WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN MONTANA, OCTOBER 1989 THROUGH SEPTEMBER 1991

Compiled by C.J. Harksen and Karen S. Midtlyng

U.S. GEOLOGICAL SURVEY

Open-File Report 91-191

Prepared in cooperation with the

STATE OF MONTANA AND OTHER AGENCIES

Helena, Montana
June 1991

U.S. DEPARTMENT OF THE INTERIOR

MANUEL LUJAN, JR., Secretary

U.S. GEOLOGICAL SURVEY

Dallas L. Peck, Director

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301 South Park, Drawer 10076
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Federal Center, Building 810
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Denver, CO 80225-0425

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CONVERSION FACTORS

Multiply	By	To obtain
acre	4,047	square meter
cubic foot per second	0.028317	cubic meter per second
foot	0.3048	meter
inch	25.4	millimeter
mile	1.609	kilometer
million gallons per day	3,785	cubic meter per day

MESSAGE FROM THE DISTRICT CHIEF

The U.S. Geological Survey has collected and disseminated information on the quality and quantity of water in Montana's streams, lakes, and aquifers for more than a century. Our first gaging station, on the Missouri River at Fort Benton, has provided streamflow records since 1890. Through cooperative and collaborative programs with local, State, and other Federal agencies, we have monitored streamflow at hundreds of sites throughout the State and have investigated the occurrence and availability of water in numerous study areas. Information obtained from our data-collection programs, investigative studies, and research efforts has been made available to water-resource managers, regulators, and developers through annual data reports, formal published reports, and open-file releases to the public.

This report provides a brief summary of our current programs and activities. Major cooperating agencies and sources of funds that support our operations are acknowledged. Lists of surface-water gaging stations, crest-stage gaging stations, surface-water-quality monitoring stations, and ground-water-level observation wells are included with maps showing distribution of data-collection sites. Current investigations are summarized with brief statements of problem, objective, approach, progress, future plans, and information products; projects are identified by title, location, period of activity, project chief, and funding source. Additional information about specific projects can be obtained by contacting me or the project chief directly (phone (406) 449-5263).

During the past few years, Montana has experienced an extreme drought that has greatly impacted the hydrologic programs of the U.S. Geological Survey. The need for real-time data from gaging stations for operational purposes by water-management agencies has been unprecedented. Several gaging stations have been installed to obtain information at key locations, and streamflow has been measured at numerous sites of discontinued gaging stations and along streams with critically low flows. Concerns about the effects of burned watersheds, which occurred from major wildfires during the summer of 1988, prompted several agencies to request new or expanded monitoring to document changes in runoff and water quality.

Interest in ground-water resources has emerged as a priority hydrologic issue in Montana. The severe drought has focused attention on ground water as an alternative source of water for municipal, industrial, domestic, and agricultural supplies. In many areas, the drought has caused water levels to decline in shallow aquifers. Ground-water-quality concerns also received considerable attention. Leaky underground storage tanks, agricultural chemicals, municipal landfills, mining activities, and hazardous-waste sites all can contribute to ground-water contamination, and several studies have been or are being conducted by the U.S. Geological Survey and others to determine the extent of contamination at numerous sites.

The next few years will see substantial change in the field of water-resources investigations as the public becomes more concerned about the availability of water and hazardous wastes and toxic substances in the environment. Intrastate water allocation issues between private, State, and Federal users will require quantification of ground and surface water even in the absence of detailed studies or long-term records. We will be challenged to develop and use more sophisticated sampling and analytical techniques to measure chemicals in trace quantities in both ground and surface water.

These issues and others will demand attention despite the severe budget constraints imposed by declining State revenues and despite the Federal deficit. Clearly, increased cooperation between agencies will be essential if we are to meet our obligations. I look forward to the promise of technically challenging programs and stronger cooperative relations.

Joe A. Moreland
District Chief
U.S. Geological Survey-WRD
Helena, Montana

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ABSTRACT

Water-resources programs and activities of the U.S. Geological Survey in Montana consist principally of hydrologic-data collection and investigative studies that address water-resource issues. The work is supported by direct Federal funding, by transfer of funds from other Federal agencies, and by joint funding agreements with State or local agencies.

The Montana District of the Geological Survey's Water Resources Division conducts its hydrologic work through a District Office in Helena, and Field Headquarters in Helena, Billings, Fort Peck, and Kalispell. Twenty-four projects are currently funded. As outlined in this report, these projects are operated under the general categories of data-collection programs and investigative studies.

This report describes the projects funded for fiscal years 1990 and 1991. In addition, it describes the operations of the Montana District, hydrologic conditions during water year 1990, activities in addition to regular programs, and sources of publications and information. It also lists reports published or released during the preceding 5 years.

BASIC MISSION AND PROGRAMS

U.S. Geological Survey

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 Geological Survey has grown and been modified to meet the changing needs of the Nation it serves. As part of the evolution, the Geological 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- and ground-water resources, and the employer of the largest number of professional earth scientists in the Nation. Today's programs serve a diversity of needs and users. Programs include:

- Conducting detailed assessments of the energy and mineral potential of 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 land and offshore areas.
- Studying the geologic features, structure, processes, and history of the other planets of our solar system.

- Conducting topographic surveys 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 and ground water.

- Conducting water-resource 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 Geological 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."

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 mission 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-resource appraisals describing the occurrence, availability, and physical, chemical, and biological characteristics of surface 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 water.

- Providing scientific and technical assistance in hydrologic fields to other Federal, State and local agencies, to licensees of the Federal Energy Regulatory Commission, and to international agencies on behalf of the U.S. Department of State.

DISTRICT OPERATIONS

The Montana District conducts its hydrologic work through a District Office in Helena and Field Headquarters in Helena, Billings, Fort Peck, and Kalispell (fig. 1). The District employs 56 people (53 full-time and 3 part-time) to work on 24 funded projects. The principal functions of the District are to investigate the occurrence, quantity, quality, distribution, and movement of surface and ground water in Montana.

Hydrologic data-collection programs and investigative studies in Montana are conducted by three operating sections (fig. 2) and four support units. The operating sections are responsible for the implementation and execution of District projects. The support units provide services and advice to the Office of the District Chief and the operating sections.

Operating Sections

The Hydrologic Surveillance and Analysis Section designs, constructs, operates, and maintains hydrologic-data networks in the State. It also manages the compilation and analysis of hydrologic data for the State network, reviews and processes data for publication, prepares water-resources data for the annual water-data report, and provides quality assurance in the collection and processing of hydrologic data.

The International Waters Section apportions the water of the St. Mary and Milk Rivers in cooperation with the Water Survey of Canada as directed by the Boundary Waters Treaty of 1909 and the International Joint Commission Order of 1921. This apportionment involves the operation of 35 streamflow-gaging stations and 7 reservoir-gaging stations; collection of data for several evaporation stations, 9 small reservoirs, and more than 300 minor diversions; computation of streamflows, reservoir contents, and natural flows; and dissemination of information to ensure the delivery of water entitlements to the United States and Canada.

The Hydrologic Investigations Section plans, conducts, and reports on multidiscipline water-resources projects. These investigations involve ground-water hydraulics and mathematical modeling of aquifer systems; hydraulic effects of manmade structures; magnitude and frequency of floods and droughts; assessment of surface-water availability and water use; and assessment or prediction of the effects of natural forces or human activities on the quality of water in hydrologic systems.

Support Units

The Administrative Services Unit provides administrative support for the District in the form of programming, budgeting, accounting, management of personnel, property inventory, travel records, vehicle management, and related services. The Computer Services Unit is responsible for day-to-day operation of the District's computer and peripheral equipment, programming support to the staff, and recommendations for hardware and software that can enhance computer capability. The Publications Unit is responsible for adequacy of publications and adherence to Survey and Division policy and format; the Unit assists the District staff in the design, preparation, and processing of publications. The Special Equipment Unit fulfills the equipment needs of the staff by stockpiling routine materials and supplies, ordering needed equipment, maintaining and repairing major equipment, monitoring equipment inventories, and providing technical assistance for major construction.

Office Addresses

Inquiries regarding projects and available data may be directed to the District Office. Requests for current streamflow may be directed to the Field Headquarters nearest the area of concern, or to the District Office.

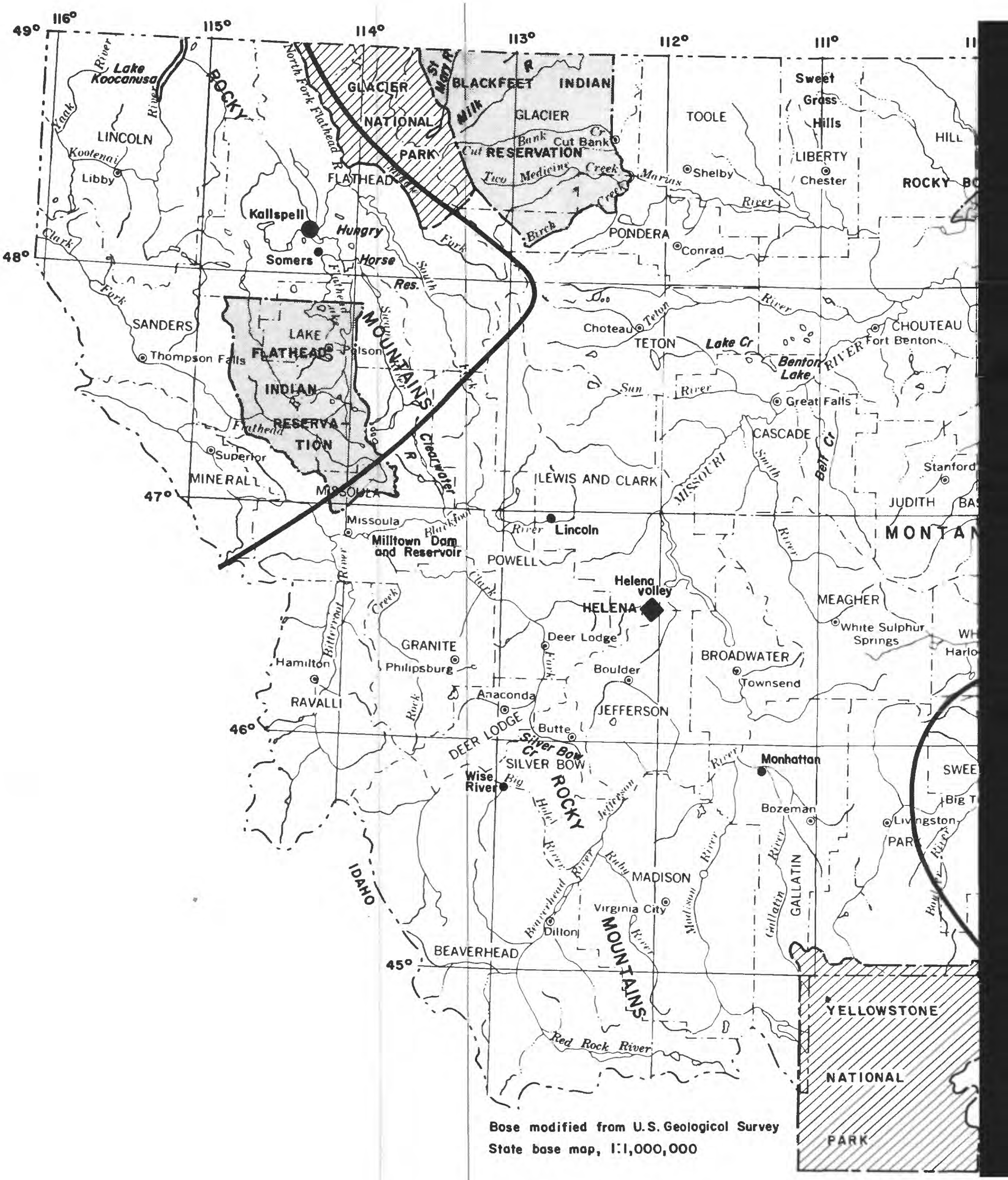
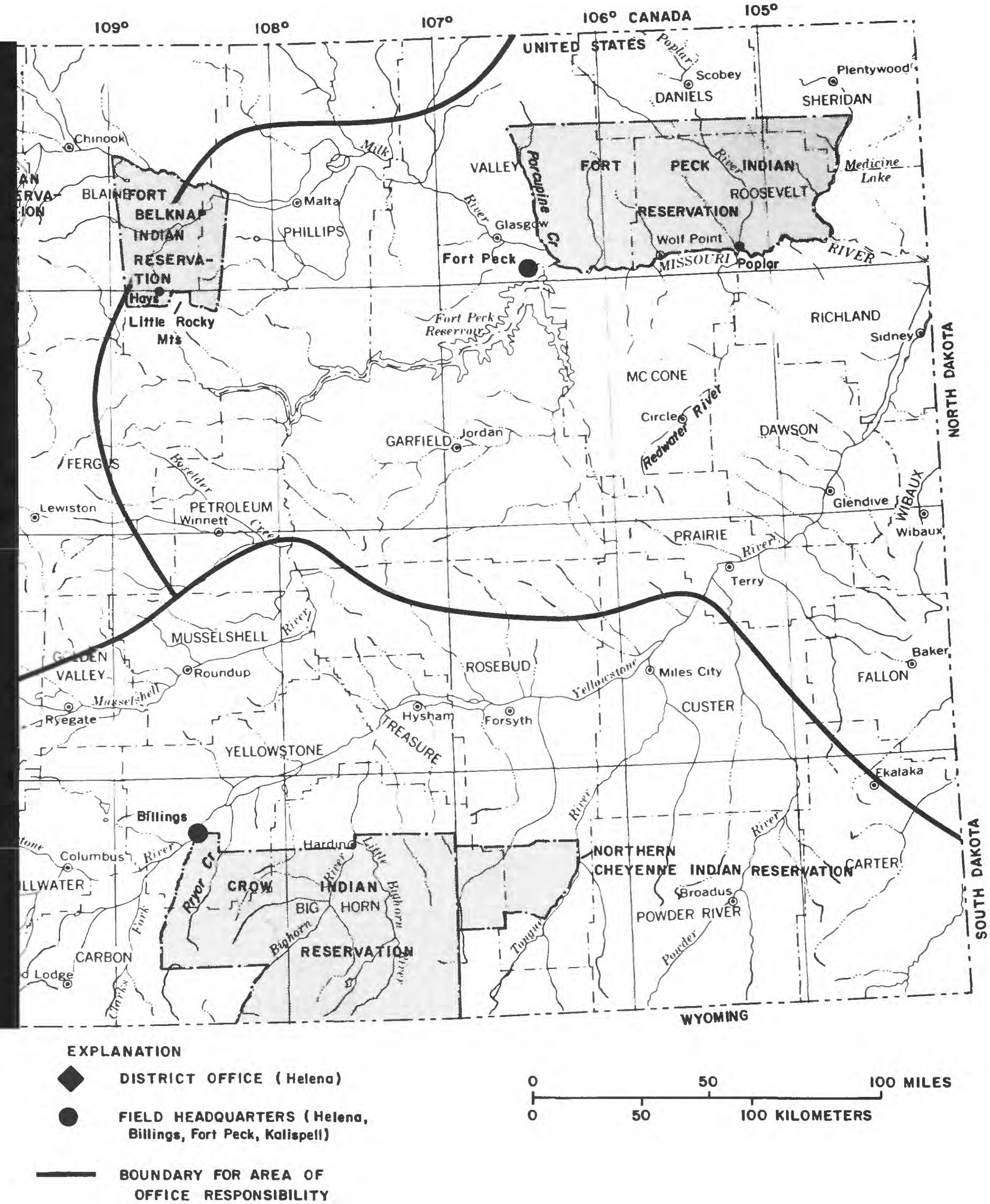


Figure 1.--Location of offices in the Montana District, general



area of responsibility, and selected geographic features.

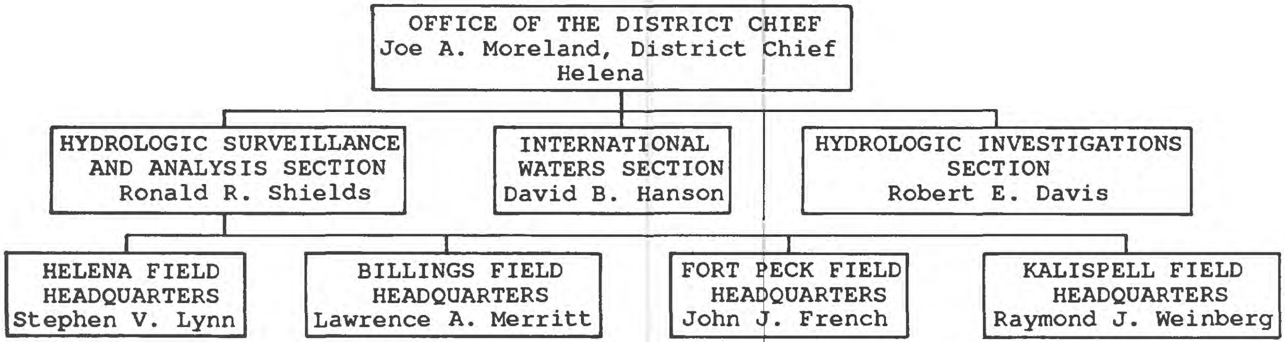


Figure 2.--Organization chart.

The offices have the following telephone numbers and addresses:

District Office Chief: Joe A. Moreland	(406) 449-5263	U.S. Geological Survey Water Resources Division 428 Federal Building 301 South Park, Drawer 10076 Helena, MT 59626-0076
Helena Field Headquarters Technician-in-charge: Stephen V. Lynn	(406) 449-5263	U.S. Geological Survey Water Resources Division 428 Federal Building 301 South Park, Drawer 10076 Helena, MT 59626-0076
Billings Field Headquarters Hydrologist-in-charge: Lawrence A. Merritt	(406) 657-6113	U.S. Geological Survey Water Resources Division Eastern Montana College, Box 111 1500 North 30th Billings, MT 59101-0111
Fort Peck Field Headquarters Technician-in-charge: John J. French	(406) 526-3532	U.S. Geological Survey Water Resources Division Administration Building P.O. Box 124 Fort Peck, MT 59223-0124
Kalispell Field Headquarters Technician-in-charge: Raymond J. Weinberg	(406) 755-6686	U.S. Geological Survey Water Resources Division 1015 East Idaho Street P.O. Box 1012 Kalispell, MT 59903-1012

Types of Funding

The Montana District is supported by funds appropriated directly to the Geological Survey (Federal program); by funds transferred from other Federal agencies (OFA program); and by services and (or) funds provided by State or other agencies, matched on a 50-50 basis with Federal funds (cooperative program). In fiscal year[1] 1990, total funding support for program operation in Montana was $3,295,615. Funding sources are illustrated in figure 3.

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[1] A fiscal year is the 12-month period October 1 through September 30. It is designated by the calendar year in which it ends. Thus, fiscal year 1990 extends from October 1, 1989, through September 30, 1990.

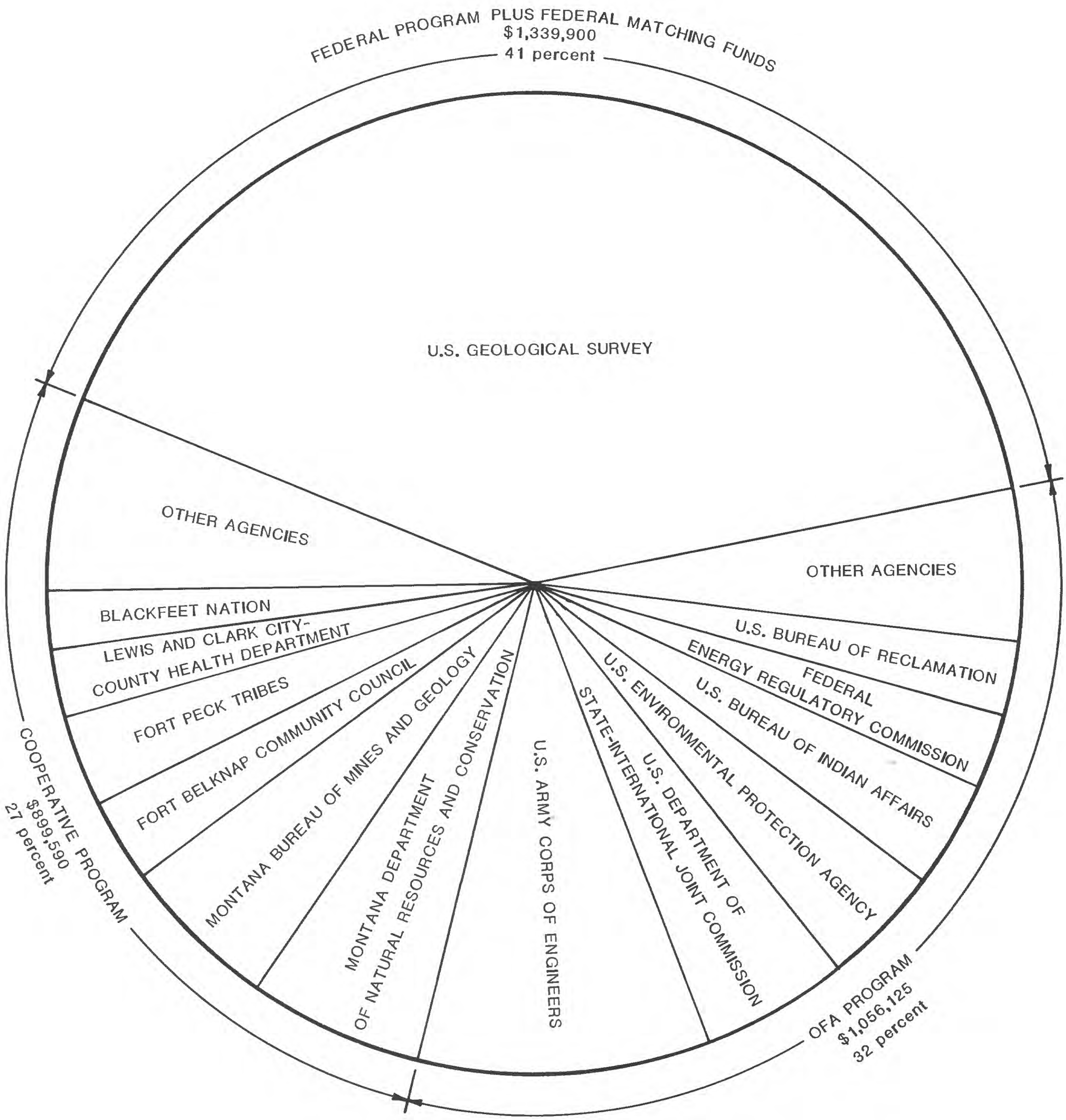

Figure 3.--Funding sources for the water-resources program in Montana. Funding amounts are for Federal fiscal year 1990.

Cooperating Agencies

The following agencies participated in program operation of the Montana District in fiscal year 1990 by providing funds and (or) services:

Federal Agencies
- U.S. Geological Survey
- U.S. Army Corps of Engineers
- U.S. Department of State-International Joint Commission, Waterways Treaty
- U.S. Environmental Protection Agency
- U.S. Bureau of Indian Affairs
- Federal Energy Regulatory Commission
- U.S. Bureau of Reclamation
- U.S. Department of the Interior, Office of the Secretary
- National Park Service
- Bonneville Power Administration
- U.S. Forest Service
- U.S. Bureau of Land Management
- Federal Highway Administration

State and Local Agencies
- Montana Department of Natural Resources and Conservation
- Montana Bureau of Mines and Geology
- Fort Belknap Community Council
- Fort Peck Tribes
- Lewis and Clark City-County Health Department
- Blackfeet Nation
- Confederated Salish and Kootenai Tribes of the Flathead Reservation
- Montana Department of Fish, Wildlife and Parks
- Montana Department of Health and Environmental Sciences
- Montana Department of Highways
- Montana Department of State Lands
- Wyoming State Engineer
- City of Helena
- Montana State University

HYDROLOGIC CONDITIONS

Montana has two distinct hydrogeologic regimes: mountains and intermontane valleys in the western and south-central areas, and plains in the eastern and north-central areas. Precipitation and mountain snowpack generally provide abundant streamflow suitable for most uses in the west and south (fig. 4). However, streamflows are depleted by irrigation during the summer and fall of some years. Smaller streams, particularly in the eastern and north-central areas of the State, do not provide dependable supplies except during spring runoff.

Hydrologic conditions during water year[2] 1990 were varied. Mountain and valley precipitation was near normal, except in northeastern Montana, where it was less than normal. Annual precipitation, measured at valley locations, ranged from 59 to 130 percent of normal. Northwestern Montana recorded the most precipitation. A November rainstorm in northwestern Montana caused streams and rivers to rise to flood levels having 10-year recurrence intervals. Snowfall was near normal through March but was less than normal in April. High temperatures in April generated greater than average rates of snowmelt, and streamflow responded accordingly. By May 1, the water content of the snowpack was less than 60 percent of normal in the upper Missouri River basin. Normal May-June precipitation, declining snowpack, and near normal runoff were recorded at all precipitation and streamflow-gaging stations except those in the upper Missouri basin. Yearly mean discharge, when compared to long-term data for selected streamflow-gaging stations, ranged from 13

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[2] A water year is the 12-month period October 1 through September 30. It is designated by the calendar year in which it ends in the same manner as a fiscal year.

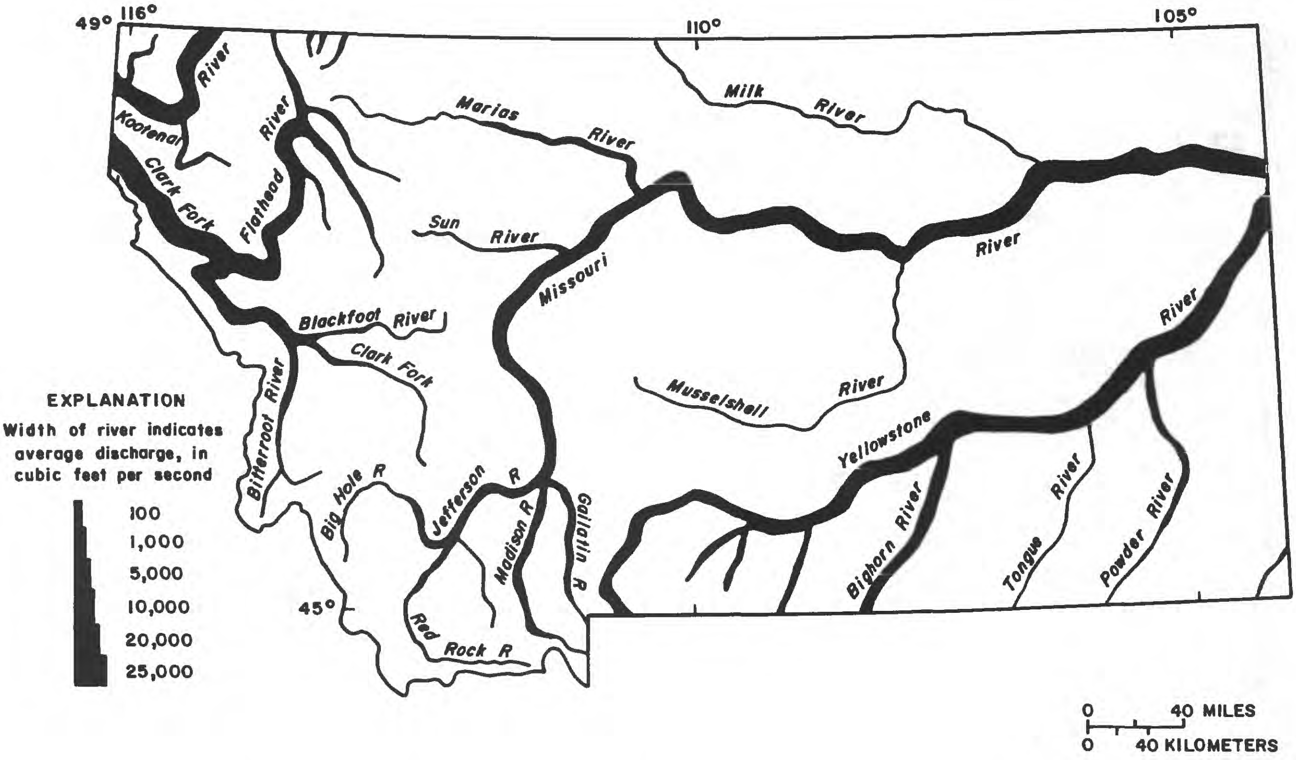

Figure 4.--Major river systems and long-term average discharge.

percent of average (Redwater River at Circle, station 06177500) to 133 percent of average (Middle Fork Flathead River near West Glacier, station 12358500).

Periodic flooding can occur suddenly in low-lying areas along most streams in the State. Selected areas subject to flooding (fig. 5) have been delineated on maps to assist administrators, planners, and engineers concerned with future land developments. More detailed maps, prepared by the Geological Survey as part of flood-insurance studies, are available for the densely populated areas of Cascade County, Hill County, Wibaux County, and Belt Creek near Belt.

Streamflow quality generally is suitable for most uses statewide, except in parts of eastern Montana where large dissolved-solids concentrations periodically render the water unsuitable for some domestic and agricultural uses. Current concerns focus on determining the transport of suspended sediment in the upper parts of the Yellowstone River, Clark Fork, and North Fork Flathead River; trace-metal concentrations as a result of past mining activities in the Clark Fork basin; arsenic inputs to the Missouri River from geothermal sources in Yellowstone National Park; return flows from irrigation statewide; and the effects of nutrient enrichment from point and nonpoint sources.

Irrigation in Montana is dependent on abundant surface-water sources. During 1985, the date of the most recent water-use compilation, irrigation accounted for about 8,300 million gallons per day of the total 8,650 million gallons per day withdrawn from Montana's surface- and ground-water sources[3]. Total water use by county is shown in figure 6. Surface water was the source for 98 percent of the total water withdrawals in Montana, and 98 percent of the surface-water withdrawals

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[3]Parrett, Charles, and Johnson, D.R., 1990, Montana water supply and use, *in* National water summary 1987--Hydrologic events and water supply and use: U.S. Geological Survey Water-Supply Paper 2350, p. 337-344.

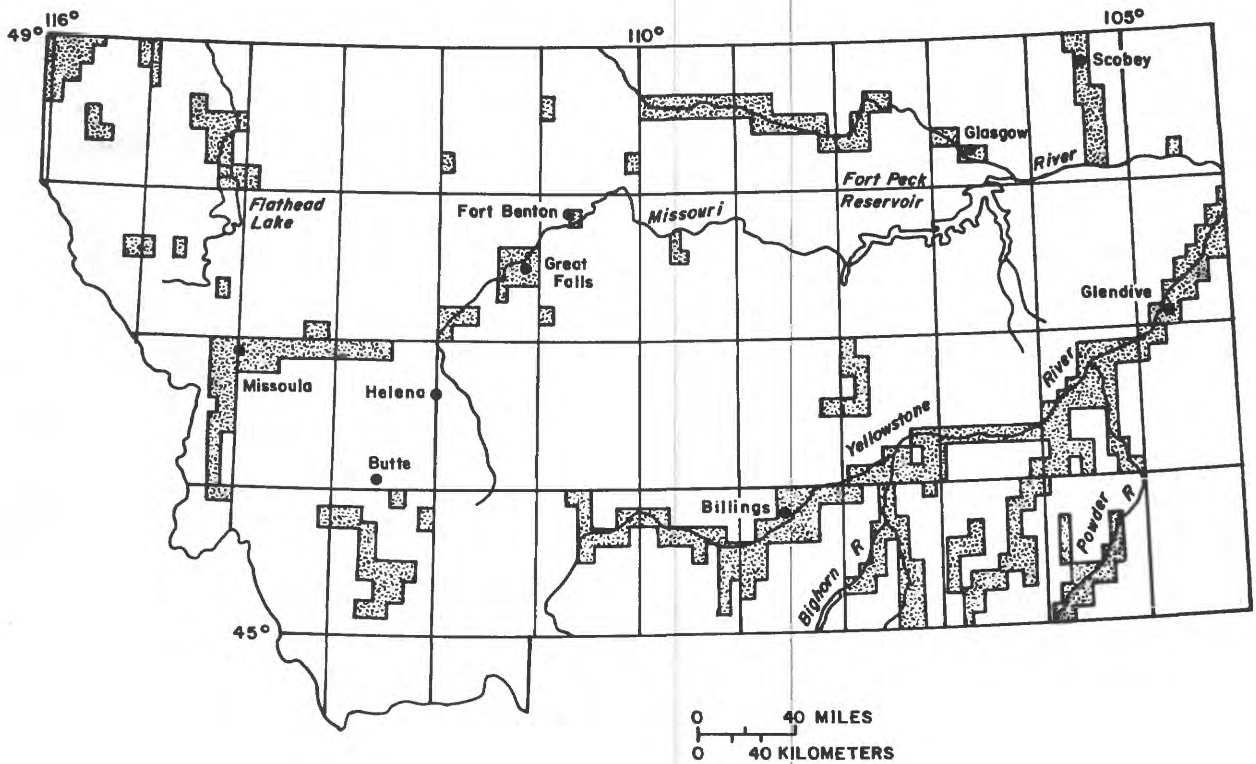


Figure 5.--Selected flood-prone areas in Montana (patterned) that have been identified by the U.S. Geological Survey.

was for irrigated agriculture. About 200 million gallons per day was withdrawn from ground-water sources during 1985. Water use for irrigated agriculture accounted for about 47 percent of all ground-water withdrawals.

Ground water is available in nearly every part of Montana. Water occurs principally in unconsolidated deposits along streams and in consolidated rocks underlying most of the State. Water also occurs in basin-fill deposits beneath intermontane valleys in the west.

Hydrologic information is being collected to address several issues concerning ground water in Montana. In some areas, ground-water levels have declined or may decline in response to past or projected water use and drought and low-streamflow conditions. The potential for degradation of ground-water quality is a major concern, and the effects of human activities on ground-water resources are being evaluated by hydrologic study and research. As examples, the effects on water quality of surface coal mining in southeastern Montana and of irrigation in west-central Montana are being investigated. Other investigations are focused on defining the hydrologic systems and the availability of ground water in areas throughout the State.

These and other water-resources problems can be solved only by long-term comprehensive planning and management, which require reliable hydrologic information. The current activities of the Montana District address many of the State's hydrologic problems. These activities, described in the following pages, are designed to provide information needed for optimal utilization of Montana's water resources.

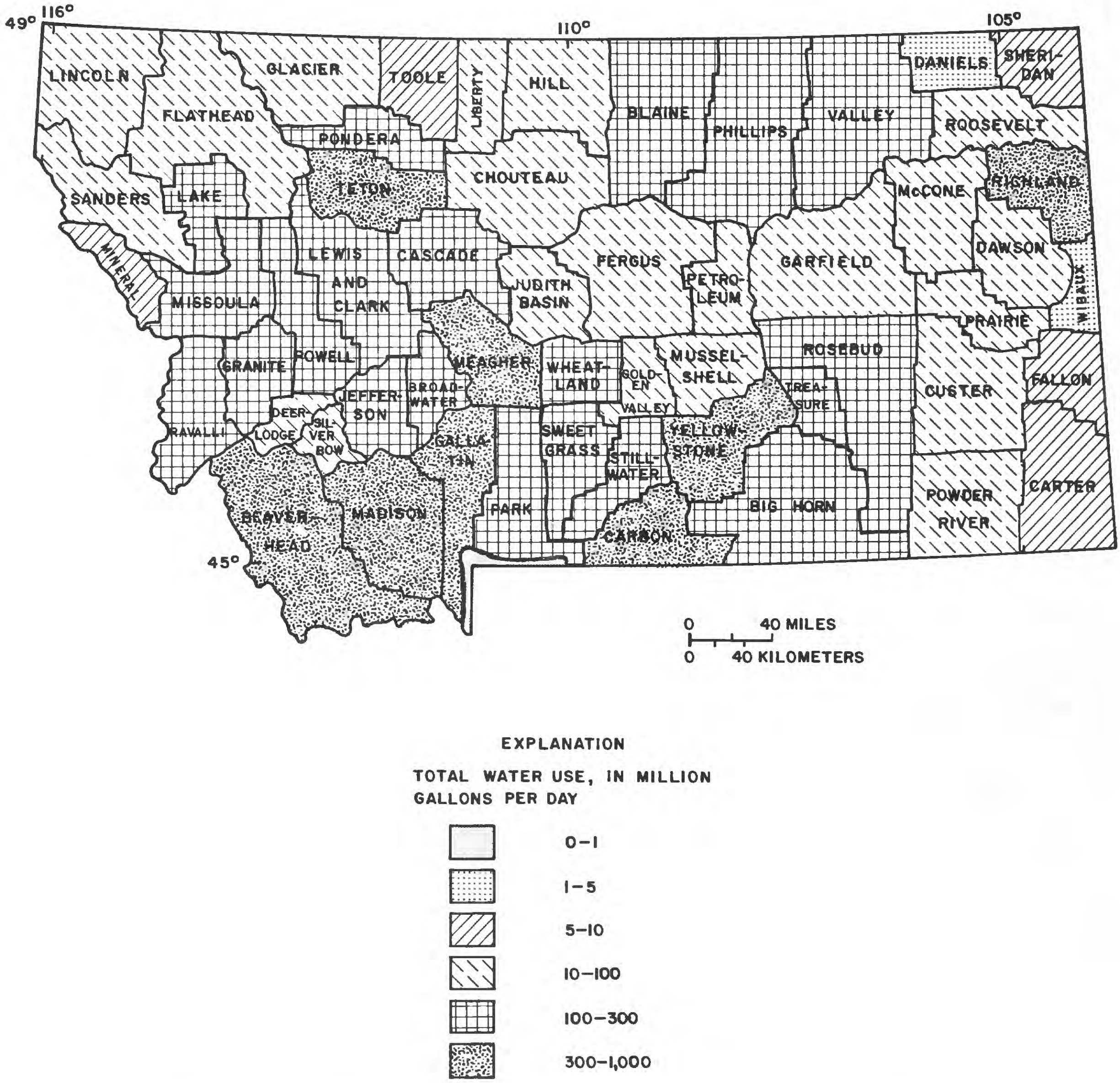


Figure 6.--Total water use in Montana counties, 1985.

DATA-COLLECTION PROGRAMS

Hydrologic-data stations are maintained at selected sites throughout Montana for the collection of basic information concerning stream discharge and stage, reservoir and lake storage, ground-water levels, quality of surface and ground water, quality of atmospheric water, depth and water content of snowpack, and water use. The station networks are revised periodically in response to changing needs for information to ensure collection of relevant data. Much of the collected information is published annually in water-data reports. Most is stored in computer files for efficient processing and retrieval. The computer-stored data are maintained in the Geological Survey's National Water Data Storage and Retrieval System (WATSTORE) and are available on request to managers, planners, investigators, and others involved in making decisions affecting the State's water resources. Assistance in the acquisition of data obtained from these station networks can be obtained from the District Chief at the address shown at the front of this report.

Surface-water-discharge (streamflow), stage (water-level), and reservoir-contents data were being obtained in October 1990 at the following number of stations.

Station classification		Number of stations
Stream stations.		394
Continuous record:		
Discharge and stage.	229	
Stage only	4	
Partial record:		
Peak (maximum) flow only	161	
Lake and reservoir stations.		64
Stage and contents	64	
Total.		458

The location of active continuous-record surface-water gaging stations on streams, reservoirs, and lakes is shown in figure 7 at the back of the report; corresponding information on financial support and gage equipment is given in table 1. The location of active crest-stage gaging stations is shown in figure 8 at the back of the report; corresponding information on period of record is given in table 2. Data are also available from the District Office for 634 continuous-record surface-water gaging stations and 170 partial-record crest-stage gaging stations discontinued in previous years.

Water-quality data were being obtained in October 1990 at 79 streamflow-gaging stations. Sixteen of the stations are part of a Geological Survey nationwide network known as the National Stream Quality Accounting Network (NASQAN), which is used to assess the quality of the Nation's streams. The types of data determined at the surface-water-quality stations are given below. Inasmuch as several types of data may be determined at a particular site and not all types of data are determined at each site, the numbers given will not equal the total number of stations.

Data classification	Number of sites
Onsite data:	
Water temperature	79
Specific conductance.	63
pH.	45
Dissolved oxygen.	37
Sediment data	48
Chemical data (inorganic constituents).	63
Biological data	18

The location of active surface-water-quality stations on streams and reservoirs is shown in figure 9 at the back of the report; corresponding information on financial support and sampling frequency is given in table 3.

Water levels in wells, discharges of springs and wells, and water-quality data are key characteristics in monitoring ground-water trends. However, these hydrologic characteristics must be integrated with other observations and ground-water-system studies to have the fullest meaning and usefulness. In Montana, the Geological Survey regularly monitors water levels in selected wells (called observation wells). Other wells and springs are inventoried as part of ground-water projects throughout the State. Although the project wells and springs are not part of the observation-well program, the data obtained from these sources are available. The number of wells measured regularly and the number of project wells and springs at which water-level or discharge measurements were made during the past year are given below.

Site classification	Number of sites
Observation wells	302
Project wells	170
Project springs	5

The basic observation-well network is shown in figure 10 at the back of the report; corresponding information on water-level measurements and chemical analyses is given in table 4. Project wells and springs are not identified.

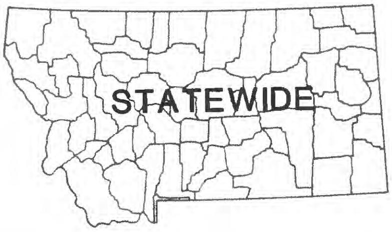
Water-quality data are obtained at some of the project wells and springs listed above. The types of water-quality data determined at these ground-water sites during the past year are given in the following table. The numbers will not equal the total number of sites inasmuch as several types of data may be determined at a single site and not all types of data are determined at each site.

Data classification	Wells	Springs
Onsite data:		
Water temperature	107	5
Specific conductance	54	5
pH	54	5
Chemical data (inorganic constituents)	111	5
Chemical data (chloride, pH, specific conductance, and nitrogen)	53	0

Ground-water-quality sampling sites are not identified in figure 10.

The six projects described on the following pages are concerned mainly with the collection of basic hydrologic data. The project number is given after each project title.

Project title: Surface-Water Stations (MT001)



Location: Statewide

Period of project: Continuing

Project chief: Ronald R. Shields, Helena

Funding source(s): Multiple agencies identified in tables 1 and 2

Problem: Surface-water information is needed for surveillance, planning, design, hazard warning, operation, and management in water-related fields such as water supply, hydroelectric power, flood control, irrigation, bridge and culvert design, wildlife management, pollution abatement, flood-plain management, and water-resources development. To provide this information, an appropriate data base is needed.

Objective(s): (1) To collect current surface-water data sufficient to satisfy needs for multipurpose uses, such as (a) assessment of water resources, (b) operation of reservoirs or industries, (c) forecasting, (d) waste disposal and pollution controls, (e) compact and legal requirements, and (f) research or special studies. (2) To collect data necessary for analytical studies to define for any location the statistical properties of, and trends in, the occurrence of water in streams, lakes, and other surface-water bodies for use in planning and design.

Approach: Use standard methods of data collection as described in the series, "Techniques of Water-Resources Investigations of the United States Geological Survey." Use partial-record gaging instead of complete-record gaging where it serves the required purpose.

Progress during fiscal year 1990: Data collection was maintained on schedule at all stations in the network. Streamflow was near normal during most of the year.

Plans for fiscal year 1991: Continue to operate streamflow stations in the network, and, if appropriate, change the network based on user needs and funding.

Information product(s): Hull, J.A., and Omang, R.J., in press, Annual peak discharges from small drainage areas in Montana through September 1989: U.S. Geological Survey Open-File Report 90-577, 143 p.

Merritt, L.A., Caprio, J.M., and Brasch, R.G., Montana floods and droughts, *in* National water summary 1988-89--Hydrologic events and floods and droughts: U.S. Geological Survey Water-Supply Paper 2375 (in preparation).

Shields, R.R., Knapton, J.R., White, M.K., Brosten, T.M., and Reed, T.E., Water resources data, Montana, water year 1990: U.S. Geological Survey Water-Data Report MT-90-1 (in preparation).

Yellowstone River Compact Commission, 1990, Thirty-ninth annual report, Yellowstone River Compact Commission: Annual report (planned).

MT001 Streamflow-gaging station 12339450 on the Clearwater River near Clearwater. Photograph by R.R. Shields, U.S. Geological Survey.

Project title: Ground-Water Stations (MT002)

Location: Statewide

Period of project: Continuing

Project chief: Thomas E. Reed, Helena

Funding source(s): Montana Bureau of Mines and Geology, Montana Department of Natural Resources and Conservation, Montana State University, and U.S. Geological Survey

Problem: Long-term water-level records are needed to evaluate the effects of climatic variations on recharge to and discharge from ground-water systems, to provide a data base from which to measure the effects of development, to assist in prediction of future supplies, and to provide data for resource management.

Objective(s): (1) To collect water-level data sufficient to provide a minimum long-term data base so that the general response of the hydrologic system to natural climatic variations and induced stresses is known and potential problems can be defined early enough to allow proper planning and management. (2) To provide a data base against which the short-term records acquired in areal studies can be analyzed. This analysis may (a) provide an assessment of the ground-water resource, (b) allow prediction of future conditions, (c) detect and define pollution and supply problems, or (d) provide the data base necessary for management of the resource.

Approach: Evaluate the regional geology to permit a broad, general definition of aquifer systems and their boundary conditions. Within this framework and with some knowledge of the stress on the system in time and space and the hydrologic properties of the aquifers, determine the most advantageous locations for observation of long-term system behavior. Refine this network as records become available and detailed areal studies of the ground-water system more closely define the aquifers, their properties, and the stresses to which they are subjected.

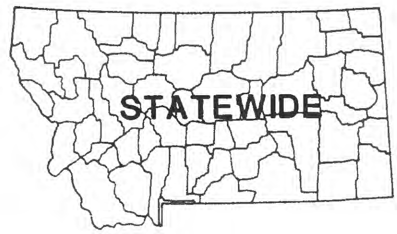
Progress during fiscal year 1990: Measured water levels in observation wells. Checked and entered data into data bases. Conducted aquifer tests in the Gallatin River valley near Bozeman.

Plans for fiscal year 1991: Continue operation of statewide observation-well network.

Information product(s): Shields, R.R., Knapton, J.R., White, M.K., Brosten, T.M., and Reed, T.E., Water resources data, Montana, water year 1990: U.S. Geological Survey Water-Data Report MT-90-1 (in preparation).

MT002 Two-inch monitoring well being developed with compressed air in the Fort Belknap Indian Reservation. Photograph by T.E. Reed, U.S. Geological Survey.

Project title: Water-Quality Stations (MT003)



Location: Statewide

Period of project: Continuing

Project chief: J. Roger Knapton, Helena

Funding source(s): Multiple agencies identified in table 3

Problem: Water-resource planning and water-quality assessment require a nationwide data base of relatively standardized information. For effective planning and realistic assessment of the water resource, the chemical and physical quality of the rivers and streams needs to be defined and monitored.

Objective(s): (1) To provide a national bank of water-quality data for broad Federal and State planning and action programs. (2) To provide data for Federal management of interstate and international waters. (3) To provide data necessary for statistical analysis of current water-quality conditions and trends with time.

Approach: Operate a network of water-quality stations to provide spatial and temporal information for chemical concentrations, loads, and time trends as required by planning and management agencies.

Progress during fiscal year 1990: Maintained data collection on schedule at all stations in the network. Analyzed and prepared the annual records for publication. Published the water year 1989 records.

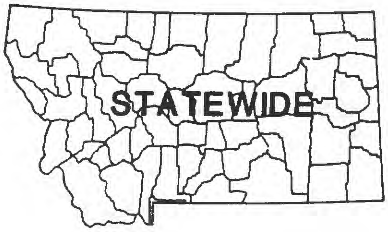
Plans for fiscal year 1991: Continue collection and analysis of samples from the network. Evaluate the network and make changes where appropriate.

Information product(s): Knapton, J.R., and Bahls, L.L., Montana stream water quality, *in* National water summary 1990-91--Hydrologic events and stream water quality: U.S. Geological Survey Water-Supply Paper 2400 (in preparation).

Shields, R.R., Knapton, J.R., White, M.K., Brosten, T.M., and Reed, T.E., Water resources data, Montana, water year 1990: U.S. Geological Survey Water-Data Report MT-90-1 (in preparation).

MT003 Routine water-quality work is conducted at about 60 gaging stations throughout Montana as part of the hydrologic surveillance and analysis program. Photograph by John H. Lambing, U.S. Geological Survey.

Project title: Sediment Stations (MT004)



Location: Statewide

Period of project: Continuing

Project chief: John H. Lambing, Helena

Funding source(s): Multiple agencies identified in table 3

Problem: Water-resource planning and water-quality assessment require a nationwide data base of relatively standardized information. Sediment concentrations and sediment discharges in rivers and streams need to be defined and monitored for assessment and management of erosion, reservoir sedimentation and design, navigation, and water quality.

Objective(s): (1) To provide a national bank of sediment data for use in broad Federal and State planning and action programs. (2) To provide data for Federal management of interstate and international waters. (3) To provide data necessary to define the sediment-transport characteristics of streams and the relation to water quality.

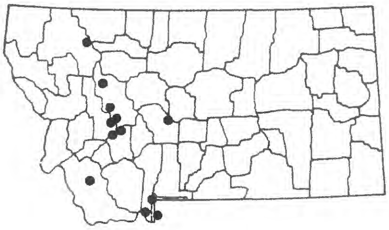
Approach: Establish and operate a network of sediment stations to provide spatial and temporal averages and trends of sediment concentration, sediment discharge, and particle size of sediment being transported by rivers and streams.

Progress during fiscal year 1990: Maintained data collection on schedule. Analyzed annual records and prepared them for publication. Established one new daily sediment station.

Plans for fiscal year 1991: Continue collection of sediment data. Evaluate sampling requirements necessary to meet objectives and make changes where appropriate.

Information product(s): Shields, R.R., Knapton, J.R., White, M.K., Brosten, T.M., and Reed, T.E., Water resources data, Montana, water year 1990: U.S. Geological Survey Water-Data Report MT-90-1 (in preparation).

MT004 Chemical and sediment sample collection during high flow using bridge-operated equipment. A sampling device is lowered by cable to the river, then passed through the entire depth of flowing water. This process is repeated at multiple points across the stream to obtain a composite sample. Photograph by J.R. Knapton, U.S. Geological Survey.



Project title: Precipitation Stations (MT005)

Location: West-central Montana

Period of project: Continuing

Project chief: Ronald R. Shields, Helena

Funding source(s): U.S. Army Corps of Engineers and U.S. Geological Survey

Problem: Increasing use of streamflow for irrigation, municipal, industrial, and other uses requires additional planning for distribution and greater utilization. Effective planning and management require more detailed data on precipitation quantities than are currently available. Forecasting of streamflow and estimating future availability, especially for successive irrigation seasons, require a knowledge of snowpack characteristics.

Objective(s): To measure the depth and water content of the snowpack at 12 designated snow courses at specified intervals and to monitor the chemical quality of precipitation at 2 locations.

Approach: Use standard methods to measure the depth and water content at 10 sites on each snow course. Use methods prescribed by National Trends Program to collect and analyze precipitation samples.

Progress during fiscal year 1990: Measured all snow courses according to schedule. Collected continuous samples at two National Trends Network precipitation-monitoring stations. Compiled data and distributed to cooperating agencies, or compiled data and prepared for publication.

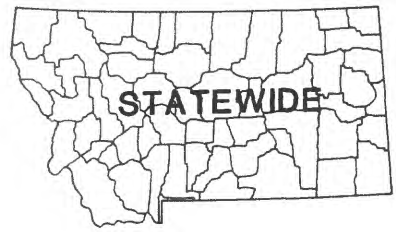
Plans for fiscal year 1991: Continue measurement of snow depths and computation of water content at 12 snow courses. At two National Trends Network stations, continue collection of precipitation samples for chemical analysis.

Information product(s): Results of measurements are included in U.S. Soil Conservation Service report, "Water supply outlook for Montana."

Shields, R.R., Knapton, J.R., White, M.K., Brosten, T.M., and Reed, T.E., Water resources data, Montana, water year 1990: U.S. Geological Survey Water-Data Report MT-90-1 (in preparation).

MT005 Snow course measurement site in southwestern Montana. Photograph by R.R. Shields, U.S. Geological Survey.

Project title: Water Use (MT007)



Location: Statewide

Period of project: Continuing

Project chief: Dave R. Johnson, Helena

Funding source(s): Montana Department of Natural Resources and Conservation, Blackfeet Nation, U.S. Bureau of Indian Affairs, and U.S. Geological Survey

Problem: Water-use data are needed to administer various State laws governing appropriation, allocation, and use of water. Water-development planning necessitates a firm data base of current water use to evaluate various alternatives for expanded or revised use patterns.

Objective(s): (1) To obtain water-use data responsive to the needs of local, State, and Federal agencies and private individuals. (2) To develop means for efficiently storing, retrieving, and disseminating the data.

Approach: Develop joint water-use data collection and analysis plans and strategies with cooperating agencies. Conduct cooperative data collection and analysis projects using techniques and procedures approved by cooperating agencies.

Progress during fiscal year 1990: Estimated water use in Pryor Creek basin.

Plans for fiscal year 1991: Inventory and compile data on statewide water use for 1990 and prepare for publication in two reports.

Information product(s): Water-use information will be supplied to requesters. Reports will be prepared as part of projects MT129 and MT130.

MT007 Inlet structure for Warm Springs canal at the Gallatin River, about 5 miles southeast of Manhattan. Photograph by Dave R. Johnson, U.S. Geological Survey.

INVESTIGATIVE STUDIES

The Geological Survey is often asked by Federal, State, or local agencies to investigate hydrologic problems of limited areal extent. These problem-oriented studies range in scope from cursory examination of baseline conditions to detailed investigations of cause and effect. For problems of a recurring nature, continuing projects are established to provide an ongoing service to the funding agency. Other problems, such as evaluation of ground-water conditions in local areas, may or may not be of a recurring nature.

The 18 projects described on the following pages are concerned mainly with collection and analysis of hydrologic data and application of results to the solution of hydrologic problems. The project number is given after each project title.

Project title: Lake Koocanusa and Hungry Horse Reservoir Trophic Dynamics (MT102)

Location: Northwestern Montana

Period of project: October 1983 through September 1990

Project chief: Robert E. Davis, Helena

Funding source(s): Montana Department of Fish, Wildlife and Parks

Problem: The Montana Department of Fish, Wildlife and Parks has contracted with the Bonneville Power Administration to quantify seasonal water levels needed to maintain or enhance principal gamefish species in Lake Koocanusa and Hungry Horse Reservoir. The Department plans to collect data on water quality, fish food organisms, critical life stages of gamefish, and gamefish population levels. Attempts will be made to relate these data to reservoir levels. Methods are needed to predict effects of reservoir drawdown on fish production. Simulation models are necessary to accomplish these predictions.

Objective(s): (1) To evaluate various model techniques and selected potential models for application to Lake Koocanusa. (2) To construct and test a simulation model that could relate reservoir drawdown to trophic dynamics of Lake Koocanusa. (3) To determine data requirements for various models and evaluate adequacy of data-collection programs for use in developing predictive models of Lake Koocanusa and Hungry Horse Reservoir.

Approach: Review various models for application to Lake Koocanusa. Relate data on gamefish productivity (water quality, fish food organisms, life stages of gamefish, and gamefish population levels) to reservoir levels or drawdown to determine relations between productivity and reservoir operation. Select applicable models for simulation of reservoir conditions. If results indicate need for changes in data-collection programs, suggest appropriate modifications.

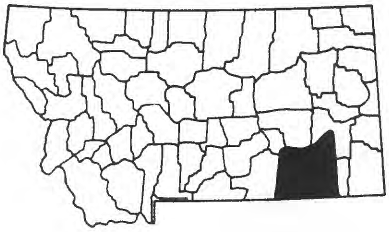
Progress during fiscal year 1990: Collected water-quality data for both reservoirs and obtained review of report.

Plans for fiscal year 1991: Modify draft report, obtain approval, and publish.

Information product(s): Ferreira, R.F., and Adams, D.B., Development of thermal models for Hungry Horse Reservoir and Lake Koocanusa, northwestern Montana and British Columbia: U.S. Geological Survey Water-Resources Investigations Report (in preparation).

MT102 Mooring buoy used to tether a work boat on Lake Koocanusa. Water samples are collected routinely and a variety of water-quality measurements are made in the water column from the surface to bottom. Photograph by J.R. Knapton, U.S. Geological Survey.

Project title: Powder River Coal Region Geographic Information System Data Base and Mine-Spoils Geochemistry (MT118)



Location: Southeastern Montana

Period of project: July 1987 through September 1990

Project chief: Michael R. Cannon, Helena

Funding source(s): Montana Department of State Lands, U.S. Bureau of Land Management, and U.S. Geological Survey

Problem(s): (1) Attempts to use the considerable quantity of data available for Cumulative Hydrologic Impact Assessments (CHIA) require considerable effort to review and compile the data. Recent advances in computer technology make the Geographic Information System (GIS) a logical tool to surmount this problem. (2) Additional knowledge of the hydrogeochemical processes affecting mine-spoils water, both onsite and offsite, is necessary to fully understand how water-quality changes occur and to more accurately predict the effects of mining.

Objective(s): (1) To develop a GIS data base from relevant and available industry, State, and Federal data files for future use in CHIA studies. (2) To expand the knowledge of hydrogeochemical processes that occur both onsite and offsite in ground water as a result of surface coal mining in southeastern Montana.

Approach: (1) Determine data availability and form, acquire necessary computer software and hardware, enter data into GIS, demonstrate system capabilities to cooperating agencies, transfer data files to cooperating agencies, and prepare report. (2) Select drilling sites at two mines, prepare drilling contract, complete drilling and sampling of solid and aqueous phases for chemical and mineralogical characteristics including isotopes, and model the geochemical characteristics.

Progress during fiscal year 1990: Prepared GIS report and obtained approval for publication. Resampled mine-spoils wells, completed geochemical models, and prepared report for review.

Plans for fiscal year 1991: Publish GIS report. Obtain review and approval of mine-spoils geochemistry report and publish.

Information product(s): Cannon. M.R., in press, A Geographic Information System data base for coal and water resources of the Powder River coal region, southeastern Montana: U.S. Geological Survey Open-File Report 90-568, 83 p.

Clark, D.W., Geochemical processes in ground water resulting from surface mining of coal in the Big Sky and West Decker coal-mining areas, southeastern Montana: U.S. Geological Survey Water-Resources Investigations Report (in preparation).

MT118 Water discharging from a coal bed in the Powder River coal region of southeastern Montana. Photograph by Dex A. Hight, U.S. Bureau of Land Management.

Project title: Powder River Water Quality (MT121)

Location: Southeastern Montana and northeastern Wyoming

Period of project: July 1988 through September 1990

Project chief: Lawrence E. Cary, Billings

Funding source(s): Montana Department of Natural Resources and Conservation, and U.S. Geological Survey

Problem: Water from the Powder River and its tributaries is used for irrigation, industry, and domestic and livestock supply. Water in the downstream reach of the river is of marginal quality for irrigation. Dissolved-solids concentrations tend to be greater during periods of low flow, particularly during the summer irrigation season, and less during periods of high flow, such as spring runoff. Additional knowledge and understanding of the water-quality characteristics of the river system are needed before managers can evaluate potential changes in quality resulting from hydrologic changes.

Objective(s): (1) To compile available water-quality data for the basin. (2) To determine water-quality characteristics of the Powder River and its major tributaries. (3) To develop a conceptual model of the river system. (4) To develop a computer-based mass-balance accounting model for the river system.

Approach: (1) Compile existing data, measure daily specific conductance of streamflow at Moorhead and Locate, sample eight sites on an approximately monthly basis for 18 months, and analyze samples for common ions and field (onsite) parameters. (2) Conduct synoptic flow and water-quality measurements on the mainstem and significant tributaries, determine land and water use, and evaluate data for trends. (3) Develop a conceptual model based on old and new data. (4) Develop a mass-balance model to check the conceptual model and to provide managers with a means to evaluate the resource in the future. Related study being conducted by the Wyoming District of the U.S. Geological Survey in cooperation with the Wyoming State Engineer and the Wyoming Water Development Commission.

Progress during fiscal year 1990: Completed a trend analysis. Prepared report documenting the trend analysis and obtained review. For the mass-balance model, completed the analysis and prepared part of the report.

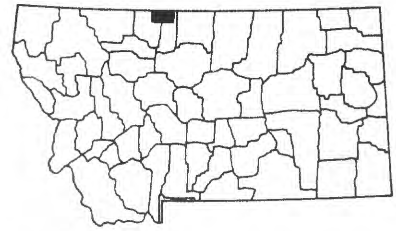
Plans for fiscal year 1991: Complete the model report and obtain approval and publish both reports.

Information product(s): Cary, L.E., Trends in selected water-quality characteristics, Powder River and tributaries, Montana and Wyoming, water years 1968-88 and 1975-88: U.S. Geological Survey Water-Resources Investigations Report (in preparation).

Lindner-Lunsford, J.B., Parrett, Charles, Wilson, J.F., Jr., and Eddy, C.A., Chemical quality of surface water and mathematical simulation of the surface-water system, Powder River drainage basin, northeastern Wyoming and southeastern Montana: U.S. Geological Survey Water-Resources Investigations Report (in preparation).

MT121 Upstream view of the Powder River at Broadus. The silt deposits are indicative of water-quality problems in the basin. Photograph from U.S. Geological Survey files.

Project title: Sweet Grass Hills Ground-Water Resources (MT122)



Location: North-central Montana

Period of project: October 1988 through April 1992

Project chief: Lori K. Tuck, Helena

Funding source(s): Montana Bureau of Mines and Geology and U.S. Geological Survey

Problem: Several small tributaries of the Milk River originate in the Sweet Grass Hills and flow northward into Canada. Increasing surface-water use and recent drought conditions have resulted in concern over water apportionments by users in the United States and Canada. Historical stream records for these tributaries are fragmented or nonexistent; therefore, costs to monitor flows and to apportion the water would be substantial. One solution to alleviate growing water-apportionment problems is to augment surface water with ground water. However, before the potential for this solution can be evaluated, the hydrogeologic framework of the Sweet Grass Hills area needs to be known.

Objective(s): (1) To describe the hydrogeologic framework of the Sweet Grass Hills. (2) To determine the feasibility of using ground water to supplement surface-water resources. Specific objectives to be addressed are (a) determine the location of wells and springs and the use of the water, (b) determine the hydraulic characteristics of the principal aquifer(s), (c) determine, if possible, the hydraulic interconnection of water-bearing zones, and (d) characterize chemical quality of the water of the principal aquifers to the extent possible using water samples from existing wells.

Approach: Compile information from Canadian, State, Federal, and local agencies, and from scientific literature. Obtain information on subsurface geology, aquifer geometry, and hydraulic characteristics from geophysical logs from selected files of the Montana Board of Oil and Gas Conservation. Inventory wells, conduct specific-capacity tests of the wells, sample wells and analyze the samples for common ions and trace constituents, and establish a monthly ground-water-level monitoring network with digital recorders installed at key sites.

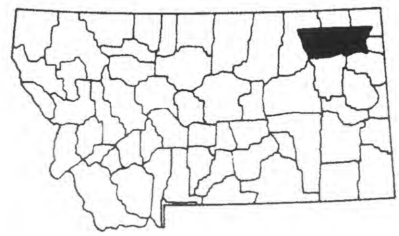
Progress during fiscal year 1990: Measured streamflow gain or loss to determine ground water-surface water interactions, conducted a supplementary water-well inventory, obtained supplementary water-quality samples, monitored water levels monthly, and annotated the report outline.

Plans for fiscal year 1991: Complete draft report and submit report for approval.

Information product(s): Tuck, L.K., Reconnaissance of the hydrogeology and water quality along the north flank of the Sweet Grass Hills, north-central Montana: U.S. Geological Survey Water-Resources Investigations Report (in preparation).

MT122 West-facing slopes of Middle Butte in the Sweet Grass Hills. Photograph by L.K. Tuck, U.S. Geological Survey.

Project title: Fort Peck Indian Reservation Ground-Water Resources (MT123)



Location: Northeastern Montana

Period of project: October 1988 through September 1990

Project chief: Joanna N. Thamke, Helena

Funding source(s): Fort Peck Tribes and U.S. Geological Survey

Problem: Availability and quality of ground water in the Fort Peck Indian Reservation are of concern to the Fort Peck Tribes. This concern exists because, in many parts of the reservation, ground water is the only available source of water. In recent years, some tribal residents have claimed that the quality of water from their household wells has deteriorated. To assist the Fort Peck Tribes in wisely managing the ground-water resource of the reservation, additional ground-water information needs to be readily accessible to tribal officials.

Objective(s): To establish a network of wells that will aid in quantifying water availability for major aquifers in the area and will help to describe areas of water-quality concerns.

Approach: Compile existing well information from the Water Resources Office of the Fort Peck Tribes and from Federal and State agencies. Select wells for onsite inventory, considering spatial and aquifer distribution. Establish an observation-well network for monitoring water levels monthly. Obtain water samples from about 20 wells and analyze samples for common and trace constituents, selected isotopes, and trace halides. Enter all measurements into a data base for use by tribal officials.

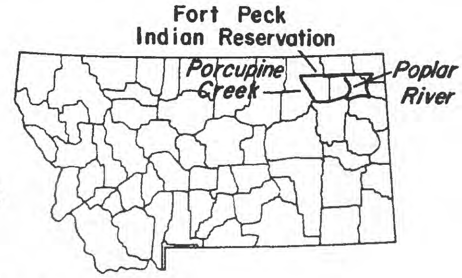
Progress during fiscal year 1990: Data base was provided to the tribes. Completed the report and obtained review.

Plans for fiscal year 1991: Obtain report approval and publish.

Information product(s): Thamke, J.N., Reconnaissance of ground-water resources of the Fort Peck Indian Reservation, northeastern Montana: U.S. Geological Survey Water-Resources Investigations Report (in preparation).

MT123 Water-level measurement in a livestock-watering well in the Fork Peck Indian Reservation. Photograph by David W. Clark, U.S. Geological Survey.

Project title: Fort Peck Indian Reservation 100-Year Flood Plains (MT124)



Location: Northeastern Montana

Period of project: October 1988 through September 1992

Project chief: Robert J. Omang, Helena

Funding source(s): Fort Peck Tribes and U.S. Geological Survey

Problem: Areas prone to flooding along rivers and streams in the Fort Peck Indian Reservation need to be delineated so that the Fort Peck Tribes can make zoning decisions concerning the location of buildings, structures, roads, or other facilities.

Objective(s): To conduct the necessary hydrologic and hydraulic evaluations of selected major streams to determine the extent of flooding that would occur as a result of a stream discharge having a recurrence interval of 100 years (a 100-year flood).

Approach: Conduct a reconnaissance and survey of channel and flood-plain cross sections along reaches of selected streams. Determine flood-discharge-frequency relations using local historical information, streamflow-gaging station records, and existing flood-frequency reports. Determine water-surface profiles at each surveyed cross section using step-backwater models and from these elevations determine the lateral extent of the flood at each section. Include results for each stream studied in a report.

Progress during fiscal year 1990: Compiled information, prepared a map report of the Poplar River flood plain, and received approval.

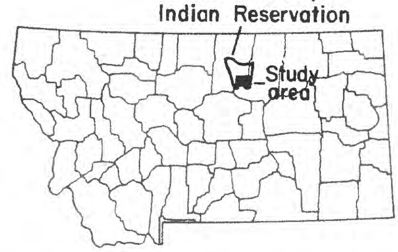
Plans for fiscal year 1991: Publish the Poplar River flood-plain report. Survey the channel and flood-plain cross sections along a 30-mile reach of Porcupine Creek. Use a step-backwater model to calculate water-surface elevations for the 100-year flood at each surveyed cross section. Prepare a map report showing the area subject to flooding along Porcupine Creek.

Information product(s): Omang, R.J., in press, Water-surface profile and flood boundaries for the computed 100-year flood, Poplar River, Fort Peck Indian Reservation, Montana: U.S. Geological Survey Water-Resources Investigations Report 90-4169, 2 sheets.

_______Flood boundaries on Porcupine Creek, Middle Fork to mouth, Fort Peck Indian Reservation, Montana: U.S. Geological Survey Water-Resources Investigations Report (planned).

MT124 Downstream view of the Poplar River and its flood plain, 2 miles north of Poplar. Photograph by R.J. Omang, U.S. Geological Survey.

Project title: Fort Belknap Indian Reservation Alluvial Hydrology (MT125)



Location: North-central Montana

Period of project: October 1988 through September 1990

Project chief: David W. Briar, Helena

Funding source(s): U.S. Bureau of Indian Affairs, Fort Belknap Community Council, and U.S. Geological Survey

Problem: Plans for improvement of agricultural productivity in the Fort Belknap Indian Reservation include the need for more water for irrigation than is available from surface-water sources. A previous study[4] of ground-water resources in the reservation has indicated that development of irrigation water supplies may be possible from alluvial deposits along Little Peoples, Jim Brown, Lodgepole, and Beaver Creeks near the northern flank of the Little Rocky Mountains. However, additional knowledge of the geologic and hydrologic framework of these aquifers and the quality of water they contain is needed before plans for proper development can proceed.

Objective(s): To describe the ground-water hydrology of alluvial deposits along Little Peoples, Jim Brown, Lodgepole, and Beaver Creeks near the northern flank of the Little Rocky Mountains in the reservation. Specific items to be defined are (a) the geometry of the alluvial aquifers, (b) the flow systems of the aquifers, (c) the quality of water in the alluvial aquifers, and (d) the capacity of the aquifers to yield large quantities of water.

Approach: Compile information from State and Federal agencies regarding previous work in the area: 67 test wells have been completed and monitored for water level, 7 aquifer tests have been conducted, 51 ground-water-quality samples have been collected and analyzed, and surface-geophysical surveys have been conducted. Develop a flow model of the alluvial deposits along Little Peoples Creek. Describe the ground-water flow system along Little Peoples, Jim Brown, Lodgepole, and Beaver Creeks.

Progress during fiscal year 1990: Prepared two draft reports.

Plans for fiscal year 1991: Complete reports, obtain approval, and publish.

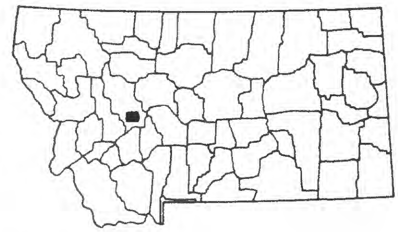
Information product(s): Briar, D.W., Christensen, P.C., and Oellermann, D.J., Hydrology of valley-fill deposits and potential for additional ground-water withdrawals along the north flank of the Little Rocky Mountains, Fort Belknap Indian Reservation, north-central Montana: U.S. Geological Survey Water-Resources Investigations Report (in preparation).

Briar, D.W. and Christensen, P.C., Lithologic logs of observation wells and test holes drilled in valley-fill deposits in 1987 in the southern Fort Belknap Indian Reservation, north-central Montana: U.S. Geological Survey Open-File Report (in preparation).

MT125 U.S. Geological Survey drilling rig in operation in the Fort Belknap Indian Reservation. Photograph by T.E. Reed, U.S. Geological Survey.

[4]Feltis, R.D., 1983, Ground-water resources of the Fort Belknap Indian Reservation, north-central Montana: Montana Bureau of Mines and Geology Memoir 53, 36 p.

Project title: Helena Valley Ground-Water Resources (MT127)



Location: Southwestern Montana

Period of project: October 1989 through September 1991

Project chief: David W. Briar, Helena

Funding source(s): Lewis and Clark City-County Health Department and U.S. Geological Survey

Problem: Shallow aquifers underlying the Helena Valley, which are the sole source of drinking water for 13,000 residents, are susceptible to contamination. Increased knowledge of the hydrogeologic system is needed to assess the existing water quality and to manage the resource to minimize potential impacts.

Objective(s): To describe the valley aquifer system by (a) locating and quantifying ground-water recharge and discharge, (b) establishing a long-term water-level and water-quality monitoring network of wells, (c) defining ground-water flow patterns, (d) characterizing existing water quality, (e) evaluating effects of present and potential withdrawals, and (f) establishing a computerized data framework for future use by managers.

Approach: Compile existing data, inventory new wells, establish a monitoring-well network, measure streamflow gain or loss, develop a three-dimensional finite difference model of the aquifer system, and sample selected wells for common, trace, and nutrient constituents of interest or concern.

Progress during fiscal year 1990: Established and maintained a monitoring-well network, drilled 21 wells, performed 6 aquifer tests, and collected 39 samples of water from wells for chemical analysis. Conducted two streamflow gain-loss investigations. Began work on a computer flow model and data-base maintenance. Began development of Geographic Information System (GIS) coverages for the study area.

Plans for fiscal year 1991: Continue measuring water levels in wells and streamflow, develop the model, prepare the report, obtain approval, and publish. Continue developing GIS coverages.

Information product(s): Briar, D.W., and Madison, J.P., Geohydrologic evaluation of the Helena Valley, Montana: U.S. Geological Survey Water-Resources Investigations Report (in preparation).

MT127 Well in Helena Valley, north of Helena, that is used for domestic supply. Water from the well flows to land surface at this site. Photograph by K.R. Wilke, U.S. Geological Survey.

Project title: Northern Rocky Mountains Intermontane Basins Regional Aquifer-System Analysis (MT128)

Location: Western Montana, northern and central Idaho

Period of project: January 1990 through September 1994

Project chief: David W. Clark, Helena

Funding source(s): U.S. Geological Survey

Problem: Unconsolidated deposits in valleys of the study area are important aquifers. For many residents, these aquifers are the main source of water for public-supply, rural-domestic, agricultural, and industrial uses. The ground-water resource is hydraulically connected to the surface-water resource, which is used extensively for recreation. Knowledge of the ground-water resource is needed for effective management, utilization, and protection.

Objective(s): To document and describe the (a) hydrogeologic systems within intermontane basins, (b) relations between ground and surface water in individual basins, (c) hydrologic relations between selected basins, and (d) baseline water quality.

Approach: Compile existing data, inventory wells onsite, develop a Geographic Information System (GIS) data base, measure streamflow gain or loss, establish surface-water-flow monitoring sites, and describe recharge, discharge, ground-water flow, and water budget. For four selected basins, conduct test drilling, surface geophysics, aquifer tests, and flow modeling.

Progress during fiscal year 1990: Selected a project chief and subproject chief, who are on staff. Filled some staff positions. Submitted vacancy announcements for the remaining full-time positions. Began work on plan of study. Developed tentative work plans for fiscal year 1991. Wrote informational summaries for major basins in Montana. Started data-base development.

Plans for fiscal year 1991: Complete the staffing. Complete the detailed plan of study. Continue data-base development, including analysis of logs of water, oil, and gas wells. Develop suitable GIS coverages. Prepare for field work and determine data-base needs. Inventory wells in intermontane basins, conduct mass water-level measurements, and conduct preliminary geophysical work.

Information product(s): Clark, D.W., Northern Rocky Mountains intermontane basins regional aquifer-system study, *in* Regional Aquifer-System Analysis program of the U.S. Geological Survey--Summary of projects, 1985-90: U.S. Geological Survey Circular (in preparation).

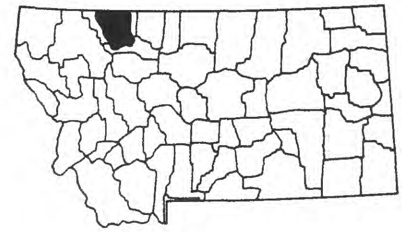
______Regional Aquifer-System Analysis of the Northern Rocky Mountains intermontane basins: American Water Resources Association RASA Monograph (in preparation).

______Plan of study for the aquifer systems of the Northern Rocky Mountains intermontane basins: U.S. Geological Survey Open-File Report (planned).

______Regional Aquifer-System Analysis--Northern Rocky Mountains intermontane basins: U.S. Geological Survey Professional Paper 1425 (planned).

MT128 **Alluvial valley of the Big Hole River near Wise River. Photograph by David W. Clark, U.S. Geological Survey.**

Project title: Blackfeet Indian Reservation Ground-Water Resources (MT129)



Location: Northwestern Montana

Period of project: March 1990 through September 1993

Project chief: Michael R. Cannon, Helena

Funding source(s): Blackfeet Nation and U.S. Geological Survey

Problem: Water resources are important to the Blackfeet Nation. Surface-water resources are used extensively for irrigation and recreation purposes. Ground water provides most of the drinking water for residents of the reservation. However, knowledge of the water resources is insufficient for proper utilization and protection.

Objective(s): To describe the ground-water resources of the Blackfeet Indian Reservation. Specific objectives are to (a) identify hydrogeologic units and describe the water-bearing characteristics of each, (b) determine recharge-discharge relations between aquifers and major streams, (c) determine water quality of aquifers, and (d) establish a ground-water data base for tribal use.

Approach: Compile existing data, conduct onsite inventory of wells and springs, map hydrogeologic units, collect and analyze about 50 water samples from wells and springs for chemical characteristics, conduct streamflow gain-loss investigations, and establish a data base.

Progress during fiscal year 1990: Initiated onsite inventory of wells and springs. Started mapping hydrogeologic units from field notes, well logs, and existing geologic maps. Began compilation of well information for the ground-water data base.

Plans for fiscal year 1991: Continue hydrogeologic mapping, onsite inventory of wells and springs, and development of data base. Drill wells for aquifer testing. Collect ground-water samples for chemical analysis. Water use in the study area will be investigated as part of project MT007.

Information product(s): Cannon, M.R., Hydrogeology of the Blackfeet Indian Reservation, northwestern Montana: U.S. Geological Survey Hydrologic Investigations Atlas (planned).

MT129 Duck Lake and Chief Mountain in the northwestern part of the Blackfeet Indian Reservation. Photograph by M.R. Cannon, U.S. Geological Survey.

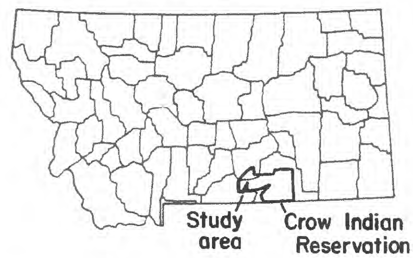
Project title: Upper Pryor Creek Basin Water Resources, Crow Indian Reservation (MT130)

Location: South-central Montana

Period of project: October 1989 through September 1991

Project chief: Charles Parrett, Helena

Funding source(s): U.S. Bureau of Indian Affairs



Problem: Surface-water supplies in the upper Pryor Creek basin are inadequate to provide water for present and future irrigation requirements. A preliminary reconnaissance indicates that ground-water supplies may be available to supplement surface-water supplies, but additional information and analysis are required to define the availability of surface and ground water.

Objective(s): (1) To define the surface-water resources in the upper Pryor Creek basin. (2) To determine present water use.

Approach: Estimate monthly streamflow at 12 sites on Pryor Creek and its tributaries using discharge measurements made in 1989. Estimate irrigation water use using crop irrigation-requirement calculations.

Progress during fiscal year 1990: Completed streamflow measurements, measured streamflow gain or loss, and sampled water quality. Completed estimates of water use and water availability.

Plans for fiscal year 1991: Complete the analysis of water use and water availability and prepare and publish report. Investigate water use as part of project MT007.

Information product(s): Johnson, D.R., Water resources of the upper Pryor Creek basin, Crow Indian Reservation, south-central Montana: U.S. Geological Survey Water-Resources Investigations Report (in preparation).

MT130 Downstream view of Pryor Creek at Pryor (gaging station 06216000) and its alluvial valley. In this area, surface water is used principally for the irrigation of alfalfa. Photograph from U.S. Geological Survey files.

Project title: Fort Belknap Indian Reservation Bedrock Hydrology (MT131)

Location: North-central Montana

Period of project: October 1989 through September 1991

Project chief: Steven E. Slagle, Helena

Funding source(s): Fort Belknap Community Council

Problem: Sandstone and limestone aquifers along the northwestern flank of the Little Rocky Mountains are a potential source of water supply. However, the quantity and quality of ground water that might be available are largely unknown.

Objective(s): To determine the quantity and quality of water in sandstone and limestone aquifers along the northwestern flank of the Little Rocky Mountains on the Fort Belknap Indian Reservation.

Approach: Install about 25 monitoring wells, conduct aquifer tests using selected monitoring wells, and sample all wells for water quality. Prepare geologic and potentiometric-surface maps.

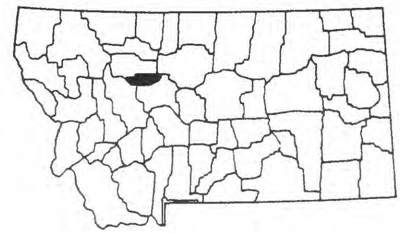
Progress during fiscal year 1990: Sampled 12 monitoring wells and 3 springs for water quality. Surveyed location and altitude of new monitoring wells. Conducted two aquifer tests. Measured water levels in all monitoring wells monthly.

Plans for fiscal year 1991: Complete draft of final report, submit report for review and approval, and publish report.

Information product(s): Slagle, S.E., Hydrology and water quality of sandstone and limestone aquifers, Fort Belknap Indian Reservation, north-central Montana: U.S. Geological Survey Water-Resources Investigations Report (in preparation).

MT131 Type section of the Mission Canyon Limestone of the Mississippian Madison Group south of Hays. Photograph from U.S. Geological Survey files.

Project title: Sun River Irrigation Drainage Detailed Study (MT132)



Location: West-central Montana

Period of project: May 1990 through September 1993

Project chief: J.R. Knapton, Helena

Funding source(s): U.S. Department of the Interior, Office of the Secretary

Problem: Results of a reconnaissance study conducted during 1986-87 indicated that water, bottom sediments, and biota in some locations receiving drainage water from the Sun River Irrigation Project had concentrations of selenium and other toxic contaminants that were moderately to considerably larger than established criteria. Similar contamination at Kesterson National Wildlife Refuge in California has led to incidences of mortality, birth defects, and reproductive failures in waterfowl, as well as concern for effects on humans.

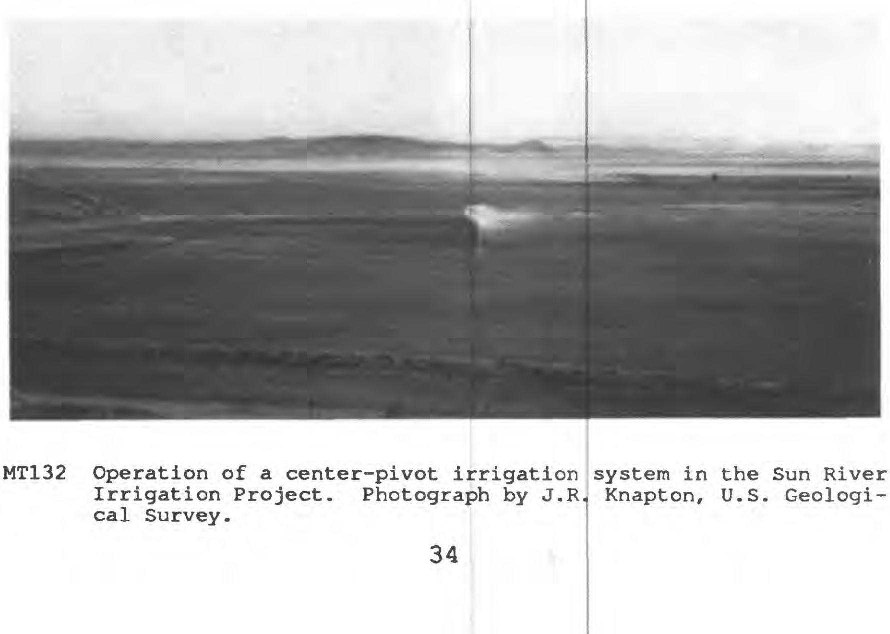
Objective(s): (1) To determine the sources, distribution, and movement of selenium and other toxic constituents within the hydrologic system. (2) To determine the effects of selenium and other toxic constituents on humans, fish, and wildlife.

Approach: Establish a network of surface- and ground-water sampling stations throughout the study area to measure contaminant concentrations from source areas to sinks. Analyze soil in the sinks and in paths between sources and sinks. Conduct special studies to determine the geochemical nature of contaminants within soils, aquifers, and sinks.

Progress during fiscal year 1990: Completed and revised the work plan after review by Department of the Interior, Irrigation Drainage Committee. Completed one interval of surface-water sampling on Lake Creek and inventoried selected wells. Installed 17 wells near Benton Lake. Completed reconnaissance for soils work.

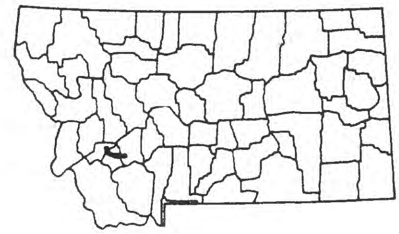
Plans for fiscal year 1991: Continue surface-water sampling in streams, irrigation network, ponds, and seeps. Collect and analyze bottom-material samples. Install ground-water wells, measure water levels, and collect water samples. Collect soil samples, then process and send to laboratory. Begin analysis of data as results are received from the laboratory.

Information product(s): Knapton, J.R., Lambing, J.H., and Nimick, D.A., Investigation of toxic substances associated with irrigation drainage in the Sun River area, west-central Montana, 1990-92: U.S. Geological Survey Water-Resources Investigations Report (planned).



MT132 Operation of a center-pivot irrigation system in the Sun River Irrigation Project. Photograph by J.R. Knapton, U.S. Geological Survey.

Project title: Silver Bow Creek National Priorities List Site--Technical Assistance (MT133)



Location: Silver Bow Creek drainage, near Butte, Montana

Period of project: October 1989 through September 1990

Project chief: Robert E. Davis

Funding source(s): U.S. Environmental Protection Agency

Problem: Heavy metals from historic mining and milling operations have contaminated soils, ground water, and surface water in the Silver Bow Creek area near Butte. The U.S. Environmental Protection Agency (EPA) has included the site on the National Priorities List (NPL) for remedial activities.

Objective(s): To provide technical review of data and project evaluations.

Approach: Review draft documents and data and provide comments to EPA as needed.

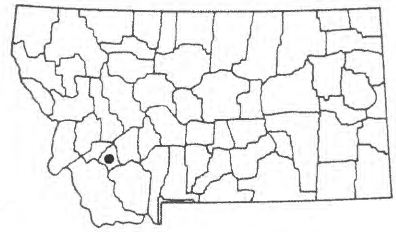
Progress during fiscal year 1990: Completed technical review of flow estimates. Provided other assistance as requested by EPA. Received authorization to provide assistance to September 1991.

Plans for fiscal year 1991: Continue to provide technical assistance upon request.

Information product(s): None.

MT133 View of Silver Bow Creek in Butte. Light-colored deposits are mine tailings and dark-colored deposits are primarily slag from smelter operations. Photograph by U.S. Environmental Protection Agency.

Project title: Silver Bow Creek National Priorities List Site, Butte Portion--Technical Assistance (MT134)



Location: Silver Bow Creek drainage, near Butte, Montana

Period of project: October 1989 through September 1990

Project chief: Robert E. Davis, Helena

Funding source(s): U.S. Environmental Protection Agency

Problem: Heavy metals from historic mining and milling operations near Butte have contaminated soils, ground water, and surface water in the Silver Bow Creek area. The U.S. Environmental Protection Agency (EPA) has included the site on the National Priorities List (NPL) for remedial activities.

Objective(s): (1) To provide technical assistance in assembling and evaluating existing technical data. (2) To provide input into the work plan development. (3) To provide other document review and project evaluations related to the mine-flooding project.

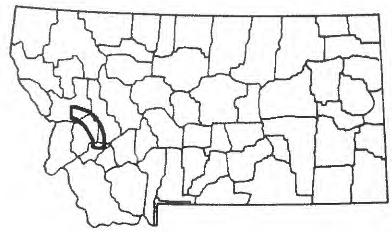
Approach: Review reports and provide technical assistance to EPA on work plans and related documents.

Progress during fiscal year 1990: Provided assistance as requested by EPA. Received authorization to provide assistance to September 1991.

Plans for fiscal year 1991: Continue to provide technical assistance upon request.

Information product(s): None.

MT134 Berkeley Pit in Butte, 1986. After mining was stopped in 1983, the pit began to fill from ground-water inflow. In January 1990, the depth of water in the pit was about 700 feet. Photograph by Robert E. Davis, U.S. Geological Survey.



Project title: Upper Clark Fork and Tributaries Water-Quality Sampling (MT135)

Location: Southwestern Montana

Period of project: October 1987 through May 1991

Project chief: John H. Lambing, Helena

Funding source(s): U.S. Environmental Protection Agency

Problem: Mine and mill tailings have contaminated the Clark Fork streambed and flood plain from the headwaters to Milltown Dam near Missoula. The U.S. Environmental Protection Agency (EPA) has designated the river as an extended National Priorities List (NPL) site, the largest in the Nation.

Objective(s): To acquire information on the occurrence and transport of sediment and metals.

Approach: Operate streamflow-gaging stations at four sites, collect periodic water samples at eight sites, and collect daily suspended-sediment samples at four sites to document transport of sediment and metals. Prepare a report describing results of data collection and water-quality characteristics.

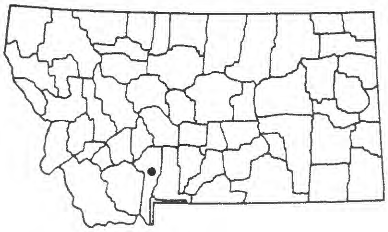
Progress during fiscal year 1990: Compiled sediment and trace-element data for water years 1985-90. Statistically analyzed data for regression relations that can be used for loading estimates of sediment and metals. Coupled duration statistics of daily values of sediment concentration with sediment-metals relations to estimate exceedance frequencies of various environmental criteria.

Plans for fiscal year 1991: Complete report, continue data collection, and submit proposal to EPA for long-term monitoring and trend analysis.

Information product(s): Lambing, J.H., Sediment and water-quality characteristics of the upper Clark Fork basin, western Montana, 1985-90: U.S. Geological Survey Water-Resources Investigations Report (in preparation).

MT135 Typical bridge-mounted platform and sampling device used at daily sediment stations. The sampling equipment is used by an onsite observer to collect daily stream samples that are analyzed for sediment concentration. Photograph by John H. Lambing, U.S. Geological Survey.

Project title: Idaho Pole National Priorities List Site--Technical Assistance (MT136)



Location: Bozeman, Montana

Period of project: October 1989 through October 1991

Project chief: Robert E. Davis, Helena

Funding source(s): U.S. Environmental Protection Agency

Problem: Creosote and pentachlorophenol from wood treatment facilities at the Idaho Pole site near Bozeman have contaminated soils, surface water, and ground water. The U.S. Environmental Protection Agency (EPA) has included the site on the National Priorities List (NPL) for remedial activities.

Objective(s): To provide technical assistance to EPA on remedial activities.

Approach: Review and comment on draft project plans, including a Work Plan and a Sampling and Analysis Plan, which consists of a Field Sampling Plan and a Quality Assurance Project Plan. Assess technical adequacy of project plans for (a) monitoring and sampling surface water and ground water and (b) developing adequate information on the hydrogeological system of the site to predict contaminant migration and develop methods to remediate the contamination. Provide onsite observation. Review reports.

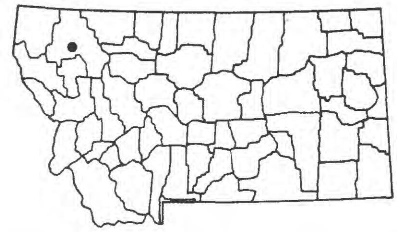
Progress during fiscal year 1990: Completed technical review of progress report. Provided other assistance as requested by EPA.

Plans for fiscal year 1991: Continue to provide technical assistance upon request.

Information product(s): None.

MT136 Organic contamination in surface water at the National Priorities List site near Bozeman. Photograph by Kevin S. Kirley, Montana Department of Health and Environmental Sciences.

Project title: Burlington Northern National Priorities List Site--Technical Assistance (MT137)



Location: Somers, Montana

Period of project: October 1989 to October 1991

Project chief: Joe A. Moreland, Helena

Funding source(s): U.S. Environmental Protection Agency

Problem: Chromated zinc chloride and creosote used to treat railroad ties at the Burlington Northern Tie Plant at Somers have contaminated soils and ground water. The U.S. Environmental Protection Agency (EPA) has included the site on the National Priorities List (NPL) for remedial activities.

Objective(s): (1) To provide technical assistance to EPA. (2) To assist EPA in overseeing remedial design and remedial action activities.

Approach: Review and comment on draft project plans, including a work plan and plans for pilot testing of the ground-water remedy. Provide technical support and oversight of onsite activities involved in designing the ground-water remedy.

Progress during fiscal year 1990: Provided review of documents as requested by EPA.

Plans for fiscal year 1991: Continue to provide technical assistance upon request.

Information product(s): None.

MT137 Installation of a collection system to remove hazardous wastes from a shallow aquifer at the National Priorities List site near Somers. Photograph from U.S. Geological Survey files.

OTHER HYDROLOGIC WORK BY THE DISTRICT

As part of its responsibility to provide information on water to all water users, the Geological Survey is involved in numerous activities in addition to regular programs of data collection and hydrologic investigation. For example, District employees serve as Federal or Survey representatives on advisory committees or ad hoc groups established for specific purposes. Some of the current special activities are:

Committee and task force memberships.--Members of the District staff are working members and advisors to several committees and task forces. Included are the International Joint Commission, the Southern Tributaries Task Force, and the Poplar River Bilateral Monitoring Committee, all involving the United States and Canada; the Yellowstone River Compact Commission involving Montana, Wyoming, and North Dakota; the Montana Ground-Water Data Task Force; the Montana Bureau of Mines and Geology Advisory Board; the Montana Water Research Center Advisory Board; the University of Montana Geology Advisory Council; and the Northern Rockies Environmental and Waste Technology Educational Partnership (NEWTEP) Advisory Board.

Review of Environmental Impact Statements and other agency reports.--The Water Resources Division reviews Environmental Impact Statements or similar documents for Federal airport and highway projects to ensure that available hydrologic data are used, that they are used correctly, and that the effect of construction on water features and resources is accurately evaluated. From time to time, the District also is asked to review reports and projects of other Federal and State agencies, primarily because of the Survey's hydrologic expertise and impartiality. As an example, the District provides technical assistance to the U.S. Environmental Protection Agency concerning activities at Superfund sites throughout the State.

Assistance to other agencies and individuals.--In addition to the Survey's formal programs and studies, water information and assistance are provided to other agencies having specific problems; for instance, to the National Park Service in locating water supplies in Yellowstone and Glacier National Parks. The District continually receives calls, visits, and mail requests from landowners, consultants, public officials, and businesses for information and data on streamflow, water quality, water use, and ground-water availability. Federal regulations prohibit activity that encroaches on the work of professional consultants in the private sector, but much information and assistance are provided to professional engineers, geologists, and other consultants.

Special activities.--The District is at times called on for certain work not covered under specific projects or data-collection programs. This work includes obtaining hydrologic data to document drought effects and direct or indirect measurement of floods, both in Montana and other States that have suffered flood disasters.

SOURCES OF GEOLOGICAL SURVEY PUBLICATIONS AND INFORMATION

Books

Current reports are listed in a pamphlet, "New Publications of the U.S. Geological Survey." Subscription to the pamphlet, which is issued monthly, is free upon request to:

U.S. Geological Survey
582 National Center
Reston, VA 22092

Professional papers, bulletins, water-supply papers, techniques of water-resources investigations, circulars, and publications of general interest (such as leaflets, pamphlets, booklets) are available by mail from:

U.S. Geological Survey
Books and Open-File Reports Section
Federal Center, Building 810
Box 25425
Denver, CO 80225

Records of streamflow, quality of water, and ground-water levels have been published for many years as Geological Survey water-supply papers. Beginning with water year 1965, however, the data were released in a new publications series, U.S. Geological Survey Water-Data Reports. This series combines for each State: streamflow data, water-quality data for surface water, and ground-water-level data from the basic network of observation wells. For Montana, an example title is, "Water Resources Data, Montana, Water Year 1989: U.S. Geological Survey Water-Data Report MT-89-1." Additional information on these publications can be obtained from the District Chief at the address shown at the front of this report.

Open-file reports and water-resources investigations reports are available for inspection at the District Office of the Geological Survey in Helena. Most reports in these series can be purchased in microfiche and paper-copy forms from:

U.S. Geological Survey
Books and Open-File Reports Section
Federal Center, Building 810
Box 25425
Denver, CO 80225

Maps

Miscellaneous investigations maps, hydrologic investigations atlases, hydrologic unit maps, topographic maps, and other maps pertaining to Montana (as well as maps of other areas in the United States, Guam, Puerto Rico, Samoa, and The Virgin Islands) are available for sale from:

U.S. Geological Survey
Map Distribution
Federal Center, Building 41
Box 25286
Denver, CO 80225

Flood-prone-area maps of selected areas are available for inspection at the Montana District Office in Helena, and are available for nominal cost from:

Montana Bureau of Mines and Geology
Main Hall
Montana College of Mineral Science and Technology
Butte, MT 59701

More detailed maps, prepared as part of flood insurance studies, are available for inspection at:

Montana Department of Natural Resources and Conservation
1520 East Sixth Avenue
Helena, MT 59620

General Information

The Public Inquiries Office (PIO) provides general information about the programs of the U.S. Geological Survey and its reports and maps. The PIO answers inquiries made in person, by mail, or by telephone and refers requests for specific technical information to the appropriate people. Direct inquiries for Montana to:

Public Inquiries Office
U.S. Geological Survey
678 U.S. Courthouse
West 920 Riverside Avenue
Spokane, WA 99201
Phone: (509) 456-2524

Requests for miscellaneous water information and information on programs in other States may be referred to:

Water Resources Division
U.S. Geological Survey
440 National Center
12201 Sunrise Valley Drive
Reston, VA 22092

The National Center of the Geological Survey maintains a library with an extensive earth-sciences collection. Local libraries may obtain books, periodicals, and maps through interlibrary loan by writing to:

U.S. Geological Survey Library
950 National Center
Room 4-A-100
12201 Sunrise Valley Drive
Reston, VA 22092

In addition to the data collected within the State, the Montana District has access to water data collected nationwide. The National Water Data Exchange (NAWDEX) of the Geological Survey provides information on location and type of data pertaining to water and related subjects from more than 400 organizations. The National Water Data Storage and Retrieval System (WATSTORE) serves as a central repository of water data collected by the Geological Survey, including large volumes of data on the quantity and quality of both surface and ground water.

General information pertaining to Montana's water resources, water programs of the Geological Survey, availability of water data, and reports describing water resources can be obtained from the District Chief at the address shown at the front of this report. Additional information on other Geological Survey programs, both within and outside the State, can be obtained from the following sources:

Water: Regional Hydrologist, Central Region
U.S. Geological Survey
Mail Stop 406, Box 25046
Federal Center
Denver, CO 80225
Phone: (303) 236-5920

Geology: Assistant Chief Geologist, Central Region
U.S. Geological Survey
Mail Stop 911, Box 25046
Federal Center
Denver, CO 80225
Phone: (303) 236-5438

National maps: Chief, Rocky Mountain Mapping Center
Earth Science Information Center (ESIC)
U.S. Geological Survey
Mail Stop 504, Box 25046
Federal Center
Denver, CO 80225
Phone: (303) 236-5829

Finally, the reader interested in obtaining information on the varied material that the Geological Survey produces and distributes is referred to U.S. Geological Survey Circular 900, "Guide to obtaining USGS information." That guide covers a wide variety of specialties such as geology, hydrology, cartography, geography, and remote sensing, as well as information on land use and energy, mineral, and water resources.

REPORTS PUBLISHED OR RELEASED DURING PRECEDING 5 YEARS

(Fiscal years 1986 through 1990)

Briar, D.W., 1989, Ground-water flow in the Sullivan Flats basin near Niarada, Flathead Indian Reservation, Montana *in* Montana Geological Society 1989 field conference guidebook, Montana centennial edition, Geologic resources of Montana, v. II, Road logs, p. ix.

Cannon, M.R., 1985, Effects of potential surface coal mining on dissolved solids in Otter Creek and in the Otter Creek alluvial aquifer, southeastern Montana: U.S. Geological Survey Water-Resources Investigations Report 85-4206, 52 p.

______1986, Reconnaissance of the water resources and potential effects of mining in the Joliet-Fromberg coal tract, Carbon County, Montana: U.S. Geological Survey Water-Resources Investigations Report 86-4155, 15 p.

______1987, Water resources and potential effects of surface coal mining in the area of the Woodson Preference Right Lease Application, Montana: U.S. Geological Survey Water-Resources Investigations Report 87-4027, 29 p.

______1989, Water resources and effects of potential surface coal mining on dissolved solids in Hanging Woman Creek basin, southeastern Montana: U.S. Geological Survey Water-Resources Investigations Report 89-4047, 76 p.

Cary, L.E., 1989, Preliminary analysis for trends in selected water-quality characteristics, Powder River, Montana and Wyoming, water years 1952-85: U.S. Geological Survey Water-Resources Investigations Report 89-4050, 25 p.

______1989, Trends in selected water-quality characteristics, Flathead River at Flathead, British Columbia, and at Columbia Falls, Montana, water years 1975-86: U.S. Geological Survey Water-Resources Investigations Report 89-4054, 14 p.

Clark, D.W., 1990, Pesticides in soils and ground water in selected irrigated agricultural areas near Havre, Ronan, and Huntley, Montana: U.S. Geological Survey Water-Resources Investigations Report 90-4023, 34 p.

Davis, R.E., 1988, U.S. Geological Survey ground-water studies in Montana: U.S. Geological Survey Open-File Report 88-126, 2 p.

Davis, R.E., and Dodge, K.A., 1986, Results of experiments related to contact of mine-spoils water with coal, West Decker and Big Sky Mines, southeastern Montana: U.S. Geological Survey Water-Resources Investigations Report 86-4002, 16 p.

Feltis, R.D., 1986, Hydrogeology of the Dry Fork-East Boulder Valley, south-central Montana *in* Proceedings of the 50th Anniversary Field Symposium of the Montana Geological Society and Yellowstone-Bighorn Research Association, Red Lodge, 1986, p. 257-264.

______1988, Hydrogeologic map of Cambrian through Permian rocks, Billings 1-degree by 2-degree quadrangle and vicinity, Montana: Montana Bureau of Mines and Geology Hydrogeologic Map 9A, 1 sheet.

______1988, Hydrogeologic map of Jurassic rocks (Ellis Group and Morrison Formation), Billings 1-degree by 2-degree quadrangle, Montana: Montana Bureau of Mines and Geology Hydrogeologic Map 9B, 1 sheet.

______1988, Hydrogeologic map of Lower Cretaceous rocks (Lakota Formation), Billings 1-degree by 2-degree quadrangle and vicinity, Montana: Montana Bureau of Mines and Geology Hydrogeologic Map 9C, 1 sheet.

______1988, Hydrogeologic map of Lower and Upper Cretaceous rocks ("Dakota sandstone" through Telegraph Creek Formation), Billings 1-degree by 2-degree quadrangle and vicinity, Montana: Montana Bureau of Mines and Geology Hydrogeologic Map 9D, 1 sheet.

______1988, Hydrogeologic map of Upper Cretaceous rocks (Eagle Sandstone through Bearpaw Shale), Billings 1-degree by 2-degree quadrangle and vicinity, Montana: Montana Bureau of Mines and Geology Hydrogeologic Map 9E, 1 sheet.

______1988, Hydrogeologic map of Upper Cretaceous rocks (Lennep Sandstone) through Quaternary rocks, Billings 1-degree by 2-degree quadrangle, Montana: Montana Bureau of Mines and Geology Hydrogeologic Map 9F, 1 sheet.

Feltis, R.D., and Litke, D.W., 1987, Appraisal of water resources of the Boulder and Stillwater River basins, including the Stillwater Complex, south-central Montana: Montana Bureau of Mines and Geology Memoir 60, 121 p.

Ferreira, R.F., Cannon, M.R., and Davis, R.E., 1987, Montana ground-water quality, *in* National water summary 1986--Hydrologic events and ground-water quality: U.S. Geological Survey Water-Supply Paper 2325, p. 339-346.

Ferreira, R.F., and Lambing, J.H., 1986, Water-quality variability in four reservoirs in Phillips and Valley Counties, Montana, May through August 1981: U.S. Geological Survey Water-Resources Investigations Report 85-4209, 85 p.

Ferreira, R.F., Lambing, J.H., and Davis, R.E., 1989, Chemical characteristics, including stable-isotope ratios, of surface water and ground water from selected sources in and near East Fork Armells Creek basin, southeastern Montana, 1985: U.S. Geological Survey Water-Resources Investigations Report 89-4024, 32 p.

Groskinsky Link, B.L., and Cary, L.E., 1986, Availability of selected meteorological data in computer-based files of the U.S. Geological Survey, Montana, North Dakota, South Dakota, and Wyoming: U.S. Geological Survey Open-File Report 85-693, 36 p.

______1987, Station descriptions and availability of discharge and water-quality data through 1985 for eastern Montana stream sites not included in the National Water Data Exchange Program: U.S. Geological Survey Open-File Report 87-770, 79 p.

Holnbeck, S.R., and Parrett, Charles, 1987, Estimating firm yield and reliability of small reservoirs on ungaged streams in north-central Montana *in* Engineering Hydrology Symposium, Williamsburg, Va., 1987, Proceedings: New York, American Society of Civil Engineers, p. 32-37.

Holnbeck, S.R., Parrett, Charles, and Johnson, D.R., 1990, Unit-hydrograph parameters for large floods in Montana: Northern Rocky Mountain Water Congress, Butte, Mont., Program.

Hotchkiss, W.R., and Levings, J.F., 1986, Hydrogeology and simulation of water flow in strata above the Bearpaw Shale and equivalents of eastern Montana and northeastern Wyoming: U.S. Geological Survey Water-Resources Investigations Report 85-4281, 72 p.

Johnston, M.F., and Dodge, K.A., 1986, Records of wells and water-level fluctuations from the statewide observation-well network in Montana through 1985: U.S. Geological Survey Open-File Report 86-528, 221 p.

Knapton, J.R., 1986, A method for determining suspended-sediment and trace-metals transport in the Clark Fork River, western Montana *in* Clark Fork River Symposium, Butte, Mont., 1985, Proceedings: p. 139-142.

Knapton, J.R., and Brosten, T.M., 1987, Supplemental arsenic data for selected streams in the Missouri River basin, Montana, 1987: U.S. Geological Survey Open-File Report 87-697, 14 p.

______1989, Arsenic and chloride data for five stream sites in the Madison River drainage, Montana, 1988: U.S. Geological Survey Open-File Report 88-722, 12 p.

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Table 1.--*Surface-water gaging stations in operation, October 1990*

Station number

Stations are listed in downstream order by standard drainage-basin number: Part 5 (Hudson Bay basin), Part 6 (Missouri River basin), and Part 12 (upper Columbia River basin). Each station number contains a 2-digit part number plus a 6-digit downstream order number. The location of streamflow- and principal-reservoir gaging stations is shown in figure 7; the location of stations at some small reservoirs is not identified on the map.

Funding source

BIA	U.S. Bureau of Indian Affairs
BPA	Bonneville Power Administration
CH	City of Helena
EPA	U.S. Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
FLRES	Confederated Salish and Kootenai Tribes of the Flathead Reservation
MBMG	Montana Bureau of Mines and Geology
MDFWP	Montana Department of Fish, Wildlife and Parks
MDHES	Montana Department of Health and Environmental Sciences
MDNRC	Montana Department of Natural Resources and Conservation
NPS	National Park Service
USAE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
WSE	Wyoming State Engineer
WWT	U.S. Department of State-International Joint Commission, Waterways Treaty

Data collection process (gage equipment)

DCP - Data-collection platform
O - Observer record
S - Stage recorder

Type of record

C - Continuous
D - Daily
M - Monthend
Se - Seasonal

Table 1.--*Surface-water gaging stations in operation, October 1990*--Continued

Station number	Station name	Funding source	Data collection process (gage equipment)	Type of record
	Part 5			
05014500	Swiftcurrent Creek at Many Glacier	USGS	S	C
05015500	Lake Sherburne at Sherburne	WWT	DCP,S	C
05016000	Swiftcurrent Creek at Sherburne	WWT	S	Se
05017500	St. Mary River near Babb	WWT	S	C
05018500	St. Mary Canal at St. Mary Crossing, near Babb	WWT	DCP,S	Se
05020500	St. Mary River at international boundary	WWT	DCP,S	C
	Part 6			
06012000	Lima Reservoir near Monida	MDNRC	O	M
06012500	Red Rock River below Lima, near Monida	USBR	DCP,S	Se
06015300	Clark Canyon Reservoir near Grant	USGS	DCP,S	M
06016000	Beaverhead River at Barretts	USBR	S	Se
06018500	Beaverhead River near Twin Bridges	USGS	DCP,S	C
06019500	Ruby River above reservoir, near Alder	MDNRC	S	C
06020500	Ruby River Reservoir near Alder	MDNRC	O	M
06020600	Ruby River below reservoir, near Alder	MDNRC	S	C
06024450	Big Hole River below Big Lake Creek, at Wisdom	MDFWP	S	Se
06025500	Big Hole River near Melrose	MDNRC	S	C
06033000	Boulder River near Boulder	MDNRC	S	C
06035000	Willow Creek near Harrison	MDNRC	S	Se
06036000	Willow Creek Reservoir near Harrison	MDNRC	O	M
06036650	Jefferson River near Three Forks	MDFWP	DCP,S	C
06036905	Firehole River near West Yellowstone	NPS	S	C
06037000	Gibbon River near West Yellowstone	NPS	S	C
06037500	Madison River near West Yellowstone	USGS	S	C
06038000	Hebgen Lake near West Yellowstone	FERC	O	M
06038500	Madison River below Hebgen Lake, near Grayling	FERC	DCP,S	C
06038800	Madison River at Kirby Ranch, near Cameron	MDFWP	S	D,Se
06040500	Ennis Lake near McAllister	FERC	O	M
06041000	Madison River below Ennis Lake, near McAllister	FERC	DCP,S	C
06043500	Gallatin River near Gallatin Gateway	MDFWP	S	C
06049500	Middle Creek Reservoir near Bozeman	MDNRC	O	M
06050000	Hyalite Creek at Hyalite Ranger Station, near Bozeman	MDNRC	S	C
06052500	Gallatin River at Logan	USAE	DCP,S	C
06054500	Missouri River at Toston	MDNRC	DCP,S	C
06058500	Canyon Ferry Lake near Helena	USGS	S	M
06058600	Helena Valley Reservoir	USBR	O	M
06061500	Prickly Pear Creek near Clancy	MDNRC	S	C
06062500	Tenmile Creek near Rimini	CH	S	C
06064500	Lake Helena near Helena	FERC	O	M
06065000	Hauser Lake near Helena	FERC	O	M
06066000	Holter Lake near Wolf Creek	FERC	O	M
06066500	Missouri River below Holter Dam, near Wolf Creek	FERC	S	C

Table 1.--*Surface-water gaging stations in operation, October 1990*--Continued

Station number	Station name	Funding source	Data collection process (gage equipment)	Type of record
	<u>Part 6--Continued</u>			
06075000	Smith River Reservoir near White Sulphur Springs	MDNRC	O	M
06076690	Smith River near Fort Logan	MDFWP	DCP,S	C
06078200	Missouri River near Ulm	USAE	DCP,S	C
06078500	North Fork Sun River near Augusta	USBR	DCP,S	Se
06079500	Gibson Reservoir near Augusta	MDNRC	O	M
06080500	Pishkun Reservoir near Augusta	MDNRC	O	M
06082000	Willow Creek Reservoir near Augusta	MDNRC	O	M
06083000	Nilan Reservoir near Augusta	MDNRC	O	M
06088500	Muddy Creek at Vaughn	USGS	S	C
06089000	Sun River near Vaughn	FERC	DCP,S	C
06090300	Missouri River near Great Falls	FERC	S	C
06090650	Lake Creek near Power	USGS	S	Se
06090800	Missouri River at Fort Benton	USGS	S	C
06090900	Lower Two Medicine Lake near East Glacier	MDNRC	O	M
06091700	Two Medicine River below South Fork, near Browning	BIA	S	C
06091800	Two Medicine Canal near Browning	BIA	S	Se
06092600	Four Horns Canal near Browning	BIA	S	Se
06093000	Four Horns Lake near Heart Butte	MDNRC	O	M
06093200	Badger Creek below Four Horns Canal, near Browning	BIA	S	C
06094000	Swift Reservoir near Dupuyer	MDNRC	O	M
06095500	Lake Frances near Valier	MDNRC	O	M
06099000	Cut Bank Creek at Cut Bank	BIA	S	C
06099500	Marias River near Shelby	USGS	DCP,S	C
06101300	Lake Elwell near Chester	USGS	O	M
06101500	Marias River near Chester	USBR	DCP,S	C
06108000	Teton River near Dutton	USGS	S	C
06109500	Missouri River at Virgelle	USAE	DCP,S	C
06110500	Ackley Lake near Hobson	MDNRC	O	M
06115200	Missouri River near Landusky	USGS	DCP,S	C
06116500	Bair Reservoir near Delpine	MDNRC	O	M
06119000	Martinsdale Reservoir near Martinsdale	MDNRC	O	M
06120500	Musselshell River at Harlowton	MDNRC	S	C
06122500	Deadmans Basin Reservoir near Shawmut	MDNRC	O	M
06122800	Musselshell River near Shawmut	MDNRC	S	Se
06126470	Half Breed Creek near Klein	MBMG	S	C
06126500	Musselshell River near Roundup	MDNRC	DCP,S	C
06127500	Musselshell River at Musselshell	MDNRC	S	Se
06130500	Musselshell River at Mosby	USAE	S	C
06131000	Big Dry Creek near Van Norman	USAE, USGS	DCP,S	C
06131500	Fort Peck Lake at Fort Peck	USAE	O	M
06131800	Missouri River stage station No. 1 near Fort Peck	USAE	S	C
06132000	Missouri River below Fort Peck Dam	USAE	S	C
06132200	South Fork Milk River near Babb	WWT	S	Se
06133000	Milk River at western crossing of international boundary	WWT	DCP,S	Se

Table 1.--*Surface-water gaging stations in operation, October 1990*--Continued

Station number	Station name	Funding source	Data collection process (gage equipment)	Type of record
	Part 6--Continued			
06133500	North Fork Milk River above St. Mary Canal, near Browning	WWT	DCP,S	Se
06134000	North Milk River near international boundary	WWT	DCP,S	Se
06134500	Milk River at Milk River, Alberta	WWT	S	C
06134700	Verdigris Coulee near mouth, near Milk River, Alberta	WWT	S	Se
06135000	Milk River at eastern crossing of international boundary	WWT	DCP,S	Se
06136500	Fresno Reservoir near Havre	MDNRC	O	M
06137400	Big Sandy Creek at reservation boundary, near Rocky Boy	BIA	S	C
06137570	Boxelder Creek near Rocky Boy	BIA	S	C
06139500	Big Sandy Creek near Havre	BIA	DCP,S	Se
06140500	Milk River at Havre	USAE	S	C
06141600	Little Boxelder Creek at mouth, near Havre	MDNRC	S	Se
06142400	Clear Creek near Chinook	BIA	DCP,S	Se
06144260	Altawan Reservoir near Govenlock, Saskatchewan	WWT	S	M
06144270	Spangler Ditch near Govenlock, Saskatchewan	WWT	S	Se
06144350	Middle Creek near Saskatchewan boundary	WWT	S	Se
06144360	Middle Creek Reservoir near Battle Creek, Saskatchewan	WWT	S	Se
06144395	Middle Creek below Middle Creek Reservoir, near Govenlock, Saskatchewan	WWT	S	Se
06144440	Middle Creek near Govenlock, Saskatchewan	WWT	S	Se
06144450	Middle Creek above Lodge Creek, near Govenlock, Saskatchewan	WWT	S	Se
06145500	Lodge Creek below McRae Creek, at international boundary	WWT	S	Se
06147950	Gaff Ditch near Merryflat, Saskatchewan	WWT	S	Se
06148500	Cypress Lake west inflow canal near West Plains, Saskatchewan	WWT	S	Se
06148700	Cypress Lake west inflow canal drain near Oxarat, Saskatchewan	WWT	S	Se
06149000	Cypress Lake west outflow canal near West Plains, Saskatchewan	WWT	S	Se
06149100	Vidora Ditch near Consul, Saskatchewan	WWT	S	Se
06149200	Richardson Ditch near Consul, Saskatchewan	WWT	S	Se
06149300	McKinnon Ditch near Consul, Saskatchewan	WWT	S	Se
06149400	Nashlyn Canal near Consul, Saskatchewan	WWT	S	Se
06149500	Battle Creek at international boundary	WWT	DCP,S	Se
06151000	Lyons Creek at international boundary	WWT	S	Se
06151500	Battle Creek near Chinook	BIA	DCP,S	Se
06154000	Milk River 'A' Canal near Harlem	BIA	S	Se
06154100	Milk River near Harlem	MDNRC	DCP,S	C
06154140	Fifteenmile Creek tributary near Harlem	BIA	S	C
06154400	Peoples Creek near Hays	BIA	S	C
06154410	Little Peoples Creek near Hays	USGS	S	C
06154430	Lodge Pole Creek at Lodge Pole	BIA	S	C
06154490	Willow Coulee near Dodson	BIA	S	C
06154510	Kuhr Coulee tributary near Dodson	BIA	S	C

Table 1.--*Surface-water gaging stations in operation, October 1990*--Continued

Station number	Station name	Funding source	Data collection process (gage equipment)	Type of record
	<u>Part 6--Continued</u>			
06154550	Peoples Creek below Kuhr Coulee, near Dodson	BIA	S	C
06155000	Nelson Reservoir near Saco	MDNRC	O	M
06155030	Milk River near Dodson	MDNRC	S	C
06156500	Belanger Creek diversion canal near Vidora, Saskatchewan	WWT	S	Se
06157000	Cypress Lake near Vidora, Saskatchewan	WWT	S	Se
06157500	Cypress Lake east outflow canal near Vidora, Saskatchewan	WWT	S	Se
06158500	Eastend Canal at Eastend, Saskatchewan	WWT	S	Se
06159000	Eastend Reservoir at Eastend, Saskatchewan	WWT	S	Se
06159500	Frenchman River below Eastend Reservoir, near Eastend, Saskatchewan	WWT	S	Se
06161300	Huff Lake pumping canal near Val Marie, Saskatchewan	WWT	S	Se
06161500	Huff Lake gravity canal near Val Marie, Saskatchewan	WWT	S	Se
06162000	Huff Lake near Val Marie, Saskatchewan	WWT	S	M
06162500	Newton Lake main canal near Val Marie, Saskatchewan	WWT	S	Se
06163000	Newton Lake near Val Marie, Saskatchewan	WWT	S	M
06163050	Frenchman River below Newton Lake, near Val Marie, Saskatchewan	WWT	S	Se
06164000	Frenchman River at international boundary	WWT	S	Se
06164510	Milk River at Juneberg Bridge, near Saco	USGS	DCP,S	C
06164590	Beaver Creek near Zortman	BIA	S	C
06164615	Little Warm Creek at reservation boundary, near Zortman	BIA	S	C
06164623	Little Warm Creek tributary near Lodge Pole	BIA	S	C
06166000	Beaver Creek below Guston Coulee, near Saco	USGS	S	Se
06169500	Rock Creek below Horse Creek, near international boundary	USGS	S	C
06172310	Milk River at Tampico	MDNRC	S	C
06174500	Milk River at Nashua	USAE	DCP,S	C
06175000	Porcupine Creek at Nashua	BIA	S	C
06175100	Missouri River stage station No. 3 at West Frazer pumping plant, near Frazer	USAE	S	C
06175510	Missouri River stage station No. 4 at East Frazer pumping plant, near Frazer	USAE	S	C
06175520	Missouri River stage station No. 5 near Oswego	USAE	S	C
06176500	Wolf Creek near Wolf Point	BIA	S	C
06177000	Missouri River near Wolf Point	USAE	DCP,S	C
06177500	Redwater River at Circle	USGS	S	C
06178000	Poplar River at international boundary	USGS	S	Se
06178500	East Poplar River at international boundary	MDNRC	S	C
06181000	Poplar River near Poplar	BIA	S	C
06181995	Beaver Creek at international boundary	WWT	S	Se
06183450	Big Muddy Creek near Antelope	USGS	S	C
06183700	Big Muddy Creek diversion canal near Medicine Lake	USGS	S	C

Table 1.--*Surface-water gaging stations in operation, October 1990*--Continued

Station number	Station name	Funding source	Data collection process (gage equipment)	Type of record
	Part 6--Continued			
06185110	Big Muddy Creek near mouth, near Culbertson	BIA	S	C
06185500	Missouri River near Culbertson	USAE	DCP,S	C
06186500	Yellowstone River at Yellowstone Lake outlet, Yellowstone National Park	NPS	S	C
06187950	Soda Butte Creek near Lamar Ranger Station, Yellowstone National Park	NPS	S	C
06188000	Lamar River near Tower Falls Ranger Station, Yellowstone National Park	MDHES	S	C
06189000	Blacktail Deer Creek near Mammoth, Yellowstone National Park	MDHES	S	C
06190540	Hot River at Mammoth, Yellowstone National Park	NPS	S	C
06191000	Gardner River near Mammoth, Yellowstone National Park	USGS	S	C
06191500	Yellowstone River at Corwin Springs	USAE	DCP,S	C
06192500	Yellowstone River near Livingston	USAE	S	C
06195600	Shields River near Livingston	MDFWP	S	C
06200000	Boulder River at Big Timber	MDNRC	S	C
06202510	Stillwater River above Nye Creek, near Nye	MDFWP	O	D
06204000	Mystic Lake near Roscoe	FERC	O	M
06204050	West Rosebud Creek near Roscoe	FERC	S	C
06205000	Stillwater River near Absarokee	USAE	S	C
06207500	Clarks Fork Yellowstone River near Belfry	MDNRC	S	C
06208500	Clarks Fork Yellowstone River at Edgar	MDNRC, WSE	S	C
06211000	Red Lodge Creek above Cooney Reservoir, near Boyd	MDNRC	S	Se
06211500	Willow Creek near Boyd	MDNRC	S	Se
06212000	Cooney Reservoir near Boyd	MDNRC	O	M
06212500	Red Lodge Creek below Cooney Reservoir, near Boyd	MDNRC	S	C
06214500	Yellowstone River at Billings	USAE	DCP,S	C
06216000	Pryor Creek at Pryor	USGS	S	C
06216900	Pryor Creek near Huntley	USGS	S	C
06286400	Bighorn Lake near St. Xavier	USGS	S	M
06286490	Bighorn Canal near St. Xavier	USBR	S	Se
06287000	Bighorn River near St. Xavier	USBR	DCP,S	C
06289000	Little Bighorn River at State line, near Wyola	USGS	S	C
06290000	Pass Creek near Wyola	BIA	S	C
06290500	Little Bighorn River below Pass Creek, near Wyola	USGS	S	C
06291000	Owl Creek near Lodge Grass	BIA	S	C
06291500	Lodge Grass Creek above Willow Creek diversion, near Wyola	BIA	S	C
06294000	Little Bighorn River near Hardin	MDNRC, WSE	S	C
06294500	Bighorn River above Tullock Creek, near Bighorn	MDNRC, WSE	DCP,S	C
06294995	Armells Creek near Forsyth	MBMG	S	C
06295000	Yellowstone River at Forsyth	USBR	S	C

Station number	Station name	Funding source	Data collection process (gage equipment)	Type of record
	Part 6--Continued			
06295113	Rosebud Creek at reservation boundary, near Kirby	USGS	S	C
06295250	Rosebud Creek near Colstrip	BIA	S	C
06296003	Rosebud Creek at mouth, near Rosebud	MBMG	S	C
06306300	Tongue River at State line, near Decker	MDNRC	S	C
06307000	Tongue River Reservoir near Decker	MDNRC	O	M
06307500	Tongue River at Tongue River Dam, near Decker	MDNRC	S	C
06307600	Hanging Woman Creek near Birney	MBMG	S	C
06307616	Tongue River at Birney Day School Bridge, near Birney	USGS	S	C
06307740	Otter Creek at Ashland	MBMG	S	C
06308500	Tongue River at Miles City	MDNRC, WSE	DCP,S	C
06309000	Yellowstone River at Miles City	USAE	DCP,S	C
06324500	Powder River at Moorhead	MDNRC	S	C
06324710	Powder River at Broadus	MDNRC	S	Se
06326500	Powder River near Locate	MDNRC, WSE	S	C
06326555	Cherry Creek near Terry	MBMG	S	Se
06326600	O'Fallon Creek near Ismay	MDNRC	S	C
06329500	Yellowstone River near Sidney	USAE	DCP,S	C
	Part 12			
12301300	Tobacco River near Eureka	USAE	S	C
12301920	Lake Koocanusa near Libby	USAE	S	C
12301933	Kootenai River below Libby Dam, near Libby	USAE	DCP,S	C
12302055	Fisher River near Libby	USAE	DCP,S	C
12303000	Kootenai River at Libby	USAE	S	C
12303100	Flower Creek near Libby	FLRES	S	C
12303500	Lake Creek at Troy	FERC	S	C
12304040	Basin Creek near Yaak	USFS	S	C
12304500	Yaak River near Troy	USAE	DCP,S	C
12323170	Silver Bow Creek above Blacktail Creek, at Butte	MBMG	S	C
12323240	Blacktail Creek at Butte	MBMG	S	C
12323250	Silver Bow Creek below Blacktail Creek, at Butte	MBMG	S	C
12323600	Silver Bow Creek at Opportunity	EPA	S	Se
12323770	Warm Springs Creek at Warm Springs	MDFWP	S	C
12323800	Clark Fork near Galen	EPA	DCP,S	C
12324200	Clark Fork at Deer Lodge	MDFWP	S	C
12324590	Little Blackfoot River near Garrison	MDNRC	S	C
12324680	Clark Fork at Goldcreek	MDFWP	S	C
12325000	Georgetown Lake near Southern Cross	FERC	O	M
12325500	Flint Creek near Southern Cross	FERC	S	C
12329500	Flint Creek at Maxville	MDNRC	S	C
12330000	Boulder Creek at Maxville	MDNRC	S	C
12331500	Flint Creek near Drummond	EPA	S	C

Table 1.--*Surface-water gaging stations in operation, October 1990*--Continued

Station number	Station name	Funding source	Data collection process (gage equipment)	Type of record
	Part 12--Continued			
12332000	Middle Fork Rock Creek near Philipsburg	MDNRC	S	C
12332500	East Fork Rock Creek Reservoir near Philipsburg	MDNRC	O	M
12334510	Rock Creek near Clinton	MDNRC	DCP,S	C
12334550	Clark Fork at Turah Bridge, near Bonner	EPA	S	C
12335500	Nevada Creek above reservoir, near Finn	MDNRC	S	C
12336500	Nevada Lake near Finn	MDNRC	O	M
12339450	Clearwater River near Clearwater	FLRES	S	C
12340000	Blackfoot River near Bonner	USGS	S	C
12340500	Clark Fork above Missoula	USAE	S	C
12342000	Painted Rocks Lake near Conner	MDNRC	O	M
12342500	West Fork Bitterroot River near Conner	MDNRC	S	C
12344000	Bitterroot River near Darby	MDNRC	DCP,S	C
12344500	Lake Como near Darby	MDNRC	O	M
12350250	Bitterroot River at Bell Crossing, near Victor	MDFWP	S	Se
12352500	Bitterroot River near Missoula	MDHES	S	C
12353000	Clark Fork below Missoula	MDHES	S	C
12354500	Clark Fork at St. Regis	BPA	DCP,S	C
12355000	Flathead River at Flathead, British Columbia	WWT	S	C
12355500	North Fork Flathead River near Columbia Falls	BPA	DCP,S	C
12358500	Middle Fork Flathead River near West Glacier	BPA	DCP,S	C
12359800	South Fork Flathead River above Twin Creek	USBR	DCP,S	Se
12362000	Hungry Horse Reservoir near Hungry Horse	USBR	S	C
12362500	South Fork Flathead River near Columbia Falls	USBR	DCP,S	C
12363000	Flathead River at Columbia Falls	FERC	DCP,S	C
12365000	Stillwater River near Whitefish	MDNRC	S	C
12366000	Whitefish River near Kalispell	MDNRC	S	C
12369200	Swan River near Condon	FLRES	S	C
12370000	Swan River near Bigfork	MDNRC	S	C
12371000	Turtle Lake near Polson	BIA	O	M
12371500	Flathead Lake at Somers	FERC	S	C
12372000	Flathead River near Polson	FERC	S	C
12372500	Little Bitterroot Lake near Marion	BIA	O	M
12373500	Hubbart Reservoir near Niarada	BIA	O	M
12374250	Mill Creek above Bassoo Creek, near Niarada	FLRES	S	C
12375000	Upper Dry Fork Reservoir near Lonepine	BIA	O	M
12375500	Dry Fork Reservoir near Lonepine	BIA	O	M
12375900	South Fork Crow Creek near Ronan	FLRES	S	C
12376700	Lower Crow Reservoir near Charlo	BIA	O	M
12377150	Mission Creek above reservoir, near St. Ignatius	FLRES	S	C
12377200	Mission Reservoir near St. Ignatius	BIA	O	M
12377300	St. Marys Lake near St. Ignatius	BIA	O	M
12377900	Pablo Reservoir near Pablo	BIA	O	M
12378200	McDonald Reservoir near Charlo	BIA	O	M
12378300	Kicking Horse Reservoir near Charlo	BIA	O	M
12378400	Ninepipe Reservoir near Charlo	BIA	O	M
12380000	Upper Jocko Lake near Arlee	BIA	O	M
12380500	Lower Jocko Lake near Arlee	BIA	O	M

Table 1.--*Surface-water gaging stations in operation, October 1990*--Continued

Station number	Station name	Funding source	Data collection process (gage equipment)	Type of record
	Part 12--Continued			
12381400	South Fork Jocko River near Arlee	FLRES	S	C
12383500	Big Knife Creek near Arlee	FLRES	S	C
12387450	Valley Creek near Arlee	FLRES	S	Se
12388200	Jocko River at Dixon	FLRES	S	C
12388400	Revais Creek below West Fork, near Dixon	FLRES	S	C
12388700	Flathead River at Perma	FLRES	S	C
12389000	Clark Fork near Plains	FERC	S	C
12389500	Thompson River near Thompson Falls	FERC	S	C
12390000	Thompson Falls Reservoir at Thompson Falls	FERC	O	M
12390700	Prospect Creek at Thompson Falls	FERC	S	C
12391300	Noxon Rapids Reservoir near Noxon	FERC	S	M
12391400	Clark Fork below Noxon Rapids Dam, near Noxon	FERC	O	C

Table 2.--*Crest-stage gaging stations in operation, October 1990*

[The stations are funded cooperatively by the Montana Department of Highways and the U.S. Geological Survey. The Federal Highway Administration of the U.S. Department of Transportation provides services related to the operation of the program]

Station number

Stations are listed in downstream order by standard drainage basin number: Part 6 (Missouri River basin) and Part 12 (upper Columbia River basin). Each station number contains a 2-digit part number plus a 6-digit downstream order number. The location of the stations is shown in figure 8.

Records available

The date shown indicates the year of first record. The period of record extends to the current year. At a few stations, the period of record contains one or more years of no data.

Table 2.--*Crest-stage gaging stations in operation, October 1990*--Continued

Station number	Station name	Records available
	Part 6	
06013500	Big Sheep Creek below Muddy Creek, near Dell	1946-
06015430	Clark Canyon near Dillon	1969-
06019400	Sweetwater Creek near Alder	1974-
06025100	Quartz Hill Gulch near Wise River	1974-
06027700	Fish Creek near Silver Star	1959-
06030300	Jefferson River tributary No. 2 near Whitehall	1958-
06031950	Cataract Creek near Basin	1973-
06038550	Cabin Creek near West Yellowstone	1974-
06043300	Logger Creek near Gallatin Gateway	1959-
06046500	Rocky Creek near Bozeman	1951-
06053050	Lost Creek near Ringling	1974-
06055500	Crow Creek near Radersburg	1919-29,1966-72,1975,1981,1989-
06056300	Cabin Creek near Townsend	1959-
06058700	Mitchell Gulch near East Helena	1959-
06061700	Jackson Creek near East Helena	1960-
06061800	Crystal Creek near East Helena	1960-
06071600	Wegner Creek at Craig	1959-
06073600	Black Rock Creek near Augusta	1974-
06076700	Sheep Creek near Neihart	1959-
06090550	Little Otter Creek near Raynesford	1974-
06090810	Ninemile Coulee near Fort Benton	1972-
06097100	Blacktail Creek near Heart Butte	1974-
06098700	Powell Coulee near Browning	1974-
06100300	Lone Man Coulee near Valier	1959-
06101520	Favot Coulee tributary near Ledger	1974-
06101700	Fey Coulee tributary near Chester	1963-
06105800	Bruce Coulee tributary near Choteau	1963-
06109530	Little Sandy Creek tributary near Big Sandy	1972-
06109560	Alkali Coulee tributary near Big Sandy	1974-
06111700	Mill Creek near Lewistown	1959-
06112800	Bull Creek tributary near Hilger	1974-
06114550	Wolf Creek tributary near Coffee Creek	1974-
06114900	Taffy Creek tributary near Winifred	1974-
06115300	Duval Creek near Landusky	1963-
06117800	Big Coulee near Martinsdale	1972-
06120800	Alkali Creek near Harlowton	1955-
06123200	Sadie Creek near Harlowton	1971-
06124600	East Fork Roberts Creek tributary near Judith Gap	1974-
06125520	Swimming Woman Creek tributary near Hedgesville	1974-
06125680	Big Coulee Creek tributary near Cushman	1974-
06127505	Fishel Creek near Musselshell	1974-
06127520	Home Creek near Sumatra	1973-
06127570	Butts Coulee near Melstone	1963-
06127585	Little Wall Creek tributary near Grassrange	1974-
06128500	South Fork Bear Creek tributary near Roy	1962-

Table 2.--*Crest-stage gaging stations in operation, October 1990*--Continued

Station number	Station name	Records available
	Part 6--Continued	
06129800	Gorman Coulee tributary near Cat Creek	1955-
06130610	Bair Coulee near Mosby	1974-
06130620	Blood Creek tributary near Valentine	1974-
06130850	Second Creek tributary No. 2 near Jordan	1958-
06130915	Russian Coulee near Jordan	1974-
06130925	Thompson Creek tributary near Cohagen	1974-
06130940	Spring Creek tributary near Van Norman	1974-
06131100	Terry Coulee near Van Norman	1974-
06131300	McGuire Creek tributary near Van Norman	1974-
06132400	Dry Fork Milk River near Babb	1961-
06134800	Van Cleeve Coulee tributary near Sunburst	1963-
06136400	Spring Coulee tributary near Simpson	1972-
06137600	Sage Creek tributary No. 2 near Joplin	1974-
06138700	South Fork Spring Coulee near Havre	1959-
06153400	Fifteenmile Creek tributary near Zurich	1974-
06154350	Peoples Creek tributary near Lloyd	1974-
06154410	Little Peoples Creek near Hays	1972-
06155300	Disjardin Coulee near Malta	1955-
06155600	Murphy Coulee tributary near Hogeland	1974-
06156100	Lush Coulee near Whitewater	1972-
06164600	Beaver Creek tributary near Zortman	1974-
06165200	Guston Coulee near Malta	1974-
06172300	Unger Creek near Vandalia	1958-
06173300	Willow Creek tributary near Fort Peck	1972-
06174300	Milk River tributary No. 3 near Glasgow	1974-
06174600	Snow Coulee at Opheim	1972-
06175700	East Fork Wolf Creek near Lustre	1955-
06176500	Wolf Creek near Wolf Point	1908-14,1950-73,1982-
06176950	Missouri River tributary No. 6 near Wolf Point	1973-
06177020	Tule Creek tributary near Wolf Point	1974-
06177050	East Fork Duck Creek near Brockway	1955-
06177700	Cow Creek tributary near Vida	1963-
06177720	West Fork Sullivan Creek near Richey	1972-
06177800	Gady Coulee near Vida	1962-
06177820	Horse Creek tributary near Richey	1974-
06179100	Butte Creek tributary near Four Buttes	1972-
06183300	Marron Creek tributary near Plentywood	1955-
06184200	Lost Creek tributary near Homestead	1972-
06185400	Missouri River tributary No. 5 at Culbertson	1963-
06201700	Hump Creek near Reed Point	1959-
06205100	Allen Creek near Park City	1961-
06207600	Jack Creek tributary near Belfry	1974-
06214150	Mills Creek at Rapelje	1974-
06216200	West Wets Creek near Billings	1955-
06217300	Twelvemile Creek near Shepherd	1973-

Table 2.--*Crest-stage gaging stations in operation, October 1990*--Continued

Station number	Station name	Records available
	Part 6--Continued	
06217700	North Fork Crooked Creek near Shepherd	1962-
06293300	Long Otter Creek near Lodgegrass	1973-
06294400	Andresen Coulee near Custer	1963-
06294600	East Cabin Creek tributary near Hardin	1973-
06294930	Sarpy Creek tributary near Colstrip	1972-
06294985	East Fork Armells Creek tributary near Colstrip	1973-
06295020	Short Creek near Forsyth	1962-
06295100	Rosebud Creek near Kirby	1959-
06296100	Snell Creek near Hathaway	1963-
06296115	Reservation Creek near Miles City	1973-
06306950	South Fork Leaf Rock Creek near Kirby	1958-
06307520	Canyon Creek near Birney	1972-
06307700	Cow Creek near Fort Howes Ranger Station, near Otter	1972-
06307720	Brian Creek near Ashland	1973-
06307780	Stebbins Creek at mouth, near Ashland	1963-
06307930	Jack Creek near Volborg	1973-
06308100	Sixmile Creek tributary near Epsie	1972-
06308200	Basin Creek tributary near Volborg	1955-
06308330	Deer Creek tributary near Volborg	1973-
06308340	La Grange Creek near Volborg	1973-
06309060	North Sunday Creek tributary No. 2 near Angela	1962-
06309078	Tree Coulee near Kinsey	1972-
06309080	Deep Creek near Kinsey	1962-
06324995	Badger Creek at Biddle	1972-
06325700	Deep Creek near Powderville	1973-
06325950	Cut Coulee near Mizpah	1973-
06326510	Locate Creek tributary near Locate	1973-
06326550	Cherry Creek tributary near Terry	1973-
06326580	Lame Jones Creek tributary near Willard	1974-
06326800	Pennel Creek tributary near Baker	1962-
06326940	Spring Creek tributary near Fallon	1972-
06326950	Yellowstone River tributary No. 5 near Marsh	1962-
06326960	Timber Fork Upper Sevenmile Creek tributary near Lindsay	1974-
06327550	South Fork Horse Creek tributary near Wibaux	1973-
06327720	Griffith Creek tributary near Glendive	1965-
06327790	Krug Creek tributary No. 2 near Wibaux	1974-
06328100	Yellowstone River tributary No. 6 near Glendive	1974-
06328400	Thirteenmile Creek tributary near Bloomfield	1972-
06329350	Alkali Creek near Sidney	1974-
06329510	Fox Creek tributary near Lambert	1972-
06329570	First Hay Creek near Sidney	1963-
06334100	Wolf Creek near Hammond	1955-
06334330	Little Missouri River tributary near Albion	1972-
06334610	Hawksnest Creek tributary near Albion	1973-
06334625	Coal Creek tributary near Mill Iron	1974-
06334720	Soda Creek tributary near Webster	1962-

Table 2.--*Crest-stage gaging stations in operation, October 1990*--Continued

Station number	Station name	Records available
	Part 12	
12300800	Deep Creek near Fortine	1959-
12301997	Richards Creek near Libby	1973-
12302400	Shaughnessy Creek near Libby	1959-
12303400	Ross Creek near Troy	1972-
12303440	Camp Creek near Troy	1972-
12304300	Cyclone Creek near Yaak	1960-
12323300	Smith Gulch near Silver Bow	1959-
12324250	Cottonwood Creek at Deer Lodge	1975-
12324700	Clark Fork tributary near Drummond	1958-
12331700	Edwards Gulch at Drummond	1959-
12338540	Monture Creek above Dunham Creek, near Ovando	1977-
12338550	Dunham Creek at mouth, near Ovando	1978-
12338600	Monture Creek at Forest Service boundary, near Ovando	1964-
12339300	Deer Creek near Seeley Lake	1974-
12339900	West Twin Creek near Bonner	1959-
12342950	Trapper Creek near Conner	1974-
12345850	Sleeping Child Creek near Hamilton	1972-
12353400	Negro Gulch near Alberton	1959-
12353820	Dry Creek near Superior	1982-
12355350	Big Creek at Big Creek Ranger Station, near Columbia Falls	1964-
12356500	Bear Creek near Essex	1946-
12369250	Holland Creek near Condon	1974-
12369650	North Fork Lost Creek near Swan Lake	1982-
12370500	Dayton Creek near Proctor	1959-
12391200	Canyon Creek near Trout Creek	1972-

Table 3.--*Surface-water-quality stations in operation, October 1990*

Station number

Stations are listed in downstream order by standard drainage basin number: Part 5 (Hudson Bay basin), Part 6 (Missouri River basin) and Part 12 (upper Columbia River basin). Each station number contains a 2-digit part number plus a 6-digit downstream order number. The location of the stations is shown in figure 9.

Funding source

BIA	U.S. Bureau of Indian Affairs
DOI	Department of the Interior
EPA	U.S. Environmental Protection Agency
MBMG	Montana Bureau of Mines and Geology
MDFWP	Montana Department of Fish, Wildlife and Parks
MDHES	Montana Department of Health and Environmental Sciences
MDNRC	Montana Department of Natural Resources and Conservation
NPS	National Park Service
USAE	U.S. Army Corps of Engineers
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
WWT	U.S. Department of State-International Joint Commission, Waterways Treaty

Sampling frequency

CR	Continuous record
DC	Once-daily, continuous
DS	Once-daily, seasonal
Numeral	Number of times scheduled per year
I	Intermittent

Table 3.--*Surface-water-quality stations in operation, October 1990*--Continued

Station number	Station name	Funding source	Sampling frequency: Chemical	Sediment	Temperature	Biological	Specific conductance
	Part 5						
05016000	Swiftcurrent Creek at Sherburne	WWT	3	-	3	-	3
05020500	St. Mary River at international boundary	USGS	6	6	6	6	6
	Part 6						
06024450	Big Hole River below Big Lake Creek, at Wisdom	MDFWP	-	-	CR	-	-
06025500	Big Hole River near Melrose	MDFWP	-	-	CR	-	-
06036905	Firehole River near West Yellowstone	NPS	-	-	CR	-	-
06037000	Gibbon River near West Yellowstone	NPS	-	-	CR	-	-
06037500	Madison River near West Yellowstone	USGS	7	-	7	-	7
06038500	Madison River below Hebgen Lake, near Grayling	USGS	7	-	7	-	7
06041000	Madison River below Ennis Lake, near McAllister	MDFWP, USGS	7	-	CR	-	7
06054500	Missouri River at Toston	USGS, MDFWP	7	4	CR	4	7
06078500	North Fork Sun River near Augusta	USFS	-	I	I	-	-
06089000	Sun River near Vaughn	USGS	9	6	DC	6	DC
06090650	Lake Creek near Power	DOI	I	I	I	-	I
06115200	Missouri River near Landusky	USGS, USAE	6	DC	DC	6	6
06120500	Musselshell River at Harlowtown	USGS	6	6	6	-	6
06127500	Musselshell River at Musselshell	USGS	6	6	6	-	6
06130500	Musselshell River at Mosby	USGS, USAE	5	DC	DC	4	5
06132200	South Fork Milk River near Babb	WWT	3	-	3	-	3
06133500	North Fork Milk River above St. Mary Canal, near Browning	WWT	3	-	3	-	3
06154410	Little Peoples Creek near Hays	USGS	2	-	2	-	2
06164510	Milk River at Juneberg Bridge, near Saco	USGS	9	-	DC	-	DC
06169500	Rock Creek below Horse Creek, near international boundary	USGS	4	4	4	4	4
06174500	Milk River at Nashua	USGS	6	6	6	6	6
06178000	Poplar River at international boundary	MDNRC	5	5	5	-	5
06178500	East Poplar River at international boundary	MDNRC	6	6	DC	-	DC
06179000	East Fork Poplar River near Scobey	MDNRC	6	6	6	-	6
06181000	Poplar River near Poplar	USGS	6	6	6	6	6
06181995	Beaver Creek at international boundary	WWT	4	4	4	-	4
06183450	Big Muddy Creek near Antelope	USGS	4	-	4	-	4
06188000	Lamar River near Tower Falls Ranger Station, Yellowstone National Park	MDHES, NPS	-	DS	DS	-	-

Table 3.--*Surface-water-quality stations in operation, October 1990*--Continued

Station number	Station name	Funding source	Sampling frequency: Chemical	Sediment	Temperature	Biological	Specific conductance
	Part 6--Continued						
06190370	Gardner River above Mammoth Springs outflow, near Mammoth, Yellowstone National Park	NPS	9	-	9	-	9
06190415	Mammoth Springs outflow at Mammoth, Yellowstone National Park	NPS	9	-	9	-	9
06190525	Gardner River sinkhole diversion at Mammoth, Yellowstone National Park	NPS	9	-	9	-	9
06190530	Clematis Creek at Mammoth, Yellowstone National Park	NPS	9	-	9	-	9
06190540	Hot River at Mammoth, Yellowstone National Park	NPS	9	-	9	-	9
06191000	Gardner River near Mammoth, Yellowstone National Park	NPS	9	-	9	-	9
06191400	La Duke Hot Springs near Corwin Springs	NPS	9	-	9	-	9
06191500	Yellowstone River at Corwin Springs	NPS	-	DS	DS	-	-
06192500	Yellowstone River near Livingston	USGS	6	6	6	6	6
06214500	Yellowstone River at Billings	USGS	4	4	4	4	4
06294700	Bighorn River at Bighorn	USGS	6	6	6	6	6
06294995	Armells Creek near Forsyth	MBMG	4	4	4	-	4
06296003	Rosebud Creek at mouth, near Rosebud	MBMG	4	4	4	-	4
06307500	Tongue River at Tongue River Dam, near Decker	MBMG	9	9	9	-	9
06307600	Hanging Woman Creek near Birney	MBMG	4	4	4	-	4
06307616	Tongue River at Birney Day School Bridge, near Birney	USGS	3	-	3	-	3
06307740	Otter Creek at Ashland	MBMG	4	4	4	-	4
06308500	Tongue River at Miles City	USGS	4	4	4	4	4
06324500	Powder River at Moorhead	USGS	-	DC	DC	-	-
06324710	Powder River at Broadus	USGS	-	DC	DC	-	-
06326500	Powder River near Locate	USGS	6	6	6	6	6
06326555	Cherry Creek near Terry	MBMG	-	DC	DC	-	-
06329500	Yellowstone River near Sidney	USGS, USAE	6	DC	DC	6	6
	Part 12						
12300110	Lake Koocanusa at international boundary	USAE	5	-	5	-	5
12301830	Lake Koocanusa at Tenmile Creek, near Libby	USAE	7	-	7	7	7
12301919	Lake Koocanusa at Forebay, near Libby	USAE	7	-	7	-	7
12301933	Kootenai River below Libby Dam, near Libby	USAE	12	-	12	-	12
12323800	Clark Fork near Galen	EPA	8	8	8	-	8

Table 3.--*Surface-water-quality stations in operation, October 1990*--Continued

Station number	Station name	Funding source	Sampling frequency: Chemical	Sediment	Temperature	Biological	Specific conductance
	Part 12--Continued						
12324200	Clark Fork at Deer Lodge	EPA	8	DC	DC	-	8
12324590	Little Blackfoot River near Garrison	EPA	4	4	4	-	4
12331500	Flint Creek near Drummond	EPA	4	4	4	-	4
12334510	Rock Creek near Clinton	EPA	4	4	4	-	4
12334550	Clark Fork at Turah Bridge, near Bonner	EPA	8	DC	DC	-	8
12340000	Blackfoot River near Bonner	EPA	4	DC	DC	-	4
12340500	Clark Fork above Missoula	EPA	8	DC	DC	-	8
12353000	Clark Fork below Missoula	USGS	6	6	6	6	6
12353450	Fish Creek below West Fork, near Tarkio	MDFWP	-	-	CR	-	-
12353650	Clark Fork at Superior	MDFWP	-	-	CR	-	-
12354000	St. Regis River near St. Regis	MDFWP	-	-	CR	-	-
12354700	Clark Fork near Paradise	MDFWP	-	-	CR	-	-
12355000	Flathead River at Flathead, British Columbia	USGS, MDFWP	4	DC	CR	4	4
12355500	North Fork Flathead River near Columbia Falls	MDFWP	-	-	CR	-	-
12362500	South Fork Flathead River near Columbia Falls	MDFWP	-	-	CR	-	-
12363000	Flathead River at Columbia Falls	USGS, MDFWP	4	4	CR	4	4
12375800	Little Bitterroot River near Perma	BIA	6	6	6	-	6
12376900	Crow Creek at mouth near Ronan	BIA	6	6	6	-	6
12379600	Mission Creek at National Bison Range at Moiese	BIA	6	6	6	-	6
12388200	Jocko River at Dixon	BIA	6	6	6	-	6
12388700	Flathead River at Perma	BIA	6	6	6	-	6

Table 4.--*Ground-water-level observation-well network, October 1990*

[The network is funded cooperatively by the Montana Bureau of Mines and Geology, the Montana Department of Natural Resources and Conservation, and the U.S. Geological Survey]

Local number--based on Federal system of land subdivision. The first numeral and letter indicate the township; the second, the range; and the third, the section. The first letter following the section number denotes the 160-acre tract; the second, the 40-acre tract; the third, the 10-acre tract; and the fourth, the 2.5-acre tract. Letters are assigned in a counterclockwise direction, beginning with "A" in the northeast quadrant. The last two digits are a sequential number.

Site identification--15-digit identification number, based on latitude-longitude location. The location of the wells is shown in figure 10.

Well depth--reported in feet below land surface.

Principal aquifer--the following codes were computer retrieved from the National Water Data Storage and Retrieval System (WATSTORE) and some may not follow current usage of the U.S. Geological Survey:

110ALVM - Quaternary alluvium
111ALVM - Holocene alluvium
111SPBK - Holocene spoil banks
112ALVM - Pleistocene alluvium
112DRFT - Pleistocene glacial drift
112GCLO - Pleistocene glacial outwash
112GLCC - Pleistocene glaciolacustrine deposits
112OTSH - Pleistocene outwash
112TILL - Pleistocene glacial till
112TRRC - Pleistocene terrace deposits
120SDMS - Tertiary sediments
120TRTR - Tertiary System
121FLXV - Pliocene Flaxville Formation
125FRUN - Paleocene Fort Union Formation
125LEBO - Paleocene Lebo Shale Member of Fort Union Formation
125TGRV - Paleocene Tongue River Member of Fort Union Formation
125TLCK - Paleocene Tullock Member of Fort Union Formation
210CRCS - Cretaceous System
211EGLE - Upper Cretaceous Eagle Sandstone
211FHHC - Upper Cretaceous Fox Hills-Hell Creek aquifer
211FXHL - Upper Cretaceous Fox Hills Sandstone
211HLCK - Upper Cretaceous Hell Creek Formation
211JDRV - Upper Cretaceous Judith River Formation of Montana Group
211PRKM - Upper Cretaceous Parkman Sandstone of Montana Group
211TMDC - Upper Cretaceous Two Medicine Formation of Montana Group
211VRGL - Upper Cretaceous Virgelle Sandstone Member of Eagle Sandstone
217FLOD - Lower Cretaceous Flood Shale Member of Black Leaf Formation
217KOTN - Lower Cretaceous Kootenai Formation
217FCCK - Lower Cretaceous First Cat Creek sandstone of Colorado Group
217TCCK - Lower Cretaceous Third Cat Creek sandstone of Kootenai Formation
221SWFT - Upper Jurassic Swift Formation of Ellis Group
331MDSN - Upper Mississippian Madison Group
331MSNC - Upper Mississippian Mission Canyon Limestone

Begin year water level--year water-level measurements began.

Measurement frequency--A, annual; C, continuous recorder; M, monthly; Q, quarterly; S, semiannual; Z, other.

Begin year chemical analysis--year well first sampled for chemical analysis.

Type of chemical analysis--B, common ions; C, trace elements.

Analyzing agency--DH, Montana Department of Health and Environmental Sciences, Helena, Montana; GS, U.S. Geological Survey, Denver, Colorado; MB, Montana Bureau of Mines and Geology, Butte, Montana; PL, Private laboratory; --, unknown.

Table 4.--*Ground-water-level observation-well network, October 1990*--Continued

Local number	Site identification	Well depth (feet)	Principal aquifer	Water level: Begin year	Water level: Measurement frequency	Chemical analysis: Begin year	Chemical analysis: Type	Chemical analysis: Analyzing agency
37N27W21CBAB01	485721115073101	45	112GLCC	1973	A	--	--	--
37N27W24BABB01	485746115032601	230	112GCLO	1977	A	1976	B	MB
37N27W27ACCB01	485634115054401	320	112GLCC	1977	A	--	--	--
37N47E01ABBB01	485958105274901	53	112OTSH	1978	A	1978	C	GS
37N47E01ABBB02	485958105274801	83	125TGRV	1978	A	1978	C	GS
37N47E12BBBB01	485859105282801	147	125TGRV	1978	A	1978	B	MB
37N47E13AADD01	485754105271001	208	125TGRV	1978	A	1978	B	MB
37N47E13ADAA01	485753105271001	45	112OTSH	1978	A	--	--	--
37N47E17DABB02	485741105324202	266	125TGRV	1978	A	--	--	--
37N47E23AADD02	485704105282902	120	125TGRV	1978	A	1978	B	MB
37N48E05AAAA01	485956105243301	218	125FRUN	1976	A	1978	B,C	GS
37N48E05BABB01	485957105252901	43	112OTSH	1978	A	1978	B	MB
37N48E23BBDC01	485703105214301	400	211FHHC	1978	A	1978	B	MB
36N28W01ADC 01	485448115090801	206	112TILL	1972	A	--	--	--
36N28W11AADB01	485411115101901	290	112GLCC	1971	A	--	--	--
36N27W05DCBC01	485428115065601	168	112GLCC	1966	A	--	--	--
36N09E05DBAD01	485420110345801	1,015	211EGLE	1978	A	1978	B	GS
36N25E06CBCB01	485422108311001	75	121FLXV	1975	A	--	--	--
36N26E33DBD 01	485001108195501	67	121FLXV	1975	A	--	--	--
35N02E27AABD01	484603111270301	250	211EGLE	1979	A	--	--	--
35N24E09DBBC01	484825108354501	53	121FLXV	1976	A	--	--	--
35N33E19DBA 01	484600107271001	246	211JDRV	1978	A	1978	B	MB
34N24E06DCCC01	484342108382801	200	211FXHL	1975	A	--	--	--
33N06W12AAA 03	483812112191203	250	211TMDC	1965	A	--	--	--
32N11W03DAD 01	483345113004501	12	112DRFT	1968	A	--	--	--
32N15E17DDDC01	483138109481001	180	110ALVM	1947	A	1947	B	GS
32N58E04DBBD02	483318104105402	143	112OTSH	1984	A	1984	B	MB
31N14E03CDDC01	482804109535301	215	211JDRV	1978	A	1978	B	MB
31N24E06BCC 01	482823108401101	70	111ALVM	1960	A	--	--	--
30N33W05ABAB01	482357115503801	187	112GLCC	1980	A	1980	B,C	MB
30N33W30DAAD01	481958115513601	43	112GLCC	1980	A	1980	B,C	MB
30N33W30DAAD02	481958115513602	23	112GLCC	1980	A	1980	B,C	MB
30N05W33DDB 01	481839112151501	122	211VRGL	1968	A	--	--	--
30N38E09CADB01	482211106473201	195	211JDRV	1969	A	1978	B	MB
29N22W14BBDD01	481652114220501	220	112GLCC	1964	A	--	--	--
29N22W28ACCC01	481458114240901	200	112GLCC	1965	A	--	--	--
29N22W36BCBD01	481407114205601	452	112GLCC	1976	A	--	--	--
29N21W20CCCC01	481519114182501	278	112GLCC	1963	A	--	--	--
29N13E21AABA02	481542110023501	210	112ALVM	1947	A	--	--	--
27N56E34AABC01	480315104275001	118	125TGRV	1980	A	--	--	--
26N23E23ACAA02	475949108430601	244	211VRGL	1989	A	1990	B,C	MB
26N24E31BADC01	475812108405901	174	217FCCK	1988	A	1988	B	MB
26N24E31BDDC01	475759108410001	226	217TCCK	1988	A	1988	B	MB
26N24E32BCBA01	475811108400301	140	331MSNC	1989	A	1990	B,C	MB
26N49E13ACAB01	480034105195401	180	211FHHC	1982	A	--	--	--

Table 4.--*Ground-water-level observation-well network, October 1990*--Continued

				Water level		Chemical analysis		
Local number	Site identification	Well depth (feet)	Principal aquifer	Begin year	Measurement frequency	Begin year	Type	Analyzing agency
26N54E17DCAA01	480005104460401	240	125TGRV	1982	A	--	--	--
26N59E22DBDD01	475914104044501	212	125TGRV	1980	A	1980	B,C	MB,GS
25N47E04DAAB01	475652105385701	200	211FHHC	1982	A	--	--	--
25N50E24CBDA01	475408105123901	220	125LEBO	1982	A	--	--	--
24N23W21BCDA01	474940114332901	250	112TILL	1975	A	--	--	--
24N44E20CABD01	474929106061401	300	211FHHC	1982	A	--	--	--
24N47E35BBBA01	474815105393601	101	125LEBO	1980	A	1980	B	GS
24N47E35BBBC01	474812105393501	640	211FHHC	1984	A	1985	B	GS
24N54E29CACB01	474827104492100	190	125TGRV	1975	A	--	--	--
24N56E25DDAC01	474822104280301	60	125TGRV	1980	A	1980	B	MB
23N24W27CDDD01	474305114392801	184	112ALVM	1967	A	--	--	--
23N24W34ADAA01	474251114385201	377	110ALVM	1943	C	--	--	--
23N43E34BABC01	474258106112901	175	211FHHC	1978	A	--	--	--
23N51E20BBBD01	474448105124200	175	125FRUN	1975	A	--	--	--
22N58E10CCCC01	474027104160801	135	125FRUN	1976	A	--	--	--
21N20W24CAAA02	473355114061302	290	112TILL	1974	A	1975	B	MB
21N23E13CBBB01	473456108430601	1,630	211EGLE	1980	A	1980	B	MB
21N45E26DAAD01	473231105534001	95	125TGRV	1990	A	--	--	--
21N47E12CCCC01	473259105544001	213	125TGRV	1976	A	--	--	--
21N51E10ABCD01	473602105090500	131	125TGRV	1975	A	--	--	--
21N53E08ADCC01	473542104562701	70	125TGRV	1975	A	1976	B	GS
21N56E28ADDC01	473306104315001	220	125TGRV	1978	A	1975	B	--
20N22W30DADD01	472740114260901	155	110ALVM	1969	A	--	--	--
20N20W26CCBD01	472733114065601	200	112GLCC	1967	A	--	--	--
20N02E01AABA01	473124111244501	605	331MDSN	1979	A	1979	B	MB
20N03E28CCCD01	472703111220201	85	217FLOD	1973	A	--	--	--
20N03E32ADDC01	472636111221801	215	217FLOD	1973	A	--	--	--
20N47E36ADDD01	472700105394501	220	125TGRV	1976	A	1976	B	GS
20N52E17BBBB01	472959105074601	180	125TGRV	1982	A	--	--	--
20N53E04DAAA01	473117104573601	280	125TGRV	1981	A	1981	B,C	MB
20N53E14BBCC01	472948104561701	206	125TGRV	1981	A	1981	B	MB
20N53E20CCCC01	472816105000901	259	125TGRV	1981	A	1981	B	MB
20N54E01DCDD01	473052104463001	220	125TGRV	1975	A	1976	B	GS
20N55E32AAAA01	472721104433401	200	125TGRV	1981	A	1981	B,C	MB
20N55E32AAAA02	472721104433402	112	125TGRV	1981	A	1981	B,C	MB
20N56E08DDCD01	473002104360501	223	125TGRV	1985	A	1985	B,C	MB
20N56E08DDCD02	473002104360502	180	125TGRV	1985	A	1985	B,C	MB
19N20W35AAA 01	472211114054801	54	112GLCC	1967	A	--	--	--
19N03E01AABA01	472606111171201	65	217KOTN	1979	A	--	--	--
19N06E23BADA01	472403110553701	75	221SWFT	1979	A	--	--	--
19N06E26ACAD01	472303110552101	435	331MDSN	1982	A	--	--	--
19N44E35DDDD01	472118106135001	140	125TGRV	1981	A	1981	B,C	MB
19N53E24CCDC01	472302104544801	220	125TGRV	1982	A	1981	B,C	MB
18N20W14DBDC01	471900114061001	30	112TILL	1974	A	--	--	--
18N30E19BBBA01	471850107562601	1,003	211JDRV	1978	A	1978	B	MB

Table 4.--*Ground-water-level observation-well network, October 1990*--Continued

Local number	Site identification	Well depth (feet)	Principal aquifer	Water level: Begin year	Water level: Measurement frequency	Chemical analysis: Begin year	Chemical analysis: Type	Chemical analysis: Analyzing agency
18N38E20BBAB01	471837106544001	518	211HLCK	1983	A	--	--	--
18N40E01DBBB01	472046106334601	159	125FRUN	1965	A	--	--	--
18N44E13AAAC01	471925106023501	278	125TGRV	1975	A	1976	C	GS
18N50E16CBBB01	471906105214701	161	125LEBO	1982	A	--	--	--
17N47E16DDDD01	471329105432801	242	125TGRV	1981	A	--	--	--
16N15W08ACBD01	470946114013201	307	110ALVM	1990	A	--	--	--
16N44E25BBAA01	470711106061401	263	125TGRV	1980	A	--	--	--
16N44E25BBAB01	470711106051501	1,460	211FHHC	1980	A	--	--	--
16N44E25BBAC01	470709106061401	103	125TGRV	1983	A	--	--	--
16N45E29CDDB01	470624106032501	172	125TGRV	1985	A	--	--	--
16N50E06DDCD01	470958105260401	380	125TGRV	1981	A	1982	B	MB
16N51E36DCCC01	470535105122201	202	125TLCK	1981	A	--	--	--
15N12W36BCDD01	470049113035401	206	112DRFT	1975	A	1976	B	GS
15N14E16DCDD01	470322109570601	1,620	217KOTN	1988	A	1980	B,C	MB
15N19E09BABC01	470459109193501	90	217TCCK	1980	A	1980	B,C	MB
15N46E04BBBC01	470531105545901	160	125TGRV	1982	A	--	--	--
15N53E12ABAB01	470446104565501	317	125LEBO	1981	A	1981	B	GS
15N53E12ABAB02	470446104565502	193	125TGRV	1981	A	1981	B	GS
15N53E12ABAB03	470446104565503	172	125TGRV	1981	A	1981	B	GS
15N55E12ABDC01	470432104414001	675	211FHHC	1977	A	--	--	--
14N49E21AAAA01	465745105305501	440	125TLCK	1981	A	--	--	--
13N19W29DADD01	465110114010601	84	110ALVM	1958	A	--	--	--
13N51E31BCDD01	465024105190701	565	211HLCK	1979	A	--	--	--
13N51E31BCDD02	465026105190701	340	125TLCK	1979	A	1979	B,C	MB
13N51E31BDCB01	465026105190401	860	211FHHC	1979	A	1979	B,C	MB
13N53E18ABAA01	465326105031701	62	125TGRV	1980	A	--	--	--
13N56E30CCBC01	465258104411701	100	211FHHC	1962	A	--	--	--
12N55E20DCCD01	464627104492801	1,185	211FHHC	1962	A	1962	B	PL
12N55E25CDCC01	464535104444401	1,275	211FHHC	1964	A	--	--	--
12N56E23CCDA01	464626104384301	1,449	211FHHC	1981	A	--	--	--
12N56E23DCCA01	464624104380601	1,195	211FHHC	1962	A	--	--	--
12N56E24CABD01	464639104370801	145	211FXHL	1962	A	--	--	--
12N56E25CBDB01	464547104372701	1,480	211FHHC	1962	A	--	--	--
12N56E34DAAC01	464457104390001	1,467	211FHHC	1962	A	--	--	--
11N03W30BBBC01	464118112022501	127	110ALVM	1979	A	--	--	--
11N03W30DADA01	464009112011601	44	110ALVM	1978	A	1978	B	MB
11N36E28BACD01	464055107121101	2,745	217TCCK	1978	A	1978	B	MB
11N54E29CACD01	464025104572901	800	211FHHC	1976	A	1976	B	MB
11N57E21CDBB01	464127104334003	1,230	211FHHC	1963	A	1957	B	PL
10N07W30BBC 01	463540112320301	70	120TRTR	1961	A	--	--	--
10N04W02CBAA01	463906112043901	110	210CRCS	1976	M	--	--	--
10N04W10DDDA01	463754112050601	23	110ALVM	1978	A	1979	B	MB
10N03W03BACB01	463931111581801	65	110ALVM	1978	A	1979	B	MB
10N03W08BBAA01	463844112005701	23	110ALVM	1978	A	1978	B	MB
10N03W09ACCC01	463823111591801	64	110ALVM	1979	A	1978	B	MB

Table 4.--*Ground-water-level observation-well network, October 1990*--Continued

Local number	Site identification	Well depth (feet)	Principal aquifer	Water level: Begin year	Water level: Measurement frequency	Chemical analysis: Begin year	Chemical analysis: Type	Chemical analysis: Analyzing agency
10N03W11DDCC01	463754111562201	40	110ALVM	1978	A	1978	B	MB
10N03W15DDCA01	463707111573401	326	110ALVM	1990	A	1990	B,C	GS
10N03W17ACAD01	463735112001701	28	110ALVM	1978	A	1978	B	MB
10N03W22AAAA01	463700111572501	23	110ALVM	1978	A	1979	B	MB
10N02W18DDCD01	463707111534701	70	120SDMS	1981	A	1981	B,C	MB
10N36E06CACA01	463847107144001	195	211JDRV	1978	A	--	--	--
10N45E28BBBA01	463602106044601	951	211FHHC	1979	A	1980	B	MB
10N45E28BBBA02	463559106044501	362	125TLCK	1979	A	--	--	--
10N45E28BBBB01	463602106044801	762	211HLCK	1980	A	1980	B	MB
10N55E25CDCD01	464530104444001	1,150	211FHHC	1962	A	--	--	--
10N58E19ABBA01	463650104280601	166	211FHHC	1962	A	--	--	--
08N20W19BAAD03	462631114084603	52	120TRTR	1957	A	--	--	--
08N19W07CBBD01	462748114014101	117	120SDMS	1956	A	--	--	--
08N09W27BDDD01	462510112424901	94	120SDMS	1985	A	--	--	--
08N31E36DDDD01	462343107465501	1,175	211FHHC	1980	A	1981	B	MB
08N31E36DDDD02	462343107465502	850	211HLCK	1980	A	1981	B	MB
08N31E36DDDD03	462343107465503	486	211HLCK	1980	A	1981	B	MB
08N50E18BDBC01	462704105311801	280	125TLCK	1976	A	--	--	--
07N09W08ADD 01	462239112444401	13	112ALVM	1957	A	--	--	--
07N47E24AAD 01	462120105470001	50	125FRUN	1947	A	--	--	--
07N50E05CCBD01	462250105303001	700	211FHHC	1965	A	--	--	--
07N57E24BBCB01	462057104325501	362	125TGRV	1977	A	--	--	--
06N20W19CCCC02	461518114090802	40	110ALVM	1970	C	--	--	--
06N09W21CDBC01	461515112441201	150	120SDMS	1960	A	--	--	--
06N44E36CACD01	461341106100301	902	211FXHL	1980	A	1981	B	MB
06N44E36CACD02	461341106100302	609	211HLCK	1980	A	1981	B	MB
06N44E36CACD03	461341106100303	316	211HLCK	1981	A	1981	B	MB
05N10W10CCBC01	461150112505101	115	120SDMS	1985	Q	--	--	--
05N01E27CCBB01	460915111354501	215	120SDMS	1977	A	--	--	--
05N25E16CCCC01	461035108364401	1,350	211FXHL	1980	A	1981	B	MB
05N25E16CCCC02	461035108364402	427	211HLCK	1980	A	1981	B	MB
05N55E23AADB01	461041104470001	1,080	211FHHC	1977	A	1977	B	GS
05N58E14BBBB01	461120104253501	360	125TGRV	1977	A	--	--	--
04N10W10DC 02	460632112493502	20	111ALVM	1960	Z	--	--	--
04N01E02BBCC01	460801111343601	191	120SDMS	1977	A	--	--	--
04N01E10BBCB01	460712111354901	447	120SDMS	1977	S	--	--	--
04N01E13BCAC01	460615111330901	209	120SDMS	1977	A	--	--	--
04N01E15BCBB01	460612111355001	348	120SDMS	1977	A	--	--	--
04N23E14ABBA01	460612108494201	80	211FHHC	1980	A	1980	B	GS
04N40E31DCAA01	460311106475601	199	211HLCK	1976	A	1976	B	MB
02N27E35DBAB01	455209108193601	5,070	331MSNC	1983	A	1978	C	GS
02N40E31DCCD01	455236106473901	165	125TGRV	1972	A	1972	B	MB,GS
02N43E24CCBC01	455424106200801	60	110ALVM	1979	A	1979	C	GS
02N43E24CDDA01	455419106193701	21	110ALVM	1979	A	--	--	--
01N04E25DCD 01	454809111095401	101	110ALVM	1951	A	--	--	--

Table 4.--*Ground-water-level observation-well network, October 1990*--Continued

Local number	Site identification	Well depth (feet)	Principal aquifer	Water level: Begin year	Water level: Measurement frequency	Chemical analysis: Begin year	Chemical analysis: Type	Chemical analysis: Analyzing agency
01N25E36CBDA01	454721108335001	12	110ALVM	1966	A	--	--	--
01N25E36CDDD01	454705108333101	17	110ALVM	1978	A	--	--	--
01N26E10ABBA01	455122108280201	193	211EGLE	1978	A	1978	B	MB
01N26E31CCBC01	454713108325001	17	110ALVM	1986	A	--	--	--
01N41E21DBDB01	454921106380601	125	125TGRV	1981	A	1981	B,C	MB
01N41E22CCAD01	454914106372401	72	111SPBK	1981	A	1981	B,C	MB
01N41E26BCAB01	454848106361600	195	125TGRV	1973	A	1976	B	MB
01N41E36DCBA01	454732106342801	150	125TGRV	1980	A	--	--	--
01N54E18DDAC01	455001105024301	8,422	331MSNC	1977	A	1977	B,C	GS
01N54E18DDBA01	455004105024302	400	211FHHC	1977	A	--	--	--
01S25E05CD 01	454611108400901	62	110ALVM	1968	A	--	--	--
01S25E17AAAA01	454518108393201	42	110ALVM	1968	A	--	--	--
01S26E08DABA01	454532108324301	24	110ALVM	1968	A	--	--	--
01S33E19DAA 01	454350107410001	25	112TRRC	1957	S	1935	B	DH
01S33E24BCBC02	454401107360302	26	110ALVM	1960	S	--	--	--
02S23E16DADD01	453923108530301	63	110ALVM	1968	A	--	--	--
02S41E19DABA01	453904106424400	43	110ALVM	1968	A	--	--	--
02S44E35DAAB01	453709106152101	84	110ALVM	1979	A	1979	B	GS
02S49E22DCCA04	453832105393904	118	125TGRV	1977	A	1977	B,C	GS
03S33E09DCC 01	453441107385501	74	112TRRC	1966	Z	--	--	--
03S33E16BBBB01	453419107393701	19	110ALVM	1965	Z	--	--	--
03S33E16BBBB02	453419107393702	46	110ALVM	1965	Z	--	--	--
03S35E18DABD01	453413107260201	400	211PRKM	1977	A	1977	B	MB
03S44E09ADD 01	453527106174801	84	110ALVM	1968	A	1968	B	GS
03S45E05DBAA01	453608106114901	148	125TGRV	1979	Q	1979	B	MB
04S06W16AAAA02	452942112202002	57	120SDMS	1965	A	--	--	--
04S06W35BBBB01	452703112190301	170	120SDMS	1963	A	--	--	--
04S32E35AAAA01	452647107431501	39	110ALVM	1965	Z	--	--	--
04S45E04BDDB01	453107106110601	68	110ALVM	1979	C	1980	B,C	MB
04S45E15BCDD01	452932106100701	60	110ALVM	1980	A	--	--	--
04S45E28BDDD01	452738106110801	269	125TGRV	1977	A	1977	B,C	MB,GS
05S07W23ABA 01	452334112254301	20	120SDMS	1964	A	--	--	--
05S06W10BCCA01	452459112201201	200	120SDMS	1965	A	--	--	--
05S45E04ABCC01	452606106110101	223	125TGRV	1977	A	1977	B,C	GS
05S45E16ADDD01	452409106102801	320	125TGRV	1983	A	1983	B,C	MB
05S45E23ABCA02	452333106083101	44	110ALVM	1979	A	1980	B,C	MB
05S45E23BBAA01	452341106085801	169	125TGRV	1979	A	1980	B,C	MB
05S45E23BBAA02	452341106085802	106	125TGRV	1979	A	1980	B,C	MB
05S45E23BBAA03	452341106085803	65	125TGRV	1979	A	1980	B,C.	MB
05S51E10ABAB01	452501105243001	1,010	211FHHC	1975	A	--	--	--
06S08W26CCCA02	451641112332802	51	120SDMS	1965	A	--	--	--
06S07W06AAA 01	452052112295801	107	120SDMS	1964	A	--	--	--
06S39E26AABB01	451752106550201	130	125TGRV	1977	A	--	--	--
06S41E08CCAC01	451930106443801	128	125TGRV	1976	A	1986	B,C	GS,MB
06S41E17ADDD01	451857106433301	19	110ALVM	1979	A	1986	B,C	GS,MB

Local number	Site identification	Well depth (feet)	Principal aquifer	Water level: Begin year	Water level: Measurement frequency	Chemical analysis: Begin year	Chemical analysis: Type	Chemical analysis: Analyzing agency
06S41E25CDAC01	451653106392401	144	125TGRV	1978	A	1986	B,C	GS,MB
06S41E26BBDD01	451728106405101	23	110ALVM	1978	A	1978	B	MB
06S41E29ADCA01	451717106434601	393	125TGRV	1978	A	1978	B,C	GS
06S41E29ADCA02	451717106434602	322	125TGRV	1978	A	1978	B,C	GS
06S41E34CDAA01	451604106414701	364	125TGRV	1978	A	1978	B,C	GS
06S41E34CDAA02	451604106414702	155	125TGRV	1979	A	1979	B,C	MB
06S42E31DBBA01	451617106375201	68	110ALVM	1979	A	1986	B,C	GS,MB
06S43E19DDBA02	451746106301101	67	110ALVM	1988	C	--	--	--
07S08W03BDC 02	451521112341902	40	110ALVM	1965	Z	--	--	--
07S08W17DDC 02	451307112361001	50	120SDMS	1965	Z	--	--	--
07S44E34BAAD01	451137106194901	86	125TGRV	1975	A	1975	B,C	GS
07S44E35DCCA01	451051106182901	213	125TGRV	1981	A	1983	B	MB
07S44E35DCCA02	451051106182902	132	125TGRV	1981	A	1982	B	GS
07S45E32CADD01	451102106145801	207	125TGRV	1981	A	1982	B	GS
07S45E32CADD02	451102106145802	42	125TGRV	1981	A	1982	B	GS
07S45E32DCBA02	451058106145201	18	110ALVM	1980	A	1982	B	GS
07S49E13ABBB01	451602105394801	--	211FHHC	1975	A	--	--	--
07S49E28DAAC01	451143105425801	452	125TLCK	1979	A	--	--	--
7.5S40E32DBDA01	451027106511801	120	125TGRV	1978	A	--	--	--
08S09W01CCCC01	450937112393701	47	120SDMS	1966	A	--	--	--
08S40E26ACBC01	450622106473801	172	125TGRV	1981	A	1986	B,C	MB
08S42E06ADBA01	451020106374201	398	125TGRV	1976	A	--	--	--
08S42E14DBAD02	450823106325302	103	125TGRV	1975	A	1986	B,C	MB
08S43E20DABA01	450714106285001	222	125TGRV	1974	A	1986	B,C	MB
08S43E21BBDD03	450752106283002	13	110ALVM	1980	A	1986	B,C	MB
08S43E21BDBB01	450747106282901	223	125TGRV	1981	A	1981	B	MB
08S43E21BDBB02	450747106282902	146	125TGRV	1981	A	1981	B	MB
08S43E23CACA03	450729106255302	29	110ALVM	1980	A	1980	B,C	MB
08S43E23CDAA01	450721106254401	78	125TGRV	1981	A	1981	B	MB
08S43E23CDAA02	450721106254402	329	125TGRV	1981	A	1981	B	MB
08S43E31BBDA01	450609106310001	131	125TGRV	1981	A	1981	B,C	MB
08S43E31BBDA02	450609106310002	257	125TGRV	1981	A	1981	B,C	MB
08S44E02BACD01	451016106174901	15	110ALVM	1980	A	1980	B,C	MB
08S44E03CBBD01	450947106191601	201	125TGRV	1975	A	1982	B	GS
08S44E03CBBD02	450947106191602	129	125TGRV	1975	A	1982	B	GS
08S44E09DABB01	450906106194501	28	110ALVM	1980	A	1980	B,C	MB
08S44E12ACDC01	450909106161301	351	125TGRV	1981	A	1983	B	MB
08S44E12ACDC02	450909106161302	252	125TGRV	1981	A	1982	B	GS
08S44E12ADBC02	450915106160202	14	110ALVM	1980	A	1982	B	MB
08S44E14ABAB01	450839106172801	337	125TGRV	1981	A	1982	B	GS
08S44E14ABAB02	450839106172802	250	125TGRV	1981	A	1982	B	GS
08S44E14ABAB03	450839106172803	161	125TGRV	1981	A	1982	B	GS
08S44E19CBBB01	450723106231301	190	125TGRV	1975	A	1986	B,C	MB
08S44E19CBBB02	450723106231302	130	125TGRV	1975	A	1986	B,C	MB
08S44E19CBCB02	450717106232801	36	110ALVM	1980	A	1982	B	MB

Table 4.--*Ground-water-level observation-well network, October 1990*--Continued

Local number	Site identification	Well depth (feet)	Principal aquifer	Water level: Begin year	Water level: Measurement frequency	Chemical analysis: Begin year	Chemical analysis: Type	Chemical analysis: Analyzing agency
08S45E16DBCB01	450806106124401	188	125TGRV	1975	A	1975	B	GS
08S45E16DBCB02	450806106124402	66	125TGRV	1975	A	1975	B	GS
08S45E34BCBC01	450548106120301	253	125TGRV	1976	A	1976	B	GS
08S46E17CBCD01	450804106071001	18	110ALVM	1983	A	1983	B	MB
08S46E18DDAC01	450759106072201	18	110ALVM	1983	A	1984	B	MB
08S46E27CDAB01	450616106042001	233	125TGRV	1983	A	1983	B	MB
08S46E27CDAB02	450616106042002	138	125TGRV	1983	A	1983	B	MB
08S46E32DDAC01	450524106061001	30	110ALVM	1983	A	1983	B	MB
09S40E20BDAC01	450159106513701	380	125TGRV	1981	A	1981	B,C	MB
09S42E01BCAD02	450507106321501	34	110ALVM	1980	A	1980	B	MB
09S42E11BDAA01	450417106330901	222	125TGRV	1975	A	1980	B,C	MB
09S43E04ABDD02	450512106275602	26	110ALVM	1980	A	1986	B,C	MB
09S43E07CADB01	450438106301301	165	125TGRV	1979	A	1986	B,C	MB
09S43E07CADB02	450359106304402	218	125TGRV	1981	A	1986	B,C	MB
09S43E12ADBB02	450418106240902	40	110ALVM	1977	A	1986	B,C	MB
09S43E21BADA01	450240106281101	229	125TGRV	1975	A	--	--	--
09S43E21BADA02	450240106281102	135	125TGRV	1975	A	--	--	--
09S43E22ACCA01	450227106264901	129	125TGRV	1976	A	1986	B,C	MB
09S44E07BBCC03	450411106231703	92	125TGRV	1977	A	1986	B,C	MB
09S45E03DABB01	450447106111101	144	125TGRV	1975	A	1976	B,C	GS
09S45E03DABB04	450447106111104	65	125TGRV	1976	A	--	--	--
09S45E03DABB05	450447106111105	71	125TGRV	1976	A	--	--	--
09S45E11ADDB01	450400106094801	307	125TGRV	1975	A	1984	B	MB,GS
09S45E11CCAA01	450343106103701	218	125TGRV	1976	A	--	--	--
09S46E08BACB01	450413106065701	240	125TGRV	1983	A	1983	B	MB,GS
09S46E09ADCD01	450356106050201	176	125TGRV	1983	A	1984	B	MB
09S46E09DABA01	450357106050201	110	125TGRV	1975	A	1983	B	MB,GS
09S46E09DABA02	450355106050202	209	125TGRV	1983	A	1983	B	MB
09S46E09DBAB02	450355106051301	30	110ALVM	1983	A	1983	B	MB
09S46E11BACC02	450412106031601	18	110ALVM	1983	A	1984	B	MB
09S46E11BBAB01	450419106032601	262	125TGRV	1983	A	1983	B	MB
09S46E11BBAB02	450419106032602	208	125TGRV	1983	A	1983	B	MB

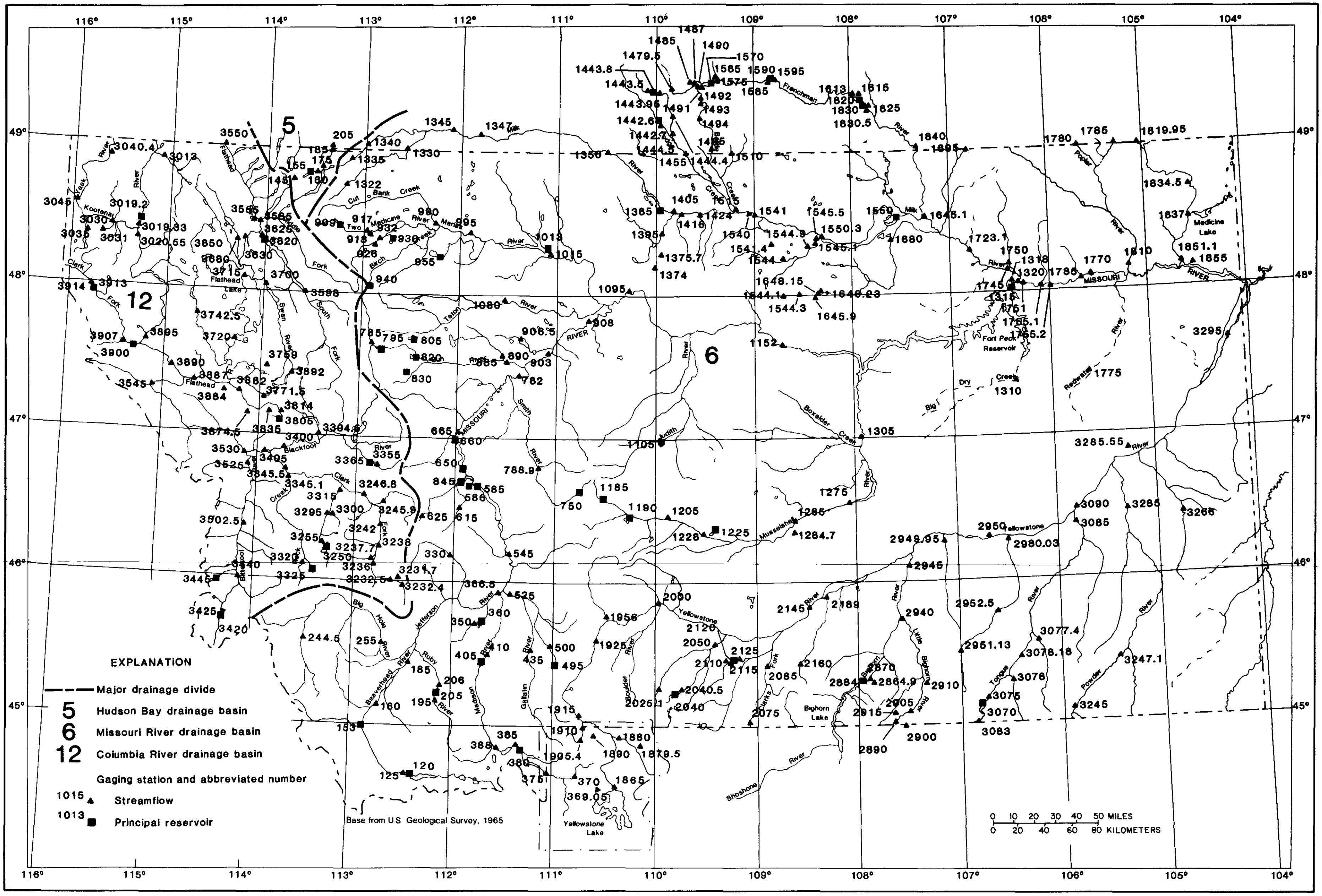

Figure 7.--Location of surface-water gaging stations in operation, October 1990.

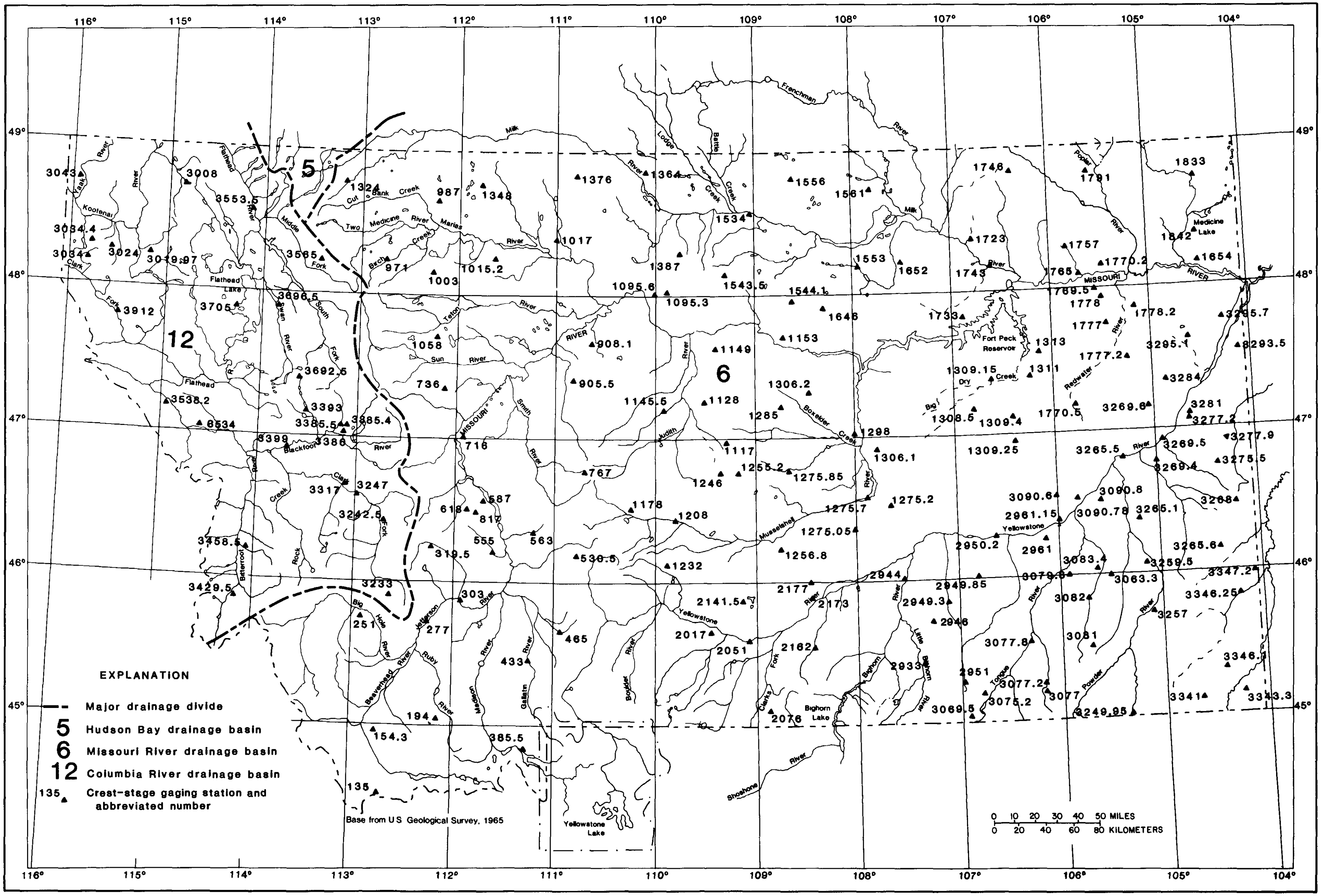

Figure 8.--Location of crest-stage gaging stations in operation, October 1990.

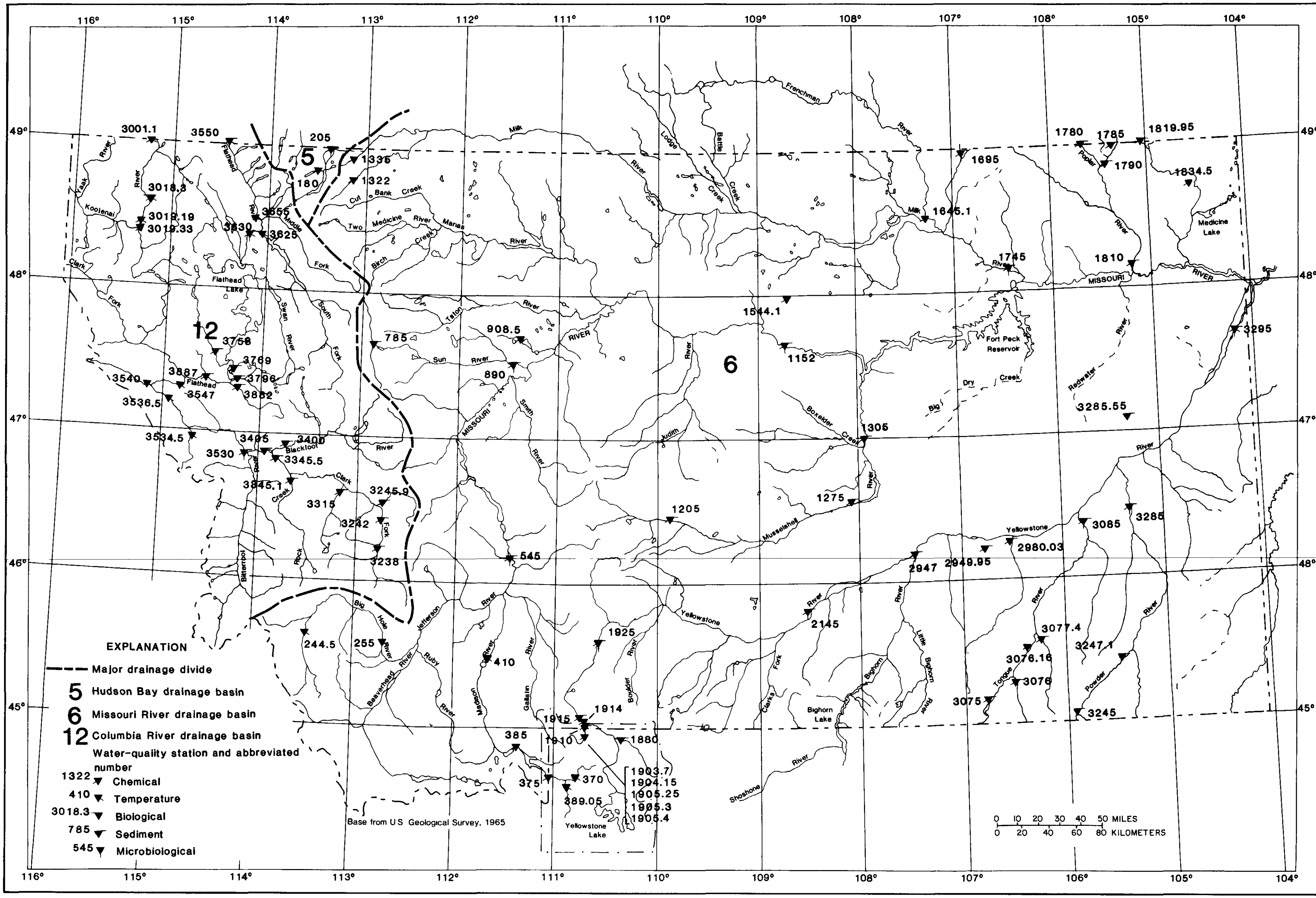

Figure 9.--Location of surface-water-quality stations in operation, October 1990.

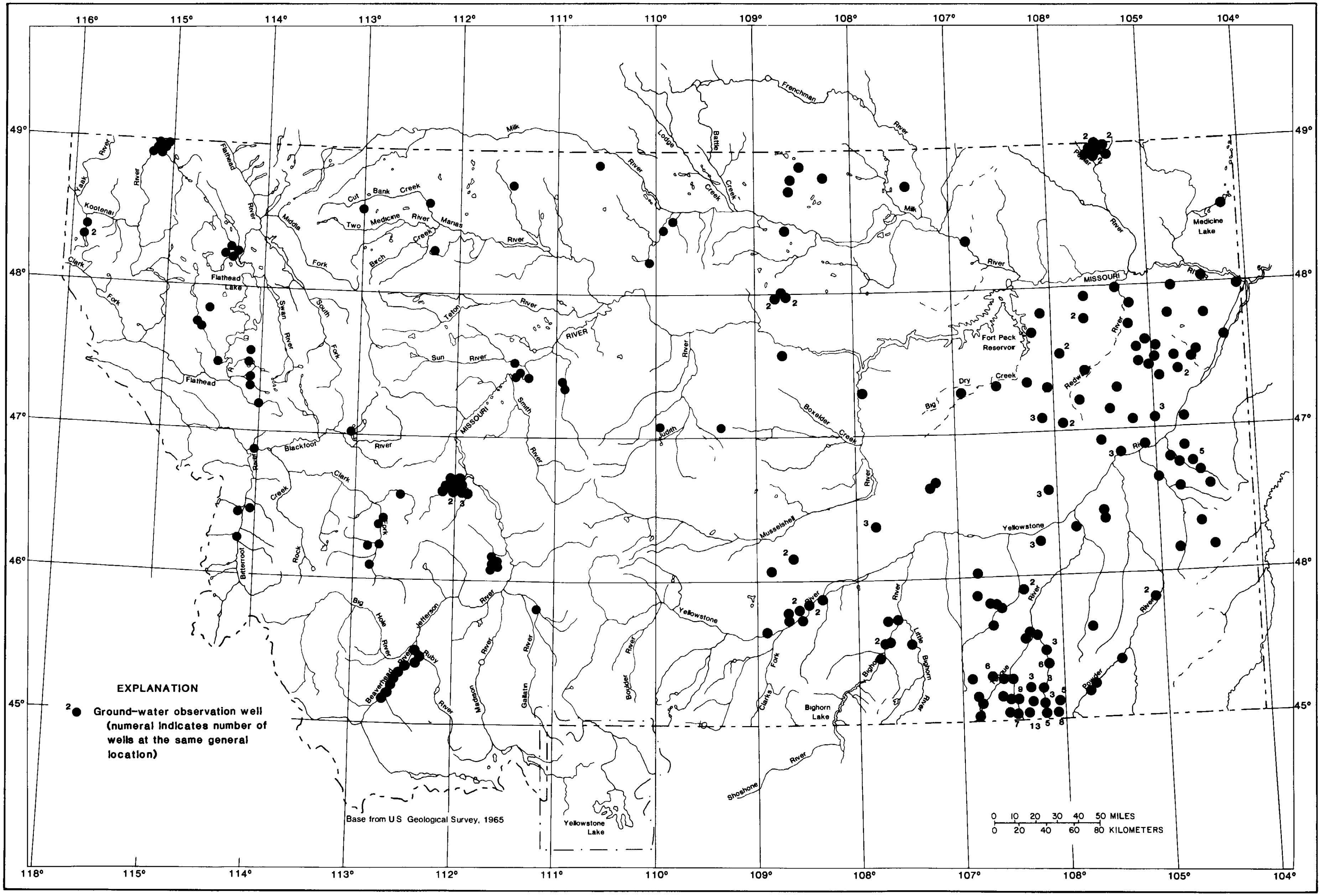

Figure 10.--Location of ground-water-level observation wells, October 1990.