WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN MONTANA, OCTOBER 1987 THROUGH SEPTEMBER 1989

Compiled by Joanna N. Thamke

U.S. GEOLOGICAL SURVEY

Open-File Report 89-591

Prepared in cooperation with the

STATE OF MONTANA AND OTHER AGENCIES

Helena, Montana
1989

UNITED STATES DEPARTMENT OF THE INTERIOR

MANUEL LUJAN, JR., Secretary

GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information
write to:

District Chief
U.S. Geological Survey
428 Federal Building
301 South Park, Drawer 10076
Helena, MT 59626-0076

Copies of this report can be
purchased from:

U.S. Geological Survey
Books and Open-File Reports Section
Federal Center, Building 810
Box 25425
Denver, CO 80225-0425

CONTENTS

ILLUSTRATIONS

TABLES

CONVERSION FACTORS

The following factors can be used to convert inch-pound units in this report to metric (International System) units.

Multiply inch-pound unit	By	To obtain metric unit
acre	4,047	square meter
cubic foot per second	0.028317	cubic meter per second
foot	0.3048	meter
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 nearly 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 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, and future plans; projects are identified by title, location, period of activity, and project chief. Additional information about specific projects can be obtained by contacting me or the project chief directly (phone 406-449-5263).

During the past year, Montana experienced an extreme drought that 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 was unprecedented. Several gaging stations were installed to obtain information at key locations, and streamflow was measured at numerous sites of discontinued gaging stations and along streams with critically low flows. During the summer, several major wildfires burned large areas of the State. Concerns about the effects of burned watersheds on future hydrologic conditions prompted several agencies to request new or expanded monitoring to document changes in runoff and water quality.

Interest in ground-water resources emerged as a priority hydrologic issue in Montana during the past year. The severe drought focused attention on ground water as an alternative source of water for municipal, industrial, domestic, and agricultural supplies. In many areas, the drought caused water levels to decline in shallow aquifers and some wells became dry. Numerous requests were received by Federal and State agencies for information about replacement supplies. 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 were 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 changes in the field of water-resources investigations as the public becomes more concerned about hazardous wastes and toxic substances in the environment. 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. 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.

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 relationships.

Joe A. Moreland

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

WATER-RESOURCES ACTIVITIES OF THE

U.S. GEOLOGICAL SURVEY IN MONTANA,

OCTOBER 1987 THROUGH SEPTEMBER 1989

Compiled by

Joanna N. Thamke

ABSTRACT

Water-resources programs and activities of the U.S. Geological Survey in Montana consist principally of hydrologic-data collection and local, areal, or statewide hydrologic investigations. 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 headquarters office in Helena, and field offices in Helena, Billings, Fort Peck, and Kalispell. Eighteen 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 1988 and 1989. In addition, it describes the operations of the Montana District, water conditions during water year 1988, activities in addition to regular programs, and sources of publications and information, and 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 offices in Helena, Billings, Fort Peck, and Kalispell (fig. 1). The District employs 60 people (53 full-time and 7 part-time) to work on 18 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 interpretive 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 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; assessment or prediction of the effects of natural forces or human activities on the quality of water in hydrologic systems; and time-of-travel and dispersion studies.

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

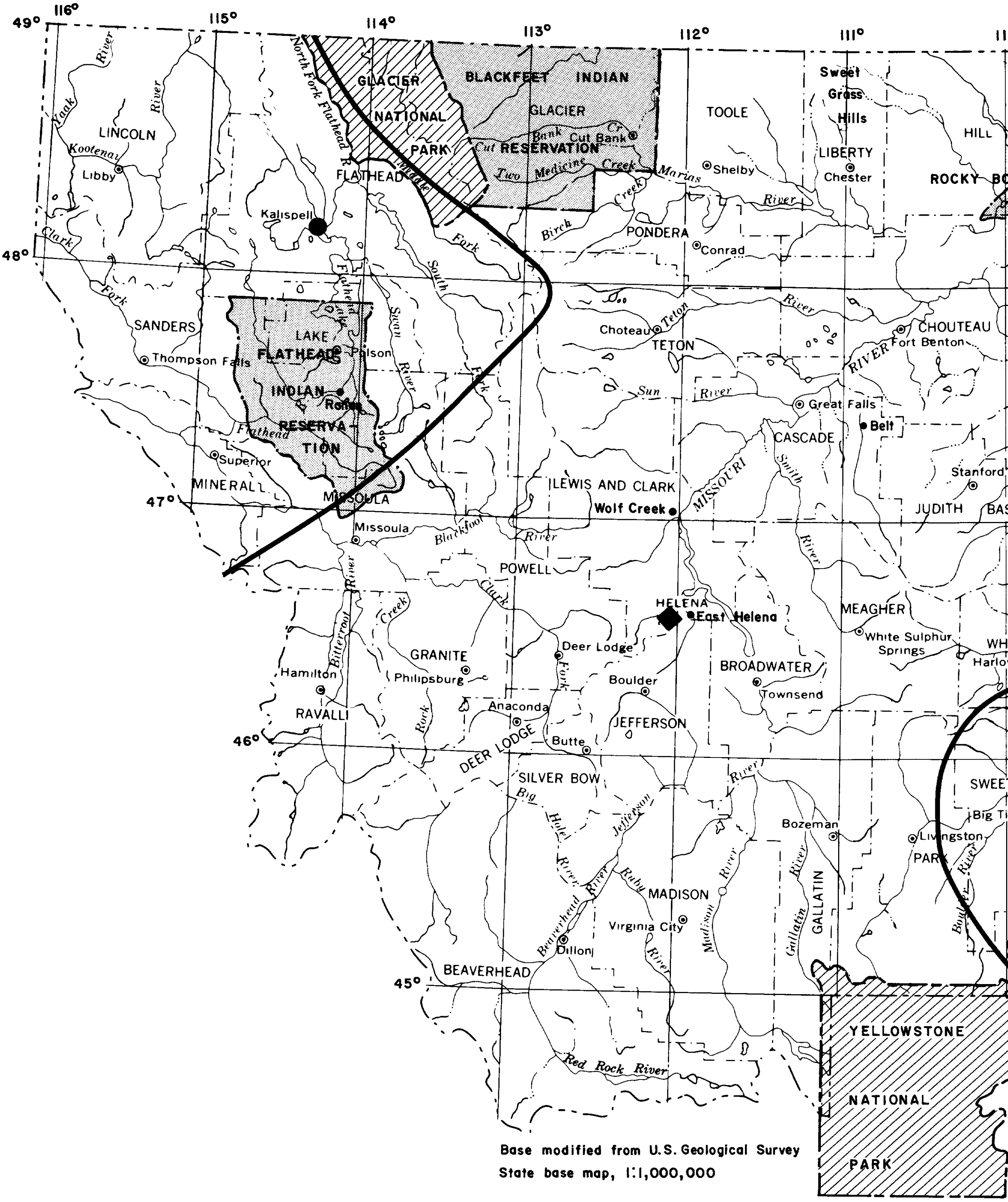
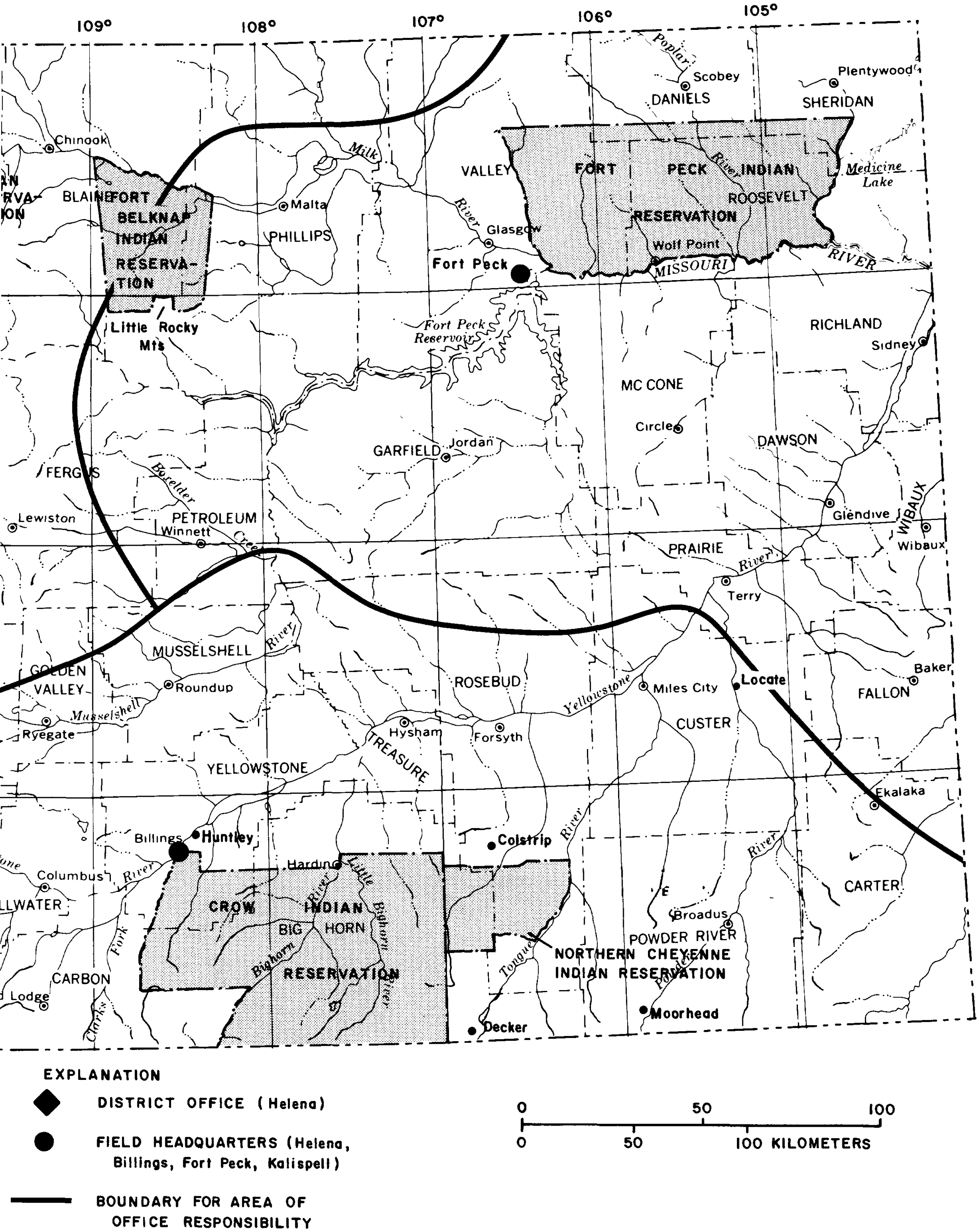


Figure 1.--Location of field offices in the Montana District, general



area of responsibility, and selected geographic features.

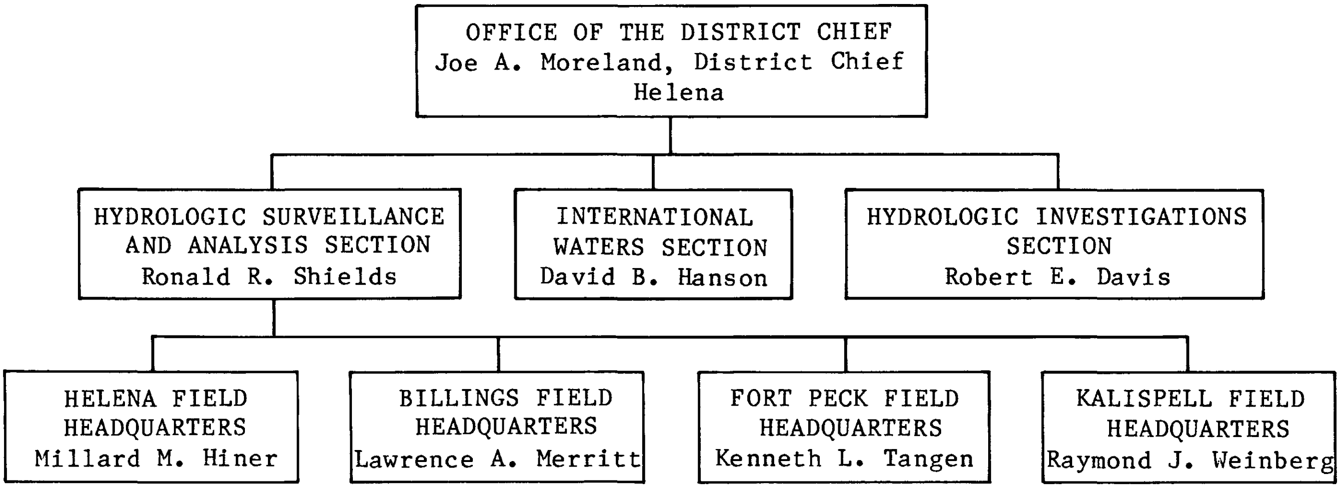


Figure 2.--Organization chart.

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 office nearest the area of concern, or to the District Office.

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: Millard M. Hiner	(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 (406) 657-6113
Hydrologist-in-charge: Lawrence A. Merritt

U.S. Geological Survey
Water Resources Division
Eastern Montana College, Box 111
1500 North 30th
Billings, MT 59101-0111

Fort Peck Field Headquarters (406) 526-3532
Technician-in-charge: Kenneth L. Tangen

U.S. Geological Survey
Water Resources Division
Administration Building
P.O. Box 124
Fort Peck, MT 59223-0124

Kalispell Field Headquarters (406) 755-6686
Technician-in-charge: Raymond J. Weinberg

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 1988[1], total funding support for program operation in Montana was about $3,320,560. Funding sources are illustrated in figure 3.

Cooperating Agencies

The following agencies participated in program operation of the Montana District in fiscal year 1988 by providing funds and (or) services:

Federal Agencies
- U.S. Geological Survey
- U.S. Bureau of Indian Affairs
- U.S. Army Corps of Engineers
- U.S. Bureau of Land Management
- U.S. Department of State-International Joint Commission
- Federal Energy Regulatory Commission
- U.S. Environmental Protection Agency
- U.S. Bureau of Reclamation
- National Park Service
- Bonneville Power Administration
- U.S. Fish and Wildlife Service
- U.S. Forest Service

---

[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 1988 extends from October 1, 1987, through September 30, 1988.

Figure 3.--Funding sources for the water-resources program in Montana. Funding amounts are for Federal fiscal year 1988.

State and Local Agencies

- Montana Department of Natural Resources and Conservation
- Montana Bureau of Mines and Geology
- Montana Department of State Lands
- Montana Department of Fish, Wildlife and Parks
- Confederated Salish and Kootenai Tribes of the Flathead Indian Reservation
- Montana Department of Highways
- Lower Musselshell Conservation District
- Montana State University
- Wyoming State Engineer
- Lewis and Clark City-County Health Department
- Fort Peck Tribes
- Montana Department of Health and Environmental Sciences
- University of Montana
- City of Helena

WATER CONDITIONS

Montana has two distinct hydrogeologic regimes: mountains and intermontane valleys in the west and south-central areas, and plains in the east and north-central areas. Precipitation and mountain snowpack generally provide abundant supplies of water 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 east and north-central areas of the State, do not provide dependable supplies except during spring runoff.

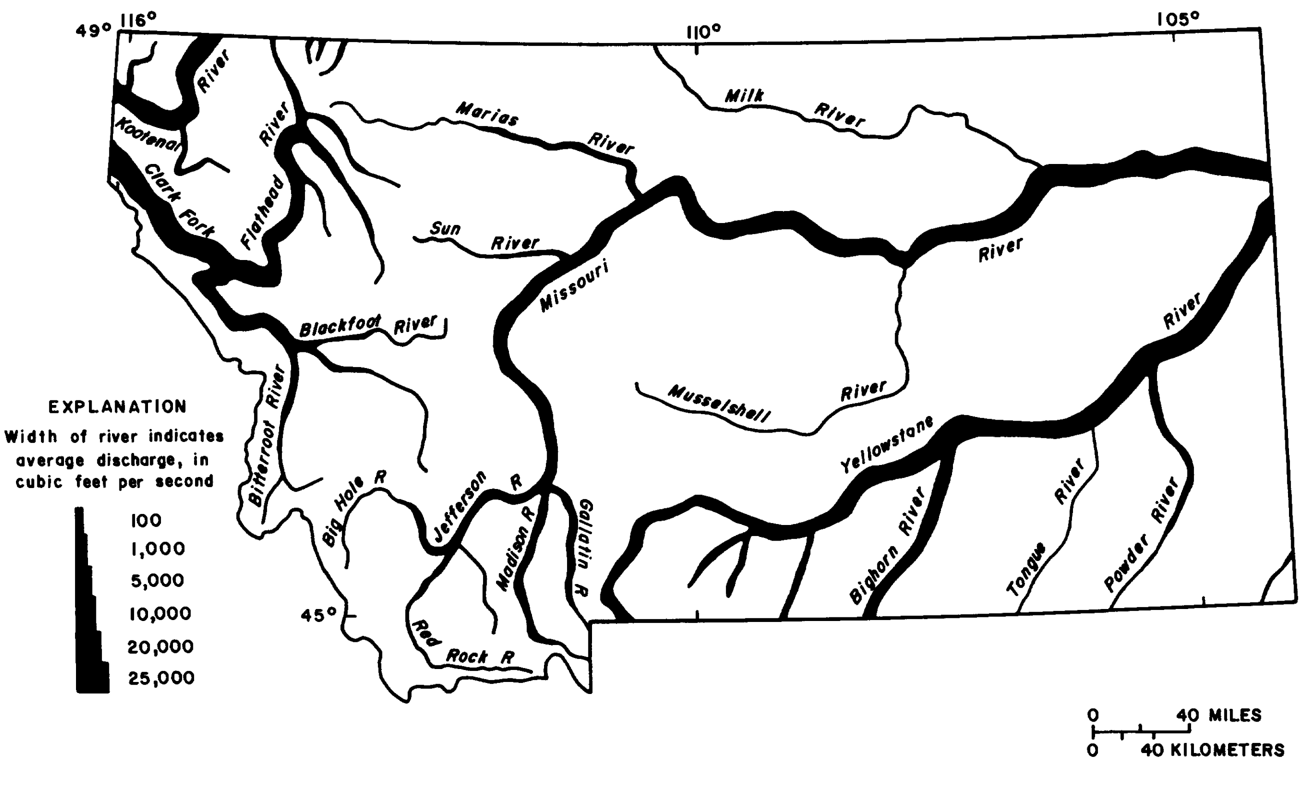


Figure 4.--Major river systems and long-term average discharge.

Water year 1988[2] was a period of major drought conditions statewide. Mountain and valley precipitation was substantially less than normal. Snowfall was substantially less than normal throughout the winter until March and was near normal during March and April. However, by mid-April, the precipitation was still less than 80 percent of normal. Snowmelt runoff started early and snowpack levels continued to decrease. By May 1, the water content of the snowpack was less than 70 percent of normal and by June 1 most areas were bare, which is 2-3 weeks earlier than normal. Many areas received little or no precipitation from June through August. The lack of spring runoff and irrigation demands that were greater than average precluded the filling of many irrigation and multipurpose reservoirs. Large irrigation demands decreased storage levels to empty or near empty in many reservoirs. Streamflows were record minimums at numerous sites during the late summer. As a result of the large irrigation demands, rivers such as the Big Hole and Jefferson were severely dewatered and major fishkills were reported. Owing to the lack of summer moisture, numerous forest and range fires scourged the countryside. The fires in Yellowstone National Park were the most extensive in its 100-year history. In September, precipitation quantities increased, extinguishing most of the fires and bringing some relief to agricultural interests.

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

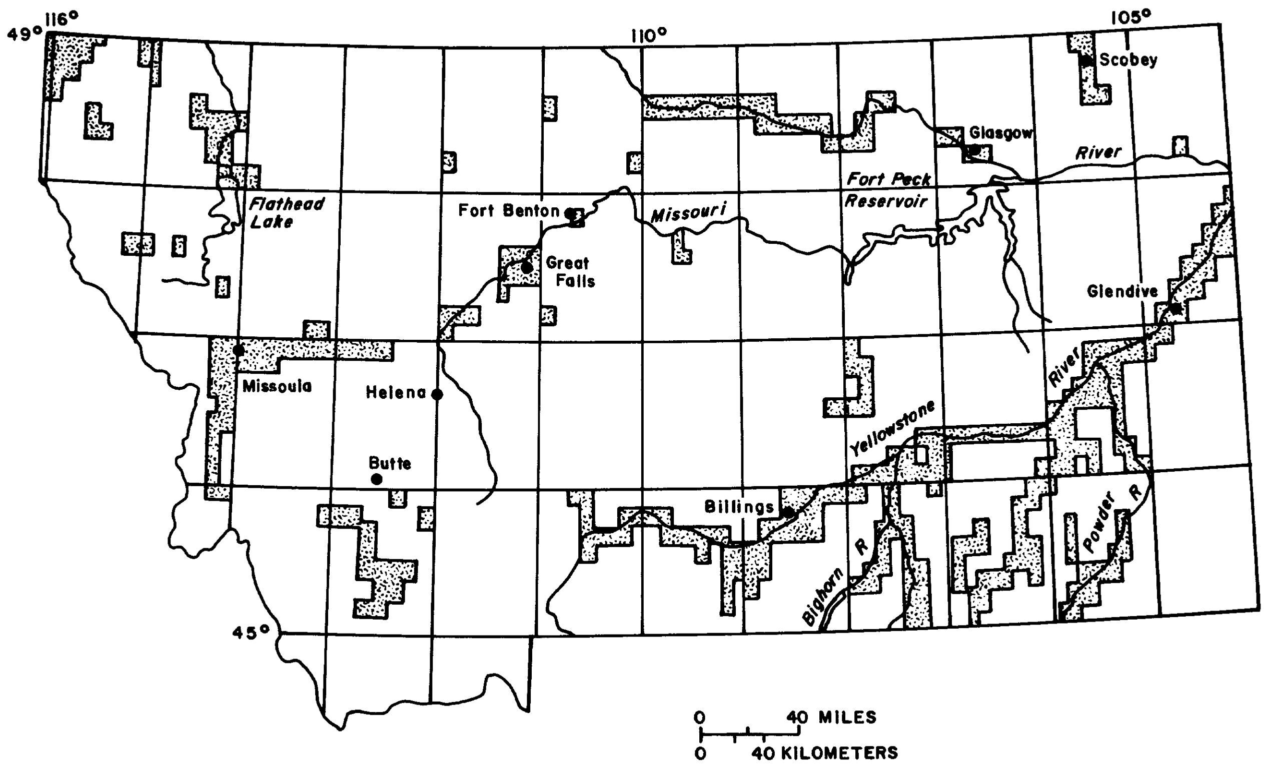


Figure 5.--Flood-prone areas (patterned) mapped in Montana.

---

[2]A water year is the 12-month period October 1 through September 30. It is identified in the same manner as a fiscal year.

maps to assist administrators, planners, and engineers concerned with future land developments. More detailed maps, prepared by the U.S. Geological Survey as part of flood-insurance studies, are available for Helena and East Helena and the densely populated areas of Cascade County, Lewis and Clark 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; dissolved-solids concentrations in the Powder River; and the effects of forest fires on stream sedimentation and water quality.

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 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 from drought and low-streamflow conditions. The potential for degradation of water quality by surface coal mining in the eastern part of the State is a major concern. The effects of coal and metals mining on water resources are being evaluated by hydrologic study and research.

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.

---

[3]Parrett, Charles, and Johnson, D.R., in press, 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.

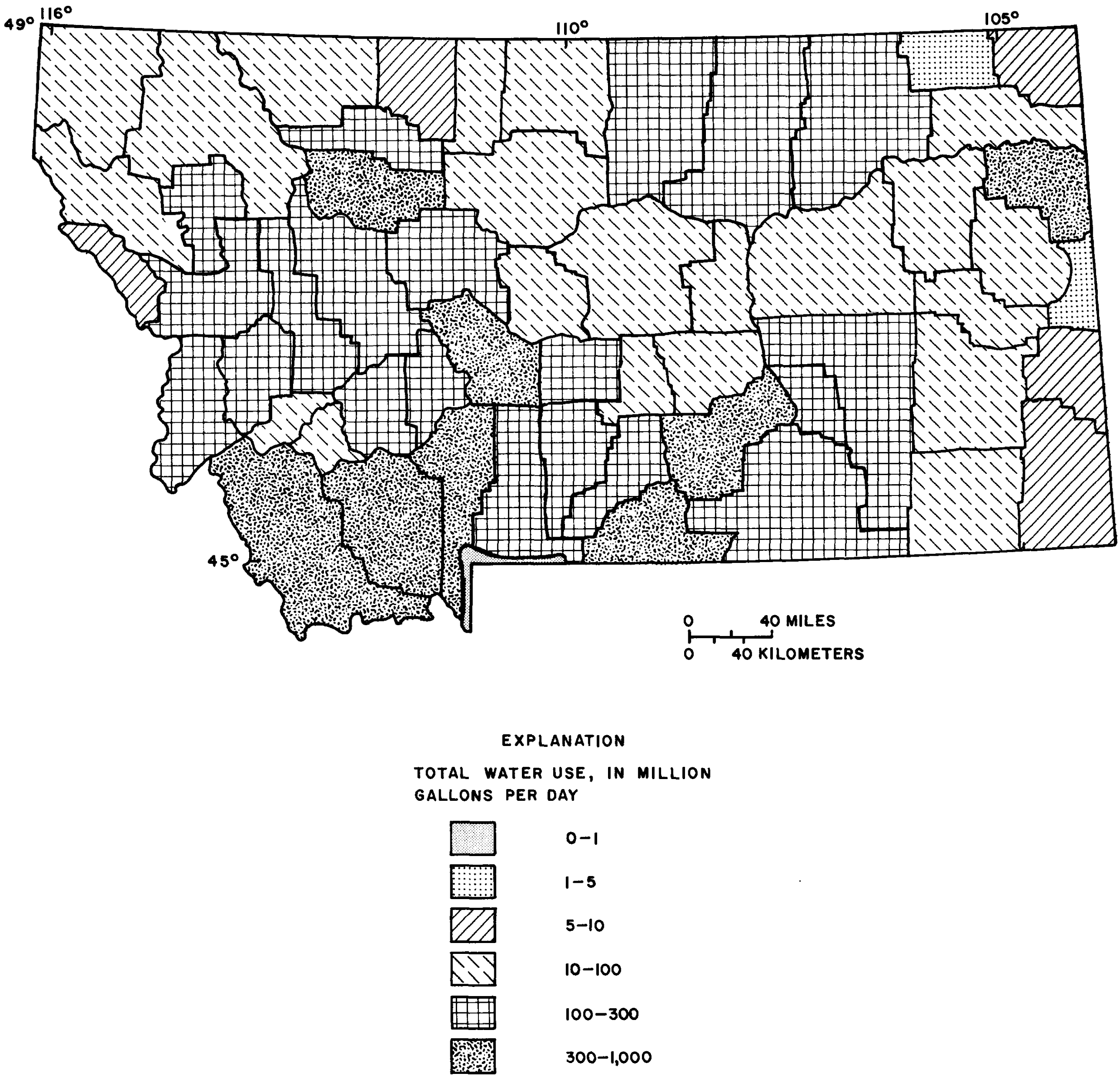


Figure 6.--Total water use in Montana, 1985.

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 meaningful and worthwhile 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 1988 at the following number of stations.

Station classification		Number of stations
Stream stations		402
Continuous record:		
Discharge and stage	236	
Stage only	5	
Partial record:		
Peak (maximum) flow only	161	
Lake and reservoir stations		55
Stage and contents	54	
Stage only	1	
Total		457

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 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 170 crest-stage stations discontinued in previous years.

Water-quality data were being obtained in October 1988 at 94 surface-water stations. Sixteen of the stations are part of a U.S. Geological Survey nationwide network known as the National Stream Quality Accounting Network (NASQAN), which is used to detect nationwide trends in water quality. The types of water-quality data determined at the surface-water 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	94
Specific conductance	79
pH	59
Dissolved oxygen	52
Sediment data	54
Chemical data (inorganic constituents)	82
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 U.S. 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.	575
Project springs.	3

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.

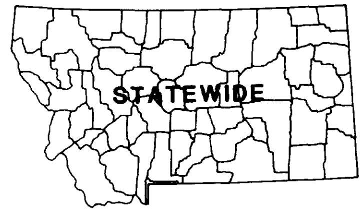
Water-quality data are obtained at some of the observation wells and project wells and springs listed above. The types of water-quality data determined at these ground-water sites during the past year are given in the following table. The numbers will not equal the total number of sites inasmuch as several 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	474	3
Specific conductance.	478	3
pH.	409	3
Chemical data (inorganic constituents). .	143	3
Chemical data (chloride, pH, specific conductance, and nitrogen).	167	

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. The status of information products is dated October 1, 1988.

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.

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." Partial-record gaging will be used instead of complete-record gaging where it serves the required purpose.

Progress during fiscal year 1988: Continued data collection on schedule for all stations in the network. There are 457 active sites.

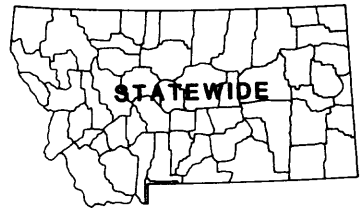
Plans for fiscal year 1989: Continue to operate streamflow stations in the network and, if appropriate, make changes in the network based on financing or user needs.

Information product(s): Parrett, Charles, 1988, Fire-related flooding and debris flows in the Beaver Creek drainage, Lewis and Clark County, Montana *in* Selected papers in the hydrologic sciences 1988: U.S. Geological Survey Water-Supply Paper 2310 (in press).

Shields, R.R., Knapton, J.R., White, M.K., Brosten, T.M., and Lambing, J.H., Water resources data, Montana, water year 1988: U.S. Geological Survey Water-Data Report MT-88-1 (in preparation).

Yellowstone River Compact Commission, 1988, Thirty-seventh annual report, Yellowstone River Compact Commission: Annual report (planned).

Project title: Ground-Water Stations (MT002)



Location: Statewide

Period of project: Continuing

Project chief: Thomas E. Reed, Helena

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

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

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.

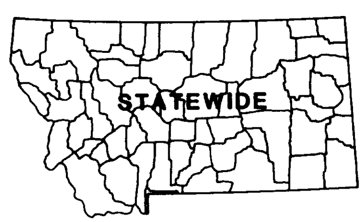
Approach: Evaluate the regional geology to permit broad, general definition of aquifer systems and their boundary conditions. Within this framework and with some knowledge of the areal and temporal stress on the system and the hydrologic properties of the aquifers, determine the most advantageous locations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

Progress during fiscal year 1988: Measured water levels in all observation wells as scheduled. There are 302 active sites.

Plans for fiscal year 1989: Continue operation of the statewide observation-well network.

Information product(s): Shields, R.R., Knapton, J.R., White, M.K., Brosten, T.M., and Lambing, J.H., Water resources data, Montana, water year 1988: U.S. Geological Survey Water-Data Report MT-88-1 (in preparation).

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 chemical concentrations, loads, and time trends as required by planning and management agencies.

Progress during fiscal year 1988: Maintained data collection on schedule at all stations in the network. Analyzed the annual records and prepared them for publication. Published the water year 1987 records.

Plans for fiscal year 1989: Continue collection and analysis of samples from the network. Evaluate the network and make changes where appropriate.

Information product(s): Knapton, J.R., and Brosten, T.M., 1989, Arsenic and chloride data for five stream sites in the Madison River drainage, Montana, 1988: U.S. Geological Survey Open-File Report (in preparation).

Shields, R.R., Knapton, J.R., White, M.K., Brosten, T.M., and Lambing, J.H., Water resources data, Montana, water year 1988: U.S. Geological Survey Water-Data Report MT-88-1 (in preparation).

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 the planning and management of Federal and State water-resource 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.

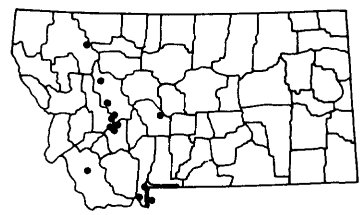
Approach: Establish and operate a network of sediment stations to characterize spatial and temporal variation of sediment concentration, sediment discharge, and particle size of sediment being transported by rivers and streams.

Progress during fiscal year 1988: Maintained data collection on schedule at all stations in the network. Analyzed the annual records and prepared for publication. Published the water year 1987 records. One station on the Canadian border was converted to an international sediment station, with joint data collection and publication. Two previously discontinued stations in and near Yellowstone National Park were restarted to monitor effects of forest fires.

Plans for fiscal year 1989: Continue collection and analysis of samples from the network. Digitize sediment data. Evaluate the network and make changes where appropriate.

Information product(s): Shields, R.R., Knapton, J.R., White, M.K., Brosten, T.M., and Lambing, J.H., Water resources data, Montana, water year 1988: U.S. Geological Survey Water-Data Report MT-88-1 (in preparation).

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

Problem: Increasing use of streamflow for irrigation, municipal, industrial, and other purposes 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, particularly for successive irrigation seasons, require a knowledge of snowpack characteristics.

Objective(s): To periodically measure the depth and water content of snowpack at 13 designated snow courses.

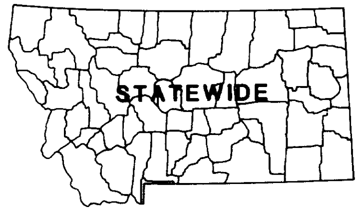
Approach: Use standard methods to measure the depth and water content at 10 sites on each snow course.

Progress during fiscal year 1988: Measured all 13 snow courses according to schedule. Compiled data and distributed to cooperating agencies.

Plans for fiscal year 1989: Continue measurements on same schedule as last year.

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

Project title: Water Use (MT007)



Location: Statewide

Period of project: Continuing

Project chief: Charles Parrett, Helena

Funding source(s): Montana Department of Natural Resources and Conservation, 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 is enhanced by a firm data base of current water use that can be used 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 plans and strategies each year with the Montana Department of Natural Resources and Conservation for joint collection and analysis of water-use data. Conduct cooperative data-collection and analysis projects using techniques and procedures approved by cooperating agencies.

Progress during fiscal year 1988: Measured Musselshell River tributaries 12 times so that long-term monthly streamflow characteristics could be determined. Tributary inflows will be used in a detailed water-use accounting model presently being developed by the cooperating agency.

Plans for fiscal year 1989: Estimate long-term monthly streamflow characteristics using three different techniques. The results will be used in a water-use accounting model to more accurately estimate irrigation water use.

Information product(s): Water-use information will be supplied to requesters. Parrett, Charles, and Johnson, D.R., Estimates of mean monthly streamflow for selected sites in the Mussellshell River basin, Montana, base period water years 1937-86: U.S. Geological Survey Water-Resources Investigations Report (in preparation).

______Montana water supply and use, *in* National water summary 1987--Hydrologic events and water supply and demand: U.S. Geological Survey Water-Supply Paper 2350 (in preparation).

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 beneath local areas, may or may not be of a recurring nature.

The 12 projects described on the following pages are concerned mainly with the collection and analysis of hydrologic data and application of the results to the solution of hydrologic problems. The project number is given after each project title. The status of information products is dated October 1, 1988.

Project title: National Water Information System (MT106)

Location: Nationwide

Period of project: October 1985 through September 1989

Project Chief: Lawrence E. Cary, Billings

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

Problem: Meteorological data stored by the U.S. Geological Survey and other organizations are indexed in the Master Water Data Index of the National Water Data Exchange (NAWDEX). Meteorological data stored by the U.S. Geological Survey in the National Water Data Storage and Retrieval System (WATSTORE) are indexed in the Station Header File and the Ground-Water Site-Inventory File. These indexes are to be integrated into a single Site Index of the new National Water Information System (NWIS). The integration will require conversion to NWIS specifications, computation and validation of frequency codes, computation of frequency of collection, and validation of the period of record.

Objective(s): To make available by September 1989 the complete, efficient, tested, and documented software for the conversion and validation of the Master Water Data Index meteorological data base for storage in the NWIS.

Approach: Develop and test computer code in FORTRAN to accomplish the integration into the Master Water Data Index. Prepare a program maintenance manual, a user's manual, and an operations manual to document the program that is developed; the initial program will be developed on the District's computer. Make final testing on the AMDAHL V7 computer.

Progress during fiscal year 1988: No further progress has been made owing to delays in the completion of the preceding computer programs.

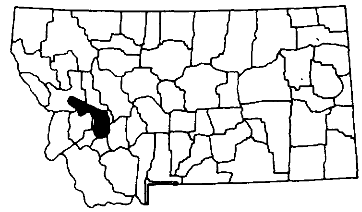
Plans for fiscal year 1989: Completely test the program. Revise the computer code if indicated by test results. Complete the draft of user's and operations manuals.

Information product(s): Cary, L.E., Program maintenance manual for the National Water Information System meteorological site index data: U.S. Geological Survey Open-File Report (planned).

_____User's manual for the National Water Information System meteorological site index data: U.S. Geological Survey Open-File Report (planned).

_____Operations manual for the National Water Information System meteorological site index data: U.S. Geological Survey Open-File Report (planned).

Project title: Upper Clark Fork Ground Water (MT107)



Location: Southwestern Montana

Period of project: October 1985 through September 1988

Project chief: Thomas D. Brooks, Helena

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

Problem: Large-scale mining activities since the 1860's have created a multitude of water-quality problems in the Clark Fork (River) basin. Acid mine drainage and transport of metal-laden tailings and ore-processing wastes combined with impacts from wood processing, domestic sewage, electrical power generation, and irrigation and livestock activities have degraded the quality of the river. Although remedial actions are being taken to improve the water quality, management of the river requires detailed knowledge of the shallow-aquifer system.

Objective(s): (1) To assess the occurrence of water in shallow aquifers along the Clark Fork from the headwaters to the confluence with the Blackfoot River near Missoula. (2) To assess the occurrence and magnitude of chemical constituents, including metals, in water in those aquifers. Specifically, the project will determine (a) characteristics of ground-water flow systems, (b) seasonal changes in the systems, (c) quality of ground water in the systems, and (d) relations between ground water and surface water.

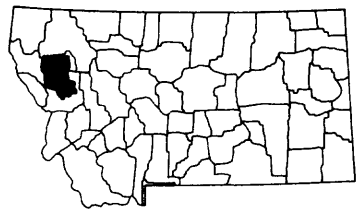
Approach: Obtain existing data from files of the U.S. Geological Survey and other Federal and State agencies. Supplement existing data by (a) selective onsite inventory of existing wells, (b) installation of test wells, (c) low-flow measurements along the upper Clark Fork, (d) establishment of a network of wells for periodic water-level measurement, and (e) establishment of a network of wells for annual water-quality sampling.

Progress during fiscal year 1988: Data were analyzed and draft report was begun.

Plans for fiscal year 1989: Complete preparation of the report and begin the review process.

Information product(s): Brooks, T.D., Hydrogeology of shallow aquifers along the upper Clark Fork, western Montana: U.S. Geological Survey Water-Resources Investigations Report (in preparation).

Project title: Flathead Indian Reservation Canal Leakage (MT108)



Location: Northwestern Montana

Period of project: October 1985 through March 1988

Project chief: Steven E. Slagle, Helena

Funding source(s): Confederated Salish and Kootenai Tribes, and U.S. Geological Survey

Problem: Most of the canals in the Flathead Irrigation Project are unlined and water losses by leakage are large, especially along reaches underlain by coarse-grained sediments. Quantitative knowledge of canal losses would provide a base for development of management plans to decrease the leakage and provide additional water for application to presently irrigated land or for expansion of irrigated acreage. However, losses from the canals recharge underlying aquifers, which supply water for domestic, stock, irrigation, and municipal supplies. Therefore, decreases in canal losses may affect ground-water users in some areas.

Objective(s): (1) To determine the magnitude and time distribution of canal leakage in representative geologic terranes within the reservation. (2) To determine the hydraulic, thermal, and geochemical effects, including introduction of pollutants, on the ground-water system near canals.

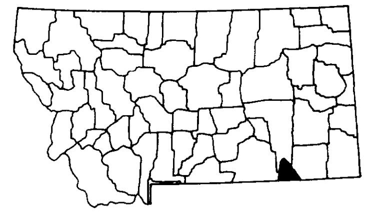
Approach: During the initial phase, review the canal system and geology, and select sites representative of typical geologic terranes. During the second phase, install (a) shallow wells to collect water samples and to monitor water-level changes and temperature gradients, (b) infiltrometers to monitor infiltration rates, and (c) continuous water-level recorders on monitoring wells and canals. During the third phase, collect data and interpret the results, including (a) monitoring of ground-water levels and canal stages, (b) monitoring of surface-water temperatures and ground-water temperature gradients, (c) collecting of water samples, and (d) conducting of tracer tests to determine rate of subsurface flow.

Progress during fiscal year 1988: Report completed, submitted to colleague review, and returned from colleague review.

Plans for fiscal year 1989: Obtain Director's approval and publish report.

Information product(s): Slagle, S.E., Irrigation-canal leakage at five sites on the Flathead Indian Reservation, northwestern Montana: U.S. Geological Survey Water-Resources Investigations Report (in review).

Project title: Hanging Woman Creek Salinity Model (MT111)



Location: Hanging Woman Creek, southeastern Montana

Period of project: October 1985 through April 1988

Project chief: Michael R. Cannon, Helena

Funding source(s): U.S. Bureau of Land Management

Problem: Hanging Woman Creek is a small stream in the Powder River Coal Region of southeastern Montana and northeastern Wyoming. Water supplies in the basin are used primarily for agriculture and are obtained from Hanging Woman Creek and shallow aquifers of coal, sandstone, and alluvium. Previous studies in the region indicate that coal mining would introduce large quantities of dissolved solids into local aquifers. Also, increased salinity would severely limit the agricultural productivity of the basin. A need exists to determine the cumulative effects of surface coal mining on dissolved solids in Hanging Woman Creek and the valley alluvium.

Objective(s): (1) To determine the pre-mining dissolved-solids load from the Hanging Woman Creek basin. (2) To determine the ground-water flow rates. (3) To determine the salinity production potential of overburden for areas of the basin that contain strippable coal. (4) To determine the quantity of dissolved solids that coal mining might add to Hanging Woman Creek and the alluvial aquifer. (5) To determine the potential post-mining load of dissolved solids from the Hanging Woman Creek basin.

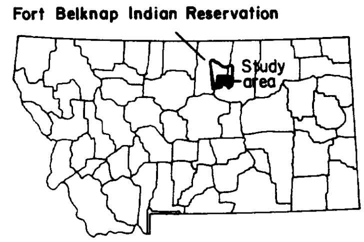
Approach: Determine pre-mining dissolved-solids loads from the basin using water discharge and quality data from Hanging Woman Creek and shallow aquifers. Determine the hydraulic conductivity and gradient of the coal beds to permit determination of ground-water flow rates. Extensively sample the overburden and analyze the results to evaluate the salinity production potential of the overburden; overburden analysis will involve batch-mixing experiments and saturated-paste extract tests. Combine the predicted dissolved-solids loads from mined lands with the pre-mining loads to evaluate post-mining concentrations of dissolved solids in Hanging Woman Creek and the alluvial aquifer.

Progress during fiscal year 1988: Saturation extracts of 158 coal-overburden samples from 29 sites were analyzed to evaluate post-mining dissolved-solids loads from mine spoils.

Plans for fiscal year 1989:: Obtain Director's approval and publish report.

Information product(s): Cannon, M.R., 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 (in preparation).

Project Title: Fort Belknap Indian Reservation Ground Water (MT112)



Location: Southern part of reservation, north-central Montana

Period of project: October 1985 through September 1990

Project chief: David W. Briar, Helena

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

Problem: Previous studies have indicated that alluvial deposits along Little Peoples Creek, Jim Brown Creek, Lodgepole Creek, and Beaver Creek near the northern flank of the Little Rocky Mountains may be a source of irrigation water. However, additional knowledge of the geologic and hydrologic framework of these aquifers and the quality of water they contain is needed for proper development.

Objective(s): To determine the potential for development of water supplies from alluvial aquifers. Specific items to be defined include: (a) the geometry of the alluvial aquifers, (b) the flow systems in the aquifers, (c) the quality of water in the alluvial aquifers, and (d) the capacity of the aquifers to yield sufficient quantities of water suitable for irrigation.

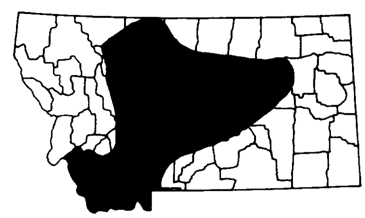
Approach: Compile existing information. Install 110 test wells to verify geometry, determine areal and vertical hydraulic-head distribution, observe water-level changes, and determine water quality and hydraulic characteristics. Use digital modeling techniques to evaluate potential stresses to the aquifers.

Progress during fiscal year 1988: Installed and tested one large-capacity well, retested four monitoring wells for aquifer characteristics, monitored water levels in all wells monthly, and installed and operated continuous water-level recorders on five wells.

Plans for fiscal year 1989: Sample 20 wells for water quality, complete data collection and interpretation, and complete the final draft of the report.

Information product(s): Briar, D.W., Geohydrology and water quality of valley-fill deposits on the Fort Belknap Indian Reservation, north-central Montana: U.S. Geological Survey Water-Resources Investigations Report (in preparation).

Project title: Upper Missouri Streamflow (MT117)



Location: Missouri River basin upstream from Fort Peck

Period of project: April 1987 through September 1989

Project chief: Charles Parrett, Helena

Funding source(s): Montana Department of Fish, Wildlife and Parks, and U.S. Geological Survey

Problem: Estimates of monthly percentile discharge at about 200 ungaged small-stream sites in the Missouri River basin upstream from Fort Peck are needed by the Montana Department of Fish, Wildlife and Parks. The estimates of monthly percentile discharge will be used to help establish an instream flow reservation for future use for fish and wildlife purposes.

Objective(s): To provide estimates of mean monthly discharge and monthly mean discharge with exceedance probabilities of 90, 80, 50, and 20 percent for each month at about 200 stream sites identified by the cooperator.

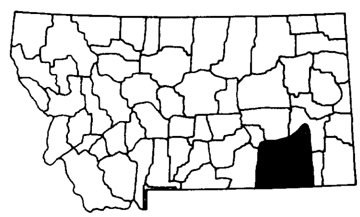
Approach: Three separate methods will be used to make about 140 of the streamflow estimates. The final estimates at each of these sites will be weighted averages of the three. One set of estimates will be based on a variation of the concurrent measurement technique, one from regression equations relating monthly flow to basin characteristics, and one from regression equations relating monthly flow to channel width. The other 60 estimates will be made using one or two methods (no streamflow measurements).

Progress during fiscal year 1988: All streamflow measurements and channel geometry measurements were completed in the Missouri River basin. Monthly streamflow estimates were completed for the upper one-half of the basin (about 170 sites).

Plans for fiscal year 1989: All monthly streamflow estimates will be completed and a report will be written summarizing results.

Information product(s): Parrett, Charles, Johnson, D.R., and Hull, J.A., Estimates of streamflow characteristics at selected sites in the upper Missouri River basin, Montana, base period water years 1937-86: U.S. Geological Survey Water-Resources Investigations Report (in preparation).

Project title: A Geographic Information System and 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: Considerable effort is required to review and compile large quantities of data available for Cumulative Hydrologic Impact Analysis (CHIA). Recent advances in computer technology make the Geographic Information System (GIS) a logical tool to surmount this problem. 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 availability and form of existing data, purchase 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, model the geochemical characteristics, and prepare report.

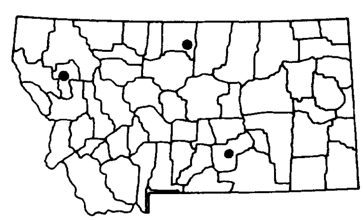
Progress during fiscal year 1988: Obtained pertinent data on coal and water resources from several sources and entered data into the GIS data base. Selected the drilling sites, drilled 16 monitor wells, and collected solid-phase samples.

Plans for fiscal year 1989: Continue to collect existing data on coal and water resources and enter data into the GIS data base. Produce maps displaying coal and water data to demonstrate capabilities of the GIS. Collect water samples, analyze solid and aqueous phase samples for chemical and mineralogic characteristics, analyze and interpret results, and prepare reports.

Information product(s): Cannon, M.R., Description of a Geographic Information System data base, southeastern Montana: U.S. Geological Survey Open-File Report (planned).

Clark, D.W., Hydrogeochemistry of mine spoils, southeastern Montana: U.S. Geological Survey Water-Resources Investigations Report (planned).

Project title: Pesticides in the Environment (MT119)



Location: Selected sites in Montana

Period of project: January 1988 through September 1989

Project chief: David W. Clark, Helena

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

Problem: Lack of knowledge about the movement and chemical fate of pesticides in the environment is considered by some as one of the top water-quality concerns in the country. Although studies have been conducted in the Midwest and other parts of the country, the magnitude of the potential for water-quality degradation in the semiarid climate and alkaline soil conditions found in areas of Montana is unknown.

Objective(s): (1) To document whether selected pesticides are present in solid-phase material above the water table and in shallow ground water. (2) To assess the persistence and mobility of the selected pesticides in the hydrologic system.

Approach: Select three sites, compile available data, install monitoring wells, sample both solid and aqueous phases, assess results, and prepare report.

Progress during fiscal year 1988: Selected three study sites, compiled available data, installed 21 monitoring wells, collected 20 solid- and aqueous-phase samples and analyzed for particular pesticides, and collected 10 ground-water samples and analyzed for inorganic constituents.

Plans for fiscal year 1989: Assess data, interpret results, and prepare report.

Information product(s): Clark, D.W., Occurrence of pesticides in ground water and soils in selected agricultual areas near Havre, Ronan, and Huntley, Montana: U.S. Geological Survey Water-Resources Investigations Report (in preparation).

Project title: Powder River Water Quality (MT121)

Location: Powder River, 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 greatest during periods of low flow, particularly during the summer irrigation season, and least during periods of high flow, such as spring runoff. Additional knowledge of the water-quality characteristics of the river system is needed for managers to evaluate the potential changes in quality resulting from hydrologic changes.

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

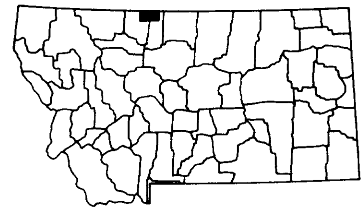
Approach: (1) Compile existing data, measure daily specific conductance of streamflow at Moorhead and Locate, and on a near-monthly basis for 18 months measure water properties and collect water samples for analysis of common ions. (2) Synoptically measure streamflow and water quality on the mainstem and significant tributaries, determine land and water use, and evaluate the data for trends. (3) Develop a conceptual hydrologic model based on available 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.

Progress during fiscal year 1988: Compiled existing water-quality data on the computer of the Wyoming District and computed the summary statistics. Began water-quality data collection in July. Preliminarily determined the mass-balance model to be used and tentatively identified the model nodes. Began compilation of land-use information.

Plans for fiscal year 1989: Continue data collection including synoptic sampling. Statistically analyze the data for trends in water-quality characteristics at major stations. Develop conceptual model. Develop regression relations required in mass-balance model. Calibrate mass-balance model. Model alternate development options. Write draft report.

Information product(s): Cary, L.E., Water quality of the Powder River, Wyoming and Montana: U.S. Geological Survey Water-Resources Investigations Report (planned).

Project title: Sweet Grass Hills Ground Water (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 about water apportionments by users in the United States and Canada. Historical stream records for these tributaries are fragmented or non-existent; therefore, costs to monitor flows and to apportion the water would be substantial. One solution to alleviate increasing water-apportionment problems is to augment surface water with ground water. However, to examine this potential solution, the hydrogeologic framework of the north flank of the Sweet Grass Hills needs to be understood.

Objective(s): To describe the hydrogeologic framework of the Sweet Grass Hills area and to determine the feasibility of using ground water to supplement surface-water resources. Specific objectives 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 from existing wells.

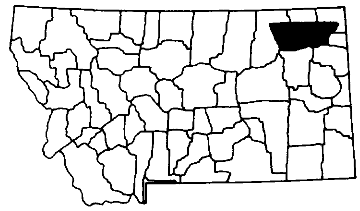
Approach: Compile information from Canadian, State, Federal, and local agencies, and from scientific literature. Obtain information on subsurface geology, aquifer geometry, and hydraulic characteristics from geophysical logs from selected files of the Montana Board of Oil and Gas Conservation. Initial onsite work will consist of well inventory and specific-capacity tests of wells. The next phase will involve synoptic samplings of water quality by means of a standard analysis of common ions and trace metals. Finally, establish a monthly monitoring-well network with digital continuous water-level recorders installed at key sites.

Progress during fiscal year 1988: Project initiated October 1988.

Plans for fiscal year 1989: (1) Complete aquifer structure-contour and thickness maps from geophysical and drillers' logs. (2) Complete well inventory and specific-capacity tests. (3) Synoptically sample for water quality. (4) Select monitoring-well network and initiate monthly water-level monitoring. (5) Install digital recorders. (6) Collect, compile, and analyze hydrogeologic data.

Information product(s): Tuck, L.K., Hydrogeologic reconniassance of the Sweet Grass Hills, north-central Montana: U.S. Geological Survey Water-Resources Investigations Report (planned).

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



Location: Northeastern Montana

Period of project: October 1988 through December 1989

Project chief: Joanna N. Thamke, Helena

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

Problem: Availability and quality of ground water on the Fort Peck Indian Reservation are of great 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 and, in recent years, some tribal residents have claimed that the quality of water from their household wells has deteriorated. If the Fort Peck Tribes are to be able to wisely manage the ground-water resource of the reservation, additional ground-water information needs to be readily accessible for use by tribal officials.

Objectives(:) To establish a network of wells that will aid in quantifying water availability from major aquifers and will help define areas of water-quality concerns.

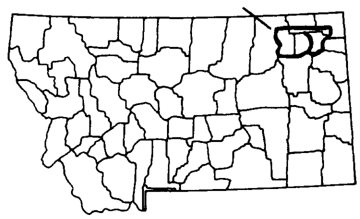
Approach: Compile existing well information from the Fort Peck Tribes Water-Resources Office and Federal and State agencies. Locate wells and compile well data. Select wells for onsite inventory, considering uniform spacial and aquifer distribution. Establish a monthly monitoring network. Obtain water 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. Prepare a data report.

Progress during fiscal year 1988: Project initiated October 1988.

Plans for fiscal year 1989: Compile existing well information. Select 100 wells for onsite inventory. Select 60 wells for monthly monitoring. Sample 20 wells for common and trace constituents, selected isotopes, and trace halides. Enter measurements into data base.

Information product(s): Thamke, J.N., Hydrogeologic data for the Fort Peck Indian Reservation, northeastern Montana: U.S. Geological Survey Open-File Report (planned).

Project title: Poplar River Flood Plain (MT124)



Location: Northeastern Montana

Period of project: October 1988 through December 1989

Project chief: Robert J. Omang, Helena

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

Problem: Areas subject to flooding along rivers need to be delineated to permit the Fort Peck Tribes to make zoning decisions concerning the location of buildings, structures, roads, or other facilities within the Fort Peck Indian Reservation.

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

Approach: Conduct a reconnaissance and survey of 48 channel and flood-plain cross sections along a 36-mile reach of the Poplar River. Determine flood-discharge frequency relations using local historical information, gaging-stations records, and existing flood-frequency reports. Determine water-surface profiles and elevations at each surveyed cross section using step-backwater models and from these elevations determine the lateral extent of the flood at each section. Furnish the results in a report.

Progress during fiscal year 1988: Project initiated October 1988.

Plans for fiscal year 1989: Survey channel and flood-plain cross sections along the Poplar River. Use a step-backwater model to calculate water-surface elevations for the 100-year flood at each surveyed cross section and determine the lateral extent of the flood at that section. Prepare a report that contains a map showing the extent of a 100-year flood.

Information product(s): Omang, R.J., Flood boundaries on the Poplar River, mouth of West Fork to Poplar, Fort Peck Indian Reservation, Montana: U.S. Geological Survey Water-Resources Investigations Report (planned).

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 investigations. 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 described below:

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 City of Helena Ground-Water Task Force; the Helena-Lewis and Clark County Solid Waste Study Committee; the Montana Bureau of Mines and Geology Advisory Board; the Water Resources Research Institute Advisory Board; and the University of Montana Geology Advisory Council.

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.

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 Geological Survey." Subscription to the pamphlet, which is issued monthly, is free upon request to the 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 the 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 the 1965 water year, however, the data were released in a new publications series, U.S. Geological Survey Water-Data Reports. This new series combines for each State: streamflow data, water-quality data for surface and ground 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 1987: U.S. Geological Survey Water-Data Report MT-87-1." 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 the Montana Bureau of Mines and Geology, Montana College of Mineral Science and Technology, Butte, MT 59701. More detailed maps, prepared as part of flood insurance studies, are available on request to the 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--NCIC
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 1984 through 1988)

Brosten, T.M., and Jacobson, M.A., 1985, Historical water-quality data for the Clark Fork (River) and the mouths of selected tributaries, western Montana: U.S. Geological Survey Open-File Report 85-168, 89 p.

Cannon, M.R., 1983, Potential effects of surface coal mining on the hydrology of the Bloomfield coal tract, Dawson County, eastern Montana: U.S. Geological Survey Water-Resources Investigations Report 83-4229, 33 p.

______1984, Potential effects of surface coal mining on the hydrology of the Circle West coal tracts, McCone County, eastern Montana: U.S. Geological Survey Water-Resources Investigations Report 84-4181, 46 p.

______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.

Cary, L.E., 1984, Application of the U.S. Geological Survey's precipitation-runoff modeling system to the Prairie Dog Creek basin, southeastern Montana: U.S. Geological Survey Water-Resources Investigations Report 84-4178, 95 p.

Davis, R.E., 1984, Example calculations of possible ground-water inflow to mine pits at the West Decker, East Decker, and proposed North Decker Mines, southeastern Montana: U.S. Geological Survey Water-Resources Investigations Report 84-4199, 31 p.

______1984, Geochemistry and geohydrology of the West Decker and Big Sky coal-mining areas, southeastern Montana: U.S. Geological Survey Water-Resources Investigations Report 83-4225, 109 p.

______1984, Geochemistry and geohydrology of the West Decker and Big Sky coal-mining areas, southeastern Montana *in* Abstracts--Rocky Mountain Ground-Water Conference, Great Falls, 1984: Montana Bureau of Mines and Geology Special Publication 91, p. 58-59.

______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.

Davis, R.E., and Rogers, G.D., 1984, Assessment of selected ground-water-quality data in Montana: U.S. Geological Survey Water-Resources Investigations Report 84-4173, 177 p.

Feltis, R.D., 1984, Map showing configuration of the top of the Madison Group, Cut Bank 1-degree by 2-degree quadrangle, Montana: Montana Bureau of Mines and Geology Geologic Map 33, 1 sheet.

______1984, Map showing configuration of the top of the Madison Group, Choteau 1-degree by 2-degree quadrangle, Montana: Montana Bureau of Mines and Geology Geologic Map 34, 1 sheet.

______1984, Map showing configuration of the top of the Madison Group, Roundup 1-degree by 2-degree quadrangle, Montana: Montana Bureau of Mines and Geology Geologic Map 35, 1 sheet.

______1984, Map showing configuration of the top of the Madison Group, Billings 1-degree by 2-degree quadrangle, Montana: Montana Bureau of Mines and Geology Geologic Map 36, 1 sheet.

______1984, Map showing configuration of the top of the Madison Group, Hardin 1-degree by 2-degree quadrangle, Montana: Montana Bureau of Mines and Geology Geologic Map 37, 1 sheet.

______1985, Map showing configuration of the top of the Madison Group, Bozeman 1-degree by 2-degree quadrangle, Montana: Montana Bureau of Mines and Geology Geologic Map 38, 1 sheet.

______1985, Map showing configuration of the top of the Madison Group, White Sulphur Springs 1-degree by 2-degree quadrangle, Montana: Montana Bureau of Mines and Geology Geologic Map 39, 1 sheet.

______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.

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., 1984, Simulated effects of surface coal mining and agriculture on dissolved solids in Rosebud Creek, southeastern Montana: U.S. Geological Survey Water-Resources Investigations Report 84-4101, 60 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., 1984, Suitability of water quality for fish propagation, waterfowl habitat, livestock watering, and recreational use at 12 reservoirs in eastern Montana: U.S. Geological Survey Water-Resources Investigations Report 84-4085, 96 p.

______1985, Simulated effects of surface coal mining and agriculture on dissolved solids in the Redwater River, east-central Montana: U.S. Geological Survey Water-Resources Investigations Report 85-4180, 69 p.

______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.

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.

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., 1985, Field guidelines for collection, treatment, and analysis of water samples, Montana District: U.S. Geological Survey Open-File Report 85-409, 86 p.

______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.

Knapton, J.R., and Horpestad, A.A., 1987, Arsenic data for streams in the upper Missouri River basin, Montana and Wyoming: U.S. Geological Survey Open-File Report 87-124, 25 p.

Knapton, J.R., Jones, W.E., and Sutphin, J.W., 1987, Reconnaissance investigation of water quality, bottom sediment, and biota associated with irrigation drainage in the Sun River area, west-central Montana, 1986-87: U.S. Geological Survey Water-Resources Investigations Report 87-4244, 78 p.

Lambing, J.H., 1983, Statistical analysis and evaluation of water-quality data for selected streams in the coal area of east-central Montana: U.S. Geological Survey Water-Resources Investigations Report 83-4224, 89 p.

______1984, Sediment yields in eastern Montana--Summary of data and proposed techniques for estimating sediment yields from small, ungaged watersheds: U.S. Geological Survey Water-Resources Investigations Report 84-4200, 45 p.

______1987, Water-quality data for the Clark Fork and selected tributaries from Deer Lodge to Milltown, Montana, March 1985 through June 1986: U.S. Geological Survey Open-File Report 87-110, 48 p.

______1988, Water quality data (July 1986 through September 1987) and statistical summaries (March 1985 through September 1987) for the Clark Fork and selected tributaries from Deer Lodge to Missoula, Montana: U.S. Geological Survey Open-File Report 88-308, 55 p.

Lambing, J.H., and Ferreira, R.F., 1986, Variability in base streamflow and water quality of streams and springs in Otter and Rosebud Creek basins, southeastern Montana: U.S. Geological Survey Water-Resources Investigations Report 85-4302, 49 p.

Lambing, J.H., Jones, W.E., and Sutphin, J.W., 1987, Reconnaissance investigation of water quality, bottom sediment, and biota associated with irrigation drainage in Bowdoin National Wildlife Refuge and adjacent areas of the Milk River basin, northeastern Montana, 1986-87: U.S. Geological Survey Water-Resources Investigations Report 87-4243, 71 p.

Lambing, J.H., and others, 1987, Hydrology of Area 43, Northern Great Plains and Rocky Mountain Coal Provinces, Montana: U.S. Geological Survey Water-Resources Investigations Open-File Report 85-88, 95 p.

Leonard, R.B., and Wood, W.A., 1988, Evaluation of a hydrothermal anomaly near Ennis, Montana: U.S. Geological Survey Professional Paper 1044-K, 53 p.

Levings, G.W., 1984, Reconnaissance evaluation of contamination in the alluvial aquifer in the East Poplar Oil Field, Roosevelt County, Montana: U.S. Geological Survey Water-Resources Investigations Report 84-4174, 29 p.

______1985, Selected hydrogeologic data for the Big Muddy Creek valley near Plentywood, northeastern Montana: U.S. Geological Survey Open-File Report 85-406, 22 p.

______1986, Preliminary appraisal of ground water in and near the ancestral Missouri River valley, northeastern Montana: U.S. Geological Survey Water-Resources Investigations Report 86-4138, 41 p.

Levings, G.W., Ferreira, R.F., and Lambing, J.H., 1984, Water resources of Lake Creek Valley, northwestern Montana: Montana Bureau of Mines and Geology Memoir 56, 81 p.

Levings, J.F., 1985, Hydrogeologic data related to the potential for stock-water development on federally owned rangeland near Dillon, Montana: U.S. Geological Survey Open-File Report 85-170, 22 p.

______1986, Water resources of the Clarks Fork Yellowstone River valley, Montana: Montana Bureau of Mines and Geology Hydrogeologic Map 8, 3 sheets.

______1986, Water resources of the Big Hole basin, southwestern Montana: Montana Bureau of Mines and Geology Memoir 59, 72 p.

Levings, J.F., Davis, R.E., and Parrett, Charles, 1985, Montana ground-water resources *in* National water summary 1984--Hydrologic events, selected water-quality trends, and ground-water resources: U.S. Geological Survey Water-Supply Paper 2275, p. 285-290.

McClymonds, N.E., 1984, Potential effects of surface coal mining on the hydrology of the Corral Creek area, Hanging Woman Creek coal field, southeastern Montana: U.S. Geological Survey Water-Resources Investigations Report 83-4260, 53 p.

______1984, Potential effects of surface coal mining on the hydrology of the West Otter area, Ashland and Birney-Broadus coal fields, southeastern Montana: U.S. Geological Survey Water-Resources Investigations Report 84-4087, 70 p.

______1985, Potential effects of surface coal mining on the hydrology of the Horse Creek area, Sheridan and Moorhead coal fields, southeastern Montana: U.S. Geological Survey Water-Resources Investigations Report 84-4239, 61 p.

______1985, Potential effects of surface coal mining on the hydrology of the Little Bear Creek area, Moorhead coal field, southeastern Montana: U.S. Geological Survey Water-Resources Investigations Report 85-4201, 91 p.

Moreland, J.A., Liebscher, Hugh, Van Voast, W.A., and Feltis, R.D., 1987, Ground water-surface water relations in the Flathead River valley near the proposed Cabin Creek coal mine, British Columbia, Canada: U.S. Geological Survey Open-File Report 87-28, 20 p.

Omang, R.J., 1984, Streamflow characteristics of the Yellowstone River basin, Montana, through September 1982: U.S. Geological Survey Water-Resources Investigations Report 84-4063, 78 p.

Omang, R.J., and Parrett, Charles, 1984, A method for estimating mean annual runoff of ungaged streams based on basin characteristics in central and eastern Montana: U.S. Geological Survey Water-Resources Investigations Report 84-4143, 15 p.

Omang, R.J., Parrett, Charles, and Hull, J.A., 1986, Methods for estimating magnitude and frequency of floods in Montana based on data through 1983: U.S. Geological Survey Water-Resources Investigations Report 86-4027, 85 p.

Parrett, Charles, 1985, Streamflow characteristics of mountain streams in the upper Yellowstone River basin in Montana: Montana Department of Natural Resources and Conservation, Energy Division, 22 p.

______1986, Simulation of rain floods on Willow Creek, Valley County, Montana: U.S. Geological Survey Water-Resources Investigations Report 86-4341, 89 p.

Parrett, Charles, Carlson, D.D., Craig, G.S., and Chin, E.H., 1984, Floods of May 1978 in southeastern Montana and northeastern Wyoming: U.S. Geological Survey Professional Paper 1244, 74 p.

Parrett, Charles, and Hull, J.A., 1985, A method for estimating mean and low flows of streams in national forests of Montana: U.S. Geological Survey Water-Resources Investigations Report 85-4071, 13 p.

______1985, Streamflow characteristics of mountain streams in western Montana: U.S. Geological Survey Water-Supply Paper 2260, 58 p.

______1986, Estimated monthly percentile discharges at ungaged sites in the upper Yellowstone River basin in Montana: U.S. Geological Survey Water-Resources Investigations Report 86-4009, 34 p.

Parrett, Charles, Hull, J.A., and Omang, R.J., 1987, Revised techniques for estimating peak discharges from channel width in Montana: U.S. Geological Survey Water-Resources Investigations Report 87-4121, 34 p.

Parrett, Charles, and Johnson, D.R., 1988, Estimation of surface-water withdrawals for irrigation and irrigated acreage, 1985, Gallatin County, Montana *in* Symposium on Water-Use Data for Water Resources Management, Tucson, Ariz., 1988, Proceedings: p. 641-647.

Parrett, Charles, and Omang, R.J., 1986, Montana surface-water resources, *in* National water summary 1985--Hydrologic events and surface-water resources: U.S. Geological Survey Water-Supply Paper 2300, p. 309-314.

Roberts, R.S., 1984, Water-resources investigations of the U.S. Geological Survey in Montana, October 1983 through September 1984: U.S. Geological Survey Open-File Report 84-435, 44 p.

______1986, Water-resources activities of the U.S. Geological Survey in Montana, October 1985 through September 1986: U.S. Geological Survey Open-File Report 86-421W, 81 p.

______1987, Selected hydrogeologic data for the Southwest Glendive Preliminary Logical Mining Unit and adjacent areas, Dawson County, Montana: U.S. Geological Survey Open-File Report 87-390, 34 p.

Shields, R.R., Knapton, J.R., White, M.K., Jacobson, M.A., and Kasman, M.L., 1984, Water resources data, Montana, Water year 1983, v. 1, Hudson Bay basin and Missouri River basin: U.S. Geological Survey Water-Data Report MT-83-1, 585 p.

______1984, Water resources data, Montana, water year 1983, v. 2, Columbia River basin: U.S. Geological Survey Water-Data Report MT-83-2, 192 p.

______1985, Water resources data, Montana, water year 1984, v. 1, Hudson Bay basin and Missouri River basin: U.S. Geological Survey Water-Data Report MT-84-1, 589 p.

______1985, Water resources data, Montana, water year 1984, v. 2, Columbia River basin: U.S. Geological Survey Water-Data Report MT-84-2, 169 p.

Shields, R.R., Knapton, J.R., White, M.K., Brosten, T.M., and Kasman, M.L., 1986, Water resources data, Montana, water year 1985, v. 1, Hudson Bay basin and Missouri River basin: U.S. Geological Survey Water-Data Report MT-85-1, 483 p.

______1986, Water resources data, Montana, water year 1985, v. 2, Columbia River basin: U.S. Geological Survey Water-Data Report MT-85-2, 180 p.

Shields, R.R., Knapton, J.R., White, M.K., Brosten, T.M., and Lambing, J.H., 1987, Water resources data, Montana, water year 1986, v. 1, Hudson Bay basin and Missouri River basin: U.S. Geological Survey Water-Data Report MT-86-1, 437 p.

______1987, Water resources data, Montana, water year 1986, v. 2, Columbia River basin: U.S. Geological Survey Water Data Report MT-86-2, 170 p.

______1988, Water resources data, Montana, water year 1987, v. 1, Hudson Bay basin and Missouri River basin: U.S. Geological Survey Water-Data Report MT-87-1, 432 p.

______1988, Water resources data, Montana, water year 1987, v. 2, Columbia River basin: U.S. Geological Survey Water-Data Report MT-87-2, 176 p.

Shields, R.R., and White, M.K., 1985, Uses, funding, and availability of continuous streamflow data in Montana: U.S. Geological Survey Open-File Report 84-862, 61 p.

Slagle, S.E., 1983, Water resources of the Fort Union coal region, east-central Montana: U.S. Geological Survey Water-Resources Investigations Report 83-4151, 37 p.

______1988, Geohydrology of the Flathead Indian Reservation, northwestern Montana: U.S. Geological Survey Water-Resources Investigations Report 88-4142, 119 p.

Slagle, S.E., Lewis, B.D., and Lee, R.W., 1985, Ground-water resources and potential hydrologic effects of surface coal mining in the northern Powder River Basin, southeastern Montana: U.S. Geological Survey Water-Supply Paper 2239, 35 p.

Slagle, S.E., and others, 1984, Hydrology of Area 45, Northern Great Plains and Rocky Mountain Coal Provinces, Montana and North Dakota: U.S. Geological Survey Water-Resources Investigations Open-File Report 83-527, 90 p.

______1984, Hydrology of Area 48, Northern Great Plains and Rocky Mountain Coal Provinces, Montana and Wyoming: U.S. Geological Survey Water-Resources Investigations Open-File Report 84-141, 91 p.

Thompson, R.E., Jr., 1986, Natural flow and water consumption in the Milk River basin, Montana and Alberta, Canada: U.S. Geological Survey Water-Resources Investigations Report 86-4006, 40 p.

U.S. Geological Survey, 1984, National water summary 1983--Hydrologic events and issues: U.S. Geological Survey Water-Supply Paper 2250, 243 p.

Wood, W.A., 1984, Hydrogeologic data for selected test wells drilled in the Fort Union coal region, eastern Montana: U.S. Geological Survey Open-File Report 84-464, 63 p.

Yellowstone River Compact Commission, 1983, Thirty-second annual report, Yellowstone River Compact Commission: Annual report, 22 p.

______1984, Thirty-third annual report, Yellowstone River Compact Commission: Annual report, 22 p.

______1985, Thirty-fourth annual report, Yellowstone River Compact Commission: Annual report, 27 p.

______1986, Thirty-fifth annual report, Yellowstone River Compact Commission: Annual report, 27 p.

______1987, Thirty-sixth annual report, Yellowstone River Compact Commission: Annual report, 27 p.

Table 1.--*Surface-water gaging stations in operation, October 1988*

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
BLM	U.S. Bureau of Land Management
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 Indian 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
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WSE	Wyoming State Engineer
WWT	U.S. Department of State-International Joint Commission, Waterways Treaty

Gage equipment

A - Thermograph recorder
B - Minimonitor
C - DCP (data-collection platform)
D - Digital recorder
G - Graphic recorder
M - Manometer (bubbler) gage
O - Observer record only
P - Electrical power
R - Rain gage
S - Selsyn unit
T - Telemark, BDT (binary decimal transmitter)
U - Other agency Telemark
W - Well gage

Table 1.--*Surface-water gaging stations in operation, October 1988*--Continued

Station number	Station name	Funding source	Gage equipment
	Part 5		
05014500	Swiftcurrent Creek at Many Glacier	USGS	GPW
05015500	Lake Sherburne at Sherburne	WWT	GMP
05016000	Swiftcurrent Creek at Sherburne	WWT	DGPW
05017500	St. Mary River near Babb	WWT	GW
05018500	St. Mary Canal at St. Mary Crossing, near Babb	WWT	CDW
05020500	St. Mary River at international boundary	WWT	CGPUW
	Part 6		
06007000	Tom Creek near Lakeview	USFWS	0
06010600	Red Rock River at Brundage Bridge, near Lakeview	USFWS	0
06012000	Lima Reservoir near Monida	MDNRC	0
06012500	Red Rock River below Lima, near Monida	USBR	CDGW
06015300	Clark Canyon Reservoir near Grant	USGS	CG
06016000	Beaverhead River at Barretts	USBR	DGPW
06018500	Beaverhead River near Twin Bridges	USGS	CDGPW
06019500	Ruby River above reservoir, near Alder	MDNRC	DGW
06020500	Ruby River Reservoir near Alder	MDNRC	0
06020600	Ruby River below reservoir, near Alder	MDNRC	DW
06024450	Big Hole River below Big Lake Creek, at Wisdom	MDFWP	ADGM
06025500	Big Hole River near Melrose	MDNRC	ADGPW
06033000	Boulder River near Boulder	MDNRC	DGW
06035000	Willow Creek near Harrison	MDNRC	DGW
06036000	Willow Creek Reservoir near Harrison	MDNRC	0
06036650	Jefferson River near Three Forks	MDFWP	CDGMPR
06036905	Firehole River near West Yellowstone	NPS	ADGM
06037000	Gibbon River near West Yellowstone	NPS	ADGM
06038000	Hebgen Lake near West Yellowstone	FERC	0
06038500	Madison River below Hebgen Lake, near Grayling	FERC	CDGPW
06038800	Madison River at Kirby Ranch, near Cameron	MDFWP	0
06040500	Ennis Lake near McAllister	FERC	0
06041000	Madison River below Ennis Lake, near McAllister	FERC	ACDGPSW
06043500	Gallatin River near Gallatin Gateway	MDFWP	DGTW
06049500	Middle Creek Reservoir near Bozeman	MDNRC	0
06050000	Hyalite Creek at Hyalite Ranger Station, near Bozeman	MDNRC	DGPW
06052500	Gallatin River at Logan	USAE	CDGPW
06054500	Missouri River at Toston	MDNRC	ACDGPRW
06058500	Canyon Ferry Lake near Helena	USGS	GPSW
06058600	Helena Valley Reservoir	USBR	0

Table 1.--*Surface-water gaging stations in operation, October 1988*--Continued

Station number	Station name	Funding source	Gage equipment
	Part 6--Continued		
06061500	Prickly Pear Creek near Clancy	MDNRC	DGW
06062500	Tenmile Creek near Rimini	CH	DGPW
06064500	Lake Helena near Helena	FERC	O
06065000	Hauser Lake near Helena	FERC	O
06066000	Holter Lake near Wolf Creek	FERC	O
06066500	Missouri River below Holter Dam, near Wolf Creek	FERC	DGPSW
06075000	Smith River Reservoir near White Sulphur Springs	MDNRC	O
06076690	Smith River near Fort Logan	MDFWP	CDGMR
06078200	Missouri River near Ulm	USAE	CDGRW
06079500	Gibson Reservoir near Augusta	MDNRC	O
06080500	Pishkun Reservoir near Augusta	MDNRC	O
06082000	Willow Creek Reservoir near Augusta	MDNRC	O
06083000	Nilan Reservoir near Augusta	MDNRC	O
06088500	Muddy Creek at Vaughn	USGS	DGM
06089000	Sun River near Vaughn	FERC	CDGPRW
06090300	Missouri River near Great Falls	FERC	DGMPS
06090800	Missouri River at Fort Benton	USGS	DGPTW
06090900	Lower Two Medicine Lake near East Glacier	MDNRC	O
06091700	Two Medicine River below South Fork, near Browning	BIA	DGM
06091800	Two Medicine Canal near Browning	BIA	DW
06092600	Four Horns Canal near Browning	BIA	GW
06093000	Four Horns Lake near Heart Butte	MDNRC	O
06093200	Badger Creek below Four Horns Canal, near Browning	BIA	DGPW
06094000	Swift Reservoir near Dupuyer	MDNRC	O
06095500	Lake Frances near Valier	MDNRC	O
06099000	Cut Bank Creek at Cut Bank	BIA	DGM
06099500	Marias River near Shelby	USGS	CDGMP
06101300	Lake Elwell near Chester	USGS	O
06101500	Marias River near Chester	USBR	CDW
06108000	Teton River near Dutton	USGS	DGMP
06109500	Missouri River at Virgelle	USAE	CDGPRW
06110500	Ackley Lake near Hobson	MDNRC	O
06115200	Missouri River near Landusky	USGS	CDGMPRW
06116500	Bair Reservoir near Delpine	MDNRC	O
06119000	Martinsdale Reservoir near Martinsdale	MDNRC	O
06120500	Musselshell River at Harlowton	MDNRC	DCTW
06122500	Deadmans Basin Reservoir near Shawmut	MDNRC	O
06122800	Musselshell River near Shawmut	MDNRC	GW
06126470	Half Breed Creek near Klein	MBMG	DGM

Table 1.--*Surface-water gaging stations in operation, October 1988*--Continued

Station number	Station name	Funding source	Gage equipment
	Part 6--Continued		
06126500	Musselshell River near Roundup	MDNRC	CDGPRW
06127500	Musselshell River at Musselshell	MDNRC	DGW
06130500	Musselshell River at Mosby	USAE	DGM
06131000	Big Dry Creek near Van Norman	USAE, USGS	CDGMR
06131120	Timber Creek near Van Norman	BLM	GM
06131500	Fort Peck Lake at Fort Peck	USAE	O
06131800	Missouri River stage station No. 1 near Fort Peck	USAE	DPW
06132000	Missouri River below Fort Peck Dam	USAE	DGM
06132200	South Fork Milk River near Babb	WWT	GPW
06133000	Milk River at western crossing of international boundary	WWT	CGW
06133500	North Fork Milk River above St. Mary Canal, near Browning	WWT	CGPW
06134000	North Milk River near international boundary	WWT	CGW
06134500	Milk River at Milk River, Alberta	WWT	CGPUW
06134700	Verdigris Coulee near mouth, near Milk River	WWT	CGW
06135000	Milk River at eastern crossing of international boundary	WWT	CDGPTW
06136500	Fresno Reservoir near Havre	MDNRC	O
06137400	Big Sandy Creek at reservation boundary, near Rocky Boy	BIA	DGM
06137570	Boxelder Creek near Rocky Boy	BIA	DGPW
06137580	Sage Creek near Whitlash	MDNRC	DGM
06139500	Big Sandy Creek near Havre	BIA	CGW
06140500	Milk River at Havre	USAE	DGM
06141600	Little Boxelder Creek at mouth, near Havre	MDNRC	DW
06142400	Clear Creek near Chinook	BIA	CGW
06144260	Altawan Reservoir near Govenlock, Saskatchewan	WWT	GM
06144270	Spangler Ditch near Govenlock, Saskatchewan	WWT	GW
06144350	Middle Creek near Saskatchewan boundary	WWT	GW
06144360	Middle Creek Reservoir near Battle Creek, Saskatchewan	WWT	GM
06144395	Middle Creek below Middle Creek Reservoir, near Govenlock, Saskatchewan	WWT	GW
06144440	Middle Creek near Govenlock, Saskatchewan	WWT	GW
06144450	Middle Creek above Lodge Creek	WWT	GW
06145500	Lodge Creek below McRae Creek, at international boundary	WWT	GPUW
06147950	Gaff Ditch near Merryflat, Saskatchewan	WWT	GW
06148500	Cypress Lake west inflow canal near West Plains, Saskatchewan	WWT	GW
06148700	Cypress Lake west inflow canal drain near Oxarat, Saskatchewan	WWT	GW

Table 1.--*Surface-water gaging stations in operation, October 1988*--Continued

Station number	Station name	Funding source	Gage equipment
	Part 6--Continued		
06149000	Cypress Lake west outflow canal near West Plains, Saskatchewan	WWT	GPW
06149100	Vidora Ditch near Consul, Saskatchewan	WWT	GW
06149200	Richardson Ditch near Consul, Saskatchewan	WWT	GW
06149300	McKinnon Ditch near Consul, Saskatchewan	WWT	GW
06149400	Nashlyn Canal near Consul, Saskatchewan	WWT	GW
06149500	Battle Creek at international boundary	WWT	GW
06151000	Lyons Creek at international boundary	WWT	GW
06151500	Battle Creek near Chinook	BIA	CGM
06154000	Milk River 'A' Canal near Harlem	BIA	GW
06154100	Milk River near Harlem	MDNRC	CDGM
06154140	Fifteenmile Creek tributary near Harlem	BIA	GW
06154400	Peoples Creek near Hays	BIA	DGW
06154410	Little Peoples Creek near Hays	USGS	DGM
06154430	Lodge Pole Creek at Lodge Pole	BIA	GW
06154490	Willow Coulee near Dodson	BIA	GM
06154500	Peoples Creek near Dodson	BIA	DGMW
06154510	Kuhr Coulee tributary near Dodson	BIA	GM
06154550	Peoples Creek below Kuhr Coulee, near Dodson	BIA	DGM
06155000	Nelson Reservoir near Saco	MDNRC	O
06155030	Milk River near Dodson	MDNRC	DGM
06156500	Belanger Creek diversion canal near Vidora, Saskatchewan	WWT	GPW
06157000	Cypress Lake near Vidora, Saskatchewan	WWT	GM
06157500	Cypress Lake east outflow canal near Vidora, Saskatchewan	WWT	GPW
06158500	Eastend Canal at Eastend, Saskatchewan	WWT	GW
06159000	Eastend Reservoir at Eastend, Saskatchewan	WWT	GM
06159500	Frenchman River below Eastend Reservoir, near Eastend, Saskatchewan	WWT	GPW
06161300	Huff Lake pumping canal near Val Marie, Saskatchewan	WWT	GW
06161500	Huff Lake gravity canal near Val Marie, Saskatchewan	WWT	GW
06162000	Huff Lake Reservoir near Val Marie, Saskatchewan	WWT	GM
06162500	Newton Lake main canal near Val Marie, Saskatchewan	WWT	GW
06163000	Newton Lake near Val Marie, Saskatchewan	WWT	GM
06163050	Frenchman River below Newton Lake, near Val Marie, Saskatchewan	WWT	GW
06164000	Frenchman River at international boundary	WWT	GPTW
06164510	Milk River at Juneberg Bridge, near Saco	USGS	CDGMPR
06164590	Beaver Creek near Zortman	BIA	DGM
06164615	Little Warm Creek at reservation boundary, near Zortman	BIA	DGM

Table 1.--*Surface-water gaging stations in operation, October 1988*--Continued

Station number	Station name	Funding source	Gage equipment
	Part 6--Continued		
06164623	Little Warm Creek tributary near Lodge Pole	BIA	GW
06166000	Beaver Creek below Guston Coulee, near Saco	USGS	GM
06169500	Rock Creek below Horse Creek, near international boundary	USGS	DGPW
06172310	Milk River at Tampico	MDNRC	DGM
06174500	Milk River at Nashua	USAE	CDGMPW
06175000	Porcupine Creek at Nashua	BIA	GM
06175100	Missouri River stage station No. 3 at West Frazer pumping plant, near Frazer	USAE	DPW
06175510	Missouri River stage station No. 4 at East Frazer pumping plant, near Frazer	USAE	DPW
06175520	Missouri River stage station No. 5 near Oswego	USAE	GM
06176500	Wolf Creek near Wolf Point	BIA	GMW
06177000	Missouri River near Wolf Point	USAE	CDGMP
06177500	Redwater River at Circle	BLM	DGPW
06178000	Poplar River at international boundary	USGS	CDGMPW
06178500	East Poplar River at international boundary	MDNRC	CDGPW
06181000	Poplar River near Poplar	BIA	DGW
06181995	Beaver Creek at international boundary	WWT	GPW
06183450	Big Muddy Creek near Antelope	USGS	DGMP
06183700	Big Muddy Creek diversion canal near Medicine Lake	USGS	DGM
06183750	Lake Creek near Dagmar	USFWS	GW
06183800	Cottonwood Creek near Dagmar	USFWS	GW
06183850	Sand Creek near Dagmar	USFWS	GW
06185110	Big Muddy Creek near mouth, near Culbertson	BIA	GM
06185500	Missouri River near Culbertson	USAE	CDGMR
06187950	Soda Butte Creek near Lamar Ranger Station, Yellowstone National Park	USGS	DGM
06188000	Lamar River near Tower Falls Ranger Station, Yellowstone National Park	NPS	DGMO
06189000	Blacktail Deer Creek near Mammoth	USGS	DGM
06190370	Gardiner River above Mammoth Springs outflow, near Mammoth	USGS	O
06190415	Mammoth Springs outflow at Mammoth	USGS	O
06190540	Hot River at Mammoth	USGS	BDGW
06191000	Gardiner River near Mammoth	USGS	DGW
06191400	La Duke Hot Springs near Corwin Springs	USGS	O
06191500	Yellowstone River at Corwin Springs	USAE	CDGPW
06192500	Yellowstone River near Livingston	USAE	DGPTW
06195600	Shields River near Livingston	MDFWP	DGM
06200000	Boulder River at Big Timber	MDNRC	DGPTW
06202510	Stillwater River above Nye Creek, near Nye	MDFWP	O

Table 1.--*Surface-water gaging stations in operation, October 1988*--Continued

Station number	Station name	Funding source	Gage equipment
	Part 6--Continued		
06204000	Mystic Lake near Roscoe	FERC	O
06204050	West Rosebud Creek near Roscoe	FERC	DGPW
06205000	Stillwater River near Absarokee	USAE	DGMTW
06207500	Clarks Fork Yellowstone River near Belfry	MDNRC	DGMW
06208500	Clarks Fork Yellowstone River at Edgar	MDNRC, WSE	DGW
06211000	Red Lodge Creek above Cooney Reservoir, near Boyd	MDNRC	DGW
06211500	Willow Creek near Boyd	MDNRC	DGW
06212000	Cooney Reservoir near Boyd	MDNRC	O
06212500	Red Lodge Creek below Cooney Reservoir, near Boyd	MDNRC	DPW
06214000	Rock Creek at Rockvale	MDNRC	DGM
06214500	Yellowstone River at Billings	USAE	CDGPRTW
06216000	Pryor Creek at Pryor	USGS	DPW
06216900	Pryor Creek near Huntley	USGS	DGM
06286400	Bighorn Lake near St. Xavier	USGS	GW
06286490	Bighorn Canal near St. Xavier	USBR	GPW
06287000	Bighorn River near St. Xavier	USBR	CDGPW
06289000	Little Bighorn River at State line, near Wyola	USGS	DGW
06290000	Pass Creek near Wyola	BIA	DGM
06290500	Little Bighorn River below Pass Creek, near Wyola	USGS	DGW
06291000	Owl Creek near Lodge Grass	BIA	DGM
06291500	Lodge Grass Creek above Willow Creek diversion, near Wyola	BIA	DGM
06294000	Little Bighorn River near Hardin	MDNRC, WSE	DW
06294500	Bighorn River above Tullock Creek, near Bighorn	MDNRC, WSE	CDGMR
06295000	Yellowstone River at Forsyth	USBR	DGMP
06295100	Rosebud Creek near Kirby	BLM	GW
06295113	Rosebud Creek at reservation boundary, near Kirby	USGS	GM
06295250	Rosebud Creek near Colstrip	BIA	DGM
06296003	Rosebud Creek at mouth, near Rosebud	BLM	DGM
06306300	Tongue River at State line, near Decker	MDNRC	DGPW
06307000	Tongue River Reservoir near Decker	MDNRC	O
06307500	Tongue River at Tongue River Dam, near Decker	MDNRC	DGW
06307600	Hanging Woman Creek near Birney	BLM	DW
06307616	Tongue River at Birney Day School Bridge, near Birney	USGS	DPW
06307740	Otter Creek at Ashland	BLM	DGW
06308500	Tongue River at Miles City	MDNRC, WSE	CDGMR

Table 1.--*Surface-water gaging stations in operation, October 1988*--Continued

Station number	Station name	Funding source	Gage equipment
	Part 6--Continued		
06309000	Yellowstone River at Miles City	USAE	CDGMPR
06324500	Powder River at Moorhead	MDNRC	DGPW
06324710	Powder River at Broadus	MDNRC	DGM
06326500	Powder River near Locate	MDNRC, WSE	CDGMPR
06326600	O'Fallon Creek near Ismay	MDNRC	DGM
06326952	Clear Creek near Lindsay	BLM	GW
06329500	Yellowstone River near Sidney	USAE	CDGMP
	Part 12		
12301300	Tobacco River near Eureka	USAE	GW
12301920	Lake Koocanusa near Libby	USAE	GW
12301933	Kootenai River below Libby Dam, near Libby	USAE	CDGMP
12302055	Fisher River near Libby	USAE	DCGPW
12303000	Kootenai River at Libby	USAE	DGPTW
12303100	Flower Creek near Libby	FLRES	GW
12303500	Lake Creek at Troy	FERC	DGMP
12304500	Yaak River near Troy	USAE	DCGPW
12323170	Silver Bow Creek above Blacktail Creek, at Butte	MBMG	DGWP
12323200	Blacktail Creek near Butte	MBMG	DGM
12323240	Blacktail Creek at Butte	MBMG	DGM
12323250	Silver Bow Creek below Blacktail Creek, at Butte	MBMG	DGM
12323600	Silver Bow Creek at Opportunity	EPA	GW
12323770	Warm Springs Creek at Warm Springs	MDFWP	DGW
12323800	Clark Fork near Galen	EPA	DGPTW
12324200	Clark Fork at Deer Lodge	MDFWP	DGM
12324590	Little Blackfoot River near Garrison	MDNRC	DGM
12324680	Clark Fork at Goldcreek	MDFWP	DGM
12325000	Georgetown Lake near Southern Cross	FERC	O
12325500	Flint Creek near Southern Cross	FERC	DW
12329500	Flint Creek at Maxville	MDNRC	DGW
12330000	Boulder Creek at Maxville	MDNRC	DGW
12331900	Clark Fork near Clinton	MDFWP	O
12332000	Middle Fork Rock Creek near Philipsburg	MDNRC	DGW
12332500	East Fork Rock Creek Reservoir near Philipsburg	MDNRC	O
12334510	Rock Creek near Clinton	MDNRC	CDGPW
12334550	Clark Fork at Turah Bridge, near Bonner	EPA	DGM
12335500	Nevada Creek above reservoir, near Finn	MDNRC	DGM
12336500	Nevada Lake near Finn	MDNRC	O
12339450	Clearwater River near Clearwater	FLRES	DGW
12340000	Blackfoot River near Bonner	USGS	DGPTW
12340500	Clark Fork above Missoula	USAE	DGPTW

Table 1.--*Surface-water gaging stations in operation, October 1988*--Continued

Station number	Station name	Funding source	Gage equipment
	Part 12--Continued		
12342000	Painted Rocks Lake near Conner	MDNRC	0
12342500	West Fork Bitterroot River near Conner	MDNRC	DGPW
12344000	Bitterroot River near Darby	MDNRC	CDGPW
12344500	Lake Como near Darby	MDNRC	0
12350250	Bitterroot River at Bell Crossing, near Victor	MDFWP	DGM
12353000	Clark Fork below Missoula	MDHES	DGPTW
12354500	Clark Fork at St. Regis	BPA,USGS	CDGPW
12355000	Flathead River at Flathead, British Columbia	WWT	ACGM
12355150	Tuchuck Creek near Flathead, British Columbia	MBMG	GW
12355500	North Fork Flathead River near Columbia Falls	USGS	ACGM
12358500	Middle Fork Flathead River near West Glacier	BPA	CGPW
12359800	South Fork Flathead River above Twin Creek	USBR	CGW
12362000	Hungry Horse Reservoir near Hungry Horse	USBR	CGW
12362500	South Fork Flathead River near Columbia Falls	USBR	ACDGPSW
12363000	Flathead River at Columbia Falls	FERC	ACDGPTW
12365000	Stillwater River near Whitefish	MDNRC	GW
12366000	Whitefish River near Kalispell	MDNRC	GW
12369200	Swan River near Condon	FLRES	GW
12370000	Swan River near Bigfork	MDNRC	DGW
12371500	Flathead Lake at Somers	FERC	GW
12372000	Flathead River near Polson	FERC	DGPSW
12374250	Mill Creek above Bassoo Creek, near Niarada	FLRES	GM
12374800	Cromwell Creek near Niarada	FLRES	GM
12375900	South Fork Crow Creek near Ronan	FLRES	DGM
12377150	Mission Creek above reservoir, near St. Ignatius	FLRES	DGM
12380500	Lower Jocko Lake near Arlee	BIA	0
12381400	South Fork Jocko River near Arlee	FLRES	DGM
12383500	Big Knife Creek near Arlee	FLRES	DGM
12387450	Valley Creek near Arlee	FLRES	GW
12388400	Revais Creek below West Fork, near Dixon	FLRES	DGM
12388700	Flathead River at Perma	FLRES	DGMP
12389000	Clark Fork near Plains	FERC	DGPTW
12389500	Thompson River near Thompson Falls	FERC	GPW
12390000	Thompson Falls Reservoir at Thompson Falls	FERC	0
12390700	Prospect Creek at Thompson Falls	FERC	GPW
12391300	Noxon Rapids Reservoir near Noxon	FERC	GW
12391400	Clark Fork below Noxon Rapids Dam, near Noxon	FERC	0

Table 2.--*Crest-stage stations in operation, October 1988*

[The stations are funded cooperatively by the Montana Department of Highways, the Federal Highway Administration of the U.S. Department of Transportation, the Forest Service of the U.S. Department of Agriculture, and the U.S. Geological Survey]

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 stations in operation, October 1988*--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	1957-
06031950	Cataract Creek near Basin	1973-
06038550	Cabin Creek near West Yellowstone	1974-
06043300	Logger Creek near Gallatin Gateway	1959-
06046500	Rocky Creek (head of East Gallatin River) near Bozeman	1951-
06053050	Lost Creek near Ringling	1974-
06055500	Crow Creek near Radersburg	1919-29, 1966-
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 Virgelle	1972-
06109560	Alkali Coulee tributary near Virgelle	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	Dirty Creek near Martinsdale	1972-

Table 2.--*Crest-stage stations in operation, October 1988*--Continued

Station number	Station name	Records available
	Part 6--Continued	
06120800	Antelope Creek tributary No. 2 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 Living Springs	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 Flatwillow	1974-
06128500	South Fork Bear Creek tributary near Roy	1962-
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-
06131120	Timber Creek near Van Norman	1982-
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	Murray Coulee tributary near Hogeland	1974-
06156100	Lush Coulee near Whitewater	1972-
06164600	Beaver Creek tributary near Zortman	1974-
06165200	Beaver Creek tributary No. 2 near Malta	1974-
06172300	Unger Creek near Vandalia	1958-
06173300	Willow Creek tributary near Fort Peck	1972-

Table 2.--*Crest-stage stations in operation, October 1988*--Continued

Station number	Station name	Records available
	Part 6--Continued	
06174300	Milk River tributary No. 3 near Glasgow	1974-
06174600	Snow Coulee at Opheim	1972-
06175700	East Fork Wolf Creek near Lustre	1955-
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	Wolf Creek tributary near Vida	1962-
06177820	Horse Creek tributary near Richey	1974-
06179100	Butte Creek tributary near Four Buttes	1972-
06183300	Spring Creek 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-
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	1960-
06296100	Snell Creek near Hathaway	1963-
06296115	Reservation Creek near Miles City	1973-
06306950	South Fork Leaf Rock Creek near Kirby	1959-
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-

Table 2.--*Crest-stage stations in operation, October 1988*--Continued

Station number	Station name	Records available
	Part 6--Continued	
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 near Baker	1962-
06326940	Spring Creek tributary near Fallon	1972-
06326950	Yellowstone River tributary No. 5 near Marsh	1962-
06326952	Clear Creek near Lindsay	1982-
06326960	Timber Fork 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 tributary 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	Hawks Nest Creek tributary near Albion	1973-
06334625	Coal Creek near Mill Iron	1974-
06334720	Soda Creek tributary near Webster	1962-

Table 2.--*Crest-stage stations in operation, October 1988*--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 (head of Lake 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-
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 1988*

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
BLM	U.S. Bureau of Land Management
EPA	U.S. Environmental Protection Agency
MDFWP	Montana Department of Fish, Wildlife and Parks
MDNRC	Montana Department of Natural Resources and Conservation
MPC	Montana Power Company
NPS	National Park Service
USAE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WWT	U.S. Department of State-International Joint Commission, Waterways Treaty

Sampling frequency

0	Once-daily, continuous
1	Once-daily, seasonal
3	Monthly
4	Bimonthly
5	Quarterly
6	Miscellaneous
7	Continuous record

Table 3.--*Surface-water-quality stations in operation, October 1988*--Continued

Station number	Station name	Funding source	Sampling frequency: Chemical	Sediment	Temperature	Biological	Specific conductance
	Part 5						
05020500	St. Mary River at international boundary	USGS	4	4	4	4	4
	Part 6						
06007000	Tom Creek near Lakeview	USFWS	-	1	1	-	-
06024450	Big Hole River below Big Lake Creek, at Wisdom	MDFWP	-	-	7	-	-
06025500	Big Hole River near Melrose	MDFWP	-	-	7	-	-
06036905	Firehole River near West Yellowstone	USGS	3	6	7	-	3
06037000	Gibbon River near West Yellowstone	USGS	3	6	7	-	3
06041000	Madison River below Ennis Lake, near McAllister	MDFWP	-	-	7	-	-
06054500	Missouri River at Toston	USGS, MDFWP	5	5	7	5	5
06089000	Sun River near Vaughn	USGS	4	4	0	4	0
06091700	Two Medicine River below South Fork, near Browning	BIA	6	-	6	-	6
06093200	Badger Creek below Four Horns Canal, near Browning	BIA	6	-	6	-	6
06099000	Cut Bank Creek at Cut Bank	BIA	6	-	6	-	6
06115200	Missouri River near Landusky	USGS, USAE	4	0	0	4	4
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	0	0	5	5
06137400	Big Sandy Creek at reservation boundary, near Rocky Boy	BIA	6	-	6	-	6
06139500	Big Sandy Creek near Havre	BIA	6	6	6	-	6
06145500	Lodge Creek below McRae Creek, at international boundary	WWT	6	-	6	-	-
06149500	Battle Creek at international boundary	WWT	6	-	6	-	-
06154410	Little Peoples Creek near Hays	USGS, BIA	6	6	6	-	6
06154430	Lodge Pole Creek at Lodge Pole	BIA	6	6	6	-	6
06154500	Peoples Creek near Dodson	BIA	6	-	6	-	6

Table 3.--*Surface-water-quality stations in operation, October 1988*--Continued

Station number	Station name	Funding source	Sampling frequency: Chemical	Sediment	Temperature	Biological	Specific conductance
	Part 6--Continued						
06154550	Peoples Creek below Kuhr Coulee, near Dodson	BIA	6	-	6	-	6
06164000	Frenchman River at international boundary	WWT	6	-	6	-	-
06164510	Milk River at Juneberg Bridge, near Saco	USGS	4	-	0	-	0
06164615	Little Warm Creek at reservation boundary, near Zortman	BIA	6	-	6	-	6
06169500	Rock Creek below Horse Creek, near international boundary	USGS	5	5	5	5	5
06174500	Milk River at Nashua	USGS	4	4	4	4	4
06175000	Porcupine Creek at Nashua	BIA	6	-	6	-	6
06178000	Poplar River at international boundary	MDNRC	3	3	3	-	3
06178500	East Poplar River at international boundary	MDNRC	3	3	0	-	0
06179000	East Fork Poplar River near Scobey	MDNRC	3	3	3	-	3
06179200	Poplar River above West Fork, near Bredette	BIA	6	-	6	-	6
06180400	West Fork Poplar River near Bredette	BIA	6	-	6	-	6
06181000	Poplar River near Poplar	USGS	4	4	4	4	4
06181995	Beaver Creek at international boundary	WWT	5	5	5	-	5
06183450	Big Muddy Creek near Antelope	USGS	6	-	6	-	6
06185110	Big Muddy Creek near mouth, near Culbertson	BIA	6	-	6	-	6
06187950	Soda Butte Creek near Lamar Ranger Station, Yellowstone National Park	USGS	6	6	6	-	6
06188000	Lamar River near Tower Falls Ranger Station, Yellowstone National Park	USGS, NPS	6	1	1	-	6
06189000	Blacktail Deer Creek near Mammoth	USGS	6	6	6	-	6
06190370	Gardner River above Mammoth Spring outflow, near Mammoth	USGS	3	-	3	-	3
06190415	Mammoth Spring outflow at Mammoth	USGS	3	-	3	-	3
06190540	Hot River at Mammoth	USGS	3	-	7	-	7

Table 3.--*Surface-water-quality stations in operation, October, 1988*--Continued

Station number	Station name	Funding source	Sampling frequency: Chemical	Sediment	Temperature	Biological	Specific conductance
	Part 6--Continued						
06191000	Gardner River near Mammoth	USGS	3	6	3	-	3
06191400	La Duke Hot Spring near Corwin Springs	USGS	3	-	3	-	3
06191500	Yellowstone River at Corwin Springs	USGS, NPS	6	1	1	-	6
06192500	Yellowstone River near Livingston	USGS	4	4	4	4	4
06214500	Yellowstone River at Billings	USGS	5	5	5	5	5
06215000	Pryor Creek above Pryor	BIA	6	-	6	-	6
06288500	Bighorn River near Hardin	BIA	6	-	6	-	6
06294000	Little Bighorn River near Hardin	BIA	6	-	6	-	6
06294700	Bighorn River at Bighorn	USGS	4	4	4	4	4
06294995	Armells Creek near Forsyth	BLM	6	6	6	-	6
06296003	Rosebud Creek at mouth, near Rosebud	BLM	6	6	6	-	6
06307500	Tongue River at Tongue River Dam, near Decker	BLM	3	3	3	-	3
06307600	Hanging Woman Creek near Birney	BLM	6	6	6	-	6
06307616	Tongue River at Birney Day School Bridge, near Birney	USGS	6	-	6	-	6
06307740	Otter Creek at Ashland	BLM	6	6	6	-	6
06308500	Tongue River at Miles City	USGS	5	5	5	5	5
06324500	Powder River at Moorhead	MDNRC	3	1	0	-	0
06324710	Powder River at Broadus	MDNRC	3	1	1	-	3
06325550	Little Powder River at mouth, near Broadus	MDNRC	3	-	3	-	3
06325650	Powder River at Powderville	MDNRC	3	-	3	-	3
06326300	Mizpah Creek near Mizpah	MDNRC	3	-	3	-	3
06326500	Powder River near Locate	USGS	3	4	0	4	0
06329500	Yellowstone River near Sidney	USGS, USAE	4	0	0	4	4
	Part 12						
12300110	Lake Koocanusa at international boundary	USAE	6	-	6	-	6

Table 3.--*Surface-water-quality stations in operation, October 1988*--Continued

Station number	Station name	Funding source	Sampling frequency: Chemical	Sediment	Temperature	Biological	Specific conductance
			Part 12--Continued				
12301830	Lake Koocanusa at Tenmile Creek, near Libby	USAE	4	-	4	4	4
12301919	Lake Koocanusa at Forebay, near Libby	USAE	4	-	4	-	4
12301933	Kootenai River below Libby Dam, near Libby	USAE	3	-	3	-	3
12323800	Clark Fork near Galen	EPA	6	6	6	-	6
12324200	Clark Fork at Deer Lodge	EPA	6	0	0	-	6
12324590	Little Blackfoot River near Garrison	EPA	6	6	6	-	6
12331500	Flint Creek near Drummond	EPA	6	6	6	-	6
12334510	Rock Creek near Clinton	EPA	6	6	6	-	6
12334550	Clark Fork at Turah Bridge, near Bonner	EPA	6	0	0	-	6
12340000	Blackfoot River near Bonner	EPA	6	0	0	-	6
12340500	Clark Fork above Missoula	MPC	-	0	0	-	-
12353000	Clark Fork below Missoula	USGS	4	4	4	4	4
12353450	Fish Creek below West Fork, near Tarkio	MDFWP	-	-	7	-	-
12353650	Clark Fork at Superior	MDFWP	-	-	7	-	-
12354000	St. Regis River at St. Regis	MDFWP	-	-	7	-	-
12354700	Clark Fork near Paradise	MDFWP	-	-	7	-	-
12355000	Flathead River at Flathead, British Columbia	USGS, MDFWP	5	0	7	5	5
12355500	North Fork Flathead River near Columbia Falls	MDFWP	-	-	7	-	-
12362500	South Fork Flathead River near Columbia Falls	MDFWP	-	-	7	-	-
12363000	Flathead River at Columbia Falls	USGS, MDFWP	5	5	7	5	5
12375800	Little Bitterroot River near Perma	BIA	4	4	4	-	4
12376900	Crow Creek at mouth near Ronan	BIA	4	4	4	-	4
12379600	Mission Creek at National Bison Range at Moiese	BIA	4	4	4	-	4
12388200	Jocko River at Dixon	BIA	4	4	4	-	4
12388700	Flathead River at Perma	BIA	4	4	4	-	4

Table 4.--*Ground-water-level observation-well network, October 1988*

[The network is funded cooperatively by the U.S. Bureau of Land Management, the Montana Bureau of Mines and Geology, 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
120PLNC - Tertiary plutonic rocks
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
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.

Table 4.--*Ground-water-level observation-well network, October 1988*--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	1975	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	--	-	--
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	1015	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	1975	A	--	-	--
35N33E19DBA 01	484600107271001	246	211JDRV	1978	A	1978	B	MB
34N24E06DCCC01	484342108382801	200	211FXHL	1975	A	--	-	--
33N06W12AAA 02	483812112191202	400	211VRGL	1965	A	--	-	--
33N06W12AAA 03	483812112191203	250	211TMDC	1966	A	--	-	--
33N48E18DCB 01	483633104290101	325	211HLCK	1979	A	--	-	--
32N11W03DAD 01	483345113004501	12	112DRFT	1968	A	--	-	--
32N15E17DDDC01	483138109481001	180	110ALVM	1961	A	1947	B	--
31N31W33CCBB01	482408115344701	40	110ALVM	1972	C	--	-	--
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	--	-	--

Table 4.--*Ground-water-level observation-well network, October 1988*--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
30N38E09CADB01	482211106473201	195	211JDRV	1978	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	--	-	--
26N20E36ADCC01	475758109051101	1,470	211EGLE	1978	A	--	-	--
26N49E13ACAB01	480034105195401	180	211FHHC	1982	A	--	-	--
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	--	-	--
22N52E28B 01	473829105032401	1,151	211FHHC	1983	A	1975	B	--
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
21N51E10ABCD01	473602105090500	131	125TGRV	1975	A	--	-	--
21N53E08ADCC01	473542104562701	70	125TGRV	1975	A	1976	B	GS
21N56E28ADDC01	473306104315001	220	125TGRV	1976	A	--	-	--
20N22W30DADD01	472740114260901	155	110ALVM	1969	A	--	-	--
20N20W26CCBD01	472733114065601	200	112GLCC	1967	A	--	-	--
20N02E01AABA01	473124111244501	605	331MDSN	1979	A	1979	B	--
20N03E28CCCD01	472703111220201	85	217FLOD	1973	A	--	-	--
20N03E32ADDC01	472636111221801	215	217FLOD	1973	A	--	-	--

Table 4.--*Ground-water-level observation-well network, October 1988*--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
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	--	-	--
20N56E08DDCD02	473002104360502	180	125TGRV	1985	A	--	-	--
19N20W35AAA 01	472211114054801	54	112GLCC	1967	A	--	-	--
19N03E01AABA01	472606111171201	65	217KOTN	1979	A	--	-	--
19N06E23BADA01	472403110553701	75	221SWFT	1979	A	--	-	--
19N06E26ACAD01	472303110552101	435	331MDSN	1978	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
18N38E20BBAB01	471837106544001	518	211HLCK	1983	A	--	-	--
18N40E01DBBB01	472046106334601	159	125FRUN	1965	A	1965	-	--
18N44E13AAAC01	471925106023501	278	125TGRV	1976	A	1976	C	GS
18N50E16CBBB01	471906105214701	161	125LEBO	1982	A	--	-	--
17N47E16DDDD01	471329105432801	242	125TGRV	1981	A	--	-	--
16N44E25BBAA01	470711106061401	263	125TGRV	1980	A	--	-	--
16N44E25BBAB01	470711106051501	1,460	211FHHC	1980	A	--	-	--
16N44E25BBAC01	470709106061401	103	125TGRV	1983	A	--	-	--
16N50E06DDCD01	470958105260401	380	125TGRV	1981	A	--	-	--
16N51E36DCCC01	470535105122201	202	125TLCK	1981	A	--	-	--
15N12W36BCDD01	470049113035401	206	112DRFT	1975	A	--	-	--
15N07W28ABB 01	470146112291201	130	120PLNC	1970	A	1970	B	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	1982	B	GS
15N53E12ABAB03	470446104565503	172	125TGRV	1981	A	1982	B	GS

Table 4.--*Ground-water-level observation-well network, October 1988*--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
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	--	-	--
12N55E27BADD01	464605104470501	1,000	211FHHC	1962	A	--	-	--
12N56E23CCDA01	464626104384301	1,449	211FHHC	1962	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	--	-	--
11N36E28BACD01	464055107121101	2,745	217TCCK	1978	A	1978	B	MB
11N54E29CACD01	464025104572901	800	211FHHC	1976	A	--	-	--
11N57E21CDBB01	464127104334003	1,230	211FHHC	1957	A	1957	B	PL
11N57E32BBBD01	464010104345601	980	211FHHC	1963	A	1970	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
10N03W11DDCC01	463754111562201	40	110ALVM	1978	A	1978	B	MB
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	--	-	--

Table 4.--*Ground-water-level observation-well network, October 1988*--Continued

Local number	Site identification	Well depth (feet)	Prin-cipal aquifer	Water level: Begin year	Water level: Meas-ure-ment fre-quency	Chemical analysis: Begin year	Chemical analysis: Type	Chemical analysis: Ana-lyzing agency
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	--	-	--
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	1962	A	--	-	--
05N25E16CCCC01	461035108364401	1,350	211FXHL	1980	A	1981	B	MB
05N25E16CCCC02	461035108364402	427	211HLCK	1980	A	1981	B	MB
05N33E32DABC01	460825107365801	102	211FHHC	1980	A	--	-	--
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	1958	S	--	-	--
04N01E13BCAC01	460615111330901	209	120SDMS	1977	A	--	-	--
04N01E15BCBB01	460612111355001	348	120SDMS	1967	A	--	-	--
04N23E14ABBA01	460612108494201	80	211FHHC	1980	A	1980	B	GS
04N23E16BCCC01	460547108525901	1,100	211EGLE	1980	A	1980	B	GS
04N40E31DCAA01	460311106475601	199	211HLCK	1976	A	1976	B	MB
02N27E35DBAB01	455209108193601	5,070	331MSNC	1983	A	1978	B,C	GS
02N40E31DCCD01	455236106473901	165	125TGRV	1972	A	1972	B,C	MB,GS

Table 4.--*Ground-water-level observation-well network, October 1988*--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
02N43E24CCBC01	455424106200801	60	110ALVM	1979	A	1979	C	GS
02N43E24CDDA01	455419106193701	21	110ALVM	1979	A	--	-	--
01N04E25DCD 01	454809111095401	101	110ALVM	1951	A	--	-	--
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	1978	A	--	-	--
01N41E21DBDB01	454921106380601	131	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	Q	1979	B,C	GS
02S49E22DCCA04	453832105393904	118	125TGRV	1977	A	--	-	--
03S15W16DCCD01	453404113272601	205	120SDMS	1982	A	--	-	--
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

Table 4.--*Ground-water-level observation-well network, October 1988*--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
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	--	-	--
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	GS
06S41E17ADDD01	451857106433301	19	110ALVM	1979	A	1986	B	MB
06S41E25CDAC01	451653106392401	144	125TGRV	1978	A	1986	B,C	GS
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
07S08W03BDC 02	451521112341902	40	110ALVM	1965	Z	--	-	--
07S08W17DDC 02	451307112361001	50	120SDMS	1965	Z	--	-	--
07S44E34BAAD01	451137106194901	86	125TGRV	1975	A	1975	B	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	1984	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	--	-	--

Table 4.--*Ground-water-level observation-well network, October 1988*--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
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
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	--	-	--
08S46E32DDAC01	450524106061001	30	110ALVM	1983	A	1983	B	MB
09S40E09DBAD01	450330106500101	120	111SPBK	1981	A	1986	B,C	MB
09S40E20BDAC01	450159106513701	380	125TGRV	1981	A	--	-	--
09S42E01BCAD02	450507106321501	34	110ALVM	1980	A	1980	B	MB
09S42E11BDAA01	450417106330901	222	125TGRV	1975	A	1980	B,C	MB

Table 4.--*Ground-water-level observation-well network, October 1988*--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
09S43E04ABDD02	450512106275602	26	110ALVM	1980	A	1986	B,C	MB
09S43E04CBAB01	450458106283501	186	125TGRV	1980	A	1980	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	1976	A	1976	B,C	GS
09S45E03DABB04	450447106111104	65	125TGRV	1976	A	--	-	--
09S45E03DABB05	450447106111105	71	125TGRV	1976	A	--	-	--
09S45E11ADDB01	450400106094801	307	125TGRV	1975	A	1976	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	1976	B	MB,GS
09S46E09DABA02	450355106050202	209	125TGRV	1983	A	1983	B	MB
09S46E09DBAB02	450355106051301	30	110ALVM	1983	A	1984	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

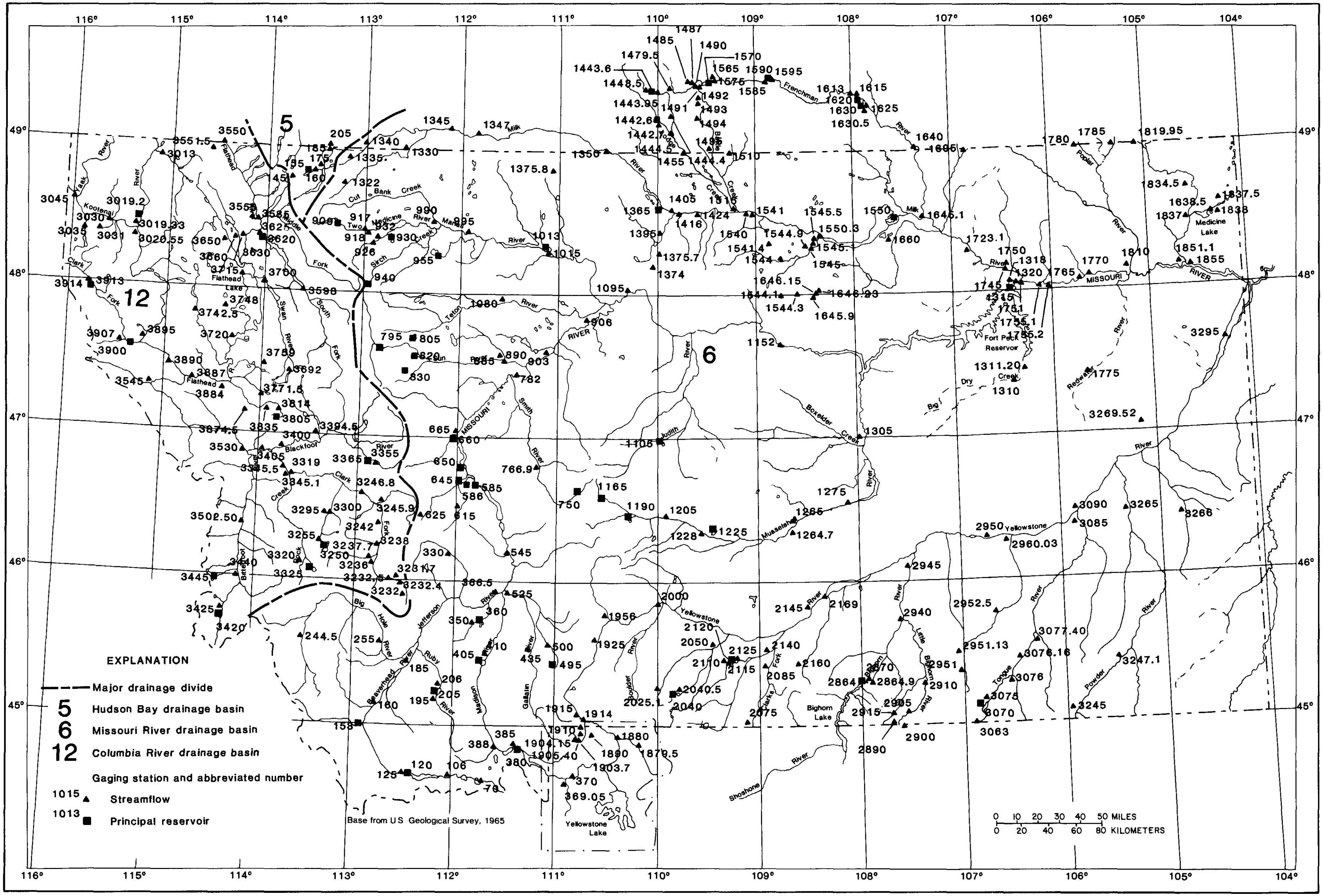


Figure 7.--Location of surface-water gaging stations in operation, October 1988.

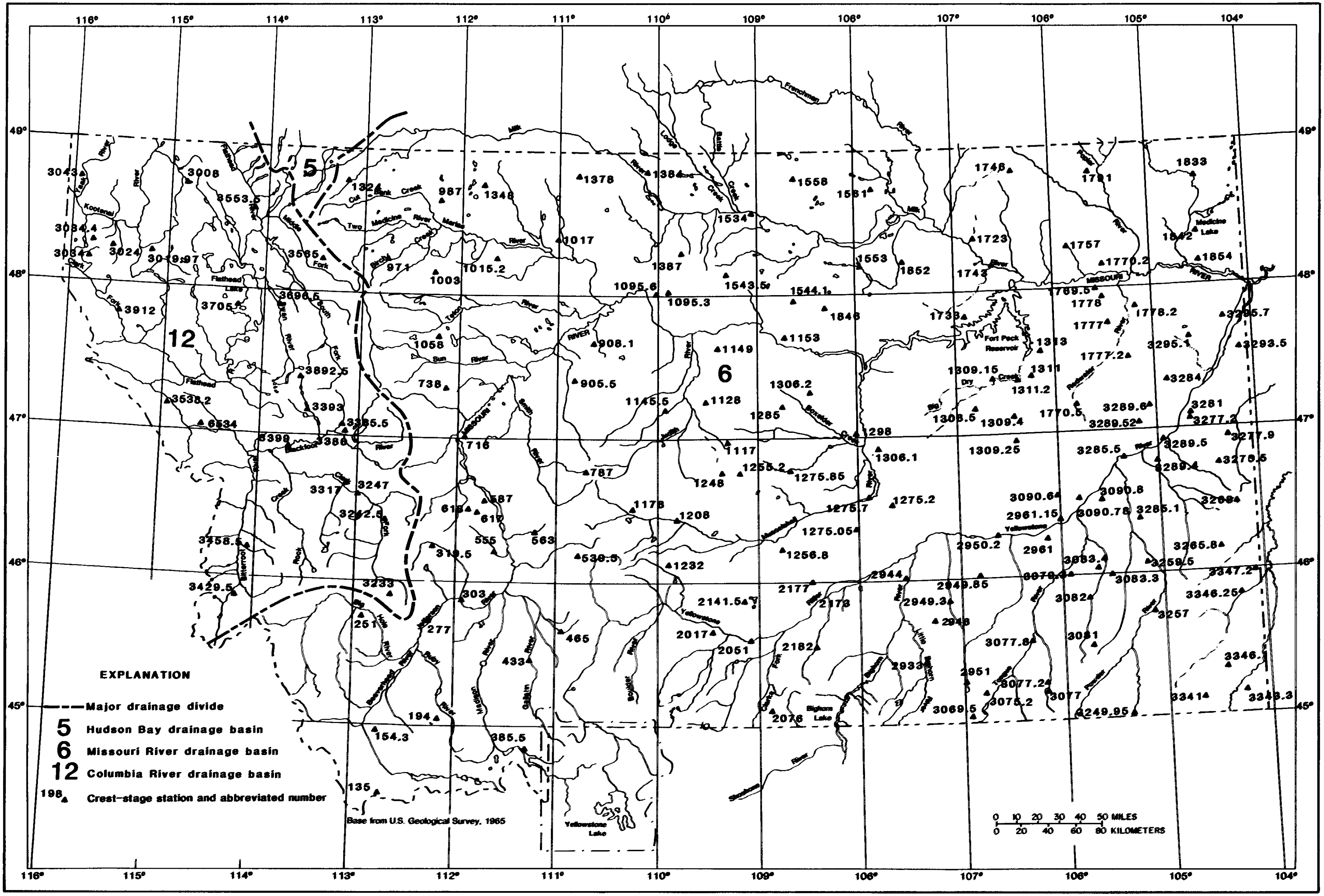


Figure 8.--Location of crest-stage stations in operation, October 1988.

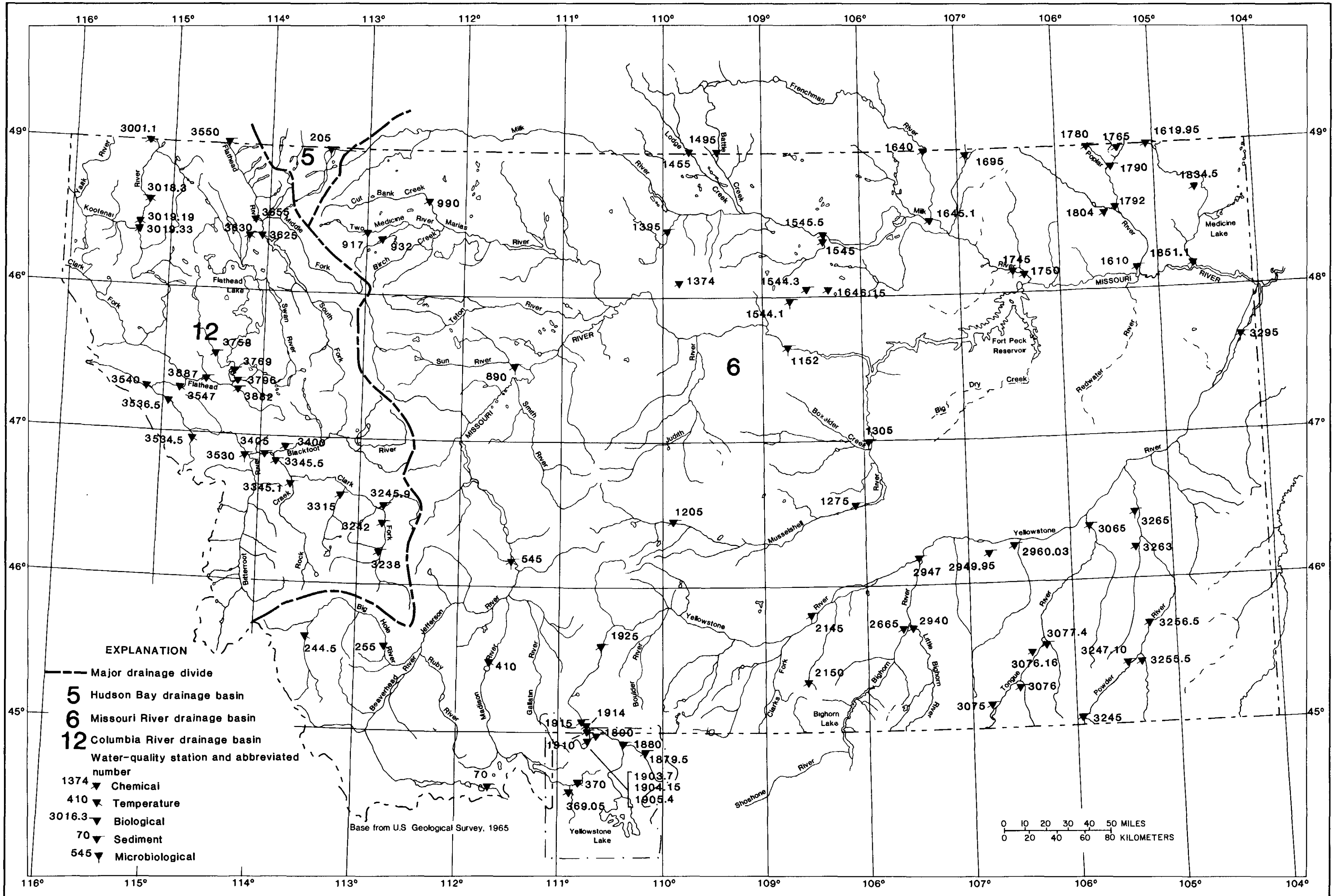


Figure 9.--Location of surface-water-quality stations in operation, October 1988.

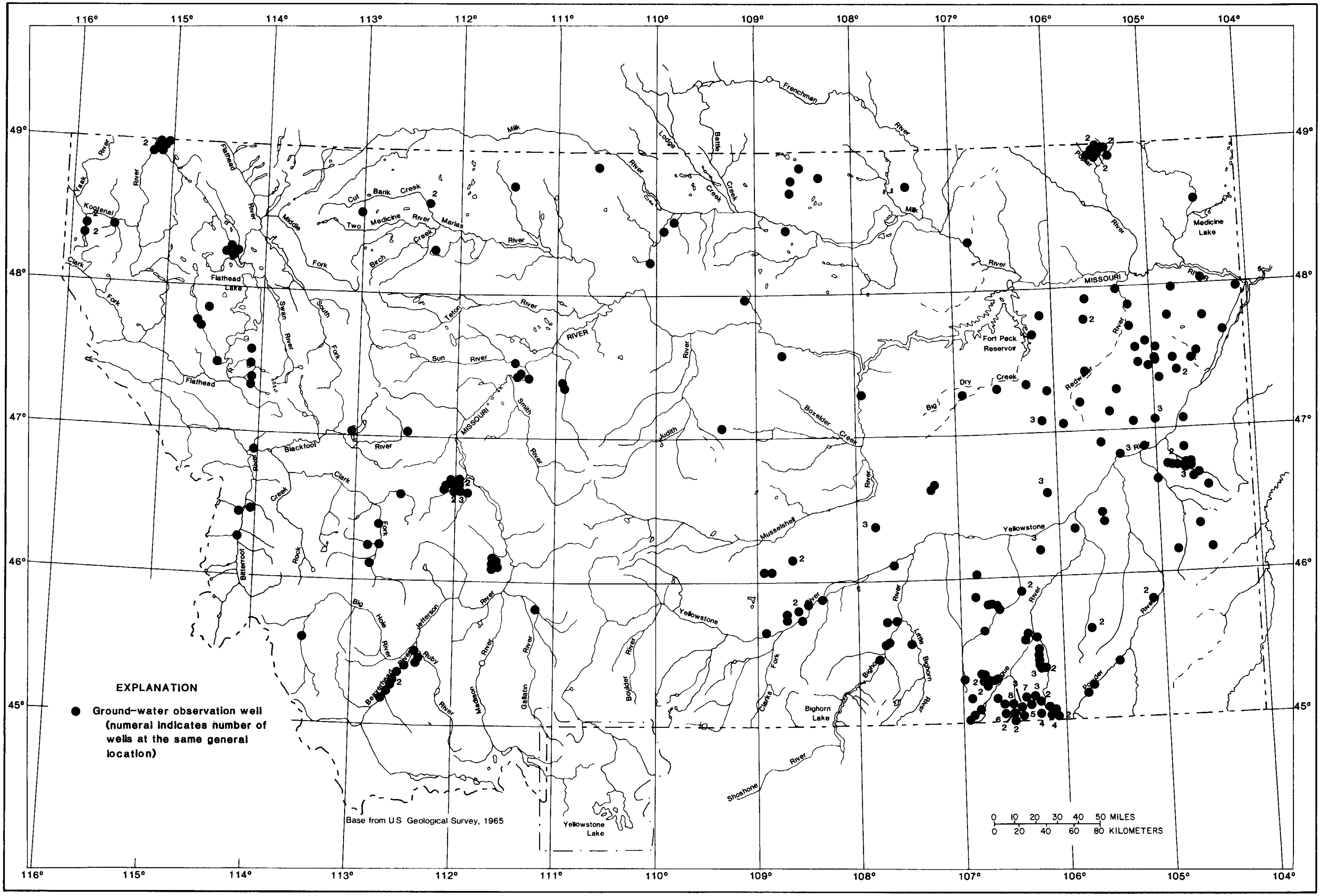


Figure 10.--Location of ground-water-level observation wells, October 1988.