

U.S. Department of the Interior ■ U.S. Geological Survey

For more than 100 years, the U.S. Geological Survey (USGS) has provided the information needed to manage the Nation's earth resources, to mitigate natural hazards, and to understand the environment. In South Dakota, the USGS works cooperatively with local, State, and other Federal agencies, as well as with universities, to study earth science issues.

## Topographic Mapping

Among the most popular and versatile products of the USGS are its 1:24,000-scale topographic maps (1 inch on the map represents 2,000 feet on the ground). These maps depict the basic natural and cultural features of the landscape, such as lakes and streams, highways and railroads, boundaries, and geographic names. Contour lines are used to depict the elevation and shape of terrain. South Dakota is covered by 1,552 maps at this scale. These maps are used by scientists and managers for engineering, land-use planning, natural-resource monitoring, and other technical applications and have long been favorites with the general public for outdoor uses. These maps also serve as bases for many special purpose maps produced by other agencies, such as State, county, and local highway maps; land-use and ownership maps; geologic maps; and recreational maps.

Recent technological advances, particularly in the field of geographic information systems (GIS), have increased demand for digital map products for South Dakota, especially of the Black Hills area. This area was identified as having priority map data requirements by the Bureau of Land Management, the Bureau of Reclamation, the U.S. Fish and Wildlife Service (USFWS), the National Park Service (NPS), and other agencies. To minimize duplication of effort, the USGS is currently producing digital map data for more than 100 1:24,000-scale maps of the Black Hills area. The data provide the base cartographic data needed by many Federal and State agency users for their specific GIS and resource-management activities in the region. The USGS has cooperative agreements to produce digital elevation models

(DEM's) and digital orthophotoquads (DOQ's) in South Dakota. DOQ's are digitized images of aerial photographs with relief distortion removed. In cost-sharing agreements with the NPS, the USGS is producing DOQ's for Mount Rushmore National Memorial, Badlands National Park, Wind Cave National Park, and Jewel Cave National Monument.

The USGS also has cooperative programs to produce digital cartographic data for the Bureau of Indian Affairs (BIA) Area Office in South Dakota. DOQ's have been produced for the Flandreau Indian Tribe in southeastern South Dakota, and DEM's are scheduled for several areas of the State. These data provide a foundation for natural-resource management for the BIA and tribal governments.

The USGS recently completed the digitizing of Public Land Survey System data for the State east of the Missouri River. The USFWS' Wetland Habitat Office uses the township, range, and section information as a base for wetlands analysis.

## Water-Resource Data Collection

Data on quantity and quality of streamflow and ground water provide an increased understanding of the water resources of South Dakota. These data are necessary for forecasting floods and droughts, designing reservoirs and water-supply systems, sizing highway structures, and managing water use. The USGS began systematic collection of streamflow data in 1903 with the establishment of 13 gaging stations in the Black Hills area. During 1996, the USGS, in cooperation with 31 Federal, State, and local agencies, has been operating an extensive data-collection network. The network includes 137 continuous-record gaging stations on streams and lakes, 23 crest-stage stations, 46 precipitation stations, 27 water-quality and sediment stations, and 7 observation wells (fig. 1). The USGS also processes and stores water-level data for about 65 additional wells operated by the State. Most of the basic data are published annually in *Water Resources Data—South Dakota*. Selected streamflow data also are available on the World-Wide Web.

### Index of Subjects

- Topographic Mapping
- Water-Resource Data Collection
- Geologic Mapping and Mineral-Resource Appraisals
- Water-Resource Appraisals
- Earth Resources Observation Systems Data Center
- Geologic Information for Land-Use Planning
- Water-Resources Information for Indian Tribes
- Lake and Reservoir Sedimentation
- Use of Bedrock Aquifers for Water Supply in the Black Hills Area
- Quality of Urban Stormwater Runoff
- Effects of Floods and Droughts
- Environmental Concerns at Defense Facilities
- National Water-Quality Assessment Program

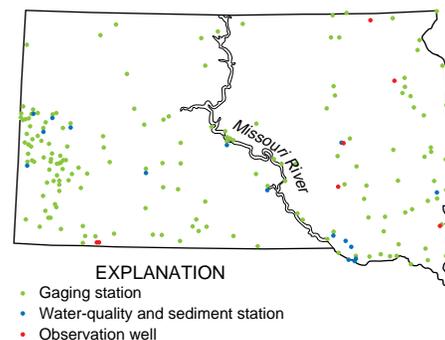


Figure 1. Locations where streamflow, water-quality, sediment, and water-level data were collected by the USGS during 1996.

## Geologic Mapping and Mineral-Resource Appraisals

Geologic mapping and research by the USGS is of direct benefit to numerous Federal, State, and local agencies. As an example, the USGS, in cooperation with the South Dakota Geological Survey (SDGS), is compiling and publishing a new State geologic map.

Mapping and research benefit numerous agencies in their land-use planning and such commercial ventures as the mining and tourism industries of the Black Hills. Because the economic health of the northern Black Hills depends, in large part, on the \$150-million-a-year mining industry, western South Dakota has a vested interest in a viable mining indus-

try. The interaction of science and technology ensures that mining in the future is compatible with other industries and will be conducted with due regard for private and Federal lands and the environment. Preparation of a new geologic map of the Black Hills at a scale of 1:100,000, in cooperation with the South Dakota School of Mines and Technology, is underway and is intended to serve as a base for all future investigations in the Black Hills area. Ongoing geologic research by the USGS, in cooperation with private industry at the Homestake and the Annie Creek Mines, will streamline exploration, improve ore-reserve estimation, improve metallurgical techniques, and assess the future impacts of mining in the northern Black Hills. Information from the research aids USGS hydrologists in modeling the long-term quality of surface and ground waters in the entire Black Hills area. Other beneficiaries include the U.S. Forest Service for their assessments of future developments on forest lands and Federal and State agencies for making effective and informed land-use decisions.

## Water-Resource Appraisals

The USGS, in cooperation with the SDGS and various counties, Indian Tribes, and Water Development Districts, has been appraising water resources in South Dakota since 1958 (fig. 2). Typically, the studies are done on a county-by-county basis and last 3 to 4 years; many studies have involved multiple counties. Most county studies in the eastern part of the State have been completed, and areal studies have recently begun in the western part. The studies typically use extensive test-hole drilling and observation-well installation and monitoring to determine the availability, movement, recharge, discharge, and quality of water in glacial and bedrock aquifers. The studies usually result in four reports, three of which—detailed geology, major aquifers, and sand and gravel—are

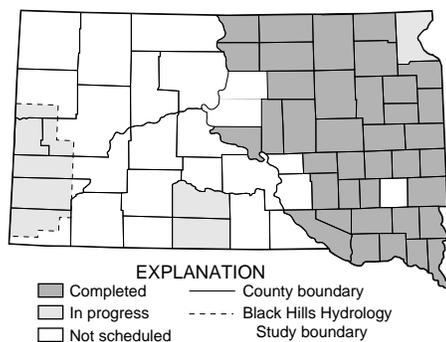


Figure 2. South Dakota counties and status of county and multicounty water-resources appraisals.

published by the SDGS, and one—detailed water resources—is published by the USGS. The reports are useful for water-resource planning by State and local agencies and by local citizens.

## Earth Resources Observation Systems Data Center

The USGS Earth Resources Observation Systems (EROS) Data Center near Sioux Falls is the world's largest nonmilitary repository of remotely sensed data of the Earth's land surface. Much earth science research is based on images from the EROS archives, which hold worldwide digital image data from satellite-borne sensors and more than 7 million aerial mapping photographs of the Nation. EROS distributes large quantities of digital and photographic products to governmental and commercial users and to the general public at the cost of reproduction.

EROS hosted the Scientific Assessment and Strategy Team (SAST), which was a Federal response to massive flooding in the Missouri River and the Mississippi River drainage basins that devastated crops, homes, and businesses during 1993. The SAST effort was summarized in a report that provides scientific advice and assistance to Federal officials responsible for making decisions with respect to flood recovery and supplies information regarding nonstructural and structural approaches to river basin management.

EROS participation as a cooperator in the Great Plains Initiative is another example of its regional role. The Great Plains Initiative, which was one of the results of the Western Governors Conference, is demonstrating that economic development and ecological management can be served by preventing the decline of wildlife species and their ecosystems. The work involves gathering and linking data bases of the ecosystems of the Great Plains. The EROS contribution to this cooperative interagency effort is to provide earth science information and to develop data-transfer technologies.

South Dakota also benefits from EROS data collection, research, and dissemination of information at continental and global scales. Because of repeated coverage of large areas, satellite sensors can detect changes on the Earth's surface. For example, EROS scientists use data from these sensors to construct timely maps that show vegetation condition or "greenness" information (fig. 3), and provide these data to the South Dakota Department of Agriculture as part of the Grassland Fire Danger Assessment Project. This statewide information is updated on a weekly basis. Greenness information also is

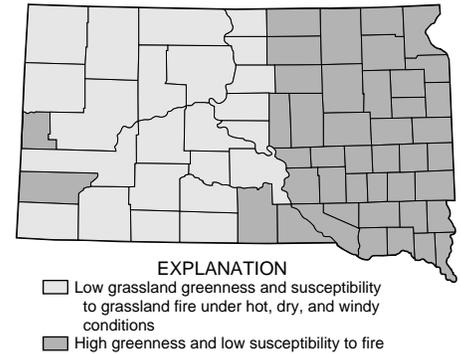


Figure 3. Grassland "greenness" by county, for the week of September 21, 1995.

sent to the National Weather Service in Sioux Falls where it is combined with daily weather information to forecast fire danger conditions. Whenever severe conditions exist, current information is provided to emergency monitoring centers and the news media for broadcast to the public. Numerous global-scale applications, such as showing probable migration routes of locust hordes in Africa, also exist.

As part of its outreach and educational activities within South Dakota, EROS is a partner in the South Dakota Space Grant Consortium. This group, which is dedicated to improving research capabilities within the State, works closely with several universities. Through the program, EROS hosts researchers who work in areas of mutual interest each summer.

The USGS Earth Science Information Centers (ESIC) provide information about the USGS, its programs, products, and technological developments to the public. The USGS operates an ESIC at the EROS Data Center and in Vermillion, which was established under a cooperative agreement between the USGS and the SDGS. As part of the national ESIC network, these offices provide information on such earth science topics as cartography, geography, digital data, remote sensing, geology, geophysics, geochemistry, hydrology, geohydrology, aerial photography, and land use. Each ESIC is supported by the USGS with reference materials, technical assistance, training and outreach activities, products available to purchase, and access to USGS data bases.

## Geologic Information for Land-Use Planning

USGS geologists, in cooperation with the SDGS, are identifying potential consequences of land-use and land-management activities. The distribution, thickness, and engineering characteristics of surficial deposits are being mapped and compiled for the *Quaternary*

*Atlas of the United States.* Detailed maps that show bedrock geology, erosion and deposition, areas of geologic hazards, and potential effects of land use and development in South Dakota are being prepared as part of a regional study of environmental change in the Missouri River Basin.

## Water-Resources Information for Indian Tribes

Water-resources information is critical for water-resource planning by South Dakota's nine Indian Tribes (fig. 4). Hydrogeologic studies for six Tribes were completed by the USGS during the 1970's and the 1980's as a part of the U.S. Department of the Interior's Program for Development of the Missouri River Basin. Water-resource studies are now in progress for five of the Tribes to meet today's changing needs.

Water-resources investigations are underway by the USGS in cooperation with the Sisseton-Wahpeton and Rosebud Tribes, the Bureau of Indian Affairs, SDGS, local counties, and local water districts. Water-resources appraisals of the Lower Brule, Cheyenne, and Pine Ridge Reservations will be used to support development of comprehensive water plans. Subsequent studies have begun for several tribes to integrate hydrologic and geologic data by using GIS analysis. The USGS has completed aquifer tests on the Pine Ridge Reservation to evaluate ground water as a source for irrigation. Sampling is underway to evaluate water quality at the proposed intake for the Mni Wiconi rural water system.

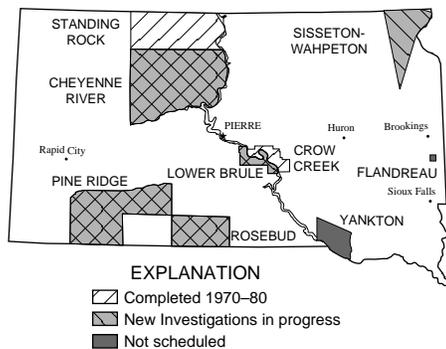


Figure 4. Status of geohydrologic investigations for South Dakota Indian Tribes.

## Lake and Reservoir Sedimentation

In response to public concern about the water quality and sedimentation of South Dakota lakes, the Department of Environment and Natural Resources (DENR) is undertaking diagnostic/feasibility studies in conjunction with the Clean Lakes Program in the State. The USGS, in cooperation with the

DENR and local lake associations, is conducting sediment surveys of several lakes.

The U.S. Army Corps of Engineers (USACE) is concerned about sedimentation of Missouri River reservoirs, especially Lake Francis Case near the confluence of the White River and Lake Sharpe near the confluence of the Bad River. The USGS recently completed a sediment survey near the White River confluence. The USGS, in cooperation with the local Conservation District and the Natural Resources Conservation Service, also collects hydrologic data in support of sediment studies within the Bad River Basin; this Basin has been identified as one of the demonstration projects for "Ecosystem Management."

## Use of Bedrock Aquifers for Water Supply in the Black Hills Area

A series of bedrock aquifers that underlie much of the State is recharged in outcrop areas of the Black Hills. Population growth and associated development in this area are increasing the demand for water from and the potential for contamination of these aquifers. Several studies are underway to address these issues.

The Black Hills Hydrology Study (fig. 2) is a planned 10-year hydrogeologic study in a six-county area that began during 1990 in cooperation with the DENR and local cooperators. Preliminary efforts have focused on determining the quantity and quality of surface and ground waters. Water-level records from an extensive network of observation wells are used to monitor water-level trends. Observation wells also are being used for water-quality monitoring and isotope analyses. Study efforts include hydrologic budgeting, determination of aquifer characteristics, and modeling of ground-water flow.

The Madison and the Minnelusa aquifers are particularly important to the Black Hills area because large well yields are possible. Objectives of ongoing studies in cooperation with Rapid City and Spearfish include determination of aquifer characteristics, well-head protection, and modeling of ground-water flow and solute transport. Solute transport is of particular concern because of the fractured nature of most Black Hills aquifers. The aquifers also are being studied as part of the USGS National Research Program on fractured limestone aquifers.

## Quality of Urban Stormwater Runoff

The USGS, in cooperation with Sioux Falls, is studying urban stormwater quality to

assist the city with collection of technical information about impacts of nonpoint source runoff on stream quality. The information is necessary for obtaining a National Pollutant Discharge Elimination System permit, which is required by the U.S. Environmental Protection Agency (USEPA) for cities with more than 100,000 people. The study includes evaluation of stormwater quality in selected storm channels and evaluation of methods for predicting water-quality conditions in urban environments. The results of this study will be applicable to other communities with similar environmental settings.

## Effects of Floods and Droughts

Sustained flooding occurred over much of South Dakota during 1995. USGS stream-flow-gaging station data were vital in determining the magnitude and extent of flooding. Record peaks were measured at 34 gaging stations, and peaks with recurrence intervals of greater than 10 years were recorded at an additional 22 stations. Peaks with recurrence intervals of 100 years or greater occurred at two stations, Hay Creek at Belle Fourche and James River near Redfield. Flood conditions are summarized in USGS Fact Sheet FS-164-95 entitled *Floods in South Dakota, Spring 1995*.

A comprehensive understanding of flood characteristics is necessary for the design of highway and flood-control structures, land-use planning, establishment of flood-insurance rates, and development of evacuation plans. Statewide flood-frequency studies from 15 to 20 years ago that related peak-flow magnitudes to basin characteristics are being updated in cooperation with the South Dakota Department of Transportation (DOT). The USGS, in cooperation with North Sioux City and Lincoln County, is analyzing hydrologic data in support of a Federal Emergency Management Agency National Flood Insurance Program study.

A 1991 survey of bridge failures in the United States since 1950 showed that 60 percent of the failures were associated with channel instability and scour around bridge piers and abutments. The USGS, in cooperation with the DOT and the Federal Highway Administration, has recently completed a 5-year investigation of channel scour at 31 bridges in South Dakota.

Droughts in South Dakota are devastating to the State's agriculture industry. During periods of drought, the USGS works with numerous agencies to disseminate the streamflow and water-level data needed by State agencies to regulate water rights and to maintain instream-flow requirements.

# For More Information

An example of flood information disseminated by the USGS is shown in figure 5. EROS Landsat satellite images of a part of the James River Basin north of Redfield show the contrast between less-than-normal streamflow on May 25, 1993, and flood conditions on May 15, 1995.

## Environmental Concerns at Defense Facilities

The USGS, in cooperation with Ellsworth Air Force Base, is studying the possible hydrologic effects of the explosive demolition of Minuteman II missile silos in western South Dakota in compliance with the Strategic Arms Reduction Treaty. Nearby wells have been tested to ensure that no adverse effects occur during silo demolition.

The USGS provides technical support to Restoration Advisory Boards that deal with local concerns in southwestern South Dakota relating to an abandoned U.S. Army ordnance depot near Igloo and potential contaminants on the former Badlands Bombing Range. The USACE oversees investigation of buried chemical and explosive ordnance at the Igloo site, which is frequently proposed as a waste-disposal site.

## National Water-Quality Assessment Program

The goals of the National Water-Quality Assessment (NAWQA) Program are to

describe the status and trends of a large, representative part of the Nation's surface- and ground-water resources and to identify the natural and human factors that affect the quality of these resources. The Cheyenne/Belle Fourche River Basin is identified as one of the 60 NAWQA Program study units.

A nationwide synthesis of volatile organic compounds (VOC's) is being performed by USGS in South Dakota as part of the NAWQA Program. The VOC synthesis is intended to describe current water-quality conditions, define trends or lack of trends, and identify, describe, and explain relations among the occurrence and distribution of VOC's in ground and surface waters.

The VOC team has published two reports on the occurrence and distribution of the fuel oxygenate methyl tert-butyl ether (MTBE) in ground water. MTBE is a VOC derived primarily from natural gas that is added to gasoline to increase the octane level and to reduce carbon monoxide and ozone levels in the air. Currently, the USEPA tentatively classifies MTBE as a possible human carcinogen. The Office of Science and Technology Policy, Executive Office of the President, has begun an inter-agency assessment of the scientific basis and effectiveness of oxygenated-gasoline programs. The VOC team and other USGS staff are major participants in this effort.

USGS State representative  
1608 Mt. View Road  
Rapid City, SD 57702  
(605) 394-1780  
Fax: (605) 394-5373  
Email: dc\_sd@usgs.gov

Additional earth science information can be found by accessing the USGS Home Page on the World Wide Web at <http://www.usgs.gov/>

For more information on all USGS reports and products (including maps, images, and computerized data), call **1-800-USA-MAPS**



A



B

Figure 5. Landsat Thematic Mapper images of the James River north of Redfield. A, Less-than-normal streamflow conditions, May 25, 1993. B, Peak flood conditions, May 15, 1995.

The **USGS** provides maps, reports, and information to help others meet their needs to manage, develop, and protect America's water, energy, mineral, biological, and land resources. We help find the natural resources needed to build tomorrow and supply the scientific understanding needed to help minimize or mitigate the effects of natural hazards and environmental damage caused by natural and human activities. The results of our efforts touch the daily life of almost every American.

U.S. Geological Survey  
Fact Sheet FS-041-96