordinating all Federal water-data acquisition.
- Using remotely sensed data to develop new cartographic, geologic, and hydrologic research techniques for natural-resources planning and management.
- Providing earth-science information through an extensive publications program and a network of public access points.

Along with its continuing commitment to meet the growing and changing earth-science needs of the Nation, the Survey remains dedicated to its original mission to collect, analyze, interpret, publish, and disseminate information about the natural resources of the Nation--providing "Earth Science in the Public Service."

Basic Mission and Program of the Water Resources Division

The mission of the Water Resources Division is to provide the hydrologic information and understanding needed for the optimum utilization and management of the Nation's water resources for the overall benefit of the people of the United States.

This is accomplished, in large part, through cooperation with other Federal and non-Federal agencies, by:

- Collecting, on a systematic basis, data needed for the continuing determination and evaluation of the quantity, quality, and use of the Nation's water resources.
- Conducting analytical and interpretive water-resources appraisals describing the occurrence, availability, and the physical, chemical, and biological characteristics of surface water and ground water.
- Conducting supportive basic and problem-oriented research in hydraulics, hydrology, and related fields of science to improve the scientific basis for investigations and measurement techniques and to understand hydrologic systems sufficiently well to quantitatively predict their response to stress, either natural or manmade.
- Disseminating the water data and the results of these investigations and research through reports, maps, computerized information services, and other forms of public releases.
- Coordinating the activities of Federal agencies in the acquisition of water data for streams, lakes, reservoirs, estuaries, and ground waters.
- Providing scientific and technical assistance in hydrologic fields to other Federal, State, and local agencies, to licensees of the Federal Power Commission, and to international agencies on behalf of the Department of State.
- Acquiring, developing, and disseminating information on water-related natural hazards such as droughts, floods, landslides, land subsidence, mudflows, and volcanoes.
- Administering the provisions of the Water Resources Research Act of 1984, which include the State Water Resources Research Institutes and the Research Grants and Contracts Programs.
- Supporting the provisions of the National Environmental Policy Act of 1969 and managing the Geological Survey conduct of natural resources surveys in response to the Comprehensive Environmental Response, Compensation, and Liability Act (Superfund Act) of 1980.

Operation of the Ohio District

The Ohio District is part of the U.S. Department of the Interior, Geological Survey, Water Resources Division. There are a total of 47 districts; each State is a district except for four States (Delaware, Rhode Island, New Hampshire, and Vermont), which are parts of districts. Recent Water Resources Division reorganization further grouped the 47 districts into 13 areas within 4 major regions. Ohio, Indiana, and Kentucky constitute the Ohio Valley Area.

The Ohio District is comprised of the district office in Columbus and a field office in New Philadelphia. There are two major sections in the district office--Hydrologic Investigation and Program Development and Hydrologic Surveillance and Information Management. The New Philadelphia field office is part of the Hydrologic Surveillance and Information Management Section.

Steven M. Hindall, District Chief, is responsible for the overall operation and management of the District and is assisted by Section Chiefs Richard V. Swisshelm, Jr., and Harold L. Shindel. To carry out the diversity of tasks in support of its varied program, the Ohio District's 50-member staff consists of hydrologists, engineers, hydrologic technicians, and other administrative, clerical, and support personnel.

The chart on the following page depicts the organization of the Ohio District and explains the functions of the individual sections and units within those sections.

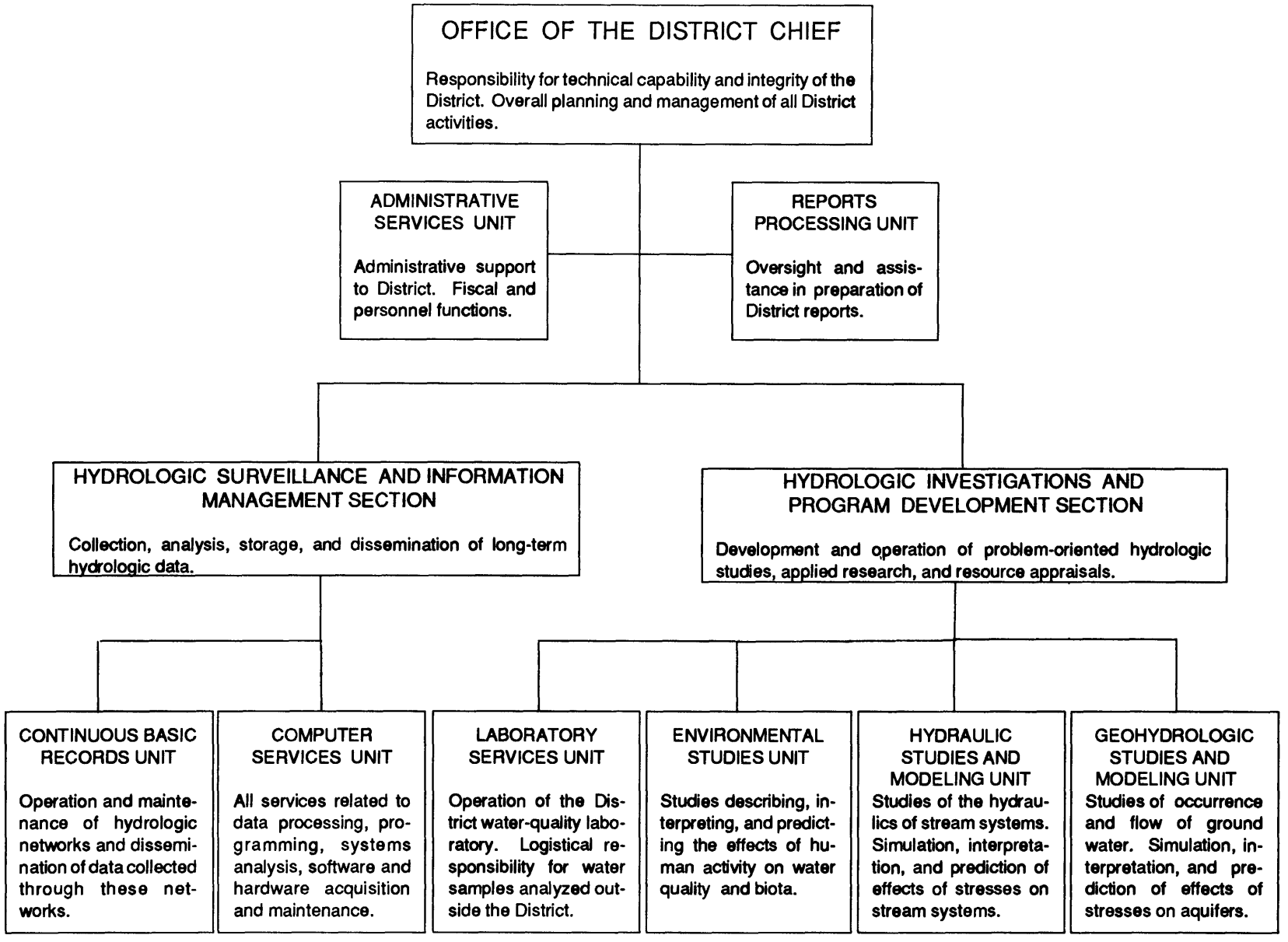
Types of Funding and Cooperating Agencies

Funds to support the work performed by the Ohio District, Water Resources Division, are derived from three principal sources:

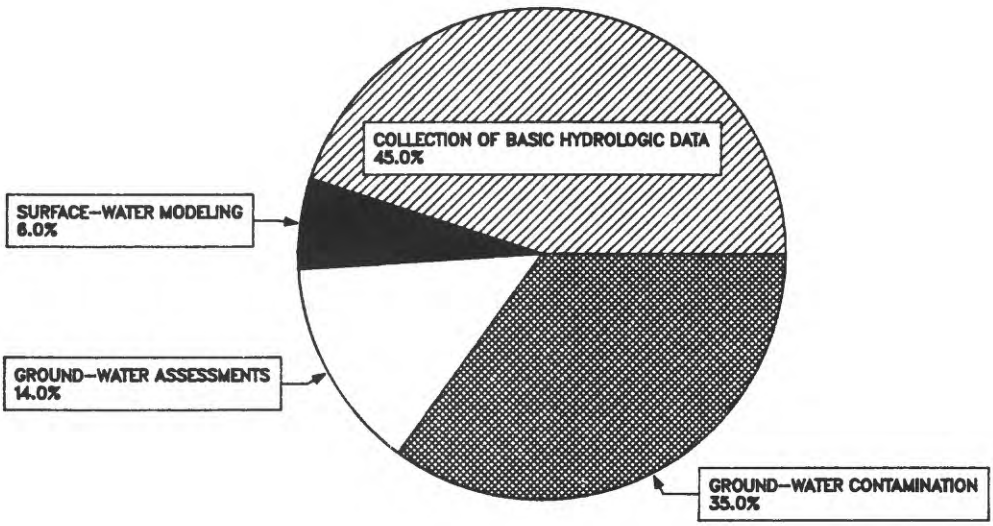
- Federal Program--Funds for the Federal Program are appropriated by the Congress, and are specifically identified in the annual Geological Survey budget. These funds are used to support research, data collection, high-priority topical programs including Regional Aquifer Systems Analysis (RASA), National Water Quality Assessment program (NAWQA), climate research, coordination of all Federal programs related to collection of water data, and internal support services.

- Federal-State Cooperative Program--Federal funds are appropriated by the Congress and used to match those furnished by State and other tax-supported agencies. These funds are used for a variety of hydrologic data-collection activities and water-resources investigations in which the Water Resources Division represents the national responsibilities and the cooperating agencies represent State and local interests.

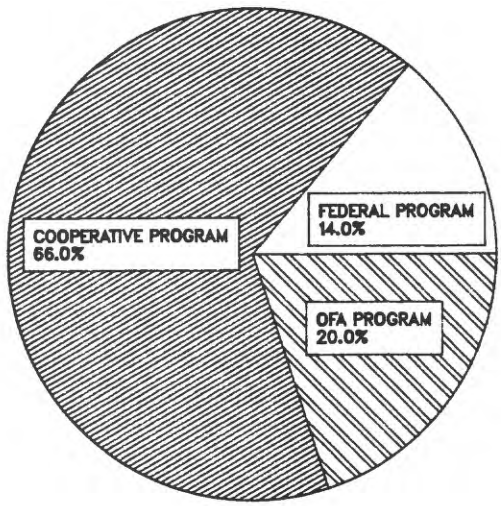
- Other Federal Agencies (OFA) Program--In this program, the funds are transferred to the Geological Survey as reimbursement for work performed at the request of another Federal agency.


OFFICE OF THE DISTRICT CHIEF
Responsibility for technical capability and integrity of the District. Overall planning and management of all District activities.
ADMINISTRATIVE SERVICES UNIT
Administrative support to District. Fiscal and personnel functions.
REPORTS PROCESSING UNIT
Oversight and assistance in preparation of District reports.
HYDROLOGIC SURVEILLANCE AND INFORMATION MANAGEMENT SECTION
Collection, analysis, storage, and dissemination of long-term hydrologic data.
HYDROLOGIC INVESTIGATIONS AND PROGRAM DEVELOPMENT SECTION
Development and operation of problem-oriented hydrologic studies, applied research, and resource appraisals.
CONTINUOUS BASIC RECORDS UNIT
Operation and maintenance of hydrologic networks and dissemination of data collected through these networks.
COMPUTER SERVICES UNIT
All services related to data processing, programming, systems analysis, software and hardware acquisition and maintenance.
LABORATORY SERVICES UNIT
Operation of the District water-quality laboratory. Logistical responsibility for water samples analyzed outside the District.
ENVIRONMENTAL STUDIES UNIT
Studies describing, interpreting, and predicting the effects of human activity on water quality and biota.
HYDRAULIC STUDIES AND MODELING UNIT
Studies of the hydraulics of stream systems. Simulation, interpretation, and prediction of effects of stresses on stream systems.
GEOHYDROLOGIC STUDIES AND MODELING UNIT
Studies of occurrence and flow of ground water. Simulation, interpretation, and prediction of effects of stresses on aquifers.

The diagram below shows the percentage of the District's projects for fiscal 1991 in each of the broad categories of basic hydrologic data collection, surface-water modeling, ground-water assessments, and ground-water-contamination studies.



The programs are supported by funds provided by State and local units of government and Federal funds from the U.S. Geological Survey and other Federal agencies (OFA program). About 65 percent of the funds contributed by the Geological Survey are used to match funds contributed by the State and other local units of government. In fiscal year 1991, the total financial support for all programs in Ohio is about $4.0 million and is distributed as follows:



Public-Information and Public-Service Activities

The activities of the Ohio District staff are not confined to project work. Much of the daily activity of the staff is devoted to answering requests from landowners, public officials, and business concerns on a wide range of hydrologic and geologic topics. For example, the Ohio District spent 342 hours answering 650 telephone and mail inquiries during 1990.

District personnel also are involved in education. Staff hydrologists and hydrologic technicians have served as instructors and guest lecturers for water-resources courses at The Ohio State University, Ohio University, Central State University, and other U.S. Geological Survey offices. The District also has sponsored seminars and information-exchange meetings with themes ranging from well design to political and social water-resources issues in Ohio.

Equally important is the involvement of district staff in work groups, committees, and task forces of professional societies and other government agencies. Among these groups are:

- Technical Committee and Toxic Strategy Subcommittee of the Ohio River Valley Water Sanitation Commission (ORSANCO).
- Public Advisory Groups of the Ohio Environmental Protection Agency.
- Water Management Association of Ohio (WMAO).
- Program Review Panel for The Ohio State University Water Resources Center.
- Steering Committee for the Ohio Water Seminar Luncheon Series.
- Board of Directors of the Ohio Lake Management Society.
- Ohio State section of the American Institute of Hydrology.
- The Ohio State University Student Chapter of the American Society of Civil Engineers (advisory role).
- Planning committees for technical conferences and annual meetings.

Summary of Water Conditions in Ohio

The availability of water has been an important factor in Ohio's development. Ohio's principal streams (fig. 1) were the settlers' first avenues of transportation and their first sources of power for manufacturing. Shallow, hand-dug wells provided water to a growing farm population. The construction of canals beginning in 1825 continued to encourage the growth of cities and industries and to stimulate agricultural production. Today, Ohio is still characterized by a diverse economy in which water resources play a vital part.

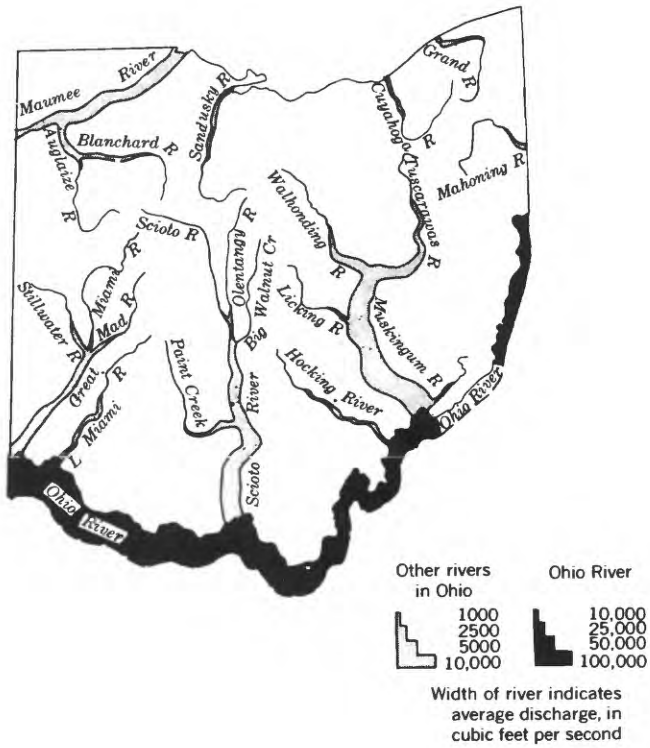


Figure 1.--Average discharge of principal streams in Ohio.

Ohio receives about 38 inches of precipitation annually. About 10 inches runs off immediately, 2 inches is retained at or near the surface and evaporates or transpires, and 26 inches enters the ground. Of the 26 inches that enters the ground, 20 inches is retained in the unsaturated zone and is later lost by evapotranspiration. The remaining 6 inches reaches the water table. Of this 6 inches, 2 inches is eventually discharged to streams, and the rest is lost by evapotranspiration or consumptive use.

Ohio's water problems tend to be localized. Generally, these problems involve excess water (flooding or poor drainage) or water quality. Nonpoint source (NPS) contamination of surface water and ground water is becoming a significant problem in Ohio as more is being learned of the effects of NPS on water-resource systems.

Serious local flooding occurs in Ohio nearly every year. Most Ohio floods are either flash floods resulting from intense summer thunderstorms or large-stream floods resulting from a combination of rain and snowmelt. Accelerated erosion of bare ground and streambanks and deposition of sediment in stream channels, culverts, and drainage ditches are negative side effects of flooding. Eight projects are active in the Ohio District in fiscal year 1991 that directly or indirectly contribute to our knowledge of flooding and (or) related sedimentation problems in the State.

The focus of concern about Ohio's water quality in recent years has been on waste disposal and its effects on ground-water quality. Despite the predominance of surface water in terms of total withdrawal, the importance of ground water to Ohio cannot be overlooked. Nearly 80 percent of the public water-supply systems in the State depends to some extent on ground water as a source, and 42 percent of the Ohio population uses ground water as their primary supply. The principal aquifers in Ohio are the unconsolidated deposits of coarse- or fine-grained sediments and sedimentary rocks of shaly sandstone and (or) limestone (carbonate). Geographic distribution of the principal aquifers in Ohio is shown in figure 2.

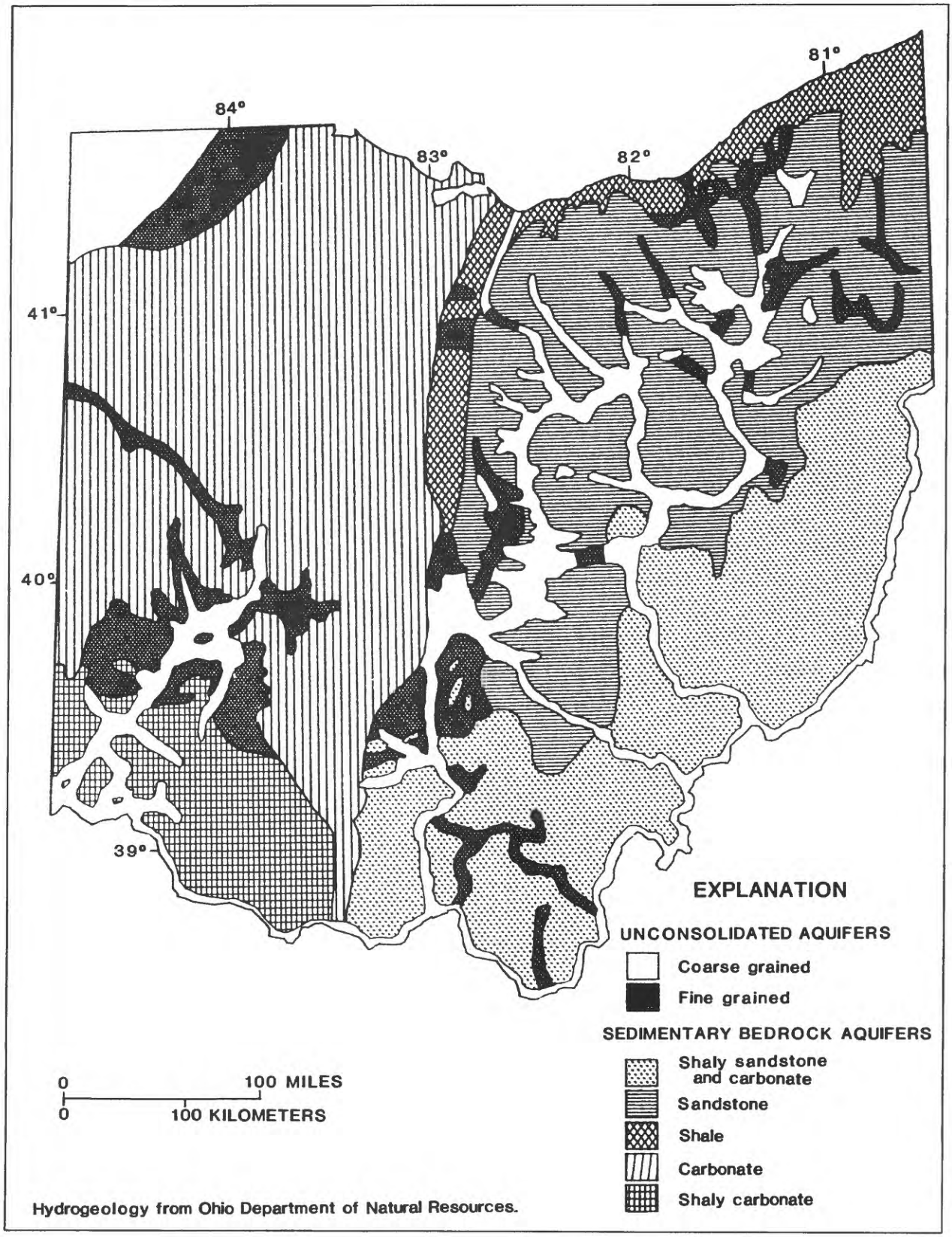


Figure 2.--Geographic distribution of principal aquifers in Ohio.

INFORMATION CONTAINED IN THIS REPORT

Information is presented in the remainder of this report in four parts: (1) A listing and brief description of current projects, (2) a listing of surface-water hydrologic data stations, (3) a listing of ground-water hydrologic data stations, and (4) selected references on Ohio hydrology. The first part contains information on the status of all projects in which there has been activity during 1991. Further information concerning project activities is available from the project leader or from Richard V. Swisshelm, Jr., Chief, Hydrologic Investigation and Program Development Section. The second and third parts contain tables showing station numbers, station names, and types of data collected. Further information on statewide station activities, unpublished records, or provisional data prior to publication is available from Harold L. Shindel, Chief, Hydrologic Surveillance and Information Management Section. The fourth part is a selected list of reports issued by the U.S. Geological Survey and its cooperating agencies concerning hydrologic investigations in Ohio. Further information on these reports is available from Ann E. Arnett, Information Officer for the Ohio District.

These contact people can be reached at:

District Office
Water Resources Division
U.S. Geological Survey
975 W. Third Avenue
Columbus, OH 43212
(614) 469-5553

Information about data-collection activities in northeastern Ohio also can be obtained by contacting:

Lowell Trimble
New Philadelphia Field Office
Water Resources Division
U.S. Geological Survey
551 Wabash Avenue, P.O. Box 272
New Philadelphia, OH 44663
(216) 343-2343

OTHER INFORMATION AVAILABLE

The U.S. Geological Survey publishes an annual series of reports titled "Water Resources Data--Ohio," in which the hydrologic data collected during each water year are presented. Information about these reports and how to obtain them is available from the district office at the address and phone number given above.

Flood-prone-area maps for selected parts of Ohio also are available from the district office. These maps were prepared in cooperation with the U.S. Department of Housing and Urban Development, Federal Insurance Administration, to serve as guides for public agencies and private citizens concerned with present and future land development. The maps were prepared on standard 7-1/2 minute topographic quadrangles, and show the approximate area subject to inundation by a 100-year flood.

CURRENT PROJECTS

The project descriptions that follow show the project number, title, period of the project, cooperating agencies, project leader, purpose of the project, and progress and significant results.

SURFACE-WATER STATIONS
(OH001)

Period of Project:
Continuous since October 1915

Project Leader:
Harold L. Shindel

Cooperators:
- Ohio Department of Natural Resources
- City of Columbus
- Miami Conservancy District
- Ohio Environmental Protection Agency
- City of Canton
- U.S. Army Corps of Engineers
- Seneca Soil and Water District
- Ross County
- City of Fremont
- Toledo Metropolitan Area Council of Governments
- University of Cincinnati
- Eastgate Development
- City of Lima
- City of Akron
- U.S. Department of Energy

Purpose: Provide a surface-water data base through collection, analysis, and publication of records for streamflow-gaging stations and selected sites along streams, lakes, and reservoirs throughout Ohio. The gaging-station network is operated in cooperation with other Federal, State, and local agencies. The surface-water data base provides information for research purposes of surveillance, planning, design, hazards warning, accounting systems, operation, and management in various water-related fields.

Progress and significant results: Field data were collected on schedule and prepared for publication (water year 1990) as "U.S. Geological Survey, Water Resources Data--Ohio, 1990, volumes 1 and 2." Network maintenance was continued, including modernization of equipment in places to improve record quality. Modifications to the network, such as additions or deletions of stations or data-collecting activity, were made in response to program needs.

GROUND-WATER STATIONS
(OH002)

Period of Project:
Continuous since January 1938

Project Leader:
Stephen A. Vivian

Cooperator:
Ohio Department of Natural Resources

Purpose: Observe the effects on ground-water quantity and quality exerted by such factors as climatic variations and withdrawal patterns. Water-level data are collected to provide a data base against which short- and long-term fluctuations can be compared for proper planning and management.

Progress and significant results: Field data were collected and processed on schedule for annual report publication. The network currently consists of 10 sites instrumented with continuous recorders, 14 sites at which periodic measurements are made, and 92 State-operated sites instrumented with continuous recorders.

WATER-QUALITY STATIONS
(OH003)

Period of Project:
Continuous since January 1946

Project Leader:
Charles N. Owens

Cooperators:
Miami Conservancy District
Ohio Environmental Protection Agency

▼ NASQAN station
■ Benchmark station
● Ground-water site

Purpose: Collect, analyze, and publish water-quality records for selected sites in Ohio in cooperation with State and local agencies. The records contribute to a national water-quality data base requisite to nationwide and regional planning and action programs.

Progress and significant results: Surface-water stations operated by the U.S. Geological Survey consist of nine NASQAN stations and one Benchmark station in the water-quality network in water year 1991. Four Miami Conservancy District ground-water sites also were sampled. The Geological Survey collects a water sample at the NASQAN sites for the Ohio Environmental Protection Agency for the determination of chemical oxygen demand. Data for water year 1990 were published in the annual report.

SEDIMENT STATIONS
(OH004)

Period of Project:
Continuous since July 1970

Project Leader:
Jesse H. Klingler

Cooperator:
Ohio Department of Natural Resources

Purpose: Provide a data base needed to assess sedimentation characteristics of drainage areas required for planning and management of State and Federal programs. The data also are needed to evaluate effectiveness of Ohio House Bill 513, which concerns the abatement of sediment pollution in agricultural and urban situations.

Progress and significant results: A network of five daily sediment stations representative of Ohio's major physiographic provinces is being operated to provide spatial and temporal averages of concentration, discharge, and particle-size distribution of suspended sediment carried by major streams. Suspended-sediment data also were collected from finite-duration studies in selected agricultural, mined, and urban areas. All 1990 data were collected and processed on schedule for publication in the annual report.

FLOOD INVESTIGATIONS
(OH006)

Period of Project:
March 1984 (reestablished)
through September 1991

Project Leader:
K. Scott Jackson

Cooperator:
Federal Emergency Management
Agency (FEMA)

Purpose: Conduct the necessary hydrologic and hydraulic evaluations and studies of areas assigned by the Federal Emergency Management Agency (FEMA) and to present the results in an appropriate format. The National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973 provide for the operation of a flood-insurance program. Flood studies in selected areas are needed by FEMA to determine applicable flood-insurance premium rates.

Progress and significant results: Work has been completed on FEMA-FIA Type 15 flood-insurance studies at Crooksville, Perry County, and London, Madison County, Ohio. Seventeen Limited-Detail Studies have been completed: St. Marys, Auglaize County; Darbyville, Pickaway County; Jewett, Harrison County; Amesville, Athens County; Middlefield, Geauga County; Jeffersonville, Fayette County; Belle Valley, Noble County; Sabina, Clinton County; Lynchburg, Highland County; Hamden, Vinton County; Salineville, Columbiana County; Coalton, Jackson County; Rutland, Meigs County; Roseville, Perry County; Westerville, Franklin County; Pickerington, Fairfield County; and Montgomery, Hamilton County. A new Limited-Detail Study area, Louisville, Stark County, is in progress. One Limited-Map Maintenance Program restudy, for the community of Reynoldsburg, Franklin, Licking, and Fairfield Counties, has been completed.

WATER USE IN OHIO
(OH007)

Period of Project:
Continuous since October 1977

Project Leader:
Vance E. Nichols

Cooperator:
Ohio Department of Natural Resources

Purpose: Establish an effective and coordinated program for collecting, storing, accessing, and disseminating water-use data. The data are organized to be compatible with a National data base for water use. In Ohio, there is a demonstrated need for local and statewide water-use information that is consistent with regard to definitions, standards, and methods of presentation.

Progress and significant results: U.S. Geological Survey Open-File Report 89-423, "Withdrawal and distribution of water by public water supplies in Ohio, 1985" (released March 14, 1990), and U.S. Geological Survey Water-Supply Paper 2350, "National Water Summary 1987, Hydrologic Events and Water Supply and Use" (released June 21, 1990), were published. A microcomputer data base, developed in cooperation with the Ohio Department of Natural Resources, Division of Water, was installed at the Division of Water to store and organize data on water users who withdraw more than 100,000 gallons per day (reporting of water use in excess of 100,000 gallons per day is now required by State law). Public-water-supply, commercial, and industrial data continued to be entered into the updated version of the National Water Inventory System's Site Specific Water Use Data System data base on the District's computer system. Quality-assurance and quality-control evaluation of the entered data also continues.

HYDRAULICS OF RIVER VALLEYS AND BRIDGE SITES (OH010)

Period of Project:
Continuous since June 1963

Project Leader:
G.F. Koltun

Cooperator:
Ohio Department of Transportation

Purpose: Evaluate the hydraulic effects of proposed or existing bridges and highway fills at selected locations. Such structures can decrease the capacity of river valleys for conveying floodwaters and, in turn, could cause backwater and excessive upstream flooding. This project also provides information to highway engineers on miscellaneous hydrologic topics related to the design or maintenance of highway properties.

Progress and significant results: Monitoring of discharge from conventional sand-and-gravel-fill and geotextile longitudinal highway drains continues. The conventional drain generally exhibits the quicker, more peaked response after a storm; however, an appreciably greater volume of water discharges from the geotextile drain over time.

AUTOMATIC MEASUREMENT OF TEMPERATURE, SPECIFIC CONDUCTANCE, DISSOLVED OXYGEN AND pH IN SELECTED STREAMS IN OHIO (OH042)

Period of Project:
Continuous (re-established October 1985)

Project Leader:
Max S. Katzenbach

Cooperators:
Ohio Department of Natural Resources
Ross County

Purpose: (1) Continuously collect stream-temperature, dissolved-oxygen, specific-conductance and pH data, which will serve as either direct or surrogate indicators of water-quality conditions in analyses conducted by the U.S. Geological Survey and State agencies to determine the effect of human activity on surface waters; and (2) provide relevant standardized data collected continously for comprehensive study by the U.S. Geological Survey and other agencies for planning purposes and pollution control.

Progress and significant results: Data collection and processing continued at all 10 water-quality monitor stations. Five stations have been added to the real-time data network. Modifications to the network, such as additions or deletions of stations, were made in response to program's needs. Data for 1990 were published in the annual hydrologic data report.

FLOOD-VOLUME FREQUENCY IN SMALL DRAINAGE BASINS IN OHIO (OH056)

Period of Project:
February 1981 through
September 1992

Project Leader:
James M. Sherwood

Cooperator:
Ohio Department of Transportation
and U.S. Department of Transportation,
Federal Highway Administration

Purpose: Define the magnitude and frequency of flood volumes as a function of duration from small (less than 10 square miles) rural basins in Ohio, and (2) develop a method for deriving a design-flow hydrograph from small rural basins in Ohio. A simple and straightforward method for determining the magnitude and frequency of flood runoff-volumes and for deriving flood hydrograph shapes is needed to allow drainage planners to design hydraulic structures that safely and economically convey flood flows. A review of existing data in Ohio indicates that complete hydrograph records are not generally available for rural basins.

Progress and significant results: Reanalysis of synthetic flood-volume data prior to publication of the final report was approved by the cooperating agencies and is underway currently.

QUALITY OF SURFACE WATER AND GROUND WATER IN ACTIVE COAL-MINING AREAS OF OHIO
(OH084)

Period of Project:
July 1985 through
September 1992

Project Leader:
A.C. Sedam

Cooperator:
Ohio Department of Natural Resources, Division of Reclamation

Purpose: Collect and interpret baseline water-quality data on ground water and surface water in the active coal-mining areas of Ohio. These data will be used by the Ohio Department of Natural Resources as a reference in evaluating surface-mining-permit applications and compliance with surface-mining regulations and in assessing the effects of present and future mining and reclamation. Twenty-one basins in southeastern Ohio will be investigated and monitored during a 7-year period.

Progress and significant results: A long-term network of 41 surface-water sites has been sampled twice annually during periods of suitable low flow. Each year, as many as three basins were selected for additional study consisting of one-time sampling of 5 to 10 additional stream sites. In each of these selected basins, four ground-water samples were collected if shallow productive aquifers were present. To date, 17 basins have been studied in this manner.

Two intermim reports have been prepared: "Geologic setting and water quality of selected basins in the active coal mining areas of Ohio, June 1985 through December 1986," by A.L. Jones, released in 1989, and "Geologic setting and water quality of selected basins in active coal mining areas of Ohio, 1987-88," by A.C. Sedam, to be released in 1991.

EFFECTS OF HIGHWAY DEICING CHEMICALS ON SHALLOW UNCONSOLIDATED AQUIFERS IN OHIO (OH092)

Period of Project:
January 1988 through
December 1997

Project Leader:
Allison L. Jones

Cooperator:
Ohio Department of Transportation

Purpose: Determine the effects of highway-deicing chemicals, predominantly chloride, on the ground-water quality of shallow unconfined aquifers that underlie highways in Ohio, (2) determine those effects in different soil-type and climatic areas of Ohio, (3) track the movement of chlorides away from the highway to observe seasonal variations in chloride migration, (4) determine yearly changes in chloride concentration caused by variation in snowfall, and (5) determine the concentrations of selected ions in the soil and unsaturated zone. In Ohio, there is a lack of detailed knowledge concerning the movement of deicing salts after they have been applied to roads. The use of road salts has been increasing continuously since about 1940. There is growing indication that all applied salts do not leave the area of application, but that some, in fact, accumulate. The Ohio Department of Transportation (ODOT) needs long-term data on the effects of salts on soil and ground water in Ohio.

Progress and significant results: Eight sites were selected from a group of 55 potential sites through the use of maps of geology, glacial features, snowfall, and soil types. Records of county salt-application rates, water-well logs, and other literature also were consulted. Each site is being investigated by use of a ground-conductivity electromagnetic geophysical system. Test drilling was done at each potential site to determine formation type and content, water levels, and direction and velocity of ground-water flow. The eight study sites were selected in the following counties: Lucas, Pickaway, Champaign, Clark, Richland, Ashland, Portage, and Ashtabula. Seven to nine wells were drilled at each site and developed. Background water-quality samples were collected at all wells. Results of slug tests and a solute-transport model were used to help predict ground-water velocity and determine placement of permanent wells.

Detailed programs for electronic data logging and storage devices were prepared. Instrumentation assembly and installation were completed. Detailed geophysical surveys were done at each site. State-of-the-art surveying equipmnet was used to make topographic maps of each site. Monthly sampling has begun at all sites. An annotated outline of the first report was begun. Soil samples were collected and analyzed. Each site was doublechecked for any other possible sources of chloride.

HYDROGEOLOGY AND GROUND-WATER QUALITY OF WRIGHT-PATTERSON AIR FORCE BASE, SOUTHWESTERN OHIO (OH093)

Period of Project:
June 1987 through
February 1993

Project Leader:
Jeffrey T. de Roche

Cooperator:
U.S. Air Force,
Air Force Logistics Command
2750th Air Base Wing
Office of Environmental Management

Purpose: Investigate, on a regional basis, the hydrogeology of Wright-Patterson Air Force Base (WPAFB). The objective of the study is to characterize the hydrogeologic setting of the base within the framework of the regional ground-water-flow system. Specific tasks include: (1) compiling information on historic and current ground-water flow and quality; (2) defining of areal geology, ground-water occurrence, and ground-water flow, and (3) developing a numerical ground-water model as an interpretive tool for understanding the regional ground-water-flow system.

Progress and significant results: A computerized data base has been completed and delivered to WPAFB. The data base, which includes data in the USGS WATSTORE and GWSI systems, is a listing of selected domestic, industrial, public-supply, and observation wells and associated water-quality data. A geophysical investigation was completed by use of seismic-refraction and electrical-resistivity techniques. Two rounds of water-level measurements were made. Maps and hydrogeologic sections showing bedrock contours, drift thickness, and ground-water flow were prepared. A conceptual model of the ground-water-flow system was prepared. An exploratory drilling program to determine the specific nature and thickness of the glacial deposits was completed.

The USGS has now installed a total of 34 observation wells on base. Aquifer testing by means of slug-injection methods was completed. A geophysical well-logging program was completed. An Open-File Data Report containing all information on the well network is being prepared. An Open-File Data Report containing information on historical ground-water quality also is being prepared. A numerical ground-water model of WPAFB and outlying areas is being prepared.

HYDROLOGIC EFFECTS OF LONGWALL MINING IN OHIO (OH095)

Period of Project:
July 1987 through
June 1992

Project Leader:
Alban W. Coen, III

Cooperator:
Ohio Department of Natural Resources,
Division of Reclamation

Purpose: Examine the effects of longwall mining on (1) the magnitude of stream discharge, and (2) the chemical and biological quality of surface water. Little is known about the effects that longwall mining will have on hydrologic systems, even though longwall mining is rapidly becoming the primary form of mining in Ohio. The effects of longwall mining on surface-water flow and quality need to be measured, interpreted, and reported in Ohio to determine and describe the effects of longwall mining on selected hydrologic environments typical of those found in Ohio.

Progress and significant results: Streams have been sampled and discharges have been measured at eight sites near a longwall coal mine in southern Ohio. In 1990, the scope of the project was changed to include the study of a segment of a stream that is being undermined by longwall mining. An interim data report is planned for 1991 in which streamflow, water-quality, and biological data for the first 3 years of the study will be presented.

LAKE ERIE TRIBUTARY LOADING--OHIO, INDIANA, AND MICHIGAN (OH096)

Period of Project:
Continous since August 1987

Project Leader:
John W. Roberts

Cooperator:
Ohio Department of Natural Resources

Purpose: Determine phosphorus, sediment, and selected chemical loads in several major streams tributary to Lake Erie. Agriculture is the primary land use in the Ohio part of the Lake Erie basin and is considered responsible for much of the water-quality degradation of Lake Erie and its tributaries. In June 1983, the United States and Canada agreed to reduce phosphorus loading to Lake Erie by an additional 2,000 metric tons per year. A network of data-collection stations is needed on Lake Erie tributaries to determine (1) if this goal is being met, (2) the amounts of other chemicals entering the lake, and (3) other effects of agricultural land use.

Progress and significant results: A network of data-collection stations has been established in Ohio on the Huron, Maumee, Sandusky, Cuyahoga, and Grand Rivers, and Honey Creek. Suspended-sediment and water-quality samples were collected along with continuous discharge data at all five sites (Honey Creek sampling was discontinued at the end of the 1989 water year). Annual loads were computed for suspended sediment, total phosphorus, total kjeldahl-nitrogen, nitrite plus nitrate, and chloride.

ESTIMATION OF PEAK-FREQUENCY RELATIONS, FLOOD HYDROGRAPHS, AND VOLUME-DURATION-FREQUENCY RELATIONS OF UNGAGED SMALL URBAN STREAMS IN OHIO
(OH098)

Period of Project:
January 1989 through
July 1991

Project Leader:
James M. Sherwood

Cooperator:
Ohio Department of Transportation

Purpose: Develop simple and straightforward method for estimating peak discharges, flood hydrographs, and maximum flood volumes of specific durations and frequencies at ungaged small urban streams in Ohio to allow drainage engineers to safely and economically design hydraulic structures, such as culverts and detention-retention basins, in which the temporary storage of water is a critical element of the design criteria. To do this, statewide multiple-regression equations will be developed for estimating peak discharges, basin lagtimes, and volume-duration-frequency relations at ungaged urban sites from physical and climatic variables and a measure of basin development. Hydrologic models from 30 sites calibrated during a recent urban flood-peak frequency study will be used to synthesize long-term (80-year) hydrograph records from long-term rainfall records.

Progress and significant results: Multiple-regression analyses and all other analyses were completed. The final report has been completed and is currently in review.

EVALUATION OF BRIDGE-SCOUR DATA AT SELECTED SITES IN OHIO (OH099)

Period of Project:
January 1989 through
October 1996

Project Leader:
K. Scott Jackson

Cooperator:
Ohio Department of Transportation

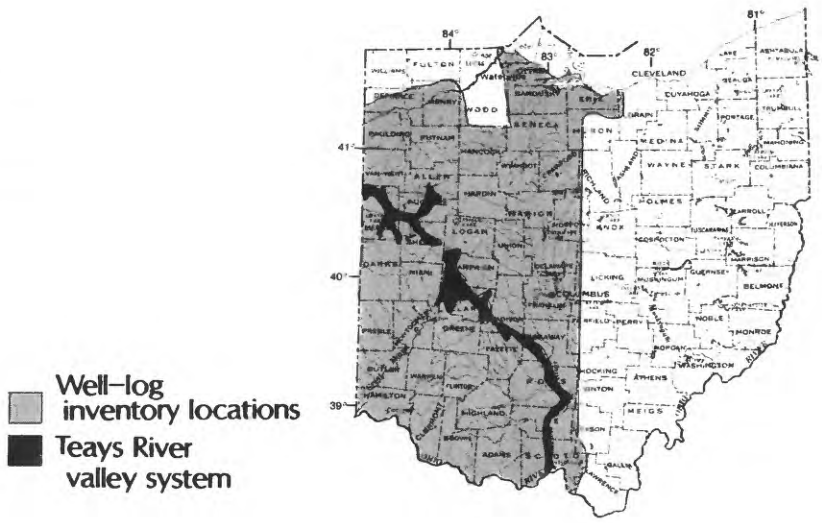
Purpose: (1) Collect reliable and sufficient data during flood events to determine whether local scour, construction scour, and general scour are taking place at 20 selected sites in Ohio; (2) compare and evaluate published local scour-prediction equations with observed data; and (3) compare local scour data collected by means of geophysical techniques with local scour data defined by physical measurements. Adequate definition of the potential scour (erosion of bed materials) at bridge sites is essential to proper design, construction, and maintenance of hydraulic structures in Ohio. Data will be collected during a 5-year period, which should provide 50 total measurements and 2 measurements at each site.

Progress and significant results: Twenty data-collection sites were established, and collection of high-flow scour data was begun. Geophysical data were collected for the 20 sites. The report outline was completed and the first draft of the final report was begun.

THE REGIONAL HYDROGEOLOGY OF THE BURIED TEAYS RIVER VALLEY SYSTEM (OH100)

Period of Project:
May 1989 through
September 1993

Project Leader:
Rodney A. Sheets



Purpose: (1) Compile hydrogeologic data for the buried Teays River valley system and enter it into a computerized format, (2) supplement existing geohydrologic data for the Teays system through water-level measurements, water-quality sampling, and surface and borehole geophysics, and (3) interpret the collected data to determine and describe how the Teays ground-water system interacts with the carbonate-glacial system and the surface-water system on a regional scale. The character of flow and chemistry of aquifer water within the Teays River valley system needs to be examined to effectively investigate its role in the regional flow and chemistry of the carbonate and glacial aquifer system.

Progress and significant results: A search of the literature of the Teays system has been completed. One of three site-specific areas has been chosen. A well-log inventory and locations and a low-flow study plan have been completed for site 1. The report for the original data-compilation project is complete and will be published soon.

CALIBRATION OF A DYNAMIC STREAMFLOW SIMULATION MODEL FOR SUMMIT COUNTY, OHIO
(OH101)

Period of Project:
August 1989 through
July 1999

Project Leader:
James M. Sherwood

Cooperator:
Summit County

Purpose: Provide Summit County engineers with a means of accurately testing the effects of proposed development and runoff-controlling mechanisms on the flood characteristics of four drainage basins and numerous subbasins in west-central Summit County. The analytical tool to be developed will be based on on-site streamflow and rainfall data and will provide detailed information on peak-discharge frequency, volume-duration frequency, flood profiles, flood hydrographs, and flow velocities. The HSPF (Hydrologic Simulation Program--FORTRAN) model will be calibrated for each of the four basins. Data from 10 stream gages, 10 rain gages, and 10 crest-stage gages will be used to calibrate the models.

Progress and significant results: Equipment was purchased for instrumentation, and reconnaissance and site selection were completed in two of the four basins. Installation of stream gages has begun, and data collection will begin soon.

ANALYSIS OF GROUND-WATER FLOW AT THE SOUTH WELL FIELD, COLUMBUS, OHIO, BY USE OF A TRANSIENT GROUND-WATER-FLOW MODEL AND PARTICLE-TRACKING COMPUTATIONS
(OH102)

Period of Project:
November 1989 through
January 1994

Project Leader:
William L. Cunningham

Cooperator:
City of Columbus, Ohio

Purpose: Determine estimated ground-water traveltimes and flow paths under transient flow from potential contamination sites to eventual discharge points at the South Well Field. Reports of the study will describe (1) the ground-water-flow system at the South Well Field, (2) a transient-flow model used to simulate the ground-water-flow system, and (3) a particle-tracking procedure used to determine the zone of contribution to the well field. The reports also will describe the hydrogeologic framework of the study area. A four-phase approach to the study will be to (1) collect ground-water-level and water-quality data; (2) evaluate results of previous aquifer testing, numerical input, and results of previous flow models, and water-level measurements for use in the numerical ground-water-flow model; (3) construct a three-dimensional transient ground-water-flow model; and (4) determine the zone of contribution to the well field and predict the effects of possible stresses on the system, including quarrying, infiltration galleries, and pumping variations.

Progress and significant results: Water-level and water-quality data are being collected. Geologic interpretation is complete. Steady-state model calibration is complete, and transient calibration is in progress. Preliminary steady-state particle tracking has been done, and report writing is underway.

Two reports are planned: (1) Simulation of transient ground-water flow at the South Well Field, Columbus, Ohio, and (2) Analysis of ground-water flow at the South Well Field, Columbus, Ohio, by use of a transient ground-water-flow model and particle-tracking computations.

GROUND-WATER FLOW AND GEOCHEMISTRY BENEATH SURFACE-MINED WATERSHEDS RECLAIMED WITH FLUE-GAS-DESULFURIZATION BYPRODUCTS AS SPOIL AND SOIL AMENDMENTS, SOUTHEASTERN OHIO (OH103)

Period of Project:
September 1990 through
April 1994

Project Leader:
Ralph J. Haefner

Cooperator:
The Ohio State University
Research Foundation (OSURF)

Purpose: (1) Determine short-term changes and develop the capability to detect long-term changes in ground-water quality beneath surface mines reclaimed with flue-gas-desulfurization (FGD) byproduct, and (2) describe the occurrence and mobility of elements in ground water that are derived from FGD byproduct. Flue-gas desulfurization at coal-fired electric utilities creates tons of byproduct that must be stockpiled and eventually disposed of. The byproduct is a mixture of calcium sulfate, calcium hydroxide, and fly ash that contains metals and other trace elements from the feed coal. Disposal is expensive, and use as a soil and spoil amendment for surface-mine reclamation is an alternative to landfilling. Potential benefits of FGD byproduct as a mine-land amendment may be offset by the effects of byproduct leachate on ground water. To assess the potential effects on ground water, the USGS is studying ground-water flow and geochemistry beneath mine-land watersheds to be reclaimed with FGD byproduct as a soil and spoil amendment.

Progress and significant changes: A computerized literature file including abstracts was established. An inventory of candidate field sites was begun. Preliminary drilling specifications for a field site were developed. Tests of the computer program MODFLOW for simulation of ground water in a surface-mine setting were run. GIS interfacing capabilities for data processing and display were developed.

EVALUATION OF THE EFFECTS OF PHYSICAL, CHEMICAL, AND BIOLOGICAL FACTORS ON PESTICIDE SORPTION, BIOTRANSFORMATION, AND TRANSPORT IN A BURIED-VALLEY AQUIFER
(OH105)

Period of Project:
March 1990 through
September 1994

Project Leader:
Martha L. Jagucki

Purpose: Evaluate the effects of physical, chemical, and biological factors on pesticide sorption, biotransformation, and transport. Specific objectives are: (1) characterize spatial (areal and vertical) variations in the physical properties of the buried-valley aquifer, (2) characterize spatial variations in microbial numbers and diversity in the buried-valley aquifer, (3) characterize spatial and temporal variations in the aqueous chemistry of the buried-valley aquifer, (4) determine whether the geomicrobial population in the buried-valley aquifer can degrade atrazine (if so, determine the rate of degradation and the metabolic pathway used), (5) determine whether a correlation exists between microbial numbers and physical aquifer properties and (or) aqueous constituent concentrations, and (6) determine whether a correlation exists between aqueous chemistry and sorptive capacity of aquifer sediments and (or) microbial activity of the sediments.

Progress and significant results: A literature search on the transport and degradation of atrazine was completed. A proposal was prepared for U.S. Geological Survey research at the Ohio Management System Evaluation Area. Cooperating investigators met with Ohio District staff to coordinate project goals, data needs, field methodologies, well design, and task scheduling. Drilling and instrumentation specifications were prepared. In conjunction with cooperating agencies, a detailed work plan was written to address project goals for the Ohio Management System Evaluation Area, data-collection methodologies and schedule, well locations and design, quality assurance/quality-control procedures, and a project-management scheme.

DISCHARGE CHARACTERISTICS OF SELECTED LONGITUDINAL DRAIN MATERIALS (OH106)

Period of Project:
October 1990 to
September 1994

Project Leader:
Greg F. Koltun

Cooperator:
Ohio Department of Transportation

Purpose: Document the relative performance of four longitudinal drain-material products (in terms of discharge in response to rainfall) under nearly equal geological and environmental field settings. Damp highway subbases are known to hasten pavement deterioration. As a consequence, current recommended design standards generally include permeable base courses with longitudinal drains underlying the shoulder to main-lane joint.

Progress and significant results: Data-collection equipment has been acquired and installation has begun.

SURFACE-WATER STATIONS FOR WHICH RECORDS ARE PUBLISHED

This section contains a list of hydrologic data stations for which daily records have been published by the U.S. Geological Survey in 1991. Surface-water stations are numbered and listed in downstream order along the main stem. A station on a tributary entering between two main-stem stations is listed between them. A similar order is followed in listing stations on first rank, second rank, and other ranks of tributaries. This downstream-order numbering system is a permanent system of numerical designations adopted by the Survey in 1950.

Surface-water stations for which daily data are collected are classified as: discharge, stage only, sediment, continuous-record water quality, and reservoir or lake contents and (or) elevation. Daily discharge and stage-only stations are sites instrumented to provide a continuous stage record. For daily discharge stations, calculations of mean daily discharge, peak flows during floods, and total monthly and yearly runoff are made by applying stage data to a stage-discharge rating curve derived from actual discharge measurements.

Pool-elevation data collected at reservoir or lake stations are used to determine periodic changes in the amount of water held in storage. Continuous-record water-quality stations are sites equipped to record one or more physical or chemical characteristics. The record is used to determine maximum and minimum daily values. For daily sediment stations, samples collected daily are analyzed for their suspended-sediment concentrations to develop a curve from which daily mean concentrations are determined. Suspended-sediment discharges are computed by multiplying water discharge times concentration times a conversion factor.

In addition to the daily stations listed, data are collected at many sites where daily stations are not feasible. At these "partial-record stations," data are collected at regular intervals ranging from once to several times annually. Types of data collected include peak discharge, low-flow discharge, chemical quality, sediment, and biologic. Information about locations of partial-record stations and types of data collected is available upon request.

SURFACE-WATER STATIONS FOR WHICH RECORDS ARE PUBLISHED

Standard abbreviations used in station names:

ab	above	e	east	nr	near
b	branch	f	fork	r	river
bk	brook	g	great	re	reservoir
bl	below	l	little	rn	run
c	creek	lk	lake	s	south
ca	canal	m	middle	tr	tributary
d	ditch	n	north	w	west

The letters after the station names designate type of data: (B) biological, (C) chemical, (D) discharge, (E) contents and (or) elevation, (M) water-quality monitor, (NASQAN) National stream-quality accounting network, (R) radiochemical, (S) sediment, and (T) temperature.

Station number	Station	Type of data
	OHIO RIVER BASIN	
	Ohio River:	
	BEAVER RIVER BASIN	
03086500	Mahoning R (head of Beaver R) at Alliance	D
03090500	Mahoning R bl Berlin Dam, nr Berlin Center	D
03091500	Mahoning R at Pricetown	D
03092000	Kale C nr Pricetown	D
03092090	W B Mahoning R nr Ravenna	D
03092460	W B Mahoning R bl M.J. Kirwan Dam, at Wayland	D
03093000	Eagle C at Phalanx Station	D
03094000	Mahoning R at Leavittsburg	D
	Mosquito Creek:	
03095500	Mosquito C bl Mosquito C Dam, nr Cortland	D
03097550	Mahoning R at Ohio Edison Power Plant at Niles	D
03098600	Mahoning R bl West Avenue Bridge at Youngstown	D
03099500	Mahoning R at Lowellville	D
03099510	Mahoning R at OH-PA State line bl Lowellville	CMT
	Shenango River:	
03102950	Pymatuning C at Kinsman	D
	LITTLE BEAVER CREEK BASIN	
	North Fork L Beaver Creek:	
03109500	L Beaver C nr East Liverpool	D
	YELLOW CREEK BASIN	
03110000	Yellow C nr Hammondsville	D
	SHORT CREEK BASIN	
	Short Creek:	
03111500	Short C nr Dillonvale	D

SURFACE-WATER STATIONS--Continued

Station number	Station	Type of data
	WHEELING CREEK BASIN	
03111548	Wheeling C bl Blaine	DS
	CAPTINA CREEK BASIN	
03114000	Captina C at Armstrongs Mills	D
	MUSKINGUM RIVER BASIN	
	Tuscarawas R (head of Muskingum R):	
03117000	Tuscarawas R at Massillon	D
03117100	Tuscarawas R at Navarre	MT
03117500	Sandy C at Waynesburg	D
03118000	M B Nimishillen C (head of Nimishillen Creek) at Canton	D
03118500	Nimishillen C at North Industry	D
	McGuire Creek:	
03120500	McGuire C bl Leesville Dam, nr Leesville	D
03122500	Tuscarawas R bl Dover Dam, nr Dover	D
03124000	Sugar Creek bl Beach City Dam, nr Beach City	D
03124500	Sugar Creek at Strasburg	D
	Stillwater Creek:	
03126000	Stillwater C at Piedmont	D
03127000	Stillwater C at Tippecanoe	D
03127500	Stillwater C at Uhrichsville	D
	Clear Fork (head of L Stillwater Creek):	
03128500	L Stillwater C bl Tappan Dam, at Tappan	D
03129000	Tuscarawas R at Newcomerstown	D
03130000	Black F (head of Walhonding River) bl Charles Mill Dam, nr Mifflin	D
03131500	Black F at Loudonville	D
03133500	Clear F bl Pleasant Hill Dam nr Perrysville	D
	Mohican R (continuation of Black Fork):	
	Lake Fork:	
03135000	L F bl Mohicanville Dam, nr Mohicanville	D
03136500	Kokosing R nr Mount Vernon	D
03138500	Walhonding R (continuation of Mohican R) bl Mohawk Dam, at Nellie	D
03139000	Killbuck C at Killbuck	D
03140000	Mill C nr Coshocton	D
03140500	Muskingum R (continuation of Tuscarawas R) nr Coshocton	D
	Wills Creek:	
	Seneca Fork:	
03141500	Seneca F bl Senecaville Dam, nr Senecaville	D
03142000	Wills C at Cambridge	D
03143500	Wills C bl Wills C Dam, at Wills Creek	D
03144000	Wakatomika C nr Frazeysburg	D
	Licking River	
03145000	S F Licking R (head of Licking River) nr Hebron	D
03146500	Licking R nr Newark	D
03147500	Licking R bl Dillon Dam, nr Dillon Falls	D

SURFACE-WATER STATIONS--Continued

Station number	Station	Type of data
03150000	Muskingum R at McConnelsville (NASQAN)	DCBS
	HOCKING RIVER BASIN	
	Hocking River:	
03157000	Clear C nr Rockbridge	D
03157500	Hocking River at Enterprise	D
03159510	Hocking River bl Athens (NASQAN)	DCS
	SHADE RIVER BASIN	
03159540	Shade R nr Chester	D
	RACCOON CREEK BASIN	
03201929	Zinns Rn nr Radcliff	DC
03201947	Strongs R nr Ewington	DC
	SCIOTO RIVER BASIN	
03219500	Scioto R nr Prospect	D
03219590	Bokes C nr Warrensburg	D
03220000	Mill C nr Bellepoint	D
03221000	Scioto R bl O'Shaughnessy Dam nr Dublin	D
	Olentangy River:	
03223000	Olentangy R at Claridon	D
03225500	Olentangy R nr Delaware	D
03227200	Scioto R at Broad Street, Columbus	D
03227500	Scioto R at Columbus	D
03228300	Big Walnut C at Sunbury	D
03228500	Big Walnut C at Central College	D
03228805	Alum C at Africa	D
03229000	Alum C at Columbus	D
03229500	Big Walnut C at Rees	D
03230500	Big Darby C at Darbyville	D
03230900	Deer C nr Pancoastburg	D
03231000	Deer C at Williamsport	D
03231500	Scioto R at Chillicothe	DM
	Paint Creek:	
03232470	Paint C bl Paint C Dam nr Bainbridge	D
	Rocky Fork:	
03232500	Rocky F nr Barretts Mills	D
03234000	Paint C nr Bourneville	D
03234300	Paint C at Chillicothe	DM
03234500	Scioto R at Higby (NASQAN)	DCBMTS
03237041	Little Beaver C nr Piketon	D
03237060	Big Run at Wakefield	D
	Reservoirs in Scioto R basin	E
	UPPER TWIN CREEK BASIN	
03237280	Upper Twin C at McGaw (HBM)	DCBMSR
	OHIO BRUSH CREEK BASIN	
03237500	Ohio Brush C nr West Union	D
	WHITEOAK CREEK BASIN	
03238500	Whiteoak C nr Georgetown	D

SURFACE-WATER STATIONS--Continued

Station number	Station	Type of data
	LITTLE MIAMI RIVER BASIN	
03240000	L Miami R nr Oldtown	D
03241500	Massies C at Wilberforce	D
03245500	L Miami R at Milford (NASQAN)	DCBTS
03247050	E F L Miami R nr Batavia	D
03247500	E F L Miami R at Perintown	D
03248100	L Miami R at Cincinnati	D
	MIAMI CREEK BASIN	
03255500	Mill C at Reading	D
03259000	Mill C at Carthage	D
	GREAT MIAMI RIVER BASIN	
	G Miami River:	
03260700	Bokengehalas C nr De Graff	D
03261500	G Miami R at Sidney	D
03261950	Loramie C nr Newport	D
03262000	Loramie C at Lockington	D
03262700	G Miami R at Troy	D
03263000	G Miami R at Taylorsville	D
	Stillwater River:	
03264000	Greenville C nr Bradford	D
03265000	Stillwater R at Pleasant Hill	D
03266000	Stillwater R at Englewood	D
03267000	Mad R nr Urbana	D
03267900	Mad R (at St. Paris Pike) at Eagle City	D
03269500	Mad R nr Springfield	D
03270000	Mad R nr Dayton	D
03270500	G Miami R at Dayton	D
03271000	Wolf C at Dayton	D
03271500	G Miami R at Miamisburg	D
03271510	G Miami R nr Linden Ave at Miamisburg	M
03271800	Twin C nr Ingomar	D
03272000	Twin C nr Germantown	D
	Sevenmile Creek:	
03272700	Sevenmile C at Camden	D
03274000	G Miami at Hamilton	D
03274600	G Miami R at New Baltimore (NASQAN)	CBTS
	ST. LAWRENCE RIVER BASIN	
	(STREAMS TRIBUTARY TO LAKE ERIE)	
04177000	Ottawa R at Toledo University	D
04185000	Tiffin R at Stryker	D
04185440	Lost C nr Farmer	D
04186500	Auglaize R nr Ft Jennings	D
04187100	Ottawa R at Lima	D
04189000	Blanchard R nr Findlay	D
04191500	Auglaize R nr Defiance	D

SURFACE-WATER STATIONS--Continued

Station number	Station	Type of data
04192500	Maumee R nr Defiance	D
04193500	Maumee R at Waterville (NASQAN)	DCBTS
04195500	Portage R at Woodville	D
	SANDUSKY RIVER BASIN	
04196800	Tymochtee C at Crawford	D
04197100	Honey C at Melmore	D
04197170	Rock C at Tiffin	D
04198000	Sandusky R nr Fremont (NASQAN)	DCMBTS
04199000	Huron R at Milan	DSC
04199155	Old Woman's C at Berlin Road	D
04199165	Old Woman's C at U.S. 6 nr Huron	E
04199175	Lake Erie at Ruggles Beach	E
04199287	Vermilion R nr Fitchville	D
04200500	Black R at Elyria	D
04201500	Rocky R nr Berea	D
04202000	Cuyahoga R at Hiram Rapids	D
04206000	Cuyahoga R at Old Portage	D
04207200	Tinkers C at Bedford	D
04208000	Cuyahoga R at Independence (NASQAN)	DCMTS
04209000	Chagrin R at Willoughby	D
04212100	Grand R nr Painesville	DSC
04212200	Grand R at Painesville (NASQAN)	DCTS
04212680	Fields Bk at Ashtabula	M
04213000	Conneaut C at Conneaut	D

GROUND-WATER STATIONS FOR WHICH RECORDS ARE PUBLISHED

The following table is a list of ground-water stations in Ohio for which the U.S. Geological Survey is publishing data in 1991. The first six digits of the well numbers denote degrees, minutes, and seconds of latitude, and the next seven digits denote degrees, minutes, and seconds of longitude. The last two digits are used, if needed, for sequential numbering within a 1-second grid.

In addition to the sites listed, data on water levels, yield, and chemical quality of ground water have been collected at many other locations in Ohio. Information about these miscellaneous measurements is available upon request.

GROUND-WATER STATIONS FOR WHICH RECORDS ARE PUBLISHED

[Letter after station location designates type of data: c chemical; l, water level.]

Well number	Local number	Location
		ASHLAND COUNTY
405303082170700	AS-2	Ashland (l)
405425082173000	AS-3	Jerome Fork (l)
		ATHENS COUNTY
392004082071600	AT-2A	Athens (l)
392009082072200	AT-5	Athens (l)
		AUGLAIZE COUNTY
403233083574500	AU-3	Southwest of New Hampshire (l)
		BELMONT COUNTY
400118081082200	B-3	Mount Olivett (l)
		BUTLER COUNTY
391805084261800	BU-9	Northwest of Sharonville (l)
393202084241500	BU-15	Middletown (l)
391904084371800	BU-12	East of Ross (l)
392017084345200	BU-7	Fairfield (l)
392021084340300	BU-56	Fairfield (l)
392048084311400	BU-8	East of Hamilton (l)
392445084333000	BU-36	Hamilton (c)
392515084322000	BU-5	North of Hamilton (l)
392939084231700	BU-3	Middletown (l)
393103084240900	BU-2	Middletown (l)
		CARROLL COUNTY
403709081052800	C-1	North of Carrollton (l)
		CHAMPAIGN COUNTY
400638083453900	CH-3	Urbana (l)
		CLARK COUNTY
395639084012200	CL-9	New Carlisle (l)
395840083495200	CL-7	Northwest of Springfield (l)

GROUND-WATER STATIONS--Continued

Well number	Local number	Location
		COSHOCTON COUNTY
401256081525100	CS-3	North of Conesville (1)
		CRAWFORD COUNTY
404838082563100	CR-1	Bucyrus (1)
		DARKE COUNTY
400514084345700	D-2	East of Greenville (1)
		DELAWARE COUNTY
402126083040400	DL-3	Delaware (1)
		FAIRFIELD COUNTY
393450082403600	F-7	Southeast of Amanda
394257082362900	F-6	Lancaster (1)
394544082271000	F-1	West Rushville (1)
395053082361900	F-5	Baltimore (1)
		FAYETTE COUNTY
393153083322000	FA-1	West of Washington Court House (1)
		FRANKLIN COUNTY
394956083002700	FR-18	Shadeville (1)
395118083573300	FR-3	Southwest of Rees (1)
395157083003500	FR-109	Columbus (1)
395224083000000	FR-274	Columbus (1)
400101083021800	FR-10	Columbus (1)
		GALLIA COUNTY
383638082103300	G-2	East of Crown City (1)
		GEAUGA COUNTY
412518081221500	GE-3A	Southeast of Chagrin Falls (1)

GROUND-WATER STATIONS--Continued

Well number	Local number	Location
		GREENE COUNTY
394330083531400	GR-11	Near Wilberforce
394411083561300	GR-1	North of Xenia (1)
394425083551100	GR-10	North of Xenia (1)
		HAMILTON COUNTY
391039084291500	H-11	Cincinnati (1)
391101084172100	H-3	Southeast of Miamiville (1)
391201084281600	H-10	Cincinnati (1)
391214084470100	H-1	Southeast of Harrison (1)
391324084272500	H-9	Cincinnati (1)
391341084275300	H-8	Wyoming (1)
391442084262900	H-7	Evendale (1)
391608084254400	H-6	Glendale (1)
391733084392400	H-2	South of Ross (1)
391748084393800	H-19	Southwest of Venice (c)
391817084393300	H-4	Southwest of Ross (1)
		HANCOCK COUNTY
405940083275500	HA-3	North of Van Lue
		HARDIN COUNTY
404218083503700	HN-1	Alger (1)
404648083412600	HN-2A	Southeast of Dola (1)
		HENRY COUNTY
412123083574000	HY-2	Southwest of McClure (1)
		HOCKING COUNTY
393200082235300	HK-1	Logan (1)
		KNOX COUNTY
402344082300700	K-1	Mt. Vernon (1)
		LUCAS COUNTY
413704083362200	LU-1	Toledo (1)

GROUND-WATER STATIONS--Continued

Well number	Local number	Location
		MADISON COUNTY
395301083272200	M-2	London (1)
395352083292100	M-5	Near London
395357083304400	M-4	Northwest of London (1)
395740083255700	M-3	North of London (1)
		MAHONING COUNTY
410042080453800	MA-1	Canfield (1)
		MARION COUNTY
403413083170500	MN-4	Southeast of New Bloomington (1)
403443083230400	MN-1	LaRue (1)
403601083110400	MN-2	West of Marion (1)
		MEDINA COUNTY
410120081431800	MD-3	Wadsworth (1)
410142082005900	MD-1	Lodi (1)
		MERCER COUNTY
402833084375200	MR-2	Coldwater (1)
		MIAMI COUNTY
395848084085500	MI-3	Northeast of Tipp City (1)
400208084112900	MI-44	Troy (c)
		MONTGOMERY COUNTY
393757084173600	MT-928	Miamisburg (c)
394012084151700	MT-55	West Carrollton (1)
394025084162800	MT-49	West Carrollton (1)
394425084113200	MT-3	Dayton (1c)
394533084113800	MT-6	Dayton (1)
394811084095000	MT-74	Dayton (1)
		MUSKINGUM COUNTY
395804081593200	MU-1A	Zanesville (1)
		OTTAWA COUNTY
413434082494000	O-2	Catawba Island

GROUND-WATER STATIONS--Continued

Well number	Local number	Location
		PICKAWAY COUNTY
393327082571600	PK-7	South of Circleville (1)
393402082572500	PK-4	South of Circleville (1)
393638082572300	PK-6	Northwest of Circleville (1)
393438083072200	PK-8	Williamsport (1)
394742083094800	PK-9	Near Orient (1)
		PIKE COUNTY
390359083015100	PI-2	West of Piketon (1)
		PORTAGE COUNTY
411401081025000	PO-1	Windham (1)
410540081213600	PO-7	Brimfield (1)
410920081192000	PO-6	East of Kent (1)
		PREBLE COUNTY
394438084335900	PR-2	East of Eaton (1)
		PUTNAM COUNTY
405505084032900	PU-1	Columbus Grove (1)
		RICHLAND COUNTY
404625082305100	R-4	Mansfield (1)
405753082360800	R-3	Shiloh (1)
		ROSS COUNTY
391341083172200	RO-7	West of Bainbridge (1)
391913082580500	RO-8	Chillicothe (1)
		SANDUSKY COUNTY
411914083045300	S-3	Fremont (1)
412703083213600	S-2	Woodville (1)
		SENECA COUNTY
410802083093900	SE-2	Tiffin (1)
		SHELBY COUNTY
401712084103500	SH-4	Sidney (1)

GROUND-WATER STATIONS--Continued

Well number	Local number	Location
		STARK COUNTY
404939081203800	ST-5A	Canton (1)
405211081253500	ST-27	North Canton (1)
		SUMMIT COUNTY
410141081315200	SU-4A	Akron (1)
410330081282000	SU-6	Akron (1)
410846081271600	SU-7	Cuyahoga Falls (1)
		TRUMBULL COUNTY
411604080505600	T-3	Near Warren (1)
		TUSCARAWAS COUNTY
403207081293800	TU-3	Dover (1)
403557081313600	TU-4	Strasburg (1)
403653081321800	TU-1	North of Strasburg (1)
403823081324200	TU-5	Near Strasburg (1)
		UNION COUNTY
401826083255200	U-4	Southeast of Raymond (1)
		VAN WERT COUNTY
405215084335400	VW-1	Van Wert (1)
		VINTON COUNTY
391452082282900	V-1	McArthur (1)
		WARREN COUNTY
392712084191700	W-5	East of Monroe (1)
		WASHINGTON COUNTY
392553081281600	WA-2	Marietta (1)
		WAYNE COUNTY
404655081553200	WN-3	Near Wooster (1)
404802081583100	WN-2A	Near Wooster (1)
405745081510200	WN-7	Near Sterling (1)
405805081462300	WN-6	Rittman (1)

GROUND-WATER STATIONS--Continued

Well number	Local number	Location
		WILLIAMS COUNTY
412821084313600	WM-1	Near Bryan (1)
412930084320900	WM-3	Bryan (1)
413108084415300	WM-12	East of Blakeslee (1)
		WYANDOT COUNTY
405009083172600	WY-1	Upper Sandusky (1)

SELECTED REFERENCES ON OHIO HYDROLOGY

Selected references on water resources in Ohio are listed below; many of them are available for inspection at the Ohio District office and at large public and university libraries. The publications are grouped as follows: (1) U.S. Geological Survey publications; (2) reports prepared by the Geological Survey in cooperation with specific agencies and which can be obtained from the cooperating agencies; and (3) other publications, such as contributions to technical journals.

Professional Papers

450-B Temperature-depth relations in wells as indicators of semiconfining beds in valley-train aquifers, by S.E. Norris and A.M. Spieker. 1962.

450-E Permeability of glacial till, by S.E. Norris. 1963.

475-D Anomalous streamflow-ground-water regimen in the Mad River basin, near Springfield, Ohio, by W.P. Cross and A.J. Feulner. 1963.

511 Geology and ground-water resources of Portage County, Ohio, by J.D. Winslow and G.W. White. 1966.

525-D Relation of permeability to particle size in a glacial-outwash aquifer at Piketon, Ohio, by S.E. Norris and R.E. Fidler. 1965.

550-C Water-quality variations in the Cuyahoga River at Cleveland, Ohio, by M.E. Schroeder and C.R. Collier. 1966.

550-D Effect of sampling and testing methods on computed hydraulic properties of glacial outwash at Piketon, Ohio, by S.E. Norris and R.E. Fidler. 1966.

605-A Ground-water hydrology and geology of the lower Great Miami River valley, Ohio, by A.M. Spieker. 1968.

605-B Seismic refraction survey of Pleistocene drainage channels in the lower Great Miami River valley, Ohio, by J.S. Watkins and A.M. Spieker. 1971.

605-C Effects of increased pumping of ground water in the Fairfield-New Baltimore area (Hamilton County), Ohio--A prediction by analog-model study, by A.M. Spieker. 1968.

605-D Future development of the ground-water resources in the lower Great Miami River valley, Ohio--Problems and alternative solutions, by A.M. Spieker. 1968.

650-B Correlation of carbonate rock units in northwest Ohio by natural gamma logging, by S.E. Norris and R.E. Fidler. 1969.

700-D The effect of stream discharge on streambed leakage to a glacial outwash aquifer, by S.E. Norris, in Geological Survey Research 1970, Chapter D, p. D262-D265. 1970.

750-B Availability of ground water from limestone and dolomite aquifers in northwest Ohio and its relation to geologic structure, by S.E. Norris and R.E. Fidler, in Geological Survey Research 1971, Chapter B, p. B229-B235. 1971.

750-C Carbonate equilibria distribution and its relation to an area of high ground-water yield in northwest Ohio, by S.E. Norris and R.E. Fidler, in Geological Survey Research 1971, Chapter C, p. C202-C206. 1971.

750-D Resistivity and neutron logging in Silurian dolomite of northwest Ohio, by L.M. MacCary, in Geological Survey Research 1971, Chapter D, p. D190-D197. 1971.

813-A Summary appraisals of the Nation's ground-water resources--Ohio Region, by R.M. Bloyd, Jr. 1974.

813-J Summary appraisals of the Nation's ground-water resources--Great Lakes Region, by W.G. Weist, Jr. 1978.

Water-Supply Papers

161 Quality of water in the upper Ohio River basin and at Erie, Pa., by S.J. Lewis. 1906.

179 Prevention of stream pollution by distillery refuse, based on investigations at Lynchburg, Ohio, by Herman Stabler. 1906.

186 Stream pollution by acid-iron wastes, a report based on investigations made at Shelby, Ohio, by Herman Stabler. 1906.

334 The Ohio valley flood of March-April, 1913, including comparisons with some earlier floods, by A.H. Horton and H.J. Jackson. 1913.

800 The floods of March 1936--Part 3, Potomac, James, and upper Ohio Rivers, by N.C. Grover, with a section on the weather associated with the floods of March 1936, by Stephen Lichtblau, U.S. Weather Bureau. 1937.

838 Floods of Ohio and Mississippi Rivers, January-February 1937, by N.C. Grover, with a section on flood deposits of the Ohio River, January-February 1937, by G.R. Mansfield. 1938.

869 Flood of August 1935 in the Muskingum River basin, Ohio, by C.V. Youngquist and W.B. Langbein. 1941.

999 Ground-water resources of the Cincinnati area, Butler and Hamilton Counties, Ohio, by F.H. Klaer, Jr., and D.G. Thompson. 1948.

1460-E Geological and geophysical study of the preglacial Teays valley in west-central Ohio, by S.E. Norris and H.C. Spicer. 1958.

1619-A Hydrogeology of a spring in a glacial terrane near Ashland, Ohio, by S.E. Norris. 1963.

1750-A Floods of January-February 1959 in Ohio and adjacent states, by E.L. Hendricks. 1964.

1798-I Fluvial sediment in Hocking River subwatershed 1 (North Branch Hunters Run, Hocking County), Ohio, by R.F. Flint. 1972.

1808 Ground-water resources of the Dayton area (Montgomery County), Ohio, by S.E. Norris and A.M. Spieker. 1966.

1840-A Floods of March 1964 along the Ohio River, by H.C. Beaber and J.O. Rostvedt. 1965.

1859-C Analysis of water quality of the Mahoning River in Ohio, by G.A. Bednar, C.R. Collier, and W.P. Cross. 1968.

1872 Hydrogeology of the Scioto River valley near Piketon (Pike County), Ohio, by S.E. Norris and R.E. Fidler. 1969.

1893 Potential development and recharge of ground water in Mill Creek valley, Butler and Hamilton Counties, Ohio, based on analog model analysis, by R.E. Fidler. 1970.

2045 Fluvial sediment in Ohio, by P.W. Anttila and R.L. Tobin. 1978.

2220 Basic ground-water hydrology, by R.C. Heath. 1983.

2250 National water summary, 1983.

2275 National water summary, 1984.

2295-A Water-quality data-collection activities in Colorado and Ohio: Phase I--inventory and evaluation of 1984 programs and costs, by Janet Hren, T.H. Chaney, J.M. Norris, and C.J. Oblinger Childress. 1987.

2295-B Water-quality data-collection activities in Colorado and Ohio: Phase II--evaluation of 1984 field and laboratory quality-assurance practices, by Carolyn J. Oblinger Childress, Thomas H. Chaney, Donna N. Myers, J. Michael Norris, and Janet Hren. 1989.

2300 National water summary, 1985.

2325 National water summary, 1986.

2350 National water summary, 1987.

Bulletins

1133-A Geology and hydrology of the Piqua area (Miami County), Ohio, by S.E. Norris and A.M. Spieker. 1961.

Circulars

177 Water resources of the Mahoning River basin, Ohio, with special reference to the Youngstown area, by W.P. Cross, M.E. Schroeder, and S.E. Norris. 1952.

340 Water resources of the Wheeling-Steubenville area, West Virginia and Ohio, by R.C. Smith, W.L. Doll, and Garland Stratton. 1955.

418 Floods of January-February 1959 in Ohio, by W.P. Cross and H.P. Brooks. 1959.

526 Stream quality in Appalachia as related to coal-mine drainage, 1965, by J.E. Biesecker and J.R. George. 1966.

546 Time of travel of water in the Great Miami River, Dayton to Cleves, Ohio, by D.P. Bauer. 1968.

719 The National Stream Quality Accounting Network (NASQAN)--Some questions and answers, by J.F. Ficke and R.O. Hawkinson. 1975.

1029 National and regional trends in water-well drilling in the United States, 1964-84, by S.M. Hindall and Michael Eberle. 1989.

Journal of Research of the U.S. Geological Survey

Norris, S.E., 1974, Regional flow system and ground-water quality in western Ohio: U.S. Geological Survey Journal of Research, v. 2, no. 5, p. 527-531.

Hydrologic Investigations Atlases

40 Floods at Mount Vernon (Knox County), Ohio, by G.W. Edelen, Jr., F.H. Ruggles, Jr., and W.P. Cross. 1961 (revised 1964).

43 Floods at Springfield (Clark County), Ohio, in 1913 and 1959, by G.W. Edelen, Jr., F.H. Ruggles, Jr., and W.P. Cross. 1961.

44 Floods at Newark (Licking County), Ohio, by G.W. Edelen, Jr., F.H. Ruggles, Jr., and W.P. Cross. 1962 (revised 1964).

45 Floods at Chillicothe (Ross County), Ohio, by G.W. Edelen, Jr., F.H. Ruggles, Jr., and W.P. Cross. 1964.

46 Floods at Zanesville (Muskingum County), Ohio, by G.W. Edelen, Jr., F.H. Ruggles, Jr., and W.P. Cross. 1964.

47 Floods at Fremont (Sandusky County), Ohio, by G.W. Edelen, Jr., F.H. Ruggles, Jr., and W.P. Cross. 1962.

48 Floods at Circleville (Pickaway County), Ohio, by G.W. Edelen, Jr., F.H. Ruggles, Jr., and W.P. Cross. 1964.

49 Floods at Barberton (Summit County), Ohio, by G.W. Edelen, Jr., F.H. Ruggles, Jr., and W.P. Cross. 1962.

50 Floods at Canton (Stark County), Ohio, by G.W. Edelen, Jr., W.P. Somers, and W.P. Cross. 1962.

51 Floods at Warren (Trumbull County), Ohio, by G.W. Edelen, Jr., F.H. Ruggles, Jr., and W.P. Cross. 1963.

52 Floods at Columbus (Franklin County), Ohio, by G.W. Edelen, Jr., F.H. Ruggles, Jr., W.P. Somers, and W.P. Cross. 1962.

56 Floods on Crab Creek at Youngstown (Mahoning County), Ohio, by G.W. Edelen, Jr., W.P. Cross, and W.P. Somers. 1963.

198 Water resources of the Appalachian Region, Pennsylvania to Alabama, by W.J. Schneider and others. 1965.

295 Ground-water resources of the Appalachian region, by G.G. Wyrick. 1968.

324 Floods at Amesville (Athens County), Ohio, by R.I. Mayo and E.E. Webber. 1969.

325 Floods at Jackson (Jackson County), Ohio, by E.E. Webber and R.I. Mayo. 1968.

341 Hydrogeology of the Berea and Cussewago Sandstones in northeastern Ohio, by J.L. Rau. 1969.

366 Saline ground-water resources of Ohio, by A.C. Sedam and R.B. Stein. 1970.

494 Hydrogeology of the Pottsville Formation in northeastern Ohio, by A.C. Sedam. 1973.

Miscellaneous Investigations Series

316 Glacial map of Ohio, by R.P. Goldthwait, G.W. White, and J.L. Forsyth. 1961 (revised in part, 1967).

Hydrologic Unit Map

U.S. Geological Survey, 1988, Hydrologic unit map of Ohio. An overprint of the 1:500,000 scale state base map. No contours. Sheet is 36 by 40 inches. 1951 base, drainage modified in 1988. This map and accompanying table show hydrologic units that are basically hydrographic in nature. The Cataloging Units shown supplant those previously used by the U.S. Geological Survey in its Catalog of Information on Water Data (1966-72).

Open-File Reports of the U.S. Geological Survey

Open-file reports are available for inspection at the Columbus, Ohio, and Reston, Va., offices of the U.S. Geological Survey. For information about purchasing these reports, contact Books and Open-File Reports, U.S. Geological Survey, Box 25425, Federal Center, Denver, CO 80225, telephone (303) 236-7476.

Unnumbered Open-File Reports

Anttila, P.W., 1970, A proposed streamflow program for Ohio.

Cross, W.P., 1967, Flood of July 12, 1966, in the vicinity of Sandusky (Huron County), Ohio.

Deutsch, Morris, and Wallace, J.C., 1966, Six illustrations showing water-resources information on Maumee River basin, Ohio.

Feulner, A.J., 1960, The ground-water resources of Champaign County, Ohio.

Mayo, R.I., Webber, E.E., and Ellis, D.W., 1971, Floods of July 4-8, 1969, in north-central Ohio.

U.S. Geological Survey, 1961-64, Surface-water records of Ohio (published annually).

----- 1964, Water-quality records of Ohio.

----- 1965-74, Water-resources data for Ohio--Part 1, Surface-water records; Part 2, Water-quality records (published annually).

Webber, E.E., and Mayo, R.I., 1970, Flood of July 5, 1969, in the vicinity of Wooster (Wayne County), Ohio.

----- 1971, Low-flow study for southwest Ohio streams.

Numbered Open-File Reports

76-768 Floods in Ohio--magnitude and frequency, by E.E. Webber and W.P. Bartlett, Jr. 1976.

77-399 Hydraulic analysis, Mad River at State Highway 41, Springfield, Ohio, by R.I. Mayo. 1977.

78-684 Hydrologic environment of the Silurian salt deposits in parts of Michigan, Ohio, and New York, by S.E. Norris. 1978.

79-269 The Silurian salt deposits in eastern Lake, northwestern Ashtabula, and northeastern Geauga Counties, Ohio, by S.E. Norris. 1978.

81-343 Hydrology of Area 4, Eastern Coal Province, Pennsylvania, Ohio, and West Virginia, by D.K. Roth, M.J. Engelke, Jr., and others. 1981.

81-350 Hydraulic analysis, Paint Creek at State Route 772, Chillicothe, Ohio, by R.I. Mayo and W.P. Bartlett, Jr. 1981.

81-409 Assessment of water quality in streams draining coal-producing areas in Ohio, by C.L. Pfaff, D.R. Helsel, D.P. Johnson, and C.G. Angelo. 1981.

81-414 Flood of August 20, 1979, on a tributary of Chickamauga Creek, near Gallipolis, Ohio, by R.I. Mayo and E.E. Webber. 1981.

81-815 Hydrology of Area 7, Eastern Coal Province, Ohio, by M.J. Engelke, Jr., D.K. Roth, and others. 1981.

81-913 Ground-water hydrology of strip-mine areas in eastern Ohio, by J.O. Helgesen and A.C. Razem. 1981.

81-919 Ground-water quality in the vicinity of landfill sites, southern Franklin County, Ohio, by J.T. de Roche and A.C. Razem, 1981.

81-1105 Floodflow characteristics related to channel geometry in Ohio, by E.E. Webber and J.W. Roberts. 1981.

81-1195 Low-flow characteristics of Ohio streams, by D.P. Johnson and K.D. Metzker. 1981.

82-109 Potential impacts of a proposed reservoir on hydrologic and water-quality conditions in Little Rush Creek watershed, Fairfield County, Ohio, by Janet Hren and R.L. Jones. 1982.

82-170 Water resources of the Black Hand Sandstone Member of the Cuyahoga Formation and associated aquifers of Mississippian age in southeastern Ohio, by S.E. Norris and G.C. Mayer. 1982.

83-217 Drift mine reclamation in Big Four Hollow near Lake Hope, Ohio--A preliminary data report, by V.E. Nichols. 1983.

83-681 Guidelines for use of water-quality monitors, by A.B. Gordon and M.S. Katzenbach. 1983.

84-233 Hydrology of Area 11, Eastern Coal Province, Ohio, Kentucky, and West Virginia, by D.K. Roth and S.C. Cooper. 1984.

84-249 Chemical and biological quality of selected lakes in Ohio, 1978 and 1979, by C.G. Angelo and J.D. Youger. 1985.

84-470 Preliminary report on a study to establish flood volumes of small rural streams in Ohio--Methods, site selection, and data base, by J.M. Sherwood. 1985.

84-619 Literature review and need for additional study of surface-water quality in the Cuyahoga Valley National Recreation Area, Ohio, by C.J. Oblinger Childress. 1984.

84-824 Low-flow data for selected partial-record stations in Ohio, by R.R. Schwartz. 1985.

85-099 Occurrence of uranium in ground water in the vicinity of the U.S. Department of Energy Feed Materials Production Center, Fernald, Ohio, by A.C. Sedam. 1984.

85-194 Preliminary evaluation of magnitude and frequency of floods in selected small drainage basins in Ohio, by J.R. Kolva. 1985.

85-552 Sedimentation and water quality in the West Branch Shade River basin, Ohio, 1984 water year, by C.J. Oblinger Childress and R.L. Jones. 1985.

85-574 Water-quality data-collection activities in Colorado and Ohio: Phase I--Inventory and evaluation of 1984 programs and costs, by Janet Hren, T.H. Chaney, J.M. Norris, and C.J. Oblinger Childress. 1985.

85-639 Offstream water withdrawals by thermoelectric powerplants and public water supplies in Ohio. 1982, by Michael Eberle and J.A. McClure. 1986.

86-308 Water-resources activities in Ohio, 1986, by S.M. Hindall. 1986.

87-33 Water-quality data-collection activities in Colorado and Ohio: Phase II--evaluation of 1984 field and laboratory quality-assurance practices, by C.J. Oblinger Childress, T.H. Chaney, Donna Myers, J.M. Norris, and Janet Hren. 1987.

88-128 Water fact sheet: U.S. Geological Survey ground-water studies in Ohio, by S.M. Hindall. 1988.

88-196 Water fact sheet: Water-resources activities in Ohio, 1988, by L.D. Camp. 1988.

89-272 Ground-water levels and flow near the industrial excess landfill, Uniontown, Ohio, by E. Scott Bair and S.E. Norris. 1989.

89-376 Flood of July 1-2, 1987, in North-Central Ohio, by Ronald I. Mayo and James P. Mangus. 1989.

89-391 Water-quality data-collection activities in Colorado and Ohio: Phase III--Evalution of existing data for use in assessing regional water-quality conditions and trends, by J.M. Norris, Janet Hren, D.N. Myers, T.H. Chaney, and C.J. Oblinger Childress. 1990.

89-423 Withdrawal and distribution of water by public water supplies in Ohio, 1985, by V.E. Nichols. 1989.

90-151 Plan of study for the Ohio-Indiana carbonate-bedrock and glacial-aquifer system, by E.F. Bugliosi. 1990.

90-590 Selected geologic and hydrologic data for the regional carbonate-bedrock and glacial aquifers in western Ohio, by R.A. Sheets.

Water-Resources Investigations Reports of the U.S. Geological Survey

Reports in this series are available for inspection at the Columbus, Ohio, and Reston, Va., offices of the U.S. Geological Survey. Information about these reports can be obtained from the District Chief, Water Resources Division, in Columbus.

17-73 Availability of water from limestone and dolomite aquifers in southwest Ohio and the relation of water quality to the regional flow system, by S.E. Norris and R.E. Fidler. 1973.

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Publications of the Ohio Department of Natural Resources, Division of Water, Prepared by or in Cooperation with the U.S. Geological Survey

These reports may be obtained from the Chief, Division of Water, who can furnish a more complete list of reports of the Ohio Department of Natural Resources, or they may be consulted in the offices of the Chief, Division of Water, or of the District Chief, Water Resources Division, U.S. Geological Survey, at the address given in this report.

Archer, R.J., 1960, Sediment discharge of Ohio streams during floods of January-February 1959: Miscellaneous Report 13.

Cross, W.P., 1961, Floods of January-February 1959 in Ohio: Bulletin 35.

----- 1963, Low-flow frequencies and storage requirements for selected Ohio streams: Bulletin 37.

----- 1964, Floods of March 1963 in Ohio: Bulletin 38.

----- 1964, Floods of March 1964 in Ohio: Bulletin 39.

----- 1965, Low-flow frequency and storage-requirement indices for Ohio streams: Bulletin 40.

----- 1966, Flood of July 23, 1965, in the vicinity of Hillsboro (Highland County), Ohio: Miscellaneous Report 16.

----- 1967, Drainage areas of Ohio streams, supplement to Gazetteer of Ohio streams: Inventory Report 12a.

----- 1968, Flow duration of Ohio streams, based on gaging-station records through 1965: Bulletin 42.

Cross, W.P., and Hedges, R.E., 1959, Flow duration of Ohio streams: Bulletin 31.

Cross, W.P., and Mayo, R.I., 1969, Floods in Ohio, magnitude and frequency--Supplement to Bulletin 32 (Cross and Webber, 1959): Bulletin 43.

Cross, W.P., and Webber, E.E., 1950, Ohio streamflow characteristics--Part 2, Water supply and storage requirements: Bulletin 13.

----- 1959, Floods in Ohio--Magnitude and frequency: Bulletin 32.

Cummins, J.W., and Sanderson, E.E., 1947, The water resources of Tuscarawas County, Ohio: (Ohio Water Resources Board) Bulletin 6.

Dove, G.D., 1960, Water resources of Licking County, Ohio: Bulletin 36.

----- 1961, A hydrologic study of the valley-fill deposits in the Venice area (Butler County), Ohio: Technical Report 4.

Hubble, J.H., and Collier, C.R., 1960, Quality of surface waters in Ohio, 1946-58: Inventory Report 14.

Kaser, Paul, and Harstine, L.J., 1965, Ground-water levels in Ohio, October 1959-September 1964: Bulletin 41.

Lamar, W.L., and Schroeder, M.E., 1951, Chemical character of surface waters in Ohio, 1946-50: Bulletin 23.

Norris, S.E., 1959, The water resources of Madison County, Ohio: Bulletin 33.

----- 1959, Vertical leakage through till as a source of recharge to a buried-valley aquifer at Dayton (Montgomery County), Ohio: Technical Report 2.

Norris, S.E., Cross, W.P., and Goldthwait, R.P., 1948, The water resources of Montgomery County, Ohio: (Ohio Water Resources Board) Bulletin 12.

----- 1950, The water resources of Greene County, Ohio: Bulletin 19.

Norris, S.E., Cross, W.P., Goldthwait, R.P., and Sanderson, E.E., 1952, The water resources of Clark County, Ohio: Bulletin 22.

Ohio Department of Natural Resources, Division of Water, 1970, Ground water for planning in northwest Ohio--A study of the carbonate rock aquifers: Inventory Report 22.

Schaefer, E.J., White, G.W., and Van Tuyl, D.W., 1946, The ground-water resources of the glacial deposits in the vicinity of Canton (Stark County), Ohio: (Ohio Water Resources Board) Bulletin 3.

Schmidt, J.J., 1958, The ground-water resources of Franklin County, Ohio: Bulletin 30.

Smith, R.C., and White, G.W., 1953, The ground-water resources of Summit County, Ohio: Bulletin 27.

Walton, W.C., 1953, The hydraulic properties of a dolomite aquifer underlying the village of Ada (Hardin County), Ohio: Technical Report 1.

Walton, W.C., and Scudder, G.D., 1960, Ground-water resources of the valley-train deposits in the Fairborn area (Greene County), Ohio: Technical Report 3.

Winslow, J.D., White, G.W., and Webber, E.E., 1953, The water resources of Cuyahoga County, Ohio: Bulletin 26.

Other Publications

Address inquiries about availability of these reports and papers to the publishers.

Bair, E.S., Sheets, R.A., and Eberts, S.M., 1990, Particle-tracking analysis of flow paths and traveltimes from hypothetical spill sites within the capture area of a wellfield: Ground Water, v. 28, no. 6, November-December 1990.

Breen, K.J., 1988, Factors affecting major-ion chemistry of ground water in the Lockport Dolomite of northwestern Ohio, in 33rd Annual Midwest Ground Water Conference, Program with Abstracts: p. 2.

Breen, K.J., 1988, Geochemistry of the stratified-drift aquifer in Killbuck Creek Valley west of Wooster, Ohio, in Randall, A.D., and Johnson, A.I., eds., Regional aquifer systems of the United States--the northeast glacial aquifers: American Water Resources Association Monograph Series No. 11, p. 105-131.

Cross, W.P., 1949, The relation of geology to dry-weather stream flow in Ohio: Transactions of the American Geophysical Union, v. 30, no. 4, p. 563-566.

Crouch, T.M., Collins, H.R., and Helgesen, J.O., 1980, Abandoned subsurface coal mines as a source of water for coal conversion in eastern Ohio: Ohio Department of Natural Resources Division of Geological Survey Report of Investigations 118.

Deutsch, Morris, Dove, G.D., Jordan, P.R., and Wallace, J.C., 1967, Ground-water distribution and potential in the Ohio River basin: U.S. Army Corps of Engineers, Ohio River Basin Comprehensive Survey, v. VII, app. E--Ground Water.

Dove, G.D., 1960, Drainage of the Teays-stage Mount Vernon and Cambridge Rivers: Ohio Journal of Science, v. 60, no. 2, p. 122-124.

----- 1962, Ground-water resources, in Geology of Fairfield County: Ohio Department of Natural Resources Division of Geological Survey Bulletin 60.

Eberts, S.M., and Bair, E.S., 1987, Effects of quarry dewatering on ground-water levels and landfill-leachate migration, southern Franklin County, Ohio, in 32nd Annual Midwest Ground Water Conference, Program with Abstracts: p. 9.

Eberts, S.M., and Bair, E.S., 1990, Simulated effects of quarry dewatering near a municipal well field: Ground Water, v. 28, no. 1, p. 37-47.

Feulner, A.J., 1961, Cyclic-fluctuation methods for determining permeability as applied to valley train in the Mad River valley in Champaign County, Ohio: Ohio Journal of Science, v. 61, no. 2, p. 99-106.

Feulner, A.J., and Hubble, J.H., 1960, Occurrence of strontium in the surface and ground waters of Champaign County, Ohio: Economic Geology, v. 55, no. 1, p. 176-186.

Hamon, W.R., Haghiri, Faz, and Knochenmus, Darwin, 1977, Research on the hydrology and water quality of watersheds subjected to surface mining, in Fifth Symposium on Surface Mining and Reclamation: Louisville, Ky., National Coal Association and Bituminous Coal Research, Inc., p. 37-40.

Hamon, W.R., Bonta, J.V., Haghiri, Faz, and Helgesen, J.O., 1979, Research on the hydrology and water quality of watersheds subjected to surface mining, I--Premining hydrology and water quality conditions, in Coal Conference and Expo V, Symposium on Surface Coal Mining and Reclamation, Louisville, Ky.: Coal Age, p. 70-98.

Helgesen, J.O., and Razem, A.C., 1980, Preliminary observation of surface-mine impacts on ground water in two small watersheds in eastern Ohio, in Symposium on Surface Mining Hydrology, Sedimentation and Reclamation: Lexington, Ky., University of Kentucky and Institute for Mining and Minerals Research.

Helsel, D.R., and Pfaff, C.L., 1982, Surface-water quality in coal regions of Ohio, in Proceedings, Abandoned Mine Reclamation Symposium, St. Clairsville, Ohio, November 3-5, 1982: Soil Conservation Society of America, All-Ohio Chapter, p. 2/1-2/7.

Hindall, S.M., [in press], Trends in fluvial sediment discharge in Ohio: Soil and Water Conservation Journal.

Lamar, W.L., and Collier, C.R., 1956, Suspended sediment characteristics of Ohio streams: Journal of Soil and Water Conservation, v. 11, no. 5, p. 233-237.

Nichols, V.E., 1982, Drift mine reclamation in Big Four Hollow near Lake Hope, Ohio--An overview of preliminary data, in Proceedings, Abandoned Mine Reclamation Symposium, St. Clairsville, Ohio, November 3-5, 1982: Soil Conservation Society of America, All-Ohio Chapter, p. 16/1-16/9.

Norris, S.E., 1948, The bedrock surface and former drainage systems of Montgomery County, Ohio: Ohio Journal of Science, v. 48, no. 4, p. 146-150.

----- 1951, The bedrock surface and the distribution of the consolidated rocks in Montgomery, Greene, Clark, and Madison Counties, Ohio: Ohio Journal of Science, v. 51, no. 1, p. 13-15.

----- 1957, Groundwater investigations--Problems faced by geologists in Ohio: Water Well Journal, July, 1957, p. 1-3.

----- 1957, Characteristics of limestone and dolomite aquifers in western Ohio: Journal of the American Water Works Association, v. 49, no. 4, p. 464-468.

----- 1959a, Minford silt and ground water quality in western Ohio: Journal of the American Water Works Association, v. 51, no. 9, p. 1170-1174.

----- 1959b, Buried topography and its relation to an important aquifer in Franklin County, Ohio: Ohio Journal of Science, v. 59, no. 6, p. 341-343.

----- 1967, Effects on ground-water quality and induced infiltration of wastes disposed into the Hocking River at Lancaster (Fairfield County), Ohio: Ground Water, v. 5, no. 3, p. 15-19.

----- 1967, The ground-water situation in Ohio: Ohio Chamber of Commerce.

----- 1969, The ground-water situation in Ohio: Ground Water, v. 7, no. 5, p. 25-33.

----- 1972, The use of gamma logs in determining the character of unconsolidated sediments and well construction features: Ground Water, v. 10, no. 6, p. 14-21.

----- 1975a, The ground-water situation in the Circleville area (Pickaway County), south-central Ohio: Ohio Department of Natural Resources Division of Geological Survey Report of Investigations 96.

----- 1975b, Geological structure of near-surface rocks in western Ohio: Ohio Journal of Science, v. 75, no. 5, p. 225-228.

----- 1976, Change in drawdown caused by enlarging a well in a dolomite aquifer: Ground Water, v. 14, no. 4, p. 191-193.

----- 1979, Hydraulic properties of a limestone-dolomite aquifer near Marion, north-central Ohio: Ohio Department of Natural Resources Division of Geological Survey Report of Investigations 110.

----- 1983a, Aquifer tests and well field performance, Scioto River valley, Ohio; Part I: Ground Water, v. 21, no. 3, p. 287-92.

----- 1983b, Aquifer tests and well field performance, Scioto River valley, Ohio; Part II: Ground Water, v. 21, no. 4, p. 438-44.

Norris, S.E., and Eagon, H.B., Jr., 1971, Recharge characteristics of a watercourse aquifer system at Springfield (Clark County), Ohio: Ground Water, v. 9, no. 1, p. 30-41.

Norris, S.E., and Fidler, R.E., 1966, Use of type curves developed from electric analog studies of unconfined flow to determine the vertical permeability of an aquifer at Piketon (Pike County), Ohio: Ground Water, v. 4, no. 3, p. 43-48.

Razem, A.C., 1982, Comparisons of premining, mining, and postmining ground-water conditions in three small watersheds in eastern Ohio: Geological Society of America Abstracts with Programs, v. 15, no. 7.

----- 1983, Ground-water monitoring of three small surface-mined watersheds of eastern Ohio (abstract): Ground Water Monitoring Review, v. 3, no. 1, p. 153.

Razem, A.C., and Helgesen, J.O., 1981, Preliminary observation of surface-mine impacts on ground water in two small watersheds in eastern Ohio (abstract), in Indiana Water Resources Second Annual Symposium, Spencer, Ind.

Schneider, W.J., 1957, Relation of geology to streamflow in the Upper Miami basin: Ohio Journal of Science, v. 57, no. 1, p. 11-14.

Sheets, R.A., Bair, E.S., and Eberts, S.M., 1988, Determination of flow paths and traveltimes of contaminants from hypothetical spill sites surrounding a municipal well field, in 33rd Annual Midwest Ground Water Conference, Program with Abstracts: p. 20.

Sherwood, J.M., 1989, Estimation of volume-duration-frequency relations of small rural streams in Ohio: Preprint for Transportation Research Board, 68th Annual Meeting, January 22-26, 1989, Washington, D.C.

White, G.W., 1951, Illinoian and Wisconsin drift of the southern part of the Grand River lobe in eastern Ohio: Geological Society of America Bulletin, v. 62, no. 9, p. 967-977.

----- 1953, Sangamon soil and early Wisconsin loesses at Cleveland (Cuyahoga County), Ohio: American Journal of Science, v. 251, no. 5, p. 362-368.

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