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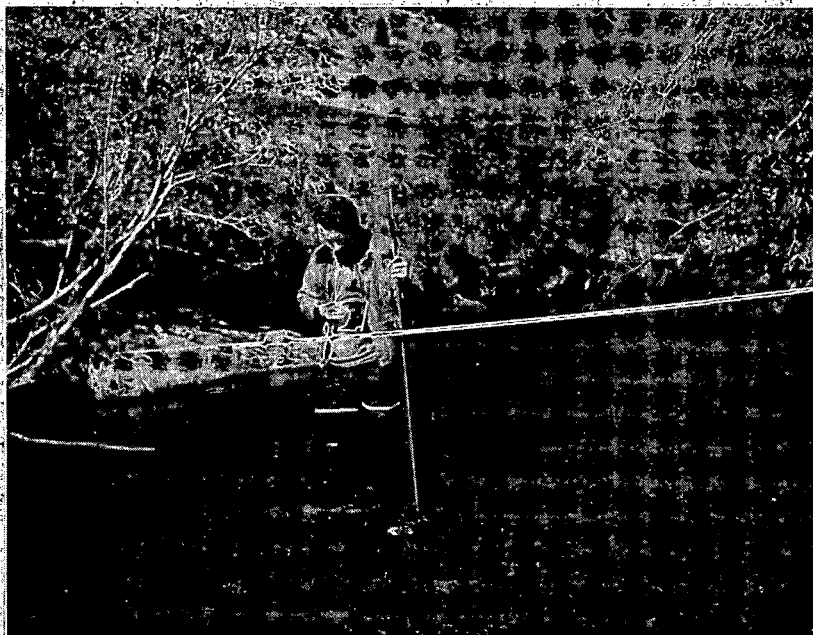
WATER-RESOURCES INVESTIGATIONS OF THE
U.S. GEOLOGICAL SURVEY IN MONTANA,
OCTOBER 1978 THROUGH SEPTEMBER 1979

U.S. GEOLOGICAL SURVEY
Open-File Report 79-418



Prepared in cooperation with the
State of Montana and other agencies

UNIVERSITY OF UTAH
RESEARCH INSTITUTE
EARTH SCIENCE LAB.



UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

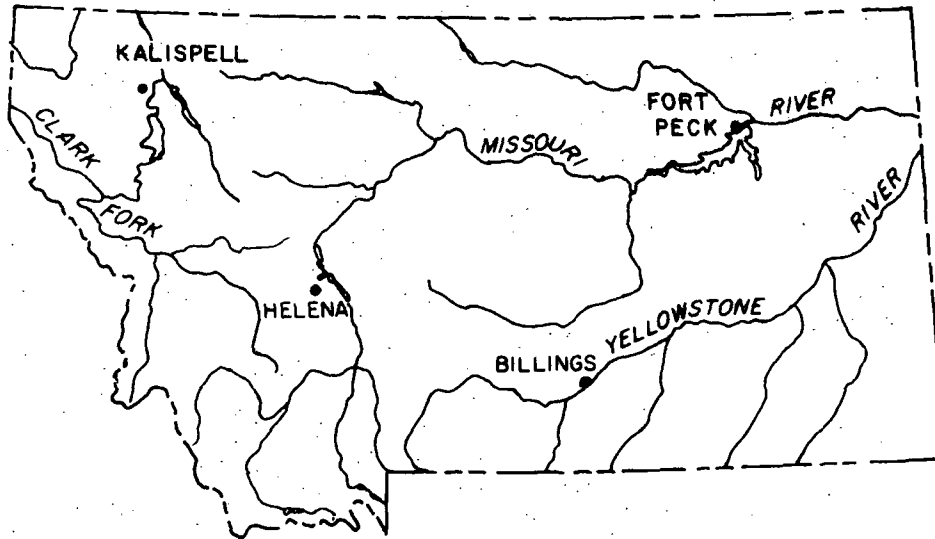
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Helena, Montana

April 1979



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WATER-RESOURCES INVESTIGATIONS OF THE
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INTRODUCTION

The U.S. Geological Survey was established as an agency in the Department of the Interior on March 3, 1879, 30 years to the day after establishment of the Department itself. The initial purpose of the Survey was to prepare a plan that would secure the best possible results at the least possible cost for surveying and mapping the Territories of the United States. One mission of the Geological Survey 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:

1. Collecting data needed for the continuing determination and evaluation of the Nation's water resources;
2. Conducting water-resources investigations to describe the occurrence, availability, and characteristics of surface and ground waters;
3. Conducting supportive research in hydraulics, hydrology, and related fields of science to improve the scientific basis for investigations and measurements and to understand hydrologic systems sufficiently well to be able to predict their response to stress;
4. Disseminating the water data and the results of these investigations and research through reports, maps, and other forms of public release;
5. Coordinating the activities of Federal agencies in the acquisition of water data for streams, lakes, reservoirs, and ground waters; and
6. 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 Department of State.

The Montana district of the Geological Survey conducts its hydrologic work through a headquarters office in Helena (Federal Office Building, 301 S. Park), a subdistrict office in Billings, and field offices in Kalispell and Fort Peck. The district employs 88 people (57 full-time and 31 less than full-time) to work on 26 funded projects. Funding for program operation comes from cooperative agreements with State and local agencies, direct Federal allotments to the U.S. Geological Survey, and transfer of funds from other Federal agencies.

The following projects are funded for fiscal year 1979 in Montana:

001	Surface-Water Stations	048	Effects of Mining
002	Ground-Water Stations	049	Madison Limestone
003	Water-Quality Stations	052	Geothermal Hydrology
004	Sediment Stations	056	Madison Aquifer in Northern Montana
005	Precipitation Stations	059	Coal-Lease Monitoring
010	Peak-Flow Analysis	060	Poplar River Basin
022	National Parks Studies	064	Reservoir Study
023	Bridge-Site Investigations	065	Stream-Response Modeling
026	Lower Flathead River Basins	066	EMRIA Sites
030	Special Investigations	067	Northern Great Plains
043	Fort Union Formation	068	Helena Valley
044	Flood-Hazard Mapping	069	Cascade County
047	Saline Seeps	070	Channel Geometry

These projects are described in following sections of this report under the general headings of: (1) Data-collection programs, (2) Problem-oriented studies, (3) Areal appraisals, (4) Coal-related studies, (5) Regional studies, and (6) Research projects. An additional section describes grants and contracts administered by the Montana district to research organizations.

DATA-COLLECTION PROGRAMS

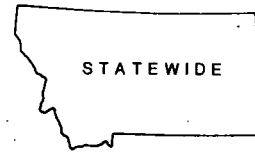
Hydrologic-data stations are maintained at selected sites throughout Montana to collect basic information concerning streamflow, ground-water levels, quality of water, sediment concentrations in streams, and depth and water content of snowpack. The network of stations is revised periodically to ensure collection of meaningful and worthwhile data. Information collected from the network is kept on file for use by managers, investigators, and users of water resources. Much of the information is published annually in water-data reports, most is stored in computer files for efficient processing and retrieval, and all is available to requesters.

The locations of data-collection stations are shown on figure 2 for surface water and figure 3 for surface-water quality. Surface-water stations in operation as of October 1978 are listed in table 1. Surface-water-quality stations are listed in table 2.

Surface-Water Stations

(MT-001)

Location: Statewide



Period of project: Continuing

Project chief: George M. Pike, Helena

Objectives: (1) To collect surface-water data sufficient to satisfy needs for current-purpose uses, such as (a) assessment of water resources, (b) operation of reservoirs or industries, (c) forecasting, (d) disposal of wastes and pollution control, (e) discharge data to accompany water-quality measurements, (f) compact and legal requirements, and (g) research and 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 so forth, for use in planning and design.

Information products: U.S. Geological Survey, Water-resources data for Montana--Water year 1977: U.S. Geological Survey Water-Data Report MT-77-1 (in press).

Moore, L. G., and Shields, R. R., Yellowstone River basin streamflow characteristics: U.S. Geological Survey Open-File Report (in preparation).

Yellowstone River Compact Commission, Twenty-seventh annual report (in preparation).

Ground-Water Stations

(MT-002)

Location: Statewide



Period of project: Continuing

Project chief: Thomas E. Reed, Helena

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

Information products: Coffin, D. L., Reed, T. E., and Ayers, S. D., 1977, Water-level changes in wells along the west side of the Cedar Creek anticline, southeastern Montana: U.S. Geological Survey Water-Resources Investigations 77-93, 11 p.

Roberts, R. S., Water-resources data for selected coal areas in the Circle-Richey-Wibaux area, northeastern Montana: U.S. Geological Survey Open-File Report (in preparation).

Water-Quality Stations

(MT-003)

Location: Statewide

Period of project: Continuing

Project chief: J. Roger Knapton, Helena

Objectives: (1) To provide a national bank of water-quality data for broad Federal planning and action programs. (2) To provide data for Federal management of interstate and international waters.

Information products: U.S. Geological Survey, Water-resources data for Montana--Water year 1977: U.S. Geological Survey Water-Data Report MT-77-1 (in press).



Sediment Stations

(MT-004)

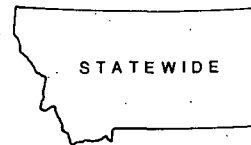
Location: Statewide

Period of project: Continuing

Project chief: J. Roger Knapton, Helena

Objectives: (1) To provide a national bank of sediment data for use in broad Federal and State planning and action programs. (2) To provide data for Federal management of interstate and international waters.

Information products: U.S. Geological Survey, Water-resources data for Montana--Water year 1977: U.S. Geological Survey Water-Data Report MT-77-1 (in press).



Precipitation Stations

(MT-005)

Location: West-central Montana

Period of project: Continuing

Project chief: Ronald R. Shields, Helena



Objective: To obtain the depth and water content of the snowpack at 13 designated snow courses for use in runoff forecasting.

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

PROBLEM-ORIENTED 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, such as bridge-site investigations for the Montana Department of Highways, continuing projects are established to provide an ongoing service to the funding agency. Some problems are of sufficient scope to warrant formal projects such as the investigation of the factors relating to development and expansion of saline seeps in central Montana.

In addition to the recurring-problem projects and the large-scope projects, an umbrella project entitled "Special Investigations" has been established. This project provides a mechanism for handling special problems on short notice. Examples of work included under this project are investigations of water-level declines in small basins, documentation of groundwater-quality problems, and investigation of water-supply problems for other Federal agencies.

National Parks Studies

(MT-022)

Location: Statewide

Period of project: Continuing

Project chief: Joe A. Moreland, Helena



Objectives: (1) To provide technical assistance to the National Park Service in the development of suitable water supplies at selected sites.

(2) To conduct aquifer tests, collect water samples for chemical analysis, and monitor water-level fluctuations in selected wells.

Information products: Letters to National Park Service as appropriate.

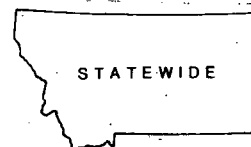
Bridge-Site Investigations

(MT-023)

Location: Statewide

Period of project: Continuing

Project chief: Robert J. Omang, Helena



Objective: To supply the Montana Department of Highways with sufficient hydrologic and hydraulic information at selected sites to allow the most economic and hydraulically safe bridge or culvert design possible.

Information products: Johnson, M. V., 1978, Floods of June 4 and 12, 1976, at Culbertson, Montana: U.S. Geological Survey Open-File Report 78-429, 6 p.

Special Investigations

(MT-030)

Location: Statewide

Period of project: Continuing

Project chief: Joe A. Moreland, Helena



Objectives: (1) To assist State and other Federal agencies in solving water-resources problems on short notice. (2) To furnish the basic data to the cooperator soon after the fieldwork is completed. (3) To improve the quality of all district reports and their usefulness to the cooperator. Included in this project are all reports from completed studies which are not yet approved for release or published. The project provides a funding mechanism to complete manuscript revisions and final drafting of illustrations.

Information products: Feltis, R. D., Water resources of the Judith Basin, central Montana: Montana Bureau of Mines and Geology Hydrologic Atlas (in press).

Knapton, J. R., Evaluation and correlation of water-quality data for the North Fork Flathead River, northwestern Montana: U.S. Geological Survey Water-Resources Investigations report (in press).

Miller, W. R., Water resources of the central Powder River area of southeastern Montana: Montana Bureau of Mines and Geology Bulletin (in press).

Montana Bureau of Mines and Geology and U.S. Geological Survey, Ground water of the Fort Union Coal Region, eastern Montana: Montana Bureau of Mines and Geology Special Publication (in press).

Feltis, R. D., Potential sources of ground water for irrigation, domestic, and municipal supply, Fort Belknap Indian Reservation, north-central Montana: Montana Bureau of Mines and Geology Bulletin (in review).

Miller, W. R., Water resources of the southern Powder River area of southeastern Montana: Montana Bureau of Mines and Geology Bulletin (in review).

Stoner, J. D., Hydrogeology of the Fort Union coal region, eastern Montana: U.S. Geological Survey Miscellaneous Investigations Map (in review).

Boettcher, A. J., Thermal-infrared imagery and heat modeling of the Madison River and Lake Ennis, southwestern Montana: U.S. Geological Survey Water-Resources Investigations report (in preparation).

Feltis, R. D., and Shields, R. R., Streamflow losses to Madison Group rocks in the Little Belt and Big Snowy Mountains, Montana: U.S. Geological Survey Water-Resources Investigations report (in preparation).

McMurtrey, R. G., Ground-water data for the Lake Koochanusa area, Montana: U.S. Geological Survey Open-File Report (in preparation).

Flood-Hazard Mapping

(MT-044)

Location: Statewide

Period of project: Continuing

Project chief: Robert J. Omang, Helena



Objective: To identify and label on U.S. Geological Survey topographic quadrangle maps the flood-prone areas of cities and towns over 2,500 population, and adjacent areas. Where adequate maps are available, the flood frequency-drainage area relationship can then be determined.

Information products: A total of 234, 7-1/2-minute quadrangles have been mapped in previous years.

Saline Seeps

(MT-047)

Location: Central Montana

Period of project: July 1974 to September 1980

Project chief: Barney D. Lewis, Billings



Objective: To define and understand the effects of geology, climate, and hydrology on the formation or expansion of saline-seep areas. Ground-water recharge, movement, and discharge need to be defined in space and time. As understanding of the system increases, management will be provided with alternative plans for reducing or at least controlling the spread of salt accumulation and the deterioration of the surface-water and shallow ground-water resources of the region.

Information products: Lewis, B. D., Custer S. G., and Miller, M. R., Saline-seep development in the Hailstone basin, northern Stillwater County, Montana: U.S. Geological Survey Water-Resources Investigations Report (in review).

AREAL APPRAISALS

The Geological Survey has a continuing program of areal studies designed to provide hydrologic information needed in managing the State's water resources. These studies evaluate the occurrence and movement of ground water, thickness and extent of aquifers, distribution of streamflow in time and space, and quality of surface and ground waters. The studies generally include a ground-water basin, hydrologic unit, county, or other convenient subunit of the State.

Each areal investigation is uniquely designed to address hydrologic conditions, development potential, and specific hydrologic problems associated with the area in question. Some studies are aimed primarily at evaluating the potential for development of ground-water supplies, some deal primarily with water-quality problems, and some are broad investigations of the hydrologic system. All are intended to provide a clearer understanding of the State's water resources.

Lower Flathead River Basins

(MT-026)

Location: Northwestern Montana

Period of project: July 1969 to April 1979

Project chief: Arnold J. Boettcher, Helena



Objective: To determine the (a) location and hydrologic characteristics of wells and springs, (b) types of rocks beneath the area and the capacity of the rocks to yield water to wells, (c) areas where ground water is recharged and discharged, (d) approximate depth and volume of basin-fill deposits, (e) areas where wells might be expected to yield large quantities of water, (f) areas where ground-water quality may have deteriorated owing to natural or man-caused reasons, and (g) effects of various development schemes on the ground-water system based on existing or proposed use of the water.

Information products: Boettcher, A. J., Ground-water resources of the central part of the Flathead Indian Reservation, northwestern Montana: Montana Bureau of Mines and Geology Bulletin (in review).

Madison Aquifer in Northern Montana

(MT-056)

Location: Central and northern Montana

Period of project: October 1975 to September 1979

Project chief: Richard D. Feltis, Billings



Objective: To compile information from test holes and wells and prepare maps describing the (a) structural configuration of the top of the aquifer, (b) potentiometric surface, and (c) quality of water. These maps will form the basis for a future evaluation of the aquifer and will supplement an intensive study of the Madison aquifer in eastern and southeastern Montana.

Information products: Feltis, R. D., Map showing configuration of the top of the Madison Group, Great Falls 1-degree by 2-degree quadrangle, Montana: Montana Bureau of Mines and Geology Special Publication (in press).

_____ Map showing configuration of the top of the Madison Group, Havre 1-degree by 2-degree quadrangle, Montana: Montana Bureau of Mines and Geology Special Publication (in press).

_____ Map showing configuration of the top of the Madison Group, Lewistown 1-degree by 2-degree quadrangle, Montana: Montana Bureau of Mines and Geology Special Publication (in press).

_____ Map showing configuration of the top of the Madison Group, Shelby 1-degree by 2-degree quadrangle, Montana: Montana Bureau of Mines and Geology Special Publication (in press).

- _____ Map showing dissolved-solids concentration of water in the Madison Group, eastern Montana: Montana Bureau of Mines and Geology Special Publication (in press).
- _____ Map showing ratio of sodium, potassium, and chloride to dissolved-solids concentration in water of the Madison Group, eastern Montana: Montana Bureau of Mines and Geology Special Publication (in press).
- _____ Map showing ratio of sulfate to total anions in water of the Madison Group, eastern Montana: Montana Bureau of Mines and Geology Special Publication (in press).
- _____ Map showing potentiometric surface of water in the Madison Group, eastern Montana: Montana Bureau of Mines and Geology Special Publication (in review).
- _____ Map showing configuration of the top of the Madison Group, Roundup 1-degree by 2-degree quadrangle, Montana: Montana Bureau of Mines and Geology Special Publication (in preparation).
- _____ 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 Special Publication (in preparation).
- _____ Map showing configuration of the top of the Madison Group, Glasgow 1-degree by 2-degree quadrangle, Montana: Montana Bureau of Mines and Geology Special Publication (in preparation).
- _____ Map showing configuration of the top of the Madison Group, Wolf Point 1-degree by 2-degree quadrangle, Montana: Montana Bureau of Mines and Geology Special Publication (in preparation).
- _____ Map showing configuration of the top of the Madison Group, Jordan 1-degree by 2-degree quadrangle, Montana: Montana Bureau of Mines and Geology Special Publication (in preparation).
- _____ Map showing configuration of the top of the Madison Group, Glendive 1-degree by 2-degree quadrangle, Montana: Montana Bureau of Mines and Geology Special Publication (in preparation).

Poplar River Basin

(MT-060)

Location: Northeastern Montana

Period of project: March 1977 to September 1979

Project chief: Richard D. Feltis, Billings



Objective: To determine baseline ground-water conditions in an area of the United States for future evaluation of the effects of mining and power-plant emissions in Saskatchewan, Canada. The project will include a study of the shallow ground-water systems and the relationship of surface water to these systems. A ground-water monitoring system also will be initiated.

Information products: Feltis, R. D., Ground-water resources of shallow aquifers in the upper Poplar River basin, northeastern Montana: U.S. Geological Survey Water-Resources Investigations report (in review).

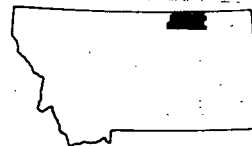
Reservoir Study

(MT-064)

Location: Northern Valley and Phillips Counties

Period of project: October 1977 to September 1979

Project chief: Rodger F. Ferreira, Helena



Objectives: (1) To characterize the present physical, chemical, and biological conditions in 12 reservoirs in Valley County and 11 reservoirs in Phillips County. (2) To evaluate the suitability of the reservoirs for various uses.

Information products: Ferreira, R. F., Limnological reconnaissance of reservoirs in Valley County, Montana: U.S. Geological Survey Water-Resources Investigations report (in preparation).

Ferreira, R. F., Limnological reconnaissance of reservoirs in Phillips County, Montana: U.S. Geological Survey Water-Resources Investigations report (in preparation).

Helena Valley

(MT-068)

Location: West-central Montana

Period of project: July 1978 to September 1979

Project chief: Arnold J. Boettcher, Helena



Objectives: (1) To define ground-water quality in shallow aquifers. (2) To determine depth to water and water-table fluctuations in selected areas. (3) To determine the lithology of the basin-fill deposits. (4) To monitor the movement of effluent from various types of septic systems.

Information products: Boettcher, A. J., Geohydrology of the Helena valley, west-central Montana: U.S. Geological Survey Water-Resources Investigations report (in preparation).

Cascade County

(MT-069)

Location: Cascade County

Period of project: December 1978 to December 1979

Project chief: Kathleen R. Wilke, Helena

Objectives: (1) To investigate the occurrence and availability of ground water for domestic use. (2) To determine the quality of water in aquifers in the Great Falls area.

Information products: A U.S. Geological Survey Water-Resources Investigations report will be prepared at the conclusion of the study.



COAL-RELATED STUDIES

The nation's pressing need for an expanded domestic energy base has resulted in increased interest in Montana's vast coal resources. Environmental impacts associated with exploration, mining, conversion, and transportation of coal must be considered in planning and managing the coal-mining activities. Many of the activities associated with coal utilization may significantly affect the water resources in Montana. To address these problems, the Geological Survey is involved in several hydrologic projects relating to coal development.

Projects include investigations of potential effects of mining on shallow ground-water systems, studies designed to provide baseline hydrologic information at proposed coal-lease sites, and mapping projects designed to identify areal distribution of aquifer units. A considerable amount of hydrologic data is needed to evaluate the potential impacts of mining activities.

Fort Union Formation

(MT-043)

Location: Southeastern Montana

Period of project: Continuing



Project chief: Steven E. Slagle, Billings

Objectives: (1) To collect and compile data to describe ground-water conditions before and after mining. (2) To describe the relations between surface and ground water in the Fort Union Formation in mined areas and potential mine areas. (3) To establish an observation well network to detect water-level and quality-of-water changes in reclaimed and unmined areas.

Information products: Slagle, S. E., and Stimson, J. R., Hydrogeologic data for the northern Powder River Basin, southeastern Montana: U.S. Geological Survey Water-Resources Investigations report (in preparation).

Effects of Mining

(MT-048)

Location: Southeastern Montana

Period of project: July 1974 to June 1979

Project chief: Steven E. Slagle, Billings



Objectives: (1) To define and understand the regional and local flow systems in aquifers above the Pierre Shale. (2) To develop a semi-quantitative conceptual model as a basis for predictive models. (3) To develop predictive models to assess the effects of mining on water levels and the yield of wells and springs. (4) To develop "first estimate" water-quality models to predict rate and direction of movement of poor quality water from spoil banks and other sources. (5) To utilize all the models to evaluate and revise the data-collection program. (6) To assure that the data-collection and interpretation (modeling) programs meet the needs of other Federal and State agencies.

Information products: Knapton, J. R., and McKinley, P. W., 1977, Water quality of selected streams in the coal area of southeastern Montana: U.S. Geological Survey Water-Resources Investigations 77-80, 145 p.

Lewis, B. D., and Roberts, R. S., 1978, Geology and water-yielding characteristics of rocks of the northern Powder River Basin, southeastern Montana: U.S. Geological Survey Miscellaneous Investigations Map I-847-D. (Released as U.S. Geological Survey Open-File Report 77-75 pending publication.)

Lee, R. W., Geochemistry of water in the Fort Union Formation of the northern Powder River Basin, southeastern Montana: U.S. Geological Survey Water-Resources Investigations report (in review).

Lewis, B. D., and Hotchkiss, W. R., Thickness, percent sand, and configuration of shallow hydrogeologic units in the Powder River Basin, Montana and Wyoming: U.S. Geological Survey Miscellaneous Investigations Map (in review).

McKinley, P. W., Water quality of selected streams in the coal area of east-central Montana: U.S. Geological Survey Water-Resources Investigations report (in review).

Ferreira, R. F., Runoff characteristics of small drainage basins in the coal area of southeastern Montana: U.S. Geological Survey Water-Resources Investigations report (in preparation).

Knapton, J. R., and Ferreira, R. F., Statistical analyses of surface-water-quality variables in the coal area of southeastern Montana: U.S. Geological Survey Water-Resources Investigations report (in preparation).

Lee, R. W., Ground-water-quality data for the northern Powder River Basin, southeastern Montana: U.S. Geological Survey Open-File Report (in preparation).

Lee, R. W., Slagle, S. E., and Stimson, J. R., Hydrogeology and water quality of base flow of selected perennial streams of southeastern Montana: U.S. Geological Survey Water-Resources Investigations (in preparation).

Slagle, S. E., and others, Effects of mining and related activities on the shallow ground-water system, southeastern Montana: U.S. Geological Survey Water-Supply Paper (in preparation).

Coal-Lease Monitoring

(MT-059)

Location: Southeastern Montana

Period of project: February 1977 to September 1979

Project chief: Kathleen R. Wilke, Helena



Objectives: (1) To determine the characteristics of the regional water-resources system. (2) To detect and document changes in the system or in its components that may be associated with coal mining should changes occur.

Information products: Wilke, K. R., Surface- and ground-water data from southeastern Montana: U.S. Geological Survey Open-File Report (in preparation).

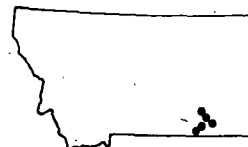
EMRIA Sites

(MT-066)

Location: Southeastern Montana

Period of project: October 1977 to September 1979

Project chief: Neal E. McClymonds, Helena



Objectives: (1) To collect hydrologic data at selected coal-lease application sites. (2) To evaluate potential hydrologic impacts of coal development at the sites. (3) To design monitoring networks to define baseline conditions and document changes in the hydrologic system associated with mining and reclamation.

Information products: Results of studies are planned for inclusion in EMRIA reports.

REGIONAL STUDIES

In addition to areal appraisals within the State, the Montana district of the Geological Survey participates in larger-scale studies of regional hydrologic systems. Because these studies transect State boundaries, coordination through the Regional Office is necessary to minimize duplication and assure compatibility of interpretations. The Montana district is currently participating in an analysis of the Northern Great Plains regional aquifer systems and an investigation of water from the Madison Limestone of Mississippian age.

A statewide regional study to collect and evaluate peak-flow data for small drainage areas has been underway since 1955. Information is evaluated to develop regional relationships for various climatic and geomorphic areas of the State.

Peak-Flow Analysis

(MT-010)

Location: Statewide

Period of project: Continuing

Project chief: Robert J. Omang, Helena



Objective: To collect adequate base data to enable definition, within a specified degree of accuracy, of the magnitude and frequency of floods to be expected from any given small drainage in Montana.

Information products: Johnson, M. V., and Omang, R. J., 1976, A method for estimating magnitude and frequency of floods in Montana: U.S. Geological Survey Open-File Report 75-650, 35 p.

Omang, R. J., and Hull, J. A., 1978, Annual peak discharges from small drainage areas in Montana through September 1977: U.S. Geological Survey Open-File Report 78-219, 204 p.

Omang, R. J., Hull, J. A., and Parrett, Charles, Annual peak discharges from small drainage areas in Montana for stations discontinued before 1978: U.S. Geological Survey Open-File Report (in preparation).

Omang, R. J., Parrett, Charles, and Hull, J. A., Annual peak discharges from small drainage areas in Montana through September 1978: U.S. Geological Survey Open-File Report (in preparation).

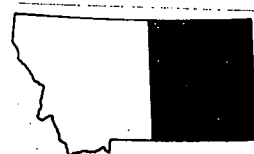
Madison Limestone

(MT-049)

Location: Eastern Montana

Period of project: July 1974 to September 1980

Project chief: W. Roger Miller, Billings



Objectives: (1) To evaluate the quantity and quality of water available from the aquifer using existing data. (2) To test various conceptual models to develop a reliable understanding of the aquifer. (3) To test drill at selected locations and make hydraulic tests of zones that appear capable of yielding water. (4) To extrapolate the data from the test holes, through geologic and geophysical studies, to large areas. (5) To use the information to describe water quality and potential availability. (6) To predict the consequences of alternative development plans for water use.

Information products: Miller, W. R., 1976, Water in carbonate rocks of the Madison Group in southeastern Montana--A preliminary evaluation: U.S. Geological Survey Water-Supply Paper 2043, 51 p.

Blankennagel, R. K., Miller, W. R., Brown, D. L., and Cushing E. M., 1977, Report on preliminary data for Madison test well No. 1, NE1/4 SE1/4 sec.15, T.57 N., R.65 W., Crook County, Wyoming: U.S. Geological Survey Open-File Report 77-164, Feb., 97 p.

Brown, D. L., Blankennagel, R. K., Busby, J. F., and Lee, R. W., 1977, Preliminary data for Madison Limestone test well 2, SE1/4 SE1/4 sec. 18, T.1 N., R.54 E., Custer County, Montana: U.S. Geological Survey Open-File Report 77-863, 135 p.

Konikow, L. F., 1978, Hydrologic considerations for an interstate groundwater compact on the Madison aquifer, Northern Great Plains: U.S. Geological Survey Open-File Report 78-138, 8 p.

Northern Great Plains

(MT-067)

Location: Eastern Montana

Period of project: October 1977 to September 1981

Project chief: William R. Hotchkiss, Helena



Objectives: (1) To compile and examine existing basic data and develop a program to selectively collect additional data. (2) To identify and map geohydrologic units and construct structure, tectonic, percent sand, transmissivity, and storage coefficient maps for each unit. (3) To prepare potentiometric, water-level change, and inter-aquifer head-difference maps for each unit. (4) To develop water budgets. (5) To describe water quality within the regional framework and define geochemical trends and anomalies. (6) To construct and calibrate regional and sub-regional models and interface with adjacent States.

Information products: A series of reports is planned to summarize the data and conclusions for various phases of the project.

RESEARCH PROJECTS

The Montana district program includes basic and applied research on various hydrologic principles. All projects directly or indirectly benefit from the results of research activities and contribute data needed in research programs. However, certain projects are primarily research-oriented and are designed to develop or apply new or unconventional hydrologic methods. Three such projects are currently underway.

Geothermal Hydrology

(MT-052)

Location: Southwestern Montana

Period of project: June 1975 to September 1979

Project chief: Robert B. Leonard, Helena



Objectives: (1) To describe the areal distribution, depth of occurrence, temperature, and chemical character of the thermal waters in part of southwestern Montana. (2) To determine the nature of the geologic controls on occurrence of the thermal waters. (3) To develop conceptual models of the hydrothermal flow systems to provide a rational basis for appraisal and potential development of the resource.

Information products: Leonard, R. B., Brosten, T. M., and Midtlyng, N. A., 1978, Selected data from thermal-spring areas, southwestern Montana: U.S. Geological Survey Open-File Report 78-438, 71 p.

Leonard, R. B., and Janzer, V. J., 1978, Natural radioactivity in geothermal waters, Alhambra Hot Springs and nearby areas, Jefferson County, Montana: U.S. Geological Survey Journal of Research v. 6, no. 4, p.529-540.

Leonard, R. B., Shields, R. R., and Midtlyng, N. A., 1978, Water-quality investigation near the Chico and Hunters geothermal lease-application areas, Park and Sweet Grass Counties, Montana: U.S. Geological Survey Open-File Report 78-199, 23 p.

Chadwick, R. A., and Leonard, R. B., Structural controls of hot-springs systems in southwestern Montana: U.S. Geological Survey Open-File Report (in review).

Leonard, R. B., and Chadwick, R. A., Geohydrologic characteristics of hot-spring areas in southwestern Montana: U.S. Geological Survey Professional Paper (in preparation).

Leonard, R. B., and Galloway, M. J., Geothermal water in fractured crystalline rocks in the Alhambra, Broadwater, and Marysville areas, Montana: U.S. Geological Survey Professional Paper (in preparation).

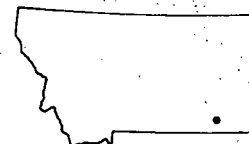
Stream-Response Modeling

(MT-065)

Location: Prairie Dog Creek

Period of project: October 1977 to September 1980

Project chief: Lawrence E. Cary, Billings



Objective: To develop a stream-response model capable of simulating effects of land-use changes on runoff. The model will include problems associated with (a) runoff and infiltration for frozen-ground conditions, (b) runoff from melting snow, (c) redistribution of snowpack, and (d) changes in base flow due to changes in ground-water flow pattern (if applicable).

Information products: A series of reports is planned to summarize the data, techniques, and conclusions for the project.

Channel Geometry

(MT-070)

Location: Statewide

Period of project: October 1978 to September 1980

Project chief: Robert J. Omang, Helena



Objectives: (1) To collect information on channel characteristics of selected streams in Montana. (2) To develop equations relating channel geometry to streamflow characteristics. (3) To statistically analyze the results from channel-geometry calculations to determine the accuracy of estimates.

Information products: A series of reports describing the results of the study is planned.

GRANT AND CONTRACT PROGRAM

In addition to the projects conducted by its own personnel, the Montana district administers grants and contracts to other agencies and universities to participate in hydrologic studies and perform research on particular problems. This program not only provides research essential to program operation, but it also greatly increases the district capabilities by utilizing expertise of personnel in other agencies. In the past, this program has funded test-drilling projects, research in stream biology, and development of computer programs for data storage and retrieval.

Geohydrologic Data in Fort Union Coal Region

Grantee: Montana Bureau of Mines and Geology

Project chief: Wayne A. Van Voast, Billings

Objectives: (1) To provide a ground-water data base from which an assessment can be made of the resource, future response to stress predicted, and pollution and supply problems predicted. (2) To provide a test-drilling program that can be directed by the U.S. Geological Survey to areas of critical need for hydrologic information or to areas of impending leasing.

Benthic Study of Streams

Grantee: Montana Department of Health and Environmental Sciences

Project chief: Duane A. Klarich, Billings

Objectives: (1) To obtain biological data on periphytic and macroinvertebrate components of stream benthos at selected sites in the southern part of the Fort Union coal region. (2) To assess the effects of salinity on stream biota. The study will attempt to provide information on potential effects of increased salinity resulting from mining activities on stream biota.

Sulfur-Cycle Study

Grantee: Montana State University

Project chief: Gordon McFeters, Bozeman

Objective: To determine what role bacteria play in the sulfur cycle. The project is based on observations that (a) sulfate concentrations in ground waters in the Fort Union coal region are relatively high and (b) sulfate reduction has been observed but the mechanism is poorly understood.

Water-Quality Data for Northern Great Plains

Grantee: Montana Bureau of Mines and Geology

Project chief: Marvin R. Miller, Butte

Objective: To compile ground-water-quality data for the Northern Great Plains region of Montana, verify the data, and place in a format compatible with the U.S. Geological Survey water-quality file.

Intermediate-Depth Drilling in Northern Great Plains

Grantee: Montana Bureau of Mines and Geology

Project chief: Wayne A. Van Voast, Billings

Objective: To drill hydrologic test holes at selected locations in the Northern Great Plains region of Montana, install casing, perform hydrologic tests, and collect ground-water samples.

REPORTS PUBLISHED OR RELEASED DURING PRECEDING
YEAR (OCTOBER 1977 THROUGH SEPTEMBER 1978)

- Boettcher, A. J., and Haralick, R. M., 1977, Use of thermal-infrared imagery in ground-water investigations in Montana, in Eleventh International Symposium on Remote Sensing of Environment Proceedings: Ann Arbor, Mich., Environmental Research Institute of Michigan, p. 1161-1170.
- Boettcher, A. J., and Wilke, K. R., 1978, Ground-water resources in the Libby area, northwestern Montana: Montana Bureau of Mines and Geology Bulletin 106, 36 p.
- Coffin, D. L., Reed, T. E., and Ayers, S. D., 1977, Water-level changes in wells along the west side of the Cedar Creek anticline, southeastern Montana: U.S. Geological Survey Water-Resources Investigations 77-93, 11 p.
- Hotchkiss, W. R., 1978, Developing a hydrologic model of the shallow aquifer of the Powder River Basin, Montana and Wyoming in Nichols, D. G., and others, eds., Energy and the environment: Fifth National Conference Proceedings, Cincinnati, published by Dayton Section, American Institute of Chemical Engineers, p. 212-217.
- Johnson, M. V., 1978, Floods of June 4 and 12, 1976, at Culbertson, Montana: U.S. Geological Survey Open-File Report 78-429, 6 p.
- Leonard, R. B., Brosten, T. M., and Midtlyng, N. A., 1978, Selected data from thermal-spring areas, southwestern Montana: U.S. Geological Survey Open-File Report 78-438, 71 p.
- Leonard, R. B., and Janzer, V. J., 1978, Natural radioactivity in geothermal waters, Alhambra Hot Springs and nearby areas, Jefferson County, Montana: U.S. Geological Survey Journal of Research, v. 6, no. 4, p. 529-540.
- Leonard, R. B., Shields, R. R., and Midtlyng, N. A., 1978, Water-quality investigation near the Chico and Hunters geothermal lease-application areas, Park and Sweet Grass Counties, Montana: U.S. Geological Survey Open-File Report 78-199, 23 p.
- Lewis, B. D., and Roberts, R. S., 1978, Geology and water-yielding characteristics of rocks of the northern Powder River Basin, southeastern Montana: U.S. Geological Survey Miscellaneous Investigations Map I-847-D, 2 sheets.
- Miller, W. R., 1978, Water resources of the central Powder River area of southeastern Montana: U.S. Geological Survey Open-File Report 78-237, 90 p.

Omang, R. J., and Hull, J. A., 1978, Annual peak discharges from small drainage areas in Montana through September 1977: U.S. Geological Survey Open-File Report 78-219, 204 p.

Wilke, K. R., and Johnson, M. V., 1978, Maps showing depth to water table, September 1976, and area inundated by the June 1975 flood, Helena valley, Lewis and Clark County, Montana: U.S. Geological Survey Open-File Map 78-110, 2 sheets.

Yellowstone River Compact Commission, 1977, Twenty-sixth annual report, Yellowstone River Compact Commission: Annual report, 26 p.

Table 1.--Surface-water gaging stations in operation as of October 1978

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. Locations of streamflow and major-reservoir stations are shown on figure 2; locations of stations for small reservoirs are not identified on the map.

Cooperation

BIA	U.S. Bureau of Indian Affairs
BLM	U.S. Bureau of Land Management
BPA	Bonneville Power Administration
FPC	Federal Energy Regulatory Commission
MDHES	Montana Department of Health and Environmental Sciences
MDNRC	Montana Department of Natural Resources and Conservation
MF&G	Montana Department of Fish and Game
MSU	Montana State University
USAE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USGS	U.S. Geological Survey
USGS-C	USGS--Contracted outside
WSE	Wyoming State Engineer
WWT	International Joint Commission Waterways Treaty

Operating office

- B - Records computed by Billings office
- F - Records computed by Fort Peck office
- H - Records computed by Helena office
- I - Records computed by International Waters Section, Helena office
- K - Records computed by Kalispell office

Gage equipment

- D - Digital recorder
- G - Graphic recorder
- M - Manometer (bubbler) gage
- O - Observer record only
- P - Electrical power
- S - Selsyn unit
- T - Telemark, BDT, satellite
- W - Well gage

Table 1.--Surface-water stations in operation as of October 1978--Continued

Station number	Station name	Cooperation	Operating office	Gage equipment
<u>Part 5</u>				
05014000	Grinnell Creek near Many Glacier	USGS	I	GW
05014500	Swiftcurrent Creek at Many Glacier	USGS	I	DW
05015500	Lake Sherburne at Sherburne	WWT	I	GM
05016000	Swiftcurrent Creek at Sherburne	WWT	I	DGW
05017500	St. Mary River near Babb	WWT	I	DGW
05018500	St. Mary Canal at St. Mary Crossing, near Babb	WWT	I	GW
05020500	St. Mary River at International boundary	WWT	I	GWT
<u>Part 6</u>				
06012000	Lima Reservoir near Monida	MDNRC	H	O
06012500	Red Rock River below Lima Reservoir, near Monida	USBR	H	DW
06013500	Big Sheep creek below Muddy Creek, near Dell	BLM	H	DGW
06014500	Red Rock River at Red Rock	USBR	H	DW
06015300	Clark Canyon Reservoir near Grant	USGS	H	G
06015400	Beaverhead River near Grant	USBR	H	DGW
06016000	Beaverhead River at Barretts	USGS	H	DGWP
06018000	Beaverhead River near Dillon	USBR	H	DGW
06018500	Beaverhead River near Twin Bridges	USGS	H	DGW
06019500	Ruby River above reservoir, near Alder	MDNRC	H	DW
06020500	Ruby River Reservoir near Alder	MDNRC	H	O
06020600	Ruby River below reservoir, near Alder	MDNRC	H	DW
06024590	Wise River near Wise River	MDNRC	H	DGW
06025500	Big Hole River near Melrose	USGS	H	DWTP
06035000	Willow Creek near Harrison	MDNRC	H	DW
06036000	Willow Creek Reservoir near Harrison	MDNRC	H	O
06036650	Jefferson River near Three Forks	MF&G	H	DGM
06038000	Hebgen Lake near West Yellowstone	FPC	H	O
06038500	Madison River below Hebgen Lake, near Grayling	FPC	H	DW
06038800	Madison River at Kirby Ranch, near Camerson	MF&G	H	O
06040300	Jack Creek near Ennis	MDNRC	H	GW
06040500	Ennis Lake near McAllister	FPC	H	O
06041000	Madison River below Ennis Lake near McAllister	FPC	H	DWGSP
06043500	Gallatin River near Gallatin Gateway	USAE	H	DGWT
06049500	Middle Creek Reservoir near Bozeman	MDNRC	H	O

Table 1.--Surface-water stations in operation as of October 1978--Continued

Station number	Station name	Cooperation	Operating office	Gage equipment
<u>Part 6--Continued</u>				
06050000	Hyalite Creek at Hyalite ranger station, near Bozeman	MDNRC	H	DGW
06052500	Gallatin River at Logan	USAE	H	DWTP
06054500	Missouri River at Toston	USGS	H	DGWT
06058500	Canyon Ferry Reservoir near Helena	USGS	H	GWSP
06062500	Tenmile Creek near Rimini	MSU	H	DGW
06064500	Lake Helena near Helena	FPC	H	O
06065000	Hauser Lake near Helena	FPC	H	O
06066000	Holter Lake near Wolf Creek	FPC	H	O
06066500	Missouri River below Holter Dam, near Wolf Creek	FPC	H	DGWSP
06075000	Smith River Reservoir near White Sulphur Springs	MDNRC	H	O
06076690	Smith River near Fort Logan	MF&G	H	DGM
06078200	Missouri River near Ulm	FPC	H	DW
06079500	Gibson Reservoir near Augusta	USBR	H	O
06080500	Pishkun Reservoir near Augusta	USBR	H	O
06080900	Sun River below diversion dam, near Augusta	USGS	H	DGM
06082000	Willow Creek Reservoir near Augusta	USBR	H	O
06083000	Nilan Reservoir near Augusta	MDNRC	H	O
06085800	Sun River at Simms	USGS	H	DGMT
06088300	Muddy Creek near Vaughn	USGS	H	DGM
06088500	Muddy Creek at Vaughn	USGS	H	DGM
06089000	Sun River near Vaughn	FPC	H	DGWP
06090300	Missouri River near Great Falls	FPC	H	DGMSP
06090500	Belt Creek near Monarch	USGS	H	DWP
06090800	Missouri River at Fort Benton	USGS	H	DGWTP
06090900	Lower Two Medicine Lake near East Glacier	MDNRC	H	O
06091700	Two Medicine River below South Fork Two Medicine River, near Browning	USGS	H	DGM
06093000	Four Horns Lake near Heart Butte	MDNRC	H	O
06093200	Badger Creek below Four Horns Canal, near Browning	USGS	H	DGW
06094000	Swift Reservoir near Dupuyer	MDNRC	H	O
06095500	Lake Frances near Valier	MDNRC	H	O
06098100	Birch Creek near Valier	USGS	H	DGM
06099500	Marias River near Shelby	USGS	H	DGMT
06101200	Willow Creek near Galata	MDNRC	H	GM
06101300	Tiber Reservoir near Chester	USGS	H	O
06101500	Marias River near Chester	USBR	H	DWT

Table 1.--Surface-water stations in operation as of October 1978--Continued

Station number	Station name	Cooperation	Operating office	Gage equipment
<u>Part 6--Continued</u>				
06101560	Pondera Coulee near Chester	MDNRC	H	GM
06108000	Teton River near Dutton	USGS	H	DGWTMP
06109500	Missouri River at Virgelle	USAE	H	DGWP
06109780	Middle Fork Judith River near Utica	USGS	H	DGM
06109800	South Fork Judith River near Utica	USGS	H	GW
06110500	Ackley Lake near Hobson	MDNRC	H	O
06115200	Missouri River near Landusky	USGS	B	DGMP
06115500	North Fork Musselshell River near Delpine	MDNRC	B	DW
06116500	Bair Reservoir near Delpine	MDNRC	H	O
06118500	South Fork Musselshell River above Martinsdale	MDNRC	B	DW
06119000	Martinsdale Reservoir near Martinsdale	MDNRC	H	O
06120500	Musselshell River at Harlowton	MDNRC	B	DGWT
06112500	Deadman's Basin Reservoir near Shawmut	MDNRC	H	O
06123500	Musselshell River near Ryegate	MDNRC	B	O
06126470	Half Breed Creek near Klein	BLM	B	GM
06126500	Musselshell River near Roundup	MDNRC	B	DGW
06127500	Musselshell River at Musselshell	MDNRC	B	DGW
06130500	Musselshell River at Mosby	MDNRC	B	O
06131000	Big Dry Creek near Van Norman	USAE	F	GW
06131200	Nelson Creek near Van Norman	BLM	F	GM
06131500	Fort Peck Lake at Fort Peck	USAE	H	GW
06132000	Missouri River below Fort Peck Dam	USGS	F	DGM
06132200	South Fork Milk River near Babb	WWT	I	DW
06133000	Milk River at western crossing of international boundary	WWT	I	GW
06133500	North Fork Milk River above St. Mary Canal, near Browning	WWT	I	DGW
06134000	North Milk River near international boundary	WWT	I	GW
06134500	Milk River at Milk River, Alberta	WWT	I	GWT
06134850	Milk River near Writing-on-Stone Provincial Park, Alberta	WWT	I	GW
06134950	Milk River near Pendant d'Oreille, Alberta	WWT	I	GM
06135000	Milk River at eastern crossing of international boundary	WWT	I	DGWT
06135500	Sage Creek at Q Ranch, near Wild Horse, Alberta	WWT	I	GW
06136000	Sage Creek at international boundary	WWT	I	GW
06136500	Fresno Reservoir near Havre	USBR	H	O
06137570	Boxelder Creek near Rocky Boy	USGS	H	DGW
06137580	Sage Creek near Whitlash	MDNRC	H	GW

Table 1.--Surface-water stations in operation as of October 1978--Continued

Station number	Station name	Coop- era- tion	Oper- ating office	Gage equip- ment
<u>Part 6--Continued</u>				
06140500	Milk River at Havre	USAE	H	O
06144100	Walburger Coulee near Govenlock, Saskatchewan	WWT	I	GW
06144260	Altawan Reservoir near Govenlock, Saskatchewan	WWT	I	GW
06144270	Spangler Ditch near Govenlock, Sask.	WWT	I	GW
06144350	Middle Creek near Alberta boundary	WWT	I	GW
06144360	Middle Creek Reservoir near Battle Creek, Saskatchewan	WWT	I	GM
06144395	Middle Creek below Middle Creek Reservoir, near Govenlock, Saskatchewan	WWT	I	GW
06145500	Lodge Creek below McRae Creek, at international boundary	WWT	I	GWT
06147950	Gaff Ditch near Merryflat, Saskatchewan	WWT	I	GW
06148500	Cypress Lake west inflow canal near West Plains, Saskatchewan	WWT	I	GW
06148700	Cypress Lake west inflow canal drain near Oxarat, Saskatchewan	WWT	I	GW
06149000	Cypress Lake west outflow canal near West Plains, Saskatchewan	WWT	I	GW
06149100	Vidora Ditch near Consul, Saskatchewan	WWT	I	GW
06149200	Richardson Ditch near Consul, Saskatchewan	WWT	I	GW
06149300	McKinnon Ditch near Consul, Saskatchewan	WWT	I	GW
06149400	Nashlyn Canal near Consul, Saskatchewan	WWT	I	GW
06149500	Battle Creek at international boundary	WWT	I	GWT
06151000	Lyons Creek at international boundary	WWT	I	GW
06154400	Peoples Creek near Hays	USGS	F	DGW
06154410	Little Peoples Creek near Hays	USGS	F	GM
06155000	Nelson Reservoir near Saco	USBR	H	O
06156000	Whitewater Creek near international boundary	WWT	I	GW
06156500	Belanger Creek diversion canal near Vidora, Saskatchewan	WWT	I	GW
06157000	Cypress Lake near Vidora, Saskatchewan	WWT	I	GW
06157500	Cypress Lake east outflow canal near Vidora, Saskatchewan	WWT	I	GW
06158500	Eastend Canal at Eastend, Saskatchewan	WWT	I	GW
06159000	Eastend Reservoir at Eastend, Saskatchewan	WWT	I	O
06159500	Frenchman River below Eastend Reservoir, near Eastend, Saskatchewan	WWT	I	GW

Table 1.--Surface-water stations in operation as of October 1978--Continued

Station number	Station name	Coop- era- tion	Oper- ating office	Gage equip- ment
<u>Part 6--Continued</u>				
06161300	Val Marie west pumping canal near Val Marie, Saskatchewan	WWT	I	GW
06161500	Val Marie west gravity canal near Val Marie, Saskatchewan	WWT	I	GW
06162000	Val Marie West Reservoir near Val Marie, Saskatchewan	WWT	I	GW
06162500	Val Marie Main Canal near Val Marie, Saskatchewan	WWT	I	GW
06163000	Val Marie Reservoir near Val Marie, Saskatchewan	WWT	I	GM
06163050	Frenchman River below Val Marie Reservoir, near Val Marie, Saskatchewan	WWT	I	GW
06163400	Denniel Creek near Val Marie, Saskatchewan	WWT	I	GW
06164000	Frenchman River at international boundary	WWT	I	GW
06164510	Milk River at Juneberg Bridge, near Saco	USBR	F	GM
06164800	Beaver Creek above Dix Creek, near Malta	MDNRC	F	GW
06169500	Rock Creek below Horse Creek, near international boundary	WWT	I	DGW
06174000	Willow Creek near Glasgow	USGS	F	GW
06174500	Milk River at Nashua	USAE	F	DGW
06175540	Prairie Elk Creek near Oswego	BLM	F	GM
06177000	Missouri River near Wolf Point	USAE	F	DGW
06177500	Redwater River at Circle	USGS	F	DGW
06177825	Redwater River near Vida	USGS-C	F	GM
06178000	Poplar River at international boundary	WWT	I	DGWT
06178500	East Poplar River at international boundary	WWT	I	DGW
06179000	East Fork Poplar River near Scobey	MDNRC	F	DGM
06181000	Poplar River near Poplar	MDNRC	F	GW
06181995	Beaver Creek at international boundary	WWT	F	GW
06183450	Big Muddy Creek near Antelope	USGS	F	GM
06185500	Missouri River near Culbertson	USAE	F	DGM
06186000	Yellowstone Lake at Bridge Bay, Yellowstone National Park	USGS	B	O
06186500	Yellowstone River at Yellowstone Lake Outlet, Yellowstone National Park	USGS	B	GW
06191500	Yellowstone River at Corwin Springs	USAE	B	GWT
06191800	Big Creek near Emigrant	MDNRC	B	DW
06192500	Yellowstone River near Livingston	USAE	B	DGWT
06195600	Shields River near Livingston	MF&G	B	DGM
06200000	Boulder River at Big Timber	MDNRC	B	DGWT
06204000	Mystic Lake near Roscoe	FPC	H	O
06204050	West Rosebud Creek near Roscoe	FPC	B	GDW

Table 1.--Surface-water stations in operation as of October 1978--Continued

Station number	Station name	Cooperation	Operating office	Gage equipment
<u>Part 6 - Continued</u>				
06205000	Stillwater River near Absarokee	USAE	B	DWT
06207500	Clarks Fork Yellowstone River near Belfry	MDNRC	B	DW
06208800	Clarks Fork Yellowstone River near Silesia	MDNRC,WSE	B	DGW
06209500	Rock Creek near Red Lodge	MDNRC	B	GW
06211000	Red Lodge Creek above Cooney Reservoir, near Boyd	MDNRC	B	DW
06211500	Willow Creek near Boyd	MDNRC	B	DW
06212000	Cooney Reservoir near Boyd	MDNRC	H	O
06212500	Red Lodge Creek below Cooney Reservoir, near Boyd	MDNRC	B	DW
06214500	Yellowstone River at Billings	USAE	B	DGWMT
06216000	Pryor Creek at Pryor	USGS	B	DW
06216900	Pryor Creek near Huntley	USGS	B	DGM
06217750	Fly Creek at Pompeys Pillar	USGS	B	O
06286400	Bighorn Lake near St. Xavier	USGS	H	GW
06287000	Bighorn River near St. Xavier	USBR	B	DGW
06289000	Little Bighorn River at State line, near Wyola	USGS	B	DGW
06290500	Little Bighorn River below Pass Creek, near Wyola	USGS	B	DGW
06294000	Little Bighorn River near Hardin	MDNRC,WSE	B	DGMT
06294690	Tullock Creek near Bighorn	MDNRC	B	GM
06294700	Bighorn River at Bighorn	MDNRC,WSE	B	DGW
06294940	Sarpy Creek near Hysham	MDNRC	B	DGW
06294995	Armells Creek near Forsyth	MDNRC	B	GW
06295000	Yellowstone River at Forsyth	MDNRC	B	DGM
06295250	Rosebud Creek near Colstrip	USGS	B	GM
06296003	Rosebud Creek at mouth, near Rosebud	USGS	B	GM
06306100	Squirrel Creek near Decker	BLM	B	GM
06306250	Prairie Dog Creek near Acme, Wyoming	MDNRC,WSE	B	DW
06306300	Tongue River at State line, near Decker	MDNRC	B	DW
06307000	Tongue River Reservoir near Decker	MDNRC	H	O
06307500	Tongue River at Tongue River Dam, near Decker	MDNRC	B	DW
06307560	East Trail Creek near Otter	BLM	B	GM
06307600	Hanging Woman Creek near Birney	MDNRC	B	DGW
06307740	Otter Creek at Ashland	MDNRC	B	DW
06307830	Tongue River below Brandenberg Bridge, near Ashland	MDNRC	B	DGW
06308400	Pumpkin Creek near Miles City	MDNRC	B	DW
06308500	Tongue River at Miles City	MDNRC,WSE	B	DGW
06309000	Yellowstone River at Miles City	USAE	B	DGWT

Table 1.--Surface-water stations in operation as of October 1978--Continued

Station number	Station name	Cooperation	Operating office	Gage equipment
<u>Part 6--Continued</u>				
06309075	Sunday Creek near Miles City	MDNRC	B	GDM
06324500	Powder River at Moorhead	MDNRC	B	DGW
06324710	Powder River at Broadus	USGS	B	DGM
06326300	Mizpah Creek near Mizpah	BLM	B	DGM
06326500	Powder River near Locate	MDNRC,WSE	B	DGMT
06326600	O'Fallon Creek near Ismay	USGS-C	B	DGM
06329200	Burns Creek near Savage	BLM	F	GM
06329500	Yellowstone River near Sidney	USAE	F	DGM
06336500	Beaver Creek at Wibaux	BLM	F	GM
<u>Part 12</u>				
12301300	Tobacco River near Eureka	USAE	K	DGW
12301550	Pinkham Creek near Rexford	USAE	K	GWM
12301810	Big Creek near Rexford	USAE	K	GWM
12301920	Lake Koocanusa near Libby	USAE	K	GW
12301933	Kootenai River below Libby Dam, near Libby	USAE	K	DGM
12302055	Fisher River near Libby	USAE	K	DCW
12303000	Kootenai River at Libby	USAE	K	DGWT
12303100	Flower Creek near Libby	MSU	K	GW
12304500	Yaak River near Troy	USAE	K	DGWT
12323750	Silver Bow Creek at Warm Springs	MDHES	H	DGM
12324200	Clark Fork at Deer Lodge	USGS	H	DGM
12324590	Little Blackfoot River near Garrison	MDNRC	H	DGW
12324680	Clark Fork at Goldcreek	MF&G	H	DGM
12325000	Georgetown Lake near Southern Cross	FPC	H	0
12325500	Flint Creek near Southern Cross	FPC	H	0
12329500	Flint Creek at Maxville	MDNRC	H	DGW
12330000	Boulder Creek at Maxville	MDNRC	H	0
12331600	Clark Fork at Drummond	MDNRC	H	0
12332000	Middle Fork Rock Creek near Philipsburg	MDNRC	H	DGW
12332500	East Fork Rock Creek Reservoir near Philipsburg	MDNRC	H	0
12334510	Rock Creek near Clinton	MDNRC	H	DGWP
12335500	Nevada Creek above reservoir, near Finn	MDNRC	H	DW
12336500	Nevada Creek Reservoir near Finn	MDNRC	H	0
12338690	Monture Creek near Ovando	MDNRC	H	DGW
12339450	Clearwater River near Clearwater	MDNRC	K	GW
12340000	Blackfoot River near Bonner	USGS	K	DGWT
12340500	Clark Fork above Missoula	USAE	K	DGWT
12342000	Painted Rocks Lake near Conner	MDNRC	H	0

Table 1.--Surface-water stations in operation as of October 1978--Continued

Station number	Station name	Coop- era- tion	Oper- ating office	Gage equip- ment
<u>Part 12--Continued</u>				
12342500	West Fork Bitterroot River near Conner	MDNRC	K	DGW
12344000	Bitterroot River near Darby	MDNRC	K	DGWTS
12344500	Lake Como near Darby	MDNRC	H	O
12346500	Skalkaho Creek near Hamilton	MDNRC	K	GW
12353000	Clark Fork below Missoula	MDHES	K	DGWT
12353280	Ninemile Creek near Huson	MDNRC	K	GW
12354500	Clark Fork at St. Regis	USGS	K	DGWT
12355000	Flathead River at Flathead, British Columbia	WWT	K	GM
12355500	North Fork Flathead River near Columbia Falls	USGS	K	DGMS
12358500	Middle Fork Flathead River near West Glacier	BPA	K	DGWT
12359800	South Fork Flathead River above Twin Creek near Hungry Horse	BPA	K	DGWS
12362000	Hungry Horse Reservoir near Hungry Horse	USBR	K	GW
12362500	South Fork Flathead River near Columbia Falls	USBR	K	DGW
12363000	Flathead River at Columbia Falls	FPC	K	DGWT
12363920	Stillwater River at Olney	MDNRC	K	O
12365000	Stillwater River near Whitefish	MDNRC	K	GW
12365800	Swift Creek near Whitefish	MDNRC	K	GW
12366000	Whitefish River near Kalispell	MDNRC	K	GW
12369200	Swan River near Condon	MDNRC	K	GW
12370000	Swan River near Bigfork	BPA	K	DGW
12371500	Flathead Lake at Somers	FPC	K	GW
12372000	Flathead River near Polson	FPC	K	DGW
	Camas Reservoirs - Group of 4	BIA	H	O
	Mission Valley Reservoirs - Group of 8	BIA	H	O
12380500	Lower Jocko Lake near Arlee	BIA	H	O
12389000	Clark Fork near Plains	FPC	K	DGWT
12389500	Thompson River near Thompson Falls	FPC	K	DGW
12390000	Thompson Falls Reservoir at Thompson Falls	FPC	H	O
12390700	Prospect Creek at Thompson Falls	FPC	K	DGW
12391300	Noxon Rapids Reservoir near Noxon	FPC	H	GW
12391400	Clark Fork below Noxon Rapids Dam, near Noxon	FPC	H	O
12391550	Bull River near Noxon	MDNRC	K	GM

Table 2.--Surface-water-quality stations in operation as of October 1978

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. Locations of the stations are shown on figure 3.

Cooperation

BLM	U.S. Bureau of Land Management
BPA	Bonneville Power Administration
EPA	U.S. Environmental Protection Agency
MF&G	Montana Department of Fish and Game
USAE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USGS	U.S. Geological Survey
USGS-C	USGS--Contracted outside
WWT	International Joint Commission Waterways Treaty

Operating office

B - Data collected by Billings office
 F - Data collected by Fort Peck office
 H - Data collected by Helena office
 I - Data collected by International Waters
 Section, Helena office
 K - Data collected by Kalispell office

Sampling frequency

0	Once-daily, continuous
1	Once-daily, seasonal
2	Semimonthly
3	Monthly, seasonal
4	Monthly
5	Miscellaneous
6	Continuous record

Table 2.--Water-quality stations in operation as of October 1978--Continued

Station number	Station name	Coop- era- tion	Oper- ating office	Chem- ical	Sampling frequency			Spec- ific con- duc- tance
					Sedi- ment	Tem- pera- ture	Bio- log- ical	
<u>Part 5</u>								
05020500	St. Mary River at international boundary	USGS	H	4	4	4	4	0
<u>Part 6</u>								
06013500	Big Sheep Creek below Muddy Creek near Dell	BLM	H	-	1	1	-	-
06018500	Beaverhead River near Twin Bridges	USGS	H	4	-	0	-	0
06025500	Big Hole River near Melrose	MF&G	H	-	-	6	-	-
06041000	Madison River below Ennis Lake, near McAllister	MF&G	H	-	-	6	-	-
06054500	Missouri River at Toston	USGS, MF&G	H	4	4	6	4	0
06058502	Missouri River below Canyon Ferry Dam near Helena	USGS	H	4	-	0	-	0
06080900	Sun River below diversion dam, near Augusta	USGS	H	4	-	0	-	0
06088300	Muddy Creek near Vaughn	USGS	H	4	0	0	-	0
06088500	Muddy Creek at Vaughn	USGS	H	4	0	0	-	0
06089000	Sun River near Vaughn	USGS	H	4	-	0	-	0
06090500	Belt Creek near Monarch	MF&G	H	-	-	6	-	-
06098100	Birch Creek near Valier	USGS	H	4	-	0	-	0
06101500	Marias River near Chester	USGS	H	4	4	4	4	0
06109500	Missouri River at Virgelle	USGS, MF&G	H	4	4	6	4	0
06115200	Missouri River near Landusky	USAE, MF&G	B	-	0	5	-	-
06126450	Rehder Coulee near Klein	BLM	B	4	4	4	-	4
06126470	Half Breed Creek near Klein	BLM	B	4	4	4	-	4
06126500	Musselshell River near Roundup	BLM	B	4	4	4	-	4
06127150	East Parrot Creek near Roundup	BLM	B	4	4	4	-	4
06127160	West Parrot Creek near Roundup	BLM	B	4	4	4	-	4
06127300	Fattig Creek near Delphia	BLM	B	4	4	4	-	4
06130500	Musselshell River at Mosby	USGS	B	4	4	0	3	0
06130935	Crow Rock Creek near Cohagen	USGS-C	-	3	3	3	3	3
06131120	Timber Creek near Van Norman	BLM	F	4	4	4	-	4
06131200	Nelson Creek near Van Norman	BLM	F	4	4	4	-	4
06132000	Missouri River below Fort Peck Dam	USGS	F	4	4	0	4	0

Table 2.--Water-quality stations in operation as of October 1978--Continued

Station number	Station name	Coop- era- tion	Oper- ating office	Chem- ical	Sampling frequency				Spec- ific con- duc- tance
					Sedi- ment	Tem- per- ature	Bio- log- ical		
<u>Part 6--Continued</u>									
06137570	Boxelder Creek near Rocky Boy	USGS	H	5	5	5	-	5	
06145500	Lodge Creek below McRae Creek at international boundary	WWT	I	5	-	-	-	-	
06154410	Little Peoples Creek near Hays	USGS	F	5	5	5	-	5	
06156000	Whitewater Creek near international boundary	WWT	I	5	-	-	-	-	
06164510	Milk River at Juneburg Bridge, near Saco	USGS	F	4	-	0	-	0	
06169500	Rock Creek below Horse Creek at international boundary	WWT	F	4	4	4	4	4	
06170000	McEachern Creek at international boundary	WWT	F	5	-	-	-	-	
06174500	Milk River at Nashua	USGS	F	4	4	0	4	0	
06175540	Prairie Elk Creek near Oswego	BLM	F	4	4	4	-	4	
06177500	Redwater River at Circle	USGS	F	4	4	4	-	4	
06177520	Horse Creek near Circle	BLM	F	4	4	4	-	4	
06177825	Redwater River near Vida	USGS	F	4	4	4	-	4	
06178000	Poplar River at international boundary	EPA	F	4	4	4	-	4	
06178150	Poplar River near Scobey	EPA	F	4	4	4	-	4	
06178500	East Poplar River at international boundary	WWT	F	4	4	6	4	4	
06179000	East Fork Poplar River near Scobey	EPA	F	4	4	6	-	4	
06179200	Poplar River above West Fork near Bredette	EPA	F	4	4	4	-	4	
06179500	West Fork Poplar River at international boundary	EPA	F	4	4	4	-	4	
06180400	West Fork Poplar River near Bredette	EPA	F	4	4	4	-	4	
06181000	Poplar River near Poplar	EPA	F	4	4	4	-	4	
06181995	Beaver Creek at international boundary	USGS	F	5	5	5	-	5	
06183450	Big Muddy Creek near Antelope	USGS	F	5	5	5	-	5	
06185500	Missouri River near Culbertson	USGS	F	4	4	0	4	0	
06191500	Yellowstone River at Corwin Springs	MF&G	B	-	-	6	-	-	
06192500	Yellowstone River near Livingston	USGS, MF&G	B	4	-	6	-	0	
06205200	Yellowstone River at Laurel	EPA	B	2	-	2	2	2	

Table 2.--Water-quality stations in operation as of October 1978--Continued

Station number	Station name	Coop- era- tion	Oper- ating office	Sampling frequency				
				Chem- ical	Sedi- ment	Tem- per- ature	Bio- log- ical	Spec- ific con- duc- tance
<u>Part 6--Continued</u>								
06208800	Clarks Fork Yellowstone River near Silesia	MF&G	B	-	-	6	-	-
06214500	Yellowstone River at Billings	USGS	B	4	0	0	4	0
06217500	Yellowstone River at Huntley	EPA	B	2	4	2	2	2
06217750	Fly Creek at Pompeys Pillar	USGS	B	4	-	0	-	0
06287000	Bighorn River near St. Xavier	USGS	B	4	-	0	-	0
06294000	Little Bighorn River near Hardin	USGS	B	4	-	0	-	0
06294700	Bighorn River at Bighorn	USGS, MF&G	B	4	4	6	4	0
06294940	Sarpy Creek near Hysham	BLM	B	4	4	4	-	4
06294980	East Fork Armells Creek near Colstrip	USGS	B	4	4	4	-	4
06294995	Armells Creek near Forsyth	USGS	B	4	4	4	-	4
06295000	Yellowstone River at Forsyth	EPA	B	4	0	0	3	4
06295110	Rosebud Creek near Kirby	BLM	B	4	4	4	-	4
06295250	Rosebud Creek near Colstrip	USGS	B	4	4	4	-	4
06295420	Snyder Creek near Brandenburg	BLM	B	4	4	4	-	4
06296003	Rosebud Creek at mouth near Rosebud	USGS	B	4	4	4	-	4
06296120	Yellowstone River near Miles City	EPA, USGS	B	2	4	0	2	0
06306100	Squirrel Creek near Decker	BLM	B	4	4	4	-	4
06306900	Spring Creek near Decker	BLM	B	4	4	4	-	4
06307500	Tongue River at Tongue River Dam, near Decker	USGS	B	4	4	4	-	4
06307528	Prairie Dog Creek near Birney	BLM	B	4	4	4	-	4
06307560	East Fork Trail Creek near Otter	BLM	B	4	4	4	-	4
06307570	Hanging Woman Creek below Horse Creek, near Birney	EPA	B	4	4	4	-	4
06307600	Hanging Woman Creek near Birney	BLM	B	4	4	4	-	4
06307610	Tongue River below Hanging Woman Creek, near Birney	EPA	B	4	4	4	3	4
06307665	Otter Creek near Otter	BLM	B	4	4	4	-	4
06307717	Otter Creek below Fifteenmile Creek, near Otter	BLM	B	4	4	4	-	4
06307735	Home Creek near Ashland	BLM	B	4	4	4	-	4
06307740	Otter Creek at Ashland	BLM	B	4	4	4	-	4
06307830	Tongue River below Brandenburg Bridge, near Ashland	BLM	B	4	0	0	-	4
06308160	Pumpkin Creek near Loesch	BLM	B	4	4	4	-	4
06308400	Pumpkin Creek near Miles City	BLM	B	4	4	4	-	4

Table 2.--Water-quality stations in operation as of October 1978--Continued

Station number	Station name	Coop- era- tion	Opera- ating office	Sampling frequency				Spec- ific con- duc- tance
				Chem- ical	Sedi- ment	Tem- pera- ture	Bio- log- ical	
<u>Part 6--Continued</u>								
06308500	Tongue River at Miles City	USGS	B	4	0	6	3	0
06309000	Yellowstone River at Miles City	MF&G	B	-	-	6	-	-
06309079	Muster Creek near Kinsey	USGS-C	-	3	3	3	3	3
06309145	Custer Creek near Kinsey	USGS-C	-	3	3	3	3	3
06324500	Powder River at Moorhead	USGS, EPA	B	4	4	4	-	4
06326050	Mizpah Creek at Olive	BLM	B	4	4	4	-	4
06326300	Mizpah Creek near Mizpah	BLM	B	4	4	4	-	4
06326500	Powder River near Locate	USGS, MF&G	B	4	1	6	4	0
06326530	Yellowstone River near Terry	EPA	B	4	4	4	3	4
06326555	Cherry Creek near Terry	BLM	B	4	4	4	-	4
06326600	O'Fallon Creek near Ismay	USGS-C	-	4	4	4	4	4
06326953	Clear Creek near Hoyt	USGS-C	-	3	3	3	3	3
06326995	Upper Sevenmile Creek near Lindsay	USGS-C	-	3	3	3	3	3
06327850	Glendive Creek near Glendive	BLM	F	4	4	4	-	4
06328000	Deer Creek near Glendive	USGS-C	-	3	3	3	3	3
06329000	Cottonwood Creek near Intake	BLM	F	4	4	4	-	4
06329200	Burns Creek near Savage	BLM	F	4	4	4	-	4
06329500	Yellowstone River near Sidney	EPA, USGS, MF&G	F	2	0	6	2	0
--	Huntley Project Dam No. 7 near Worden	USBR	B	4	-	4	-	4
<u>Part 12</u>								
12300110	Lake Koocanusa at international boundary	USAE	K	2	-	2	2	2
12301300	Tobacco River near Eureka	USAE	K	-	-	6	-	-
12301830	Lake Koocanusa at Tenmile Creek, near Libby	USAE	K	2	-	2	2	2
12301919	Lake Koocanusa at Forebay, near Libby	USAE	K	2	-	2	2	2
12301933	Kootenai River below Libby Dam, near Libby	USAE	K	2	-	6	-	2
12302055	Fisher River near Libby	USAE	K	-	-	6	-	-
12304500	Yaak River near Troy	USAE	K	-	-	6	-	-

Table 2.--Water-quality stations in operation as of October 1978--Continued

Station number	Station name	Coop- era- tion	Oper- ating office	Sampling frequency					Spec- ific con- duc- tance
				Chem- ical	Sedi- ment	Tem- per- ature	Bio- log- ical		
<u>Part 12--continued</u>									
12324200	Clark Fork at Deer Lodge	MF&G	K	-	-	6	-	-	
12340500	Clark Fork above Missoula	MF&G	K	-	-	6	-	-	
12353000	Clark Fork below Missoula	MF&G	K	4	4	6	4	0	
12355000	Flathead River at Flathead, British Columbia	USGS, MF&G	K	4	4	6	4	0	
12359800	South Fork Flathead River above Twin Creek near Hungry Horse	BPA	K	-	-	6	-	-	
12365000	Stillwater River near Whitefish	MF&G	K	-	-	6	-	-	
12365800	Swift Creek near Whitefish	MF&G	K	-	-	6	-	-	
12366000	Whitefish River near Kalispell	MF&G	K	-	-	6	-	-	
12372000	Flathead River near Polson	MF&G	K	-	-	6	-	-	
12389000	Clark Fork near Plains	BPA	K	-	-	6	-	-	
12389500	Thompson River near Thompson Falls	MF&G	K	-	-	6	-	-	
12391550	Bull River near Noxon	MF&G	K	-	-	6	-	-	

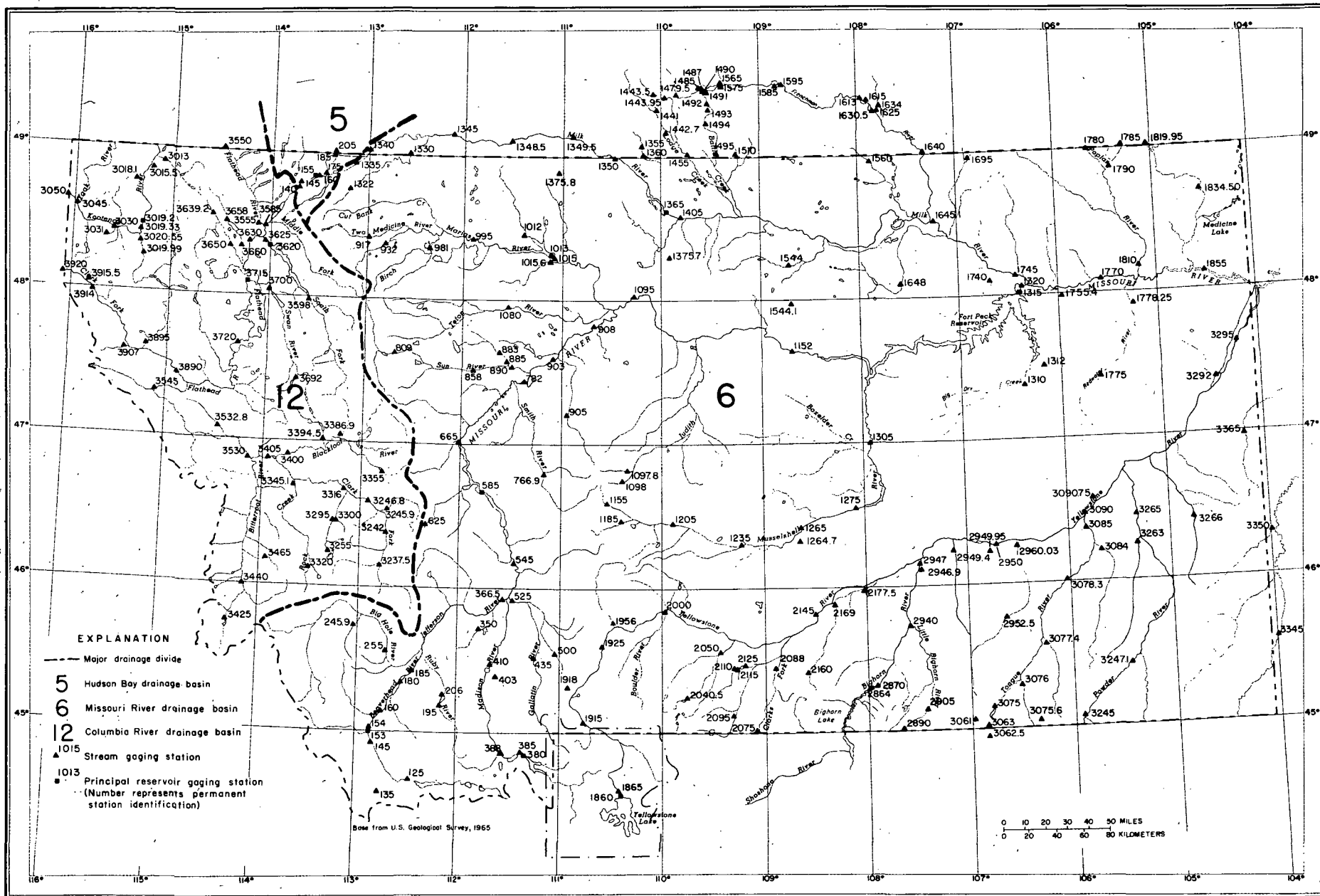


Figure 2.--Locations of surface-water gaging stations, October 1978.

