# A PROPOSED STREAMFLOW DATA PROGRAM FOR NORTH DAKOTA

by

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UNITED STATES
DEPARTMENT OF THE INTERIOR
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OPEN-FILE REPORT
BISMARCK, NORTH DAKOTA

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## ABSTRACT

An evaluation of the streamflow data available in North Dakota was made to provide guidelines for planning future programs. The basic steps in the evaluation procedure were (1) definition of the long-term goals of the streamflow data program in quantitative form, (2) examination and analysis of all available data to determine which goals have already been met, and (3) consideration of alternate programs and techniques to meet the remaining objectives. None of the goals could be met by generalization of the data for gaged basins by regression analysis. This fact indicates that significant changes should be made in the present data program to obtain better areal coverage to achieve the goals set. A streamflow data program based on the guidelines developed in this study is proposed for the future.

# INTRODUCTION

The streamflow program of the U.S. Geological Survey in North Dakota has evolved through the years as the Federal and State interests in surface-water resources have increased and as funds for operating the stream-gaging station network have become available.

The collection of streamflow information in a systematic fashion began in 1882 with the establishment of a gaging station on the Red River of the North at Grand Forks. This was a stage station with infrequent discharge measurements maintained for navigational purposes. Stage records were obtained on the Missouri River at Bismarck in 1881-82, 1886-99 by the Missouri River Commission. Gaging stations were established and operated by the Geological Survey in the years 1901-09 in a cooperative agreement with the State as a result of the National Reclamation Act of 1902 and the disastrous floods of 1897 in the Red River Basin. Additional interest was created as problems with Canada concerning the division of waters along the international boundary resulted in the formation of the International Joint Commission in 1912. Eight gaging stations were being operated in 1925 when State cooperation was discontinued. Only five federally operated stations were continued. Cooperation resumed in 1931, but funds were very limited from 1934 to 1938. However, the Rivers and Harbors Act of 1927 and the Flood Control Acts of 1928 and 1936 resulted in the

Corps of Engineers supporting a considerable expansion of the work. The U.S. Biological Survey cooperated in establishing five stations in 1937. There were 41 streamflow stations in the State when the Bismarck District (North Dakota-South Dakota) was created on October 16, 1944. Plans for the coordinated development of the waters of the Missouri River Basin with respect to flood control, navigation, power, and irrigation were formulated in 1943-44 by the Corps of Engineers, the Bureau of Reclamation, and the States in the basin. These plans resulted in a rapid increase in the stream-gaging program and by June 1947 there were 64 gaging stations in operation. Since June 1947 there has been a gradual increase to 109 stations in June 1969. Very few gaging stations have been discontinued.

In 1954 a crest-stage partial-record network was established to define peak-flow characteristics on small drainage areas. A supplementary program to establish the role of basin characteristics was added in 1965. There are 91 gages in this network at present, of which 11 are equipped with continuous-stage and rainfall recorders.

A network of 30 low-flow partial-record stations was operated from 1954 to 1956.

The purpose of this study is to evaluate the streamflow-data program and use this evaluation to design a program that will most efficiently produce the types of information needed. The increasing cost of operation, the restraint on funds and manpower, and the need for a greater variety of hydrologic information made it imperative that a systematic evaluation of the streamflow-data program be made to determine how to apply the funds and manpower available in order to best serve State and Federal interests.

The concepts and procedures used in this study are presented in detail by Carter and Benson (1970) in "Concepts for the Design of Streamflow Data Programs," and are summarized only briefly in this report. The basic steps are (1) definition of the long-term objectives of the streamflow-data program in quantitative form, (2) examination and analysis of all available data to determine which objectives have already been met, (3) consideration of alternate means of meeting the remaining objectives, and (4) preparation of a proposed program of data collection and analysis to meet the remaining objectives.

## PHYSICAL AND HYDROLOGICAL DESCRIPTION

North Dakota is located in two provinces of the Interior Plains. Fenneman (1931, 1938) defines the boundary between these provinces; the Great Plains lie to the west and the Central Lowland to the east. The line that separates these provinces (fig. 1) passes through the middle of North Dakota along the base of the eastern escarpment of the Great Plains. The southwestern half of the State is drained by the Missouri River and is characteristic of the Great Plains with a well defined drainage pattern except for the morainic portion along the eastern edge. Many buttes and mesas, remnants of the higher formations,

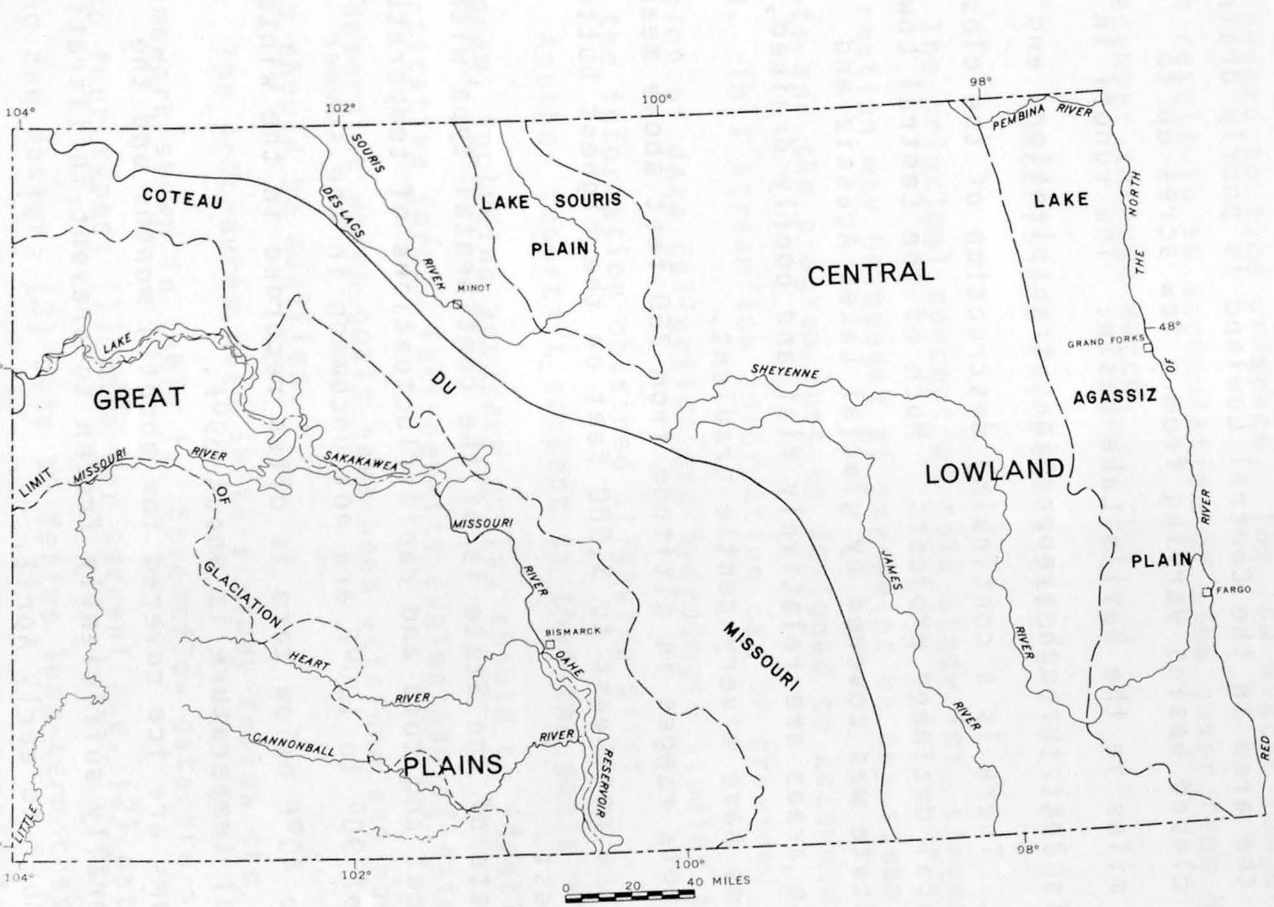



FIGURE 1.—Physiographic divisions in North Dakota.

stand above the general level of the plateau. A large number of small lakes and potholes are scattered through the morainic portion and generally do not contribute directly to surface runoff.

Much of the area in the Central Lowland is poorly drained and includes closed basins varying from a few acres up to 3,130 square miles in the Devils Lake basin. The runoff in these areas is lost through evaporation, transpiration, and infiltration. There is a continuing destruction of the closed systems by local drainage projects. Much of the Central Lowland in the State was covered by glacial Lakes Agassiz and Souris. These areas are relatively flat and poorly drained, and the streams have a very gentle gradient.

North Dakota ranges in altitude from 750 feet above mean sea level in the northeast to 3,500 feet on the highest buttes in the southwest.

The climate of the State is of the continental type with extremes of heat and cold and rapid fluctuations of temperature. Temperatures of $90^{\circ}$ to $100^{\circ}F$ are not uncommon in the summer whereas $30^{\circ}$ to $40^{\circ}F$ below zero is often recorded in the winter. The mean annual temperature is about $39^{\circ}F$.

The streams are ice covered for about 4 months and the ground is generally sufficiently frozen to prevent infiltration from mid-November to early April.

Precipitation is derived chiefly from air masses moving from the Gulf of Mexico and the Atlantic Ocean. The average annual precipitation varies from less than 15 inches in the west to 22 inches in the east. The precipitation as either rain or snow is of cyclonic origin. Most of the rainfall comes in local summer thunderstorms causing large variations with regard to time or space. The low winter temperatures often result in an accumulation of snow cover from November or December through March.

## CONCEPTS AND PROCEDURES USED IN THIS STUDY

The principal concept of this study is: streamflow information may be needed at any point on any steam in North Dakota and the program must be designed to accommodate this need. This streamflow information can be provided by a combination of data collection and hydrologic studies that generalize the information obtained at gaging sites.

Another important concept is that the goals of the program, including accuracy goals, should be identified in quantitative form. This permits evaluation of existing data to determine which goals have been attained and how the program should be modified.

The procedures used in this study follow the general framework shown in table 1. Streamflow data are separated into four types; (1) data for current use, (2) data for planning and design, (3) data to define long-term trends, and (4) data on stream environment. For the second type of data, streams are classified as natural or regulated. Each of these

Table 1.—*Framework for design of data collection program*

| Type of data | Current use | Planning and Design | | | | Long-term trends | Stream environment |
|---|---|---|---|---|---|---|---|
| | | Natural Flow | | Regulated Flow | | | |
| | | Minor streams | Principal streams | Minor streams | Principal streams | | |
| Goals | To provide current data on streamflow needed for day-by-day decisions on water management as required. | To provide information on statistical characteristics of flow at any site on any stream to the specified accuracy. | | | | To provide a long-term data base of homogeneous records on natural-flow streams. | To describe the hydrologic environment of stream channels and drainage basins. |
| Drainage area limits | Full range | Less than 500* sq mi. | Greater than 500* sq mi. | Less than 500* sq mi. | Greater than 500* sq mi. | Full range | Full range |
| Accuracy goal | As required | Equivalent to 10 years of record. | Equivalent to 25 years of record. | Equivalent to 10 years of record. | Equivalent to 25 years of record. | Highest obtainable | As required |
| Approach | Operate gaging stations as required to provide specific information needed. | Relate flow characteristics to drainage basin characteristics using data for gaged basins. | Operate gaging stations to obtain 25 years of record (or the equivalent by correlation) at a network of points on principal streams; interpolate between points. | Develop generalized relations that account for the effect of storage, diversion or regulation on natural flow characteristics. | Utilize analytical model of stream system with observed data as input to compute homogeneous records for both natural flow conditions and present conditions of development. | Operate a number of carefully selected gaging stations indefinitely. | Observe and publish information on stream environment. |
| Evaluate available data | Identify stations where data is used currently and code the specific use of data. | Develop relationship for each flow characteristic and compare standard error with accuracy goal. Evaluate sample. | Lay out network of points on principal streams and compare data available at these points with goal. | Appraise type of regulation, data available, and areas where relationships are needed. | Identify stream systems that should be studied using model approach and determine data requirements. | Select two stations in each WRC subregion to operate indefinitely for this purpose. | Evalualte information available in relation to goals. |
| Design future program | | Identify goals that have not been attained. Consider alternate means of attaining goals. Identify elements of future program. | | | | | |

*May be varied with terrain and hydrologic conditions.

classifications is further subdivided into principal or minor, with the separation of the two occurring at a drainage area of 500 square miles.

In the initial phase of the study, program goals were established for each type of data. All available data were then examined and analyzed. This led to a comparison of the information now available with the goals that had been set and to consideration of the elements that should be included in the future program.

Criteria for each of the four types of data, and the methods used to obtain information, are discussed in the following sections.

## Data for Current Use

Current information on streamflow is needed at many sites for day-to-day decisions on water management, for assessment of current water availability, for the management of water quality, for the forecast of water hazards, and for the surveillance necessary to comply with legal requirements. Sites at which the needed data are collected are termed "current-purpose" streamflow stations.

Data for current use are obtained by operating gaging stations to obtain the data specifically required for water-management systems. Current-purpose-data stations are identified separately in this study because (1) justification can be related to specific needs; (2) the data may have little or no transfer value in a hydrologic sense; and (3) the locations of the stations, the accuracy requirements, and the periods of operation are specified by the user of the data, who usually provides the financing. This part of the program is not subject to design, but changes in response to the need for water-management data.

## Data for Planning and Design

Streamflow records form the principal basis for the planning and design of water-related facilities. Past hydrologic experience, however, is never precisely duplicated in the future--the exact sequence of wet and dry years probably will not occur again. Therefore, designers and planners commonly utilize statistical characteristics of streamflow rather than the records of flow at specific times. It is assumed that the probability of occurrence of a flow of a given magnitude or other statistical parameter in the future can be approximated from the frequency of such occurrence in the past. Typical statistical characteristics are the mean flow, the flood of 50-year recurrence interval, and the standard deviation of annual mean flows.

A long record of streamflow at a specific site is desirable for defining statistical characteristics of streamflow at that site. Although it is not feasible to collect a long, continuous streamflow record at every site where it may be needed, a number of such sites are required to provide information that can be transferred to ungaged sites or to sites where little streamflow information is available.

## Natural-Flow Streams

The transfer of information on natural-flow streams is done by relating flow characteristics to basin characteristics, such as drainage area, topography, and climate; by relating a short record to a longer one; or by interpolating between gaged points on a stream channel.

To evaluate the statistical characteristics of streamflow, the streams in North Dakota were identified as having either natural- or regulated-flow conditions. For the purpose of this study, streams were also defined under each of the above categories as being minor streams (drainage area less than 500 sq mi), or principal streams (drainage area greater than 500 sq mi). The principal-stream network was further defined by identifying sites with drainage areas of about 500 square miles on the upstream segment of all streams, and then identifying the following sites from the upstream station to the mouth at points where the drainage area has approximately doubled.

## Regulated-Flow Streams

The natural flow regime of many streams is altered by the construction of storage reservoirs and the diversion of water for consumptive use. These alterations increase the scope of both the data collection and the analysis that is required to provide information on the flow characteristics.

To be useful in statistical prediction, streamflow data must be homogeneous in time. Frequently, however, it is not possible to obtain a long record under one condition of development before additional development occurs.

Definition of the flow characteristics at any point on any stream is also much more difficult under conditions of regulation. The procedures used for natural streams--regression, correlation, interpolation, etc.--cannot be applied.

For regulated streams, a systems approach seems to be the most efficient way of providing meaningful information on the statistical characteristics of flow. This approach requires some sort of analytical model of the stream system. Such models are simple in concept and generally consist of water-budget equations and flow-storage equations. However, in many instances the use of the digital computer is required for complex equations, or to handle large volumes of data. A computer program tailored to the individual system can be prepared.

Development of an analytical model requires information on stage-capacity curves of reservoirs, stage-discharge curves at the outlets, operating-rule curves for the release of water, losses due to evaporation and seepage, the geometry of the stream channel, and records of diversions and return flow. Information on streamflow at some point or points is also needed as input to the model to verify the output. Frequently aquifer characteristics and ground-water pumpage should be considered. All historical streamflow records for both natural and regulated flows could be used as input to the model.

The model and the associated data can be used to derive homogeneous data for both the natural and the regulated conditions. Furthermore, data could also be derived for ungaged sites in the stream system.

## Accuracy Goals

In using past hydrologic experience to appraise the probability of future occurrences, some error must be tolerated. Natural streamflow, like other events related to climate, is generally random in occurrence and varies greatly in time and space. Statistical techniques used in the analysis of random events, therefore, are considered applicable. Measures of the variability of annual mean flow and other streamflow characteristics with time are determined from the historical streamflow data, and the probable errors involved in defining streamflow characteristics can be appraised. The principal measure of the accuracy with which a particular streamflow characteristic can be determined is the statistical measure of error, "standard error of estimate," and is expressed in this report as a percentage of the average value of the characteristic. The standard error is the estimated limit above and below the average within which about 67 percent of future values of the characteristics are expected to fall. Conversely, there is only one chance in three that future values will differ from the average by more than one standard error.

In general, the longer the record, the more reliable are the estimates of probable future occurrences. However, even with a long record, say 50-100 years or more, it is not possible to determine with great precision the probability of certain flow characteristics, such as floods of a given magnitude. The standard error of various streamflow parameters decreases with the years of available record, but at a decreasing rate, as shown in figure 2. The incremental economic value of the additional years of record beyond a reasonable limit in the planning and design of projects is under continuing study.

Accuracy goals for streamflow characteristics are expressed as the accuracy equivalent of an arbitrary number of years of record. These goals are the same for natural and regulated flows; in this study the accuracy equivalent to that which would be obtained from 10 years of record at the site for minor streams, and which would be obtained from 25 years of record for principal streams.

At sites on natural-flow streams where streamflow records are not available, the desired streamflow characteristics may be defined by relating the streamflow parameter to the characteristics of the drainage basin. This definition is accomplished by multiple-regression analysis, a statistical method of handling sample data that can relate a streamflow

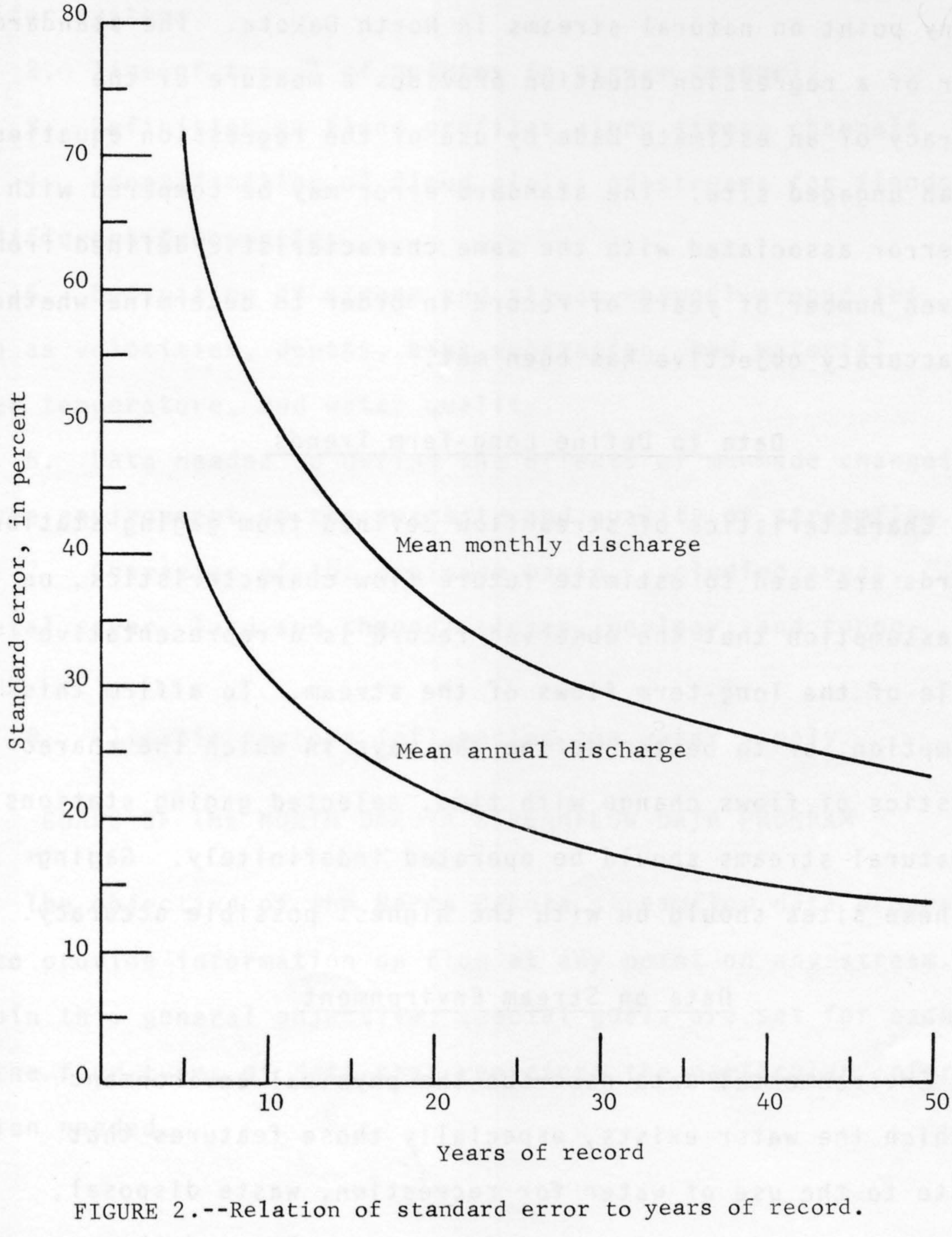



FIGURE 2.--Relation of standard error to years of record.

characteristic to the topographic and climatic characteristics that affect streamflow. The analysis produces a regression equation that can be used to compute the flow characteristics at any point on natural streams in North Dakota. The standard error of a regression equation provides a measure of the accuracy of an estimate made by use of the regression equation for an ungaged site. The standard error may be compared with the error associated with the same characteristic defined from a given number of years of record in order to determine whether the accuracy objective has been met.

## Data to Define Long-Term Trends

Characteristics of streamflow defined from gaging-station records are used to estimate future flow characteristics, on the assumption that the observed record is a representative sample of the long-term flows of the stream. To affirm this assumption, or to better define the ways in which the characteristics of flows change with time, selected gaging stations on natural streams should be operated indefinitely. Gaging at these sites should be with the highest possible accuracy.

## Data on Stream Environment

Environmental data describe the physical environment in which the water exists, especially those features that relate to the use of water for recreation, waste disposal, conjunctive surface-water-ground-water supply, and the preservation of the esthetic character of water features.

Some types of data required are as follows:

1. The geologic and hydraulic properties of the stream-aquifer systems.

2. Time of travel of solutes in stream channels.

3. Definition of flood profiles along stream channels.

4. Identification of flood plains of streams for floods of different frequencies.

5. Definition of stream and stream-channel properties, such as velocities, depths, bank vegetation, bed material, water temperature, and water quality.

6. Data needed to define the effects of manmade changes in the environment on the quantity and quality of streamflow.

7. Character of the drainage basin, including areas, vegetal cover, land and channel slopes, geology, and topography.

8. Climatic factors influencing the water supply.

## GOALS OF THE NORTH DAKOTA STREAMFLOW DATA PROGRAM

The objective of the North Dakota streamflow data program is to provide information on flow at any point on any stream. Within this general objective, special goals are set for each of the four types of data that represent the particular information needed.

## Data for Current Use

The program goal for this type of data is to provide the particular information needed at specific sites for current use. Accuracy goals at a given site, as specified by the data user, can be met by intensive observation, or by more sophisticated instrumentation if needed.

## Data for Planning and Design

The goal for this type of data is to define, within the given accuracy, the statistical flow characteristics listed in table 2. This definition applies not only to all streams with natural flow, but also to those streams that are affected by regulation and diversion. The accuracy goals shown for each flow characteristic are equivalent to 10 years of record for minor streams and 25 years of record for principal streams. The standard errors were calculated from a theoretical relation of standard error to index of variability (for North Dakota streams) and number of years of record.

## Data to Define Long-Term Trends

The goal for this type of data is to operate indefinitely a small network of gaging stations on streams that are expected to be relatively free from manmade changes. One or two stations should be located in each major drainage area in the State, and stations should be located on streams that differ in physical characteristics.

TABLE 2.--Accuracy goals

| Streamflow characteristics | Standard error (percent) | |
|---|---|---|
| | 10 years | 25 years |
| Mean annual discharge-------- | 31 | 19 |
| Standard deviation of annual mean discharges------------ | 22 | 14 |
| Mean monthly discharge (average)------------------ | 52 | 33 |
| Standard deviation of monthly discharges (average)-------- | 22 | 14 |
| 50-year flood---------------- | 90 | 55 |
| 7-day 2-year low flow--------- | 40 | 26 |
| 7-day 2-year high flow-------- | 43 | 27 |
| 7-day 50-year high flow------- | 80 | 35 |

Data on Stream Environment

Environmental data describe the flow and the stream channel in terms that will be valuable in planning the use of the stream for any purpose such as recreation, waste disposal, conjunctive surface-water-ground-water supply, and in guarding against water hazards. The long-trend goals for this type of data in North Dakota are given below.

1. Hydrometric surveys of stream-aquifer systems.
2. Surveys of time of travel of solutes in stream channels.
3. Definition of flood profiles along stream channels.
4. Identification of flood plains of streams for floods of different frequencies.
5. Reconnaissance surveys of streamflow and stream-channel parameters that are related to the use of the stream for recreation, such as velocities, depths, bank vegetation, bed material, water temperature, water quality, and accessibility.
6. Research studies of the effect of manmade changes in the environment on streamflow.

## EVALUATION OF EXISTING DATA IN NORTH DAKOTA

In this evaluation, all available data are considered and analyzed in relation to program objectives. A separate evaluation is made for each of the four types of data.

## Data for Current Use

About 78 percent of the gaging stations in North Dakota are operated to provide data for current use. It is assumed that the need for this type of data is being met, and that this part of the program can be modified as requirements change. The gaging stations operated in North Dakota to satisfy the need for current data are identified in table A-1 in the appendix. The principal uses of the data from each station are also shown in this table.

## Data for Planning and Design

The statistical characteristics of streamflow can be defined by sample gaging, analytical methods of regionalization, systems studies, or any combination of the three. The discussion of the evaluation of these types of data follows the framework shown in table 1.

### Evaluation of the Natural-Flow Systems

The purpose of the evaluation is to determine how accurately the statistical characteristics that are listed as goals can be defined by regionalization of the data now available.

At present, the most effective way to define statistical streamflow characteristics on a broad scale is to relate the streamflow characteristics to basin characteristics in equations developed by use of multiple-regression techniques applied to past data.

Once the equation and its constants are defined, streamflow characteristics for a specific site in a given basin can be computed by substituting the appropriate values of the hydrologic variables in the equations.

The 157 streamflow records used in this study are those having 10 or more years of unregulated flow. Both minor and principal streams were included. Records were not adjusted to a base period. Because of the type of record collected, not all flow characteristics were defined from each record. At one station regulation materially affected peaks but insignificantly affected low flow. No records from very large streams (Missouri River and Red River of the North) were used because these streams are regulated, and because there are no large ungaged streams in the State to which regression equations could be applied.

Streamflow characteristics

The following streamflow characteristics defined at gaging stations include the full range of flow and represent the characteristics required for planning and design.

1. Low-flow characteristics are the annual minimum 7-day flows at 2-year, 10-year, and 20-year recurrence intervals ($M_{7,2}$, $M_{7,10}$, and $M_{7,20}$). These characteristics were determined from graphical low-flow frequency curves.

2. Flood-peak characteristics are represented by discharges from the annual flood-frequency curve at recurrence intervals of 2, 5, 10, 25, and 50 years. In this report, the peak-flow rates are denoted as $Q_2$, $Q_5$, etc. The frequency curves were prepared as described by the U.S. Water Resources Council (1967).

3. Flood-volume characteristics are the annual highest 7-day mean flows at recurrence intervals of 2, 10, and 50 years. These characteristics are noted symbolically in this report as $V_{7,2}$, $V_{7,10}$, and $V_{7,50}$. They were determined from frequency curves prepared as described by the U.S. Water Resources Council (1967).

4. Mean-flow characteristics are described by the mean of the annual means, $Q_a$; and by the means of record for each calendar month, $q_n$, where the subscript "n" refers to the numerical order of the month beginning with January as 1.

5. Flow-variability characteristics are represented by the standard deviations of the annual and monthly means. The symbols used are, respectively, $SD_a$ and $SD_n$, where the subscript "n" refers to the numerical order of months with January as 1.

Values of selected streamflow characteristics for each of the 157 gaging stations are listed in table A-2 in the appendix.

Drainage-basin characteristics

Drainage-basin characteristics defined for this study are:

1. Drainage area (A), is the contributing drainage area, in square miles, as shown in the latest Geological Survey streamflow report.

2. Slope (S), is the main-channel slope, in feet per mile, determined from elevations at points 10 percent and 85 percent of the distance along the channel between the gaging station and the divide. This index was described and used by Benson (1962, 1964).

3. Length (L), is the main-channel length, in miles, from the gaging station to the basin divide, as measured by dividers in 0.2 mile or less increments.

4. Storage (St), is the area of lakes and ponds, expressed as a percentage of the drainage area, determined from available topographic maps and Soil Conservation Service reports of stockponds.

5. Elevation (E), is the mean-basin elevation, in feet above mean sea level, measured on 1:250,000 Army Map Service maps or U.S. Geological Survey topographic maps by laying a grid over the map, determining the elevation at each grid intersection, and averaging the determined elevations. The grid spacing was selected to give at least 25 intersections within each basin boundary.

6. Forest (F), is the forest cover, expressed as a percentage of the drainage area covered by forests as shown on the topographic map, determined by the grid method.

7. Precipitation (P), is the mean annual precipitation, in inches, as determined from maps in Environmental Science Services Administration (ESSA) publication "Climatic Atlas of the United States" (1968).

8. Rainfall intensity ($I_{2,24}$), is the maximum 24-hour rainfall having a recurrence interval of 2 years (24-hour 2-year rainfall), expressed in inches. These values were determined from the U.S. Weather Bureau (USWB) publication "Rainfall Frequency Atlas of the United States" (1961).

9. Temperature ($T_3$), is the mean maximum March temperature, in degrees Fahrenheit, from USWB publication "Climates of the States, North Dakota" (1959).

10. Temperature ($T_1$), is the mean minimum January temperature, in degrees Fahrenheit, from USWB (1959).

11. Temperature ($T_7$), is the mean maximum July temperature, in degrees Fahrenheit, from USWB (1959).

12. Soils infiltration index (Si), is an index to soil infiltration capacity, expressed in inches, from a map prepared from information supplied by the Soil Conservation Service.

13. Shape (Sh), is a ratio of length to width, obtained by dividing the length squared by the area.

14. Orientation (Or), is a basin orientation factor, represented by a number 1 or 2, indicating that the basin is predominantly east-west or north-south.

15. Snowfall (Sn), is mean annual snowfall, in inches, from ESSA (1968).

16. Snow ($Sn_{10}$), is the maximum water equivalent of March snow cover, in inches, having a recurrence interval of 10 years, from USWB publication "Frequency of Maximum Water Equivalent of March Snow Cover in North Central United States" (1964).

17. Snow ($Sn_{100}$), is the maximum water equivalent of March snow cover, in inches, having a recurrence interval of 100 years,,from USWB (1964).

18. Evaporation (Ev), is mean annual evaporation, in inches, from ESSA (1968).

19. Geographic factor (G), is a numerical expression obtained by combining areas of like residuals from regression equations using the basin characteristics.

Values of the above basin characteristics used in the analysis are listed in table A-3 in the appendix for each of the 157 gaging stations. In actual use it was necessary to alter some of the variables with a constant to avoid unwieldy figures in the regression analysis. Other basin and climatic factors were investigated but found to be too closely correlated to those listed to be of value.

Regression analysis

The next step was to relate each of the streamflow characteristics to basin and climatic characteristics in equations developed by using multiple-regression techniques. The equation has the form

$$Y = aA^{b_1}S^{b_2}P^{b_3},$$

where Y is a statistical streamflow characteristic;

A, S, and P are topographic or climatic characteristics;

a, is the regression constant; and

$b_1$, $b_2$, and $b_3$ are coefficients obtained by regression.

These regression techniques were described by Benson (1962). In this study, all topographic and climatic characteristics were used initially in each regression. The computer calculated the regression equation, the standard error of estimate, and the significance of each basin parameter. The computer then automatically repeated the calculations, omitting the least significant basin parameter in each calculation until only the most significant parameter remained. After relations for a given streamflow characteristic had all been computed, the entire computation process was repeated using another streamflow characteristic along with the same set of basin characteristics.

Table 3 illustrates the output of the regression analyses of mean annual flow. On the basis of the regression analyses, the equation, which includes all statistically significant

TABLE 3.--Summary of regression analyses of mean annual flow

| Dependent variable | Regression coefficients for independent variables[1] | | | | | | Regres-sion constant | Standard error of estimate | |
|---|---|---|---|---|---|---|---|---|---|
| | Area | Slope | March temper-ature | Evapor-ation | Forest cover | Shape factor | | Percent | Percent change[2] |
| Mean | 0.975 | 0.360 | 1.176 | -1.363 | 0.084 | 0.359 | 0.054 | 61 | --- |
| annual | 1.041 | .532 | 1.125 | -1.656 | ----- | .352 | .051 | 64 | 3 |
| flow. | 1.120 | .396 | .938 | -1.529 | ----- | ----- | .094 | 68 | 4 |
| | 1.159 | .406 | ----- | - .682 | ----- | ----- | .057 | 73 | 5 |
| | 1.108 | .454 | ----- | ----- | ----- | ----- | .014 | 77 | 4 |
| | .972 | ----- | ----- | ----- | ----- | ----- | .065 | 85 | 8 |

1/ All regression coefficients are significant at 1-percent level.

2/ Percent change when least significant variables are dropped.

variables, for determining mean annual discharge at ungaged sites in North Dakota is

$$Q_A = 0.54A^{0.975}S^{0.360}(Ev-12)^{-1.363}(T_3-26)^{1.176}Sh^{0.359}(F+0.01)^{0.084},$$

where $Q_A$ is mean annual discharge, in cubic feet per second;

$A$ is drainage area, in square miles;

$S$ is the main-channel slope, in feet per mile;

$Ev$ is the mean annual evaporation, in inches (minus 12);

$T_3$ is the mean maximum March temperature, in degrees Fahrenheit (minus 26);

$Sh$ is the shape factor length squared over area; and

$F$ is the forest cover, in percent of total drainage area (plus 0.01).

By eliminating the shape and forest factors from the equation, the standard error is increased only 7.0 percent. The equation using only drainage area, slope, evaporation, and March temperatures probably would be most useful, as this will eliminate the necessity of computing the shape and forest factors.

Table A-4 shows the regression constant, the regression coefficients (exponents) for basin parameters that significantly reduce the standard error, and the standard error for each of 37 streamflow characteristics.

The standard errors shown in table A-4 can be compared with the corresponding values of table 2 to determine how close they are to meeting the goals that have been set. The regression results do not meet the accuracy goals for minor streams (the equivalent of 10 years of record), or principal streams (the equivalent of 25 years of record). Changes were made in the analysis in an attempt to meet the goals--dividing the State on the basis of geologic differences, using a geographic factor based on residuals from the previous regressions--but there was no significant improvement.

At the present time, the goals can be met only by gaging-station operation, because the accuracy objectives cannot be achieved by techniques of regionalization using the data available. It is possible that improvement on the model in the handling of the independent variables or better definition of these variables would result in achievement of the accuracy goals. Also, other variables such as channel geometry might be considered. The study identifies the minor- and principal-stream networks and evaluates the length of record available at the sites.

The present principal-streams network includes 32 sites on unregulated streams, with at least 25 years of record at 16 of these sites; the present minor-streams network includes 39 sites on unregulated streams, with at least 10 years of record at 24 of the sites.

## Evaluation of the Regulated-Flow Systems

The goals for regulated streams are more difficult to attain because the technique of regionalization does not apply, the characteristics are not necessarily stationary in time, and a meaningful correlation seldom exists between flows at two sites if at least one of the flows is regulated. A systems approach may be used to define the characteristics of regulated streamflow under different patterns of regulation, or under the condition of natural flow. Systems studies for all the regulated-stream systems in North Dakota will require a major effort. Therefore, the present evaluation is limited to (1) identifying the regulated streams, and (2) describing briefly the approach that would be used.

The stream systems in North Dakota materially affected by regulation are: Red River of the North; Sheyenne River below Baldhill Dam; South Branch Park River and Park River below Homme Reservoir; Tongue River; Souris River; Missouri River; Square Butte Creek below Nelson Lake, Sweetbriar Creek below Sweetbriar Dam; Heart River below Dickinson; North Fork Grand River; James River below Arrowwood National Wildlife Refuge. The Missouri River and the Red River of the North are major interstate streams with complex regulation patterns; systems studies for these streams should not be limited to the parts in North Dakota.

Streamflow data obtained before and after reservoir construction and records of reservoir contents will be very useful in systems studies. Available streamflow records for regulated North Dakota streams are shown in table 4. Records of daily contents are available for all major reservoirs in records of the U.S. Geological Survey and others.

The approach that might be used in future studies of regulated streams can be described by using the Sheyenne River as an example. This stream was unregulated prior to construction of Baldhill Dam in 1949. The reservoir (Lake Ashtabula) is operated by the Corps of Engineers for flood control and water supply. Streamflow records are available at a site about 7 miles above the lake from 1944 to present; at a site 17.5 miles below the dam from 1938 to present; and on the only sizeable tributary from 1956 to present. These data adequately define the flow characteristics under natural conditions. Twenty-one years of record at a site immediately below the dam are available for defining the characteristics under the regulated condition. A longer homogeneous record at the gage site, or at any downstream point, could be computed by (1) developing a flow-storage model of the reservoir and channel, and (2) using the natural-flow record and the rule curve for operation of the reservoir as inputs to the model. The statistical characteristics of regulated streamflow could be computed from these synthesized records. Construction of the proposed dam downstream near Kindred would result in a revised

TABLE 4.--Records on regulated-stream systems

| Station number | Station name | Length of record | |
|---|---|---|---|
| | | Before reservoir construction | After reservoir construction |
| 5-0515 | Red River of the North at Wahpeton------------ | 0 | 26 |
| 5-0540 | Red River of the North at Fargo---------------- | 40 | 28 |
| 5-0580 | Sheyenne River below Baldhill Dam----------- | 0 | 20 |
| 5-0585 | Sheyenne River at Valley City------------------- | 11 | 20 |
| 5-0587 | Sheyenne River at Lisbon- | 0 | 13 |
| 5-0590 | Sheyenne River near Kindred---------------- | 0 | 20 |
| 5-0595 | Sheyenne River at West Fargo------------------ | 22 | 20 |
| 5-0645 | Red River of the North at Halstad, Minn.------ | 0 | 8 |
| 5-0825 | Red River of the North at Grand Forks--------- | 48 | 39 |
| 5-0890 | South Branch Park River below Homme Dam-------- | 0 | 20 |
| 5-0900 | Park River at Grafton---- | 18 | 20 |
| 5-0920 | Red River of the North at Drayton------------ | 0 | 20 |
| 5-1010 | Tongue River at Akra----- | 3 | 15 |
| 5-1140 | Souris (Mouse) River near Sherwood---------- | 27 | 12 |

TABLE 4.--Records on regulated-stream systems, Continued

| Station number | Station name | Length of record | |
|---|---|---|---|
| | | Before reservoir construction | After reservoir construction |
| 5-1160 | Souris (Mouse) River near Foxholm------------ | 0 | 34 |
| 5-1165 | Des Lacs River at Foxholm----------------- | 0 | 26 |
| 5-1175 | Souris (Mouse) River above Minot------------ | 32 | 34 |
| 5-1200 | Souris (Mouse) River near Verendrye--------- | 0 | 32 |
| 5-1220 | Souris (Mouse) River near Bantry------------ | 0 | 32 |
| 5-1240 | Souris (Mouse) River near Westhope---------- | 5 | 34 |
| 6-3390 | Missouri River below Garrison Dam------------ | 5 | 16 |
| 6-3422.6 | Square Butte Creek below Center------------ | 2 | 2 |
| 6-3425 | Missouri River at Bismarck---------------- | 8 | 33 |
| 6-3440 | Heart River below Dickinson Dam near Dickinson-------------- | 0 | 18 |
| 6-3455 | Heart River near Richardton-------------- | 26 | 19 |
| 6-3465 | Heart River below Heart Butte Dam near Glen Ullin------------------ | 6 | 20 |
| 6-3480 | Heart River near Lark---- | 3 | 20 |

TABLE 4.--Records on regulated-stream systems, Continued

| Station number | Station name | Length of record | |
|---|---|---|---|
| | | Before reservoir construction | After reservoir construction |
| 6-3485 | Sweetbriar Creek near Judson------------------ | 12 | 6 |
| 6-3490 | Heart River near Mandan------------------ | 16 | 20 |
| 6-3550 | North Fork Grand River at Haley---------------- | 30 | 3 |
| 6-4685 | James River near Pingree----------------- | 0 | 16 |
| 6-4700 | James River at Jamestown--------------- | 0 | 34 |
| 6-4705 | James River at LaMoure---------------- | 0 | 19 |

rule curve for operation of the reservoir, and a set of different statistical characteristics for the regulated streamflow.

## Data to Define Long-Term Trends

At present two gaging stations on unregulated streams, Beaver Creek near Finley and Bear Den Creek near Mandaree, are designated as long-term stations for indefinite operation. No stations on regulated streams are now so designated.

## Data on Stream Environment

Many environmental factors were determined for the drainage basins used in the present study, particularly basin characteristics such as drainage area, extent of forest cover, stream slopes, land elevations, and area of lakes and ponds. Average annual precipitation and rainfall intensity were also determined.

Flood plains have been outlined on 26 topographic quadrangle maps and flood profiles defined for selected streams. Detail channel surveys have been made at the two gaging stations designated as long-term stations. Channel surveys have been made at many sites in connection with indirect determinations of peak flows for unusual floods.

## DISCUSSION OF THE EVALUATION

Of the four data categories used in this study, only one, "data for planning and designing of water projects," is clearly subject to design. The requirements for other types of data are established in response to specific needs, or are defined by hydrologic judgment.

The evaluation of available streamflow data by regression analysis was based on data from 88 continuous-record gaging stations and 69 partial-record stations. Records from both minor and principal natural-flow streams were included. The conclusions and implications drawn from the results, based on standard errors shown in tables 2 and A-4, are:

1. For natural flows, applications of the regression equations will not provide estimates of any of the selected streamflow characteristics at ungaged sites within the accuracy objectives.

2. Regression equations are not defined for any of the streamflow characteristics except flood peaks for drainage areas of less than about 200 square miles. Continuous-record stations must be operated to define the streamflow characteristics for small-drainage areas.

3. The objectives established for identifying the principal-stream network included sites with drainage areas of about 500 square miles on the most upstream segment of the stream and, proceeding downstream, sites where the drainage

area is approximately double that of the previous site. The accuracy objective of 25 years of record, or equivalent, has been attained at two of the six stations on natural-flow principal streams identified solely in this category. To meet the objective of sampling progressively doubled increments of drainage areas on principal streams, two additional stations are needed.

## THE PROPOSED PROGRAM

The information developed in different segments of this study has been merged and applied in planning a streamflow-information program that would eventually attain as many of the remaining goals as possible within the limits of available funds. For the optimum program, a balance must be maintained between data collection and data analysis, as continuous interaction between the two is needed to gain a better understanding of the hydrologic system and to guide future evaluation of the program in meeting ever changing needs and in adapting to changing technology.

### Data Collection

#### Data for Current Use

Operation of the 83 stations, identified as presently meeting the needs for current-use data (table A-1), should be continued. The changing needs will be assessed continuously, and the data-collection network will be modified by adding or discontinuing stations as needs change for current-use data. Also the need for this type of data will be examined for each site, and a determination made as to whether a continuous record of daily discharge is required or a measure of a specific flow characteristic, such as peak flow or instantaneous flow, would suffice. The locations of stream-gaging stations included in the present program for current use are shown in figure 3.

## Data for Planning and Design

Some of the objectives have been attained through length of record; however, continued operation of certain stations to obtain either continuous-record or partial-record data is indicated.

Low-flow characteristics at ungaged sites cannot be estimated at present by regression methods, as most of the streams are ephemeral and have extended periods of no flow. At the sites where low-flow characteristics are meaningful, a reasonable estimate can probably be made by correlating a few low-flow measurements at the site with concurrent flow data at a suitable continuous-record index station where similar hydrologic conditions prevail. No additional index stations appear to be needed in North Dakota.

Flood-peak characteristics at recurrence intervals of 100 years are often estimated for project degisn. Although the objective includes only the 50-year flood, it would be

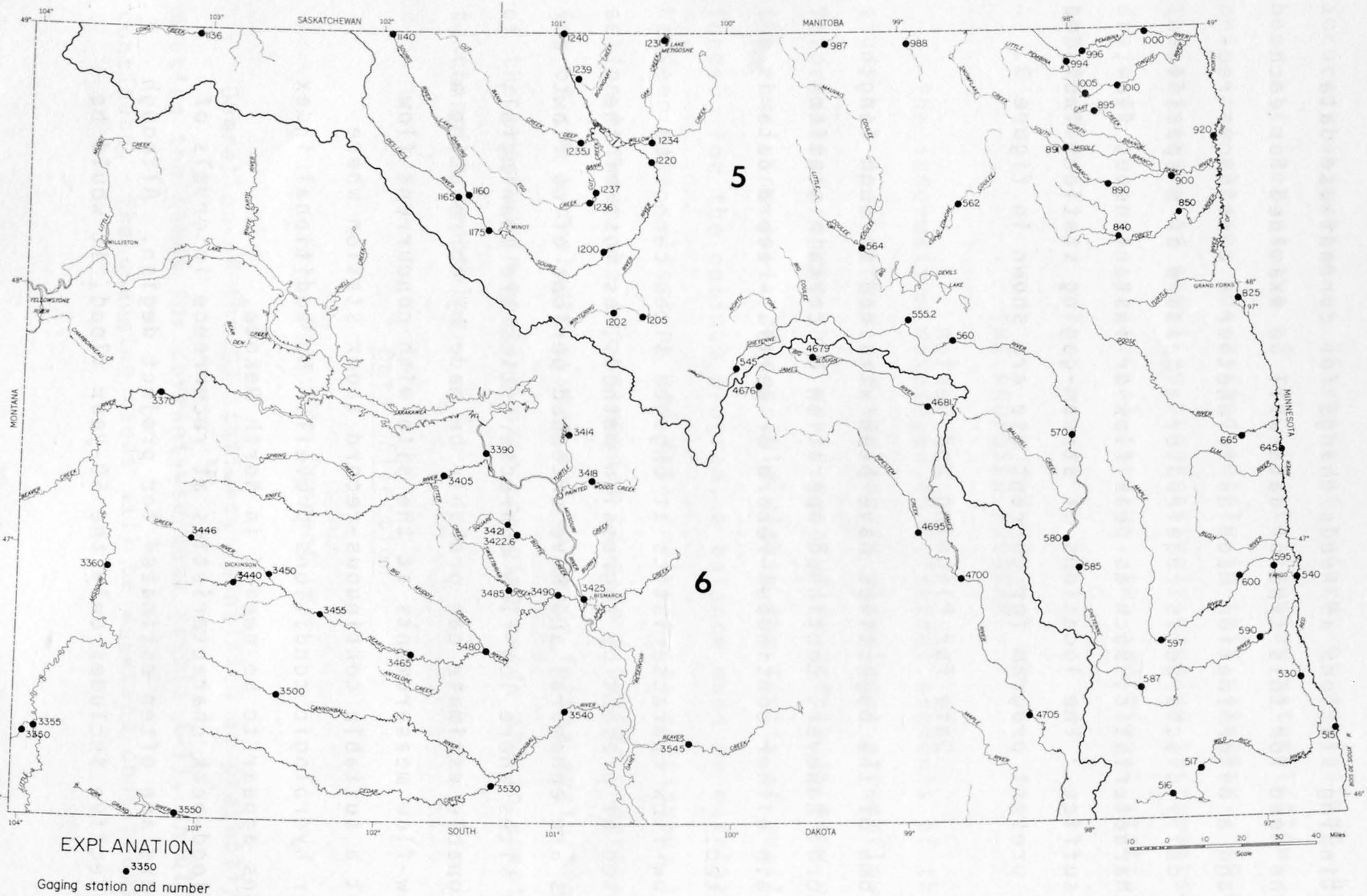



FIGURE 3.-- Locations of current-purpose gaging stations.

desirable to continue collecting flood-peak data at selected sites indefinitely. For each streamflow station subject to discontinuance, consideration will be given to the continued collection of peak-flow data. The needed data can thus be obtained at a lower cost by operating a partial-record station.

Natural flow, minor streams

Application of the regression equations will not give flow-characteristic results within the accuracy goals for minor streams. Of the 40 stations identified in this category, a record of 10 years, or equivalent, has been obtained at six stations identified solely in this category of data. Twenty-three of the stations identified under this category of data, 16 of which have 10 or more years of record, also are identified as current-purpose stations and must be continued in operation to meet those specific needs for data. As a result of this study, a conservative definition of an adequate time sample is 20 years of record. It is recommended that 80 percent of the stations with 20 or more years of record be discontinued and the remaining 20 percent be operated until the goals have been met. The following stations in the natural-flow, minor-streams network are not recommended for inclusion in the program.

| | |
|---|---|
| 5-0605 | Rush River at Amenia |
| 6-3430 | Heart River near South Heart |
| 6-3475 | Big Muddy Creek near Almont |

It is recommended that the following stations be established or reactivated to fill gaps in the areal coverage of the minor-streams sampling. These stations were chosen primarily as a result of discrepancies or lack of data indicated on plots of median annual runoff.

| | |
|---|---|
| 5-0525 | Antelope Creek at Dwight |
| 5-0596 | Maple River near Hope |
| 5-0622 | Elm River near Kelso |
| 5-0657 | Middle Branch Goose River near Finley |
| 5-0922 | Unnamed tributary near Glasston |
| 5-1161.8 | Stony Run Creek near Perella |
| 5-1176 | Gassman Coulee near Minot |
| 6-3302 | Little Muddy Creek near Appam |
| 6-3316.8 | Tobacco Garden Creek near Watford City |
| 6-3324.8 | Little Knife River near New Town |
| 6-3357.5 | Deep Creek near Amidon |
| 6-3360.5 | Andrews Creek near Medora |
| 6-3368 | Bicycle Creek near Grassy Butte |
| 6-3375.8 | Middle Branch Douglas Creek near Emmet |
| 6-3392.8 | Deep Creek near Manning |
| 6-3491 | Unnamed tributary to Alkaline Lake near Napoleon |
| 6-3496 | Little Heart River near St. Anthony |
| 6-3499 | Cannonball River at New England |
| 6-3516.8 | White Butte Fork Cedar Creek near Scranton |
| 6-3544 | South Branch Beaver Creek near Strasburg |

6-3548.2 Porcupine Creek near Fort Yates

6-3576 Hiddenwood Creek at Haynes

6-4682.5 Kelly Creek near Bordulac

6-4703 Beaver Creek near Sydney

6-4708 Bear Creek near Oakes

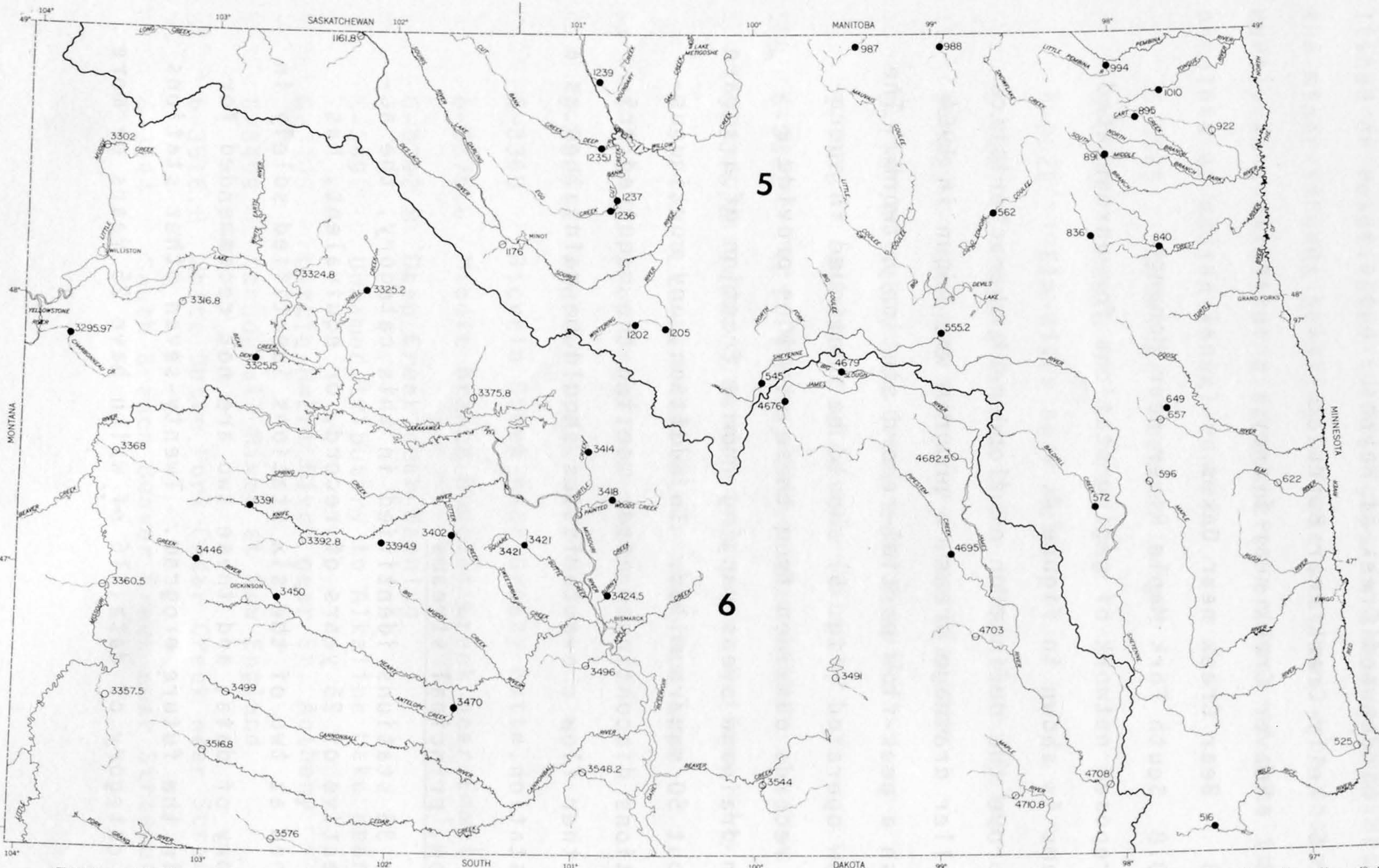
6-4710.8 South Fork Maple River near Monango

The proposed network of gaging stations for unregulated minor streams is shown in figure 4.

To improve the definition of flood-peak characteristics for the smaller drainage areas, a program was begun in 1954 to establish a peak-flow partial-record station network. The stations now operated (fig. 5) should be continued in operation. The records obtained from these stations provide a sample from drainage areas ranging from a fraction of a square mile to about 50 square miles. In addition, any continuous-record stations discontinued after meeting the required criteria for other flow characteristics should be maintained as a peak-flow station.

Natural flow, principal streams

Of the 33 stations identified in this category, the accuracy objective of 25 years of record, or equivalent, has been attained at two of the six stations identified solely in this category of data, and these two are not recommended for inclusion in the future program. Twenty-seven other stations under this category of data, 16 of which have 25 years or more




EXPLANATION

●562
Existing gaging station and number

○525
Proposed gaging station and number

FIGURE 4.-- Proposed network of gaging stations for unregulated minor streams.

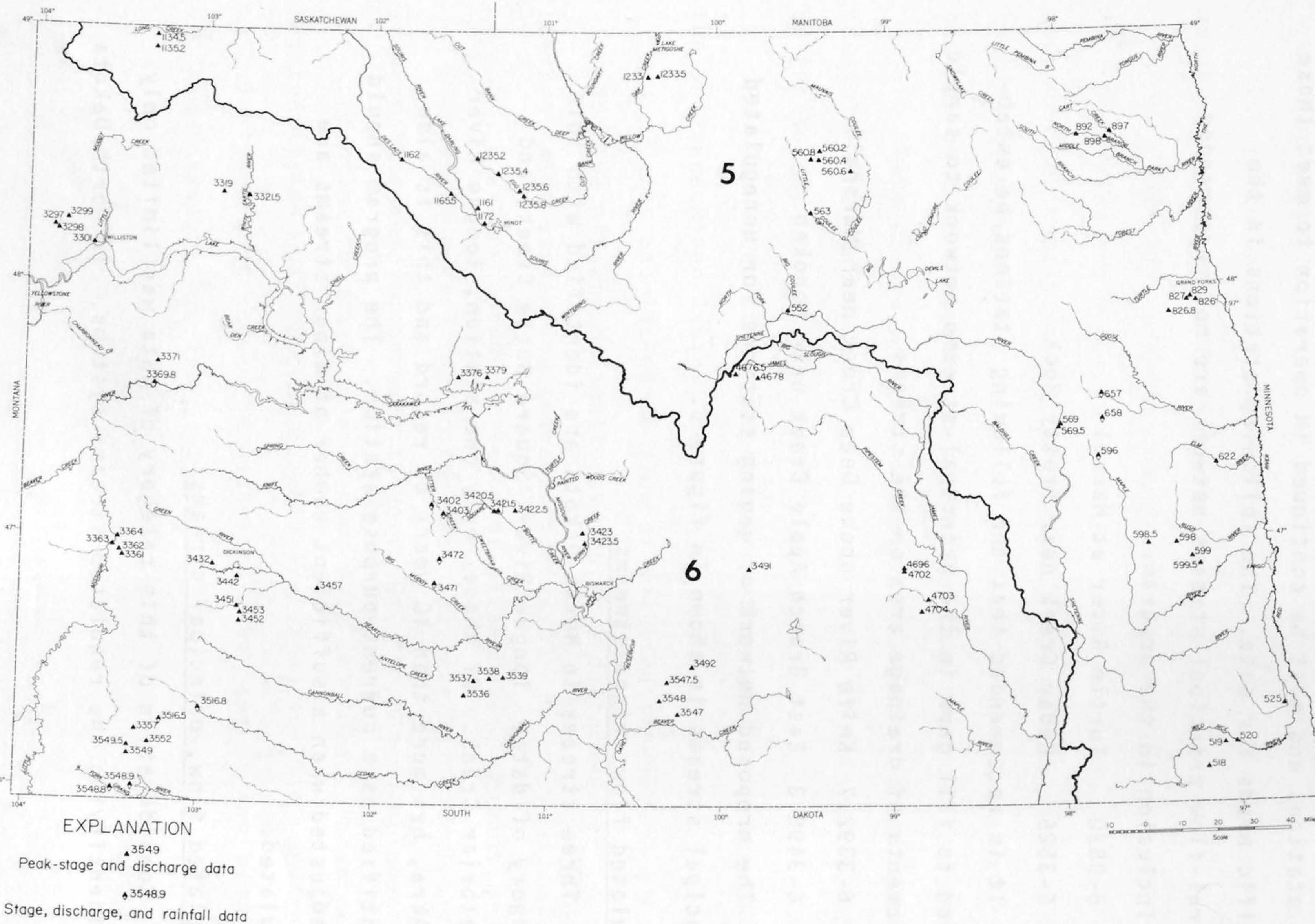



FIGURE 5.-- Locations of partial-record sites at which flood data are being collected.

of record, also are identified as current-purpose or long-term stations and must be continued in operation to meet those specific needs for data. The following stations in the natural-flow principal-streams network are not recommended for inclusion in the program.

5-0830 Turtle River at Manvel

6-3525 Cedar Creek near Pretty Rock

It is recommended that the following stations be established to fill gaps in the principal-streams network to sample increments of drainage area on the streams.

6-3392.7 Knife River above Deep Creek near Marshall

6-3490.3 East Branch Apple Creek near Menoken

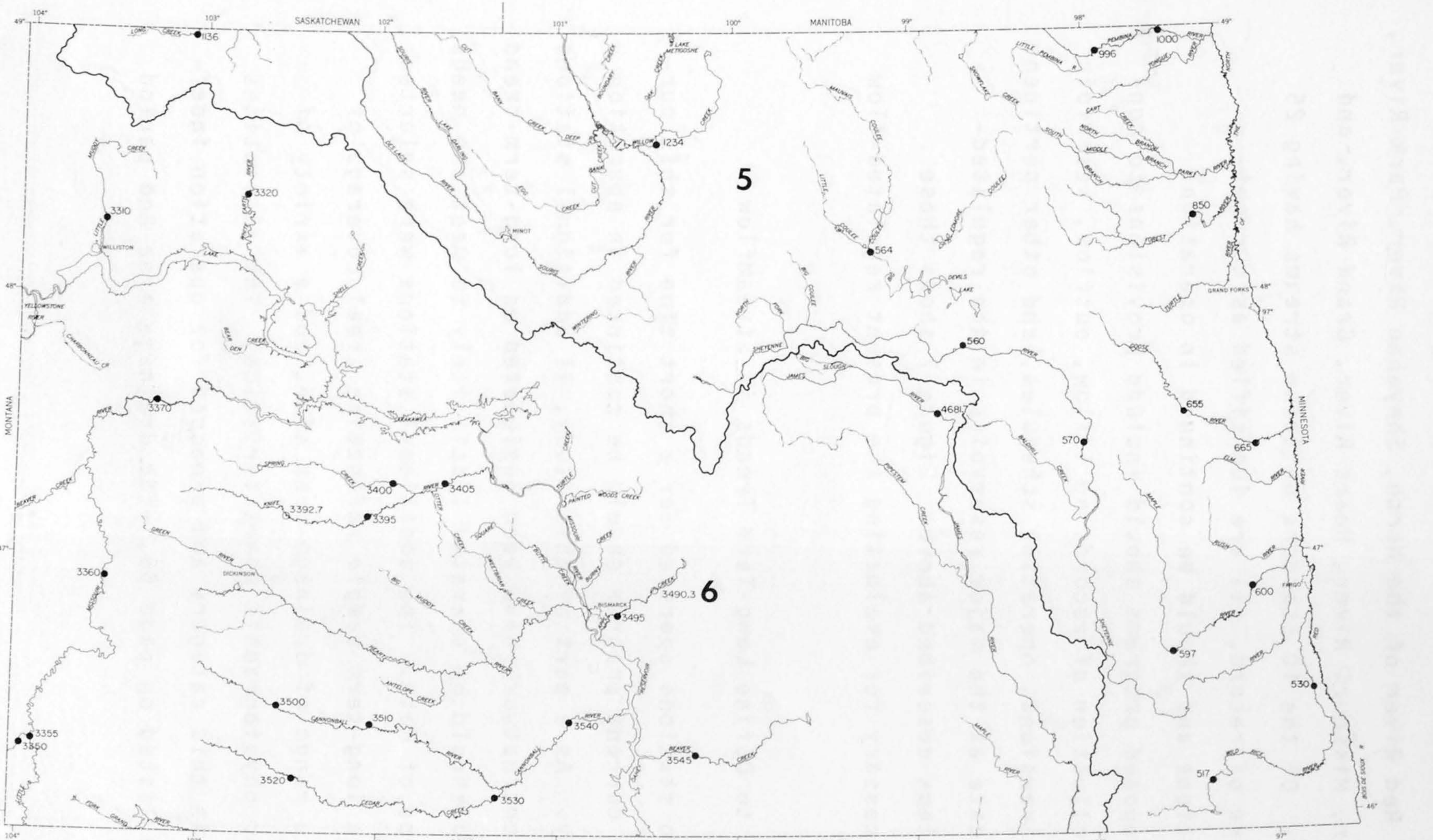
The proposed network of gaging stations for unregulated principal streams is shown in figure 6.

Regulated flow, minor streams

Three streams in North Dakota are identified with this category of data: Tongue River, Square Butte Creek, and Sweetbriar Creek. Of these, only one station, Tongue River at Akra, has more than 10 years of record and this is also identified as a current-purpose station. The program should be adjusted when a sufficient number of minor streams are regulated.

Regulated flow, principal streams

Consideration of this category of data was limited only to identifying the regulated-streams systems. In North Dakota




EXPLANATION

564 Existing gaging station and number

3392.7 Proposed gaging station and number

FIGURE 6.-- Proposed network of gaging stations for unregulated principal streams.

these are: Red River of the North, Sheyenne River, Park River, Souris River, Missouri River, Heart River, Grand River, and James River. Of the 10 stations on these streams having 25 years or more of record, all are identified as current-purpose stations and should be continued in operation.

The proposed programs should include provisions to continue the collection of records on inflow, outflow, reservoir contents, diversions, operating schedules, and other pertinent hydrologic data at the major reservoirs in the regulated-streams systems described above. Figure 7 shows those stations necessary for evaluating the present regulated-flow systems.

### Data to Define Long-Term Trends in Streamflow

The two stations operated for a short time for this purpose in the current program should be continued in operation indefinitely. As a part of this study, 11 additional stations in the present network have been designated as long-term-trend stations and should be operated indefinitely to meet the needs for this type of data. The additional stations were selected to provide a long-term sample reflecting areal coverage of the State, a range of drainage-area size, and a variety of climatic and physiographic characteristics. The 13 stations identified in this category and proposed for operation indefinitely are listed on page 50, with drainage area and period

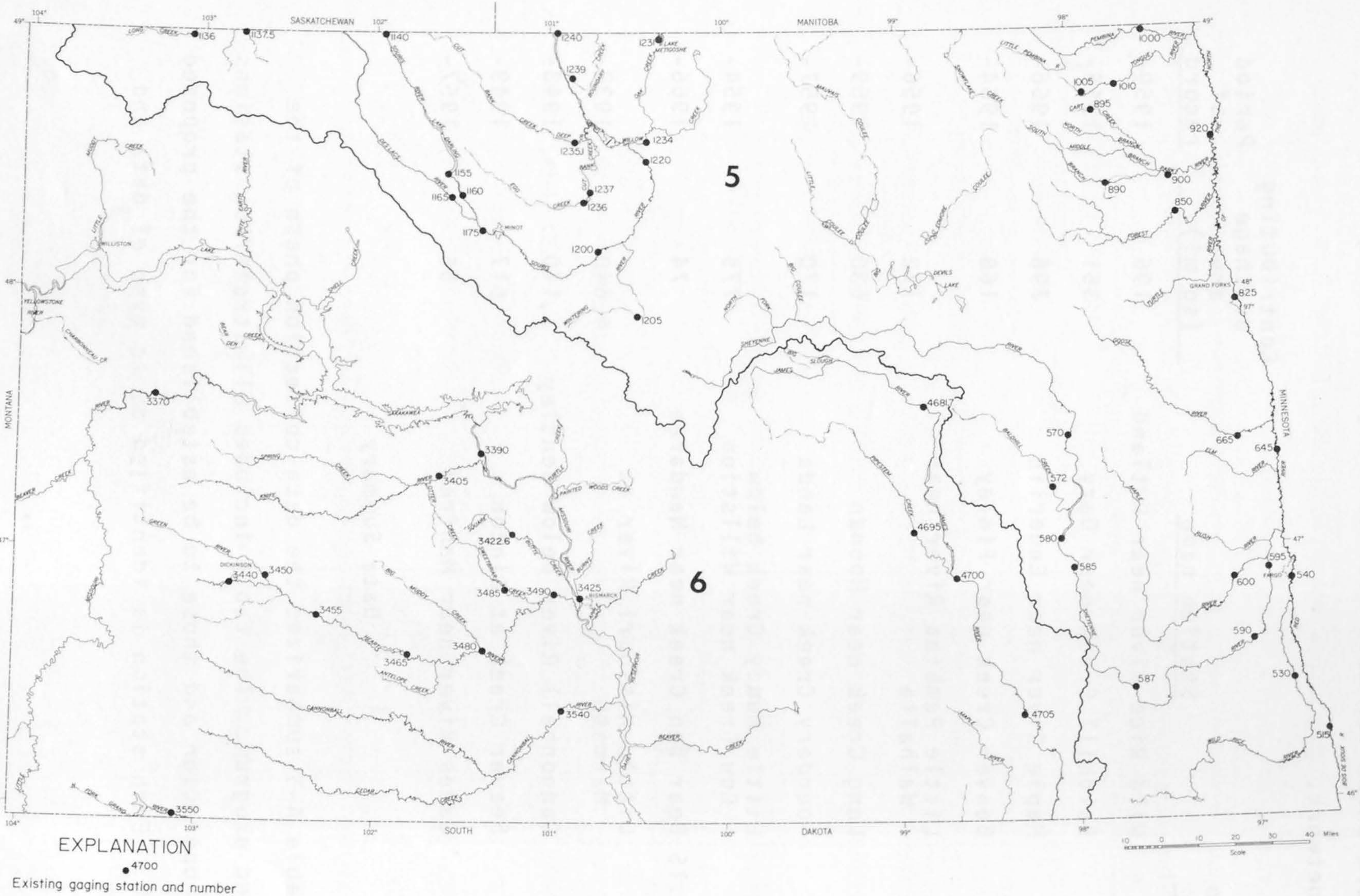


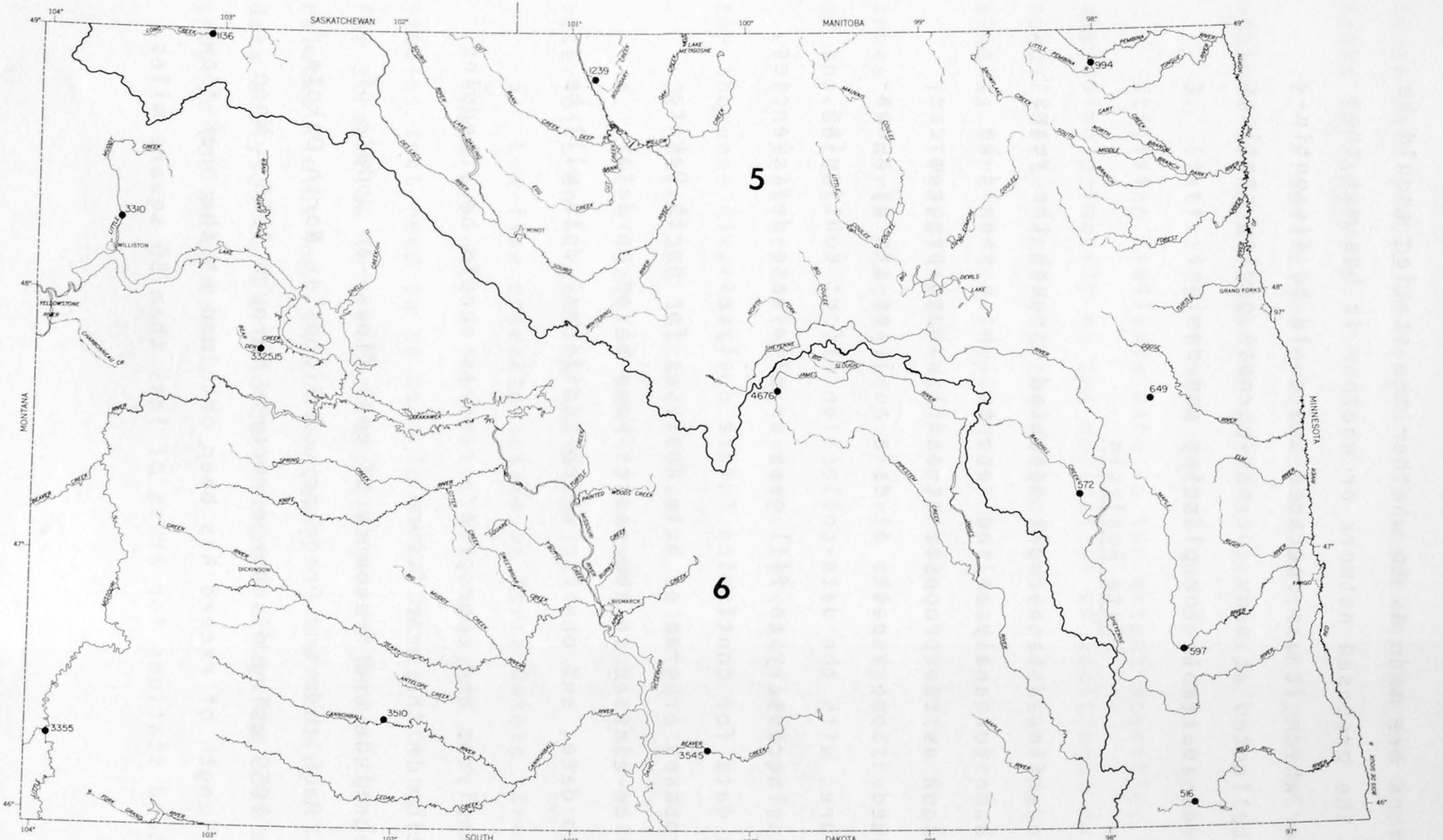

FIGURE 7.-- Proposed network of gaging stations for evaluating the present regulated-flow systems.

of record shown for each station. Figure 8 shows the proposed network.

| Station number | Station name | Contributing drainage area (sq mi) | Period of record |
|---|---|---|---|
| 5-0516 | Wild Rice River near Rutland | 196 | 1959- |
| 5-0572 | Baldhill Creek near Dazy | 351 | 1956- |
| 5-0597 | Maple River near Enderlin | 796 | 1956- |
| 5-0649 | Beaver Creek near Finley | 160 | 1964- |
| 5-0994 | Little Pembina River near Walhalla | 172 | 1956- |
| 5-1136 | Long Creek near Noonan | 630 | 1959- |
| 5-1239 | Boundary Creek near Landa | 170 | 1957- |
| 6-3310 | Little Muddy Creek below Cow Creek near Willstion | 775 | 1954- |
| 6-3325.15 | Bear Den Creek near Mandaree | 74 | 1966- |
| 6-3355 | Little Missouri River at Marmath | 4,640 | 1938- |
| 6-3510 | Cannonball River below Bentley | 1,140 | 1943- |
| 6-3545 | Beaver Creek at Linton | 617 | 1949- |
| 6-4676 | James River near Manfred | 56 | 1957- |

## Data Summary

Table A-5 summarizes the data-collection phase of the proposed program. The table includes all streamflow stations now in operation and those to be established for the proposed program. Each station is identified as to type of data and




EXPLANATION

516 Gaging station and number

FIGURE 8.-- Proposed network of gaging stations for monitoring long-term trends in streamflow.

recommendations are made as to whether the station should be included in the proposed network or whether it has met the objective for which it was operated and could be discontinued. Data collected at many current-purpose gaging stations are considered available for planning and design.

## Data Analysis

The streamflow-data network operated through the years supplies a base for analyses and reports, which should be started as soon as the proposed streamflow-data program can be implemented. Some aspects of data analyses are of a continuing nature, with the data-collection effort continuing, reoriented as necessary to fill gaps or eliminate deficiencies, and provide data for continuing future analyses.

The proposed program of data analyses for North Dakota streams may be classed in two phases--one based on data collected to date, and one for which additional data will be required.

Data analyses and appropriate reports should be scheduled for completion in the near future:

1. Magnitude and frequency of peak flows--an update of the report "Magnitude and Frequency of Floods in North Dakota," prepared in 1959 using discharge records through 1955. When sufficient length of record has been obtained at the peak-flow partial-record stations for areas of less than 50 square miles,

these data should be merged with those for larger drainage areas for analysis.

2. Flood-volume frequency based on analysis of annual maximum average flows for selected periods of time.

3. Statistics of mean annual and mean monthly flows.

Utilizing available data to the extent possible, but depending primarily on the collection of additional data specifically required, the following studies should be initiated as part of the proposed streamflow-data program.

1. Time of travel and dispersion of solutes in selected areas in North Dakota, giving first priority to the Red River of the North.

2. Regulated-streams systems, giving first priority to the Sheyenne River Basin.

3. Gains and losses of flow of selected streams.

4. The effects of small reservoirs and stock-water reservoirs on streamflow characteristics.

5. Low-flow characteristics of North Dakota streams.

These are only a few of the data analyses and hydrologic studies that need to be made in North Dakota. Changing needs for streamflow information and changes in technology in water-related fields must be continuously evaluated in light of the data analyses that should be generated under the streamflow program for North Dakota.

## REFERENCES

Benson, M. A., 1962, Factors influencing the occurrence of floods in a humid region of diverse terrain: U.S. Geol. Survey Water-Supply Paper 1580-B, 64 p.

_____1964, Factors affecting the occurrence of floods in the Southwest: U.S. Geol. Survey Water-Supply Paper 1580-D, 70 p.

Carter, R. W., and Benson, M. A., 1970, Concepts for the design of streamflow data programs: U.S. Geol. Survey open-file report, 33 p.

Environmental Science Services Administration, 1968, Climatic atlas of the United States, 80 p.

Fenneman, N. M., 1931, Physiography of western United States: 1st ed., New York and London, McGraw-Hill Book Co., Inc., 534 p., map.

_____1938, Physiography of eastern United States: 1st ed., New York and London, McGraw-Hill Book Co., Inc., 714 p.

U.S. Water Resources Council, 1967, A uniform technique for determining flood flow frequencies: U.S. Water Resources Council Bull. 15, 15 p.

U.S. Weather Bureau, 1959, Climates of the States, North Dakota: Climatography of the United States no. 60-32, 16 p.

_____1961, Rainfall frequency atlas of the United States: U.S. Weather Bureau Tech. Paper no. 40, 115 p.

_____1964, Frequency of maximum water equivalent of March snow cover in north central United States: U.S. Weather Bureau Tech. Paper no. 50, 24 p.

_____ 1954, Frequency of maximum water equivalent of March snow cover in north central United States: U.S. Weather Bureau Tech. Paper no. 50, 24 p.

TABLE A-1.--Current-purpose gaging stations

| Station number | Station name | Purpose: Accounting | Operation | Forecasting | Disposal | Water quality | Compact or legal | Research or special studies |
|---|---|---|---|---|---|---|---|---|
| 5-0515 | Red River of the North at Wahpeton | ------- | X | X | ------- | ------- | ------- | ------- |
| 5-0516 | Wild Rice River near Rutland | ------- | X | X | ------- | X | ------- | ------- |
| 5-0517 | Wild Rice River near Cayuga | ------- | X | X | ------- | ------- | ------- | ------- |
| 5-0530 | Wild Rice River near Abercrombie | ------- | ------- | X | ------- | X | ------- | ------- |
| 5-0540 | Red River of the North at Fargo | X | ------- | X | X | X | ------- | ------- |
| 5-0545 | Sheyenne River above Harvey | ------- | X | X | ------- | ------- | ------- | ------- |
| 5-0555.2 | Big Coulee near Fort Totten | ------- | X | X | ------- | ------- | ------- | ------- |
| 5-0560 | Sheyenne River near Warwick | ------- | X | ------- | ------- | X | ------- | ------- |
| 5-0562 | Edmore Coulee near Edmore | ------- | X | ------- | ------- | ------- | ------- | ------- |
| 5-0564 | Big Coulee near Churchs Ferry | ------- | X | X | ------- | ------- | ------- | ------- |
| 5-0570 | Sheyenne River near Cooperstown | ------- | X | X | ------- | X | ------- | ------- |
| 5-0580 | Sheyenne River below Baldhill Dam | ------- | X | X | ------- | ------- | ------- | ------- |
| 5-0585 | Sheyenne River at Valley City | ------- | X | X | ------- | ------- | ------- | ------- |
| 5-0587 | Sheyenne River at Lisbon | ------- | X | X | ------- | X | ------- | ------- |
| 5-0590 | Sheyenne River at Kindred | ------- | X | X | ------- | ------- | ------- | ------- |
| 5-0595 | Sheyenne River at West Fargo | ------- | X | X | ------- | ------- | ------- | ------- |
| 5-0597 | Maple River near Enderlin | ------- | ------- | X | ------- | ------- | ------- | ------- |
| 5-0600 | Maple River near Mapleton | ------- | ------- | X | ------- | ------- | ------- | ------- |
| 5-0645 | Red River of the North at Halstad, Minn. | ------- | ------- | X | ------- | ------- | ------- | ------- |
| 5-0665 | Goose River at Hillsboro | ------- | ------- | X | ------- | ------- | ------- | ------- |
| 5-0825 | Red River of the North at Grand Forks | X | X | X | X | X | X | ------- |
| 5-0840 | Forest River near Fordville | ------- | X | ------- | ------- | ------- | ------- | ------- |
| 5-0850 | Forest River near Minto | ------- | X | ------- | ------- | ------- | ------- | ------- |
| 5-0890 | South Branch Park River below Homme Dam | ------- | X | X | X | ------- | ------- | ------- |
| 5-0891 | Middle Branch Park River near Union | ------- | X | ------- | ------- | ------- | ------- | ------- |
| 5-0895 | Cart Creek at Mountain | ------- | X | ------- | ------- | ------- | ------- | X |
| 5-0900 | Park River at Grafton | ------- | ------- | X | ------- | ------- | ------- | ------- |
| 5-0920 | Red River of the North at Drayton | ------- | ------- | X | X | ------- | X | ------- |
| 5-0987 | Hidden Island Coulee near Hansboro | ------- | X | ------- | ------- | ------- | X | ------- |
| 5-0988 | Long River near Sarles | ------- | X | ------- | ------- | ------- | X | ------- |
| 5-0994 | Little Pembina River near Walhalla | ------- | X | ------- | ------- | ------- | X | ------- |
| 5-0996 | Pembina River at Walhalla | ------- | X | X | ------- | X | ------- | ------- |
| 5-1000 | Pembina River at Neche | ------- | ------- | X | ------- | ------- | X | ------- |
| 5-1005 | Herzog Creek near Concrete | ------- | X | ------- | ------- | ------- | ------- | X |
| 5-1010 | Tongue River at Akra | ------- | X | ------- | ------- | ------- | ------- | X |
| 5-1136 | Long Creek near Noonan | ------- | X | X | ------- | ------- | X | ------- |
| 5-1140 | Souris (Mouse) River near Sherwood | X | X | X | ------- | ------- | X | ------- |
| 5-1160 | Souris (Mouse) River near Foxholm | ------- | X | X | ------- | ------- | X | ------- |
| 5-1165 | Des Lacs River at Foxholm | ------- | X | X | ------- | ------- | ------- | ------- |

TABLE A-1.--Current-purpose gaging stations--Continued

| Station number | Station name | Purpose | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Account-ing | Operation | Fore-casting | Disposal | Water quality | Compact or legal | Research or special studies |
| 5-1175 | Souris (Mouse) River above Minot | ------- | X | X | ------- | ------- | X | ------- |
| 5-1200 | Souris (Mouse) River near Verendrye | ------- | X | X | ------- | X | ------- | ------- |
| 5-1202 | Wintering River near Bergen | ------- | X | X | ------- | ------- | ------- | ------- |
| 5-1205 | Wintering River near Karlsruhe | ------- | X | X | ------- | ------- | X | ------- |
| 5-1220 | Souris (Mouse) River near Bantry | ------- | X | X | ------- | ------- | ------- | ------- |
| 5-1231 | Oak Creek at Lake Metigoshe Outlet near Bottineau | ------- | X | ------- | ------- | ------- | ------- | ------- |
| 5-1234 | Willow Creek near Willow City | ------- | X | X | ------- | ------- | ------- | ------- |
| 5-1235.1 | Deep River near Upham | ------- | X | X | ------- | ------- | ------- | ------- |
| 5-1236 | Egg Creek near Granville | ------- | X | X | ------- | ------- | ------- | ------- |
| 5-1237 | Cutbank Creek below North Lake Outlet near Granville | ------- | X | X | ------- | ------- | ------- | ------- |
| 5-1239 | Boundary Creek near Landa | ------- | X | X | ------- | ------- | ------- | ------- |
| 5-1240 | Souris (Mouse) River near Westhope | X | X | X | ------- | ------- | X | ------- |
| 5-3350 | Little Beaver Creek near Marmarth | ------- | X | X | ------- | ------- | ------- | ------- |
| 6-3355 | Little Missouri River at Marmarth | ------- | X | X | ------- | ------- | ------- | ------- |
| 6-3360 | Little Missouri River at Medora | ------- | X | X | ------- | ------- | ------- | ------- |
| 6-3370 | Little Missouri River at Watford City | X | X | X | ------- | ------- | ------- | ------- |
| 6-3405 | Knife River at Hazen | X | X | X | ------- | ------- | ------- | ------- |
| 6-3414 | Turtle Creek near Turtle Lake | ------- | X | X | ------- | X | ------- | ------- |
| 6-3418 | Painted Woods Creek near Wilton | ------- | X | X | ------- | X | ------- | ------- |
| 6-3421 | Square Butte Creek trib #2 near Center | ------- | X | ------- | ------- | ------- | ------- | ------- |
| 6-3422.6 | Square Butte Creek below Center | ------- | X | ------- | ------- | ------- | ------- | ------- |
| 6-3425 | Missouri River at Bismarck | ------- | X | X | ------- | X | ------- | ------- |
| 6-3440 | Heart River below Dickinson Dam | ------- | X | ------- | ------- | ------- | ------- | ------- |
| 6-3446 | Green River near New Hradec | ------- | X | ------- | ------- | ------- | ------- | ------- |
| 6-3450 | Green River near Gladstone | ------- | X | ------- | ------- | ------- | ------- | ------- |
| 6-3455 | Heart River near Richardton | ------- | X | X | ------- | ------- | ------- | ------- |
| 6-3465 | Heart River below Heart Butte Dam near Glen Ullin | ------- | X | ------- | ------- | ------- | ------- | ------- |
| 6-3480 | Heart River near Lark | ------- | X | ------- | ------- | ------- | ------- | ------- |
| 6-3485 | Sweetbriar Creek near Judson | ------- | X | ------- | ------- | ------- | ------- | ------- |
| 6-3490 | Heart River near Mandan | X | X | ------- | X | ------- | ------- | ------- |
| 6-3500 | Cannonball River at Regent | ------- | X | ------- | ------- | ------- | ------- | ------- |
| 6-3530 | Cedar Creek near Raleigh | ------- | X | ------- | ------- | ------- | ------- | ------- |
| 6-3540 | Cannonball River at Breien | X | X | X | ------- | ------- | ------- | ------- |
| 6-3545 | Beaver Creek at Linton | ------- | X | ------- | ------- | ------- | ------- | ------- |
| 6-3550 | North Fork Grand River at Haley | ------- | X | ------- | ------- | ------- | ------- | ------- |
| 6-4676 | James River near Manfred | ------- | X | X | ------- | X | ------- | ------- |
| 6-4679 | Big Slough at Hamberg | ------- | X | X | ------- | X | ------- | ------- |
| 6-4681.7 | James River near Grace City | ------- | X | X | ------- | X | ------- | ------- |
| 6-4695 | Pipestem Creek near Buchanan | ------- | X | X | ------- | ------- | ------- | ------- |
| 6-4700 | James River at Jamestown | ------- | X | X | ------- | ------- | ------- | ------- |
| 6-4705 | James River at LaMoure | ------- | X | X | ------- | ------- | ------- | ------- |

TABLE A-2.--Selected streamflow characteristics at gaging stations

| Station number | Mean annual flow ($Q_a$) | Standard deviation of annual flow ($SD_a$) | 25-year peak flow ($Q_{25}$) | 50-year peak flow ($Q_{50}$) | 10-year 7-day high flow ($V_{7,10}$) | 50-year 7-day high flow ($V_{7,50}$) | 2-year 7-day low flow ($M_{7,2}$) | 20-year 7-day low flow ($M_{7,20}$) |
|---|---|---|---|---|---|---|---|---|
| 5-0517 | 18.6 | 21.5 | 1,220 | - | 634 | - | 0 | 0 |
| 5-0518 | - | - | 32.0 | - | - | - | - | - |
| 5-0519 | - | - | 45.2 | - | - | - | - | - |
| 5-0520 | - | - | 1,840 | 2,480 | - | - | - | - |
| 5-0525 | - | - | 4,790 | 6,270 | - | - | - | - |
| 5-0530 | 66.7 | 83.6 | 5,950 | 7,480 | 2,650 | 5,350 | 0 | 0 |
| 5-0545 | 4.04 | 2.98 | 564 | - | 169 | - | 0 | 0 |
| 5-0550 | 13.9 | 12.3 | 1,740 | - | 634 | - | 0 | 0 |
| 5-0551 | 4.10 | 4.01 | - | - | 180 | - | 0 | 0 |
| 5-0552 | 2.73 | 2.50 | 791 | - | 182 | - | 0 | 0 |
| 5-0555 | 41.7 | 42.1 | 3,980 | - | 2,300 | - | 0 | 0 |
| 5-0560 | 47.3 | 44.8 | 5,920 | - | 1,960 | - | 1.12 | .09 |
| 5-0560.2 | - | - | 270 | - | - | - | - | - |
| 5-0560.4 | - | - | 500 | - | - | - | - | - |
| 5-0560.6 | - | - | 1,700 | - | - | - | - | - |
| 5-0560.8 | - | - | 970 | - | - | - | - | - |
| 5-0561 | 7.68 | 9.73 | 3,100 | - | 650 | - | 0 | 0 |
| 5-0562 | 11.0 | 13.6 | 1,830 | - | 692 | - | 0 | 0 |
| 5-0563 | 1.51 | 2.96 | 650 | - | 56.0 | - | 0 | 0 |
| 5-0564 | 13.4 | 23.8 | 1,300 | - | 550 | - | 0 | 0 |
| 5-0570 | 95.6 | 81.7 | 6,580 | 9,060 | 2,870 | 6,040 | 2.12 | 0 |
| 5-0572 | 11.5 | 8.48 | 3,280 | - | 556 | - | 0 | 0 |
| 5-0585 | 106 | 77.9 | 4,640 | - | 2,730 | - | 0.82 | 0 |
| 5-0595 | 133 | 89.4 | 3,160 | 3,740 | 2,060 | 3,850 | 14.0 | 3.76 |
| 5-0597 | 30.3 | 32.5 | 6,960 | - | 1,540 | - | 1.57 | .76 |
| 5-0598 | - | - | 518 | - | - | - | - | - |
| 5-0598.5 | - | - | 1,990 | - | - | - | - | - |
| 5-0599 | - | - | 998 | - | - | - | - | - |
| 5-0599.5 | - | - | 315 | - | - | - | - | - |
| 5-0600 | 54.1 | 53.2 | 6,690 | 9,090 | 2,520 | - | 0 | 0 |
| 5-0605 | 7.26 | 6.76 | 1,552 | 1,980 | 407 | - | 0 | 0 |
| 5-0610 | 74.4 | 22.9 | 1,710 | 1,980 | 1,100 | 1,570 | 13.5 | 8.4 |
| 5-0615 | 57.3 | 38.7 | 5,300 | 6,950 | 1,980 | 3,450 | 0 | 0 |
| 5-0620 | 124 | 80.5 | 5,200 | 6,500 | 3,080 | 5,500 | 0 | 0 |
| 5-0622 | - | - | 2,000 | - | - | - | - | - |
| 5-0625 | 165 | 99.9 | 4,700 | 5,800 | 2,080 | 3,100 | 16.4 | 2.80 |
| 5-0655 | 26.3 | 41.7 | 5,460 | 8,150 | 1,600 | 4,040 | 0 | 0 |
| 5-0665 | 55.9 | 76.7 | 9,370 | 13,270 | 2,630 | 6,210 | .08 | 0 |
| 5-0690 | 64.3 | 48.0 | 4,420 | 6,100 | 1,900 | 4,500 | 6.90 | 2.07 |
| 5-0826 | - | - | 192 | - | - | - | - | - |
| 5-0826.8 | - | - | 508 | - | - | - | - | - |
| 5-0827 | - | - | 770 | - | - | - | - | - |
| 5-0829 | - | - | 1,515 | - | - | - | - | - |
| 5-0830 | 49.6 | 61.1 | 11,050 | 18,860 | 2,580 | - | 0 | 0 |
| 5-0840 | 35.7 | 36.8 | 10,570 | 14,290 | 1,900 | 4,020 | 2.78 | .85 |
| 5-0850 | 47.3 | 55.4 | 10,010 | 14,680 | 2,550 | - | .18 | 0 |
| 5-0875 | 41.1 | 30.4 | 2,400 | 2,730 | 1,320 | 2,000 | 0 | 0 |
| 5-0880 | 28.6 | 30.5 | - | - | 1,910 | - | 0 | 0 |
| 5-0892 | - | - | 2,330 | - | - | - | - | - |
| 5-0895 | 2.77 | 1.67 | 1,360 | - | 131 | - | 0 | 0 |
| 5-0897 | - | - | 4,280 | - | - | - | - | - |
| 5-0898 | - | - | 145 | - | - | - | - | - |
| 5-0900 | 39.0 | 43.5 | 8,060 | - | 2,560 | 6,720 | 0 | 0 |
| 5-0955 | 103 | 107 | 3,650 | 4,400 | 2,450 | 4,350 | 0 | 0 |
| 5-0960 | 8.52 | 18.4 | 670 | 940 | 290 | 750 | 0 | 0 |
| 5-0994 | 16.9 | 12.6 | 6,610 | - | 1,050 | - | .09 | 0 |
| 5-0996 | 192 | 144 | 12,930 | 17,340 | 4,150 | 7,960 | 2.24 | 0 |
| 5-1000 | 162 | 135 | 6,200 | 7,620 | 3,140 | 5,710 | 2.64 | 0 |
| 5-1005 | 2.91 | 2.12 | 260 | - | 96.1 | - | 0 | 0 |
| 5-1010 | 20.3 | 14.6 | 3,280 | 5,190 | 588 | - | .66 | 0 |
| 5-1015 | 21.3 | 15.1 | - | - | 742 | - | 0 | 0 |
| 5-1135 | 25.9 | 27.0 | 3,690 | - | 1,420 | - | 0 | 0 |
| 5-1161 | - | - | 32.0 | - | - | - | - | - |
| 5-1162 | - | - | 180 | - | - | - | - | - |
| 5-1165.5 | - | - | 260 | - | - | - | - | - |
| 5-1175 | 157 | 184 | 5,140 | 5,750 | 3,830 | 6,470 | .92 | 0 |
| 5-1202 | 3.63 | 3.50 | 1,050 | - | 237 | - | 0 | 0 |
| 5-1205 | 11.0 | 8.97 | 1,320 | 2,160 | 369 | - | 0 | 0 |
| 5-1225 | 14.0 | 17.3 | 718 | - | 319 | - | 0 | 0 |
| 5-1234 | 18.9 | 25.5 | 3,830 | - | 504 | - | 0 | 0 |

TABLE A-2.--Selected streamflow characteristics at gaging stations--Continued

| Station number | Mean annual flow ($Q_a$) | Standard deviation of annual flow ($SD_a$) | 25-year peak flow ($Q_{25}$) | 50-year peak flow ($Q_{50}$) | 10-year 7-day high flow ($V_{7,10}$) | 50-year 7-day high flow ($V_{7,50}$) | 2-year 7-day low flow ($M_{7,2}$) | 20-year 7-day low flow ($M_{7,20}$) |
|---|---|---|---|---|---|---|---|---|
| 5-1235.1 | 1.73 | 3.27 | 7,600 | - | 200 | - | 0 | 0 |
| 5-1235.2 | - | - | 200 | - | - | - | - | - |
| 5-1235.4 | - | - | 585 | - | - | - | - | - |
| 5-1235.6 | - | - | 27.0 | - | - | - | - | - |
| 5-1235.8 | - | - | 256 | - | - | - | - | - |
| 5-1236 | 1.68 | 1.67 | 1,200 | - | 160 | - | 0 | 0 |
| 5-1239 | 6.76 | 7.40 | 2,520 | - | 277 | - | 0 | 0 |
| 6-3298 | - | - | 153 | - | - | - | - | - |
| 6-3299 | - | - | 150 | - | - | - | - | - |
| 6-3301 | - | - | 1,060 | - | - | - | - | - |
| 6-3310 | 26.9 | 17.6 | 7,000 | - | 1,370 | - | 2.17 | .54 |
| 6-3315 | 45.4 | 14.9 | 3,660 | - | 1,302 | - | 1.80 | 0 |
| 6-3320 | 17.1 | 11.8 | 2,550 | - | 746 | - | .28 | 0 |
| 6-3345 | 125 | 87.8 | 7,060 | - | 3,930 | 0 | .40 | 0 |
| 6-3350 | 38.8 | 29.2 | 10,490 | 12,590 | 2,000 | 3,700 | 0 | 0 |
| 5-3355 | 314 | 224 | 37,040 | 46,250 | 12,180 | 21,680 | 0 | 0 |
| 6-3360 | 426 | 280 | 42,210 | 53,590 | 14,000 | 24,190 | 0 | 0 |
| 6-3362 | - | - | 230 | - | - | - | - | - |
| 6-3363 | - | - | 120 | - | - | - | - | - |
| 6-3364 | - | - | 471 | - | - | - | - | - |
| 6-3370 | 547 | 327 | 59,300 | 77,650 | 17,990 | 27,360 | 0 | 0 |
| 6-3376 | - | - | 106 | - | - | - | - | - |
| 6-3395 | 91.2 | 53.4 | 10,680 | 11,800 | 4,390 | 6,910 | 1.65 | 0 |
| 6-3400 | 38.3 | 22.5 | 5,150 | 5,860 | 2,110 | - | 1.22 | 0 |
| 6-3405 | 169 | 105 | 24,660 | 32,890 | 8,090 | 16,080 | 7.00 | .20 |
| 6-3414 | .32 | .19 | 111 | - | 19.6 | - | 0 | 0 |
| 6-3418 | 4.42 | 3.72 | - | - | 365 | - | 0 | 0 |
| 6-3420.5 | - | - | 8,000 | - | - | - | - | - |
| 6-3421 | - | - | 2,250 | - | - | - | - | - |
| 6-3421.5 | - | - | 44.1 | - | - | - | - | - |
| 6-3422.5 | - | - | 147 | - | - | - | - | - |
| 6-3423 | - | - | 1,380 | - | - | - | - | - |
| 6-3423.5 | - | - | 851 | - | - | - | - | - |
| 6-3430 | 25.1 | 17.6 | 5,440 | - | 1,860 | - | .12 | .02 |
| 6-3432 | - | - | 85.5 | - | - | - | - | - |
| 6-3442 | - | - | 88.0 | - | - | - | - | - |
| 6-3450 | 31.4 | 22.4 | 7,110 | 9,050 | 2,220 | - | .13 | 0 |
| 6-3451 | - | - | 8,000 | - | - | - | - | - |
| 6-3452 | - | - | 2,000 | - | - | - | - | - |
| 6-3453 | - | - | 1,550 | - | - | - | - | - |
| 6-3455 | 104 | 67.1 | 19,230 | 25,120 | 4,500 | 7,330 | .70 | 0 |
| 6-3457 | - | - | 4,100 | - | - | - | - | - |
| 6-3470 | 12.7 | 12.2 | 6,740 | - | 927 | - | 0 | 0 |
| 6-3475 | 34.2 | 27.6 | 5,960 | - | 2,150 | - | .10 | 0 |
| 6-3485 | .51 | 7.37 | 3,960 | - | 724 | - | .05 | 0 |
| 6-3490 | 260 | 154 | 30,000 | - | 11,370 | - | .15 | 0 |
| 6-3492 | - | - | 1,350 | - | - | - | - | - |
| 6-3495 | 37.0 | 53.7 | 3,930 | - | 1,430 | - | .18 | 0 |
| 6-3500 | 30.4 | 24.8 | 13,060 | - | 1,880 | - | .27 | 0 |
| 6-3510 | 76.6 | 70.3 | 21,250 | 28,530 | 5,200 | 10,460 | .87 | 0 |
| 6-3520 | 23.6 | 22.4 | 14,430 | - | 1,750 | - | .19 | 0 |
| 6-3525 | 64.2 | 74.2 | 20,800 | 31,320 | 4,520 | 8,510 | 0 | 0 |
| 6-3536 | - | - | 25.0 | - | - | - | - | - |
| 6-3537 | - | - | 190 | - | - | - | - | - |
| 6-3538 | - | - | 320 | - | - | - | - | - |
| 6-3539 | - | - | 1,700 | - | - | - | - | - |
| 6-3540 | 220 | 208 | 23,100 | 27,930 | 11,310 | 13,130 | .50 | 0 |
| 6-3545 | 43.5 | 40.4 | 3,860 | - | 2,260 | - | .05 | 0 |
| 6-3547 | - | - | 3,800 | - | - | - | - | - |
| 6-3548 | - | - | 2,000 | - | - | - | - | - |
| 6-3549 | - | - | 2,100 | - | - | - | - | - |
| 6-3549.5 | - | - | 1,200 | - | - | - | - | - |
| 6-3550 | 29.8 | 33.3 | 13,500 | 20,000 | 2,140 | 4,490 | .16 | 0 |
| 6-3552 | - | - | 920 | - | - | - | - | - |
| 6-3555 | 58.6 | 84.6 | 25,000 | - | 4,800 | - | 0 | 0 |
| 6-3560 | 7.42 | 4.27 | 2,730 | - | 274 | - | .19 | 0 |
| 6-3565 | 53.8 | 59.8 | 28,000 | 54,000 | 2,450 | - | 0 | 0 |
| 6-4676 | 2.06 | 2.43 | 710 | - | 211 | - | 0 | 0 |
| 6-4676.5 | - | - | 410 | - | - | - | - | - |
| 6-4678 | - | - | 140 | - | - | - | - | - |
| 6-4679 | 1.34 | 2.15 | - | - | 120 | - | 0 | 0 |

TABLE A-2.--Selected streamflow characteristics at gaging stations--Continued

| Station number | Mean annual flow ($Q_a$) | Standard deviation of annual flow ($SD_a$) | 25-year peak flow ($Q_{25}$) | 50-year peak flow ($Q_{50}$) | 10-year 7-day high flow ($V_{7,10}$) | 50-year 7-day high flow ($V_{7,50}$) | 2-year 7-day low flow ($M_{7,2}$) | 20-year 7-day low flow ($M_{7,20}$) |
|---|---|---|---|---|---|---|---|---|
| 6-4680 | 37.5 | 4.84 | 1,500 | - | 2,600 | 5,500 | 0 | 0 |
| 6-4695 | 18.2 | 16.1 | 3,810 | - | 1,050 | - | 0 | 0 |
| 6-4696 | - | - | 78.0 | - | - | - | - | - |
| 6-4700 | 66.5 | 111 | 4,480 | - | 2,040 | - | .90 | .14 |
| 6-4702 | - | - | 49.0 | - | - | - | - | - |
| 6-4703 | - | - | 1,380 | - | - | - | - | - |
| 6-4704 | - | - | 366 | - | - | - | - | - |
| 6-4712 | 18.7 | 21.2 | - | - | 1,050 | - | 0 | 0 |
| 6-4715 | 44.9 | 41.6 | 7,280 | 9,730 | 2,790 | - | .34 | 0 |

TABLE A-3.--Selected basin characteristics at gaging stations

| Station number | Area (A) | Slope (S) | Storage (St) | Ele-vation (E) | Forest cover (F) | Soil index (Si) | Shape factor (Sh) | Orien-tation (Or) | Mean annual precipi-tation (P) | 2-year 24-hour rainfall ($I_{2,24}$) | Mean maximum March temper-ature ($T_3$) | Mean annual snow-fall (Sn) | Mean annual evapor-ation (Ev) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5-0517 | 565 | 2.7 | 0.44 | 1,270 | 0 | 3.33 | 13 | 1 | 18.9 | 1.8 | 35 | 35 | 32 |
| 0518 | .61 | 10 | 0 | 1,110 | 0 | 3.33 | 2.4 | 1 | 19.6 | 1.9 | 35 | 36 | 31 |
| 0519 | 4.06 | 24 | 0 | 1,050 | 0 | 3.33 | .80 | 2 | 19.7 | 1.9 | 35 | 36 | 31 |
| 0520 | 808 | 2.6 | .35 | 1,210 | 0 | 3.33 | 25 | 1 | 19.1 | 1.8 | 35 | 35 | 32 |
| 0525 | 278 | 3.4 | .02 | 1,000 | 0 | 3.33 | 7.0 | 1 | 19.8 | 1.9 | 35 | 36 | 30 |
| 0530 | 1,490 | 2.1 | .21 | 1,100 | 0 | 3.33 | 32 | 2 | 19.3 | 1.9 | 33 | 35 | 31 |
| 0545 | 154 | 3.0 | 1.48 | 1,670 | 0 | 3.33 | 9.9 | 1 | 16.4 | 1.8 | 33 | 34 | 32 |
| 0550 | 173 | 2.7 | 1.44 | 1,660 | 0 | 3.33 | 14 | 2 | 16.4 | 1.8 | 32 | 34 | 32 |
| 0551 | 203 | 4.0 | .63 | 1,560 | 0 | 3.33 | 3.6 | 1 | 16.4 | 1.8 | 32 | 35 | 31 |
| 0552 | 97 | 3.3 | .14 | 1,600 | 0 | 3.33 | 5.5 | 1 | 16.5 | 1.8 | 32 | 36 | 31 |
| 0555 | 660 | 2.0 | .62 | 1,580 | 0 | 3.33 | 24 | 2 | 16.5 | 1.8 | 32 | 35 | 32 |
| 0560 | 760 | 1.6 | .54 | 1,570 | 0 | 3.33 | 34 | 2 | 16.6 | 1.8 | 32 | 35 | 32 |
| 0560.2 | 2.83 | 9.0 | .01 | 1,720 | 0 | 2.82 | 4.3 | 1 | 16.3 | 1.9 | 30 | 37 | 30 |
| 0560.4 | 8.48 | 7.1 | .01 | 1,550 | 0 | 2.82 | 10 | 1 | 16.3 | 1.9 | 30 | 37 | 30 |
| 0560.6 | 60.2 | 11 | .01 | 1,580 | 0 | 2.82 | 19 | 1 | 16.4 | 1.9 | 30 | 37 | 30 |
| 0560.8 | 24.4 | 10 | .01 | 1,640 | 0 | 2.82 | 16 | 1 | 16.2 | 1.9 | 30 | 37 | 30 |
| 0561 | 377 | 5.1 | .01 | 1,640 | 0 | 2.82 | 15 | 1 | 16.5 | 1.9 | 30 | 37 | 30 |
| 0562 | 282 | 3.5 | .06 | 1,550 | 0 | 2.82 | 6.9 | 2 | 17.7 | 1.9 | 30 | 38 | 28 |
| 0563 | 140 | 4.2 | 2.68 | 1,560 | 0 | 2.82 | 7.8 | 1 | 16.2 | 1.9 | 31 | 37 | 30 |
| 0564 | 1,820 | 4.4 | .62 | 1,500 | 0 | 2.82 | 5.5 | 2 | 16.7 | 1.9 | 31 | 37 | 29 |
| 0569 | 15.2 | 29 | 0 | 1,450 | 0 | 3.33 | 2.7 | 2 | 18.2 | 1.9 | 32 | 35 | 30 |
| 0569.5 | .08 | 300 | 0 | 1,460 | 0 | 3.33 | 2.2 | 1 | 18.0 | 1.9 | 32 | 35 | 30 |
| 0570 | 1,270 | 0.8 | .35 | 1,520 | 0 | 3.33 | 47 | 1 | 17.2 | 1.9 | 32 | 35 | 31 |
| 0572 | 351 | 3.0 | .16 | 1,460 | 0 | 3.33 | 8.3 | 1 | 17.7 | 1.9 | 33 | 35 | 30 |
| 0585 | 2,110 | .85 | .24 | 1,480 | 0 | 3.33 | 43 | 1 | 17.9 | 1.9 | 33 | 35 | 29 |
| 0595 | 3,090 | 1.2 | .17 | 1,370 | 0 | 3.33 | 91 | 1 | 18.1 | 1.9 | 33 | 35 | 30 |
| 0597 | 796 | 3.0 | .02 | 1,240 | 0 | 3.16 | 8.2 | 1 | 18.4 | 1.9 | 34 | 35 | 30 |
| 0598 | 32.9 | 12.0 | 0 | 1,160 | 0 | 3.16 | 12 | 1 | 18.9 | 1.9 | 33 | 35 | 30 |
| 0598.5 | 4.24 | 12.9 | 0 | 1,200 | 0 | 3.16 | 2.4 | 1 | 18.8 | 1.9 | 34 | 35 | 30 |
| 0599 | 56.6 | 10.5 | 0 | 1,120 | 0 | 3.16 | 15 | 1 | 19.1 | 1.9 | 34 | 35 | 30 |
| 0599.5 | 14.1 | 7.7 | 0 | 960 | 0 | 3.16 | 7.1 | 1 | 19.1 | 1.9 | 34 | 35 | 30 |
| 0600 | 1,380 | 2.3 | .01 | 1,130 | 0 | 3.16 | 16 | 1 | 18.7 | 1.9 | 34 | 35 | 30 |
| 0605 | 116 | 3.5 | 0 | 1,030 | 0 | 3.33 | 6.8 | 1 | 19.0 | 1.9 | 33 | 35 | 29 |
| 0610 | 322 | 8.1 | 5.2 | 1,250 | 14 | 3.51 | 7.46 | 2 | 22.0 | 2.3 | 33 | 41 | 27 |
| 0615 | 522 | 13.8 | 1.7 | 990 | 1.4 | 2.82 | 2.09 | 1 | 20.0 | 2.3 | 33 | 39 | 28 |
| 0620 | 1,040 | 9.7 | 2.5 | 1,170 | 5.8 | 3.16 | 5.27 | 2 | 21.0 | 2.3 | 33 | 40 | 28 |
| 0622 | 193 | 5.5 | .01 | 1,030 | 0 | 3.16 | 13 | 1 | 19.0 | 1.9 | 33 | 35 | 29 |
| 0625 | 888 | 7.2 | 7.0 | 1,380 | 38.5 | 5.15 | 5.52 | 2 | 22.0 | 2.3 | 32 | 40 | 26 |
| 0655 | 407 | 7.0 | .17 | 1,250 | 0 | 3.16 | 17 | 1 | 18.6 | 1.9 | 32 | 36 | 29 |
| 0665 | 1,090 | 4.1 | .08 | 1,060 | 0 | 3.16 | 14 | 1 | 18.8 | 1.9 | 32 | 36 | 29 |
| 0690 | 405 | 7.2 | 3.5 | 1,110 | 5.4 | 2.82 | 12.3 | 1 | 21.0 | 2.2 | 31 | 37 | 26 |
| 0826 | 4.7 | 3.4 | 0 | 850 | 0 | 3.16 | 4.3 | 2 | 19.9 | 1.9 | 31 | 36 | 27 |
| 0826.8 | 22 | 17 | .02 | 1,040 | 0 | 3.16 | 4.5 | 2 | 19.2 | 1.9 | 31 | 36 | 28 |
| 0827 | 110 | 12 | .02 | 1,000 | 0 | 3.16 | 7.1 | 2 | 19.1 | 1.9 | 31 | 36 | 28 |
| 0829 | 31 | 6.4 | .02 | 890 | 0 | 3.16 | 10 | 2 | 19.5 | 1.9 | 31 | 36 | 28 |
| 0830 | 556 | 7.8 | .02 | 1,040 | 0 | 3.16 | 12 | 2 | 18.4 | 1.9 | 31 | 36 | 28 |
| 0840 | 336 | 11 | .10 | 1,440 | 0 | 3.16 | 7.7 | 1 | 17.8 | 1.9 | 31 | 37 | 28 |
| 0850 | 620 | 10 | .07 | 1,210 | 0 | 3.16 | 14 | 2 | 18.1 | 1.9 | 31 | 37 | 28 |
| 0875 | 265 | 7.5 | 7.5 | 1,070 | 21.5 | 2.66 | 10.2 | 2 | 20.0 | 2.1 | 32 | 35 | 25 |
| 0880 | 214 | 8.3 | .02 | 1,460 | 5 | 3.16 | 10 | 1 | 18.0 | 1.9 | 30 | 38 | 28 |
| 0892 | 35 | 19 | .01 | 1,410 | 10 | 3.16 | 10 | 1 | 18.2 | 1.9 | 30 | 39 | 27 |
| 0895 | 17 | 58 | .02 | 1,280 | 15 | 3.16 | 5.5 | 2 | 18.4 | 1.9 | 30 | 39 | 27 |
| 0897 | 74 | 12 | .05 | 1,100 | 10 | 3.16 | 17 | 1 | 18.4 | 1.9 | 30 | 39 | 27 |
| 0898 | 3.8 | 6.4 | 0 | 920 | 0 | 3.16 | 6.6 | 1 | 18.5 | 1.9 | 30 | 39 | 27 |
| 0900 | 695 | 6.5 | .13 | 1,140 | 5 | 3.16 | 10 | 1 | 18.3 | 1.9 | 30 | 39 | 27 |
| 0955 | 644 | 5.4 | 8.5 | 1,020 | 16.8 | 2.66 | 8.39 | 1 | 20.0 | 2.1 | 31 | 33 | 25 |
| 0960 | 32 | 5.0 | 62.5 | 1,000 | 12.5 | 1.90 | 2.26 | 2 | 20.0 | 2.1 | 31 | 33 | 25 |
| 0994 | 172 | 11.6 | .01 | 1,590 | 5 | 1.90 | 12 | 1 | 18.3 | 1.9 | 29 | 39 | 27 |
| 0996 | 3,350 | 3.85 | .43 | 1,580 | 5 | 1.90 | 7.9 | 1 | 17.2 | 1.9 | 29 | 39 | 28 |
| 1000 | 3,410 | 3.99 | .42 | 1,480 | 5 | 1.90 | 13 | 1 | 17.3 | 1.9 | 29 | 39 | 28 |
| 1005 | 18.9 | 33.3 | 2.11 | 1,250 | 35 | 1.90 | 5.3 | 1 | 18.5 | 1.9 | 29 | 40 | 27 |
| 1010 | 162 | 21.7 | .03 | 1,600 | 15 | 1.90 | 9.9 | 2 | 18.5 | 1.9 | 29 | 40 | 27 |
| 1015 | 167 | 19.6 | .03 | 1,600 | 15 | 1.90 | 13 | 2 | 18.5 | 1.9 | 29 | 40 | 27 |
| 1135 | 540 | 2.65 | .09 | 2,030 | 0 | 2.99 | 16 | 1 | 13.3 | 1.8 | 33 | 34 | 35 |
| 1161 | .13 | 270 | 0 | 1,700 | 0 | 3.33 | 1.9 | 2 | 16.0 | 1.8 | 32 | 35 | 33 |
| 1162 | 3.82 | 113 | 0 | 2,000 | 0 | 2.99 | 7.4 | 2 | 15.4 | 1.8 | 32 | 34 | 34 |
| 1165 | 5.9 | 49 | 0 | 2,000 | 0 | 2.99 | 18 | 2 | 15.7 | 1.8 | 32 | 35 | 33 |
| 1172 | 2.04 | 60 | 0 | 1,720 | 0 | 3.33 | 3.3 | 2 | 16.0 | 1.8 | 32 | 35 | 33 |
| 1175 | 3,900 | 1.13 | .25 | 1,900 | 0 | 3.33 | 31 | 1 | 14.5 | 1.8 | 32 | 35 | 34 |
| 1202 | 126 | 21 | .25 | 1,790 | 0 | 3.33 | 3.1 | 2 | 16.2 | 1.8 | 33 | 34 | 33 |

TABLE A-3.--Selected basin characteristics at gaging stations--Continued

| Station number | Area (A) | Slope (S) | Storage (St) | Elevation (E) | Forest cover (F) | Soil index (Si) | Shape factor (Sh) | Orientation (Or) | Mean annual precipitation (P) | 2-year 24-hour rainfall ($I_{2,24}$) | Mean maximum March temperature ($T_3$) | Mean annual snowfall (Sn) | Mean annual evaporation (Ev) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5-1205 | 285 | 3.7 | .14 | 1,700 | 0 | 3.33 | 12 | 2 | 16.2 | 1.8 | 33 | 35 | 32 |
| 1225 | 91 | 36.4 | 5.73 | 1,940 | 45 | 3.16 | 2.3 | 1 | 16.2 | 1.9 | 30 | 38 | 30 |
| 1233 | 3.1 | 58.3 | 0 | 1,780 | 30 | 3.16 | 3.3 | 2 | 16.0 | 1.9 | 30 | 37 | 31 |
| 1233.5 | .56 | 135 | 0 | 1,820 | 0 | 3.16 | 4.6 | 2 | 16.0 | 1.9 | 30 | 37 | 31 |
| 1234 | 730 | 2.01 | 2.13 | 1,600 | 15 | 3.16 | 9.7 | 2 | 16.1 | 1.9 | 30 | 37 | 31 |
| 1235.1 | 369 | 2.43 | .06 | 1,560 | 0 | 3.51 | 21 | 1 | 16.2 | 1.8 | 31 | 36 | 32 |
| 1235.2 | 7.0 | 4.38 | 0 | 1,680 | 0 | 3.51 | 7.0 | 1 | 16.2 | 1.8 | 32 | 35 | 33 |
| 1235.4 | 26 | 5.16 | .01 | 1,630 | 0 | 3.51 | 7.8 | 1 | 16.2 | 1.8 | 32 | 35 | 33 |
| 1235.6 | 3.50 | 6.00 | 0 | 1,590 | 0 | 3.51 | 4.6 | 1 | 16.2 | 1.8 | 32 | 35 | 33 |
| 1235.8 | 41 | 4.16 | .02 | 1,620 | 0 | 3.51 | 19 | 1 | 16.2 | 1.8 | 32 | 35 | 33 |
| 1236 | 143 | 3.58 | .04 | 1,590 | 0 | 3.51 | 17 | 1 | 16.2 | 1.8 | 32 | 35 | 33 |
| 1239 | 170 | 5.89 | .05 | 1,720 | 15 | 3.33 | 13 | 2 | 16.1 | 1.9 | 30 | 37 | 31 |
| 6-3298 | 17.4 | 35 | .02 | 2,300 | 0 | 3.70 | 3.2 | 1 | 13.5 | 1.7 | 34 | 34 | 36 |
| 3299 | 8.3 | 30 | 0 | 2,300 | 0 | 3.70 | 4.8 | 1 | 13.5 | 1.7 | 34 | 34 | 36 |
| 3301 | 38.2 | 20 | .03 | 2,150 | 0 | 3.70 | 14 | 1 | 13.7 | 1.7 | 34 | 34 | 36 |
| 3310 | 775 | 8.3 | .04 | 2,110 | 0 | 3.16 | 6.7 | 1 | 13.6 | 1.7 | 34 | 34 | 35 |
| 3315 | 789 | 7.5 | .04 | 2,110 | 0 | 3.16 | 8.1 | 1 | 13.6 | 1.7 | 34 | 34 | 35 |
| 3320 | 490 | 7.4 | .06 | 2,220 | 0 | 3.33 | 2.4 | 2 | 14.3 | 1.7 | 34 | 33 | 35 |
| 3345 | 1,970 | 3.78 | .10 | 3,700 | 5.6 | 1.9 | 23 | 2 | 15.2 | 1.8 | 39 | 36 | 40 |
| 3350 | 587 | 11.4 | .04 | 3,280 | 0 | 1.50 | 6.8 | 2 | 13.5 | 1.3 | 39 | 33 | 39 |
| 3355 | 4,640 | 3.28 | .04 | 3,480 | 2.8 | 2.20 | 22 | 2 | 13.9 | 1.4 | 40 | 34 | 40 |
| 3360 | 6,190 | 3.32 | .04 | 2,790 | 2.4 | 2.25 | 32 | 2 | 14.1 | 1.4 | 39 | 34 | 38 |
| 3361 | .29 | 129 | 0 | 2,440 | 0 | 2.34 | 2.4 | 1 | 15.2 | 1.5 | 37 | 34 | 37 |
| 3362 | .42 | 91 | 0 | 2,520 | 0 | 2.34 | 2.6 | 2 | 15.2 | 1.5 | 37 | 34 | 37 |
| 3363 | .32 | 195 | 0 | 2,490 | 0 | 2.34 | 2.3 | 1 | 15.1 | 1.5 | 37 | 34 | 37 |
| 3364 | 3.80 | 36.5 | 0 | 2,430 | 0 | 2.34 | 6.6 | 1 | 15.2 | 1.5 | 37 | 34 | 37 |
| 3370 | 8,310 | 3.21 | .04 | 2,760 | 0 | 2.34 | 38 | 2 | 14.2 | 1.5 | 38 | 34 | 38 |
| 3376 | 1.39 | 53 | 0 | 2,010 | 0 | 3.70 | 2.3 | 1 | 15.8 | 1.7 | 34 | 35 | 34 |
| 3379 | 1.22 | 17 | 0 | 1,930 | 0 | 3.70 | 8.4 | 2 | 15.9 | 1.7 | 34 | 35 | 34 |
| 3395 | 1,230 | 3.18 | .06 | 2,110 | 0 | 2.99 | 15 | 1 | 15.8 | 1.6 | 36 | 36 | 36 |
| 3400 | 549 | 3.27 | .37 | 2,330 | 0 | 2.99 | 15 | 1 | 15.7 | 1.6 | 35 | 35 | 35 |
| 3405 | 2,240 | 2.78 | .06 | 2,060 | 0 | 2.99 | 15 | 2 | 15.8 | 1.6 | 36 | 36 | 35 |
| 3414 | 115 | 2.08 | .04 | 1,870 | 0 | 3.33 | 1.6 | 1 | 16.0 | 1.7 | 34 | 35 | 33 |
| 3418 | 117 | 3.46 | .27 | 1,860 | 0 | 3.70 | 6.9 | 1 | 16.2 | 1.7 | 34 | 35 | 33 |
| 3420.5 | 56.8 | 15.6 | .05 | 2,120 | 0 | 3.70 | 3.8 | 1 | 15.8 | 1.7 | 35 | 36 | 34 |
| 3421 | 13.0 | 28.0 | .05 | 2,080 | 0 | 3.70 | 3.0 | 1 | 15.8 | 1.7 | 35 | 36 | 34 |
| 3421.5 | 0.19 | 158 | 0 | 2,090 | 0 | 3.70 | 3.0 | 1 | 15.8 | 1.7 | 35 | 36 | 34 |
| 3422.5 | 1.68 | 59.8 | 0 | 2,100 | 0 | 3.70 | 3.2 | 2 | 15.8 | 1.7 | 35 | 36 | 34 |
| 3423 | 2.98 | 43.8 | 0 | 2,050 | 0 | 3.70 | 1.9 | 1 | 16.0 | 1.7 | 35 | 36 | 34 |
| 3423.5 | 2.12 | 67.9 | 0 | 2,020 | 0 | 3.70 | 2.3 | 1 | 16.0 | 1.7 | 35 | 36 | 34 |
| 3430 | 315 | 3.1 | .08 | 2,650 | 0 | 3.16 | 5.3 | 2 | 15.5 | 1.5 | 37 | 35 | 37 |
| 3432 | 0.13 | 148 | 0 | 2,500 | 0 | 3.16 | .89 | 2 | 15.7 | 1.5 | 36 | 35 | 36 |
| 3442 | 1.72 | 32.6 | 0 | 2,510 | 0 | 3.16 | 1.9 | 1 | 15.9 | 1.5 | 36 | 36 | 36 |
| 3450 | 356 | 2.97 | .06 | 2,590 | 0 | 3.16 | 18 | 1 | 15.5 | 1.5 | 36 | 35 | 36 |
| 3451 | 69.2 | 15 | .08 | 2,700 | 0 | 3.16 | 5.8 | 2 | 15.9 | 1.5 | 37 | 35 | 36 |
| 3452 | 13.0 | 25 | 0 | 2,700 | 0 | 3.16 | 4.0 | 2 | 16.0 | 1.5 | 37 | 36 | 36 |
| 3453 | 22.4 | 23 | 0 | 2,700 | 0 | 3.16 | 4.1 | 2 | 16.0 | 1.5 | 37 | 36 | 36 |
| 3455 | 1,240 | 3.94 | .27 | 2,540 | 0 | 3.16 | 9.8 | 1 | 15.8 | 1.5 | 37 | 36 | 36 |
| 3457 | 33.4 | 12 | .08 | 2,480 | 0 | 3.16 | 5.1 | 1 | 16.1 | 1.6 | 36 | 36 | 36 |
| 3470 | 221 | 5.17 | .04 | 2,280 | 0 | 3.16 | 15 | 2 | 16.2 | 1.6 | 37 | 36 | 36 |
| 3475 | 456 | 7.26 | .07 | 2,140 | 0 | 3.16 | 6.0 | 1 | 16.0 | 1.6 | 36 | 36 | 35 |
| 3485 | 157 | 8.68 | .07 | 2,220 | 0 | 3.16 | 7.9 | 1 | 15.9 | 1.7 | 36 | 36 | 35 |
| 3490 | 3,310 | 3.62 | .31 | 2,290 | 0 | 3.16 | 20 | 2 | 15.9 | 1.6 | 36 | 36 | 36 |
| 3492 | 16.5 | 14.6 | .02 | 2,000 | 0 | 3.70 | 4.4 | 2 | 16.3 | 1.7 | 36 | 34 | 34 |
| 3495 | 1,180 | 4.05 | .03 | 1,890 | 0 | 3.70 | 3.5 | 2 | 16.2 | 1.7 | 35 | 35 | 34 |
| 3500 | 580 | 4.52 | .11 | 2,740 | 0 | 2.20 | 14 | 1 | 15.7 | 1.5 | 37 | 35 | 37 |
| 3510 | 1,140 | 3.44 | .07 | 2,640 | 0 | 2.20 | 19 | 1 | 15.7 | 1.5 | 37 | 36 | 36 |
| 3520 | 553 | 4.19 | .09 | 2,760 | 0 | 2.20 | 17 | 1 | 15.1 | 1.5 | 38 | 35 | 37 |
| 3525 | 1,340 | 3.78 | .05 | 2,600 | 0 | 2.20 | 25 | 1 | 15.2 | 1.5 | 38 | 35 | 37 |
| 3536 | .29 | 64.6 | 0 | 2,200 | 0 | 2.20 | 1.8 | 1 | 16.1 | 1.6 | 37 | 36 | 35 |
| 3537 | .76 | 62.2 | 0 | 2,150 | 0 | 2.20 | 3.7 | 1 | 16.1 | 1.6 | 37 | 36 | 35 |
| 3538 | 7.70 | 36.8 | .02 | 2,120 | 0 | 2.20 | 2.7 | 1 | 16.0 | 1.6 | 37 | 36 | 35 |
| 3539 | 110 | 16.2 | .04 | 2,180 | 0 | 2.20 | 5.2 | 2 | 16.0 | 1.6 | 37 | 36 | 35 |
| 3540 | 4,100 | 3.65 | .06 | 2,410 | 0 | 220 | 20 | 2 | 15.6 | 1.6 | 37 | 36 | 36 |
| 3545 | 617 | 2.99 | .41 | 1,950 | 0 | 3.51 | 9.9 | 2 | 16.6 | 1.7 | 36 | 35 | 34 |
| 3547 | 22.9 | 20.2 | .02 | 1,880 | 0 | 3.51 | 4.3 | 2 | 16.2 | 1.7 | 36 | 35 | 34 |
| 3548 | 23.3 | 22.4 | .02 | 2,000 | 0 | 3.51 | 4.8 | 2 | 16.1 | 1.7 | 36 | 35 | 34 |
| 3549 | 51.2 | 20 | .04 | 3,000 | 0 | 2.66 | 6.5 | 1 | 14.3 | 1.4 | 38 | 34 | 38 |
| 3549.5 | 11.4 | 20 | .02 | 3,000 | 0 | 2.66 | 8.3 | 1 | 14.4 | 1.4 | 38 | 34 | 38 |
| 3550 | 509 | 4.9 | .04 | 3,050 | 0 | 2.66 | 6.4 | 1 | 14.0 | 1.4 | 38 | 34 | 38 |
| 3552 | 3.39 | 15 | 0 | 3,000 | 0 | 2.66 | 3.0 | 2 | 14.4 | 1.4 | 38 | 34 | 38 |
| 3555 | 1,190 | 8.85 | .5 | 2,900 | .5 | 2.95 | 6.7 | 1 | 14.0 | 1.9 | 38 | 36 | 37 |

TABLE A-3.--Selected basin characteristics at gaging stations--Continued

| Station number | Area (A) | Slope (S) | Storage (St) | Ele-vation (E) | Forrest cover (F) | Soil index (Si) | Shape factor (Sh) | Orien-tation (Or) | Mean annual precipi-tation (P) | 2-year 24-hour rainfall ($I_{2,24}$) | Mean maximum March temper-ature ($T_3$) | Mean annual snow-fall (Sn) | Mean annual evapor-ation (Ev) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-3560 | 148 | 17.8 | 1.4 | 3,000 | .50 | 2.66 | 14.2 | 2 | 12.0 | 1.9 | 39 | 36 | 38 |
| 3565 | 1,350 | 7.90 | .4 | 2,800 | .50 | 2.66 | 3.86 | 1 | 12.7 | 1.9 | 39 | 36 | 38 |
| 4676 | 56 | 6.38 | .04 | 1,690 | 0 | 3.33 | 9.9 | 1 | 16.6 | 1.8 | 33 | 34 | 32 |
| 4676.5 | 39.4 | 4.35 | .04 | 1,630 | 0 | 3.33 | 2.7 | 2 | 16.5 | 1.8 | 33 | 34 | 32 |
| 4678 | 20.6 | 5.77 | .02 | 1,620 | 0 | 3.33 | 1.7 | 1 | 16.6 | 1.8 | 33 | 34 | 32 |
| 4679 | 42 | 3.06 | .04 | 1,580 | 0 | 3.33 | 2.4 | 1 | 16.7 | 1.8 | 32 | 34 | 31 |
| 4680 | 279 | 2.42 | .04 | 1,610 | 0 | 3.33 | 20 | 2 | 16.8 | 1.8 | 33 | 34 | 32 |
| 4695 | 298 | 2.34 | .04 | 1,680 | 0 | 2.66 | 29 | 1 | 17.2 | 1.8 | 33 | 33 | 32 |
| 4696 | 9.91 | 30.9 | .02 | 1,780 | 0 | 3.33 | 9.1 | 2 | 17.3 | 1.8 | 34 | 33 | 32 |
| 4700 | 1,170 | 1.51 | .72 | 1,580 | 0 | 3.33 | 25 | 1 | 17.1 | 1.8 | 33 | 34 | 32 |
| 4702 | .19 | 48.6 | 0 | 1,600 | 0 | 3.33 | 4.9 | 1 | 17.3 | 1.8 | 34 | 33 | 32 |
| 4703 | 62 | 14.1 | .02 | 1,680 | 0 | 3.33 | 9.1 | 1 | 17.4 | 1.8 | 34 | 33 | 32 |
| 4704 | 11.3 | 20.9 | .01 | 1,680 | 0 | 3.33 | 6.9 | 1 | 17.4 | 1.8 | 34 | 33 | 32 |
| 4712 | 480 | 4.80 | 3.5 | 1,600 | .10 | 2.99 | 6.56 | 1 | 18.0 | 2.2 | 35 | 35 | 33 |
| 4715 | 1,170 | 3.12 | 3.9 | 1,600 | .10 | 2.99 | 6.23 | 1 | 18.0 | 2.2 | 35 | 35 | 33 |

TABLE A-4.--Summary of regression equations

Model is $Y = aA^{b_1} S^{b_2} (Ev-12)^{b_3} (T_3-26)^{b_4} Sh^{b_5} (F+.01)^{b_6} (St+.01)^{b_7} (P-11)^{b_8} (E \times 10^{-3})^{b_9} (I_{2,24})^{b_{10}} Or^{b_{11}} (Sn-30)^{b_{12}} Si^{b_{13}}$

| Dependent variable | Regression coefficients for independent variables | | | | | | | | | | | | | Regression constant | Standard error of estimate (percent) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Y | $b_1$ | $b_2$ | $b_3$ | $b_4$ | $b_5$ | $b_6$ | $b_7$ | $b_8$ | $b_9$ | $b_{10}$ | $b_{11}$ | $b_{12}$ | $b_{13}$ | | |
| $Q_a$ | 0.975 | 0.360 | -1.363 | 1.176 | 0.359 | 0.084 | ----- | ----- | ----- | ----- | ----- | ----- | ----- | 0.054 | 61 |
| $q_1$ | 1.117 | ----- | -3.544 | ----- | ----- | ----- | 0.220 | ----- | 3.530 | ----- | ----- | ----- | ----- | 1.833 | >100 |
| $q_2$ | 1.054 | ----- | -6.069 | 3.233 | ----- | ----- | ----- | ----- | 5.239 | ----- | ----- | ----- | ----- | .718 | >100 |
| $q_3$ | .870 | ----- | ------ | 1.088 | ----- | ----- | ----- | 1.193 | 1.341 | ----- | ----- | ----- | ----- | .002 | 90 |
| $q_4$ | 1.048 | .522 | -1.856 | .881 | .507 | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | .386 | 85 |
| $q_5$ | 1.025 | .411 | -.940 | ----- | .502 | .083 | ----- | ----- | ----- | 0.147 | ----- | ----- | ----- | .174 | 70 |
| $q_6$ | 1.052 | .482 | -1.510 | 2.010 | ----- | .141 | ----- | ----- | ----- | ----- | 0.389 | ----- | ----- | .012 | 78 |
| $q_7$ | 1.079 | .330 | ------ | .881 | ----- | .094 | .127 | .871 | ----- | ----- | ----- | ----- | ----- | .001 | 66 |
| $q_8$ | 1.143 | ----- | ------ | ----- | ----- | .170 | ----- | ----- | ----- | ----- | ----- | ----- | ----- | .009 | >100 |
| $q_9$ | 1.323 | .419 | -.893 | ----- | ----- | .118 | ----- | ----- | ----- | ----- | .735 | ----- | ----- | .006 | >100 |
| $q_{10}$ | 1.077 | ----- | -1.792 | 1.083 | ----- | .209 | ----- | ----- | ----- | ----- | ----- | ----- | ----- | .073 | >100 |
| $q_{11}$ | .994 | ----- | -1.567 | 1.042 | ----- | .161 | ----- | ----- | ----- | ----- | ----- | ----- | ----- | .061 | >100 |
| $q_{12}$ | 1.165 | .613 | -1.726 | 1.215 | ----- | ----- | .223 | ----- | ----- | ----- | ----- | ----- | ----- | .004 | >100 |
| $SD_a$ | .990 | ----- | ------ | ----- | ----- | .089 | ----- | .460 | ----- | ----- | ----- | ----- | ----- | .030 | 70 |
| $SD_1$ | 1.091 | .593 | ------ | ----- | ----- | ----- | .328 | ----- | ----- | ----- | ----- | ----- | ----- | .001 | >100 |
| $SD_2$ | .985 | ----- | ------ | 1.339 | ----- | ----- | .402 | ----- | ----- | -7.666 | ----- | ----- | ----- | .094 | >100 |
| $SD_3$ | .827 | .381 | ------ | 1.375 | .313 | ----- | ----- | .919 | ----- | ----- | ----- | ----- | ----- | .002 | 78 |
| $SD_4$ | 1.040 | .516 | ------ | ----- | .443 | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | .039 | 98 |
| $SD_5$ | 1,052 | .553 | -1.331 | ----- | .605 | ----- | .167 | ----- | ----- | ----- | ----- | ----- | ----- | .303 | 97 |
| $SD_6$ | 1.079 | .802 | ------ | 1.250 | .444 | .111 | .132 | .944 | ----- | ----- | ----- | -7.800 | ----- | .001 | 77 |
| $SD_7$ | 1.055 | .389 | ------ | .693 | ----- | .926 | .113 | 1.098 | ----- | ----- | ----- | -.819 | ----- | .006 | 81 |
| $SD_8$ | 1.026 | ----- | ------ | ----- | ----- | .142 | ----- | ----- | ----- | ----- | ----- | ----- | ----- | .029 | >100 |
| $SD_9$ | 1.084 | ----- | -1.299 | ----- | ----- | .108 | ----- | ----- | ----- | ----- | 1.090 | ----- | ----- | .186 | >100 |
| $SD_{10}$ | 1.042 | ----- | -1.542 | ----- | ----- | .207 | ----- | ----- | ----- | ----- | .865 | -1.185 | ----- | 3.25 | >100 |
| $SD_{11}$ | .936 | ----- | ------ | ----- | ----- | .182 | ----- | ----- | -.989 | ----- | .605 | ----- | ----- | .024 | 82 |
| $SD_{12}$ | 1.198 | ----- | .506 | ----- | ----- | ----- | ----- | ----- | ----- | ----- | .143 | -.845 | ----- | .004 | >100 |
| $M_{7,2}$ | .876 | ----- | -4.625 | ----- | ----- | -.341 | .317 | ----- | 4.358 | ----- | 2.524 | ----- | ----- | .020 | >200 |
| $M_{7,10}$ | ----- | ----- | -2.894 | 2.498 | ----- | ----- | ----- | ----- | ----- | ----- | ----- | 1.841 | 1.892 | .001 | >200 |
| $M_{7,20}$ | ----- | ----- | -2.964 | 2.560 | ----- | ----- | ----- | ----- | ----- | ----- | ----- | 1.655 | 1.910 | .001 | >200 |
| $V_{7,2}$ | .898 | .534 | -2.088 | 1.732 | .448 | .085 | ----- | ----- | ----- | -3.020 | ----- | ----- | ----- | 6.47 | 93 |
| $V_{7,10}$ | .834 | .567 | ------ | .881 | .408 | ----- | ----- | .676 | ----- | ----- | ----- | ----- | ----- | .063 | 66 |
| $V_{7,50}$ | .478 | ----- | ------ | ----- | ----- | ----- | -1.140 | ----- | ----- | ----- | ----- | ----- | ----- | 177 | 44 |
| $Q_2$ | .731 | .618 | ------ | 1.028 | .404 | ----- | ----- | ----- | ----- | ----- | ----- | .921 | ----- | .026 | >100 |
| $Q_5$ | .797 | .476 | ------ | ----- | ----- | ----- | -.108 | ----- | .599 | ----- | ----- | ----- | ----- | 3.39 | 86 |
| $Q_{10}$ | .683 | .340 | -1.808 | 1.106 | .243 | ----- | -.138 | ----- | 1.512 | ----- | ----- | .639 | ----- | 14.0 | 77 |
| $Q_{25}$ | .665 | .351 | -.945 | .932 | .216 | ----- | ----- | ----- | ----- | -3.702 | ----- | .836 | ----- | 83.6 | 81 |
| $Q_{50}$ | .535 | .505 | ------ | ----- | ----- | ----- | -.130 | ----- | .876 | ----- | ----- | ----- | ----- | 66.8 | 56 |

TABLE A-5.--Streamflow stations now in operation and those needed for proposed network

| Station number | Station name | Types of data | | | | Recommendations | |
|---|---|---|---|---|---|---|---|
| | | | Planning and design | | | | |
| | | Current purpose | Minor streams | Principal streams | Long-term trend | Include in network | Not recommended for inclusion |
| 5-0515 | Red River of the North at Wahpeton | X | --------- | --------- | --------- | X | --------- |
| 5-0516 | Wild Rice River near Rutland | X | X | --------- | X | X | --------- |
| 5-0517 | Wild Rice River near Cayuga | X | --------- | X | --------- | X | --------- |
| 5-0525 | ANTELOPE CREEK AT DWIGHT[a] | --------- | X | --------- | --------- | X | --------- |
| 5-0530 | Wild Rice River near Abercrombie | X | --------- | X | --------- | X | --------- |
| 5-0540 | Red River of the North at Fargo | X | --------- | --------- | --------- | X | --------- |
| 5-0545 | Sheyenne River above Harvey | X | X | --------- | --------- | X | --------- |
| 5-055.2 | Big Coulee near Fort Totten | X | X | --------- | --------- | X | --------- |
| 5-0560 | Sheyenne River near Warwick | X | --------- | X | --------- | X | --------- |
| 5-0561 | Mauvais Coulee near Cando | --------- | X | --------- | --------- | X | --------- |
| 5-0562 | Edmore Coulee near Edmore | X | X | --------- | --------- | X | --------- |
| 5-0564 | Big Coulee near Churchs Ferry | X | --------- | X | --------- | X | --------- |
| 5-0570 | Sheyenne River near Cooperstown | X | --------- | X | --------- | X | --------- |
| 5-0572 | Baldhill Creek near Dazey | -------- | X | --------- | X | X | --------- |
| 5-0580 | Sheyenne River below Baldhill Dam | X | --------- | --------- | --------- | X | --------- |
| 5-0585 | Sheyenne River at Valley City | X | --------- | --------- | --------- | X | --------- |
| 5-0587 | Sheyenne River at Lisbon | X | --------- | --------- | --------- | X | --------- |
| 5-0590 | Sheyenne River near Kindred | X | --------- | --------- | --------- | X | --------- |
| 5-0595 | Sheyenne River at West Fargo | X | --------- | --------- | --------- | X | --------- |
| 5-0596 | MAPLE RIVER NEAR HOPE[a] | --------- | X | --------- | --------- | X | --------- |
| 5-0597 | Maple River near Enderlin | X | --------- | X | X | X | --------- |
| 5-0600 | Maple River near Mapleton | X | --------- | X | ---------- | X | --------- |
| 5-0605 | Rush River at Amenia | --------- | X | --------- | ---------- | --------- | X |
| 5-0622 | ELM RIVER NEAR KELSO[a] | --------- | X | --------- | --------- | X | --------- |
| 5-0645 | Red River of the North at Halstad, Minn. | --------- | --------- | --------- | --------- | X | --------- |
| 5-0649 | Beaver Creek near Finley | --------- | X | --------- | X | X | --------- |
| 5-0655 | Goose River near Portland | X | --------- | X | --------- | X | --------- |
| 5-0657 | MIDDLE BRANCH GOOSE RIVER NEAR FINLEY[a] | --------- | X | --------- | --------- | X | --------- |
| 5-0665 | Goose River at Hillsboro | X | --------- | X | --------- | X | --------- |
| 5-0825 | Red River of the North at Grand Forks | X | --------- | --------- | --------- | X | --------- |
| 5-0830 | Turtle River at Manvel | --------- | --------- | X | --------- | --------- | X |
| 5-0836 | Middle Branch Forest River near Whitman | --------- | X | --------- | --------- | X | --------- |
| 5-0840 | Forest River near Fordville | X | X | --------- | --------- | X | --------- |
| 5-0850 | Forest River at Minto | X | --------- | X | --------- | X | --------- |
| 5-0890 | South Branch Park River below Homme Dam | X | --------- | --------- | --------- | X | --------- |
| 5-0891 | Middle Branch Park River near Union | X | X | --------- | --------- | X | --------- |
| 5-0895 | Cart Creek at Mountain | X | X | --------- | --------- | X | --------- |
| 5-0900 | Park River at Grafton | X | --------- | --------- | --------- | X | --------- |
| 5-0920 | Red River of the North at Drayton | X | --------- | --------- | --------- | X | --------- |
| 5-0922 | UNNAMED TRIBUTARY NEAR GLASSTON[a] | --------- | X | --------- | --------- | X | --------- |

TABLE A-5.--Streamflow stations now in operation and those needed for proposed network--Continued

| Station number | Station name | Types of data | | | | Recommendations | |
|---|---|---|---|---|---|---|---|
| | | Current purpose | Planning and design: Minor streams | Planning and design: Principal streams | Long-term trend | Include in network | Not recommended for inclusion |
| 5-0987 | Hidden Island Coulee near Hansboro | X | X | --------- | --------- | X | --------- |
| 5-0988 | Long River near Sarles | X | X | --------- | --------- | X | --------- |
| 5-0994 | Little Pembina River near Walhalla | X | X | --------- | X | X | --------- |
| 5-0996 | Pembina River at Walhalla | X | --------- | X | --------- | X | --------- |
| 5-1000 | Pembina River at Neche | X | --------- | X | --------- | X | --------- |
| 5-1005 | Herzog Creek near Concrete | X | --------- | --------- | --------- | X | --------- |
| 5-1010 | Tongue River at Akra | X | X | --------- | --------- | X | --------- |
| 5-1136 | Long Creek near Noonan | X | --------- | X | X | X | --------- |
| 5-1140 | Souris (Mouse) River near Sherwood | X | --------- | --------- | --------- | X | --------- |
| 5-1160 | Souris (Mouse) River near Foxholm | X | --------- | --------- | --------- | X | --------- |
| 5-1161.8 | STONY RUN CREEK NEAR PERELLA[a] | --------- | X | --------- | --------- | X | --------- |
| 5-1165 | Des Lacs River at Foxholm | X | --------- | --------- | --------- | X | --------- |
| 5-1175 | Souris (Mouse) River above Minot | X | --------- | --------- | --------- | X | --------- |
| 5-1176 | GASSMAN COULEE NEAR MINOT | --------- | X | --------- | --------- | X | --------- |
| 5-1200 | Souris (Mouse) River near Verendrye | X | --------- | --------- | --------- | X | --------- |
| 5-1202 | Wintering River near Bergen | X | X | --------- | --------- | X | --------- |
| 5-1205 | Wintering River near Karlsruhe | X | X | --------- | --------- | X | --------- |
| 5-1220 | Souris (Mouse) River near Bantry | X | --------- | --------- | --------- | X | --------- |
| 5-1225 | Willow Creek at Dunseith | --------- | X | --------- | --------- | X | --------- |
| 5-1231 | Oak Creek at Lake Metigoshe Outlet near Bottineau | X | --------- | --------- | --------- | X | --------- |
| 5-1234 | Willow Creek near Willow City | X | --------- | X | --------- | X | --------- |
| 5-1235.1 | Deep River near Upham | X | X | --------- | --------- | X | --------- |
| 5-1236 | Egg Creek near Granville | X | X | --------- | --------- | X | --------- |
| 5-1237 | Cutbank Creek below North Lake Outlet near Granville | X | X | --------- | --------- | X | --------- |
| 5-1239 | Boundary Creek near Landa | X | X | --------- | X | X | --------- |
| 5-1240 | Souris (Mouse) River near Westhope | X | --------- | --------- | --------- | X | --------- |
| 6-3295.97 | Charbonneau Creek near Charbonneau | --------- | X | --------- | --------- | X | --------- |
| 6-3302 | LITTLE MUDDY CREEK NEAR APPAM[a] | --------- | X | --------- | --------- | X | --------- |
| 6-3310 | Little Muddy Creek below Cow Creek near Williston | --------- | --------- | X | X | X | --------- |
| 6-3316.8 | TOBACCO GARDEN CREEK NEAR WATFORD CITY[a] | --------- | X | --------- | --------- | X | --------- |
| 6-3320 | White Earth River at White Earth | --------- | --------- | X | --------- | X | --------- |
| 6-3324.8 | LITTLE KNIFE RIVER NEAR NEW TOWN[a] | --------- | X | --------- | --------- | X | --------- |
| 6-3325.15 | Bear Den Creek near Mandaree | --------- | X | --------- | X | X | --------- |
| 6-3325.2 | Shell Creek near Parshall | --------- | X | --------- | --------- | X | --------- |
| 6-3350 | Little Beaver Creek near Marmarth | X | --------- | X | --------- | X | --------- |
| 6-3355 | Little Missouri River at Marmarth | X | --------- | X | X | X | --------- |
| 6-3357.5 | DEEP CREEK NEAR AMIDON[a] | --------- | X | --------- | --------- | X | --------- |
| 6-3360 | Little Missouri River near Medora | X | --------- | X | --------- | X | --------- |
| 6-3360.5 | ANDREWS CREEK NEAR MEDORA[a] | --------- | X | --------- | --------- | X | --------- |

TABLE A-5.--Streamflow stations now in operation and those needed for proposed network--Continued

| Station number | Station name | Types of data | | | | Recommendations | |
|---|---|---|---|---|---|---|---|
| | | | Planning and design | | | | |
| | | Current purpose | Minor streams | Principal streams | Long-term trend | Include in network | Not recommended for inclusion |
| 6-3368 | BICYCLE CREEK NEAR GRASSY BUTTE[a] | --------- | X | --------- | --------- | X | --------- |
| 6-3370 | Little Missouri River near Watford City | X | --------- | X | --------- | X | --------- |
| 6-3375.8 | MIDDLE BRANCH DOUGLAS CREEK NEAR EMMET[a] | --------- | X | --------- | --------- | X | --------- |
| 6-3390 | Missouri River below Garrison Dam | X | --------- | --------- | --------- | X | --------- |
| 6-3391 | Knife River at Manning | --------- | X | --------- | --------- | X | --------- |
| 6-3392.7 | KNIFE RIVER ABOVE DEEP CREEK NEAR MARSHALL[a] | --------- | --------- | X | --------- | X | --------- |
| 6-3392.8 | DEEP CREEK NEAR MANNING[a] | --------- | X | --------- | --------- | X | --------- |
| 6-3394.9 | Elm Creek near Golden Valley | --------- | X | --------- | --------- | X | --------- |
| 6-3395 | Knife River near Golden Valley | X | --------- | X | --------- | X | --------- |
| 6-3400 | Spring Creek at Zap | --------- | --------- | X | --------- | X | --------- |
| 6-3402 | West Branch Otter Creek near Beulah | X | X | --------- | --------- | X | --------- |
| 6-3405 | Knife River at Hazen | X | --------- | X | --------- | X | --------- |
| 6-3414 | Turtle Creek near Turtle Lake | X | X | --------- | --------- | X | --------- |
| 6-3418 | Painted Woods Creek near Wilton | X | X | --------- | --------- | X | --------- |
| 6-3421 | Square Butte Creek trib #2 near Center | X | X | --------- | --------- | X | --------- |
| 6-3422.6 | Square Butte Creek below Center | X | --------- | --------- | --------- | X | --------- |
| 6-3424.5 | Burnt Creek near Bismarck | --------- | X | --------- | --------- | X | --------- |
| 6-3425 | Missouri River at Bismarck | X | --------- | --------- | --------- | X | --------- |
| 6-3430 | Heart River near South Heart | --------- | X | --------- | --------- | --------- | X |
| 6-3440 | Heart River below Dickinson Dam near Dickinson | X | --------- | --------- | --------- | X | --------- |
| 6-3446 | Green River near New Hradec | --------- | X | --------- | --------- | X | --------- |
| 6-3450 | Green River near Gladstone | X | X | --------- | --------- | X | --------- |
| 6-3455 | Heart River near Richardton | X | --------- | --------- | --------- | X | --------- |
| 6-3465 | Heart River below Heart Butte Dam near Glen Ullin | X | --------- | --------- | --------- | X | --------- |
| 6-3470 | Antelope Creek near Carson | --------- | X | --------- | --------- | X | --------- |
| 6-3475 | Big Muddy Creek near Almont | --------- | X | --------- | --------- | --------- | X |
| 6-3480 | Heart River near Lark | X | --------- | --------- | --------- | X | --------- |
| 6-3485 | Sweetbriar Creek near Judson | X | --------- | --------- | --------- | X | --------- |
| 6-3490 | Heart River near Mandan | X | --------- | --------- | --------- | X | --------- |
| 6-3490.3 | EAST BRANCH APPLE CREEK NEAR MENOKEN[a] | --------- | --------- | X | --------- | X | --------- |
| 6-3491 | UNNAMED TRIBUTARY TO ALKALINE LAKE[a] | --------- | X | --------- | --------- | X | --------- |
| 6-3495 | Apple Creek near Menoken | --------- | --------- | X | --------- | X | --------- |
| 6-3496 | LITTLE HEART RIVER NEAR ST. ANTHONY[a] | --------- | X | --------- | --------- | X | --------- |
| 6-3499 | CANNONBALL RIVER AT NEW ENGLAND[a] | --------- | X | --------- | --------- | X | --------- |
| 6-3500 | Cannonball River at Regent | X | --------- | X | --------- | X | --------- |
| 6-3510 | Cannonball River below Bentley | --------- | --------- | X | X | X | --------- |
| 6-3516.8 | WHITE BUTTE FORK CEDAR CREEK NEAR SCRANTON[a] | --------- | X | --------- | --------- | X | --------- |
| 6-3520 | Cedar Creek near Haynes | --------- | --------- | X | --------- | X | --------- |
| 6-3525 | Cedar Creek near Pretty Rock | --------- | --------- | X | --------- | --------- | X |

TABLE A-5.--Streamflow stations now in operation and those needed for proposed network--Continued

| Station number | Station name | Types of data | | | | Recommendations | |
|---|---|---|---|---|---|---|---|
| | | | Planning and design | | | | |
| | | Current purpose | Minor streams | Principal streams | Long-term trend | Include in network | Not recommended for inclusion |
| 6-3530 | Cedar Creek near Raleigh | X | --------- | X | --------- | X | --------- |
| 6-3540 | Cannonball River at Breien | X | --------- | X | --------- | X | --------- |
| 6-3544 | SOUTH BRANCH BEAVER CREEK NEAR STRASBURG[a] | --------- | X | --------- | --------- | X | --------- |
| 6-3545 | Beaver Creek at Linton | X | --------- | X | X | X | --------- |
| 6-3548.2 | PORCUPINE CREEK NEAR FORT YATES[a] | --------- | X | --------- | --------- | X | --------- |
| 6-3550 | North Fork Grand River at Haley | X | --------- | --------- | --------- | X | --------- |
| 6-3576 | HIDDENWOOD CREEK AT HETTINGER[a] | --------- | X | --------- | --------- | X | --------- |
| 6-4676 | James River near Manfred | X | X | --------- | --------- | X | --------- |
| 6-4679 | Big Slough at Hamberg | X | X | --------- | --------- | X | --------- |
| 6-4681.7 | James River near Grace City | X | --------- | X | --------- | X | --------- |
| 6-4682.5 | KELLY CREEK NEAR BORDULAC[a] | --------- | X | --------- | --------- | X | --------- |
| 6-4695 | Pipestem Creek near Buchanan | X | X | --------- | --------- | X | --------- |
| 6-4700 | James River at Jamestown | X | ---------- | --------- | --------- | X | --------- |
| 6-4703 | BEAVER CREEK NEAR SYDNEY[a] | --------- | X | --------- | --------- | X | --------- |
| 6-4705 | James River at La Moure | X | ---------- | --------- | --------- | X | --------- |
| 6-4708 | BEAR CREEK NEAR OAKES[a] | --------- | X | --------- | --------- | X | --------- |
| 6-4710.8 | SOUTH FORK MAPLE RIVER NEAR MONANGO[a] | --------- | X | --------- | --------- | X | --------- |

a - Continuous-record gaging station to be established.



GPO 831-834

A PROPOSED STREAMFLOW DATA PROGRAM FOR NORTH DAKOTA BY ORLO A. CROSBY