WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN SOUTH DAKOTA--FISCAL YEARS 1987-88

Compiled by Ella M. Decker

U.S. GEOLOGICAL SURVEY

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Huron, South Dakota
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DEPARTMENT OF THE INTERIOR

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CONVERSION FACTORS

The inch-pound units used in this report may be converted to metric units by the following conversion factors:

Multiply	By	To obtain
acre-foot	1,233	cubic meter
cubic foot per second	0.028317	cubic meter per second
foot per day	0.3048	meter per day
inch	25.40	millimeter
square foot	0.0920	square meter
square mile	2.590	square kilometer

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THE U.S. GEOLOGICAL SURVEY

The U.S. Geological Survey (USGS) 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 the 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 USGS has grown and been modified to meet the changing needs of the Nation it serves. As part of that evolution, the USGS has become the Federal Government's largest earth-science research agency, the Nation's largest civilian map-making 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. Today programs serve a diversity of needs and users. Programs include:

* Conducting detailed assessments of the energy and mineral potential of the Nation's land and offshore areas.

* Investigating and issuing warnings of earthquakes, volcanic eruptions, landslides, and other geologic and hydrologic hazards.

* Conducting research on the geologic structure of the Nation.

* Studying the geologic features, structure, processes, and history of the other planets of our solar system.

* Conducting topographic surveys of the Nation and preparing topographic and thematic maps and related cartographic products.

* Developing and producing digital cartographic data bases and products.

* Collecting data on a routine basis to determine the quantity, quality, and use of surface and ground water.

* Conducting water-resource appraisals in order 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 USGS 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."

THE WATER RESOURCES DIVISION

The mission of the U.S. Geological Survey's Water Resources Division is to provide the hydrologic information and understanding needed for the optimum use and management of the Nation's water resources for the overall benefit of the people of the United States. For more than 100 years, the U.S. Geological Survey has studied the occurrence, quantity, quality, distribution, and movement of the surface and underground water that composes the Nation's water resources. As the principal Federal water-data agency, the Geological Survey collects and disseminates about 70 percent of the water data currently being used by numerous State, local, private, and other Federal agencies to develop and manage our water resources. This nationwide program, which is carried out through the Water Resources Division's 43 District offices and 4 Regional offices, includes the collection, analysis, and dissemination of hydrologic data and water-use information, areal resource appraisals and other interpretive studies, and research projects. Much of this work is a cooperative effort in which planning and financial support are shared by State and local governments and other Federal agencies.

The Geological Survey, through its Office of Water Data Coordination (OWDC), also coordinates the water-data-acquisition activities of other Federal agencies. Information on these Federal activities is made available to all users of water data by means of a national network of assistance centers managed by the Geological Survey's National Water Data Exchange (NAWDEX). In South Dakota, NAWDEX services can be obtained from the District Chief, U.S. Geological Survey, Water Resources Division, Federal Building, Huron, SD 57350. A leaflet explaining NAWDEX services is available from the Assistance Center or from the NAWDEX Program Office, U.S. Geological Survey, 421 National Center, Reston, VA 22092.

HISTORICAL SUMMARY - SOUTH DAKOTA DISTRICT

During 1979, the U.S. Geological Survey observed its 100th anniversary. In South Dakota, the first collection of streamflow data by the U.S. Geological Survey was in 1903. The early records collected during 1903-06 were from Black Hills area streams, and from 1912-20 data were collected at sites in the Standing Rock, Rosebud, and Pine Ridge Indian Reservations. During 1928-30, the U.S. Army Corps of Engineers provided financial support for the establishment and operation of 18 gaging stations in the Missouri River basin in South Dakota. One station has been in operation on the Missouri River continuously since 1930.

Despite its early beginning, it was not until October 16, 1944, that the Bismarck District, comprising the states of North Dakota and South Dakota, was created to assess the water resources of the two states with R. E. Marsh

as District Engineer. To operate the South Dakota stream-gaging stations, a subdistrict office, with W. M. Littlefield in charge, was established in Pierre, South Dakota. The Pierre office was virtually independent of Bismarck, except for major questions of policy. Marsh and Littlefield were the only experienced men in the District yet it was a period of expansion and in less than three years the number of stream-gaging stations increased from 28 to 63. A second subdistrict office in South Dakota was later opened in Rapid City to establish and maintain stations on streams and ditches in the Black Hills area.

The next major increase in collection of surface-water records occurred during the mid-1940's as a result of the Pick-Sloan Plan for Missouri Basin development. Most of the stations established during this period were financed by Interior Department Missouri Basin funds and were primarily associated with U.S. Bureau of Reclamation studies.

Attempts had been made by State officials at various times to obtain State funds for cooperation in stream gaging but without success as the Legislature, reflecting the attitude of the citizens, was not water-minded. However, in 1944, the new Governor became convinced that with the proposed development of the Missouri Basin, then coming actively into the picture, the State should participate in the inventory of its water resources. Having no specific appropriation for that purpose, he decided that a number of State agencies should contribute from their general funds, and as the work would be done in cooperation with the U.S. Geological Survey, it seemed logical to him that the State Geological Survey should be designated as the cooperating State agency. Accordingly, that agency, the Highway Commission, and the Department of Game and Fish, each contributed equal amounts of funding totaling $2,400 for the years 1944 and 1945. By 1958 the cooperative surface-water program had grown to $57,000 in cooperation with the State Water Resources Commission. The network of gaging stations has continued to expand and presently records of daily flow are collected at about 144 sites.

In addition, in 1955, a cooperative program was begun with the South Dakota Highway Commission to determine the magnitude and frequency of floods in South Dakota. It was recognized that hydrologic data for floods from small drainage areas were lacking and provision was made for establishment of approximately 60 crest-stage gages in 16 areas in the State, mostly on basins of less than 10 square miles.

The State Geologist started a small observation-well program in 1936, and in the fall of 1939, he began cooperation with the USGS for the purpose of enlarging that program; $400 was allotted annually through the fiscal year 1945, when cooperation ceased. At that time, Missouri Basin funds for ground-water investigations became available.

A formal program of ground-water investigation was begun in South Dakota in 1946, with investigations in a proposed unit of the Oahe Irrigation Project. The Oahe Unit studies were begun under the supervision of the district engineer at Bismarck, North Dakota. A field office was established in Huron on May 13, 1947. This office conducted the ground-water activities while surface-water activities in South Dakota continued to be supervised from the Bismarck office. The early ground-water studies were made in cooperation with the U.S. Bureau of Reclamation (USBR) and were financed by funds appropriated for studies in the Missouri River basin. In addition to the long-range investigations in the Oahe area, several smaller projects were initiated in cooperation with the USBR between 1946 and 1956. The first

ground-water studies in South Dakota utilizing the State-Federal Cooperative Program began in 1955 when the South Dakota State Water Resources Commission entered into a cooperative agreement with the U.S. Geological Survey to investigate the large and wasteful uncontrolled flow from artesian wells throughout the State. In 1958, the South Dakota State Geological Survey entered into a cooperative agreement for a study of ground-water resources with particular emphasis to be placed upon the determination of ground-water resources primarily in the eastern counties of the State.

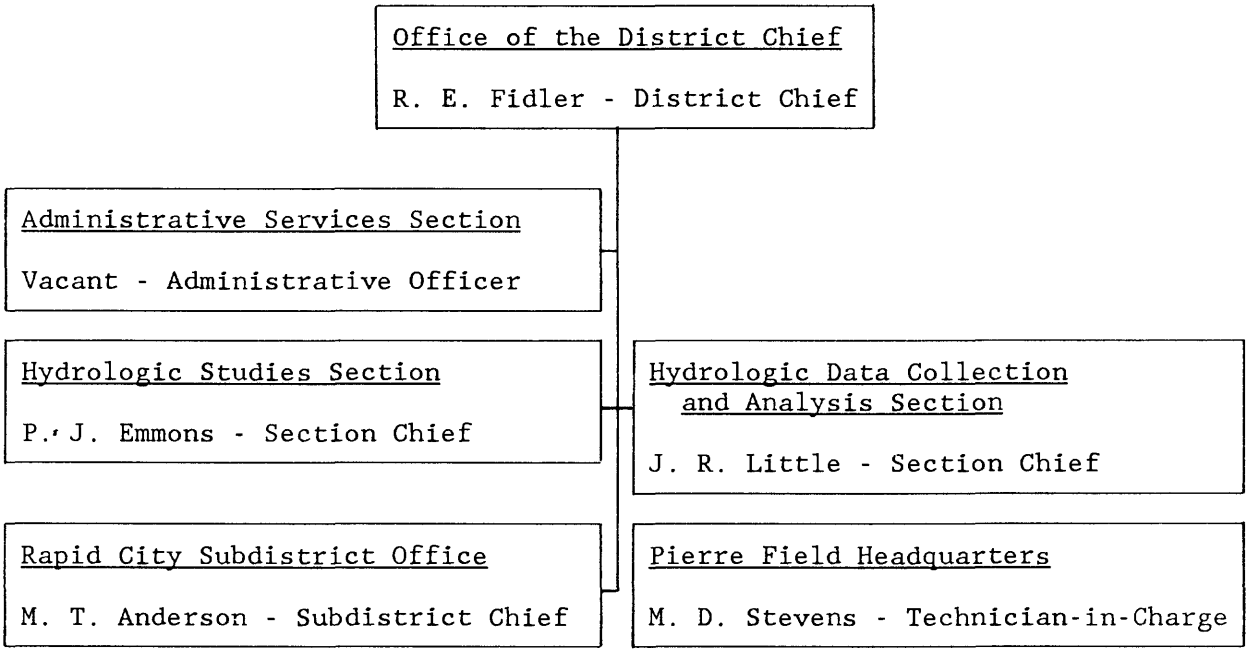
As part of the reorganization of the Water Resources Division in 1966, South Dakota was separated from the Bismarck District and both surface- and ground-water activities were supervised from Huron. John E. Powell was the first District Chief.

During the early years of USGS activity in South Dakota, interest in water quality centered on ground water, and studies of the chemical quality of water were made as integral parts of ground-water investigations. Laboratory work was done either in the Geological Survey Laboratory in Washington, D.C., or was contracted to other laboratories. Because of the need for large amounts of water-quality information in connection with plans for development of the Missouri River basin, the Quality of Water Branch of the U.S. Geological Survey established laboratories in Lincoln, Nebraska, in 1945, which served the South Dakota District for many years. One Central Laboratory, located in Arvada, Colorado, provides analytical services for the Geological Survey offices today.

Since 1944, more than 100 water-resources studies have been made in South Dakota. These range from reconnaissance-type studies of counties and Indian reservations to research on small-basin runoff and toxic wastes, the quality of water in lakes, the use of remote sensing for defining aquifers, and studies using digital models to describe the ground-water regimen and surface-water hydraulics such as those currently underway in the James River basin and the Big Sioux River basin. During the past 20 years, 140 formal reports describing the studies and results of investigations have been prepared to inform the public and the scientific community.

DISTRICT ORGANIZATION

The South Dakota District of the Water Resources Division consists of two operating sections and one support unit. Water-resources projects conducted by the District are assigned an operating section with the responsibility for a project assigned to a project chief. Personnel are based at the District office in Huron, the Subdistrict office in Rapid City, and the Field Headquarters in Pierre. The District is assisted and advised by research centers, laboratories, technical consultants, and training centers maintained throughout the United States by the Water Resources Division.



Inquiries regarding work of the U.S. Geological Survey, Water Resources Division, in South Dakota may be directed to the following offices:

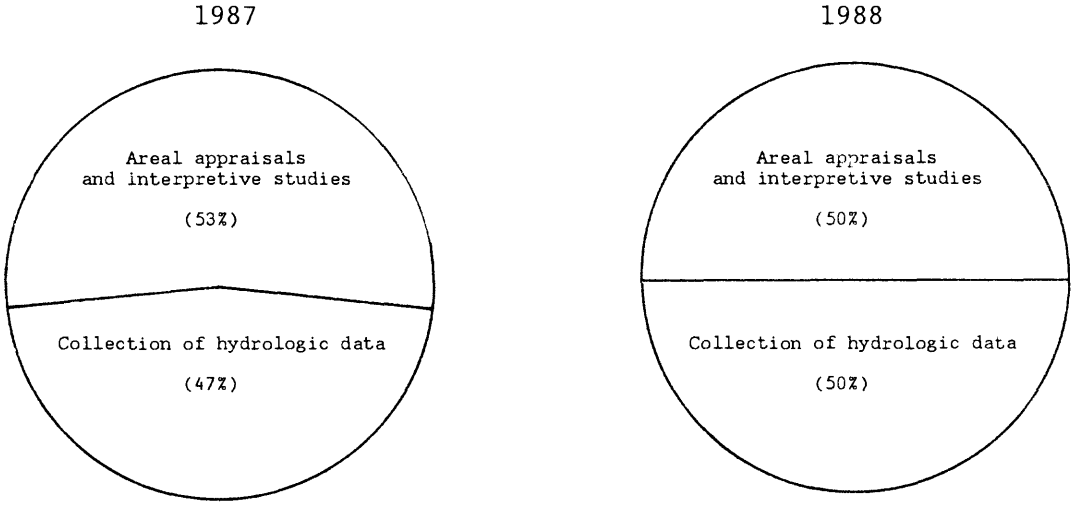
South Dakota District Office
U.S. Geological Survey
Water Resources Division
Room 408, Federal Building
200 4th St. SW
Huron, SD 57350
(605) 353-7176

Rapid City Subdistrict Office
U.S. Geological Survey
Water Resources Division
Federal Building/Courthouse
Room 237 - 515 9th St.
Rapid City, SD 57701
(605) 394-1781

Pierre Field Headquarters
U.S. Geological Survey
Water Resources Division
P.O. Box 220
Pierre, SD 57501
(605) 773-5388

TYPES OF INVESTIGATIONS

The diagram below shows the percentage of water resources investigations in South Dakota for fiscal years 1987 and 1988 in the broad categories of collection of hydrologic data, and areal appraisals and interpretive studies, as a percent of total budget.



The investigations are directed toward obtaining the information needed by managers and planners for the solution or alleviation of water problems in the State.

The investigations are supported (table 1) by services and (or) funds provided by State and local agencies, matched on a 50-50 basis by Federal/State cooperative program funds; by funds transferred from other Federal agencies (OFA program); and by funds appropriated directly to the Geological Survey for research, data collection, and special projects (Federal program). In fiscal years 1987 and 1988, the financial support for these programs in South Dakota was about $2,700,000 and $3,240,000, respectively, which was distributed as follows:

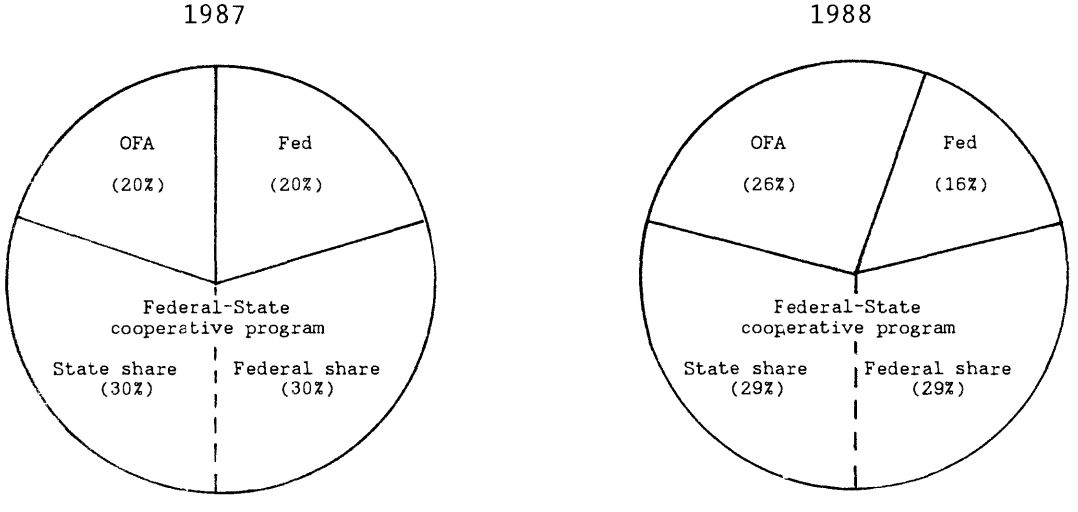


Table 1.--Agencies supporting water-resources investigations in South Dakota during fiscal years 1987-88

State Agencies

South Dakota Department of Transportation
South Dakota Department of Game, Fish & Parks
- Custer State Park Division
- Fish and Wildlife Division

South Dakota Department of Water and Natural Resources
- Division of Water Rights
- Division of Water Quality
- Geological Survey

South Dakota School of Mines & Technology
South Dakota State University

Local Agencies

East Dakota Water Development District
James River Water Development District
Mid-Dakota Water Development District
West Dakota Water Development District
Counties of:

Brookings	Kingsbury	Lincoln	Spink
Codington	Lake	Minnehaha	Turner
Grant	Lawrence	Moody	Union
Hutchinson			

City of Aberdeen
City of Rapid City
City of Sioux Falls
City of Watertown
Oglala Sioux Tribe
Sisseton-Wahpeton Sioux Tribe

Federal Agencies

Department of Agriculture
- U.S. Forest Service

Department of the Army
- Corps of Engineers, Omaha District

Department of the Interior
- Bureau of Indian Affairs
- Bureau of Reclamation
- EROS Data Center
- Office of the Secretary
- Fish and Wildlife Service
- National Park Service

Tennessee Valley Authority

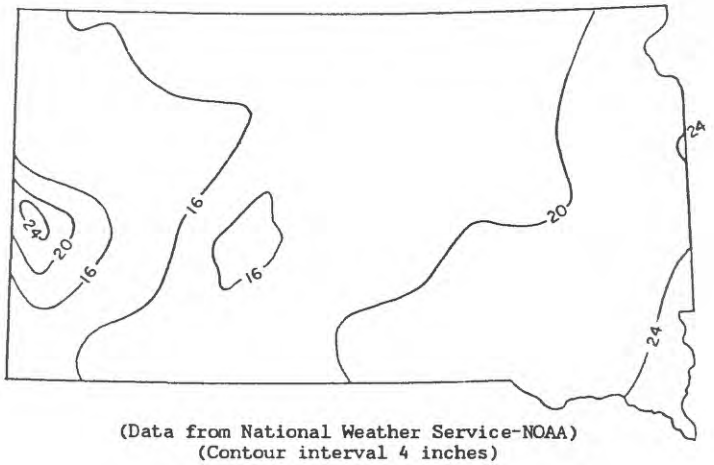
WATER RESOURCES SUMMARY

South Dakota has an average annual precipitation of about 18 inches, ranging from slightly less than 16 inches in the northwest to more than 24 inches in the Black Hills and in the southeast (fig. 1). In most years, 75 to 85 percent of the precipitation occurs between April and September. Droughts, especially those of the 1930's, 1950's, and 1970's, have been disastrous to agriculture, the State's dominant industry. With the exception of the Missouri River, where 31 million acre-feet of water can be stored in four large reservoirs in South Dakota, streamflow during low flows generally is not dependable for continued irrigation or for municipal or industrial withdrawals (fig. 2).

The large dams on the Missouri River, built under the Pick-Sloan Missouri River Program, provide flood protection and navigation benefits for the basin States downstream. However, the tributary streams are subject to periodic flooding resulting from spring snowmelt and intense summer thunderstorms. The majority of damage is to lands used for agriculture. The U.S. Geological Survey outlines flood-prone areas on topographic maps as part of a nationwide Federal program for managing flood losses. Parts of these topographic maps showing flood-prone urban areas also have been published in urban-area pamphlets. In South Dakota, 311 flood-prone area maps and 73 urban-area pamphlets have been completed (fig. 3). Information on these maps and pamphlets is available on request from the District Chief, U.S. Geological Survey, Huron, South Dakota.

Ground-water constitutes a large and reliable source of water for domestic, industrial, stock, and municipal use. Historically, water from confined (artesian) bedrock aquifers has been important in settlement of the State and in development of its chief industry, agriculture. Although artesian aquifers (from which water flows or can be pumped from moderate depth) underlie nearly all the State, shallow ground water is absent or scarce in much of the State, especially the unglaciated western part. Hence, the availability of artesian water and the development of inexpensive methods of drilling deep wells were of special importance in bringing about early settlement, which otherwise might have been restricted to river valleys where water is available from shallow alluvium. Much of the artesian water is of inferior chemical quality for drinking-water supplies, but it has been used nevertheless.

The other major source of ground water in the State is the glacial drift that blankets South Dakota east of the Missouri River. Several hundred million acre-feet of water, much of it suitable for irrigation, is stored in glacial outwash and alluvium. These deposits are irregular in shape and size, and are scattered throughout the area. Figure 4 shows areas in the State where glacial deposits containing large amounts of ground water are known to occur. The major glacial-drift aquifers have been mapped as a result of cooperative Federal, State, county, and water-development district water-resources studies.



(Data from National Weather Service-NOAA)
(Contour interval 4 inches)

Figure 1.--Average annual precipitation, in inches.

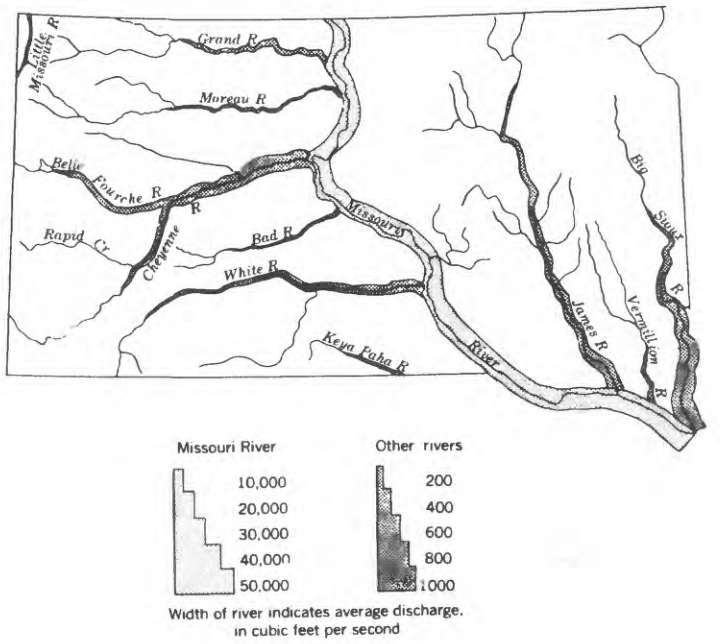


Figure 2.--Average discharge of the principal streams.

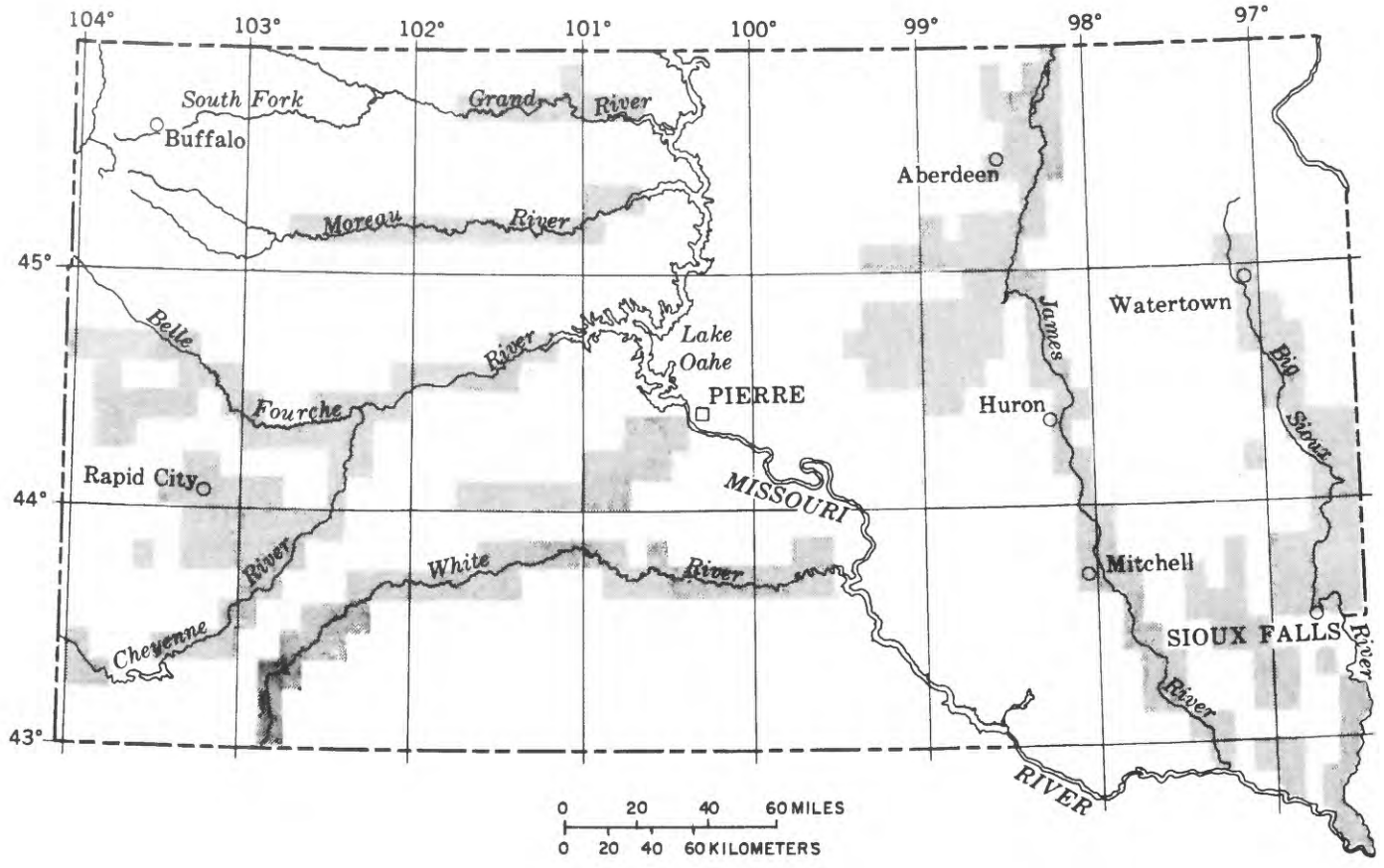


Figure 3.--Flood-prone area maps completed in South Dakota.

Figure 4.--Major glacial aquifers in eastern South Dakota. (Updated from Bardwell, 1984.)

HYDROLOGIC-DATA PROGRAM

Surface Water

Surface-water discharge (streamflow) and stage (water level) data (table 2, fig. 5) are collected for hydrologic purposes such as assessment of water resources, areal analyses, determination of long-term trends, research and special studies, or for management and operational purposes. Each year surface-water gaging stations are added and others are terminated as the needs and financial resources of the water-data users change. All data collected are stored in the Survey's National Water Data Storage and Retrieval System (WATSTORE) and are available on request to water planners and others involved in making decisions affecting the State's water resources. These data can be retrieved in machine-readable form or in the form of computer-printed tables or graphs, statistical analyses, and digital plots. Local assistance in the acquisition of services or products from WATSTORE can be obtained from the District Chief, U.S. Geological Survey, Water Resources Division, in Huron.

Table 2.--Surface-water stations in operation in South Dakota, fiscal years 1987-88

[Classification: B, bench-mark or long-term-change station; C, current-purpose station; H, hydrologic station to meet objective of defining regional streamflow characteristics; P, principal stream station to meet objective of measuring principal unregulated streams; R, regulated stream station required to meet objective of defining regulated flow; S, stage. Equipment: D, digital water-stage recorder; M, servo-manometer unit; R, graphic water-stage recorder; T, telemark; P, data-collection platform. Supported by: COE, U.S. Army Corps of Engineers; BIA, Bureau of Indian Affairs; BR, Bureau of Reclamation; ED, East Dakota Water Development District; WD, West Dakota Water Development District; FED, Federal; MRB, Missouri River Basin Program; DWNR, Department of Water and Natural Resources; WAT, City of Watertown; RC, City of Rapid City; WY, State of Wyoming; BM, Federal bench-mark station; TVA, Tennessee Valley Authority; SWST, Sisseton-Wahpeton Sioux Tribe; GFP, Department of Game, Fish and Parks.]

Station number	Station name	Classification	Gage equipment	Period of record (calendar year) Begin	End	Supported by
05051650	La Belle Creek near Veblen.	H,P	D,M	1987		SWST
05289985	Big Coulee near Peever.	H,P	D,M	1987		SWST
06334500	Little Missouri River at Camp Crook . . .	C,P	D,M	1903	1906	DWNR
				1956		
06354882	Oak Creek near Wakpala.	H,P	D,M	1984		BIA
06355500	North Fork Grand River near White Butte .	C,R	D,M	1945		DWNR
06356000	South Fork Grand River at Buffalo	C,H	D,M	1955		DWNR
06356500	South Fork Grand River near Cash.	C,H	D,M	1945		COE
06357500	Grand River at Shadehill.	C,R	D,R	1943		BR
06357800	Grand River at Little Eagle	C,R	D,M,P,T	1958		COE
06359500	Moreau River near Faith	C,H,P	D,M	1943		COE
06360500	Moreau River near Whitehorse.	C,H,P	D,M,P,T	1954		COE
06395000	Cheyenne River at Edgemont.	C,H,P	D,P,R	1903	1906	DWNR,TVA
				1928	1933	
				1946		
06400000	Hat Creek near Edgemont	C,H,P	D,M	1905	1906	DWNR
				1950		
06400497	Cascade Springs near Hot Springs.	C	D,M	1976		DWNR

Table 2.--Surface-water stations in operation in South Dakota, fiscal years 1987-88--Continued

Station number	Station name	Classification	Gage equipment	Period of record (calendar year) Begin	End	Supported by
06400875	Horsehead Creek at Oelrichs	C	D,M	1983		DWNR
06401500	Cheyenne River below Angostura Dam.	C,R	D,P	1945		BR
06402000	Fall River at Hot Springs	C,R	D,M	1937		COE
06402500	Beaver Creek near Buffalo Gap	C,H	D,M	1937		DWNR
06403300	French Creek above Fairburn	C,H	D,M	1981		DWNR
06404000	Battle Creek near Keystone.	C	D,M	1945 1961	1947	DWNR
06404998	Grace Coolidge Creek near Game Lodge, near Custer	C,H,P	D,M	1976		GFP
06406000	Battle Creek at Hermosa	C	D,M	1949		DWNR
06407900	Spring Creek near Rockerville	C,H	D,M	1985		WD
06408500	Spring Creek near Hermosa	C	D,M	1949		DWNR
06408700	Rhoads Fork near Rochford	C,H	D,M	1981		DWNR
06409000	Castle Creek above Deerfield Reservoir, near Hill City.	B,C	D,M	1948		BM
06410000	Castle Creek below Deerfield Reservoir.	C,R	D,M,R	1946		BR
06410500	Rapid Creek above Pactola Reservoir, at Silver City.	C,R	D,M	1953		DWNR
06411500	Rapid Creek below Pactola Dam	C,R	D	1928 1946	1932	BR
06412500	Rapid Creek above Canyon Lake, near Rapid City	C,R	D,M,T	1946		DWNR
06412600	Cleghorn Springs main channel at fish hatchery, at Rapid City	H	D	1987		GFP,RC
06412700	Cleghorn Springs south channel at fish hatchery, at Rapid City.	H	D	1987		GFP,RC
06412800	Cleghorn Springs north channel at fish hatchery, at Rapid City.	H	D	1987		GFP,RC

Table 2.--Surface-water stations in operation in South Dakota, fiscal years 1987-88--Continued

Station number	Station name	Classification	Gage equipment	Period of record (calendar year) Begin	End	Supported by
06412900	Rapid Creek below Cleghorn Springs, at Rapid City	H	D	1987		GFP,RC
06413100	Canyon Lake at Rapid City	H	D	1987		GFP,RC
06413200	Rapid Creek below Park Drive, at Rapid City	H	D	1987		GFP,RC
06413300	Leedy Ditch at headgate below Canyon Lake Dam, at Rapid City	H	D	1987		GFP,RC
06413550	Leedy Ditch at mouth, at Rapid City	H	D	1987		GFP,RC
06413570	Rapid Creek above Jackson Boulevard, at Rapid City	H	D	1987		GFP,RC
06413650	Lime Creek at mouth at Sioux Park, at Rapid City	H	D	1987		GFP,RC
06413660	Storybook Ditch at headgate, at Rapid City	H	D	1987		GFP,RC
06413670	Storybook Ditch at mouth, at Rapid City	H	D	1987		GFP,RC
06413700	Rapid Creek above water treatment plant, at Rapid City	H	D	1987		GFP,RC
06413800	Deadwood Avenue drain at Rapid City	H	D	1987		GFP,RC
06414000	Rapid Creek at Rapid City	C,R	D,M,T	1903 1942	1906	COE
06418900	Rapid Creek below Sewage Treatment Plant, near Rapid City.	C	D,M	1981		DWNR
06421500	Rapid Creek near Farmingdale.	C,R	D,M	1946		RC,WD,DWNR
06422500	Boxelder Creek near Nemo.	C,H	D,M	1945 1966	1947	DWNR
06423010	Boxelder Creek near Rapid City.	C	D,M	1978		DWNR
06423500	Cheyenne River near Wasta	C,R	D,M,P	1914 1928 1934	1915 1932	COE

Table 2.--Surface-water stations in operation in South Dakota, fiscal years 1987-88--Continued

Station number	Station name	Classification	Gage equipment	Period of record (calendar year) Begin	End	Supported by
06425100	Elk Creek near Rapid City	C	D,M	1979		DWNR
06425500	Elk Creek near Elm Springs	C	D,M	1949		DWNR
06428500	Belle Fourche River at Wyoming-South Dakota State line	C,R	D	1946		FED
06429997	Murray Ditch above headgate, at Wyoming-South Dakota State line	C,R	D	1987		FED
06430000	Murray Ditch at Wyoming-South Dakota State line	C,R	D,R	1954		WY,DWNR
06430500	Redwater Creek at Wyoming-South Dakota State line	C,R	D	1929 1936 1954	1931 1937	WY,DWNR
06431500	Spearfish Creek at Spearfish	C	D,M	1946		DWNR
06433000	Redwater River above Belle Fourche	C,R	D,M	1945		DWNR
06433500	Hay Creek at Belle Fourche	C,R	D	1953		COE,FED
06434500	Inlet Canal near Belle Fourche	C,R	D	1945		BR
06436000	Belle Fourche River near Fruitdale	C,R	D,M	1945		DWNR
06436170	Whitewood Creek at Deadwood	C	D,M	1981		DWNR
06436180	Whitewood Creek above Whitewood	C	D,M,T	1983		FED
06436190	Whitewood Creek near Whitewood	C	D,M	1981		DWNR
06436198	Whitewood Creek above Vale	C	D,M,T	1983		FED
06436760	Horse Creek above Vale	C,R	D,M	1962		MRB
06437000	Belle Fourche River near Sturgis	C,R	D,M,P,T	1945		DWNR
06438000	Belle Fourche River near Elm Springs	C,R	D,M	1928 1934	1932	COE
06439000	Cherry Creek near Plainview	C,H,P	D,M	1945		COE
06439300	Cheyenne River at Cherry Creek	C,R	D,M,P	1960		COE
06439430	Cottonwood Creek near Cherry Creek	H,P	D,M	1982		BIA
06441000	Bad River near Midland	C,P	D,M	1945		COE

Table 2.--Surface-water stations in operation in South Dakota, fiscal years 1987-88--Continued

Station number	Station name	Classification	Gage equipment	Period of record (calendar year) Begin	End	Supported by
06441500	Bad River near Fort Pierre.	C,H,P	M,P,R,T	1928		COE
06442000	Medicine Knoll Creek near Blunt	C,H	D,M	1950		DOE,FED
06442500	Medicine Creek at Kennebec.	C,H	D,M	1954		COE
06442718	Campbell Creek near Lee's Corner.	H	D,M	1987		BIA
06442900	Elm Creek near Gann Valley.	H	D,M	1987		MRB
06445685	White River near Nebraska-South Dakota State line.	C,H	D,M	1987		BIA
06445980	White Clay Creek near Oglala.	C,H	D,M	1965	1981	BIA
06446000	White River near Oglala	C	D,M	1943		DWNR
06447000	White River near Kadoka	C,H,P	D,M,R	1942		COE
06447500	Little White River near Martin.	C	D	1938 1962	1940	DWNR
06449000	Lake Creek below refuge, near Tuthill . .	C,R	D,R	1938 1962	1940	DWNR
06449100	Little White River near Vetal	C	D,M	1959		MRB
06449300	Little White River above Rosebud.	C	D,M	1981		BIA
06449400	Rosebud Creek at Rosebud.	C,P	D,M	1974		MRB
06449500	Little White River near Rosebud	C,P	D,M	1943		DWNR
06450500	Little White River below White River. . .	C,H,P	D,M,R	1949		DWNR
06452000	White River near Oacoma	C,H	D,M,R	1928		COE
06453010	Missouri River at Greenwood	S	D,M,R	1981		COE
06453255	Choteau Creek near Avon	H,P	D,M	1982		BIA
06464100	Keya Paha River near Keyapaha	C	D,M	1981		DWNR
06464500	Keya Paha River at Wewela	C,H,P	D,M	1937 1947	1940	DWNR
06466700	Lewis and Clark Lake at Springfield . . .	S	D,M,R	1981		COE
06467500	Missouri River at Yankton	C,R	D,M,P,T	1930		COE,FED
06471000	James River at Columbia	C,R	M,R,T	1945		DWNR

Table 2.--Surface-water stations in operation in South Dakota, fiscal years 1987-88--Continued

Station number	Station name	Classification	Gage equipment	Period of record (calendar year) Begin	End	Supported by
06471200	Maple River at North Dakota-South Dakota State line	C,H	D,M	1956		DWNR
06471500	Elm River at Westport	C,R	D,M	1945		DWNR
06473000	James River at Ashton	C,R	D,M	1945		MRB
06473700	Snake Creek near Ashton	H,P	D,M	1955	1969	BR
				1984		
06473750	Wolf Creek near Ree Heights	H,P	D,M	1959	1981	BR
				1984		
06474000	Turtle Creek near Tulare	H,P	D,M	1953	1956	BR
				1965	1981	
				1984		
06474300	Medicine Creek near Zell	H,P	D,M	1959	1981	BR
				1984		
06475000	James River near Redfield	C,R	D,M	1950		MRB
06476000	James River at Huron	C,R	D	1928	1932	DWNR
				1943		
06476500	Sand Creek near Alpena	C,H	D,M	1950		DWNR
06477000	James River near Forestburg	C,R	D,M,T	1950		DWNR
06477500	Firesteel Creek near Mount Vernon	C,H	D,M	1955		DWNR
06478052	Enemy Creek near Mitchell	C	D,M	1975		MRB
06478390	Wolf Creek near Clayton	C,H	D,M	1975		MRB
06478500	James River near Scotland	C,R	D,M,P,T	1928		COE
06478513	James River near Yankton	C,R	D,M	1981		DWNR
06478515	Missouri River near Gayville	S	D,M	1969		COE
06478533	Lake Thompson near Ramona	S	D,M	1986		DWNR
06478535	East Fork Vermillion River near Ramona	C,P	D,M	1986		DWNR
06478540	Little Vermillion River near Salem	B,C,H	R	1966		BM
06478690	West Fork Vermillion River near Parker	C,P	D,M	1961		DWNR
06479010	Vermillion River near Vermillion	C,P	D,M,P	1984		COE

Table 2.--Surface-water stations in operation in South Dakota, fiscal years 1987-88--Continued

Station number	Station name	Classification	Gage equipment	Period of record (calendar year) Begin	End	Supported by
06479215	Big Sioux River near Florence	C,H,P	D,M	1984		ED
06479438	Big Sioux River near Watertown	C,H,P	D,M	1972		ED,WAT
06479525	Big Sioux River near Castlewood	C,H	D,M	1976		DWNR
06479928	Battle Creek near Nunda	H	D,M	1987		ED
06479980	Medary Creek near Brookings	H,P	D,M	1980		ED
06480000	Big Sioux River near Brookings	C,P	D	1953		DWNR
06480400	Spring Creek near Flandreau	H,P	D,M	1982		DWNR
06480650	Flandreau Creek above Flandreau	H,P	D,M	1981		ED
06481000	Big Sioux River near Dell Rapids	C,P	D,M,T	1948		COE
06481480	Skunk Creek near Chester	H,P	D,M	1984		ED
06481500	Skunk Creek at Sioux Falls	C,P	D,M,T	1948		COE
06482020	Big Sioux River at North Cliff Avenue, at Sioux Falls	C,P	D,M,P,T	1972		COE
06482610	Split Rock Creek at Corson	H,P	M,D	1970		MRB
06482848	Beaver Creek at Canton	H,P	D,M	1982		DWNR
06485500	Big Sioux River at Akron, Iowa	C,P	D,P	1928		COE
06485696	Brule Creek near Elk Point	H,P	D,M	1982		DWNR

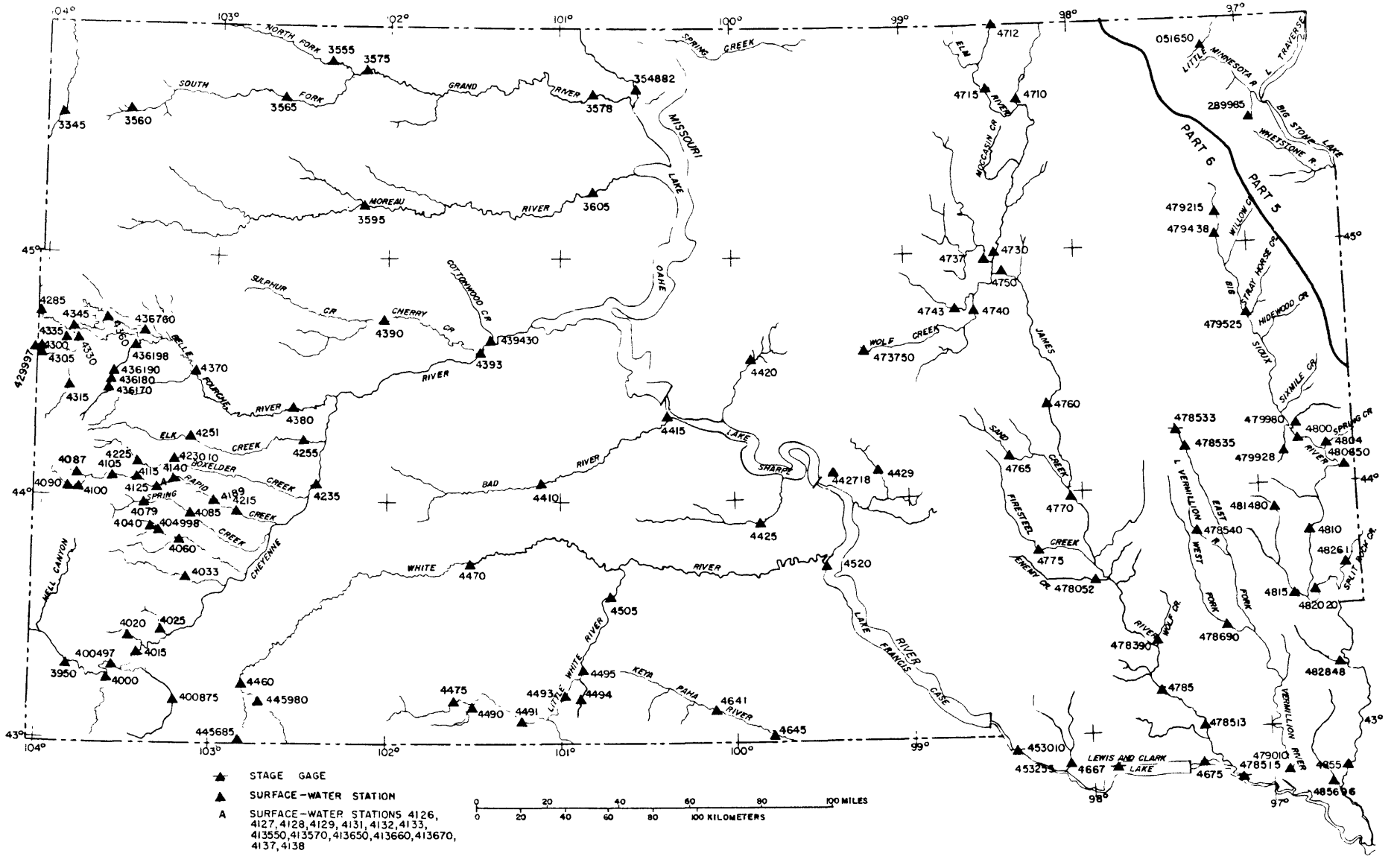


Figure 5.--Location of lake and stream-gaging stations, fiscal years 1987-88.

Water-quality data are obtained at many of the surface-water stations (table 3, fig. 6) and occasionally at other surface-water sites where discharge and stage are not measured routinely. In addition to monitoring the quality of surface water in South Dakota, eight of these stations also are part of a U.S. Geological Survey nationwide network known as the National Stream Quality Accounting Network (NASQAN), which is used to detect trends in water quality.

Table 3.--Water-quality and sediment stations in operation in South Dakota, fiscal years 1987-88

[Supported by: COE, U.S. Army Corps of Engineers; BIA, Bureau of Indian Affairs; BM, Federal bench-mark station; BR, Bureau of Reclamation; NASQAN, National stream-quality accounting network; MRB, Missouri River Basin Program.]

Station number	Station name	Supported by	
		Water quality	Sediment
06357800	Grand River at Little Eagle	NASQAN	NASQAN
06360500	Moreau River near Whitehorse	NASQAN	NASQAN
06409000	Castle Creek above Deerfield Reservoir, near Hill City	BM	BM
06434500	Inlet Canal near Belle Fourche	MRB	
06436760	Horse Creek above Vale	MRB	
06437000	Belle Fourche River near Sturgis	MRB	
06438000	Belle Fourche River near Elm Springs	NASQAN	NASQAN
06439300	Cheyenne River at Cherry Creek	NASQAN	NASQAN
06441500	Bad River near Fort Pierre		COE
06449100	Little White River near Vetal	MRB,BR	MRB,BR
06449300	Little White River above Rosebud	BIA,MRB,BR	BR
06452000	White River near Oacoma	NASQAN	NASQAN,COE
06452380	Andes Creek near Armour	MRB	MRB
06452383	Lake Andes tributary No. 3 near Armour	MRB	MRB
06452386	Lake Andes tributary No. 2 near Lake Andes	MRB	MRB
06452389	Lake Andes tributary No. 1 near Lake Andes	MRB	MRB
06452392	Lake Andes near Lake Andes	MRB	
06452410	Lake Andes below Lake Andes	MRB	
06453200	Choteau Creek near Wagner	MRB	BR
06453252	Choteau Creek near Dante	MRB	BR
06470985	Mud Lake near Houghton	BR	
06470988	Sand Lake, bay site, near Houghton	BR	
06470990	Sand Lake, open water site (near Aberdeen), near Columbia	BR	
06470992	Sand Lake near Columbia	BR	
06471000	James River at Columbia	NASQAN,BR	NASQAN
06473000	James River at Ashton	MRB,BR	BR
06473700	Snake Creek near Ashton	BR	
06473750	Wolf Creek near Ree Heights	BR	
06474000	Turtle Creek near Tulare	BR	
06474300	Medicine Creek near Zell	BR	
06476000	James River at Huron	MRB,BR	BR
06478500	James River near Scotland	NASQAN,BR	NASQAN
06485500	Big Sioux River at Akron, Iowa	NASQAN	NASQAN

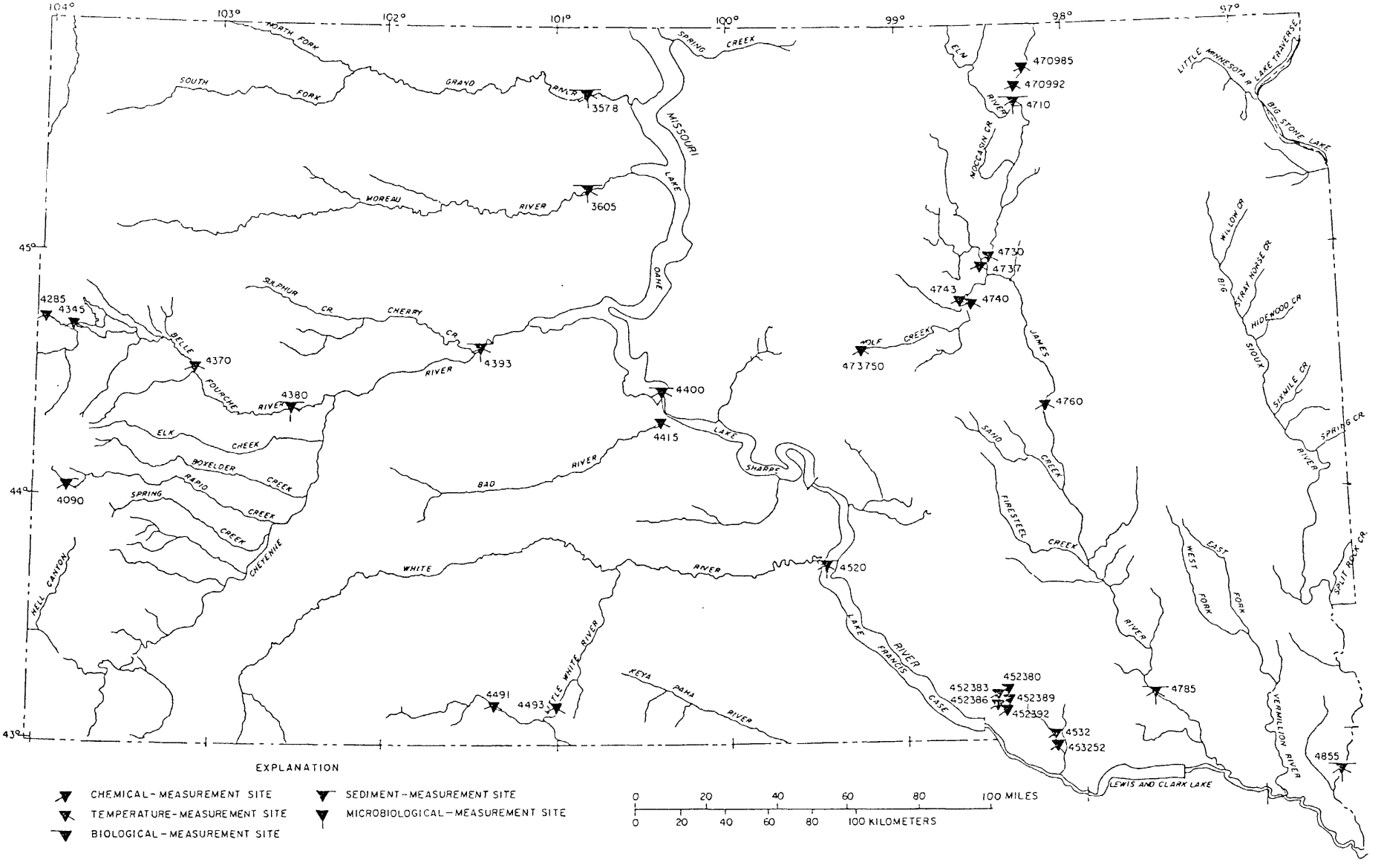


Figure 6.--Location of surface-water quality stations, fiscal years 1987-88.

Ground Water

Water levels in wells, discharge from 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 in order to have the fullest meaning and usefulness. In South Dakota, the U.S. Geological Survey makes annual water-level measurements in a number of observation wells (table 4, fig. 7) completed in bedrock artesian aquifers. Other wells, which are known as project wells, are used for specific (generally short-term) studies and, although they are not part of the observation-well program, data obtained from them also are available. In addition, the South Dakota Department of Water and Natural Resources maintains and measures more than 1,400 observation wells that are not listed in table 4.

Table 4.--Observation wells in bedrock aquifers in South Dakota, fiscal years 1987-88

[Well number: The wells are numbered according to a system based on the Federal land surveys of South Dakota. The well number consists of the township number followed by "N," the range number followed by "W," and the section number, followed by a maximum of four uppercase letters that indicate, respectively, the 160-, 40-, 10-, and 2½-acre tract in which the well is located. These letters are assigned in a counter-clockwise direction beginning with "A" in the northeast quarter. A serial number following the last letter is used to distinguish between wells in the same tract. Thus, well 103N65W21ADCC is the well in the SW¼, SW¼, SE¼, NE¼, sec. 21, T. 103 N., R. 65 W.]

County	Well number	Formation	Date of first measurement
Aurora	101N66W34BBBC	Dakota Formation	7-19-60
	103N65W21ADCC	do.	7-18-79
	103N65W21CAA	do.	8-20-76
	105N63W33CDBB	do.	7-21-77
	105N64W13DDA	do.	6- 9-61
Beadle	109N61W 6BAAC	do.	10-30-63
	109N64W33ACCD	do.	11- 2-60
	110N62W 9BBAD2	do.	10-16-67
	110N62W 9BBAD3	Greenhorn Limestone	7-16-68
	113N65W16DDCD	Dakota Formation	11- 4-63
Bon Homme	94N58W 1CCC	do.	10- 5-60
Brookings	111N52W25DDCC	do.	10- 9-63
Brown	122N60W 8CBBA2	do.	6-21-60
	128N61W 5DCCC	do.	5-26-60
Brule	104N70W26DCBC	Lakota Formation	3-23-59
	105N68W11CDB	Dakota Formation	7-14-60

Table 4.--Observation wells in bedrock aquifers in South Dakota, fiscal years 1987-88--Continued

County	Well number	Formation	Date of first measurement
Buffalo	107N73W 1BA	Dakota Formation	11- 6-73
	108N72W12BBCA	do.	9-26-61
	108N73W35DDA3	Inyan Kara Group	7-19-79
Butte	8N 2E21CDBC	Lakota Formation	6- 4-80
	8N 2E23DCCA	Inyan Kara Group	6-10-80
	8N 3E12DBB	do.	10-22-70
	8N 3E33CCB	Minnelusa Formation	6- 4-80
	11N 1E17DCAC	Inyan Kara Group	7- 3-79
Campbell	127N78W20DCDD	Fall River Formation	8-14-62
Charles Mix	99N68W31DDDB	Dakota Formation	3-24-59
Clark	115N59W15CAAB	do.	3-10-83
	116N59W23DDAA	do.	8-13-76
Clay	93N52W28AAD	do.	6-21-61
	95N51W 7ADA	do.	6-21-61
Corson	18N25E23DAD	Fox Hills Formation	7-15-80
	19N22E 1DB	do.	7-15-80
	20N29E25BBBC	Pierre Shale	7-14-80
	22N18E 4DBAC	Fort Union Formation	7-15-80
	22N19E32CBDA	Ludlow Member of the Lance Formation	7-15-80
	23N17E23ADCB	Fort Union Formation	7-15-80
Custer	2S 7E34ABBC	Minnelusa Formation	7-27-83
	2S 7E36CBCB	Lakota Formation	6-29-83
	3S 7E23DDAC	do.	6- 5-80
	3S 7E35DBB	do.	6- 5-80
	3S 8E17BACB	Graneros Shale	5-22-80
	3S 8E19BBBB	Morrison Formation	6-28-83
	3S 8E22ACDB	Inyan Kara Group	8-17-76
	3S 8E22ACDB2	do.	8- 1-77
	4S 7E 1DAAB	Dakota Formation	6-11-80
	4S 7E28DBBC	Fall River Formation	5-22-80
	5S 6E12DAAD	Sundance Formation	5-22-80
	6S 6E15ABDD	Madison Group	6-11-80
Davison	102N61W30CAC2	Dakota Formation	6- 2-83
	104N61W30DAA	do.	7-29-60
Dewey	12N22E 7ACC	Fox Hills Formation	7-16-80
	12N24E17CBBD	Madison Formation	7-15-81
	12N25E12BB	Fox Hills Formation	7- 6-80
	14N29E36DBDD	Sundance Group	5-19-81
	15N26E12CDB	Dakota Formation	6- 9-82
	15N30E26CCDA	Inyan Kara Group	9-25-75

Table 4.--Observation wells in bedrock aquifers in South Dakota, fiscal years 1987-88--Continued

County	Well number	Formation	Date of first measurement
Edmunds	121N68W 3AAAB	Dakota Formation	4-12-66
Fall River	7S 2E 3ACDD	Sundance Formation	6-12-80
	7S 2E 3DAAB	do.	7-25-83
	7S 5E12CDBB	Minnelusa Formation	6-13-80
	7S 6E 1AAAD	Fall River Formation	5-22-80
	8S 2E 8AADD	do.	6-12-80
	8S 2E20DACC	Lakota Formation	6-12-80
	8S 2E36ADBB	Dakota Formation	6-12-80
	8S 2E36ADBC	Fall River Formation	4-11-81
	8S 3E32BDAB	Dakota Formation	6-12-80
Faulk	117N72W15CCCA	Inyan Kara Group	10-12-82
	118N67W16DBCC	Dakota Formation	6-22-60
	119N66W11ABAA	do.	6-23-60
Grant	120N48W 2ABBB	Cretaceous sandstone, undifferentiated	7-31-62
	121N47W36BBCB	do.	7-23-76
Haakon	1N20E14DADB	Madison Group	7-23-80
	1N23E33CACC	Fall River Formation	- -83
	2N23E 4DA	do.	7- 6-80
	3N23E10BCAA	Newcastle Sandstone	7-15-80
	4N23E35AA	do.	- -83
	6N23E31DB	Fall River Formation	7-16-80
Hamlin	113N55W23BBAB	Dakota Formation	10-10-63
Hand	110N67W 7CBBB2	do.	5- 5-77
	116N67W31DDDB	do.	10-10-62
Hanson	104N58W13DCC	Codell Sandstone Member of the Carlile Shale	6-15-61
Harding	15N 1E13AADD	Fox Hills Formation	5-12-80
	19N 5E30DDA	Hell Creek Formation	7-16-80
Hughes	110N79W 4CAAA	Madison Group	5-13-81
	111N74W15BDAD	Dakota Formation	7-20-76
Hutchinson	99N60W 1BBBC	do.	3-27-59
	99N61W 4AAD	do.	9-16-60
Hyde	109N72W32BAA	do.	5- 4-60
	109N73W12BDCB	Sundance Formation and Minnelusa Formation	6-24-70
	110N72W 1CDAA	Minnelusa Formation	6-24-70
	116N72W18DAAB	Inyan Kara Group	9-14-62

Table 4.--Observation wells in bedrock aquifers in South Dakota, fiscal years 1987-88--Continued

County	Well number	Formation	Date of first measurement
Jackson	1S22E10CCCC	Inyan Kara Group	5-17-66
	1S22E19AADA	Fall River Formation	9-12-63
	1S22E28DAAA	Inyan Kara Group	7-22-80
	2S22E28BAD	Dakota Formation	8- -65
	2S22E32ABAD	do.	12-13-55
	2S24E11BDAC	Inyan Kara Group	7-22-80
	2S24E23DADD	Dakota Formation	8-17-76
	2S24E27CADA	do.	8-18-76
Jerauld	106N67W26CCDB	do.	11- 3-78
	108N63W20DCB	do.	4-27-61
Jones	1S28E36BBDB	Minnelusa Formation	7- 9-80
	2N26E31CBD	Dakota Formation	8-28-63
	2N27E17DDD	do.	8-28-63
	2S28E 8ADD	do.	5-17-78
	2S28E 8CBAC	do.	8-18-76
Kingsbury	110N53W10DAAA	do.	8- 2-84
	110N58W32CCBC	do.	7-12-76
	111N58W13AAAA	do.	3-10-83
Lake	107N53W20BBC	do.	7-17-61
Lawrence	6N 2E 4BDD	Minnekahta Limestone	6- 4-80
	6N 2E23BBBA	Minnelusa Formation	6- 2-80
	6N 2E10BCBB	Spearfish Formation	6-10-80
	6N 4E21DBC	Minnelusa Formation	6-10-80
	7N 1E14CCDD	do.	6- 4-80
	7N 1E20AAD	do.	6- 2-80
	7N 1E21BBC	do.	6- 2-80
	7N 1E26ACD	do.	6-20-80
	7N 1E30BDA	Minnekahta Limestone	8-10-60
	7N 1E30BDA2	--	8-25-80
	7N 2E26BCDA	Minnelusa Formation	6- 3-80
	7N 2E32DD	Spearfish Formation	6- 4-80
	7N 3E 7AABA	Minnelusa Formation	8-27-62
	7N 4E 2BDBD	Fall River Formation	5-28-80
Lincoln	97N49W33AAAA	Dakota Formation	7- 6-61
	98N49W23DAD	Big Sioux Formation	10-31-86
	98N50W32AAAA2	Dakota Formation	8-22-79
Lyman	101N72W35DADA	do.	7-10-63
	103N78W12BBAD	do.	10-21-75
	105N73W21CCBA2	do.	7-18-79
	105N78W 9CABD	do.	8- 6-76
	105N78W14ADDA	do.	8-17-76
	108N77W21CCAB	do.	7-18-63

Table 4.--Observation wells in bedrock aquifers in South Dakota, fiscal years 1987-88--Continued

County	Well number	Formation	Date of first measurement
McPherson	125N66W23ABAA	Dakota Formation	8- 8-62
	127N66W 5BBBD	do.	8- 8-62
Marshall	127N58W19AABB	do.	4-22-65
	127N58W23DAD	do.	7- 1-70
	128N59W24CBBB	do.	6- 4-63
Meade	3N 6E15ABBB	Minnelusa Formation	7- 7-84
	3N 6E23DCB	Spearfish Formation	6-29-80
	4N 6E19AABA	Minnelusa Formation	7-10-84
	6N 5E19ADCD	Fall River Formation	5-28-80
	6N 5E22DDBC	Inyan Kara Group	5-28-80
	7N14E25BDD	Newcastle Sandstone	6-23-80
	10N16E 3DB	Fox Hills Formation	6-11-80
Mellette	41N27W25DBDC	do.	6-27-78
	41N32W28CCD	Arikaree Formation	7- 8-80
	43N27W14ACD	Dakota Formation	7-25-63
	43N30W 8BBC	do.	7-30-63
	43N30W29A	Inyan Kara Group	7- 8-80
	44N31W20BBBB	Dakota Formation	7- 7-83
Miner	105N58W31BACC	do.	7-30-79
Moody	106N48W13BAAC	do.	7-13-61
	107N48W30DCCC	do.	7-13-61
Pennington	1N 7E14CBBD	Spearfish Formation	5-30-80
	1N 7E29DAC	Deadwood Formation	6-10-83
	1N 7E29CAD	Deadwood Formation	6-30-84
	1N16E31CDA	Fall River Formation	8-19-70
	2N 7E17BAAD	Minnelusa Formation	7- 3-84
	2N 8E28BCB	Spearfish Formation	5-22-80
	1S 7E11ADB	Madison Group	11- 1-84
	1S 8E19BBBB	do.	3-13-84
	1S16E 6AAB	Fall River Formation	2- 2-61
	3S14E22DADA	Lakota Formation	6- 2-80
Perkins	13N14E 9DDA	Fox Hills Formation	6-17-80
	20N11E35BBA	Hell Creek Formation	6-18-80
	21N14E23C	Ludlow Member of the Lance Formation	6-18-80
	23N16E20ACAC	Fox Hills Formation	6-17-80
	23N17E31BBB	Ludlow Member of the Lance Formation	6-18-80
Potter	118N76W25AB	Dakota Formation	11-24-74
	120N76W33CDDB	Minnelusa Formation	7-24-76

Table 4.--Observation wells in bedrock aquifers in South Dakota, fiscal years 1987-88--Continued

County	Well number	Formation	Date of first measurement
Roberts	126N51W 9CCCA	Dakota Formation	6-20-62
	127N49W29BBBC	do.	6-20-62
Sanborn	106N62W30BCBA	do.	10-28-60
Spink	112N63W20DCC2	do.	4-29-64
	115N65W 4ADDC	do.	3-15-66
	116N62W 5DDCC	do.	3-15-66
Stanley	3N25E32BCDD	Inyan Kara Group	6-23-80
Tripp	100N76W17ABB	Dakota Formation	6- 9-80
	101N74W 8DDCC	Graneros Shale	6- 9-80
	102N74W28CDAA	Dakota Formation	6-19-63
Turner	96N53W36DDDA	do.	7- 7-61
	97N54W 5AB	Niobrara Formation	3-31-66
Union	93N50W 4DAA	do.	6-30-61
	95N49W16ACD	do.	7- 7-61
Yankton	93N55W 4BBC	Dakota Formation	10- 6-60
Ziebach	13N18E29BBB	Fox Hills Formation	7-22-80
	13N21E31BDDA	do.	7-15-81

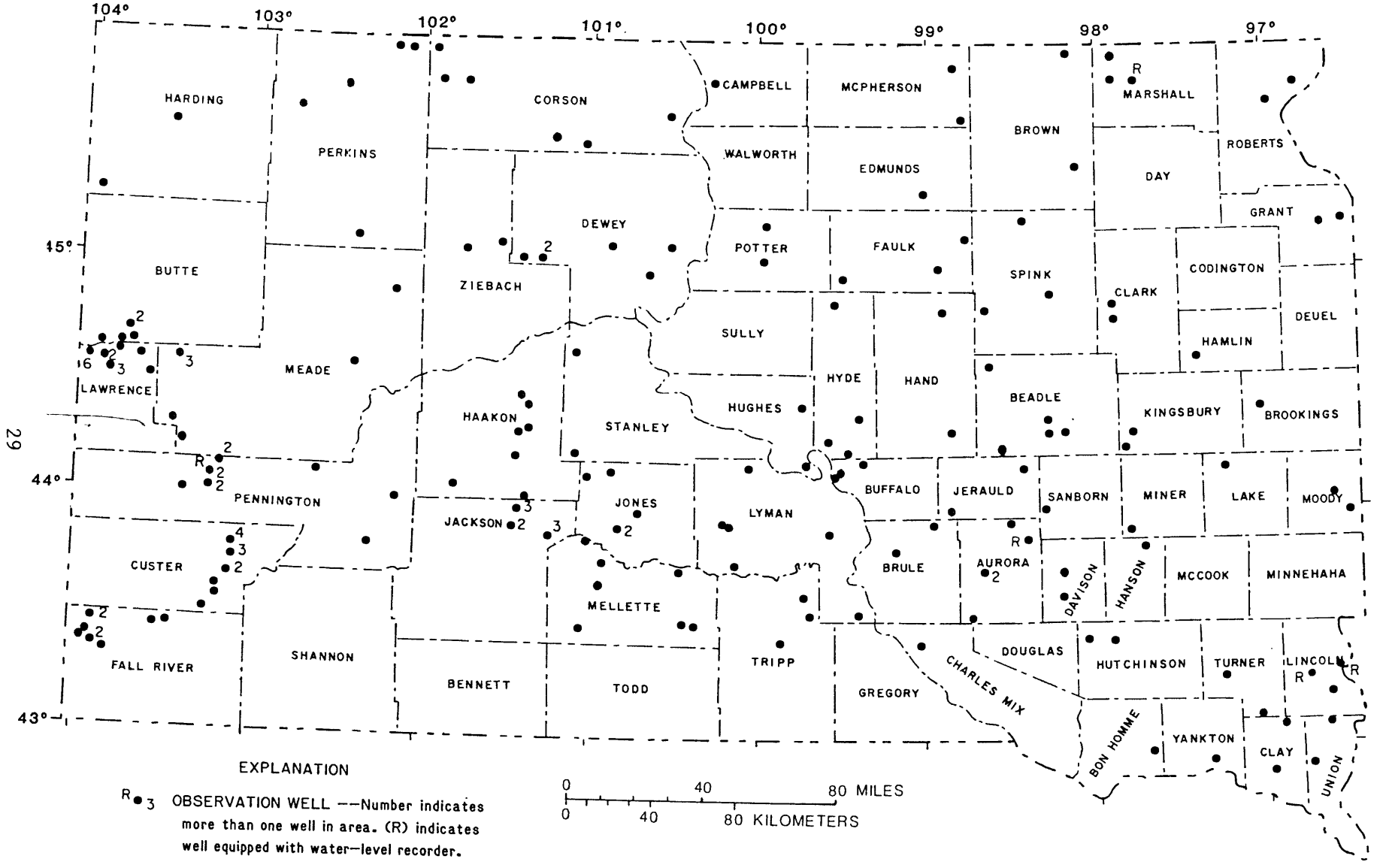
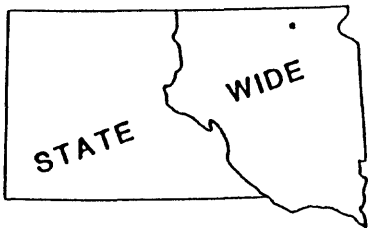


Figure 7.--Location of observation wells in bedrock aquifers, fiscal years 1987-88.

CURRENT PROJECTS

The project descriptions in this section show the location, project number, title, period of the project, cooperating agencies, project leader, purpose of the project, progress, plans, and completed reports.

SURFACE-WATER STATIONS
(SD001)



Project leader: John R. Little

Project period: Continuous

Cooperators: South Dakota Department of Water and Natural Resources, East Dakota Water Development District, West Dakota Water Development District, City of Watertown, City of Rapid City, U.S. Bureau of Reclamation, U.S. Army Corps of Engineers, U.S. Bureau of Indian Affairs, Tennessee Valley Authority, Missouri River Basin Program, U.S. Geological Survey (Federal Program).

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

Objective: A. To collect surface-water data sufficient to satisfy needs for current-purpose uses, such as 1) assessment of water resources, 2) operation of reservoirs or industries, 3) forecasting, 4) disposal of wastes and pollution controls, 5) discharge data to accompany water-quality measurements, 6) compact and legal requirements, and 7) research or special studies. B. 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, etc., for use in planning and design.

Approach: Standard methods of data collection will be used 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.

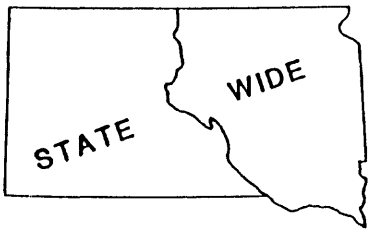
Progress and significant results during fiscal year 1988: Data were collected and published in U.S. Geological Survey Water-Data Report SD-87-1. The network was increased by 26 continuous-record sites.

Plans for 1989: Review network and consult with cooperators as to their needs. Expect to continue on about the same scale as last year. Data will be published in USGS Water-Data Report SD-88-1. Requests for data will be answered.

Completed reports:

U.S. Geological Survey, 1988, Water resources data for South Dakota, water year 1987: U.S. Geological Survey Water-Data Report SD-87-1, 307 p.

GROUND-WATER RECORDS
(SD002)



Project leader: John R. Little

Project period: Continuous

Cooperators: South Dakota Department of Water and Natural Resources, City of Sioux Falls, West Dakota Development District, Missouri River Basin Program.

Problem: Long-term water-level records are needed to evaluate the effects of climatic variations on the recharge to and discharge from the 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 resources.

Objective: A. 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. B. To provide a data base against which the short-term records acquired in areal studies can be analyzed.

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

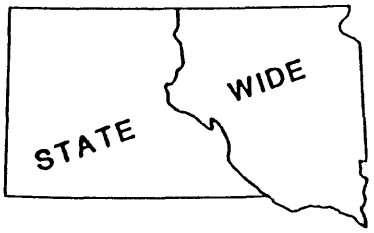
Progress and significant results during fiscal year 1988: Hydrologic data were collected for bedrock aquifers. All water levels for bedrock aquifers have either been prepared for entry, or already entered, into the computer. Data for six observation wells were published in U.S. Geological Survey Water-Data Report SD-87-1.

Plans for 1989: Continue collecting water-level data on observation wells and establish new observation wells in areas of poor coverage.

Completed reports:

U.S. Geological Survey, 1988, Water resources data for South Dakota, water year 1987: U.S. Geological Survey Water-Data Report SD-87-1, 307 p.

WATER-QUALITY STATIONS
(SD003)



Project leader: Donald S. Hansen

Project period: Continuous

Cooperator: U.S. Bureau of Reclamation, U.S. Bureau of Indian Affairs, Missouri River Basin Program, U.S. Geological Survey (Federal Program).

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

Objective: To provide a national bank of water-quality data for broad Federal planning and action programs and to provide data for Federal management of interstate and international waters.

Approach: Operation of a network of water-quality stations to provide average chemical concentrations, loads, and time trends as required by planning and management agencies.

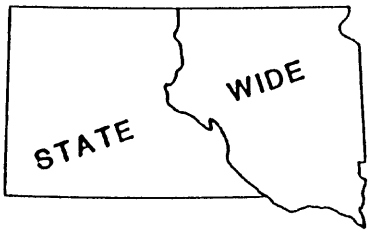
Progress and significant results during fiscal year 1988: Fourteen continuous sites were added to the network at the beginning of FY 1988. Water-quality data were published in U.S. Geological Survey Water-Data Report SD-87-1.

Plans for 1989: The network will continue to be operated.

Completed reports:

U.S. Geological Survey, 1988, Water resources data for South Dakota, water year 1987: U.S. Geological Survey Water-Data Report SD-87-1, 307 p.

SEDIMENT STATIONS
(SD004)



Project leader: Michael J. Burr

Project period: Continuous

Cooperators: U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, Missouri River Basin Program, U.S. Geological Survey (Federal Program).

Problem: Water-resource planning and water-quality assessment require a nationwide base level of relatively standardized information. Sediment concentrations and discharges in rivers and streams must be defined and monitored.

Objective: To provide a national bank of sediment data for use in broad Federal and State planning and action programs and to provide data for Federal management of interstate and international waters.

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

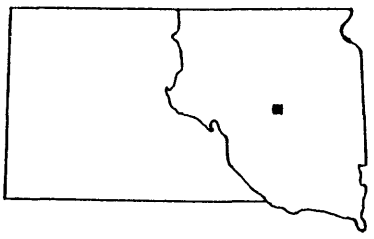
Progress and significant results during fiscal year 1988: Data collected as scheduled and published in U.S. Geological Survey Water-Data Report SD-87-1. Three sites were added to the network.

Plans for 1989: Continue network operation.

Completed reports:

U.S. Geological Survey, 1988, Water resources data for South Dakota, water year 1987: U.S. Geological Survey Water-Data Report SD-87-1, 307 p.

NATIONAL TRENDS NETWORK FOR MONITORING ATMOSPHERIC DEPOSITION (SD005)



Project leader: Steven K. Sando

Project period: Continuous

Cooperator: Federal (USGS).

Problem: To establish and operate a nationwide long-term monitoring network to detect and measure levels of atmospheric deposition.

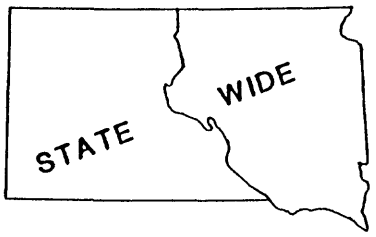
Objective: To determine variations in atmospheric deposition that occur on a week to week basis. To collect wet and dry deposition products for analysis of elements and compounds that can contribute to the chemical composition of surface waters.

Approach: Set up monitoring stations as part of the National Trends Network. Maintain stations, make on-site measurements, process samples, and submit samples to an analytical laboratory. Verify data retrievals and report on results.

Progress and significant results during fiscal year 1988: Data were collected as scheduled.

Plans for 1989: Water-quality data which are collected will be stored in WATSTORE files and daily rainfall data which are collected will be stored in the ADAPS files.

SOUTH DAKOTA WATER-USE DATA PROGRAM
(SD007)



Project leader: Rick D. Benson

Project period: Continuous

Cooperator: South Dakota Department of Water and Natural Resources.

Problem: Water requirements for various uses within South Dakota have increased considerably in recent years. A State Water Plan has been developed in order to implement a priority system for all State decisions affecting water-resource development. An important part of the State Water Plan is a comprehensive statewide water-use assessment program.

Objective: To develop and maintain a statewide water-use data program that will include field-collection procedures and computer storage, retrieval, manipulation, and dissemination of water-use data for 12 categories of water use.

Approach: The U.S. Geological Survey will provide direction, management, and standards development to meet the needs of the National Water-Use Program. The South Dakota Department of Water and Natural Resources will provide annual water-use data to the USGS for categories for which data are available.

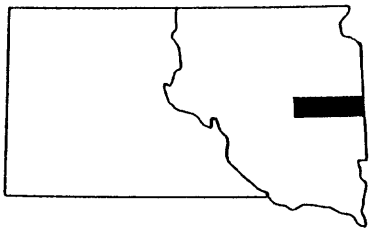
Progress and significant results during fiscal year 1988: A report was published as Open-File Report 88-313 during FY 1988. A poster was presented during the Poster Session at the American Water Resources Association Symposium on Water-Use Data for Water Resources Management in Tucson, Arizona, on August 30, 1988. Irrigation questionnaire data for 1987 were received from the South Dakota Department of Water and Natural Resources during September 1988; however, the data would not load onto the State Water Use Data System (SWUDS) due to a defective magnetic tape (a second magnetic tape was requested).

Plans for 1989: Irrigation questionnaire data for both 1987 and 1988 will be entered into SWUDS. Questionnaires for other water-use categories will be developed and, if satisfactory to DWNR, will be sent out by DWNR to water users. If time permits, latitude/longitude data and aquifer codes (for ground water) will be entered into SWUDS for all water users.

Completed reports:

Benson, R. D., 1988, Estimated water use in South Dakota, 1985: U.S. Geological Survey Open-File Report 88-313, 1 sheet.

WATER RESOURCES OF BROOKINGS AND KINGSBURY COUNTIES, SOUTH DAKOTA (SD060)



Project leader: Louis J. Hamilton

Project period: October 1981 to September 1987

Cooperator: South Dakota Department of Water and Natural Resources.

Problem: The study will help to complete the overall water-resources picture in eastern South Dakota. A complete knowledge of the hydrology of the aquifers will be valuable in future land-use planning and in the development of irrigation and rural water systems in the area. Identification of significant new sources of ground water would undoubtedly encourage some changes from dryland to irrigation farming. The counties are heavily populated in the rural areas, which should favor the development of rural water systems. Recent drought conditions have increased local interest in irrigation development from ground-water sources.

Objective: To provide reliable and up-to-date basic data and analyses needed for water-resources evaluation and for efficient use of these resources by agriculture, rural water systems, and municipalities. Specifically, the study will concentrate on determining the availability of surface- and ground-water resources, the operation of the hydrologic system as it influences availability, the quality of surface and ground water, and the effects on the hydrologic system of developing the water resources. Areas of current or potential hydrologic problems as related to water use will be identified.

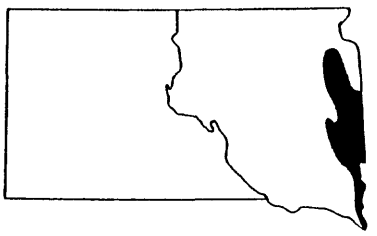
Approach: Water resources will be evaluated using standard geologic and hydrologic techniques. Glacial and bedrock aquifers will be delineated and hydrologic characteristics described. Pump tests, using existing wells, will be run whenever feasible. A geologic study will be made by the State Survey and there will be extensive test drilling by State drill rigs. A preliminary report discussing the major aquifers will be prepared. A report on the hydrology will be published and a report on the geology of the county will be prepared by a State Survey geologist.

Progress and significant results during fiscal year 1988: The interpretive report on hydrology was sent to the Director, returned for revisions, and subsequently resubmitted for approval. The report was approved as WRIR 88-4185 on October 7, 1988. Project complete.

Completed report:

Hamilton, L.H., in press, Water resources of Brookings and Kingsbury Counties, South Dakota: U.S. Geological Survey Water-Resources Investigations Report 88-4185.

WATER RESOURCES OF THE BIG SIOUX RIVER BASIN, SOUTH DAKOTA (SD065)



Project leader: Donald S. Hansen

Project period: October 1982 to September 1989

Cooperator: South Dakota Department of Water and Natural Resources.

Problem: The Big Sioux River basin of eastern South Dakota represents a sizeable aquifer system of major importance to the economy of South Dakota. Management problems already exist and, as development continues, the problems continue to increase in number and complexity. Although it is possible to estimate the amount of water in the basin, management is extremely difficult. The aquifers are complex, consisting of many small aquifers that are hydrologically associated with several large aquifers and the Big Sioux River. A comprehensive model study is needed to aid in optimum development of water resources in the basin.

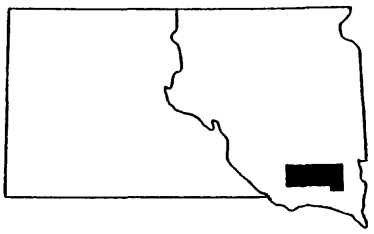
Objective: To provide a scientific basis for evaluation and efficient use of water resources and to explore the possibility of application of a solute-transport model to describe rates and directions of movement. Information will be provided on the availability of surface-water and ground-water resources, operation of the hydrologic system, and the effect of water-resources development on the hydrologic system. The study will provide basic data for use in developing digital models of major aquifers.

Approach: The study will include hydrologic data collection and an extensive test-drilling program by the State Survey. Two-dimensional models of the Big Sioux aquifer will be developed and the feasibility of the application of a solute-transport model to describe rates and directions of movement, and concentrations of both naturally occurring and artificially introduced organic and inorganic constituents will be determined. Development alternatives will be tested and analyzed for possible impacts on the hydrologic system. Reports will be prepared summarizing the hydrology and recommending needs for further study and data collection.

Progress and significant results during fiscal year 1988: Completed final drafts of reports for major aquifers of Codington and Grant Counties and of Minnehaha County. Completed steady-state model simulations for the Big Sioux aquifer in Codington and Grant Counties. Prepared aquifer maps for Lincoln and Union Counties.

Plans for 1989: Model studies of the Big Sioux aquifer in Codington and Grant Counties will be completed. The major aquifer report for Lincoln and Union Counties will be completed. Model studies of the Big Sioux aquifer in Lincoln and Union Counties will continue.

WATER RESOURCES OF HUTCHINSON AND TURNER COUNTIES, SOUTH DAKOTA (SD066)



Project Chief: Richard J. Lindgren

Period of project: October 1982 to September 1987

Cooperator: South Dakota Department of Water and Natural Resources.

Problem: Several productive aquifers mapped during U.S. Geological Survey studies in adjacent counties probably extend into Hutchinson and Turner Counties. A knowledge of the hydrology of these aquifers will be valuable in future land-use planning and in the development of irrigation and rural water systems. Identification of significant new sources of ground water would undoubtedly encourage some changes from dryland to irrigation farming. Also, the counties are heavily populated in rural areas, which should favor the development of rural water systems that will benefit by the more detailed knowledge of the ground-water resources resulting from this study.

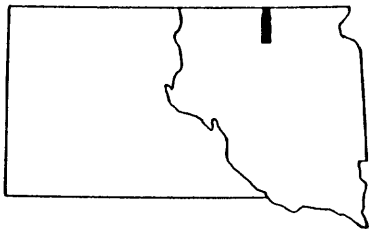
Objective: Provide reliable and current basic data and analyses needed for water-resources evaluation for the efficient use of these resources by agriculture, rural water systems, and municipalities. The study will determine the availability of surface and ground water, the operation of the hydrologic system as it influences availability, and the quality of surface and ground water. Current or potential problems related to development of the water resources will be identified. These problems may include declining water levels, decreased natural discharge, and changes in water quality due to induced recharge from materials adjacent to the aquifers.

Approach: Water resources will be evaluated using standard geologic and hydrologic techniques. Existing precipitation, streamflow, and well data will be collected. A well inventory will be conducted and a test-drilling program will be completed during the first two field seasons. An observation-well network will be established and water samples collected for chemical analysis. Glacial and bedrock aquifers will be delineated and hydrologic characteristics described. Aquifer tests will be conducted whenever feasible.

Progress and significant results during fiscal year 1988: A report "Water resources of Hutchinson and Turner Counties, South Dakota" was submitted to the Central Region for further processing on Sept. 16, 1988. Project complete except report.

Plans for 1989: Publish interpretive report.

HYDROLOGY OF THE GLACIAL AQUIFERS, ABERDEEN AREA, SOUTH DAKOTA (SD072)



Project leader: Patrick J. Emmons

Period of project: October 1983 to September 1987

Cooperators: South Dakota Department of Water and Natural Resources, City of Aberdeen.

Problem: Two glacial-outwash aquifers in Brown County, the Elm and Middle James aquifers, can provide a major source of water in the area. Identification of aquifer properties and the prevailing flow regime will allow management decisions to be made in the context of quantified storage, transmission, recharge and discharge characteristics of the ground-water reservoir. With the anticipated large increases in water use from these aquifers, there is an urgent need to better define the hydrologic system of these aquifers and to evaluate the effects of increased water demand on the water resources in this area.

Objective: To define the ground-water system of the Elm and James River aquifers, develop a digital model of the aquifer system, and determine the hydrologic effects of the anticipated increase in water development in the aquifers.

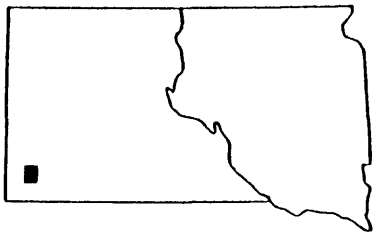
Approach: Evaluate historical data and prepare maps for aquifer simulation. Obtain current aquifer data and determine rates of recharge and discharge from hydrographs and precipitation records. Prepare maps of prepumping and current water table, saturated aquifer thickness and areal distribution of coefficients. Prepare a hydrologic budget and develop a digital model to simulate the aquifer system. A U.S. Geological Survey model will be used to determine long-term yield of the aquifer and to test selected pumping distribution plans. Prepare a Water-Resources Investigations Report.

Progress and significant results during fiscal year 1988: The final report was approved as WRIR 88-4198 on October 18, 1988. Project complete.

Completed reports:

Emmons, P.J., in press, A digital simulation of the glacial-aquifer system in the northern three-fourths of Brown County, South Dakota: U.S. Geological Survey Water-Resources Investigations Report 88-4198.

SOUTH DAKOTA SIDE-LOOKING AIRBORNE RADAR STUDY (SD078)



Project leader: Lewis Howells

Period of project: May 1985 to September 1987

Cooperator: Federal (USGS).

Problem: Information on the relationship between the hydraulic conductivity of shale and fracturing of shale is needed for ongoing research and anticipated investigations in South Dakota. Investigation of the hydrology of the Upper Cretaceous shale has been hampered by the complexity of the hydrology, lack of data, and difficulty in applying standard methods. Lineaments, mapped using Landsat and Skylab imagery of South Dakota, may represent fractures and ground-water movement may be related to these lineaments. If the permeability of the shale is fracture controlled, a relationship may be shown for the hydraulic conductivity and linear features in the shale.

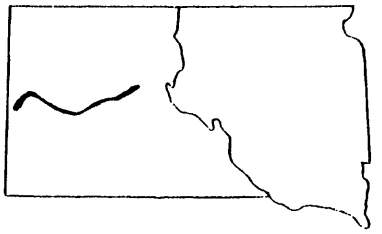
Objective: Test the hypothesis that the hydraulic conductivity of the Carlile Shale, of Upper Cretaceous age, in southwestern South Dakota is related to lineaments. The area of the investigation is in the Hot Springs, South Dakota, quadrangle. Measurements of hydraulic conductivity of the Carlile Shale within an area of about 10 square miles will be compared with lineaments throughout a 55-square-mile area mapped from a variety of remote sensing techniques, including Landsat, side-looking airborne radar, and thematic imagery, aerial photographs, and digitized topographic data.

Approach: Compile existing data consisting of hydraulic conductivity measurements in the Carlile Shale, geophysical surveys by a consulting firm, and similar data collected for Department of Energy. In addition, Landsat, thematic mapping, and digital topographic imagery are available from the Earth Resources Observation Satellite (EROS) Data Center. To supplement existing imagery, the area will be mapped as part of the U.S. Geological Survey FY85 Side-Looking Airborne Radar (SLAR) program. The SLAR imagery and data will be combined with existing imagery and data and the linear features mapped, field checked, and compared with known geologic features. Hydraulic conductivities determined from existing data will be analyzed statistically to determine if a relationship exists between hydraulic conductivity and mapped lineaments.

Progress and significant results during fiscal year 1988: Radar imagery was acquired from EROS. An agreement was made with the Remote Sensing Institute, South Dakota State University, for acquisition and analysis of additional imagery and data for preparation of geohydrologic maps. The Remote Sensing Institute submitted a preliminary report, outlining a detailed plan of study, during October 1988.

Plans for 1989: If additional funding is approved, Landsat imagery will be acquired, SLAR enhancements and classification will be completed, ARC/INFO files will be compiled and evaluated using GIS, and the final report will be completed.

SEDIMENT CHEMISTRY - WHITEWOOD CREEK, WEST-CENTRAL SOUTH DAKOTA (SD079)



Project leader: Kimball E. Goddard

Period of project: April 1985 to September 1989

Cooperator: Federal (USGS).

Problem: Arsenic hydrogeochemistry in natural systems is largely undefined due to the complexity of the element's interrelationships with the environment. The transport of arsenic through a river system is dependent upon chemical transformations between ionic species, the sorption of arsenic species on solid materials, and the physical transport of sediment. The Cheyenne River basin, widely contaminated by arsenic-laden mill tailings discharged to a small tributary stream, provides an excellent field site to investigate the processes that control the distribution and movement of arsenic and other trace elements through the environment.

Objective: (1) Define the mechanisms responsible for the transport of arsenic and trace metals by the surface-water system, (2) describe the occurrence and distribution of arsenic and selected trace metals in water and sediment, and (3) develop and refine appropriate methods for field sampling, sample processing, and laboratory analysis. Other project objectives are being developed by Water Resources Division researchers and are to be accomplished separately.

Approach: A number of interrelated investigations will be conducted to define the distribution, transport, and fate of sediment and sediment-associated contaminants in the Cheyenne River basin. Laboratory experiments will be used to determine the sorption-desorption characteristics of tailings, alluvium, and suspended sediment. Geomorphologic and geometric measurements of flood-plain deposits will allow definition of sediment-source areas. In-stream sediment and chemistry data will be obtained at sites throughout the basin to determine the transport rates of contaminants.

Progress and significant results during fiscal year 1988: Sediment and water-sample collection was continued at five primary sites. Ground-water monitoring was initiated at the Berger and Sheeler sites. Bed-load samples were collected at the five primary sites. District projects to define arsenic partitioning in the solid phase were completed and results were presented at national meetings. National Research Program projects were continued and most NRP researchers visited the site. A comprehensive data report for FY 1985 and FY 1986 data collection was approved and published as Open-File Report 88-484.

Plans for 1989: Prepare and publish comprehensive data report for FY 1987 and FY 1988. Complete the manuscript of a Water-Supply Paper on arsenic contamination and subsequently receive Director's approval of the WSP.

Completed reports:

Goddard, K.E., ed., 1988, U.S. Geological Survey applied research studies of the Cheyenne River system, South Dakota: Description and collation of data, water years 1985-86: U.S. Geological Survey Open-File Report 88-484, 158 p.

WASTE DISPOSAL PLANNING STUDY
(SD080)

Project leader: Mark T. Anderson

Period of project: June 1985 to September 1987

Cooperator: Federal (USGS).

Problem: Reports on field studies of active or abandoned low-level radioactive waste-disposal sites all point to a need for careful and comprehensive pre-siting studies of proposed sites. In addition, Nuclear Regulatory Commission (NRC) regulations governing disposal of low-level radioactive waste list a number of disposal-site suitability requirements and site characteristics that must be addressed before a site is accepted for licensing. A "generic" plan of study for proposed disposal sites could form the basis for evaluation of many proposed sites.

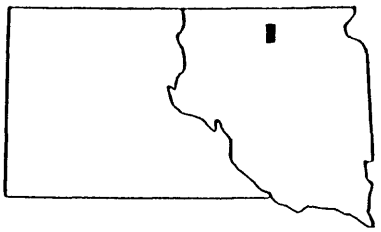
Objective: Develop a plan for evaluating the hydrogeologic suitability of potential sites for the shallow land disposal of low-level radioactive waste. The plan would specify the kinds and amounts of hydrogeologic information necessary for review and reasonable judgement by appropriate agencies as to the technical adequacy of a proposed disposal site.

Approach: The study will be in two phases. The first phase (FY85) will begin with consultation with personnel associated with the Radioactive Waste Hydrology Program to establish firm guidelines and direction for the planning study. This will be followed by a review of the literature on the operating practices and hydrologic consequences thereof for a substantial number of low-level radioactive waste sites. The second phase of the project (FY86-87) will be preparation of a report outline and a detailed plan for the study of geohydrology and geochemistry of potential sites for shallow land disposal of low-level radioactive waste. The plan for site evaluation will be published as a U.S. Geological Survey Circular.

Progress and significant results during fiscal year 1988: A draft of the report was completed and a "within-District" colleague review was completed on June 17, 1988. The author is currently responding to review comments. Project complete except report.

Plans for 1989: Complete the review process, obtain Director's approval, and publish report.

PRELIMINARY ASSESSMENT OF THE ARTIFICIAL RECHARGE POTENTIAL AND WELL YIELD CAPABILITIES OF THE ELM AND MIDDLE JAMES AQUIFERS IN THE ABERDEEN AREA, SOUTH DAKOTA (SD081)



Project leader: Patrick J. Emmons

Period of project: October 1985 to September 1986

Cooperator: U.S. Bureau of Reclamation.

Problem: Two glacial-outwash aquifers in Brown County, the Elm and Middle James aquifers, have the potential of being major sources of water in the area. Identification of aquifer properties will allow management decisions to be made in the context of quantified storage, transmission, recharge and discharge characteristics of the ground-water reservoir. The U.S. Bureau of Reclamation is in urgent need of these data to evaluate the feasibility of using the Elm and Middle James aquifers for temporary storage of surplus water from the James River. Specifically, the U.S. Bureau of Reclamation needs a preliminary assessment of the aquifer's artificial-recharge potential and the feasibility of retrieving the stored water via high-capacity wells. There is also a need to better define the hydrologic system of these aquifers in order to determine how development of these aquifers will fit in with development of other water resources in the area.

Objective: To define the ground-water system of the Elm and Middle James aquifers including a preliminary assessment of the aquifer's artificial-recharge potential and well-yield capabilities.

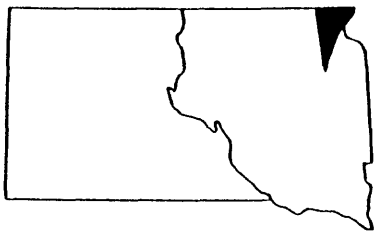
Approach: A sufficiently large and detailed data base, including the Ground-Water Site Inventory (GWSI) and National Water Data Storage and Retrieval System (WATSTORE) water-quality computer files, test-hole and well logs, aquifer-test analyses, pumpage data, and water-level data already exist. These data will be evaluated to define and prepare maps showing the areal extent of the Elm and Middle James aquifers, thickness, hydraulic conductivity, and quality of water. Areas where artificial recharge is feasible using spreading ponds will be determined by mapping where the aquifer is within 5 feet of land surface or overlain by permeable material. Well spacing, yield, and well depth will be estimated based on an evaluation of existing high-capacity wells and by extrapolating to other areas of the aquifer with similar hydrologic characteristics.

Progress and significant results during fiscal year 1987: The final report was published as Water-Resources Investigations Report 87-4017 in 1987. Project complete.

Completed report:

Emmons, P.J., 1987, Preliminary assessment of potential well yields and the potential for artificial recharge of the Elm and Middle James aquifers in the Aberdeen area, South Dakota: U.S. Geological Survey Water-Resources Investigations Report 87-4017, 33 p.

APPRAISAL OF THE WATER RESOURCES OF THE SISSETON INDIAN RESERVATION IN SOUTH DAKOTA (SD082)



Project leader: Stephen J. Lawrence

Period of project: April 1986 to September 1987

Cooperator: Federal (USGS).

Problem: The surface water of the reservation consists primarily of small lakes or ponds in the Coteau area, and tributaries to the Minnesota, Big Sioux, and Red Rivers. Ground-water resources include the glacial-outwash aquifers and the confined sandstone aquifers. Surface- and ground-water supplies are important to the agricultural, mining, and recreational industries within and surrounding the reservation. The Sisseton Reservation is the last of the reservations in South Dakota awaiting an appraisal of its water resources. Six of the reservation studies were funded under the Missouri River Basin (MRB) program. Although, the Sisseton Reservation is within the Missouri River basin, funding under the MRB program was not available. In 1977 the Sisseton-Wahpeton Tribal Council made a formal request to the U.S. Geological Survey for a hydrologic study, but no source of funding was available. Officials from the Bureau of Indian Affairs support the appraisal study as a first step in solving the reservation's need for good-quality water. It is generally felt that economic and social improvement of Indians living in the reservation is hampered by a lack of adequate and reliable information on the quantity and quality of water within the reservation. The need for additional water supplies of good quality is especially critical since new housing development is proceeding in the reservation. This study would provide the necessary foundation for water-resources development within the reservation.

Objective: The primary objectives of the study are to provide detailed and current information on the extent, availability, and quality of the surface and ground water within the reservation. A secondary objective is to determine the beneficial uses of the water within the reservation.

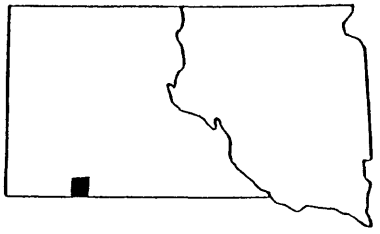
Approach: Geologic, ground-water, and surface-water resources will be evaluated using available data from the U.S. Geological Survey, South Dakota Department of Water and Natural Resources, Bureau of Indian Affairs, Environmental Protection Agency, and Bureau of Reclamation. These data will be used to determine quality and quantity of both surface and ground water within the reservation. Meetings will be held with the Bureau of Indian Affairs, tribal officials, farmers, and local officials to determine water problems and needs. A detailed work plan will be prepared by the project chief during the first two months of the study. A final report will be published by the U.S. Geological Survey as a Water Resources Investigations Report.

Progress and significant results during fiscal year 1988: A report was approved as Water-Resources Investigations Report 88-4031 on February 25, 1988. Project complete.

Completed report:

Lawrence, S.J., in press, Water-resources appraisal of the Lake Traverse Indian Reservation in South Dakota: U.S. Geological Survey Water-Resources Investigations Report 88-4031.

AVAILABILITY OF WATER FOR IRRIGATION ON THE PINE RIDGE INDIAN RESERVATION NEAR PINE RIDGE, SOUTH DAKOTA (SD083)



Project leader: Mark T. Anderson

Period of project: April 1986 to September 1989

Cooperator: Oglala Sioux Tribe.

Problem: The Pine Ridge Indian Reservation is an economically depressed area and determination of the quantity and quality of ground and surface water would greatly enhance economic development. There is a great need to develop industry to decrease massive unemployment on the reservation. The Tribe is looking at agriculture-related industries; however, an adequate water supply is a prerequisite to this industrial development. The economic future of the Pine Ridge Indian Reservation is heavily dependent upon the capacity of underlying aquifers to sustain withdrawals. Irrigation systems have been established but have not operated because of a lack of a sufficient water supply. Knowledge as to the high-yield capabilities of the aquifers is lacking. Previous studies dealt only with geologic mapping or an inventory of existing water development. Information is lacking on the aquifer-yield capabilities or the capacity of the aquifer to sustain withdrawals.

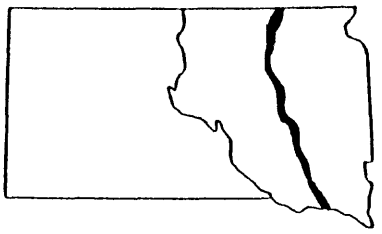
Objective: To provide reliable and up-to-date information and analyses needed for water-resources evaluation and for the efficient use of these resources for agriculture, rural-water systems, and municipalities. Specifically, the study will concentrate on determination of the potential for obtaining well yields of 500 gallons per minute or more and the capability of aquifers to sustain withdrawals.

Approach: Water resources will be evaluated using standard geologic and hydrologic techniques. Test drilling will be conducted at selected sites to determine aquifer thickness and sand size. An aquifer test may be conducted where there is a sufficient aquifer thickness to provide a yield of more than 200 gallons per minute. Multiple wells will be considered where yield from a single well is not sufficient for irrigation. Transport of water by pipeline from ground-water sources to existing irrigation systems will be considered. Existing precipitation, streamflow, and well data will be compiled and analyzed. The Oglala Sioux Tribe will provide the drilling and material for additional test holes and observation wells and will also provide or contract for the power supply, the pump, and the personnel needed to run an aquifer test and dispose of the water during the test. A detailed work plan will be prepared by the project chief during the first two months of the study. Oral progress reports will be made to the cooperator during the study period. A final report will be published by the U.S. Geological Survey.

Progress and significant results during fiscal year 1988: A revised work plan was prepared and subsequently reviewed and approved by the Central Region Ground-Water Specialist. Aquifer tests were conducted on the shallow and deep production wells. Dye tracing was attempted between the observation well and the deep production well.

Plans for 1989: Conduct aquifer test and subsequently compile and analyze data on shallow production well. Prepare a report for the BIA and Oglala Sioux Tribe summarizing results of the study.

JAMES RIVER DATA, GARRISON DIVERSION UNIT REFORMULATION (SD084)



Project leader: Rick D. Benson

Project period: October 1986 to September 1987

Cooperator: U.S. Bureau of Reclamation.

Problem: The Garrison Diversion Unit Reformulation Act of 1986 (H.R. 1116) directs the Secretary of the Interior to submit a comprehensive report to the Congress as soon as practicable but not later than the end of FY88 (Amended Section 5(C) (1) Public Law 89-108). The Reformulation Act identifies eight specific study areas, seven of which are directly associated with impacts on the James River. The Bureau of Reclamation has prepared a detailed work statement for evaluating the potential effects on the James River in South Dakota caused by the GDU. Work items identified by the Bureau include: (1) Potential flooding (timing, magnitude, and duration)--frequency events with and without the project will be evaluated; (2) channel conveyance studies--channel capacities will be evaluated on the entire reach within South Dakota (from Sand Lake NWR to the confluence with the Missouri River); (3) degradation--potential degradation as a result of increased flows in the river will be evaluated to the extent possible; and (4) bank stabilization evaluation--the potential need for bank stabilization will be evaluated. The Bureau requested by memorandum dated August 28, 1986, that the Survey provide assistance relative to the GDU, South Dakota Impacts Study.

Objective: To provide stream-discharge data (of specified return periods and durations at various locations) for the James River and certain tributaries for the Bureau's use in development of water-surface profiles and inundation areas. The study effort will be devoted to analysis of existing records for the James River within South Dakota. Specifically, to analyze: (1) Flood-flow frequency--Frequency analyses will be conducted for the James River main stem and for certain tributaries; (2) Flow duration--Duration analyses will be conducted for the James River main-stem gages and for tributary gages; (3) Dominant (channel-forming) flow -- The effects of the flow regime on channel characteristics/changes will be addressed for the main stem.

Approach: Flood-flow frequency analyses will be conducted for the James River main-stem gages and for tributary gages using data stored in the National Water Data Storage and Retrieval System (WATSTORE) Peak Flow File. Drainage areas will be determined for the entire basin in South Dakota so that frequency data for gaged tributaries can be projected down to the confluence with the James River and so that frequency data for ungaged tributaries can also be developed using methods developed by Becker (1974 and 1980). Determination of frequency data for the main stem and for tributaries during the "summer" period, June through September, will also be made using maximum mean daily flow data. Duration hydrograph tables and plots will be prepared using data stored in the WATSTORE Daily Values File. The channel-forming (dominant flow) characteristic of the James River in South Dakota will also be addressed using existing data.

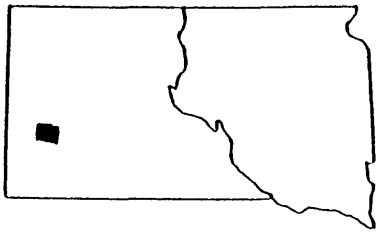
Progress and significant results during fiscal year 1988: A report was approved by the Director for publication as Water-Resources Investigations Report 87-4208. A report was approved for publication as Open-File Report 87-572. Project complete.

Completed report:

Benson, R.D., 1988, Analysis of flood-flow frequency, flow duration, and channel-forming flow for the James River in South Dakota: U.S. Geological Survey Water-Resources Investigations Report 87-4208, 136 p.

Benson, R.D., Freese, M.E., Amundson, F.D., and Wipf, V.J., 1987, Drainage areas in the James River basin in eastern South Dakota: U.S. Geological Survey Open-File Report 87-572, 1 sheet.

NITROGEN GAS IN GROUND WATER, EASTERN BLACK HILLS, SOUTH DAKOTA (SD085)



Project leader: Mark T. Anderson

Project period: October 1986 to September 1989

Cooperators: City of Rapid City and South Dakota Department of Game, Fish and Parks.

Problem: The City of Rapid City secures its municipal water supply primarily from three infiltration galleries along Rapid Creek. Because surface waters are fully appropriated, future water supplies are expected to tap the Madison Limestone aquifer which is known to be hydraulically connected to Rapid Creek. Since several long-term water agreements will be renegotiated within the next five years, the City would like a comprehensive hydrologic budget of Rapid Creek that defines the ground-water/surface-water relationship. The mainstay of the City's water supply is Cleghorn Springs. Cleghorn Springs water is supersaturated with nitrogen gas which is limiting fish production at the South Dakota Game, Fish and Parks Department fish hatchery. The origin and process of nitrogen gas supersaturation is unknown.

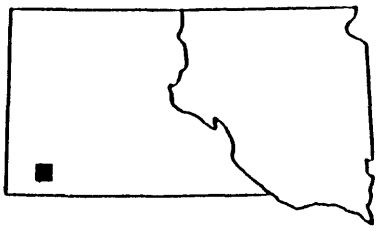
Objective: First, a hydrologic budget will be developed for the Rapid Creek drainage from Pactola Reservoir through Rapid City. This will involve: (1) Tracing the sources and relative contributions of water discharged from Cleghorn Springs; and (2) identifying the source of water withdrawn from the City's infiltration galleries. Second, the occurrence of dissolved nitrogen gas and the process of gas supersaturation will be studied for ground water of the Black Hills area. Third, the study will test the use of nitrogen gas as a tracer of ground water.

Approach: The hydrologic budget between Pactola Reservoir and Rapid City will be estimated by evaluating existing and new streamflow records and withdrawal records of water users. The source of water will be determined for each infiltration gallery by use of observation wells, nitrogen gas concentrations, and stable isotopes. The origin and pathways of Cleghorn Springs water will be studied by determining the isotopic signatures at recharge and discharge points of Madison aquifer water. The process of nitrogen gas supersaturation in ground water will be studied by sampling gas concentrations and water temperatures at recharge points of the Madison and along known routes of water movement through the aquifer. Nitrogen gas as a tracer will be evaluated by comparison with the results using stable isotopes.

Progress and significant results during fiscal year 1988: Monitoring of observation wells and streamflow gaging stations continued. Pumping from the infiltration galleries was cycled on and off to determine the effects of pumping on Rapid Creek. Water quality, nitrogen gas, radon, radium, and stable isotope samples were collected and analyzed. Samples of aquifer materials were collected from 2 sites. Three Master of Science theses were completed.

Plans for 1989: The evaluation of the effects on Rapid Creek caused by pumping from the infiltration galleries will be continued. Determination of aquifer characteristics will continue. Water quality, nitrogen gas, and stable isotope sampling will continue. A report on the origin and processes affecting nitrogen gas will be completed.

DEPARTMENT OF INTERIOR IRRIGATION DRAINAGE PROGRAM FIELD-SCREENING STUDY OF THE ANGOSTURA UNIT, SOUTH DAKOTA (SD086)



Project leader: Earl A. Greene

Project period: February 1988 to September 1989

Cooperators: Department of the Interior.

Problem: The concentrations of selenium in both surface and ground waters in the western United States have come under careful scrutiny in recent years. This sudden interest in selenium has resulted from the high concentrations found in the Kesterson Wildlife Refuge in the lower San Joaquin Valley, California. High egg and chick mortality rates as well as numerous birth defects in the hatchlings of waterfowl nesting in the refuge have been correlated with the large selenium concentrations. The Sacramento Bee newspaper published a series of investigative reports in 1985 which implicated 23 sites in nine western states as having significant concentrations of selenium in water, sediment, and plant material. Many of those sites were associated with irrigation projects developed by the Bureau of Reclamation, U.S. Department of the Interior. The Angostura Unit, South Dakota, was identified as one of those 23 problem sites because selenium concentrations in algae/mud samples taken by the Sacramento Bee (2,128 ppb) were greater than selenium concentrations expected to occur 95 percent of the time in soils of the conterminous United States (less than 1,500 ppb). The Bee found selenium concentrations in algae (915 ppb) they sampled to be just below the concentration considered high for this area based on preliminary comparisons of selenium concentrations in algae from Volta and Kesterson Wildlife areas, California.

Objective: The field screening study is designed to determine if selenium and other potentially toxic constituents reach concentrations sufficiently high to cause, or have the potential to cause, harmful effects on human health or on fish and wildlife within or immediately downstream from the Angostura Unit. Although selenium is the constituent of major concern in the project area, a consideration of the presence and potential problems of pesticide and herbicide residues is warranted because of the often extensive use of such chemicals on crops.

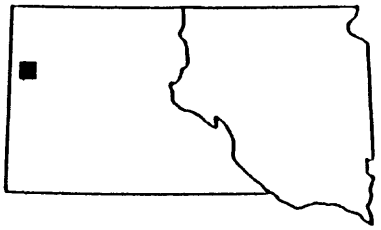
Approach: Samples of geochemical media (water and bottom sediments) will be obtained at 9 sites and biological media (benthic invertebrates and fish) will be obtained at 3 sites within or near the Angostura Unit. Samples will be collected during periods of the year when maximum concentrations could be expected in one or more of the sampled media. These periods are (1) late March to early April, pre-irrigation period when return flows should be at the yearly minimum and game fish are spawning in the Angostura Reservoir, (2) early to mid-June, generally a period when pre-crop fertilizers and herbicides have been applied and when crops should be established. Precipitation generally is greatest during this time, and the potential for surface runoff is high. Surface runoff may carry herbicides applied in April and May into the study area, (3) mid-August to early September, the period when irrigation reaches its maximum in the project area and irrigation tailwater comprises the largest proportion of in-steam discharge, and (4) early November, the period of maximum impact of ground-water return flow. Water and bottom-material samples will be collected by experienced personnel of the U.S. Geological Survey familiar with water-data collection. All procedures and sample

preservation techniques will follow those used by the U.S. Geological Survey in national programs. Benthic invertebrate, fish, and waterfowl sample collection will be conducted by experienced personnel of the U.S. Fish and Wildlife Service. Sampling and sample handling will be in accordance with procedures normally used by the agency as presented in "USFWS Instructional Memorandum 130.01, April 16, 1985."

Progress and significant results during fiscal year 1988: Three field trips were made during FY 1988 to collect water-quality samples. One site was not sampled because of drought conditions. Fish and waterfowl samples were obtained by the U.S. Fish and Wildlife Service according to schedule. The U.S. Fish and Wildlife Service also finished sampling for invertebrates during August. Background sites had conductivities of 1180-3550 microsiemens per centimeter and selenium concentrations of less than 3 micrograms per liter, except for Iron Draw and Cottonwood Creek which had concentrations of 6 and 5 micrograms per liter, respectively.

Plans for 1989: The fourth field trip will occur during late October 1988. Water-quality and bottom-sediment samples will be collected. The Project Chief plans to attend the Irrigation Drainage Project Review meeting during February 1989. Data analysis and report preparation will occur during FY 1989.

DEPARTMENT OF THE INTERIOR IRRIGATION DRAINAGE PROGRAM FIELD-SCREENING STUDY OF THE BELLE FOURCHE PROJECT, SOUTH DAKOTA (SD087)



Project leader: William R. Roddy

Period of project: February 1988 to September 1989

Cooperator: Department of the Interior.

Problem: The concentrations of selenium in both surface and ground waters in the western United States have come under careful scrutiny in recent years. This sudden interest in selenium has resulted from the high concentrations found in the Kesterson Wildlife Refuge in the lower San Joaquin Valley, California. High egg and chick mortality rates as well as numerous birth defects in the hatchlings of waterfowl nesting in the refuge have been correlated with the large selenium concentrations. The Sacramento Bee newspaper published a series of investigative reports in 1985 which implicated 23 sites in nine western states as having significant concentrations of selenium in water, sediment, and plant material. Many of those sites were associated with irrigation projects developed by the Bureau of Reclamation, U.S. Department of the Interior. The Belle Fourche Project, South Dakota, was identified as one of those 23 problem sites because dissolved selenium concentrations from Horse Creek (33 ppb) exceeded Environmental Protection Agency criterion for drinking water (10 ppb) and algae/mud samples collected by the Sacramento Bee were greater than would be expected 95 percent of the time from soils in the conterminous United States. It is also not known whether other normally trace elements and pesticide residues are present at elevated concentrations.

Objective: The field screening study is designed to determine if selenium and other potentially toxic constituents reach concentrations sufficiently high to cause, or have the potential to cause, harmful effects on human health or fish and wildlife within or immediately downstream from the Belle Fourche Project. Although selenium is the constituent of major concern in the Belle Fourche project area, the application of pesticides and herbicides is widespread in the project area, and given their affinity for soil particles, may be found in the bottom sediments.

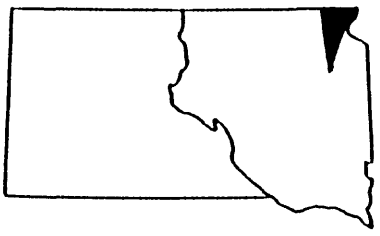
Approach: Samples of geochemical media (water and bottom sediments) will be obtained at 10 sites within or near the Belle Fourche Project and at one well-removed background site. Samples of biological media (benthic invertebrates and fish) will be obtained at 3 sites within the project area. Sites and analyses used in the U.S. Geological Survey Surface water Toxics Program will be used as much as possible. Samples will be collected during periods of the year when maximum concentrations could be expected in one or more of the sampled media. These periods are (1) late March to early April, pre-irrigation period when return flows should be at the yearly minimum and game fish are spawning in Belle Fourche Reservoir, (2) early to mid-June, generally a period when pre-crop fertilizers and herbicides have been applied and when crops should be established. Precipitation generally is greatest during this time, and the potential for surface runoff is high. Surface runoff may carry herbicides applied in April and May into the study area, (3) mid-August to early September, the period when crops are reaching maturity and when irrigation reaches its maximum in the project area and irrigation tailwater comprises the largest proportion of in-stream discharge, and (4) early November, the period of maximum impact of ground-water return flow. Water and

bottom-material samples will be collected by experienced personnel of the U.S. Geological Survey familiar with water-data collection. All procedures and sample preservation techniques will follow those used by the U.S. Geological Survey in national programs. Benthic invertebrate, fish sample, and waterfowl collection will be conducted by experienced personnel of the U.S. Fish and Wildlife Service (USFWS). Sampling and sample handling will be in accordance with procedures normally used by the agency as presented in "USFWS Instructional Memorandum 130.01, April 16, 1985".

Progress and significant results during fiscal year 1988: Three field trips were made during FY 1988 to collect water-quality samples. Two sites were not sampled because of drought conditions. Fish and waterfowl samples were obtained by the U.S. Fish and Wildlife Service according to schedule. The USFWS also finished sampling for invertebrates during August and September. Background sites had conductivities of 1500-1800 microsiemens per centimeter and selenium concentrations of less than 3 micrograms per liter. Pre-irrigation-season conductivities in Horse Creek were 5000 microsiemens per centimeter and selenium concentrations were about 10 micrograms per centimeter.

Plans for 1989: The fourth field trip will occur during late October 1988. Water quality and bottom-sediment samples will be collected. Data analysis and report preparation will occur during FY 1989.

WATER RESOURCES OF THE LAKE TRAVERSE RESERVATION IN NORTH AND SOUTH DAKOTA (SD088)



Project leader: Lewis W. Howells

Period of project: October 1987 to September 1991

Cooperator: Sisseton-Wahpeton Sioux Tribe.

Problem: Indian-owned trust lands within the Lake Traverse Reservation are scattered through seven counties and two states, mostly in northeastern South Dakota and a small part of southeastern North Dakota. Because land-ownership patterns are complex, attempting to determine the detailed water resources of scattered, individual parcels of trust land or of Indian-owned land would be prohibitively expensive in manpower, time, and money. Therefore, the area to be studied will include the entire 1,595 square miles within the original boundaries of the Lake Traverse Reservation. An appraisal of the water resources of the Lake Traverse Reservation (SD082), to provide detailed, up-to-date information delineating the extent and quality of available water supplies and to identify areas where data are missing, has been completed. Conclusions from that study indicate that, although a significant amount of data are available for surface water and ground water, key pieces of data are missing. Additional gaging stations are needed to monitor streamflow leaving the reservation. An in-depth study of Bitter Lake and Lake Hillebrands could provide insight into hydrogeochemical processes within closed lakes. Data are needed on chloride, sulfate, nutrients, fecal coliform, and fecal streptococcus bacteria, sediment transport, and trace metals in both streams and lakes. Water-level data from aquifers are needed to define areas of recharge and discharge. Additional well logs are needed to define thickness and areal extent of sand and gravel deposits, and delineation of aquifers. Additional data are also needed on the water quality and chemistry of ground water. Economic and social improvement of Indians living on the reservation is hampered by a lack of adequate and reliable information on the quantity and quality of water within the reservation. The need for additional water supplies of good quality is especially critical since new housing development is proceeding on the reservation. This study would provide the necessary foundation for water-resources development within the reservation.

Objective: Provide reliable and current basic data and analyses needed for water-resources evaluation in order to facilitate efficient use of these resources by agriculture, rural water systems, and municipalities. The study will determine the availability of surface and ground water, the operation of the hydrologic system as it influences availability, and the quality of surface and ground water.

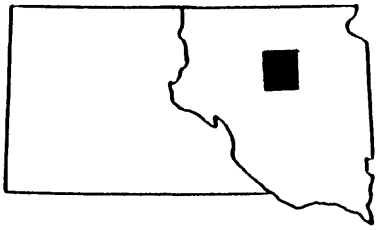
Approach: Water resources will be evaluated using standard geologic and hydrologic techniques. Existing precipitation, streamflow, and well data will be assembled. A well inventory will be conducted and a test-drilling program will be completed during the first two field seasons. An observation-well network will be established and water samples collected for chemical analysis. Glacial and bedrock aquifers will be delineated and hydrologic characteristics described. Aquifer tests will be run wherever feasible. Assistance from outside Water Resources Division will consist of drilling provided by a contract well-drilling company. Oral progress reports will be made to the cooperator during the study period. A preliminary report outlining the major aquifers and discussing their productivity and water quality will be prepared

following the last field season. A final report on the hydrology will be published as a Water-Resources Investigations Report. The project will be funded under a Joint Funding agreement with the Sisseton-Wahpeton Sioux Tribe. Drilling costs will be provided by the U.S. Bureau of Indian Affairs under contract.

Progress and significant results during fiscal year 1988: Existing precipitation, streamflow, and well data were assembled. Two additional streamflow gaging stations were installed. A well inventory was begun. Ten test holes were drilled in northeastern Roberts County. Water levels were measured in observation wells, including six newly completed wells.

Plans for 1989: The well inventory will be completed. Additional test drilling will be accomplished and observation wells will be constructed. Water samples will be collected for chemical analysis. Analysis of data will continue.

WATER RESOURCES OF SPINK COUNTY, SOUTH DAKOTA (SD089)



Project leader: Louis J. Hamilton

Period of project: October 1987 to September 1991

Cooperator: South Dakota Department of Water and Natural Resources, James River Water Development District, Mid-Dakota Water Development District, Spink County.

Problem: Spink County is located in the James River basin in northeastern South Dakota. It is bisected from north to south by the James River. Agriculture is the basic industry, consisting of grains supplemented by the feeding of livestock. About three-fourths of the total area of the county is cropland. Average annual precipitation is about 18 inches; growing-season precipitation is about 13.5 inches. Population is about 8,850. The dryland agricultural economy of Spink County, adversely affected by extended droughts, has been improved by pumping water for irrigation from the James River and from aquifers. However, the James River does not provide a dependable supply, especially during drought periods. In addition, a computer-model appraisal of one aquifer indicates that pumpage may have to be restricted in order to prevent excessive drawdown and decreased yield of wells. Little is known about the glacial-outwash aquifers, even though aquifers which have been mapped in adjacent counties probably extend into Spink County. A knowledge of the hydrology of these aquifers will be valuable in future development of water supplies for municipalities, industry, irrigation, and rural water systems.

Objective: To provide reliable and up-to-date basic data and analyses needed for water-resources evaluation and for efficient use of these resources. Specifically, the study will concentrate on determining the availability of surface- and ground-water resources, the operation of the hydrologic system as it influences availability, the quality of surface and ground water, and the effects on the hydrologic system of developing the water resources. Areas of current and potential hydrologic problems as related to water use will be identified.

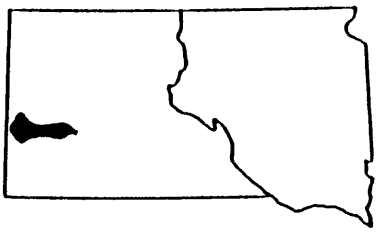
Approach: Water resources will be evaluated using standard geologic and hydrologic techniques. Precipitation, streamflow, and well data will be collected. A well inventory will be conducted and a test-drilling program will be completed during the first three field seasons. An observation-well network will be established and water samples collected for chemical analysis. Glacial and bedrock aquifers will be delineated and their hydrologic characteristics described. Aquifer tests will be performed wherever feasible. A concurrent geologic study will be made by the South Dakota Geological Survey, with extensive test drilling by State Survey drill rigs. Oral progress reports will be made to the cooperator during the study period. The U.S. Geological Survey will prepare a preliminary report summarizing the major aquifers and discussing their productivity and water quality, followed by a final comprehensive report on the hydrology. A State Survey geologist will prepare a report on the geology of the county.

Progress and significant results during fiscal year 1988: A well inventory was nearly completed for the entire county. About 600 wells were inventoried and field tests were performed on water samples from about 300 wells. Twenty

water samples were collected from wells and from the James River for complete chemical analyses. A terrain conductivity survey (E.M. 34 Hula Hoop Survey) was conducted in order to delineate areas of better quality water. Reports on the water resources and geology of the study area were reviewed and a work plan was prepared to collect additional information.

Plans for 1989: The well inventory will be completed. Data will be evaluated and incorporated in maps, graphs, and tables. Water samples will be collected from about 50 wells for complete chemical analyses. A test-drilling program will begin. Observation wells and several streamflow gaging stations will be installed and monitored.

WATER QUALITY OF SURFACE AND GROUND WATERS OF THE RAPID CREEK BASIN, SOUTH DAKOTA (SD090)



Project leader: Mark T. Anderson

Period of project: January 1988 to September 1991

Cooperator: South Dakota School of Mines and Technology

Problem: The hydrology and quality of water in the Black Hills of South Dakota is highly complex, due in part to the region's size, diverse land and recreational use, climate, geology, karst hydrology, and ground-water/surface-water interactions. Increased development pressures are occurring in the Black Hills due to the renewed interest in surface mining for gold and the expansion of irrigation, housing projects, and recreational activities--especially boating, fishing and snowmobiling. Many of these developmental activities are occurring on or near the recharge zones of regionally important aquifers, such as the Minnelusa and Madison Formations. Concern has been expressed by local authorities and citizens that continued development of the Black Hills may significantly degrade both the quantity and quality of water in the area's surface water (streams and lakes) and ground water (wells and springs).

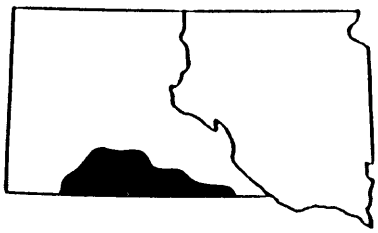
Objective: The overall objective of this investigation is to provide a comprehensive understanding and documentation of the water quality, both surface and ground water, of the Rapid Creek basin. Particular emphasis will be placed on those water resources within the Rapid Creek basin that are known or suspected to have degraded water quality. Examples include (1) Deerfield and Pactola Reservoirs and eutrophication therein; (2) Canyon Lake and recent taste and odor concerns; (3) Rapid Creek alluvium in Rapid City and gasoline contamination thereof; (4) urban runoff in Rapid City and heavy-metal transport and high loadings associated therewith; (5) Minnelusa and Madison aquifers and possible contamination from onsite sewage disposal by residential communities; and (6) occurrence of radon, radium, and other natural radioactive isotopes in surface and ground waters. The major outcome of the study will be a comprehensive, basin-wide assessment of water quality in both the surface and ground waters of the Rapid Creek basin. In addition, more focused water-quality data will be collected at sites where known or suspected contamination is occurring. This latter information will indicate where more intensive, interpretative studies are warranted.

Approach: Because of the enormity and complexity of appraising the quality of surface and ground water in the entire Rapid Creek basin, it is proposed that this investigation utilize both the staff of the Water Resources Division (WRD) and the faculty and graduate students of the Civil Engineering Department, South Dakota School of Mines and Technology--a South Dakota funded institution of higher education. The characterization of water quality will be completed by a combination of (1) a comprehensive compilation, review, and evaluation of historical water-quality data; and (2) collection of additional water-quality data, via both field and laboratory analysis. Both the U.S. Geological Survey Central Laboratory, as well as the SDSM&T's Environmental Engineering Laboratory, will be used to complete analytical testing, as deemed warranted by the Project Leader as the investigation proceeds. The quality of water will be studied from recharge to discharge to determine the extent of contamination.

Progress and significant results during fiscal year 1988: During FY 1988, considerable effort was devoted to: (a) Developing a better understanding of the existence, availability, and scope of historical water-quality data for surface and ground waters within the Rapid Creek watershed, and (b) defining specific water-quality subjects that will be investigated during the remaining phases of the project. Significant progress was made in compiling water-quality data and preparing reports thereof. WRD personnel gave several oral presentations on various phases of the project and prepared a detailed work plan for FY 1989.

Plans for 1989: The following water-quality subjects will be investigated during FY 1989: (1) Continued investigation of the occurrence and spatial distribution of nitrogen and phosphorus species along Rapid Creek, with expansion to include the stream reach between Pactola Dam and Farmingdale; (2) initiation of a reconnaissance-level study of the concentration of radiochemicals in the Deadwood Formation; and (3) initiation of a water-quality sampling program to define: (a) the suitability of water from the Rapid Creek alluvial aquifer as an additional water-supply source, and (b) the degradation of water quality within the Rapid Creek alluvial aquifer throughout Rapid City. In addition, three reports and a work plan for FY 1990 will be prepared.

HIGH PLAINS AQUIFER MONITORING, SOUTH DAKOTA (SD091)



Project leader: John R. Little

Period of project: April 1988 to September 1992

Cooperator: South Dakota Department of Water and Natural Resources.

Problem: Based on concerns that have been expressed relative to water-level decline in the High Plains aquifer, Congress has directed the U.S. Geological Survey to investigate the circumstances relating to this decline and to report back to Congress annually.

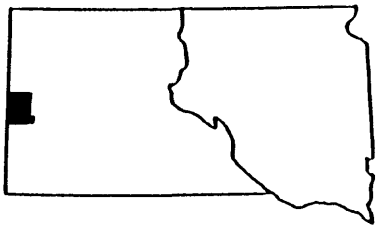
Objective: In order to meet Congressional directives, data will be collected and summarized relative to the changes in water levels, storage, and water quality within the High Plains aquifer. Factors affecting these changes will be studied also.

Approach: Analyze and interpret existing data and collect, analyze, and interpret new data relative to water levels, storage, and water quality within the High Plains aquifer. Identify additional data needs. Publish annual report.

Progress and significant results during fiscal year 1988: Provided information and data to the Regional Project Chief as requested.

Plans for 1989: Evaluate current observation-well network to determine if it is satisfactory. Install one continuous-record digital recorder on a well near Pine Ridge. Collect and enter water-level data into Ground Water Site Inventory for 126 observation wells. Continue to provide information and data to Regional Project Chief as requested.

NORTHERN BLACK HILLS HYDROLOGY STUDY, SOUTH DAKOTA (SD092)



Project leader: Earl A. Greene

Period of project: June 1988 to September 1991

Cooperator: Lawrence County.

Problem: The Black Hills area of South Dakota lacks a regional hydrology study to characterize and describe fundamental information on quantity and quality of the surface- and ground-water resources. The Black Hills area is experiencing an expansion of mining activity, urbanization, and recreational activity. There is concern about the potential for this development to affect the quantity and quality of surface and ground water in the Black Hills. This study needs to specifically address (1) the lack of baseline information on water quantity and quality; (2) the bedrock aquifers and the ground-water and surface-water interaction; and (3) the lack of information necessary to predict effects of resource development on the water resources of the Black Hills.

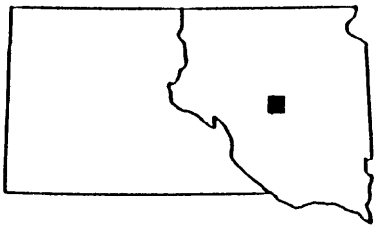
Objective: (1) To inventory wells completed in bedrock aquifers in the northern Black Hills, with emphasis on the area of Lawrence County south of Spearfish, and to inventory wells completed in the shallow alluvial aquifer along Spearfish Creek. (2) To study the surface waters of the northern Black Hills area, which will involve (a) an inventory of the springs, lakes, and streams; and (b) the establishment of a long-term streamflow monitoring program at sites where data are lacking and where resource conflicts are anticipated. (3) To determine existing water-quality conditions of both ground water and surface water at selected sites.

Approach: A ground-water inventory will be conducted through the collection and analysis of water-well data and by obtaining geophysical logs of wells. In general, this objective will be accomplished by inventorying wells to obtain information on aquifer locations, extent, depth, thickness, ground-water levels, water quality, character of the aquifer, and ground-water movement. An attempt will be made to inventory and catalog all wells within the aquifers. It is anticipated that selected wells drilled by mining companies will be available for data collection. The surface-water resources of Lawrence County will be studied by field inventory and measurement of the lakes, streams, and springs. In addition, a network of precipitation and streamflow gages will be installed. Water-quality conditions will be defined by examining data and gathering samples from selected wells and streams.

Progress and significant results during fiscal year 1988: A network of precipitation and streamflow gages, as well as a network of water-quality sampling stations, were installed. Water-quality samples were collected during the last half of FY 1988. Borehole geophysical logs were obtained from three State observation wells. Meetings were held with each of the mining companies to obtain information on local geology and hydrogeology.

Plans for 1989: Four field trips will be made to collect water-quality samples. Water-quality samples will be collected at selected wells completed in major aquifers. Borehole geophysical logging will obtain information on lithology. An inventory of large-yield wells within the study area will be completed.

GROUND-WATER RECHARGE DEMONSTRATION NEAR HURON, SOUTH DAKOTA (SD093)



Project leader: Patrick J. Emmons

Period of project: October 1987 to September 1993

Cooperator: South Dakota Department of Water and Natural Resources.

Problem: The drought in South Dakota from 1974-76 and the near-drought conditions in 1980-81 have resulted in increased demand on the ground-water resources within the James River basin. The South Dakota Department of Water and Natural Resources water-level monitoring program has identified areas in the basin in which a loss of head and subsequent ground-water-level declines have occurred. The city of Huron municipal well field is in one of these areas. The well field currently is being used as a "backup" water supply to the James River, the city's primary water source. Due to anticipated increases in the demand for municipal and industrial water and the uncertainty of the James River, especially during periods of drought, the city may be required to rely more on ground water to meet municipal demands.

Objective: The general purpose of the study is to demonstrate, at a specific site (city of Huron well field), the potential for artificial recharge of the glacial aquifers in eastern South Dakota. The specific objectives are: (1) Evaluate the use of an injection well and an infiltration gallery to recharge a buried glacial-outwash aquifer; (2) determine the rates of artificial recharge using James River water and spring and/or storm runoff; (3) determine the water-level effects of artificial recharge on the aquifer; (4) determine water-quality changes due to introduction of artificial-recharge water into the aquifer; and (5) develop an evaluation technique to assess the artificial recharge potential of other areas in South Dakota.

Approach: Because of large variability in the glacial drift over short distances, approximately 50 observation wells will be drilled in the Huron well-field areas. These wells will provide additional information on the drift composition and aquifer properties, and allow water levels to be monitored and water samples to be collected. Due to the thickness of the silt and clay overlying the aquifer material, artificial recharge will be conducted using a recharge well and a large-diameter infiltration gallery. Treated municipal water from the James River will be pumped through the city of Huron's existing pipeline to the city's well field for artificial recharge. Spring runoff and/or storm runoff from an intermittent stream will be used for artificial recharge providing the water can meet drinking-water standards with only minimal onsite treatment. Ground-water and chemical-flow models will be used to aid in gaining a better understanding of the ground-water regime before and during artificial recharge. A geochemical model will be developed to aid in gaining a better understanding of the chemical interactions between the recharge and ground waters. The models will be used, in part, to aid in development of a technique to evaluate the recharge potential of other areas of South Dakota.

Plans for 1989: Collate and revise existing hydrologic and geologic data for the artificial recharge area, drill approximately 50 observation wells, install 5 continuous water-level recorders, install 5 continuous water-quality monitors, collect bimonthly water-level data, and collect 12 water-quality samples.

PUBLICATIONS OF THE U.S. GEOLOGICAL SURVEY

General Information

The U.S. Geological Survey announces all its publications in a monthly report "New Publications of the Geological Survey." Subscriptions to this monthly listing are available upon request to the U.S. Geological Survey, 582 National Center, Reston, VA 22092. All publications are for sale unless specifically stated otherwise. Prices, which are subject to change, are not included here. Prepayment is required and information on price and availability should be obtained from listed sales offices before placing an order.

The "U.S. Geological Survey Yearbook" provides a comprehensive description of the Federal Government's largest earth-science agency; copies are available for fiscal years beginning with 1975 and may be purchased at the address where Professional Papers are sold (see below). Summaries of research in progress and results of completed investigations were formerly published each fiscal year in the Professional Paper series "Geological Survey Research" (see under heading "Professional Papers"). This series was discontinued in 1984. A pamphlet entitled "Geologic and Water-Supply Reports and Maps for South Dakota," which lists reports on the geology and water resources of South Dakota, is available upon request to the U.S. Geological Survey, Books and Open-File Reports, Federal Center, Bldg. 810, Box 25425, Denver, CO 80225.

Water-Resources Information

A monthly summary of the national water situation presented in the "National Water Conditions" (formerly called "Water Resources Review") is available on request to the U.S. Geological Survey, 419 National Center, Reston, VA 22092. Water-resources activity reports (similar to this one) are available for each of the 50 States and Puerto Rico and the Virgin Islands.

Beginning with the 1975 water year, streamflow data, water-quality data for surface and ground water, and ground-water level data for each State are combined and published in the annual series "U.S. Geological Survey Water-Data Reports." See section "U.S. Geological Survey Water-Data Reports available only through NTIS" for listing of these reports.

Records of discharge of streams, and contents (or stage) of lakes and reservoirs were first published in a series of USGS Water-Supply Papers entitled, "Surface Water Supply of the United States." Through September 30, 1960, these Water-Supply Papers were in an annual series and then in a multiyear series for 1961-65 and 1966-70. Records of chemical quality, water temperatures, and suspended sediment were published from 1941 to 1970 in an annual series of Water-Supply Papers entitled, "Quality of Surface Waters of the United States." Records of ground-water levels were published from 1935 to 1974 in a series of Water-Supply Papers entitled, "Ground-water levels in the United States." Water-Supply Papers may be consulted in the libraries of the principal cities in the United States or may be purchased from the U.S. Geological Survey, Books and Open-File Reports, Federal Center, Bldg. 810, Box 25425, Denver, CO 80225. Pamphlets (mentioned under "General Information") listing the reports for each State by number and title may be obtained on request from that address also.

SELECTED LITERATURE ON WATER RESOURCES

Because the number of publications pertaining to water resources in South Dakota is large, the publications listed below were selected to show the types of information available to those interested in or in need of water facts. Many of these publications are available for inspection at the offices of the Geological Survey in Huron, Rapid City, and Pierre, and at large public and university libraries. The publications are grouped as follows: Publications of the U.S. Geological Survey (USGS); publications of State agencies prepared by or in cooperation with the U.S. Geological Survey; other publications, such as technical journals.

USGS Professional Papers

Professional Papers are sold by the U.S. Geological Survey, Books and Open-File Reports, Federal Center, Bldg. 810, Box 25425, Denver, CO 80225.

P 600-D. Temperature variations of deep flowing wells in South Dakota, by D. G. Adolphson and E. F. LeRoux, in Geological Survey Research 1968, Chap. D, by U.S. Geological Survey, p. D60-D62. 1968.

P 650-B. Effects of reservoir filling on a buried aquifer of glacial origin in Campbell County, South Dakota, by N C. Koch, in Geological Survey Research 1969, Chap. B, by U.S. Geological Survey, p. B169-B173. 1969.

P 813-B. Summary appraisals of the Nation's ground-water resources--Upper Mississippi Region, by R. M. Bloyd, Jr. 1975.

P 813-K. Summary appraisals of the Nation's ground-water resources--Souris-Red-Rainy Region, by Harold O. Reeder. 1978.

P 813-Q. Summary appraisals of the Nation's ground-water resources--Missouri Basin Region, by O. James Taylor. 1978.

P 877. The Black Hills--Rapid City flood of June 9-10, 1972: A description of the storm and the flood, by F. K. Schwarz, M. S. Peterson, and others. 1975.

P 1015. Proceedings of the first annual William Pecora Memorial Symposium, October 1975, Sioux Falls, South Dakota, by P. W. Woll and W. A. Fischer, editors. 1977.

USGS Water-Supply Papers

Water-Supply Papers are sold at the above-listed Denver, Colo., address.

W 1137-A. Missouri River basin floods of April-May 1950 in North and South Dakota, by R. E. Oltman and others. 1951.

W 1260-B. Floods of April 1952 in the Missouri River basin. 1955.

W 1298. Reconnaissance of geology and ground water in the lower Grand River valley, South Dakota, by P. C. Tychsen and R. C. Vorhis, with a section on Chemical quality of the water, by R. A. Krieger. 1959.

W 1425. Ground water in the Crow Creek--Sand Lake area, Brown and Marshall Counties, South Dakota, by F. C. Koopman. 1957.

W 1460-G. Ground-water resources of the lower Niobrara River and Ponca Creek basins, Nebraska and South Dakota, by T. G. Newport, with a section on Chemical quality of the water, by R. A. Krieger. 1959.

W 1475-D. Geology and occurrence of ground water at Jewel Cave National Monument, South Dakota, by C. F. Dyer. 1961.

W 1531. Hydrology of the Upper Cheyenne River basin, by R. C. Culler, R. F. Hadley, and S. A. Schumm. 1961.

W 1534. Progress report on wells penetrating artesian aquifers in South Dakota, by R. W. Davis, C. F. Dyer, and J. E. Powell. 1961.

W 1539-T. Geology and ground-water resources of the Lake Dakota plain area, South Dakota, by W. B. Hopkins and L. R. Petri. 1963.

W 1769. Chemical quality of surface waters, and sedimentation in the Grand River drainage basin, North and South Dakota, by C. H. Hembree, R. A. Krieger, and P. R. Jordan, 1964.

W 1800. The role of ground water in the national water situation, by C. L. McGuinness. 1963.

W 1865. Water resources and geology of Mount Rushmore National Memorial, South Dakota, by J. E. Powell, J. J. Norton, and D. G. Adolphson. 1973.

W 2024. Water resources of the Big Sioux River valley near Sioux Falls, South Dakota, by D. G. Jorgensen and E. A. Ackroyd. 1973.

W 2090. Ground-water levels in the United States, 1967-71--north-central States. 1973.

W 2163. Ground-water levels in the United States, 1972-74, north-central States. 1977.

W 2250. National Water Summary 1983, includes State water-issue summaries - South Dakota, p. 209-211. 1984.

W 2275. National Water Summary 1984, includes State summaries of ground-water resources - South Dakota, p. 385-390. 1985.

W 2300. National Water Summary 1985, includes State summaries of surface-water resources - South Dakota, p. 419-424. 1986.

W 2325. National Water Summary 1986, includes State summaries of hydrologic events and ground-water quality - South Dakota, p. 457-464. 1988.

USGS Circulars

Single copies of circulars still in print are available free from the above-listed Denver, Colo., address.

C 54. Geology and ground-water hydrology of the Angostura irrigation project, South Dakota, by R. T. Littleton, with a section on Mineral quality of the waters, by H. A. Swenson. 1949.

C 201. Ground-water resources of the Rapid Valley unit, Cheyenne Division, South Dakota, by A. J. Rosier, with a section on Surface waters of Rapid Valley, by L. J. Snell. 1953.

C 270. Chemical quality of water and sedimentation in the Moreau River drainage basin, South Dakota, by B. R. Colby, C. H. Hembree, and E. R. Jochens. 1953.

C 676. Estimated use of water in the United States in 1970, by C. R. Murray and E. B. Reeves. 1972.

C 765. Estimated use of water in the United States in 1975, by C. R. Murray and E. B. Reeves. 1977.

C 1001. Estimated use of water in the United States in 1980, by W. B. Solley, E. B. Chase, and W. B. Mann IV. 1983.

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

Reports in this series are available for inspection at the South Dakota and Reston, Va., offices of the U.S. Geological Survey. Selected reports may be purchased either as microfilm or hard copy from the National Technical Information Service (NTIS), U.S. Department of Commerce, Springfield, VA 22161; the NTIS ordering number is given in parenthesis at the end of the citation. Reports not listing a NTIS ordering number can be purchased from the U.S. Geological Survey, Books and Open-File Reports, Federal Center, Bldg. 810, Box 25425, Denver, CO 80225. Further information about these reports may be obtained from the District Chief, WRD, Huron, South Dakota.

WRIR 35-74. A method for estimating magnitude and frequency of floods in South Dakota, by L. D. Becker. 1974. (PB-239 831/AS)

WRIR 80-80. Techniques for estimating flood peaks, volumes, and hydrographs on small streams in South Dakota, by L. D. Becker. 1980. (PB-81 136 145)

WRIR 80-100. Appraisal of the water resources of the Big Sioux aquifer, Brookings, Deuel, and Hamlin Counties, South Dakota, by N. C. Koch. 1980. (PB-81 164 584)

WRIR 82-31. Magnitude and frequency of floods from selected drainage basins in South Dakota, by L. D. Becker. 1982 (PB 82-237470)

WRIR 82-4064. A digital-computer model of the Big Sioux aquifer in Minnehaha County, South Dakota, by N. C. Koch. 1982.

WRIR 83-4077. A preliminary assessment of the hydrologic characteristics of the James River in South Dakota, by R. D. Benson. 1983.

WRIR 83-4108. Water resources of Hanson and Davison Counties, South Dakota, by D. S. Hansen. 1983.

WRIR 83-4175. A two-dimensional, finite-difference model of the High Plains aquifer in southern South Dakota, by K. E. Kolm and H. L. Case III. 1983.

WRIR 83-4234. Evaluation of the response of the Big Sioux aquifer to extreme drought conditions in Minnehaha County, South Dakota, by N. C. Koch. 1983.

WRIR 84-4030. Water resources of Aurora and Jerauld Counties, South Dakota, by L. J. Hamilton. 1985.

WRIR 84-4069. Water resources of Deuel and Hamlin Counties, South Dakota, by Jack Kume. 1986.

WRIR 84-4078. Appraisal of the water resources of the eastern part of the Tulare aquifer, Beadle, Hand, and Spink Counties, South Dakota, by L. K. Kuiper. 1984.

WRIR 84-4195. Water resources of Hughes County, South Dakota, by L. J. Hamilton. 1986.

WRIR 84-4209. Water resources of Lake and Moody Counties, South Dakota, by D. S. Hansen. 1986.

WRIR 84-4241. Water resources of Yankton County, South Dakota, by E. F. Bugliosi. 1986.

WRIR 84-4312. Simulated artificial recharge in the Big Sioux aquifer in Minnehaha County, South Dakota, by N. C. Koch. 1984.

WRIR 85-4015. Water resources of Walworth County, South Dakota, by Jack Kume and L. W. Howells. 1987.

WRIR 85-4021. Evaluation of techniques for mapping land and crops irrigated by center pivots from computer-enhanced Landsat imagery in part of the James River basin near Huron, South Dakota, by K. E. Kolm. 1985.

WRIR 85-4022. Availability and quality of water from the bedrock aquifers in Rapid City area, South Dakota, by K. D. Peter. 1985.

WRIR 85-4053. Geologic structure and altitude of the top of the Minnelusa Formation, northern Black Hills, South Dakota and Wyoming, and Bear Lodge Mountains, Wyoming, by K. D. Peter, D. P. Kyllonen, and K. R. Mills. 1987.

WRIR 85-4069. Geochemical survey to determine water-quality characteristics of the Big Sioux aquifer in eastern South Dakota, by N. F. Leibbrand. 1985.

WRIR 85-4217. Analysis of flood-flow frequency for selected gaging stations in South Dakota, by R. D. Benson, E. B. Hoffman, and V. J. Wipf. 1985.

WRIR 85-4233. Geologic structure and altitude of the top of the Minnelusa Formation, northeastern Black Hills, South Dakota, by K. D. Peter, D. P. Kyllonen, and K. R. Mills. 1988.

WRIR 86-4035. Water resources of Miner County, South Dakota, by N. C. Koch and S. D. McGarvie. 1988.

WRIR 86-4158. Geohydrology and water quality of the Inyan Kara, Minnelusa, and Madison aquifers of the northern Black Hills, South Dakota and Wyoming, and Bear Lodge Mountains, Wyoming, by D. P. Kyllonen and K. D. Peter. 1987.

WRIR 87-4017. Preliminary assessment of potential well yields and the potential for artificial recharge of the Elm and Middle James aquifers in the Aberdeen area, South Dakota, by P. J. Emmons. 1987.

WRIR 87-4057. Appraisal of the water resources of the Big Sioux aquifer, Moody County, South Dakota, by D. S. Hansen. 1988.

WRIR 87-4082. A digital simulation of the glacial-aquifer system in Sanborn and parts of Beadle, Miner, Hanson, Davison, and Jerauld Counties, South Dakota, by P. J. Emmons. 1988.

WRIR 87-4208. Analysis of flood-flow frequency, flow duration, and channel-forming flow for the James River in South Dakota, by R. D. Benson. 1988.

USGS Water-Data Reports Available Only Through NTIS

The water-data reports listed below may be purchased as hard copy or microfiche only from the National Technical Information Service (NTIS), U.S. Department of Commerce, Springfield, VA 22161. They are available for inspection only at the South Dakota and Reston, Va., offices of the U.S. Geological Survey. The PB number in parenthesis is the NTIS ordering number.

SD-75-1 Water resources data for South Dakota--water year 1975, by U.S. Geological Survey. 1976. (PB-251 861/AS)

SD-76-1 Water resources data for South Dakota--water year 1976, by U.S. Geological Survey. 1977. (PB-266 453/AS)

SD-77-1 Water resources data for South Dakota--water year 1977, by U.S. Geological Survey. 1978. (PB-281 757)

SD-78-1 Water resources data for South Dakota--water year 1978, by U.S. Geological Survey. 1979. (PB-296 426)

SD-79-1 Water resources data for South Dakota--water year 1979, by U.S. Geological Survey. 1980. (PB80-195936)

SD-80-1 Water resources data for South Dakota--water year 1980, by U.S. Geological Survey. 1981. (PB82-101338)

SD-81-1 Water resources data for South Dakota--water year 1981, by U.S. Geological Survey. 1982. (PB83-102715)

SD-82-1 Water resources data for South Dakota--water year 1982, by U.S. Geological Survey. 1983. (PB84-117175)

SD-83-1 Water resources data for South Dakota--water year 1983, by U.S. Geological Survey. 1984. (PB85-127850)

SD-84-1 Water resources data for South Dakota--water year 1984, by U.S. Geological Survey. 1985. (PB86-130507)

SD-85-1 Water resources data for South Dakota--water year 1985, by U.S. Geological Survey. 1986. (PB87-152062).

SD-86-1 Water resources data for South Dakota--water year 1986, by U.S. Geological Survey. 1987. (PB88-118575)

SD-87-1 Water resources data for South Dakota--water year 1987, by U.S. Geological Survey. 1988. (PB88-236344)

USGS Hydrologic Investigations Atlases

Hydrologic Investigations Atlases (and other maps of areas west of the Mississippi River) are sold by the U.S. Geological Survey, Map Distribution, Federal Center, Bldg. 810, Box 25286, Denver, CO 80225.

HA-195. Hydrogeology of the glacial drift in the Skunk Creek--Lake Madison drainage basin, southeastern South Dakota, by M. J. Ellis and D. G. Adolphson. 1965.

HA-311. Hydrology of a part of the Big Sioux drainage basin, eastern South Dakota, by M. J. Ellis, D. G. Adolphson, and R. E. West. 1968.

HA-355. Hydrology of the Rosebud Indian Reservation, South Dakota, by M. J. Ellis, J. H. Ficken, and D. G. Adolphson. 1971.

HA-357. Hydrology of the Pine Ridge Indian Reservation, South Dakota, by M. J. Ellis and D. G. Adolphson. 1971.

HA-499. Geohydrology of Crow Creek and Lower Brule Indian Reservations, South Dakota, by L. W. Howells. 1974.

HA-511. Flood of June 9-10, 1972, at Rapid City, South Dakota, by O. J. Larimer. 1973.

HA-585. Geohydrology of the Cheyenne River Indian Reservation, South Dakota, by L. W. Howells. 1979.

HA-644. Geohydrology of the Standing Rock Indian Reservation, North and South Dakota, by L. W. Howells. 1982.

USGS Hydrologic Unit Maps

Hydrologic unit maps are sold at the above-listed Denver address.

U.S. Geological Survey, 1978, Hydrologic unit map--1978 State of South Dakota.

USGS Open-File Reports and Maps

Open-File Reports, which may be in manuscript form, generally are not reproduced and distributed in quantity. These reports are available for inspection in the Huron, South Dakota, and Reston, Va., offices of the U.S. Geological Survey. Most numbered open-file reports may be purchased from the U.S. Geological Survey, Books and Open-File Reports, Federal Center, Bldg. 810, Box 25425, Denver, CO 80225. Information on the availability of the unnumbered reports may be obtained from the District Chief, USGS, Water Resources Division, Huron, South Dakota.

USGS Numbered Open-File Reports

OFR 70-194. A proposed streamflow-data program for South Dakota, by O. J. Larimer. 1970.

OFR 79-563. A geohydrologic overview for the Pecora Symposium field trip, June 1979, by N. C. Koch. 1979.

OFR 81-222. Water-level records for the Big Sioux aquifer, Minnehaha County, South Dakota, by W. L. Bradford. 1981.

OFR 81-627. Water levels in bedrock aquifers in South Dakota, by W. L. Bradford. 1981.

OFR 81-924. Records of water levels in unconsolidated deposits in eastern South Dakota, by W. L. Bradford. 1981.

OFR 82-1020. Records of water levels in the Big Sioux aquifer, Minnehaha County, South Dakota, 1981, by D. R. Winter. 1983.

OFR 83-207. Summary of water withdrawals in the United States, 1950-80, by W. B. Mann IV, W. B. Solley, and E. B. Chase. 1983.

OFR 83-754. Water resources investigations of the U.S. Geological Survey in South Dakota, project status summary, July 1, 1983, by E. F. LeRoux and E. M. Decker. 1983.

OFR 83-773. Streamflow and sediment data collected at seven stream-gaging stations in the James River basin downstream from Forestburg, S. Dak., from October 1, 1981, to September 30, 1983, by J. R. Little. 1983.

OFR 84-148. Geologic and hydrologic data from a test-drilling program in the High Plains area of South Dakota, 1979-80, by C. L. Loskot, H. L. Case, and D. G. Hern. 1984.

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Reports Pending Publication

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WRIR 86-4167. Map showing geologic structure and altitude of the top of the Minnelusa Formation and orientation of mapped cave passages in the Madison Limestone, southern Black Hills, South Dakota, by K. D. Peter, K. R. Mills, and C. L. Loskot.

WRIR 87-4051. Composition, distribution, and hydrologic effects of mine and mill wastes discharged to Whitewood Creek at Lead/Deadwood, South Dakota, by K. E. Goddard.

WRIR 87-4156. Appraisal of water resources of the Skunk Creek aquifer in Minnehaha County, South Dakota, by G. L. Ohland.

WRIR 88-4031. Water-resources appraisal of the Lake Traverse Indian Reservation in South Dakota, by S. J. Lawrence.

WRIR 88-4185. Water resources of Brookings and Kingsbury Counties, South Dakota, by L. J. Hamilton.

WRIR 88-4198. A digital simulation of the glacial-aquifer system in the northern three-fourths of Brown County, South Dakota, by P. J. Emmons.

WRIR 89-4039 Streamflow at selected gaging stations on the James River in North Dakota and South Dakota, 1953-82, with a section on climatology, by G. J. Wiche, R. D. Benson, and D. G. Emerson.

OFR 87-45. Summary of data pertaining to land use, rainfall, dryfall, stream discharge, and storm runoff collected as part of a study of the effects of urban runoff on Rapid Creek, Rapid City area, South Dakota, by K. E. Goddard, T. K. Lockner, L. L. Harms, and M. H. Smith.