Computations of Total Sediment Discharge Niobrara River Near Cody, Nebraska

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By B. R. Colby and C. H. Hembree

ABSTRACT

A natural chute in the Niobrara River near Cody, Nebr., constricts the flow of the river except at high stages to a narrow channel in which the turbulence is sufficient to suspend nearly the total sediment discharge. Because much of the flow originates in the sandhills area of Nebraska, the water discharge and sediment discharge are relatively uniform.

Sediment discharges based on depth-integrated samples at a contracted section in the chute and on streamflow records at a recording gage about 1,900 feet upstream are available for the period from April 1948 to September 1953 but are not given directly as continuous records in this report. Sediment measurements have been made periodically near the gage and at other nearby relatively unconfined sections of the stream for comparison with measurements at the contracted section.

Sediment discharge at these relatively unconfined sections was computed from formulas for comparison with measured sediment discharges at the contracted section. A form of the Du Boys formula gave computed tonnages of sediment that were unsatisfactory. Sediment discharges as computed from the Schoklitsch formula agreed well with measured sediment discharges that were low, but they were much too low at measured sediment discharges that were higher. The Straub formula gave computed discharges, presumably of bed material, that were several times larger than measured discharges of sediment coarser than 0.125 millimeter. All three of these formulas gave computed sediment discharges that increased with water discharges much less rapidly than the measured discharges of sediment coarser than 0.125 millimeter.

The Einstein procedure when applied to a reach that included 10 defined cross sections gave much better agreement between computed sediment discharge and measured sediment discharge than did any one of the three other formulas that were used. This procedure does not compute the discharge of sediment that is too small to be found in the stream bed in appreciable quantities. Hence, total sediment discharges were obtained by adding computed discharges of sediment larger than 0.125 millimeter to measured discharges of sediment smaller than 0.125 millimeter. The size distributions of the computed sediment discharge compared poorly with the size distributions of sediment discharge at the contracted section. Ten sediment discharges computed from the Einstein procedure as applied to a single section averaged several times the measured sediment discharge for the contracted section and gave size distributions that were unsatisfactory.

The Einstein procedure was modified to compute total sediment discharge at an alluvial section from readily measurable field data. The modified procedure uses measurements of bed-material particle sizes, suspended-sediment concentrations and particle sizes from depth-integrated samples, streamflow, and water temperatures. Computations of total sediment discharge were made by using this modified procedure, some for the section at the gaging station and some for each of two other relatively unconfined sections. The size distributions of the computed and the measured sediment discharges agreed reasonably well. Major advantages of this modified procedure include applicability to a single section rather than to a reach of channel, use of measured velocity instead of water-surface slope, use of depth-integrated samples, and apparently fair accuracy for computing both total sediment discharge and approximate size distribution of the sediment. Because of these advantages this modified procedure is being further studied to increase its accuracy, to simplify the required computations, and to define its limitations.

In the development of the modified procedure, some relationships concerning theories of sediment transport were reviewed and checked against field data. Vertical distributions of suspended sediment at relatively unconfined sections did not agree well with theoretical distributions. The universal constant for turbulent exchange was computed from vertical velocity curves and was found to vary widely. Also, the computed shear velocity seemed to have little practical relation to the vertical distribution of sediment.

INTRODUCTION

The general study of fluvial sediments of the Niobrara River basin is a part of the program of the Department of the Interior for the development of the Missouri River basin. The investigation on the Niobrara River near Cody, Nebr., was started by the Geological Survey at the request of the Bureau of Reclamation. A sediment station was needed at a contracted section in a narrow flume that was cut naturally in clayey siltstone. Measurements of sediment discharge were made not only in the natural flume as requested but also, for comparison, at nearby sections. They were begun in an exploratory way in December 1947 and have been on a more systematic basis since April 1948.

In May 1951 personnel of the Bureau of Reclamation and of the Geological Survey jointly located 10 additional cross sections and agreed on field operations to obtain data for computations of total sediment discharge. These data were to be studied jointly, and a report was to be published by the Geological Survey to include "the practicability of a procedure for combining measurements of suspended-sediment discharge and use of Einstein's or other formulas for determination of total sediment discharge." This report was prepared to meet that objective on the basis of data collected prior to October 1, 1953.

The Niobrara River, like other streams that drain the sandhills region of Nebraska, has very uniform flow and transports sediments that are mostly in the range of sand sizes. Near Cody the Niobrara River during recent years has had a flow between 250 and 400 cfs perhaps 75 percent of the time. (See fig. 20.) Discharge of suspended sediment through the chute near Cody is relatively uniform, ranging between 500 and 2,000 tons per day much of the time. (See fig. 19.) Except at high flows the sediment is sand that comes mainly from the sandhills areas. Much of this sand is transported on or near the stream bed except at laterally confined sections of the channel. As depth-integrating samplers usually do not sample closer to the stream bed than 0.3 foot, much of the sand load is not collected in depth-integrated samples. In the natural flume of the Niobrara River near Cody, samples are collected where the river is constricted to a width of about 11 feet. At this section, streamflow is so swift and turbulent that most of the sand load of the stream is suspended and can be measured with depth-integrating samplers. Measurements of suspended sediment at the contracted section represent approximately the total sediment discharge of the stream.

PERSONNEL AND ACKNOWLEDGMENTS

The investigation was under the supervision of P. C. Benedict, regional engineer, Geological Survey. Field and laboratory work was under the supervision of R. B. Vice, succeeded by R. F. Kreiss, hydraulic engineers, Geological Survey. For the Bureau of Reclamation, W. M. Borland, head of the sedimentation section, Hydrology Branch of the Project Planning Division; O. H. Hansen, engineer, Region 7; and C. E. Burdick, area engineer, Ainsworth office, assigned engineers from Denver and Ainsworth to join in setting up the field investigation and in obtaining field data. K. B. Schroeder, assistant head of the sedimentation section, supervised Bureau of Reclamation personnel who computed some sediment discharges by Einstein's original method. J. M. Busalacchi and D. B. Raitt of the Ainsworth office, O. H. Hansen, K. B. Schroeder, and R. B. Vice planned the field investigation that was started during 1951. C. R. Miller and D. B. Raitt, hydraulic engineers, materially assisted in the collection of field data.

An earlier analysis by E. F. Serr, III, of the results of the investigation through November 1948 has been published as U. S. Geological Survey Circular 67, "Progress report, Investigations of fluvial sediments of the Niobrara River near Cody, Nebraska."

Unpublished records of water discharge and other streamflow data were furnished by D. D. Lewis, district engineer, Geological Survey. D. W. Hubbell and D. Q. Matejka, engineers, Geological Survey, assisted materially in several studies that supplement the computations of sediment discharge.

PURPOSE AND SCOPE OF THE INVESTIGATION

When the investigation of the fluvial sediments of the Niobrara River about 8 miles south of Cody was begun, the general objectives were to determine the suitability of the contracted section as a site for measuring nearly total sediment discharge of the stream, to determine the differences in the measured quantities of sediment discharge at the contracted section and at two other cross sections of the river, which are relatively unconfined, and to determine the relation of these differences in measured sediment discharge to water discharge, to sediment discharge, and to time from season to season or year to year. In 1951 the investigation was expanded to include 10 additional cross sections from which data were obtained specifically for use in formulas for the computation of total sediment discharge. Only the parts of the investigation that relate directly or indirectly to the computation of total sediment discharge of the stream are covered by this report.

Field and laboratory work included determinations of streamflow, stream cross sections, suspended-sediment discharges, and particle sizes of suspended sediment and of bed material. Vertical and lateral distributions of velocity, concentration, and particle sizes occasionally were defined for most of the sections. Water-surface slopes and air and water temperatures were measured. Depth-integrated samples were collected daily at one vertical at the contracted section.

Office work included computation of daily discharge of suspended sediment at the contracted section for the period April 1948 through September 1953. Stream cross sections were plotted; distributions of velocity, concentration, and particle sizes were graphed. Measurements of streamflow and of suspended-sediment discharge were tabulated. The unmeasured sediment discharge as shown by the difference in discharges of suspended sediment at the contracted section and at less confined sections was computed and was studied in relation to total sediment discharge, water discharge, and water temperature.

Computations were made of total sediment discharge by formulas that were applied to measurements at cross sections in alluvial reaches. The computed total sediment discharges were compared with the measured sediment discharges at the contracted section. From these studies, conclusions were drawn with respect to the effectiveness of the turbulence at the contracted section in suspending the total sediment discharge of the river, to the amount and variability of the unmeasured sediment discharge, and to the applicability of the formulas for the computation of total sediment discharge for this reach of the Niobrara River. Finally, one of the standard procedures was modified to compute the total sediment discharge.

SEDIMENT AND STREAMFLOW RECORDS

Information on the suspended-sediment discharges, the particle sizes, and the lateral and vertical distributions of sediment and streamflow was obtained at five cross sections of the Niobrara River near Cody. Soundings and water-surface slopes were obtained periodically at eight other cross sections.

Before computations of total sediment discharge are attempted, the basic information and the sections at which it was obtained should be understood. The necessary background includes definitions that will help to avoid misunderstanding, descriptions of the individual sections for which data were obtained and for which computations of total sediment discharge are to be made, and tabulations of the measured sediment and streamflow records at these sections. The sections are discussed in downstream order following the definitions.

DEFINITIONS

As the definitions of terms that apply to fluvial sediment are not completely standardized, some of the terms in this report are defined as follows:

Suspended sediment or suspended load is sediment that is moved in suspension in water and is maintained in suspension by the upward components of turbulent currents or by colloidal suspension.

Bed load or sediment discharged as bed load is the sediment that is moved along in essentially continuous contact with the stream bed.

Total sediment discharge or total sediment load is the sum of the suspended-sediment discharge and the bed-load discharge. It is the total quantity of sediment, as measured by dry weight or volume, that is discharged during a given time.

Measured suspended-sediment discharge is the suspended-sediment discharge that can be computed from water discharge and the concentration of depth-integrated samples.

Unmeasured sediment discharge or unmeasured sediment load is the difference between total sediment discharge and measured suspended-sediment discharge.

Depth-integrated sample is a sample of sediment that is accumulated continuously in a sampler that moves vertically at a constant transit rate and that admits water and sediment mixture at a velocity about equal to the stream velocity at every point of the sampler's travel. Depth-integrating samplers now in use normally collect water and sediment mixture only from the surface to about 0.3 foot from the stream bed. The part of the stream traversed by depth-integrating samplers is called in this report the "sampling zone" or the "sampled zone." Depth-integrating samplers used in the investigation included the US D-43, US D-49, and US DH-48 samplers.

Point-integrated sample is a sample of sediment that is accumulated continuously in a sampler that is held at a relatively fixed point and that admits a water and sediment mixture at a velocity about equal to the instantaneous stream velocity at that point. The samplers, US P-46, US DH-48 with air-control mechanism, and US DH-48 with finger-control mechanism, were all used as point-integrating samplers during the investigation.

Normal section is any relatively unconfined section of a stream, even though one or both banks may be somewhat stabilized and parts of the bed maybe siltstone or other cohesive material rather than unconsolidated sediment. Ideally, a normal section should be in an alluvial reach of the stream.

The size classification is the classification that has been recommended by the American Geophysical Union Subcommittee on sediment terminology (Lane and others, 1947, p. 937). According to this classification, clay-size particles have diameters between 0.0002 and 0.004 millimeter, silt-size particles have diameters between 0.004 and 0.062 millimeter, and sand-size particles have diameters between 0.062 and 2.0 millimeters.

The median, or median diameter, as defined by Twenhofel and Tyler (1941, p. 110) "is the midpoint in the size distribution of a sediment of which one-half of the weight is composed of particles larger in diameter than the median and one-half of smaller diameter. The median diameter may be read directly from the cumulative curve by noting the diameter value at the point of intersection of the 50-percent line and the curve."

The geometric mean size is the size that is computed as the square root of the product of the upper and lower limits of a given size range. For the range of smallest particle sizes, the lower limit for this report was arbitrarily assumed to be 0.002 millimeter.

Water discharge is the discharge of natural water of a stream. The natural water contains both dissolved solids and suspended sediment.

FORD SECTION

The farthest upstream section at which streamflow and suspended-sediment discharge measurements were made for this investigation is called the ford section. (See fig. 1 for the relative locations of the different cross sections and the water-stage recorder.) This is a wide, shallow section (fig. 2) about 750 feet upstream from the recorder. The section is in a meandering reach of the river (fig. 3). The banks are alluvium, but siltstone is usually exposed on part of the bottom. After a cableway was installed across the river just below the recorder on February 24, 1949, streamflow and sediment discharge measurements were no longer taken at the ford section.

Streamflow measurements at the ford section are listed in table 1 and sediment discharge measurements, in table 2. Water-surface slopes were not determined and bed-material samples were not collected for this section. The particle-size analyses of suspended sediment are given in table 3.

GAGING-STATION SECTION

The gaging station is about 750 feet downstream from the ford section and about 1,900 feet upstream from the contracted section in the chute. (See fig. 1.) The gaging-station section, at which both streamflow measurements and sediment samples are taken, is at the cableway about 30 feet downstream from

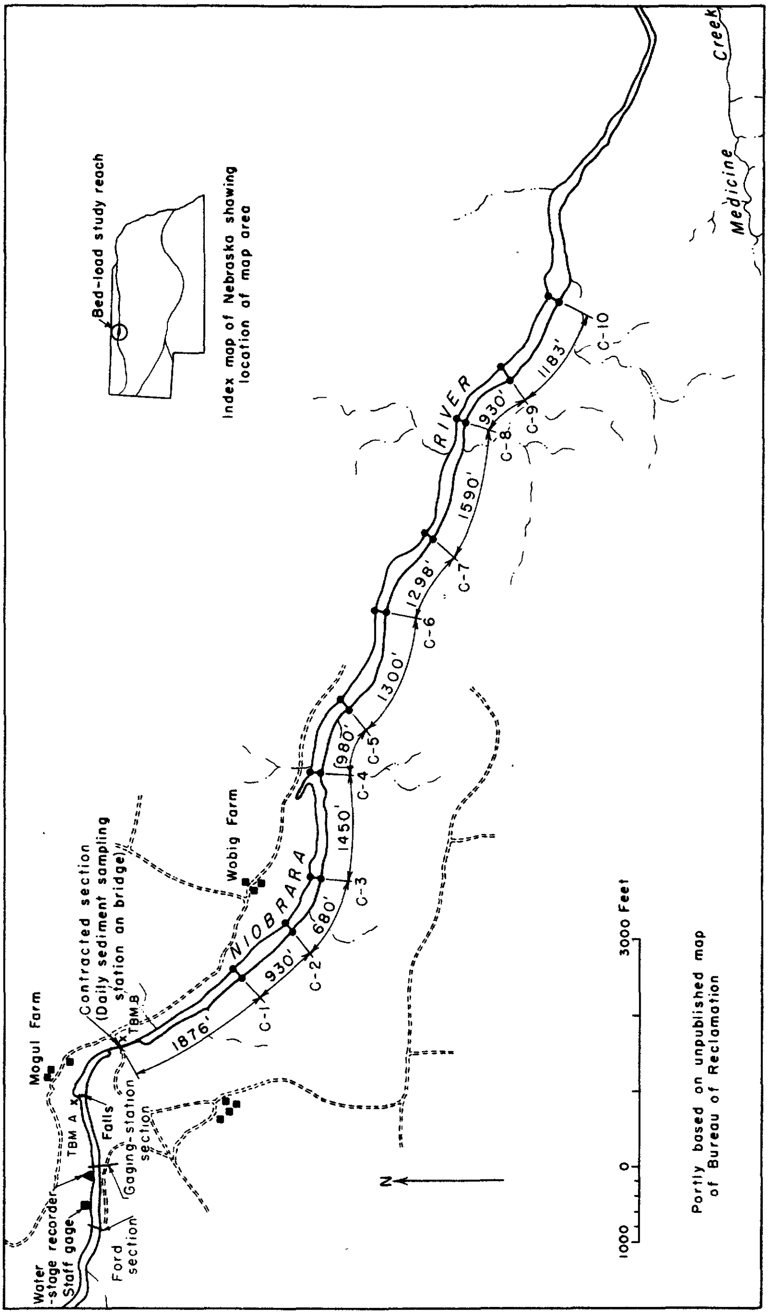


Figure 1.--Outline map of Niobrara River near Cody, Nebr.

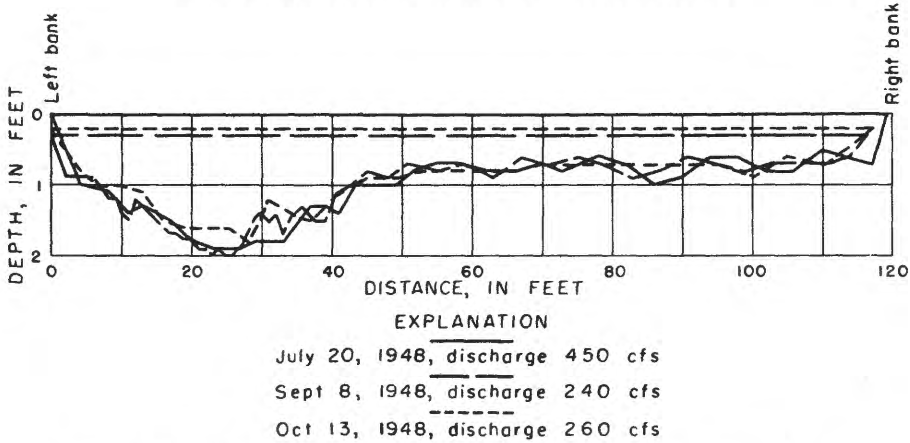


Figure 2.--Channel cross section at the ford section for streamflow measurements and sediment sampling.

Figure 3.--A view downstream along the Niobrara River valley toward the ford section and the gaging station near Cody, Nebr.

the water-stage recorder. Although this section has been used throughout this investigation as a site for collecting data to compare with determinations at the contracted section, it is not a typical alluvial section of the stream. At times of high flow the streambed at this section sometimes scours down to clayey siltstone. Also, the section is laterally confined by reasonably stable banks, which are overflowed at high stages only. At low flow the channel is about 70 feet wide. The cross section at the gaging-station section is shown in figure 4 for three different times. Streamflow measurements are listed in table 4 and suspended-sediment discharge measurements, in table 5. Water-surface slopes in table 4 were computed from the difference in altitude of the water surface at two staff gages, one 470 feet upstream from the water-stage recorder and one at the recorder. A profile of the water surface from the ford section to the water-stage recorder (fig. 5) shows that on April 22, 1953, the slope of the water surface was flatter near the gaging-station section than the average slope between the two gages.

Since April 15, 1953, a continuous record of water temperature has been obtained at the gage.

DISTRIBUTIONS IN THE CROSS SECTION

Lateral distributions of velocity, concentration, and depth are shown in figure 4 for three different times. The gaging-station section is reasonably uniform across the channel.

Many sets of point-integrated samples have been taken to show the vertical distribution of concentration and particle sizes at the gaging-station section. Some results of three of these sets of samples are given in figures 6 to 8. Velocities plotted on these figures are based on the volumes and filling times of the samples and may be somewhat inaccurate. However, most of these vertical velocity curves seem to have logical shapes. The particle-size analyses and the concentrations of the point-integrated samples are listed in table 6.

Velocities based on volumes and on filling times of sediment samples are computed on the assumption that the entrance velocity at the nozzle of the sampler is about equal to the velocity of the water when undisturbed by the sampler. From the cross-sectional area of the nozzle at its entrance, from the volume of the sample, and from the filling time, the approximate average velocity of the stream at the point where the sample was taken can be computed. Similarly, the average velocity throughout the part of a vertical that was sampled at a constant rate of travel of the sampler can be computed.

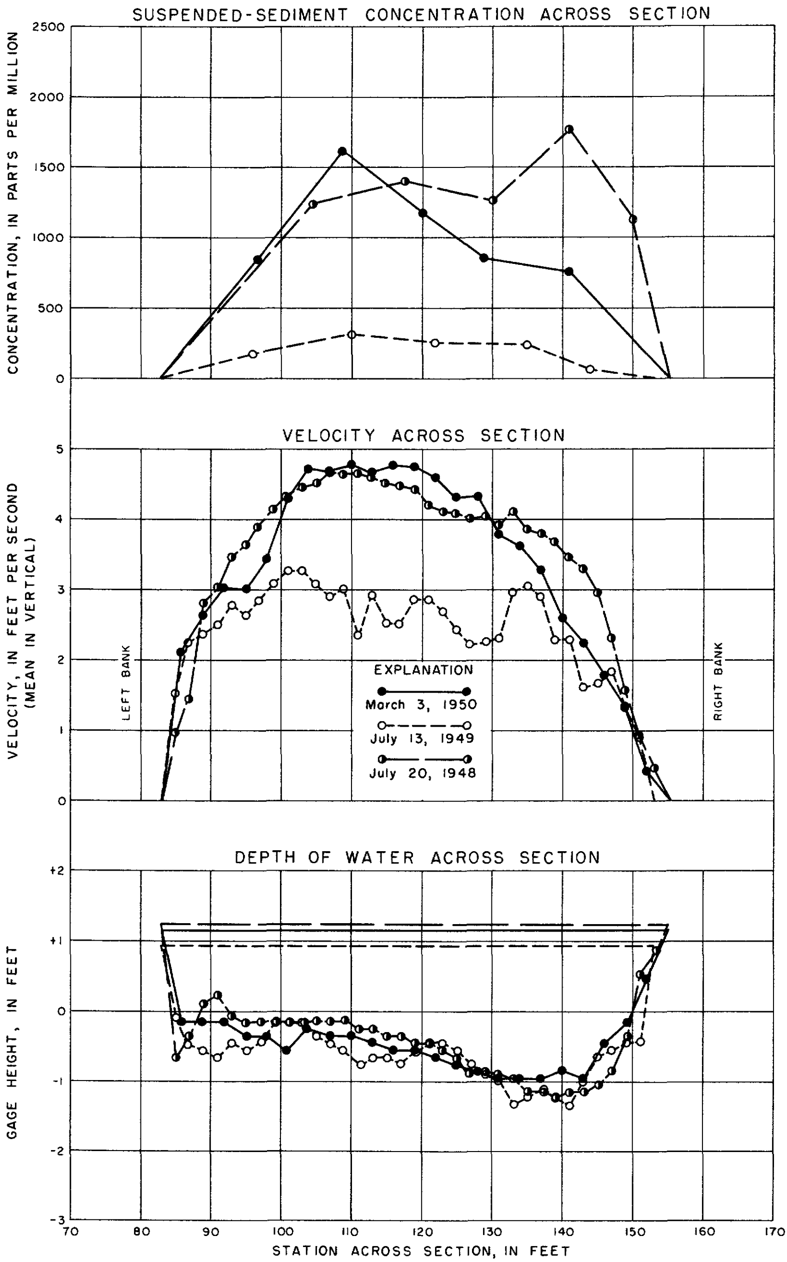


Figure 4.--Lateral distribution of depth, velocity, and concentration of suspended sediment, gaging-station section, Niobrara River near Cody.

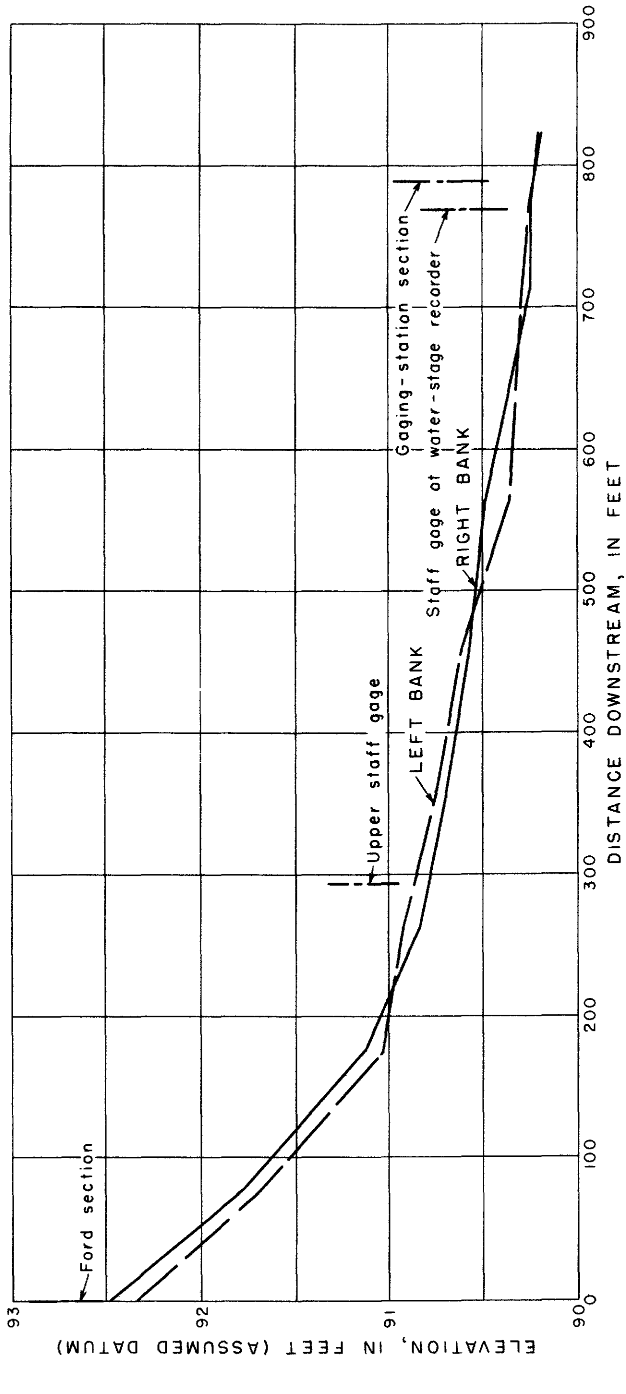


Figure 5.--Longitudinal profiles of the water surface of a reach of the Niobrara River near Cody, Nebr. April 22, 1953.

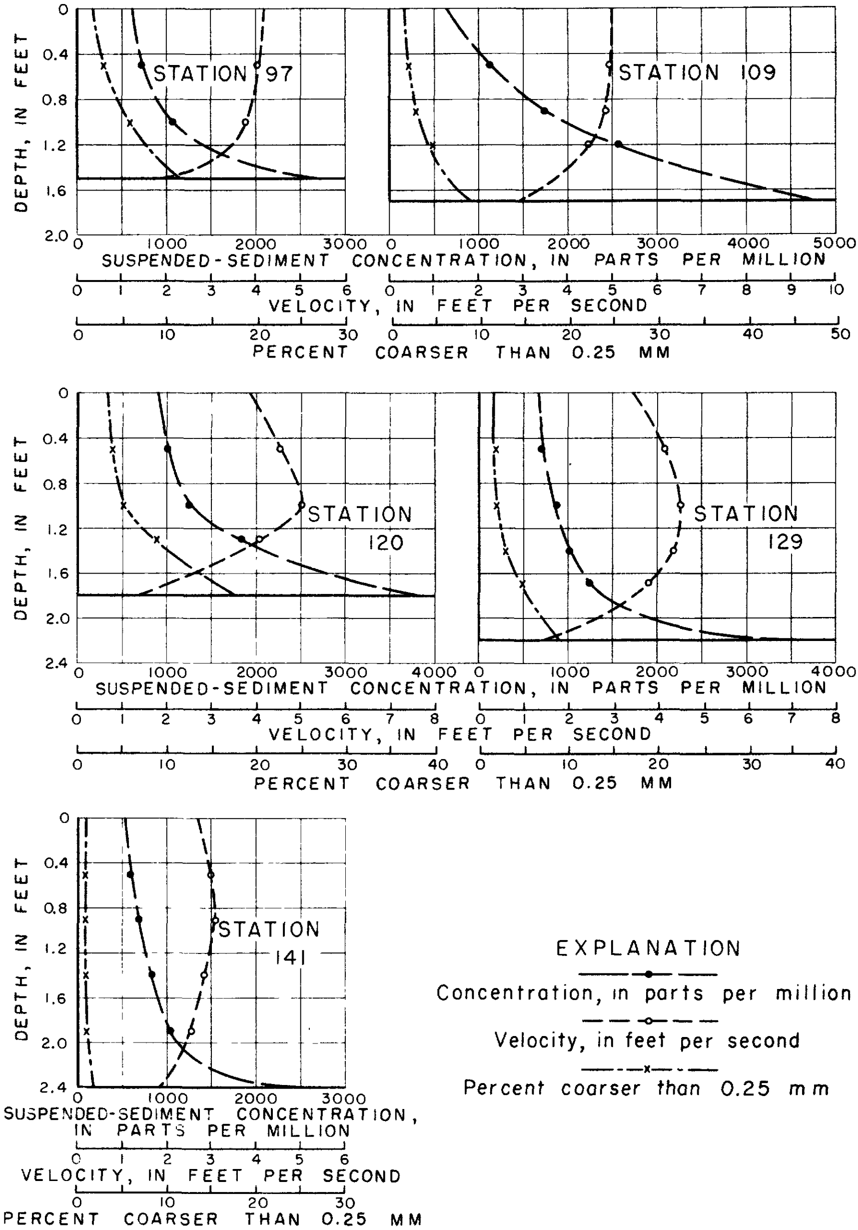


Figure 6.--Vertical distributions at gaging-station section, March 3, 1950.

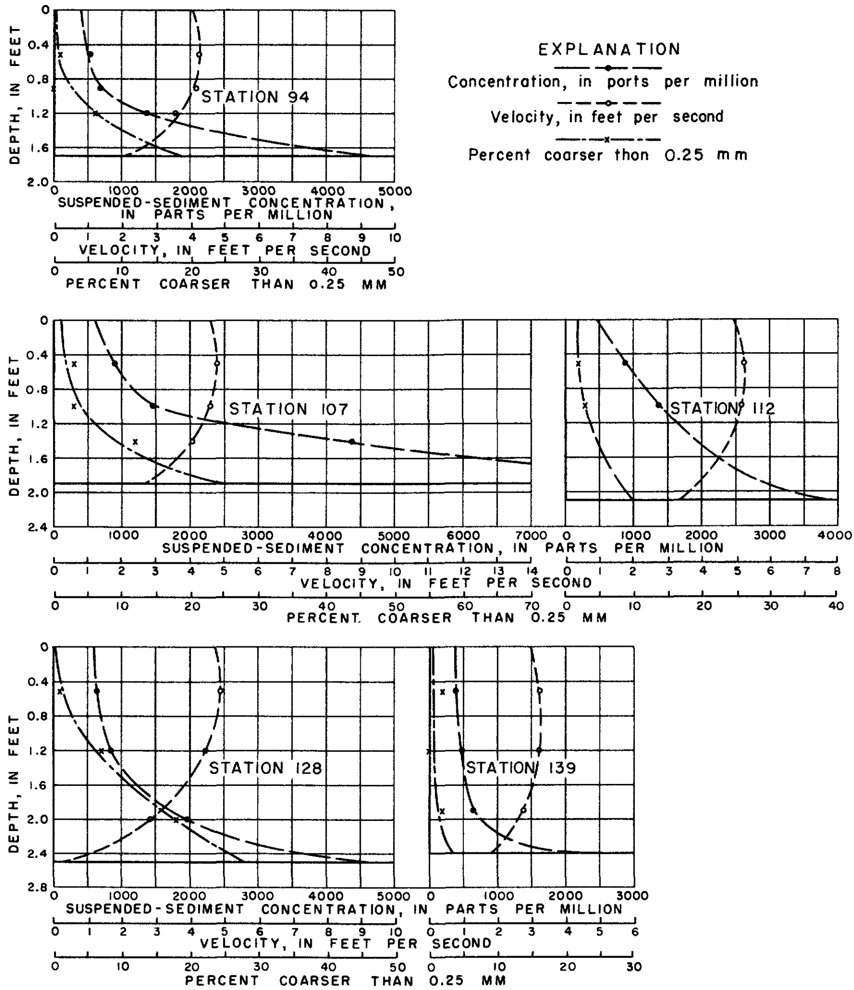


Figure 7.--Vertical distributions at gaging-station section, April 27, 1951.

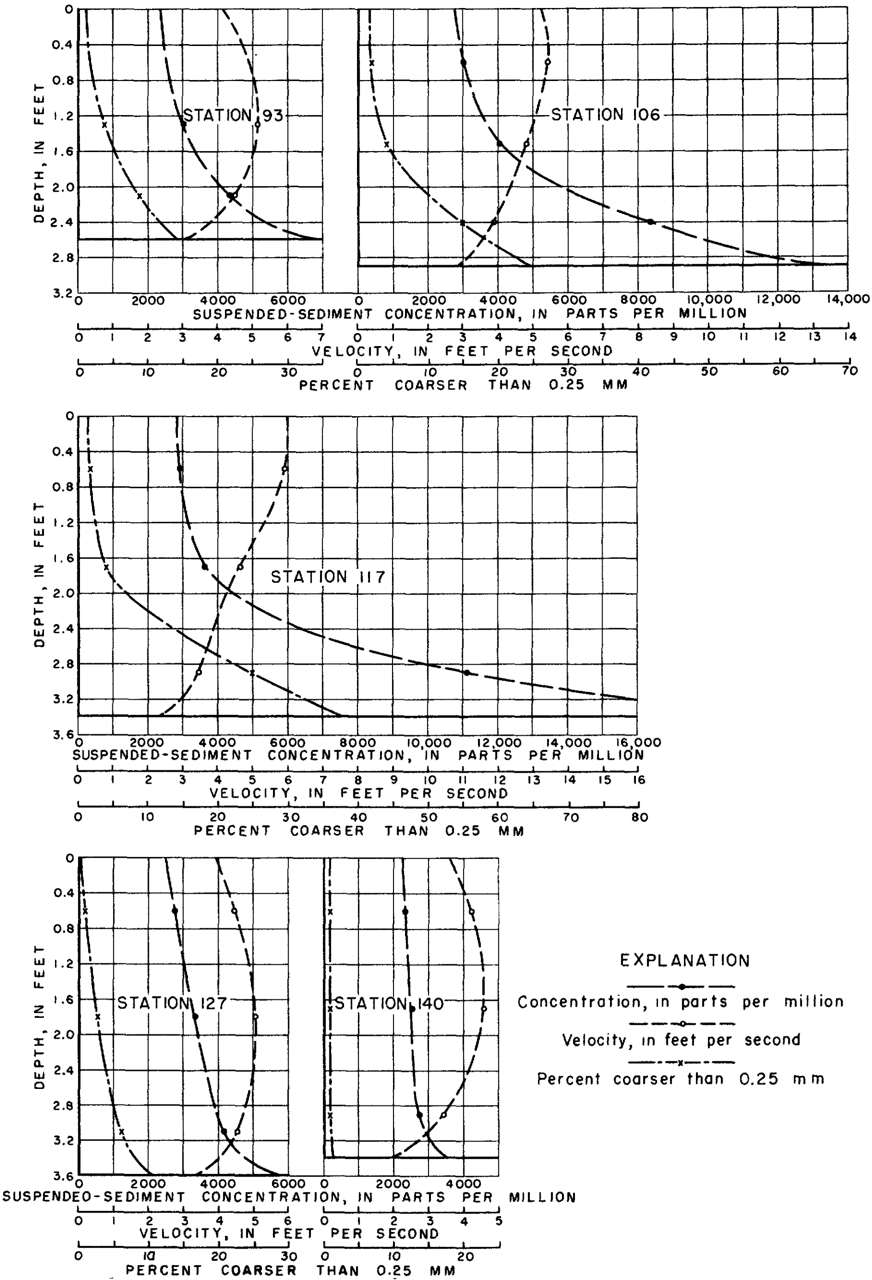


Figure 8.--Vertical distributions at gaging-station section, March 30, 1952.

In general, the concentrations of sediment are clearly shown to increase rapidly with depth, but the observed vertical distribution of sediment concentrations differs from one vertical to another, partly because of experimental errors. Many curves of vertical distribution of concentration with depth have been plotted, some against the depth and some against the function $(d-y)/y$, in which d is depth and y is distance above the stream bed. Curves, drawn as straight lines on the logarithmic scales of figures 9 and 10, were fitted by eye to the plotted points of individual concentrations and were grouped by verticals. These figures indicate for each vertical the change in slope of the lines with changing particle size and also the measure of agreement between the straight lines and the concentrations. In figure 11 the lines are grouped by size ranges to show the variations in slope from one station to another in the cross section.

According to theories of distribution of suspended sediment at a vertical of a stream section as recapitulated by Einstein (1950, p. 17), the concentrations in a size range should plot in a straight line against $(d-y)/y$ on logarithmic coordinates, and the slope of the line should define the exponent. This exponent z_1 is a measure of the rate of increase of concentration with depth. It has often been assumed to equal z and is, as restated by Einstein (1950, p. 17), defined by the equation

$$z = \frac{V_s}{0.4\, u_*}$$

in which V_s is the settling velocity of the geometric mean size of particles in a particular size range
0.4 is the universal constant for turbulent exchange
u_* is the shear velocity (Einstein uses u_*', the shear velocity with respect to the sediment particles)

The shear velocity is equal to the square root of the product of the gravity acceleration, the energy gradient, and the hydraulic radius. (The definition of all symbols is given on p. 115. In general, the symbols have the same meanings that were given them by Einstein, but some have been used with slightly different meanings.)

As defined, z is the exponent in the theoretical equation for vertical distribution of sediment of a particular size range. The equation is

$$\frac{c_y}{c_a} = \left(\frac{d-y}{y}\,\frac{a}{d-a}\right)^z$$

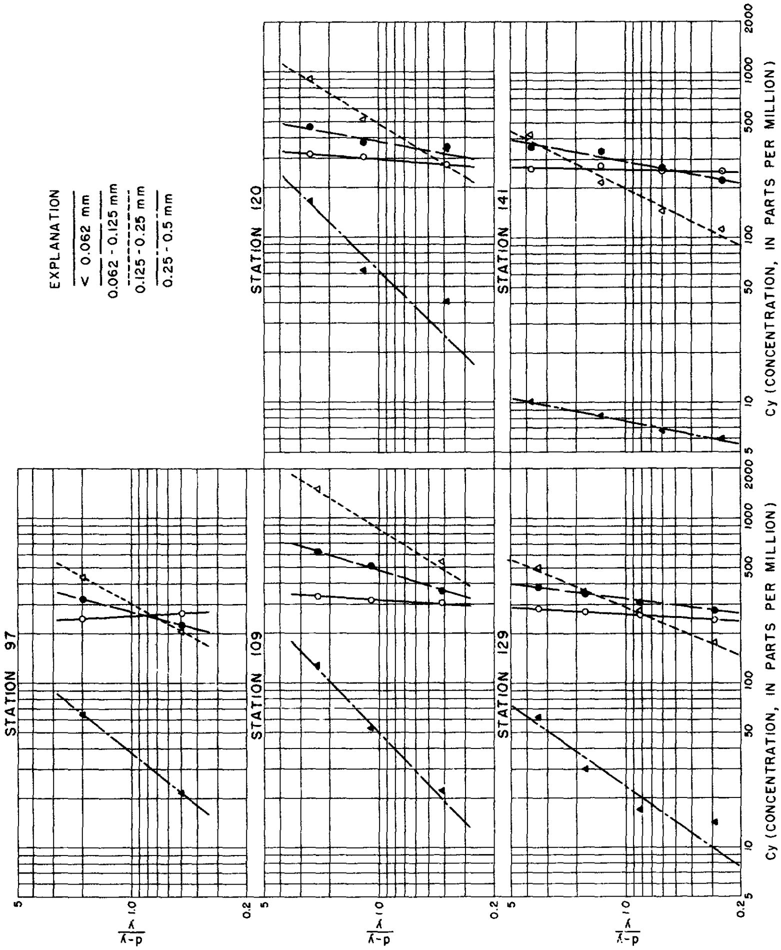


Figure 9.--Relation of (d − y)/y plotted against concentration for different size ranges, gaging-station section, March 3, 1950.

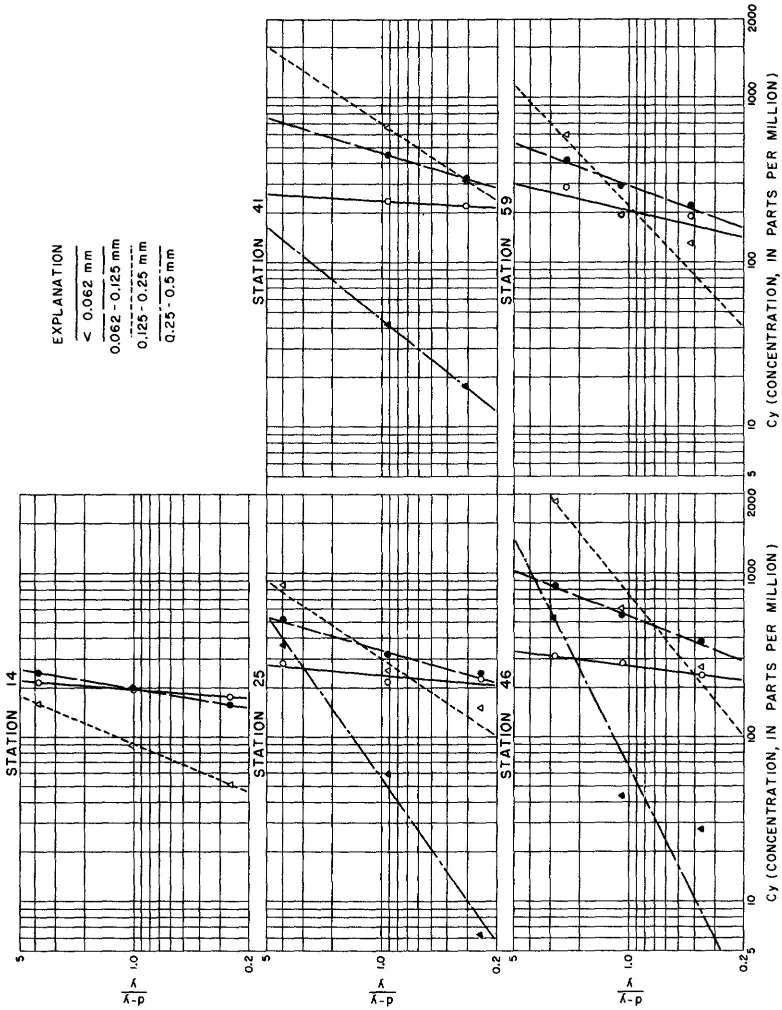


Figure 10.--Relation of (d — y)/y plotted against concentration for different size ranges, gaging-station section, April 27, 1951.

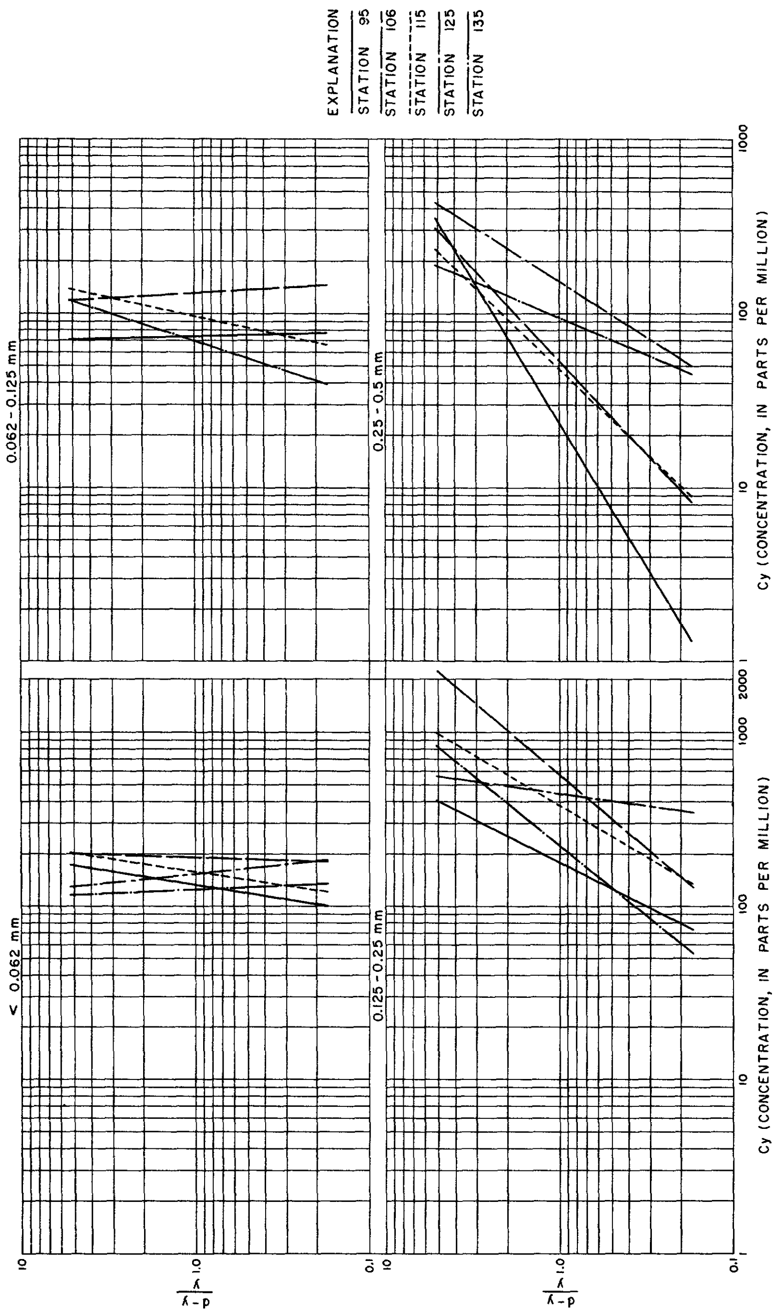


Figure 11.--Relation of (d — y)/y plotted against concentration for different size ranges, gaging-station section, November 8, 1949.

in which d is the depth of flow
a and y are distances above the stream bed
c_a and c_y are concentrations of particles of a given size range at distances a and y, respectively, above the bed

In figure 12 the exponent z_1 from figures 9 to 11 is shown to vary curvilinearly with settling velocity. For comparison, a curve showing variation of z_1 with the 0.7 power of the settling velocity has also been plotted on figure 12. Settling velocities used in this report were based on an equation given by Rubey (1933). The difference between z_1 as determined from point-integrated samples and z as defined by the equation given above is much too great to be overlooked. It is discussed in detail in the section entitled "Computation of z."

PARTICLE SIZES OF THE SEDIMENTS

Point-integrated samples of suspended sediment at the gaging-station section were individually analyzed for particle size. (See table 6.) These analyses are essential to studies of vertical distribution of the sediment but are not easily used to determine average particle-size distributions for the entire cross section of the stream.

Many depth-integrated samples of suspended sediment from the gaging-station section have been analyzed for particle-size distribution. (See table 7.) The median particle size for a large percentage of samples is about 0.10 to 0.15 millimeter. Most particles of suspended sediment are in the lower ranges of sand sizes. The suspended sediment is low in percentages of silt and clay except during and following high water discharges when appreciable amounts of the streamflow come from surface runoff that originated on soils of fine texture.

Samples of stream-bed material have been collected at the gaging-station section many times. Usually these samples were taken at three places in the cross section, and each sample was separately analyzed by sieving. The average analysis of the bed material for each sampling date is shown in table 8. An average of all the analyses has been computed and is shown graphically in figure 13. Nearly all the bed material is in the range of sand sizes. The median diameter of the sediment in the arithmetic average analysis is 0.27 millimeter.

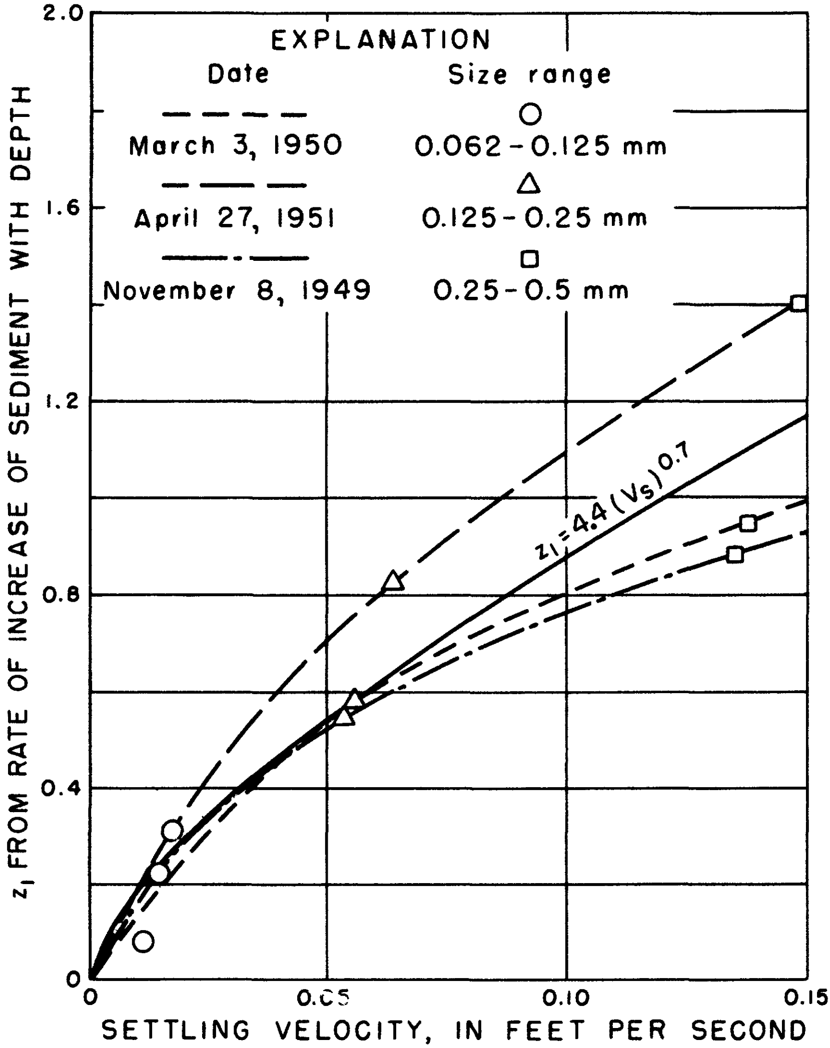


Figure 12.--Relation between z_1 as determined graphically from point-integrated samples and the settling velocity.

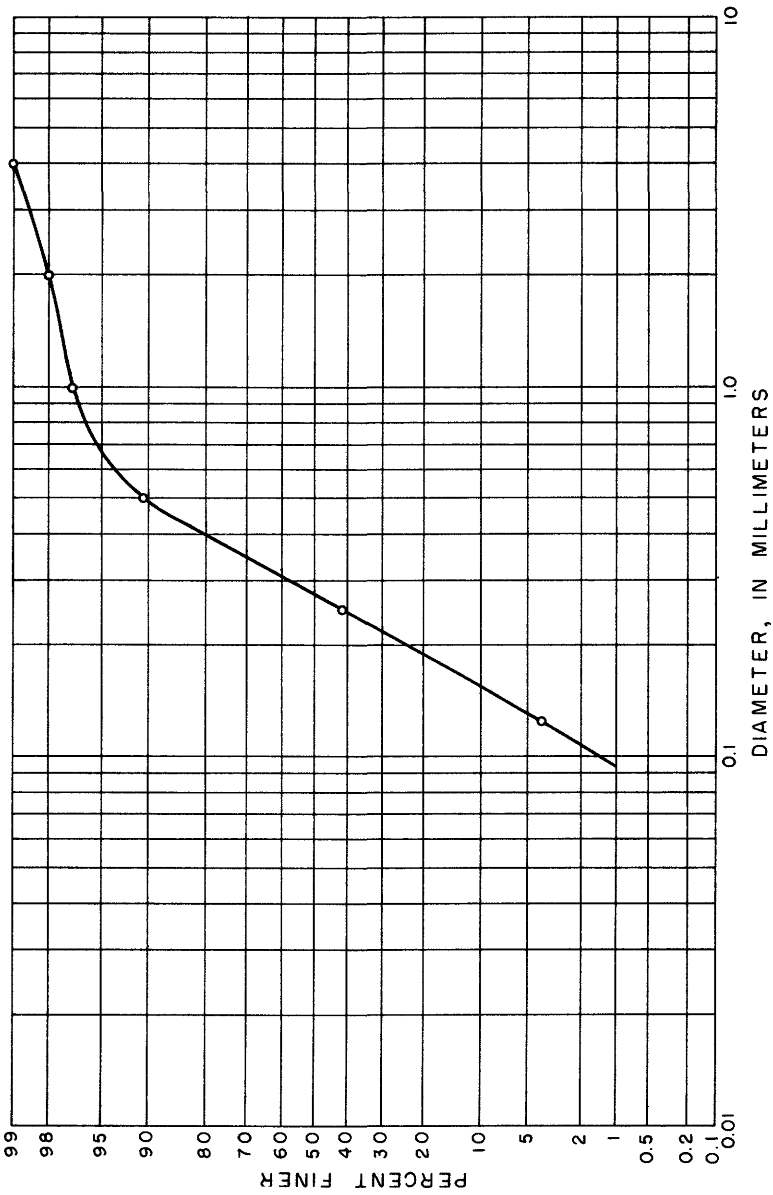


Figure 13.--Computed average analysis of 50 sets of bed-material samples at the gaging-station section.

Samples were collected with one of three types of bed-material samplers. One type was a pint ice cream carton or a tin can, which was forced into the stream bed. Another type was a metal cylinder, 2 inches in diameter. This cylinder contained a piston that could be gradually raised in relation to the cylinder as the sampler was forced into the stream bed. The third was a sampler US BM-48, a streamlined 100-pound clamshell sampler.

Bed-material sizes at a section or reach of channel may vary with water discharge, water temperature, or some other factors, but no relationship has been clearly defined for the Niobrara River near Cody. Water temperature was plotted against the particle size at which 25 percent of the bed material was finer (fig. 14). Analyses of samples of bed material from all normal sections were included. No relationship is apparent from figure 14. Also, water discharge was plotted against the size at which 25 percent is finer, the median particle size, and the size at which 75 percent is finer (fig. 15). Only samples from the gaging-station section were included in this graph. The average analysis of the samples for the highest water discharge shows much finer material than the average for all other discharges. Additional samples of bed material at high rates of flow might define a trend. Such a trend toward larger percentages of fine particles at high discharges may not be unreasonable at this station, for the sizes of suspended sediment tend to become smaller at high flows.

To further test the possibility of variation of bed-material size with water temperature and streamflow, an estimating equation was computed by multiple linear correlation. The equation based on 19 determinations at the gaging-station section was

$$D_{25} = 0.2318 + 0.000226\,T - 0.0000942\,Q$$

in which D_{25} is the size, in millimeters, at which 25 percent of the bed material by weight is finer

T is temperature of the water at time of sampling, in degrees Fahrenheit

Q is the water discharge at time of sampling, in cubic feet per second

This equation shows little average change in D_{25} for the ranges in T and Q that are covered by the available data. Also, the coefficient of multiple correlation 0.543 is not quite significant even to the 0.05 level. These computations substantiate the tentative interpretation of figures 14 and 15.

Because no definite relationship of particle size of bed material to other factors has been established for the gaging-station section, an arithmetic average of all bed-material samples has been used for comparisons and computations of sediment relations.

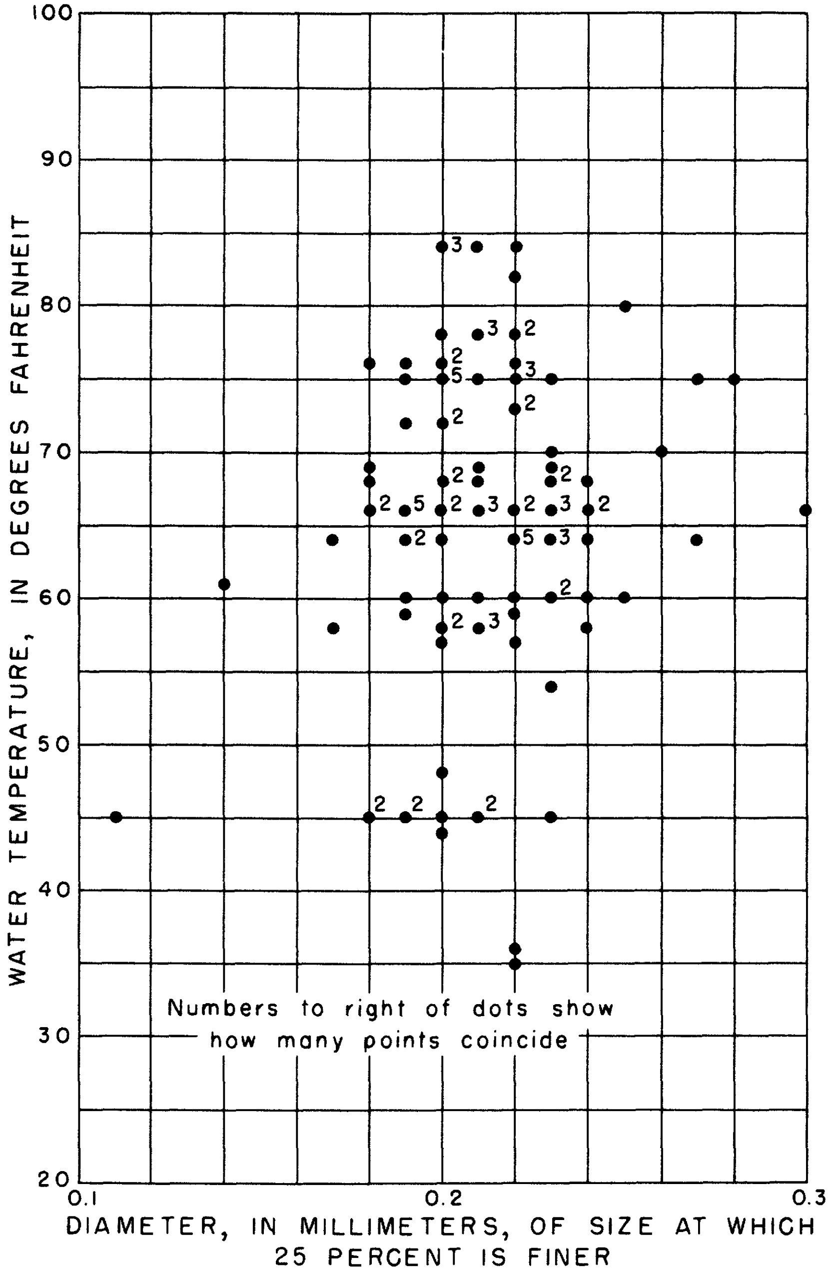


Figure 14.--Graph of first quartile size of bed material plotted against water temperature for all sections.

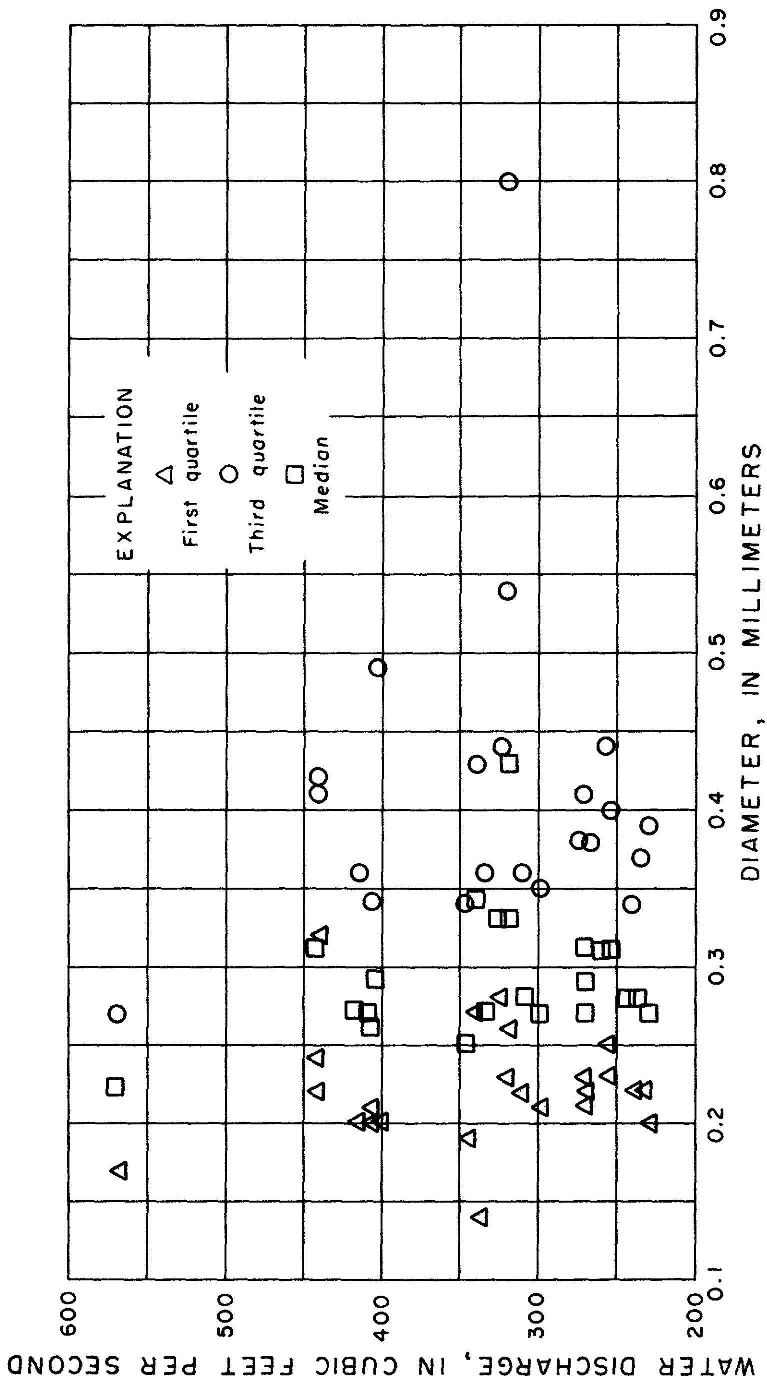


Figure 15.--Graph of particle sizes of bed material at gaging-station section plotted against streamflow.

CONTRACTED SECTION

The contracted section is at the county bridge over the chute about 8 miles south of Cody. The chute was formed as the stream entrenched itself in the argillaceous siltstone. At its upper end, about 50 feet upstream from the bridge, the chute is only 2 or 3 feet wide at the water surface (fig. 16). It expands to a width of about 11 feet at the bridge (fig. 17), and the flow becomes slower as the width increases. This section was chosen as the measuring section because investigation indicated that the maximum concentration of suspended sediment along the chute was at the bridge. A cross section at the bridge is shown in figure 18. No streamflow measurements have been made at the contracted section, but the computed average velocity at the contracted section is about 3.82 feet per second at a water discharge of 324 cfs.

Measurements of sediment discharge made at the contracted section are listed in table 9. These measurements are based on depth-integrated samples at three verticals in the cross section. Usually the concentration at the middle vertical is appreciably lower than the average concentration at the outer verticals. Water temperatures were taken once a day until April 15, 1953, when a water-temperature recorder was installed at the water-stage recorder. (See table 10.)

DISCHARGE OF SUSPENDED SEDIMENT

Daily records of suspended-sediment discharge have been computed from April 1948 through September 1953 but are not included in this report. These records are based on concentrations of daily depth-integrated samples that were collected at one vertical about at the middle of the contracted section and on streamflow at the gaging station about 1,900 feet upstream. As this one daily sampling vertical is at the part of the section where the concentration is somewhat low (p. 29), coefficients have been applied to adjust concentrations of daily samples to make them representative of the average concentration at the three verticals where samples are collected periodically. The coefficients, averaging about 1.15, were usually applied as though they varied with water discharge.

The average concentration of suspended sediment was about 1,800 ppm for 4 complete water years. Suspended-sediment discharges by days, months, and water years are presented or will appear in U. S. Geological Survey Water-Supply Papers of the series, Quality of Surface Waters of the United States. Sediment

Figure 16.--A view downstream from the upper end of the natural flume, Niobrara River near Cody.

Figure 17.--A view upstream toward the sampling point in the natural flume, Niobrara River near Cody.

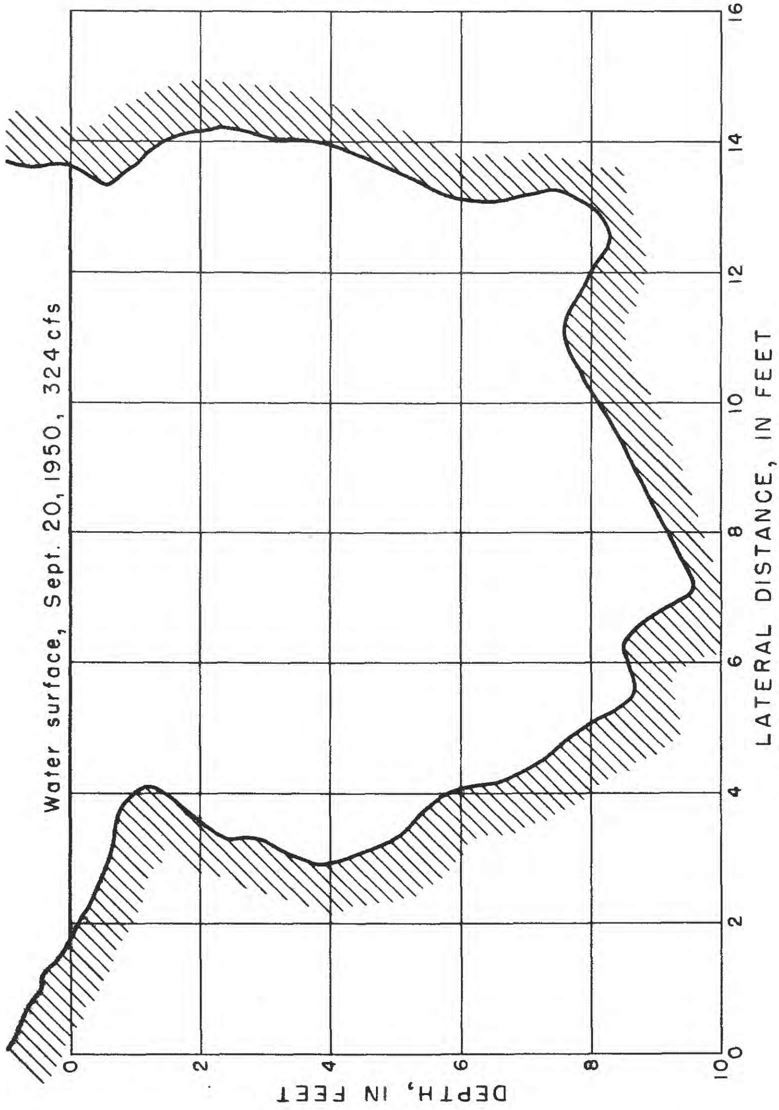


Figure 18.--Profile of contracted section.

discharge is uniform owing primarily to the regulating effect of ground-water storage in the sandhills. The uniformity is shown graphically by the duration curve of daily sediment discharge (fig. 19).

Suspended-sediment discharge at the contracted section is largely a function of the rate of streamflow, although the relation varies considerably with water temperature, size of the available material, and source of the runoff. On the average, the sediment discharge increases at least as rapidly as the cube of the water discharge below 3,000 cfs. The rate of increase with water discharge is somewhat lower above 3,000 cfs. (See fig. 20, which is a graph of daily average sediment discharge against daily average water discharge.)

DISTRIBUTIONS IN THE CONTRACTED SECTION

Lateral distributions of velocity and concentration are shown in figure 21 for three different times. These lateral distributions, based on only three verticals, are poorly defined, but they do show the tendency for the concentration to be lower near the middle of the section than at the verticals nearer the sides of the section.

Many sets of point-integrated samples have been collected to define the vertical distributions at the contracted section. These samples were analyzed for both concentration and particle size (table 11). The distributions of velocity, concentration, and percentage of particles larger than 0.25 millimeter were plotted for 3 different times in figure 22. The plotted velocities were based on the volumes and filling times of the samples and may be somewhat inaccurate.

Sediment concentrations usually increased relatively slowly with depth in the contracted section as compared with the rate of increase with depth at shallow, alluvial sections. Also, the percentage of particles larger than 0.25 millimeter did not usually increase very rapidly with depth in the contracted section. However, sometimes, particularly when water discharge is low, both concentration and percentage of the larger particles may increase rapidly with depth at some verticals. When the rate of increase with depth is no greater than it was at stations 7, 11, and 15 on March 3, 1950, stations 6 and 10 on September 16, 1949, and station 10 on May 5, 1949, the turbulence must be adequate to suspend most of the total sediment discharge of the river, and the

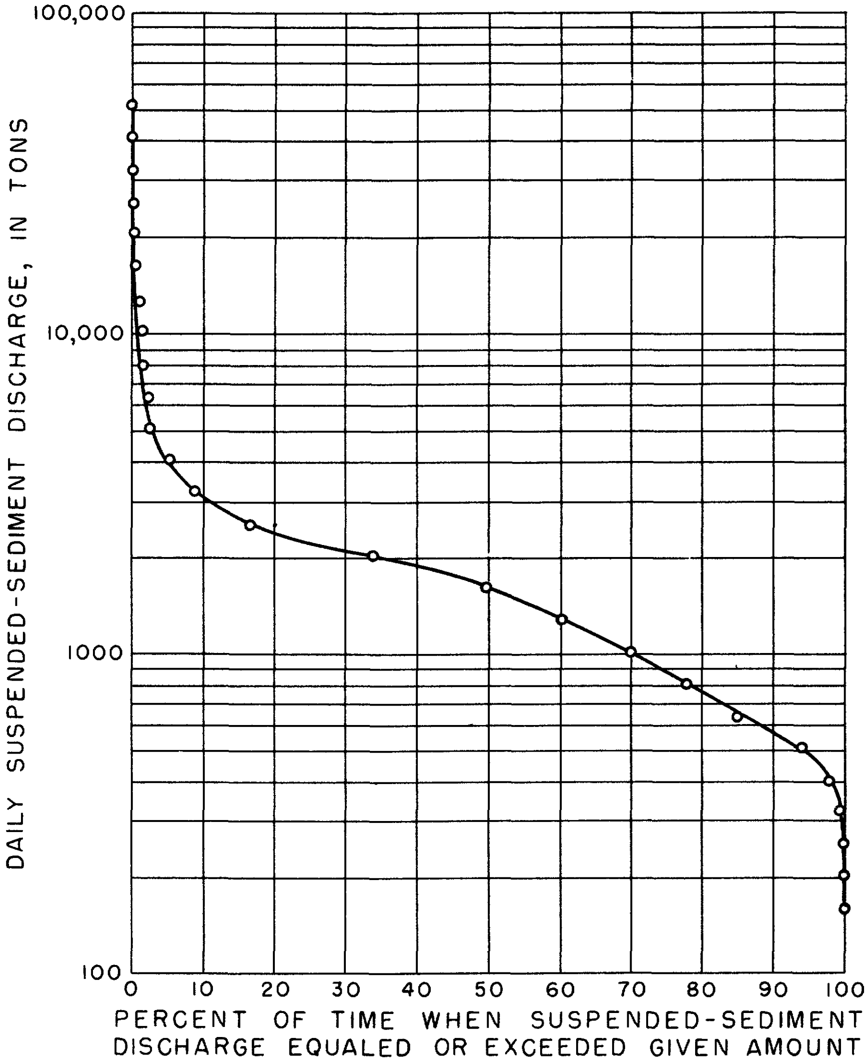


Figure 19.--Duration curve of daily suspended-sediment discharge in the contracted section of the Niobrara River near Cody, from April 9, 1948, to September 30, 1952.

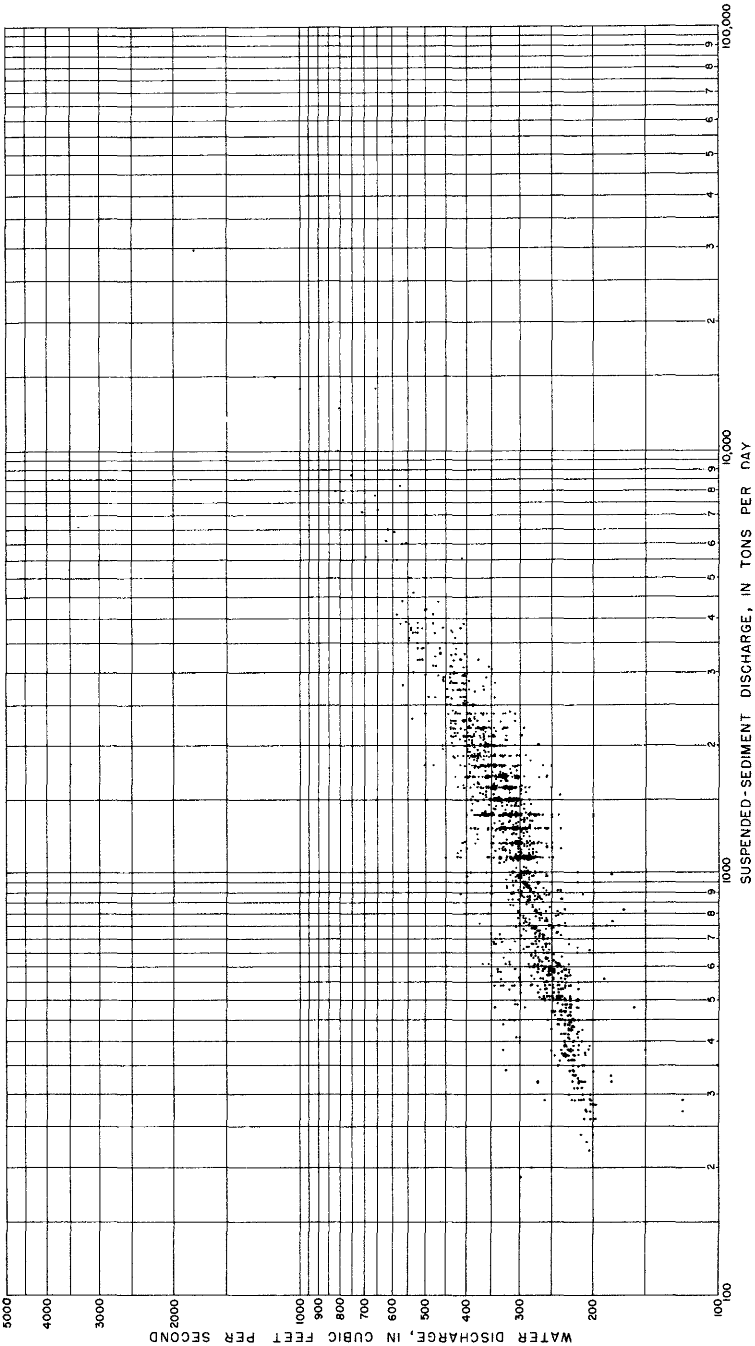


Figure 20.--Relationship of daily average suspended-sediment discharge to daily average water discharge at contracted section from April 1948 through September 1952.

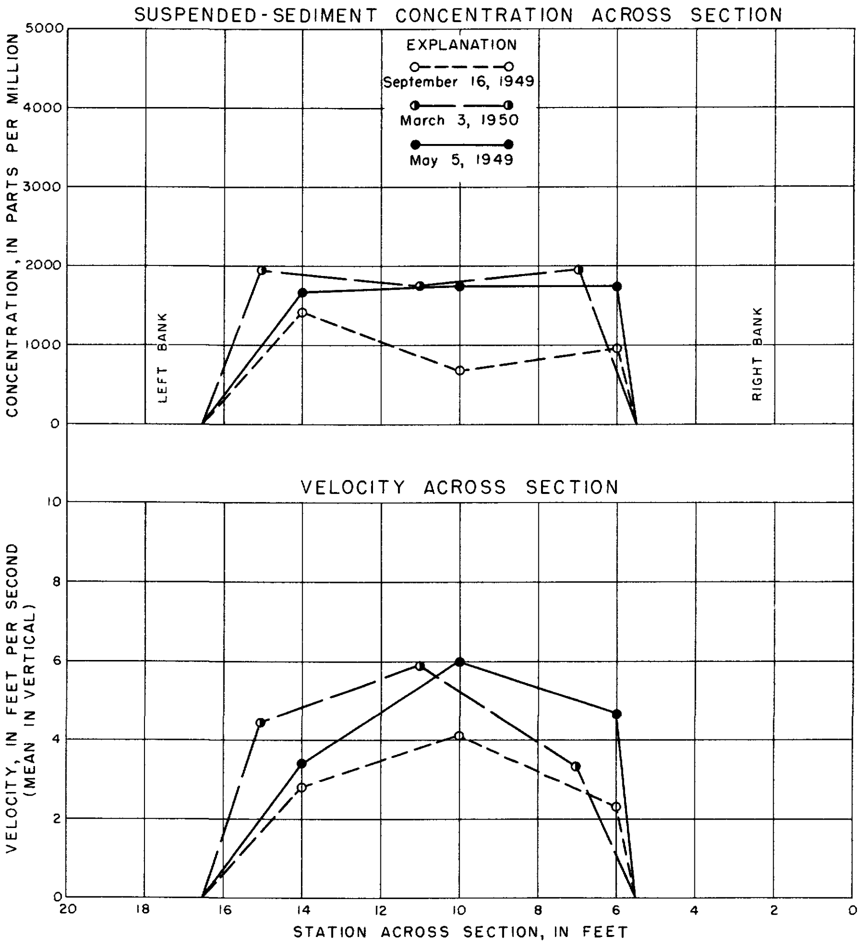


Figure 21.--Lateral distribution of velocity and concentration of suspended sediment, contracted section.

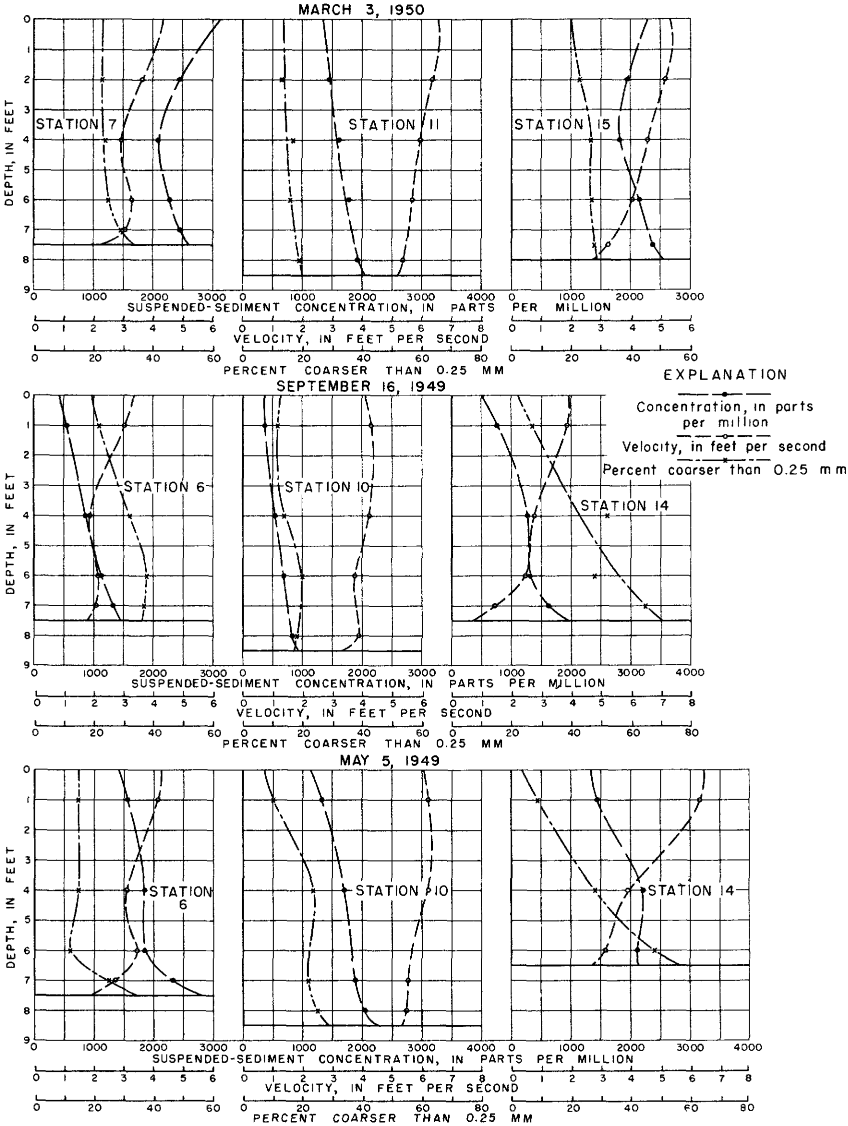


Figure 22.--Vertical distributions at contracted section.

particle sizes larger than 0.25 millimeter must be about as completely suspended as the finer particles. Rapid increase of concentration and of percentage of the coarser particles with depth probably indicates that appreciable quantities of the total sediment discharge may not be suspended but may be moving through the contracted section as bed load. Because the section is narrow and flow through it is always much more turbulent than at other sections of the channel, the bed-load discharge is probably relatively low at all times.

PARTICLE SIZES OF THE SEDIMENTS

At times, especially during the summer when the streamflow is low, bed material accumulates on the bottom of the contracted section and can be sampled. Only a few samples of stream-bed material have been taken, but these show particle sizes that are a little coarser than the bed material at normal sections of the stream. (See table 12.) The samples were collected with a sampler US BM-48. All were obtained when the water discharge was low. At higher flows, little if any bed material stays on the bottom of the contracted section.

Most analyses of suspended sediment at the contracted section show that more than 80 percent of the particles were in the range of sand sizes (table 13). For suspended-sediment discharges of less than 2,000 or 3,000 tons per day the median particle sizes of the samples of suspended sediment at the contracted section ranged from 0.13 to 0.27 millimeter and averaged about 0.19 millimeter (fig. 23). At discharges of suspended sediment above 10,000 tons per day the 4 determinations of median particle size averaged less than 0.03 millimeter. This decrease of median particle size with an increase in both sediment and water discharge is due to the inclusion of more surface runoff in the higher flows. Much of the surface runoff comes from areas that have soils of fine texture.

NORMAL SECTIONS C-1 TO C-10

In June 1951, 10 sections were selected below the chute for measurements of flow and sedimentation characteristics to be used in formulas for computing sediment discharges through alluvial sections. Sections having beds of unconsolidated sediment and little lateral confinement were chosen. The upstream one of

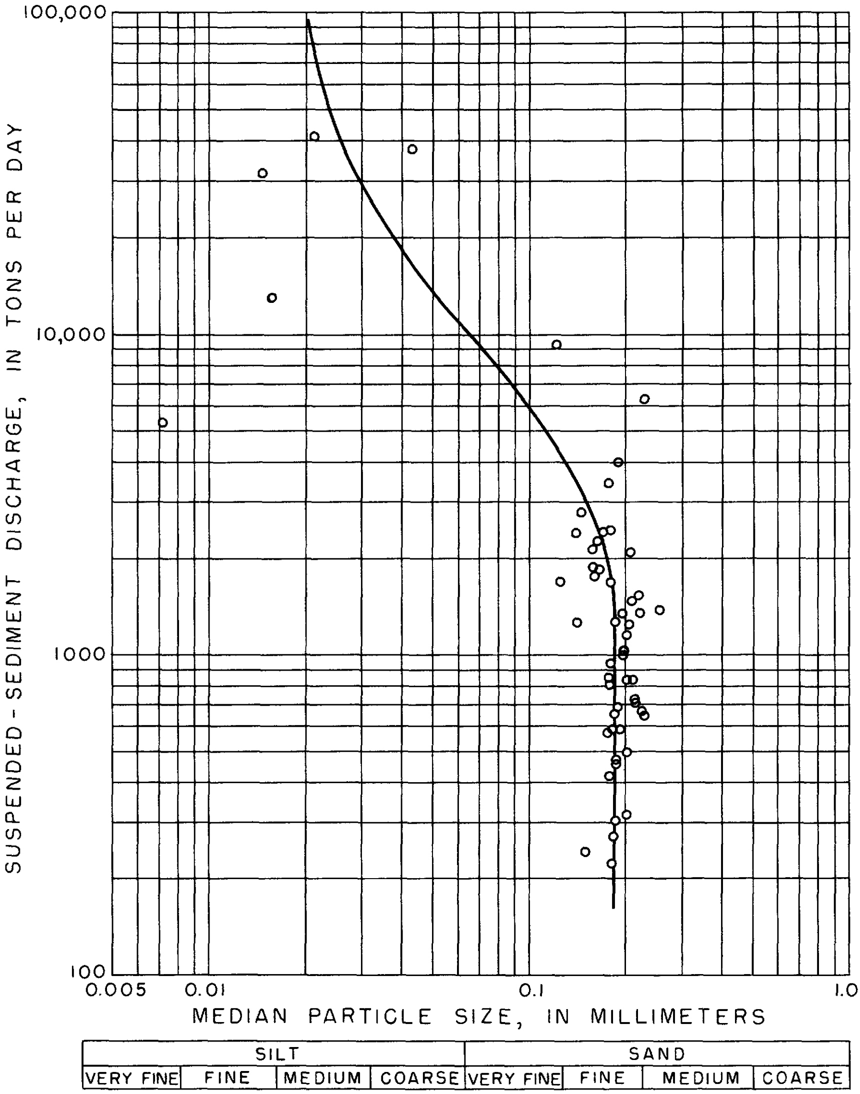


Figure 23.--Median particle size plotted against suspended-sediment discharge, contracted section.

these sections, C-1, is about 1,900 feet downstream from the contracted section. Distances between the successive sections vary considerably but average more than 1,000 feet. The farthest downstream section, C-10, is about 12,200 feet from the contracted section. Staff gages were installed on the left bank at each section and were referred to a datum 100 feet lower than the datum of the water-stage recorder, which is upstream from the contracted section. Locations of the sections are given on figure 1. Figure 24 shows the outline of the 10 cross sections as they were first defined in June 1951. The sections are wide and shallow. Sections C-2 (fig. 25) and C-6 (fig. 26) at which measurements of flow and sediment concentration were made are not in straight, uniform reaches of channel, and flow through them is not particularly smooth nor uniform. The channel at sections C-3 and C-4 is shown in figure 27, which gives a good idea of the type of channel throughout the reach from section C-1 to C-10. Tables 14 to 23 list the soundings at each section 4 times in 1951 and 4 times in 1952. Some of the sections changed considerably in less than 2 years. Altitudes of the water surface at the sections are given in table 24 for several times during 1951 and 1952. Total fall from section C-1 to section C-10 ranged from 12.0 to 13.0 feet. These amounts of fall are equivalent to 6.1 and 6.6 feet per mile.

Streamflow measurements were made only at sections C-2 and C-6 and are listed in table 25. Mean velocities at the times of measurement ranged from 1.81 to 4.48 feet per second. Areas, widths, and velocities in table 25 are those used to compute total sediment discharge and are based on velocities unadjusted for horizontal angle and on areas and widths that exclude parts of the section in which the direction of flow is upstream. Average depths were all less than 2 feet. (On September 6, 1951, the total width of section C-6 was 96 feet, but the direction of flow was upstream in 33 feet of the section.)

Table 24.--Water-surface altitudes at normal sections C-1 to C-10

Date	Altitude of water surface above assumed datum (feet)										
	C-1	C-2	C-3	C-4	C-5	C-6	C-7	C-8	C-9	C-10	Total fall
1951											
June 14...	87.19	86.04	85.14	83.40	82.19	80.53	78.97	77.12	76.09	74.43	12.76
June 16...	87.20	86.14	85.16	83.39	82.24	80.53	78.96	77.07	76.04	74.33	12.87
July 18...	87.46	86.31	85.36	83.48	82.28	80.59	79.03	77.17	76.12	74.45	13.01
July 28...	90.6	89.1	88.3	86.8	85.5	84.0	82.2	79.9	79.2	78.2	12.4
Aug. 3....	87.13	86.10	85.15	83.51	82.38	80.50	78.74	76.92	76.03	74.62	12.51
Sept. 6...	87.56	86.87	85.50	83.89	82.64	80.70	79.31	77.44	76.59	75.44	12.12
1952											
Apr. 1....	86.86	.....	84.72	83.27	82.06	80.53	78.94	77.15	76.11	74.85	12.01
May 8.....	86.87	85.72	84.71	83.24	82.10	80.48	78.91	77.16	76.14	74.51	12.36
June 19...	86.95	85.67	84.71	83.02	81.87	80.28	78.69	76.88	75.83	74.23	12.72
Sept. 26..	87.08	85.81	84.86	83.13	81.89	80.29	78.70	76.84	75.76	74.15	12.93

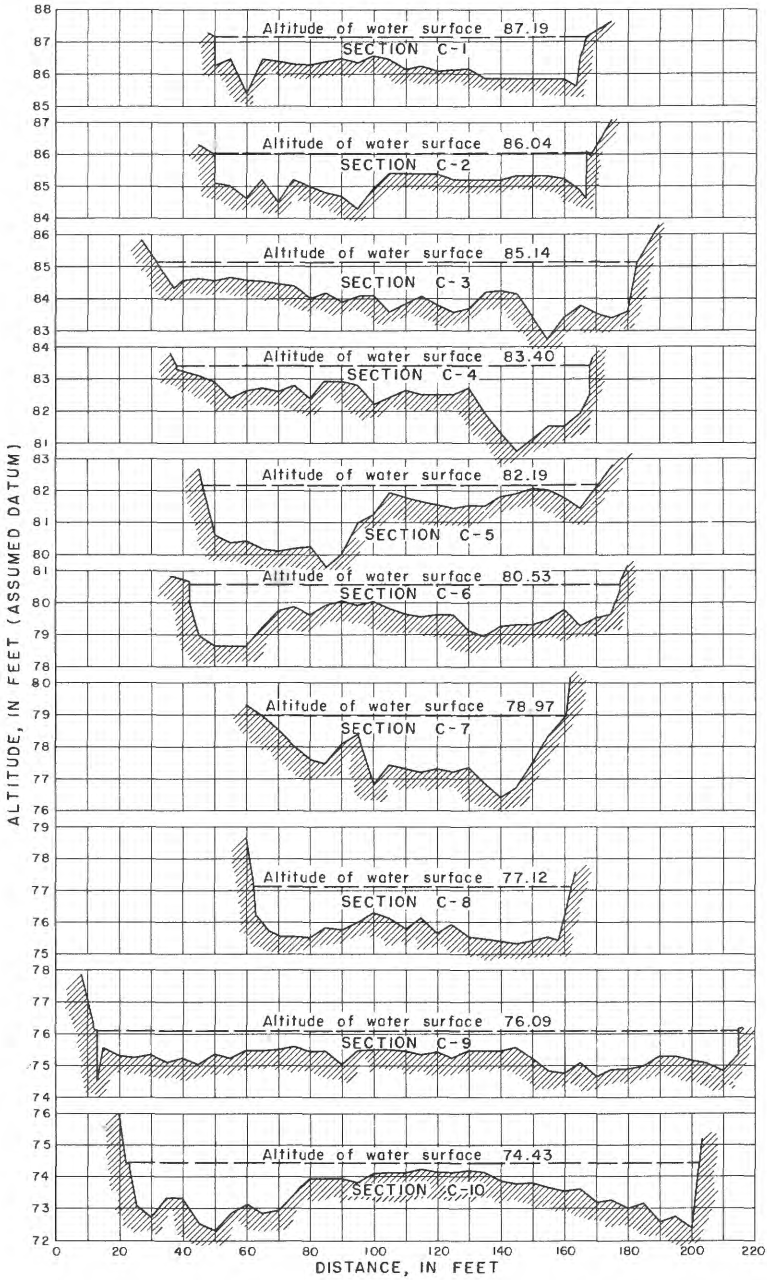


Figure 24.--Profiles of normal sections C-1 to C-10, June 14, 1951, water discharge about 319 cfs.

Figure 25.--A view upstream toward normal section C-2, Niobrara River near Cody.

Figure 26.--A view upstream toward normal section C-6, Niobrara River near Cody.

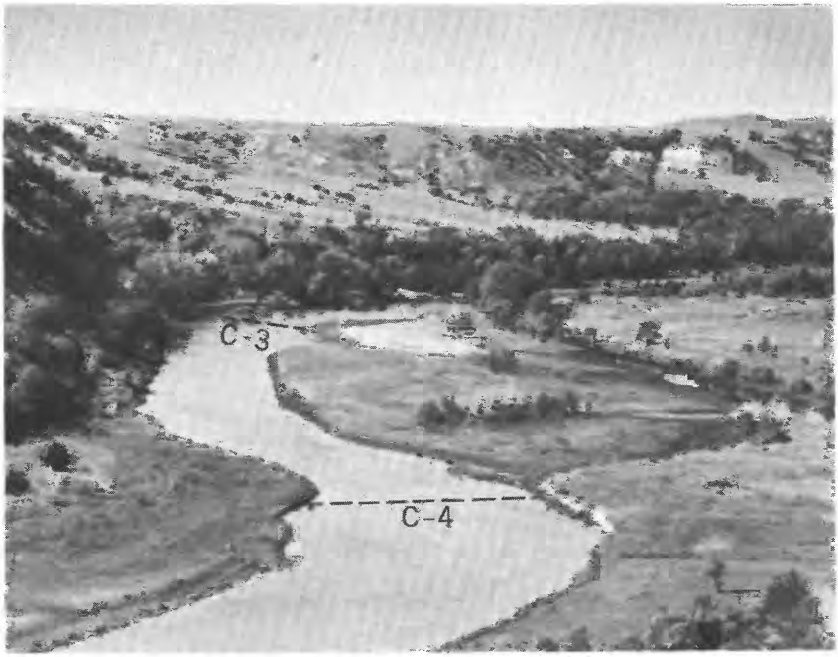


Figure 27.--Normal sections C-3 and C-4 and adjacent reach of the Niobrara River near Cody.

DISTRIBUTIONS IN THE CROSS SECTIONS

Lateral distributions of velocity and concentration were defined several times for sections C-2 and C-6. These distributions for two different times are shown in figures 28 and 29. Velocity, depth, and concentration sometimes vary considerably across the sections, especially at section C-6. Vertical distributions of velocity, concentration, and percentage of particles larger than 0.25 millimeter have been defined once for sections C-2 and C-6. (See figs. 30 and 31.) These velocities were measured with a pygmy current meter.

PARTICLE SIZES OF THE SEDIMENTS

Samples of stream-bed material were collected at all sections, usually at three places in the cross section (table 26). Particle sizes of the bed material are about the same at all sections. Average particle-size analyses for section C-2, section C-6, and for all 10 sections collectively are plotted in figure 32.

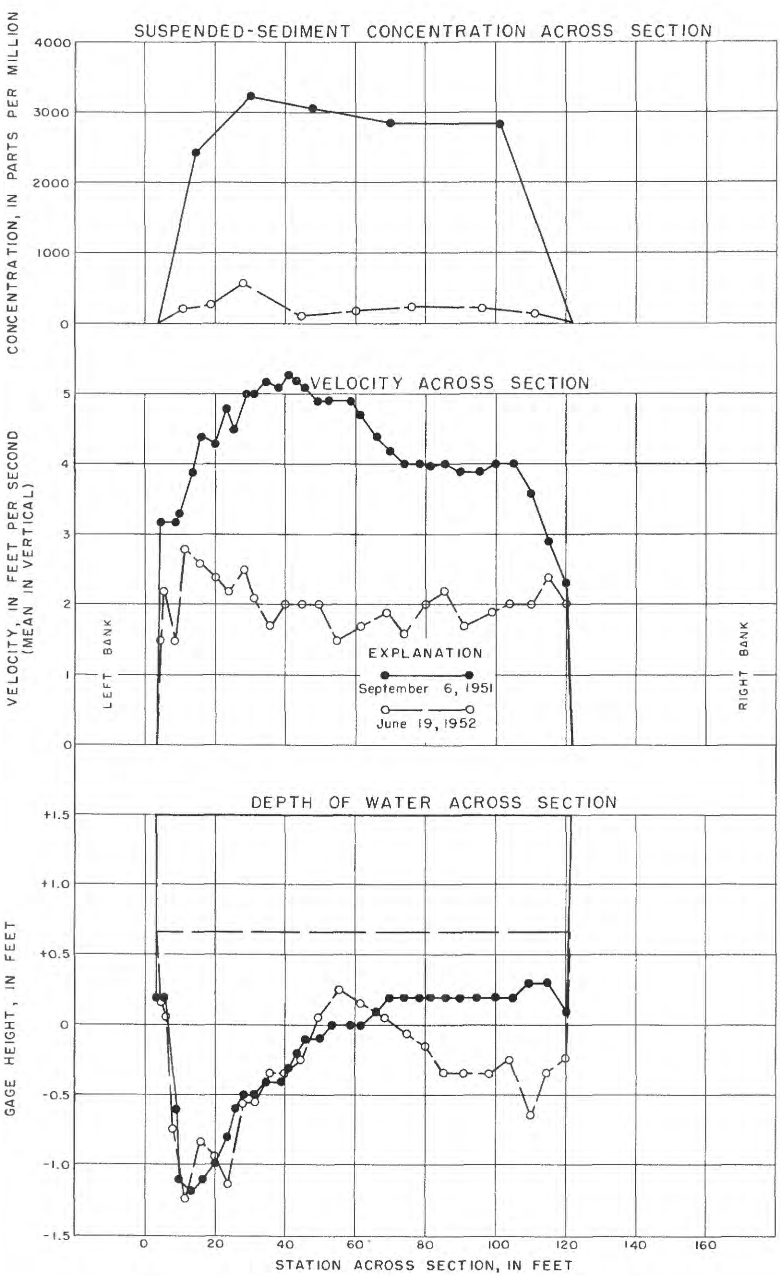


Figure 28.--Lateral distribution of depth, velocity, and concentration of suspended sediment, normal section C-2.

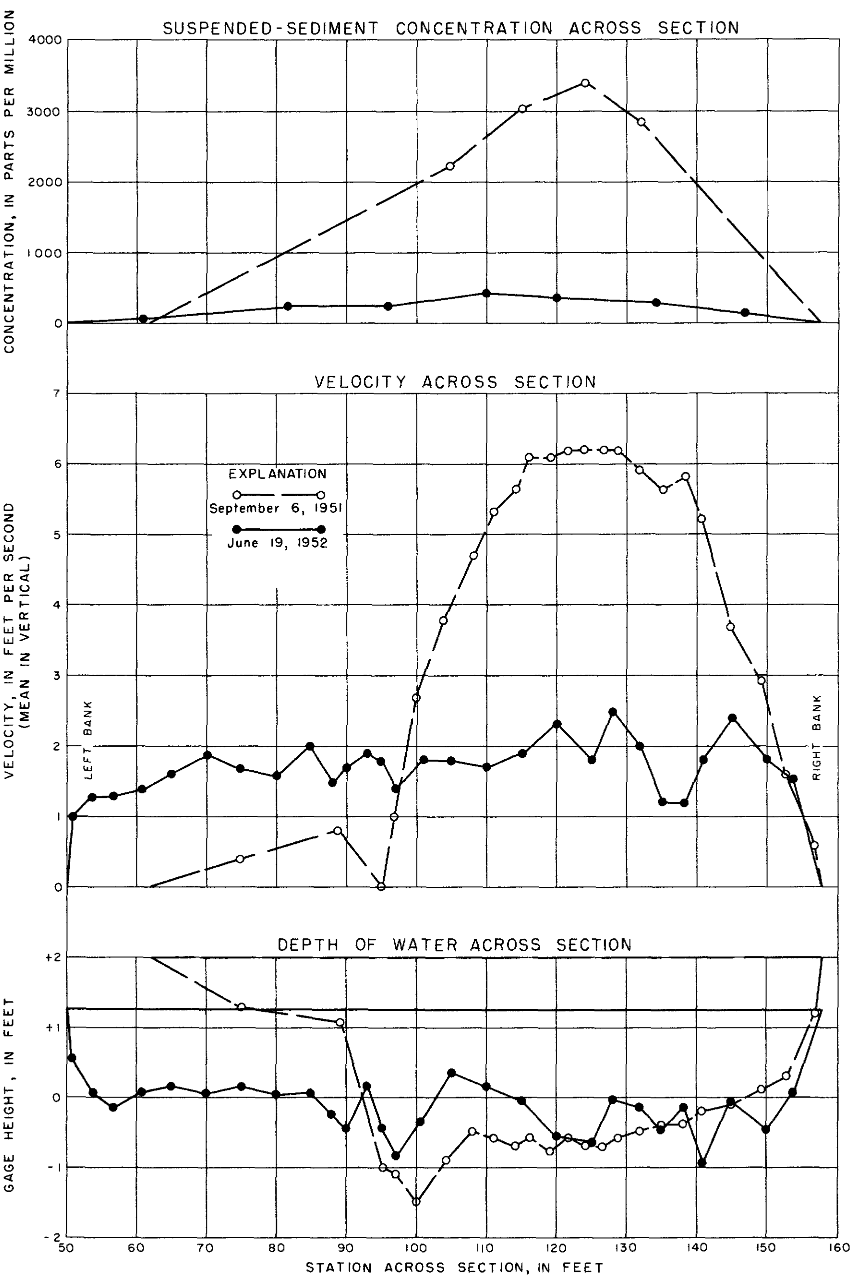


Figure 29.--Lateral distribution of depth, velocity, and concentration of suspended sediment, normal section C-6.

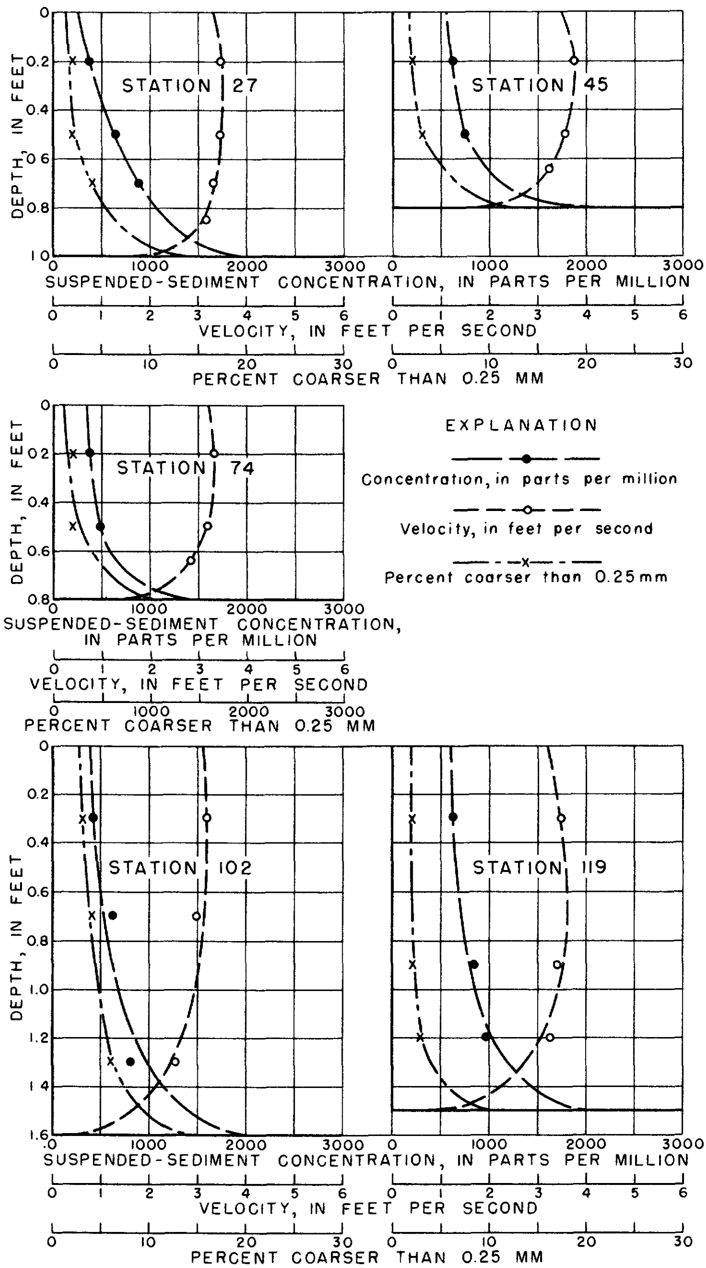


Figure 30.--Vertical distributions at section C-2, May 20, 1953.

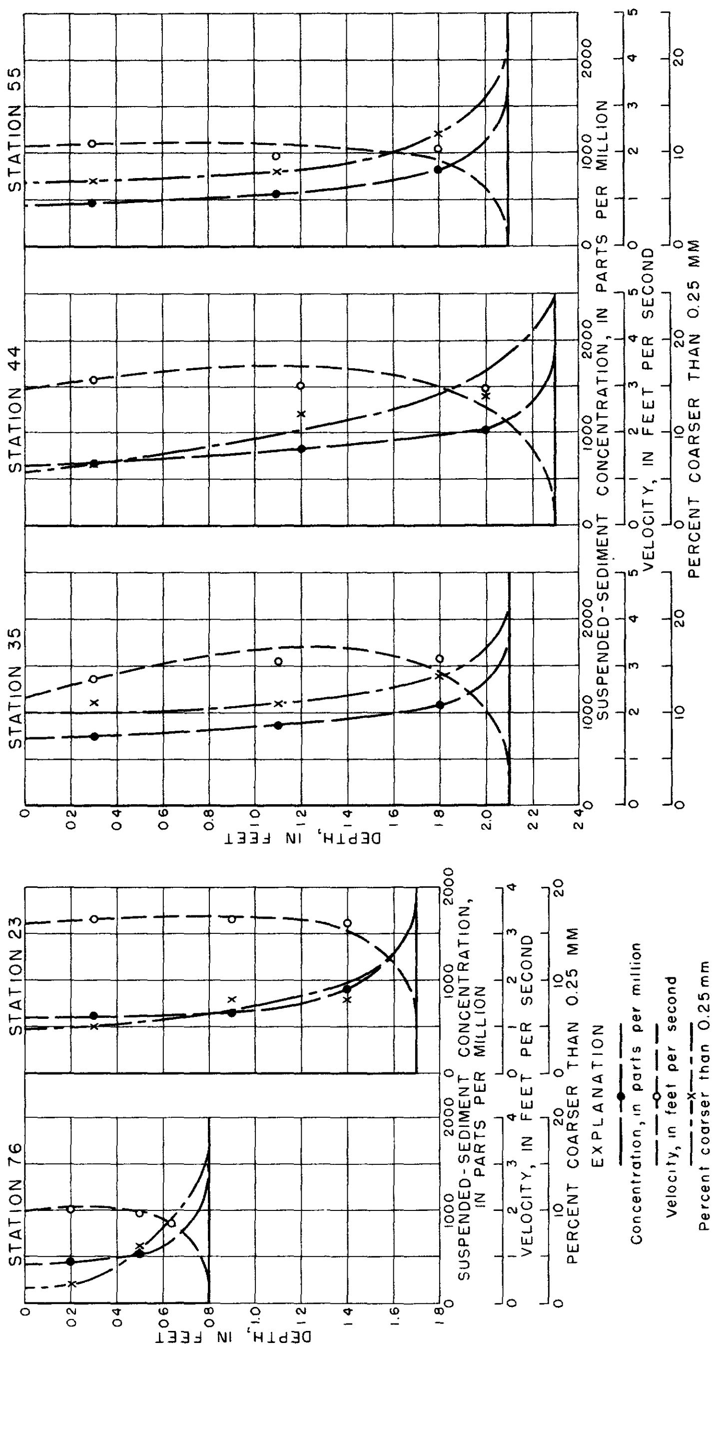


Figure 31.--Vertical distributions at section C-6, May 20, 1953.

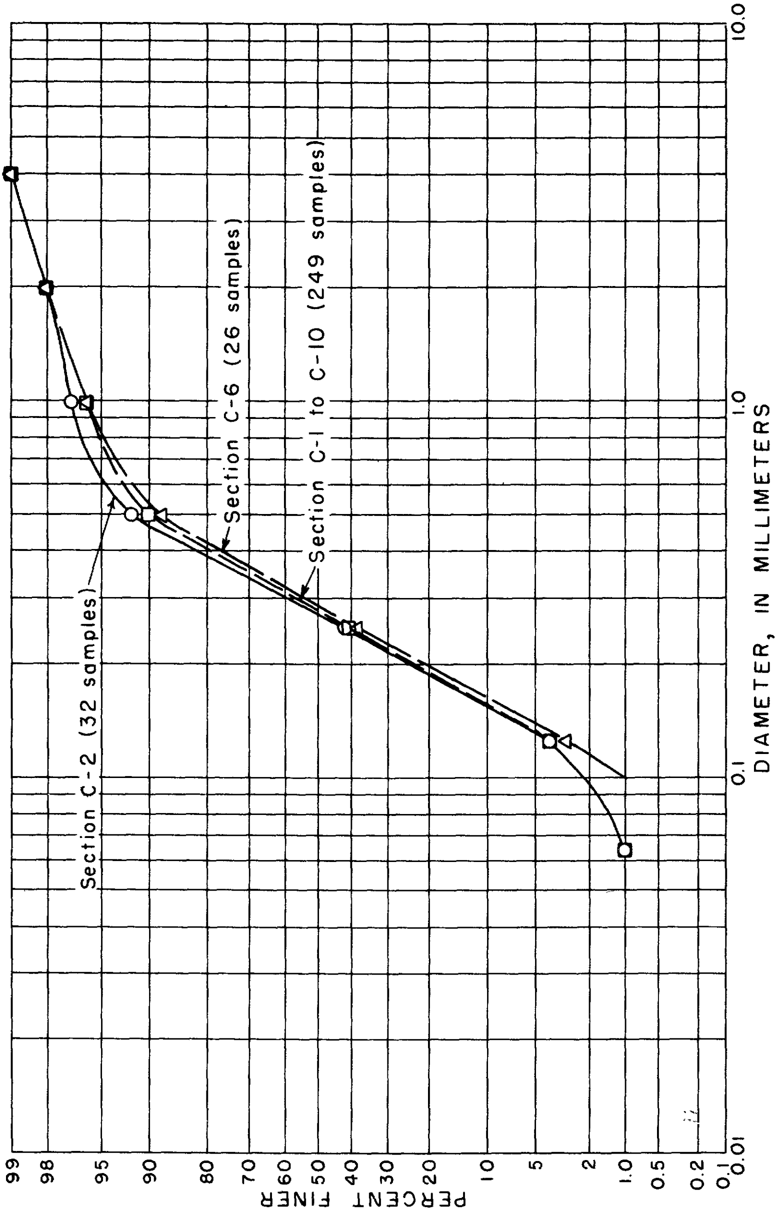


Figure 32.--Computed average analyses of bed-material samples at normal sections C-2, C-6, and C-1 to C-10.

Size analyses of the suspended sediments from depth-integrated and point-integrated samples, which were collected only at sections C-2 and C-6, are similar to the size analyses of suspended sediment at the gaging-station section (tables 7, 27, and 28). Most of the suspended sediment is in the sand sizes, much of it from 0.125 to 0.25 millimeter.

UNMEASURED SEDIMENT DISCHARGE

During this investigation, information on sediment and streamflow was obtained principally for determination of unmeasured sediment discharge or total sediment discharge. One method of studying the unmeasured sediment discharge is to compare the discharge of suspended sediment at the contracted section with that at normal sections. Another method of study is based on computations of total sediment discharge, or at least that part of the sediment discharge that is in the range of bed-material particle sizes, from formulas that can be applied to alluvial sections of a stream. This second method is more generally applicable, because a suitable contracted section in which total sediment discharge can be measured is not usually available. Of course, the measurements of suspended-sediment quantities and particle sizes at the contracted section near Cody provide useful checks on the applicability of the formulas that were used. The two general methods, as they were applied to the Niobrara River near Cody, will be discussed separately and in detail.

DIFFERENCES IN SUSPENDED-SEDIMENT DISCHARGE AT CONTRACTED AND AT NORMAL SECTIONS

Determinations of concentration and of suspended-sediment discharge have been made on many days at approximately comparable times at the contracted section and at a normal section (tables 2, 5, 9, and 29). After determinations that were based on samples at only one vertical were eliminated, 71 comparisons of concentrations were still available and are shown in table 30. For sections C-2 and C-6 as well as the gaging-station section, water discharges in table 30 are based on gage heights and rating curves at the water-stage recorder. In order to avoid the effect of small differences in water discharge, ratios of concentration at the normal section (C_{ns}) to concentration at the contracted section (C_{cs}) were compared rather than ratios of sediment discharge. These ratios of concentration averaged 0.53, 0.59, 0.36, and 0.42 for the gaging-station section, the ford section, section

Table 30.--Comparison of sediment discharge measurements at normal sections to sediment discharge measurements at the contracted section, Niobrara River near Cody

Date	Time	Gage height (feet)	Water discharge (cfs)	Concen-tration (ppm)	Sediment discharge (tons per day)	Time	Water discharge (cfs)	Concen-tration (ppm)	Sediment discharge (tons per day)	Concen-tration ratio 1/
	Ford section					Contracted section				
1948										
July 20...	6:00 p.m.	1.21	436	1,400	1,650	5:00 p.m.	452	1,800	2,200	0.78
Sept. 8...	6:52 p.m.	.91	234	410	259	11:00 a.m.	248	776	519	.53
Oct. 13...	3:05 p.m.	.98	268	538	389	4:00 p.m.	263	1,180	838	.46
	Gaging-station section					Contracted section				
1948										
July 20...	8:40 p.m.	1.24	452	1,370	1,670	5:00 p.m.	452	1,800	2,200	0.76
Sept. 8...	6:15 p.m.	.90	229	389	241	11:00 a.m.	248	776	519	.50
Oct. 13...	4:45 p.m.	.96	258	483	336	4:00 p.m.	263	1,180	838	.41
Nov. 3....	3:20 p.m.	1.06	308	564	469	2:20 p.m.	319	1,610	1,390	.35
1949										
Feb. 25...	10:30 a.m.	1.29	452	775	945	9:00 a.m.	458	954	1,180	.81
Mar. 8....	4:00 p.m.	1.76	732	1,970	3,890	2:15 p.m.	720	3,240	6,300	.61
July 13...	3:55 p.m.	.88	234	219	138	11:00 a.m.	263	970	689	.23
1950										
Mar. 3....	4:15 p.m.	1.13	392	1,060	1,120	11:25 a.m.	366	1,890	1,870	.56
Mar. 5....	9:25 a.m.	1.16	408	1,550	1,710	1:15 p.m.	408	2,140	2,360	.72
Apr. 14...	11:25 a.m.	1.14	398	813	874	1:00 p.m.	387	1,770	1,850	.46
May 11....	11:40 a.m.	1.36	566	1,040	1,590	1:20 p.m.	549	2,660	3,940	.39
June 7....	10:45 a.m.	.92	258	421	293	11:05 a.m.	253	890	608	.47

June 13...	1:40 p.m.	.85	224	366	221	10:30 a.m.	234	790	499	.46
July 9....	3:25 p.m.	.85	234	484	306	6:15 p.m.	234	670	423	.72
Aug. 2....	9:25 a.m.	.97	268	457	331	10:15 a.m.	253	1,000	683	.46
Aug. 30...	8:30 a.m.	1.09	376	956	971	9:40 a.m.	366	1,780	1,760	.54
Sept. 20..	12:10 p.m.	1.00	324	711	622	12:55 p.m.	319	1,490	1,280	.48
Oct. 6....	9:10 a.m.	.98	302	655	534	9:40 a.m.	298	1,020	823	.64
Nov. 2....	12:00 m.	1.00	310	683	572	12:45 p.m.	310	1,480	1,240	.46
1951										
Jan. 25...	10:20 a.m.	.90	310	880	737	10:40 a.m.	306	1,340	1,110	.66
Mar. 7....	1:00 p.m.	1.06	385	1,870	1,940	1:40 p.m.	385	2,340	2,440	.80
Mar. 15...	9:40 a.m.	1.15	430	1,220	1,420	10:20 a.m.	440	1,780	2,120	.69
Mar. 21...	11:00 a.m.	.90	310	1,020	854	12:06 p.m.	328	1,540	1,370	.66
Apr. 27...	11:45 a.m.	1.17	440	874	1,040	8:40 a.m.	455	1,900	2,340	.46
May 10....	10:15 a.m.	.93	314	558	473	10:50 a.m.	310	1,580	1,330	.35
May 24....	10:20 a.m.	1.13	410	782	866	8:35 a.m.	430	2,060	2,390	.38
June 15...	10:40 a.m.	.94	319	516	444	9:40 a.m.	342	1,340	1,240	.39
July 18...	11:00 a.m.	.97	298	470	378	9:40 a.m.	310	1,200	1,010	.39
July 29...	8:12 a.m.	5.77	3,760	5,520	56,000	7:50 a.m.	3,630	4,160	40,800	1.33
Aug. 2....	6:40 p.m.	1.12	324	742	649	6:20 p.m.	342	1,840	1,700	.40
Oct. 24...	11:00 a.m.	1.06	324	572	500	11:40 a.m.	319	1,590	1,370	.36
Nov. 15...	8:50 a.m.	1.09	324	955	835	9:20 a.m.	324	1,710	1,500	.56
1952										
Jan. 9....	2:00 p.m.	.99	298	294	237	11:00 a.m.	324	642	562	.46
Jan. 29...	3:50 p.m.	.98	332	432	387	1:00 p.m.	350	893	844	.48
Feb. 12...	9:20 a.m.	1.13	405	1,180	1,290	10:20 a.m.	405	1,820	1,990	.65
Mar. 11...	12:50 p.m.	1.15	415	1,010	1,130	11:40 a.m.	415	2,210	2,480	.46
Apr. 10...	12:20 p.m.	1.18	430	1,080	1,250	2:00 p.m.	420	2,120	2,400	.51

See footnotes at end of table.

Table 30.--Comparison of sediment discharge measurements at normal sections to sediment discharge measurements at the contracted section, Niobrara River near Cody--Continued

Date	Time	Gage height (feet)	Water discharge (cfs)	Concen-tration (ppm)	Sediment discharge (tons per day)	Time	Water discharge (cfs)	Concen-tration (ppm)	Sediment discharge (tons per day)	Concen-tration ratio 1/
	Gaging-station section--Continued					Contracted section--Continued				
1952--Con.										
May 8.....	10:45 a.m.	1.19	435	862	1,010	5:15 p.m.	400	1,700	1,840	0.51
May 24....	1:20 p.m.	1.23	455	890	1,090	12:30 p.m.	460	2,750	3,420	.32
June 5....	12:05 p.m.	1.04	306	514	425	3:05 p.m.	262	1,200	849	.43
June 19...	11:35 a.m.	.78	230	458	284	11:00 a.m.	234	754	476	.61
July 4....	10:10 a.m.	.90	278	462	347	11:50 a.m.	262	934	661	.49
July 20...	11:10 a.m.	.75	219	246	145	8:40 a.m.	223	503	303	.49
July 31...	1:45 p.m.	.73	212	204	117	3:40 p.m.	212	392	224	.52
Aug. 16...	10:05 a.m.	.84	254	394	270	7:45 a.m.	262	820	580	.48
Aug. 29...	11:00 a.m.	.74	208	245	138	11:05 a.m.	208	429	241	.57
Sept. 12..	9:30 a.m.	.73	223	282	170	8:30 a.m.	223	454	273	.62
Sept. 26..	11:10 a.m.	.81	234	346	219	12:00 m.	234	736	465	.47
Oct. 11...	9:55 a.m.	.94	294	446	354	10:35 a.m.	290	1,220	955	.37
Oct. 23...	12:35 p.m.	.92	286	482	372	10:20 a.m.	286	1,500	1,160	.32
Dec. 11...	2:00 p.m.	1.00	328	866	767	11:30 a.m.	328	1,520	1,350	.57
1953										
Jan. 9....	1:00 p.m.	.90	294	1,020	810	1:55 p.m.	298	1,660	1,340	.61
Feb. 3....	1:15 p.m.	1.13	400	1,080	1,170	9:40 a.m.	405	2,220	2,430	.48
Mar. 11...	9:20 a.m.	1.36	538	1,290	1,870	8:05 a.m.	532	2,060	2,960	.63
Apr. 22...	10:10 a.m.	1.08	365	605	596	8:45 a.m.	370	1,400	1,400	.43
July 8....	5:30 p.m.	.90	278	471	354	3:20 p.m.	278	792	594	.60

	Normal section C-2					Contracted section				
1951										
June 15...	12:10 p.m.	0.88	294	345	274	9:40 a.m.	342	1,340	1,240	0.26
July 18...	1:30 p.m.	.92	278	433	325	9:40 a.m.	310	1,200	1,010	.36
1952										
May 8.....	11:00 a.m.	1.18	430	752	870	5:15 p.m.	400	1,700	1,840	.44
June 19...	12:10 p.m.	.78	230	262	160	11:00 a.m.	234	754	476	.35
Sept. 26..	5:50 p.m.	.77	219	255	150	12:00 m.	234	736	465	.35
1953										
May 20....	11:50 a.m.	1.12	2/ 350	596	563	9:35 a.m.	355	1,560	1,500	.38
	Normal section C-6					Contracted section				
1951										
June 15...	1:20 p.m.	0.86	286	362	280	9:40 a.m.	342	1,340	1,240	0.27
July 18...	12:30 p.m.	.96	294	317	252	9:40 a.m.	310	1,200	1,010	.26
1952										
May 8.....	2:50 p.m.	1.13	405	874	960	5:15 p.m.	400	1,700	1,840	.51
June 19...	12:10 p.m.	.77	226	294	179	11:00 a.m.	234	754	476	.39
Sept. 26..	2:45 p.m.	.79	226	504	308	12:00 m.	234	736	465	.68
1953										
May 20....	3:05 p.m.	1.03	2/ 310	685	573	9:35 a.m.	355	1,560	1,500	.44

1 Ratio of the concentration at a relatively unconfined section to the concentration at the contracted section.

2 Water discharge based on only 16 measured verticals.

C-2, and section C-6, respectively. The total range was 0.23 to 1.33, and the overall average was 0.51. These ratios are closely equivalent to the corresponding ratios of sediment discharge and are referred to as ratios of sediment discharge in other parts of the report. The ratios are subject to large experimental errors that either are inherent in measurements of suspended-sediment discharge, are due to scour or deposition between the sections at the times of measurement, or are caused by not measuring concentration at comparable times. Probably these ratios tend to be slightly too large, because at least a small fraction of the total sediment discharge of the stream was not measured by depth-integrated sampling at the contracted section.

The ratio of measured sediment discharge at a normal section to total sediment discharge of the river might be expected to vary with streamflow, with sediment discharge, or with water temperature. Figures 33 and 34 show poorly defined relationships, but the ratios from table 30 do seem to increase somewhat with either increasing streamflow or increasing sediment discharge. The ratio must increase appreciably at very high rates of streamflow for which depths and velocities are much greater and particle sizes average much smaller than at normal and low flows. The computed ratios decrease somewhat with increasing water temperature (fig. 35). This apparent decrease with water temperature may be partly explained by the seasonal pattern of streamflow and water temperature.

Though the size distribution of the sediment that is discharged as unmeasured load at a normal section may not be the same as the size distribution of the bed material, the 2 size distributions should be similar for a stream such as the Niobrara River in which the bed material is mostly sand finer than 1.0 millimeter. Table 31 shows the comparison of the average size distributions of the sediment. The size distribution of the unmeasured sediment discharge at the gaging-station section was computed from the equation $P_c = 0.53\ P_n + 0.47\ P_u$ in which P_c, P_n, and P_u are the percentages finer than any given size at the contracted section, the gaging-station section, and in the unmeasured load at the gaging-station section, respectively. Computations of P_u were made from average particle sizes, not weighted with water discharge, for each of the 6 water years. The bed-material size distribution in table 31 and the ratio, 0.53, of measured sediment discharge at the gaging-station section to sediment discharge at the contracted section are averages for the entire period of record.

In spite of the indirect nature of the computations and the fact that all the suspended-sediment size distributions were used instead of only the sizes that were determined at comparable times,

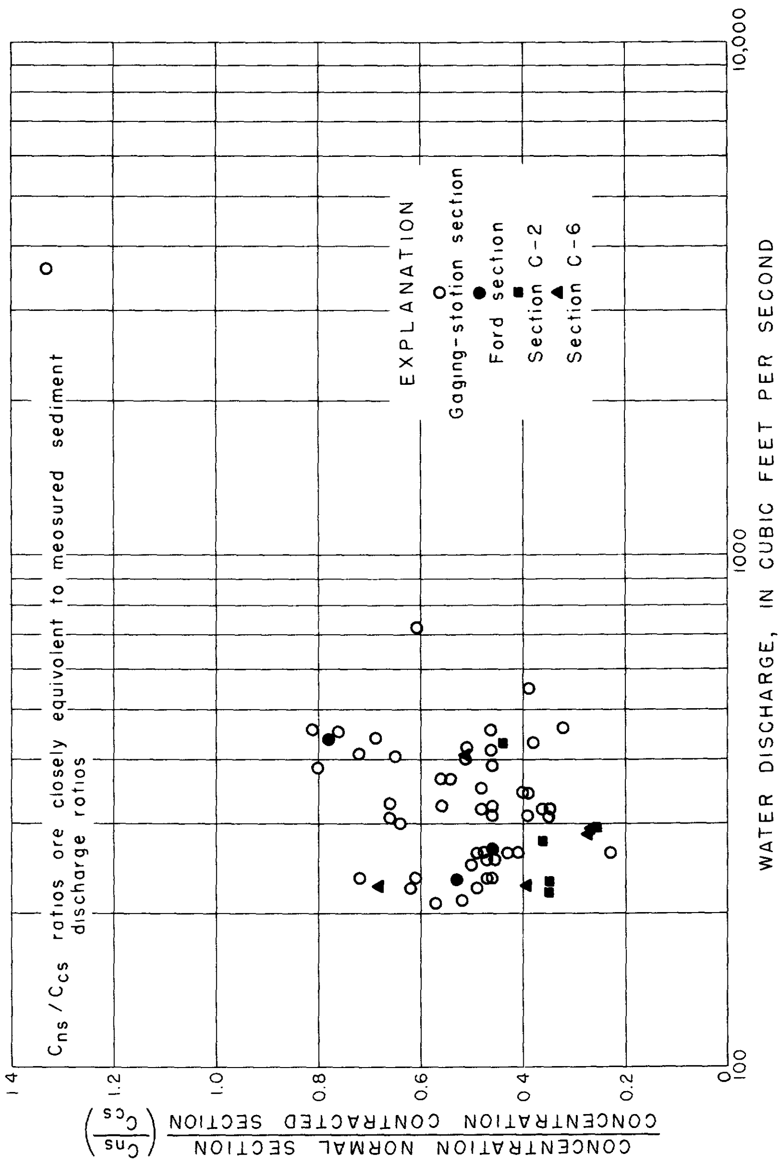


Figure 33.--Ratio of measured sediment discharge at a normal section to sediment discharge at the contracted section plotted against water discharge.

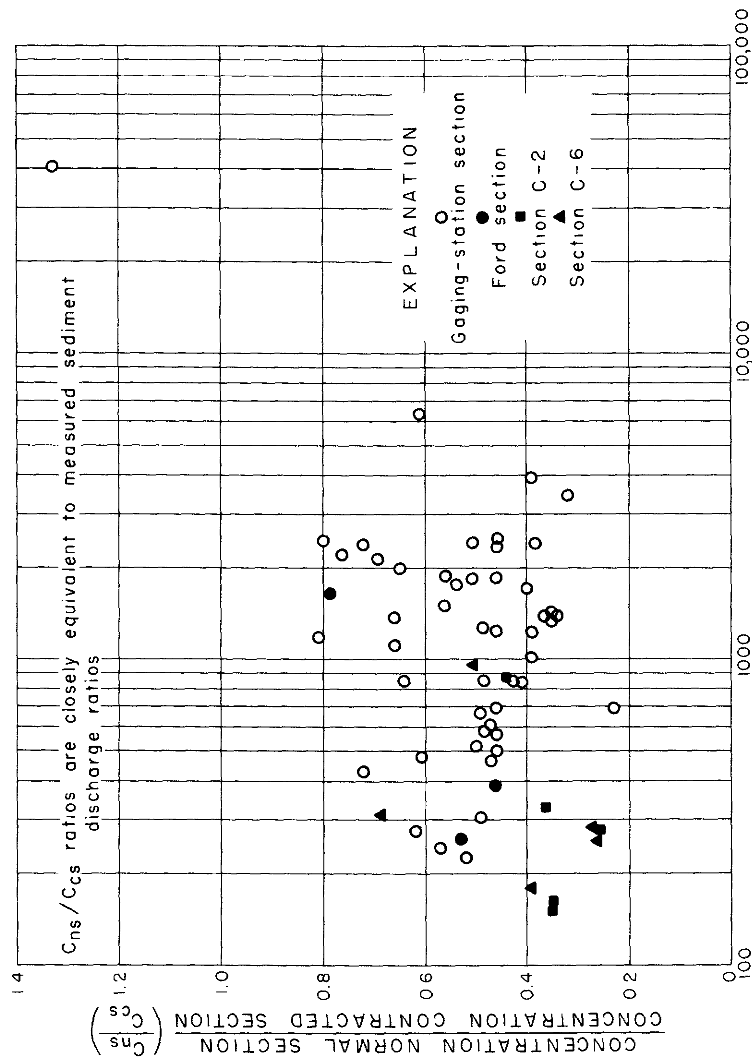


Figure 34.--Ratio of measured sediment discharge at a normal section to sediment discharge at the contracted section plotted against sediment discharge at the contracted section.

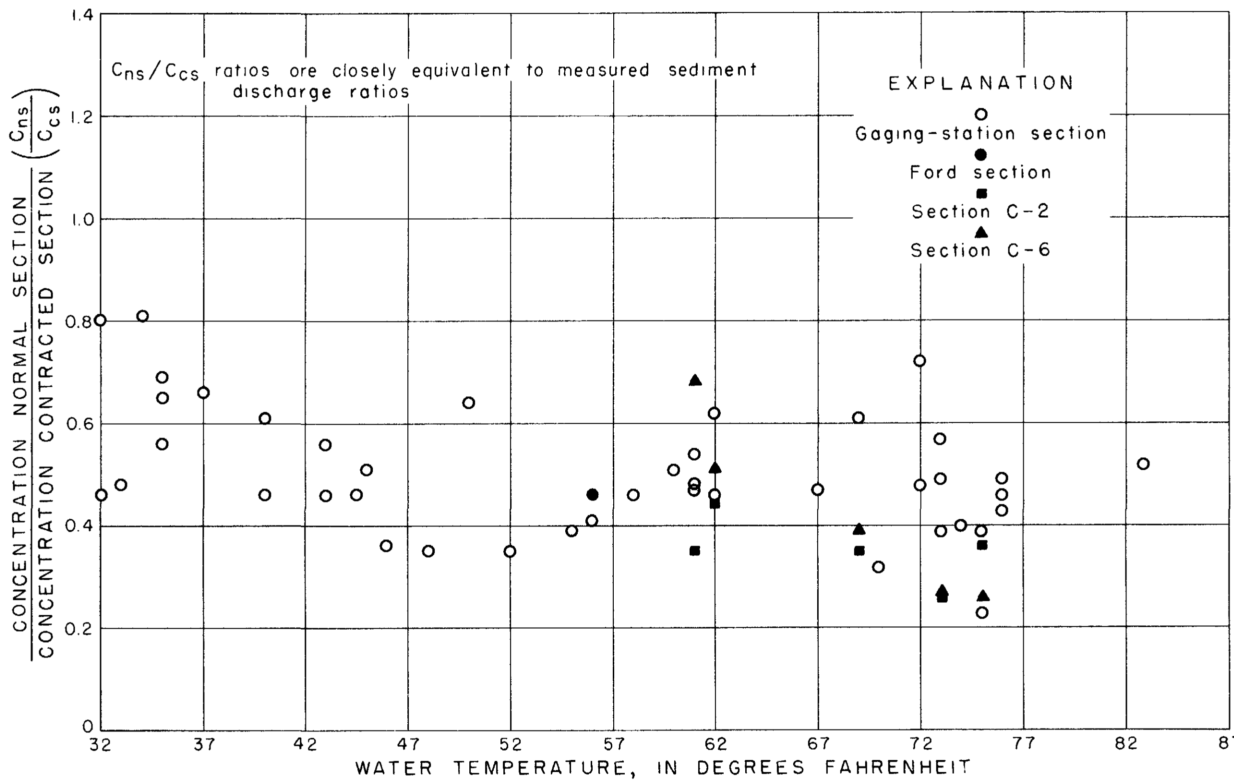


Figure 35.--Ratio of measured sediment discharge at a normal section to sediment discharge at the contracted section plotted against water temperature.

Table 31.--Average particle size of sediments of the Niobrara River near Cody

	Percent finer than indicated size		
	0.125 mm	0.25 mm	0.5 mm
1948 water year			
Suspended sediment at gaging-station section...........	47	87	97
Suspended sediment at contracted section................	35	72	94
Unmeasured sediment discharge at gaging-station section.	21	55	91
Bed material at gaging-station section..................	4	42	91
1949 water year			
Suspended sediment at gaging-station section...........	39	86	98
Suspended sediment at contracted section................	21	64	92
Unmeasured sediment discharge at gaging-station section.	2	39	85
Bed material at gaging-station section..................	4	42	91
1950 water year			
Suspended sediment at gaging-station section...........	54	92	99
Suspended sediment at contracted section................	32	71	96
Unmeasured sediment discharge at gaging-station section.	6	47	92
Bed material at gaging-station section..................	4	42	91
1951 water year			
Suspended sediment at gaging-station section...........	59	94	99.8
Suspended sediment at contracted section................	43	79	97
Unmeasured sediment discharge at gaging-station section.	25	62	94
Bed material at gaging-station section..................	4	42	91
1952 water year			
Suspended sediment at gaging-station section...........	53	92	99.8
Suspended sediment at contracted section................	28	69	97
Unmeasured sediment discharge at gaging-station section.	0	43	94
Bed material at gaging-station section..................	4	42	91
1953 water year			
Suspended sediment at gaging-station section...........	53	94	100
Suspended sediment at contracted section................	30	68	96
Unmeasured sediment discharge at gaging-station section.	4	39	91
Bed material at gaging-station section..................	4	42	91

the computed size distributions in the unmeasured sediment discharge for the water years 1949, 1950, 1952, and 1953 check well with the size distribution of the bed material. In the 1948 water year only two size analyses were available for the contracted section, and this paucity of samples may have caused the divergence between the size distributions for 1948 (table 31). During 1951 several samples from periods or following periods of relatively high flow were analyzed for size. The averaging of particle sizes of these samples with those of other samples for 1951 may account for the somewhat discordant results for that year. During these periods of high flow the bed material may have been appreciably finer than average. (See fig. 23.) Of course, the sizes of the unmeasured sediment discharge should be a little finer than the bed material because the unmeasured sediment discharge includes some suspended sediment and also the finer particles from the bed should go into suspension more frequently than the coarser particles.

COMPUTATIONS OF SEDIMENT DISCHARGE FROM FORMULAS

On most streams no suitable contracted section is available at which all or nearly all the sediment discharge can be measured. Hence, the total sediment discharge of a stream, or at least the unmeasured sediment discharge, can be determined only from computations that are based on those characteristics of flow and sediment discharge that can be measured at alluvial or moderately confined sections. Several basic formulas and procedures have been suggested for the computation of the part of the sediment discharge that consists of particle sizes that are in the stream bed in appreciable amounts. A form of each of four different formulas was used to compute some sediment discharges of the Niobrara River near Cody.

THE SCHOKLITSCH FORMULA

A formula for computing the discharge of bed material has been presented by Shulits (1935, p. 644-646, 687). It was developed by Schoklitsch from flume experiments in which the bed material was nearly uniform quartz particles. Presumably it should give the total discharge of particles of sizes large enough to be present in the bed in appreciable quantity.

The Schoklitsch formula is

$$G = \frac{86.7}{D_{50}^{1/2}} S_e^{1.5} (Q - 0.00532 \frac{wD_{50}}{S_e^{4/3}})$$

in which G = discharge of bed material, in pounds per second
D_{50} = median diameter of the particles, in inches
S_e = slope of the energy gradient
w = width of the stream, in feet
Q = water discharge, in cubic feet per second

Sediment discharges computed from this formula and multiplied by 43.2 to convert to tons per day are listed in table 32 for comparison with measured discharge at the contracted section of particles larger than 0.125 millimeter. The bed material at the normal sections contains only a small amount of sediment of sizes smaller than 0.125 millimeter. Computed tonnages of sediment from the Schoklitsch formula are plotted against the measured sediment discharges in figure 36. At low discharges of sediment, the measured and computed tonnages agree fairly well; but at higher sediment discharges, the computed tonnages are much lower than the measured tonnages. If the computed sediment discharges are squared and then divided by 280, the agreement with measured discharges becomes good. Of course, this is an arbitrary adjustment that is probably not generally applicable.

The measured sediment discharges in table 32 are for sediment larger than 0.125 millimeter and are measured only in the sense that they are based, but not always directly, on samples at the contracted section and on streamflow at the gaging station. That is, the measurements at the contracted section were not correctly timed to be comparable with determinations of streamflow and water-surface slopes at the normal sections. Hence the measured sediment discharges include possible inaccuracies in adjustments for changes in concentration at the contracted section and for changes in and time of travel of water discharges. (See p. 97 for a more complete description of adjustments to obtain measured sediment discharges for comparison.) On days like September 6, 1951, and September 26, 1952, the sediment discharge at the contracted section changed so much during the day that it may have been a poor basis for comparison with computed sediment discharges for normal sections.

Table 32.--Comparison of computed bed-material discharge from three formulas with measured sediment discharge at the contracted section

Date	Discharge (tons per day)			
	Measured sediment larger than 0.125 mm	Computed		
	Contracted section	From the Schoklitsch formula	From $\frac{40{,}000w}{D_{50}^{3/4}}(dS_e)^2$	From the Straub formula
		Gaging-station section		
1950				
Mar. 3....	1,250	667	2,360	6,360
1951				
May 10....	1,020	634	1,490	3,880
1952				
Sept. 26..	358	296	1,030	2,590
		Section C-2		
1951				
June 15...	767	454	994	2,750
July 18...	702	429	1,340	3,250
Aug. 3....	1,030	453	1,280	4,790
Sept. 6...	4,950	1,260	2,250	6,010
1952				
Apr. 1....	5,040	1,140	1,980	5,160
May 8.....	1,440	649	1,510	4,300
June 19...	352	375	1,010	2,640
Sept. 26..	285	349	896	3,270
		Section C-6		
1951				
July 18...	750	379	1,110	2,750
Aug. 3....	1,080	534	1,220	3,660
Sept. 6...	3,840	1,000	1,360	6,800
1952				
May 8.....	1,330	517	1,980	5,110
June 19...	345	293	1,220	2,960
Sept. 26..	331	274	782	3,070

THE DU BOYS FORMULA

Several modifications of the general Du Boys formula have been suggested for computing sediment discharge of particle sizes that are large enough to be in the bed in appreciable quantities.

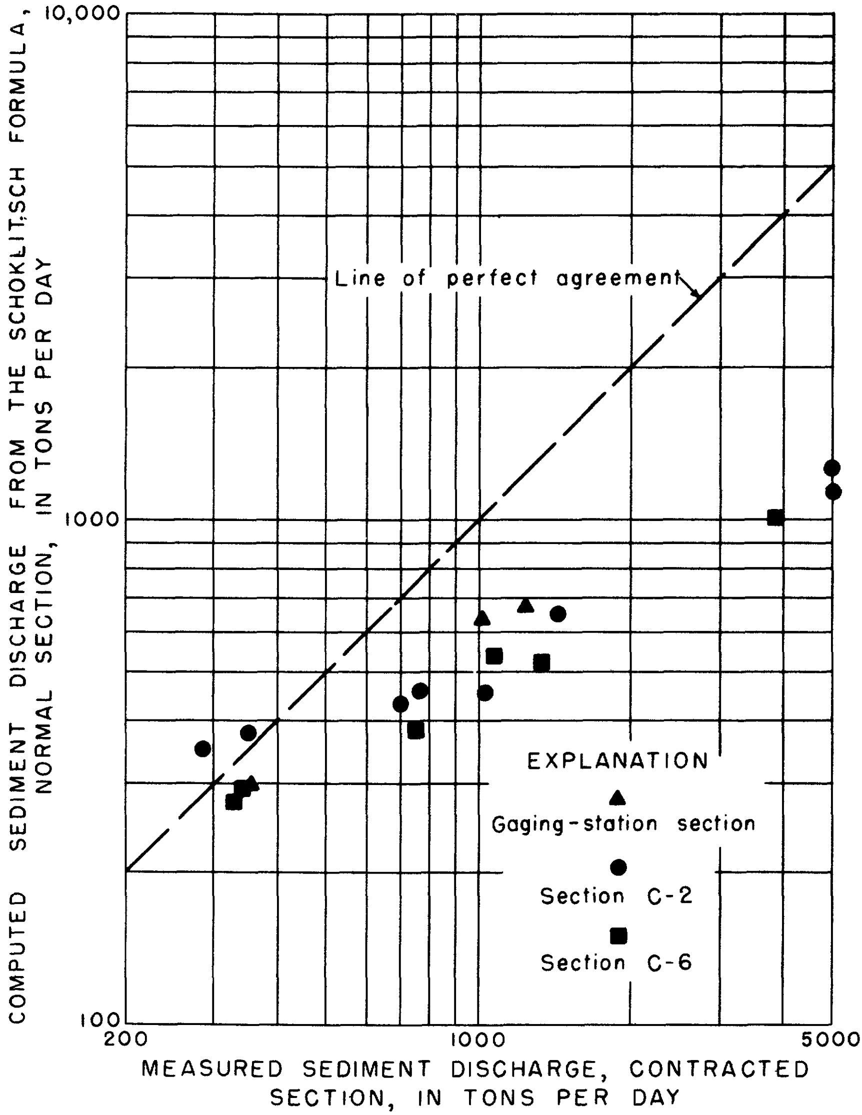


Figure 36.--Comparison of computed sediment discharge from the Schoklitsch formula at a normal section to measured sediment discharge of particles larger than 0.125 mm at the contracted section.

A simplified form has been used in this report. It is

$$q_{BM} = \frac{K_1}{D_{50}^{3/4}} (d\,S_e)^2$$

and

$$Q_{BM} = 43.2\ w\ q_{BM}$$

$$= \frac{K_2}{D_{50}^{3/4}} (d\,S_e)^2\ w$$

in which q_{BM} is discharge of bed material, in pounds per second per foot of width

K_1 is a constant to be defined

D_{50} is median particle diameter of the bed material, in millimeters

d is average depth, in feet

S_e is hydraulic slope

Q_{BM} is discharge of bed material, in tons per day

43.2 is the constant to convert pounds per second to tons per day

w is width of stream, in feet

$K_2 = 43.2\ K_1$

This simplified form of the equation implies that $1 - (\tau_o/\tau)$ is a constant and is included in K_1; τ is the transporting force, and τ_o is the particular transporting force that is required to start movement of the bed material. Actually $1 - (\tau_o/\tau)$ varies less than 10 percent from its average for the range of computations that were made.

To determine K_2, sediment discharges were computed from this formula and an assumed K_2. Then, measured sediment discharges for particles larger than 0.125 millimeter were computed from total measured sediment discharges and size distributions for the contracted section. They were divided by the width of the river at the normal section to get sediment discharge per foot of width. The measured sediment discharges so obtained were totaled, and the sum was divided by the sum of the sediment discharges that were computed from the equation and the assumed K_2. The quotient multiplied by the assumed K_2 indicated that K_2 should average about 40,000. The equation for total sediment discharge, in tons per day, of the size fractions larger than 0.125 millimeter thus became

$$Q_{BM} = \frac{40{,}000}{D_{50}^{3/4}} (d\,S_e)^2\ w$$

Sediment discharges computed from this equation are listed in table 32 and are plotted on figure 37 against the comparable measured sediment discharges at the contracted section. The comparison shows that a lower numerical value for K_2 would have given much better agreement except for three times of relatively high sediment and water discharge. K_2 should have been much larger to obtain agreement between measured and computed sediment discharge for these three times. Sediment discharges computed from this formula were not satisfactorily accurate. They, like the sediment discharges that were computed from the Schoklitsch formula, increased too slowly with increasing water discharge.

THE STRAUB FORMULA

Straub (Cong. Doc., 1935, p. 1135) shows a formula for the computation of sediment discharge that seems to have been intended to compute only the discharge of the sediment that moves near the bed. This formula is a modification of the DuBoys formula and has been used in the form

$$Q_{BM} = 43.2\, \Theta\, S_e^2\, wd\,(d - d_o)$$

in which Q_{BM} is the sediment discharge, in tons per day
43.2 is the constant for converting pounds per second to tons per day
Θ is a sediment characteristic constant equivalent to Straub's Ψ, in pounds per cubic foot per second, from a curve drawn through data given by Straub (Cong. Doc., 1935, p. 1135)
S_e is the energy gradient, but the slope of the water surface was used as an approximation
w is the width of the channel cross section, in feet
d is the depth of water, in feet
d_o is the depth, in feet, at which the tractive force is just great enough to start moving sediment along the bed and is computed from a table given by Straub (Cong. Doc., 1935, p. 1135) for the tractive force required to start the bed sediment in motion

Each cross section was divided into 20 to 30 subareas, and the sediment discharge was in effect computed for each by summing up $wd(d - d_o)$ for all the subareas. The work was checked roughly by substituting average depth for d and making one computation for the entire cross section.

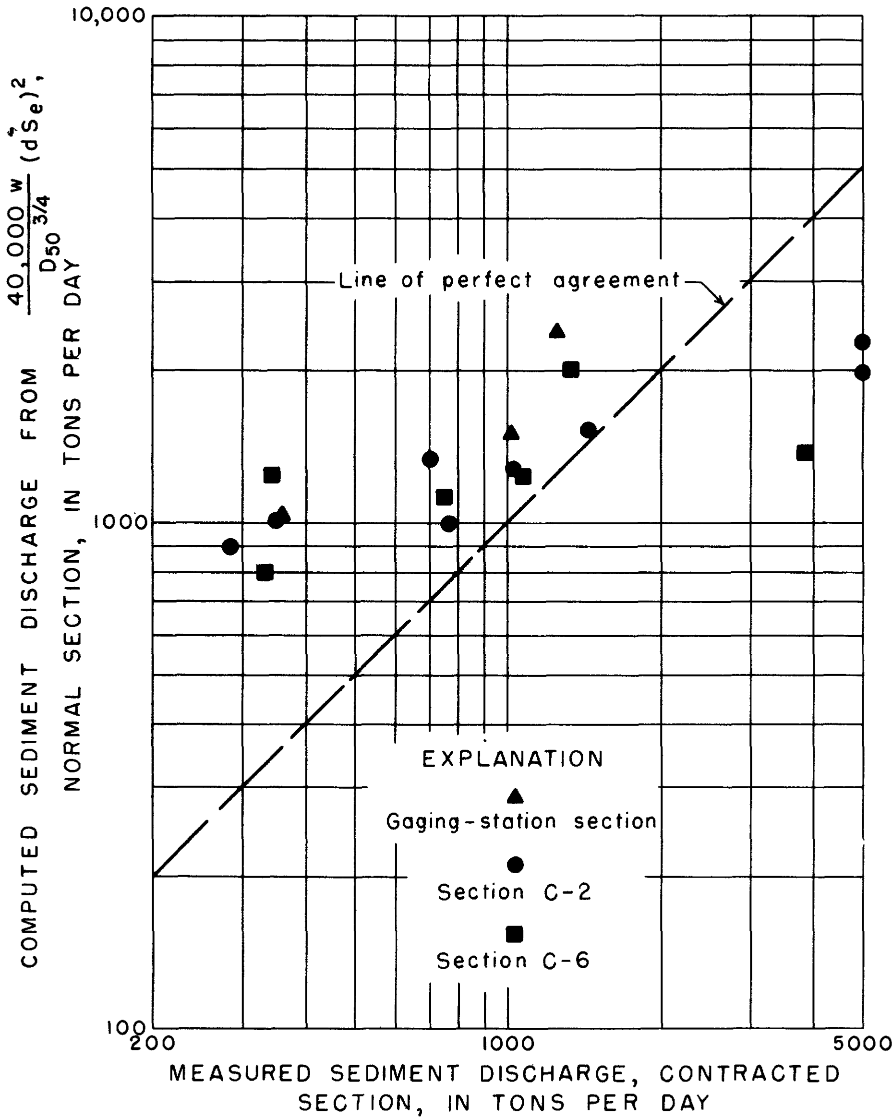


Figure 37.--Comparison of computed sediment discharge from a form of the Du Boys formula at a normal section to measured sediment discharge at the contracted section. (Sediment discharge is for particles larger than 0.125 mm.)

Seventeen computations were made with the Straub formula. Even when compared with measured discharge at the contracted section of sediment coarser than 0.125 millimeter, the sediment discharges computed from the Straub formula are much too large, particularly when the measured sediment discharge is small. (See table 32 and fig. 38.) The trend of the computed discharges seems to indicate that the formula may apply much better to larger streams.

THE EINSTEIN PROCEDURE

H. A. Einstein (1950) has developed and outlined a complex procedure, which required several formulas and graphs, for computing sediment discharge in the size ranges that are found in significant quantity in the stream bed. His procedure for computing discharge of suspended sediment is based on integration of the product of the theoretical velocity and suspended-sediment concentration along a representative vertical in the cross section. The bottom of the curve of suspended-sediment concentration is equated to the computed concentration of sediment in the bed-load layer, which is assumed to be 2 grain diameters thick. The rate of movement and the concentration in the bed-load layer are based on dimensionless expressions for the probability that a given particle will move from its position in the stream bed. The discharge of each of several size ranges of the sediment that forms the stream bed is computed separately.

His procedure was developed for use when the only data available would be an average cross section of a reach of channel, a slope through the reach, and an average particle-size distribution of the bed material. These base data are not easily obtained for a given time and reach. The water-surface slope requires essentially simultaneous gage readings on two or more gages that are referred to the same datum. At the time of the gage readings a representative cross section throughout the reach should be defined. The representative cross section should be based on several measured cross sections that are averaged. Einstein suggests averaging the areas of the cross sections and also averaging their wetted perimeters to obtain the representative cross section. Bed-material samples are required in sufficient number to determine a good average size analysis of the bed material throughout the reach at the time for which the computation is to be made.

The Einstein procedure does not compute the suspended-sediment discharge of particles too small to be in the stream bed in appreciable quantities. Therefore, the discharge of the finer particles must be measured if total sediment discharge of

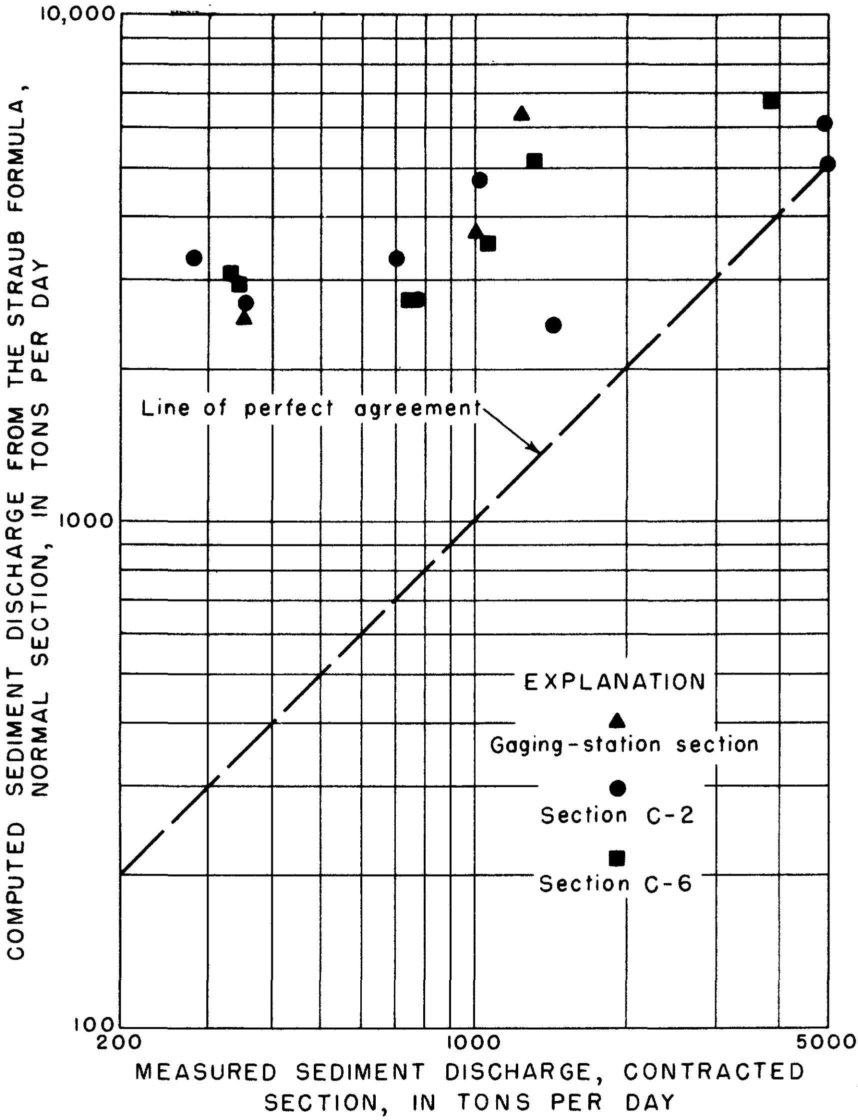


Figure 38.--Comparison of computed sediment discharge from the Straub formula at a normal section to measured sediment discharge of particles larger than 0.125 mm at the contracted section.

a stream is to be computed. In some manner the measured discharge of sediment of the finer sizes must be combined with the computed discharges of the coarser sediments. A completely satisfactory method of combining the two is not known to the writers.

Sediment-discharge computations, nearly all by the Bureau of Reclamation, have been made for 8 days during 1951 and 1952 by applying the Einstein procedure to data from sections C-1 to C-10. Although the procedure was developed and was carefully restricted by Einstein to an average section in a reach of a stream, it has been applied to section C-2 for the same 8 days and to the gaging-station section for 2 days. These Einstein-type computations for individual cross sections were made mostly by the Bureau of Reclamation for comparison of relative accuracy with computations that were made for a single section by a modified method. Of course, the use of a single section requires so much less work than the use of a reach that it is much more economical provided suitable accuracy can be obtained at the single section. Tonnages computed by the Einstein procedure for several size ranges are listed in table 33 both for the reach and for section C-2. For comparison, sediment discharges at the contracted section are also listed for the same days. For some of the days, the breakdown for the contracted section into tonnages by size ranges was based on size analyses of samples for other days. (See table 33.) Computed sediment discharges by size ranges compare very poorly with the sediment discharges at the contracted section. The computed size distributions (table 33) indicate that the Einstein procedure gives median particle sizes that become larger as the total sediment discharge decreases. In other words, in proportion to their availability in the stream bed, the smaller sand particles move less readily compared to the larger particles as the water discharge decreases. Such a relationship seems illogical.

Sediment discharges of particles larger than 0.125 millimeter are given in table 33 for the Einstein procedure and for the contracted section. The computed discharges of sediment larger than 0.125 millimeter for the reach from sections C-1 to C-10 ranged from 63 to 272 percent and averaged 132 percent of the discharge of sediment larger than 0.125 millimeter at the contraction. The larger percentages tend to accompany the larger sediment discharges at the contracted section. For the same range of particle sizes, the sediment discharges computed for section C-2 ranged from 14 to 1,091 percent and averaged 498 percent.

The discharge of sediment of all sizes was obtained by adding the discharge that was computed by the Einstein procedure for particles larger than 0.125 millimeter to the discharge at the

Table 33.--Comparison of computed sediment discharge from Einstein procedure 1/ applied to sections C-1 to C-10 and to section C-2 with measured sediment discharge at the contracted section

[For all particle sizes, the tons per day is the sum of computed tonnages of sediment larger than 0.125 mm and measured tonnages at normal section of sediments smaller than 0.125 mm, except for the contracted section, which is a daily mean]

Date	Section	Sediment discharge (tons per day)											
		Smaller than 0.062 mm	0.062 to 0.125 mm	0.125 to 0.25 mm	0.25 to 0.5 mm	0.5 to 1.0 mm	1.0 to 2.0 mm	2.0 to 4.0 mm	4.0 to 8.0 mm	Larger than 0.125 mm: Tons per day	Larger than 0.125 mm: Percent of measured	All particle sizes: Tons per day	All particle sizes: Percent of measured
1951													
June 14...	Sections C-1 to C-10.	....	3	97	518	68	56	1	......	740	63	1,017	64
	Contracted section 2/.	160	272	1,168	......	......	......	......	......	1,168	....	1,600	....
	Section C-2..........	....	....	2	129	29	3	......	......	163	14	437	27
July 18...	Sections C-1 to C-10.	....	2	64	388	42	4	......	......	498	69	578	63
	Contracted section...	74	130	419	270	37	......	......	......	726	....	930	....
	Section C-2..........	....	462	2,170	1,590	126	8	14	......	3,908	538	4,028	433
Aug. 3....	Sections C-1 to C-10.	....	4	130	449	58	9	......	......	646	82	1,008	84
	Contracted section 3/.	252	156	384	360	24	12	12	......	792	....	1,200	....
	Section C-2..........	....	700	1,730	1,173	90	15	5	......	3,013	380	3,417	285
Sept. 6...	Sections C-1 to C-10.	1,153	2,355	9,570	3,302	364	65	22	5	13,328	272	17,458	175
	Contracted section...	4,100	1,000	2,200	2,300	300	100	......	......	4,900	....	10,000	....
	Section C-2..........	....	7,950	35,200	4,600	360	29	33	......	40,222	821	44,942	449
1952													
Apr. 1....	Sections C-1 to C-10.	....	1,690	6,100	2,235	185	33	21	......	8,574	175	10,254	142
	Contracted section 4/.	936	1,370	2,806	1,944	144	......	......	......	4,894	....	7,200	....
	Section C-2..........	....	5,550	24,900	4,620	314	30	......	......	29,864	610	31,649	440
May 8.....	Sections C-1 to C-10.	193	2,610	1,630	198	32	14	......	......	1,874	139	2,434	128
	Contracted section 5/.	266	285	779	532	38	......	......	......	1,349	....	1,900	....
	Section C-2..........	....	414	3,980	1,950	107	56	20	......	6,113	453	6,696	352
June 19...	Sections C-1 to C-10.	....	1	31	346	59	6	......	......	442	140	523	125
	Contracted section...	46	59	189	113	13	......	......	......	315	....	420	....
	Section C-2..........	....	1,004	2,260	1,054	94	23	6	......	3,437	1,091	3,520	838
Sept. 26..	Sections C-1 to C-10.	....	....	31	327	49	6	......	......	413	119	486	108
	Contracted section...	40	63	216	122	9	......	......	......	347	....	450	....
	Section C-2..........	....	....	6	207	29	9	1	......	252	73	315	70
Average.	Sections C-1 to C-10.	....	....	....	......	......	......	......	......	....	132	....	111
	Section C-2..........	....	....	....	......	......	......	......	......	....	498	....	362

1 Sediment discharge by size ranges for sections C-1 to C-10 and for section C-2 was computed by the Bureau of Reclamation except for Sept. 6, 1951, and Sept. 26, 1952.
2 Size on June 15, 1951.
3 Size on Aug. 2, 1951.
4 Size on Apr. 10, 1952.
5 Size on May 24, 1952.

normal section or sections of sediment smaller than 0.125 millimeter. The computed total discharge of sediment of all sizes for the reach from sections C-1 to C-10 ranged from 63 to 175 percent and averaged 111 percent of the discharge at the contracted section. The larger percentages were usually for days when the sediment discharge was large (fig. 39). The computed discharges of sediment of all sizes for section C-2 ranged from 27 to 838 percent and averaged 362 percent of the sediment discharge at the contracted section.

Computed tonnages by the Einstein procedure as applied to the gaging-station section were 25,800 and 24,200 tons per day exclusive of fine particles as compared with measured daily sediment discharges at the contracted section of 2,190 and 420 tons per day on March 3, 1950, and on June 19, 1952, respectively. These comparisons are so unsatisfactory that the computed tonnages were not included in table 33. One reason for the high computed tonnages is that the water-surface slope at the gaging-station section is probably lower than the slope computed from staff gages at each end of the reach. (See fig. 5.)

On the basis of the computations by the Einstein procedure, the procedure is totally unsuited for application to either the gaging-station section or to section C-2. (The procedure was not designed to apply to single sections.) The total tonnages that were computed by applying the procedure to the reach from sections C-1 to C-10 and by adding measured discharge of sediment smaller than 0.125 millimeter were on the average reasonably good percentages of the tonnages at the contracted section. However, the relative tonnages in the different size ranges compared poorly with those for the contracted section.

MODIFIED PROCEDURE BASED ON EINSTEIN'S FORMULAS

The principal objective of the study of sediment discharge at sections C-1 to C-10 of the Niobrara River near Cody was to develop a method or to modify an existing method for computing total sediment discharge. A satisfactory procedure should, as far as possible:

1. Permit the computation, with reasonable accuracy, of the total sediment discharge, not just one part of the discharge and especially not an indefinite part.

2. Give the approximate size distribution of the computed discharge of sediment.

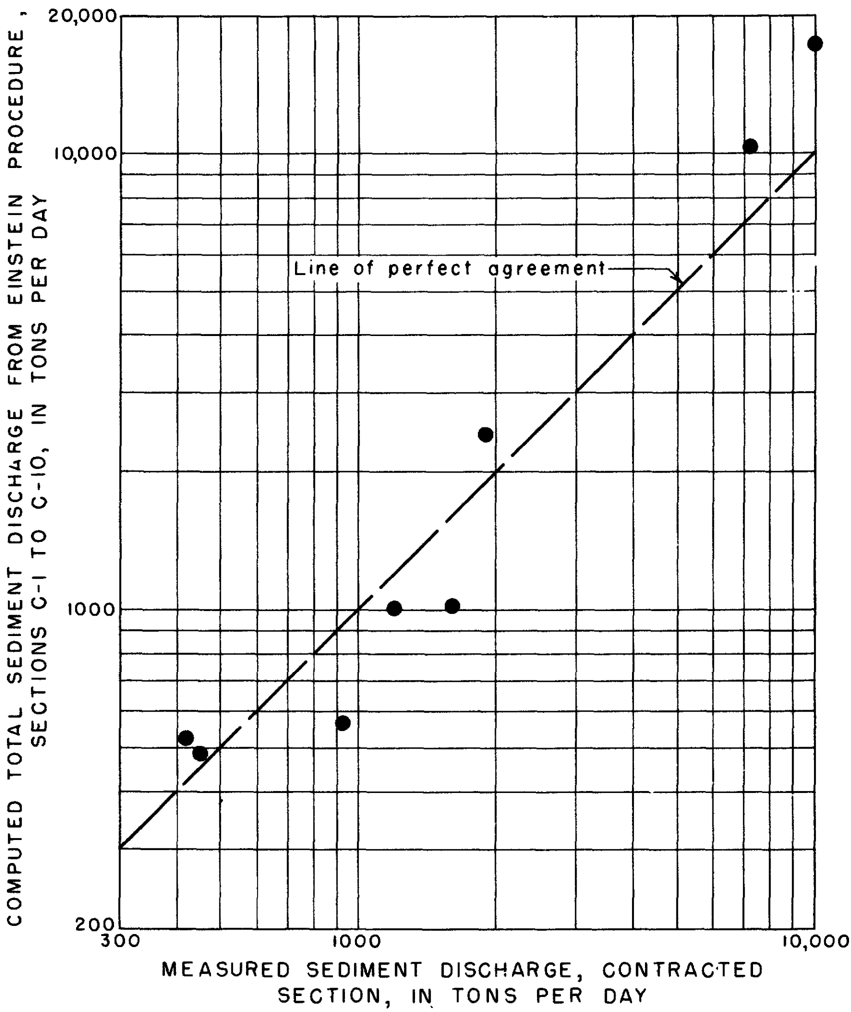


Figure 39.--Comparison of computed total sediment discharge from the Einstein procedure at sections C-1 to C-10 to measured sediment discharge at the contracted section.

3. Be computed from data that were obtained at only one cross section or within a short reach.

4. Be applicable to sections that are not in a uniform reach of channel and, insofar as possible, to sections in which the lateral distribution of flow is not uniform.

5. Use streamflow measurements rather than the water discharge that is computed from formulas.

6. Use depth-integrated samples of suspended sediment rather than point-integrated samples.

7. Be reasonably simple to use.

A promising procedure was developed to meet, in part, the above objectives. It is based on Einstein's formulas and consists of computing the sediment discharge for several ranges of particle sizes by applying different methods of computation for the ranges of small particle sizes than for the ranges of large particle sizes. In each range of the small particle sizes, the sediment discharge is computed by multiplying the suspended-sediment discharge in the sampled zone by the ratio of theoretical total suspended-sediment discharge in the size range to the theoretical suspended-sediment discharge of the same particle sizes in the sampled zone. The ratio is computed by dividing the integrated products of theoretical velocity and theoretical concentration from the stream surface to the top of the bed layer by similar integrated products from the stream surface to the lower limit of the sampled zone. In the size ranges of the larger particles, the total sediment discharge is computed about as explained by Einstein except that different methods of computation are used for the exponential measure z of the increase in sediment discharge with depth, the shear velocity with respect to the sediment particles, and the intensity of bed-load transport. These three major departures from the Einstein procedure will be explained in detail in the following sections.

COMPUTATION OF Z

The exponent z is the exponential measure of the vertical distribution of suspended sediment in a size range. For a given cross section of a stream at a given time, z was intended to be the slope of the logarithmic plot of concentration c_y in a size range versus $(d - y)/y$ (Einstein, 1950, p. 17, equation 29) in which d is the depth of water and y is the distance above the stream bed. Einstein (1950, p. 17, equation 27) computes z from the equation

$$z = \frac{V_s}{0.4\, u_*'}$$

in which V_s is the fall velocity of the geometric mean particle size of a size range

0.4 is the universal constant for turbulent exchange

u_*' is the shear velocity with respect to the sediment particles

This equation as well as most of the others that are used in the computations or explanations of the modified Einstein procedure is dimensionless so that any units of measurement can be used. Principal exceptions are those equations that contain sediment discharge for the entire width of a stream, and these discharges are in tons per day rather than in the foot-pound-second units that have otherwise been used. The z's as computed from the above equation sometimes are far from a correct measure of the vertical distribution of the sediment in a stream. Also, the equation makes computed z's vary directly with the fall velocity of the sediment particles, whereas the measured vertical distributions of sediment in different size ranges indicate a variation with about the 0.7 power of the fall velocity.

RELATIONSHIPS INVOLVING z_1, z_2, AND K

Anderson (1942, p. 682) has shown that z_1, the exponent that is determined by measured vertical distribution of sediment particles of a given size range, did not increase nearly so rapidly with increasing particle size in the Enoree River in South Carolina as the theoretically computed z's increased. His data indicate a rate of increase about proportional to the 0.7 power of the fall velocity. Einstein and Ning Chien (1952) have recognized the need for a revised theory for the computation of z. They have suggested two approaches to a second approximation for z, but the computations are somewhat complex and for the Missouri River at Omaha do not show a consistently good agreement with z_1.

To further test the relation between computed z's and measured z_1's, 22 sets of point-integrated samples from 6 different streams were used to determine z_1 for each of 3 ranges of particle sizes. Each set consisted of point-integrated samples at 2 to 4 depths in each of 3 to 5 verticals. Graphs like figures 9 and 10 were prepared, and z_1's for all verticals of each section were averaged for each of the three size ranges. The average z_1's are plotted against $z_m = V_s/(0.4\,u_m)$ on figure 40. The subscript m denotes quantities that are computed according to the modified procedure. Specifically, the symbol u_m is used in place of Einstein's u_*' because u_m is equal to $\sqrt{g\,(SR)_m}$ in which g is the gravity constant and $(SR)_m$ is computed from the mean velocity as shown by a discharge measurement and from the velocity equation. (See equation (E), p. 83.) Also, z_m is a z that is computed from the equation $z_m = V_s/(0.4\,u_m)$. For this report fall velocities are based on equations given by Rubey (1933).

Figure 40 shows that for any day at any given cross section (that is, when u_m is constant) z_1 usually varies as about the 0.7 power of the fall velocity of the geometric mean of its size range in spite of experimental errors. When z_1 for one size range is either higher or lower than average, the z_1's for the other size ranges generally have a somewhat similar relation to their averages. However, z_1 for a given range of particle sizes varies widely from one cross section to another and from time to time at the same section. For the size range from 0.125 to 0.250 millimeter, the z_1's were expressed in ratios to the average z_1's for the given fall velocities by dividing each z_1 by $3.66(V_s)^{0.7}$. These ratios show no definite relationship to computed shear velocity u_m (fig. 41).

As will be explained later, for each one of some size ranges a type of z can be computed from the ratio of sediment discharge in the sampled zone of a normal section to sediment discharge at the contracted section. This type of z, called z_3, is the exponential measure of the vertical distribution of sediment that, for a given size range, will make the total sediment discharge as computed for a normal section equal the suspended-sediment discharge as measured at a contracted (total-load) section. Fourteen sets of z_3's were computed for each of three size ranges. The z_3's were plotted against $z_m = V_s/(0.4\,u_m)$ on figure 42. For a particular time and cross section, z_3's for different size ranges, like the z_1's of figure 40, varied as about the 0.7 power of the fall velocity of the geometric mean particle sizes. Between different cross sections or different times at the same cross section, z_3's showed wide variations. Ratios of z_3's to average z_3's for the given fall velocities did not correlate with the shear velocity (fig. 43).

Einstein and Ning Chien (1952, fig. 4) found not only that k, the universal constant for turbulent exchange, decreased on the average with an increase in concentration as earlier reported by Vanoni (1941, p. 613) but also that k for the Missouri River at Omaha, Nebr., varied widely from its average. Changes in vertical distribution of velocity as measured by k are likely to be associated with changes in the vertical distribution of sediment

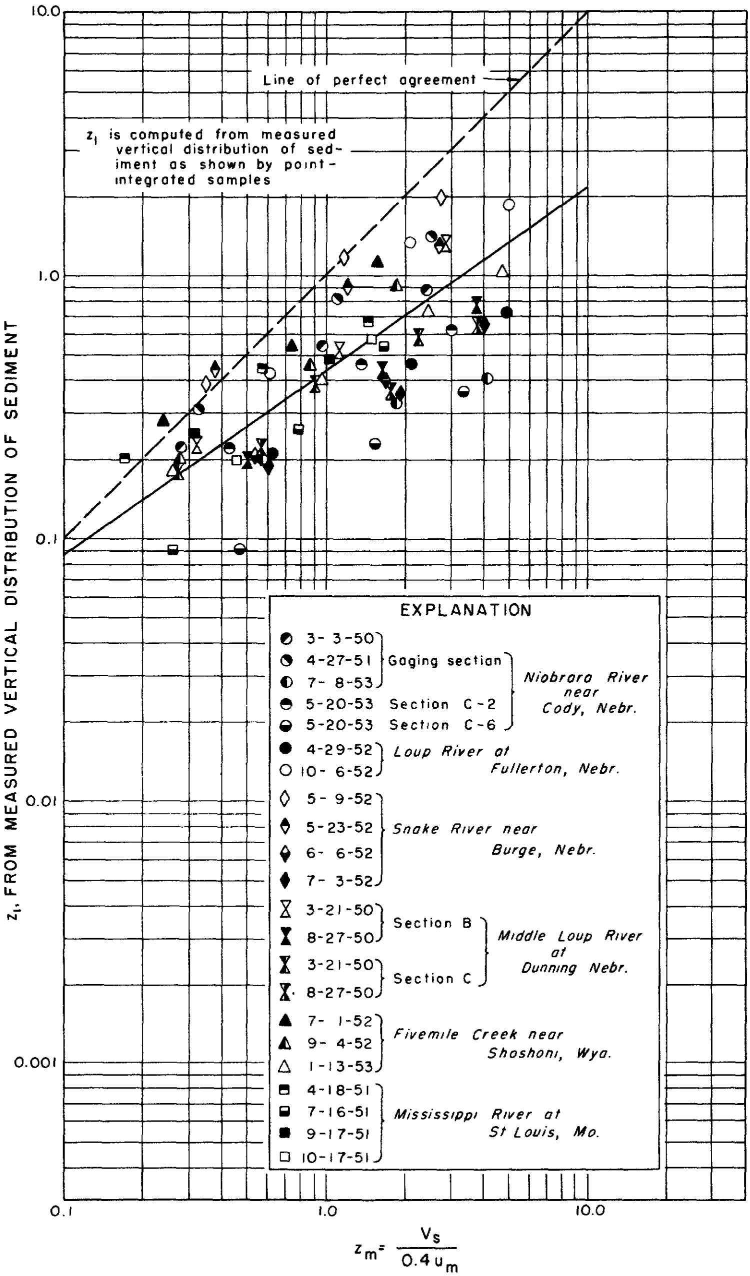


Figure 40.--Graph of z_1 plotted against z_m.

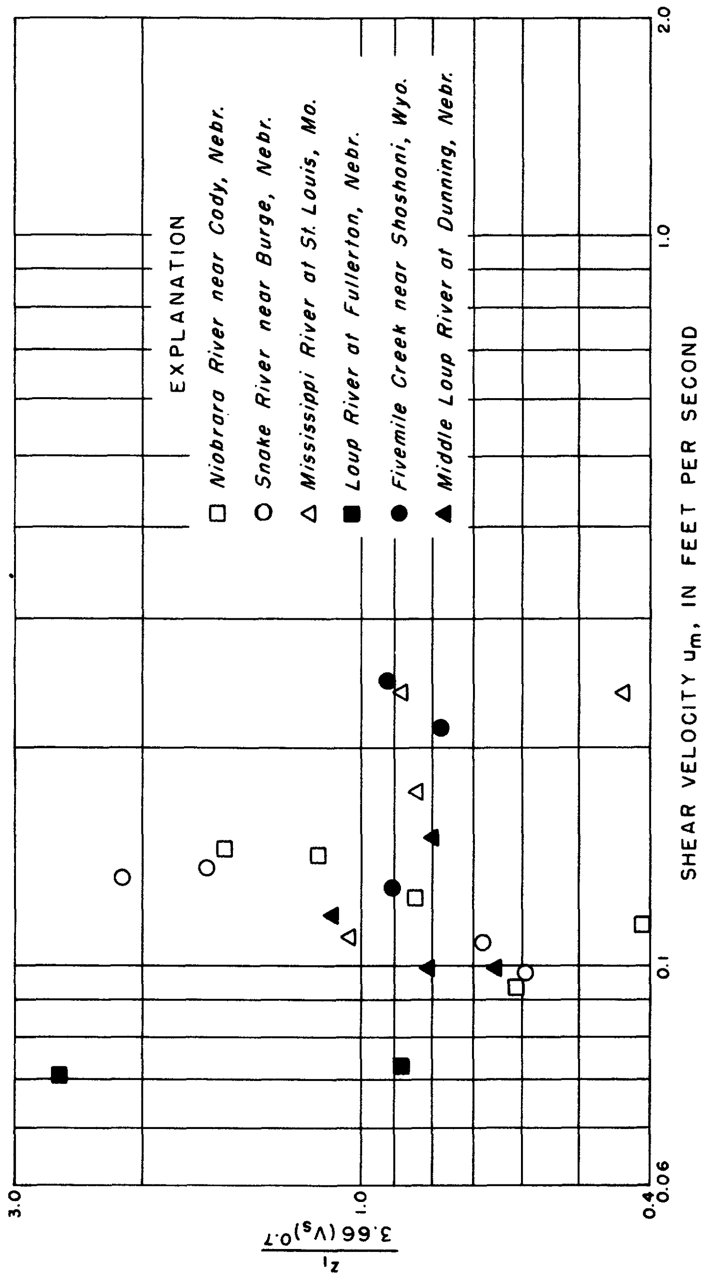


Figure 41.--Graph of z_1 adjusted for fall velocity plotted against shear velocity.

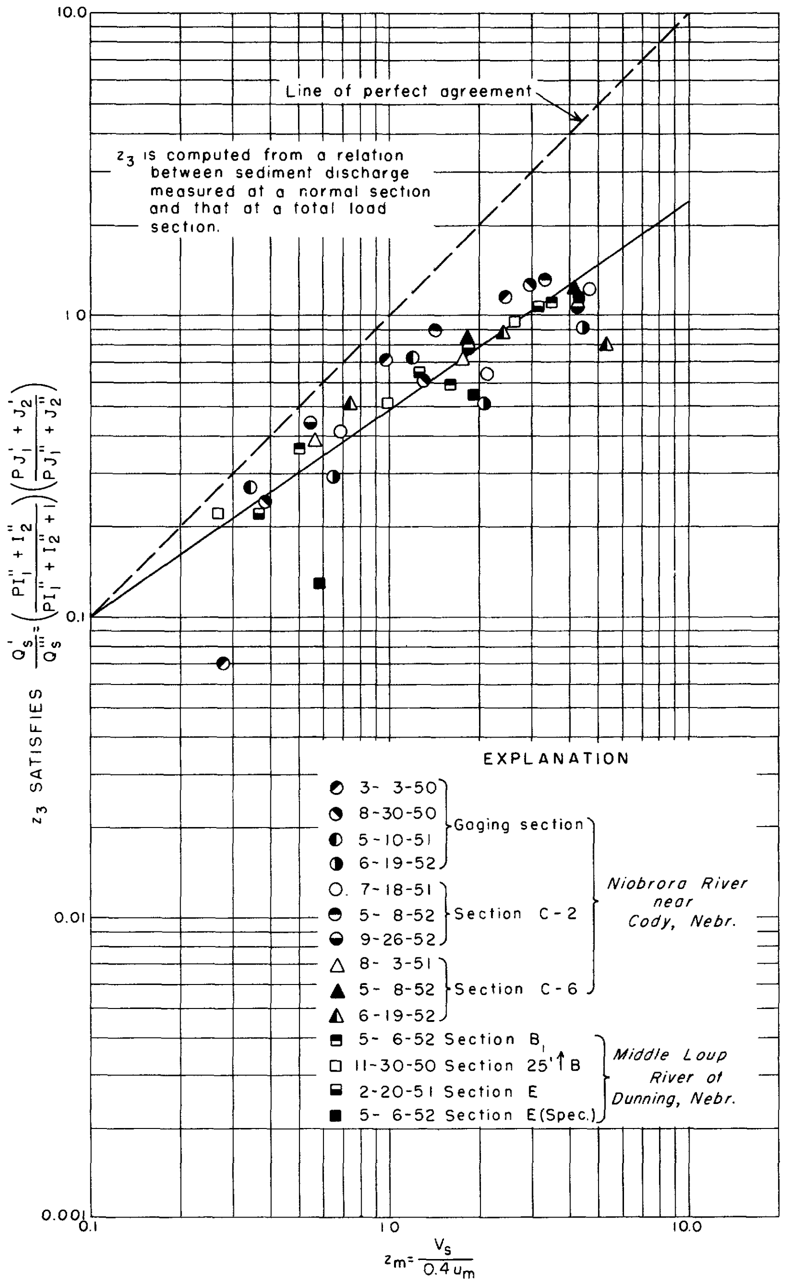


Figure 42.--Graph of z_3 plotted against z_m.

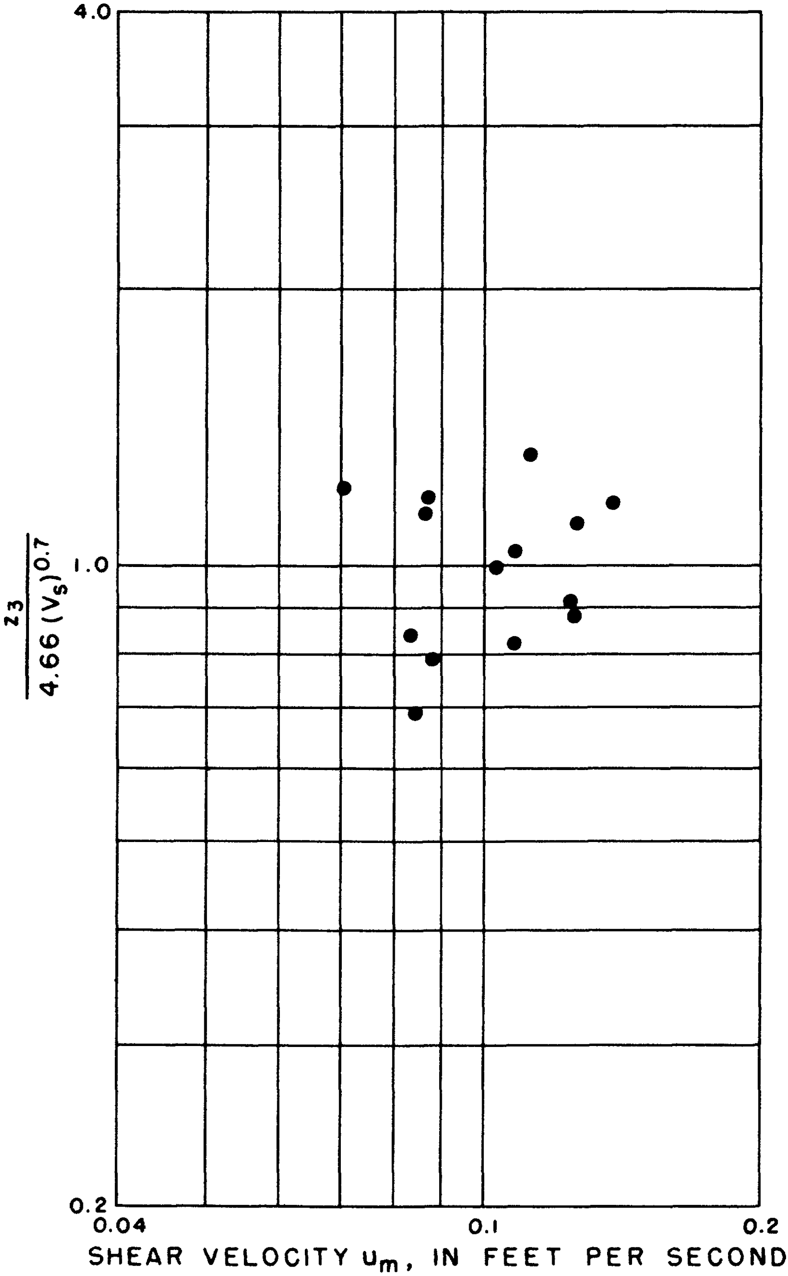


Figure 43.--Graph of z_3 adjusted for fall velocity plotted against shear velocity.

as measured by z_1. Unfortunately, natural inaccuracies in determining k are increased for the gaging-station section near Cody because vertical velocity curves were not defined by current-meter measurements. At sections C-2 and C-6 vertical velocity curves were defined by current-meter measurements when point-integrated samples were collected on May 20, 1953, only. At section C-2 on May 20, 1953, the z_1's were very low; at section C-6 on the same day they were slightly below average; and on April 27, 1951, at the gaging-station section they were much higher than average. The k's for these three times and cross sections were computed to see if they would correlate with the z_1's. Filling times of the point-integrated samples were used to compute velocities at points in the gaging-station section.

To determine k, such point velocities for each vertical were plotted along a rectangular coordinate scale against distance above the stream bed along a logarithmic scale. The slope M of the line through the plotted points on the semilogarithmic graph equals the quantity $(2.303\ u_*)/k$. This fact follows from the velocity equation that is given by Einstein (1950, p. 8, equation 3) when 5.75 is replaced by 2.303/k (Keulegan, 1938, p. 711-713). The velocity equation then becomes

$$\bar{u}_y = \frac{2.303}{k}\ u_*\ \log_{10}\ \frac{30.2\ yx}{k_s}$$

in which $\bar{u}_y$ is the time-averaged velocity at a distance y above the stream bed

y is the distance above the stream bed

x is a dimensionless parameter determined from figure 44

k_s is the roughness diameter, that particle size for which 65 percent of the bed material by weight is finer

The slopes of the lines for all verticals of a cross section (one unrepresentative vertical was not included in the average for section C-6) were averaged to obtain a slope M for the cross section. Then u_* was computed from average depth and average water-surface slope, and k was determined from $k = (2.303\ u_*)/M$. As the following table shows, computed k's varied widely and inversely with z_1's. On the basis of only the three computations of k, the variation of k seems to explain much of the scatter of the points on figure 40. Large variations in k may mask the theoretical relationship between z_1's and shear velocity.

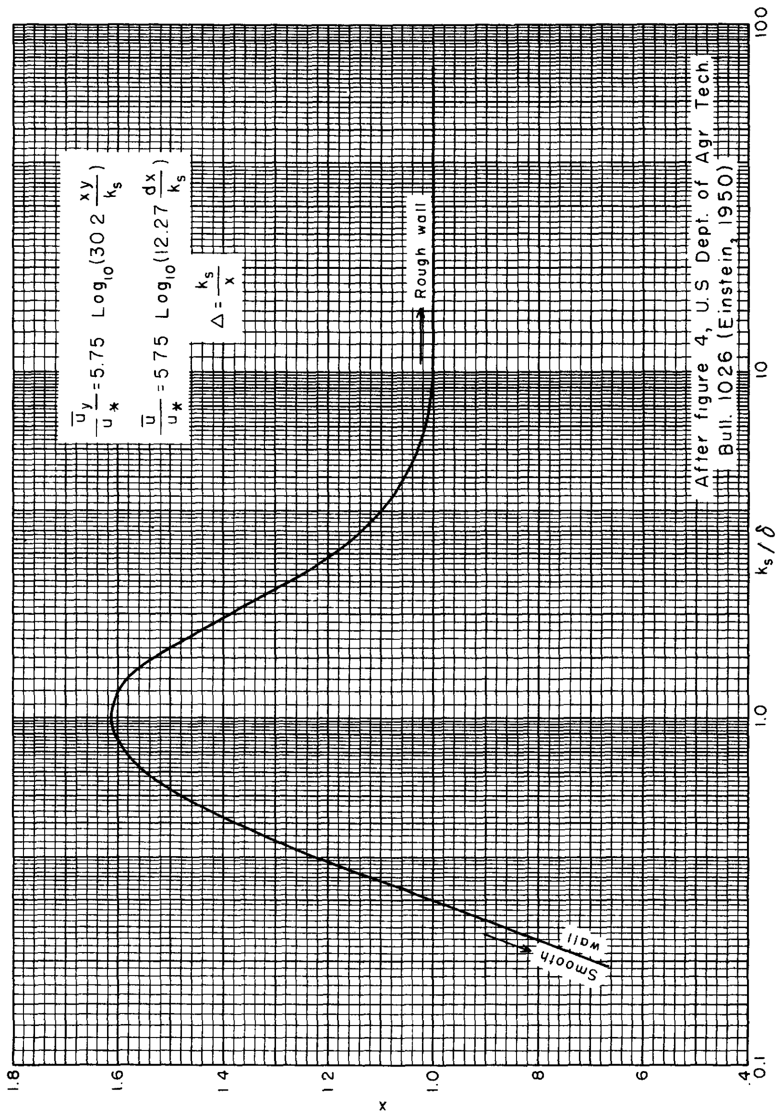


Figure 44.--Correction x in terms of k_s/δ .

Comparison of z_1's and computed k's

Date	Section	z_1			k
		0.062 to .125 mm	0.125 to .250 mm	0.250 to .500 mm	
1951					
Apr. 27....	Gaging station	0.31	0.82	1.40	0.42
1953					
May 20	C-2	.22	.46	.62	.86
	C-6	.09	.23	.36	2.8

Computed k's in the above table may not apply near the stream bed where they were not defined. Hence, they may be suitable for correlation with the z_1's, which are determined for the same ranges of depth, without being correct for computation of total sediment discharge near the stream bed.

TRIAL-AND-ERROR COMPUTATION OF Z

For some ranges of particle size, z_2 (the subscript denotes a z computed directly by trial and error or based on a trial-and-error z) can be computed from an equation that can be derived from relationships that have been stated by Einstein. This method for computing z_2 is described below. It requires only depth-integrated samples, not point-integrated samples.

P, I_1, I_2, J_1, and J_2 are symbols introduced by Einstein (1950) as abbreviations of certain functions and are defined as follows:

$$P = 2.303 \log_{10} \frac{30.2\,dx}{k_s}$$

$$I_1 = 0.216 \frac{A^{z-1}}{(1-A)^z} \int_A^1 \left(\frac{1-y}{y}\right)^z dy$$

$$= 0.216 \frac{A^{z-1}}{(1-A)^z} J_1$$

$$I_2 = 0.216 \frac{A^{z-1}}{(1-A)^z} \int_A^1 \left(\frac{1-y}{y}\right)^z \log_e (y)\,dy$$

$$= 0.216 \frac{A^{z-1}}{(1-A)^z} J_2$$

in which d is depth of water

A is the distance from the stream bed to the lower limit of integration divided by the depth d

For a given time at a given cross section of a stream, equation (34) (Einstein, 1950, p. 24) becomes simply

$$q_s = K(PJ_1 + J_2)$$

Then

$$\frac{q_s'}{q_s''} = \frac{Q_s'}{Q_s''}$$

$$= \frac{PJ_1' + J_2'}{PJ_1'' + J_2''} \qquad \text{equation (A)}$$

in which q_s is suspended-sediment discharge, in pounds per second per foot of width, for a given range of particle sizes

Q_s is suspended-sediment discharge through the cross section, in tons per day, for a given range of particle sizes

K is a constant at a particular time and cross section

A single prime mark designates a symbol that is associated with the sampling depth, and a double prime mark designates a symbol that is associated with the total depth through which suspended-sediment is discharged. Except for the use of prime marks, the nomenclature generally follows that of Einstein (1950).

Equation (61) (Einstein, 1950, p. 40) can be put in the form

$$Q_s'' = 43.2\, w\, i_B q_B (PI_1'' + I_2'')$$

If $43.2\, w\, i_B q_B$ is replaced by $i_B Q_B$,

$$Q_s'' = i_B Q_B (PI_1'' + I_2'') \qquad \text{equation (B)}$$

In these equations 43.2 is the coefficient for changing sediment discharge in pounds per second to tons per day

w is the width of the channel, in feet

$i_B q_B$ is sediment discharge, in pounds per second per foot of width, through the bed layer of particles of a given size range

$i_B Q_B$ is sediment discharge, in tons per day, through the bed layer of particles of a given size range

Equations (A) and (B) combine into

$$\frac{Q_s'}{i_B Q_B} = (PI_1'' + I_2'') \frac{PJ_1' + J_2'}{PJ_1'' + J_2''}$$

$$= 0.216 \frac{A^{z-1}}{(1 - A)^z} (PJ_1' + J_2')$$

$$= \frac{I_2''}{J_2''} (PJ_1' + J_2')$$

$$= \frac{I_1''}{J_1''} (PJ_1' + J_2') \qquad \text{equation (C)}$$

The discharge of suspended sediment in the sampling zone for one size range, Q_s', can be computed from size analyses and concentrations of depth-integrated samples and from water discharge through the sampled zone. The sediment samplers, US DH-48, US D-43, and US D-49, used for collecting depth-integrated samples do not normally sample within about 0.3 or 0.4 foot of the bottom unless they settle into the bed. As most samples at the normal sections were taken with the hand sampler DH-48, the assumption has been made for this report that the sampled zone extends from the water surface to 0.3 foot above the stream bed. In shallow streams several percent of the streamflow and a larger percentage of the suspended-sediment discharge may be discharged within 0.3 foot of the bed. Integration of the velocity equation (3) (Einstein, 1950, p. 8) in the form

$$\bar{u}_y = 5.75 \sqrt{32.2 S_e R'} \log_{10} \frac{30.2 yx}{k_s}$$

was the basis for the curves of figure 45 for P equal to 4, 8, 11, and 14. In this equation $\bar{u}_y$ is the time-averaged velocity at a distance y above the streambed, S_e is the energy gradient, and R' is the hydraulic radius with respect to the grain (according to Einstein). P is usually about 11, but figure 45 was prepared to include a wide range of P because certain experimental determinations of P, or at least of a quantity that is considered to be analogous to P, may cover a wide range.

Figure 45 can be used to determine the approximate proportion of the total streamflow that the sediment sampler traversed. The accuracy of the proportion depends on the closeness of agreement between the velocity equation and the average actual velocity profile for the cross section. The proportion expressed as a fraction can be multiplied by the total streamflow, in cubic feet per second; by the average concentration from depth-integrated

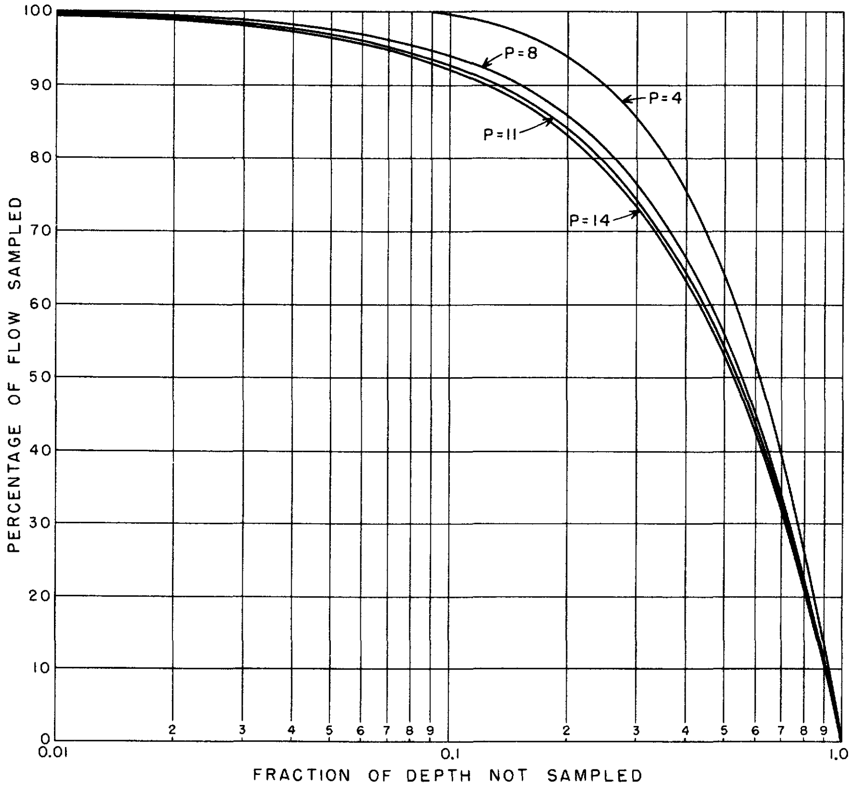


Figure 45.--Vertical distribution of streamflow.

samples, in parts per million; and by the constant 0.0027 to compute the sediment discharge through the sampling zone.1/

The next step in the solution of equation (C) is to compute $i_B Q_B$ according to Einstein's procedure or modifications of his procedure. Then equation (C) can be solved by trial and error because I_1'', I_2'', J_1', J_2', J_1'', and J_2'' are determined by z and known quantities. Figure 46 shows an approximate relationship that can be used to obtain a good first approximation of z_2. Two or three trial solutions of equation (C) should determine z_2 to the nearest 0.01 if that much accuracy is desired.

The z_2 as computed from equation (C) is the one numerical value of z that will give the measured discharge of suspended sediment in the sampled zone and also be consistent with the computed $i_B Q_B$. It is also the one numerical value for which the

1/ Larger constants are used for concentrations greater than 35,000 ppm.

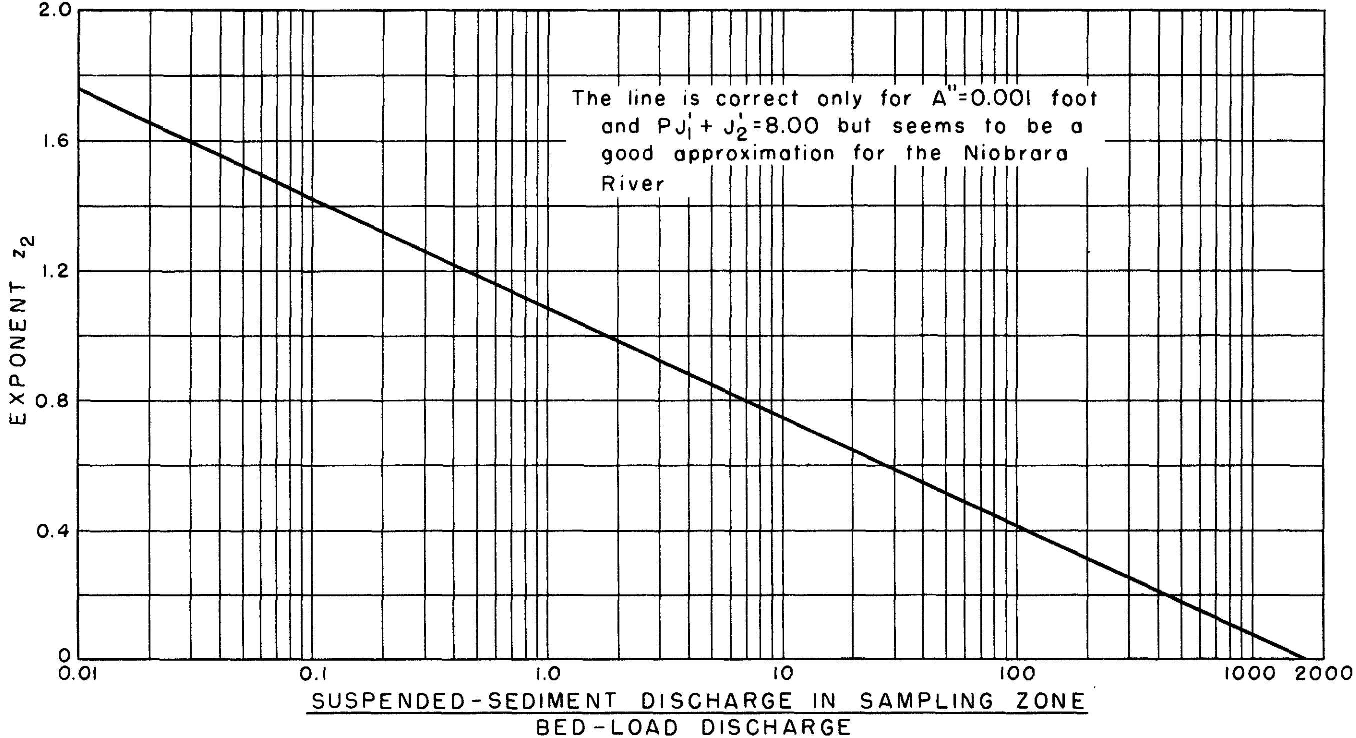


Figure 46.--Approximate relation of z_2 to the ratio of suspended-sediment discharge in the sampling zone to bed-load discharge.

same suspended-sediment discharge is computed by the modified Einstein procedure for the ranges of small particle sizes as by the modified procedure for the larger particle sizes. (See p. 96 for discussion of differences between the application of the modified Einstein procedure to the smaller particle sizes and to the larger particle sizes.) Because inaccuracies in determining the suspended-sediment discharge and in computing i_BQ_B are likely to be relatively large when these quantities are small, z_2 should be computed from equation (C) for a size range that has appreciable quantities of bed-load discharge and of suspended-sediment discharge in the sampled zone. For the Niobrara River, the size range from 0.125 to 0.25 millimeter seems to be best suited for the computation of z_2 from equation (C). This size range, which has a geometric mean size of 0.00058 foot, is sometimes referred to as the reference size.

After z_2 has been computed for the reference size range, z_2's for the other size ranges are computed in proportion to the 0.7 power of the fall velocities of the geometric mean particle sizes. This computation is simplified by use of plate 1 or a table that is based on plate 1. This plate gives the multipliers for computing z_2's for other size ranges from z_2 for the 0.125 to 0.25 millimeter range.

If the total sediment discharge of a stream is measured at a contracted section, another type of z can be computed by trial and error. This type of z, designated z_3, will for a given size range make the computed total sediment discharge through a normal section equal the measured discharge of sediment at the contracted section. Let Q_s''' be the measured discharge, in tons per day, of sediment of a given size range that passes through the contraction. If total sediment discharge is computed at the contracted section, then

$$Q_s''' = Q_s'' + i_BQ_B$$

and from equation (B)

$$Q_s''' = i_BQ_B(PI_1'' + I_2'') + i_BQ_B$$

$$= i_BQ_B(PI_1'' + I_2'' + 1)$$

Substitution in equation (C) gives

$$\frac{Q_s'}{Q_s'''} = \frac{1}{(PI_1'' + I_2'' + 1)} \frac{I_1''}{J_1''} (PJ_1' + J_2') \qquad \text{equation (D)}$$

The z_3's can be computed by trial and error from equation (D).

COMPUTATION OF SHEAR VELOCITY

Another major difference between the Einstein and the modified procedures is in the computation of the shear velocity with respect to the sediment particles. In the modified procedure the shear velocity, $\sqrt{32.2\,(SR)_m}$, is computed from a slight modification of equation (9) (Einstein, 1950, p. 10). The modified equation is

$$\bar{u} = 5.75\sqrt{32.2\,(SR)_m}\,\log_{10}\frac{12.27\,d\,x}{k_s} \qquad \text{equation (E)}$$

or

$$u_m = \frac{\bar{u}}{5.75\,\log_{10}\dfrac{12.27\,dx}{k_s}}$$

in which $\bar{u}$ is the average velocity for the cross section and is usually taken from a streamflow measurement

$(SR)_m$ is the quantity that is obtained by solving equation (E) for SR for a known numerical value of $\bar{u}$

Note that the depth d is used under the log sign rather than R' as given by Einstein. In equation (E), x is indirectly a function of the shear velocity, so the equation must be solved by trial. However, the first guess for x is frequently close enough to make a second trial computation unnecessary.

Shear velocities, u_m, computed from equation (E) for the Niobrara River near Cody are usually much smaller than the shear velocities as computed by the Einstein procedure. Therefore, the mean velocities computed by the Einstein procedure are usually appreciably higher than measured average velocities. Shear velocities, u_m, being based on measured velocities in the cross section, probably are more representative of the sediment transporting power of a stream than are shear velocities as computed by the Einstein procedure. However, the use of shear velocities, u_m, that are based on actual velocities probably makes these shear velocities not directly applicable to the computation of bed-load discharge from the Ψ_* versus Φ_* relationship of plate 2. Ψ_* is the intensity of shear for sediment grains of a size range and is computed from equation (F). Φ_* is the intensity of bed-load transport.

COMPUTATION OF THE INTENSITY OF BED-LOAD TRANSPORT

According to the Einstein procedure, the intensity of bed-load transport is computed from a basic equation for shear intensity Ψ_* and three graphs. The equation (Einstein, 1950, p. 37, equations 49 and 54) is

$$\Psi_* = \xi \, Y \, (\beta/\beta_x)^2 \, (S_s - 1) \frac{D}{S_e R'} \qquad \text{equation (F)}$$

in which ξ and Y are two correction factors to be defined by graphs
β and β_x are certain logarithmic functions
S_s is the specific gravity of the sediment particles
D is the geometric mean diameter of the sediment particles of a size range

Also, Ψ_* computed from equation (F) is related to the intensity of bed-load transport, Φ_*, by a theoretical equation (Einstein, 1950, p. 37, equation 57). The constants in the equation were determined by Einstein from bed-load experiments in which uniform sediment was used. Plate 2 gives the curve that represents the equation for the relation between Ψ_* and Φ_*.

If $(SR)_m$ is to be used in place of $S_e R'$, equation (F) presumably no longer applies directly. That is, it computes a Ψ_m that is numerically different than Ψ_*. Consequently, the Ψ_m versus Φ_* relationship cannot be expected to be the same as the Ψ_* versus Φ_* relationship.

A further objection to the direct use of equation (F) in the modified procedure is that the curve (Einstein, 1950, fig. 7) for ξ in terms of D/X (X is a characteristic grain size or characteristic distance, in feet) seems to have an incorrect slope for small sand sizes. A slope that might be correct for z's that are assumed to vary directly with the fall velocity cannot be expected to be correct for z's that vary with about the 0.7 power of the fall velocity.

If the z_1's or z_3's for different ranges of sediment sizes are known and the sediment discharges through the sampled zone for these size ranges can be determined, part of the ξ versus D/X relationship can be computed. To make the computations, equation (C) is used in the form

$$i_B Q_B = \frac{J_1'' \, Q_s'}{I_1'' \, (PJ_1' + J_2')}$$

Then from an equation given by Einstein (1950, p. 59, step 34) plus self-evident transformations

$$\Phi_* = \frac{i_B \, Q_B}{43.2 \, w \, 1{,}200 \, i_b \, D^{3/2}} \qquad \text{equation (G)}$$

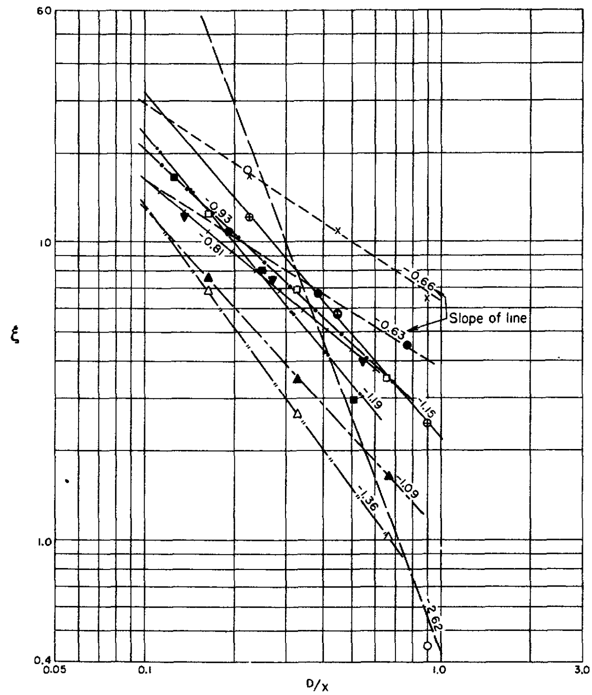
The constants of Einstein's equation in foot-pound-second units equal 1,200, and i_b is the fraction of the bed material in the size range. From Φ_* and plate 2, Ψ_* can be determined. Finally, ξ can be computed from equation (F). Figure 47 shows the relationship between computed ξ and D/X. Although the points scatter considerably, the slope of most lines that are drawn through individual sets of points averages about 45 degrees for z's that vary as the 0.7 power of the fall velocity.

A change in the assumed relation between z and the fall velocity greatly changes the slope of the lines on figure 47 as the computations for May 11, 1950, show. A z of 0.68 for the size range from 0.125 to 0.250 millimeter was used with z's that were varied with the 1.0 power of the fall velocity and also with z's that were varied with the 0.7 power of the fall velocity. The slope of the line for variation with the 1.0 power of the fall velocity was more than double that for variation with the 0.7 power.

As z becomes smaller, the slope of the lines on figure 47 becomes flatter. (See fig. 48 and pairs of slopes on fig. 47 for May 11, 1950, and Aug. 3, 1951.) The tendency for the slope of the ξ versus D/X curve to become flatter as z decreases has been established only for a fixed relation between z and fall velocity. An incomplete analysis of available data has not yet established the relation of figure 48 for z's that are determined for different size classes without use of such a fixed relation. Though figure 48 may indicate a possible limitation on an assumed variation of ξ with D/X, yet ξ can fairly safely be assumed to vary inversely with D/X within a range of z's of perhaps 0.5 to 0.8 for the size class from 0.125 to 0.250 millimeter. Also, as X is constant for any one set of points on figure 47, ξ varies nearly inversely with D throughout the ranges of size for which Q_s' was large enough to define a point on the figure, or up to a size of at least 0.5 millimeter.

Variations in X are not large and do not seem to explain any significant amount of the scatter of points on figure 47. This scatter in computed ξ's appears to be characteristic whenever z's are determined individually or from an average curve and are then used to compute corresponding ξ's.

If ξ is assumed to be inversely proportional to D below some undefined particle size, then according to equation (F) Ψ_*, and consequently Φ_*, does not change from one range of particle sizes to another below this undefined size. A question still remains as to how to compute Ψ_* or a function to replace Ψ_*.



EXPLANATION

Symbol	Stream	Section	Date	z for 0.125 to 0.250 mm	Variation of z with fall velocity
—●—	Middle Loup R at Dunning	C-2	7-14-50	0.37	0.7 power
—○—	Niobrara R near Cody	gaging station	5-11-50	.68	1.0 power
—⊕—	Niobrara R near Cody	gaging station	5-11-50	.68	.7 power
—×—	Niobrara R near Cody	gaging station	5-11-50	.47	.7 power
—△—	Niobrara R near Cody	C-2	8-3-51	.88	.7 power
—▲—	Niobrara R. near Cody	C-2	8-3-51	.78	.7 power
—□—	Niobrara R. near Cody	C-2	5-8-52	.60	.7 power
—■—	Niobrara R. near Cody	C-2	9-26-52	.72	.7 power
—▼—	Niobrara R. near Cody	C-6	9-26-52	.42	.7 power

Figure 47.--Relation between ξ and D/X for the geometric mean of three ranges of particle sizes 0.062 to 0.125 mm, 0.125 to 0.250 mm, and 0.250 to 0.500 mm.

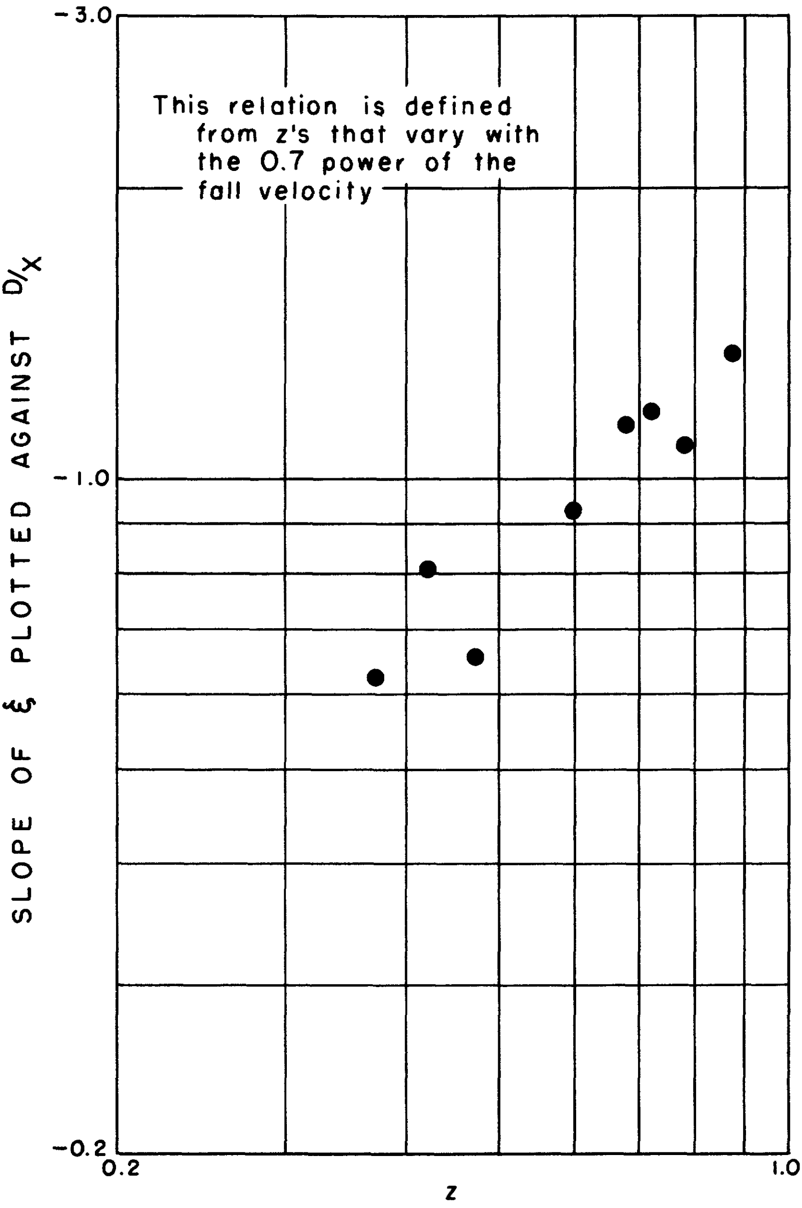


Figure 48.--Approximate relation between z for sediment in size range of 0.125 to 0.250 mm and slope of the ξ plotted against D/X curve.

Einstein (1950, p. 10) states that sediment transport "is a function of a flow function of the type":

$$\Psi = (S_s - 1) \frac{D_{35}}{R' S_e}$$

or for the modified procedure in which $(SR)_m$ differs from $S_e R'$

$$\Psi_m = (S_s - 1) \frac{D_{35}}{(SR)_m}$$

$$= \frac{1.65 D_{35}}{(SR)_m} \qquad \text{equation (H)}$$

in which D_{35} is the particle size of the bed material at which 35 percent by weight of the grains is finer. Equation (H) is used to compute Ψ_m for some size ranges.

Computations of the type that determined the points of figure 47 cannot be made from available field data to define the particle size at which D or D/X is no longer inversely proportional to ξ. So for the ranges of larger particle sizes the assumption was made that $\xi Y(\beta/\beta_x)^2$, which is a term in equation (F) for computing Ψ_*, can be replaced by 0.4 in a corresponding equation for Ψ_m. Actual determinations of $Y(\beta/\beta_x)^2$ have ranged from about 0.3 to 0.6, and for these larger particle sizes ξ = 1.00. Throughout the range of particle sizes, the quantity Ψ_m is computed from the equations

$$\Psi_m = \frac{1.65 D_{35}}{(SR)_m} \qquad \text{equation (H)}$$

$$\Psi_m = 0.4 \frac{1.65 D}{(SR)_m}$$

$$= \frac{0.66 D}{(SR)_m} \qquad \text{equation (I)}$$

and the larger Ψ_m from these equations is used for each geometric mean particle size. In terms of particle size, the shift from equation (H) to equation (I) comes at 2.5 D_{35}.

One further modification was made in the computation of the intensity of bed-load transport. This modification was based on comparison, for the reference size range from 0.125 to 0.250 millimeter, of average computed z_2's with averages of the more directly determined z_1's and z_3's. An average z_1 and an average z_3 for the reference size were computed from the data that were plotted on figures 40 and 42. Several computations of z_2 were made from equation (C). For insertion in equation (C), $i_B Q_B$ was computed from Φ_* that, in turn, was determined from Ψ_m and plate 2. Twenty of these computed z_2's averaged about 0.80 as compared to averages of 0.68 for z_3's and 0.53 for z_1's. Therefore, the z_2's appeared to be appreciably too high.

Another check on the size of the z_2's can be made. The z_2's for the size range from 0.25 to 0.5 millimeter were computed from the z_2's for the reference size range and were found to be too large to give approximately correct sediment discharges by equation (A), which is sensitive to small changes in z when z is large. To reduce the average z_2 nearer to the average z_1 and z_3, the bed-load transport intensity, Φ_*, was arbitrarily divided by 2. This division by 2 reduced z_2 by about 0.10.

NECESSARY BASIC DATA

The Einstein procedure was modified to make as effective use as possible of readily measurable base data for a single section. The required data for computation of total sediment discharge by the modified procedure at a particular time are:

1. Stream width, average depth, and mean velocity from a streamflow measurement or other suitable source.

2. Average concentration of suspended sediment preferably from depth-integrated samples, but the concentration can be computed above some specific distance from the stream bed from point-integrated samples.

3. Size analyses of the suspended sediment that was included in the average concentration.

4. Average depth at the verticals where the suspended-sediment samples were collected.

5. Size analyses of the bed material.

6. Water temperature.

For a stream such as the Niobrara River near Cody, bed-material samples that were collected over a period and a range of water discharge may be averaged, because the bed-material size distribution does not seem to change significantly with either time or water discharge. (See p. 23-25.) If the bed-material size distribution at a section is likely to change from time to time, bed-material samples should be collected for size analyses at the time for which each computation of total sediment discharge is to be made.

In addition to these required data, point-integrated samples might be collected and analyzed for size and concentration. Then z_1's can be determined for comparison with z_2's. Also, total sediment discharge can be computed on the basis of the z_1's for comparison with total sediment discharge that was based on z_2's. However, point-integrated samples are not essential to the method, and z_1's do not give more accurate computed sediment discharges.

A good cross section for computations by the modified Einstein procedure has a uniform lateral distribution of depth, velocity, and concentration, a mean velocity at least 2.0 feet per second, and an average depth of at least 1.0 foot; also it is in a straight, undisturbed reach of alluvial channel. Sections far from ideal usually seem to give reasonably accurate computations even though the stream slope is changing somewhat along the reach, the section is at a slight contraction, or part of the stream bed is scoured down to bedrock. The flow does not have to be perpendicular to the section; but in computing the mean velocity and the cross-sectional area, any horizontal-angle correction must be applied to the width and not to the velocity. Sediment transportation varies as an exponential power of the velocity. Hence the sediment transportation should be computed along the direction of flow. The horizontal-angle corrections can be applied to measured lateral distances. This application of angle corrections is consistent with the assumption that sediment transportation varies directly with width.

No simple statement can now be made with respect to allowable variations in lateral distributions of depth and velocity in a cross section intended for use with computations of total sediment discharge by the modified procedure. In general, the lateral distribution of concentration probably is not critical if adequately defined by samples. If the flow and sediment across the section are not thoroughly mixed, for example, close below the mouth of a tributary, then the section may not be usable. Also, any section in which most of the area has velocities higher than 2.0 feet per second is probably satisfactory with respect to lateral distributions. Sections in which a relatively small area of the cross section has low velocities are usually satisfactory, but sections with large cross-sectional areas in which the flow is below 1.5 feet per second may not be satisfactory. Of course, such sections can be divided into two or more parts, and separate computations can be made for each if enough samples are taken across the stream.

For August 3, 1951, section C-2 was divided into two parts for sediment computation by the modified Einstein procedure. The total sediment discharge so computed varied little from that computed for the cross section as a unit. For section C-6 the cross section seemed to be least uniform laterally on August 3 and July 18, 1951, and on September 26, 1952. Sediment discharge on these 3 days was computed for 2 parts of the section. The sum of the sediment discharges for the 2 parts exceeded the discharge for the section as a whole by 5 percent for July 18, 1951. Even though the cross sections were far from uniform on the other 2 days, the computed sediment discharge was changed only about 1 percent by dividing the section into 2 parts.

SAMPLE COMPUTATION OF TOTAL SEDIMENT DISCHARGE

Probably the best way to learn or to evaluate the modified Einstein procedure is to follow through a sample computation. The computation form currently used is shown as plate 3. Computations for section C-2 of the Niobrara River near Cody for June 19, 1952, are entered on the form and will be explained in detail. Vertical lettering indicates information that is part of the basic computation form. Information and computations that are inserted on the form are in slant lettering. Most computations are to slide-rule accuracy only. Column numbers have been added to the form to simplify the explanations. In general, the terminology suggested by Einstein (1950) is followed, and symbols that have not already been defined are defined where they are first mentioned.

Figures of base data are first entered on the computation form in the box headed "Preliminary data and computations." The width, mean velocity, average depth, and average depth d_s at the sampling verticals all in foot-pound-second units are 118, 2.08, 0.98, and 1.22, respectively. These units are used throughout the computations except for sediment discharges that are represented by symbols with a Q and are in tons per day. On the average 65 percent of the bed material is finer than 0.00105 foot, and 35 percent is finer than 0.00075 foot. The mean concentration from depth-integrated samples is 262 ppm; Q_{sM}, measured sediment discharge (product of concentration in parts per million, streamflow in cubic feet per second, and 0.0027) is 163 tons per day; and water temperature is 64°F. The particle-size analyses of the suspended sediment at the time for which the computation is to be made, the average size distribution of suspended sediment for a mean concentration of 262 ppm, and the size distribution of the suspended sediment at the contracted section are listed at the bottom of this box on the computation form. The average size distribution is obtained for each size range from average curves of percentage of sediment in each size range versus sediment concentration in the sampled zone. An average size distribution may show large inaccuracies in an individual size analysis and indicate that the individual analysis should not be used. Also, the average size analyses can be used, and have been used although the computations are not shown on plate 3, to compute the sediment discharge at a normal section. (See p. 102.)

The computations begin with the determination of $(SR)_m$ from equation (E) (p. 83) for $\bar{u} = 2.08$ feet per second.

$$\sqrt{(SR)_m} = \frac{2.08}{5.75\sqrt{32.2}\,\log_{10}\dfrac{12.27\,d\,x}{k_s}}$$

Assume on the basis of past experience or an approximate computation on scratch paper that $x = 1.54$. Then

$$\sqrt{(SR)_m} = \frac{2.08}{32.6\,\log_{10}\dfrac{12.27 \cdot 0.98 \cdot 1.54}{0.00105}}$$

$$= 0.0150$$

$$(SR)_m = 0.000225$$

The shear velocity is computed from

$$u_m = \sqrt{(SR)_m}\sqrt{g}$$

$$= 0.0150 \cdot 5.68$$

$$= 0.0853$$

The kinematic viscosity, ν, is 0.0000114 square foot per second at 64°F. The thickness of the laminar sublayer, δ, is

$$\delta = \frac{11.6\,\nu}{u_m}$$

$$= \frac{11.6 \cdot 0.0000114}{0.0853}$$

$$= 0.00155$$

so

$$\frac{k_s}{\delta} = \frac{0.00105}{0.00155}$$

$$= 0.68$$

and from figure 44, $x = 1.54$. As the assumed x is the same as the computed x, no recomputation is necessary. In fact the whole quantity under the log sign is so large that x can differ considerably from its assumed numerical value without necessitating a recomputation.

By definition

$$P = 2.303 \log_{10} \frac{30.2\ dx}{k_s}$$

$$= 2.303 \log_{10} \frac{30.2 \cdot 0.98 \cdot 1.54}{0.00105}$$

$$= 10.7$$

Also $A' = d_n/d_s$ and d_n is the vertical distance, in feet, not sampled; that is, the distance from the bottom of the sampled zone to the stream bed. Thus

$$A' = \frac{0.3}{1.22}$$

$$= 0.246$$

Figure 45 indicates that 80 percent of the streamflow was sampled. The discharge through the sampled zone, Q_{ts}', of sediment particles of all sizes is 163 x 0.80 = 130 tons per day.

The next major step is the computation of i_BQ_B. (See "Computation of i_BQ_B" box on pl. 3.) Column 1 contains the geometric mean particle sizes in fractions of a foot for bed-material size ranges of 0.125 to 0.25, 0.25 to 0.5, 0.5 to 1.0, 1.0 to 2.0, and 2.0 to 4.0 millimeters. Neither smaller nor larger sized particles would have appreciable bed-load discharges. These geometric mean sizes are the square roots of the products of the limits of the size ranges.

The intensity of shear on the particles, Ψ_m, is computed from equations (H) and (I)

$$\Psi_m = \frac{1.65\ D_{35}}{(SR)_m} \qquad \text{equation (H)}$$

$$\Psi_m = \frac{0.66\ D}{(SR)_m} \qquad \text{equation (I)}$$

in which D is the geometric mean particle size from column 1. The number 1.65 is the specific gravity of the sediment particles

columns 8 to 11 and 13 and 14. Column 12 contains the ratio $(PJ_1'' + J_2'')/(PJ_1' + J_2')$ for each range of particle sizes. These ratios are computed from $P = 10.7$ and from entries in columns 8 to 11. Column 15 contains the numerical values of $PI_1'' + I_2'' + 1$.

Total discharge of sediment through the cross section is next computed for entry in column 16 (pl. 3) by multiplying together figures from column 2 and ratios from column 12 for the ranges of fine particle sizes and figures from columns 4 and 15 for the ranges of coarser particle sizes. The sum of the figures in column 16 is the computed total sediment discharge at the section. Column 18 contains, for comparison, the measured discharges of suspended sediment at the contracted section. The percentages by which the computed sediment discharges in the size ranges and the total sediment discharge differed from the measured sediment discharges at the contracted section are given in column 19.

The computation methods are different for the ranges of the finer particle sizes than for the ranges of the coarser particles because of two limitations. In the reference size range the two methods will compute the same sediment discharge if z_2 is precisely correct and if i_BQ_B is added to the computed discharge of the finer particles. (In the sample computation, i_BQ_B is not added to the computed discharge of sediment for the two ranges of smallest particle sizes because it is negligibly small.) Theoretically, either the $(PJ_1'' + J_2'')/(PJ_1' + J_2')$ method or the $PI_1'' + I_2'' + 1$ method can be used throughout the range of particle sizes. Practically, the first method is limited to ranges of particle sizes for which Q_s' can be determined with fair accuracy; the second method, to ranges of particle sizes for which i_b can be determined with fair accuracy. Another practical limitation on the choice of method is that a given percentage of variation in z_2 changes the computed sediment discharges more by the first method when z_2 is large and more by the second method when z_2 is small.

The bottom part of the computation form (pl. 3) is for computations that are based on z_1's from point-integrated samples, z_3's from measured sediment discharges at a contracted section (that is, a section at which nearly total sediment discharge can be measured), or z_4's (z's computed from an empirical equation). Columns 1, 2, 5, and 7 are filled in with the same figures as for the computation that is based on z_2's. The z for the reference size is listed in column 6. Then the z's for other size ranges are computed by use of plate 1 and are also entered in column 6.

The sample computation on plate 3 is for a z_4 computed from the equation $z_4 = 4.6\ (V_s)^{0.7}$. Equation (C) can be used to compute i_BQ_B for the reference size range. Thus if $z_4 = 0.69$,

$A' = 0.246$, and $A'' = 0.00118$;

$$i_BQ_B = \frac{J_1'' \, Q_s'}{I_1'' \, (PJ_1' + J_2')}$$

$$= \frac{2.21 \cdot 51}{3.90 \, (10.7 \cdot 0.62 - 0.47)}$$

$$= 4.69$$

For other size ranges in which Q_s' cannot be measured satisfactorily, i_BQ_B can be assumed to be proportional to the figures in column 8 of the upper right computation box. For the reference size, the ratio of bed-load discharges is 4.69/8.30. The figures of column 8 can each be multiplied by this ratio to obtain the figures for column 4 of the lower computation box. The figures in columns 8 to 19 are computed in the same way as for the method that is based on z_2's.

As the sample computations are not based on z_1's, additional suggestions might be helpful. The z_1's can be used directly for each size range for which they are known, the z_1 for the reference size only can be used and the other z's can be computed from plate 1, or the z_1's can be weighted to obtain an average z_1 for the reference size. The last method was used for this report. The z_1's for size ranges other than the reference size were divided by the multipliers from plate 1 to obtain z_1's that would be equivalent to z_1's for the reference size. The equivalent z_1's and the z_1 for the reference size were then weighted according to percentage of sediment in their size ranges to get a weighted z_1 for the reference size. Thus all the z_1's were given at least some weight. The z_1's for all other size ranges were computed from the multipliers of plate 1.

The measured sediment discharge at the contracted section is measured only in the sense that it is based more or less directly on the concentration of samples that were collected in the contracted section. Several computations were involved in trying to adjust the water discharge and sediment concentration at the contracted section to make them comparable to those at a normal section. On June 15, 1951, at section C-2 a water discharge of 322 cfs was measured at 11 a.m., and sediment samples were collected at 12:10 p.m. Time of travel of water from the gaging station to section C-2 was estimated to be 30 minutes on the basis of measured velocity and distance between sections. Thus at the gaging station the equivalent measuring and sampling times were 10:30 a.m. and 11:40 a.m. Between these 2 times the stage at the gage dropped 0.04 foot, which according to the rating table is equivalent to a decrease in flow of 17 cfs. Hence, the water discharge at section C-2 at 12:10 p.m. is computed to be 305 cfs.

The measured sediment discharges at the contracted section (tables 34-36) have been adjusted for time of travel of the water and for changes in flow (p. 97-98) to make them directly comparable with computed sediment discharges at normal sections. Any one of these measured discharges may, however, be incorrect by 20 percent or more.

Variations of the modified Einstein procedure include computations that are based on z_1's, z_4's, or on the use of average size distributions rather than actual analyses of suspended sediment.

Sediment discharges computed from the z_1's, which were determined from the analyses of point-integrated samples, are given in table 35 and are plotted on figure 50. The method of computation is explained on pages 96-97. These computed sediment discharges compare well with measured sediment discharges at the contracted section when the z_1's for the size range from 0.125 to 0.250 millimeter are relatively large and hence are comparable with z_2's. The computed total sediment discharges tend to become too low as the z_1's decrease.

Total sediment discharge of a stream can be computed from z_4's, the z's that are computed from an equation. The equation

$$z_4 = 4.6\,(V_s)^{0.7} \qquad \text{equation (J)}$$

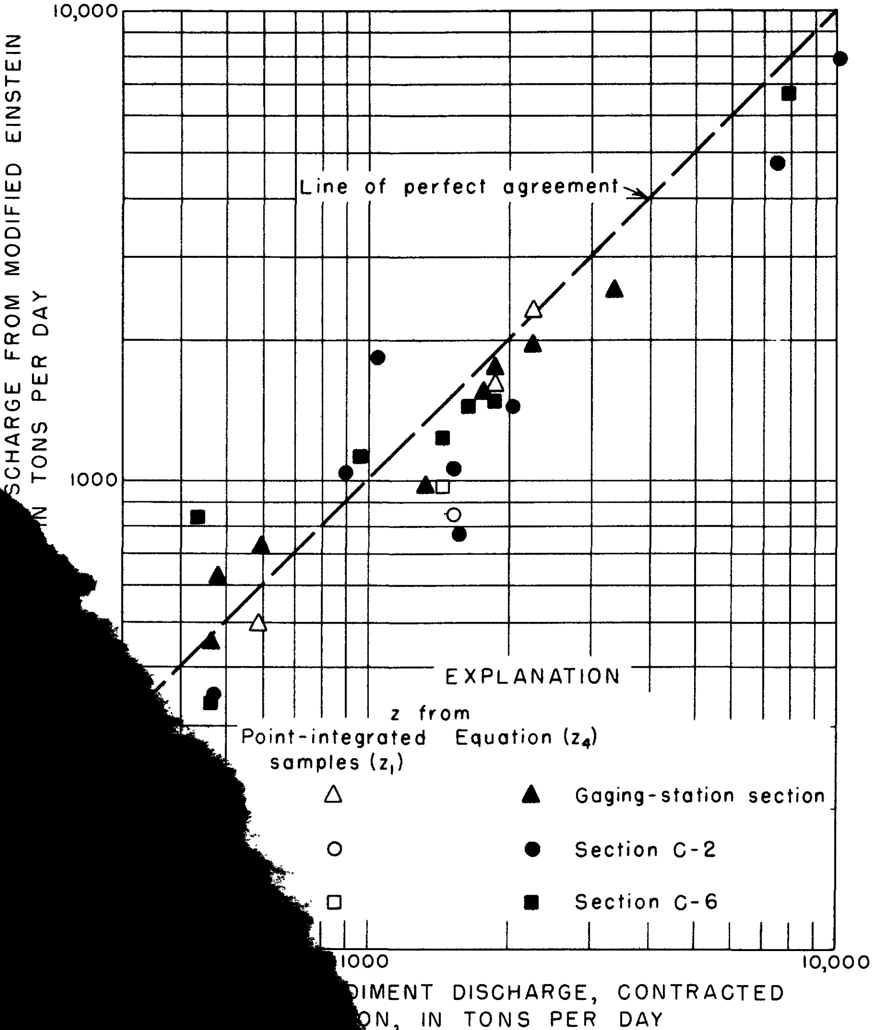
was used. This equation is based on variation of z_1's and z_3's with the 0.7 power of the fall velocity (figs. 40 and 42). The average of 10 determinations of z_3 for the Niobrara River near Cody and 4 determinations of z_3 for the Middle Loup River near Dunning, Nebr., was 0.68 for the size range from 0.125 to 0.250 millimeter. The corresponding average of fall velocities was 0.0645 foot per second. The equation defines a line on logarithmic coordinates that has a 0.7 slope and passes through the point that represents these averages. After the z_4's are computed from the equation, the method of computation is the same as for z_1's. For ease of computation, plate 1 can be used to compute z_4's for other size ranges from the z_4 for the reference size range. The fall velocities for different temperatures and ranges of particle sizes are given on figure 51. Total sediment discharges computed from the z_4's are given in table 36 and are plotted on figure 50. Of course, if z_4 exactly equals z_2 for the reference size range and for a particular time and cross section, the tonnages computed in the upper and the lower parts of the main computation box of plate 3 will be the same except for small differences in rounding numbers during the computations.

One source of inaccuracy in computations of total sediment discharge by the modified Einstein procedure is unrepresentative size analyses of suspended sediment at the normal sections. As

Table 34.--Comparison of computed sediment discharge from modified Einstein procedure applied to normal sections with measured sediment discharge at contracted section

Date	Section	Sediment discharge (tons per day) Less than 0.062 mm	0.062 to 0.125 mm	0.125 to 0.25 mm	0.25 to 0.50 mm	0.50 to 1.00 mm	1.00 to 2.00 mm	2.00 to 8.00 mm	Total	Percentage of measured sediment discharge
1950										
Mar. 3...	Gaging station.	328	436	883	411	57	6	2	2,120	113
	Contracted.....	243	374	842	337	19	56	....	1,870	....
May 11...	Gaging station.	324	725	1,345	675	89	12	6	3,180	95
	Contracted.....	301	501	1,470	969	100	....	....	3,340	....
Aug. 30..	Gaging station.	436	251	649	351	46	4	1	1,740	99
	Contracted.....	475	229	493	493	70	....	....	1,760	....
1951										
Apr. 27..	Gaging station.	190	473	948	504	70	7	3	2,200	98
	Contracted.....	269	448	829	582	112	....	....	2,240	....
May 10...	Gaging station.	77	218	561	316	44	4	1	1,220	92
	Contracted.....	93	213	559	426	40	....	....	1,330	....
June 15..	C-2 1/........	62	289	988	576	45	2	....	1,960	187
	Contracted.....	105	178	766	.....	....	....	....	1,050	....
July 18..	C-2...........	42	110	397	239	17	1	....	806	90
	Contracted.....	72	126	405	261	36	....	....	900	....
	C-6 2/........	43	28	425	285	39	2	....	822	86
	Contracted.....	77	134	433	278	38	....	....	960	....
Aug. 3...	C-2 1/........	418	7	242	182	17	1	....	867	56
	Contracted 3/..	328	203	499	468	31	16	16	1,560	....
	C-6...........	212	202	515	371	58	5	....	1,360	83
	Contracted 3/..	344	213	525	492	33	16	16	1,640	....
Sept. 6..	C-2...........	4,190	1,040	1,960	1,220	142	24	13	8,590	85
	Contracted.....	4,140	1,010	2,220	2,320	303	101	....	10,100	....
	C-6...........	2,950	825	1,740	875	152	31	8	6,580	84
	Contracted.....	3,220	785	1,730	1,800	236	78	....	7,850	....
1952										
Apr. 1...	C-2...........	1,020	1,030	2,240	1,140	130	20	11	5,590	75
	Contracted 4/..	963	1,410	2,890	2,000	148	....	....	7,410	....
May 8....	C-2...........	216	436	617	382	39	3	1	1,690	83
	Contracted 5/..	284	304	832	568	41	....	....	2,030	....
	C-6...........	192	336	507	256	29	1	....	1,320	71
	Contracted.....	262	280	767	524	37	....	....	1,870	....
June 19..	Gaging station.	44	67	259	133	11	....	....	514	107
	Contracted.....	53	67	216	130	14	....	....	480	....
	C-2...........	46	53	186	124	11	....	....	420	89
	Contracted.....	52	66	212	127	14	....	....	470	....
	C-6...........	42	50	128	74	8	....	....	302	66
	Contracted.....	51	64	207	124	14	....	....	460	....
Sept. 26.	Gaging station.	31	63	226	108	10	....	....	438	94
	Contracted.....	42	65	223	126	9	....	....	465	....
	C-2...........	30	47	188	136	13	1	....	415	112
	Contracted.....	33	52	178	100	7	....	....	370	....
	C-6...........	38	63	297	206	24	1	....	629	146
	Contracted.....	39	60	206	116	9	....	....	430	....

See footnotes at end of table.



computed total sediment discharge
ocedure based on z_1's and z_4's
ischarge at the contracted section.

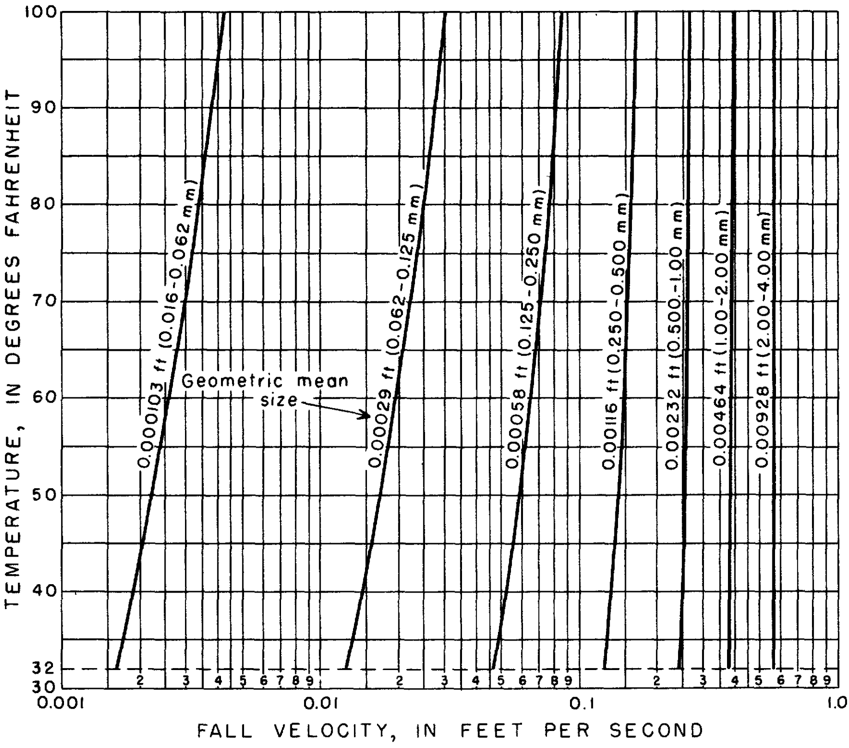


Figure 51.--Variation of fall velocity with temperature.

Table 37.--Percentage comparison between sediment discharge computed by the modified Einstein procedure and measured sediment discharge at the contracted section

Date	Computed total sediment discharge at a normal section in percentage of measured discharge					
	Less than 0.062 mm	0.062 to 0.125 mm	0.125 to 0.250 mm	0.250 to 0.500 mm	More than 0.500 mm	All sizes
Gaging-station section						
1950						
Mar. 3......	135	117	105	122	87	113
May 11......	108	145	92	70	107	95
Aug. 30.....	92	110	132	71	73	99
1951						
Apr. 27.....	71	106	114	87	71	98
May 10......	83	102	100	74	122	92
1952						
June 19.....	83	100	120	102	79	107
Sept. 26....	74	97	101	86	111	94
1953						
July 8......	92	114	144	105	44	114
Average...	92	111	114	90	87	102
Section C-2						
1951						
June 15 1/..	59	162	129	....	....	187
July 18.....	58	87	98	92	50	90
Aug. 3 1/...	127	3	48	39	38	56
Sept. 6.....	101	103	88	53	44	85
1952						
Apr. 1......	106	73	78	57	109	75
May 8.......	76	143	74	67	105	83
June 19.....	88	80	88	98	79	89
Sept. 26....	91	90	106	136	200	112
1953						
May 20......	106	91	87	121	193	100
Average...	89	95	88	89	111	91
Section C-6						
1951						
July 18.....	56	21	98	103	108	86
Aug. 3......	62	95	98	75	97	83
Sept. 6.....	92	105	101	49	61	84
1952						
May 8.......	73	120	66	49	81	71
June 19.....	82	78	62	60	57	66
Sept. 26....	97	105	144	178	2/ 278	146
1953						
May 20......	98	60	101	129	2/ 303	101
Average...	80	83	96	92	115	91

1 Incorrect size analysis; omitted from averages.
2 Used as 200 percent in computing average.

to high percentages, which frequently were based on small tonnages of sediment. All percentage figures of table 37 were based directly on sediment discharges in table 34.

Vertical distribution of sediment in the size range below 0.062 millimeter is so nearly uniform that errors in its computation by the modified Einstein procedure are almost negligible. That is, inaccuracy in the percentages in the column for sediment finer than 0.062 millimeter is due almost entirely to inaccurate basic information rather than to errors in computation. Similarly, large inaccuracies in percentages for the size range from 0.062 to 0.125 millimeter are due to unreliable basic information rather than to the computation procedure, for computation errors are necessarily small in this size range. Therefore, the percentages for the range of smallest particles and, to a slightly less degree, for the range of next larger sizes are measures of the inaccuracy of the basic data. Variations in these percentages and inaccuracy in averages of these percentages probably indicate approximately the minimum amount of inaccuracy to be expected in the computed percentages for the ranges of larger sizes.

Except for sediment larger than 0.5 millimeter (tonnages of such sediment are small), individual and average percentages from table 37 show about as close comparisons for sediment coarser than 0.125 millimeter as for the 2 ranges of smallest particles.

On the basis of the few computations that have been made with z's from point-integrated samples, the use of z_1's rather than trial-and-error z_2's decreased the accuracy of the computations of total sediment discharge.

Total sediment discharges from z_4's that were computed from equation (J) are plotted in figure 50. They are somewhat more erratic and average a little lower than the other computed sediment discharges. Also, an equation of this type for computing z_4's contains no parameter of flow or turbulence and is not likely to be generally applicable to other streams than the one for which it is defined.

Total sediment discharges computed from average size distributions show no clear-cut advantages except when they are used in place of obviously incorrect suspended-sediment size analyses, such as those for section C-2 on June 15 and August 3, 1951.

The modified Einstein procedure with trial-and-error z_2's and with actual size analyses of the suspended sediment has not been applied to enough streams to learn its limitations. Six computed total sediment discharges for the Niobrara River near Valentine, Nebr., ranged from 76 to 129 percent and averaged 112

8. For sections C-1 to C-10 the total sediment discharge obtained by adding measured discharge of sediment finer than 0.125 millimeter to sediment discharge that was computed from the Einstein formulas for coarser particles averaged 111 percent (8 determinations) of the measured sediment discharge at the contracted section. Similarly computed sediment discharges, 8 for section C-2 and 2 for the gaging-station section, were erratic and averaged several times the measured tonnages. The size distribution of the computed sediment discharge was usually much different than that of the measured sediment discharge.

9. The equation $z = V_s/0.4\,u_*'$ is not applicable for computing an exponent that will agree with either the actual vertical distribution of suspended sediment, z_1, or the exponent, z_3, that will make the computed sediment discharge equal the measured sediment discharge at the contracted section. From one size range to another, z_1 and z_3 vary as about the 0.7 power of the fall velocity of the geometric mean particle size if the fall velocity is based on equations given by Rubey (1933). The shear velocity as computed from the velocity equation and from measured average velocities shows no consistent inverse variation with z_1 or z_3. Also 0.4, which represents the universal constant of turbulent exchange, k, is questionable. Three computations of k based on vertical distributions of velocity in the sampling zone ranged from 0.42 to 2.8. The low k was for a time when z_1 was unusually high, and the high k, for a time when z_1 was unusually low.

10. For particle sizes smaller than 0.5 millimeter, Einstein's ξ (1950, p. 36) varies about inversely as the geometric mean particle size for z's that are about 0.5 to 0.8 and that vary with the 0.7 power of the fall velocity.

11. A promising modified procedure based on Einstein's formulas was developed for computing total sediment discharge from streamflow measurements, depth-integrated samples, bed-material samples, and water temperatures. In 24 comparisons, some based on the gaging-station section and some on sections C-2 and C-6, the computed total sediment discharge ranged from 56 to 187 percent and averaged 97 percent of the measured sediment discharges at the contracted section. If 2 computations that were based on unrepresentative size analyses of suspended sediment were omitted, the remaining 22 comparisons ranged from 66 to 146 percent and averaged 95 percent of the measured sediment discharges at the contracted section.

12. The computation inaccuracies from the modified procedure for the size range of sediment smaller than 0.062 millimeter and to a slightly lesser degree for the size range from 0.062 to 0.125 millimeter are so small that the computed total sediment

discharges in these size ranges are good indicators of the accuracy of the basic information. Comparisons for sediment discharges in these two size ranges are little, if any, better than for the computed sediment discharges in the ranges of larger particle sizes. Similarly, average percentages for each normal section show that comparisons for computed total discharges of sediment of all sizes are as good or better than those for the computed discharges for the two ranges of smallest particle sizes. In these two ranges the inaccuracies are nearly independent of computation methods.

13. Size distributions of the total sediment discharges that were computed by the modified Einstein procedure agreed reasonably well with size distributions of the measured sediment discharges at the contracted section.

14. Principal disadvantages of the modified Einstein procedure for computing total sediment discharge are inaccuracies and uncertainties with respect to vertical velocity distribution and other variables and relationships of the Einstein procedure, amount of time required for the computations, and need for obtaining streamflow measurements and accurate size distributions of suspended sediment and bed material. Further development of the method should decrease these inaccuracies and uncertainties and shorten the required time for the computations.

15. Besides reasonably good accuracy of particle-size distribution and quantities of computed total sediment discharge, the outstanding advantage of the modified Einstein procedure for computing total sediment discharges is that it greatly reduces the necessary field work. Information is collected only at one cross section, and neither point-integrated samples nor water-surface slopes are required.

		See page
G	Discharge of bed material, in pounds per second	56
g	The gravity constant, 32.2 feet per second per second	70
I_1	Mathematical abbreviation which contains J_1	77
I_2	Mathematical abbreviation which contains J_2	77
$i_B Q_B$	Sediment discharge through the bed layer of particles of a size class, in tons per day	78
$i_B q_B$	Sediment discharge through the bed layer of particles of a size class, in pounds per second per foot of width	78
i_b	Fraction by weight of bed material in a size range	85
J_1	Equals $\int_A^1 \left(\frac{1-y}{y}\right)^z dy$	77
J_2	Equals $\int_A^1 \left(\frac{1-y}{y}\right)^z \log_e (y)\, dy$ and J_2 is always negative	77
K	Constant for a given time and cross section to simplify Einstein's equation (34)	78
K_1	Constant to be defined for computing bed-material discharge	59
K_2	Equals $43.2\ K_1$	59
k	The universal constant for turbulent exchange	70
k_s	Roughness diameter, that particle size of bed material for which 65 percent by weight is finer	75
M	Slope, averaged for all verticals, of the semilogarithmic graph of velocity versus $P/2.303$. It is used to compute k	75
m	Subscript denoting quantity that is computed according to the modified Einstein procedure	70

		See page
P	Equals 2.303 $\log_{10}$ (30.2 d x/k_s)	77
P_c	Percentage of suspended sediment finer than any given size at the contracted section	50
P_n	Percentage of suspended sediment finer than any given size at the gaging-station section	50
P_u	Percentage finer than any given size in the unmeasured sediment discharge at the gaging-station section	50
Q	Water discharge	23
Q_{BM}	Sediment discharge of bed material (or assumed to be bed material), in tons per day	59
Q_s	Discharge of sediment of a size range, in tons per day	78
Q_{sM}	Measured suspended-sediment discharge; the product of water discharge and total concentration of suspended sediment of all particle sizes, in tons per day	91
Q_{ts}'	Sediment discharge through the sampled zone of all particle sizes, in tons per day	93
Q_s'''	Measured suspended-sediment discharge through the contracted section of sediment of a given size range, in tons per day	82
q_{BM}	Sediment discharge of bed material, in pounds per second per foot of width	59
q_s	Suspended-sediment discharge of particles of a size range, in pounds per second per foot of width	78
R	Hydraulic radius with respect to the sediment particles	79
S_e	Slope of the energy gradient	56
S_s	Specific gravity of the solid sediment particles	84
$(SR)_m$	Computed product of slope and hydraulic radius from velocity equation and measured average velocity in the cross section	83

TABLES OF BASIC DATA

Table 1.--Streamflow measurements, Niobrara River near Cody, Nebr., ford section

Date	Made by	Width (feet)	Cross-sectional area (sq ft)	Mean velocity (fps)	Gage height (feet)	Dis-charge (cfs)	Number of sections
1948							
Apr. 9..	Zellars.	126	108	3.48	1.16	376	48
Apr. 22.	...do...	120	113	3.58	1.19	404	46
Apr. 27.	...do...	124	138	3.90	1.51	539	49
May 7...	...do...	112	118	3.28	1.16	387	44
May 13..	...do...	121	120	3.54	1.22	425	47
May 27..	...do...	119.5	93.9	3.26	1.01	304	42
June 1..	...do...	119	87.7	2.94	.92	258	41
June 15.	...do...	120	89.5	3.11	.96	278	54
June 23.	...do...	119	134	3.97	1.41	532	34
June 30.	...do...	118.5	100	3.58	1.12	358	43
July 13.	...do...	118	88.2	2.97	.97	262	41
July 20.	...do...	119	118	3.81	1.20	450	42
Aug. 2..	...do...	118	84.4	3.15	.99	266	42
Aug. 18.	...do...	118	85.7	2.89	.94	248	53
Sept. 8.	...do...	116.5	80.0	3.00	.91	240	57
Oct. 13.	Vice....	115	83.9	3.10	.98	260	29
1949							
Jan. 27.	Zellars.	119	116	2.42	1.47	281	27
Feb. 16.	...do...	117	112	2.87	1.23	322	34

Table 2.--Sediment-discharge measurements, ford section

Date	Time	Gage height (feet)	Water discharge (cfs)	Suspended sediment	
				Mean concentration (ppm)	Discharge (tons per day)
1948					
June 12.....	1:20 p.m.	0.93	263	427	303
July 20.....	6:00 p.m.	1.21	436	1,400	1,650
Sept. 8.....	6:52 p.m.	.91	234	410	259
Oct. 13.....	3:05 p.m.	.98	268	538	389

Table 3.—Particle-size analyses of suspended sediment, ford section

[Method of analysis: Bottom-withdrawal tube in native water]

Date	Time	Water discharge (cfs)	Suspended sediment							
			Concentration of sample (ppm)	Concentration of suspension analyzed (ppm)	Percent finer than indicated size, in millimeters					
					0.016	0.031	0.062	0.125	0.250	0.500
1948										
June 12..	1:20 p.m.	263	427	1,640	3	5	14	52	94	99
July 20..	6:00 p.m.	436	1,400	2,810	38	46	56	69	88	96
Sept. 8..	6:52 p.m.	234	410	842	12	16	27	50	87	98
Oct. 13..	3:05 p.m.	268	538	....	2	4	10	26	94	100

Table 4.--Streamflow measurements, Niobrara River near Cody, Nebr., gaging-station section

[Bureau of Reclamation employees making measurements were J. Busalacchi, C. R. Miller, D. B. Raitt, R. Wertenberger, and G. J. Whitsel]

Date	Made by	Width (feet)	Cross-sectional area (sq ft)	Mean velocity (fps)	Gage height (feet)	Discharge (cfs)	Number of sections	Water-surface slope (ft per mile)
1947								
Dec. 14..	Zellars................	69	102	3.26	0.88	333	34	....
Dec. 18..	.....do................	74	95.4	3.17	.90	302	37	....
Dec. 27..	.....do................	74	104	3.38	1.11	351	37	....
1948								
Jan. 5...	.....do................	74	106	3.43	1.13	364	37	....
Jan. 12..	.....do................	74	106	3.14	1.05	333	37	....
Jan. 21..	.....do................	74	101	3.37	1.04	340	37	....
Jan. 29..	.....do................	73	79.2	3.01	.84	238	37	....
Feb. 4...	.....do................	73	92.6	2.90	.90	269	37	....
Feb. 21..	.....do................	73	107	3.22	1.07	345	35	....
Mar. 4...	.....do................	74	105	3.23	1.05	339	35	....
Mar. 13..	.....do................	73	92.2	3.32	.95	306	41	....
	.....do................	76	120	4.21	1.31	506	38	....
Mar. 16..	.....do................	81	210	5.62	2.43	1,180	27	....
Mar. 19..	.....do................	74	138	3.80	1.36	524	37	....
Mar. 29..	.....do................	74	125	3.78	1.35	473	37	....
July 20..	.....do................	72	118	3.62	1.24	428	36	....
Aug. 25..	.....do................	69	86.5	2.58	.88	223	38	....
Sept. 8..	.....do................	70	105	2.31	.96	243	38	....
Sept. 25.	.....do................	70	107	3.06	1.09	327	45	....
Oct. 5...	.....do................	70	94.8	2.81	.97	266	35	....
Oct. 13..	Vice...................	69	89.8	2.90	.98	260	28	....
Oct. 14..	Zellars................	70.5	94.6	2.96	1.00	280	43	....
Oct. 25..	.....do................	71	96.2	3.12	1.07	300	37	....
Nov. 3...	.....do................	71	102	3.20	1.09	326	44	7.6
Nov. 17..	.....do................	72	105	3.24	1.11	340	44	8.2
Nov. 30..	.....do................	71	102	3.29	1.08	332	36	7.7
Dec. 8...	.....do................	72	95.7	3.10	1.02	297	35	....
Dec. 20..	.....do................	71	100	2.94	.97	294	35	....
1949								
Mar. 3...	.....do................	73	201	4.84	2.16	973	35	....
Mar. 27..	.....do................	72	132	4.14	1.44	546	36	....
Apr. 26..	.....do................	70	105	3.24	1.04	340	35	....
May 16...	.....do................	72	119	3.86	1.26	460	36	....
June 1...	.....do................	70.5	118	3.07	1.07	363	36	....

Table 4.--Streamflow measurements, Niobrara River near Cody, Nebr., gaging-station section--Continued

Date	Made by	Width (feet)	Cross-sectional area (sq ft)	Mean velocity (fps)	Gage height (feet)	Discharge (cfs)	Number of sections	Water-surface slope (ft per mile)
1953--Con.								
Apr. 16..	Zellars...............	71	106	3.41	1.08	363	31	8.5
Apr. 22..	Hubbell...............	71	107	3.36	1.09	360	22	....
May 3....	Ericson...............	71	152	4.36	1.56	663	27	....
May 19...	.....do...............	72	98.3	3.47	1.06	341	36	....
May 20...	Johnson, Busch.........	70	110	3.36	1.16	370	28	....
June 2...	Ericson...............	60	80	3.30	.91	264	30	....
June 10..	Stevens, Alden.........	69	122	2.69	1.02	328	25	....
June 18..	Calver, Ericson........	61	87.7	2.70	.82	236	26	....
June 29..	Calver.................	69	109	2.14	.79	234	25	....
July 8...	Johnson, Kasparek......	69	117	2.41	.90	283	26	....
July 15..	Steele.................	71	124	1.82	.76	225	37	....
July 27..	Calver.................	66	89.7	2.63	.81	233	40	....
Aug. 4...	Hull, Busch............	70	115	2.51	.92	289	24	....
Aug. 12..	Steele.................	68	98.7	2.35	.78	232	36	7.0
Aug. 27..	Steele, Ericson........	70	108	2.18	.76	236	36	....
Sept. 9..	Calver.................	63	83.9	2.65	.78	221	23	....
Sept. 10.	Hull, Kasparek.........	69	98	2.33	.78	228	22	....
Sept. 22.	Steele.................	70	106	2.22	.78	235	25	....

Table 5.--Sediment-discharge measurements, gaging-station section

Date	Time	Gage height (feet)	Water discharge (cfs)	Suspended sediment		Water temperature (°F)
				Mean concentration (ppm)	Discharge (tons per day)	
1947						
Dec. 17......	10:42 a.m.	......	....	842	....	....
Dec. 18......	3:10 p.m.	0.90	248	794	532	....
Dec. 27......	1:50 p.m.	1.11	355	951	912	....
1948						
Jan. 5.......	2:45 p.m.	1.13	366	1,110	1,100	....
Jan. 21......	12:05 p.m.	1.05	334	737	665	....
Jan. 29......	12:30 p.m.	.84	238	656	421	....
Feb. 4.......	12:40 p.m.	.90	268	773	559	....
Feb. 21......	12:40 p.m.	1.06	350	1,180	1,120	....
Mar. 4.......	1:10 p.m.	1.02	329	946	840	....
Mar. 13......	12:35 p.m.	1.07	371	1,330	1,330	....
Mar. 16......	3:50 p.m.	2.41	1,160	3,470	10,900	....
Mar. 19......	12:55 p.m.	1.36	492	1,280	1,700	....
Mar. 29......	1:10 p.m.	1.35	486	1,070	1,400	....
Apr. 9.......	1:50 p.m.	1.16	382	844	870	....
Apr. 27......	1:00 p.m.	1.58	620	1,460	2,440	....
May 7........	9:30 a.m.	1.16	382	894	922	....
May 13.......	10:10 a.m.	1.23	420	648	735	....
May 27.......	2:00 p.m.	1.02	308	720	599	....
June 1.......	1:45 p.m.	.94	268	534	386	....
June 15......	12:20 p.m.	.97	283	406	310	....
June 23......	12:20 p.m.	1.44	537	1,280	1,860	....
June 30......	9:20 a.m.	1.15	376	721	732	....
July 13......	12:00 m.	.96	258	328	228	....
July 20......	8:40 p.m.	1.24	452	1,370	1,670	....
Aug. 2.......	10:30 a.m.	1.00	278	475	356	....
Aug. 18......	9:50 a.m.	.92	238	634	407	....

Table 5.--Sediment-discharge measurements, gaging-stetion section--Continued

Date	Time	Gage height (feet)	Water discharge (cfs)	Suspended sediment		Water temperature (°F)
				Mean concentration (ppm)	Discharge (tons per day)	
1948--Con.						
Aug. 25......	11:35 a.m.	0.88	219	394	233	....
Sept. 8......	6:15 p.m.	.90	229	389	241	....
Sept. 25.....	2:45 p.m.	1.06	308	518	431	....
Oct. 5.......	2:10 p.m.	.97	263	366	260	....
Oct. 13......	4:45 p.m.	.96	258	483	336	....
Oct. 14......	4:15 p.m.	.96	258	340	237	....
Oct. 25......	1:00 p.m.	1.06	308	492	409	....
Nov. 3.......	3:20 p.m.	1.06	308	564	469	....
Nov. 17......	2:20 p.m.	1.10	329	751	667	....
Dec. 8.......	1:55 p.m.	1.00	288	864	672	....
Dec. 20......	2:50 p.m.	.96	278	643	483	....
1949						
Feb. 16......	2:50 p.m.	......	320	423	365	....
Feb. 25......	10:30 a.m.	1.29	452	775	945	....
Mar. 3.......	9:20 a.m.	2.13	972	2,990	7,850	....
Mar. 8.......	4:00 p.m.	1.76	732	1,970	3,890	....
Mar. 27......	3:25 p.m.	1.43	531	1,220	1,750	....
Apr. 26......	2:10 p.m.	1.00	319	634	546	....
May 16.......	1:40 p.m.	1.25	452	859	1,050	....
June 1.......	12:15 p.m.	1.03	340	613	563	....
June 14......	2:15 p.m.	1.11	366	584	577	....
June 27......	1:20 p.m.	.90	253	408	279	....
July 13......	3:55 p.m.	.88	234	219	138	....
July 27......	3:20 p.m.	.81	210	243	138	....
Aug. 9.......	12:05 p.m.	.86	238	299	192	....
Aug. 31......	3:40 p.m.	.84	234	366	231	....
Sept. 29.....	3:30 p.m.	.82	224	362	219	....
Oct. 6.......	2:20 p.m.	1.49	578	1,940	3,030	....
Oct. 22......	4:45 p.m.	.98	298	482	388	....
Nov. 14......	12:00 m.	1.02	319	661	569	....
Nov. 29......	12:20 p.m.	1.03	324	682	597	....
1950						
Jan. 27......	2:35 p.m.	1.07	291	451	354	....
Feb. 10......	3:55 p.m.	1.14	344	324	301	....
Feb. 24......	2:15 p.m.	1.21	436	1,350	1,590	....
Mar. 3.......	4:15 p.m.	1.13	392	1,060	1,120	....
Mar. 5.......	9:25 a.m.	1.16	408	1,550	1,710	....
Mar. 14......	3:30 p.m.	1.18	420	1,460	1,660	....
Mar. 21......	12:50 p.m.	1.11	382	893	921	....
Mar. 30......	12:00 m.	1.18	420	1,050	1,190	....
Apr. 12......	12:55 p.m.	1.20	430	963	1,120	....
Apr. 14......	11:25 a.m.	1.14	398	813	874	....
May 4........	12:20 p.m.	1.16	387	745	778	....
May 11.......	11:40 a.m.	1.36	566	1,040	1,590	....
May 20.......	12:50 p.m.	1.34	555	528	791	....
June 7.......	10:45 a.m.	.92	258	421	293	....
June 13......	1:40 p.m.	.85	224	366	221	....
July 9.......	3:25 p.m.	.85	234	484	306	....
July 20......	1:20 p.m.	.95	258	620	432	....
Aug. 2.......	9:25 a.m.	.97	268	457	331	....
Aug. 9.......	12:50 p.m.	.94	253	1,030	704	....
Aug. 27......	10:45 a.m.	2.15	972	4,430	11,600	....
Aug. 30......	8:30 a.m.	1.09	376	956	971	....
Sept. 5......	9:20 a.m.	.87	253	537	367	....
Sept. 18.....	1:15 p.m.	.98	298	570	459	....
Sept. 20.....	12:10 p.m.	1.00	324	711	622	....
Oct. 6.......	9:10 a.m.	.98	302	655	534	50
Oct. 31......	10:50 a.m.	1.02	319	498	429	48
Nov. 2.......	12:00 m.	1.00	310	683	572	43
Nov. 15......	1:25 p.m.	1.03	324	670	586	40
Dec. 7.......	2:10 p.m.	1.07	203	302	166	33

Table 5.--Sediment-discharge measurements, gaging-station section--Continued

Date	Time	Gage height (feet)	Water discharge (cfs)	Suspended sediment		Water temperature (°F)
				Mean concentration (ppm)	Discharge (tons per day)	
1951						
Jan. 1.......	2:30 p.m.	0.99	306	836	691	33
Jan. 23......	4:00 p.m.	.97	319	942	811	34
Jan. 25......	10:20 a.m.	.90	310	880	737	37
Feb. 14......	3:00 p.m.	1.00	300	430	348	34
Mar. 7.......	1:00 p.m.	1.06	385	1,870	1,940	32
Mar. 15......	9:40 a.m.	1.15	430	1,220	1,420	35
Mar. 21......	11:00 a.m.	.90	310	1,020	854	39
Apr. 4.......	1:10 p.m.	.98	346	730	682	48
Apr. 17......	12:55 p.m.	.96	337	516	470	51
Apr. 27......	11:45 a.m.	1.17	440	874	1,040	58
May 1........	11:20 a.m.	1.07	380	721	740	55
May 10.......	10:15 a.m.	.93	314	558	473	52
May 23.......	1:45 p.m.	1.10	395	594	634	69
May 24.......	10:20 a.m.	1.13	410	782	866	....
June 7.......	1:50 p.m.	.99	342	922	851	70
June 15......	10:40 a.m.	.94	319	516	444	70
June 30......	3:00 p.m.	.86	286	461	356	66
July 18......	11:00 a.m.	.97	298	470	378	78
July 23......	11:30 a.m.	.89	266	406	292	70
July 29......	5:42 a.m.	4.50	2,700	3,710	27,000	....
	8:12 a.m.	5.77	3,760	5,520	56,000	73
	2:40 p.m.	3.93	2,240	5,980	36,200	....
Aug. 2.......	6:40 p.m.	1.12	324	742	649	74
Sept. 6......	12:00 m.	1.83	760	2,860	5,870	66
Sept. 8......	10:50 a.m.	1.31	460	594	738	....
Sept. 24.....	1:40 p.m.	1.02	319	456	393	51
Oct. 7.......	2:50 p.m.	.98	302	488	398	56
Oct. 24......	11:00 a.m.	1.06	324	572	500	46
Nov. 5.......	3:55 p.m.	1.17	360	948	921	36
Nov. 15......	8:50 a.m.	1.09	324	955	835	35
Dec. 3.......	1:20 p.m.	1.12	337	830	755	....
1952						
Jan. 9.......	2:00 p.m.	.99	298	294	237	32
Jan. 10......	1:45 p.m.	1.01	314	387	328	33
Jan. 29......	3:50 p.m.	.98	332	432	387	33
Feb. 8.......	1:30 p.m.	1.08	380	912	936	34
Feb. 12......	9:20 a.m.	1.13	405	1,180	1,290	35
Mar. 9.......	3:00 p.m.	1.09	385	802	834	....
Mar. 11......	12:50 p.m.	1.15	415	1,010	1,130	40
Mar. 30......	2:15 p.m.	2.03	935	3,340	8,430	47
Apr. 1.......	11:40 a.m.	1.60	662	2,030	3,630	....
Apr. 6.......	4:30 p.m.	1.20	440	951	1,130	....
Apr. 10......	12:20 p.m.	1.18	430	1,080	1,250	45
May 8........	10:45 a.m.	1.19	435	862	1,010	....
May 16.......	3:00 p.m.	1.11	395	734	783	62
May 24.......	1:20 p.m.	1.23	455	890	1,090	70
June 5.......	12:05 p.m.	1.04	306	514	425	76
June 15......	1:45 p.m.	.78	230	354	220	83
June 19......	11:35 a.m.	.78	230	458	284	69
July 4.......	10:10 a.m.	.90	278	462	347	73
July 20......	11:10 a.m.	.75	219	246	145	76
July 31......	1:45 p.m.	.73	212	204	117	83
Aug. 16......	10:05 a.m.	.84	254	394	270	72
Aug. 20......	10:30 a.m.	.78	223	354	213	73
Aug. 29......	11:00 a.m.	.74	208	245	138	73
Sept. 9......	3:05 p.m.	.72	219	260	154	75
Sept. 12.....	9:30 a.m.	.73	223	282	170	....

Table 5.--Sediment-discharge measurements, gaging-station section--Continued

Date	Time	Gage height (feet)	Water discharge (cfs)	Suspended sediment		Water temperature (°F)
				Mean concentration (ppm)	Discharge (tons per day)	
1952--Con.						
Sept. 26.....	11:10 a.m.	0.81	234	346	219	61
Oct. 11......	9:55 a.m.	.94	294	446	354	52
Oct. 12......	11:15 a.m.	.90	278	514	386	....
Oct. 23......	12:35 p.m.	.92	286	482	372	52
Oct. 28......	2:20 p.m.	.93	266	515	370	....
Nov. 13......	12:15 p.m.	.96	310	563	471	....
Dec. 6.......	3:50 p.m.	.98	319	791	681	....
Dec. 11......	2:00 p.m.	1.00	328	866	767	....
1953						
Jan. 9.......	1:00 p.m.	.90	294	1,020	810	....
Jan. 22......	1:40 p.m.	1.14	405	902	986	....
Feb. 3.......	1:15 p.m.	1.13	400	1,080	1,170	....
Feb. 27......	1:50 p.m.	1.37	490	1,580	2,090	....
Mar. 11......	9:20 a.m.	1.36	538	1,290	1,870	42
Mar. 27......	12:40 p.m.	1.05	350	934	883	....
Mar. 30......	2:50 p.m.	.99	324	728	637	....
Apr. 16......	2:35 p.m.	1.07	360	1,010	982	....
Apr. 22......	10:10 a.m.	1.08	365	605	596	....
July 8.......	5:30 p.m.	.90	278	471	354	....

Table 6.--Particle-size analyses of suspended sediment, point-integrated samples, gaging-station section

[Methods of analysis: B, bottom-withdrawal tube; N, in native water; W, in distilled water; S, sieve; M, mechanically dispersed; P, pipette; C, chemically dispersed]

Date	Time	Water discharge (cfs)	Sampling station	Total depth (feet)	Suspended sediment														Methods of analysis
					Sampling point			Percent finer than indicated size, in millimeters											
					Velocity (fps)	Depth (feet)	Concentration (ppm)	0.002	0.004	0.008	0.016	0.031	0.062	0.125	0.250	0.500	1.000		
1949																			
Mar. 8....	6:35 p.m.	732	95	1.9	5.83	1.0	2,450	.....	.....	.....	4	8	17	36	76	96	.....		BN
	6:20 p.m.	732	95	1.9	4.17	1.4	4,860	.....	.....	.....	2	3	8	21	70	96	.....		BN
	6:10 p.m.	732	115	2.6	6.09	.5	1,750	.....	.....	.....	3	6	14	43	93	99	.....		BN
	5:55 p.m.	732	115	2.6	5.73	1.5	2,750	.....	.....	.....	5	7	14	34	78	97	.....		BN
	5:45 p.m.	732	115	2.6	3.77	2.1	4,200	.....	.....	.....	3	6	11	24	69	98	.....		BN
	5:30 p.m.	732	135	3.6	5.21	.5	920	.....	.....	.....	10	21	43	72	100	.....	.....		BN
	5:15 p.m.	732	135	3.6	4.80	1.5	1,190	.....	.....	.....	10	15	32	67	96	99	.....		BN
	5:10 p.m.	732	135	3.6	3.05	2.5	1,540	.....	.....	.....	5	9	23	64	97	100	.....		BN
	5:00 p.m.	732	135	3.6	2.70	3.1	1,900	.....	.....	.....	2	6	10	38	91	99	.....		BN
Apr. 8....	4:50 p.m.	398	95	1.5	3.38	.2	380	.....	.....	.....	.....	9	32	70	87	98	.....		BN
	4:45 p.m.	398	95	1.5	3.96	.6	570	.....	.....	.....	.....	8	24	60	92	99	.....		BN
	4:40 p.m.	398	95	1.5	3.74	.8	690	.....	.....	.....	.....	6	22	56	93	100	.....		BN
	4:35 p.m.	398	95	1.5	3.56	1.0	970	.....	.....	.....	.....	5	18	40	90	100	.....		BN
	4:15 p.m.	403	109	1.7	5.25	.2	570	.....	.....	.....	.....	.....	29	62	95	99	.....		BN
	4:10 p.m.	403	109	1.7	5.19	.6	1,140	.....	.....	.....	.....	.....	14	44	94	99	.....		BN
	4:00 p.m.	403	109	1.7	4.83	1.0	2,100	.....	.....	.....	.....	.....	9	28	86	98	.....		BN
	4:00 p.m.	403	109	1.7	4.38	1.2	2,640	.....	.....	.....	.....	2	7	27	83	98	.....		BN
	3:40 p.m.	403	119	2.0	4.72	.3	720	.....	.....	.....	5	10	22	54	83	97	.....		BN
	3:35 p.m.	403	119	2.0	5.03	.8	980	.....	.....	.....	1	1	16	44	86	98	.....		BN
	3:30 p.m.	403	119	2.0	4.97	1.3	1,520	.....	.....	.....	.....	.....	12	36	86	98	.....		BN
	3:20 p.m.	403	119	2.0	4.40	1.5	2,280	.....	.....	.....	2	3	8	28	83	98	.....		BN
	3:00 p.m.	403	129	2.1	3.95	.2	530	.....	.....	.....	12	14	32	65	97	99	.....		BN
	2:55 p.m.	403	129	2.1	4.74	.8	710	.....	.....	.....	9	13	28	58	85	97	.....		BN
	2:45 p.m.	403	129	2.1	4.53	1.2	770	.....	.....	.....	10	13	25	53	91	98	.....		BN
	2:40 p.m.	403	129	2.1	4.14	1.6	1,170	.....	.....	.....	3	6	16	40	81	98	.....		BN

	2:15 p.m.	408	139	2.3	3.21	.5	370	.....	.....	.....	.....	5	28	70	94	99	.....	BN
	2:10 p.m.	408	139	2.3	3.28	1.0	500	.....	.....	.....	10	18	39	68	94	99	.....	BN
	2:05 p.m.	408	139	2.3	3.20	1.5	530	.....	.....	.....	.....	8	23	58	90	99	.....	BN
	2:00 p.m.	408	139	2.3	2.69	1.8	710	.....	.....	.....	.....	3	22	52	85	98	.....	BN
May 5.....	5:05 p.m.	382	95	1.7	3.82	.4	680	.....	.....	.....	12	16	27	66	94	99	.....	BN
	5:00 p.m.	382	95	1.7	3.96	.8	1,020	.....	.....	.....	.....	8	18	48	91	99	.....	BN
	4:55 p.m.	382	95	1.7	3.80	1.2	1,620	.....	.....	.....	3	5	13	42	91	97	.....	BN
	4:35 p.m.	382	105	1.8	4.84	.4	820	.....	.....	.....	9	13	26	60	95	99	.....	BN
	4:30 p.m.	382	105	1.8	4.40	1.0	1,570	.....	.....	.....	.....	8	15	37	84	97	.....	BN
	4:25 p.m.	387	105	1.8	4.05	1.3	2,630	.....	.....	.....	1	2	7	25	98	100	.....	BN
	4:05 p.m.	387	115	2.1	4.06	.2	550	.....	.....	.....	.....	17	35	73	95	99	.....	BN
	3:55 p.m.	387	115	2.1	4.25	.8	760	.....	.....	.....	12	12	26	57	94	99	.....	BN
	3:50 p.m.	387	115	2.1	4.23	1.2	1,020	.....	.....	.....	8	12	23	53	94	99	.....	BN
	3:45 p.m.	387	115	2.1	3.11	1.6	2,520	.....	.....	.....	4	5	9	28	90	100	.....	BN
	3:25 p.m.	392	125	2.3	3.58	.4	650	.....	.....	.....	15	27	30	63	82	96	.....	BN
	3:20 p.m.	392	125	2.3	3.87	1.0	710	.....	.....	.....	10	13	28	58	93	99	.....	BN
	3:15 p.m.	392	125	2.3	3.50	1.4	950	.....	.....	.....	13	15	25	51	94	99	.....	BN
	3:05 p.m.	392	125	2.3	2.62	1.8	1,900	.....	.....	.....	5	6	11	27	97	99	.....	BN
	2:45 p.m.	398	135	2.2	3.44	.4	440	.....	.....	.....	15	21	41	77	99	100	.....	BN
	2:40 p.m.	398	135	2.2	3.26	1.0	920	.....	.....	.....	9	12	22	46	95	100	.....	BN
	2:35 p.m.	398	135	2.2	3.36	1.4	1,020	.....	.....	.....	.....	10	19	45	95	100	.....	BN
	2:30 p.m.	398	135	2.2	2.82	1.7	1,520	.....	.....	.....	3	6	12	36	92	99	.....	BN
June 6....	4:35 p.m.	314	95	1.6	2.86	.4	480	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....
	4:25 p.m.	314	95	1.6	2.92	.8	690	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....
	4:10 p.m.	314	95	1.6	2.96	1.1	980	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....
	4:05 p.m.	314	105	1.5	3.31	.3	860	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....
	4:00 p.m.	314	105	1.5	3.86	.7	1,060	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....
	3:50 p.m.	314	105	1.5	3.55	1.0	1,320	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....
	3:30 p.m.	314	115	1.5	3.70	.5	930	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....
	3:25 p.m.	314	115	1.5	3.61	1.0	1,230	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....
	3:10 p.m.	314	125	2.0	3.80	.5	600	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....
	3:05 p.m.	314	125	2.0	3.47	1.1	1,100	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....
	2:55 p.m.	314	125	2.0	3.14	1.5	1,130	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....

Table 6.--Particle-size analyses of suspended sediment, point-integrated samples, gaging-station section--Continued

Date	Time	Water discharge (cfs)	Sampling station	Total depth (feet)	Suspended sediment: Sampling point: Velocity (fps)	Sampling point: Depth (feet)	Sampling point: Concentration (ppm)	Percent finer than indicated size, in millimeters: 0.002	0.004	0.008	0.016	0.031	0.062	0.125	0.250	0.500	1.000	Methods of analysis
1949--Con.																		
June 6....	2:35 p.m.	308	135	2.2	3.17	0.5	490	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....
	2:30 p.m.	308	135	2.2	3.21	1.3	750	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....
	2:10 p.m.	308	135	2.2	2.76	1.7	1,130	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....
Sept. 16..	5:35 p.m.	238	95	1.7	2.83	.8	300	.....	.....	.....	.....	26	31	43	89	98	.....	BW
	5:25 p.m.	238	95	1.7	2.53	1.2	2,870	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	BW
	5:10 p.m.	238	105	1.6	2.94	.3	290	.....	.....	.....	.....	.....	33	44	84	99	.....	BW
	5:05 p.m.	238	105	1.6	2.99	.8	540	.....	.....	.....	.....	.....	20	31	75	96	.....	BW
	4:55 p.m.	238	105	1.6	2.93	1.1	770	.....	.....	.....	.....	.....	18	24	92	99	.....	BW
	4:30 p.m.	238	115	1.4	2.02	.2	160	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....
	4:20 p.m.	238	115	1.4	3.35	.6	390	.....	.....	.....	.....	.....	29	42	95	99	.....	BW
	4:16 p.m.	238	115	1.4	2.38	.9	840	.....	.....	.....	.....	10	13	22	86	99	.....	BW
	4:00 p.m.	238	125	1.8	2.81	.4	360	.....	.....	.....	.....	21	25	37	91	99	.....	BW
	3:56 p.m.	238	125	1.8	3.23	.9	340	.....	.....	.....	.....	24	33	47	97	99	.....	BW
	3:52 p.m.	238	125	1.8	2.68	1.3	510	.....	.....	.....	.....	18	22	26	78	95	.....	BW
	3:43 p.m.	238	135	1.8	3.27	.4	310	.....	.....	.....	.....	30	39	48	79	97	.....	BW
	3:40 p.m.	238	135	1.8	3.50	.9	330	.....	.....	.....	.....	25	30	46	86	99	.....	BW
	3:35 p.m.	238	135	1.8	3.06	1.3	400	.....	.....	.....	.....	.....	33	45	90	99	.....	BW
Oct. 15...	5:07 p.m.	273	95	1.4	3.32	.3	740	.....	.....	.....	.....	.....	51	74	97	99	.....	BW
	5:05 p.m.	273	95	1.4	3.50	.6	360	.....	.....	.....	.....	.....	38	57	100	.....	.....	BW
	5:00 p.m.	273	95	1.4	3.27	.9	630	.....	.....	.....	.....	.....	22	40	89	93	.....	BW
	4:50 p.m.	273	105	1.5	4.31	.3	600	.....	.....	.....	.....	.....	28	48	98	100	.....	BW
	4:45 p.m.	278	105	1.5	4.00	.7	1,100	.....	.....	.....	.....	.....	21	35	100	.....	.....	BW
	4:30 p.m.	278	105	1.5	3.66	1.0	1,880	.....	.....	.....	.....	.....	10	24	84	98	.....	BW
	4:20 p.m.	278	115	1.7	4.19	.4	460	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....
	4:17 p.m.	278	115	1.7	4.03	.8	740	.....	.....	.....	.....	.....	24	37	92	99	.....	BW
	4:12 p.m.	283	115	1.7	3.66	1.2	1,340	.....	.....	.....	.....	9	14	30	85	99	.....	BW

	3:55 p.m.	288	125	2.1	3.58	.5	640	.....	.....	.....	.....	14	28	40	81	99	.....	BW
	3:45 p.m.	288	125	2.1	3.39	1.0	810	.....	.....	.....	.....	.....	21	32	73	96	.....	BW
	3:40 p.m.	288	125	2.1	2.86	1.6	1,150	.....	.....	.....	.....	.....	17	29	79	96	.....	BW
	3:20 p.m.	288	135	2.2	3.49	.5	760	.....	.....	.....	.....	.....	12	16	45	78	.....	BW
	3:25 p.m.	288	135	2.2	3.31	1.0	320	.....	.....	.....	.....	.....	39	58	89	98	.....	BW
	3:28 p.m.	288	135	2.2	3.13	1.5	420	.....	.....	.....	.....	.....	29	42	84	99	.....	BW
	3:30 p.m.	288	135	2.2	2.83	1.7	460	.....	.....	.....	.....	.....	25	45	87	98	.....	BW
Nov. 8....	12:30 p.m.	329	95	1.4	3.60	.3	320	.....	.....	.....	.....	.....	39	62	99	100	.....	BW
	....	329	95	1.4	3.72	.6	340	.....	.....	.....	.....	21	33	56	96	100	.....	BW
	....	329	95	1.4	3.42	.9	580	.....	.....	.....	.....	.....	28	39	87	99	.....	BW
	....	329	105	1.5	4.37	.3	500	.....	.....	.....	.....	29	35	63	96	100	.....	BW
	....	329	105	1.5	4.35	.7	960	.....	.....	.....	.....	.....	20	34	96	100	.....	BW
	....	334	105	1.5	4.06	1.0	1,550	.....	.....	.....	.....	8	12	20	80	100	.....	BW
	....	334	115	1.6	4.13	.4	470	.....	.....	.....	.....	.....	28	45	91	98	.....	BW
	....	334	115	1.6	3.89	.8	680	.....	.....	.....	.....	.....	24	38	93	98	.....	BW
	....	334	115	1.6	3.56	1.1	1,120	.....	.....	.....	.....	.....	16	27	86	97	.....	BW
	....	334	125	2.0	3.01	.5	780	.....	.....	.....	.....	.....	18	31	76	96	.....	BW
	....	334	125	2.0	3.10	1.0	830	.....	.....	.....	.....	.....	19	28	90	100	.....	BW
	....	334	125	2.0	3.21	1.5	1,120	.....	.....	.....	.....	.....	11	19	62	94	.....	BW
	....	334	135	2.3	3.12	.5	410	.....	.....	.....	.....	.....	28	41	80	96	.....	BW
	....	334	135	2.3	2.98	1.3	550	.....	.....	.....	.....	24	25	39	78	97	.....	BW
	2:15 p.m.	334	135	2.3	2.24	1.8	1,110	.....	.....	.....	.....	7	9	19	82	98	.....	BW
1950																		
Mar. 3....	5:00 p.m.	392	97	1.5	4.06	.5	720	.....	.....	.....	.....	.....	37	68	97	100	.....	S
	4:55 p.m.	392	97	1.5	3.80	1.0	1,060	.....	.....	.....	.....	.....	23	53	94	100	.....	S
	4:50 p.m.	392	109	1.7	4.90	.5	1,120	.....	.....	.....	.....	.....	27	59	98	100	.....	S
	4:45 p.m.	392	109	1.7	4.87	.9	1,750	.....	.....	.....	.....	.....	18	47	97	100	.....	S
	4:40 p.m.	392	109	1.7	4.48	1.2	2,570	.....	.....	.....	.....	.....	13	37	95	100	.....	S
	4:30 p.m.	392	120	1.8	4.58	.5	1,020	.....	.....	.....	.....	.....	27	62	96	100	.....	S
	4:25 p.m.	392	120	1.8	5.05	1.0	1,260	.....	.....	.....	.....	.....	24	54	95	100	.....	S
	4:15 p.m.	392	120	1.8	4.08	1.3	1,850	.....	.....	.....	.....	.....	17	42	91	100	.....	S

Table 6.--Particle-size analyses of suspended sediment, point-integrated samples, gaging-station section--Continued

Date	Time	Water discharge (cfs)	Sam-pling station	Total depth (feet)	Suspended sediment													Methods of analysis
					Sampling point			Percent finer than indicated size, in millimeters										
					Velocity (fps)	Depth (feet)	Concentration (ppm)	0.002	0.004	0.008	0.016	0.031	0.062	0.125	0.250	0.500	1.000	
1950--Con.																		
Mar. 3....	4:10 p.m.	392	129	2.2	4.19	0.5	710	.....	.....	.....	.....	.....	34	73	98	100	.....	S
	4:05 p.m.	392	129	2.2	4.52	1.0	860	.....	.....	.....	.....	.....	32	68	98	100	.....	S
	4:00 p.m.	398	129	2.2	4.36	1.4	1,010	.....	.....	.....	.....	.....	27	62	97	100	.....	S
	3:50 p.m.	398	129	2.2	3.82	1.7	1,240	.....	.....	.....	.....	.....	23	54	95	100	.....	S
	3:45 p.m.	398	141	2.4	2.98	.5	600	.....	.....	.....	.....	.....	42	80	99	100	.....	S
	3:35 p.m.	398	141	2.4	3.10	.9	670	.....	.....	.....	.....	.....	38	77	99	100	.....	S
	3:30 p.m.	398	141	2.4	2.84	1.4	830	.....	.....	.....	.....	.....	33	73	99	100	.....	S
	3:25 p.m.	398	141	2.4	2.54	1.9	1,040	.....	.....	.....	.....	.....	25	59	99	100	.....	S
July 10...	2:27 p.m.	234	10	2.0	2.22	.5	130	.....	.....	.....	.....	.....	61	88	99	100	.....	S
	2:17 p.m.	234	10	2.0	2.12	1.0	180	.....	.....	.....	.....	.....	48	78	98	100	.....	S
	2:07 p.m.	238	10	2.0	1.26	1.5	200	.....	.....	.....	.....	.....	41	72	98	100	.....	S
	2:43 p.m.	234	30	1.8	2.31	.3	250	.....	.....	.....	.....	.....	35	62	92	100	.....	S
	2:36 p.m.	234	30	1.8	2.14	.8	400	.....	.....	.....	.....	.....	36	55	89	100	.....	S
	2:32 p.m.	234	30	1.8	1.90	1.3	460	.....	.....	.....	.....	.....	20	34	75	100	.....	S
	2:54 p.m.	234	45	1.4	2.56	.4	270	.....	.....	.....	.....	.....	34	65	99	100	.....	S
	2:48 p.m.	234	45	1.4	2.47	.9	420	.....	.....	.....	.....	.....	20	46	93	100	.....	S
	3:06 p.m.	234	60	1.6	2.40	.5	230	.....	.....	.....	.....	.....	33	55	89	100	.....	S
	3:01 p.m.	234	60	1.6	2.68	1.1	310	.....	.....	.....	.....	.....	27	62	97	100	.....	S
Oct. 6....	11:24 a.m.	302	10	1.5	1.82	.5	270	.....	.....	.....	.....	.....	43	82	100	.....	.....	SWM
	11:14 a.m.	302	10	1.5	1.56	1.0	300	.....	.....	.....	.....	.....	38	75	99	100	.....	SWM
	11:42 a.m.	298	20	2.1	3.19	.5	340	.....	.....	.....	.....	.....	40	75	97	100	.....	SWM
	11:26 a.m.	302	20	2.1	2.46	1.6	820	.....	.....	.....	.....	.....	17	45	94	100	.....	SWM
	11:53 a.m.	298	26	1.8	3.47	.5	400	.....	.....	.....	.....	.....	35	69	98	100	.....	SWM
	11:46 a.m.	298	26	1.8	2.86	1.3	780	.....	.....	.....	.....	.....	19	47	95	100	.....	SWM
	12:02 p.m.	298	34	1.9	3.42	.5	340	.....	.....	.....	.....	.....	40	76	98	100	.....	SWM
	11:59 a.m.	298	34	1.9	2.90	1.4	1,040	.....	.....	.....	.....	.....	15	41	88	100	.....	SWM

	12:30 p.m.	298	42	1.7	4.00	.5	560	.....	.....	.....	.....	.....	26	55	97	100	.....	SWM
	12:21 p.m.	298	42	1.7	4.13	1.2	1,460	.....	.....	.....	.....	.....	11	31	88	100	.....	SWM
	12:58 p.m.	294	52	1.6	3.69	.5	670	.....	.....	.....	.....	.....	22	55	98	100	.....	SWM
	12:53 p.m.	294	52	1.6	3.62	1.1	1,670	.....	.....	.....	.....	.....	11	34	90	99	100	SWM
	1:13 p.m.	294	60	1.6	3.13	.5	480	.....	.....	.....	.....	.....	31	70	98	100	.....	SWM
	1:05 p.m.	294	60	1.6	3.04	1.1	2,700	.....	.....	.....	.....	.....	7	22	65	98	100	SWM
1951 Jan. 25...	12:41 p.m.	319	19	1.5	2.92	.5	777	.....	.....	.....	.....	.....	18	49	96	100	.....	SWM
	12:36 p.m.	319	19	1.5	2.81	1.0	1,360	.....	.....	.....	.....	.....	8	33	90	100	.....	SWM
	12:19 p.m.	319	31	1.8	3.41	.5	927	.....	.....	.....	.....	.....	15	44	91	99	100	SWM
	12:14 p.m.	319	31	1.8	2.94	1.3	4,060	.....	.....	.....	.....	.....	4	20	87	100	.....	SWM
	12:09 p.m.	319	41	1.8	1.80	.5	983	.....	.....	.....	.....	.....	18	54	94	100	.....	SWM
	12:03 p.m.	314	41	1.8	2.32	1.3	1,910	.....	.....	.....	.....	.....	8	30	81	100	.....	SWM
	11:56 a.m.	310	50	2.0	2.67	.5	484	.....	.....	.....	.....	.....	25	63	98	100	.....	SWM
	11:53 a.m.	310	50	2.0	2.21	1.5	733	.....	.....	.....	.....	.....	16	48	94	100	.....	SWM
	11:46 a.m.	310	60	2.2	2.30	.5	334	.....	.....	.....	.....	.....	36	70	97	100	.....	SWM
	11:05 a.m.	310	60	2.2	2.10	1.7	634	.....	.....	.....	.....	.....	18	48	96	100	.....	SWM
Apr. 27...	1:40 p.m.	440	14	2.4	3.26	.5	393	.....	.....	.....	.....	.....	45	85	98	100	.....	SWM
	1:36 p.m.	440	14	2.4	3.21	1.2	478	.....	.....	.....	.....	.....	41	82	100	.....	.....	SWM
	1:31 p.m.	440	14	2.4	2.78	1.9	636	.....	.....	.....	.....	.....	34	73	98	100	.....	SWM
	2:01 p.m.	440	25	2.5	4.90	.5	626	.....	.....	.....	.....	.....	36	75	99	100	.....	SWM
	1:55 p.m.	440	25	2.5	4.46	1.2	843	.....	.....	.....	.....	.....	25	63	93	100	.....	SWM
	1:46 p.m.	440	25	2.5	2.88	2.0	1,980	.....	.....	.....	.....	.....	14	40	82	100	.....	SWM
	2:34 p.m.	435	41	2.1	5.26	.5	868	.....	.....	.....	.....	.....	25	62	98	100	.....	SWM
	2:26 p.m.	435	41	2.1	5.19	1.0	1,360	.....	.....	.....	.....	.....	17	50	97	100	.....	SWM
	5:28 p.m.	405	46	1.9	4.82	.5	903	.....	.....	.....	.....	.....	26	68	97	100	.....	SWM
	5:26 p.m.	405	46	1.9	4.61	1.0	1,460	.....	.....	.....	.....	.....	19	56	97	100	.....	SWM
	2:43 p.m.	435	46	1.9	4.02	1.4	4,360	.....	.....	.....	.....	.....	7	26	88	100	.....	SWM
	5:39 p.m.	405	59	1.7	4.28	.5	540	.....	.....	.....	.....	.....	35	75	99	100	.....	SWM
	5:35 p.m.	405	59	1.7	4.17	.9	680	.....	.....	.....	.....	.....	28	72	100	.....	.....	SWM
	5:30 p.m.	405	59	1.7	3.60	1.2	1,360	.....	.....	.....	.....	.....	21	51	94	100	.....	SWM

Table 6.--Particle-size analyses of suspended sediment, point-integrated samples, gaging-station section--Continued

Date	Time	Water discharge (cfs)	Sampling station	Total depth (feet)	Suspended sediment: Sampling point: Velocity (fps)	Depth (feet)	Concentration (ppm)	Percent finer than indicated size, in millimeters: 0.002	0.004	0.008	0.016	0.031	0.062	0.125	0.250	0.500	1.000	Methods of analysis
1951--Con.																		
May 24....	3:25 p.m.1/	342	14	2.3	3.24	0.5	392	.....	.....	.....	.....	.....	36	64	80	100	.....	SWM
	....	342	14	2.3	3.05	1.2	393	.....	.....	.....	.....	.....	38	79	99	100	.....	SWM
	....	342	14	2.3	2.68	1.8	569	.....	.....	.....	.....	.....	32	76	99	100	.....	SWM
	....	342	24	2.3	3.98	.5	460	.....	.....	.....	.....	.....	54	73	98	100	.....	SWM
	....	342	24	2.3	4.06	1.2	580	.....	.....	.....	.....	.....	27	65	96	100	.....	SWM
	....	342	24	2.3	3.42	1.8	1,010	.....	.....	.....	.....	.....	19	53	94	100	.....	SWM
	....	342	35	2.0	4.43	.5	707	.....	.....	.....	.....	.....	64	68	98	100	.....	SWM
	....	342	35	2.0	4.08	1.2	1,510	.....	.....	.....	.....	.....	5	43	95	100	.....	SWM
	....	342	46	1.6	4.81	.5	1,110	.....	.....	.....	.....	.....	16	52	97	100	.....	SWM
	....	342	46	1.6	4.55	.8	1,560	.....	.....	.....	.....	.....	11	48	96	100	.....	SWM
	....	342	46	1.6	3.69	1.1	6,650	.....	.....	.....	.....	.....	4	20	84	100	.....	SWM
	....	342	60	1.6	3.62	.5	538	.....	.....	.....	.....	.....	29	69	98	100	.....	SWM
	....	342	60	1.6	3.68	.8	726	.....	.....	.....	.....	.....	23	63	98	100	.....	SWM
	....	342	60	1.6	3.02	1.1	1,550	.....	.....	.....	.....	.....	12	47	96	100	.....	SWM
1952																		
Mar. 30...	6:57 p.m.	883	93	2.6	5.13	1.3	3,010	20	28	33	38	44	57	78	96	100	.....	SPWCM
	6:57 p.m.	883	93	2.6	4.47	2.1	4,370	14	19	23	27	32	59	60	91	100	.....	SPWCM
	6:38 p.m.	890	106	2.9	5.43	.6	3,050	21	28	34	39	46	59	80	98	100	.....	SPWCM
	6:38 p.m.	890	106	2.9	4.82	1.5	4,020	16	22	27	31	35	46	67	96	100	.....	SPWCM
	6:38 p.m.	890	106	2.9	3.90	2.4	8,370	7	10	13	15	16	24	42	85	100	.....	SPWCM
	6:21 p.m.	902	117	3.4	5.93	.6	2,940	20	29	36	41	47	59	81	98	100	.....	SPWCM
	6:21 p.m.	902	117	3.4	4.65	1.7	3,630	19	23	29	34	38	48	70	96	100	.....	SPWCM
	6:21 p.m.	902	117	3.4	3.49	2.9	11,100	6	8	10	11	13	18	29	75	100	.....	SPWCM

	6:04 p.m.	922	127	3.6	4.47	.6	2,760	23	32	38	44	51	65	85	99	100	.....	SPWCM
	6:04 p.m.	922	127	3.6	5.04	1.8	3,350	.....	.....	.....	.....	.....	56	77	97	100	.....	SW
	6:04 p.m.	922	127	3.6	4.58	3.1	4,170	15	21	26	30	34	43	64	94	100	.....	SPWCM
	5:38 p.m.	916	140	3.4	4.26	.6	2,320	27	40	47	51	58	78	94	99	100	.....	SPWCM
	5:38 p.m.	916	140	3.4	4.59	1.7	2,540	26	36	46	51	59	71	90	99	100	.....	SPWCM
	5:38 p.m.	916	140	3.4	3.45	2.9	2,760	24	31	41	44	52	68	86	99	100	.....	SPWCM
May 8.....	2:38 p.m.	405	20	2.6	3.96	.5	646	.....	.....	.....	.....	.....	38	79	99	100	.....	SW
	2:38 p.m.	405	20	2.6	3.93	1.1	746	.....	.....	.....	.....	.....	34	71	96	100	.....	SW
	2:38 p.m.	405	20	2.6	3.30	2.1	1,410	.....	.....	.....	.....	.....	21	52	91	100	.....	SW
	2:59 p.m.	400	31	2.7	5.86	.5	504	.....	.....	.....	.....	.....	42	82	98	100	.....	SW
	2:59 p.m.	400	31	2.7	5.92	1.3	849	.....	.....	.....	.....	.....	29	71	97	100	.....	SW
	2:59 p.m.	400	31	2.7	4.02	2.2	1,730	.....	.....	.....	.....	.....	16	48	91	100	.....	SW
	3:14 p.m.	395	42	2.2	4.17	.5	780	.....	.....	.....	.....	.....	29	68	96	100	.....	SW
	3:14 p.m.	395	42	2.2	4.08	1.1	872	.....	.....	.....	.....	.....	8	50	93	100	.....	SW
	3:14 p.m.	395	42	2.2	4.67	1.7	7,760	.....	.....	.....	.....	.....	4	13	44	98	100	SW
	3:33 p.m.	390	53	2.2	4.43	.5	625	.....	.....	.....	.....	.....	36	76	96	100	.....	SW
	3:33 p.m.	390	53	2.2	3.27	1.1	1,160	.....	.....	.....	.....	.....	24	59	93	100	.....	SW
	3:33 p.m.	390	53	2.2	4.33	1.7	1,360	.....	.....	.....	.....	.....	55	72	94	100	.....	SW
	3:53 p.m.	395	65	2.2	3.40	.5	507	.....	.....	.....	.....	.....	40	76	97	100	.....	SW
	3:53 p.m.	395	65	2.2	2.94	1.1	589	.....	.....	.....	.....	.....	36	75	99	100	.....	SW
	3:53 p.m.	395	65	2.2	2.67	1.7	797	.....	.....	.....	.....	.....	27	67	98	100	.....	SW
June 19...	12:28 p.m.	226	12	2.1	4.28	.5	313	.....	.....	.....	.....	.....	28	62	96	100	.....	SW
	12:28 p.m.	226	12	2.1	3.87	1.1	477	.....	.....	.....	.....	.....	23	56	95	100	.....	SW
	12:28 p.m.	226	12	2.1	3.45	1.8	573	.....	.....	.....	.....	.....	20	50	91	100	.....	SW
	12:40 p.m.	230	22	2.2	5.44	.5	196	.....	.....	.....	.....	.....	38	66	93	100	.....	SW
	12:40 p.m.	230	22	2.2	4.97	1.1	380	.....	.....	.....	.....	.....	23	43	81	100	.....	SW
	12:40 p.m.	230	22	2.2	4.73	1.9	448	.....	.....	.....	.....	.....	19	37	79	100	.....	SW
	12:52 p.m.	215	32	1.8	5.14	.5	285	.....	.....	.....	.....	.....	28	56	93	100	.....	SW
	12:52 p.m.	215	32	1.8	4.94	.9	410	.....	.....	.....	.....	.....	21	43	91	100	.....	SW
	12:52 p.m.	215	32	1.8	4.66	1.5	795	.....	.....	.....	.....	.....	15	26	84	100	.....	SW
	1:06 p.m.	226	45	2.0	5.29	.5	338	.....	.....	.....	.....	.....	22	46	90	100	.....	SW
	1:06 p.m.	226	45	2.0	3.22	1.0	2,830	.....	.....	.....	.....	.....	3	10	71	100	.....	SW
	1:06 p.m.	226	45	2.0	.78	1.5	1,770	.....	.....	.....	.....	.....	5	16	76	100	.....	SW

See footnotes at end of table.

Table 6.--Particle-size analyses of suspended sediment, point-integrated samples, gaging-station section--Continued

Date	Time	Water discharge (cfs)	Sampling station	Total depth (feet)	Suspended sediment: Sampling point: Velocity (fps)	Depth (feet)	Concentration (ppm)	Percent finer than indicated size, in millimeters: 0.002	0.004	0.008	0.016	0.031	0.062	0.125	0.250	0.500	1.000	Methods of analysis
1952--Con.																		
June 19...	1:18 p.m.	223	58	1.0	4.91	0.3	315	.....	.....	.....	.....	.....	25	51	95	100	.....	SW
	1:18 p.m.	223	58	1.0	4.93	.5	363	.....	.....	.....	.....	.....	24	51	94	100	.....	SW
	1:18 p.m.	223	58	1.0	4.87	.7	510	.....	.....	.....	.....	.....	16	41	94	100	.....	SW
1953																		
June 10 2/.	11:13 a.m.	319	14	1.3	3.07	.4	303	.....	.....	.....	.....	.....	39	88	99	100	.....	SW
	11:25 a.m.	298	14	1.3	2.57	.7	233	.....	.....	.....	.....	.....	59	91	100	.....	.....	SW
	11:25 a.m.	298	14	1.3	2.61	.7	234	.....	.....	.....	.....	.....	55	88	100	.....	.....	SW
	11:00 a.m.	324	14	1.3	2.50	.8	1,010	.....	.....	.....	.....	.....	23	58	98	100	.....	SW
	11:00 a.m.	324	14	1.3	2.44	.8	929	.....	.....	.....	.....	.....	16	51	98	100	.....	SW
	12:00 m.	324	24	2.3	3.47	.4	321	.....	.....	.....	.....	.....	36	70	96	100	.....	SW
	11:55 a.m.	324	24	2.3	3.64	1.2	410	.....	.....	.....	.....	.....	50	64	94	100	.....	SW
	11:50 a.m.	319	24	2.3	3.60	1.6	519	.....	.....	.....	.....	.....	24	55	91	100	.....	SW
	11:45 a.m.	319	24	2.3	3.43	1.8	856	.....	.....	.....	.....	.....	18	41	87	100	.....	SW
	12:20 p.m.	328	34	1.3	3.60	.4	442	.....	.....	.....	.....	.....	37	60	93	100	.....	SW
	12:17 p.m.	328	34	1.3	3.52	.7	554	.....	.....	.....	.....	.....	22	51	90	100	.....	SW
	12:15 p.m.	328	34	1.3	3.60	.8	709	.....	.....	.....	.....	.....	21	47	91	100	.....	SW
	12:37 p.m.	332	46	1.4	2.86	.4	1,240	.....	.....	.....	.....	.....	11	28	68	98	100	SW
	12:31 p.m.	332	46	1.4	3.28	.7	1,560	.....	.....	.....	.....	.....	11	25	67	99	100	SW
	12:27 p.m.	332	46	1.4	3.43	.9	1,530	.....	.....	.....	.....	.....	9	25	69	99	100	SW
	12:57 p.m.	328	62	1.7	3.89	.4	405	.....	.....	.....	.....	.....	38	65	95	100	.....	SW
	12:55 p.m.	328	62	1.7	3.14	.8	512	.....	.....	.....	.....	.....	31	63	94	100	.....	SW
	12:58 p.m.	328	62	1.7	3.89	1.0	468	.....	.....	.....	.....	.....	36	62	93	100	.....	SW
	12:53 p.m.	328	62	1.7	2.66	1.2	659	.....	.....	.....	.....	.....	23	52	90	100	.....	SW
July 8 2/..	7:30 p.m.	270	12	2.0	2.85	.4	251	.....	.....	.....	.....	.....	43	78	98	100	.....	SW
	7:30 p.m.	270	12	2.0	2.75	.8	306	.....	.....	.....	.....	.....	40	77	98	100	.....	SW
	7:30 p.m.	270	12	2.0	2.58	1.2	388	.....	.....	.....	.....	.....	32	71	97	100	.....	SW
	7:30 p.m.	270	12	2.0	2.20	1.6	445	.....	.....	.....	.....	.....	28	69	98	100	.....	SW

7:10 p.m.	274	22	2.0	3.20	.4	327	.....	.....	.....	.....	.....	33	64	94	100	.....	SW
7:10 p.m.	274	22	2.0	3.16	.8	372	.....	.....	.....	.....	.....	32	63	95	100	.....	SW
7:10 p.m.	274	22	2.0	3.07	1.2	412	.....	.....	.....	.....	.....	25	57	94	100	.....	SW
7:10 p.m.	274	22	2.0	2.68	1.6	496	.....	.....	.....	.....	.....	22	54	94	100	.....	SW
6:40 p.m.	274	33	1.7	2.61	.2	471	.....	.....	.....	.....	.....	21	46	85	99	100	SW
6:40 p.m.	274	33	1.7	2.78	.6	561	.....	.....	.....	.....	.....	18	43	85	100	.....	SW
6:40 p.m.	274	33	1.7	2.88	1.0	626	.....	.....	.....	.....	.....	18	44	81	99	100	SW
6:40 p.m.	274	33	1.7	2.85	1.4	772	.....	.....	.....	.....	.....	15	39	82	99	100	SW
6:00 p.m.	274	48	2.5	3.24	.4	535	.....	.....	.....	.....	.....	20	52	92	99	100	SW
6:00 p.m.	274	48	2.5	2.26	1.0	707	.....	.....	.....	.....	.....	18	46	88	99	100	SW
6:00 p.m.	274	48	2.5	.848	1.5	766	.....	.....	.....	.....	.....	16	43	87	99	100	SW
6:00 p.m.	274	48	2.5	.832	2.0	1,290	.....	.....	.....	.....	.....	10	32	83	100	.....	SW
5:30 p.m.	274	59	1.5	2.69	.2	308	.....	.....	.....	.....	.....	39	81	99	100	.....	SW
5:30 p.m.	274	59	1.5	2.62	.6	559	.....	.....	.....	.....	.....	22	60	97	100	.....	SW
5:30 p.m.	274	59	1.5	2.54	.9	703	.....	.....	.....	.....	.....	17	56	95	100	.....	SW
5:30 p.m.	274	59	1.5	2.12	1.2	951	.....	.....	.....	.....	.....	14	49	95	100	.....	SW

1 Mean time for all samples on May 24.
2 Point velocities for June 10 and July 8 measured by pygmy current meter.

Table 7.--Particle-size analyses of suspended sediment, depth-integrated samples, gaging-station section

[Methods of analysis: B, bottom-withdrawal tube; N, in native water; W, in distilled water; S, sieve; C, chemically dispersed; P, pipette; M, mechanically dispersed]

Date	Time	Water discharge (cfs)	Suspended sediment: Concentration of sample (ppm)	Concentration of suspension analyzed (ppm)	Percent finer than indicated size, in millimeters: 0.002	0.004	0.008	0.016	0.031	0.062	0.125	0.250	0.500	1.000	Methods of analysis
1948															
Mar. 19......	2:40 p.m.	492	1,280	2,560	9	11	13	19	37	59	71	85	92	......	BN
Mar. 29......	3:45 p.m.	486	1,070	2,180	8	11	15	18	45	88	99	100	......	......	BN
Apr. 9.......	4:00 p.m.	382	844	1,550	......	......	......	5	9	21	44	82	98	......	BN
Apr. 27......	12:55 p.m.	620	1,460	1,850	......	......	......	8	12	23	50	92	99	......	BN
May 7........	11:20 a.m.	382	894	1,950	......	......	......	7	9	15	29	91	99	......	BN
May 13.......	11:35 a.m.	420	648	1,300	......	......	......	7	12	19	50	83	98	......	BN
May 27.......	3:20 p.m.	308	720	1,690	......	......	......	......	11	18	39	96	98	......	BN
June 1.......	3:10 p.m.	268	534	1,180	......	......	......	5	7	20	30	88	97	......	BN
June 12......	12:35 p.m.	273	743	....	......	......	......	4	4	8	21	90	99	......	BN
June 15......	2:20 p.m.	283	406	756	......	......	......	12	19	30	56	84	98	......	BN
June 23......	1:45 p.m.	537	1,280	2,490	......	......	......	15	22	33	54	92	99	......	BN
June 30......	11:10 a.m.	376	721	1,360	......	......	......	12	17	25	46	97	99	......	BN
July 13......	1:45 p.m.	258	328	641	......	......	......	10	13	30	65	96	100	......	BN
July 20......	8:40 p.m.	452	1,370	....	......	......	31	44	54	61	76	95	99	......	BN
Aug. 2.......	12:15 p.m.	278	475	842	......	......	......	10	13	19	31	80	96	......	BN
Aug. 18......	9:20 a.m.	238	634	1,280	......	......	......	6	7	12	22	47	89	......	BN
Aug. 25......	1:20 p.m.	219	394	764	......	......	......	5	7	11	25	82	97	......	BN
Sept. 8......	6:15 p.m.	229	389	....	......	......	......	7	10	19	39	87	98	......	BN
Sept. 25.....	2:30 p.m.	308	518	867	......	......	......	8	12	20	43	80	97	......	BN
Oct. 5.......	2:10 p.m.	263	383	....	......	......	......	......	8	15	26	74	96	......	BN
Oct. 13......	4:45 p.m.	258	483	....	......	......	......	......	4	9	24	72	96	......	BN
Oct. 14......	4:15 p.m.	258	340	....	......	......	......	......	6	17	37	86	99	......	BN
Oct. 25......	1:00 p.m.	308	492	....	......	......	......	7	10	19	40	92	99	......	BN
Nov. 3.......	3:20 p.m.	308	564	....	......	......	......	9	12	17	36	86	98	......	BN
Nov. 17......	2:20 p.m.	329	751	1,540	......	......	......	......	16	19	28	80	97	......	BW
Dec. 8.......	1:55 p.m.	288	864	1,540	......	......	......	......	14	20	36	90	99	......	BW

1949															
Feb. 25......	10:30 a.m.	452	775	1,160	......	......	......	15	16	25	37	72	95	......	BW
Mar. 8.......	4:00 p.m.	732	1,970	....	......	......	......	5	9	18	36	75	98	......	BN
May 16.......	1:40 p.m.	452	859	1,660	......	......	......	......	21	32	53	98	100	......	BW
June 14......	2:15 p.m.	366	584	1,270	......	......	......	......	20	30	51	93	100	......	BW
June 27......	1:20 p.m.	253	408	784	......	......	......	......	24	31	43	83	97	......	BW
July 13......	3:55 p.m.	234	219	....	......	......	......	......	......	......	41	92	99	......	BW
July 27......	3:20 p.m.	210	243	445	......	......	......	......	32	39	51	92	99	......	BW
Aug. 9.......	12:05 p.m.	238	299	580	......	......	......	......	27	35	48	91	99	......	BW
Aug. 31......	3:40 p.m.	234	366	653	......	......	......	......	18	23	40	96	100	......	BW
Oct. 15......	4:30 p.m.	278	650	770	......	......	......	......	......	29	45	94	99	......	BW
Oct. 22......	4:45 p.m.	298	482	....	......	......	......	......	......	22	51	96	100	......	SC
Nov. 8.......	3:00 p.m.	329	700	750	......	......	......	......	......	23	36	90	100	......	BW
1950															
Jan. 27......	2:35 p.m.	290	450	....	......	......	......	......	......	15	35	85	99	100	SC
Feb. 10......	3:55 p.m.	343	320	....	......	......	......	......	......	28	52	87	99	100	SC
Mar. 3.......	4:30 p.m.	392	1,060	....	......	......	......	......	......	29	61	96	100	......	SC
Mar. 5.......	9:25 a.m.	403	1,550	....	......	......	......	......	......	18	50	94	100	......	SC
	9:25 a.m.	403	1,550	2,300	......	......	......	4	8	15	35	76	95	......	BWC
	9:25 a.m.	403	1,550	2,010	......	......	......	4	6	15	40	88	98	......	BN
Mar. 14......	3:40 p.m.	420	1,460	....	......	......	......	......	......	28	57	94	100	......	SC
Mar. 21......	12:50 p.m.	382	893	....	......	......	......	......	......	16	50	95	100	......	S
Mar. 30......	12:00 m.	420	1,050	....	......	......	......	......	......	24	56	94	100	......	S
May 11.......	11:40 a.m.	566	1,040	....	......	......	......	......	......	20	57	95	100	......	S
May 20.......	12:50 p.m.	329	530	....	......	......	......	......	......	13	54	96	100	......	S
June 7.......	10:45 a.m.	258	421	....	......	......	......	......	......	27	43	85	100	......	S
Aug. 9.......	12:50 p.m.	248	1,030	1,420	46	58	64	66	68	74	85	97	100	......	SPC
	12:50 p.m.	248	1,030	890	......	56	61	63	65	69	78	90	98	......	BWC
	12:50 p.m.	248	1,030	660	......	36	49	53	56	60	72	90	98	......	BN
Aug. 27......	6:20 a.m.	1,318	5,750	5,180	......	38	......	53	......	66	79	95	100	......	SPC
Aug. 30......	8:30 a.m.	376	960	1,580	......	26	......	32	......	45	66	95	100	......	SPC
Sept. 5......	9:20 a.m.	253	540	....	......	......	......	......	......	24	47	92	100	......	S
Sept. 20.....	12:10 p.m.	340	720	....	......	......	......	......	......	18	33	92	98	100	S
Oct. 6.......	9:10 a.m.	302	655	....	......	......	......	......	......	20	50	96	100	......	SWM
Oct. 31......	10:50 a.m.	319	498	....	......	......	......	......	......	17	45	95	100	......	SWM
Nov. 2.......	12:00 m.	310	683	....	......	......	......	......	......	11	33	91	100	......	SWM
Dec. 7.......	2:10 p.m.	203	302	....	......	......	......	......	......	14	40	89	100	......	SWM

Table 7.--Particle-size analyses of suspended sediment, depth-integrated samples, gaging-station section--Continued

Date	Time	Water discharge (cfs)	Suspended sediment												Methods of analysis
			Concentration of sample (ppm)	Concentration of suspension analyzed (ppm)	Percent finer than indicated size, in millimeters										
					0.002	0.004	0.008	0.016	0.031	0.062	0.125	0.250	0.500	1.000	
1951															
Jan. 1.......	2:30 p.m.	306	836	....	....	....	....	....	....	20	52	93	100	....	SWM
Jan. 23......	4:00 p.m.	319	942	....	....	....	....	....	....	16	44	91	100	....	SWM
Mar. 15......	9:40 a.m.	430	1,220	....	....	....	....	....	....	14	41	91	100	....	SWM
Apr. 17......	12:55 p.m.	337	516	....	....	....	....	....	....	23	60	97	100	....	SWM
Apr. 27......	11:45 a.m.	440	874	....	....	....	....	....	....	18	55	97	100	....	SWM
May 10.......	10:15 a.m.	314	558	....	....	....	....	....	....	16	53	100	....	....	SWM
May 23.......	1:45 p.m.	395	594	....	....	....	....	....	....	37	71	98	100	....	SWM
May 24.......	10:20 a.m.	410	782	....	....	....	....	....	....	26	66	98	100	....	SWM
June 15......	10:40 a.m.	319	516	....	....	....	....	....	....	19	48	100	....	....	SWM
July 18......	11:00 a.m.	298	470	....	....	....	....	....	....	14	40	100	....	....	SWM
July 29......	5:42 a.m.	2,700	3,710	6,680	....	9	....	15	....	43	61	90	100	....	SPWCM
	8:12 a.m.	3,760	5,520	15,000	....	33	....	48	....	67	76	91	99	100	SPWCM
	2:40 p.m.	2,240	5,980	15,800	....	41	....	56	....	77	85	95	100	....	SPWCM
Aug. 2.......	6:40 p.m.	324	742	1,160	....	19	....	37	....	53	66	93	100	....	SPWCM
Sept. 6......	12:00 m.	760	2,860	2,900	31	39	47	55	59	68	84	92	100	....	BN
	12:00 m.	760	2,860	2,630	30	39	44	49	55	64	76	88	95	....	BWCM
	12:00 m.	760	2,860	2,150	27	41	45	52	56	70	84	98	100	....	SPNM
	12:00 m.	760	2,860	1,690	27	34	42	50	52	65	79	97	100	....	SPWCM
Sept. 8......	10:50 a.m.	460	594	....	....	....	....	....	....	27	50	88	100	....	SWM
Sept. 24.....	1:40 p.m.	319	456	....	....	....	....	....	....	34	67	98	100	....	SWM
Oct. 7.......	2:50 p.m.	302	488	....	....	....	....	....	....	26	60	97	100	....	SW
Oct. 24......	11:00 a.m.	328	572	....	....	....	....	....	....	24	52	96	100	....	SW
1952															
Mar. 30......	2:15 p.m.	935	3,340	....	23	27	32	37	42	58	76	96	100	....	SPWCM
Apr. 1.......	11:40 a.m.	662	2,030	....	....	....	....	....	....	28	56	94	100	....	SW
Apr. 6.......	4:30 p.m.	440	951	....	....	....	....	....	....	35	68	96	100	....	SW
Apr. 10......	12:20 p.m.	430	1,080	....	....	....	....	....	....	20	52	96	100	....	SW
May 8........	10:45 a.m.	435	862	....	....	....	....	....	....	23	57	98	100	....	SW

May 24......	1:20 p.m.	455	890	....	......	......	......	......	......	31	64	97	100	......	SW
June 5......	12:05 p.m.	306	514	....	......	......	......	......	......	32	67	97	100	......	SW
June 15......	1:45 p.m.	230	354	....	......	......	......	......	......	30	59	93	100	......	SW
June 19......	11:35 a.m.	230	458	....	......	......	......	......	......	15	35	86	100	......	SW
July 4......	10:10 a.m.	278	462	....	......	......	......	......	......	23	47	86	100	......	SW
July 20......	11:10 a.m.	219	246	....	......	......	......	......	......	22	40	80	99	100	SW
July 31......	1:45 p.m.	212	204	....	......	......	......	......	......	22	47	85	99	100	SW
Aug. 16......	10:05 a.m.	254	394	....	......	......	......	......	......	23	51	93	100	......	SW
Aug. 29......	11:00 a.m.	208	245	....	......	......	......	......	......	22	49	91	99	100	SW
Sept. 12......	9:30 a.m.	223	282	....	......	......	......	......	......	16	37	83	100	......	SW
Sept. 26......	11:10 a.m.	234	346	....	......	......	......	......	......	14	37	89	100	......	SW
Oct. 11......	9:55 a.m.	294	446	....	......	......	......	......	......	20	49	93	100	......	SW
Oct. 23......	12:35 p.m.	286	482	....	......	......	......	......	......	21	49	93	100	......	SW
Nov. 13......	12:15 p.m.	310	563	....	......	......	......	......	......	22	54	96	100	......	SW
Dec. 6......	3:50 p.m.	319	791	....	......	......	......	......	......	16	42	92	100	......	SW
Dec. 11......	2:00 p.m.	328	866	....	......	......	......	......	......	18	45	93	100	......	SW
1953															
Jan. 9......	1:00 p.m.	294	1,020	....	......	......	......	......	......	25	57	95	100	......	SW
Jan. 22......	1:40 p.m.	405	902	....	......	......	......	......	......	27	58	94	100	......	SW
Feb. 3......	1:15 p.m.	400	1,080	....	......	......	......	......	......	22	50	94	100	......	SW
Mar. 11......	9:20 a.m.	538	1,290	....	......	......	......	......	......	24	52	94	100	......	SW
Mar. 27......	12:40 p.m.	350	934	....	......	......	......	......	......	18	54	96	100	......	SW
Mar. 30......	2:50 p.m.	324	728	....	......	......	......	......	......	23	60	96	100	......	SW
Apr. 16......	2:35 p.m.	360	1,010	....	......	......	......	......	......	20	51	94	100	......	SW
Apr. 22......	10:10 a.m.	365	605	....	......	......	......	......	......	26	61	97	100	......	SW
July 8......	5:30 p.m.	278	471	....	......	......	......	......	......	23	56	94	100	......	SW

Table 8.--Particle-size analyses of stream-bed material, gaging-station section

[Method of analysis, sieve. Samples analyzed individually. Mar. 30, 1952, and July 8, 1953, were taken at 4 sampling points; Jan. 9, 1952, at 2 points; all others, at 3 points]

Date	Bed material: Percent finer than indicated size, in millimeters							Location (station numbers)
	0.062	0.125	0.250	0.500	1.000	2.000	4.000	
1949								
May 5....	.....	3	43	88	96	98	100	100, 110, 120
June 6....	.....	1	34	94	99	99	100	100, 115, 130
July 13...	.....	2	35	92	98	99	100	95, 120, 140
Aug. 25...	.....	3	46	87	93	96	98	96, 118, 135
Sept. 16..	.....	1	27	80	95	98	100	100, 115, 130
Oct. 15...	.....	2	38	83	93	97	99	95, 115, 135
1950								
Mar. 3....	.....	4	42	76	86	92	98	101, 119, 136
Apr. 14...	.....	4	42	93	99	100	.....	20, 35, 50
May 11....	.....	6	66	100	.....	.....	.....	90, 100, 108
June 7....	.....	2	42	89	95	98	100	20, 40, 60
June 13...	.....	1	37	97	99	100	.....	22, 40, 62
July 9....	.....	1	26	83	95	98	99	20, 40, 60
Aug. 2....	.....	1	34	91	97	99	100	20, 40, 60
Aug. 30...	.....	4	49	94	99	100	.....	20, 40, 60
Sept. 20..	.....	23	41	94	98	99	100	20, 40, 60
Oct. 6....	0	4	54	98	100	.....	.....	20, 40, 60
1951								
Jan. 25...	0	4	39	94	100	.....	.....	15, 35, 55
Mar. 15...	1	4	38	85	95	98	99	18, 35, 52
Apr. 27...	0	2	34	86	96	99	100	20, 41, 55
May 10....	0	4	34	86	93	96	99	26, 41, 52
May 24....	0	4	45	94	98	99	100	17, 35, 56
June 15...	0	2	34	73	83	91	98	25, 43, 56
July 18...	1	2	48	91	97	99	100	15, 32, 55
Aug. 3....	1	1	18	86	98	98	99	20, 40, 55
Oct. 24...	1	5	51	97	100	.....	.....	21, 34, 58
Nov. 15...	1	4	47	92	97	98	99	29, 44, 62
1952								
Jan. 9....	2	10	70	100	.....	.....	.....	10, 50
Jan. 29...	0	2	28	81	84	85	87	18, 37, 54
Feb. 12...	1	7	61	99	100	.....	.....	26, 44, 60
Mar. 11...	2	7	54	94	98	99	100	20, 35, 50
Mar. 30...	1	10	58	98	100	.....	.....	93, 106, 117, 127
Apr. 10...	1	10	68	99	100	.....	.....	26, 45, 61
May 8.....	0	2	42	97	100	.....	.....	23, 42, 61
May 24....	1	9	62	98	100	.....	.....	24, 44, 60
	0	5	51	98	100	.....	.....	24, 44, 60
June 5....	0	3	49	93	97	98	99	22, 40, 61
June 19...	0	1	41	91	99	100	.....	15, 32, 54
July 4....	0	1	31	90	97	99	100	25, 47, 66
	0	1	32	94	98	99	99	25, 47, 66
July 20...	0	1	42	94	98	99	100	16, 33, 56
July 31...	0	2	31	87	97	99	100	23, 45, 64

Table 8.--Particle-size analyses of stream-bed material, gaging-station section--Continued

Date	Bed material: Percent finer than indicated size, in millimeters							Location (station numbers)
	0.062	0.125	0.250	0.500	1.000	2.000	4.000	
1952--Con.								
Aug. 16...	0	2	40	83	92	95	99	12, 33, 56
Aug. 29...	1	2	27	77	90	96	99	24, 47, 63
Sept. 12..	0	1	33	91	98	99	100	15, 32, 54
Sept. 26..	0	1	36	91	99	100	.....	21, 46, 62
Oct. 11...	.....	1	25	86	96	98	99	28, 43, 58
Oct. 23...	0	2	42	91	97	99	100	17, 36, 55
1953								
Mar. 11...	0	3	44	97	99	100	.....	32, 45, 57
Apr. 22...	0	4	48	90	97	99	100	24, 42, 62
July 8....	0	4	47	92	97	98	99	12, 33, 48, 59

Table 9.--Sediment-discharge measurements, contracted section

[Ratio is that of concentration at cross section to concentration at daily sampling station]

Date	Time	Gage height (feet)	Water discharge (cfs)	Suspended sediment: Ratio	Suspended sediment: Mean concentration (ppm)	Suspended sediment: Discharge (tons per day)	Water temperature (°F)
1948							
July 20...	5:00 p.m.	1.24	452	.....	1,800	2,200	....
Sept. 8...	11:00 a.m.	.94	248	.....	776	519	....
Oct. 13...	4:00 p.m.	.97	263	.....	1,180	838	....
Nov. 3....	2:20 p.m.	1.08	319	.....	1,610	1,390	....
1949							
Feb. 25...	9:00 a.m.	1.30	458	.....	954	1,180	....
Mar. 8....	2:15 p.m.	1.74	720	.....	3,240	6,300	....
Apr. 8....	10:30 a.m.	1.21	420	.....	2,030	2,300	....
May 5.....	11:40 a.m.	1.15	398	.....	1,700	1,830	....
June 6....	10:30 a.m.	1.02	334	.....	1,520	1,370	....
July 13...	11:00 a.m.	.94	263	.....	970	689	....
Aug. 25...	12:00 m.	.83	224	.....	1,140	689	....
Sept. 16..	12:00 m.	.93	268	.....	1,020	738	....
Oct. 15...	12:20 p.m.	1.06	340	.....	1,630	1,500	....
Nov. 8....	9:55 a.m.	1.00	308	.....	1,400	1,160	....
1950							
Mar. 3....	11:25 a.m.	1.08	366	.....	1,890	1,870	....
Mar. 5....	1:15 p.m.	1.16	408	1.12	2,140	2,360	....
Apr. 14...	1:00 p.m.	1.12	387	1.11	1,770	1,850	....
	9:10 a.m.	1.13	395	1.21	2,000	2,130	....
	4:30 p.m.	1.08	366	1.11	1,970	1,950	....

Table 9.--Sediment-discharge measurements, contracted section--Continued

[Ratio is that of concentration at cross section to concentration at daily sampling station]

Date	Time	Gage height (feet)	Water discharge (cfs)	Suspended sediment			Water temperature (°F)
				Ratio	Mean concentration (ppm)	Discharge (tons per day)	
1950--Con.							
May 11....	8:40 a.m.	1.40	590	0.99	1,780	2,840	....
	1:20 p.m.	1.33	549	1.09	2,660	3,940	....
June 7....	8:15 a.m.	.96	278	1.18	780	585	....
	11:05 a.m.	.91	253	1.07	890	608	....
June 13...	10:30 a.m.	.87	234	1.18	790	499	....
July 9....	1:35 p.m.	.86	238	1.34	910	585	....
	6:15 p.m.	.85	234	1.29	670	423	....
Aug. 2....	10:15 a.m.	.94	253	1.37	1,000	683	....
Aug. 30...	9:40 a.m.	1.07	366	1.20	1,780	1,760	....
Sept. 20..	12:55 p.m.	.99	319	1.07	1,490	1,280	....
Oct. 6....	9:40 a.m.	.97	298	.93	1,020	823	....
Nov. 2....	12:45 p.m.	1.00	310	1.29	1,480	1,240	43
1951							
Jan. 25...	10:40 a.m.	.89	306	1.16	1,340	1,110	34
Mar. 7....	1:40 p.m.	1.06	385	1.03	2,340	2,440	....
Mar. 15...	10:20 a.m.	1.17	440	1.22	1,780	2,120	35
Mar. 21...	12:06 p.m.	.94	328	.....	1,540	1,370	....
Apr. 27...	8:40 a.m.	1.20	455	1.10	1,900	2,340	....
May 10....	10:50 a.m.	.92	310	1.13	1,580	1,330	52
May 24....	8:35 a.m.	1.17	430	1.10	2,060	2,390	68
June 15...	9:40 a.m.	.99	342	1.10	1,340	1,240	68
July 18...	9:40 a.m.	1.00	310	1.25	1,200	1,010	75
July 29...	7:50 a.m.	5.62	3,630	.83	4,160	40,800	....
Aug. 2....	6:20 p.m.	1.16	342	1.34	1,840	1,700	74
Oct. 24...	11:40 a.m.	1.05	319	1.19	1,590	1,370	46
Nov. 15...	9:20 a.m.	1.09	324	1.07	1,710	1,500	35
1952							
Jan. 9....	11:00 a.m.	1.05	324	1.14	642	562	32
Jan. 29...	1:00 p.m.	1.02	350	1.34	893	844	37
Feb. 12...	10:20 a.m.	1.13	405	1.14	1,820	1,990	37
Mar. 11...	11:40 a.m.	1.15	415	1.09	2,210	2,480	38
Apr. 10...	2:00 p.m.	1.16	420	1.18	2,120	2,400	45
May 8.....	5:15 p.m.	1.12	400	1.20	1,700	1,840	59
May 24....	12:30 p.m.	1.24	460	1.21	2,750	3,420	70
June 5....	3:05 p.m.	.93	262	1.13	1,200	849	76
June 19...	11:00 a.m.	.79	234	1.48	754	476	68
July 4....	11:50 a.m.	.86	262	.76	934	661	78
July 20...	8:40 a.m.	.76	223	1.23	503	303	70
July 31...	3:40 p.m.	.73	212	1.43	392	224	84
Aug. 16...	7:45 a.m.	.86	262	1.35	820	580	69
Aug. 29...	11:05 a.m.	.74	208	1.11	429	241	73
Sept. 12..	8:30 a.m.	.73	223	1.36	454	273	62
Sept. 26..	12:00 m.	.81	234	1.06	736	465	61
Oct. 11...	10:35 a.m.	.93	290	.....	1,220	955	52
Oct. 23...	10:20 a.m.	.92	286	.....	1,500	1,160	47
Dec. 11...	11:30 a.m.	1.00	328	.....	1,520	1,350	36

Table 9.--Sediment-discharge measurements, contracted section--Continued

/Ratio is that of concentration at cross section to concentration at daily sampling station/

Date	Time	Gage height (feet)	Water discharge (cfs)	Suspended sediment			Water temperature (°F)
				Ratio	Mean concentration (ppm)	Discharge (tons per day)	
1953							
Jan. 9....	1:55 p.m.	0.91	298	.....	1,660	1,340	....
Feb. 3....	9:40 a.m.	1.14	405	.....	2,220	2,430	....
Mar. 11...	8:05 a.m.	1.35	532	.....	2,060	2,960	42
Apr. 22...	8:45 a.m.	1.09	370	.....	1,400	1,400	54
May 3.....	11:25 a.m.	1.57	668	.....	2,340	4,220	47
May 20....	9:35 a.m.	1.13	355	.....	1,560	1,500	63
June 2....	11:20 a.m.	.90	258	.....	1,000	697	68
June 10...	3:15 p.m.	.95	298	.....	954	768	82
June 29...	3:30 p.m.	.78	230	.....	490	304	86
July 8....	3:20 p.m.	.90	278	.....	792	594	68
July 27...	3:15 p.m.	.78	230	.....	480	298	84
Aug. 4....	3:40 p.m.	.91	282	.....	1,080	822	79
Aug. 27...	10:10 a.m.	.75	234	.....	507	320	....
Sept. 10..	4:05 p.m.	.77	226	.....	659	402	77
Sept. 22..	1:00 p.m.	.77	226	.....	666	406	64

Table 10.--Temperature (°F) of water, Niobrara River near Cody, October 1948 to September 1953

/Once-daily temperature measurement at approximately 8 a.m. until May 1, 1953. Water temperature measurement during the afternoon indicated by letter a/

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
							1949 water year					
1	55	43	a 35	....	33	34	35	48	68	72	68	54
2	49	42	....	34	a 32	35	39	49	62	69	65	61
3	51	42	....	33	a 32	35	43	58	60	72	67	64
4	53	45	....	32	a 32	38	41	61	62	71	69	61
5	55	35	....	a 32	33	35	43	55	60	73	70	59
6	50	34	....	a 33	33	40	47	52	66	68	69	61
7	40	38	....	a 34	a 32	40	47	52	57	68	68	60
8	38	31	a 33	a 32	a 32	41	49	54	56	75	67	58
9	45	31	....	32	a 32	40	49	53	63	68	77	59
10	45	a 37	....	a 34	a 34	36	45	55	62	68	68	63
11	40	31	a 34	....	a 34	41	41	60	62	67	70	59
12	41	34	34	32	a 33	37	48	62	69	68	69	53
13	44	34	32	a 34	a 34	36	50	63	61	75	69	47
14	42	35	....	a 34	33	33	41	71	59	66	70	53
15	49	37	....	33	33	34	40	....	64	66	68	55
16	40	39	....	33	33	a 37	41	a 61	64	68	67	58
17	35	39	....	a 32	33	37	41	60	69	68	68	54
18	47	35	....	33	33	36	43	62	62	66	67	52
19	39	32	....	a 33	32	39	53	57	68	67	69	50
20	41	32	a 34	a 32	a 32	42	56	59	69	68	65	55
21	40	31	32	a 33	33	42	57	57	66	63	65	53
22	42	32	33	32	33	39	52	58	68	65	68	55
23	41	36	31	33	33	44	47	55	69	69	68	51
24	42	34	....	a 32	34	42	52	....	63	71	67	55
25	49	37	a 32	a 32	34	36	55	60	65	71	68	52

Table 10.--Temperature (°F) of water, Niobrara River near Cody, October 1948 to September 1953--Continued

[Once-daily temperature measurement at approximately 8 a.m. until May 1, 1953. Water temperature measurement during the afternoon indicated by letter a]

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
						1949 water year--Continued						
26	43	37	32	a 33	35	42	54	60	67	64	66	58
27	42	32	32	a 32	33	38	54	62	75	68	64	51
28	44	a 35	32	a 32	33	42	54	67	67	69	60	50
29	50	32	32	a 32	....	40	53	62	67	66	61	50
30	47	a 34	32	33	....	40	53	64	68	66	60	54
31	53	....	a 34	a 32	....	33	....	66	....	69	59	....
						1950 water year						
1	55	42	37	33	33	37	41	43	52	68	63	66
2	55	40	37	....	33	33	46	49	58	69	63	64
3	56	39	40	....	33	41	40	47	54	66	66	64
4	52	40	37	....	33	43	37	44	58	67	67	63
5	55	40	36	....	34	40	39	38	59	63	63	63
6	57	42	35	33	35	40	47	39	66	66	68	60
7	54	40	a 33	33	35	a 33	45	44	65	68	63	59
8	49	40	33	33	34	33	38	40	60	71	70	63
9	41	41	35	33	34	41	40	43	54	72	69	61
10	48	43	a 38	33	36	33	35	49	55	71	66	58
11	45	45	....	33	33	....	37	53	61	74	66	52
12	45	42	....	....	33	33	41	54	67	65	65	53
13	49	40	....	....	33	33	34	53	74	57	66	51
14	43	44	....	33	33	36	44	57	71	65	68	53
15	51	39	....	....	34	38	45	57	71	62	66	54
16	47	36	a 35	....	37	32	50	58	66	68	68	53
17	46	36	a 35	....	34	39	49	56	63	63	60	50
18	50	36	35	....	34	33	49	60	61	64	63	66
19	44	44	34	....	34	33	40	55	60	63	60	59
20	40	39	....	33	33	35	38	56	65	70	58	61
21	39	35	a 32	33	33	40	45	52	69	67	52	57
22	38	36	34	34	35	35	48	57	70	67	59	70
23	44	38	....	33	34	41	52	65	65	66	63	54
24	44	39	33	....	33	40	52	57	65	64	65	56
25	46	39	....	....	35	43	36	52	71	67	62	56
26	42	43	33	a 34	39	39	41	51	59	66	61	55
27	41	43	33	a 32	40	34	40	51	69	65	65	56
28	43	45	33	34	39	35	43	58	67	71	60	56
29	41	39	33	34	....	36	34	59	62	75	63	55
30	40	34	33	33	....	41	39	63	58	65	60	50
31	40	....	33	33	....	46	....	53	....	63	64	....
						1951 water year						
1	47	47	36	a 33	33	33	37	55	47	60	70	66
2	43	43	....	33	33	33	35	47	41	61	74	65
3	40	33	a 34	....	34	33	36	49	46	60	75	63
4	37	46	....	....	....	33	39	50	47	60	70	63
5	47	42	....	....	34	33	44	52	55	63	77	62
6	50	44	....	....	33	a 35	45	47	59	68	69	59
7	57	45	a 33	....	33	33	37	47	58	72	70	62
8	53	38	....	....	34	33	39	50	60	70	66	63
9	37	....	....	....	33	33	35	55	57	65	65	64
10	47	35	....	....	34	33	38	52	59	60	62	57
11	47	39	33	a 33	37	33	35	49	61	55	61	59
12	47	35	a 37	33	33	33	33	53	57	56	66	55
13	48	36	33	33	33	35	34	57	63	57	66	51
14	47	35	36	33	33	34	44	57	62	67	65	54
15	60	36	33	36	33	35	34	62	70	70	57	56
16	55	39	34	36	33	37	33	60	65	70	61	47
17	50	38	34	33	33	33	40	59	65	65	65	51

Table 10.--Temperature (°F) of water, Niobrara River near Cody, October 1948 to September 1953--Continued

[Once-daily temperature measurement at approximately 8 a.m. until May 1, 1953. Water temperature measurement during the afternoon indicated by letter a]

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
							1951 water year--Continued					
18	55	43	34	34	41	33	46	58	63	78	65	58
19	55	33	33	33	34	33	43	59	65	73	66	57
20	52	43	35	33	33	33	38	60	62	71	65	57
21	50	37	35	33	33	39	34	56	61	73	58	49
22	47	37	35	35	33	39	33	50	59	65	61	43
23	48	....	37	33	34	37	41	52	62	70	61	49
24	a 55	a 36	38	33	41	34	44	68	54	70	67	47
25	a 53	32	40	34	34	36	42	60	65	70	70	47
26	46	37	....	33	33	40	45	54	63	73	64	53
27	....	39	a 35	....	35	45	58	53	65	74	63	42
28	....	36	35	....	33	42	54	64	58	70	67	40
29	....	34	34	....	....	34	57	60	60	73	69	a 62
30	....	33	34	....	....	36	58	57	59	72	70	49
31	48	....	35	a 33	....	34	....	52	....	71	68	....
							1952 water year					
1	54	33	38	33	33	32	39	55	57	72	68	57
2	58	33	42	32	34	32	38	55	61	72	69	49
3	55	34	38	33	34	32	40	60	62	60	67	53
4	55	34	34	33	34	32	41	61	60	67	63	60
5	50	33	35	33	34	32	39	60	63	70	66	63
6	46	36	a 33	33	33	35	42	58	66	72	68	60
7	46	33	a 33	33	35	34	47	56	68	58	70	70
8	46	34	a 33	33	a 39	38	45	57	65	56	65	68
9	46	35	a 33	33	35	42	35	54	60	60	64	67
10	46	35	33	32	35	37	34	46	67	65	67	62
11	48	40	35	32	35	38	39	45	68	67	62	64
12	52	39	34	32	35	35	43	50	68	66	64	62
13	52	46	33	33	38	32	42	54	70	67	67	64
14	47	36	....	34	33	32	40	58	72	57	70	53
15	49	35	....	32	32	32	43	60	74	60	70	50
16	44	35	....	32	32	35	48	53	62	66	68	56
17	40	33	....	32	35	41	47	51	62	70	67	55
18	43	33	....	33	32	37	47	49	63	....	67	58
19	40	33	....	35	32	35	50	50	62	....	70	56
20	44	33	....	32	32	36	53	55	64	a 80	71	55
21	43	36	....	33	32	34	51	49	61	65	65	54
22	40	33	....	32	32	32	45	56	67	68	63	49
23	38	33	....	32	32	32	43	58	70	63	65	51
24	43	33	....	33	32	33	47	50	68	67	69	50
25	45	35	....	33	32	35	51	58	63	70	70	52
26	41	34	....	33	32	34	54	61	66	64	67	52
27	36	39	....	34	34	35	57	56	64	70	69	55
28	38	40	....	36	34	40	58	51	63	67	66	57
29	42	35	a 35	33	32	41	55	59	65	64	65	55
30	40	42	37	33	....	42	58	58	69	61	65	55
31	34	....	36	35	....	43	....	49	....	66	60	....

1953 water year

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May Max.	May Min.	June Max.	June Min.	July Max.	July Min.	Aug. Max.	Aug. Min.	Sept. Max.	Sept. Min.
1	53	40	a 35	a 33	a 42	a 32	44	44	43	75	61	86	71	88	73	80	71
2	46	39	a 38	a 35	a 41	a 35	37	43	41	76	63	81	70	79	72	75	69
3	49	32	a 35	a 36	a 44	a 35	33	47	42	74	59	80	65	76	70	69	64
4	46	43	a 35	a 35	a 42	a 35	33	53	45	73	59	83	71	79	67	68	61
5	40	43	....	a 32	a 42	a 38	40	58	47	66	59	72	66	82	68	69	60
6	33	39	a 36	a 35	a 43	a 35	46	64	50	59	55	79	61	82	69	72	64
7	32	59	a 35	a 37	a 41	33	48	65	53	62	57	79	66	78	64	74	65

Table 10.--Temperature (°F) of water, Niobrara River near Cody, October 1948 to September 1953--Continued

[Once-daily temperature measurement at approximately 8 a.m. until May 1, 1953. Water temperature measurement during the afternoon indicated by letter a]

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May		June		July		Aug.		Sept.	
1953 water year--Continued																	
								Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
8	38	38	a 36	a 38	a 41	34	43	64	54	77	57	72	65	80	64	74	66
9	40	36	a 37	a 38	a 33	39	40	66	54	72	65	73	64	86	69	75	66
10	45	32	a 36	a 35	a 32	39	34	57	50	81	63	80	64	78	67	77	68
11	45	36	a 36	a 38	a 33	41	38	59	46	88	72	84	69	73	64	73	66
12	48	37	a 37	a 39	a 35	40	37	48	42	81	69	82	70	80	62	71	64
13	48	40	a 33	a 39	a 37	41	38	52	41	89	73	85	68	85	65	72	64
14	46	a 50	a 34	a 33	a 37	39	44	63	44	86	74	83	69	76	68	73	64
15	39	a 47	a 38	a 33	a 36	33	33	65	51	78	69	82	68	70	63	72	64
16	43	a 42	a 36	a 33	a 33	37	34	58	53	79	62	77	68	69	64	72	64
17	43	a 39	a 34	a 33	a 39	42	35	61	54	84	65	82	66	73	64	72	66
18	42	a 42	a 34	a 32	a 37	39	35	68	54	85	69	84	70	76	64	70	62
19	43	a 33	a 34	34	....	38	33	71	56	82	64	85	70	75	63	71	64
20	43	a 39	a 37	a 35	....	44	37	67	61	77	62	86	69	76	65	68	62
21	42	a 38	a 34	a 34	a 33	43	38	65	55	79	63	82	69	75	64	66	57
22	43	a 37	a 32	a 32	a 33	40	49	69	53	74	63	84	67	76	65	69	59
23	42	a 34	a 32	a 36	a 37	38	51	64	58	84	66	82	68	71	67	70	64
24	45	a 33	a 32	a 38	a 32	33	50	73	57	76	66	83	70	79	64	68	63
25	47	a 32	a 32	a 39	a 36	32	37	74	59	77	60	86	71	81	67	66	58
26	44	a 32	a 32	a 40	a 35	40	38	71	59	74	61	85	71	82	69	66	60
27	45	a 32	a 32	a 39	a 37	40	45	75	61	80	66	85	71	81	70	67	60
28	35	a 35	a 36	a 37	a 32	38	46	74	64	78	65	81	73	78	72	68	62
29	35	a 37	a 34	a 42	....	45	45	78	65	87	69	75	70	79	70	67	62
30	40	a 35	a 36	a 35	....	45	40	72	58	86	72	80	65	78	70	66	59
31	54	....	a 34	a 39	....	45	....	77	59	....	....	86	72	81	72	....	....

Table 11.--Particle-size analyses of suspended sediment, point-integrated samples, contracted section

[Methods of analysis: B, bottom-withdrawal tube; N, in native water; W, in distilled water; S, sieve; C, chemically dispersed; M, mechanically dispersed]

Date	Time	Water discharge (cfs)	Sampling station	Total depth (feet)	Suspended sediment: Sampling point: Velocity (fps)	Depth (feet)	Concentration (ppm)	Percent finer than indicated size, in millimeters: 0.008	0.016	0.031	0.062	0.125	0.250	0.500	1.000	2.000	Methods of analysis
1948																	
Mar. 16...	11:43 a.m.	1,330	13	11.0	....	3.0	5,890	10	13	20	28	49	80	97	.....	.....	BN
	11:55 a.m.	1,330	13	11.0	....	5.0	5,210	7	10	14	27	37	59	81	.....	.....	BN
	12:05 p.m.	1,300	13	11.0	....	8.0	5,080	9	12	17	28	40	77	97	.....	.....	BN
	4:14 p.m.	1,160	13	11.0	....	1.0	4,340	8	11	14	22	33	74	95	.....	.....	BN
	3:55 p.m.	1,160	13	11.0	....	4.0	4,520	9	12	15	20	26	53	79	.....	.....	BN
	4:08 p.m.	1,160	13	11.0	....	8.0	5,040	8	12	16	22	29	55	91	.....	.....	BN
June 12...	10:40 a.m.	283	10	9.5	....	1.4	781	.....	2	3	8	22	89	99	.....	.....	BN
	10:30 a.m.	283	10	9.5	....	3.9	757	.....	4	6	12	26	90	98	.....	.....	BN
	10:20 a.m.	283	10	9.5	....	6.8	1,010	.....	4	4	8	19	96	100	.....	.....	BN
	9:45 a.m.	288	10	9.5	....	9.1	1,120	.....	3	4	7	16	70	91	.....	.....	BN
Sept. 8...	2:20 p.m.	224	6	7.6	2.9	1.0	513	.....	5	6	13	28	79	94	.....	.....	BN
	2:10 p.m.	229	6	7.6	2.5	3.0	739	.....	4	6	11	22	72	88	.....	.....	BN
	1:45 p.m.	229	6	7.6	2.2	5.0	924	.....	3	4	8	18	44	76	.....	.....	BN
	1:10 p.m.	229	6	7.6	1.6	7.1	920	.....	.....	5	9	18	43	80	.....	.....	BN
	5:15 p.m.	224	10	9.0	4.1	2.0	485	.....	5	7	15	31	64	89	.....	.....	BN
	4:59 p.m.	224	10	9.0	3.7	4.0	556	.....	6	9	14	32	88	98	.....	.....	BN
	4:52 p.m.	224	10	9.0	3.2	6.0	709	.....	2	5	10	25	82	95	.....	.....	BN
	4:36 p.m.	224	10	9.0	1.8	8.6	1,240	.....	3	3	7	16	50	81	.....	.....	BN
	3:44 p.m.	224	14	8.6	3.3	2.0	759	.....	4	5	10	24	71	86	.....	.....	BN
	3:20 p.m.	224	14	8.6	2.9	4.0	871	.....	3	4	10	21	56	86	.....	.....	BN
	3:12 p.m.	224	14	8.6	3.0	6.0	931	.....	2	3	8	17	60	85	.....	.....	BN
	2:52 p.m.	224	14	8.6	1.2	8.2	1,430	.....	2	2	4	13	41	74	.....	.....	BN
Oct. 13...	10:30 a.m.	283	6	8.8	3.6	2.0	1,220	.....	4	5	7	15	78	98	.....	.....	BN
	10:30 a.m.	283	6	8.8	1.8	5.0	2,000	.....	2	3	4	10	60	95	.....	.....	BN
	10:30 a.m.	283	6	8.8	2.0	7.0	3,810	.....	1	1	2	6	32	80	.....	.....	BN
	3:00 p.m.	283	6	8.8	.6	8.3	4,370	.....	1	2	2	4	24	67	.....	.....	BN

Table 11.--Particle-size analyses of suspended sediment, point-integrated samples, contracted section--Continued

Date	Time	Water discharge (cfs)	Sampling station	Total depth (feet)	Suspended sediment: Sampling point: Velocity (fps)	Depth (feet)	Concentration (ppm)	Percent finer than indicated size, in millimeters: 0.008	0.016	0.031	0.062	0.125	0.250	0.500	1.000	2.000	Methods of analysis
1948--Con.																	
Oct. 13....	10:30 a.m.	283	10	9.7	4.5	2.0	860	.....	5	5	9	19	74	96	.....	.....	BN
	10:30 a.m.	283	10	9.7	3.6	5.0	1,220	.....	3	3	6	14	72	97	.....	.....	BN
	10:30 a.m.	283	10	9.7	3.2	8.0	1,960	.....	2	2	4	9	55	93	.....	.....	BN
	10:30 a.m.	283	10	9.7	1.1	9.2	3,210	.....	1	2	3	7	77	98	.....	.....	BN
	10:30 a.m.	283	14	8.1	4.6	2.0	980	.....	3	5	8	19	81	98	.....	.....	BN
	10:30 a.m.	283	14	8.1	4.2	4.0	1,270	.....	2	3	7	16	74	98	.....	.....	BN
	10:30 a.m.	283	14	8.1	2.3	6.0	1,440	.....	2	3	6	14	70	95	.....	.....	BN
	10:30 a.m.	283	14	8.1	.8	7.6	2,070	.....	1	2	4	10	51	91	.....	.....	BN
Nov. 3....	12:36 p.m.	319	6	9.0	3.5	2.0	1,090	.....	19	20	22	30	84	98	.....	.....	BN
	12:26 p.m.	319	6	9.0	1.3	4.5	2,320	.....	3	3	3	10	40	84	.....	.....	BN
	12:08 p.m.	319	6	9.0	1.2	7.0	3,740	.....	.....	2	2	6	28	72	.....	.....	BN
	11:23 a.m.	319	6	9.0	.7	8.5	3,230	.....	.....	1	2	5	18	66	.....	.....	BN
	2:00 p.m.	319	10	9.6	5.5	2.0	1,050	.....	6	7	10	20	60	94	.....	.....	BN
	1:54 p.m.	319	10	9.6	6.4	5.0	1,490	.....	5	5	8	14	45	87	.....	.....	BN
	1:48 p.m.	319	10	9.6	3.1	8.0	2,250	.....	.....	1	2	8	42	86	.....	.....	BN
	1:36 p.m.	319	10	9.6	.5	9.1	3,300	.....	.....	.....	1	5	30	75	.....	.....	BN
	10:25 a.m.	319	14	8.0	6.1	2.0	1,410	.....	2	4	6	15	56	92	.....	.....	BN
	10:36 a.m.	319	14	8.0	4.4	4.5	1,660	.....	2	3	5	12	53	91	.....	.....	BN
	10:46 a.m.	319	14	8.0	2.1	6.5	2,230	.....	2	3	5	20	48	88	.....	.....	BN
	11:16 a.m.	319	14	8.0	1.8	7.5	2,080	.....	2	2	5	11	41	84	.....	.....	BN
1949																	
Mar. 8....	12:15 p.m.	739	6	8.5	7.10	2.0	3,670	.....	.....	4	11	22	40	76	.....	.....	BN
	12:00 m.	739	6	8.5	5.88	5.0	3,580	.....	2	4	9	25	66	90	.....	.....	BN
	11:45 a.m.	739	6	8.5	5.56	7.0	3,940	.....	3	5	11	22	50	90	.....	.....	BN
	11:40 a.m.	739	6	8.5	3.04	8.0	4,240	.....	5	7	12	22	47	85	.....	.....	BN
	1:05 p.m.	739	10	10.5	9.73	2.0	3,120	.....	3	6	11	25	60	94	.....	.....	BN
	1:00 p.m.	739	10	10.5	9.07	5.0	3,220	.....	4	6	12	22	45	84	.....	.....	BN
	12:55 p.m.	739	10	10.5	7.65	8.0	3,630	.....	3	5	11	24	44	83	.....	.....	BN
	12:50 p.m.	739	10	10.5	3.47	10.0	3,780	.....	.....	4	8	25	55	93	.....	.....	BN

	12:00 m.	739	14	8.5	9.94	2.0	3,030	.....	1	2	8	26	86	99	.....	.....	BN
	10:10 a.m.	752	14	8.5	7.03	5.0	3,510	.....	3	5	11	22	45	83	.....	.....	BN
	10:20 a.m.	752	14	8.5	7.11	7.0	3,690	.....	4	6	13	24	52	89	.....	.....	BN
	11:00 a.m.	745	14	8.5	5.82	8.0	4,400	.....	2	4	9	27	49	85	.....	.....	BN
Apr. 8....	10:20 a.m.	425	6	7.5	4.79	1.0	2,080	.....	2	3	9	25	63	97	.....	.....	BN
	10:15 a.m.	425	6	7.5	3.68	4.0	2,300	.....	1	3	9	25	62	87	.....	.....	BN
	10:10 a.m.	425	6	7.5	3.50	6.0	2,230	.....	1	3	9	24	61	96	.....	.....	BN
	10:05 a.m.	425	6	7.5	3.30	7.0	2,510	.....	2	4	7	23	57	92	.....	.....	BN
	11:40 a.m.	420	10	9.0	6.69	1.0	1,310	.....	2	6	14	30	78	97	.....	.....	BN
	11:35 a.m.	420	10	9.0	6.35	4.5	1,920	.....	2	3	7	21	78	98	.....	.....	BN
	11:30 a.m.	420	10	9.0	5.15	7.5	2,440	.....	.....	0	7	23	77	96	.....	.....	BN
	11:25 a.m.	420	10	9.0	3.73	8.5	2,870	.....	.....	1	6	18	73	96	.....	.....	BN
	8:45 a.m.	425	14	7.5	6.60	1.0	1,370	.....	2	4	18	37	85	98	.....	.....	BN
	8:50 a.m.	425	14	7.5	5.11	4.0	1,730	.....	2	6	14	34	84	97	.....	.....	BN
	9:35 a.m.	425	14	7.5	5.64	7.0	2,140	.....	5	6	10	27	70	96	.....	.....	BN
May 5.....	9:50 a.m.	398	6	7.5	4.18	1.0	1,580	.....	6	8	16	34	85	98	.....	.....	BN
	10:00 a.m.	398	6	7.5	3.06	4.0	1,870	.....	7	8	16	32	85	98	.....	.....	BN
	10:10 a.m.	398	6	7.5	3.41	6.0	1,840	.....	3	5	12	30	88	98	.....	.....	BN
	10:25 a.m.	398	6	7.5	2.70	7.0	2,320	.....	.....	8	14	28	75	99	.....	.....	BN
	12:30 p.m.	398	10	8.5	6.24	1.0	1,330	.....	8	10	18	39	90	99	.....	.....	BN
	12:35 p.m.	398	10	8.5	6.22	4.0	1,710	.....	6	7	12	26	76	96	.....	.....	BN
	12:40 p.m.	398	10	8.5	5.53	7.0	1,890	.....	4	6	13	32	78	96	.....	.....	BN
	12:45 p.m.	398	10	8.5	5.50	8.0	2,050	.....	4	5	11	28	75	98	.....	.....	BN
	11:10 a.m.	398	14	6.5	6.34	1.0	1,440	.....	5	6	12	34	91	99	.....	.....	BN
	11:15 a.m.	398	14	6.5	3.97	4.0	2,220	.....	7	8	14	25	72	96	.....	.....	BN
	11:25 a.m.	398	14	6.5	3.16	6.0	2,210	.....	.....	8	12	24	52	92	.....	.....	BN
June 6....	10:00 a.m.	340	6	8.3	4.05	1.0	940	.....	.....	.....	12	24	71	98	.....	.....	BN
	10:10 a.m.	340	6	8.3	3.31	4.0	1,330	.....	.....	.....	10	23	77	98	.....	.....	BN
	10:20 a.m.	340	6	8.3	2.50	7.0	1,960	.....	.....	.....	5	14	66	96	.....	.....	BN
	10:30 a.m.	340	6	8.3	.43	7.8	970	.....	.....	.....	15	30	41	95	.....	.....	BN
	10:40 a.m.	334	10	9.9	5.07	1.0	640	.....	.....	.....	19	38	90	98	.....	.....	BN
	10:50 a.m.	334	10	9.9	5.16	4.0	940	.....	.....	.....	12	28	85	99	.....	.....	BN
	11:00 a.m.	334	10	9.9	4.70	7.0	1,330	.....	.....	.....	11	20	57	96	.....	.....	BN
	11:10 a.m.	334	10	9.9	.95	9.4	3,740	.....	.....	.....	2	5	26	91	.....	.....	BN

Table 11.--Particle-size analyses of suspended sediment, point-integrated samples, contracted section--Continued

Date	Time	Water discharge (cfs)	Sampling station	Total depth (feet)	Suspended sediment: Sampling point: Velocity (fps)	Depth (feet)	Concentration (ppm)	Percent finer than indicated size, in millimeters: 0.008	0.016	0.031	0.062	0.125	0.250	0.500	1.000	2.000	Methods of analysis
1949--Con.																	
June 6....	9:15 a.m.	340	14	8.5	4.91	1.0	950	.....	.....	.....	15	31	85	97	.....	.....	BN
	9:30 a.m.	340	14	8.5	3.61	4.0	1,350	.....	.....	.....	8	18	63	96	.....	.....	BN
	9:40 a.m.	340	14	8.5	2.15	7.0	2,070	.....	.....	.....	17	27	61	98	.....	.....	BN
	9:45 a.m.	340	14	8.5	1.19	8.0	2,050	.....	.....	.....	6	14	56	97	.....	.....	BN
July 13...	10:26 a.m.	268	6	8.5	2.36	1.0	460	.....	.....	.....	4	22	84	99	.....	.....	BN
	10:30 a.m.	268	6	8.5	1.85	4.0	930	.....	.....	3	15	25	87	99	.....	.....	BN
	10:40 a.m.	268	6	8.5	2.42	6.0	870	.....	.....	.....	7	18	74	98	.....	.....	BN
	10:55 a.m.	268	6	8.5	.46	8.0	220	.....	.....	.....	19	27	62	84	.....	.....	BN
	11:30 a.m.	258	10	9.8	4.79	1.0	300	.....	.....	13	23	42	91	99	.....	.....	BN
	11:40 a.m.	253	10	9.8	4.33	4.0	450	.....	.....	11	19	35	81	98	.....	.....	BN
	11:46 a.m.	253	10	9.8	3.84	6.0	510	.....	.....	.....	10	21	67	97	.....	.....	BN
	11:52 a.m.	253	10	9.8	.44	9.0	1,420	.....	.....	.....	.....	8	42	85	.....	.....	BN
	9:36 a.m.	268	14	9.0	4.60	1.0	480	.....	.....	4	8	25	82	98	.....	.....	BN
	9:41 a.m.	268	14	9.0	3.23	4.0	940	.....	.....	1	5	14	53	97	.....	.....	BN
	9:50 a.m.	268	14	9.0	2.82	6.0	1,090	.....	.....	.....	.....	14	57	97	.....	.....	BN
	10:10 a.m.	268	14	9.0	1.06	7.5	1,460	.....	.....	2	5	10	40	85	.....	.....	BN
Sept. 16..	11:40 a.m.	273	6	7.5	3.02	1.0	550	.....	.....	19	24	32	78	99	.....	.....	BW
	11:45 a.m.	273	6	7.5	1.88	4.0	870	.....	.....	11	14	22	68	98	.....	.....	BW
	11:50 a.m.	273	6	7.5	2.19	6.0	1,130	.....	.....	8	12	19	62	97	.....	.....	BW
	11:55 a.m.	273	6	7.5	2.05	7.0	1,320	.....	.....	.....	10	13	63	94	.....	.....	BW
	1:15 p.m.	258	10	8.5	4.32	1.0	360	.....	.....	26	30	45	88	99	.....	.....	BW
	1:20 p.m.	253	10	8.5	4.23	4.0	530	.....	.....	.....	26	38	86	98	.....	.....	BW
	1:22 p.m.	253	10	8.5	3.77	6.0	680	.....	.....	12	15	26	80	98	.....	.....	BW
	1:28 p.m.	253	10	8.5	3.89	8.0	820	.....	.....	13	15	26	82	98	.....	.....	BW
	9:45 a.m.	278	14	7.5	3.87	1.0	760	.....	.....	12	18	27	73	95	.....	.....	BW
	9:50 a.m.	278	14	7.5	2.77	4.0	1,280	.....	.....	9	11	16	48	95	.....	.....	BW
	10:00 a.m.	273	14	7.5	2.45	6.0	1,310	.....	.....	8	10	15	52	90	.....	.....	BW
	11:20 a.m.	273	14	7.5	1.43	7.0	1,630	.....	.....	.....	9	13	35	90	.....	.....	BW

Oct. 15...	12:05 p.m.	345	6	6.5	3.65	2.0	1,180	.....	.....	.....	14	22	75	97	.....	.....	BW
	12:07 p.m.	345	6	6.5	2.18	4.0	1,710	.....	.....	.....	12	19	58	93	.....	.....	BW
	12:12 p.m.	340	6	6.5	2.85	6.0	1,610	.....	.....	.....	11	18	54	97	.....	.....	BW
	12:50 p.m.	334	10	8.5	6.51	2.0	1,020	.....	.....	.....	18	28	75	97	.....	.....	BW
	12:55 p.m.	334	10	8.5	5.08	4.0	920	.....	.....	7	13	35	66	97	.....	.....	BW
	12:45 p.m.	334	10	8.5	3.62	6.0	1,080	.....	.....	.....	17	25	74	97	.....	.....	BW
	1:00 p.m.	329	10	8.5	4.38	8.0	1,500	.....	.....	2	11	20	67	96	.....	.....	BW
	10:41 a.m.	345	14	6.5	3.89	2.0	1,310	.....	.....	7	12	21	60	98	.....	.....	BW
	10:50 a.m.	345	14	6.5	2.91	4.0	1,790	.....	.....	8	12	19	56	96	.....	.....	BW
	10:53 a.m.	345	14	6.5	2.71	6.0	1,740	.....	.....	11	13	20	54	96	.....	.....	BW
Nov. 8....	9:30 a.m.	298	6	7.5	3.96	2.0	1,010	.....	.....	.....	13	21	82	98	.....	.....	BW
	9:35 a.m.	298	6	7.5	2.24	4.0	1,550	.....	.....	.....	11	19	79	97	.....	.....	BW
	9:40 a.m.	303	6	7.5	2.61	6.0	1,670	.....	.....	6	9	15	53	97	.....	.....	BW
	9:45 a.m.	308	6	7.5	1.95	7.0	2,030	.....	.....	.....	.....	.....	.....	.....	.....	.....	....
	10:30 a.m.	308	10	8.5	5.19	2.0	960	.....	.....	10	15	22	55	96	.....	.....	BW
	10:35 a.m.	308	10	8.5	4.98	4.0	1,050	.....	.....	.....	10	17	69	95	.....	.....	BW
	10:40 a.m.	308	10	8.5	4.68	6.0	1,230	.....	.....	8	12	18	70	96	.....	.....	BW
	10:45 a.m.	308	10	8.5	4.79	8.0	1,520	.....	.....	.....	8	15	53	96	.....	.....	BW
	8:55 a.m.	298	14	7.5	4.59	2.0	1,190	.....	.....	9	13	20	60	97	.....	.....	BW
	9:00 a.m.	298	14	7.5	3.10	4.0	1,570	.....	.....	.....	8	16	63	97	.....	.....	BW
	9:05 a.m.	298	14	7.5	2.65	6.0	1,930	.....	.....	.....	7	12	43	87	.....	.....	BW
	9:10 a.m.	298	14	7.5	3.03	7.0	1,670	.....	.....	.....	9	14	48	85	.....	.....	BW
1950 Mar. 3....	11:00 a.m.	366	7	7.5	3.65	2.0	2,440	.....	.....	.....	12	28	77	98	100	.....	SC
	11:05 a.m.	366	7	7.5	2.94	4.0	2,090	.....	.....	.....	9	27	76	98	100	.....	SC
	11:15 a.m.	366	7	7.5	3.30	6.0	2,290	.....	.....	.....	10	26	75	97	99	100	SC
	11:25 a.m.	366	7	7.5	3.04	7.0	2,450	.....	.....	.....	5	23	71	96	99	100	SC
	11:40 a.m.	366	11	8.5	6.38	2.0	1,460	.....	.....	.....	17	42	87	99	100	.....	SC
	11:45 a.m.	371	11	8.5	5.98	4.0	1,640	.....	.....	.....	15	38	83	99	100	.....	SC
	11:45 a.m.	371	11	8.5	5.70	6.0	1,780	.....	.....	.....	16	38	84	99	100	.....	SC
	11:50 a.m.	371	11	8.5	5.39	8.0	1,910	.....	.....	.....	13	34	81	98	99	100	SC
	10:25 a.m.	361	15	8.0	5.12	2.0	1,950	.....	.....	.....	11	29	77	98	100	.....	SC
	10:30 a.m.	366	15	8.0	4.58	4.0	1,810	.....	.....	.....	10	26	73	97	99	100	SC
	10:40 a.m.	366	15	8.0	4.06	6.0	2,150	.....	.....	.....	10	27	73	97	99	100	SC
	10:45 a.m.	366	15	8.0	3.26	7.5	2,370	.....	.....	.....	10	26	72	93	96	99	SC

Table 11.--Particle-size analyses of suspended sediment, point-integrated samples, contracted section--Continued

Date	Time	Water discharge (cfs)	Sampling station	Total depth (feet)	Suspended sediment: Sampling point: Velocity (fps)	Depth (feet)	Concentration (ppm)	Percent finer than indicated size, in millimeters: 0.008	0.016	0.031	0.062	0.125	0.250	0.500	1.000	2.000	Methods of analysis
1950--Con.																	
July 10...	4:20 p.m.	234	8	8.9	3.33	2.0	340	.....	.....	.....	25	46	85	100	.....	.....	S
	4:15 p.m.	234	8	8.9	1.40	6.0	650	.....	.....	.....	16	30	73	100	.....	.....	S
	4:10 p.m.	234	8	8.9	1.42	8.4	1,620	.....	.....	.....	8	17	55	95	100	.....	S
	4:42 p.m.	234	11	9.0	3.48	2.0	360	.....	.....	.....	28	49	85	100	.....	.....	S
	4:37 p.m.	234	11	9.0	3.55	6.0	380	.....	.....	.....	26	41	79	100	.....	.....	S
	4:30 p.m.	234	11	9.0	2.68	8.5	1,080	.....	.....	.....	9	21	68	98	100	.....	S
	6:12 p.m.	234	14	9.4	3.48	1.0	430	.....	.....	.....	21	41	83	100	.....	.....	S
	5:50 p.m.	234	14	9.4	1.12	6.0	2,220	.....	.....	.....	6	12	58	88	100	.....	S
	5:28 p.m.	234	14	9.4	1.64	8.9	1,880	.....	.....	.....	6	14	50	94	100	.....	S
1951																	
Jan. 25...	2:45 p.m.	332	7	8.0	2.78	.5	1,320	.....	.....	.....	12	32	76	98	100	.....	SWM
	2:51 p.m.	332	7	8.0	3.51	2.5	1,410	.....	.....	.....	12	31	76	99	.....	.....	SWM
	3:00 p.m.	332	7	8.0	2.11	5.0	1,940	.....	.....	.....	10	26	67	97	.....	.....	SWM
	3:10 p.m.	332	7	8.0	2.62	7.5	3,430	.....	.....	.....	8	22	63	97	.....	.....	SWM
	3:44 p.m.	337	11	9.8	3.08	.5	1,570	.....	.....	.....	14	34	77	99	.....	.....	SWM
	3:42 p.m.	337	11	9.8	4.09	3.0	1,330	.....	.....	.....	13	32	75	99	.....	.....	SWM
	3:36 p.m.	332	11	9.8	3.68	6.5	1,990	.....	.....	.....	9	24	67	98	.....	.....	SWM
	3:28 p.m.	332	11	9.8	1.64	9.3	5,750	.....	.....	.....	4	11	46	96	100	.....	SWM
	4:21 p.m.	337	14	7.1	3.08	.5	1,530	.....	.....	.....	12	29	72	98	.....	.....	SWM
	4:18 p.m.	337	14	7.1	4.38	2.5	1,740	.....	.....	.....	10	26	67	96	.....	.....	SWM
	4:04 p.m.	337	14	7.1	1.46	4.5	3,330	.....	.....	.....	7	17	53	90	97	.....	SWM
	3:52 p.m.	337	14	7.1	3.48	6.6	3,320	.....	.....	.....	8	24	64	95	.....	.....	SWM
Apr. 27...	9:12 a.m.	455	8	......	7.31	.5	1,360	.....	.....	.....	15	46	89	.....	.....	.....	SWM
	9:46 a.m.	450	8	......	6.29	2.5	1,720	.....	.....	.....	13	36	83	.....	.....	.....	SWM
	9:50 a.m.	450	8	......	5.79	5.0	1,990	.....	.....	.....	10	32	77	98	.....	.....	SWM
	11:17 a.m.	445	11	9.6	7.58	3.0	1,410	.....	.....	.....	15	39	84	100	.....	.....	SWM
	11:14 a.m.	445	11	9.6	7.19	6.0	1,750	.....	.....	.....	11	33	75	99	.....	.....	SWM
	11:02 a.m.	445	11	9.6	2.69	9.1	2,310	.....	.....	.....	8	25	66	98	.....	.....	SWM

	11:27 a.m.	440	14	10.0	6.88	.5	1,490	.....	.....	.....	14	36	78	99	.....	.....	SWM
	11:42 a.m.	440	14	10.0	7.13	3.5	1,830	.....	.....	.....	12	30	73	98	100	.....	SWM
	12:16 p.m.	440	14	10.0	3.67	7.0	2,470	.....	.....	.....	9	25	65	97	98	.....	SWM
	12:46 p.m.	440	14	10.0	1.76	9.5	4,580	.....	.....	.....	17	18	54	90	94	98	SWM
May 24....	12:44 p.m.	380	8	8.0	4.84	.5	1,350	.....	.....	.....	27	38	80	99	99	.....	SWCM
	12:56 p.m.	380	8	8.0	5.22	3.0	1,960	.....	.....	.....	11	29	74	99	.....	.....	SWCM
	1:14 p.m.	380	8	8.0	2.49	6.0	2,920	.....	.....	.....	9	23	64	98	99	.....	SWCM
	1:45 p.m.	380	8	8.0	.93	7.5	3,080	.....	.....	.....	7	21	62	.....	.....	.....	SWCM
	12:22 p.m.	380	11	10.2	5.74	.5	1,240	.....	.....	.....	16	40	74	.....	.....	.....	SWCM
	12:32 p.m.	380	11	10.2	5.71	3.0	1,860	.....	.....	.....	17	35	74	.....	.....	.....	SWM
	12:35 p.m.	380	11	10.2	5.96	6.0	2,140	.....	.....	.....	25	31	71	.....	.....	.....	SWM
	12:42 p.m.	380	11	10.2	1.46	9.7	6,650	.....	.....	.....	7	14	45	94	.....	.....	SWM
	11:12 a.m.	410	14	10.0	5.32	.5	1,100	.....	.....	.....	17	43	76	.....	.....	.....	SWM
	11:55 a.m.	400	14	10.0	6.44	3.0	1,650	.....	.....	.....	12	30	65	.....	.....	.....	SWM
	12:02 p.m.	385	14	10.0	5.20	6.0	2,640	.....	.....	.....	8	22	52	.....	.....	.....	SWM
	12:19 p.m.	380	14	10.0	3.09	9.5	5,810	.....	.....	.....	34	41	74	92	98	.....	SWM
1952																	
May 8.....	6:58 p.m.	450	8	10	6.79	.5	1,190	.....	.....	.....	14	51	87	100	.....	.....	SW
	6:56 p.m.	450	8	10	8.87	3.5	1,550	.....	.....	.....	23	54	85	99	100	.....	SW
	6:53 p.m.	450	8	10	7.42	7.0	2,000	.....	.....	.....	18	46	76	97	100	.....	SW
	6:31 p.m.	440	8	10	4.64	9.5	2,120	.....	.....	.....	15	37	69	96	100	.....	SW
	7:11 p.m.	455	11	11	5.04	.5	1,140	.....	.....	.....	28	67	94	100	.....	.....	SW
	7:07 p.m.	450	11	11	10.14	4.0	1,420	.....	.....	.....	21	53	84	99	100	.....	SW
	7:04 p.m.	450	11	11	10.26	7.5	1,710	.....	.....	.....	20	48	75	93	97	100	SW
	7:02 p.m.	450	11	11	5.28	10.5	1,610	.....	.....	.....	21	49	78	97	100	.....	SW
	7:26 p.m.	465	14	10.8	5.41	.5	1,330	.....	.....	.....	35	68	92	100	.....	.....	SW
	7:23 p.m.	460	14	10.8	6.67	4.0	1,410	.....	.....	.....	22	51	80	98	100	.....	SW
	7:19 p.m.	460	14	10.8	9.00	7.5	1,390	.....	.....	.....	24	53	80	98	100	.....	SW
	7:15 p.m.	455	14	10.8	5.29	10.3	1,300	.....	.....	.....	23	55	81	98	100	.....	SW
June 5....	9:57 a.m.	324	8	9.5	5.73	.5	580	.....	.....	.....	28	51	89	100	.....	.....	SW
	10:02 a.m.	324	8	9.5	5.83	3.0	863	.....	.....	.....	20	39	82	100	.....	.....	SW
	10:20 a.m.	324	8	9.5	1.92	6.0	2,240	.....	.....	.....	9	20	58	92	95	100	SW
	9:52 a.m.	324	8	9.5	4.24	9.0	252	.....	.....	.....	55	76	95	100	.....	.....	SW

Table 11.--Particle-size analyses of suspended sediment, point-integrated samples, contracted section--Continued

Date	Time	Water discharge (cfs)	Sampling station	Total depth (feet)	Suspended sediment: Sampling point: Velocity (fps)	Depth (feet)	Concentration (ppm)	Percent finer than indicated size, in millimeters: 0.008	0.016	0.031	0.062	0.125	0.250	0.500	1.000	2.000	Methods of analysis
1952--Con.																	
June 5....	10:54 a.m.	319	11	10	3.78	0.5	1,060	.....	.....	.....	18	34	68	94	99	100	SW
	12:06 p.m.	306	11	10	4.02	3.0	1,110	.....	.....	.....	17	34	73	100	.....	.....	SW
	11:55 a.m.	306	11	10	3.98	6.0	1,520	.....	.....	.....	14	27	67	99	100	.....	SW
	10:56 a.m.	319	11	10	1.41	9.5	2,560	.....	.....	.....	8	17	54	98	100	.....	SW
	1:06 p.m.	286	14	10.5	3.48	.5	929	.....	.....	.....	20	39	81	100	.....	.....	SW
	1:00 p.m.	286	14	10.5	4.02	3.5	1,460	.....	.....	.....	13	27	66	97	100	.....	SW
	12:54 p.m.	294	14	10.5	2.75	7.0	2,280	.....	.....	.....	8	19	56	96	99	100	SW
	12:35 p.m.	298	14	10.5	.72	10.0	4,000	.....	.....	.....	6	12	46	93	98	100	SW
June 19...	4:00 p.m.	223	8	7.9	3.48	.5	326	.....	.....	.....	23	48	88	100	.....	.....	SW
	3:55 p.m.	223	8	7.9	3.92	3.0	448	.....	.....	.....	17	38	81	99	100	.....	SW
	3:51 p.m.	223	8	7.9	1.80	5.5	662	.....	.....	.....	16	30	72	98	100	.....	SW
	3:27 p.m.	219	8	7.9	.74	7.4	1,620	.....	.....	.....	12	20	52	96	100	.....	SW
	4:15 p.m.	223	11	8.0	3.78	.5	256	.....	.....	.....	27	54	91	100	.....	.....	SW
	4:20 p.m.	223	11	8.0	4.20	3.0	342	.....	.....	.....	24	47	87	100	.....	.....	SW
	4:12 p.m.	223	11	8.0	4.08	5.5	561	.....	.....	.....	16	35	80	100	.....	.....	SW
	4:05 p.m.	219	11	8.0	2.41	7.5	1,520	.....	.....	.....	6	16	58	96	99	100	SW
	4:42 p.m.	226	14	8.3	3.88	.5	303	.....	.....	.....	28	46	82	98	100	.....	SW
	4:39 p.m.	226	14	8.3	4.20	3.3	614	.....	.....	.....	13	28	72	100	.....	.....	SW
	4:36 p.m.	223	14	8.3	2.57	6.0	1,270	.....	.....	.....	7	16	53	98	100	.....	SW
	4:30 p.m.	223	14	8.3	1.99	7.4	8,370	.....	.....	.....	1	5	48	98	100	.....	SW
July 31...	5:08 p.m.	208	8	8.0	2.76	.5	180	.....	.....	.....	26	51	90	100	.....	.....	SW
	5:00 p.m.	208	8	8.0	3.45	3.0	291	.....	.....	.....	20	45	86	100	.....	.....	SW
	4:51 p.m.	208	8	8.0	1.07	5.5	544	.....	.....	.....	12	28	72	98	99	100	SW
	4:18 p.m.	208	8	8.0	1.29	7.5	1,190	.....	.....	.....	6	16	56	96	100	.....	SW
	5:48 p.m.	208	11	8.3	3.13	.5	124	.....	.....	.....	37	100	.....	.....	.....	.....	SW
	5:40 p.m.	208	11	8.3	3.87	3.5	307	.....	.....	.....	15	34	72	100	.....	.....	SW
	5:34 p.m.	208	11	8.3	3.18	5.9	415	.....	.....	.....	12	33	76	100	.....	.....	SW
	5:28 p.m.	208	11	8.3	2.40	7.8	774	.....	.....	.....	6	20	64	96	100	.....	SW

	6:14 p.m.	208	14	8.6	2.81	.5	212	.....	.....	.....	25	52	100	.....	.....	.....	SW
	6:10 p.m.	208	14	8.6	3.34	3.5	475	.....	.....	.....	12	29	74	100	.....	.....	SW
	6:03 p.m.	208	14	8.6	2.34	6.0	552	.....	.....	.....	10	28	70	98	100	.....	SW
	5:56 p.m.	208	14	8.6	2.25	8.1	828	.....	.....	.....	8	22	66	98	100	.....	SW
Aug. 29...	9:20 a.m.	208	8	8.1	2.97	.5	217	.....	.....	.....	28	54	90	100	.....	.....	SW
	9:15 a.m.	208	8	8.1	3.07	3.0	299	.....	.....	.....	22	45	85	99	100	.....	SW
	9:07 a.m.	208	8	8.1	1.78	5.3	578	.....	.....	.....	12	29	72	97	100	.....	SW
	8:55 a.m.	208	8	8.1	1.08	7.6	994	.....	.....	.....	7	20	65	97	100	.....	SW
	9:52 a.m.	208	11	8.5	3.04	.5	181	.....	.....	.....	33	63	91	98	100	.....	SW
	9:46 a.m.	208	11	8.5	3.32	3.0	268	.....	.....	.....	22	48	86	99	100	.....	SW
	9:42 a.m.	208	11	8.5	3.16	5.5	467	.....	.....	.....	11	31	73	92	92	92	SW
	9:34 a.m.	208	11	8.5	1.97	8.0	1,610	.....	.....	.....	4	15	62	97	100	.....	SW
	10:35 a.m.	208	14	8.7	3.03	.5	272	.....	.....	.....	22	46	86	99	100	.....	SW
	10:30 a.m.	208	14	8.7	3.25	3.2	555	.....	.....	.....	11	28	68	98	100	.....	SW
	10:24 a.m.	208	14	8.7	1.34	5.7	1,400	.....	.....	.....	5	13	47	96	99	100	SW
	10:06 a.m.	208	14	8.7	2.44	8.2	1,280	.....	.....	.....	6	16	60	97	100	.....	SW
Sept. 26..	10:06 a.m.	242	8	9.0	3.03	.5	401	.....	.....	.....	16	38	86	99	100	.....	SW
	10:16 a.m.	242	8	9.0	3.49	3.0	458	.....	.....	.....	13	34	85	99	100	.....	SW
	10:28 a.m.	242	8	9.0	1.08	5.5	929	.....	.....	.....	9	24	69	88	91	94	SW
	10:33 a.m.	242	8	9.0	.24	8.0	1,060	.....	.....	.....	5	15	59	92	96	100	SW
	11:08 a.m.	234	11	9.2	3.34	.5	287	.....	.....	.....	18	44	92	100	.....	.....	SW
	11:04 a.m.	234	11	9.2	3.59	3.0	438	.....	.....	.....	14	33	86	99	100	.....	SW
	10:55 a.m.	238	11	9.2	2.87	6.0	807	.....	.....	.....	8	24	78	99	100	.....	SW
	10:52 a.m.	238	11	9.2	1.56	8.7	1,380	.....	.....	.....	2	13	61	97	99	100	SW
	11:32 a.m.	234	14	9.7	3.52	.5	502	.....	.....	.....	11	30	83	100	.....	.....	SW
	11:33 a.m.	234	14	9.7	3.90	3.0	654	.....	.....	.....	8	23	73	98	100	.....	SW
	11:26 a.m.	234	14	9.7	3.56	6.0	1,240	.....	.....	.....	5	16	65	98	100	.....	SW
	11:23 a.m.	234	14	9.7	.89	9.2	4,050	.....	.....	.....	2	7	53	97	100	.....	SW
Oct. 23...	9:03 a.m.	286	8	9.0	3.80	.5	906	.....	.....	.....	13	32	82	100	.....	.....	SW
	9:00 a.m.	286	8	9.0	4.53	3.5	1,020	.....	.....	.....	12	29	77	99	100	.....	SW
	8:49 a.m.	286	8	9.0	.69	6.0	2,140	.....	.....	.....	20	32	72	98	100	.....	SW
	8:34 a.m.	286	8	9.0	1.18	8.5	2,970	.....	.....	.....	5	12	49	94	99	100	SW
	9:24 a.m.	286	11	9.5	3.68	.5	687	.....	.....	.....	12	33	81	100	.....	.....	SW
	9:18 a.m.	286	11	9.5	4.14	3.0	921	.....	.....	.....	12	30	77	99	100	.....	SW
	9:14 a.m.	286	11	9.5	4.71	6.0	1,280	.....	.....	.....	10	22	72	99	100	.....	SW
	9:09 a.m.	286	11	9.5	2.74	9.0	3,380	.....	.....	.....	3	11	57	98	100	.....	SW

Table 11.--Particle-size analyses of suspended sediment, point-integrated samples, contracted section--Continued

Date	Time	Water discharge (cfs)	Sampling station	Total depth (feet)	Suspended sediment: Sampling point: Velocity (fps)	Depth (feet)	Concentration (ppm)	Percent finer than indicated size, in millimeters: 0.008	0.016	0.031	0.062	0.125	0.250	0.500	1.000	2.000	Methods of analysis
1952--Con.																	
Oct. 23...	9:44 a.m.	286	14	10.1	3.62	0.5	1,010	.....	.....	.....	9	24	74	99	100	.....	SW
	9:39 a.m.	286	14	10.1	4.02	3.5	1,690	.....	.....	.....	6	18	62	96	99	100	SW
	9:34 a.m.	286	14	10.1	1.20	6.5	2,760	.....	.....	.....	9	11	47	93	98	100	SW
	9:30 a.m.	286	14	10.1	1.66	9.6	8,360	.....	.....	.....	2	5	29	82	94	99	SW

Table 12.--Particle-size analyses of stream-bed material, contracted section

[Method of analysis, sieve. Samples analyzed individually]

Date	Number of sampling points	Bed material: Percent finer than indicated size, in millimeters: 0.062	0.125	0.250	0.500	1.000	2.000	4.000	Location (station numbers)
1951									
May 10......	4	1	4	24	56	66	71	79	8, 10, 12, 14
Oct. 24.....	1	0	1	9	32	42	57	89	9
1952									
June 19.....	3	0	2	34	83	90	95	99	8, 11, 14
July 4......	2	0	2	22	75	92	96	99	8, 14
July 20.....	3	0	2	19	64	90	96	98	8, 11, 14
July 31.....	3	0	2	37	91	98	99	100	8, 11, 14
Aug. 16.....	3	0	3	31	79	91	95	97	8, 11, 14
Aug. 29.....	3	0	2	30	83	95	97	99	8, 11, 14
Sept. 12....	3	0	1	33	89	96	99	100	8, 11, 14
Sept. 26....	3	0	5	48	84	92	95	97	8, 11, 14
Oct. 23.....	3	0	1	26	78	90	93	96	8, 11, 14
1953									
June 10.....	1	0	2	17	68	86	92	98	11

Table 13.--Particle-size analyses of suspended sediment, depth-integrated samples, contracted section

[Methods of analysis: B, bottom-withdrawal tube; N, in native water; W, in distilled water; S, sieve; C, chemically dispersed; P, pipette; M, mechanically dispersed]

Date	Time	Water discharge (cfs)	Suspended sediment: Concentration of sample (ppm)	Concentration of suspension analyzed (ppm)	Percent finer than indicated size, in millimeters: 0.004	0.016	0.031	0.062	0.125	0.250	0.500	1.000	2.000	Methods of analysis
1948														
July 20....	5:00 p.m.	452	1,800	3,280	....	22	26	34	47	80	94	98	....	BN
Sept. 8....	11:00 a.m.	253	776	1,340	....	4	6	12	23	65	94	99	....	BN
Oct. 13....	3:47 p.m.	263	1,180	1,250	....	2	3	6	14	69	97	....	....	BN
Nov. 3.....	2:26 p.m.	319	1,610	1,950	....	4	4	7	14	49	87	....	....	BN
1949														
Mar. 8.....	2:15 p.m.	720	3,240	3,020	....	4	7	13	27	53	85	....	....	BN
Apr. 8.....	10:58 a.m.	420	2,030	2,590	....	2	3	10	25	87	99	....	....	BN
May 5......	11:42 a.m.	398	1,700	2,290	....	6	7	13	31	79	97	....	....	BN
June 6.....	10:33 a.m.	334	1,520	2,020	....	....	5	9	19	57	93	....	....	BN
July 13....	11:07 a.m.	258	970	1,180	....	....	....	7	15	58	93	99	....	BN
Sept. 16...	12:20 p.m.	268	1,020	1,030	....	....	12	14	20	61	88	97	....	BW
Oct. 1.....	6:10 a.m.	298	1,000	470	....	....	....	16	23	74	99	....	....	BW
Oct. 10....	11:45 a.m.	458	1,500	....	....	....	....	23	50	87	99	100	....	SWC
Oct. 15....	12:15 p.m.	345	1,630	1,540	....	....	....	12	19	58	100	....	....	BW
Oct. 22....	1:50 p.m.	308	1,400	....	....	....	....	11	26	71	97	100	....	SWC
Nov. 1.....	3:15 p.m.	298	1,210	....	....	....	....	12	30	69	95	99	100	SWC
Nov. 8.....	10:00 a.m.	308	1,400	1,460	....	....	....	12	20	66	100	....	....	BW
Nov. 20....	10:00 a.m.	308	2,110	....	....	....	....	8	22	61	84	89	100	SWC
Dec. 9.....	4:20 p.m.	273	1,700	....	....	....	....	9	24	65	90	100	....	SWC
Dec. 31....	9:20 a.m.	240	960	....	....	....	....	12	21	60	96	100	....	SWC
1950														
Mar. 1.....	11:35 a.m.	387	2,640	....	....	....	....	12	28	72	97	100	....	SWC
Mar. 3.....	11:25 a.m.	366	1,890	....	....	....	....	13	33	78	96	97	100	SWC
Apr. 14....	9:10 a.m.	395	2,000	....	....	....	....	7	20	62	96	100	....	SW
May 11.....	8:40 a.m.	590	1,780	....	....	....	....	20	42	76	95	100	....	SW
	1:20 p.m.	549	2,660	....	....	....	....	9	24	68	97	100	....	SW

Table 13..--Particle-size analyses of suspended sediment, depth-integrated samples, contracted section--Continued

Date	Time	Water discharge (cfs)	Suspended sediment: Concentration of sample (ppm)	Concentration of suspension analyzed (ppm)	Percent finer than indicated size, in millimeters: 0.004	0.016	0.031	0.062	0.125	0.250	0.500	1.000	2.000	Methods of analysis
1950--Con.														
June 7.....	8:15 a.m.	278	780	....	....	....	....	10	26	66	96	100	....	SW
June 13....	10:30 a.m.	234	790	....	....	....	....	8	23	64	96	100	....	SW
July 9.....	1:35 p.m.	238	910	....	....	....	....	14	30	68	96	100	....	SW
	6:15 p.m.	234	670	....	....	....	....	15	31	69	96	100	....	SW
Aug. 2.....	10:15 a.m.	253	1,000	....	....	....	....	10	26	68	96	100	....	SW
Aug. 14....	12:50 p.m.	578	3,550	3,130	44	58	....	75	89	99	100	....	....	SPWCM
Aug. 27....	11:30 a.m.	913	5,470	6,230	36	50	....	60	75	94	100	....	....	SPWCM
Aug. 30....	9:40 a.m.	366	1,780	840	13	17	....	27	40	68	96	100	....	SPWCM
Sept. 20...	1:05 p.m.	319	1,490	....	....	....	....	9	25	70	95	100	....	SW
Oct. 6.....	9:40 a.m.	298	1,020	....	....	....	....	12	27	60	89	96	100	SWM
Nov. 2.....	12:45 p.m.	310	1,480	....	....	....	....	10	22	63	94	99	100	SWM
1951														
Mar. 15....	10:20 a.m.	440	1,780	....	....	....	....	15	36	77	96	99	100	SWM
Apr. 27....	8:40 a.m.	455	1,900	....	....	....	....	12	32	69	95	100	....	SWM
May 10.....	10:50 a.m.	310	1,580	....	....	....	....	7	23	65	97	100	....	SWM
May 24.....	8:35 a.m.	430	2,060	....	....	....	....	20	38	94	97	100	....	SWM
June 15....	9:40 a.m.	342	1,340	....	....	....	....	10	27	100	....	....	....	SWM
July 18....	9:40 a.m.	310	1,200	....	....	....	....	8	22	67	96	100	....	SWM
July 29....	7:50 a.m.	3,630	4,160	1,590	29	45	....	71	87	100	....	....	....	SPWCM
Aug. 2.....	6:20 p.m.	342	1,840	....	....	....	....	21	34	66	96	98	99	SWM
Sept. 5....	10:05 a.m.	2,440	5,760	5,010	20	32	....	57	76	96	100	....	....	SPWCM
	6:35 p.m.	1,740	6,840	7,190	37	51	....	68	81	94	100	....	....	SPWCM
Sept. 6....	1:20 p.m.	722	4,750	2,370	24	32	....	41	51	73	96	99	100	SPWCM
Oct. 24....	11:40 a.m.	319	1,590	....	....	....	....	9	22	65	96	98	100	SW
1952														
Apr. 10....	2:00 p.m.	420	2,120	....	....	....	....	13	32	71	98	100	....	SW
May 24.....	12:30 p.m.	460	2,750	....	....	....	....	14	29	70	98	100	....	SW

June 5.....	3:05 p.m.	262	1,200	....	....	....	....	15	30	70	97	100	....	SW
June 19....	11:00 p.m.	234	754	....	....	....	....	11	25	70	97	100	....	SW
July 4.....	11:50 a.m.	262	934	....	....	....	....	9	20	56	95	100	....	SW
July 20....	8:40 a.m.	223	503	....	....	....	....	12	26	68	97	100	....	SW
July 31....	3:40 p.m.	212	392	....	....	....	....	13	29	68	97	100	....	SW
Aug. 16....	7:45 a.m.	262	820	....	....	....	....	14	33	69	98	100	....	SW
Aug. 29....	11:05 a.m.	208	429	....	....	....	....	23	40	77	99	100	....	SW
Sept. 12...	8:30 a.m.	223	454	....	....	....	....	11	25	71	98	100	....	SW
Sept. 26...	12:00 m.	234	736	....	....	....	....	9	23	71	98	100	....	SW
Oct. 11....	10:35 a.m.	290	1,220	....	....	....	....	9	23	69	98	100	....	SW
Oct. 23....	10:20 a.m.	286	1,500	....	....	....	....	7	17	53	96	99	100	SW
Dec. 11....	11:30 a.m.	328	1,520	....	....	....	....	7	20	63	95	98	98	SW
1953														
Jan. 9.....	1:55 p.m.	298	1,660	....	....	....	....	14	32	69	96	99	100	SW
Feb. 3.....	9:40 a.m.	405	2,220	....	....	....	....	13	31	73	97	99	100	SW
Mar. 11....	8:05 a.m.	532	2,060	....	....	....	....	16	37	81	99	100	....	SW
Apr. 22....	8:45 a.m.	370	1,400	....	....	....	....	12	34	75	97	99	100	SW
May 3......	11:25 a.m.	668	2,340	....	....	....	....	14	30	72	98	100	....	SW
May 20.....	9:35 a.m.	355	1,560	....	....	....	....	12	36	75	98	100	....	SW
June 2.....	11:20 a.m.	258	1,000	....	....	....	....	11	27	68	96	99	100	SW
June 10....	3:15 p.m.	298	954	....	....	....	....	15	33	70	96	99	100	SW
June 29....	3:30 p.m.	230	490	....	....	....	....	11	31	74	98	100	....	SW
July 8.....	3:20 p.m.	278	792	....	....	....	....	15	36	70	94	97	100	SW
July 27....	3:15 p.m.	230	480	....	....	....	....	16	34	69	97	100	....	SW
Aug. 4.....	3:40 p.m.	282	1,080	....	....	....	....	18	34	61	87	92	100	SW
Aug. 27....	10:10 a.m.	234	507	....	....	....	....	16	32	66	96	98	100	SW
Sept. 10...	4:05 p.m.	226	659	....	....	....	....	10	22	64	96	99	100	SW
Sept. 22...	1:00 p.m.	226	666	....	....	....	....	10	25	60	94	99	100	SW

Table 14.--Profiles of normal section C-1

June 14, 1951		July 18, 1951		Aug. 3, 1951		Sept. 6, 1951		Apr. 1, 1952		May 8, 1952		June 19, 1952		Sept. 26, 1952	
Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude
0 - 10	95.9	0 + 17	87.4	0 + 00	91.1	0 + 17	87.6	0 + 18	86.8	0 + 18	86.8	0 + 29	86.9	0 + 18	86.3
0 + 00	91.5	0 + 17	86.8	0 + 02	90.9	0 + 17	86.6	0 + 18	86.4	0 + 20	85.7	0 + 32	85.5	0 + 20	86.3
0 + 10	88.7	0 + 20	86.9	0 + 04	89.8	0 + 20	86.5	0 + 20	85.7	0 + 25	85.0	0 + 37	85.8	0 + 25	86.2
0 + 18	87.3	0 + 25	86.9	0 + 06	89.3	0 + 25	86.8	0 + 24	85.9	0 + 30	85.1	0 + 42	85.9	0 + 30	86.3
0 + 18	87.3	0 + 30	87.0	0 + 08	88.7	0 + 30	86.9	0 + 28	86.0	0 + 35	85.8	0 + 47	86.1	0 + 35	86.3
0 + 20	87.2	0 + 35	87.0	0 + 10	88.5	0 + 35	86.9	0 + 30	86.0	0 + 40	85.8	0 + 52	86.3	0 + 40	85.9
0 + 20	86.3	0 + 40	86.9	0 + 14	88.2	0 + 40	86.9	0 + 34	86.0	0 + 45	85.7	0 + 57	86.4	0 + 45	86.2
0 + 25	86.5	0 + 45	87.0	0 + 18	87.1	0 + 45	86.9	0 + 40	85.9	0 + 50	85.9	0 + 62	86.5	0 + 50	86.2
0 + 30	85.4	0 + 50	87.0	0 + 20	86.7	0 + 50	86.9	0 + 45	85.9	0 + 55	85.7	0 + 67	86.6	0 + 55	85.9
0 + 35	86.5	0 + 55	87.0	0 + 25	86.8	0 + 55	86.0	0 + 50	85.9	0 + 60	85.3	0 + 72	86.6	0 + 60	86.4
0 + 40	86.4	0 + 60	86.9	0 + 30	86.8	0 + 60	85.9	0 + 55	85.8	0 + 65	86.0	0 + 77	86.4	0 + 65	86.2
0 + 45	86.3	0 + 65	86.6	0 + 35	87.1	0 + 65	85.1	0 + 60	85.7	0 + 70	86.0	0 + 82	86.0	0 + 70	86.0
0 + 50	86.3	0 + 70	86.6	0 + 40	87.3	0 + 70	85.8	0 + 65	85.6	0 + 75	85.9	0 + 87	85.8	0 + 75	86.0
0 + 55	86.4	0 + 75	86.0	0 + 45	87.1	0 + 75	85.5	0 + 70	85.5	0 + 80	85.7	0 + 92	85.6	0 + 80	86.3
0 + 60	86.5	0 + 80	85.6	0 + 50	86.9	0 + 80	85.5	0 + 75	85.3	0 + 85	85.2	0 + 97	86.0	0 + 85	86.3
0 + 65	86.4	0 + 85	85.5	0 + 55	86.8	0 + 85	85.9	0 + 80	85.2	0 + 90	85.7	1 + 02	86.0	0 + 90	86.1
0 + 70	86.6	0 + 90	85.3	0 + 60	86.8	0 + 90	85.4	0 + 85	85.1	0 + 95	85.6	1 + 07	86.3	0 + 95	86.2
0 + 75	86.5	0 + 95	85.6	0 + 65	86.9	0 + 95	85.2	0 + 90	84.8	1 + 00	85.5	1 + 12	86.1	1 + 00	86.7
0 + 80	86.2	1 + 00	85.8	0 + 70	86.9	1 + 00	83.7	0 + 95	84.9	1 + 05	85.2	1 + 17	86.0	1 + 05	86.3
0 + 85	86.3	1 + 05	86.3	0 + 75	86.9	1 + 05	84.2	1 + 00	84.6	1 + 10	85.0	1 + 22	85.9	1 + 10	85.5
0 + 90	86.1	1 + 10	86.5	0 + 80	86.8	1 + 10	84.4	1 + 05	84.9	1 + 15	84.9	1 + 27	85.6	1 + 15	85.5
0 + 95	86.1	1 + 15	86.4	0 + 85	84.3	1 + 15	84.6	1 + 10	84.6	1 + 20	85.1	1 + 32	85.7	1 + 20	85.1
1 + 00	86.2	1 + 20	86.3	0 + 90	84.5	1 + 20	84.9	1 + 15	84.8	1 + 25	85.3	1 + 37	85.1	1 + 25	84.5
1 + 05	85.9	1 + 25	86.1	0 + 95	84.2	1 + 25	85.0	1 + 20	84.7	1 + 30	85.5	1 + 42	85.8	1 + 30	85.1
1 + 10	85.9	1 + 30	85.9	1 + 00	84.1	1 + 30	84.9	1 + 25	84.6	1 + 35	86.1	1 + 47	86.5	1 + 35	86.1
1 + 15	85.9	1 + 35	86.9	1 + 05	83.7	1 + 35	86.0	1 + 30	85.2	1 + 38	86.8	....	....	1 + 37	87.0
1 + 20	85.9	1 + 36	87.5	1 + 10	83.7	1 + 37	87.6	1 + 35	86.3	....	....	....	....	....	....
1 + 25	85.9	....	....	1 + 15	84.6	....	....	1 + 37	86.8	....	....	....	....	....	....
1 + 30	85.9	....	....	1 + 20	84.2	....	....	....	....	....	....	....	....	....	....
1 + 34	85.7	....	....	1 + 25	84.7	....	....	....	....	....	....	....	....	....	....

1 + 35	86.6	....	....	1 + 30	84.8	....	....	....	....	....	....	....	....	....	....
1 + 36	86.8	....	....	1 + 35	85.9	....	....	....	....	....	....	....	....	....	....
1 + 36	87.2	....	....	1 + 37	87.1	....	....	....	....	....	....	....	....	....	....
1 + 37	87.2	....	....	1 + 40	88.0	....	....	....	....	....	....	....	....	....	....
1 + 45	87.7	....	....	1 + 45	88.0	....	....	....	....	....	....	....	....	....	....
1 + 55	88.6	....	....	1 + 50	87.9	....	....	....	....	....	....	....	....	....	....
1 + 59	89.3	....	....	1 + 55	89.0	....	....	....	....	....	....	....	....	....	....
1 + 61	91.3	....	....	1 + 59	89.2	....	....	....	....	....	....	....	....	....	....
1 + 70	94.0	....	....	1 + 61	91.4	....	....	....	....	....	....	....	....	....	....

Table 15.--Profiles of normal section C-2

June 14, 1951		July 18, 1951		Aug. 3, 1951		Sept. 6, 1951		Apr. 1, 1952		May 8, 1952		June 19, 1952		Sept. 26, 1952	
Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude
0 + 07	88.9	0 + 15	86.3	0 + 00	89.5	0 + 14	85.6	0 + 15	85.21	0 + 13	85.72	0 + 04	85.67	0 + 14	85.16
0 + 10	86.3	0 + 16	85.3	0 + 04	89.5	0 + 16	85.6	0 + 17	85.01	0 + 14	85.02	0 + 05	85.17	0 + 15	85.11
0 + 14	86.0	0 + 20	84.9	0 + 11	86.5	0 + 19	84.8	.0 + 20	84.81	0 + 16	84.32	0 + 06	85.07	0 + 17	84.51
0 + 14	86.0	0 + 25	84.9	0 + 13	86.1	0 + 21	84.3	0 + 23	83.60	0 + 20	83.72	0 + 08	84.27	0 + 19	84.86
0 + 15	86.0	0 + 30	84.9	0 + 15	85.1	0 + 24	84.2	0 + 26	83.80	0 + 24	83.92	0 + 12	83.77	0 + 21	84.91
0 + 15	85.1	0 + 35	84.7	0 + 19	84.0	0 + 27	84.3	0 + 29	84.00	0 + 28	84.42	0 + 16	84.17	0 + 23	84.91
0 + 20	85.0	0 + 40	84.5	0 + 23	83.6	0 + 30	84.4	0 + 32	84.20	0 + 32	84.42	0 + 20	84.07	0 + 25	84.61
0 + 25	84.6	0 + 45	85.1	0 + 27	83.8	0 + 33	84.6	0 + 35	84.30	0 + 36	83.92	0 + 24	83.87	0 + 27	84.76
0 + 30	85.2	0 + 50	85.2	0 + 29	83.6	0 + 36	84.8	0 + 38	84.30	0 + 40	83.92	0 + 28	84.47	0 + 30	85.01
0 + 35	84.5	0 + 55	85.2	0 + 31	83.3	0 + 39	84.9	0 + 42	84.40	0 + 45	84.62	0 + 32	84.47	0 + 33	85.26
0 + 40	85.2	0 + 60	85.1	0 + 33	83.2	0 + 42	84.9	0 + 46	84.50	0 + 50	85.12	0 + 36	84.67	0 + 36	85.31
0 + 45	85.0	0 + 65	85.1	0 + 36	83.6	0 + 45	85.0	0 + 50	84.50	0 + 55	85.12	0 + 40	84.67	0 + 40	85.41
0 + 50	84.8	0 + 70	85.3	0 + 39	83.6	0 + 48	85.0	0 + 54	84.50	0 + 60	85.02	0 + 45	84.77	0 + 45	85.61
0 + 55	84.7	0 + 75	85.1	0 + 42	83.6	0 + 51	85.1	0 + 58	84.40	0 + 65	84.92	0 + 50	85.07	0 + 50	85.66
0 + 60	84.3	0 + 80	85.0	0 + 45	83.2	0 + 54	85.2	0 + 62	84.40	0 + 70	85.12	0 + 56	85.27	0 + 60	85.51
0 + 65	84.9	0 + 85	85.0	0 + 48	83.9	0 + 57	85.3	0 + 66	84.50	0 + 75	85.12	0 + 62	85.17	0 + 65	85.21
0 + 70	85.4	0 + 90	85.1	0 + 52	83.9	0 + 60	85.3	0 + 70	84.30	0 + 80	85.02	0 + 68	85.07	0 + 70	85.31
0 + 75	85.4	0 + 95	85.1	0 + 56	84.2	0 + 64	85.4	0 + 74	84.30	0 + 85	84.92	0 + 74	84.97	0 + 75	85.41

Table 15.--Profiles of normal section C-2--Continued

June 14, 1951		July 18, 1951		Aug. 3, 1951		Sept. 6, 1951		Apr. 1, 1952		May 8, 1952		June 19, 1952		Sept. 26, 1952	
Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude
0 + 80	85.4	1 + 00	84.9	0 + 62	84.8	0 + 68	85.4	0 + 78	84.30	0 + 89	83.92	0 + 80	84.87	0 + 80	85.41
0 + 85	85.4	1 + 05	84.8	0 + 67	85.0	0 + 72	85.4	0 + 82	84.10	0 + 93	84.02	0 + 86	84.67	0 + 85	85.16
0 + 90	85.2	1 + 10	85.3	0 + 75	85.6	0 + 76	85.5	0 + 86	84.00	0 + 97	83.82	0 + 92	84.67	0 + 90	85.16
0 + 95	85.2	1 + 16	85.5	0 + 85	85.7	0 + 80	85.6	0 + 90	83.90	1 + 01	83.52	0 + 98	84.67	0 + 95	85.21
1 + 00	85.2	1 + 22	85.4	1 + 00	85.7	0 + 84	85.6	0 + 94	83.90	1 + 05	84.32	1 + 04	84.77	0 + 98	84.41
1 + 05	85.2	1 + 28	85.4	1 + 10	85.6	0 + 88	85.6	0 + 98	83.80	1 + 09	84.12	1 + 10	84.37	1 + 00	84.21
1 + 10	85.3	1 + 32	84.9	1 + 20	85.5	0 + 92	85.6	1 + 02	83.70	1 + 13	84.02	1 + 15	84.67	1 + 02	83.76
1 + 15	85.3	1 + 33	86.3	1 + 25	85.2	0 + 96	85.6	1 + 06	83.70	1 + 17	83.92	1 + 20	84.77	1 + 04	83.61
1 + 20	85.3	....	....	1 + 29	85.3	1 + 00	85.6	1 + 10	83.60	1 + 21	84.22	1 + 22	85.67	1 + 06	83.41
1 + 25	85.2	....	....	1 + 32	86.1	1 + 05	85.6	1 + 14	83.60	1 + 25	84.42	....	....	1 + 08	83.21
1 + 30	84.9	....	....	1 + 32	87.1	1 + 10	85.6	1 + 18	83.50	1 + 28	84.72	....	....	1 + 10	83.31
1 + 32	84.6	....	....	1 + 47	89.1	1 + 15	85.6	1 + 22	83.80	1 + 30	85.72	....	....	1 + 12	83.61
1 + 32	86.1	....	....	....	....	1 + 20	86.7	1 + 26	84.30	....	....	....	....	1 + 14	83.71
1 + 33	85.9	....	....	....	....	1 + 25	85.7	1 + 30	84.70	....	....	....	....	1 + 16	83.81
1 + 40	87.1	....	....	....	....	1 + 30	85.5	1 + 32	85.00	....	....	....	....	1 + 18	83.71
1 + 45	88.7	....	....	....	....	1 + 32	86.9	....	....	....	....	....	....	1 + 20	83.91
1 + 65	91.6	....	....	....	....	....	....	....	....	....	....	....	....	1 + 22	84.26
....	....	....	....	....	....	....	....	....	....	....	....	....	....	1 + 24	84.21
....	....	....	....	....	....	....	....	....	....	....	....	....	....	1 + 26	84.36
....	....	....	....	....	....	....	....	....	....	....	....	....	....	1 + 28	84.36
....	....	....	....	....	....	....	....	....	....	....	....	....	....	1 + 30	84.96
....	....	....	....	....	....	....	....	....	....	....	....	....	....	1 + 32	85.41

Table 16.--Profiles of normal section C-3

June 14, 1951		July 18, 1951		Aug. 3, 1951		Sept. 6, 1951		Apr. 1, 1952		May 8, 1952		June 19, 1952		Sept. 26, 1952	
Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude
0 + 08	86.59	0 + 23	85.4	0 + 05	87.4	0 + 34	85.5	0 + 23	85.6	0 + 39	84.7	0 + 33	84.7	0 + 25	84.9
0 + 12	85.95	0 + 25	84.5	0 + 09	86.8	0 + 40	85.1	0 + 29	85.5	0 + 40	84.1	0 + 36	83.8	0 + 30	84.3
0 + 17	85.81	0 + 30	85.2	0 + 13	86.0	0 + 45	84.9	0 + 36	85.2	0 + 45	83.6	0 + 41	83.1	0 + 35	84.3
0 + 22	85.12	0 + 35	85.1	0 + 17	85.9	0 + 50	84.2	0 + 38	84.7	0 + 50	83.6	0 + 46	83.3	0 + 40	84.3
0 + 27	84.34	0 + 40	85.1	0 + 21	85.8	0 + 55	83.7	0 + 42	84.2	0 + 55	84.1	0 + 51	83.8	0 + 45	84.3
0 + 30	84.55	0 + 45	85.0	0 + 26	86.0	0 + 60	84.2	0 + 47	84.3	0 + 60	84.3	0 + 56	84.1	0 + 50	84.4
0 + 35	84.61	0 + 50	84.9	0 + 31	85.8	0 + 65	84.5	0 + 50	84.2	0 + 65	84.6	0 + 61	84.3	0 + 55	84.5
0 + 40	84.58	0 + 55	84.8	0 + 37	86.1	0 + 70	84.4	0 + 55	84.1	0 + 68	84.7	0 + 66	84.2	0 + 60	84.6
0 + 45	84.65	0 + 60	85.0	0 + 43	86.0	0 + 75	84.3	0 + 60	83.9	0 + 71	84.7	0 + 71	84.1	0 + 65	84.6
0 + 50	84.56	0 + 65	84.6	0 + 46	85.3	0 + 80	84.3	0 + 65	83.9	0 + 75	84.5	0 + 76	84.0	0 + 70	84.5
0 + 55	84.53	0 + 70	85.1	0 + 50	86.2	0 + 85	84.1	0 + 70	84.0	0 + 80	84.6	0 + 81	84.2	0 + 75	84.4
0 + 60	84.47	0 + 75	84.8	0 + 55	86.1	0 + 90	84.2	0 + 75	84.0	0 + 85	84.5	0 + 86	84.1	0 + 80	84.4
0 + 65	84.38	0 + 80	84.8	0 + 60	86.0	0 + 95	84.2	0 + 80	83.9	0 + 90	84.4	0 + 91	84.2	0 + 85	84.4
0 + 70	83.99	0 + 85	84.8	0 + 65	85.9	1 + 00	84.1	0 + 85	83.9	0 + 95	84.4	0 + 96	84.1	0 + 90	84.4
0 + 75	84.15	0 + 90	84.5	0 + 70	85.8	1 + 05	84.0	0 + 90	83.8	1 + 00	84.1	1 + 01	84.1	0 + 95	84.3
0 + 80	83.94	0 + 95	84.2	0 + 75	85.7	1 + 10	83.8	0 + 95	83.7	1 + 05	83.7	1 + 06	84.1	1 + 00	84.0
0 + 85	84.09	1 + 00	84.1	0 + 79	85.2	1 + 15	83.7	1 + 00	83.6	1 + 10	83.3	1 + 11	83.2	1 + 05	83.2
0 + 90	84.11	1 + 05	83.9	0 + 80	85.0	1 + 20	83.8	1 + 05	83.7	1 + 15	84.1	1 + 16	83.9	1 + 10	83.0
0 + 95	83.59	1 + 10	83.9	0 + 85	84.8	1 + 25	83.8	1 + 10	83.7	1 + 20	84.0	1 + 21	83.6	1 + 15	83.4
1 + 00	83.82	1 + 15	83.3	0 + 90	84.9	1 + 30	83.9	1 + 15	83.7	1 + 25	83.7	1 + 26	83.6	1 + 20	83.5
1 + 05	84.05	1 + 20	83.2	0 + 95	84.8	1 + 35	84.0	1 + 20	83.7	1 + 30	83.3	1 + 31	83.5	1 + 25	83.5
1 + 10	83.84	1 + 25	83.6	1 + 00	84.7	1 + 40	84.0	1 + 25	83.6	1 + 35	82.5	1 + 36	83.2	1 + 30	83.9
1 + 15	83.57	1 + 30	84.0	1 + 05	84.6	1 + 45	84.0	1 + 30	83.6	1 + 40	82.3	1 + 41	83.5	1 + 35	83.6
1 + 20	83.75	1 + 35	84.2	1 + 10	84.7	1 + 50	84.0	1 + 35	83.1	1 + 45	82.1	1 + 46	83.5	1 + 40	83.2
1 + 25	84.23	1 + 40	84.5	1 + 15	84.7	1 + 55	84.0	1 + 40	82.8	1 + 50	81.5	1 + 51	83.4	1 + 45	83.4
1 + 30	84.27	1 + 45	84.2	1 + 20	84.6	1 + 60	84.0	1 + 45	82.6	1 + 55	80.7	1 + 56	83.2	1 + 50	83.2
1 + 35	84.18	1 + 50	83.9	1 + 25	84.6	1 + 65	83.9	1 + 50	82.4	1 + 60	80.7	1 + 61	83.1	1 + 55	83.5
1 + 40	83.38	1 + 55	83.6	1 + 30	84.2	1 + 70	83.3	1 + 55	81.9	1 + 65	81.2	1 + 66	83.1	1 + 60	83.5
1 + 45	82.74	1 + 60	83.5	1 + 35	83.9	1 + 75	83.7	1 + 60	81.0	1 + 70	83.2	1 + 71	83.8	1 + 65	83.6
1 + 50	83.42	1 + 65	84.3	1 + 40	83.4	1 + 79	85.5	1 + 65	82.0	1 + 75	84.7	1 + 74	84.7	1 + 70	83.9

Table 16.--Profiles of normal section C-3--Continued

June 14, 1951		July 18, 1951		Aug. 3, 1951		Sept. 6, 1951		Apr. 1, 1952		May 8, 1952		June 19, 1952		Sept. 26, 1952	
Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude
1 + 55	83.78	1 + 69	85.4	1 + 45	82.2	....	....	1 + 70	82.0	....	....	....	....	1 + 75	84.6
1 + 60	83.55	....	....	1 + 50	80.9	....	....	1 + 75	83.1	....	....	....	....	....	....
1 + 65	83.41	....	....	1 + 55	81.6	....	....	1 + 78	84.7	....	....	....	....	....	....
1 + 70	83.60	....	....	1 + 60	81.7	....	....	....	....	....	....	....	....	....	....
1 + 73	85.20	....	....	1 + 65	82.6	....	....	....	....	....	....	....	....	....	....
1 + 80	86.27	....	....	1 + 70	84.2	....	....	....	....	....	....	....	....	....	....
1 + 83	88.05	....	....	1 + 76	85.2	....	....	....	....	....	....	....	....	....	....
1 + 85	90.95	....	....	1 + 79	86.3	....	....	....	....	....	....	....	....	....	....
....	....	....	....	1 + 81	88.5	....	....	....	....	....	....	....	....	....	....

Table 17.--Profiles of normal section C-4

June 14, 1951		July 18, 1951		Aug. 3, 1951		Sept. 6, 1951		Apr. 1, 1952		May 8, 1952		June 19, 1952		Sept. 26, 1952	
Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude
0 + 00	87.8	0 + 09	83.5	0 + 00	87.8	0 + 08	83.8	0 + 09	83.2	0 + 08	83.2	0 + 09	83.0	0 + 08	83.1
0 + 04	87.6	0 + 10	83.0	0 + 01	86.6	0 + 10	82.9	0 + 12	82.7	0 + 10	82.4	0 + 12	82.4	0 + 10	82.7
0 + 06	83.8	0 + 15	82.4	0 + 05	84.6	0 + 15	83.0	0 + 16	82.6	0 + 15	82.6	0 + 17	82.4	0 + 15	82.4
0 + 08	83.4	0 + 20	82.5	0 + 06	83.8	0 + 20	83.3	0 + 20	82.5	0 + 20	82.4	0 + 22	82.5	0 + 20	82.0
0 + 08	83.3	0 + 25	83.0	0 + 07	83.5	0 + 25	83.8	0 + 25	82.4	0 + 25	82.2	0 + 27	82.5	0 + 25	81.8
0 + 15	83.1	0 + 30	83.1	0 + 10	83.3	0 + 30	83.5	0 + 30	82.3	0 + 30	82.3	0 + 32	82.5	0 + 30	82.0
0 + 20	82.9	0 + 35	83.0	0 + 15	83.3	0 + 35	83.2	0 + 35	82.3	0 + 35	81.8	0 + 37	82.5	0 + 35	82.1
0 + 25	82.4	0 + 40	83.0	0 + 20	83.4	0 + 40	82.9	0 + 40	82.2	0 + 40	81.3	0 + 42	82.6	0 + 40	82.1
0 + 30	82.6	0 + 45	82.9	0 + 25	82.9	0 + 45	82.9	0 + 45	82.2	0 + 45	81.3	0 + 47	82.4	0 + 45	82.1
0 + 35	82.7	0 + 50	83.0	0 + 30	83.0	0 + 50	82.9	0 + 50	82.2	0 + 50	81.8	0 + 52	82.4	0 + 50	81.9
0 + 40	82.6	0 + 55	83.1	0 + 35	83.0	0 + 55	82.8	0 + 55	82.1	0 + 55	82.1	0 + 57	82.5	0 + 55	82.4
0 + 45	82.8	0 + 60	82.9	0 + 40	83.0	0 + 60	82.7	0 + 60	82.3	0 + 60	81.8	0 + 62	82.5	0 + 60	82.4
0 + 50	82.4	0 + 65	83.2	0 + 45	83.1	0 + 65	82.5	0 + 65	82.2	0 + 65	82.2	0 + 67	82.6	0 + 65	82.5
0 + 55	82.9	0 + 70	82.7	0 + 50	83.1	0 + 70	82.7	0 + 70	82.2	0 + 70	82.1	0 + 72	82.7	0 + 70	82.5

0 + 60	82.9	0 + 75	82.7	0 + 55	82.9	0 + 75	81.7	0 + 75	82.2	0 + 75	81.8	0 + 77	82.7	0 + 75	82.5
0 + 65	82.8	0 + 80	82.9	0 + 60	83.0	0 + 80	81.2	0 + 80	82.1	0 + 80	81.6	0 + 82	82.1	0 + 80	82.3
0 + 70	82.2	0 + 85	82.5	0 + 65	83.0	0 + 85	81.0	0 + 85	82.1	0 + 85	80.9	0 + 87	81.7	0 + 85	82.4
0 + 75	82.4	0 + 90	82.7	0 + 70	82.9	0 + 90	81.1	0 + 90	81.9	0 + 90	80.7	0 + 92	81.7	0 + 90	82.3
0 + 80	82.6	0 + 95	82.5	0 + 75	82.9	0 + 95	81.5	0 + 95	81.6	0 + 95	82.0	0 + 97	81.3	0 + 95	81.4
0 + 85	82.5	1 + 00	82.5	0 + 80	82.8	1 + 00	81.4	1 + 00	81.2	1 + 00	82.1	1 + 02	81.4	1 + 00	81.2
0 + 90	82.5	1 + 05	82.3	0 + 85	82.8	1 + 05	81.2	1 + 05	81.0	1 + 05	81.5	1 + 07	81.0	1 + 05	81.5
0 + 95	82.5	1 + 10	81.5	0 + 90	82.1	1 + 10	81.4	1 + 10	80.9	1 + 10	81.0	1 + 12	80.5	1 + 10	80.6
1 + 00	82.7	1 + 15	80.4	0 + 95	81.9	1 + 15	81.5	1 + 15	80.8	1 + 15	80.9	1 + 17	81.3	1 + 15	81.0
1 + 05	81.9	1 + 20	81.7	1 + 00	81.7	1 + 20	81.6	1 + 20	81.0	1 + 20	81.8	1 + 22	81.3	1 + 20	80.9
1 + 10	81.3	1 + 25	81.8	1 + 05	81.7	1 + 25	82.1	1 + 25	81.1	1 + 25	82.1	1 + 27	81.0	1 + 25	81.9
1 + 15	80.7	1 + 30	81.6	1 + 10	81.5	1 + 30	81.8	1 + 30	81.4	1 + 30	81.9	1 + 32	81.4	1 + 30	81.9
1 + 20	81.1	1 + 35	81.5	1 + 15	81.1	1 + 35	81.9	1 + 35	82.2	1 + 35	82.1	1 + 37	82.3	1 + 35	82.0
1 + 25	81.5	1 + 38	82.4	1 + 20	81.4	1 + 40	83.8	1 + 39	83.2	1 + 38	82.2	1 + 39	83.0	1 + 40	82.5
1 + 30	81.5	1 + 39	83.5	1 + 25	81.4	....	....	....	....	1 + 39	83.2	....	....	1 + 52	83.1
1 + 35	81.9	....	....	1 + 30	81.9	....	....	....	....	....	....	....	....	....	....
1 + 38	82.5	....	....	1 + 35	82.0	....	....	....	....	....	....	....	....	....	....
1 + 38	83.4	....	....	1 + 38	83.5	....	....	....	....	....	....	....	....	....	....
1 + 39	83.6	....	....	1 + 41	84.8	....	....	....	....	....	....	....	....	....	....
1 + 45	84.4	....	....	1 + 45	84.5	....	....	....	....	....	....	....	....	....	....
1 + 52	84.0	....	....	1 + 50	84.8	....	....	....	....	....	....	....	....	....	....
1 + 72	85.0	....	....	1 + 55	85.0	....	....	....	....	....	....	....	....	....	....
....	....	....	....	1 + 60	85.0	....	....	....	....	....	....	....	....	....	....
....	....	....	....	1 + 65	84.9	....	....	....	....	....	....	....	....	....	....
....	....	....	....	1 + 70	84.8	....	....	....	....	....	....	....	....	....	....

Table 18.--Profiles of normal section C-5

June 14, 1951		July 18, 1951		Apr. 3, 1951		Sept. 6, 1951		Apr. 1, 1952		May 8, 1952		June 19, 1952		Sept. 26, 1952	
Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude
0 + 00	87.49	0 + 12	82.3	0 + 00	87.4	0 + 11	82.6	0 + 12	82.0	0 + 12	82.1	0 + 12	81.8	0 + 12	81.9
0 + 10	82.66	0 + 13	81.6	0 + 02	86.0	0 + 15	80.7	0 + 13	81.1	0 + 13	81.9	0 + 12	81.5	0 + 15	81.2
0 + 11	82.19	0 + 15	80.8	0 + 03	85.3	0 + 20	80.6	0 + 20	80.6	0 + 14	80.8	0 + 17	80.9	0 + 20	81.3

Table 18.--Profiles of normal section C-5--Continued

June 14, 1951		July 18, 1951		Apr. 3, 1951		Sept. 6, 1951		Apr. 1, 1952		May 8, 1952		June 19, 1952		Sept. 26, 1952	
Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude
0 + 15	80.57	0 + 20	81.4	0 + 05	84.5	0 + 25	80.8	0 + 25	79.9	0 + 16	80.7	0 + 22	80.8	0 + 25	81.4
0 + 20	80.36	0 + 25	81.2	0 + 08	83.7	0 + 30	80.7	0 + 30	79.8	0 + 20	80.8	0 + 27	80.9	0 + 30	81.6
0 + 25	80.40	0 + 30	81.3	0 + 10	82.7	0 + 35	80.3	0 + 35	79.5	0 + 25	80.7	0 + 32	80.9	0 + 35	81.6
0 + 30	80.17	0 + 35	81.2	0 + 12	82.4	0 + 40	80.3	0 + 40	79.9	0 + 30	80.5	0 + 37	80.7	0 + 40	81.7
0 + 35	80.11	0 + 40	81.0	0 + 15	81.2	0 + 45	80.5	0 + 45	79.9	0 + 35	80.0	0 + 42	80.7	0 + 45	81.6
0 + 40	80.25	0 + 45	80.7	0 + 20	81.3	0 + 50	80.6	0 + 50	78.9	0 + 40	80.7	0 + 47	80.8	0 + 50	81.3
0 + 45	80.21	0 + 50	80.3	0 + 25	80.9	0 + 55	80.5	0 + 65	79.1	0 + 45	80.5	0 + 52	80.8	0 + 55	81.2
0 + 50	79.59	0 + 55	80.0	0 + 30	80.9	0 + 60	80.4	0 + 70	79.5	0 + 50	80.6	0 + 57	80.6	0 + 60	80.4
0 + 55	80.01	0 + 60	79.6	0 + 35	80.2	0 + 65	80.2	0 + 75	79.8	0 + 55	79.9	0 + 62	80.1	0 + 65	79.7
0 + 60	80.95	0 + 65	80.4	0 + 40	80.4	0 + 70	80.2	0 + 80	81.1	0 + 60	80.9	0 + 67	80.7	0 + 70	79.6
0 + 65	81.22	0 + 70	80.4	0 + 45	81.1	0 + 75	80.3	0 + 85	81.4	0 + 65	81.0	0 + 72	80.6	0 + 75	79.6
0 + 70	81.91	0 + 75	80.5	0 + 50	80.9	0 + 80	80.3	0 + 90	81.3	0 + 70	80.7	0 + 77	80.2	0 + 80	79.8
0 + 75	81.76	0 + 80	80.7	0 + 55	81.0	0 + 85	80.4	0 + 95	81.4	0 + 75	80.4	0 + 82	80.1	0 + 85	80.4
0 + 80	81.63	0 + 85	81.7	0 + 60	81.0	0 + 90	80.8	1 + 00	81.4	0 + 80	80.3	0 + 87	80.0	0 + 90	80.1
0 + 85	81.55	0 + 90	81.8	0 + 65	81.0	0 + 95	81.3	1 + 05	81.1	0 + 85	79.9	0 + 92	80.4	0 + 95	80.1
0 + 90	81.44	0 + 95	81.9	0 + 70	81.0	1 + 00	81.7	1 + 08	81.5	0 + 90	79.9	0 + 97	80.5	1 + 00	80.7
0 + 95	81.50	1 + 00	81.8	0 + 75	81.2	1 + 05	81.7	1 + 13	82.0	0 + 95	80.0	1 + 02	81.0	1 + 05	81.0
1 + 00	81.49	1 + 05	81.6	0 + 80	81.4	1 + 10	82.2	1 + 17	82.7	1 + 00	80.7	1 + 07	81.3	1 + 10	81.7
1 + 05	81.77	1 + 10	82.1	0 + 85	81.2	1 + 14	82.6	1 + 23	82.8	1 + 05	80.9	1 + 10	81.8	1 + 12	81.9
1 + 10	81.91	1 + 15	82.0	0 + 90	81.3	1 + 27	82.6	1 + 30	82.5	1 + 10	81.8	....	....	....	....
1 + 15	82.04	1 + 20	82.0	0 + 95	81.4	1 + 30	82.3	1 + 35	82.3	1 + 15	82.1	....	....	....	....
1 + 20	81.98	1 + 25	81.9	1 + 00	81.4	1 + 35	81.8	....	....	....	....	....	....	....	....
1 + 25	81.79	1 + 30	81.8	1 + 05	81.5	1 + 37	82.6	....	....	....	....	....	....	....	....
1 + 30	81.50	1 + 35	81.8	1 + 10	81.4	....	....	....	....	....	....	....	....	....	....
1 + 35	82.10	1 + 37	82.3	1 + 15	81.4	....	....	....	....	....	....	....	....	....	....
1 + 40	82.80	....	....	1 + 20	81.6	....	....	....	....	....	....	....	....	....	....
1 + 45	83.58	....	....	1 + 25	81.7	....	....	....	....	....	....	....	....	....	....
1 + 52	83.59	....	....	1 + 30	81.9	....	....	....	....	....	....	....	....	....	....
1 + 60	83.28	....	....	1 + 35	81.5	....	....	....	....	....	....	....	....	....	....
1 + 70	83.35	....	....	1 + 36	82.4	....	....	....	....	....	....	....	....	....	....

1 + 80	83.40	....	....	1 + 40	82.8	....	....	....	....	....	....	....	....	....	....
....	....	....	....	1 + 45	83.6	....	....	....	....	....	....	....	....	....	....
....	....	....	....	1 + 50	83.6	....	....	....	....	....	....	....	....	....	....

Table 19.--Profiles of normal section C-6

June 14, 1951		July 18, 1951		Aug. 3, 1951		Sept. 6, 1951		May 8, 1952		June 19, 1952		Sept. 26, 1952	
Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude
0 + 00	86.4	0 + 32	80.6	0 + 00	86.4	0 + 71	80.7	0 + 63	80.48	0 + 50	80.28	0 + 34	80.29
0 + 08	83.6	0 + 34	79.4	0 + 10	82.9	0 + 84	80.0	0 + 66	79.68	0 + 51	79.58	0 + 36	79.59
0 + 12	82.1	0 + 40	79.1	0 + 12	82.1	0 + 98	79.9	0 + 70	79.18	0 + 54	79.08	0 + 40	79.69
0 + 24	82.3	0 + 45	79.1	0 + 24	82.3	1 + 04	77.7	0 + 75	78.88	0 + 57	78.88	0 + 45	79.79
0 + 26	80.8	0 + 50	79.4	0 + 26	81.0	1 + 06	77.6	0 + 80	79.08	0 + 61	79.08	0 + 50	79.89
0 + 32	80.6	0 + 55	80.1	0 + 32	80.7	1 + 09	77.2	0 + 85	79.08	0 + 65	79.18	0 + 55	79.89
0 + 32	80.6	0 + 60	80.0	0 + 32	80.5	1 + 13	77.8	0 + 90	79.18	0 + 70	79.08	0 + 60	79.89
0 + 32	79.9	0 + 65	79.9	0 + 34	79.7	1 + 17	78.2	0 + 95	78.88	0 + 75	79.18	0 + 65	79.89
0 + 35	78.9	0 + 70	79.6	0 + 42	79.9	1 + 20	78.1	1 + 00	78.48	0 + 80	79.08	0 + 70	79.89
0 + 40	78.6	0 + 75	79.8	0 + 56	80.2	1 + 23	78.0	1 + 04	79.38	0 + 85	79.08	0 + 75	79.89
0 + 45	78.6	0 + 80	79.1	0 + 71	80.2	1 + 25	78.1	1 + 08	78.78	0 + 88	78.78	0 + 80	79.69
0 + 50	78.6	0 + 85	78.9	0 + 77	80.1	1 + 28	77.9	1 + 12	77.68	0 + 90	78.58	0 + 85	79.79
0 + 55	79.2	0 + 90	79.6	0 + 84	79.5	1 + 31	78.1	1 + 16	78.28	0 + 93	79.18	0 + 90	80.09
0 + 60	79.7	0 + 95	79.0	0 + 90	78.9	1 + 33	78.0	1 + 20	78.38	0 + 95	78.58	1 + 00	79.79
0 + 65	79.8	1 + 00	79.4	0 + 96	79.2	1 + 36	78.0	1 + 24	78.48	0 + 97	78.18	1 + 10	79.69
0 + 70	79.6	1 + 05	79.6	1 + 02	78.8	1 + 38	78.1	1 + 28	78.48	1 + 01	78.68	1 + 15	79.59
0 + 75	79.9	1 + 10	79.9	1 + 06	78.8	1 + 41	78.2	1 + 32	78.18	1 + 05	79.38	1 + 20	79.59
0 + 80	80.0	1 + 15	79.4	1 + 12	78.9	1 + 44	78.3	1 + 36	77.78	1 + 10	79.18	1 + 25	79.19
0 + 85	79.9	1 + 20	79.5	1 + 16	78.6	1 + 47	78.3	1 + 40	78.28	1 + 15	78.98	1 + 30	78.49
0 + 90	80.0	1 + 25	79.4	1 + 18	78.5	1 + 50	78.5	1 + 44	78.58	1 + 20	78.48	1 + 35	77.99
0 + 95	79.8	1 + 30	79.4	1 + 24	78.7	1 + 54	78.6	1 + 48	78.88	1 + 25	78.38	1 + 40	78.69
1 + 00	79.6	1 + 35	78.9	1 + 26	78.9	1 + 58	78.8	1 + 52	78.88	1 + 28	78.98	1 + 45	78.29
1 + 05	79.5	1 + 40	78.9	1 + 34	79.1	1 + 62	79.0	1 + 56	79.28	1 + 32	78.88	1 + 50	77.69

Table 19.--Profiles of normal section C-6--Continued

June 14, 1951		July 18, 1951		Aug. 3, 1951		Sept. 6, 1951		May 8, 1952		June 19, 1952		Sept. 26, 1952	
Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude
1 + 10	79.6	1 + 45	79.8	1 + 36	79.1	1 + 66	79.9	1 + 60	78.88	1 + 35	78.58	1 + 55	77.39
1 + 15	79.6	1 + 50	80.1	1 + 42	79.1	1 + 67	80.7	1 + 64	78.98	1 + 38	78.88	1 + 60	78.19
1 + 20	79.1	1 + 55	79.8	1 + 44	79.3	....	....	1 + 66	79.48	1 + 41	78.08	1 + 65	79.59
1 + 25	78.9	1 + 60	79.3	1 + 50	79.2	....	....	1 + 68	80.48	1 + 45	78.98	1 + 67	80.29
1 + 30	79.2	1 + 65	79.8	1 + 52	79.3	....	....	....	....	1 + 50	78.58	....	....
1 + 35	79.3	1 + 68	80.6	1 + 60	79.6	....	....	....	....	1 + 54	79.08	....	....
1 + 40	79.3	....	....	1 + 66	80.5	....	....	....	....	....	....	....	....
1 + 45	79.4	....	....	1 + 70	81.8	....	....	....	....	....	....	....	....
1 + 50	79.7	....	....	1 + 72	82.2	....	....	....	....	....	....	....	....
1 + 55	79.2	....	....	1 + 76	81.6	....	....	....	....	....	....	....	....
1 + 60	79.5	....	....	....	....	....	....	....	....	....	....	....	....
1 + 65	79.6	....	....	....	....	....	....	....	....	....	....	....	....
1 + 67	80.3	....	....	....	....	....	....	....	....	....	....	....	....
1 + 67	80.6	....	....	....	....	....	....	....	....	....	....	....	....
1 + 70	81.1	....	....	....	....	....	....	....	....	....	....	....	....
1 + 75	82.1	....	....	....	....	....	....	....	....	....	....	....	....
1 + 80	83.0	....	....	....	....	....	....	....	....	....	....	....	....
1 + 90	85.2	....	....	....	....	....	....	....	....	....	....	....	....

Table 20.--Profiles of normal section C-7

June 14, 1951		July 18, 1951		Aug. 3, 1951		Sept. 6, 1951		Apr. 1, 1952		May 8, 1952		June 19, 1952		Sept. 26, 1952	
Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude
0 + 00	83.98	0 + 22	79.0	0 + 00	83.8	0 + 18	79.3	0 + 19	79.2	0 + 21	78.9	0 + 24	78.6	0 + 25	78.2
0 + 04	82.68	0 + 25	78.5	0 + 05	82.1	0 + 20	78.7	0 + 22	79.0	0 + 25	78.6	0 + 27	78.4	0 + 30	78.1
0 + 06	80.85	0 + 30	78.1	0 + 08	80.5	0 + 21	79.3	0 + 25	79.1	0 + 30	77.5	0 + 32	77.5	0 + 35	77.9
0 + 10	79.89	0 + 35	77.9	0 + 11	80.0	0 + 25	78.4	0 + 26	78.9	0 + 35	76.6	0 + 37	76.8	0 + 40	77.8
0 + 15	79.31	0 + 40	77.8	0 + 13	80.3	0 + 30	77.5	0 + 30	77.4	0 + 40	76.6	0 + 42	76.7	0 + 45	77.6

0 + 20	78.96	0 + 45	77.0	0 + 15	80.3	0 + 35	76.7	0 + 35	76.5	0 + 45	76.5	0 + 47	76.7	0 + 50	77.8
0 + 25	78.55	0 + 50	78.0	0 + 24	78.7	0 + 40	76.4	0 + 40	76.4	0 + 50	76.6	0 + 52	76.8	0 + 55	77.6
0 + 30	77.99	0 + 55	78.0	0 + 25	78.4	0 + 45	76.5	0 + 45	77.0	0 + 55	76.6	0 + 57	76.9	0 + 60	77.9
0 + 35	77.61	0 + 60	78.0	0 + 30	77.5	0 + 50	76.9	0 + 50	77.1	0 + 60	76.6	0 + 62	76.7	0 + 65	78.1
0 + 40	77.45	0 + 65	77.3	0 + 35	77.4	0 + 55	77.2	0 + 55	77.3	0 + 65	76.5	0 + 67	77.1	0 + 70	77.8
0 + 45	78.08	0 + 70	78.0	0 + 40	77.1	0 + 60	77.5	0 + 60	77.2	0 + 70	77.2	0 + 72	77.1	0 + 75	76.9
0 + 50	78.41	0 + 75	78.1	0 + 45	76.9	0 + 65	77.6	0 + 65	77.3	0 + 75	76.9	0 + 77	77.4	0 + 80	76.6
0 + 55	76.82	0 + 80	77.2	0 + 50	77.6	0 + 70	77.6	0 + 70	77.3	0 + 80	76.2	0 + 82	77.3	0 + 85	76.2
0 + 60	77.42	0 + 85	77.4	0 + 55	77.5	0 + 75	77.6	0 + 75	77.1	0 + 85	77.5	0 + 87	77.2	0 + 90	76.2
0 + 65	77.31	0 + 90	76.8	0 + 60	77.4	0 + 80	77.6	0 + 80	76.9	0 + 90	77.5	0 + 92	77.0	0 + 95	76.6
0 + 70	77.19	0 + 95	76.1	0 + 65	77.4	0 + 85	77.7	0 + 85	76.8	0 + 95	77.3	0 + 97	76.9	1 + 00	76.9
0 + 75	77.31	1 + 00	77.0	0 + 70	77.4	0 + 90	77.6	0 + 90	76.9	1 + 00	76.6	1 + 02	77.2	1 + 05	77.5
0 + 80	77.20	1 + 05	77.2	0 + 75	77.4	0 + 95	77.2	0 + 95	77.2	1 + 05	77.3	1 + 07	77.9	1 + 10	78.1
0 + 85	77.33	1 + 10	78.2	0 + 80	77.6	1 + 00	76.7	1 + 00	77.2	1 + 10	77.9	1 + 12	78.1	1 + 12	78.6
0 + 90	76.85	1 + 15	78.3	0 + 85	77.8	1 + 05	77.4	1 + 05	77.3	1 + 15	78.2	1 + 14	78.6	......	......
0 + 95	76.39	1 + 16	79.0	0 + 90	77.9	1 + 10	78.3	1 + 10	77.9	1 + 16	78.9	......	......	......	......
1 + 00	76.82	......	......	0 + 95	77.6	1 + 14	78.1	1 + 14	77.9	......	......	......	......	......	......
1 + 05	77.46	......	......	1 + 00	77.2	1 + 15	79.3	1 + 16	78.9	......	......	......	......	......	......
1 + 10	78.33	......	......	1 + 05	77.4	......	......	......	......	......	......	......	......	......	......
1 + 15	78.92	......	......	1 + 10	78.1	......	......	......	......	......	......	......	......	......	......
1 + 18	80.13	......	......	1 + 15	78.7	......	......	......	......	......	......	......	......	......	......
1 + 23	80.94	......	......	1 + 20	80.6	......	......	......	......	......	......	......	......	......	......
1 + 27	82.33	......	......	1 + 23	81.1	......	......	......	......	......	......	......	......	......	......
1 + 35	85.19	......	......	1 + 28	81.7	......	......	......	......	......	......	......	......	......	......

Table 21.--Profiles of normal section C-8

June 14, 1951		July 18, 1951		Aug. 3, 1951		Sept. 6, 1951		Apr. 1, 1952		May 8, 1952		June 19, 1952		Sept. 26, 1952	
Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude
0 - 10	83.14	0 + 07	77.2	0 + 00	81.1	0 + 06	77.4	0 + 07	77.2	0 + 06	77.2	0 + 07	76.9	0 + 07	76.2
0 - 05	82.24	0 + 10	76.4	0 + 02	80.3	0 + 10	75.9	0 + 08	76.3	0 + 07	76.6	0 + 09	76.0	0 + 10	76.1
0 + 00	81.18	0 + 15	76.3	0 + 05	78.6	0 + 15	75.6	0 + 10	75.5	0 + 10	75.9	0 + 14	75.9	0 + 15	75.4

Table 21.--Profiles of normal section C-8--Continued

June 14, 1951		July 18, 1951		Aug. 3, 1951		Sept. 6, 1951		Apr. 1, 1952		May 8, 1952		June 19, 1952		Sept. 26, 1952	
Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude
0 + 02	80.43	0 + 20	76.5	0 + 07	76.9	0 + 20	76.0	0 + 12	75.4	0 + 15	75.2	0 + 19	75.7	0 + 20	75.6
0 + 05	78.67	0 + 25	76.4	0 + 10	75.8	0 + 25	75.8	0 + 15	75.3	0 + 20	75.7	0 + 24	75.9	0 + 25	75.4
0 + 07	77.15	0 + 30	76.2	0 + 15	75.7	0 + 30	75.7	0 + 20	75.3	0 + 25	75.8	0 + 29	75.8	0 + 30	75.0
0 + 08	76.26	0 + 35	76.3	0 + 20	76.0	0 + 35	75.6	0 + 25	75.3	0 + 30	74.9	0 + 34	75.8	0 + 33	74.2
0 + 12	75.72	0 + 40	76.4	0 + 25	75.6	0 + 40	75.5	0 + 30	75.4	0 + 35	75.9	0 + 39	76.2	0 + 35	74.9
0 + 16	75.56	0 + 45	76.6	0 + 30	75.8	0 + 45	75.5	0 + 35	75.5	0 + 40	76.0	0 + 44	76.2	0 + 40	75.5
0 + 20	75.59	0 + 50	76.2	0 + 35	75.7	0 + 50	75.3	0 + 40	75.4	0 + 45	75.1	0 + 49	76.1	0 + 45	75.5
0 + 25	75.52	0 + 55	75.4	0 + 40	75.7	0 + 55	75.3	0 + 45	75.4	0 + 50	75.0	0 + 54	76.1	0 + 50	75.0
0 + 30	75.79	0 + 60	75.0	0 + 45	75.8	0 + 60	75.4	0 + 50	75.3	0 + 55	75.4	0 + 59	76.1	0 + 55	75.7
0 + 35	75.75	0 + 65	75.1	0 + 50	75.7	0 + 65	75.4	0 + 55	75.6	0 + 60	75.3	0 + 64	76.2	0 + 60	75.8
0 + 40	75.98	0 + 70	75.2	0 + 55	75.7	0 + 70	75.4	0 + 60	75.6	0 + 65	74.9	0 + 69	76.0	0 + 65	75.8
0 + 45	76.26	0 + 75	75.3	0 + 60	75.9	0 + 75	75.5	0 + 65	75.4	0 + 70	74.2	0 + 74	75.2	0 + 70	75.7
0 + 50	76.14	0 + 80	75.7	0 + 65	75.9	0 + 80	75.5	0 + 70	75.4	0 + 75	74.6	0 + 79	74.8	0 + 75	75.5
0 + 55	75.79	0 + 85	75.5	0 + 70	75.8	0 + 85	75.4	0 + 75	75.4	0 + 80	75.1	0 + 84	75.1	0 + 80	75.6
0 + 60	76.04	0 + 90	75.8	0 + 75	75.7	0 + 90	75.4	0 + 80	75.4	0 + 85	74.8	0 + 89	74.8	0 + 85	75.3
0 + 65	75.65	0 + 95	76.0	0 + 80	75.7	0 + 95	75.1	0 + 85	75.7	0 + 90	74.8	0 + 94	75.3	0 + 90	75.0
0 + 70	75.89	1 + 00	75.6	0 + 85	75.4	1 + 00	75.5	0 + 90	75.5	0 + 95	75.1	0 + 99	75.4	0 + 95	75.2
0 + 75	75.58	1 + 05	75.7	0 + 90	75.8	1 + 05	76.9	0 + 95	75.6	1 + 00	75.3	1 + 04	75.7	1 + 00	75.4
0 + 80	75.46	1 + 06	77.2	0 + 95	75.7	1 + 07	77.4	1 + 00	75.7	1 + 05	76.0	1 + 07	76.7	1 + 05	75.0
0 + 85	75.38	....	....	1 + 00	75.6	....	....	1 + 05	76.2	1 + 10	77.0	1 + 07	76.9	1 + 07	76.7
0 + 90	75.30	....	....	1 + 05	76.9	....	....	1 + 08	77.2	1 + 10	77.2	....	....	....	....
0 + 95	75.40	....	....	1 + 06	77.7	....	....	....	....	....	....	....	....	....	....
1 + 00	75.48	....	....	1 + 10	77.8	....	....	....	....	....	....	....	....	....	....
1 + 03	75.40	....	....	1 + 15	78.2	....	....	....	....	....	....	....	....	....	....
1 + 07	77.12	....	....	....	....	....	....	....	....	....	....	....	....	....	....
1 + 08	77.53	....	....	....	....	....	....	....	....	....	....	....	....	....	....
1 + 14	78.13	....	....	....	....	....	....	....	....	....	....	....	....	....	....
1 + 14	78.78	....	....	....	....	....	....	....	....	....	....	....	....	....	....
1 + 17	81.96	....	....	....	....	....	....	....	....	....	....	....	....	....	....

Table 22.--Profiles of normal section C-9

June 14, 1951		July 18, 1951		Aug. 3, 1951		Sept. 6, 1951		Apr. 1, 1952		May 8, 1952		June 19, 1952		Sept. 26, 1952	
Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude
0 + 08	77.84	0 + 13	76.1	0 + 10	76.9	0 + 11	76.6	0 + 12	74.6	0 + 12	75.5	0 + 12	75.8	0 + 12	75.0
0 + 12	76.14	0 + 15	74.9	0 + 12	76.0	0 + 15	75.9	0 + 14	74.8	0 + 14	74.2	0 + 14	74.2	0 + 15	74.8
0 + 13	76.14	0 + 20	75.6	0 + 13	75.8	0 + 20	76.2	0 + 16	75.1	0 + 16	74.4	0 + 19	74.4	0 + 20	75.0
0 + 13	74.54	0 + 25	75.8	0 + 14	76.0	0 + 25	75.9	0 + 18	75.5	0 + 20	74.5	0 + 24	74.4	0 + 25	75.1
0 + 15	75.54	0 + 30	75.7	0 + 20	76.1	0 + 30	75.8	0 + 20	75.6	0 + 25	74.4	0 + 29	74.4	0 + 30	75.2
0 + 20	75.34	0 + 35	75.5	0 + 25	76.2	0 + 35	75.8	0 + 25	75.6	0 + 30	74.3	0 + 34	73.9	0 + 35	75.2
0 + 25	75.24	0 + 40	75.3	0 + 30	76.1	0 + 40	75.8	0 + 30	75.6	0 + 35	74.5	0 + 39	74.4	0 + 40	75.1
0 + 30	75.34	0 + 45	75.3	0 + 32	76.0	0 + 45	75.3	0 + 35	75.5	0 + 40	75.0	0 + 44	74.7	0 + 45	75.1
0 + 35	75.14	0 + 50	75.3	0 + 35	75.8	0 + 50	74.9	0 + 40	75.4	0 + 45	75.2	0 + 49	74.8	0 + 50	75.0
0 + 40	75.24	0 + 55	75.4	0 + 40	75.6	0 + 55	74.8	0 + 45	75.2	0 + 50	75.0	0 + 54	75.1	0 + 55	74.7
0 + 45	75.04	0 + 60	75.5	0 + 45	75.5	0 + 60	74.8	0 + 50	74.9	0 + 55	74.9	0 + 59	75.2	0 + 60	75.0
0 + 50	75.34	0 + 65	75.4	0 + 50	75.3	0 + 65	74.7	0 + 55	74.6	0 + 60	75.0	0 + 64	75.4	0 + 65	75.5
0 + 55	75.24	0 + 70	75.6	0 + 55	75.1	0 + 70	74.7	0 + 60	74.6	0 + 65	75.2	0 + 69	75.4	0 + 70	75.5
0 + 60	75.44	0 + 75	75.6	0 + 60	74.4	0 + 75	74.9	0 + 65	74.3	0 + 70	74.9	0 + 74	75.6	0 + 75	75.4
0 + 65	75.44	0 + 80	75.5	0 + 65	74.5	0 + 80	74.8	0 + 70	74.4	0 + 75	75.1	0 + 79	75.6	0 + 80	75.3
0 + 70	75.54	0 + 85	75.4	0 + 70	75.2	0 + 85	74.8	0 + 75	74.2	0 + 80	75.3	0 + 84	75.6	0 + 85	75.3
0 + 75	75.64	0 + 90	75.5	0 + 75	75.3	0 + 90	74.7	0 + 80	74.2	0 + 85	75.2	0 + 89	75.6	0 + 90	75.3
0 + 80	75.44	0 + 95	75.5	0 + 80	75.4	0 + 95	74.6	0 + 85	74.2	0 + 90	75.3	0 + 94	75.4	0 + 95	75.3
0 + 85	75.44	1 + 00	75.6	0 + 85	75.3	1 + 00	74.6	0 + 90	74.1	0 + 95	74.6	0 + 99	75.5	1 + 00	75.4
0 + 90	75.04	1 + 05	75.4	0 + 90	75.2	1 + 05	74.6	0 + 95	74.1	1 + 00	75.0	1 + 04	75.5	1 + 05	75.4
0 + 95	75.44	1 + 10	75.5	0 + 95	75.2	1 + 10	74.7	1 + 00	74.0	1 + 05	74.9	1 + 09	75.5	1 + 10	75.3
1 + 00	75.54	1 + 15	75.6	1 + 00	75.0	1 + 15	74.6	1 + 05	74.1	1 + 10	74.7	1 + 14	75.6	1 + 15	75.2
1 + 05	75.54	1 + 20	75.3	1 + 05	75.0	1 + 20	74.7	1 + 10	74.1	1 + 15	75.1	1 + 19	75.5	1 + 20	75.1
1 + 10	75.44	1 + 25	75.4	1 + 10	75.0	1 + 25	74.8	1 + 15	74.1	1 + 20	75.3	1 + 24	75.4	1 + 25	74.9
1 + 15	75.34	1 + 30	75.3	1 + 15	75.0	1 + 30	74.9	1 + 20	74.2	1 + 25	75.1	1 + 29	74.9	1 + 30	74.6
1 + 20	75.44	1 + 35	74.9	1 + 20	74.9	1 + 35	75.0	1 + 25	74.3	1 + 30	74.7	1 + 34	75.3	1 + 35	74.0
1 + 25	75.24	1 + 40	74.8	1 + 25	74.8	1 + 40	75.1	1 + 30	74.5	1 + 35	74.7	1 + 39	75.1	1 + 40	73.9
1 + 30	75.44	1 + 45	75.0	1 + 30	74.9	1 + 45	75.2	1 + 35	74.4	1 + 40	74.9	1 + 44	74.6	1 + 45	73.9
1 + 35	75.44	1 + 50	74.9	1 + 35	74.9	1 + 50	75.2	1 + 40	74.0	1 + 45	74.7	1 + 49	74.0	1 + 50	74.4
1 + 40	75.44	1 + 55	74.8	1 + 40	74.7	1 + 55	75.2	1 + 45	74.3	1 + 50	74.6	1 + 54	74.1	1 + 55	73.8

Table 22.--Profiles of normal section G-9--Continued

June 14, 1951		July 18, 1951		Aug. 3, 1951		Sept. 6, 1951		Apr. 1, 1952		May 8, 1952		June 19, 1952		Sept. 26, 1952	
Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude
1 + 45	75.54	1 + 60	74.6	1 + 45	74.8	1 + 60	75.2	1 + 50	74.5	1 + 55	74.4	1 + 59	74.2	1 + 60	73.7
1 + 50	75.24	1 + 65	74.9	1 + 50	74.8	1 + 65	75.5	1 + 54	75.4	1 + 60	73.9	1 + 64	74.8	1 + 65	74.6
1 + 55	74.84	1 + 70	74.8	1 + 55	74.8	1 + 70	76.0	1 + 58	75.8	1 + 65	74.1	1 + 69	75.0	1 + 70	75.1
1 + 60	74.74	1 + 75	74.9	1 + 60	74.9	1 + 75	76.2	1 + 60	75.8	1 + 70	73.7	1 + 74	75.0	1 + 75	75.3
1 + 65	75.04	1 + 80	75.1	1 + 65	75.2	1 + 80	76.3	1 + 65	76.1	1 + 75	74.5	1 + 79	75.3	1 + 80	75.3
1 + 70	74.64	1 + 85	75.5	1 + 70	75.3	1 + 85	76.5	1 + 70	76.2	1 + 80	75.1	1 + 84	75.3	1 + 85	75.2
1 + 75	74.84	1 + 90	75.5	1 + 75	75.7	1 + 90	76.5	1 + 80	76.3	1 + 85	75.7	1 + 89	75.6	1 + 90	75.4
1 + 80	74.84	1 + 95	75.5	1 + 80	75.6	1 + 95	76.4	1 + 90	76.2	1 + 90	75.6	1 + 94	75.6	1 + 95	75.7
1 + 85	74.94	2 + 00	75.6	1 + 85	75.6	2 + 00	76.3	1 + 95	75.9	1 + 95	75.7	1 + 99	75.5	2 + 00	75.6
1 + 90	75.24	2 + 05	75.6	1 + 90	75.7	2 + 05	76.3	2 + 00	76.1	2 + 00	75.7	2 + 04	75.5	2 + 05	75.6
1 + 95	75.24	2 + 10	75.4	1 + 95	75.7	2 + 10	75.8	2 + 05	75.7	2 + 05	75.9	2 + 09	75.8	....	....
2 + 00	75.14	2 + 15	75.1	2 + 00	75.8	2 + 15	76.0	2 + 07	76.1	2 + 10	75.7	....	....	....	....
2 + 05	75.04	2 + 16	76.1	2 + 05	75.6	2 + 17	76.6	2 + 10	75.7	2 + 15	75.8	....	....	....	....
2 + 10	74.84	....	....	2 + 10	75.3	....	....	2 + 17	76.1	2 + 15	76.1	....	....	....	....
2 + 15	75.34	....	....	2 + 15	75.1	....	....	....	....	....	....	....	....	....	....
2 + 15	76.14	....	....	2 + 16	76.0	....	....	....	....	....	....	....	....	....	....
2 + 16	76.14	....	....	2 + 18	77.2	....	....	....	....	....	....	....	....	....	....
2 + 20	78.84	....	....	....	....	....	....	....	....	....	....	....	....	....	....

Table 23.--Profiles of normal section G-10

June 14, 1951		July 18, 1951		Aug. 3, 1951		Sept. 6, 1951		Apr. 1, 1952		May 8, 1952		June 19, 1952		Sept. 26, 1952	
Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude
0 + 05	75.96	0 + 09	74.4	0 + 04	76.3	0 + 07	75.4	0 + 05	74.5	0 + 09	74.5	0 + 09	74.2	0 + 08	74.2
0 + 07	74.34	0 + 10	73.0	0 + 06	75.5	0 + 10	75.1	0 + 09	74.2	0 + 10	74.2	0 + 12	73.3	0 + 10	73.8
0 + 08	74.37	0 + 15	72.7	0 + 08	74.6	0 + 15	74.0	0 + 12	73.8	0 + 12	74.2	0 + 17	72.9	0 + 12	73.0
0 + 10	73.10	0 + 20	72.4	0 + 10	73.7	0 + 20	73.3	0 + 18	73.6	0 + 14	74.0	0 + 22	72.8	0 + 15	72.8
0 + 15	72.69	0 + 25	72.8	0 + 15	73.1	0 + 25	74.0	0 + 20	73.5	0 + 16	73.7	0 + 27	72.7	0 + 20	72.8
0 + 20	73.34	0 + 30	73.1	0 + 20	73.0	0 + 30	74.1	0 + 25	73.7	0 + 18	73.5	0 + 32	73.1	0 + 25	72.3
0 + 25	73.30	0 + 35	73.4	0 + 25	73.4	0 + 35	74.2	0 + 30	73.5	0 + 20	73.3	0 + 37	72.8	0 + 30	72.3
0 + 30	72.50	0 + 40	73.4	0 + 30	73.7	0 + 40	74.2	0 + 35	73.9	0 + 22	73.4	0 + 42	72.9	0 + 35	73.2
0 + 35	72.33	0 + 45	73.1	0 + 35	73.9	0 + 45	74.1	0 + 40	74.1	0 + 24	73.0	0 + 47	73.4	0 + 40	73.7
0 + 40	72.83	0 + 50	73.6	0 + 40	73.9	0 + 50	74.2	0 + 50	74.2	0 + 28	73.1	0 + 52	73.4	0 + 45	73.6
0 + 45	73.09	0 + 55	73.7	0 + 45	74.1	0 + 55	74.3	0 + 60	74.3	0 + 30	73.1	0 + 57	73.6	0 + 50	73.6
0 + 50	72.85	0 + 60	73.1	0 + 50	73.6	0 + 60	74.4	0 + 70	74.2	0 + 35	73.1	0 + 62	73.7	0 + 55	73.5
0 + 55	72.92	0 + 65	73.5	0 + 55	73.8	0 + 65	74.3	0 + 80	74.1	0 + 40	73.1	0 + 67	73.8	0 + 60	73.1
0 + 60	73.38	0 + 70	74.0	0 + 60	73.7	0 + 70	74.2	0 + 90	74.1	0 + 45	72.6	0 + 72	73.7	0 + 65	73.1
0 + 62	73.66	0 + 75	73.9	0 + 65	73.7	0 + 75	74.1	0 + 95	73.8	0 + 50	73.4	0 + 77	73.6	0 + 70	73.5
0 + 65	73.93	0 + 80	73.8	0 + 70	72.8	0 + 80	74.1	1 + 00	73.1	0 + 55	73.5	0 + 82	73.7	0 + 75	73.5
0 + 70	73.92	0 + 85	74.0	0 + 75	73.1	0 + 85	74.1	1 + 05	73.1	0 + 60	73.3	0 + 87	73.5	0 + 80	73.8
0 + 75	73.92	0 + 90	73.9	0 + 80	73.1	0 + 90	74.0	1 + 10	73.1	0 + 65	74.0	0 + 92	73.6	0 + 85	73.9
0 + 80	73.78	0 + 95	73.9	0 + 85	73.4	0 + 95	74.0	1 + 15	73.3	0 + 70	73.4	0 + 97	73.6	0 + 90	74.0
0 + 85	74.07	1 + 00	73.9	0 + 90	73.4	1 + 00	74.0	1 + 20	72.9	0 + 75	73.9	1 + 02	73.7	0 + 95	74.0
0 + 90	74.11	1 + 05	74.0	0 + 95	73.7	1 + 05	74.0	1 + 25	72.7	0 + 80	73.8	1 + 07	73.8	1 + 00	74.1
0 + 95	74.09	1 + 10	74.2	1 + 00	73.5	1 + 10	73.9	1 + 30	72.9	0 + 85	73.8	1 + 12	73.8	1 + 05	74.1
1 + 00	74.20	1 + 15	74.2	1 + 05	73.6	1 + 15	73.9	1 + 35	73.1	0 + 90	73.9	1 + 17	73.9	1 + 10	74.1
1 + 05	74.13	1 + 20	74.3	1 + 10	73.4	1 + 20	73.9	1 + 40	73.2	0 + 95	73.7	1 + 22	73.8	1 + 15	74.1
1 + 10	74.13	1 + 25	74.3	1 + 15	73.7	1 + 25	73.8	1 + 45	73.2	1 + 00	73.6	1 + 27	73.7	1 + 20	74.0
1 + 15	74.11	1 + 30	74.3	1 + 20	73.6	1 + 30	73.6	1 + 50	72.9	1 + 05	73.6	1 + 32	73.7	1 + 25	74.1
1 + 20	74.11	1 + 35	74.2	1 + 25	73.5	1 + 35	73.6	1 + 60	71.9	1 + 10	73.8	1 + 37	73.7	1 + 30	74.0
1 + 25	73.85	1 + 40	74.1	1 + 30	73.2	1 + 40	73.3	1 + 70	71.9	1 + 15	73.6	1 + 42	73.8	1 + 35	73.8
1 + 30	73.74	1 + 45	74.1	1 + 35	73.4	1 + 45	73.2	1 + 80	71.6	1 + 20	73.4	1 + 47	73.8	1 + 40	74.0
1 + 35	73.76	1 + 50	74.0	1 + 40	73.7	1 + 50	73.8	1 + 82	71.8	1 + 25	73.3	1 + 52	73.7	1 + 45	74.0

Table 23.--Profiles of normal section C-10--Continued

June 14, 1951		July 18, 1951		Aug. 3, 1951		Sept. 6, 1951		Apr. 1, 1952		May 8, 1952		June 19, 1952		Sept. 26, 1952	
Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude	Station	Altitude
1 + 40	73.61	1 + 55	73.9	1 + 45	73.1	1 + 55	73.9	1 + 87	74.5	1 + 30	73.9	1 + 57	73.4	1 + 50	74.0
1 + 45	73.50	1 + 60	73.4	1 + 50	73.2	1 + 60	74.1	....	....	1 + 35	73.9	1 + 62	72.9	1 + 55	73.6
1 + 50	73.55	1 + 65	73.5	1 + 55	74.1	1 + 65	74.2	....	....	1 + 40	73.1	1 + 67	72.5	1 + 60	73.3
1 + 55	73.14	1 + 70	72.9	1 + 60	74.1	1 + 70	74.1	....	....	1 + 45	73.5	1 + 72	72.6	1 + 65	72.4
1 + 60	73.20	1 + 75	73.4	1 + 65	73.9	1 + 75	74.1	....	....	1 + 50	73.5	1 + 77	73.0	1 + 68	71.6
1 + 65	72.98	1 + 80	72.9	1 + 70	74.0	1 + 80	74.0	....	....	1 + 55	73.4	1 + 82	72.2	1 + 70	72.2
1 + 70	73.13	1 + 85	73.1	1 + 75	74.0	1 + 85	73.6	....	....	1 + 60	73.5	1 + 87	72.6	1 + 75	72.4
1 + 75	72.54	1 + 88	72.9	1 + 80	73.6	1 + 87	73.3	....	....	1 + 65	73.3	1 + 89	73.3	1 + 80	72.6
1 + 80	72.69	1 + 89	74.4	1 + 85	73.7	1 + 89	75.4	....	....	1 + 70	72.6	1 + 90	74.2	1 + 85	72.7
1 + 85	72.34	....	....	1 + 89	74.6	....	....	....	....	1 + 75	71.3	....	....	1 + 90	73.0
1 + 87	74.42	....	....	1 + 90	75.6	....	....	....	....	1 + 80	70.6	....	....	....	....
1 + 88	75.11	....	....	....	....	....	....	....	....	1 + 85	71.0	....	....	....	....
1 + 90	76.46	....	....	....	....	....	....	....	....	1 + 90	73.9	....	....	....	....
....	....	....	....	....	....	....	....	....	....	1 + 90	74.5	....	....	....	....

Table 25.--Streamflow measurements, Niobrara River near Cody, Nebr., normal sections C-2 and C-6

[Bureau of Reclamation employees making measurements were H. Kargi, J. M. Lara, C. R. Miller, D. B. Raitt, R. Steele, and G. J. Whitsel]

Date	Made by	Average depth (d_s) at sampling stations (feet)	Width (feet)	Cross-sectional area (sq ft)	Mean velocity (fps)	Gage height (feet) 1/	Discharge (cfs)	Number of sections	Water-surface slope (ft per mile)
				Normal section C-2					
1951									
June 15..	Wark...........	1.14	119	126	2.56	1.09	322	30	6.8
July 18..	Raitt, Miller..	1.27	115	140	2.13	1.31	298	27	6.9
Aug. 3...	Matejka........	2.05	110	143	2.37	1.07	339	25	6.5
Sept. 6..	Wark...........	1.78	118	188	4.27	1.50	802	34	6.8
1952									
Apr. 1...	Matejka........	1.61	117	169	4.10	.61	691	33	7.0
May 8....	Raitt..........	1.43	117	146	2.78	.72	406	30	7.1
June 19..	Raitt, Kargi...	1.22	118	115	2.08	.67	239	27	7.3
Sept. 26.	Vice, Chadwick.	1.59	114	107	2.15	.81	230	40	7.3
1953									
May 20...	Johnson, Busch.	1.14	117	128	3.05	1.12	2/ 388	16	....
				Normal section C-6					
1951									
June 15..	Whitsel, Raitt.	....	135	166	2.00	1.58	333	30	....
July 18..	Wark...........	1.22	134	146	2.14	1.56	312	29	6.6
Aug. 3...	.....do........	1.52	133	138	2.53	1.51	349	24	7.4
Sept. 6..	Wark, Matejka..	2.56	63	153	4.48	1.96	678	25	6.8
1952									
May 8....	Raitt..........	2.00	105	178	2.23	1.46	397	27	6.5
June 19..	Steele, Lara...	1.50	104	139	1.81	1.28	252	30	6.5
Sept. 26.	Steele, Miller.	1.86	130	126	1.97	1.29	249	27	6.5
1953									
May 20...	Johnson, Busch.	1.80	121	128	2.81	1.02	2/ 359	16	....

1 Staff gage at measuring section.
2 Water discharge measurement included only 16 verticals.

Table 26.--Particle-size analyses of stream-bed material, normal sections C-1 to C-10

[Method of analysis: sieve. One sample at each station]

Date	Bed material							Location	
	Percent finer than indicated size, in millimeters							Section	Station
	0.062	0.125	0.250	0.500	1.000	2.000	4.000		
1951									
June 14...	1	4	34	89	95	98	99	C-1	42
	1	8	78	99	100	.....	.....	C-1	71
	.....	4	45	95	99	100	.....	C-1	100
	.....	1	22	78	90	95	99	C-2	41
	.....	6	52	96	99	100	.....	C-2	63
	.....	2	33	92	98	99	100	C-2	91
	.....	1	32	90	97	99	99	C-3	75
	.....	3	29	83	95	99	100	C-3	115
	.....	2	37	96	99	99	100	C-3	142
	.....	3	53	98	100	.....	.....	C-4	42
	.....	2	43	94	98	99	99	C-4	80
	.....	2	39	95	99	100	.....	C-4	113
	.....	2	40	98	100	.....	.....	C-5	34
	.....	1	24	91	98	100	.....	C-5	53
	1	20	94	99	100	.....	.....	C-5	100
	.....	3	48	96	99	99	100	C-6	60
	.....	1	36	84	98	99	100	C-6	90
	.....	1	28	92	99	100	.....	C-6	130
	.....	3	47	84	93	98	99	C-7	44
	.....	2	29	98	100	.....	.....	C-7	70
	.....	2	25	91	98	99	100	C-7	90
	.....	2	46	92	98	99	100	C-8	31
	.....	2	43	94	97	99	100	C-8	50
	.....	1	27	83	94	98	100	C-8	74
	.....	3	37	84	91	95	98	C-9	38
	.....	1	23	89	98	99	100	C-9	90
	.....	3	31	87	95	97	99	C-9	175
	.....	3	36	88	97	99	100	C-10	31
	.....	6	59	96	97	97	97	C-10	50
	.....	4	52	94	98	99	100	C-10	155
June 15...	.....	2	31	94	99	100	.....	C-2	29
	.....	3	50	97	99	99	99	C-2	63
	.....	2	34	88	96	98	100	C-2	111
	1	12	70	98	100	.....	.....	C-6	51
	.....	2	42	98	100	.....	.....	C-6	110
	.....	2	31	79	90	95	99	C-6	145
July 18...	2	3	41	94	98	99	100	C-1	46
	4	4	47	96	99	100	.....	C-1	77
	.....	2	39	95	99	99	100	C-1	112
	.....	2	46	97	99	100	.....	C-2	31
	.....	2	31	78	90	96	98	C-2	68
	.....	4	55	93	98	99	100	C-2	111
	.....	1	46	97	100	.....	.....	C-3	77
	.....	3	48	90	96	98	100	C-3	104
	.....	1	26	87	96	97	99	C-3	138

Table 26.--Particle-size analyses of stream-bed material, normal sections C-1 to C-10--Continued

Date	Bed material							Location	
	Percent finer than indicated size, in millimeters							Section	Station
	0.062	0.125	0.250	0.500	1.000	2.000	4.000		
1951--Con.									
July 18...	.....	2	32	85	93	96	98	C-4	62
	.....	3	47	94	98	98	99	C-4	95
	1	2	26	90	98	99	99	C-4	114
	.....	2	52	94	98	99	100	C-5	37
	.....	1	25	92	98	100	.....	C-5	56
	2	2	32	81	91	95	100	C-5	76
	4	10	52	94	98	99	99	C-6	65
	.....	2	33	87	94	96	96	C-6	105
	.....	1	26	96	99	100	.....	C-6	140
	.....	2	30	76	91	96	99	C-7	50
	.....	1	32	92	98	99	100	C-7	75
	1	3	49	99	100	.....	.....	C-7	91
	.....	3	37	90	98	99	100	C-8	26
	2	4	40	82	88	94	100	C-8	57
	.....	1	18	89	97	98	99	C-8	84
	.....	2	35	93	99	99	100	C-9	60
	3	4	49	96	100	.....	.....	C-9	125
	.....	2	40	94	98	99	100	C-9	175
	1	1	34	94	98	99	99	C-10	48
	1	2	38	90	96	98	100	C-10	85
	.....	2	29	92	98	99	100	C-10	165
Aug. 3....	5	12	52	97	100	.....	.....	C-1	50
	1	7	47	96	99	100	.....	C-1	80
	1	1	12	76	95	98	99	C-1	110
	.....	1	21	85	94	96	98	C-2	36
	1	19	82	99	100	.....	.....	C-2	60
	1	3	36	94	98	99	100	C-2	110
	.....	2	45	97	98	98	99	C-3	105
	1	1	32	93	98	98	99	C-3	130
	.....	1	12	64	84	92	96	C-3	155
	1	4	67	97	100	.....	.....	C-4	40
	1	3	42	96	99	100	.....	C-4	70
	.....	1	27	91	97	99	99	C-4	105
	1	2	33	78	91	96	99	C-5	40
	1	2	44	98	100	.....	.....	C-5	75
	1	6	73	93	97	99	100	C-5	105
	1	3	43	97	100	.....	.....	C-6	101
	.....	2	37	71	92	96	98	C-6	124
	.....	1	24	66	80	93	99	C-6	144
	1	2	31	96	99	100	.....	C-7	47
	.....	3	44	94	98	99	100	C-7	71
	1	2	65	99	100	.....	.....	C-7	93
	1	2	57	96	99	100	.....	C-8	25
	.....	3	64	97	99	99	100	C-8	50
	1	2	48	99	100	.....	.....	C-8	75

Table 26.--Particle-size analyses of stream-bed material, normal sections C-1 to C-10--Continued

Date	Bed material							Location	
	Percent finer than indicated size, in millimeters								
	0.062	0.125	0.250	0.500	1.000	2.000	4.000	Section	Station
1951--Con.									
Aug. 3....	.....	2	38	88	96	99	100	C-9	64
	.....	6	81	100	.....	.....	.....	C-9	103
	.....	4	62	98	100	.....	.....	C-9	143
	2	4	63	98	100	.....	.....	C-10	43
	.....	3	41	90	97	98	99	C-10	86
	1	2	35	92	99	99	100	C-10	130
Sept. 6...	1	1	36	89	97	98	100	C-1	40
	2	2	17	61	78	87	94	C-1	75
	.....	1	30	89	96	99	100	C-1	110
	0	2	38	95	100	.....	.....	C-2	30
	3	7	47	90	98	99	100	C-2	58
	2	4	49	96	99	99	100	C-2	100
	.....	2	55	99	100	.....	.....	C-3	75
	1	2	15	70	81	87	90	C-3	115
	1	1	14	82	94	97	100	C-3	150
	.....	1	4	49	92	97	98	C-4	65
	1	2	26	90	99	100	.....	C-4	94
	.....	1	13	78	96	97	98	C-4	110
	1	7	55	98	100	.....	.....	C-5	30
	1	2	44	99	100	.....	.....	C-5	60
	1	4	43	97	100	.....	.....	C-5	90
	.....	1	10	83	96	98	99	C-7	40
	.....	3	64	100	.....	.....	.....	C-7	70
	.....	1	50	98	100	.....	.....	C-7	95
	4	10	71	99	100	.....	.....	C-8	30
	1	3	48	98	100	.....	.....	C-8	60
	1	5	35	98	99	100	.....	C-8	85
	6	9	32	89	97	99	100	C-9	55
	.....	1	31	94	97	98	100	C-9	100
	2	11	72	99	100	.....	.....	C-9	140
	3	3	50	96	98	98	99	C-10	50
	3	5	62	99	100	.....	.....	C-10	95
	.....	1	16	84	97	98	100	C-10	145
1952									
Apr. 1....	1	7	77	99	99	100	.....	C-1	34
	0	6	50	90	99	100	.....	C-1	105
	3	5	38	97	99	100	.....	C-1	135
	1	7	49	98	99	99	100	C-2	42
	0	2	40	97	100	.....	.....	C-2	85
	1	6	60	100	.....	.....	.....	C-2	112
	1	2	35	89	98	99	100	C-3	65
	0	2	59	98	100	.....	.....	C-3	130
	6	10	37	91	98	99	100	C-3	167
	3	19	86	100	.....	.....	.....	C-4	35
	0	5	55	99	100	.....	.....	C-4	95
	0	2	15	87	98	99	100	C-4	121

Table 26.--Particle-size analyses of stream-bed material, normal sections C-1 to C-10--Continued

Date	Bed material: Percent finer than indicated size, in millimeters							Location	
	0.062	0.125	0.250	0.500	1.000	2.000	4.000	Section	Station
1952--Con.									
Apr. 1....	3	12	40	88	98	100	.....	C-5	....
	0	3	36	96	100	.....	.....	C-5	....
	0	2	50	99	100	.....	.....	C-5	....
	1	1	6	63	80	91	98	C-7	40
	1	5	63	99	100	.....	.....	C-7	65
	0	2	49	99	100	.....	.....	C-7	100
	0	4	36	97	100	.....	.....	C-8	25
	1	2	45	99	100	.....	.....	C-8	45
	.....	0	10	88	95	96	98	C-8	95
	3	14	34	97	100	.....	.....	C-9	....
	2	10	52	93	99	100	.....	C-9	....
	24	62	96	100	.....	.....	.....	C-9	....
	0	2	25	93	98	99	99	C-10	30
	0	2	35	95	100	.....	.....	C-10	100
	4	5	52	99	100	.....	.....	C-10	155
May 8.....	0	2	45	95	98	100	.....	C-1	....
	1	2	48	97	100	.....	.....	C-1	110
	3	3	22	75	88	94	99	C-2	30
	0	3	41	94	98	99	99	C-2	77
	1	2	50	96	99	99	100	C-2	113
	0	3	51	97	99	100	.....	C-3	48
	1	4	49	92	96	97	99	C-3	110
	0	4	55	98	100	.....	.....	C-3	143
	0	2	42	91	97	99	100	C-4	40
	0	2	31	84	92	95	97	C-4	104
	1	3	31	85	95	97	98	C-4	....
	2	2	35	87	94	97	98	C-5	35
	2	6	20	41	45	48	53	C-5	85
	0	2	42	93	98	99	100	C-5	....
	2	2	24	88	96	96	97	C-6	95
	0	1	36	91	98	99	100	C-6	120
	0	2	25	82	92	96	99	C-6	143
	0	2	41	97	99	99	100	C-7	45
	0	3	34	90	97	98	100	C-7	69
	0	1	30	87	96	98	99	C-7	93
	2	3	24	86	95	97	98	C-8	28
	0	2	40	93	98	98	99	C-8	56
	2	2	27	82	94	96	98	C-8	84
	1	3	37	83	93	97	99	C-9	55
	0	2	27	80	91	95	98	C-9	110
	1	2	17	82	92	93	94	C-9	165
	1	3	41	88	96	98	100	C-10	55
	1	2	41	87	95	97	98	C-10	110
	2	2	39	92	98	99	100	C-10	165

Table 26.--Particle-size analyses of stream-bed material, normal sections C-1 to C-10--Continued

Date	Bed material							Location	
	Percent finer than indicated size, in millimeters								
	0.062	0.125	0.250	0.500	1.000	2.000	4.000	Section	Station
1952--Con.									
June 19...	0	2	52	98	99	99	99	C-1	45
	0	2	47	90	95	98	99	C-1	69
	0	3	46	93	98	99	100	C-1	110
	0	1	31	85	93	96	98	C-2	17
	0	25	60	97	99	99	100	C-2	45
	0	2	73	98	99	100	.....	C-2	102
	0	2	50	97	99	99	100	C-3	25
	1	4	46	92	97	99	99	C-3	70
	0	7	63	96	99	100	.....	C-3	120
	0	3	50	97	100	.....	.....	C-4	40
	0	7	57	92	98	99	100	C-4	61
	0	2	42	92	97	98	99	C-4	103
	0	1	25	84	93	97	99	C-5	65
	0	1	32	94	98	99	99	C-5	85
	0	1	29	89	97	99	100	C-5	112
	0	4	63	98	99	100	.....	C-6	75
	0	1	30	87	93	97	98	C-6	110
	0	2	18	78	91	94	98	C-6	140
	0	8	44	94	99	100	.....	C-7	30
	0	2	25	68	78	86	95	C-7	55
	0	1	26	92	98	99	100	C-7	70
	0	1	42	94	98	98	99	C-8	20
	0	1	30	88	96	98	99	C-8	50
	0	1	30	94	98	99	100	C-8	80
	0	1	24	84	96	98	100	C-9	60
	0	5	58	96	99	100	.....	C-9	120
	0	2	22	81	93	96	98	C-9	185
	.....	0	1	29	88	98	100	C-10	20
	1	8	43	87	95	97	99	C-10	95
	0	1	18	71	83	90	95	C-10	160
Sept. 26..	.....	0	31	89	96	98	99	C-1	40
	1	8	40	77	90	96	99	C-1	95
	0	2	28	83	93	96	99	C-1	124
	0	4	46	94	99	99	100	C-2	32
	0	1	32	96	100	.....	.....	C-2	106
	0	1	21	68	75	85	95	C-2	120
	0	3	47	91	96	98	99	C-3	62
	0	3	56	95	98	99	100	C-3	122
	0	1	31	86	96	98	100	C-3	154
	0	2	40	95	99	100	.....	C-4	42
	.....	0	31	94	100	.....	.....	C-4	109
	0	1	48	97	100	.....	.....	C-4	125
	2	18	72	98	100	.....	.....	C-5	48
	0	2	46	94	99	100	.....	C-5	70
	0	3	42	96	100	.....	.....	C-5	95

Table 26.--Particle-size analyses of stream-bed material, normal sections C-1 to C-10--Continued

Date	Bed material: Percent finer than indicated size, in millimeters							Location	
	0.062	0.125	0.250	0.500	1.000	2.000	4.000	Section	Station
1952--Con.									
Sept. 26..	0	6	57	93	97	99	99	C-6	110
	0	1	22	73	90	96	99	C-6	140
	.....	0	17	69	89	93	97	C-6	155
	0	2	47	95	99	99	100	C-7	46
	0	2	55	88	92	96	98	C-7	75
	0	2	44	93	99	100	.....	C-7	95
	0	2	45	93	98	98	100	C-8	32
	0	1	24	79	93	97	99	C-8	57
	0	1	31	92	98	99	100	C-8	82
	0	4	52	96	99	100	.....	C-9	60
	0	4	72	98	100	.....	.....	C-9	135
	0	3	58	98	100	.....	.....	C-9	165
	0	1	28	87	98	99	100	C-10	30
	0	6	60	92	97	98	99	C-10	85
	0	2	31	86	95	98	99	C-10	170
1953									
May 20....	0	1	31	95	98	98	99	C-2	27
	0	2	40	93	98	99	99	C-2	45
	0	2	40	91	98	98	99	C-2	74
	0	1	37	92	98	98	99	C-2	102
	0	2	51	94	98	99	100	C-2	119
	0	1	43	98	100	.....	.....	C-6	23
	0	2	42	99	100	.....	.....	C-6	35
	0	2	44	98	100	.....	.....	C-6	44
	0	4	58	97	99	99	100	C-6	55
	0	6	52	92	98	99	100	C-6	76

Table 27.--Comparison of particle-size analyses of depth-integrated samples

[Methods of analysis: S, sieve; W, in distilled water; M, mechanically dispersed; P, pipette; C, chemically dispersed]

Date	Time	Water discharge (cfs) 1/	Suspended sediment													Methods of analysis
			Concen-tration of sample (ppm)	Concentration of suspension analyzed (ppm)	Percent finer than indicated size, in millimeters											
					0.002	0.004	0.008	0.016	0.031	0.062	0.125	0.250	0.500	1.000	2.000	
1951																
June 15 2/....	10:40 a.m.	319	516	....	.....	.....	.....	.....	.....	19	48	100	.....	.....	.....	SWM
(3)	9:40 a.m.	342	1,340	....	.....	.....	.....	.....	.....	10	27	100	.....	.....	.....	SWM
(4)	12:10 p.m.	294	345	....	.....	.....	.....	.....	.....	21	100	.....	.....	.....	.....	SWM
July 18 2/....	11:00 a.m.	298	470	....	.....	.....	.....	.....	.....	14	40	100	.....	.....	.....	SWM
(3)	9:40 a.m.	310	1,200	....	.....	.....	.....	.....	.....	8	22	67	96	100	.....	SWM
(4)	1:30 p.m.	278	433	....	.....	.....	.....	.....	.....	12	37	93	100	.....	.....	SWM
(5)	12:30 p.m.	294	317	....	.....	.....	.....	.....	.....	16	24	100	.....	.....	.....	SWM
Aug. 2 2/.....	6:40 p.m.	324	742	1,160	.....	19	.....	37	.....	53	66	93	100	.....	.....	SPWCM
(3)	6:20 p.m.	342	1,840	....	.....	.....	.....	.....	.....	21	34	66	96	98	99	SWM
Aug. 3 4/.....	10:25 a.m.	314	588	....	.....	30	.....	40	.....	80	81	100	.....	.....	.....	SPWCM
(5)	10:15 a.m.	314	608	....	.....	16	.....	24	.....	35	62	100	.....	.....	.....	SPWCM
Sept. 6 3/....	1:20 p.m.	722	4,750	2,370	.....	24	.....	32	.....	41	51	73	96	99	100	SPWCM
(4)	12:30 p.m.	746	2,760	....	.....	43	.....	54	.....	71	85	98	99	99	99	SPWCM
(5)	4:50 p.m.	650	2,720	2,400	26	32	37	40	46	60	74	94	100	.....	.....	SPWCM
1952																
Apr. 1 2/.....	11:40 a.m.	662	2,030	....	.....	.....	.....	.....	.....	28	56	94	100	.....	.....	SW
(3)	1:15 p.m.	650	4,220	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....
(4)	1:00 p.m.	673	1,640	1,980	7	10	13	16	20	34	62	96	100	.....	.....	SPWCM
(5)	6:00 p.m.	608	1,450	3,800	8	11	14	16	21	37	66	96	100	.....	.....	SPWCM
May 8 2/......	10:45 a.m.	435	862	....	.....	.....	.....	.....	.....	23	57	98	100	.....	.....	SW
(3)	5:15 p.m.	400	1,700	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....
(4)	11:00 a.m.	406	752	....	.....	.....	.....	.....	.....	26	67	95	100	.....	.....	SW
(5)	2:50 p.m.	362	874	....	.....	.....	.....	.....	.....	22	56	92	100	.....	.....	SW

June 19 2/....	11:35 a.m.	230	458	....	.....	.....	.....	.....	.....	15	35	86	100	.....	.....	SW
(3)	11:00 a.m.	234	754	....	.....	.....	.....	.....	.....	11	25	70	97	100	.....	SW
(4)	12:10 p.m.	231	262	....	.....	.....	.....	.....	.....	28	52	91	100	.....	.....	SW
(5)	12:10 p.m.	240	294	....	.....	.....	.....	.....	.....	22	44	77	98	100	.....	SW
Sept. 26 2/...	11:10 a.m.	234	346	....	.....	.....	.....	.....	.....	14	37	89	100	.....	.....	SW
(3)	12:00 m.	234	736	....	.....	.....	.....	.....	.....	9	23	71	98	100	.....	SW
(4)	5:50 p.m.	226	255	....	.....	.....	.....	.....	.....	19	42	86	99	.....	.....	SW
(5)	2:45 p.m.	249	504	....	.....	.....	.....	.....	.....	11	27	82	100	.....	.....	SW
1953																
May 20 3/.....	9:35 a.m.	355	1,560	....	.....	.....	.....	.....	.....	12	36	75	98	100	.....	SW
(4 6)	11:50 a.m.	388	596	....	.....	.....	.....	.....	.....	32	71	97	100	.....	.....	....
(5 6)	3:05 p.m.	363	685	....	.....	.....	.....	.....	.....	25	51	91	100	.....	.....	....

1 Water discharge at sections C-2 and C-6 adjusted for difference between time of streamflow measurement and time of sampling.
2 Gaging-station section.
3 Contracted section.
4 Section C-2.
5 Section C-6.
6 Size computed from point-integrated samples.

Table 28.--Particle-size analyses of suspended sediment, point-integrated samples, sections C-2 and C-6

[Method of analysis: sieve. Point velocities measured by pygmy current meter. Water discharge adjusted for difference between time of streamflow measurement and time of sampling]

Date	Time	Water discharge (cfs)	Sampling station	Total depth (feet)	Suspended sediment							
					Sampling point			Percent finer than indicated size, in millimeters				
					Velocity (fps)	Depth (feet)	Concentration (ppm)	0.062	0.125	0.250	0.500	1.000
Section C-2												
1953 May 20	12:20 p.m.	383	27	1.0	3.47	0.2	394	44	85	98	100	.....
	12:20 p.m.	383	27	1.0	3.47	.5	649	32	72	98	100	.....
	12:20 p.m.	383	27	1.0	3.31	.7	867	24	61	96	100	.....
	12:05 p.m.	383	45	.8	3.73	.2	615	31	77	98	100	.....
	12:05 p.m.	383	45	.8	3.55	.5	762	29	68	97	100	.....
	11:50 a.m.	388	74	.8	3.31	.2	396	45	82	98	100	.....
	11:50 a.m.	388	74	.8	3.17	.5	480	36	79	98	100	.....
	11:35 a.m.	392	102	1.6	3.17	.3	410	40	73	97	100	.....
	11:35 a.m.	392	102	1.6	2.98	.7	614	29	60	96	100	.....
	11:35 a.m.	392	102	1.6	2.52	1.3	801	22	53	94	100	.....
	11:20 a.m.	392	119	1.5	3.47	.3	618	31	76	98	100	.....
	11:20 a.m.	392	119	1.5	3.39	.9	847	24	68	98	100	.....
	11:20 a.m.	392	119	1.5	3.24	1.2	951	21	63	97	100	.....
Section C-6												
1953 May 20	2:30 p.m.	355	23	1.7	3.31	0.3	609	34	65	95	100	.....
	2:30 p.m.	355	23	1.7	3.31	.9	645	28	57	92	99	100
	2:30 p.m.	355	23	1.7	3.24	1.4	905	23	52	92	100	.....
	2:45 p.m.	359	35	2.1	2.71	.3	744	23	50	89	100	.....
	2:45 p.m.	359	35	2.1	3.10	1.1	874	20	43	89	100	.....
	2:45 p.m.	359	35	2.1	3.17	1.8	1,080	16	37	86	99	100
	3:05 p.m.	363	44	2.3	3.17	.3	682	30	53	93	100	.....
	3:05 p.m.	363	44	2.3	3.04	1.2	836	21	42	88	100	.....
	3:05 p.m.	363	44	2.3	2.98	2.0	1,040	15	37	86	100	.....
	3:25 p.m.	367	55	2.1	2.22	.3	468	36	64	93	100	.....
	3:25 p.m.	367	55	2.1	1.96	1.1	555	29	58	92	99	100
	3:25 p.m.	367	55	2.1	2.08	1.8	804	23	48	88	100	.....
	3:45 p.m.	363	76	.8	2.04	.2	450	38	73	98	100	.....
	3:45 p.m.	363	76	.8	1.96	.5	525	19	56	94	99	100

Table 29.--Sediment-discharge measurements, normal sections C-2 and C-6

Date	Time	Gage height (feet)	Water discharge (cfs) 1/	Suspended sediment: Mean concentration (ppm)	Suspended sediment: Discharge (tons per day)	Water temperature (°F)
Section C-2						
1951						
June 15..	12:10 p.m.	0.88	294	345	274	73
July 18..	1:30 p.m.	.92	278	433	325	84
Aug. 3...	10:25 a.m.	1.10	314	588	499	75
Sept. 6..	12:30 p.m.	1.81	746	2,760	5,560	66
1952						
Apr. 1...	1:00 p.m.	1.58	650	1,640	2,880	....
May 8....	11:00 a.m.	1.18	430	752	870	58
June 19..	12:10 p.m.	.78	230	262	160	64
Sept. 26.	5:50 p.m.	.77	219	255	150	58
1953						
May 20...	11:50 a.m.	1.12	350	596	563	63
Section C-6						
1951						
June 15..	1:20 p.m.	0.86	286	362	280	72
July 18..	12:30 p.m.	.96	294	317	252	....
Aug. 3...	10:15 a.m.	1.10	314	608	515	75
Sept. 6..	4:50 p.m.	1.65	650	2,720	4,770	....
1952						
Apr. 1...	6:00 p.m.	1.51	608	1,450	2,380	....
May 8....	2:50 p.m.	1.13	405	874	960	60
June 19..	12:10 p.m.	.77	226	294	179	70
Sept. 26.	2:45 p.m.	.79	226	504	308	....
1953						
May 20...	3:05 p.m.	1.03	310	685	573	.66

1 Not adjusted for time of travel of the water nor for possible inflow of ground water.

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