WATER-RESOURCES ACTIVITIES, NORTH DAKOTA DISTRICT, FISCAL YEAR 1990

Compiled by Cathy R. Martin

U.S. GEOLOGICAL SURVEY

Open-File Report 91-188

Bismarck, North Dakota

1991

U.S. DEPARTMENT OF THE INTERIOR

MANUEL LUJAN, JR., Secretary

U.S. GEOLOGICAL SURVEY

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FOREWARD

The North Dakota District of the U.S. Geological Survey, Water Resources Division, collects water-resources data and conducts interpretative investigations in cooperation with many State, local, and other Federal agencies. The District operates extensive data-collection networks that provide the types of information on surface-water and ground-water quantity and quality that are needed on a continuing basis by those who are responsible for managing the State's water resources. The District also conducts interpretative projects that are relevant to contemporary water issues or problems in North Dakota.

The continuing drought of 1988-90 in North Dakota has reminded us again of the importance of our available water resources. Declining water levels in North Dakota's main-stem Missouri River reservoirs and in Devils Lake have been a great concern the past 2 years. One of North Dakota's top water-related priorities for 1990 has been to initiate the planning process to divert Missouri River water to Devils Lake to stabilize the lake level and its water quality. The District is involved in studies of Devils Lake in cooperation with the North Dakota State Water Commission, the North Dakota Game and Fish Department, the North Dakota State Department of Health, and the U.S. Army Corps of Engineers that are providing hydrologic and water-quality information that may be used to better manage the lake under either varying natural conditions or conditions created by artificial regulation of the lake levels.

The importance of the water-quality aspects of District activities continues to grow. A study that is documenting water-quality conditions and processes that affect waste-assimilative capacities of a 31-mile reach of the Red River of the North downstream of Fargo will be completed in 1991. A product of this cooperative study with the North Dakota State Department of Health will be a calibrated and verified water-quality model for the study reach of the Red River. Another District project involves assisting the U.S. Environmental Protection Agency to evaluate the hydrology and the existing potential water-quality impacts in the vicinity of a former oil refinery near Williston.

In 1990, the District began a 5-year project in cooperation with the North Dakota Department of Transportation to evaluate scour effects at selected bridge crossings on streams in North Dakota. Results of this project will help bridge designers more reliably predict scour tendency at bridge sites during high-flow conditions. Also during 1990, the District began innovative surface-geophysical studies (with assistance from the University of North Dakota) to help define the geometries of buried glacial-outwash aquifers on the Fort Berthold Indian Reservation. This 4-year investigation is in cooperation with the Three Affiliated Tribes.

The North Dakota District is involved in three important new U.S. Geological Survey initiatives. As part of the Water Resources Division's Global Climate Change Hydrology program, the District is studying the relations between upper-air flow patterns, climate, and hydrologic variability in the Red River basin. This project is a cooperative effort with the Canadian Climate Service of Environment Canada. Another new project also will focus on the Red River basin. That project is one of 20 new studies begun in 1990 as part of the Water Resources Division's National Water Quality Assessment (NAWQA) program. The project will be designed to assess the current quality of surface water and ground water in the basin, define trends (or lack of trends) in water quality, and identify the major factors that affect observed conditions and trends in water quality. Finally, the District will begin a project during 1991 under the Division's Mid-Continent Herbicide Initiative. The project will evaluate the effects of evapotranspiration on pesticide distributions and transport in the unsaturated zones of areas underlain by shallow glacial aquifers.

The District has continued its efforts to upgrade the gaging-station facilities and to further develop the statewide data-collection network with the support of various Federal, State, and local agencies. During 1990, artificial controls were installed at three gaging stations in southwestern North Dakota as part of the cooperative program with the North Dakota State Water Commission. Another major accomplishment of that program, with support from the U.S. Fish and Wildlife Service and the U.S. Army Corps of Engineers, was the installation of a sheet-pile control and low-flow measurement section at the existing gaging station on the Souris River near Foxholm.

Wm. F. Horak
District Chief

REMOVAL OF DETERIORATED WORKS PROGRESS ADMINISTRATION
DAM CONSTRUCTED IN 1934 AS CONTROL FOR
SOURIS RIVER NEAR FOXHOLM GAGING STATION

NEW SHEET-PILING CONTROL AND LOW-FLOW MEASUREMENT
SECTION CONSTRUCTED IN 1990 AT THE
SOURIS RIVER NEAR FOXHOLM GAGING STATION

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INTRODUCTION

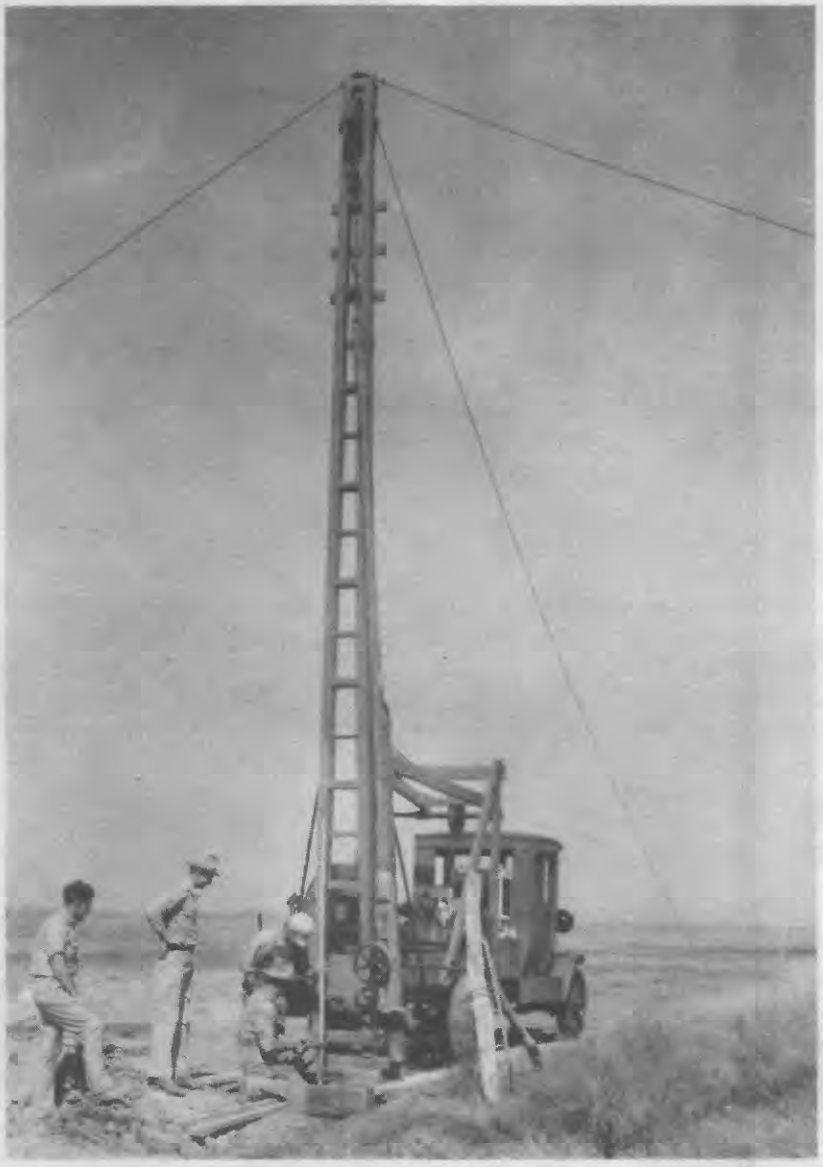
The mission of the U.S. Geological Survey, Water Resources Division, is to provide the hydrologic information and understanding needed for the optimum utilization and management of the Nation's water resources for the overall benefit of the people of the United States. This report describes water-resources activities of the Water Resources Division in North Dakota in fiscal year 1990. Information on each project includes objectives, approach, progress in fiscal year 1990, plans for fiscal year 1991, completed and planned report products, and the name of the project chief.

Origin of the U.S. Geological Survey

The U.S. Geological Survey was established by an act of Congress on March 3, 1879, to provide a permanent Federal agency to conduct the systematic and scientific 'classification of the public lands, and examination of the geological structure, mineral resources, and products of national domain.' An integral part of that original mission includes publishing and disseminating the earth-science information needed to understand, to plan the use of, and to manage the Nation's energy, land, mineral, and water resources.

Since 1879, the research and factfinding role of the U.S. Geological Survey has grown and been modified to meet the changing needs of the Nation. As part of that evolution, the U.S. Geological Survey has become the Federal Government's largest earth-science research agency, the Nation's largest civilian mapmaking agency, the primary source of data on the Nation's surface- and ground-water resources, and the employer of the largest number of professional earth scientists. Today's programs are designed to meet the needs of a diverse group of users. Programs include:

--Conducting and sponsoring research in geology, hydrology, mapping, and related sciences;
--Producing and updating geographic, cartographic, and remotely sensed information in graphic and digital forms;
--Describing the onshore and offshore geologic framework and developing an understanding of its formation and evolution;
--Assessing energy and mineral resources, determining their origin and manner of occurrence, and developing techniques for their discovery;
--Collecting and analyzing data on the quantity and quality of surface water and ground water, on water use, and on quality of precipitation;
--Assessing water resources and developing an understanding of the impact of human activities and natural phenomena on hydrologic systems;
--Evaluating hazards associated with earthquakes, volcanoes, floods, droughts, toxic materials, landslides, subsidence, and other ground failures, and developing methods for hazards prediction;



WELL DRILLING, 1938 (From Lohman, S.W.)

--Publishing reports and maps, establishing and maintaining earth-science data bases, and disseminating earth-science data and information;
--Providing scientific and technical assistance for the effective use of earth-science techniques, products, and information;
--Coordinating topographic, geologic, and land-use mapping, digital cartography, and water-data activities;
--Developing new technologies for the collection, coordination, and interpretation of earth-science data.

WELL DRILLING, 1971

Along with its continuing commitment to meet the growing and changing earth-science needs of the Nation, the U.S. Geological Survey remains dedicated to its original mission to collect, analyze, interpret, publish, and disseminate information about the natural resources of the Nation--providing 'Earth Science in the Public Service.'

Mission of the Water Resources Division

The mission of the Water Resources Division is to provide the hydrologic information and understanding needed for the optimum utilization and management of the Nation's water resources for the overall benefit of the people of the United States. This is accomplished, in large part, through cooperation with other Federal and non-Federal agencies, by:

--Collecting, on a systematic basis, data needed for the continuing determination and evaluation of the quantity, quality, and use of the Nation's water resources;

--Conducting analytical and interpretative water-resource appraisals describing the occurrence, the availability, and the physical, chemical, and biological characteristics of surface and ground water;

--Conducting supportive basic and problem-oriented research in hydraulics, hydrology, and related fields of science to improve the scientific basis for investigations and measurement techniques and to understand hydrologic systems sufficiently well to quantitatively predict their response to stress, either natural or manmade;
--Disseminating the water data and the results of these investigations and research through reports, maps, computerized information services, and other forms of public releases;
--Coordinating the activities of Federal agencies in the acquisition of water data for streams, lakes, reservoirs, estuaries, and ground waters;
--Providing scientific and technical assistance in hydrologic fields to other Federal, State, and local agencies, to licensees of the Federal Power Commission, and to international agencies on behalf of the Department of State.

Sources of Information and Water Resources Division Publications

The U.S. Geological Survey disseminates earth-science information through a network of public access points and an extensive publications program. Information on U.S. Geological Survey programs may be obtained from the Public Inquiries Office, U.S. Geological Survey, 169 Federal Building, 1961 Stout Street, Denver, CO 80294, or from U.S. Geological Survey Circular 900, "Guide to Obtaining USGS Information."

National Water Data Exchange (NAWDEX) Program

The Water Data Source Directory (WDSD) is a computerized data base developed and maintained by the National Water Data Exchange (NAWDEX) Program Office. The directory contains information about organizations that collect, store, and disseminate water data. This information includes the type of each organization; the major orientation of water-data activities conducted by each organization; the names, addresses, and telephone numbers of offices within each organization from which water data may be obtained; the types of data available from each organization and the geographic locations where these data have been collected; and alternate sources of an organization's data.

National Water Information System (NWIS)

The national Water Data Storage and Retrieval (WATSTORE) system was a large-scale computerized storage and retrieval system used by the U.S. Geological Survey to store and disseminate water data. The WATSTORE system had data-processing, storage, and retrieval capabilities as well as the capability of providing computer-printed tables and graphs, statistical analyses of data, and digital plots.

The WATSTORE system, which basically had remained unchanged for about 10 years, gradually has been replaced by a new water-data management system. The new system is called the National Water Information System (NWIS). A fundamental change from the WATSTORE system to the NWIS was the distribution of water data from a central computer in Reston, Va., to minicomputers at district offices throughout the Nation. The Reston computer remains as an archival data repository. Data-management software has been enhanced to

streamline data processing, allow for direct entry of data relayed through satellite, and permit processing of variable-interval data in addition to fixed-interval data. Results so far appear encouraging. Data management has become easier, and data can be processed more quickly than before. Improvements in timeliness of data availability have occurred and further improvements are expected as software is developed for the new system.

All surface-water streamflow and stage data available for North Dakota were downloaded to the North Dakota District minicomputer during 1984. Beginning with the 1984 water year, all data processing for surface-water data has been done on the District minicomputer. The Automatic Data Processing System (ADAPS), a series of computer data-processing programs making up a segment of the NWIS, was installed on the North Dakota District minicomputer in August 1987. Surface-water data collected during the 1987 water year were prepared for publication using the ADAPS software.

In May 1985, all ground-water site information and water levels were downloaded from the Reston computer. The Daily Values Flow Duration software currently is available within the ADAPS, and other utility programs are scheduled to be available in the future.

All water-quality data also have been downloaded to the District minicomputer. This downloading completes the distribution of data processing from the central computer in Reston, Va., to the districts.

Water-Data Program

Water-data stations at selected locations throughout the Nation are used by the U.S. Geological Survey to obtain records of stream discharge (flow) and stage (height), reservoir and lake storage, ground-water levels, well and spring discharge, and the quality of surface and ground water. These data provide a continuing record of the quantity and quality of the Nation's surface- and ground-water resources and, thus, provide the hydrologic information needed by Federal, State, and local agencies and the private sector for the development and management of land and water resources. All data collected are stored in the NWIS and also are published, by water year, for each state in a publication series entitled "U.S. Geological Survey Water-Resources Data Reports" (see section "Water Resources Division Publications" for availability of these reports). Information about the water-data program can be obtained from the Assistant Chief Hydrologist for Operations at the headquarters office in Reston, Va., or from the District Chief of the state of interest.

Water Resources Division Publications

Information on a wide variety of earth-science specialties is published in many forms, including the Federal book series and the map series. Book publications include a formal series of water-supply papers, professional papers, bulletins, circulars, techniques of water-resources investigations, and special reports and an informal series of water-resources investigations reports, open-file reports, and administrative reports. Map publications include a formal series of hydrologic investigations atlases and miscellaneous

investigations maps and an informal series of water-resources investigations reports, open-file reports, and miscellaneous field studies maps. New reports are announced monthly in "New Publications of the Geological Survey," subscriptions to which are available upon request from the U.S. Geological Survey, 582 National Center, Reston, VA 22092.

Formal series book publications are sold by the U.S. Geological Survey, Books and Open-File Reports, Federal Center, Bldg. 810, Box 25425, Denver, CO 80225; single copies of circulars still in print are available upon request from that address. Map publications pertaining to North Dakota are sold by the U.S. Geological Survey, Western Distribution Branch, Box 25286, Federal Center, Denver, CO 80225.

Water-resources investigations reports and open-file reports pertaining to North Dakota are available for inspection at the U.S. Geological Survey, Water Resources Division, 821 East Interstate Avenue, Bismarck, ND 58501; information on their availability also may be obtained from the District Chief at that address. In addition, those reports having an alpha-numeric designation in parentheses at the end of the citation may be purchased as paper copy or microfiche from the U.S. Geological Survey, Books and Open-File Reports, Federal Center, Bldg. 810, Box 25425, Denver, CO 80225--the alpha-numeric designation is required when ordering from Books and Open-File Reports.

The series of reports entitled "Water-Resources Data for (State) for (Year)," describing surface water, ground water, and water quality in each state, may be purchased from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. The reports can be inspected in U.S. Geological Survey libraries and in Water Resources Division district offices in the region of the report.

NORTH DAKOTA DISTRICT

The North Dakota District is 1 of 43 districts of the U.S. Geological Survey, Water Resources Division. The District boundaries are coincident with those of the State, and offices are located in Bismarck, Dickinson, and Grand Forks (table 1). District organization is shown in figure 1.

Funding

Funds to support water-resources activities of the North Dakota District are derived from three principal sources:

(1) Federal Program--Funds are appropriated by Congress for support of prescribed activities. In fiscal year 1990, Federal funding for North Dakota District program activities was $745,610.

(2) Federal-State Cooperative Program--Federal funds are appropriated by Congress and used to match those furnished by State and other tax-supported agencies on a 50-50 cost-share basis. These funds are used for a variety of hydrologic data-collection activities and water-resources investigations in which the U.S. Geological Survey represents the national interest and the cooperating agencies represent State and local interests. In fiscal year 1990, Federal-State Cooperative funding for the North Dakota District was $1,388,120.

Table 1.--*North Dakota District offices*

Office	Telephone number	Address
District office	(701) 250-4601 FTS 783-4601	U.S. Geological Survey Water Resources Division 821 East Interstate Avenue Bismarck, ND 58501
Dickinson field headquarters	(701) 225-2051	U.S. Geological Survey Water Resources Division 669 12th Street SW Dickinson, ND 58601
Grand Forks field headquarters	(701) 775-7221	U.S. Geological Survey Water Resources Division P.O. Box 1437 Grand Forks, ND 58206-1437

NORTH DAKOTA DISTRICT ORGANIZATION

W. F. Horak, District Chief

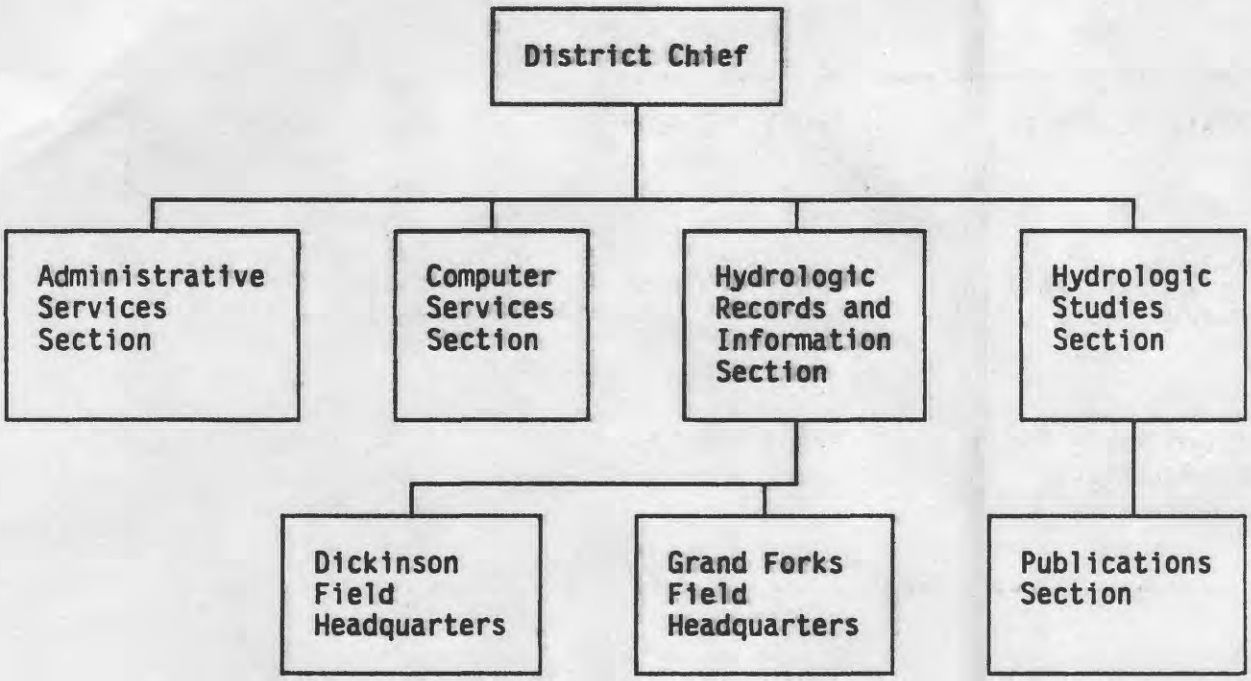


Figure 1.—North Dakota District organizational structure.

(3) Other Federal Agencies (OFA) Program--Funds are transferred to the U.S. Geological Survey as reimbursement for work performed at the request of another Federal agency. In fiscal year 1990, OFA funding was $730,785.

The total budget for fiscal year 1990 was $2,864,515. The percentage of funding from each principal source is shown in figure 2. Agencies cooperating in water-resources investigations in fiscal year 1990 are given in table 2.

The types of activities conducted by the North Dakota District include research projects, areal appraisals and interpretative studies, and collection of hydrologic data. The relative District involvement in each of these activities, in terms of funding, is about 16 percent for research projects, about 42 percent for areal appraisals and interpretative studies, and about 42 percent for collection of hydrologic data.

Water Issues in North Dakota

Many water issues received attention in North Dakota during the past 12 months. Some of those issues are highlighted in the following paragraphs.

Drought

This year (1990) was the third consecutive year of severe drought in the central and western part of the State. Late-spring snowfall and early summer rains brought some relief to parts of the State, particularly the eastern to southeastern third, but the beneficial effect of the moisture soon was neutralized by summer heat. Some areas of the State still did not receive enough moisture to enable successful germination of newly planted crops. Generally, precipitation was deficient statewide during late summer and early fall. The greatest deficiency was in the western part of the State.

At a drought task force meeting convened and chaired by Governor George Sinner in April, the U.S. Geological Survey presented information about declining streamflows and ground-water and reservoir levels. Much discussion at the meeting focused on potential impacts of the drought on water supplies. In cooperation with the North Dakota State Water Commission, the U.S. Geological Survey is planning to undertake a study to document the hydrologic effects of the drought. A report summarizing the climatic conditions and the hydrologic response associated with the drought is planned for completion in fiscal year 1993.

Missouri River

Reduced streamflow in the Missouri River and declining lake levels in Missouri River main-stem reservoirs have been a result of the continuing drought in the northern Great Plains. Since June 1988, the level of Lake Sakakawea has been lower than at any time since the lake was initially filled in the mid-1950's. The U.S. Army Corps of Engineers currently (1990) is revising its Missouri River reservoir operating manual and will consider the importance of the many contemporary needs for Missouri River water by the various basin states.

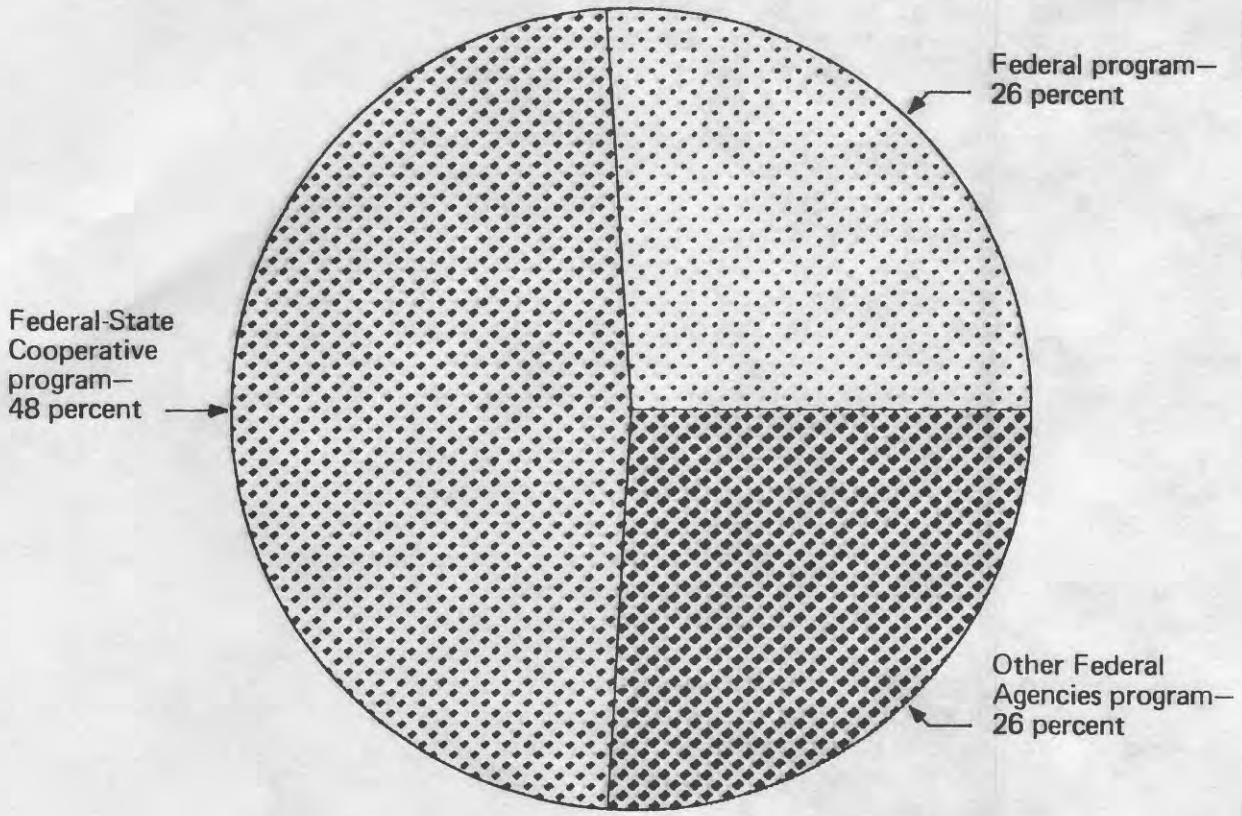


Figure 2.—Percentage of funding from principal sources for fiscal year 1990.

Table 2.--*Agencies cooperating in water-resources investigations in fiscal year 1990*

Federal agencies
U.S. Department of Agriculture
Soil Conservation Service
U.S. Department of the Army
Corps of Engineers
Omaha District
St. Paul District
U.S. Department of the Interior
Bureau of Reclamation
Fish and Wildlife Service
U.S. Department of State
International Joint Commission
Waterways Treaty Program
U.S. Environmental Protection Agency
State agencies
North Dakota Department of Transportation
North Dakota Game and Fish Department
North Dakota Geological Survey
North Dakota Parks and Recreation Board
North Dakota Public Service Commission
North Dakota State Department of Health
North Dakota State Water Commission
Local agencies
City of Dickinson
City of Minot
Lower Heart Water Resource District
Oliver County Board of Commissioners
Three Affiliated Tribes

Devils Lake

Other than the Missouri River and Lake Sakakawea, Devils Lake is North Dakota's most important recreational and fish-producing water body. As of December 1990, the water level of Devils Lake has declined about 4 feet since August 1987 when it reached a level of 1,428.8 feet, the highest level since 1885. As the water level of Devils Lake declined, interest in alleviating rising water levels was replaced by interest in lake stabilization to protect water-based recreation and the fishery. Major fish kills are forecast if the level declines another 4 feet.

A consortium of State and Federal agencies, led by the North Dakota State Water Commission, recently developed a report that details 28 alternatives for lake stabilization. The State's favored plan for lake stabilization calls for the delivery of Garrison Diversion Unit project water through existing canals and a proposed pipeline. Many international and environmental issues will have to be addressed, however, before an interbasin water-transfer plan could be affected.

Nonpoint Source Pollution

Public awareness of nonpoint source pollution, which is the major source of pollution affecting North Dakota's lakes, streams, and wetlands, has increased in recent years. The Clean Water Act, as amended in 1987, established new direction for water-quality efforts by placing more emphasis on reducing nonpoint source pollution. The primary goals of the Clean Water Act are to be met through Section 319, Nonpoint Source Management Programs. In 1990, the U.S. Environmental Protection Agency agreed to fund, through Section 319, eight projects related to nonpoint source pollution in North Dakota.

Agriculture is the main industry in North Dakota; thus, agricultural activities have the potential for impacting the State's water quality. Erosion from land under tillage and transport of nutrients and pesticides used in agricultural crop production can impact the biological community of the State's lakes, streams, and wetlands. Only relatively minor ground-water contamination has been detected in North Dakota in comparison to that detected in other midwestern states where intensive agriculture also is practiced. However, more emphasis is needed on improving farming practices and monitoring water quality to protect North Dakota's ground water. Nearly the entire rural population as well as many of the State's municipalities depend on ground water as a source of supply.

During 1989-90, the U.S. Geological Survey began multistate studies in the upper midwest to assess the occurrence and distribution of agricultural chemicals in ground water, surface water, and precipitation. Also during 1990, the U.S. Geological Survey and the U.S. Department of Agriculture began small-scale studies at several locations in the upper-midwestern states to evaluate the distribution of agricultural chemicals in water resources and the processes and factors affecting that distribution and to develop improved and acceptable farming practices that enhance water quality.

Wetlands

Wetlands issues frequently have been in the national and local news during the past year. The Bush Administration is advocating "no net loss" of wetlands and is seeking support for funding and implementing programs to accomplish its goal. A Federal "Domestic Policy Council" task force was established during 1990 to seek public comments on appropriate national policies for achievement of the "no net loss" goal. This 10-member task force listened to four panel discussions and received public comment during an August meeting in Bismarck. Much discussion at the meeting focused on the need for research into the hydrologic and water-quality functions of wetlands so that the planning of programs for preservation of existing wetlands and restoration of previously drained wetlands can be based on sound scientific principles.

The North Dakota District has proposed cooperative work with State and other Federal agencies to conduct hydrologic research necessary for wise implementation of management schemes to preserve and restore North Dakota's wetlands.

Highlights

Survey Provides Expert-Witness Testimony and Supporting Material

In June 1988, the State of North Dakota filed a suit in U.S. District Court asking for a judgment to determine the ownership of the bed of the Little Missouri River. In order to prevail, it was incumbent on the State to demonstrate that the Little Missouri River was navigable at the time of statehood in 1889. Because the United States of America was the defendant in the suit, the Justice Department asked the U.S. Geological Survey to provide expert-witness testimony to support the case of the Justice Department.

Tabular and graphic data for the three U.S. Geological Survey streamflow-gaging stations on the Little Missouri River in North Dakota were provided. The data were used by the Justice Department to support their contention that the flow of the Little Missouri River is highly variable from year to year as well as within each year. Expert-witness testimony was given by the U.S. Geological Survey on October 18, 1990. The judgment in the case is pending.

Suspended-Sediment Transport in the Missouri River Between Garrison Dam and the Headwaters of Lake Oahe (ND 88-143)

The U.S. Geological Survey is studying sediment-transport characteristics of the Missouri River downstream from Garrison Dam to Bismarck, N.Dak. Detailed sediment data are collected at 20 sites on the river during high-, medium-, and low-flow conditions. The data are used to determine where the river is scouring and depositing sediments. Samples also are taken from actively eroding banks to determine if the sediment transported by the river is from the riverbanks, the riverbed, or both. As of October 1990, data have been collected only during low-flow conditions because of drought conditions in the Missouri River basin upstream from Garrison Dam.

EROSION ON RIGHT BANK (LOOKING DOWNSTREAM) OF
MISSOURI RIVER ABOUT 31 MILES DOWNSTREAM
FROM GARRISON DAM, NORTH DAKOTA, MAY 1990

ACTIVE EROSION THREATENS TREES ON LEFT BANK (LOOKING UPSTREAM) OF MISSOURI RIVER ABOUT 70 MILES DOWNSTREAM FROM GARRISON DAM, NORTH DAKOTA, MAY 1990

BANK EROSION UNDERCUTS OAK TREE ON RIGHT BANK (LOOKING UPSTREAM) OF MISSOURI RIVER ABOUT 25 MILES DOWNSTREAM FROM GARRISON DAM, NORTH DAKOTA, MAY 1990

Water-Quality Assessment of the Red River of the North near Fargo, North Dakota (ND 89-150)

This 3-year project is in cooperation with the North Dakota State Department of Health. The North Dakota State Department of Health needs information and a calibrated water-quality model to evaluate whether additional discharge of treated wastewater to a 31-mile reach of the Red River of the North downstream from Fargo should be permitted. Current water-quality standards for both North Dakota and Minnesota limit wastewater discharge to the river to a level such that downstream dissolved-oxygen concentrations will not be less than 5 milligrams per liter and ammonia concentrations will be less than 2 milligrams per liter.

Many new data have been obtained to calibrate and verify the U.S. Environmental Protection Agency's QUAL2E model for the 31-mile reach of the river. Tracer studies using rhodamine WT dye and propane have been conducted to define traveltime, dispersion, and reaeration characteristics during three different flow conditions. Two synoptic surveys of dissolved-oxygen concentrations, streambed-oxygen demand, and nutrient concentrations were completed. The QUAL2E model was calibrated using data obtained during the August 1989 synoptic survey when flows in the study reach ranged from 100 to 200 cubic feet per second. Another synoptic survey was completed during August 1990 when flows in the study reach were about 250 cubic feet per second. Data obtained during the August 1990 synoptic survey are being used to verify the model calibration.

Hydrology of Fort Berthold Indian Reservation, North Dakota (ND 90-153)

Innovative technology is being used in this 4-year study of the hydrology of the Fort Berthold Indian Reservation. The study, which is in cooperation with the Three Affiliated Tribes, is a comprehensive water-resources investigation that has primary emphasis on ground water. All existing data and all new data obtained during this study are being stored in computer format for use in a geographic information system. Detailed data sets that include topography, hydrology, geology, and soil types, as well as road features and public-land surveys, are stored as geographic information system files. Geographic information system software used by the District has correlative and interpretative abilities that allow linkage of multiple data sets in ways that will assist in understanding the variations in the quantity and quality of ground and surface water within the reservation.

The water-resources investigation was expanded during fiscal year 1990 to include detailed gravity and seismic geophysical surveys of the reservation in order to better delineate physical properties of aquifers. Horizontal and vertical coordinates of the gravity stations were determined by using sophisticated global positioning system technology made available through a contract with the University of Texas. Coordinates determined by global positioning system surveys were accurate to within 2 centimeters both horizontally and vertically. More than 3,900 stations were accurately located in a 3-month period. The latest state-of-the-art equipment used for high-accuracy gravity surveys was made available through a contract with the University of North Dakota. The seismic part of the geophysical surveys is planned for fiscal year 1991.

EQUIPMENT SET UP FOR PROPANE-GAS INJECTION WHEN FLOW WAS ABOUT 100 CUBIC FEET PER SECOND, RED RIVER OF THE NORTH NEAR FARGO, NORTH DAKOTA, AUGUST 1989

SETTING OUT PROPANE-GAS DIFFUSERS WHEN FLOW WAS ABOUT 450 CUBIC FEET PER SECOND, RED RIVER OF THE NORTH NEAR FARGO, NORTH DAKOTA, APRIL 1990

PROPANE GAS COMING TO SURFACE (INDICATED BY BUBBLES ON TOP OF WATER), RED RIVER OF THE NORTH NEAR FARGO, NORTH DAKOTA, APRIL 1990

Bottom-Sediment/Water-Column Interactions at Devils Lake, North Dakota (ND 90-156)

For several years, the U.S. Geological Survey has studied the hydrology, limnology, and chemistry of Devils Lake. One goal of this work has been to develop chemical budgets for Devils Lake. In the course of developing these budgets, U.S. Geological Survey scientists found that information was required on how chemical exchange with sediments on the bottom of Devils Lake affected the chemistry of lake water.

To obtain information on the chemistry of bottom sediments in Devils Lake, 20 cores of sediment were collected from Main Bay and Creel Bay in July 1990. Each core was about 50 centimeters long and 7 centimeters in diameter. The chemistry of pore water and sediments was analyzed for each core, and the chemical data were used to calculate rates of chemical exchange between the bottom sediments and water column. The data show that the bottom sediments contribute a significant fraction of the dissolved solids in the lake.

SEDIMENT-CORING DEVICE READY FOR DEPLOYMENT IN DEVILS LAKE, NORTH DAKOTA, JULY 1990

CENTRIFUGE (LEFT) AND GLOVE BOX (RIGHT) USED TO PROCESS SEDIMENT FROM DEVILS LAKE, NORTH DAKOTA, JULY 1990

PROCESSING SEDIMENT IN A NITROGEN-FILLED GLOVE BAG, JULY 1990

Solid-Precipitation Measurement Intercomparison

The North Dakota District is participating in the World Meteorological Organization's comparison of methods used internationally for measuring solid precipitation. The Bismarck solid-precipitation measurement site and the gages maintained at the site are described in a Water Fact Sheet. Data collection started in November 1988.

WATER FACT SHEET
U.S. GEOLOGICAL SURVEY, DEPARTMENT OF THE INTERIOR

SOLID-PRECIPITATION (SNOWFALL) MEASUREMENT INTERCOMPARISON, BISMARCK, NORTH DAKOTA

INTRODUCTION

Difficulties involved in obtaining accurate measurements of solid precipitation (snowfall) have been recognized for many years. Many studies have been conducted to evaluate the accuracy and performance of precipitation gages. These studies show that the type of collection method used can significantly affect the quantity of precipitation measured. Although the types of collection methods evaluated differed for each study and the magnitude of measurement error differed for each study, all of the studies concluded that wind is the major cause of measurement error.

Measurement error caused by wind is the result of turbulence and wind speed in the vicinity of the gage orifice (opening). As air rises to pass over the gage, precipitation particles that would have entered the gage orifice are deflected and carried farther downwind. Measurement errors increase as wind speed increases. Studies have shown that measurement errors as great as 80 percent can be attributed to wind. Wind speed and turbulence can be reduced by shielding the gage from the wind. Several types of windshields have been built to decrease wind-related errors.

The World Meteorological Organization recognized the need for an international comparison of current methods used for measuring solid precipitation and proposed the Solid Precipitation Measurement Intercomparison. The objectives of the Intercomparison are to:

- Determine the wind-related errors in methods of solid-precipitation measurements;
- Derive standard methods for correcting solid-precipitation measurements;
- Introduce a reference method of solid-precipitation measurement for general use to calibrate any type of precipitation gage; and
- Establish a complete solid-precipitation data set that contains all necessary information for research purposes.

INTERCOMPARISON SITES

As part of the Intercomparison, about 20 solid-precipitation measurement sites have been established in about 12 countries. Four of these sites are in the United States: Bismarck, N. Dak.; Rabbit Ears Pass, Colo.; Reynolds Creek, Idaho; and Sleepers River, Vt. The Bismarck site is at the National Weather Service Forecast Office at the Bismarck Municipal Airport, which is about 2 miles southeast of the center of the city. The site is on a broad, level plain of the Missouri River valley. Topographic features of the area do not have a significant effect on the climate or on the prevailing winds.

INSTRUMENTATION AT THE BISMARCK SITE

Seven precipitation gages are maintained at the Bismarck site. The gage orifices are either 9.8 feet or 4.6 feet above the land surface. Wind speed is monitored at these two orifice heights. Wind direction and air temperature also are monitored. The seven precipitation gages are:

- Belfort Universal precipitation gage[1];
- Belfort Universal precipitation gage with an Alter-type windshield. This gage is the standard gage in the United States;
- Tretyakov precipitation gage. This gage is the standard gage in the U.S.S.R.;
- Tretyakov precipitation gage with an octagonal, vertical, double-fence windshield. This gage is designated as the reference gage for the Intercomparsion;
- Belfort Universal precipitation gage with an octagonal, vertical, double-fence windshield;
- Belfort Universal precipitation gage with a Wyoming windshield; and
- Aerochem Metrics automatic sensing wet/dry precipitation collector. This collector is the standard gage used in the evaluation of deposition of air pollutants, such as acid precipitation.

Precipitation containers for the Belfort Universal precipitation gages are mounted on a spring that is connected to a recorder. As the weight of the precipitation compresses the spring, the quantity of precipitation collected is recorded continuously. Precipitation containers for the Tretyakov precipitation gages and the Aerochem Metrics precipitation collector are removed after each precipitation event and weighed to determine the quantity of precipitation.

Belfort Universal precipitation gage.

Belfort Universal precipitation gage with an Alter-type windshield.

[1]The use of brand, firm, or trade names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

Tretyakov precipitation gage.

Octagonal, vertical, double-fence windshield.

Wyoming windshield.

Aerochem Metrics automatic sensing wet/dry precipitation collector.

DATA APPLICATION

If several types of gages are used in State, regional, or global analysis, then correction to precipitation measurements are necessary. Compatible and consistent data are needed to study the world water balance, address effects of climate change, develop reliable global-circulation models, develop and validate remote-sensing methods, and calculate accurate transport and deposition of air pollutants. The development of standard correction methods will help ensure that compatible and consistent data are available.

Plans are to collect data for at least 5 years. Data will be used to evaluate the differences in measurement among the different types of gages. The World Meteorological Organization will analyze the data from all of the sites around the world.

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For additional information about the World Meteorological Organization Solid Precipitation Measurement Intercomparison, or on the instrumentation and data collection at the site in Bismarck, N. Dak., contact:

District Chief
U.S. Geological Survey
Water Resources Division
821 East Interstate Avenue
Bismarck, North Dakota 58501

U.S. Geological Survey
Open-File Report 90–124

D.G. Emerson and
K.M. Macek-Rowland, 1990

U.S. GOVERNMENT PRINTING OFFICE: 1990 O—944-885

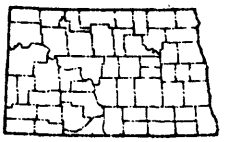
SURFACE-WATER STATIONS

PROJECT NUMBER: ND 00-001.

LOCATION: Statewide.

PERIOD OF PROJECT: Continuous.

PROJECT CHIEF: Russell E. Harkness.



STATEWIDE

COOPERATING AGENCIES: (1) City of Dickinson; (2) Lower Heart Water Resource District; (3) North Dakota Public Service Commission; (4) North Dakota State Water Commission; (5) Oliver County Board of Commissioners; (6) U.S. Department of Agriculture, Soil Conservation Service; (7) U.S. Department of the Army, Corps of Engineers; (8) U.S. Department of the Interior, Bureau of Reclamation; (9) U.S. Department of the Interior, Fish and Wildlife Service; (10) U.S. Department of State, International Joint Commission, Waterways Treaty Program; and (11) other Federal agencies of the U.S. Department of the Interior for the development of the Missouri River basin.

PROBLEM: The operation of existing water projects and the planning of future work require the availability of accurate, unbiased streamflow and water-level data. The data must be available in a timely manner in order to assure efficient and effective operation of existing water projects. The data also must be available over a wide range of space and time in order to provide statistically accurate projections used for planning.

OBJECTIVES: Objectives are (1) to collect surface-water data needed for assessment of water resources, operation of reservoirs or industries, forecasting, disposal of wastes and pollution controls, compact and legal requirements, and research or special studies; (2) to collect surface-water data needed to accompany water-quality measurements; and (3) to collect surface-water data needed for analytical studies at specific locations to define statistical distributions of, and trends in, the occurrence of water in streams, lakes, and reservoirs for use in planning and design.

APPROACH: Standard methods of data collection are used as described in the U.S. Geological Survey techniques of water-resources investigations report series. Partial-record gages are operated instead of complete-record gages where daily streamflow data are not required for the entire year. Discharge or stage data will be obtained for the stations shown in figure 3. A station-classification summary is given in table 3.

PROGRESS IN FISCAL YEAR 1990: All network data were collected on schedule, and records were prepared for publication. One new continuous-record streamflow station was installed and will begin operation in fiscal year 1991. Artificial controls were installed at several streamflow stations.

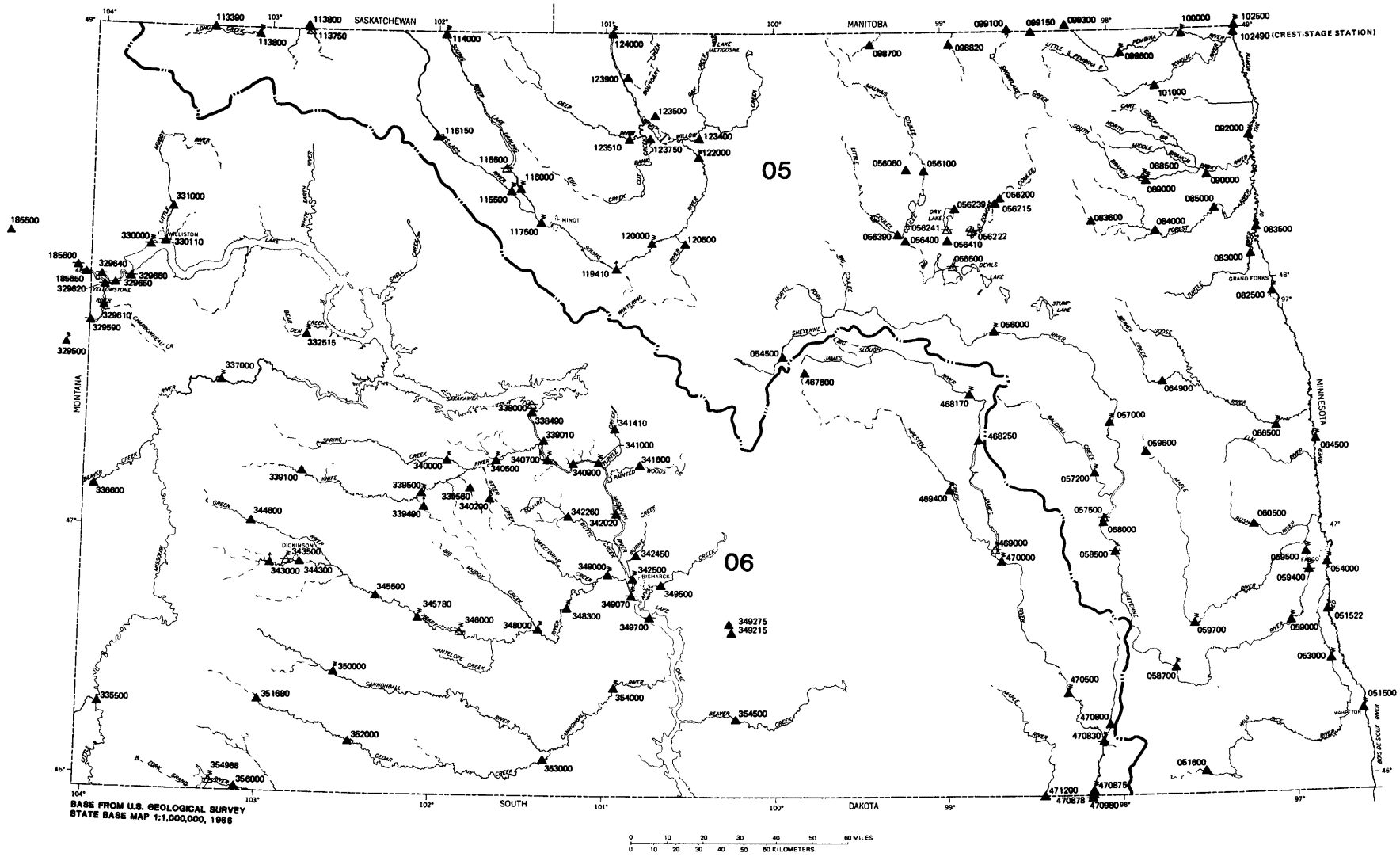


Figure 3.—Locations of lake, crest-stage, and stream-gaging stations in 1990.

Table 3.--*Station-classification summary*

Station classification		Number of stations
Stream stations		134
Continuous record:		
Discharge and stage	84	
Stage only	11	
Stage and peak flow	3	
Partial record:		
Discharge (seasonal)	20	
Stage only (seasonal)	8	
Peak (maximum) flow only	8	
Lake and reservoir stations		13
Stage and contents	10	
Stage only	3	
Total		147

PLANS FOR FISCAL YEAR 1991: The streamflow-station network will be operated as scheduled. Cooperative work with State and Federal agencies to upgrade controls at streamflow stations will continue. One streamflow station will be discontinued.

REPORT PRODUCTS: U.S. Geological Survey, 1990, Water-resources data, North Dakota, Water year 1989: U.S. Geological Survey Water-Data Report ND-89-1, 397 p.

U.S. Geological Survey, Water-resources data, North Dakota, Water year 1990 (planned).

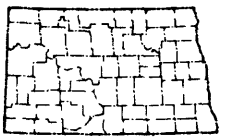
GROUND-WATER STATIONS

PROJECT NUMBER: ND 00-002.

LOCATION: Statewide.

PERIOD OF PROJECT: Continuous.

PROJECT CHIEF: Russell E. Harkness.



STATEWIDE

COOPERATING AGENCIES: (1) North Dakota Public Service Commission; (2) North Dakota State Water Commission; and (3) U.S. Department of the Army, Corps of Engineers.

PROBLEM: Planning for management and development of ground-water resources requires extensive knowledge of the occurrence and availability of ground water and use of and impacts on the ground-water system.

OBJECTIVES: The first objective is to collect water-level data sufficient to provide a minimum long-term data base. The data base is used for continued observation of the impacts of climatic variation and man's activities on the ground-water system. A statewide data base is essential for efficient resource management. The second objective is to provide a data base against which short-term records acquired in areal studies can be analyzed.

APPROACH: Evaluation of regional geology allows a general definition of aquifer systems and their boundary conditions. Within this framework and with some knowledge of (1) changes in the ground-water system in time and space and (2) the hydrologic properties of the aquifers, subjective decisions can be made in upgrading the statewide ground-water observation-well network. The ground-water observation-well network currently consists of about 800 wells. Of the 800 wells, about half are measured quarterly or more frequently and half are measured annually. The network can be refined as data become available and detailed areal studies of the ground-water system better define the aquifers, their properties, and the stresses to which they are subjected.

PROGRESS IN FISCAL YEAR 1990: All network data were collected on schedule. Water-level data from a basic network of wells (fig. 4) were prepared for publication.

PLANS FOR FISCAL YEAR 1991: Plans are to continue to operate the network and to perform scheduled well maintenance. A review of the network will be conducted in cooperation with the North Dakota State Water Commission. Some adjustments will be made in the number of wells measured and in the frequency of measurements to satisfy the needs of the major cooperator.

REPORT PRODUCTS: U.S. Geological Survey, 1990, Water-resources data, North Dakota, Water year 1989: U.S. Geological Survey Water-Data Report ND-89-1, 397 p.

U.S. Geological Survey, Water-resources data, North Dakota, Water year 1990 (planned).

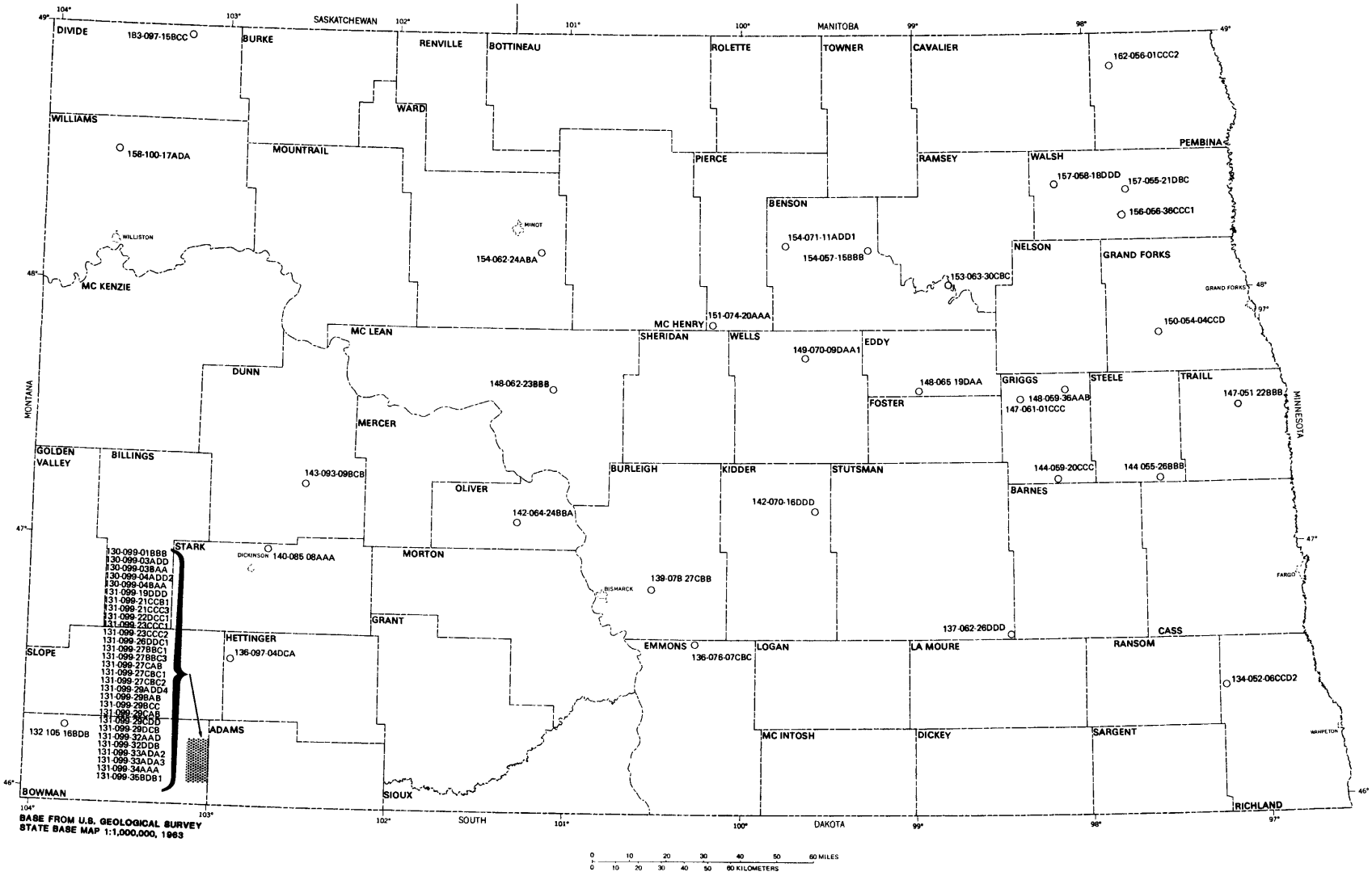


Figure 4.—Locations of ground-water observation wells in basic network in 1990.

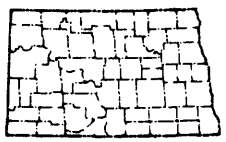
WATER-QUALITY STATIONS

PROJECT NUMBER: ND 00-003.

LOCATION: Statewide.

PERIOD OF PROJECT: Continuous.

PROJECT CHIEF: Russell E. Harkness.



STATEWIDE

COOPERATING AGENCIES: (1) City of Minot; (2) North Dakota Public Service Commission; (3) North Dakota State Water Commission; (4) U.S. Department of the Army, Corps of Engineers; (5) U.S. Department of the Interior, Bureau of Reclamation; and (6) U.S. Department of the Interior, Fish and Wildlife Service.

PROBLEM: Water-resources planning and water-quality assessment require a nationwide base level of relatively standardized information. For proper planning and assessment of the water resources, the chemical and physical qualities of surface water and ground water must be defined and monitored.

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

APPROACH: A network of water-quality stations will be operated to provide chemical concentrations, loads, and time trends as required by planning and management agencies.

PROGRESS IN FISCAL YEAR 1990: All network data were collected on schedule where possible, and records are being prepared for publication. Because of the continued drought, several streams went dry before all scheduled samples could be collected. Surface-water stations where water-quality data were collected are shown in figure 5.

PLANS FOR FISCAL YEAR 1991: Plans are to continue to operate the network with a few cooperator-requested modifications, complete the review of the Garrison Diversion Unit data report, and publish the report. Three water-quality monitoring sites on Arrowwood National Wildlife Refuge will be discontinued.

REPORT PRODUCTS: U.S. Geological Survey, 1990, Water-resources data, North Dakota, Water year 1989: U.S. Geological Survey Water-Data Report ND-89-1, 397 p.

U.S. Geological Survey, Water-resources data, North Dakota, Water year 1990 (planned).

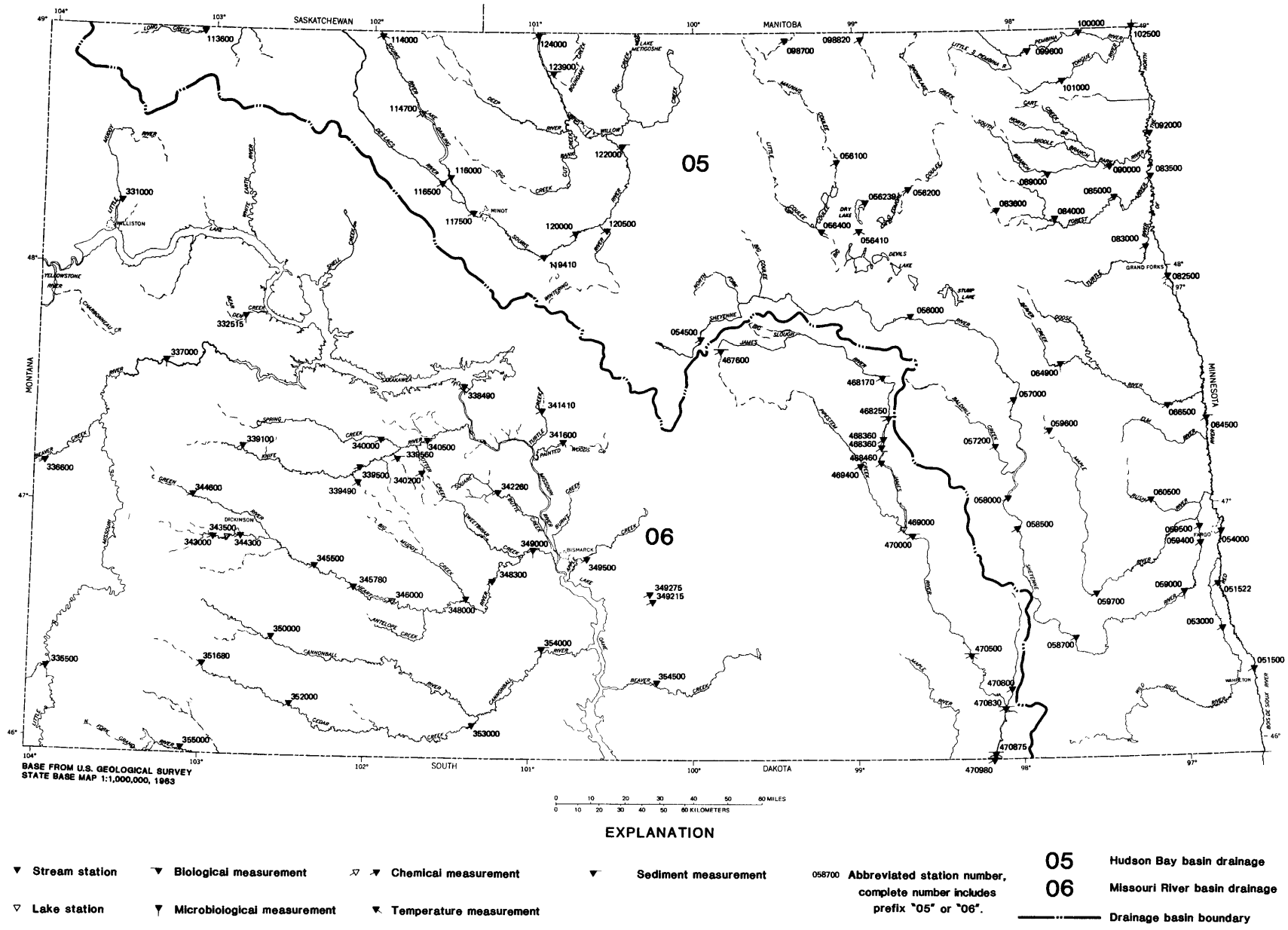


Figure 5.—Locations of surface-water stations where water-quality data were collected in 1990.

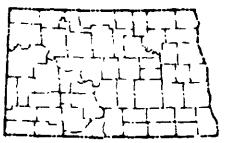
SEDIMENT STATIONS

PROJECT NUMBER: ND 00-004.

LOCATION: Statewide.

PERIOD OF PROJECT: Continuous.

PROJECT CHIEF: Russell E. Harkness.



STATEWIDE

COOPERATING AGENCIES: (1) U.S. Department of the Interior, Bureau of Reclamation; and (2) other Federal agencies of the U.S. Department of the Interior for the development of the Missouri River basin.

PROBLEM: Water-resources planning for intrastate, as well as interstate, waters requires a standardized data base containing sediment transport information. The information must be accurate, unbiased, and available to the user.

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

APPROACH: A network of sediment stations will be operated 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 IN FISCAL YEAR 1990: All network data were collected and analyzed on schedule. Data were collected and analyzed for partial-record sediment stations (fig. 5).

PLANS FOR FISCAL YEAR 1991: Plans are to continue to operate the network.

REPORT PRODUCTS: U.S. Geological Survey, 1990, Water-resources data, North Dakota, Water year 1989: U.S. Geological Survey Water-Data Report ND-89-1, 397 p.

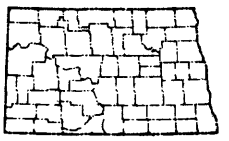
U.S. Geological Survey, Water-resources data, North Dakota, Water year 1990 (planned).

NATIONAL TRENDS NETWORK FOR ATMOSPHERIC DEPOSITION

PROJECT NUMBER: ND 00-005.

LOCATION: Statewide.

PERIOD OF PROJECT: Continuous since October 1983.



STATEWIDE

PROJECT CHIEF: Kenneth L. Lindskov.

PROBLEM: In order to determine atmospheric fluxes within the hydrologic system and man's influences on these fluxes, it is necessary to establish and operate a nationwide, long-term network for monitoring atmospheric deposition of selected chemical constituents.

OBJECTIVES: Objectives are (1) to establish and operate a nationwide, long-term monitoring network to detect and measure levels of atmospheric deposition and (2) to determine variations in atmospheric deposition that occur on a week-to-week basis by collection of wet- and dry-deposition products for analysis of elements and constituents that can contribute to the chemical composition of surface waters.

APPROACH: Monitoring stations were operated at sites near Woodworth and at Icelandic State Park as part of the National Trends Network (NTN). Station equipment includes a wet/dry precipitation collector, a paper-chart recording rain gage with event marker, and a weighing rain gage with an electronic data logger as a backup gage. Stations will be maintained, and on-site measurements of precipitation weight, specific conductance, and pH will be made. Samples will be collected, processed, and submitted to the National Atmospheric Deposition Program NTN Central Analytical Laboratory, Illinois State Water Survey. Data will be verified and stored in the NWIS. Results will be reported to the national program coordinator.

PROGRESS IN FISCAL YEAR 1990: Two atmospheric deposition stations were operated. Records for 1989 are being published, and 1990 data are undergoing prepublication review. Digitally-recording rain gages were operated at each station in addition to paper-chart recorders. The digitally-recorded precipitation records were less affected by wind and vibrations.

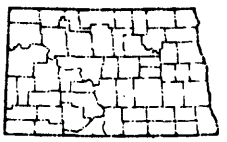
PLANS FOR FISCAL YEAR 1991: Station operation will continue. Data will be stored in NWIS files and published in the annual data report.

REPORT PRODUCTS: U.S. Geological Survey, 1990, Water-resources data, North Dakota, Water year 1989: U.S. Geological Survey Water-Data Report ND-89-1, 397 p.

U.S. Geological Survey, Water-resources data, North Dakota, Water year 1990 (planned).

WATER-USE DATA ACQUISITION AND DISSEMINATION PROGRAM

PROJECT NUMBER: ND 00-007.



STATEWIDE

LOCATION: Statewide.

PERIOD OF PROJECT: Continuous.

PROJECT CHIEF: Kathleen M. Rowland.

COOPERATING AGENCY: North Dakota State Water Commission.

PROBLEM: The water resources of North Dakota and the Nation are being used more extensively each succeeding year. In North Dakota, competition among users for available water resources in certain areas of the State has increased. In order to manage the development of the resources and to project future trends, planners and managers must be aware of existing patterns and quantity of use.

OBJECTIVES: Specific objectives are (1) to collect site-specific data to provide water-use information for the optimum utilization and management of the State's water resources; (2) to store data collected so they may be retrieved at national, regional, and various local levels; and (3) to disseminate water-use data to complement data on availability and quality of State and national water resources.

APPROACH: As an integral part of the water-permit program, the North Dakota State Water Commission collects site-specific water-withdrawal information from an annual inventory of permitted water users. Information on water withdrawals is stored in the following categories: public supply (includes municipal use and rural water systems), irrigation, and self-supplied commercial and industrial (includes mining and thermoelectric).

The North Dakota State Water Commission and the U.S. Geological Survey conduct an ongoing cooperative program to contribute data to a U.S. Geological Survey national water-use data base. The North Dakota State Water Commission furnishes annual water-withdrawal information to the U.S. Geological Survey by magnetic tape. After the site-specific data are converted from State water-use categories to national water-use categories, the data are reformatted and stored in the U.S. Geological Survey's State Water Use Data System (SWUDS) and in the National Water Use Data System (NWUDS). As needed, amounts of nonpermitted water withdrawals for rural-domestic use and for agricultural use will be estimated based on human and animal population and per capita use.

PROGRESS IN FISCAL YEAR 1990: Water-use data for 1989 were obtained from the North Dakota State Water Commission. Preparations began for obtaining water-use data for the 1990 national water-use report. Site-specific withdrawals continued to be monitored.

PLANS FOR FISCAL YEAR 1991: The remainder of the water-use data needed for the 1990 national water-use report will be obtained from the North Dakota State Water Commission. Data will be checked and entered into the site-specific State water-use data base. An aggregated water-use data base will be added to the District's computer so that the data can be grouped into county and hydrologic unit divisions for final processing before submittal to headquarters. Site-specific withdrawals will continue to be monitored.

REPORT PRODUCTS: Bader, C.D., No date, Trends in water use and estimated water use for North Dakota, 1985: North Dakota State Water Commission Information Series No. 34, 12 p.

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Wesolowski, E.A., Estimated use of water in North Dakota in 1985 and trends during 1960-85: U.S. Geological Survey Water-Resources Investigations Report 89-4003, 1 p. (in press).

BOARDS AND COMMISSIONS

PROJECT NUMBER: ND 73-064.

LOCATION: Bismarck, North Dakota.

PERIOD OF PROJECT: Continuous.

PROJECT CHIEF: William F. Horak.

COOPERATING AGENCIES: Other Federal agencies.

PROBLEM: To coordinate water-resources activities with international, other Federal, State, and local agencies, District personnel participate on numerous boards and commissions. Participation frequently includes compiling, publishing, and disseminating meeting minutes or researching special concerns of participating agencies.

OBJECTIVES: Primary objectives are (1) to assure impartial Federal representation on the International Souris River Board of Control (International Joint Commission), the Souris River Bilateral Water-Quality Monitoring Group, and the Yellowstone River Compact Commission and (2) to supply accurate, unbiased information to boards and commissions.

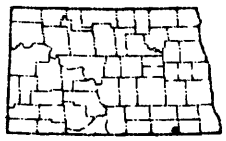
APPROACH: Chair the meetings and provide administrative support to the Yellowstone River Compact Commission. Serve as member for the United States to the International Souris River Board of Control and the Souris River Bilateral Water-Quality Monitoring Group. Furnish information requested by members of the International Souris-Red River Engineering Board.

PROGRESS IN FISCAL YEAR 1990: All meetings of the Souris River Board of Control, the Souris River Bilateral Water-Quality Monitoring Group and its task forces, and the Yellowstone River Compact Commission were attended. The Yellowstone River Compact Commission annual report was published.

PLANS FOR FISCAL YEAR 1991: Plans are to continue to participate in board and commission meetings and to prepare the annual report of the Yellowstone River Compact Commission.

HEAT AND WATER TRANSFER MODEL FOR SEASONALLY FROZEN SOILS IN NORTH DAKOTA

PROJECT NUMBER: ND 85-131.



LOCATION: Eastern Dickey County, southeastern North Dakota.

PERIOD OF PROJECT: October 1984 to September 1989.

PROJECT CHIEF: Douglas G. Emerson.

COOPERATING AGENCY: North Dakota State Water Commission.

PROBLEM: Snow cover is an important manageable water resource of the northern prairies. To take full advantage of this water resource, an understanding of the processes of runoff and water movement into and through seasonally frozen soils and an operational procedure to quantify these processes are needed.

OBJECTIVES: Objectives are (1) to develop a physically based model for simulation of flow through seasonally frozen soils, (2) to measure hydraulic properties of soil types in a study area and collect meteorologic and hydrologic data for verification of the model, (3) to use the model concurrently with the data-collection process to evaluate sensitivity of the model to variations in soil hydraulic properties and driving variables, and (4) to couple the model to the U.S. Geological Survey's precipitation-runoff modeling system.

APPROACH: A physically based heat and water transport model for seasonally frozen soils will be developed. Data collection will consist of measuring the necessary parameters to verify snow accumulation and melt, soil freezing and thawing, and soil water content.

PROGRESS IN FISCAL YEAR 1990: The report "Instrumentation and Data for a Study of Seasonally Frozen Soil in Southeastern North Dakota" was published. The report "Heat and Water Transfer Model for Seasonally Frozen Soils" has been returned from Headquarters for additional work before approval. The draft of the final report of the project has been prepared and has had an inhouse review.

PLANS FOR FISCAL YEAR 1991: Plans are to complete the review process and obtain Director's approval for publication of "Heat and Water Transfer Model for Seasonally Frozen Soils" and "Evaluation of Seasonally Frozen Soil, Southeastern North Dakota."

REPORT PRODUCTS: Emerson, D.G., 1986, Study plan for heat and water transport in frozen soils, North Dakota, *in* Proceedings of the Symposium Snow Management for Agriculture: Great Plains Agricultural Council Publication No. 120, Swift Current, Saskatchewan, p. 289-298.

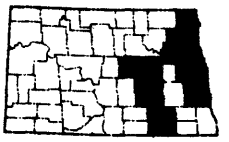
Emerson, D.G., Sweeney, M.D., Dressler, V.M., and Norbeck, S.W., 1990, Instrumentation and data for a study of seasonally frozen soil in southeastern North Dakota: U.S. Geological Survey Open-File Report 90-107, 191 p.

Emerson, D.G., Evaluation of seasonally frozen soil, southeastern North Dakota (in progress).

Emerson, D.G., Heat and water transfer model for seasonally frozen soils (in progress).

GENERATION OF A DATA BASE FOR THE JAMES RIVER SALINITY MODEL, NORTH DAKOTA AND SOUTH DAKOTA

PROJECT NUMBER: ND 85-135.



LOCATION: James River basin and Red River of the North basin, eastern North Dakota and South Dakota.

PERIOD OF PROJECT: April 1985 to September 1990.

PROJECT CHIEF: Kenneth L. Lindskov.

COOPERATING AGENCY: U.S. Department of the Interior, Bureau of Reclamation.

PROBLEM: Operation of the Garrison Diversion Unit will bring Missouri River water into the James River basin and into the Red River of the North basin. The additional flows in the James River basin and in the Red River of the North basin will permit expanded irrigation and provide a new supply of water for municipalities and industry. The addition of Missouri River water to the James River, Sheyenne River, and Red River of the North may affect the quantity and quality of streamflow in the river systems. The U.S. Bureau of Reclamation would like to assess the impacts of adding Missouri River water to the river systems.

OBJECTIVES: The original objective of this study was to generate a water-quality data base that included data for dissolved solids, carbonate hardness, sulfate, chloride, and sodium for 1953-84 for the James River basin for use in the U.S. Bureau of Reclamation's river-salinity model. The water-quality data base, along with the streamflow data base developed for an earlier project, would be used with a river-salinity model to evaluate a variety of management options. The objective and scope of the study later were expanded to include a similar data base and a monthly streamflow data base for 1931-84 for the Sheyenne River and the Red River of the North. The data bases developed for the Sheyenne River and the Red River of the North will be used in the U.S. Bureau of Reclamation's river-salinity model and monthly streamflow model to assess and predict the effect that operation of the Garrison Diversion Unit may have on water quality and streamflow of the Sheyenne River and the Red River of the North.

APPROACH: Measured water-quality data will be compiled for selected stations on the James River, Sheyenne River, and Red River of the North. For those stations where data from water-quality samples do not adequately define the variation in concentrations of the water-quality constituent, relations will be developed between water-quality constituent concentrations and streamflow, between water-quality constituent concentrations and specific conductance, and between specific conductance and streamflow. The relations will be used to estimate missing monthly values in the water-quality data bases.

Measured streamflow data will be compiled for streamflow-gaging stations on the Sheyenne River and the Red River of the North for 1931-84. Record-extension techniques will be used to estimate missing monthly streamflow values.

Water-quality and streamflow data bases for the Sheyenne River and the Red River of the North will be used in monthly water-quality and monthly streamflow models to assess the impacts of adding Missouri River water to the Sheyenne River and the Red River of the North.

PROGRESS IN FISCAL YEAR 1990: The three interpretative reports continued in the review process. The report that documents the streamflow for selected sites in the Red River of the North basin was submitted for approval. The report that documents water-quality data bases and methods for estimating monthly mean was processed nearly to the point of submittal for approval. The report that documents calibration of the model and simulated effects of proposed operating plans of the Garrison Diversion Unit on the Sheyenne River and Red River of the North was processed through editorial review.

PLANS FOR FISCAL YEAR 1991: The three interpretative reports will be submitted for Director's approval.

REPORT PRODUCTS: Briel, L.I., 1989, Dissolved-solids data for the James River salinity model, North Dakota and South Dakota: U.S. Geological Survey Open-File Report 89-43, 239 p.

Wiche, G.J., Benson, R.D., and Emerson, D.G., 1989, Streamflow at selected gaging stations on the James River in North Dakota and South Dakota, 1953-82, with a section on climatology: U.S. Geological Survey Water-Resources Investigations Report 89-4039, 99 p.

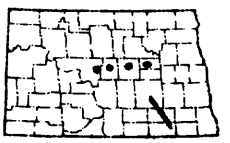
Guenthner, R.S., Methods for estimating monthly mean concentrations of selected water-quality constituents for sites in the Red River of the North basin, North Dakota and Minnesota (in progress).

Guenthner, R.S., Simulated effects of the proposed Garrison Diversion Unit on streamflow and dissolved solids in the Sheyenne River and the Red River of the North, North Dakota (in progress).

Guenthner, R.S., Weigel, J.F., and Emerson, D.G., Gaged and estimated monthly streamflow during 1931-84 for selected sites in the Red River of the North basin in North Dakota and Minnesota (in progress).

EVALUATION OF THE POTENTIAL FOR TOXIC-ELEMENT CONSEQUENCES DUE TO THE GARRISON DIVERSION UNIT, NORTH DAKOTA AND SOUTH DAKOTA

PROJECT NUMBER: ND 86-138.



LOCATION: James River basin, North Dakota and South Dakota.

PERIOD OF PROJECT: March 1986 to September 1991.

PROJECT CHIEF: Wayne R. Berkas.

COOPERATING AGENCY: U.S. Department of the Interior, Bureau of Reclamation.

PROBLEM: Recent studies in the western United States have focused on important environmental problems associated with irrigating arid and semiarid lands underlain by soils that originated from sediments deposited in a marine environment. The natural accumulation of potentially toxic elements in the sedimentary rocks makes these lands important sources for remobilization of trace elements such as selenium. Results of earlier investigations in the western San Joaquin Valley of California have demonstrated that, during intensive irrigation, trace quantities of selenium have been mobilized, transported, and concentrated in irrigation return flows. This can create a major environmental problem. Changes in environmental conditions, such as those accompanying irrigation in the Garrison Diversion Unit, could result in increased concentrations or remobilization of potentially toxic elements. This, in turn, could limit water and soil uses and affect the ecological system dependent on the water resource.

OBJECTIVES: The purpose of this study is to evaluate the potential effects of expanded irrigation within the Garrison Diversion Unit on the mobility and availability of potentially toxic trace elements, especially arsenic and selenium. Objectives include identification of the concentration, distribution, and mobility of potentially toxic trace elements in areas of proposed irrigation development within the Garrison Diversion Unit.

APPROACH: The investigation will be conducted in two phases--a reconnaissance phase and a detailed phase. The purpose of the reconnaissance phase is to review available data and define the occurrence and distribution of potentially toxic elements in soils in areas that are authorized to receive irrigation water from the Garrison Diversion Unit. All soil samples will be analyzed for total concentrations of 42 elements, including arsenic and selenium. In addition, samples will be analyzed for water-extractable concentrations of 14 elements, including three anions--chloride, fluoride, and sulfate.

The purpose of the detailed phase is to provide comprehensive information on potentially toxic elements in the soil profile, shallow ground water, and drains in the west Oakes irrigation area. This information will aid in defining conditions and processes that could mobilize potentially toxic elements. Soil samples will be analyzed for total concentrations of 38 elements. The ground-water samples will be analyzed for major and trace elements (including arsenic, mercury, and selenium), dissolved nutrients, and dissolved organic carbon.

PROGRESS IN FISCAL YEAR 1990: The need for additional sampling and interpretation was identified during preparation of the report "Geochemistry of Soils and Shallow Ground Water, with Emphasis on Arsenic and Selenium, in Part of the Garrison Diversion Unit, North Dakota, 1985-87" and while preparing the toxic-elements part of the U.S. Bureau of Reclamation's Comprehensive Study Team report to Congress. Thus, a new study plan was developed to sample soils and ground water in the Harvey Pumping, LaMoure, Lincoln Valley, New Rockford, and Turtle Lake proposed irrigation areas. Soil samples were obtained at selected depths at about 16 sites in the New Rockford area, 16 sites in the Turtle Lake area, 4 sites in the Harvey Pumping area, and 4 sites in the Lincoln Valley area. These soil samples were submitted to the Geologic Division Laboratory in Denver for determination of elemental composition of the soils and trace-element concentrations of water extractions from the soils. New wells were completed near the water table in each of the holes drilled to obtain soil samples. Previously constructed wells that were completed near the bottom of the same upper aquifer also are available at most of the sites where soil samples were obtained. After detailed examination of maps and information from previous studies, it was determined that previously obtained soil data were adequate for the LaMoure area. It also was determined that ground water from 5 to 10 existing irrigation wells in the LaMoure area should be sampled. Ground-water samples generally were obtained from both the shallow and deeper wells in the Harvey Pumping, Lincoln Valley, and Turtle Lake areas. All of the ground-water samples will be analyzed by the U.S. Geological Survey National Water Quality Laboratory for common ions and dissolved nutrients, trace elements, and dissolved organic carbon.

PLANS FOR FISCAL YEAR 1991: Ground-water sampling will be completed. A new interpretative report will be prepared to update the report "Geochemistry of Soils and Shallow Ground Water, with Emphasis on Arsenic and Selenium, in Part of the Garrison Diversion Unit, North Dakota, 1985-87."

REPORT PRODUCTS: Goolsby, D.A., Severson, R.C., and Wilson, S.A., 1989, Geochemistry of soils and shallow ground water, with emphasis on arsenic and selenium, in part of the Garrison Diversion Unit, North Dakota, 1985-87: U.S. Geological Survey Water-Resources Investigations Report 89-4104, 132 p.

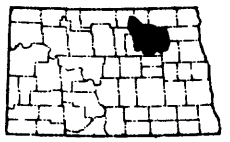
Wald, J.D., Helgesen, C.S., and Pokladnik, M.C., 1989, Water-quality data for selected wells and drains in the Oakes study area, south-central North Dakota, December 1986 through September 1987: U.S. Geological Survey Open-File Report 89-63, 60 p.

Wilson, S.A., Severson, R.C., Briggs, P.H., and Kennedy, K., 1989a, Analysis of water samples collected from wells in the James River valley, North Dakota: U.S. Geological Survey Open-File Report 89-441, 25 p.

Wilson, S.A., Severson, R.C., Briggs, P.H., and Kennedy, K., 1989b, Total chemical analysis of soil samples collected in the James River valley, North Dakota: U.S. Geological Survey Open-File Report 89-442, 30 p.

Wilson, S.A., Severson, R.C., Kennedy, K., and Briggs, P.H., 1989, Total and aqueous extraction analysis of soil samples from the James River valley, central North Dakota, part I: U.S. Geological Survey Open-File Report 89-440, 31 p.

EVAPORATION AND GROUND-WATER INTERACTION OF DEVILS LAKE, NORTH DAKOTA



PROJECT NUMBER: ND 86-139.

LOCATION: Devils Lake basin, northeastern North Dakota.

PERIOD OF PROJECT: April 1986 to September 1991.

PROJECT CHIEF: Gregg J. Wiche.

COOPERATING AGENCY: North Dakota State Water Commission.

PROBLEM: Historically, water levels of Devils Lake have fluctuated dramatically. In the early and mid-1980's, high water levels generated a multimillion-dollar fishing and tourist trade industry, but the high water threatened to inundate large areas of developed property. In the late 1980's, declining water levels have threatened the fishing industry. In order to develop a management model, State and local governments need information about how hydrologic components affect water levels. More information is needed on evaporation rates from the lake surface and on ground-water interaction.

OBJECTIVES: The purpose of this study is to measure the principal hydrologic components that cause water-level fluctuations of Devils Lake. The major emphasis will be to measure evaporation from Devils Lake and estimate the direction and magnitude of the ground-water flux component.

APPROACH: Evaporation will be computed with the energy-budget technique. Data that will be collected are incoming and reflected shortwave and longwave radiation, air temperature, dewpoint, water temperature of inlet streams, temperature and quantity of ground-water seepage, lake-surface temperature, and periodic temperature surveys of the entire water body to measure changes in stored heat. The ground-water flux will be estimated by installing a series of shallow water-table wells around Devils Lake in transects extending from the shoreline to the topographic divide.

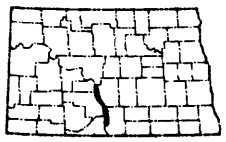
PROGRESS IN FISCAL YEAR 1990: A report that presents all of the project data collected through 1988 was approved and published. The interpretative report was written, reviewed, and submitted for approval. Data collection continued. Evaporation from the lake surface and inflow were computed for the 1989 water year. Energy-budget and mass-transfer evaporation methods were compared.

PLANS FOR FISCAL YEAR 1991: The interpretative report will be processed through Director's approval. Collection of data necessary to compute energy-budget evaporation will continue.

REPORT PRODUCTS: Sether, B.A., and Wiche, G.J., 1989, Meteorologic and hydrologic data collected for computing evaporation from Devils Lake, North Dakota, 1986-88: North Dakota State Water Commission Water Resources Investigation 10, 172 p.

Wiche, G.J., Evaporation computed by energy-budget and mass-transfer methods and water-balance estimates for Devils Lake, North Dakota, 1986-88 (in progress).

SUSPENDED-SEDIMENT TRANSPORT IN THE MISSOURI RIVER BETWEEN GARRISON DAM AND THE HEADWATERS OF LAKE OAHE



PROJECT NUMBER: ND 88-143.

LOCATION: Missouri River between Garrison Dam and Bismarck, North Dakota.

PERIOD OF PROJECT: October 1987 to September 1991.

PROJECT CHIEF: Wayne R. Berkas.

COOPERATING AGENCY: U.S. Department of the Army, Corps of Engineers, Omaha District.

PROBLEM: The Missouri River is the largest river in North Dakota and the most significant source of surface water in the State. Two problems related to sediment transport have been perceived by residents who own land along the Missouri River: (1) Bank erosion is occurring along the reach of the Missouri River between Garrison Dam and Bismarck and (2) increased deposition of sediment downstream of Bismarck is causing a delta to form.

OBJECTIVES: The purpose of this study is to quantitatively describe the characteristics of suspended-sediment movement and changes in suspended-sediment concentrations in the reach of the Missouri River between Garrison Dam and the headwaters of Oahe Reservoir. Objectives are (1) to identify areas of deposition or resuspension during steady-flow conditions along the Missouri River; (2) to determine the sources of suspended-sediment loads and estimate the contributions from bank erosion, bed erosion, and tributaries; and (3) to identify those areas where net annual deposition is occurring.

APPROACH: Suspended-sediment samples will be colleced at 20 sites on the Missouri River during high-, medium-, and low-flow conditions. At 15 sites, sediment samples will be depth integrated at five to seven vertical soundings in the cross section depending on cross-section geometry. Suspended-sediment samples will be analyzed for sand-silt split to determine areas of deposition and resuspension. At five sites, intensive sampling will be conducted by collecting samples at 20 verticals in the cross section. The 20 samples will be composited into about 3 samples, which will be analyzed for grain-size distribution. Discharge measurements will be made to ensure steady-flow conditions. Correlations will be developed between suspended-sediment concentration and location along the Missouri River.

PROGRESS IN FISCAL YEAR 1990: Missouri River streamflow did not reach the magnitudes targeted for sampling at medium or high flows; thus, no sediment sampling was done during the year. Composite samples of the top, middle, and toe of actively eroding banks in the study reach were collected at 40 locations, however, to determine if the sediment transported by the river is from the riverbanks, the riverbed, or both. Also, past sediment records for the Missouri River at Bismarck were evaluated to determine why there is a big difference between sediment loads computed by the U.S. Army Corps of Engineers and sediment loads computed by the U.S. Geological Survey.

PLANS FOR FISCAL YEAR 1991: Below-normal water levels in Lake Sakakawea that resulted from 3 years of drought may not permit the release of flows of the magnitudes needed to complete the sampling for this study. However, spring runoff may result in increased releases from the lake; thus, sampling could be completed during medium-flow conditions.

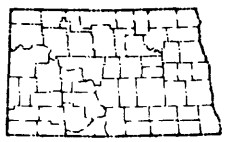
REPORT PRODUCT: Suspended-sediment characteristics of the Missouri River between Garrison Dam and Bismarck, North Dakota (planned).

PEAK-FLOW FREQUENCY FOR UNREGULATED STREAMS IN NORTH DAKOTA

PROJECT NUMBER: ND 88-145.

LOCATION: Statewide.

PERIOD OF PROJECT: July 1988 to September 1990.



STATEWIDE

PROJECT CHIEF: Tara J. Williams.

COOPERATING AGENCY: North Dakota Department of Transportation.

PROBLEM: Accurate estimates of peak flow for selected recurrence intervals such as the 100-year flood are needed for the efficient design of highway structures. Frequency relations for gaging stations are defined with log-Pearson type III analysis, and information commonly is transferred from gaged to ungaged sites by relating peak flow of selected recurrence intervals to basin and climatic characteristics. No analysis of this type has been completed since 1975. The length of record is now longer for many stations, and there are more stations with 10 or more years of record. The skew coefficient used in the log-Pearson analysis also needs further evaluation for North Dakota.

OBJECTIVES: Peak-flow and basin and climatic characteristics data for all gaging stations will be reevaluated in order to (1) develop a new method for determining the log-Pearson type III skew coefficient for frequency analysis of gaging-station data and compare results with the map in Bulletin 17B, Guidelines for Determining Flood Flow Frequency (Hydrology Subcommittee for the Interagency Advisory Committee on Water Data, 1982); (2) develop up-to-date frequency relations with log-Pearson type III analysis for all gaging stations having 10 or more years of record; and (3) develop log-linear regression equations for estimating peak flow at ungaged sites on unregulated North Dakota streams for recurrence intervals of 2, 5, 10, 25, 50, and 100 years.

APPROACH: Three methods will be tested as possibilities for making improved estimates of generalized skew for North Dakota. A listing of the mean of station skew values within homogeneous hydrologic regions, maps showing lines of equal skew, and equations to predict skew with regression techniques will be developed. The three methods will be compared for accuracy, and the most accurate will be compared to the generalized skew map in Bulletin 17B. If the new estimates of skew are not significantly different, the map in Bulletin 17B will be used.

After the best method of determining skew coefficients has been selected, the log-Pearson type III distribution will be used to compute frequency relations for all gaging stations in North Dakota and for a few stations in adjacent states. A table that includes station name, location, selected basin and climatic characteristics, period of record used, maximum peak flow of record, and peak flows for recurrence intervals of 2, 5, 10, 25, 50, and 100 years will be included in the final report.

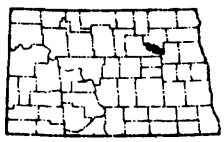
A method for estimating peak-flow frequency for ungaged sites will be developed with generalized least squares regression techniques. Several basin and climatic characteristics will be tested for significance in the regression model.

PROGRESS IN FISCAL YEAR 1990: Skew analysis was completed. It was determined that the generalized skew map in Bulletin 17B provides good estimates of skew coefficients for the State. Station frequency curves are being finalized, and regression analysis has begun. The final report is in progress.

PLANS FOR FISCAL YEAR 1991: Plans are to complete the regression analysis and publish the final report.

REPORT PRODUCT: Peak-flow characteristics of North Dakota streams (planned).

DISSOLVED-SOLIDS AND NUTRIENT BUDGETS OF DEVILS LAKE, NORTH DAKOTA



PROJECT NUMBER: ND 89-147.

LOCATION: Northeastern North Dakota.

PERIOD OF PROJECT: October 1988 to September 1991.

PROJECT CHIEF: Steven K. Sando.

COOPERATING AGENCY: North Dakota Game and Fish Department.

PROBLEM: Because of the severe drought and high temperatures during the summer of 1989, water levels in Devils Lake declined considerably and caused an increase in the growth of undesirable algae. Federal and State agencies and local and national fishing, hunting, recreational, and environmental clubs and groups have expressed concern about actual and potential changes to the quality of water in Devils Lake.

OBJECTIVES: Objectives are (1) to quantitatively describe the present quality of water entering Devils Lake and within Devils Lake and (2) to develop a dissolved-solids and nutrient budget for Devils Lake.

APPROACH: Water-quality information for Devils Lake from several previously published reports will be used to evaluate the historic variability of the concentrations of dissolved solids and nutrients. Water-quality data collected by the U.S. Geological Survey from 1969 through 1979 also will be used. About eight new water-quality sampling sites will be established on Devils Lake. Water-quality samples will be collected five times a year at the eight new sites and analyzed for common ions, selected trace elements, nutrients, phytoplankton, and chlorophyll. Field measurements of light penetration, turbidity, temperature, pH, specific conductance, and dissolved oxygen will be obtained concurrently with the water-quality sampling. Daily specific-conductance data will be collected at the gages on Big Coulee and channel A. Collected data will be used to test the applicability of several empirical models to estimate the biomass in Devils Lake. In-lake experiments may be used to verify the validity of the model.

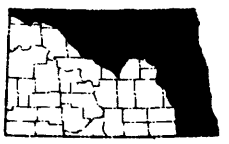
PROGRESS IN FISCAL YEAR 1990: Water-quality data were collected during five synoptic sampling trips at eight sites. Calculation of the mass of dissolved solids in different parts of the lake was completed. A literature review was completed. Preliminary dissolved-solids findings were presented at the North Dakota Water-Quality Symposium. Preliminary nutrient-budget calculations have been completed. A draft report has been started.

PLANS FOR FISCAL YEAR 1991: Nutrient-budget calculations will be completed. Relations between chlorophyll A and nutrients, dissolved solids, and zooplankton will be determined. Trace-element and plankton data will be summarized. The report will be submitted for Director's approval.

REPORT PRODUCT: Dissolved-solids budget, nutrient budget, and plankton relations in Devils Lake, North Dakota (planned).

RELATION BETWEEN UPPER-AIR FLOW PATTERNS, CLIMATE, AND HYDROLOGIC VARIABILITY IN THE RED RIVER OF THE NORTH BASIN, NORTH DAKOTA, SOUTH DAKOTA, MINNESOTA, MANITOBA, AND SASKATCHEWAN

PROJECT NUMBER: ND 89-148.



LOCATION: Eastern North Dakota, northeastern South Dakota, northwestern Minnesota, southern Manitoba, southeastern Saskatchewan.

PERIOD OF PROJECT: March 1989 to September 1991.

PROJECT CHIEF: Gregg J. Wiche.

PROBLEM: In recent years, a general consensus has emerged that a global temperature increase larger than any in recorded history will occur late in the next century because of the doubling of the concentration of carbon dioxide (or the equivalent change from all radiatively active gases). Any significant change in the hydrologic flow regimen in the Red River of the North basin caused by carbon-dioxide-induced climate change could have an adverse effect on peak, mean, and low flows and on water quality of streams within the basin. Since the Red River of the North drains parts of Minnesota, South Dakota, and North Dakota and parts of Manitoba and Saskatchewan in Canada, a change in flow regimen of streams draining the Red River basin would raise difficult interstate and international legal questions.

OBJECTIVES: The hydrology of the Red River basin will be compared to the variability of 50-kilopascal height flow patterns over western and northern North America to (1) identify those anomalous conditions that can be classified as either hydrological or agricultural droughts and prolonged wet periods; (2) develop analyses of the 50-kilopascal height and 50- to 100-kilopascal thickness patterns for the northern hemisphere for the dry and wet periods; (3) assess the possible differences between the upper-air flow patterns that accompany wet and dry periods and compare the wet and dry upper-air flow patterns to the normal flow; (4) statistically compare climate variables such as temperature, precipitation, surface pressure, and cloud cover to the upper-air flow patterns and the discharge of the Red River of the North and its tributaries during wet and dry periods; and (5) assess the circulation controls that lead to the anomalies in the upper-air flow patterns associated with the anomalous periods.

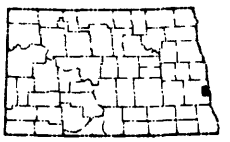
APPROACH: The 50-kilopascal height and 50- to 100-kilopascal thickness patterns will be analyzed separately and compared to the normal patterns and to each other. The patterns that occurred during the prolonged wet and dry periods will be compared to the normal pattern. Descriptive statistics such as the mean, median, and standard deviation of the 50-kilopascal height and the 50- to 100-kilopascal thickness patterns will be computed. Statistics will be computed for the monthly discharge. The accumulated departure from the mean discharge will be calculated and plotted. Periods of greater-than-normal and less-than-normal discharge will be identified. The relations among wet and dry periods, discharge, and upper-air flow patterns will be determined.

PROGRESS IN FISCAL YEAR 1990: Composite monthly precipitation data for each subbasin were developed. Percentiles of the monthly precipitation for each season were computed and used to identify the anomalous periods for the upper-air analysis. Statistical analysis of monthly streamflow for about 60 gaging stations was completed.

PLANS FOR FISCAL YEAR 1991: Composite upper-air-pressure surface-height charts (50-kilopascal, 100-kilopascal, and 50- to 100-kilopascal surfaces) will be constructed. Upper-air flow patterns to the wet and dry precipitation extremes will be identified from the composite charts. Upper-air flow patterns during the hydrologic extremes will be identified.

REPORT PRODUCT: Relation between upper-air flow patterns, climate, and hydrologic variability in the Red River of the North basin, North Dakota, South Dakota, Minnesota, Manitoba, and Saskatchewan (planned).

WATER-QUALITY ASSESSMENT OF THE RED RIVER OF THE NORTH NEAR FARGO, NORTH DAKOTA



PROJECT NUMBER: ND 89-150.

LOCATION: Fargo, North Dakota.

PERIOD OF PROJECT: August 1989 to September 1991.

PROJECT CHIEF: Edwin A. Wesolowski.

COOPERATING AGENCY: North Dakota State Department of Health.

PROBLEM: The Red River of the North near Fargo is classified as water-quality limited, which limits the maximum allowable daily loads of treated wastewater effluent that can be discharged into the river. The city of Fargo has applied to the North Dakota State Department of Health for a change in the city's discharge permit. A calibrated water-quality model is needed to determine how present and future effluent releases will impact the downstream water quality in the Red River of the North.

OBJECTIVE: The objective of this study is to document water-quality conditions and processes that affect waste-assimilative capacities of a 31-mile reach of the Red River of the North downstream of Fargo.

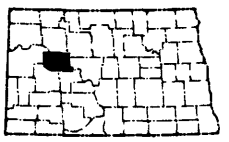
APPROACH: Data will be obtained and analyzed in order to (1) define hydraulic conditions, including traveltime and dispersion characteristics; (2) define reaeration coefficients; (3) determine ultimate biochemical and streambed-oxygen demands; and (4) calibrate and verify the QUAL2E water-quality model. Data will be collected to calibrate the model and again to verify the model.

PROGRESS IN FISCAL YEAR 1990: Traveltime and reaeration data were collected for flows of about 450 cubic feet per second. Channel cross sections were measured at 1-mile intervals in the study reach. Streambed-oxygen demand was measured at all sampling sites during August to September. Synoptic water-quality and streamflow data were collected for a 24-hour period when the flow was about 250 cubic feet per second for use in verifying the QUAL2E water-quality model.

PLANS FOR FISCAL YEAR 1991: Another traveltime and reaeration study may be conducted provided flows in the study reach are less than 100 cubic feet per second. All data will be used to further verify the QUAL2E water-quality model. The final report will be completed.

REPORT PRODUCT: Effects of treated effluent on the water quality of the Red River of the North near Fargo, North Dakota (planned).

HYDROLOGY OF FORT BERTHOLD INDIAN RESERVATION, NORTH DAKOTA



PROJECT NUMBER: ND 90-153.

LOCATION: Fort Berthold Indian Reservation, North Dakota.

PERIOD OF PROJECT: October 1989 to September 1993.

PROJECT CHIEF: Steve W. Cates.

COOPERATING AGENCY: Three Affiliated Tribes.

PROBLEM: Water of acceptable quality for domestic use is in high demand for the Fort Berthold Indian Reservation. Detailed information about the occurrence and quality of ground water and surface water on the reservation generally is not available or easily accessible.

OBJECTIVES: Objectives are (1) to describe the stratigraphy, distribution, and hydrologic properties of aquifers on the reservation; (2) to investigate the quality and movement of ground water; (3) to improve the understanding of the surface-water system; (4) to complete an inventory of current water use; (5) to prepare a report on results of the study; and (6) to add data obtained during the study to an existing geographic information system data base.

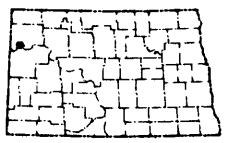
APPROACH: Existing geologic, geochemical, and hydrologic data will be reevaluated. Streamflow will be measured, water-quality samples will be obtained, and selected spring and ground-water sites will be sampled and inventoried. Hydrologic and water-quality data will be analyzed, and test drilling will be conducted to augment existing data locations. Geophysical logs will be used to define locations of buried channels and buried glacial aquifers. Data will be integrated with other available data and used to interpret the reservation's water resources.

PROGRESS IN FISCAL YEAR 1990: An inventory of 214 water wells was completed. Streamflow was measured monthly at five partial-record stations. A gain/loss study was completed on selected streams, and water samples were taken at selected gain/loss study locations for chemical analysis. A water-level inventory network that includes 45 wells was developed and data were acquired monthly at these wells. Historical data for springs were checked and an inventory network for springs is being developed. About 620 pertinent geophysical logs were obtained and organized. A geologic map based on maps from county ground-water reports is being constructed with geographic information system software. A gravity survey was organized and begun. Plans were made for fiscal year 1991 for a high-frequency high-resolution seismic survey.

PLANS FOR FISCAL YEAR 1991: Geochemical data obtained from field sampling during September 1990 will be assessed. Gravity data acquired from a survey conducted during September through November 1990 will be processed and interpreted. A seismic survey will be designed and implemented based on interpretation of gravity data. Water-level-, spring-flow-, surface-water-, and precipitation-data acquisition will continue.

REPORT PRODUCT: Hydrology of Fort Berthold Indian Reservation (planned).

HYDROLOGY OF THE FLYING J, INC., FACILITY SITE NEAR WILLISTON, NORTH DAKOTA



PROJECT NUMBER: ND 90-154.

LOCATION: Flying J facility site southeast of Williston, North Dakota.

PERIOD OF PROJECT: May 1990 to September 1991.

PROJECT CHIEF: Thomas B. Reed.

COOPERATING AGENCY: U.S. Environmental Protection Agency.

PROBLEM: An oil refinery and associated facilities constructed on a 37-acre site east of Williston, N.Dak., during 1953 produced up to 5,200 barrels of oil per day before being acquired by Flying J, Inc., in 1980. The refinery currently is not operating; however, site investigations are continuing in response to a Corrective Action Plan report submitted to the U.S. Environmental Protection Agency in 1986. The report identifies seven separate hydrocarbon plumes in the subsurface that are associated with the ground water and notes the presence of hydrocarbons in the lower sand unit. The areal extent of the contamination needs to be documented and the potential for migration offsite needs to be evaluated.

OBJECTIVES: The purpose of this study is to use existing data to evaluate the subsurface geology and ground-water flow system in the vicinity of the Flying J., Inc., facility with specific reference to the potential offsite release of contaminants. Specific objectives are (1) to compile data from various sources and in various forms into an organized computerized data set, (2) to describe geometries and lithologies of upper geologic units, (3) to determine hydrologic properties of the upper geologic units by analytical and numerical techniques, (4) to describe ground-water flow systems of the upper geologic units, (5) to describe the potential for surface-water runoff to move contaminants offsite, and (6) to identify further data collection needed in pursuit of the above objectives.

APPROACH: Existing data will be compiled, evaluated, and entered into a geographic information system data base. Subsurface geology will be evaluated from geophysical and geologic logs. Existing pumping tests will be evaluated with appropriate analytical techniques, and the results will be further evaluated with numerical-flow modeling. The ground-water flow systems also will be evaluated with numerical-flow modeling, and the potential for contamination of wetlands south of the refinery by surface-water runoff will be evaluated.

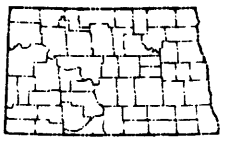
PROGRESS IN FISCAL YEAR 1990: A geographic information system data base was established, an aquifer pumping test in the lower sand unit was analyzed, and the geohydrology in the vicinity of the Flying J, Inc., facility was examined.

PLANS FOR FISCAL YEAR 1991: The aquifer pumping test will be further evaluated with numerical methods. The potential for contamination of wetlands south of the facility site and the need for additional work will be evaluated. A ground-water flow model of aquifers in the vicinity of the Flying J, Inc., facility will be developed. The aquifer pumping test analysis will be reviewed.

REPORT PRODUCT: Hydrology in the vicinity of the Flying J, Inc., facility near Williston, North Dakota (planned).

PREDICTING SCOUR AT BRIDGE CROSSINGS ON STREAMS IN NORTH DAKOTA

PROJECT NUMBER: ND 90-155.



STATEWIDE

LOCATION: Statewide.

PERIOD OF PROJECT: June 1990 to September 1994.

PROJECT CHIEF: Douglas G. Emerson.

COOPERATING AGENCY: North Dakota Department of Transportation.

PROBLEM: Bridge designers need more reliable methods to predict bridge scour. Most of the existing scour-prediction equations are based on scale-model bridge-scour measurements. The equations have not been validated because of the lack of onsite measurements, which are difficult to collect during high-flow conditions. Data bases that reflect full-scale, prototype field conditions are needed to determine which scour-prediction equations should be used for a particular set of conditions.

OBJECTIVES: The objectives are (1) to measure flow and scour during high-flow conditions to define the occurrence and extent of scour at 20 selected bridge sites, (2) to compare scour depths measured onsite with scour depths estimated using published scour-prediction equations and to evaluate the adequacy of the scour-prediction equations, (3) to use regression analyses and(or) other curve-fitting techniques to attempt to develop improved scour-prediction equations if current equations fail to accurately estimate scour in North Dakota and if adequate scour data are collected, and (4) to evaluate an additional 20 bridge sites for scour.

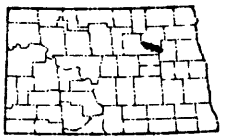
APPROACH: A total of 20 scour-measurement bridge sites will be selected. Bridge-scour measurements will be made during high-flow conditions for 3 years. The collected bridge-scour data will be used to evaluate existing scour-prediction equations or to attempt to develop improved scour-prediction equations. An additional 20 bridge sites will be selected for scour evaluation. The 20 scour-evaluation bridge sites will be evaluated according to Federal Highway Administration guidelines.

PROGRESS IN FISCAL YEAR 1990: A total of 20 scour-measurement bridge sites and an additional 20 scour-evaluation bridge sites have been selected with assistance from the North Dakota Department of Transportation. The 20 scour-measurement bridge sites established included (1) the installation of a wire-weight, outside staff, or crest-stage gage; (2) a survey of cross sections; and (3) the collection of bed-material samples.

PLANS FOR FISCAL YEAR 1991: The 20 scour-measurement bridge sites and the 20 scour-evaluation bridge sites will be evaluated according to Federal Highway Administration guidelines. Bridge scour will be measured at those measurement sites where high flow occurs.

REPORT PRODUCT: Bridge scour at selected sites in North Dakota (planned).

BOTTOM-SEDIMENT/WATER-COLUMN INTERACTIONS AT DEVILS LAKE, NORTH DAKOTA



PROJECT NUMBER: ND 90-156.

LOCATION: Devils Lake, North Dakota.

PERIOD OF PROJECT: July 1990 to December 1990.

PROJECT CHIEF: Stephen C. Komor.

COOPERATING AGENCY: North Dakota State Department of Health.

PROBLEM: The influence of benthic fluxes on the chemistry of water in Devils Lake is unknown. The effects of benthic fluxes on water-column chemistry must be defined to formulate water-use plans for Devils Lake.

OBJECTIVES: Objectives are (1) to determine the compositions of bottom sediments and pore water in Devils Lake and (2) to determine the influence of benthic fluxes on water-column chemistry.

APPROACH: Sediment cores will be collected at two locations in Devils Lake. Sediment and water chemistry and sediment mineralogy will be determined from the cores. The magnitudes and polarities of benthic fluxes will be calculated from the compositions of bottom materials.

PROGRESS IN FISCAL YEAR 1990: A total of 20 sediment cores were collected from two locations in Devils Lake. Pore water was separated from sediment by centrifuging, and water and sediments were submitted for analyses of chemical and isotopic compositions. Pore-water chemical data were received in late July 1990 and were used to make preliminary estimates of benthic fluxes and diagenetic reactions in Devils Lake bottom sediments. An abstract that describes these preliminary results was submitted for the Fall American Geophysical Union Meeting (December 1990).

PLANS FOR FISCAL YEAR 1991: The balance of the analytical data for the Devils Lake bottom sediments should arrive before the end of calendar year 1990. These data include carbon, oxygen, hydrogen, and sulfur isotope values for pore water and sediments and X-ray diffraction analyses of sediments. A final report will be written after receipt of all data.

REPORT PRODUCTS: Komor, S.C., 1990, Water chemistry and benthic fluxes in Devils Lake, northeast North Dakota: Transactions of the American Geophysical Union, v. 71, no. 43, October 23, 1990, 1 p.

Bottom-sediment chemistry and benthic fluxes in Devils Lake, northeast North Dakota (planned).

Effects of benthic fluxes and sediment diagenesis on water-column chemistry in Devils Lake, North Dakota (planned).

OTHER ACTIVITIES OF THE NORTH DAKOTA DISTRICT

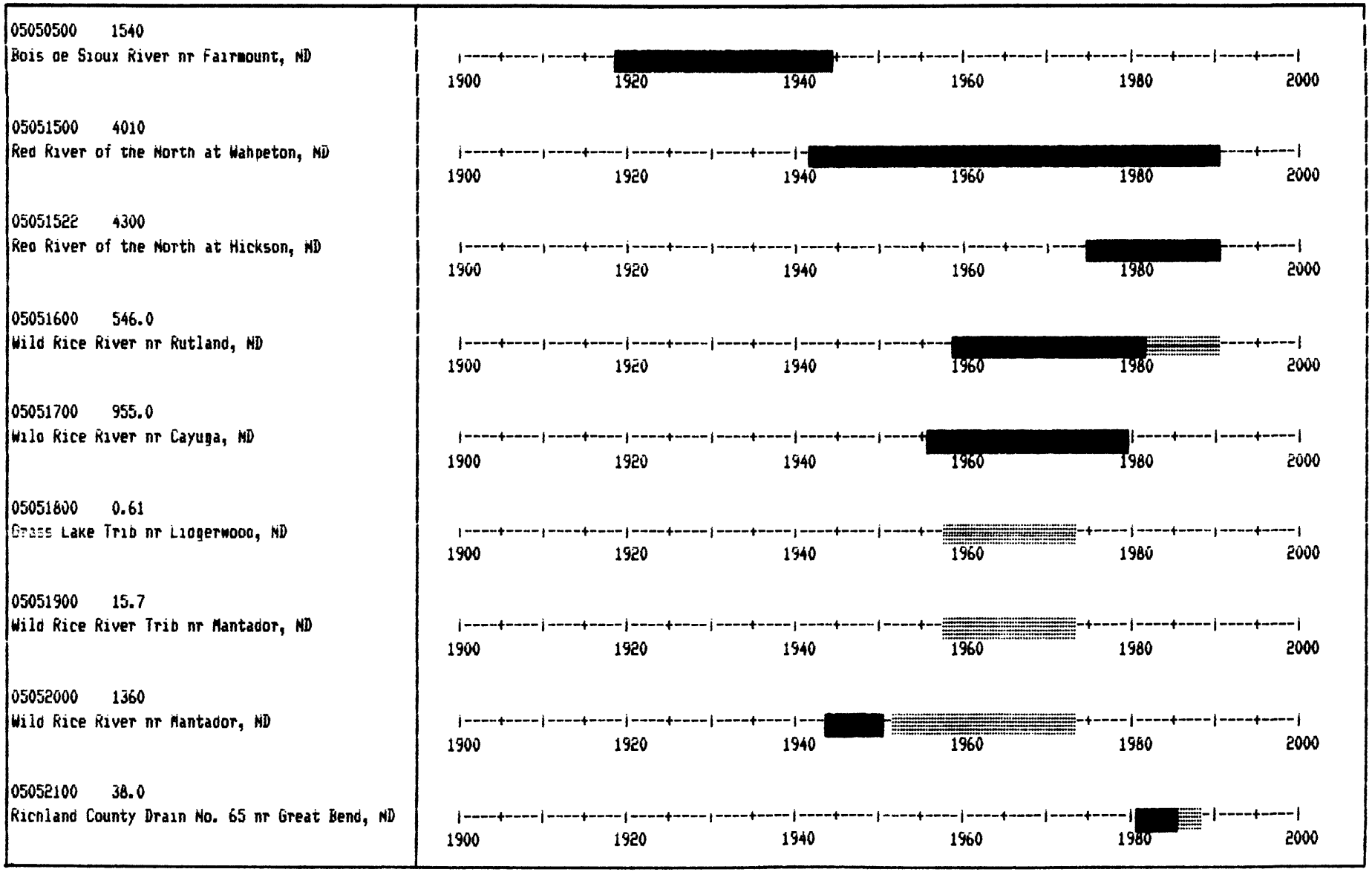
To provide the hydrologic information and understanding needed for the optimum utilization and management of the Nation's water resources, the U.S. Geological Survey, Water Resources Division, is involved in numerous activities other than its regular programs of data collection and hydrologic investigations. Representatives of the U.S. Geological Survey serve on advisory committees, task forces, and ad hoc groups set up for specific purposes. Members of the North Dakota District staff participate in meetings, provide administrative support, and furnish information requested by various committees and task forces. Included are the North Dakota Nonpoint Source Water Quality Task Force, the Red River Water Resources Council, the Yellowstone River Compact Commission, the International Souris River Board of Control, the Souris River Bilateral Water-Quality Monitoring Group and its task forces, and the International Souris-Red River Engineering Board.

District staff review Environmental Impact Statements for selected Federal projects to insure that available hydrologic data are used, that the data are used correctly, and that the impact of proposed developments on water features and resources is accurately evaluated. From time to time, the District also is asked to review reports and projects of other Federal agencies, primarily because of the Survey's hydrologic expertise and impartiality. District personnel occasionally are called upon to provide expert testimony concerning hydrologic information gathered or developed by the District that is relevant to a water-resources issue under litigation.

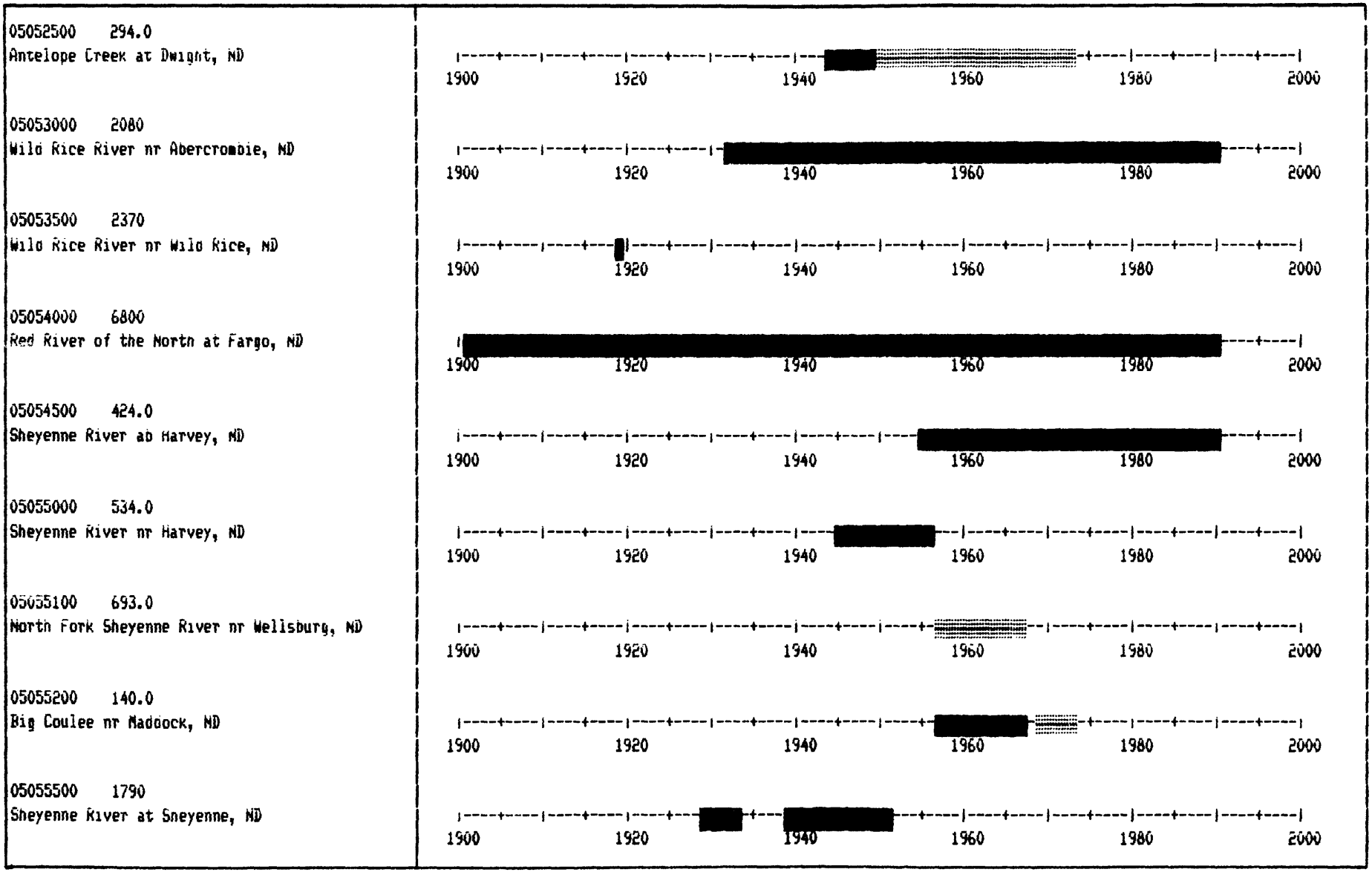
In addition to the U.S. Geological Survey's formal programs and studies, water information and assistance are provided to other agencies with specific problems. The District continually receives calls, visits, and mail requests for information on ground-water availability and water levels, streamflow magnitudes, water quality, and water use from scientists with other agencies, landowners, consultants, public officials, and business concerns.

Supplement 1.--Period of record for gaging stations in North Dakota

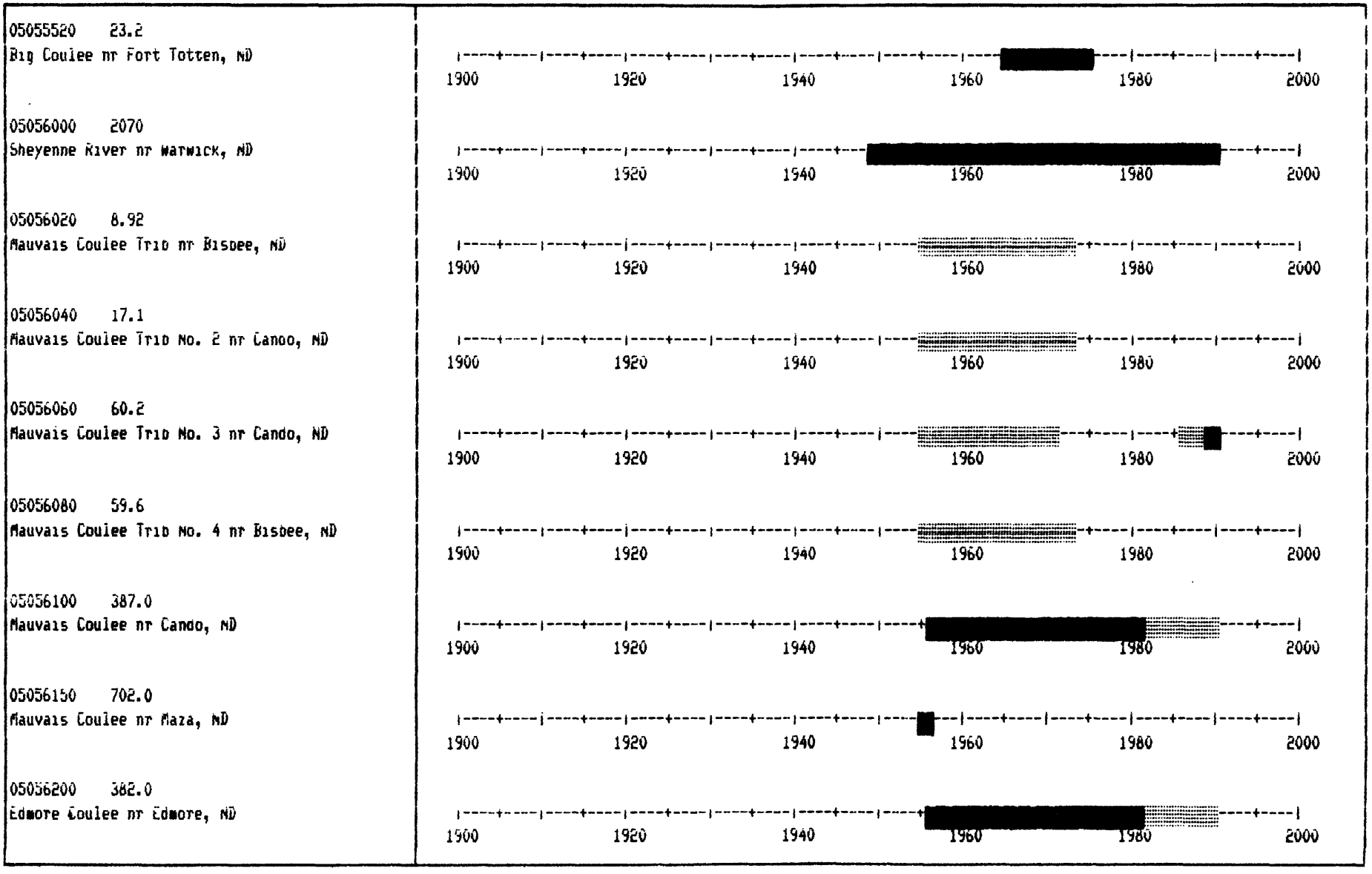
[05050500, station number; 1540, drainage area, in square miles; Bois de Sioux River nr Fairmount, ND, station name; solid bar indicates continuous record; shaded bar indicates partial record]



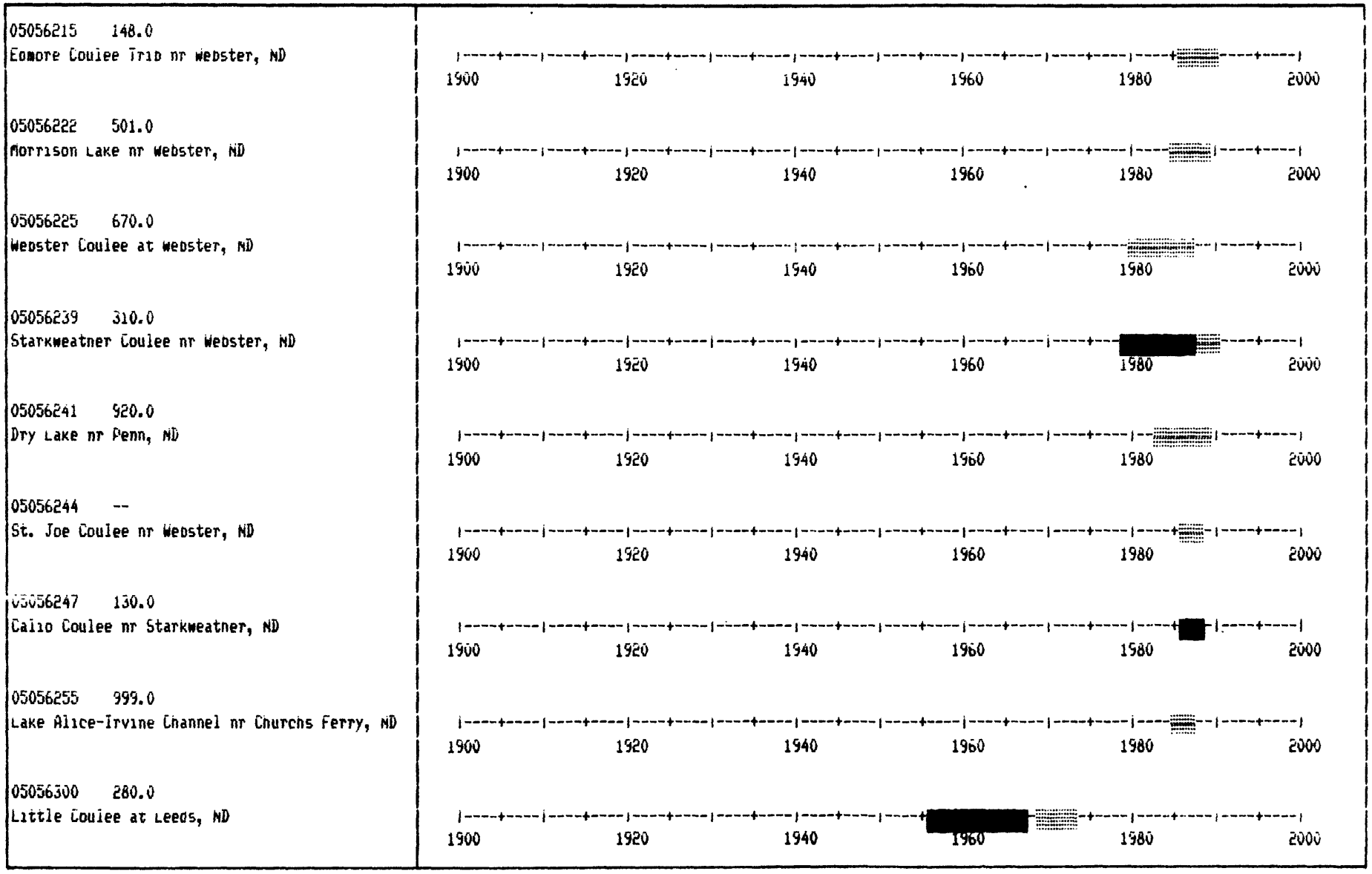
Supplement 1.--Period of record for gaging stations in North Dakota--Continued



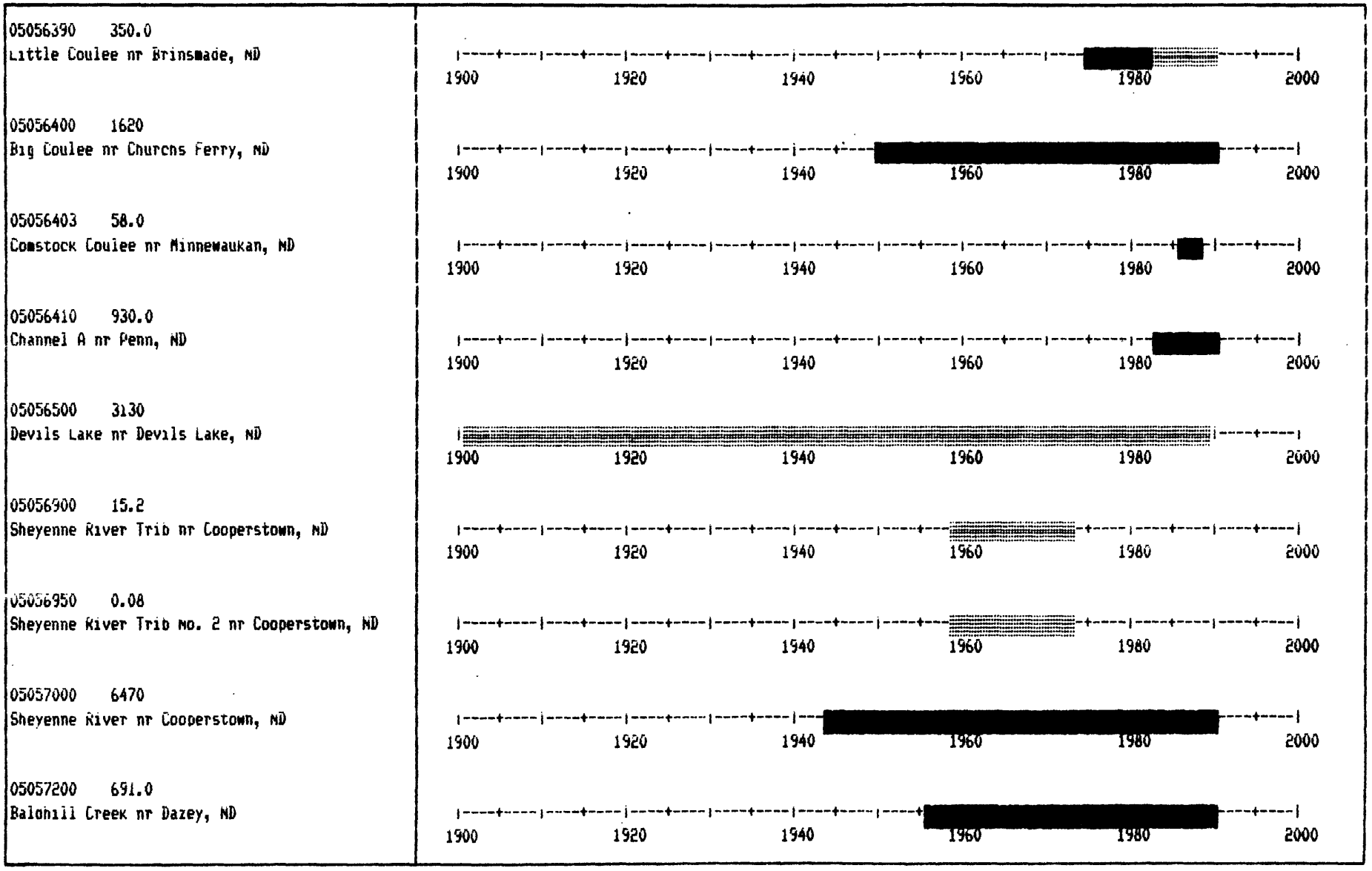
Supplement 1.--Period of record for gaging stations in North Dakota--Continued



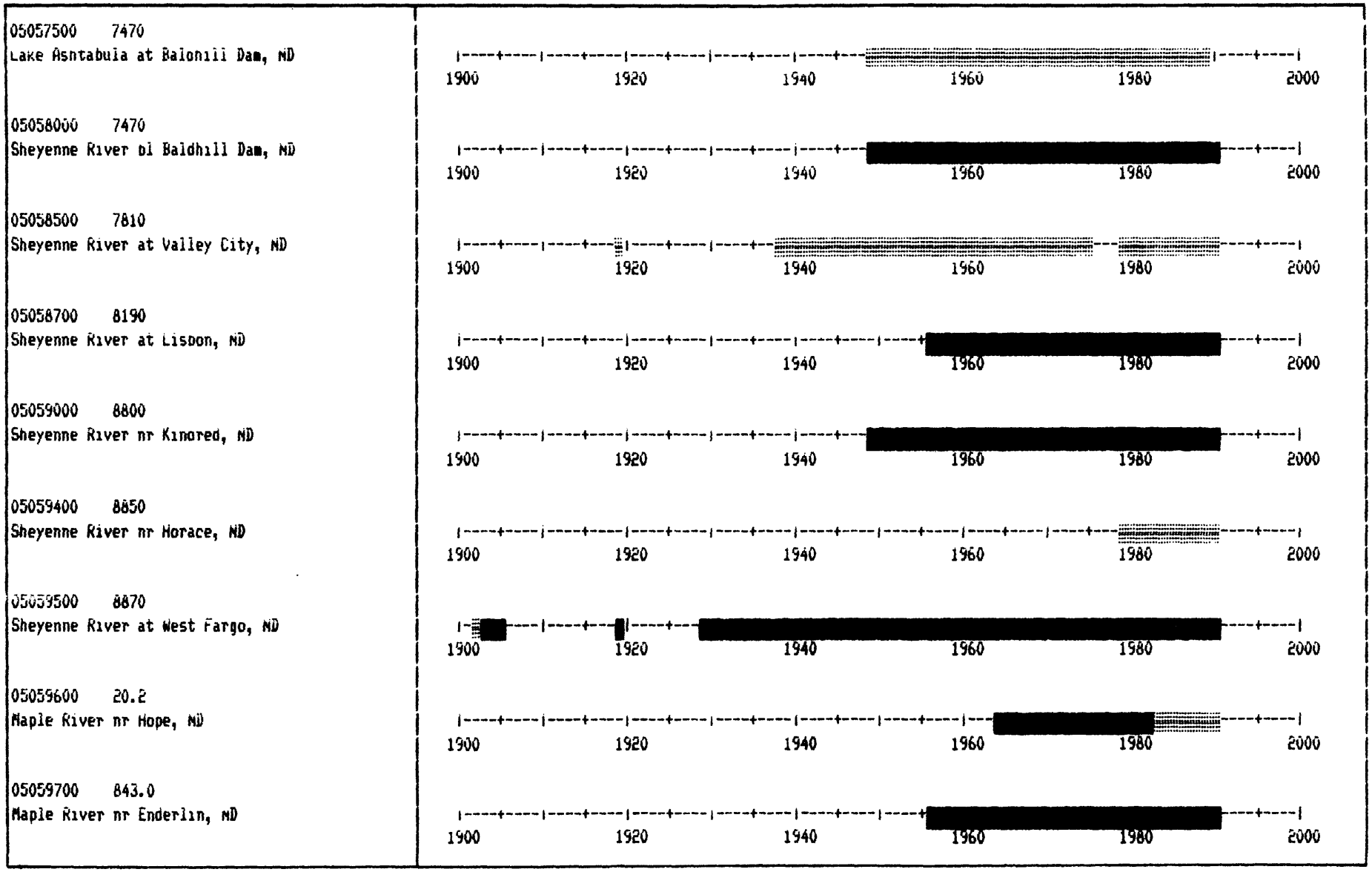
Supplement 1.--Period of record for gaging stations in North Dakota--Continued



Supplement 1.--Period of record for gaging stations in North Dakota--Continued



Supplement 1.--Period of record for gaging stations in North Dakota--Continued



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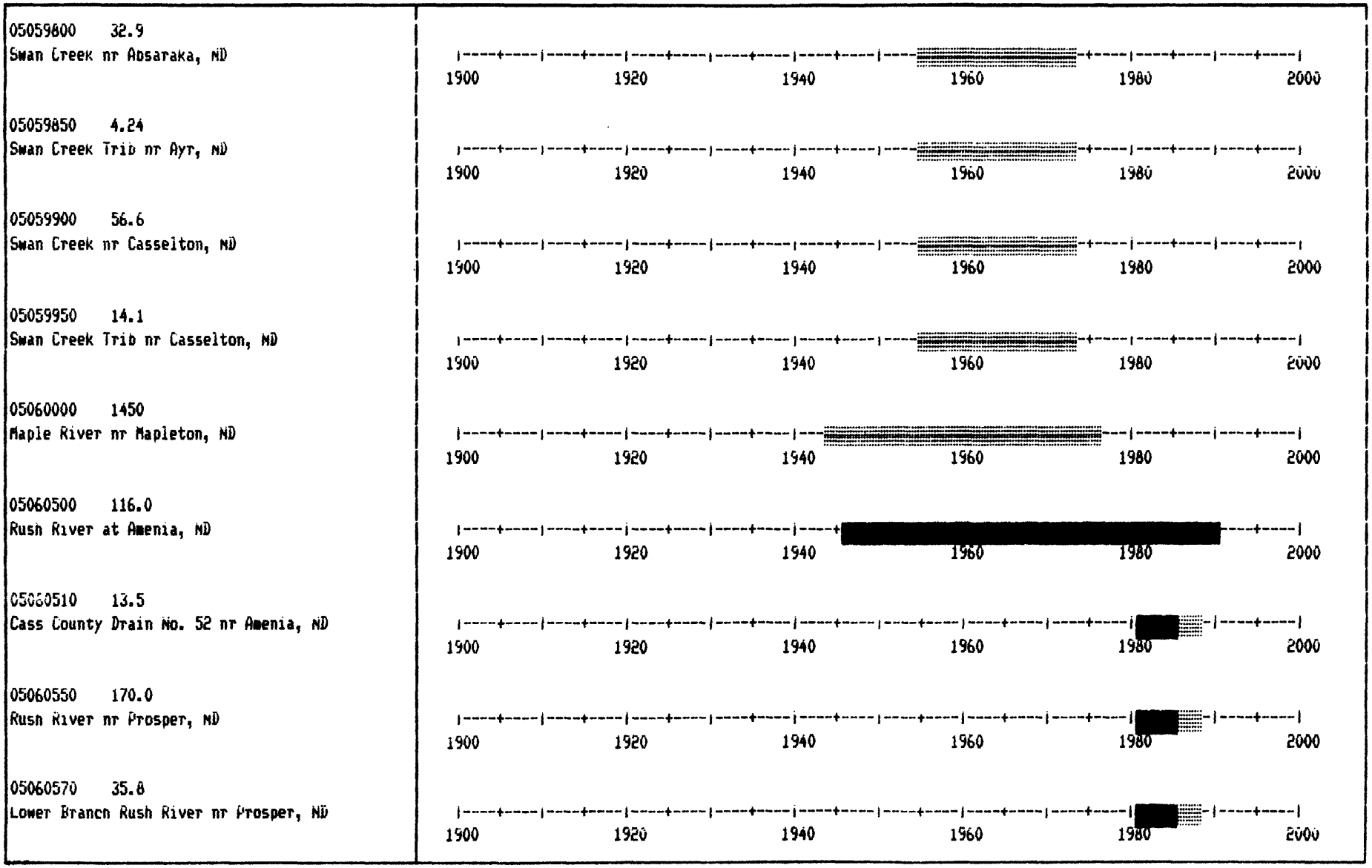
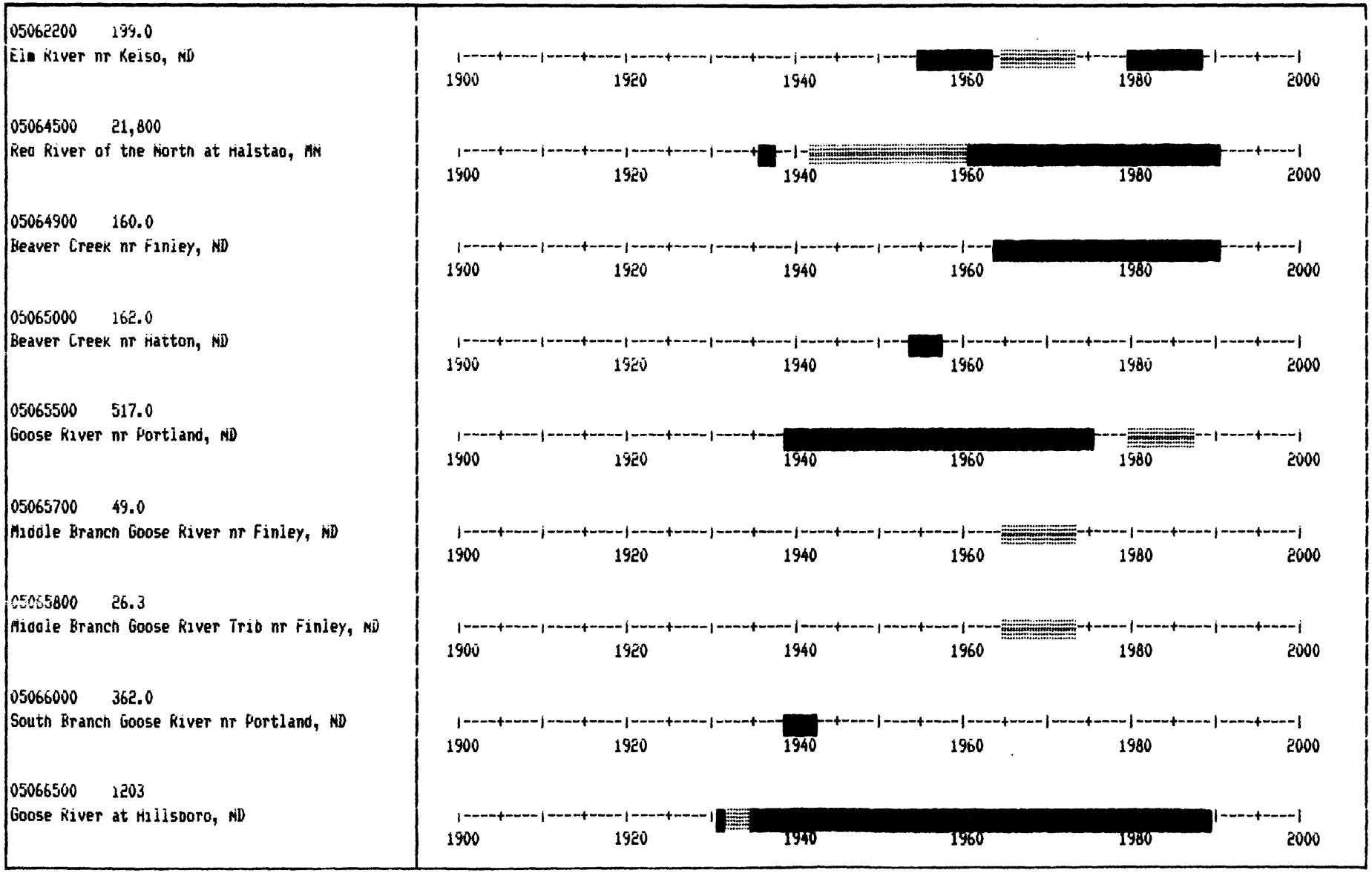
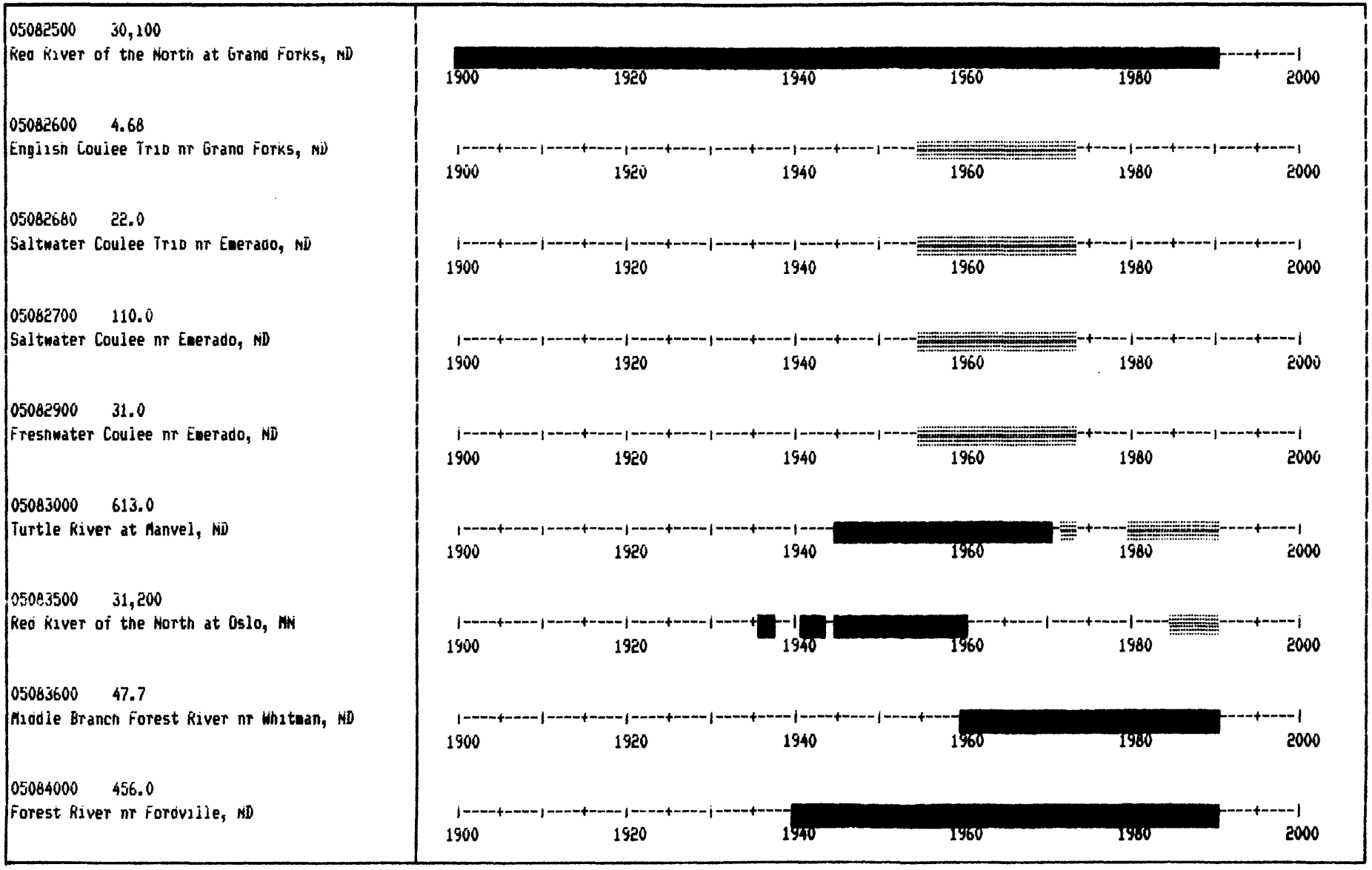


Supplement 1.--Period of record for gaging stations in North Dakota--Continued



Supplement 1.--Period of record for gaging stations in North Dakota--Continued



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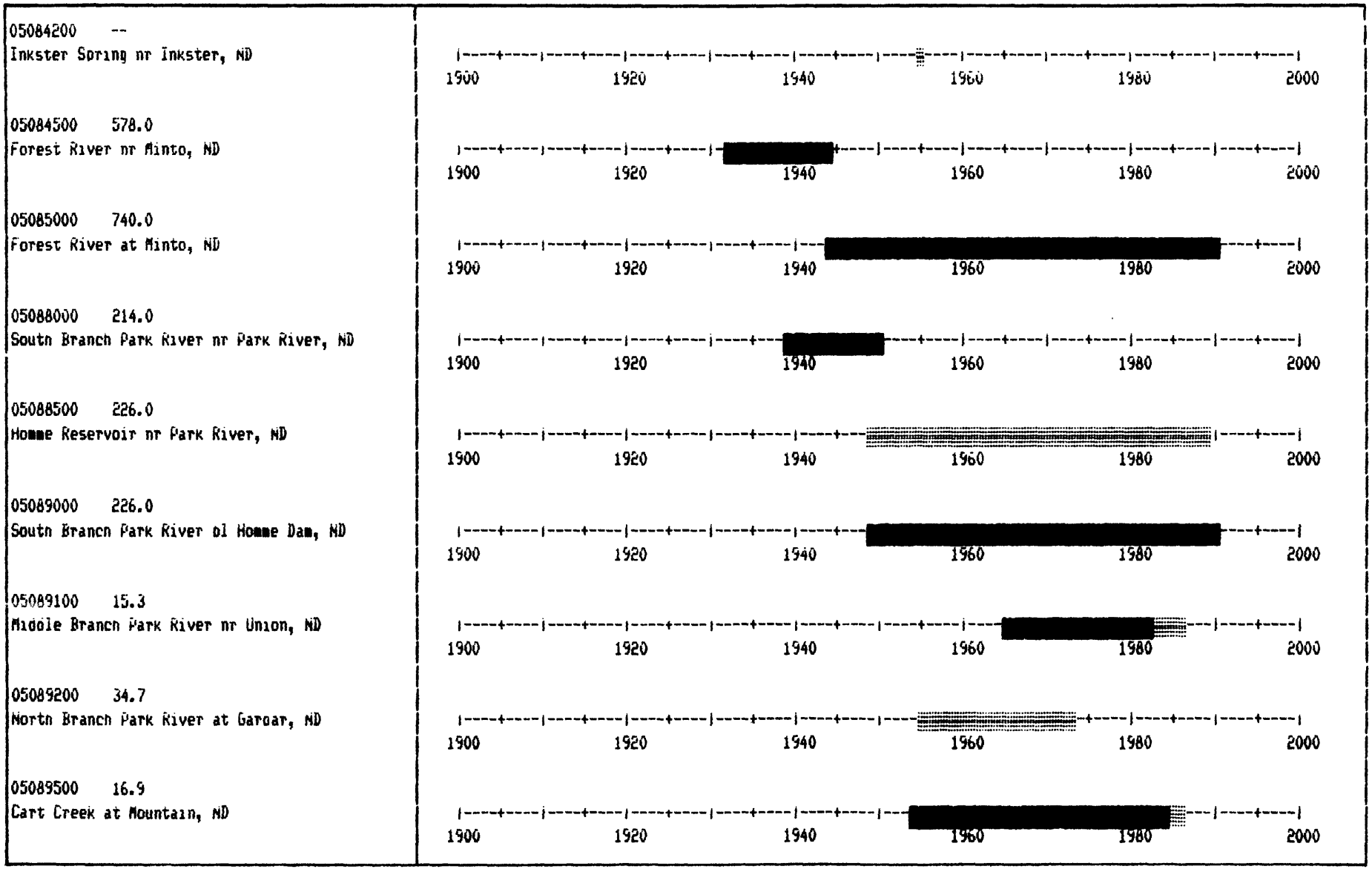

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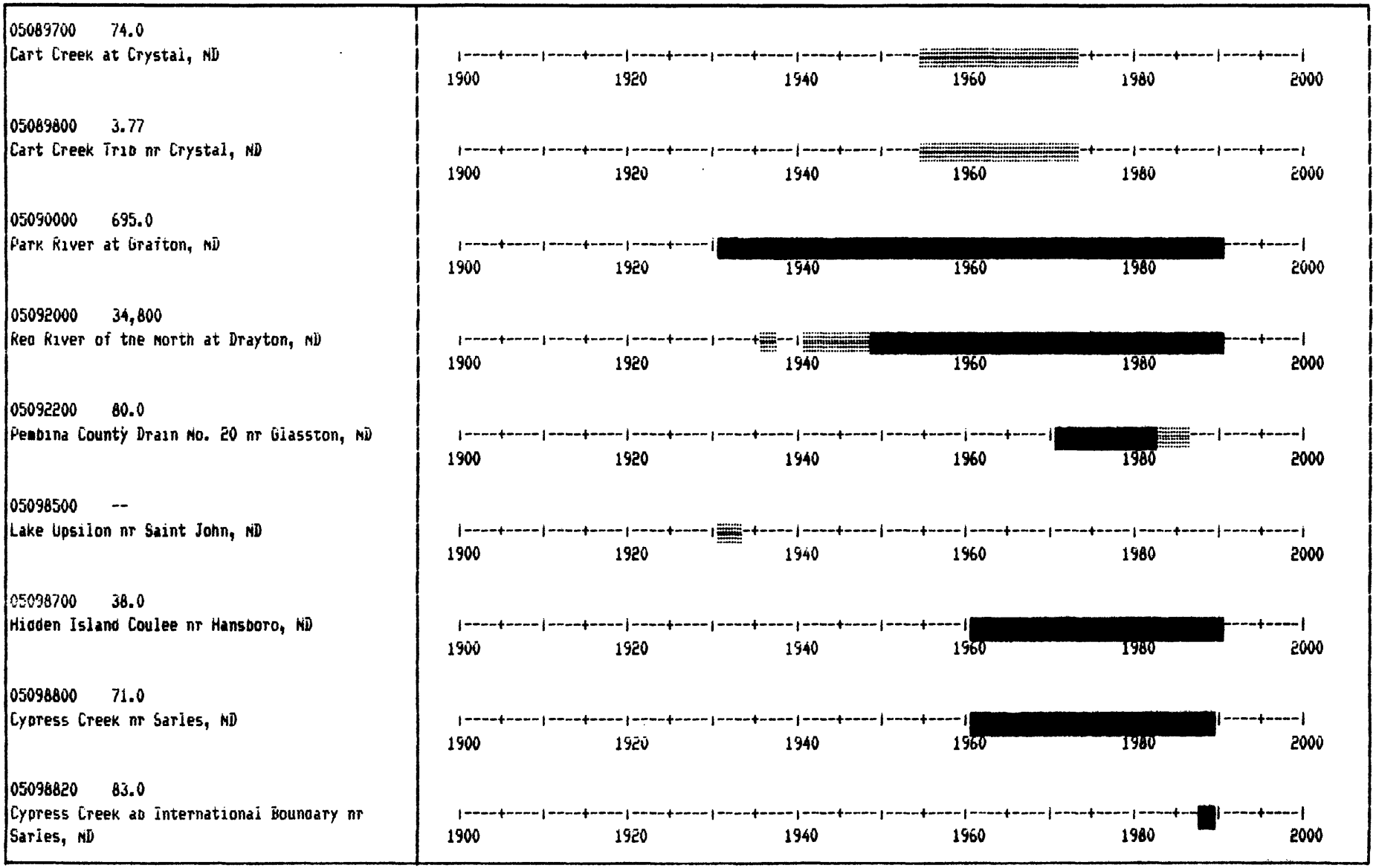
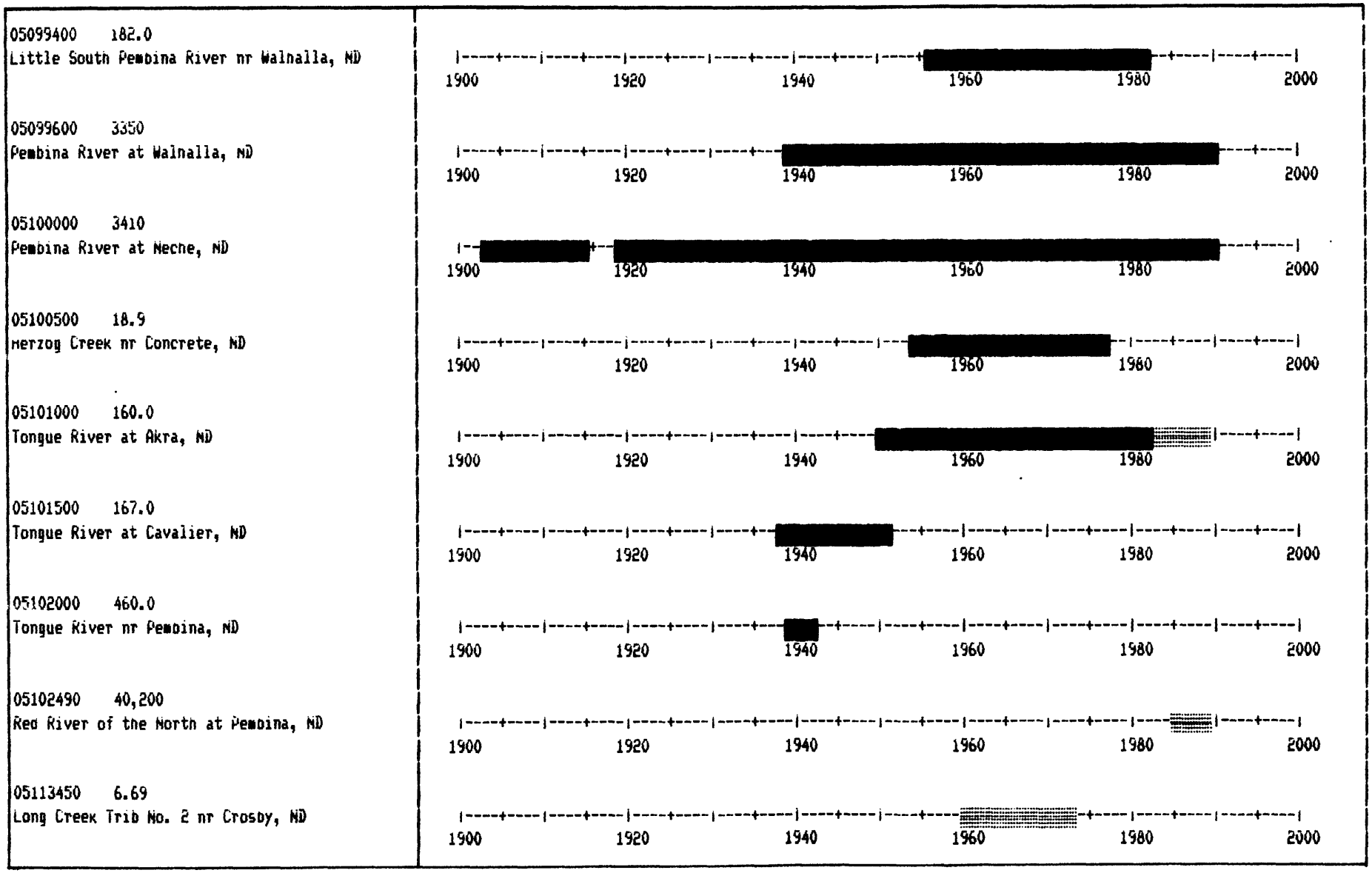


Supplement 1.--Period of record for gaging stations in North Dakota--Continued



Supplement 1.--Period of record for gaging stations in North Dakota--Continued

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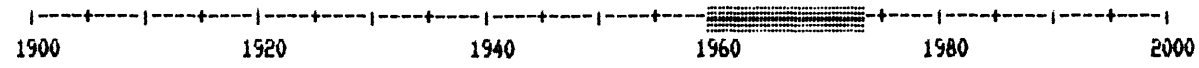
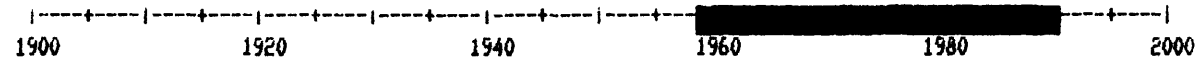
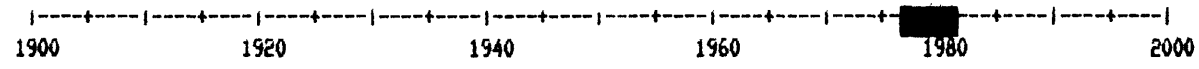
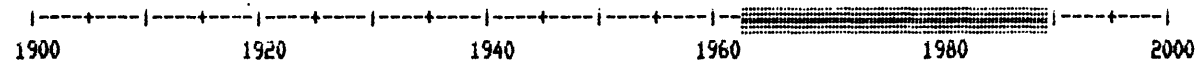
05113520 0.35 Long Creek Trib nr Crosby, ND	
05113600 1790 Long Creek nr Noonan, ND	
05113700 167.0 West Branch Short Creek nr Columbus, ND	
05113750 280.0 East Branch Short Creek Reservoir nr Columbus, ND	
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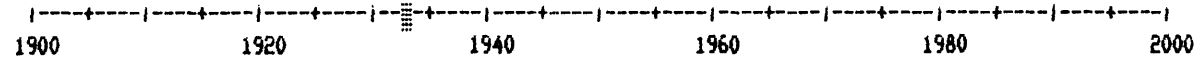
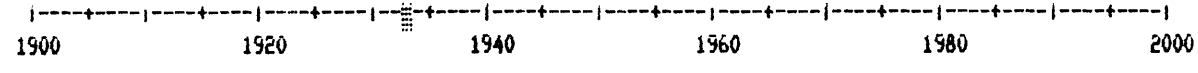
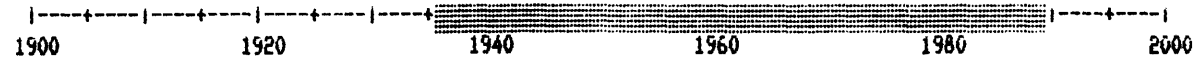
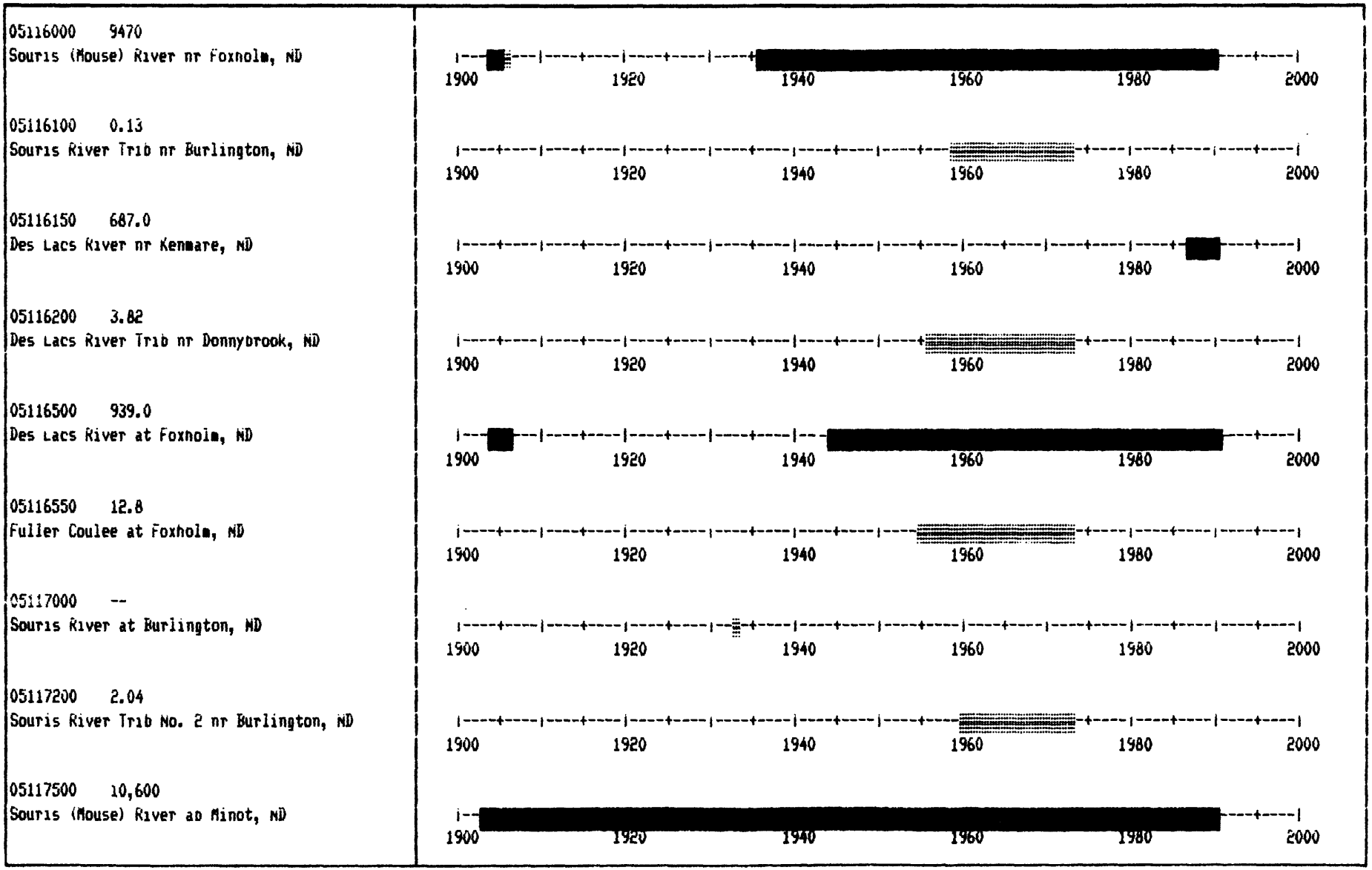
05114500 -- Souris River at McKinney, ND	
05115000 -- Souris River nr Carpio, ND	
05115500 9450 Lake Darling nr Foxholm, ND	

Supplement 1.--Period of record for gaging stations in North Dakota--Continued



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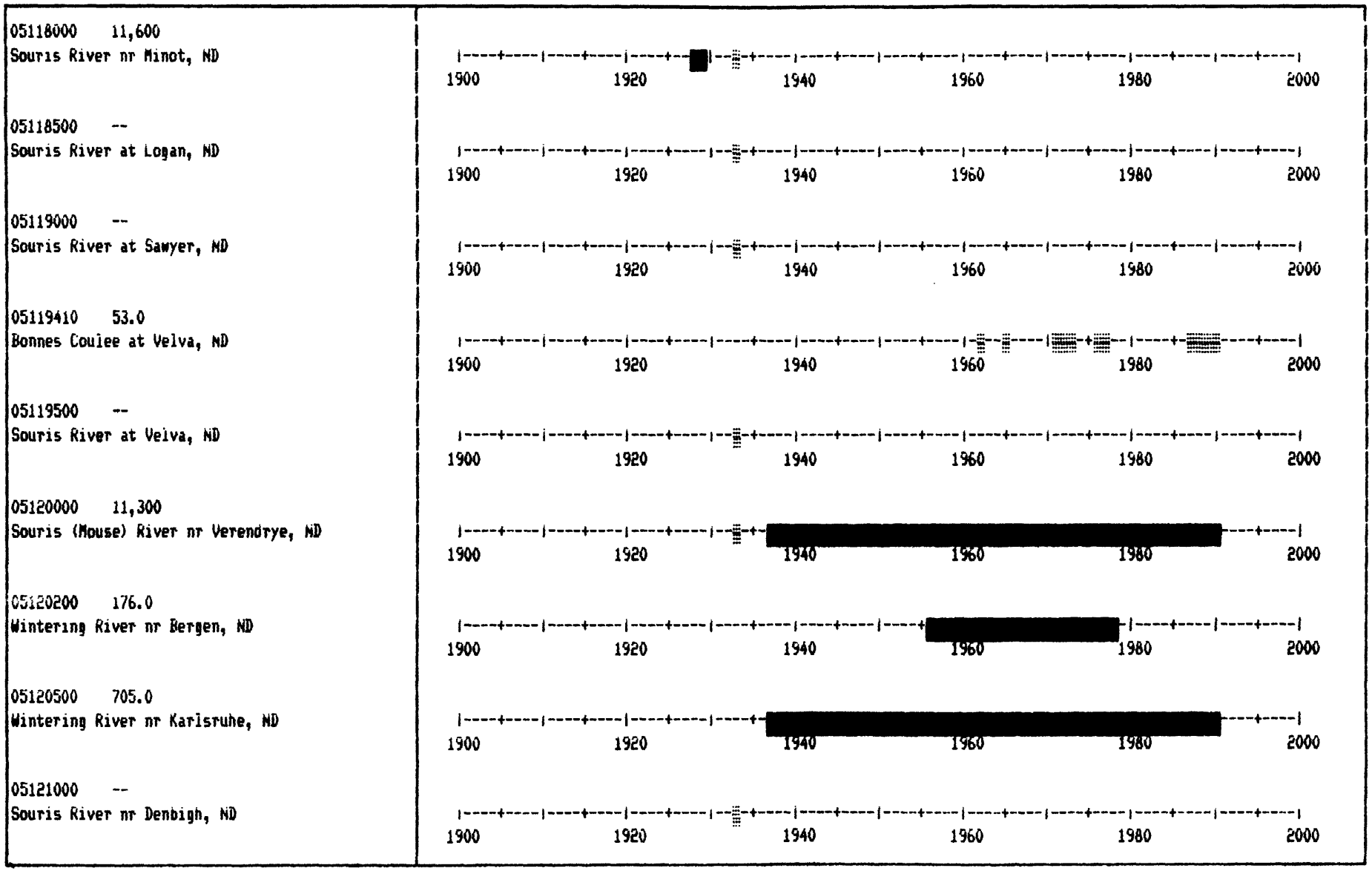

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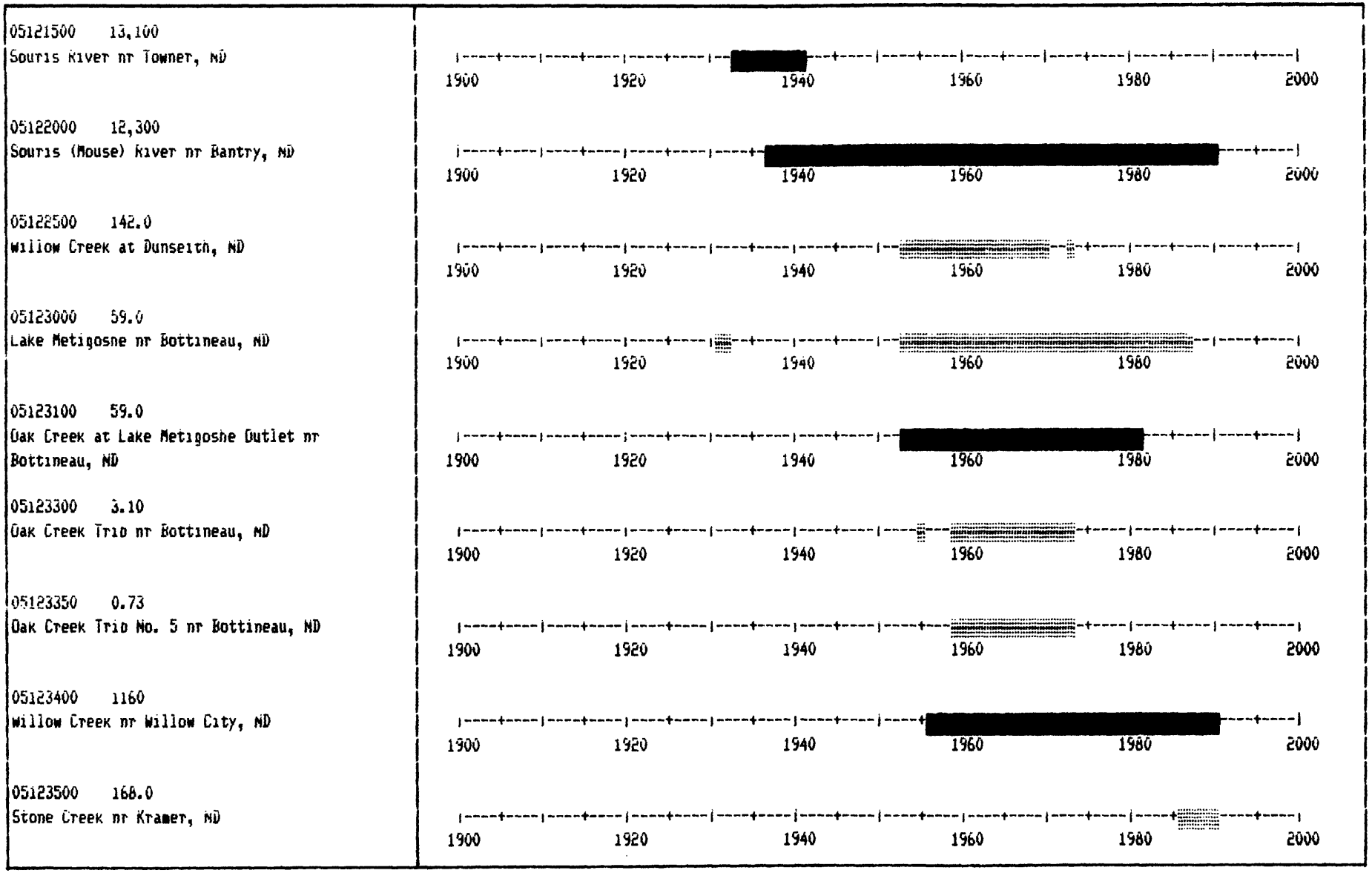
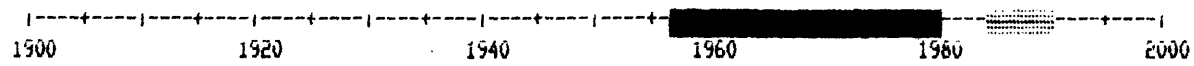
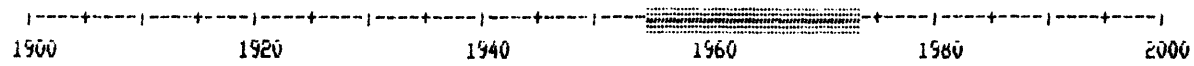
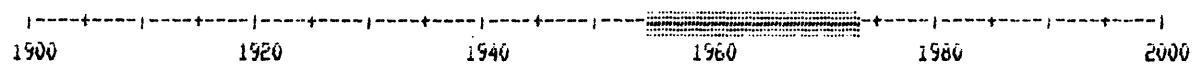
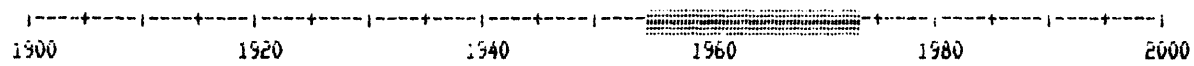
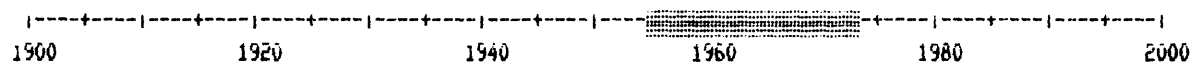
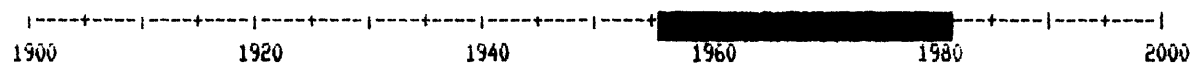
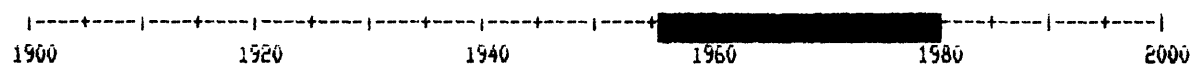
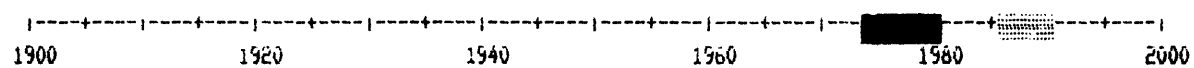
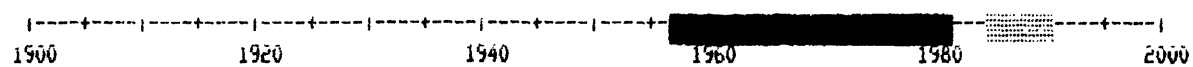


Supplement 1.--Period of record for gaging stations in North Dakota--Continued

05123510 975.0 Deep River nr Upham, ND	
05123520 20.9 Egg Creek nr Glenburn, ND	
05123540 108.4 Egg Creek nr Rutnville, ND	
05123560 4.25 Egg Creek Trib nr Deering, ND	
05123580 132.0 Egg Creek nr Deering, ND	
05123600 269.0 Egg Creek nr Granville, ND	
05123700 534.0 Cut Bank Creek at North Lake Outlet nr Granville, ND	
05123750 722.0 Cut Bank Creek at Upham, ND	
05123900 230.0 Boundary Creek nr Langa, ND	

Supplement 1.--Period of record for gaging stations in North Dakota--Continued

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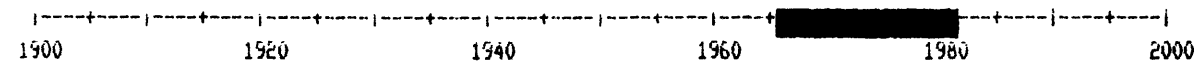
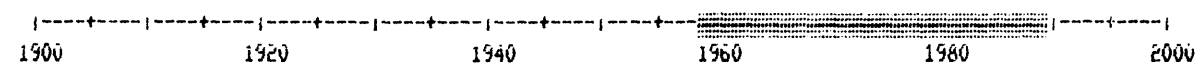
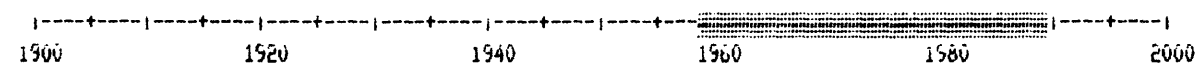
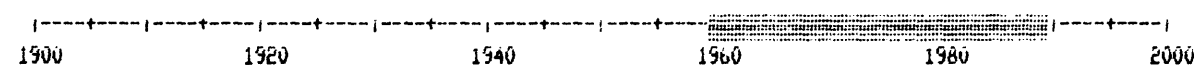
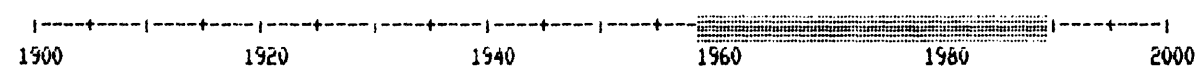
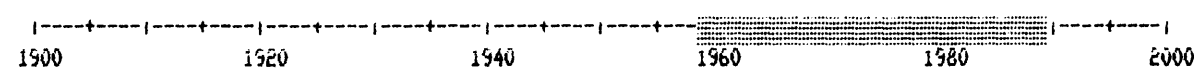
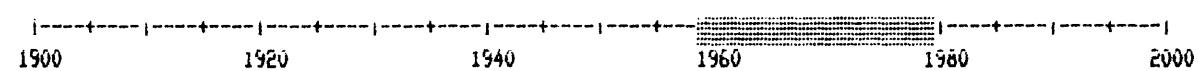
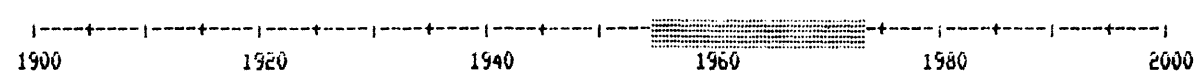
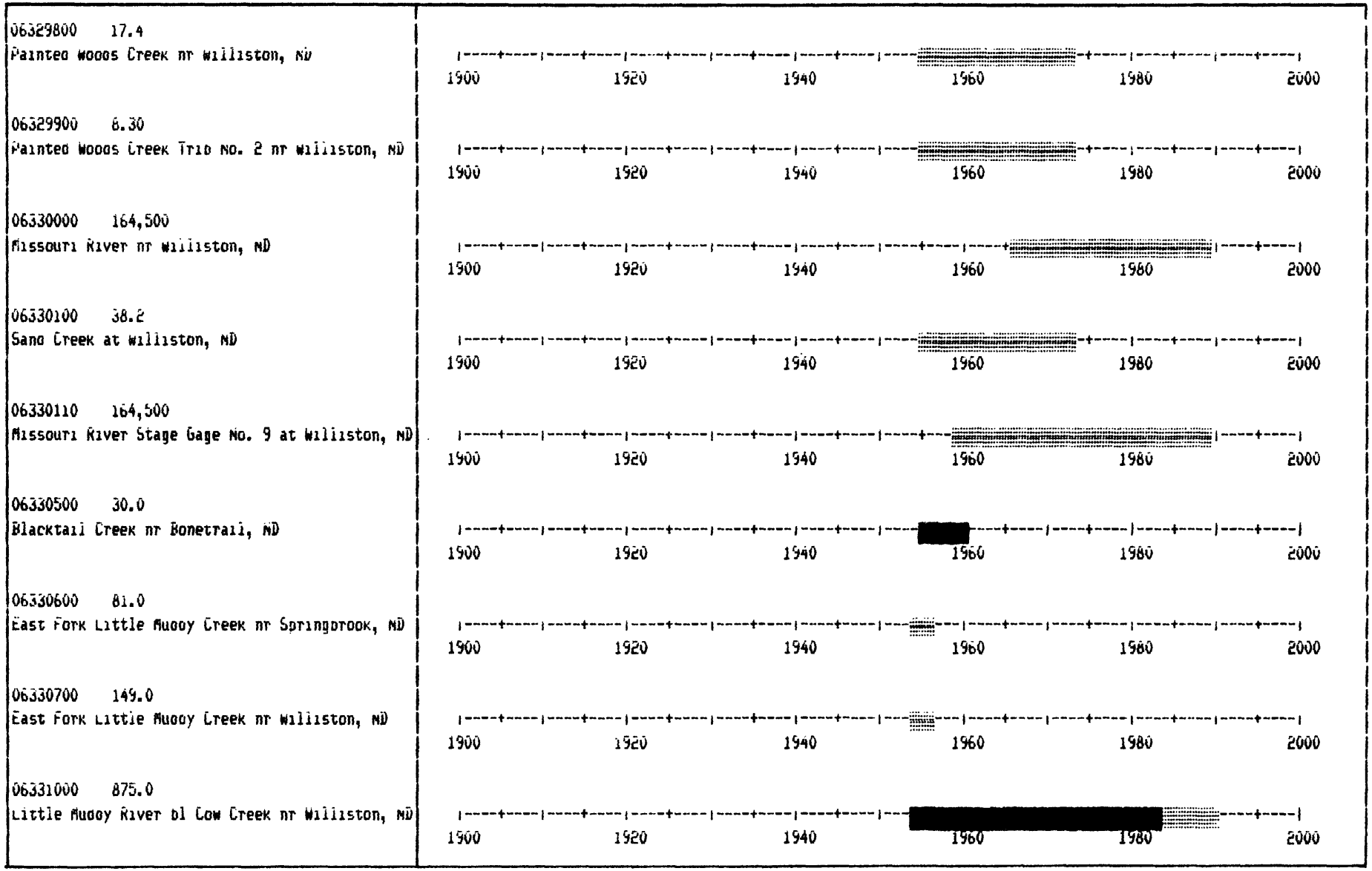
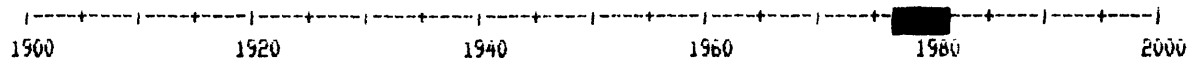
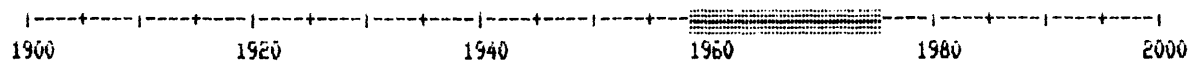
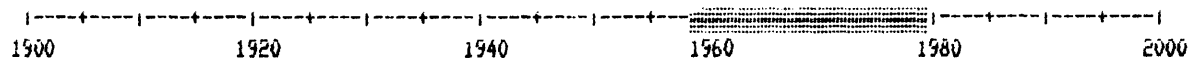
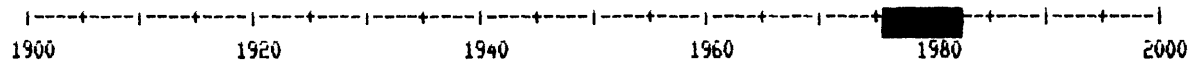
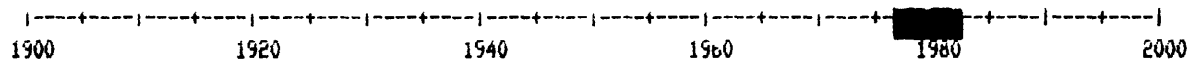
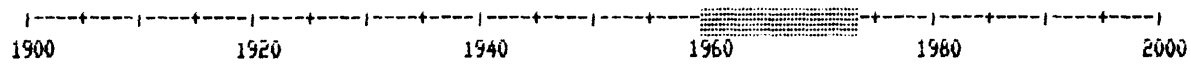
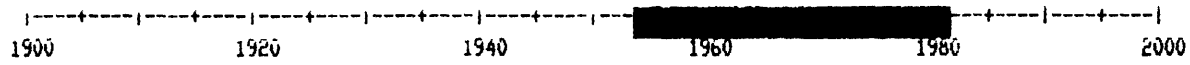
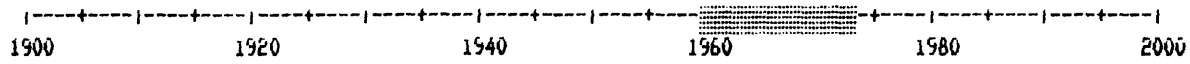
06329597 149.0 Charbonneau Creek nr Charbonneau, ND	
06329610 70,000 Yellowstone River Stage Gage No. 2 nr Cartwright, ND	
06329620 70,000 Yellowstone River Stage Gage No. 3 nr Buford, ND	
06329640 164,000 Missouri River Stage Gage No. 5A at Buford, ND	
06329650 164,000 Missouri River Stage Gage No. 6 nr Buford, ND	
06329660 164,000 Missouri River Stage Gage No. 7 nr Trenton, ND	
06329680 164,000 Missouri River Stage Gage No. 8 nr Trenton, ND	
06329700 0.35 Painted Woods Creek Trib nr Williston, ND	

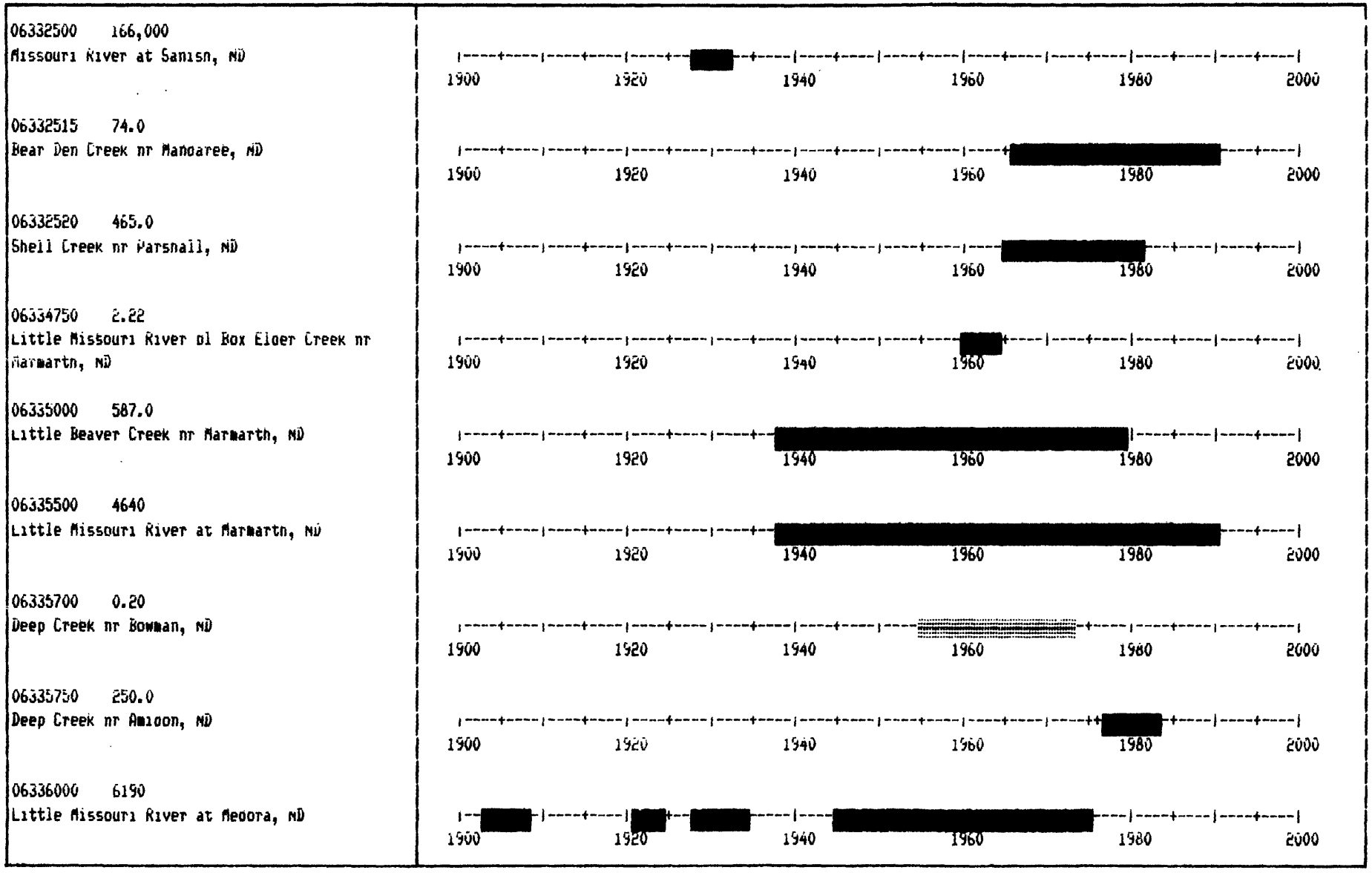
Supplement 1.--Period of record for gaging stations in North Dakota--Continued



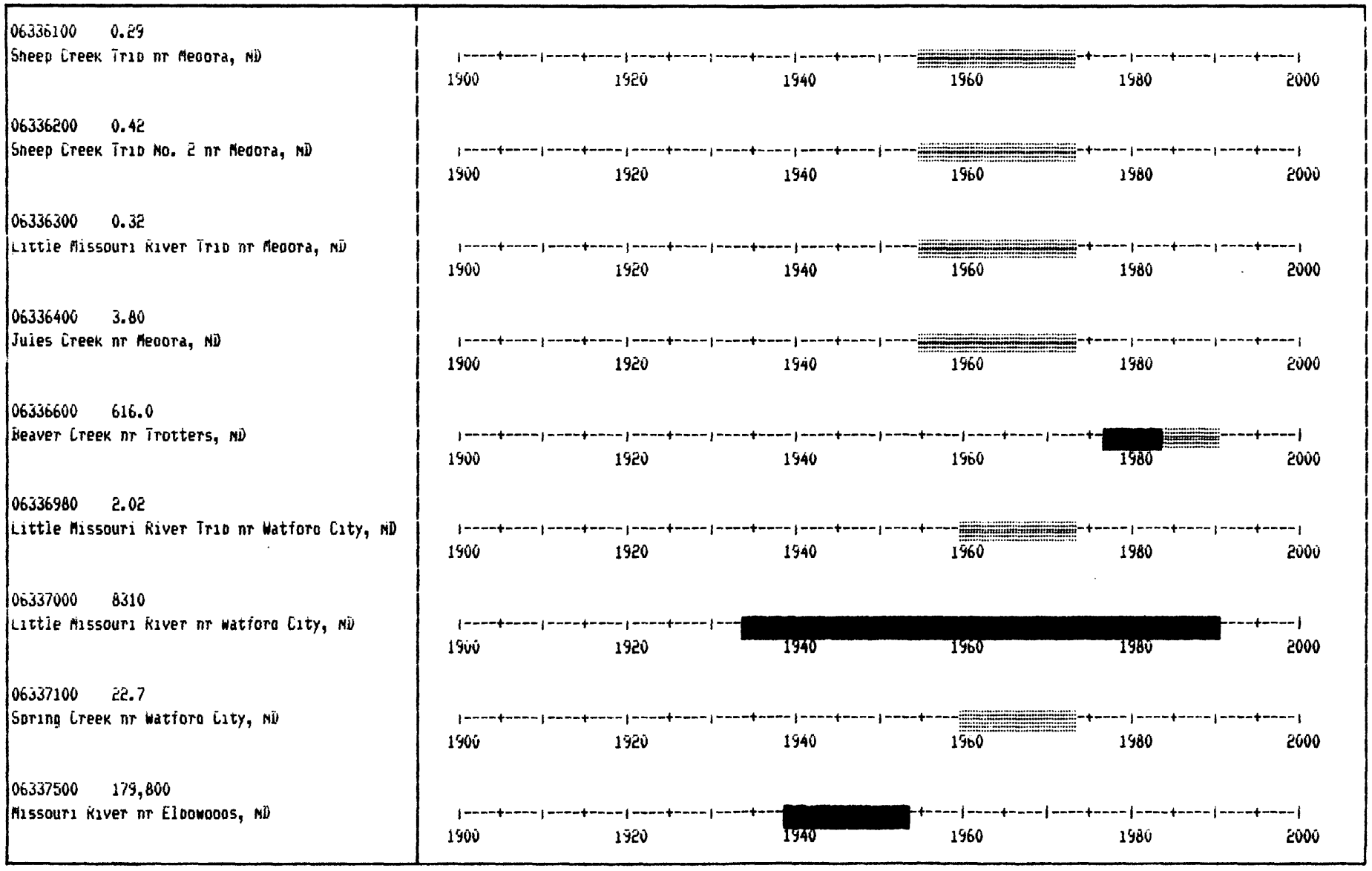
Supplement 1.--Period of record for gaging stations in North Dakota--Continued

06331500 1010 Little Muddy Creek nr Williston, ND	
06331570 146.0 Stony Creek nr Williston, ND	
06331600 165,000 Missouri River Stage Gage No. 10 nr Williston, ND	
06331650 165,000 Missouri River Stage Gage No. 11 nr Williston, ND	
06331680 135.0 Tobacco Garden Creek nr Watford City, ND	
06331850 102.0 Beaver Creek nr Ray, ND	
06331900 9.55 White Earth River Trib nr Tioga, ND	
06332000 780.0 White Earth River at White Earth, ND	
06332150 -- White Earth River Trib nr White Earth, ND	

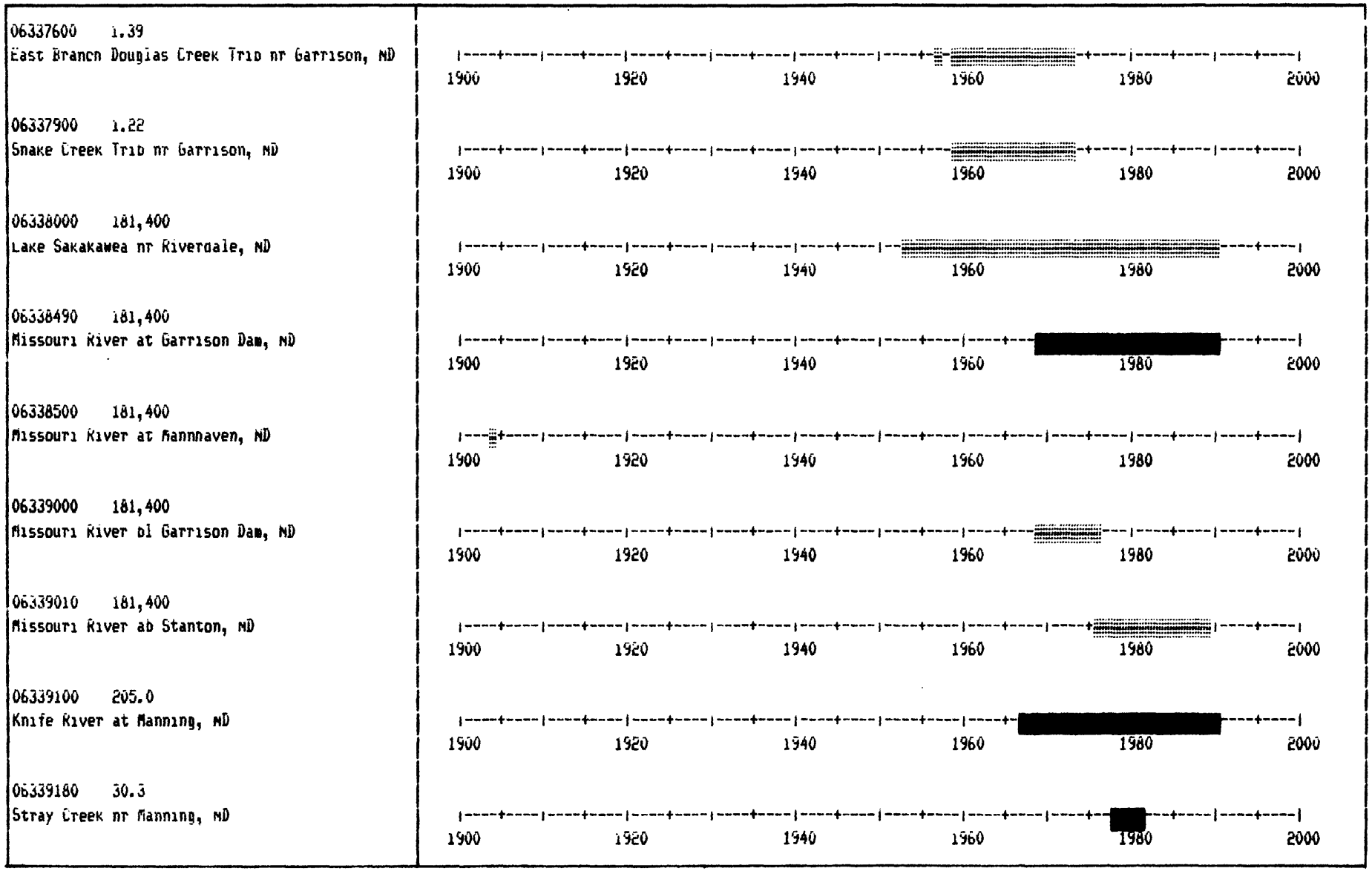
Supplement 1.--Period of record for gaging stations in North Dakota--Continued



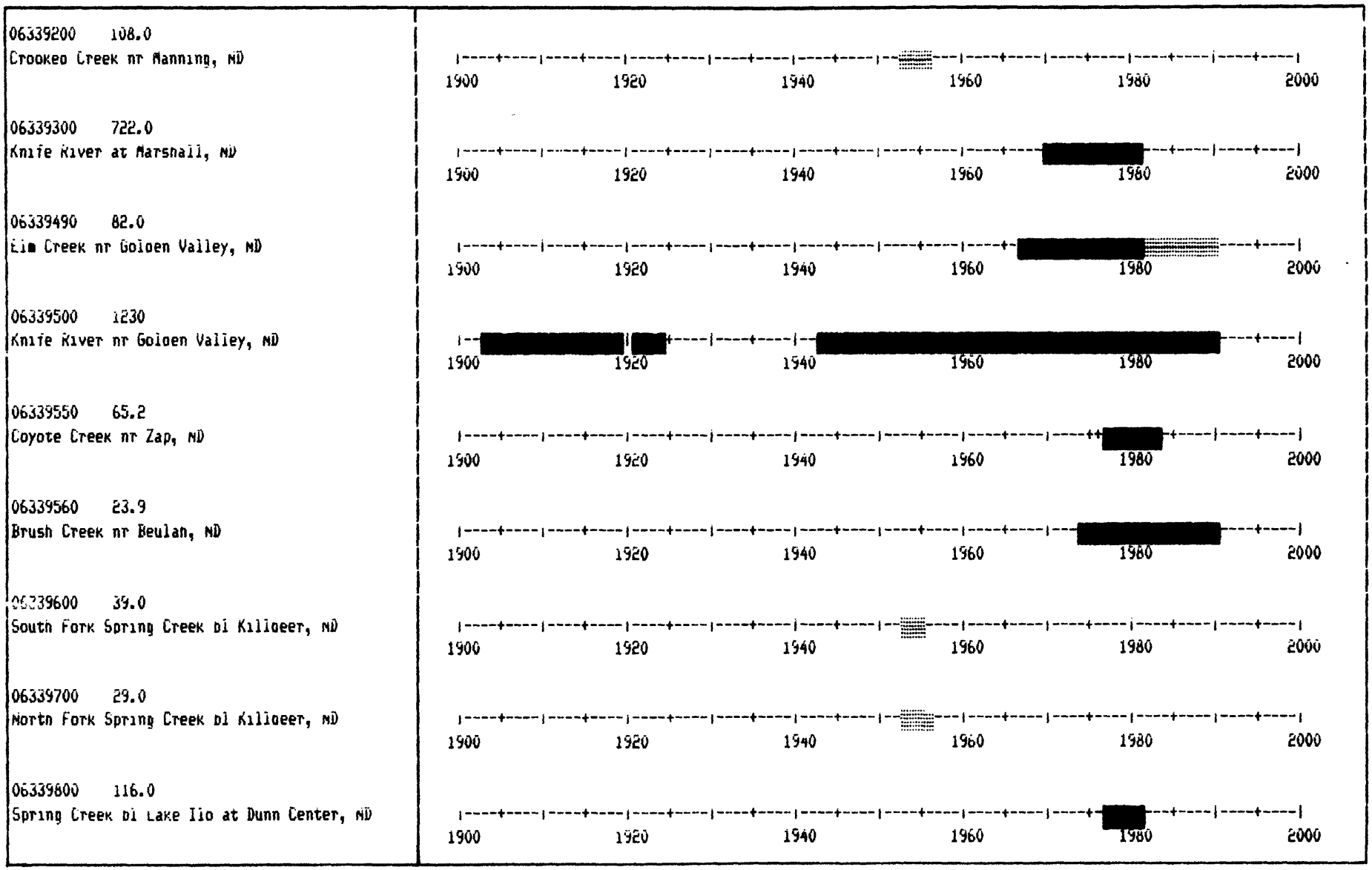
Supplement 1.--Period of record for gaging stations in North Dakota--Continued



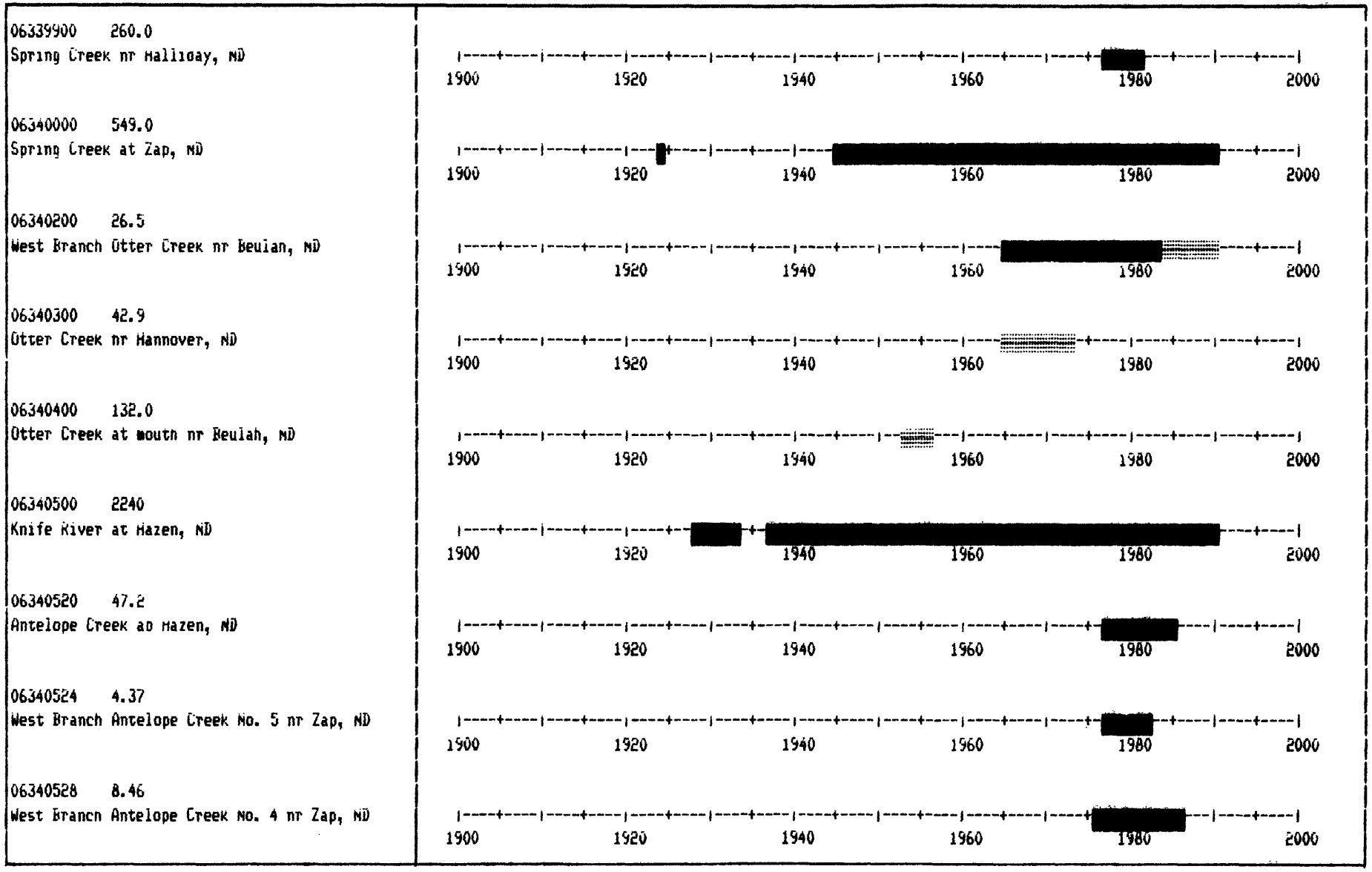
Supplement 1.--Period of record for gaging stations in North Dakota--Continued



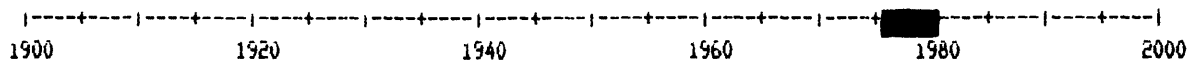
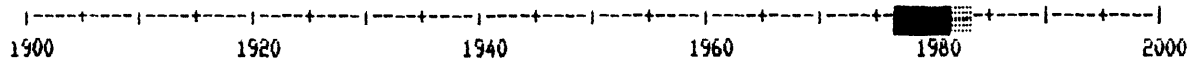
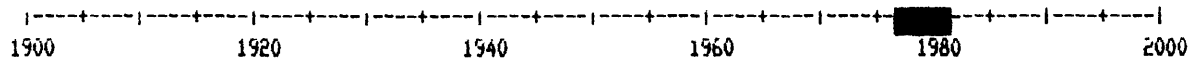
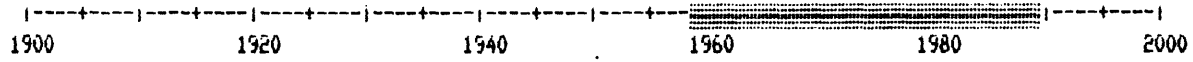
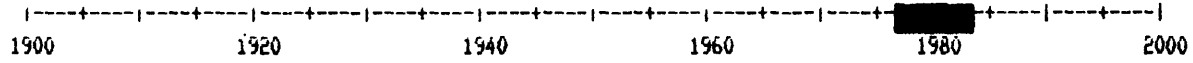
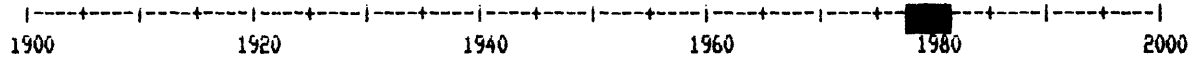
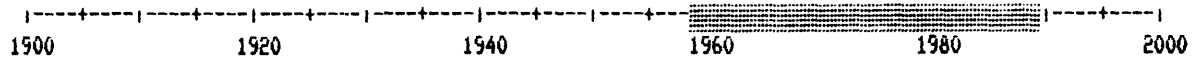
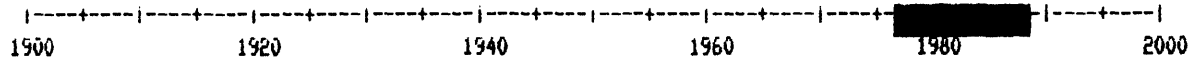
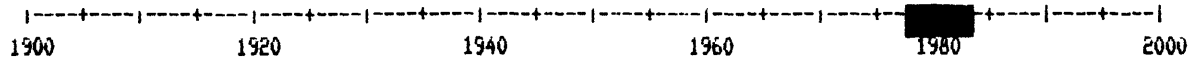
Supplement 1.--Period of record for gaging stations in North Dakota--Continued



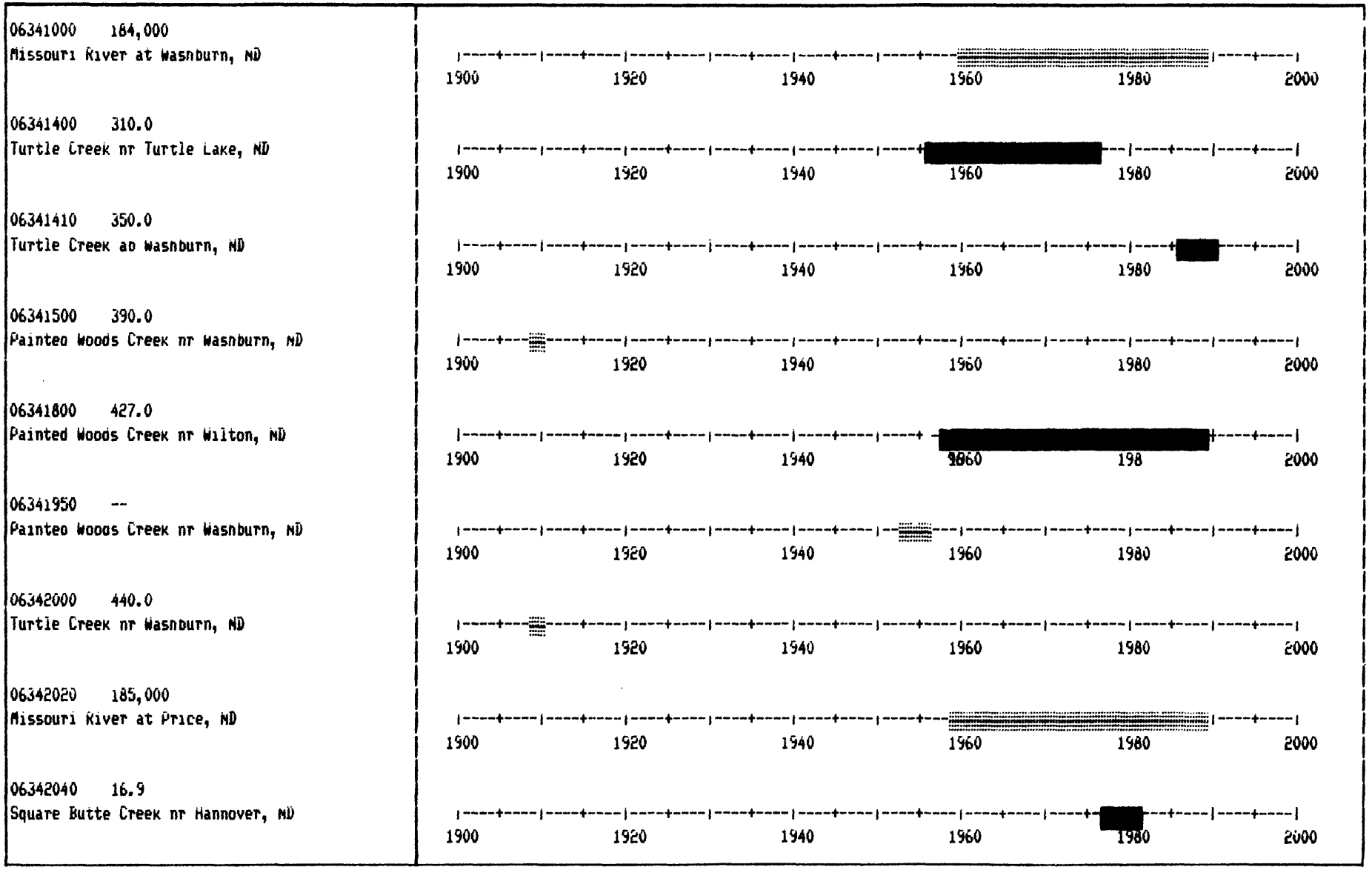
Supplement 1.--Period of record for gaging stations in North Dakota--Continued



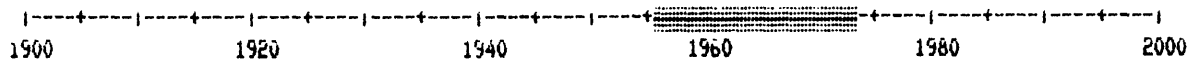
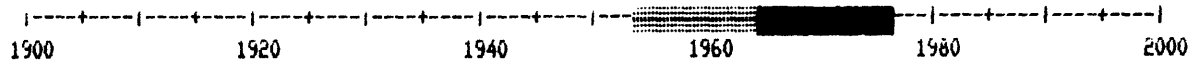
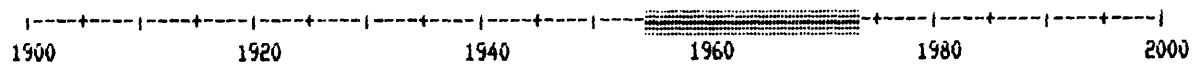
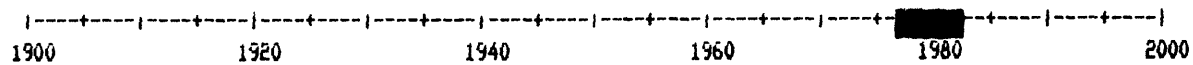
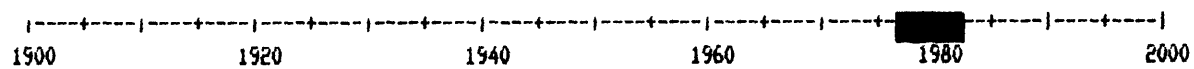
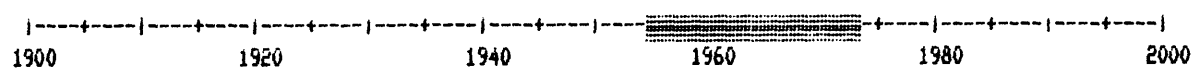
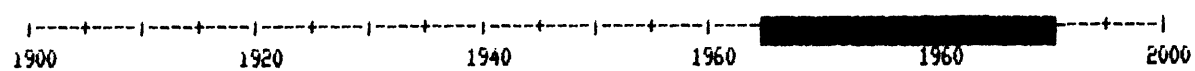
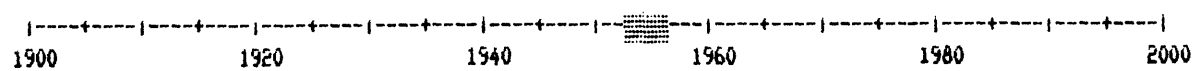
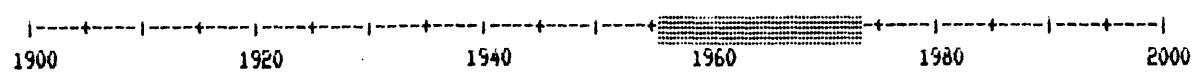
Supplement 1.--Period of record for gaging stations in North Dakota--Continued

06340536 28.3 West Branch Antelope Creek No. 2 nr Beulah, ND	
06340540 37.7 West Branch Antelope Creek nr Hazen, ND	
06340580 15.8 Coal Creek nr Stanton, ND	
06340700 182,000 Missouri River nr Stanton, ND	
06340780 21.9 Algerin Creek nr Fort Clark, ND	
06340890 9.80 Missouri River Trib No. 2 nr Hensler, ND	
06340900 183,000 Missouri River nr Hensler, ND	
06340905 70.5 Coal Lake Coulee nr Hensler, ND	
06340930 57.3 Buffalo Creek nr Washburn, ND	

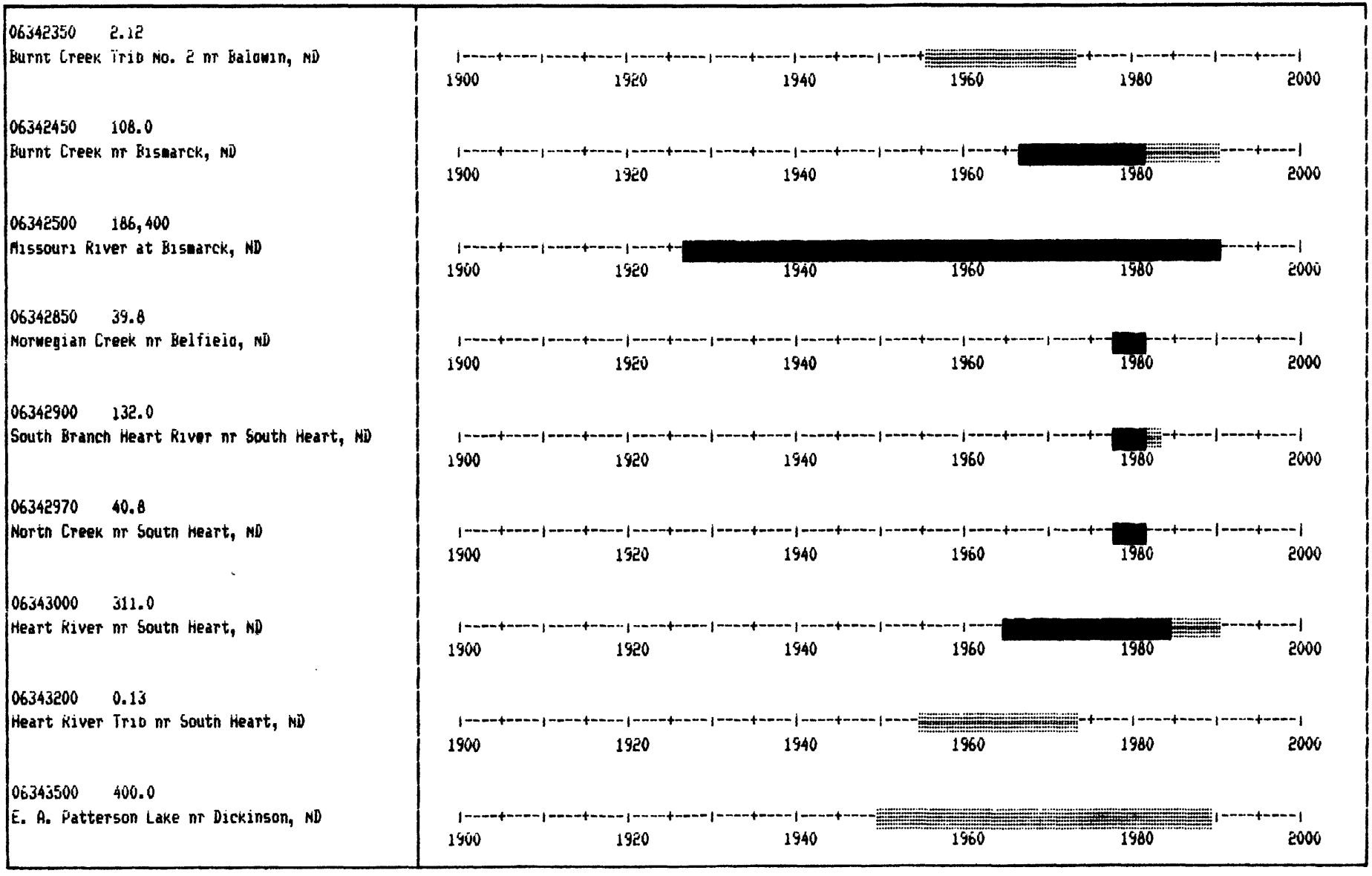
Supplement 1.--Period of record for gaging stations in North Dakota--Continued



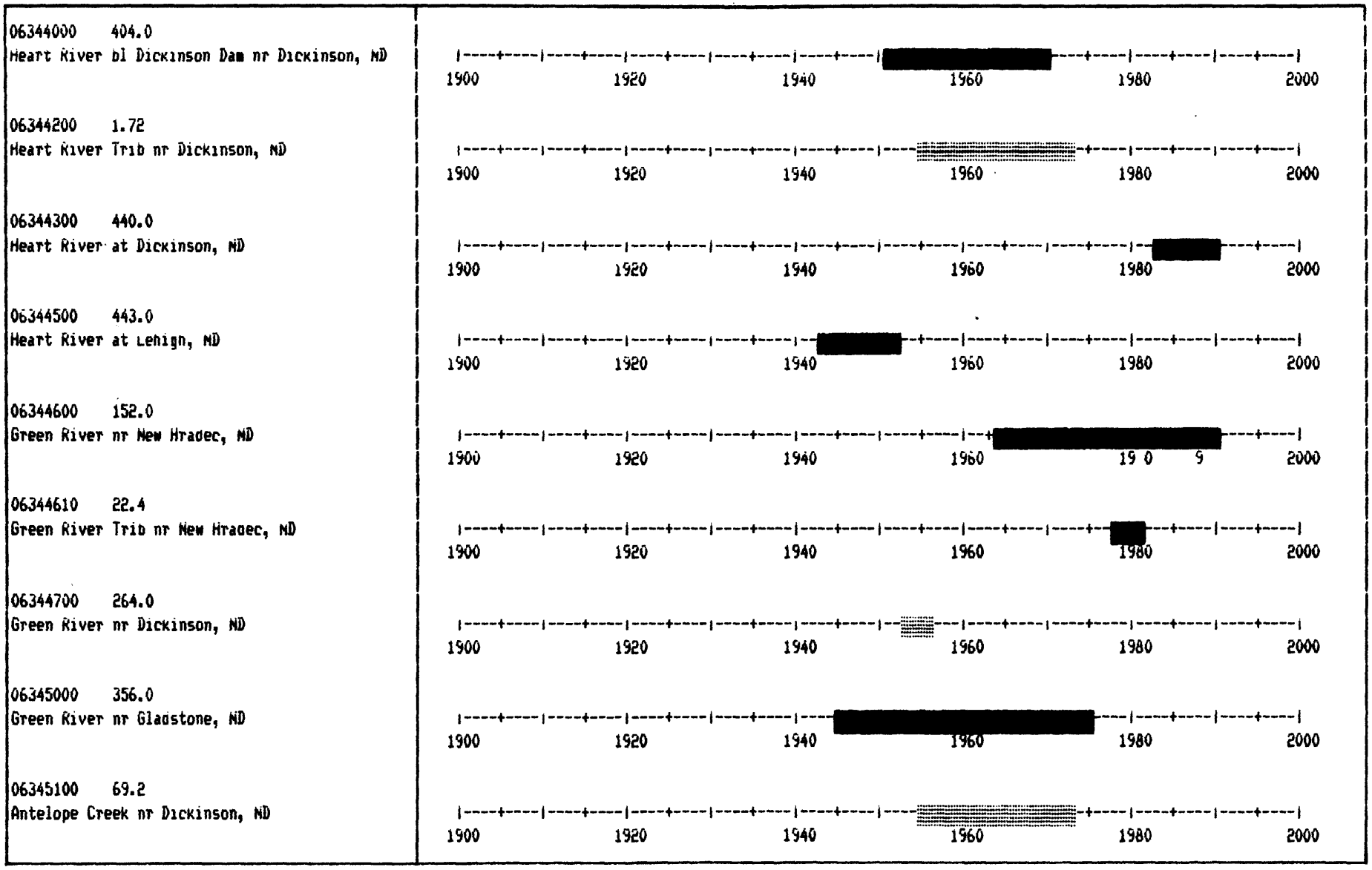
Supplement 1.--Period of record for gaging stations in North Dakota--Continued

06342050 56.8 Square Butte Creek at Center, ND	
06342100 13.0 Square Butte Creek Trib No. 2 nr Center, ND	
06342150 0.19 Square Butte Creek Trib nr Center, ND	
06342200 75.8 Square Butte Creek ab Nelson Lake nr Center, ND	
06342230 45.6 Hagel Creek nr Center, ND	
06342250 1.68 Square Butte Creek Trib No. 3 nr Center, ND	
06342260 146.0 Square Butte Creek bl Center, ND	
06342280 234.0 Square Butte Creek nr Harmon, ND	
06342300 2.98 Burnt Creek Trib nr Baldwin, ND	

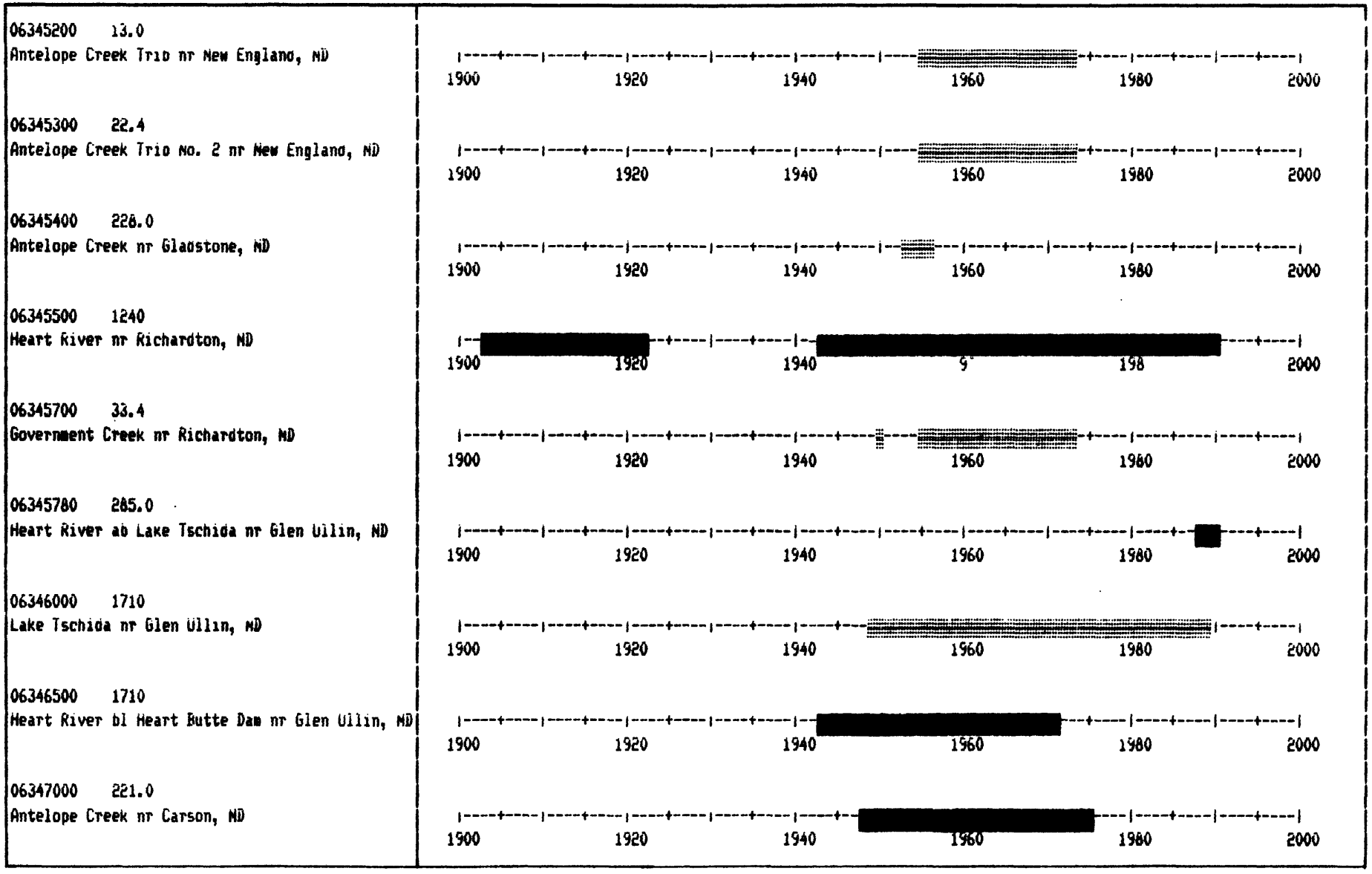
Supplement 1.--Period of record for gaging stations in North Dakota--Continued



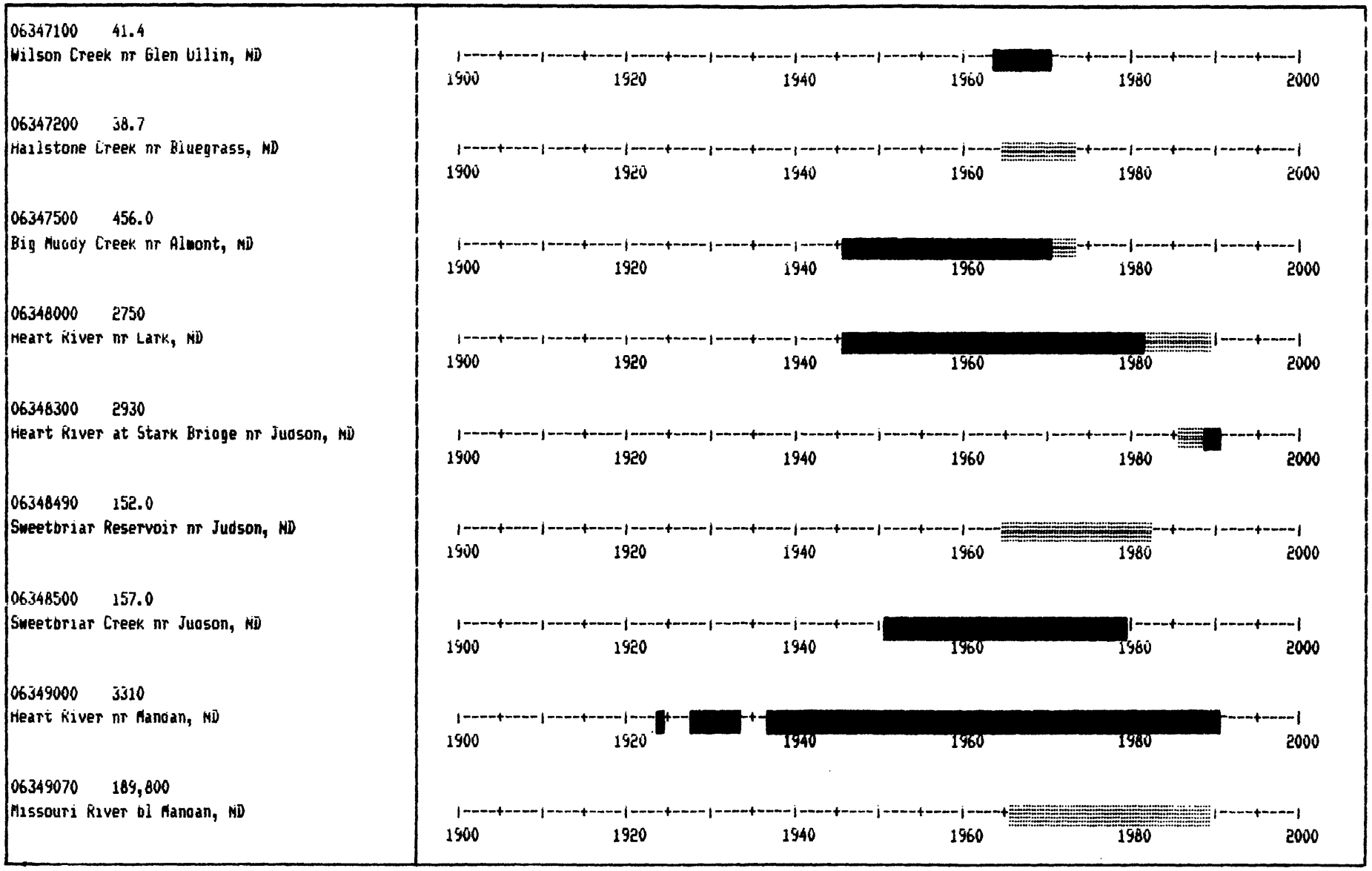
Supplement 1.--Period of record for gaging stations in North Dakota--Continued



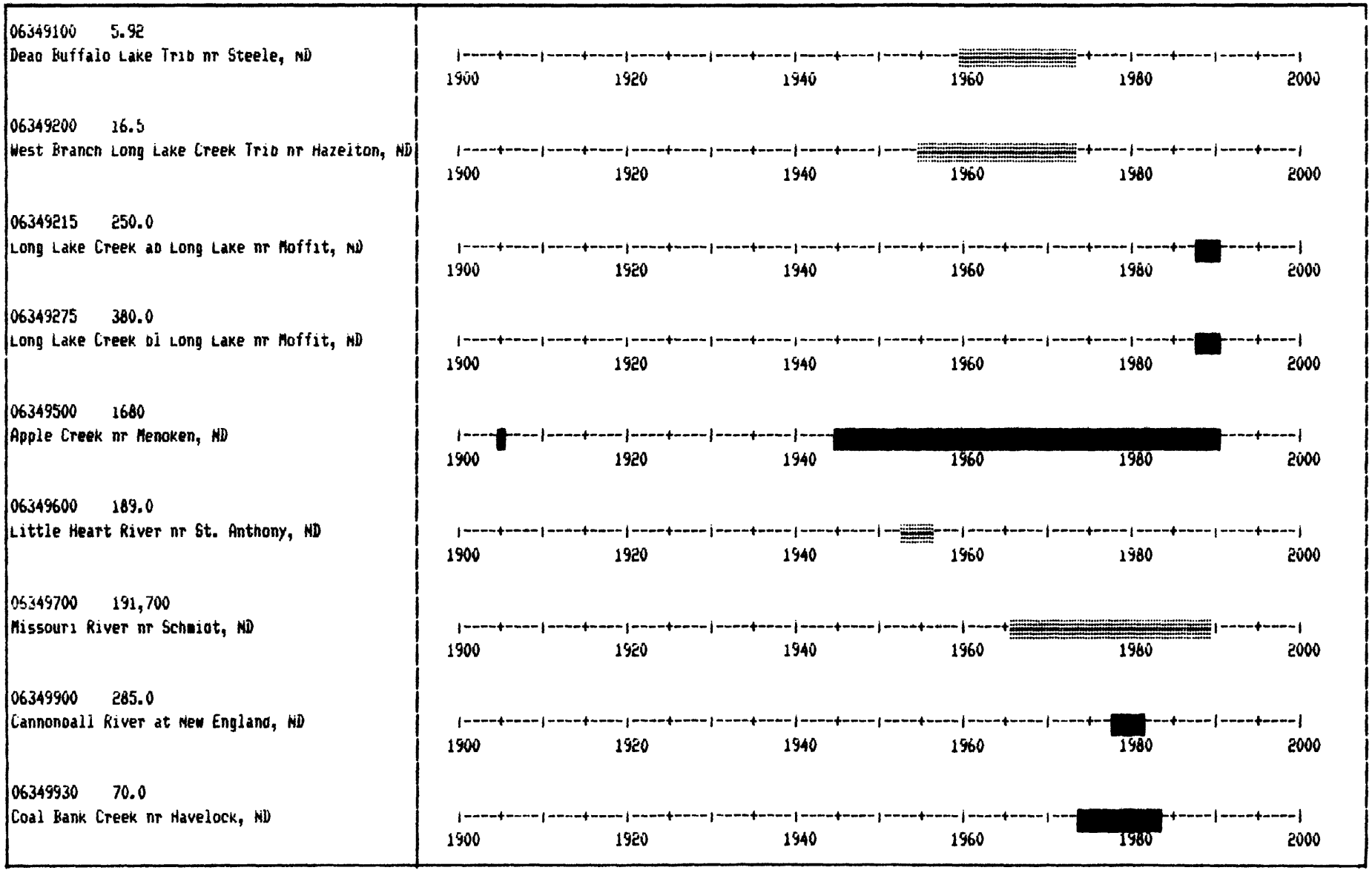
Supplement 1.--Period of record for gaging stations in North Dakota--Continued



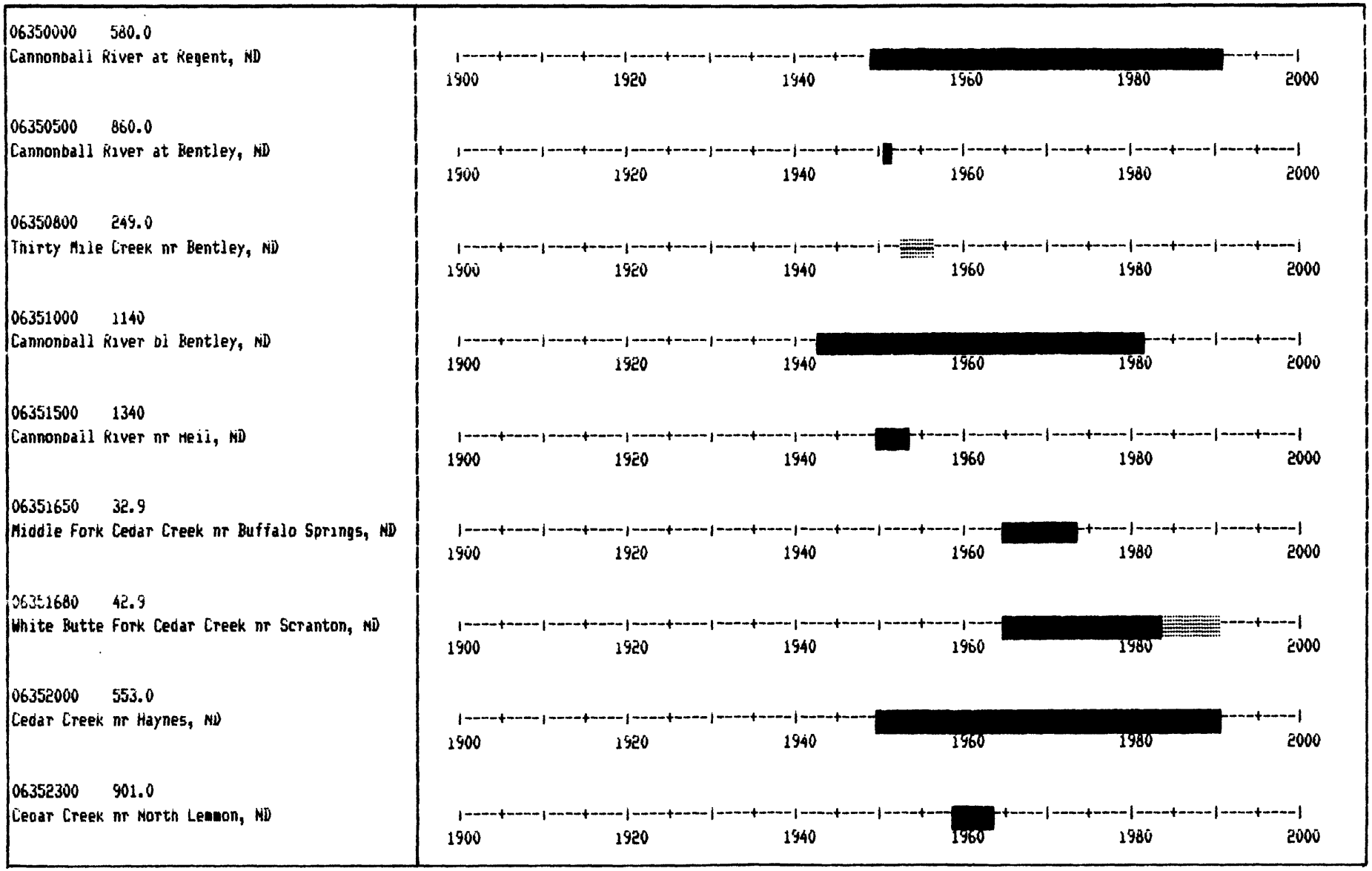
Supplement 1.--Period of record for gaging stations in North Dakota--Continued



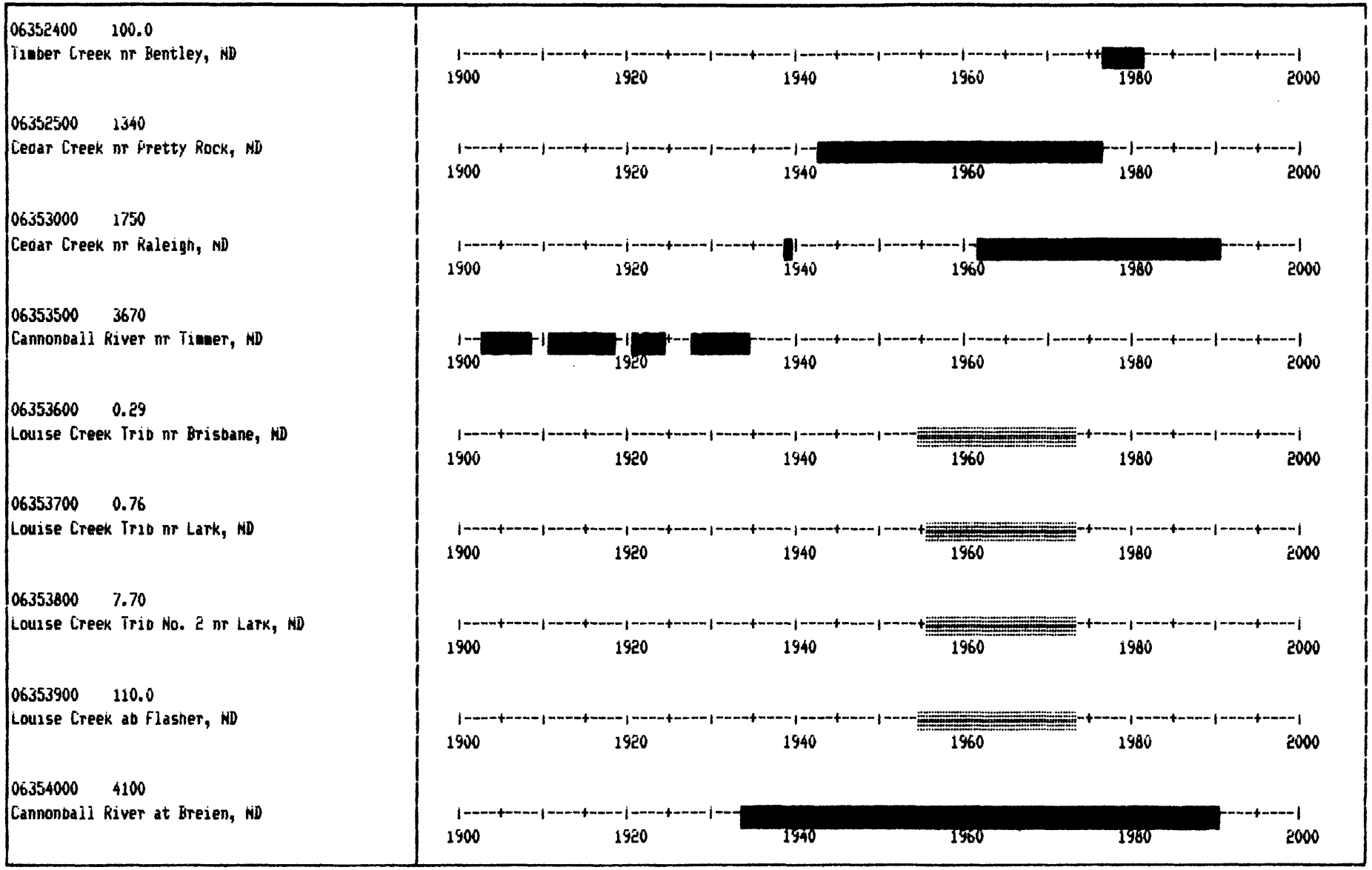
Supplement 1.--Period of record for gaging stations in North Dakota--Continued



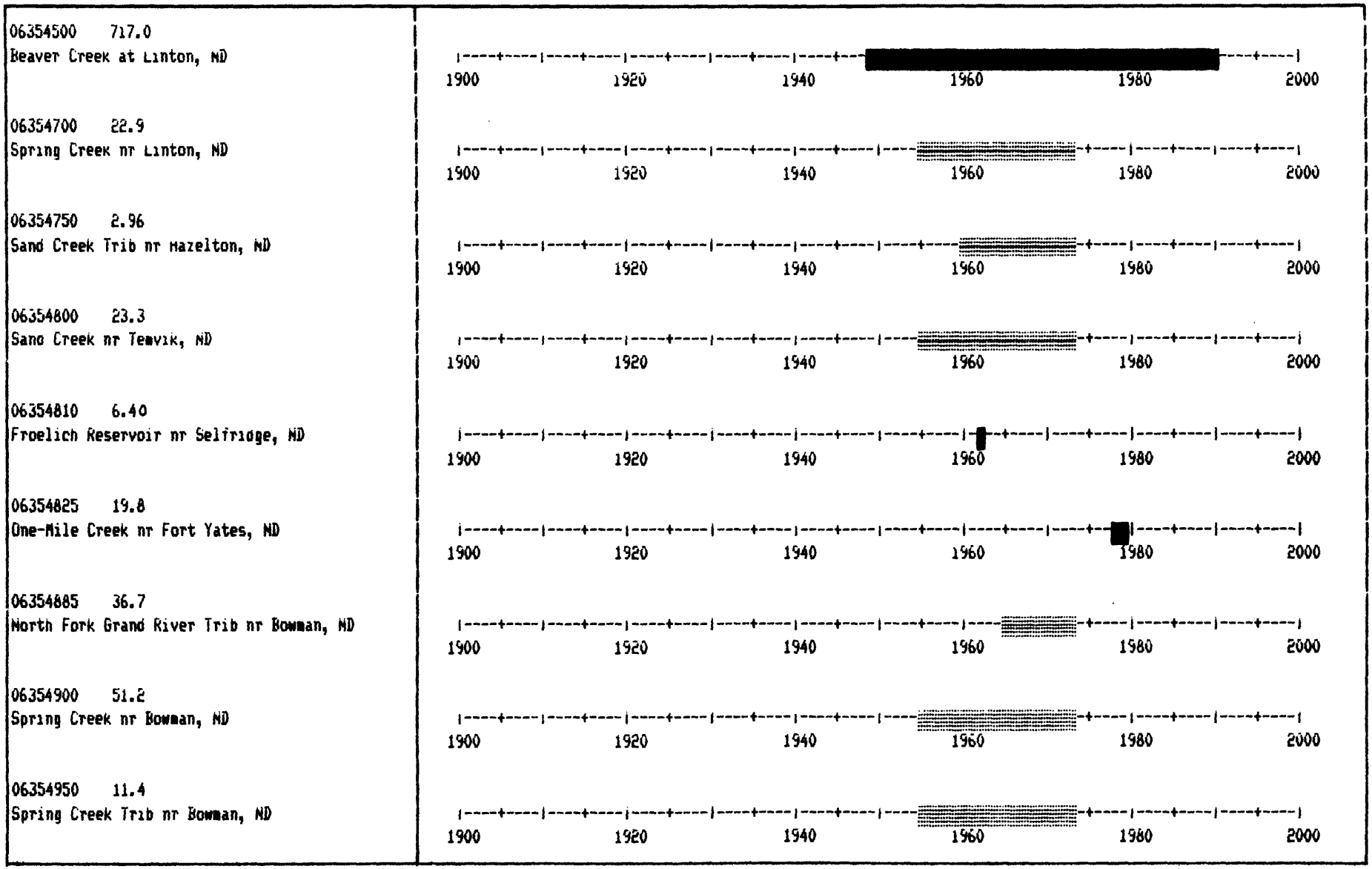
Supplement 1.--Period of record for gaging stations in North Dakota--Continued



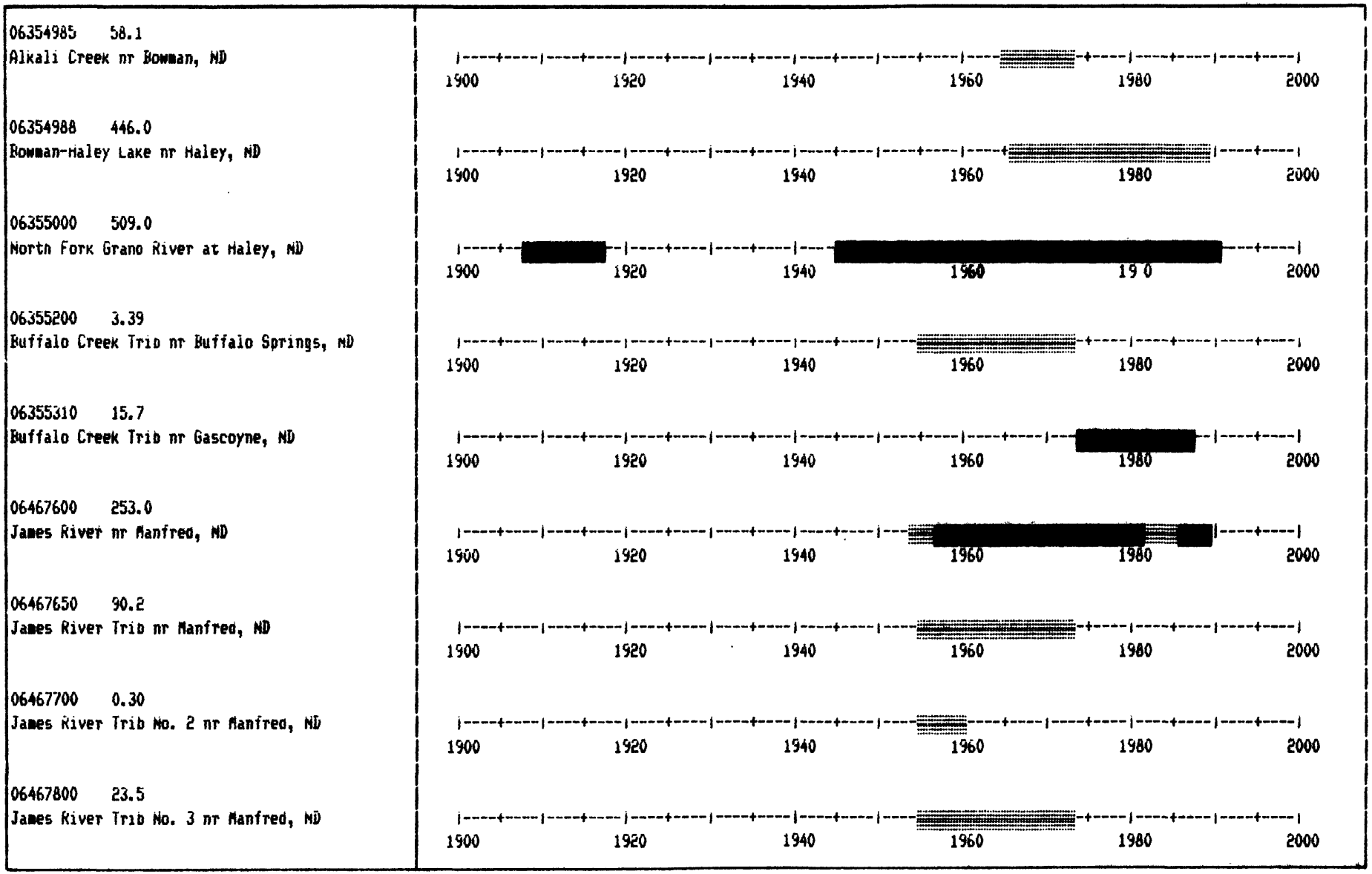
Supplement 1.--Period of record for gaging stations in North Dakota--Continued



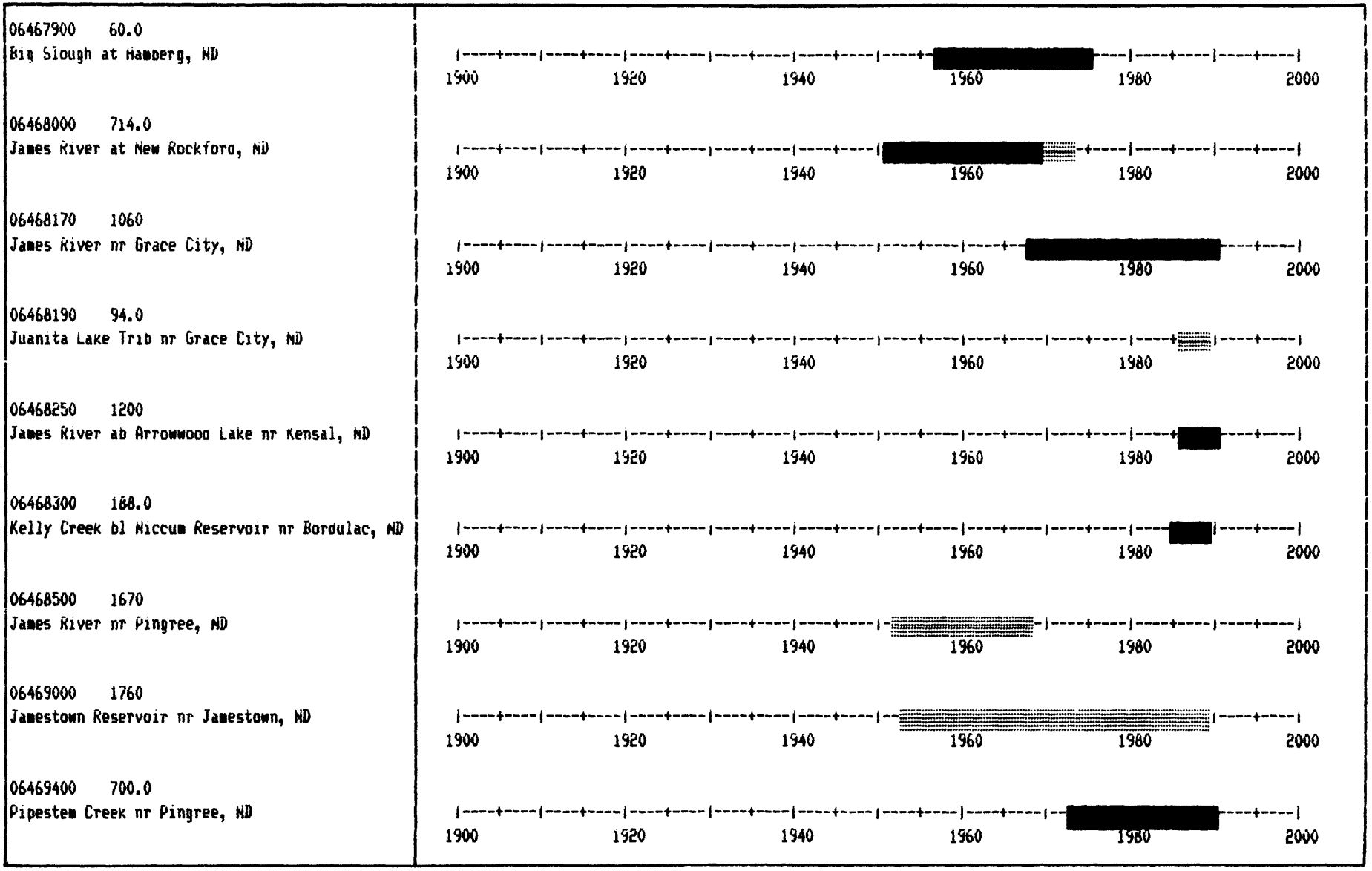
Supplement 1.--Period of record for gaging stations in North Dakota--Continued



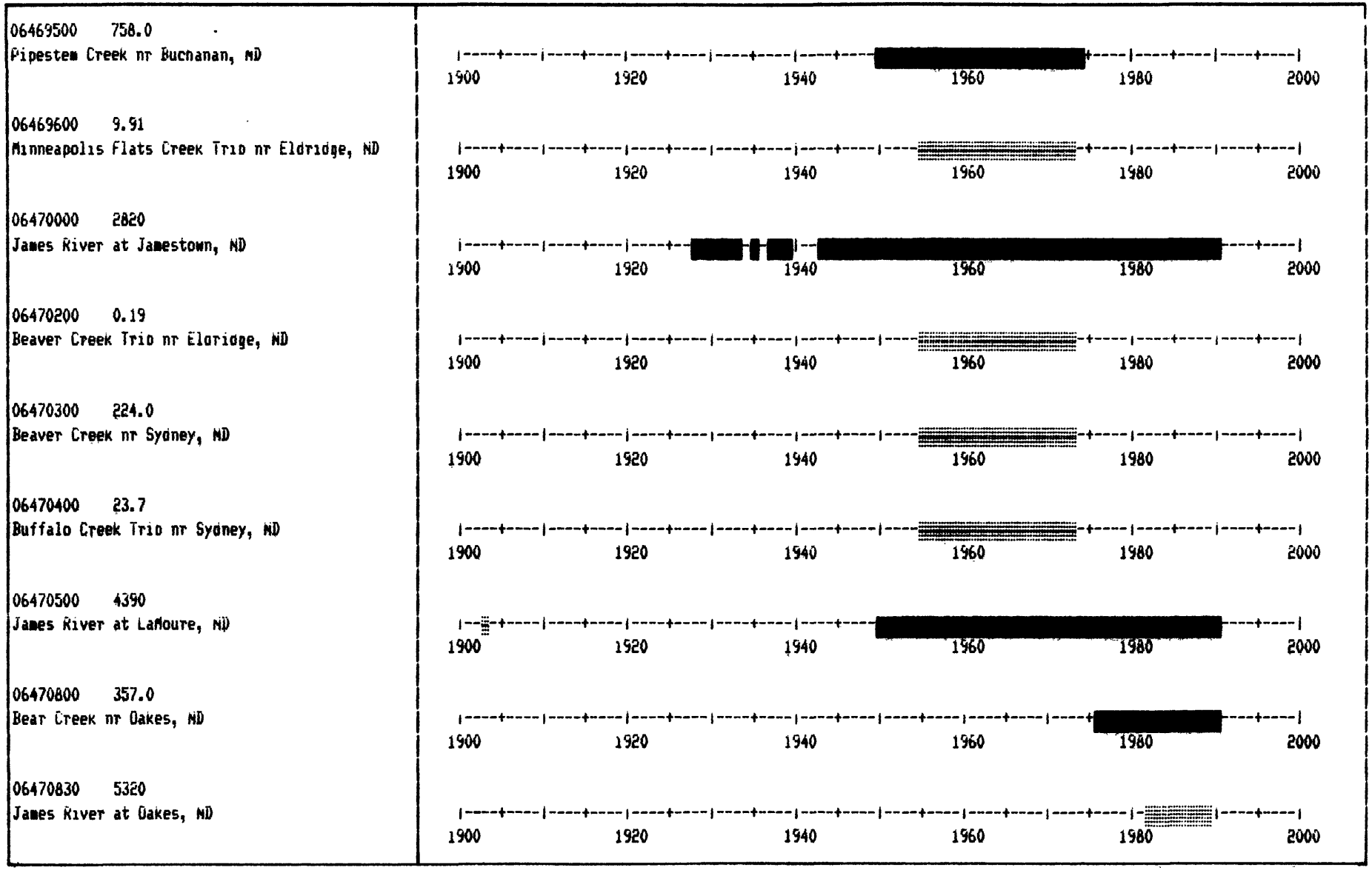
Supplement 1.--Period of record for gaging stations in North Dakota--Continued



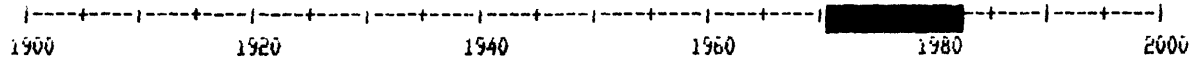
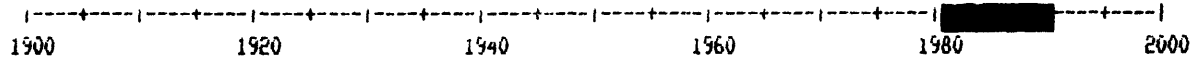
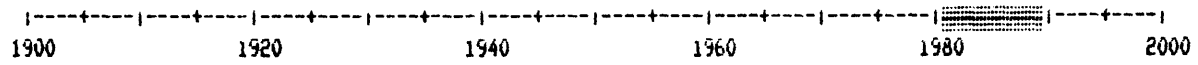
Supplement 1.--Period of record for gaging stations in North Dakota--Continued



Supplement 1.--Period of record for gaging stations in North Dakota--Continued



Supplement 1.--Period of record for gaging stations in North Dakota--Continued

06470833 5.10 Pilot Drain at Oakes, ND	
06470875 5480 James River at Dakota Lake Dam nr Ludden Dam, ND	
06470878 5480 James River at ND-SD State line	
06471200 716.0 Maple River at ND-SD State line