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A PROPOSED STREAMFLOW DATA PROGRAM FOR NEVADA

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ABSTRACT

An evaluation of the streamflow data available in Nevada 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, (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 goals. Because of the sparsity of streamflow data in Nevada, it was found that none of the goals could be met by generalization of the data for gaged basins by regression analysis. The regression method may be more successful at a future time if an adequate sample of long-term streamflow records is obtained. In the meantime, methods of transferring flow characteristics which require some information at the ungaged site may be used. A streamflow data program based on the guidelines developed in this study is proposed.

INTRODUCTION

Surface-water problems are becoming more numerous and more complex at a rapid rate within the State of Nevada. Some water information, vital to the solution of these problems, has been collected largely as part of a cooperative program between the State of Nevada and the U.S. Geological Survey.

A collection of daily discharges on the larger streams in the State was begun by other Federal agencies during the 1890's. The first water record collected in the State was the stage record of Pyramid Lake, which was begun in 1876.

In 1903 Nevada created the office of the State Engineer. This office was directed to cooperate with the Secretary of the Interior in all work of construction, operation, maintenance and management of irrigation works in and for the benefit of Nevada, and to facilitate the work of the Secretary of the Interior in carrying out the provisions of the Irrigation Act in the State of Nevada.

The streamflow program evolved through the years as the Federal and State interests in surface-water resources increased and as funds for operating the stream-gaging station network became available.

Prior to 1961, most of the streamflow data collected were for current use. Since that date, several streamflow stations have been established to define the hydrologic characteristics.

In 1962, a crest-stage partial-record network was begun in cooperation with the Nevada Highway Department. The purpose of this program is to define characteristics of peak flows from small drainage areas. There are now 103 gages in this network, 4 of which are equipped with continuous stage recorders, and 3 equipped with flood hydrograph recorders.

In 1965, 12 low-flow partial-record sites were established, at which base-flow measurements are made to define low-flow characteristics.

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 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 concepts and procedures used in this study were presented in detail by Carter and Benson (1969), and are summarized only briefly in this report. The basic steps are (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, (3) consideration of alternate means of meeting the remaining goals, and (4) preparation of a proposed program of data collection and analysis to meet the remaining goals.

PHYSICAL AND HYDROLOGIC DESCRIPTION OF NEVADA

Nevada is characterized by its hundreds of closed basins and numerous mountain ranges. These mountain ranges are roughly parallel in a north-south direction and are separated by alluvium-filled basins. There is an abrupt change of slope at the base of the mountains, between the mountain fronts and the alluvial aprons. These aprons consist mainly of gently sloping fans built up by erosional debris from the mountains. The closed basins and mountains are characterized by numerous small streams that are generally perennial until they reach the mountain front. The streams then diverge into numerous distributary channels where they flow upon the aprons. At this point most of the streamflow is lost by infiltration into the ground, by evaporation, and by transpiration. During high flows, some streams continue to the lowest part of the basin where the water is stored on a playa until it evaporates. Thus, many streams are perennial in their headwaters and ephemeral in their lower reaches.

In addition to these streams, Nevada has, particularly in the southern part of the State, thousands of streams which are ephemeral throughout their reaches. These streams usually have short periods of very high rates of runoff resulting from high-intensity storms or cloudbursts, separated by long periods of little or no flow. Although there is a great number of these streams, they carry a small percentage of the surface water available within the State. Due to their erratic runoff characteristics, the surface water in the ephemeral streams has little economic value other than impoundage in small stock and irrigation reservoirs for limited use. However, its value as a source of recharge to the ground-water system may be quite significant. For instance, floods in the ephemeral channels, where they flow over the permeable upper parts of the alluvial aprons, make significant contributions to the underground supply.

The few large streams in the State also follow the pattern of gaining in flow, to a point, and then decreasing in flow. Diversions for irrigation accentuate the downstream decrease in flow. For example, the Humboldt River commonly attains its largest mean discharge (346 cfs) in the vicinity of Palisade, where the drainage area is 5,010 square miles. At Rose Creek, where the drainage area is about three times as large, the mean discharge is only 214 cfs.

Most of Nevada lies in the rain shadow of the Sierra Nevada, which prevents the westerly winds from carrying large amounts of moisture into the State from the Pacific Ocean. Due to this, Nevada is the most arid State in the Nation. The precipitation is generally greatest in the north and decreases in a southerly direction. For example, the annual precipitation is 31.9 inches (16 years record) at Coon Creek Summit near the Idaho border, and 3.9 inches (30 years record) at Las Vegas in Southern Nevada. An orographic effect is also predominant and precipitation varies greatly with altitude.

Winter and early spring precipitation is generally from regional storms of long duration and is a larger part of the total precipitation in the high mountains than it is in the valleys. Winter precipitation usually accumulates as snow in the higher mountains. The gradual melting of this snow in the spring feeds the mountain streams which furnish much of the irrigation supplies and provides much of the ground-water recharge. Summer precipitation in the State generally comes in the form of violent local thunderstorms in the afternoon or evening of hot days.

Streamflow is greatest in the spring of the year when the snow melts and when there is also considerable rain in the mountains. By early summer most of the snow has disappeared and evapotranspiration rates are high. As a result, streamflow decreases substantially throughout the summer. Midsummer storms occasionally cause rises in streams and even flash floods; however, the volume of runoff is small and flows are not sustained.

STREAMFLOW DATA AVAILABLE

Streamflow records have been collected at many sites on the larger streams in Nevada, all of which are regulated. These streams are the Truckee, Carson, and Walker Rivers which flow from the Sierra Nevada in west-central Nevada, the Humboldt River which flows through the northern part of Nevada, and the Owyhee River in north-central Nevada which drains into the Snake River Basin.

Streamflow records have been collected at only a few sites for short periods in the remaining part of Nevada. Most of these records were collected after 1961. Large areas of the State have no streamflow records available except for short periods of peak flows collected at partial-record sites.

Table 1 shows the number of stations and years of record available in the State at the end of the 1967 water year. Only 303 station years of continuous record have been collected on unregulated streams and 1,407 station years on regulated streams.

The Nevada State Engineer's office also collected seasonal records on several perennial streams in the early 1900's.

In addition to the above records, several hundred streamflow measurements have been made at miscellaneous sites. Most of these streamflow measurements were made after 1962 as part of the reconnaissance project done in cooperation with the State of Nevada.

PROCEDURES USED IN THIS STUDY

The prodecures used in this study are outlined in table 2. First, streamflow data are classified into four types because of the different ways in which those data are obtained, and because of different goals. The subclassifications in table 2 differ from those described by Carter and Benson (1969) for reasons given later. The second step in the procedure is the setting of goals of the streamflow program in terms of the e ments to be defined and accuracy needed. Then the existing data are evaluated to determine which goals have already been met. Finally, the unmet goals are the basis for the proposed program of data collection and analysis.

Data for current uses, such as day-to-day decisions on water management, assessment of current water availability, management of water quality, forecast of water hazards, and the surveillance necessary to comply with legal requirements, are commonly obtained by operating a gaging station at the site. This element of the program is not subject to design but changes in response to needs.

Data used for planning and design are commonly the statistical characteristics of streamflow, such as mean discharge, the flood of 10-year recurrence interval, and the mean seasonal discharge. These and other characteristics can be obtained from gaging-station records. Although a long record is desirable for defining statistical characteristics at a site, it is not feasible to collect records at every site where it may be needed. But a number of such records are required to provide information that can be transferred to ungaged sites, or to sites at which little streamflow data are available.

The transfer of information on streams having natural flow may be 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.

The definition of flow characteristics of a regulated stream is often complicated because of changes in the regulation during the period of record. Frequently it is not possible to obtain a long record under one condition of development. Likewise, transference of flow characteristics from one point to another on a regulated stream is difficult because the procedures used for natural streams, such as regression and interpolation, do not apply. A systems approach seems to be the most efficient way to define the flow characteristics of regulated streams. This approach requires some sort of analytical model of the stream system using as inputs, streamflow records, stage-capacity curves of reservoirs, operating rule curves for the release of water,

Table 1.--Streamflow data available in Nevada at end of 1967 water year

Continuous record						Partial record			
Natural-flow streams		Regulated-flow streams				Peak flow		Low-flow measurements	
Number of stations	Years of record	Number of stations	Years of record	Number of stations	Years of record	Number of stations	Years of record	Number of stations	Years of record
11	1	10	1	1	22	36	1	3	1
5	2	8	2	2	24	4	2	9	2
5	3	8	4	1	25	4	3	5	3
3	4	6	5	1	27	10	4	1	4
5	5	6	6	3	28	14	5		
2	6	1	7	1	29	25	6		
3	7	5	8	3	30	15	7		
3	8	4	9	1	31				
2	9	2	10	1	32				
1	10	3	11	2	39				
1	14	1	12	2	41				
1	16	2	14	1	42				
2	19	1	15	1	48				
1	31	2	17	2	53				
1	46	4	19	1	56				
		4	20	1	60				
		2	21	1	63				

Table 2.--Framework for design of data-collection program

Type of data	Current use	Planning and design: Natural flow — Minor streams	Planning and design: Regulated flow — Principal streams	Long-term trends	Stream environment
Goals	To provide current data on streamflow needed for day-to-day decisions on water management as required.	To provide information on statistical characteristics of flow at any site on any stream in Nevada 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.
Accuracy goal	As required.	Equivalent to 10 years of record.	Equivalent to 25 years of record.	Highest obtainable.	As required.
Approach	Operate gaging stations at sites as required to provide specific information needed. Less than a complete record may be adequate for some purposes.	Gage at selected points. Transfer data to ungaged points by regression or interpolation.	Gage at selected points; record diversions, gate operations, storage changes, etc; and develop model of stream system. Use model to simulate long record of flows under regulated condition.	Operate a few carefully selected gaging stations indefinitely.	Observe, measure, and publish information on stream environment.
Evaluate available data.	Identify stations where data are used currently and code the specific use of data.	Develop relationship for each flow characteristic and compare standard error with accuracy goal. Evaluate sample.	Identify stream systems that should be studied using model approach and determine data requirements.	Are present stations, designated for this purpose, adequate?	Evaluate 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.			

Note: There are four principal streams in Nevada and the flow of each is regulated. These principal streams are identified on p. 24. All other streams are considered to be "minor."

losses due to evaporation and seepage, stream-channel geometry, and records of diversions and return flows including ground-water pumpage and aquifer characteristics. The model and associated data can be used to derive homogeneous data for both natural and regulated conditions.

Data to define long-term trends in streamflow can only be obtained by operating gaging stations indefinitely on a few natural streams. The records from these gaging stations will either affirm that the flow characteristics defined from present records are good estimates of the long-term characteristics, or they will provide a basis for adjusting those short-term characteristics.

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

In the following sections, the program goals, the evaluation of the available data, and the proposed program are described.

GOALS OF THE NEVADA STREAMFLOW PROGRAM

Streamflow information is required for the planning, design, and operation of projects, for the management of water resources, and for protection from floods. That information can be obtained by a combination of data collection and analysis, but the particular data to be collected and the applicable methods of analysis depend on the hydrology of the region, the specific goals of the program, and the cost which can be justified for this purpose.

The overall objective of a surface-water data program is to provide information of a specified accuracy at any site on any stream. The specific goals of the Nevada surface-water program are described in the following paragraphs.

Data for Current Use

The 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 are specified by the data user. Higher than usual accuracy can be obtained by intensive observation or by more sophisticated instrumentation.

Data for Planning and Design

The goals for this type of data are to define flow characteristics at ungaged sites to an accuracy that is equivalent to 10 years of record for minor streams and 25 years of record for principal streams. Accuracy, in percent, corresponding to the stated goals depends on the variability of the flow characteristic being considered. Because the variabilities are well defined at only a few sites on natural streams in Nevada, this conversion has not been made.

Carter and Benson (1969) classified streams as natural or regulated, and further subdivided each of these into principal and minor streams on the basis of drainage area. In Nevada, size of drainage area is not a useful criterion for separating principal and minor streams. Therefore, principal streams are named for this study (p.); all of these are regulated. The remaining Nevada streams are considered minor streams with virtually natural flow, although many have some diversions in their lower reaches. These minor streams may be either perennial or ephemeral and although the accuracy goals are the same, the flow characteristics to be defined differ. For this purpose a stream is considered to be perennial if it goes dry occasionally or not at all, and to be ephemeral if it is dry for several months each year.

The streamflow characteristics that need to be defined at any point on any perennial stream in that part of Nevada including, and to the north and west of, the basins of Humboldt, Truckee, Carson, and Walker Rivers are as follows:

- Mean annual discharge
- Standard deviation of annual discharge
- Mean monthly discharges
- Seasonal discharge (March through August)
- 10-year flood
- 50-year flood
- 7-day, 20-year low-flow

In that part of Nevada described above the streamflow characteristics that need to be defined at any point on any ephemeral stream are limited to the mean annual flow and the 10-year flood.

In the rest of Nevada, with the exception of the 10-year flood, it may not be necessary to define the flow characteristics of each individual stream. However, the combined flows of groups of streams are needed. The goals for such groups of streams are:

Defining mean annual flow at the mountain front
Defining losses on the alluvial aprons
Defining the amount of surface water that enters the ground-water system from streamflow.

Data to Define Long-Term Trends

The goal for this type is to operate indefinitely a small network of gaging stations on streams that are expected to be relatively free from man-made changes.

Data on Stream Environment

The long-range goals for this type of data in Nevada are given below.

1. Hydrometric surveys of stream-aquifer systems.
2. Identification of areas inundated by floods of selected frequencies on the Walker, Truckee, Carson, and Humboldt Rivers.
3. Definition of flood profiles along stream channels on the larger perennial streams.
4. Surveys of time of travel of solutes in the Humboldt, Carson, Truckee, and Walker Rivers.
5. Reconnaissance surveys of streamflow and stream-channel parameters that are related to use of the stream for recreation, such as velocities, depths, bed material, water temperature, and water quality. This is necessary only for perennial streams.
6. Definition of climatic factors influencing the water supply, such as precipitation and depth and extent of snow packs.

EVALUATION OF EXISTING DATA IN NEVADA

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

Data for Current Use

About half of the gaging stations in Nevada 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 49 current-use gaging stations are listed and classified as to principal use in table A-1 in the Appendix. Several of these stations also have hydrologic significance.

Data for Planning and Design

The statistical characteristics of streamflow can be defined by sample gaging, analytical methods of regionalization, systems studies, and empirical methods. The following discussion of evaluation of this type of data follows the framework shown in table 2.

Evaluation of Data for Natural-Flow Streams

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.

The most effective way now known for defining 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 basin characteristics in the formulas.

The 58 streamflow records used in the following analysis are those having 5 or more years of mostly unregulated flow. The length of most records were less than 10 years. Records were not adjusted to a base period. Because of some regulation, not all flow characteristics were defined from each record. For example, for some stations regulation materially affected low flows, but insignificantly affected peaks.

Streamflow characteristics.--The following streamflow characteristics defined at gaging stations were used in the regressions.

a. Mean of the annual means, Q_a.
b. Standard deviation of the annual means, SD_a.
c. Mean of record for each calendar month, q_n, where the subscript refers to the numerical order of the month beginning with January as 1.
d. Mean of the seasonal flows (period March 1 to August 31), Q_s.
e. Annual floods at recurrence intervals of 10 years and 50 years, Q_{10} and Q_{50}.
f. Annual minimum 7-day average flow of 20 year recurrence interval, $M_{7,20}$.

Streamflow characteristics listed in table A-2 are those available for regression. Monthly means are not listed.

Drainage-basin characteristics.--Drainage-basin characteristics defined for this study are:

a. Drainage area, in square miles, as shown in the latest Geological Survey streamflow reports.
b. Percent of drainage area above the mountain front, as determined by planimetering the areas on topographic maps.
c. Main-channel length, in miles, from the gaging station to the basin divide.
d. Percent of main-channel length above the mountain front, in miles.
e. Main-channel slope above the mountain front, in feet per mile, determined from altitudes at points 10 percent and 85 percent of the distance along the channel from the mountain front to the divide.
f. Main-channel slope below the mountain front, in feet per mile, determined from altitudes at points 10 percent and 85 percent of the distance along the channel from the gaging station to the mountain front.

g. Mean annual precipitation, in inches, determined from precipitation-altitude curves that have been developed for Nevada. Seven such relations have been developed, each representing a large relatively homogeneous area.
h. Aspect, in degrees, determined by measuring the angle in a clockwise direction between the axis of the drainage basin and due south.
i. Longitude of the center of the drainage basin, to the nearest 15 minutes, less 110°, in decimal form. For example, the longitude of 115°15' and 118°45' are shown as 5.25 and 8.75, respectively.
j. Latitude of the center of the drainage basin to the nearest 15 minutes, in decimal form. For example, the latitude of 39°30' is shown as 39.50.
k. Mean altitude above the mountain front, in feet.

Values of the above basin characteristics for each of the 58 gaging stations used in the analysis are listed in table A-3.

Regression analysis.--The next step was to relate each of the streamflow characteristics to basin characteristics by multiple regression. The model is

$$Y = a A^b S^c P^d$$

where Y is a streamflow characteristic; A, S, and P are basin characteristics; and the other symbols are coefficients obtained by regression. In this study all basin characteristics were used initially in the regression for each flow characteristic.

Following computation of an initial regression equation, the coefficients were tested for statistical significance and those characteristics which were found insignificant were dropped. Then the regression was computed using only the significant parameters; and the standard error, in percent, determined.

Results of the regression analyses showed the following basin characteristics to be related to one or more of the following streamflow characteristics: drainage area, drainage area above the mountain front, mean annual precipitation, latitude, main-channel length, mean altitude above the mountain front, and aspect. Examples of the final regression equations and their standard errors are given in table 3.

Table 3.--A sample of regression results

Mean annual discharge	
$Q_a = 3.71 \times 10^4 A^{0.78} P^{3.60} Su^{-0.25} E^{-2.32}$	SE = 32%
Standard deviation of mean annual discharge	
$SD_a = 1.84 A^{0.95} P^{2.09} Su^{-1.05} L^{-1.27}$	SE = 37%
Seasonal mean discharge (March 1 to August 31)	
$Q_s = 4.27 \times 10^{-23} A^{0.83} P^{2.80} Lat^{11.5}$	SE = 40%
7-day 20-year low flow	
$M_{7,20} = 1.38 \times 10^{47} P^{4.05} L^{2.50} Lat^{-34.6}$	SE = 300%
10-year flood on perennial streams	
$Q_{10} = 3.39 \times 10^{10} A^{0.68} P^{2.73} long^{1.86} E^{-3.68}$	SE = 91%
10-year flood on ephemeral streams	
$Q_{10} = 4.91 \times 10^2 A^{0.67} A_u^{0.48} P^{-1.86}$	SE = 177%

Glossary

A	total drainage area
A_u	percent of drainage area above the mountain front
P	mean annual precipitation
Su	channel slope above mountain front
E	mean altitude above the mountain front
L	main channel length
Lat	latitude
long	longitude
SE	standard error

The standard errors of the regression equations defined in this study are much greater than the equivalent error of 10 years of record at a site, which was the accuracy goal established. Furthermore, the form of some of the equations is not in accord with hydrologic principles. Use of the equations to estimate flow of ungaged streams is not recommended.

One reason that it has not been possible to regionalize streamflow characteristics satisfactorily is that gaging-station records on natural-flow streams are available at only a few sites, and the length of the records is generally short. Streamflow records more than 10 years in length on natural-flow streams are available at only 7 sites. A second reason for the poor results is that basin parameters are poorly defined, because of the lack of adequate maps and adequate data on climatic variables.

The regression method may be more successful at a future time, if an adequate sample of long-term streamflow records is obtained. In the meantime, methods of transferring flow characteristics which require some information at the site may be used. These methods are described in the next principal section.

Evaluation of Data for the Regulated-Flow Streams

The four principal streams in Nevada are regulated by reservoirs and diversions for irrigation. These streams, (1) Truckee River from Lake Tahoe to Pyramid Lake, (2) Carson River from the State line to Carson sink, (3) Walker River from State line to Walker Lake, and (4) Humboldt River main stem, are being gaged at enough points to provide data for development of system models.

Data to Define Long-Term Trends

At present, two stations, Steptoe Creek near Ely and South Twin River near Round Mountain, are designated as hydrologic bench-mark stations and are to be operated indefinitely. Due to the different climatic and hydrologic conditions in Nevada, additional stations should be designated.

Data on Stream Environment

Detailed channel surveys have been made at the two gaging stations designated as hydrologic bench-mark stations. Channel surveys have been made at many sites in connection with indirect determinations of peak flows for unusual floods. Channel-geometry measurements for estimating mean discharge have been determined at several of the gaging stations. In addition, some of the basin characteristics determined for this study, particularly stream slopes, basin elevations, and average basin precipitation are descriptors of the environment.

ALTERNATE MEANS OF TRANSFERRING STREAMFLOW DATA

The collection of additional streamflow data will ultimately lead to definition of streamflow characteristics by regression analysis. In the interim period alternate methods of transferring information to an ungaged site may be considered. Most of these methods require some information at the ungaged site, and gaging station records to define specific relationships. These methods are briefly described in the following paragraphs.

Moore (1968) and Hedman (1970) have shown that mean annual flow can be estimated from the width and depth of the lower section of the stream channel. Different relationships were developed for perennial and ephemeral streams. These relations at the present time provide a means of roughly estimating the mean annual flow at a site and better definition of the relations through research may lead to more exact definition.

Riggs (1969) showed that estimates of the mean annual flow at a site can be determined by measuring the discharge at the site near the middle of each calendar month for a water year if concurrent correlation can be established with a nearby gaging station. This method may have particular application in areas where runoff is seasonal and is due to snowmelt.

Moore (1968) developed relations between mean annual flow and altitude for certain parts of Nevada. Derived data based on channel geometry or monthly discharge measurements may be used in defining such relationships in other parts of Nevada.

Riggs (1965) describes the use of partial-record stations to define low-flow characteristics at numerous sites. A partial-record station is a site at which enough base-flow measurements are obtained to define an adequate relation with concurrent flows at a nearby gaging station. The frequency characteristics of the low flow at a partial-record station can be determined from the relation of concurrent flows and the record at the gaged site.

Exact definition of these alternate methods of analysis depends on the availability of a network of long-term streamflow records. The sparsity of such records in Nevada will limit both the application and accuracy of these methods.

THE PROPOSED PROGRAM

The information developed in this study has indicated that, with the exception of current-use data, the established goals have not been met. The information obtained from the study has been applied to planning a streamflow-information program, which should eventually meet the goals for the various types of data. For the optimum program, a balance must be maintained between data collection and data analysis, as continuous interaction between the two is needed, not only to gain a better understanding of the hydrologic system, but also 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 47 of the 49 stations, identified as presently meeting the needs for current-purpose data (table A-1), should be continued. The two stations that do not appear to be needed for this purpose are 10-3235, Humboldt River near Argenta, and 10-3200, South Fork Humboldt River above Dixie Creek, near Elko. These two stations have flows nearly equivalent to 10-3250, Humboldt River at Battle Mountain, and 10-3205, South Fork Humboldt River near Elko.

Needs should be assessed periodically, and this part of the data-collection network modified by adding or discontinuing stations as needs change. Furthermore, the need for a continuous record of discharge at each site should be examined. For some purposes a stage record or definition of peak flows may suffice.

Data for Planning and Design

None of the goals for this type of data have been attained. One reason that it has not been possible to regionalize streamflow characteristics is that gaging-station records on natural-flow streams are few and generally short. This indicates the need for continuing operation of the existing gaging stations and the establishment of others in regions where few records are available. The proposed data-collection program is described separately for perennial streams, ephemeral streams, and groups of streams because different goals were established for each of these categories.

Natural-flow, perennial-minor streams.--A network of gaging stations, well-distributed geographically, will provide flow characteristics which (1) are needed to provide regional definition by regression analysis, (2) can be transferred to sites at which discharge measurements are available, (3) may be used to define relations between channel geometry and mean flow or flood flow, and (4) may be used to confirm runoff-altitude relations.

All gaging stations on natural-flow streams now being operated should be continued in operation. In addition, the following discontinued stations should be reestablished:

10-2432.4	Baker Creek at Narrows, near Baker
10-2437	Cleve Creek near Ely
10-3105	Clear Creek near Carson City
10-3265	Big Creek near Austin
10-3473	Dog Creek near Verdi
10-3497	White Creek near Steamboat
10-3536	Kings River near Orovada

New gaging stations should be established on the following streams above all regulation for better areal distribution of gaged perennial-minor streams.

Cherry Creek near Adaven
Willow Creek near Warm Springs
McClusky Creek near Austin
Boone Creek near Austin
Fish Creek near Battle Mountain
Clear Creek near Winnemucca
Buffalo Creek near Gerlach
Mud Meadow Creek near Gerlach
Spring Valley Wash near Pioche
Trout Creek near Contact
Cottonwood Creek near Contact

Each station in the existing or proposed network should be operated until at least 25 years of record is available.

Information on flood peaks should continue to be collected at all gaging stations, active or discontinued, and at all crest-stage partial-record stations now in operation. At least 15 years of record should be obtained at the latter stations.

A rotating network of partial-record low-flow stations should be established on perennial minor streams. Sufficient base flow measurements should be obtained at each site to establish concurrent correlation with base flow at a gaging station. This network should be concentrated in one part of the State for several years and then shifted to another area.

A certain amount of effort each year should be devoted to measuring discharge and channel geometry and to testing and improving relations used to estimate flow characteristics from discharge measurements, channel-geometry measurements, and runoff-altitude relations.

Summarizing, regardless of the method of transferring data to ungaged sites, a well-distributed network of gaging stations with a minimum of 25 years of record is needed. A program of making discharge measurements and (or) channel-geometry measurements, and of verifying and applying runoff-altitude relations will furnish additional data needed to define streamflow characteristics at any site.

<u>Natural-flow ephemeral-minor streams</u>.--The goals for this type of stream are to define the mean flow and the 10-year flood at any site. To define the mean flow some continuous-record gaging stations are needed. The following six active continuous gaging stations on ephemeral streams should be continued:

9-4156	Pahranagat Valley tributary near Hiko
9-4196.1	Lee Canyon near Charleston Park
9-4196.5	Las Vegas Wash at North Las Vegas
10-2458	Newark Valley tributary near Hamilton
10-2494.11	Campbell Creek tributary near Eastgate
10-3617	Badger Creek near Vya

About a dozen additional stations of this type would be desirable. One should be the Amargosa River near Beatty (discontinued in 1968). Consideration should be given to obtaining annual flow volumes at other sites where only crest stages are now being operated.

In addition, the following partial-record gaging stations equipped with flood-hydrograph recorders should be continued:

9-4216.1	Eldorado Valley tributary near Nelson
10-2478.6	Penoyer Valley tributary near Tempiute
10-2519.8	Lovell Wash near Blue Diamond
10-3020.1	Reese River Canyon near Schurz

The above continuous and partial-record gaging stations will also provide data on flood peaks. In addition, the crest-stage partial-record stations shown on figure 1, most of which are on ephemeral streams, should be continued until such time as a satisfactory regional regression of flood characteristics on basin or channel characteristics is developed.

Regulated-flow, principal streams.--For purposes of the study, consideration of this category of data was limited only to identifying the regulated-streams systems. All 4 principal streams in Nevada--the Carson, Humboldt, Truckee, and Walker Rivers--are regulated. Most of the gaging stations on these rivers are classified as current-purpose stations and should be continued, except for the stations 10-3200, South Fork Humboldt River above Dixie Creek, near Elko, and 10-3235, Humboldt River near Argenta whose records are virtually duplicated at other sites on these rivers as stated before. An additional station should be established on the Walker River below Schurz to measure inflow to Walker Lake.

The proposed program should include provisions to collect records of inflow, outflow, reservoir contents, diversions, operations schedules, and other pertinent hydrologic data at the major reservoirs and diversion points in the regulated-streams systems described above. Priority should be given to the Truckee and Carson Rivers when system studies are started.

Groups of streams in an area.--In certain regions the mean flow at the mountain front, the losses on the alluvial aprons, and the amount of streamflow that enters the ground-water system from groups of streams are needed. It is not necessary to define the flow characteristics of each individual stream.

The runoff at a mountain front can be roughly estimated at the present time by use of runoff-altitude relations and channel-geometry measurements. With the additional gaging-station records proposed for natural-flow ephemeral and perennial streams, the runoff-altitude relations can be better defined for the State of Nevada. These additional records also will improve the relations for determining the flow characteristics by use of channel-geometry measurements. To supplement these additional gaging-station records, several discharge measurements should be made on selected perennial streams each year for a year or two during the months of September, October, and November. These measurements may be used to adjust the regional runoff-altitude relations to the specific region as explained by Moore (1968). A different area should be investigated each year.

Data Analysis

As longer records at more sites become available, regional analysis by regression should again be attempted, using a model and variables which describe the hydrologic and hydraulic processes on Nevada streams.

By 1974 there will be 10 years of record on many of the crest-stage partial-record stations. At least by that time an analysis of these data should be made to provide a method either of generalizing the 10-year flood or of estimating it at specific ungaged sites on the basis of a small amount of data at the site.

Continuing studies of methods of transferring flow characteristics to ungaged sites on the basis of some information at each site should be made. Emphasis should be placed on improving and verifying runoff-altitude relations, channel-geometry relations to flow characteristics, and generalized relations among flow characteristics at various times of the year.

Finally, a continuing appraisal of the data-collection system should be made with respect to needs for information and as modified by improved analytical methods.

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. Six additional stations in the present network are proposed as long-term stations to be operated indefinitely. The additional stations were selected to provide a long-term sample reflecting areal coverage of the State, a range of drainage-area size, type of streams, and a variety of climatic and physiographic characteristics. The eight stations identified in this category and proposed for operation indefinitely are listed in table 4 with their drainage areas and periods of record. One station, Lee Canyon near Charleston Park, is on an ephemeral stream. All others are on perennial streams.

Table 4.--Proposed long-term trend stations

Station number	Station name	Drainage area (sq mi)	Period of record
9-4196.1	Lee Canyon near Charleston Park	9.20	1963-
10-2449.5	Steptoe Creek near Ely	11.1	1966-
10-2493	South Twin River near Round Mountain	20	1965-
10-2499	Chiatovich Creek near Dyer	37.3	1960-
10-3165	Lamoille Creek near Lamoille	25	1915-23, 1943-
10-3495	Martin Creek near Paradise Valley	172	1921-
10-3476	Hunter Creek near Reno	11.5	1961-
10-3537	Leonard Creek near Denio	52	1960-

Data on Stream Environment

Data on stream environment should be collected as demands for this type of information arise and as time and funds become available. Some environmental data are being collected at the present time for hydrologic investigations and channel surveys for indirect measurements.

Gaging Stations for Proposed Program

Recommendations for gaging-station operation for each of the data types are combined in table A-4 where each station is classified as to purpose. Locations are shown in figure 2.

REFERENCES

Carter, R. W., and Benson, M. A., 1969, Concepts for the design of streamflow data programs: U.S. Geol. Survey open-file report.

Hedman, E. R., 1970, Mean annual runoff as related to channel geometry in selected streams in California: U.S. Geol. Survey Circ. (in press).

Moore, D. O., 1968, Estimating mean runoff in ungaged semiarid areas: Nevada Dept. Conserv. and Nat. Resources, Water Resources Bull. 36.

Riggs, H. C., 1969, Mean streamflow from discharge measurements: International Assoc. of Scientific Hydrology Bull. XIV, no. 4, p. 95-110.

Riggs, H. C., 1965, Estimating probability distributions of drought flows: Water and Sewage Works, v. 112, no. 5, p. 153-157.

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

Station number	Station name	Purpose					
		Assess-ment	Opera-tion	Forecast-ing	Sediment	Water quality	Compact or legal
9-4160	Muddy River near Moapa	------	X	------	------	------	------
9-4182	Mathews Canyon Wash near Caliente	------	------	X	------	------	------
9-4183	Pine Canyon Wash near Caliente	------	------	X	------	------	------
9-4190	Muddy River near Glendale	------	X	------	------	------	------
9-4196.5	Las Vegas Wash at North Las Vegas	------	X	------	------	------	------
10-2935	East Walker River above Strosnider ditch, near Mason	------	X	X	------	------	------
10-2975	West Walker River at Hoye Bridge, near Wellington	------	------	------	------	------	X
10-3000	West Walker River near Hudson	------	------	X	------	------	X
10-3015	Walker River near Wabuska	------	------	X	------	X	X
10-3090	East Fork Carson River near Gardnerville	------	X	X	------	------	------
10-3110	Carson River at Carson City	------	X	X	------	------	------
10-3119	Buckland ditch near Ft. Churchill	------	X	------	------	------	------
10-3120	Carson River near Ft. Churchill	------	X	X	------	X	------
10-3121.5	Carson River below Lahontan Reservoir near Fallon	------	X	X	------	------	------
10-3122.1	Stillwater Diversion Canal near Fallon	------	X	------	------	------	------
10-3122.2	Stillwater Slough cutoff drain near Fallon	------	X	------	------	------	------
10-3122.4	Paiute Diversion Drain near Stillwater	------	X	------	------	------	------
10-3122.6	Indian Lakes Canal near Fallon	------	X	------	------	------	------
10-3122.8	Carson River below Fallon	------	X	X	------	------	------
10-3155	Marys River above Hot Springs Creek, near Deeth	------	------	X	------	------	------
10-3175	North Fork Humboldt River at Devils Gate, near Halleck	------	X	X	------	------	------
10-3185	Humboldt River near Elko	------	X	X	------	------	------
10-3195	Huntington Creek near Lee	------	------	X	------	------	------

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

Station number	Station name	Purpose					
		Assess-ment	Opera-tion	Forecast-ing	Sediment	Water quality	Compact or legal
10-3200	South Fork Humboldt River above Dixie Creek, near Elko	-------	-------	X	-------	-------	-------
10-3205	South Fork Humboldt near Elko---	-------	X	X	-------	-------	-------
10-3210	Humboldt River near Carlin------	-------	X	-------	-------	X	-------
10-3225	Humboldt River at Palisade------	X	X	X	-------	-------	-------
10-3235	Humboldt River near Argenta-----	-------	X	-------	-------	-------	-------
10-3245	Rock Creek near Battle Mountain-	-------	X	-------	-------	-------	-------
10-3250	Humboldt River at Battle Mountain	-------	X	-------	-------	-------	-------
10-3275	Humboldt River at Comus---------	-------	X	-------	-------	-------	-------
10-3295	Martin Creek near Paradise Valley	-------	-------	X	-------	-------	-------
10-3315	Humboldt River near Rose Creek--	-------	X	-------	-------	-------	-------
10-3325	Humboldt-Lovelock Irrigation Light & Power Co's feeder canal near Imlay	-------	X	-------	-------	-------	-------
10-3330	Humboldt River near Imlay-------	-------	X	X	-------	-------	-------
10-3350	Humboldt River near Rye Patch---	-------	X	X	-------	X	-------
10-3478	Peavine Creek near Reno---------	-------	-------	-------	X	-------	-------
10-3480	Truckee River at Reno-----------	-------	X	X	-------	-------	-------
10-3500	Truckee River at Vista----------	-------	-------	X	-------	-------	X
10-3513	Truckee Canal at Wadsworth------	-------	X	-------	-------	-------	-------
10-3514	Truckee Canal near Hazen--------	-------	X	-------	-------	-------	-------
10-3516	Truckee River below Derby Dam, near Wadsworth	-------	-------	X	-------	-------	X
10-3546.5	Truckee River at Wadsworth------	-------	X	-------	-------	-------	-------
10-3517	Truckee River at Nixon----------	-------	-------	-------	X	-------	X
10-3535	Quinn River near McDermitt------	-------	X	-------	-------	-------	-------
13-1745	Owyhee River near Gold Creek----	-------	X	X	-------	-------	-------
13-1760	Owyhee River above China Diversion Dam, near Owyhee	-------	X	-------	-------	-------	-------
13-1772	South Fork Owyhee River at Spanish Ranch, near Tuscarora	-------	X	-------	-------	-------	-------
13-1778	South Fork Owyhee River near Whiterock	-------	X	-------	-------	-------	-------

Table A-2.--Streamflow characteristics available (through 1967) except monthly means

(Streamflow characteristics based on short records may be unreliable)

Station	Station name	Drainage area (sq mi)	Type of stream: Perennial	Type of stream: Ephemeral	Years of record	Mean annual discharge (cfs)	Standard deviation of mean annual discharge (cfs)	Seasonal mean flows (cfs)	10-year flood (cfs)	50-year flood (cfs)	7-day, 20-year low flow (cfs)
9-4151	Pulsipher Wash nr Mesquite	4.58	---	X	6	----	----	----	710	---	----
9-4196.2	Mormon Wells Wash near Las Vegas	115	---	X	7	----	----	----	360	---	----
9-4196.3	Telephone Canyon near Charleston Park	7.20	---	X	7	----	----	----	460	---	----
9-4196.4	Kyle Canyon nr Charleston Park	35.9	---	X	8	----	----	----	240	---	----
9-4196.63	Las Vegas Wash tributary south of Nellis Air Force Base	1.2	---	X	6	----	----	----	200	---	----
9-4196.7	Red Rock Wash nr Blue Diamond	7.60	---	X	7	----	----	----	2180	---	----
9-4216.1	Eldorado Valley tributary near Nelson	1.41	---	X	5	----	----	----	200	---	----
10-1729.13	Loray Wash trib near Cobre	21	---	X	8	----	----	----	280	---	----
10-2432.4	Baker Creek at narrows near Baker	16.4	X	----	8	8.5	4.9	14.5	190	---	----
10-2432.6	Lehman Creek near Baker	11.0	X	----	8	4.9	2.0	7.6	40	---	----
10-2437	Cleve Creek nr Ely	31.8	X	----	10	8.4	2.6	11.7	80	---	3.2
10-2447	Overland Creek nr Ruby Valley	9.0	X	----	8	11.2	3.5	20.4	150	---	----
10-2454.5	Illipah Creek tributary near Hamilton	5.47	---	X	7	----	----	----	74	---	----

Station name		Drainage area (sq mi)	Type of stream		Years of record	Streamflow characteristics (cfs)					
			Perennial	Ephemeral		Mean annual discharge	Standard deviation of mean annual discharge	Seasonal mean flows	10-year flood	50-year flood	7-day, 20-year low flow
10-2458	Newark Valley tributary near Hamilton	157	---	X	7	---	---	---	160	---	---
10-2459.5	Bean Flat trib near Austin	1.1	---	X	8	---	---	---	3	---	---
10-2460	Garden Pass Creek tributary near Eureka	2.12	---	X	7	---	---	---	50	---	---
10-2468.45	Currant Creek tributary near Currant	3.13	---	X	7	---	---	---	34	---	---
10-2494.11	Campbell Creek tributary near Eastgate	2.14	---	X	7	---	---	---	85	---	---
10-2499	Chiatovich Creek near Dyer	37.3	X	---	7	8.4	2.7	8.7	240	---	---
10-2512.7	Amargosa River tributary near Mercury	110	---	X	6	---	---	---	1890	---	---
10-3020.1	Reese River Canyon near Schurz	14	---	X	6	---	---	---	700	---	---
10-3088	Bryant Creek near Gardnerville	31.5	X	---	6	7.0	3.2	10.0	680	---	---
10-3105	Clear Creek near Carson City	15	X	---	14	5.8	2.4	5.9	110	---	0.8
10-3110	Carson River near Carson City	876	X	---	28	---	---	---	9760	30300	---
10-3120	Carson River near Fort Churchill	1,450	X	---	56	---	---	---	5300	10600	---
10-3155	Marys River above Hot Springs Creek near Deeth	415	X	---	24	---	---	---	1110	2860	---

Station name		Drainage area (sq mi)	Type of stream		Years of record	Streamflow characteristics (cfs)					
			Perennial	Ephemeral		Mean annual discharge	Standard deviation of mean annual discharge	Seasonal mean flows	10-year flood	50-year flood	7-day, 20-year low flow
10-3165	Lamoille Creek near Lamoille	25	X	----	31	42.8	11.2	81.3	800	2150	2.1
10-3175	N.F. Humboldt River at Devils Gate, nr Halleck	830	X	----	32	----	----	----	2050	5110	---
10-3185	Humboldt River near Elko	2,800	X	----	30	----	----	----	3320	5010	---
10-3190	S.F. Humboldt River near Lee	54	X	----	10	67.2	17.6	12.5	860	----	3.8
10-3205	S.F. Humbolst River near Elko	1,310	X	----	63	----	----	----	1640	1800	---
10-3225	Humboldt River at Palisade	5,010	X	----	60	----	----	----	3920	5590	---
10-3229.8	Cole Creek near Palisade	11.4	---	X	7	----	----	----	90	----	---
10-3230	Pine Creek near Palisade	999	X	----	14	----	----	----	1140	5200	---
10-3232	Bob Creek near Beowawe	13.9	---	X	7	----	----	----	160	----	---
10-3255	Reese River near Ione	53	X	----	16	10.3	8.6	18.1	340	----	0.1
10-3275	Humboldt River at Comus	12,100	X	----	53	----	----	----	2570	4590	---
10-3280	Pole Creek near Golconda	10.7	X	----	7	4.4	1.5	7.5	1410	----	---
10-3290	Little Humboldt River near Paradise Valley	1,030	X	----	29	----	----	----	370	1020	---
10-3295	Martin Creek near Paradise Valley	172	X	----	46	30.3	16.0	47.8	1540	5020	3.1
10-3300	Cottonwood Creek near Paradise Valley	14.6	X	----	9	5.4	3.5	9.0	120	----	---

Station name		Drainage area (sq mi)	Type of stream		Years of record	Streamflow characteristics (cfs)					
			Perennial	Ephemeral		Mean annual discharge	Standard deviation of mean annual discharge	Seasonal mean flows	10-year flood	50-year flood	7-day, 20-year low flow
10-3303	Mullinex Creek near Paradise Valley	27.3	X	----	7	----	----	----	1290	---	----
10-3322	Raspberry Creek near Mill City	9.41	---	X	8	----	----	----	7	---	----
10-3364.5	Dixie Valley tributary near Eastgate	11	---	X	8	----	----	----	1260	---	----
10-3473	Dog Creek near Verdi	16.2	X	----	5	3.7	4.5	5.8	630	---	----
10-3476	Hunter Creek near Reno	11.5	X	----	6	10.4	3.4	14.6	500	---	----
10-3497	White Creek near Steamboat	8.02	X	----	5	6.5	1.7	8.6	1220	---	----
10-3525	McDermitt Creek near McDermitt	225	X	----	19	28.0	20.7	42.7	2550	---	0
10-3530	E.F. Quinn River near McDermitt	140	X	----	19	24.2	15.8	38.2	890	---	0.4
10-3535	Quinn River near McDermitt	1,100	X	----	19	----	----	----	890	---	----
10-3535.2	Eagle Creek near Orovada	3.44	---	X	5	----	----	----	6	---	----
10-3536	Kings River near Orovada	15.9	X	----	5	4.5	1.1	6.5	370	---	----
10-3537	Leonard Creek near Denio	52	X	----	7	3.9	1.3	5.3	360	---	----
10-3537.7	South Willow Cr near Gerlach	31	---	X	6	----	----	----	1100	---	----
13-1613	Meadow Creek near Rowland	56	X	----	6	----	----	----	680	---	----
13-1625	E.F. Jarbidge River near Three Creek, Ida	84.6	X	----	18	56.1	19.8	100	893	---	3.2
13-1626	Columbet Creek near Jarbidge	3.4	---	X	6	----	----	----	36	---	----
13-1759	Reed Creek near Owyhee	6.51	---	X	6	----	----	----	100	---	----

Table A-3.--Basin characteristics at gaging stations

Station number (See table A-2 for names)	Drainage area (square miles)	Annual precipitation (inches)	Aspect (degrees clockwise from south)	Main channel slope above mountain front (feet per mile)	Main channel length (miles)	Mean elevation above mountain front (feet)	Mean latitude	Mean longitude	Main channel slope below mountain front (feet per mile)	Percent of drainage area above mountain front	Percent of channel length above mountain front
9-4151	4.58	5.6	170	109	3.8	1,800	36.75	4.25	--	100	100
9-4196.2	115	13.1	210	420	19.6	7,200	36.50	5.25	189	45	23
9-4196.3	7.20	16.5	120	710	5.7	7,700	36.25	5.50	--	100	100
9-4196.4	35.9	16.9	75	280	13.5	7,800	36.25	5.50	--	100	100
9-4196.63	1.20	5.5	260	550	2.8	2,600	36.25	5.00	207	87	70
9-4196.7	7.60	9.4	30	578	3.0	6,600	36.25	5.50	--	100	100
9-4216.1	1.41	6.3	350	214	4.4	3,100	35.50	4.50	--	100	100
10-1729.13	21.0	15.5	340	190	8.5	6,500	41.00	4.25	105	54	33
10-2432.4	16.4	32.8	69	569	6.8	9,700	39.00	4.25	--	100	100
10-2432.6	11.0	32.7	84	789	6.7	9,900	39.00	4.25	--	100	100
10-2437	31.8	22.3	145	353	8.9	8,900	39.25	4.50	--	100	100
10-2447	9.0	34.6	85	448	4.2	8,600	40.50	6.50	--	100	100
10-2454.5	5.47	12.5	165	145	3.5	7,300	39.50	5.50	--	100	100
10-2458	157	11.2	15	291	18.3	7,800	39.25	5.50	67	25	30
10-2459.5	1.10	9.2	340	--	3.2	6,400	39.50	6.50	142	--	--
10-2460	2.12	11.4	55	1,200	2.7	7,500	39.50	6.25	216	44	38
10-2468.45	3.13	10.8	288	176	2.2	6,700	38.75	5.25	--	100	100
10-2494.11	2.14	14.0	60	222	1.8	7,200	39.25	7.75	--	100	100
10-2499	37.3	28.4	69	646	9.5	9,700	37.75	8.25	375	97	82
10-2512.7	110	4.9	365	718	15.5	4,700	36.75	6.00	144	27	23
10-3020.1	14.0	11.8	90	290	6.3	6,300	38.75	8.75	200	98	87
10-3088	31.5	17.1	342	256	10.4	7,400	38.75	9.75	--	100	100
10-3105	15.0	22.0	94	518	8.0	6,900	39.00	9.75	--	100	100
10-3110	876	17.1	340	100	66.5	6,400	38.75	9.75	19	62	46
10-3120	1,450	15.0	30	100	97.6	6,000	39.00	9.75	20	50	31
10-3155	415	14.0	170	134	42.3	8,600	41.50	5.25	38	6	24
10-3165	25.0	37.5	317	263	10.8	9,300	40.75	6.50	--	100	100
10-3175	830	16.1	100	173	48.6	7,600	41.25	5.75	30	13	11

Table A-3.--Basin characteristics at gaging stations--Continued

Station number (See table A-2 for names)	Drainage area (square miles)	Annual precipitation (inches)	Aspect (degrees clockwise from south)	Main channel slope above mountain front (feet per mile)	Main channel length (miles)	Mean elevation above mountain front (feet)	Mean latitude	Mean longitude	Main channel slope below mountain front (feet per mile)	Percent of drainage area above mountain front	Percent of channel length above mountain front
10-3185	2,800	14.7	190	173	66.6	7,600	41.25	5.50	18	17	8
10-3190	54.0	33.5	272	533	8.5	8,600	40.50	6.50	--	100	100
10-3205	1,310	14.5	280	508	29.5	8,000	40.50	5.75	[illegible]	18	21
10-3225	5,010	14.2	240	173	115	7,300	41.00	5.75	5	22	5
10-3229.8	11.4	12.1	230	251	5.0	5,800	40.50	6.00	--	100	100
10-3230	999	13.5	40	121	66.5	6,600	40.00	6.25	16	48	27
10-3232	13.9	11.6	230	522	7.2	5,900	40.75	6.25	103	66	64
10-3255	53.0	21.8	305	142	12.7	8,800	39.75	7.50	--	100	100
10-3275	12,100	12.5	270	173	197	6,800	40.75	6.25	5	28	3
10-3280	10.7	20.4	57	440	7.1	6,500	41.00	7.50	--	100	100
10-3290	1,030	14.2	130	152	54.4	6,600	41.50	7.00	35	22	16
10-3295	172	17.5	141	80	25.0	6,100	41.50	7.50	--	100	100
10-3300	14.6	20.1	122	386	5.7	6,500	41.50	7.75	--	100	100
10-3303	27.3	16.1	115	557	10.8	5,800	41.50	7.50	95	70	45
10-3322	9.41	12.2	255	389	7.1	5,900	40.75	8.00	133	97	83
10-3364.5	11.0	7.0	322	432	8.5	6,200	39.25	8.00	136	43	44
10-3475	16.2	19.5	110	483	4.2	6,500	39.50	10.00	--	100	100
10-3476	11.5	27.2	19	561	6.8	8,000	39.50	10.00	--	100	100
10-3497	8.02	30.5	75	626	6.2	8,300	39.25	10.00	--	100	100
10-3525	225	15.4	105	68	25.5	5,700	42.00	8.00	--	100	100
10-3530	140	16.9	289	73	22.0	6,100	42.00	7.50	--	100	100
10-3535	1,100	13.9	200	68	44.0	5,900	42.00	7.75	12	64	58
10-3535.2	3.44	16.1	275	473	6.2	5,900	41.75	7.75	152	90	65
10-3536	20.5	19.8	196	378	10.8	6,400	42.00	8.25	--	100	100
10-3537	52.0	13.0	7	387	10.0	5,900	41.50	8.75	--	100	100
10-3537.7	31.0	11.9	190	170	10.6	5,700	41.00	9.25	--	100	100
13-1613	56	19.9	40	149	11.6	6,600	41.75	5.75	--	100	100
13-1625	84.6	26.0	350	125	21.3	7,600	42.00	5.30	--	100	100
13-1626	3.40	21.8	35	464	4.7	7,500	42.00	5.50	218	45	36
13-1759	6.51	19.9	260	246	6.3	6,600	41.75	6.00	--	100	100

Table A-4.--Streamflow stations recommended for the program

Station number	Station name	Types of data: Current purpose	Types of data: Planning and design: Minor perennial stream	Types of data: Planning and design: Minor ephemeral stream	Recommendations: Long-term trend	Recommendations: Include in network	Recommendations: Not recommended for inclusion
9-4156	Pahranagat Valley tributary near Hiko	--	--	X	--	X	--
9-4160	Muddy River near Moapa	X	--	--	--	X	--
9-4175	Spring Valley Creek near Ursine[1/]	--	--	--	--	--	X
9-4182	Mathews Canyon Wash near Caliente	X	--	--	--	X	--
9-4183	Pine Canyon Wash near Caliente	X	--	--	--	X	--
9-4185	Meadow Valley Wash near Caliente[1/]	--	X	--	--	X	--
9-4190	Muddy River near Glendale	X	--	--	--	X	--
9-4196.1	Lee Canyon near Charleston Park	--	--	X	X	X	--
9-4196.5	Las Vegas Wash at North Las Vegas	X	--	X	--	X	--
9-4197	Las Vegas Wash near Henderson[1/]	--	X	--	--	--	--
9-4216.1	Eldorado Valley tributary near Nelson[2/]	--	--	X	X	X	--
10-2432.4	Baker Creek at Narrows, near Baker[3/]	--	X	--	--	X	--
10-2437	Cleve Creek near Ely[4/]	--	X	--	--	X	--
10-2446.2	Franklin River near Arthur	--	X	--	--	X	--
10-2447	Overland Creek near Ely[4/]	--	X	--	--	X	--
10-2449.5	Steptoe Creek near Ely	--	X	--	X	X	--
10-2458	Newark Valley tributary near Hamilton	--	--	X	--	X	--
10-2468.46	Little Currant Creek near Current	--	X	--	--	X	--
10-2478.6	Penoyer Valley tributary near Tempiute[2/]	--	--	X	--	X	--
10-2492.8	Kingston Creek below Cougar Canyon, near Austin	--	X	--	--	X	--
10-2493	South Twin River near Round Mountain	--	X	--	X	X	--
10-2494.11	Campbell Creek tributary near Eastgate	--	--	X	--	X	--

Table A-4.--Streamflow stations--Continued

Station number	Station name	Types of data: Current purpose	Types of data: Planning and design: Minor perennial stream	Types of data: Planning and design: Minor ephemeral stream	Recommendations: Long-term trend	Recommendations: Include in network	Recommendations: Not recommended for inclusion
10-2499	Chiatovich Creek near Dyer	----	X	----	----	X	----
10-2512.2	Amargosa River near Beatty[4/]	----	----	----	----	----	X
10-2519.8	Lovell Wash near Blue Diamond[2/]	----	----	X	----	X	----
10-2935	East Walker River above Strosnider ditch, near Mason	X	----	----	----	X	----
10-2975	West Walker River at Hoye Bridge, near Wellington	X	----	----	----	X	----
10-2991	Desert Creek near Wellington	----	X	----	----	X	----
10-3000	West Walker River near Hudson	X	----	----	----	X	----
10-3015	Walker River near Wabuska	X	----	----	----	X	----
10-3020.1	Reese River Canyon near Schurz[2/]	----	----	X	X	X	----
10-3105	Clear Creek near Carson City[3/]	----	X	----	----	X	----
10-3088	Bryant Creek near Gardnerville	----	X	----	----	X	----
10-3090	East Fork Carson River near Gardnerville	X	----	----	----	X	----
10-3104	Daggett Creek near Genoa	----	X	----	----	X	----
10-3110	Carson River near Carson City	X	----	----	----	X	----
10-3119	Buckland ditch near Fort Churchill	X	----	----	----	X	----
10-3120	Carson River near Fort Churchill	X	----	----	----	X	----
10-3121.5	Carson River below Lahontan Reservoir near Fallon	X	----	----	----	X	----
10-3122.1	Stillwater Diversion Canal near Fallon	X	----	----	----	X	----
10-3122.2	Stillwater Slough cutoff drain near Stillwater	X	----	----	----	X	----
10-3122.4	Paiute diversion drain near Stillwater	X	----	----	----	X	----
10-3122.6	Indian Lakes Canal near Fallon	X	----	----	----	X	----
10-3122.8	Carson River below Fallon	X	----	----	----	X	----
10-3155	Marys River above Hot Springs Creek, near Deeth	X	----	----	----	X	----

Table A-4.--Streamflow stations--Continued

Station number	Station name	Types of data				Recommendations	
		Current purpose	Planning and design: Minor perennial stream	Planning and design: Minor ephemeral stream	Long-term trend	Include in network	Not recommended for inclusion
10-3165	Lamoille Creek near Lamoille----	------	X	--------	------	X	--------
10-3174	North Fork Humboldt River near North Fork	------	X	--------	------	X	--------
10-3175	North Fork Humboldt River at Devils Gate, near Halleck	X	------	--------	------	X	--------
10-3185	Humboldt River near Elko--------	X	------	--------	------	X	--------
10-3195	Huntington Creek near Lee-------	X	------	--------	------	X	--------
10-3200	South Fork Humboldt River above Dixie Creek, near Elko	------	------	--------	------	------	X
10-3205	South Fork Humboldt River near Elko	X	------	--------	------	X	--------
10-3210	Humboldt River near Carlin------	X	------	--------	------	X	--------
10-3225	Humboldt River near Palisade----	X	------	--------	------	X	--------
10-3235	Humboldt River near Argenta-----	------	------	--------	------	------	X
10-3245	Rock Creek near Battle Mountain-	X	------	--------	------	X	--------
10-3250	Humboldt River at Battle Mountain	X	------	--------	------	X	--------
10-3255	Reese River near Ione-----------	------	X	--------	------	X	--------
10-3265	Big Creek near Austin3/---------	------	X	--------	------	X	--------
10-3267	Reese River near Austin1/-------	------	------	--------	------	------	X
10-3275	Humboldt River at Comus---------	X	------	--------	------	X	--------
10-3280	Pole Creek near Golconda--------	------	X	--------	------	X	--------
10-3290	Little Humboldt River near Paradise Valley1/	------	X	--------	------	X	--------
10-3295	Martin Creek near Paradise Valley	------	X	--------	X	X	--------
10-3315	Humboldt River near Rose Creek---	X	------	--------	------	X	--------
10-3325	Humboldt-Lovelock Irrigation, Light, and Power Co.'s feeder canal near Imlay	X	------	--------	------	X	--------
10-3330	Humboldt River near Imlay-------	X	------	--------	------	X	--------
10-3350	Humboldt River near Rye Patch---	X	------	--------	------	X	--------
10-3473	Dog Creek near Verdi3/----------	------	X	--------	------	X	--------

Table A-4.--Streamflow stations--Continued

Station number	Station name	Types of data: Current purpose	Types of data: Planning and design: Minor perennial stream	Types of data: Planning and design: Minor ephemeral stream	Types of data: Long-term trend	Recommendations: Include in network	Recommendations: Not recommended for inclusion
10-3476	Hunter Creek near Reno----------	-----	X	-----	-----	X	-----
10-3478	Peavine Creek near Reno---------	X	-----	-----	-----	X	-----
10-3480	Truckee River at Reno-----------	X	-----	-----	-----	X	-----
10-3489	Galena Creek near Steamboat[1]---	-----	X	-----	-----	X	-----
10-3493	Steamboat Creek at Steamboat[1]--	-----	X	-----	-----	X	-----
10-3497	Whites Creek near Steamboat[3]---	-----	X	-----	-----	X	-----
10-3500	Truckee River at Vista----------	X	-----	-----	-----	X	-----
10-3513	Truckee Canal near Wadsworth----	X	-----	-----	-----	X	-----
10-3514	Truckee Canal near Hazen--------	X	-----	-----	-----	X	-----
10-3516	Truckee River below Derby Dam, near Wadsworth	X	-----	-----	-----	X	-----
10-3516.5	Truckee River at Wadsworth------	X	-----	-----	-----	X	-----
10-3517	Truckee River near Nixon--------	X	-----	-----	-----	X	-----
10-3525	McDermitt Creek near McDermitt--	-----	X	-----	-----	X	-----
10-3530	East Fork Quinn River near McDermitt	-----	X	-----	X	X	-----
10-3535	Quinn River near McDermitt------	X	-----	-----	-----	X	-----
10-3536	Kings River near Orovada[5]------	-----	X	-----	-----	X	-----
10-3536.5	Quinn River near Denio[1, 4]------	-----	-----	-----	-----	-----	X
10-3537	Leonard Creek near Denio--------	-----	X	-----	X	X	-----
10-3537.25	Red Mountain Creek near Gerlach[4]	-----	-----	-----	-----	-----	X
10-3617	Badger Creek near Vya-----------	-----	X	-----	-----	X	-----
13-1615	Bruneau River at Rowland--------	-----	X	-----	-----	X	-----
13-1745	Owyhee River near Gold Creek----	X	-----	-----	-----	X	-----
13-1760	Owyhee River above China diversion dam, near Owyhee	X	-----	-----	-----	X	-----
13-1769	Jack Creek below Schoonover Creek, near Tuscarora[6]	-----	-----	-----	-----	-----	X
13-1772	South Fork Owyhee River at Spanish Ranch, near Tuscarora	X	-----	-----	-----	X	-----
13-1778	South Fork Owyhee River near Whiterock	X	-----	-----	-----	X	-----

Table A-4.--Streamflow stations--Continued

Station number	Station name	Types of data: Current purpose	Types of data: Planning and design: Minor perennial stream	Types of data: Planning and design: Minor ephemeral stream	Types of data: Long-term trend	Recommendations: Include in network	Recommendations: Not recommended for inclusion
g-1	Cherry Creek near Adaven--------	------	X	------	------	X	----------
g-2	Willow Creek near Warm Springs--	------	X	------	------	X	----------
g-3	McClusky Creek near Austin------	------	X	------	------	X	----------
g-4	Boone Creek near Austin---------	------	X	------	------	X	----------
g-5	Fish Creek near Battle Mountain-	------	X	------	------	X	----------
g-6	Clear Creek near Winnemucca-----	------	X	------	------	X	----------
g-7	Buffalo Creek near Gerlach------	------	X	------	------	X	----------
g-8	Mud Meadow Creek near Gerlach---	------	X	------	------	X	----------
g-9	Spring Valley Wash near Pioche--	------	X	------	------	X	----------
g-10	Trout Creek near Contact--------	------	X	------	------	X	----------
g-11	Cottonwood Creek near Contact---	------	X	------	------	X	----------

1. Regulated.
2. Flood-hydrograph recorder only.
3. To be re-established.
4. Discontinued at end of 1967 water year due to lack of funds.
5. Discontinued at end of 1968 water year due to lack of funds.
6. Flow probably affected by cloud-seeding study.
g. Station number not assigned.

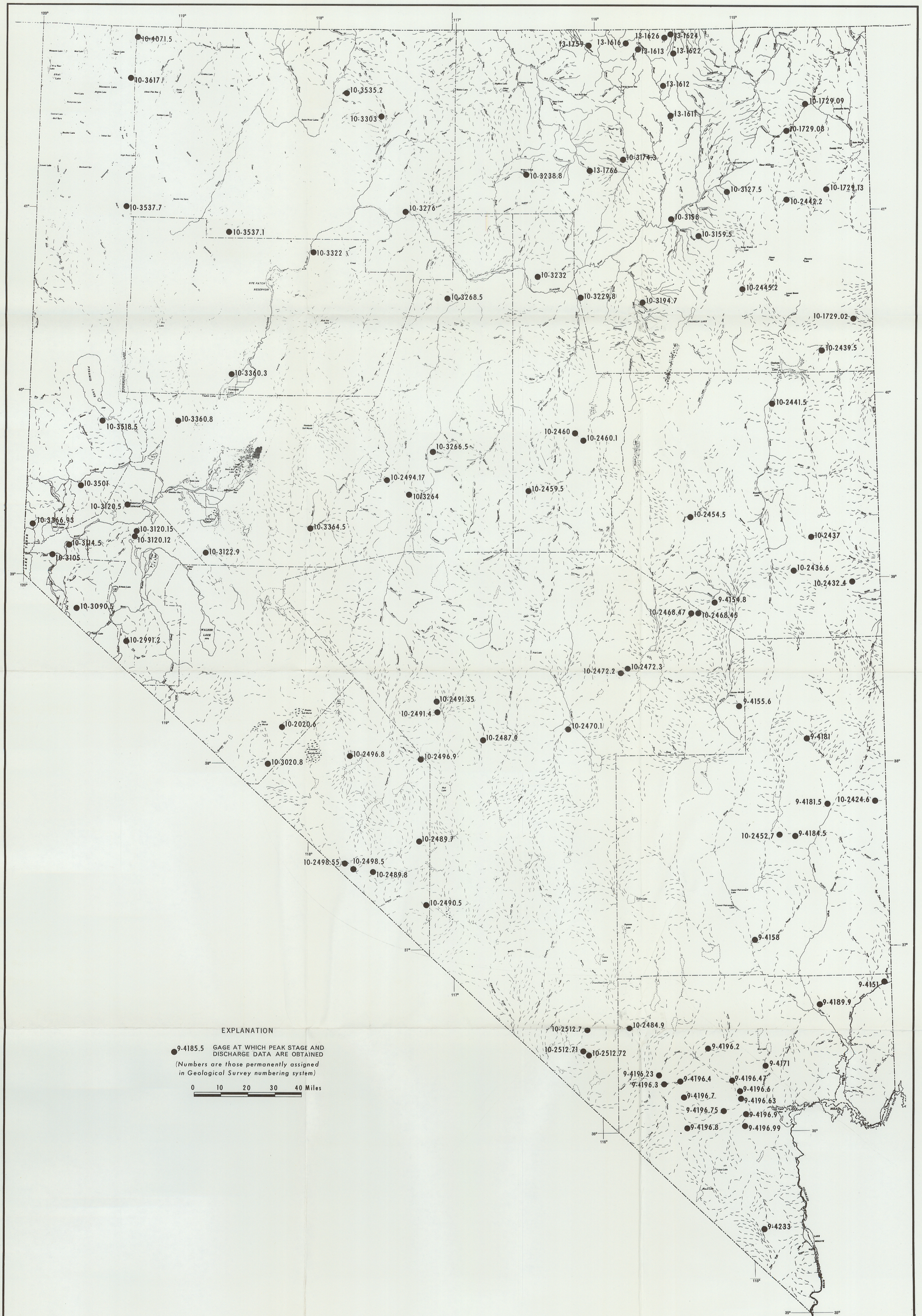

FIGURE 1.-MAP OF NEVADA SHOWING LOCATIONS OF FLOOD-PEAK PARTIAL-RECORD GAGES

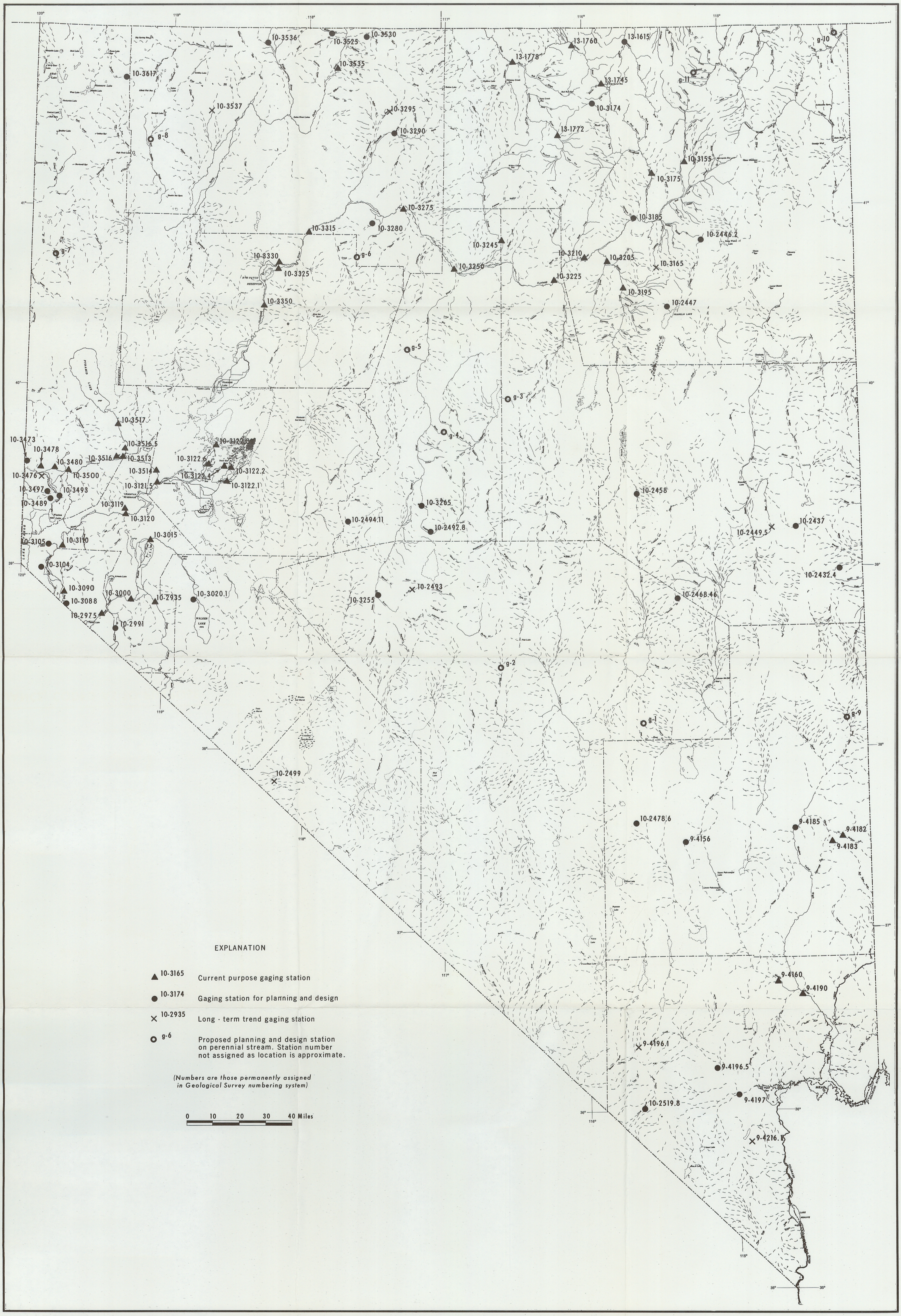

FIGURE 2.-MAP OF NEVADA SHOWING LOCATIONS OF GAGING STATIONS PROPOSED FOR CONTINUANCE, CODED AS TO PURPOSE