PROGRESS REPORT NUMBER 2

INVESTIGATIONS OF SOME SEDIMENTATION CHARACTERISTICS OF SAND-BED STREAMS

By

D. W. Hubbell, 1925-

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PROGRESS REPORT NUMBER 2
INVESTIGATIONS OF SOME SEDIMENTATION CHARACTERISTICS OF SAND-BED STREAMS

By David W. Hubbell

Abstract

Hydraulic and sediment characteristics at six river sections upstream and downstream from the confluence of the Middle Loup and Dismal Rivers were measured and studied to determine some of the interrelationships between variables and the differences that exist between common variables when two flows unite. The two streams, which flow through the Sandhills region of Nebraska, have about the same water discharge, sediment concentration, and particle-size distribution of suspended sediment and bed material. Sediment discharges and flow resistances varied widely, although water discharges remained almost constant. The factor affecting the variations was water temperature, which ranged from 32° to 80° F. The bed form, which also varied with the water temperature, seemed to have a dominating influence on the sediment discharge, flow resistance, and possibly the vertical distribution of velocity and suspended sediment. Multiple regression with parameters derived from dimensional analysis yielded an expression for predicting the flow resistance and the widths and depths of individual channel sections. Contrary to those near many other confluences, slopes were steeper and channels were wider downstream from the junction of the two rivers than they were upstream.

Introduction

An investigation of specific sediment-transport phenomena and field procedures was made during 1956 and 1957 in cooperation with the U. S. Bureau of Reclamation. The purposes of this investigation were to provide information on the regime of rivers and to improve the procedures related to the collection of sediment data. The basic data and results of the studies made in 1956 were presented in progress report number 1, "Investigations of Some Sedimentation Characteristics of a Sand-Bed Stream." Some of the basic data and results of the studies made in 1957 are given in this report.

The cooperative investigation for 1957 was discussed by personnel of the Bureau of Reclamation and the Geological Survey at a meeting on July 30, 1956, in Denver, Colo. Those attending the meeting were:

O. C. Hansen, Region 7, U. S. B. R., Denver, Colo.
K. B. Schroeder, Commissioner's Office, U. S. B. R., Denver, Colo.
D. M. Culbertson, Geological Survey, Lincoln, Nebr.

The objectives of the 1957 program, as outlined at the meeting and given by the Bureau of Reclamation in a memorandum dated July 30, 1956, were to study some of the variable hydraulic parameters that affect sediment transport in alluvial streams, to improve bed-material samplers, and to determine the general requirements for an adequate bed-material sample. The purpose of this report is to present the results of the studies on some of the variables--mainly water temperature--that affect sediment transport in alluvial streams.

The investigation was programmed by Region 7, Bureau of Reclamation; by the Division of Project Investigations, Commissioner's Office, Bureau of Reclamation; and by the Geological Survey. The part of the investigation by the Geological Survey was financed by the Missouri River basin project funds and was made under the supervision of the regional office, Quality of Water Branch, Geological Survey, Lincoln, Nebr. The field and laboratory work was done by employees of the Geological Survey, Lincoln, Nebr., under the supervision of D. M. Culbertson, area engineer. Data were analyzed by personnel of the Division of Project Investigations of the Commissioner's Office, Bureau of Reclamation, and by personnel of the Geological Survey.

Field investigations

Field data for this study were collected in the vicinity of Dunning, Nebr., at river sections upstream and downstream from the confluence of the Middle Loup and Dismal Rivers (figs. 1 and 2).

Figure 1.--Reach of the Middle Loup and Dismal Rivers near Dunning, Nebr.

Figure 2.--Confluence of the Middle Loup and Dismal Rivers (westward view).

Both the Middle Loup and Dismal Rivers upstream from Dunning are in the Sandhills region of Nebraska. The flow of these streams is derived mainly from ground water and averages about 380 cfs (cubic feet per second) for the Middle Loup River and 315 cfs for the Dismal River. Both streams have about the same sediment concentration and particle-size distribution of suspended sediment and bed material, and both flow in alluvial channels that are confined laterally by low banks. More detailed information on the character of these two streams is given by Vice and Serr (written communication, 1951); Benedict, Albertson, and Matejka (1955); and Hubbell and Matejka (1959).

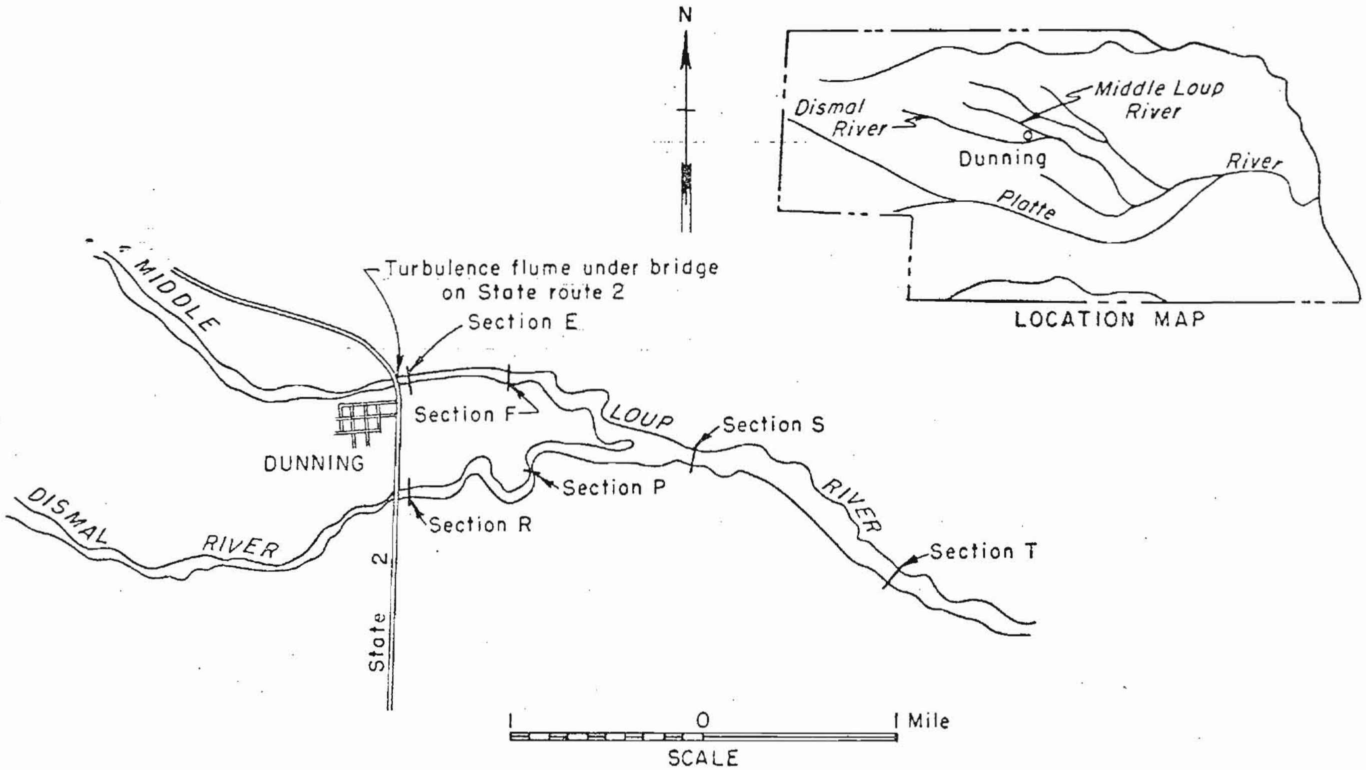


Figure 1 .-- Reach of the Middle Loup and Dismal Rivers near Dunning, Nebr.

Figure 2.--Confluence of the Middle Loup and Dismal Rivers (westward view).

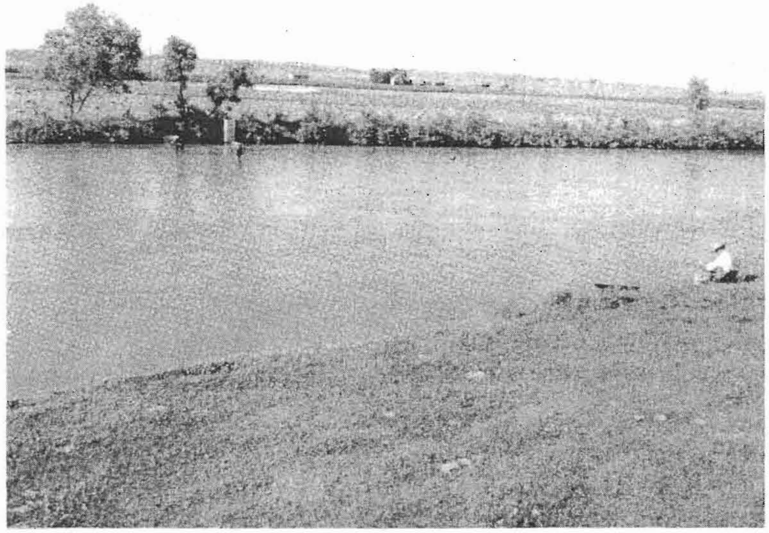
Because of the nature of the two streams, data collected at sections upstream and downstream from the confluence were anticipated to provide information on the differences that result to the various hydraulic and sediment characteristics when two similar streams unite. This information might be useful for direct application to convergence and diversion problems.

Six different sections were selected for study. Four sections are located on the Middle Loup River, two upstream and two downstream from the confluence; and two sections are located on the Dismal River (figs. 1 and 2).

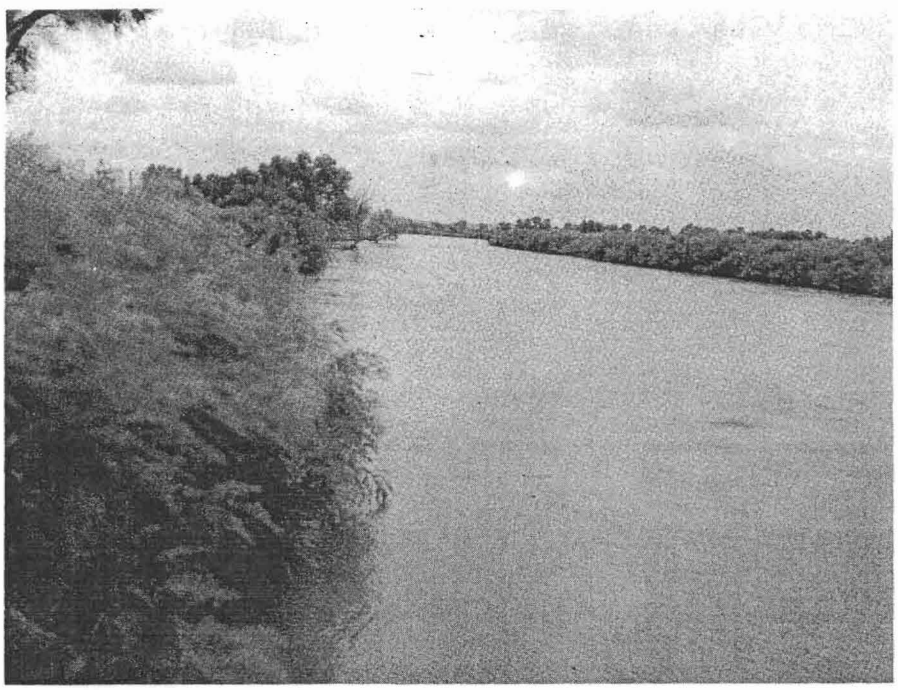
Sections E and F (fig. 3) are on the Middle Loup River about

Figure 3.--Sections E and F, Middle Loup River.

7,500 and 5,000 feet, respectively, upstream from the confluence. At section E, which normally is about 158 feet wide and has a fairly uniform cross section, one bank is subject to erosion by undercutting and the other bank is stabilized by heavy willow growth. At section F, which is about 94 feet wide and gradually deepens from the left to the right bank, brush along both banks confines the flow.



Section E



Section F

Figure 3.--Sections E and F, Middle Loup River.

Sections R and P (fig. 4) are on the Dismal River and are

Figure 4.--Sections R and P, Dismal River.

about 75 and 84 feet wide, respectively. Both sections R and P have heavy sod on one bank and willow growth on the other; section R also has some trash on the sod bank.

Sections S and T (fig. 5), which are on the Middle Loup River

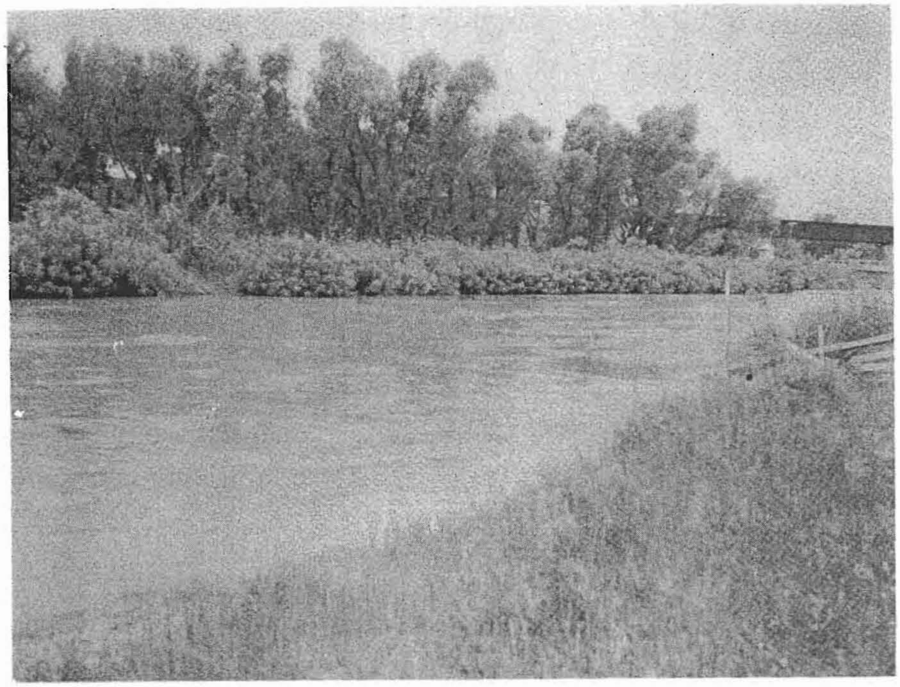
Figure 5.--Sections S and T, Middle Loup River.

downstream from the confluence, have bank-to-bank widths, including emergent bars, of about 394 and 332 feet, respectively. Both of these sections contained sandbars and some angular flow during the field observations. Section S has willow growth on both banks, and section T has sod on one bank and heavy brush growth on the other.

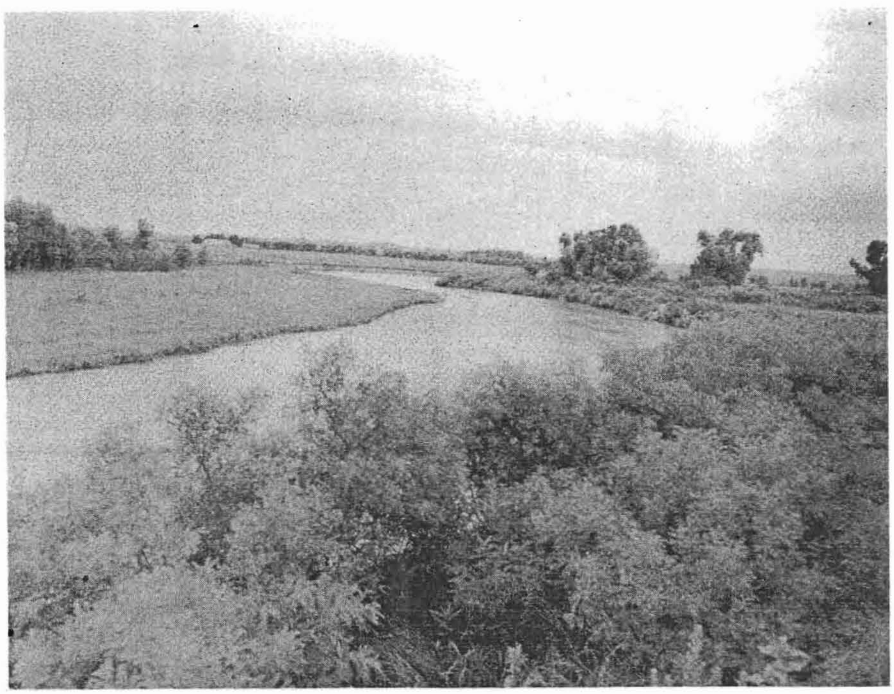
Cross-section profiles for each set of data and each section are given in figure 6. These profiles indicate the rather extensive

Figure 6.--Cross-section profiles.

changes in cross-section shape and bed configuration that occur in these streams. In particular, the figure shows the tendency for a progressive smoothening of the bed from August to November.

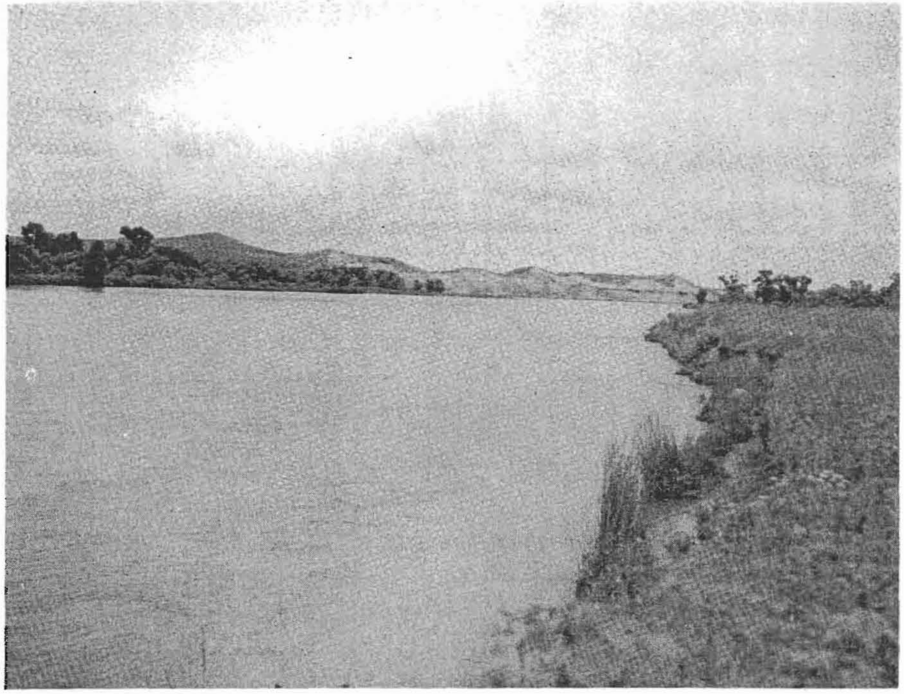


Section R

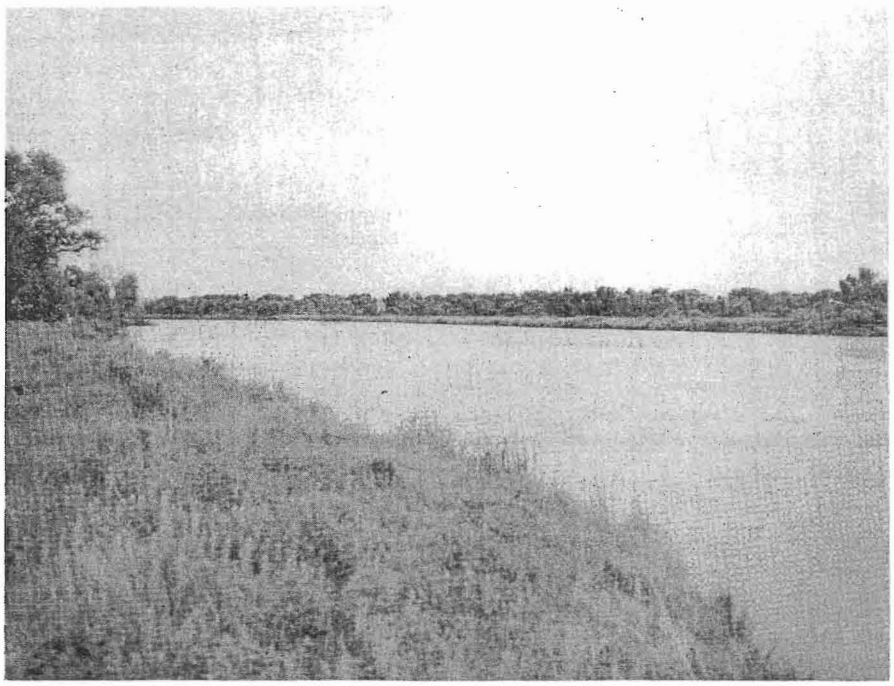


Section P

Figure 4.--Sections R and P, Dismal River.



Section S



Section T

Figure 5.--Sections S and T, Middle Loup River

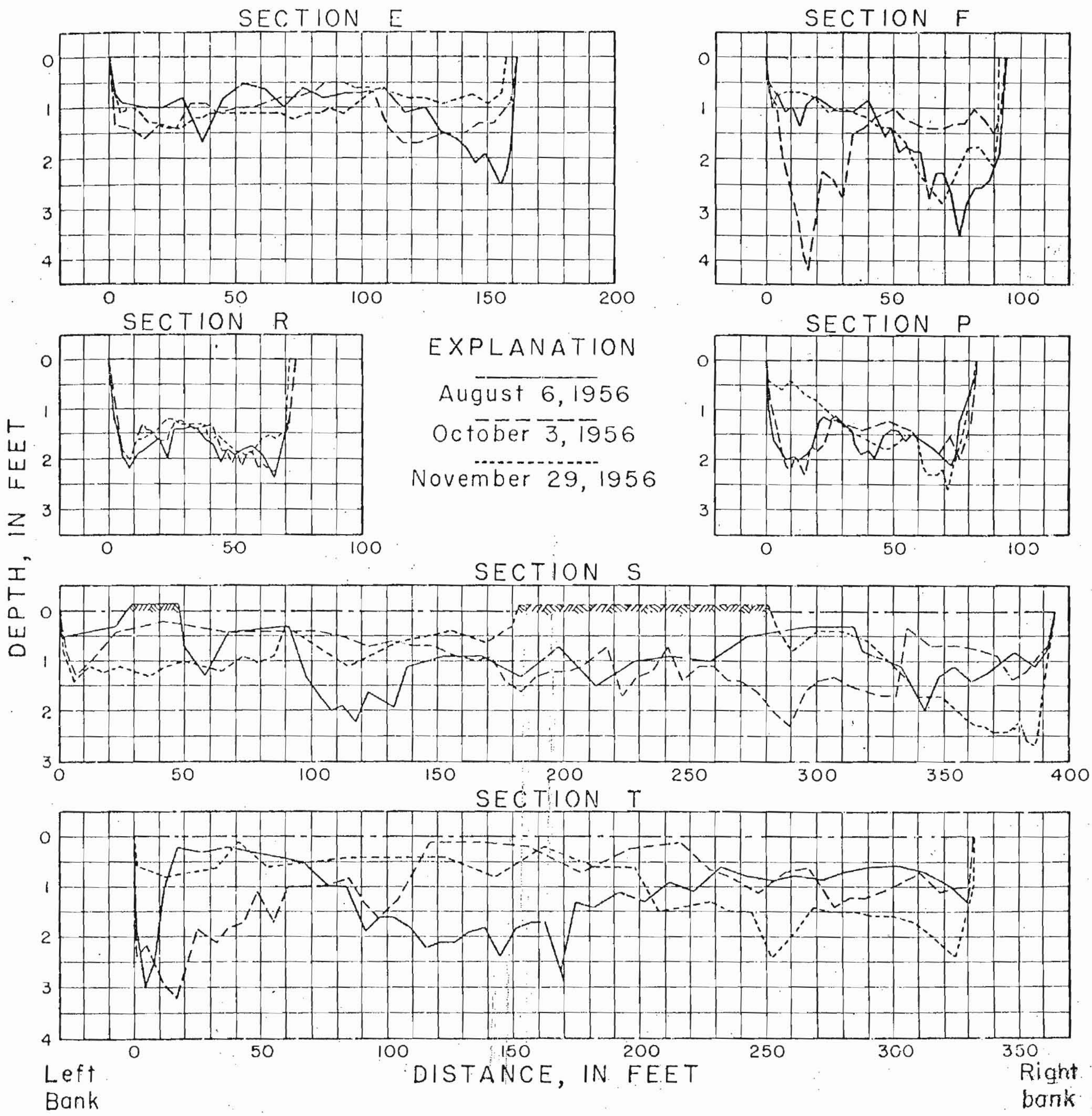


Figure 6. --Cross-section profiles.

For this study, sediment and comprehensive hydraulic data were collected at sections E, R, S, and T, and some hydraulic data were collected at sections F and P. Also, total sediment discharge measurements were made at section D, which is at the measuring sill of the turbulence flume (Benedict, Albertson, and Matejka, 1955; Hubbell and Matejka, 1959). (See fig. 1.) The measurements at section D were used to verify total sediment discharges that were computed for section E. Separate sets of data were collected on August 6 and 7, October 3 and 4, and November 28, 29, and 30, 1956. Water temperatures ranged from 69° to 80° F for the August measurements, 50° to 64° F for the October measurements, and 32° to 41° F for the November measurements. For each separate set of data the following were sampled or measured in the field:

Sections E, R, S, and T

1. Suspended sediment
2. Bed material
3. Water discharge
4. Water-surface slope
5. Water temperature

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Sections F and P

1. Cross-section width and area

2. Water-surface slope

Section D

1. Suspended sediment, which represents the concentration and particle-size distribution of the total sediment discharge.

In addition, point-integrated suspended-sediment samples were collected at sections R, S, and T on October 3 and at sections E, R, S, and T on November 29. Also, cross-section soundings were made 300 feet upstream and downstream from section S on August 7, October 3 and 4, and November 29 and 30, and 300 feet upstream and downstream from section T on August 7, October 3 and 4, and November 30. Generally, data at a single section were obtained in the following order: First, the water-surface slope over a 600-foot reach was measured; then, the water discharge was measured and suspended-sediment samples were collected simultaneously; and finally, bed-material samples were collected. Point-integrated suspended-sediment samples were usually collected after or at the same times the bed-material samples were collected.

Suspended sediment was sampled according to the equal-transit-rate method with DH-48 hand samplers having 3/16-inch nozzles, and bed material was collected with both the surface-type bed-material sampler and the core-type sampler. Both the suspended sediment and bed material were sampled at relatively close intervals with respect to the width of the channel. Point-integrated samples were generally collected at five verticals and at four points in each vertical. Water discharge measurements were made with Price current meters according to the standard procedures of the Geological Survey.

Particle-size analyses from depth-integrated and point-integrated suspended-sediment samples are given in tables 1 and 2, respectively; and particle-size analyses of bed material are given in table 3. A summary of the hydraulic and channel geometry data is given in table 4. The water discharges listed in table 4 for sections F and P are the same as those measured at sections E and R, respectively. The slopes listed in the table are water-surface slopes; those for sections E, F, P, S, and T are for 600-foot reaches, those for section R are for a 580-foot reach, and those for sections 300 feet upstream or downstream from sections S or T are for 300-foot reaches. In all the computations in this report, the water-surface slope is assumed to be equal to the energy gradient, the wetted perimeter is assumed to be equal to the stream width, and the hydraulic radius is assumed to be equal to the mean depth.

Some of the relations given in this report are based on computed data rather than measured data. Some of the preliminary computations are described in the following section.

Computations

Total sediment discharges and bed-material discharges have been computed with the modified Einstein procedure (Colby and Hembree, 1955). These discharges, by size ranges, are given in table 5. Included in the table are comparable measured total discharges from section D at the turbulence flume. The table shows good agreement between the computed loads for section E and the measured loads at section D for all water discharges, concentrations, and water temperatures.

Values of the Manning n (see table 4) have been computed from

$$n = \frac{1.486\ R^{2/3}\ S^{1/2}}{V}$$

where--

R is the hydraulic radius, which is assumed to be equal to the mean depth, d. The mean depth was computed by dividing the effective area, A, by the effective width, W

S is the energy gradient, which is assumed to be equal to the water-surface slope

V is the mean stream velocity, which is computed from Q_w/A

in which--

Q_w is the measured water discharge

A is the effective area, which is equal to the summation of the product of the mean depth and the effective width for each increment of a water discharge measurement. The effective width of each increment of a water discharge measurement is the product of the tagline width and the horizontal angle coefficient. The effective width for a cross section, W, is the summation of the effective widths of the increments and is also the length of a discontinuous line that crosses the channel and that is normal to the direction of flow at every point

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Values of n were computed on the basis of effective widths and areas for the following reasons. First, in order to conform to the principle of the continuity of flow, the discharge of each increment of a water discharge measurement is necessarily the product of the measured velocity and the effective area. Thus, a mean velocity for the stream corresponding to the actual measured velocities can only be computed by dividing the total discharge by the total effective area. Secondly, water-surface slopes are determined from the fall of the water surface over a channel distance and not over a streamline distance.

The equation for the vertical distribution of suspended sediment and the data listed in table 2 have been used to compute values of z_1, the exponent in the distribution equation. The basis for the computation is that for any given vertical and time, c_y (the concentration of a size range at any point y distance above the bed) can be expressed by $c_y = K\left(\frac{d - y}{y}\right)^{z_1}$, where K is a constant and d is the depth. In a plot of c_y against $\left(\frac{d - y}{y}\right)$ on logarithmic coordinate paper, z_1 for the size range is the slope of the line. Values of z_1 are listed in table 6.

Values of k, the coefficient for turbulent exchange or von Karman coefficient, were also computed from data presented in table 2. For any given vertical and time, the Keulegan equation for the vertical distribution of velocity can be written as $\bar{u}_y = K_1 + (2.303\, u_*/k) \log_{10} y$, where K_1 is a constant, u_* is the shear velocity, and $\bar{u}_y$ is the stream velocity at a distance y above the bed. By plotting $\bar{u}_y$ against y on semilogarithmic paper, k was determined from $M = 2.303\, u_*/k$, where M is the slope of the line. Computed k values are shown in table 6.

Presentation of results

In both rigid-boundary flow and alluvial-channel flow the resistance is related to the boundary roughness and to the fluid turbulence. However, in alluvial-channel flow the relations are particularly complicated because the boundary can be sheared and deformed and because sediment moves along the boundary and in suspension. In alluvial channels, the boundary roughness and fluid turbulence depend on many variables, such as bed form, cross-section shape, particle size of the bed and suspended material, and sediment concentration. These variables, with the possible exception of particle size, in turn, are functions of the hydraulic characteristics of the flow (including turbulence) and the boundary roughness. Thus, whenever any hydraulic or sediment characteristic changes, the entire hydraulic-sediment system must change to reestablish a quasi-equilibrium condition.

The data from this study and from previous studies at the same location show that changes in the water temperature cause large changes both in the hydraulic characteristics of the flow, particularly resistance, and in the sediment discharge. This conclusion follows from the fact that the water temperature varied widely, whereas the other dominant independent variables remained almost constant. During the study the range in water discharge at any section was so narrow that the largest difference between maximum and minimum discharges was 19 percent; the total loads were composed mostly of bed material so that concentrations were originally "effects" rather than "causes"; the slopes, depths, and widths were not changed by external forces; and the gross slopes of neither stream changed with time, although local slopes varied in a statistical sence. In general, small sediment discharges and large flow resistances (large values of the Manning n) are associated with high temperatures, and large sediment discharges and small flow resistances (small values of the Manning n) are associated with low temperatures. Also, generally, the shallowest depth, narrowest widths, and highest velocities are associated with low temperatures.

Presumably, as the fluid viscosity varies with temperature, the fall velocities or, more particularly, the drag coefficients of the sediment particles vary so that the sediment transport and bed form change. These changes, in turn, cause changes in the hydraulic variables and the entire system adjusts until a quasi-equilibrium is established. During the study, the form of the bed varied from well-developed dunes when the water temperature was high to a relatively smooth bed when the water temperature was low. Evidence of the change in bed form is given in figure 7,

Figure 7.--Variation of σ_d with water temperature.

which shows σ_d plotted against water temperature. In this figure, σ_d, which is the standard deviation of the differences between adjacent soundings of a water discharge measurement, is used as an index to the magnitude of the bed form; the assumption is made that whenever the bed is smooth, the variability of the differences between adjacent soundings will be small, and whenever the bed is rough, the variability of the differences will be large.

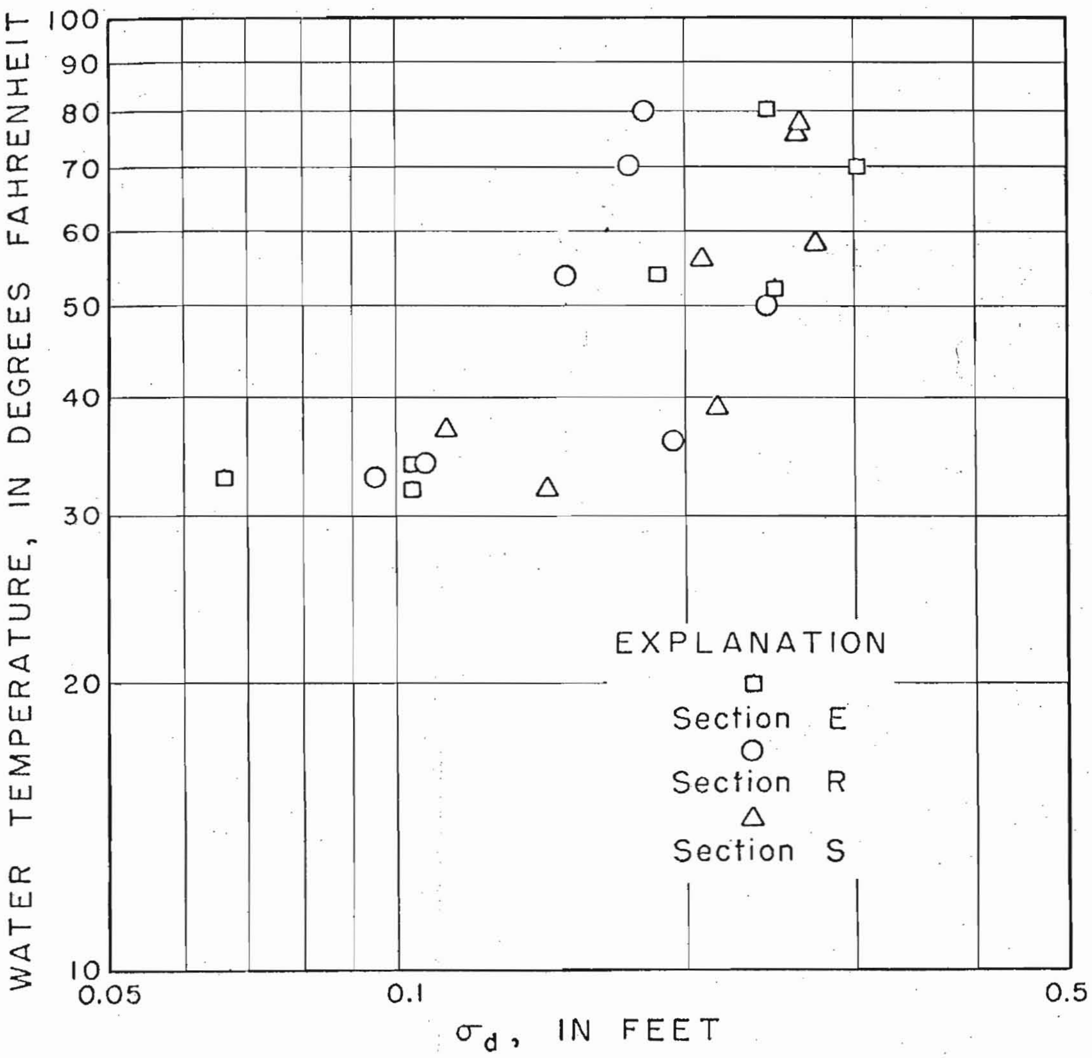

Figure 7.--Variation of σ_d with water temperature.

Computed values of the von Karman coefficient for turbulent exchange, k, also varied during the study. The fluid turbulence, no doubt, was affected by the variation in sediment concentration and form roughness. Several investigators have proposed that k decreases as the sediment concentration increases, and others contend that it does not. The effect of concentration on k for the data in this study is shown in figure 8; the relation is not well

Figure 8.--Relation between measured suspended-sediment concentration and k for individual verticals.

defined. Probably, the apparent variation in k is attributable mainly to the changes in form roughness. This conclusion is based on the fact that, in general, k values for individual verticals were less consistent during October, when the temperatures were about medium, than they were during November, when the temperatures were low. (See table 6.) However, because the velocity-distribution equation may not be exactly suited for flow over dune beds, the significance of k, as computed, is not well understood.

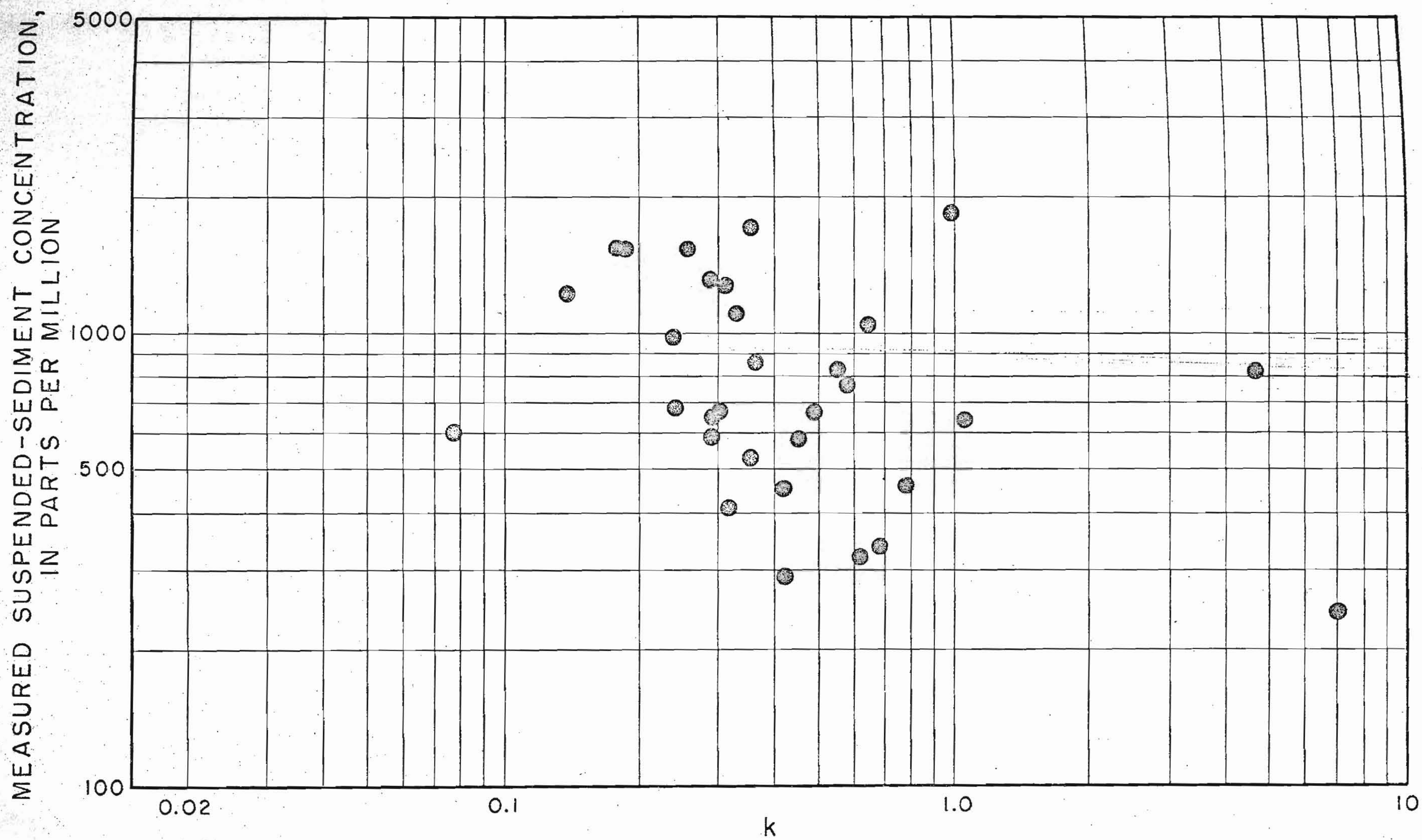

Figure 8.--Relation between measured suspended-sediment concentration and k for individual verticals.

The vertical distribution of suspended sediment also varied with temperature. Figure 9 shows that for a particular size

Figure 9.--Variation of z_1 with fall velocity.

range the concentration gradient flattens (z_1 values increase) as the fall velocity decreases because of a decreasing temperature. The meaning of this graph is not clear because each temperature is associated with particular hydraulic and sedimentation conditions that also affect the vertical distribution of suspended sediment. That is, the velocities, depths, and particularly bed form varied with temperature; thus, the fall velocity was not the only variable.

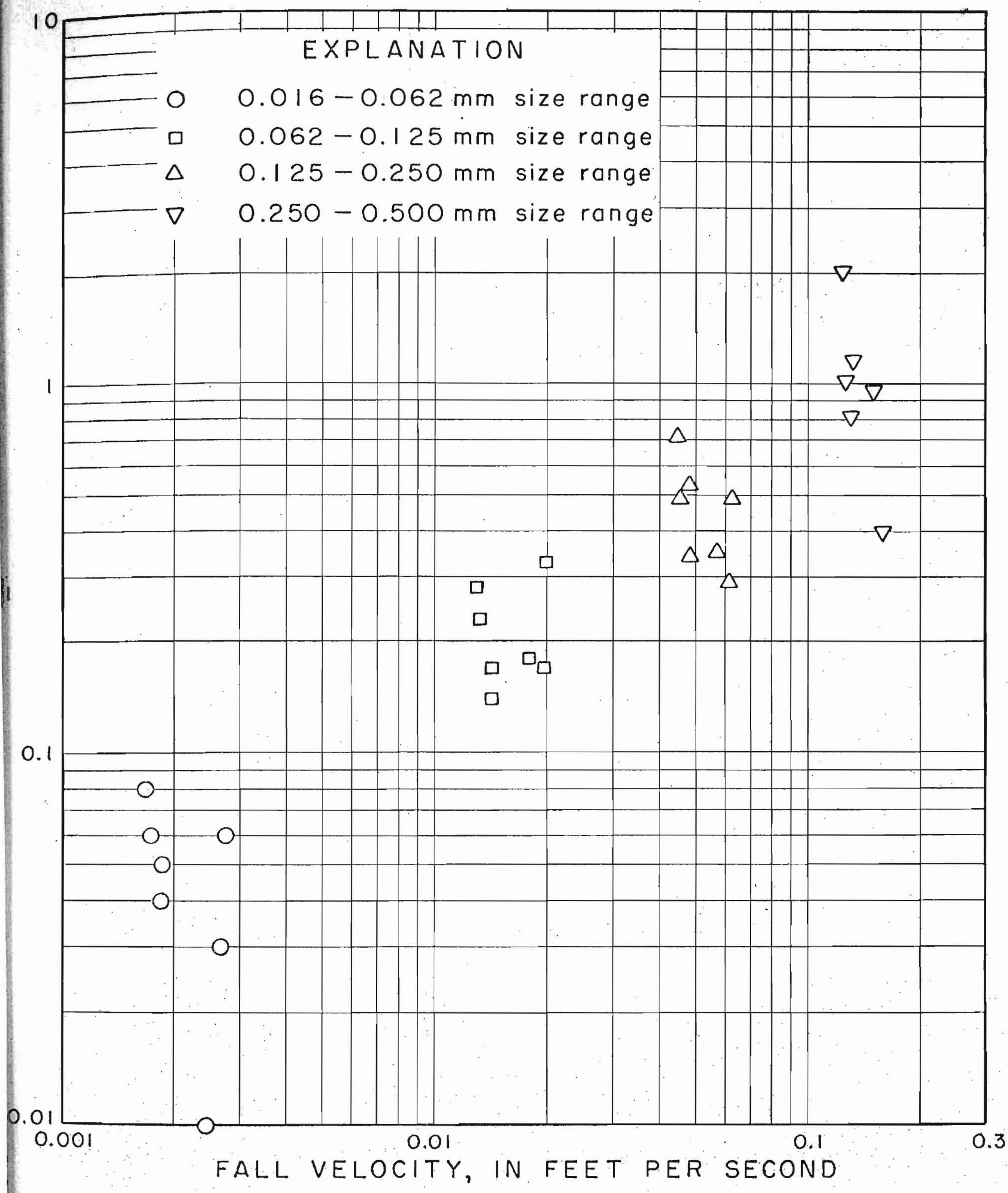

Figure 9.--Variation of z_1 with fall velocity.

Flow resistance at individual sections

During the study, the most evident and continuous changes were those of the resistance coefficients and the sediment discharge. In order to determine the relative effect of temperature and these variables on one another, the data were studied in several different ways. The most satisfactory results were obtained by using dimensional analysis and multiple regression techniques. The assumption was made that for the Middle Loup and Dismal Rivers,

$$d = \phi(W, S, V, k_s, \rho, \nu, V_s, \rho_s, \Delta\gamma) \qquad (1)$$

where--

d is the mean depth

W is the effective width of flow

S is the local water-surface slope

V is the mean velocity

k_s is a roughness diameter and is equal to the particle size of bed material for which 65 percent by weight is finer

ρ is the density of the water-sediment mixture

ν is the kinematic viscosity

V_s is the weighted fall velocity of the total sediment discharge. Values of this parameter were determined by weighting the fall velocity of each particle-size range in transport

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by the fraction that the total sediment discharge of that size range was to the total sediment discharge of all size ranges. For these data, weighting factors were determined from the total sediment discharges that were computed with the modified Einstein procedure

ρ_s is the density of the sediment in transport

$\Delta\gamma$ is the difference in the specific weights of the flow and the atmosphere, respectively

The independent variables that were selected for this analysis are not presumed to be sufficient for all streams. Wash load, for example, is probably an extremely important variable for many streams; however, it was not included because for the Middle Loup and Dismal Rivers it is a very indefinite quantity and depends largely on an arbitrary definition. Table 3 shows that every particle size in transport is present in the bed material at several of the cross sections.

Equation 1 can be written in dimensionless form as

$$\phi_1 (d/W, S, k_s/d, Vd/\nu, V/V_s, \rho/\rho_s, V^2/dg) = 0$$

or

$$\phi_2(W/d, S^2, k_s/d, Vd/\nu, V_s/V, \rho/\rho_s, 2gd/V^2) = 0 \qquad (2)$$

By combining S and $2gd/V^2$ to form a new dimensionless parameter,

$$2\,gd\,S/V^2 = f$$

and by replacing Vd/ν with its equivalent, R_e, the Reynolds number, equation 2 can be written as,

$$f = \phi_3(W/d, S, k_s/d, R_e, V_s/V, \rho/\rho_s) \qquad (3)$$

where f is the Darcy-Wiesbach friction factor when the hydraulic radius (taken as depth) rather than four times the hydraulic radius is substituted for the pipe diameter.

The constants and exponents for equation 3 as derived with multiple regression are given in the following equation

$$f = 664\left[(W/d)^{-0.28}\, S^{0.92} (k_s/d)^{-0.86}\, R_e^{-0.40} (V_s/V)^{1.24}\right]$$

or, if f is replaced by $29.16\, n^2/d^{1/3}$

$$n = 4.77\left[\frac{d^{0.54}\, S^{0.46}\, \nu^{0.20}\, V_s^{0.62}}{W^{0.14}\, k_s^{0.43}\, V^{0.82}}\right]$$

This equation was developed with data from sections E, R, and T (see table 7) by assuming ρ/ρ_s to be constant. Figure 10 shows f

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Figure 10.--Relation between friction factors computed from regression equation and from $2gSd/V^2$.

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from the regression equation plotted against $f = 2gdS/V^2$ for sections E, R, S, and T and for several other river sections. The agreement is considered to be good; standard error of estimate is 0.00284.

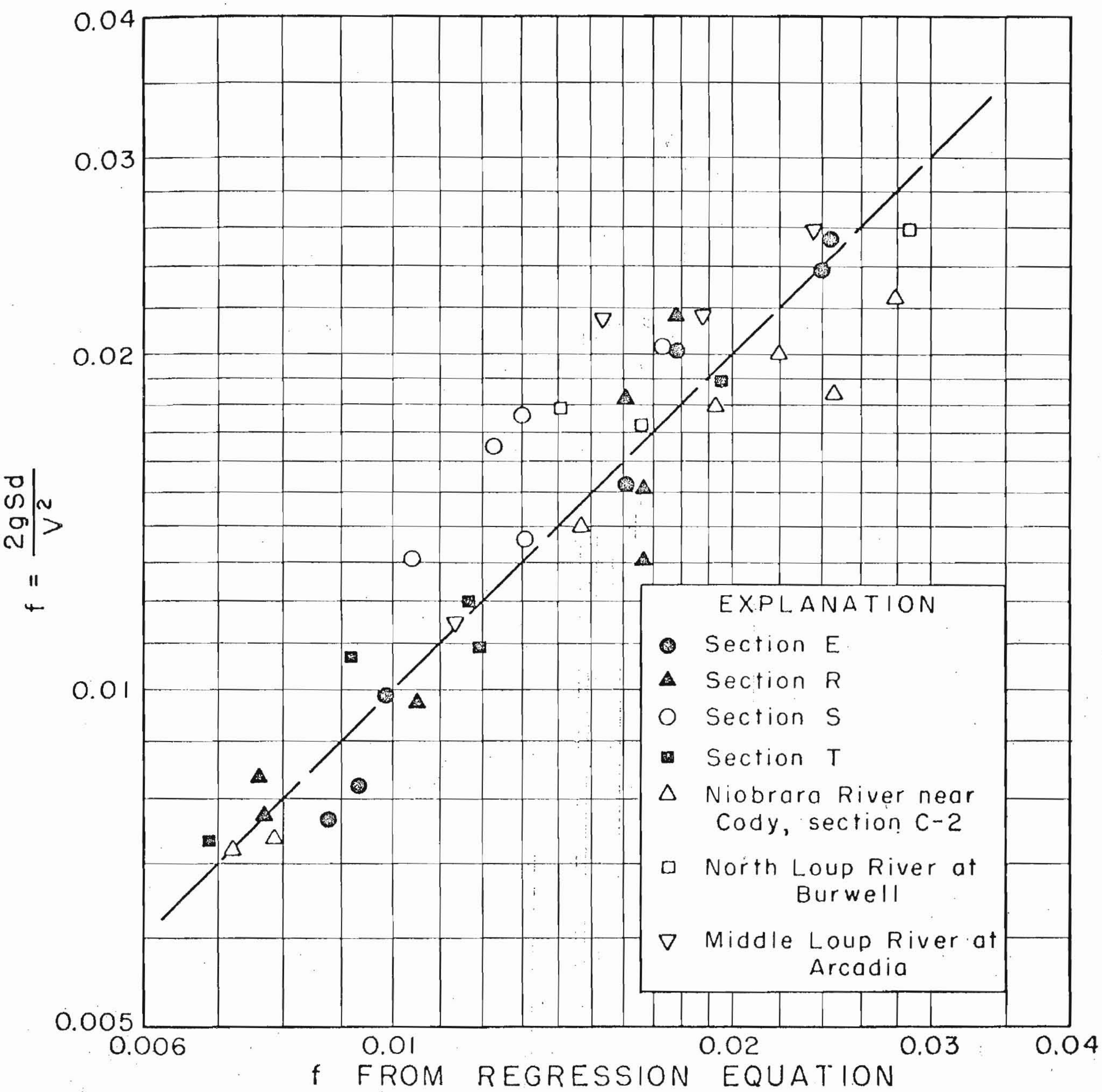

Figure 10. --Relation between friction factors computed from regression equation and from $\frac{2gSd}{V^2}$

The accuracy of the equation is limited by the range of conditions from which the equation was developed; therefore, its use is restricted to streams having little wash load, bed forms that range only from dunes to a plane bed, and bed material and channel geometry similar to Nebraska Sandhill streams. Also, the application of the equation for design purposes is limited because the total sediment discharge must be known in order to compute the parameter V_s/V. V_s was introduced into equation 1 in order to reflect the effect of the total sediment discharge for a given k_s, temperature, and natural sand-size distribution. A more absolute measure of the total sediment discharge was not used because the discharge is a function of many of the same variables as d and, therefore, cannot be considered as any independent variable.

Flow resistance has also been related to CV_s, which is the summation of the products of the total concentration (in parts per million) and the fall velocity (in feet per second) of each size range in transport. This parameter is proportional to an energy exchange per pound of water-sediment mixture. Figure 11 shows

Figure 11.--Variation of the Manning n with CV_s.

CV_s plotted against the Manning n. The relation is not well defined overall; however, the points common to each section produce rather well-defined relations for each section. These relations possibly reflect the effects of sediment movement on flow resistance. However, the relations also may be merely a coincidence; for with these data, high concentrations are always associated with low n values.

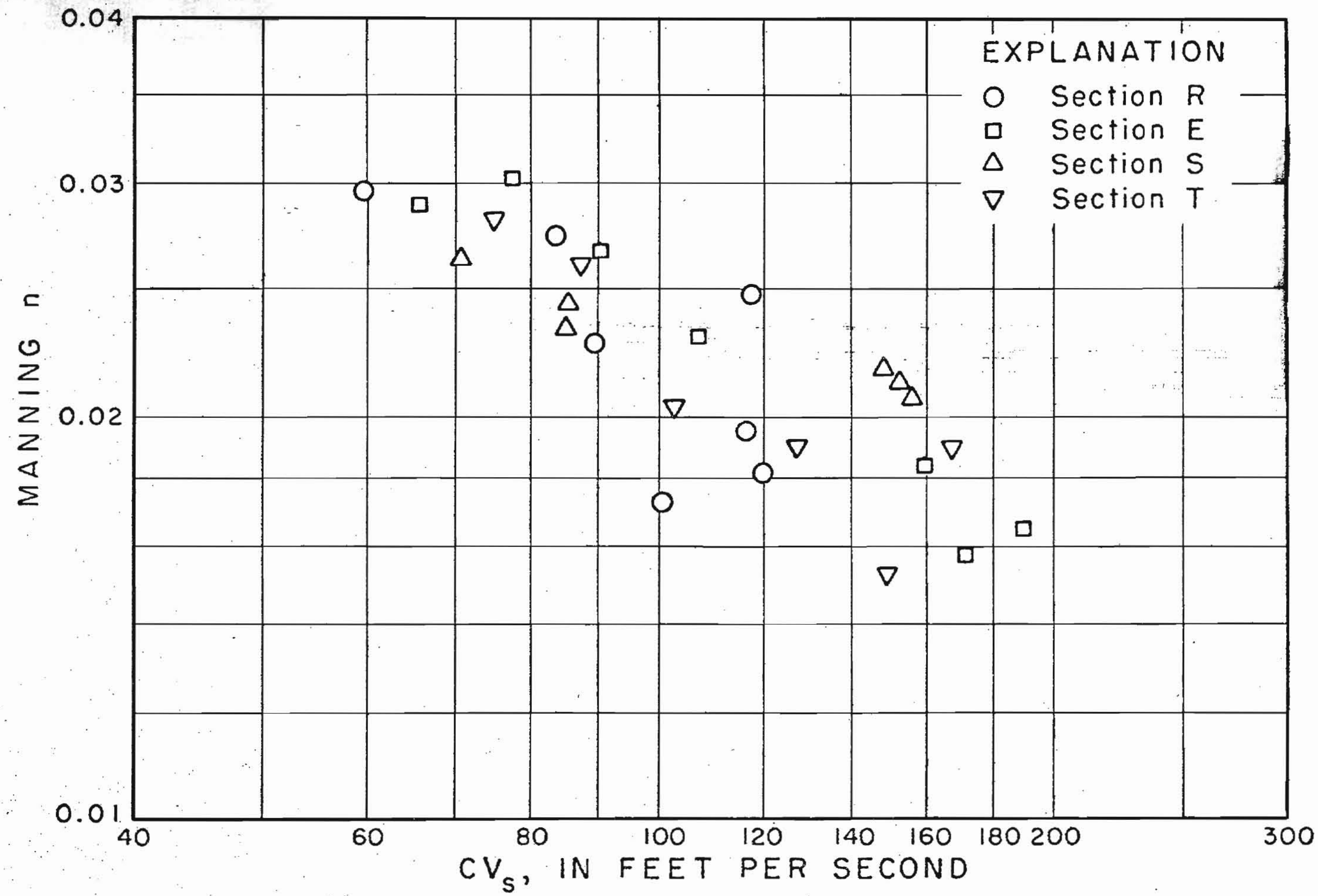

Figure 11.--Variation of the Manning n with CV_s.

Some hydraulic and sediment characteristics upstream and downstream from confluence

The data from this investigation have also been studied to determine some of the hydraulic and sedimentation changes that take place when two relatively common flows unite. The changes in any parameter, of course, are related to the changes in many other parameters; however, the general trends of certain variables, such as slope, width, flow resistance, and concentration, give a conception of the magnitude and direction of the changes.

The water-surface profile on October 4, 1956, for the entire reach is plotted in figure 12. The figure shows that the slope downstream from the confluence is steeper than the slopes upstream from the confluence. The local slopes, which are listed in table 4, show no consistent relation.

Figure 12.--Water-surface slopes on October 4, 1956.

Computations of the changes in width show that the sum of the average widths of the upstream sections is less than the average width of the downstream sections. When the effective widths are considered, the average of widths at sections E and F plus the average of widths at sections R and P are about 65 percent of the average of widths at sections S and T. When the bank-to-bank widths, exclusive of emergent bars, are considered, the percentage is 62.

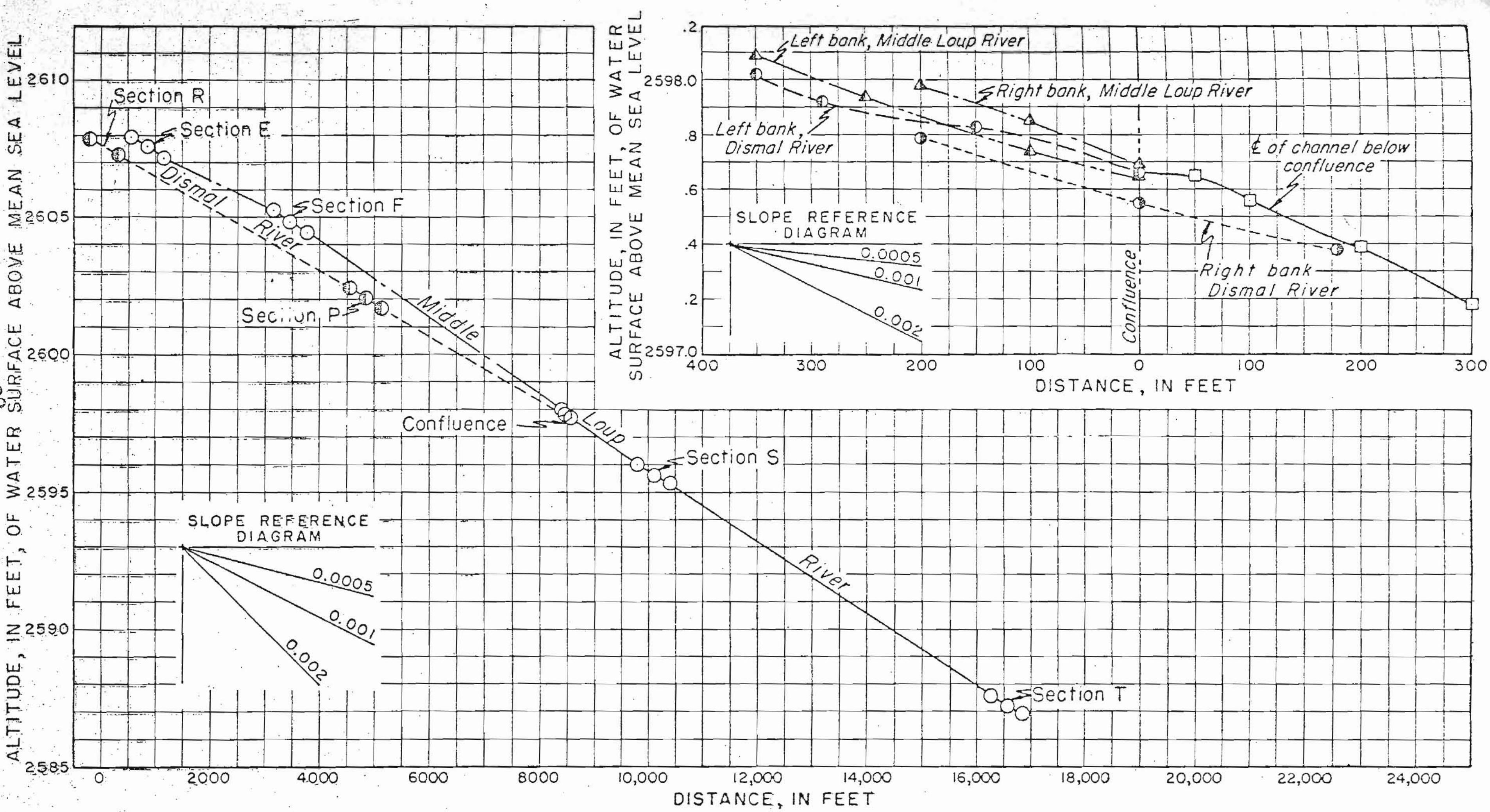

Figure 12.--Water-surface slopes on October 4, 1956.

The differences in flow resistance upstream and downstream from the confluence are diagrammed in figure 13. This figure

Figure 13.--Relation of the Manning n at sections upstream to the Manning n at sections downstream from confluence.

shows that the flow resistance, which is represented by n rather than f, is greater for the upstream sections than it is for the downstream sections but that the difference decreases generally as the flow resistance decreases.

Measured suspended-sediment concentrations are about the same upstream as they are downstream from the confluence. The relation is shown in figure 14, which is a plot of the average of the

Figure 14.--Relation of concentrations at sections upstream to concentrations at sections downstream from the confluence.

measured suspended-sediment concentrations at sections E and R against the average of similar concentrations at sections S and T. The figure also shows that the total concentration is the same upstream as it is downstream from the confluence. The total concentration was determined by dividing the total sediment load (given in table 5) by the product of the total water discharge and an appropriate unit-conversion constant.

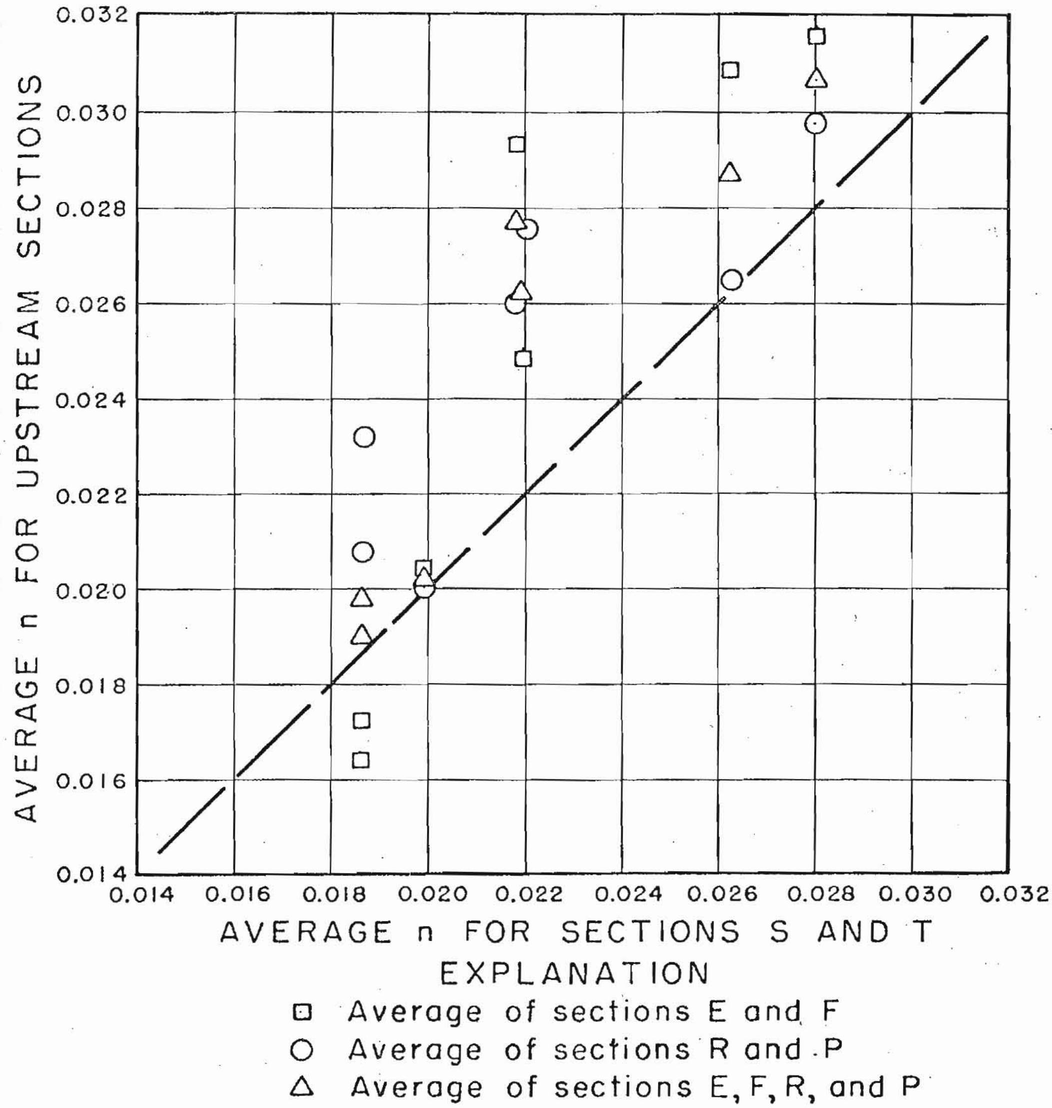

Figure 13.--Relation of the Manning n at sections upstream to the Manning n at sections downstream from confluence.

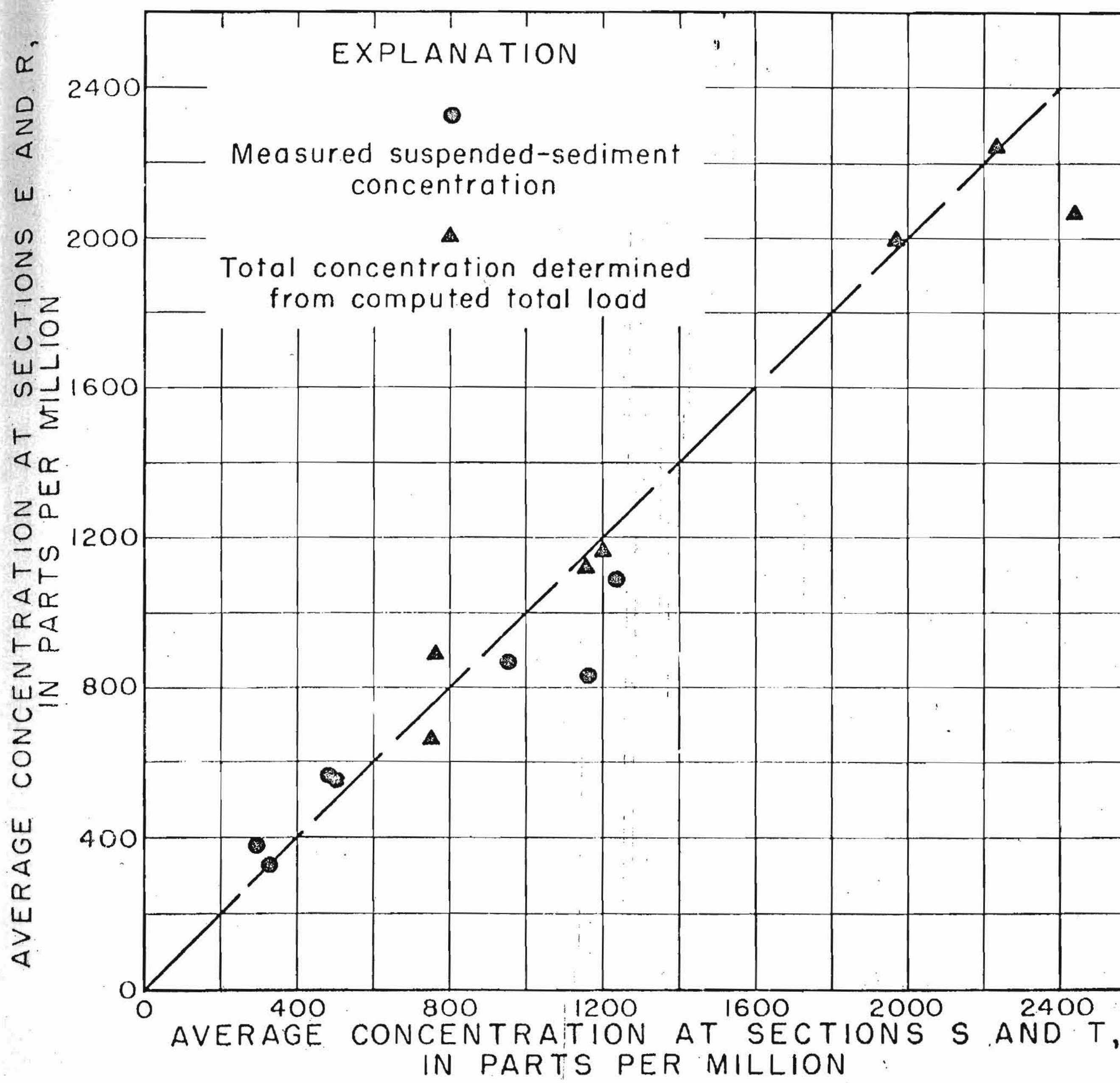

Figure 14. --Relation of concentrations at sections upstream to concentrations at sections downstream from the confluence.

The changes in slope, width, and depth upstream and downstream from the confluence of the Middle Loup and Dismal Rivers appear to be different from those at many other confluences (Miller, 1958). The anomaly may be the result of a difference in bank stability upstream and downstream from the confluence. The banks of both the Middle Loup and Dismal Rivers upstream from the confluence are protected by relatively dense brush; whereas downstream from the confluence, only the left bank is stabilized. Because of the lack of bank protection, the width downstream from the confluence is greater than the sum of the widths upstream from the confluence, and the mean depth and the discharge per foot of width is less; for many other confluences, the discharge per foot of width is greater downstream. Thus, because the flow resistance is relatively constant (the same bed form exists) upstream and downstream, the slope is steeper downstream. If this explanation is correct, then slopes can be controlled by maintaining particular width-depth ratios upstream and downstream from a confluence, provided, of course, the bed form is the same.

Channel geometry

One concept of river morphology is that rivers develop widths, depths, and slopes to accommodate the water and sediment discharges that are imposed on them by their watersheds. Several investigators have described this concept by providing general equations for the widths, depths, and slopes of canals and of average river reaches (Lacey, 1929; Leopold and Maddock, 1953; Blench, 1957). These equations are based on and reflect a condition of equilibrium between the channel geometry and the long-term effects of dominant water and sediment discharges. Consequently, the equations are not applicable for determining the widths, depths, and slopes at individual sections or short reaches of alluvial streams from any instantaneous set of hydraulic and sedimentation conditions that create aggradation or degradation; nor are they applicable if the width, depth, or slope is permanently or temporarily fixed. As a result, the data do not conform to the equations. The nonconformity with the equations is evident from the lack of uniformity of the cross sections of the same stream. (See table 4.)

In contrast, equations that are specifically defined for a given range of conditions can be used for computing the geometry of cross sections where the conditions fall within the defined range. For example, by substituting $2gdS/V^2$ for f, and Q/Wd for V, the regression equation for the friction factor can be transposed and simplified to give a series of equations that define each of the included parameters separately in terms of the others. The equations for width and depth are as follows:

$$W = \left(\frac{664}{2g}\right)^{1.57} \frac{\nu^{0.63}}{S^{0.13}} \frac{V_s^{1.95}}{k_s^{1.35}} \frac{Q^{0.56}}{d^{0.98}}$$

$$d = \left(\frac{664}{2g}\right)^{1.61} \frac{\nu^{0.65}}{S^{0.14}} \frac{V_s^{2.0}}{k_s^{1.39}} \frac{Q^{0.58}}{W^{1.03}}$$

In order to show the use of these equations, the dimensions at several different times have been computed for section C-2, Niobrara River near Cody, Nebr.; the gaging section, North Loup River at Burwell, Nebr.; and section A, Middle Loup River at Dunning, Nebr. The measured-mean depth was used in association with the other measured data when the width was computed, and the measured-effective width was used when the mean depth was computed. The computed dimensions are listed in table 8.

An examination of the width and depth equations shows that if the width factor is transposed in the depth equation, or the depth factor is transposed in the width equation, the resulting product on the left side of the equation will be the area, Wd, times the width or depth to some extremely small exponent. Because the width or depth to a small exponent is always close to one, the product is very nearly equal to the area. Thus, the equations show that the area is approximately a constant for any set of conditions, regardless of the width or depth, and that errors in computed widths or depths actually reflect errors in the computed area. Because the depths are shallow and the widths are wide, the absolute errors in depth usually will be minor, but the absolute errors in width may be rather large. However, the percentage error in depth will be almost identical to that of the width.

Figure 15 shows several of the computed cross sections of

Figure 15.--Several cross sections computed with a variation of the regression equation superimposed on corresponding measured cross sections.

typical accuracy superimposed on the corresponding measured cross sections. These cross sections are based on the computations in which the widths were taken as the measured-effective widths and the mean depths were computed.

The regression equation was derived from data collected at sections that were somewhat stabilized by vegetation. Consequently, computations with any of the possible forms of the equation are valid only if the computations are for sections that are similarly stabilized. In addition, because the data from which the equation was determined reflected instantaneous local conditions, any computed dimensions might be unreliable for expressing the final geometry of a uniform reach.

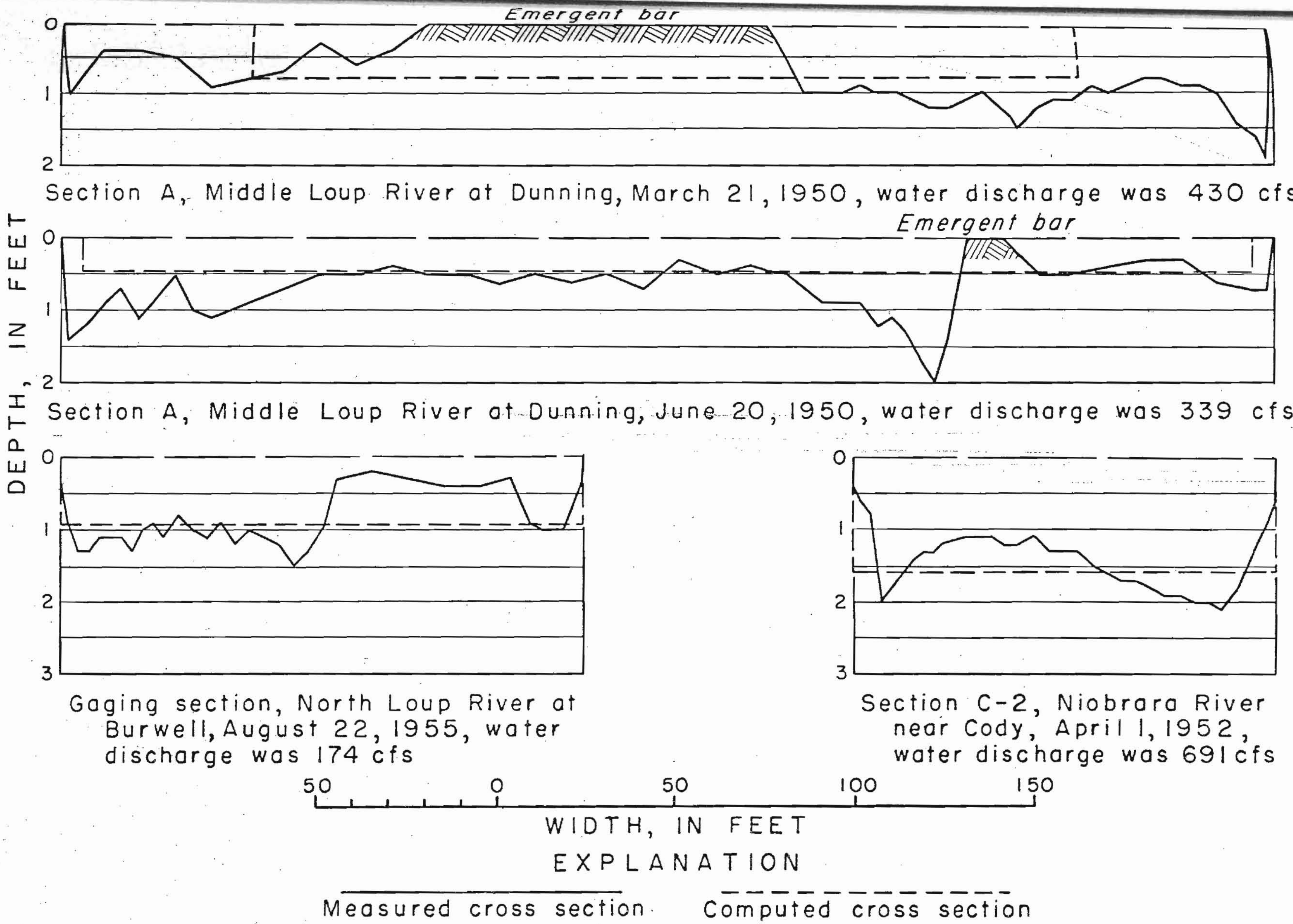

Figure 15.--Several cross sections computed with a variation of the regression equation superimposed on corresponding measured cross sections.

Recommendations

The results of this study indicate that variations in water temperature can affect bed form, sediment discharge, flow resistance, and possibly vertical distributions of suspended sediment and velocity. However, the effect of temperature was determined only for dune and plane bed forms and for bed material having a narrow range of median diameters. Therefore, further studies should be made to determine the effect of temperature on all possible bed forms for a wide range of median sizes of bed material. Basic data for these studies should be obtained at streams having different bed-material size gradations; each stream should have not only a wide variation in water temperature but also flow characteristics that develop all the possible bed forms at each water temperature.

In these studies, the use of recently developed ultrasonic sounders for measuring the bed forms is recommended. Preliminary field studies on bed-load discharge and channel roughness have been made with a precision ultrasonic depth sounder by D. W. Hubbell, C. H. Scott, and J. V. Skinner (written communication); the sounder provided accurate data on the shape and velocity of sand waves.

Because bed form seems to be a dominant factor in sediment transport phenomena, field studies are needed to provide information for determining practical relationships between the bed form and the characteristics of sediment and flow. These relationships are needed for defining stage-discharge and sediment-transport curves and for designing canals, floodways, channel-improvement works, and many other water-control and development projects. Field studies should be made for streams having a wide range of depths, velocities, fine-material loads, temperatures, and bed materials.

The vertical and horizontal distributions of suspended sediment and velocity for the various bed forms need to be studied. Measurements over the crests, troughs, and other parts of the individual bed features will aid in understanding the fundamental mechanics of sediment transportation.

Studies should be made of the sediment discharge in streams during periods of ice cover or during periods of frazil or broken ice. For the studies, basic data should be obtained from streams having wide ranges of sediment and hydraulic characteristics. The results of such studies not only would help to clarify many uncertainties about sediment transport but might also provide information on hydraulic phenomena.

Conclusions

Basic data for this investigation cover a fairly wide range of flow resistances, sediment discharges, and water temperatures and a narrow range of water discharges. These data, which were collected when the bed form was either dunes or a plane bed, show that the small sediment discharges were associated with greater depths, widths, flow resistances, and bed relief, and with lesser velocities and sediment concentrations than the high sediment discharges. The data also show that generally when sediment discharges were small and water temperatures and bed relief were high, the vertical distribution of suspended sediment was the most uniform.

The water temperature was the most important independent variable and probably effected the changes in the hydraulic and sedimentation conditions.

The changes in the boundary configuration were relatively large and were associated with changes in the hydraulic and sedimentation conditions that were caused by the different water temperatures.

The relation between the measured suspended-sediment concentration and the von Karman coefficient for turbulent exchange was not well defined. Probably, the coefficient was affected mostly by the changes in form roughness.

The flow resistances of several different Sandhill streams can be related to channel geometry, some characteristics of the sediment and flow, and total sediment discharge by the regression equation

$$f = 664\left(\frac{W}{d}\right)^{-0.28} S^{0.92}\left(\frac{k_s}{d}\right)^{-0.86} R_e^{-0.40}\left(\frac{V_s}{V}\right)^{1.24}$$

The flow resistances at sections E, R, S, and T can also be related to CV_s, which is a summation of the products of the total concentration and fall velocity of each particle size in transport; however, the relation may be only a peculiarity of the data because small flow resistances were always associated with large sediment concentrations.

The water-surface slopes of both the Middle Loup and Dismal Rivers upstream from their confluence are flatter than the slope downstream. Also, the average n values for the upstream sections were greater than the average n values for the downstream sections, the sum of average widths for the upstream sections was about 65 percent of the average widths for the downstream sections, and the measured suspended-sediment and total concentrations at the upstream sections were about the same as those at the downstream sections.

The widths, depths, and slopes of the individual cross sections that were studied cannot be predicted from river-morphology equations based on an equilibrium condition between channel geometry and long-term effects of dominant discharges because the channel geometry varied radically from section to section on the same stream. The regression equation for the friction factor can be arranged to give the width and depth for given conditions; however, the computed dimensions might be unreliable for expressing the final geometry of a uniform reach.

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TABLES

Table 1.--Particle-size analyses of suspended sediment, depth-integrated samples, Middle Loup and Dismal Rivers near Dunning, Nebr.

[Method of analysis, visual accumulation tube]

Date	Time	Water temperature (°F)	Measured discharge (cfs)	Suspended sediment								Remarks
				Concentration (ppm)	Suspended-sediment discharge (tons per day)	Percent finer than indicated size, in millimeters						
						0.062	0.125	0.250	0.500	1.000	2.000	
Section D												
Aug. 6, 1956....	4:20 p.m.	80	337	516	470	17	35	70	91	100	.....	ETR.
Aug. 7..........	9:40 a.m.	69	370	711	710	12	30	70	90	99	100	ETR.
Oct. 3..........	8:57 a.m.	54	375	876	887	6	29	69	92	99	100	ETR.
Oct. 4..........	8:28 a.m.	52	384	998	1,030	4	28	68	91	96	100	ETR.
Nov. 28.........	2:45 p.m.	...32..	395	2,190	2,340	4	22	65	88	98	100	ETR.
	4:30 p.m.	....	....	1,660	....	5	24	69	90	98	100	ETR.
Nov. 29.........	11:00 a.m.	....	416	2,560	2,880	4	19	67	94	99	100	ETR.
Nov. 30.........	9:35 a.m.	...34..	391	1,980	2,090	5	24	65	91	97	98	ETR.
Section E												
Aug. 6, 1956....	4:22 p.m.	80	337	253	230	26	54	93	100	.....	.....	ETR.
Aug. 7..........	9:38 a.m.	70	370	341	341	25	55	94	100	.....	.....	ETR.
Oct. 3..........	8:38 a.m.	54	375	469	475	12	46	85	99	100	.....	ETR.
Oct. 4..........	8:20 a.m.	52	....	472	....	10	49	93	100	.....	.....	ETR, stas. 15 to 80 and 137½ to 176
	8:20 a.m.	52	....	367	....	15	58	100	.....	.....	.....	ETR, stas. 82½ to 135.
	8:20 a.m.	52	384	471	488	10	49	93	100	.....	.....	Stas. 15 to 176½.
Nov. 28.........	2:50 p.m.	32	395	812	866	12	50	95	100	.....	.....	ETR.
Nov. 29.........	11:35 a.m.	33	416	958	1,080	13	50	95	100	.....	.....	ETR.
	12:00 m.	33	....	380	....	35	76	98	100	.....	.....	Sta. 62.
	12:10 p.m.	33	....	859	....	15	56	100	.....	.....	.....	Sta. 93.
	12:20 p.m.	33	....	1,530	....	9	43	98	100	.....	.....	Sta. 118.
	12:30 p.m.	33	....	1,510	....	11	41	94	100	.....	.....	Sta. 135.
	12:40 p.m.	33	....	1,520	....	11	42	90	100	.....	.....	Sta. 150.
Nov. 30.........	9:40 a.m.	34	391	875	924	10	52	95	100	.....	.....	ETR.
Section R												
Aug. 6, 1956....	4:50 p.m.	...80..	294	401	318	35	63	95	100	.....	.....	ETR.
Aug. 7..........	10:40 a.m.	70	335	417	377	26	60	93	100	.....	.....	ETR.
Oct. 3..........	8:50 a.m.	a 54	314	648	549	14	59	95	100	.....	.....	ETR.
	10:20 a.m.	57	....	334	....	22	66	98	100	.....	.....	Sta. 10.
	10:05 a.m.	a 55	....	580	....	16	64	99	100	.....	.....	Sta. 24.
	9:50 a.m.	a 55	....	653	....	16	64	100	.....	.....	.....	Sta. 39.
	....	......	....	640	....	17	59	99	100	.....	.....	Sta. 52.
	....	......	....	456	....	24	66	99	100	.....	.....	Sta. 65.

See footnotes at end of table.

Table 1.--Particle-size analyses of suspended sediment, depth-integrated samples, Middle Loup and Dismal Rivers near Dunning, Nebr.--Continued

Date	Time	Water temperature (°F)	Measured discharge (cfs)	Suspended sediment: Concentration (ppm)	Suspended sediment: Suspended-sediment discharge (tons per day)	Percent finer than indicated size, in millimeters: 0.062	0.125	0.250	0.500	1.000	2.000	Remarks
Section R--Continued												
Oct. 4, 1956....	8:20 a.m.	50	321	657	569	8	48	90	100	.....	.....	ETR.
Nov. 28........	2:40 p.m.	a 33	320	861	744	18	57	96	100	.....	.....	ETR.
Nov. 29........	11:35 a.m.	34	330	1,220	1,090	20	57	94	100	.....	.....	ETR.
	1:20 p.m.	a 35	....	1,060	....	20	56	93	100	.....	.....	Sta. 12.
	1:10 p.m.	a 35	....	673	....	30	70	99	100	.....	.....	Sta. 28.
	1:00 p.m.	a 35	....	1,310	....	18	52	99	100	.....	.....	Sta. 43.
	12:50 p.m.	a 35	....	1,280	....	18	56	100	.....	.....	.....	Sta. 54.
	12:25 p.m.	a 34	....	834	....	27	67	98	100	.....	.....	Sta. 64.
Nov. 30........	9:10 a.m.	36	331	848	758	14	48	96	100	.....	.....	ETR.
Section S												
Aug. 6, 1956 b/.	7:00 p.m.	77	645	673	1,170	12	25	49	77	96	100	ETR.
Aug. 7..........	11:48 a.m.	75	....	322	....	28	61	91	100	.....	.....	ETR, stas. 10 to 140.
	11:48 a.m.	75	....	317	....	27	56	96	100	.....	.....	ETR, stas. 150 to 260.
	11:48 a.m.	75	....	199	....	40	62	92	100	.....	.....	ETR, stas. 270 to 300.
	11:48 a.m.	75	....	130	....	64	87	100	.....	.....	.....	ETR, stas. 310 to 390.
	11:48 a.m.	75	719	276	536	31	60	94	100	.....	.....	Stas. 10 to 390.
Oct. 3..........	11:45 a.m.	a 61	724	388	758	18	56	95	100	.....	.....	ETR.
	1:48 p.m.	64	....	457	....	16	59	100	.....	.....	.....	Sta. 190.
	1:29 p.m.	a 63	....	321	....	21	55	99	100	.....	.....	Sta. 230.
	1:17 p.m.	62	....	813	....	11	43	99	100	.....	.....	Sta. 295.
	1:02 p.m.	62	....	601	....	13	41	85	98	100	.....	Sta. 365.
Oct. 4..........	10:55 a.m.	55	662	452	808	15	46	92	100	.....	.....	ETR.
Nov. 28........	5:00 p.m.	32	....	1,340	....	8	34	92	100	.....	.....	ETR no. 1, stas. 5 to 85.
	5:00 p.m.	32	....	1,330	....	8	30	90	100	.....	.....	ETR no. 2, stas. 5 to 85.
	5:00 p.m.	32	....	1,340	....	8	32	91	100	.....	.....	Stas. 5 to 85.
	5:00 p.m.	32	....	1,230	....	11	44	97	100	.....	.....	ETR no. 1, stas. 325 to 390.
	5:00 p.m.	32	....	970	....	13	42	92	100	.....	.....	ETR no. 2, stas. 325 to 390.
	5:00 p.m.	32	....	1,100	....	12	43	94	100	.....	.....	Stas. 325 to 390.
	5:00 p.m.	32	705	1,150	2,190	11	40	94	100	.....	.....	Stas. 5 to 85 and 325 to 390.
Nov. 29........	3:40 p.m.	37	....	1,190	....	13	45	91	100	.....	.....	ETR, stas. 5 to 85.

See footnotes at end of table.

Table 1.--Particle-size analyses of suspended sediment, depth-integrated samples, Middle Loup and Dismal Rivers near Dunning, Nebr.--Continued

Date	Time	Water temper-ature (°F)	Measured discharge (cfs)	Suspended sediment								Remarks
				Concen-tration (ppm)	Suspended-sediment discharge (tons per day)	Percent finer than indicated size, in millimeters						
						0.062	0.125	0.250	0.500	1.000	2.000	
Section S--Continued												
Nov. 29, 1956...	3:40 p.m.	37	....	1,080	....	14	43	88	100	.....	.....	ETR, stas. 325 to 390.
	3:40 p.m.	37	773	1,070	2,230	14	44	89	100	.....	.....	Stas. 5 to 85 and 325 to 390.
	4:35 p.m.	41	....	1,860	....	9	36	94	100	.....	.....	Sta. 23.
	4:50 p.m.	a 38	....	680	....	23	66	100	.....	.....	.....	Sta. 77.
	5:00 p.m.	a 38	....	1,020	....	13	39	88	100	.....	.....	Sta. 348.
	5:20 p.m.	a 38	....	1,110	....	12	38	94	100	.....	.....	Sta. 365.
	5:30 p.m.	a 38	....	667	....	21	53	87	100	.....	.....	Sta. 379.
Nov. 30.........	11:45 a.m.	39	....	860	....	12	42	95	100	.....	.....	ETR, stas. 5 to 85.
	11:45 a.m.	39	....	932	....	14	48	89	100	.....	.....	ETR, stas. 320 to 390.
	11:45 a.m.	39	738	872	1,740	13	46	91	100	.....	.....	Stas. 5 to 85 and 320 to 390.
Section T												
Aug. 6, 1956....	7:40 p.m.	74	....	149	....	75	100	.....	.....	.....	.....	ETR, stas. 5 to 70.
	7:40 p.m.	74	....	346	....	24	51	87	100	.....	.....	ETR, stas. 75 to 190.
	7:40 p.m.	74	....	330	....	33	62	95	100	.....	.....	ETR, stas. 195 to 330.
	7:40 p.m.	74	696	329	618	29	56	90	100	.....	.....	Stas. 5 to 330.
Aug. 7.........	1:00 p.m.	80	....	178	....	48	78	100	.....	.....	.....	ETR, stas. 5 to 75.
	1:00 p.m.	80	....	309	....	27	57	93	100	.....	.....	ETR, stas. 80 to 180.
	1:00 p.m.	80	....	350	....	30	61	96	100	.....	.....	ETR, stas. 185 to 330.
	1:00 p.m.	80	674	316	575	29	59	94	100	.....	.....	Stas. 5 to 330.
Oct. 3.........	9:50 a.m.	56	....	606	....	5	36	94	100	.....	.....	ETR, stas. 5 to 110.
	9:50 a.m.	56	....	598	....	10	29	72	95	100	.....	ETR, stas. 150 to 330.
	9:50 a.m.	56	746	602	1,210	7	33	85	98	100	.....	Stas. 5 to 110 and 150 to 330.
	11:50 a.m.	61	....	770	....	12	34	91	100	.....	.....	Sta. 16.
	12:00 m.	61	....	587	....	14	45	97	100	.....	.....	Sta. 37.
	12:10 p.m.	61	....	411	....	18	52	98	100	.....	.....	Sta. 64.
	12:20 p.m.	a 62	....	290	....	28	63	100	.....	.....	.....	Sta. 250.
	12:30 p.m.	a 62	....	530	....	17	51	99	100	.....	.....	Sta. 296.
Oct. 4.........	10:00 a.m.	54	....	388	....	19	54	95	100	.....	.....	ETR, stas. 5 to 110 and 140 to 180.
	10:00 a.m.	54	....	581	....	12	43	91	100	.....	.....	ETR, stas. 225 to 330.
	10:00 a.m.	54	737	507	1,010	14	46	92	100	.....	.....	Stas. 5 to 110, 140 to 180 and 225 to 330.

See footnotes at end of table.

Table 1.--Particle-size analyses of suspended sediment, depth-integrated samples, Middle Loup and Dismal Rivers near Dunning, Nebr.--Continued

Date	Time	Water temper-ature (°F)	Measured discharge (cfs)	Suspended sediment								Remarks
				Concen-tration (ppm)	Suspended-sediment discharge (tons per day)	Percent finer than indicated size, in millimeters						
						0.062	0.125	0.250	0.500	1.000	2.000	
Section T--Continued												
Nov. 28, 1956...	4:35 p.m.	32	....	1,290	....	9	37	90	100	.....	.....	ETR, stas. 6 to 146.
	4:35 p.m.	32	....	606	....	28	68	98	100	.....	.....	ETR, stas. 156 to 330.
	4:35 p.m.	32	....	1,170	....	11	40	91	100	.....	.....	Stas. 6 to 330.
Nov. 29.........	3:40 p.m.	a 38	....	1,730	....	10	38	82	97	100	.....	ETR no. 1, stas. 6 to 66 and 110 to 160.
	3:40 p.m.	a 38	....	1,350	....	12	39	78	99	100	.....	ETR no. 2, stas. 6 to 66 and 110 to 160.
	3:40 p.m.	a 38	....	1,540	....	11	38	80	98	100	.....	Stas. 6 to 66 and 110 to 160.
	3:40 p.m.	a 38	....	6,820	....	2	7	24	90	100	.....	ETR no. 1, stas. 76 to 98.
	3:40 p.m.	a 38	....	7,160	....	2	27	85	100	.....	.....	ETR no. 2, stas. 76 to 98.
	3:40 p.m.	a 38	....	6,990	....	2	17	54	95	100	.....	Stas. 76 to 98.
	3:40 p.m.	a 38	....	917	....	38	79	100	.....	.....	.....	ETR no. 1, stas. 180 to 330.
	3:40 p.m.	a 38	....	1,070	....	42	79	100	.....	.....	.....	ETR no. 2, stas. 180 to 330.
	3:40 p.m.	a 38	....	994	....	40	79	100	.....	.....	.....	Stas. 180 to 330.
	3:40 p.m.	a 38	821	1,400	3,100	16	46	84	98	100	.....	Stas. 6 to 66, 110 to 160, and 180 to 330.
	5:45 p.m.	a 37	....	1,410	....	13	40	90	100	.....	.....	Sta. 17.
	5:40 p.m.	a 37	....	1,710	....	9	33	84	100	.....	.....	Sta. 44.
	....	......	....	1,220	....	12	38	86	98	100	.....	Sta. 71.
	....	......	....	977	....	15	47	94	100	.....	.....	Sta. 101.
	5:10 p.m.	38	....	246	....	54	80	100	.....	.....	.....	Sta. 200.
Nov. 30.........	10:45 a.m.	36	....	974	....	10	43	86	100	.....	.....	ETR, stas. 6 to 106.
	10:45 a.m.	36	....	1,340	....	18	67	100	.....	.....	.....	ETR, stas. 116 to 330.
	10:45 a.m.	36	700	1,030	1,950	12	48	89	100	.....	.....	Stas. 6 to 330.

a Estimated.

b Sample probably contains bed material.

Table 2.—Particle-size analyses of suspended sediment, point-integrated samples, Middle Loup and Dismal Rivers near Dunning, Nebr.
[Duplicate samples collected with DH-48 sediment sampler having 3/16-in. nozzle. Method of analysis, visual accumulation tube]

Date	Time	Water temper-ature (°F)	Measured discharge[1] (cfs)	Sampling station	Total depth (ft)	Suspended sediment								
						Sampling point				Percent finer than indicated size, in millimeters				
						Velocity[2] (ft/sec)	Nozzle velocity[3] (ft/sec)	Depth (ft)	Concen-tration (ppm)	0.062	0.125	0.250	0.500	1.000
						Section E								
Nov. 29, 1956..	12:00 m.	33	416	62	0.6	1.35	1.67	0.1	280	43	85	100	......	......
	12:00 m.	33	416	62	.6	1.48	1.54	.2	330	36	81	100	......	......
	12:00 m.	33	416	62	.6	.44	1.48	.3	404	28	67	98	100	......
	12:10 p.m.	33	416	93	1.1	3.65	3.12	.3	601	21	66	100	......	......
	12:10 p.m.	33	416	93	1.1	3.54	3.18	.5	876	15	58	100	......	......
	12:10 p.m.	33	416	93	1.1	3.40	2.71	.6	963	15	56	100	......	......
	12:10 p.m.	33	416	93	1.1	3.13	2.68	.8	1,610	10	43	98	100	......
	12:20 p.m.	33	416	118	1.1	3.89	3.11	.3	1,310	11	51	100	......	......
	12:20 p.m.	33	416	118	1.1	3.43	2.98	.5	1,750	10	48	99	100	......
	12:20 p.m.	33	416	118	1.1	3.13	2.33	.7	2,610	7	35	96	100	......
	12:20 p.m.	33	416	118	1.1	2.77	2.25	.8	3,510	4	29	93	100	......
	12:30 p.m.	33	416	135	1.0	4.65	4.10	.3	1,040	18	55	100	......	......
	12:30 p.m.	33	416	135	1.0	4.37	2.99	.5	1,400	12	45	94	100	......
	12:30 p.m.	33	416	135	1.0	4.16	3.54	.6	2,000	8	39	91	100	......
	12:30 p.m.	33	416	135	1.0	3.94	3.33	.7	2,750	6	32	88	100	......
	12:40 p.m.	33	416	150	1.4	5.02	3.83	.3	987	19	59	100	......	......
	12:40 p.m.	33	416	150	1.4	4.75	3.51	.6	1,310	12	51	97	100	......
	12:40 p.m.	33	416	150	1.4	4.37	3.72	.9	1,780	10	40	94	100	......
	12:40 p.m.	33	416	150	1.4	3.89	2.81	1.1	4,540	4	20	74	100	......
						Section R								
Oct. 3, 1956...	10:24 a.m.	57	314	10	2.6	2.77	3.95	0.3	286	35	79	100	......	......
	10:24 a.m.	57	314	10	2.6	2.89	3.69	1.0	322	30	72	99	100	......
	10:24 a.m.	57	314	10	2.6	2.71	3.21	1.7	423	23	63	92	100	......
	10:24 a.m.	57	314	10	2.6	1.98	2.77	2.3	697	15	49	81	100	......
	10:06 a.m.	[4] 55	314	24	1.1	3.34	5.19	.3	482	22	65	100	......	......
	10:06 a.m.	[4] 55	314	24	1.1	3.34	5.27	.5	618	18	65	100	......	......
	10:06 a.m.	[4] 55	314	24	1.1	3.16	5.24	.7	701	16	59	99	100	......
	10:06 a.m.	[4] 55	314	24	1.1	2.95	5.27	.8	720	14	56	99	100	......
	9:50 a.m.	[4] 55	314	39	1.8	3.40	5.33	.3	357	30	77	100	......	......
	9:50 a.m.	[4] 55	314	39	1.8	3.32	5.19	.7	556	20	71	100	......	......
	9:50 a.m.	[4] 55	314	39	1.8	2.64	4.93	1.1	753	16	65	100	......	......
	9:50 a.m.	[4] 55	314	39	1.8	2.23	4.63	1.5	1,160	10	57	99	100	......

See footnotes at end of table.

Table 2.—Particle-size analyses of suspended sediment, point-integrated samples, Middle Loup and Dismal Rivers near Dunning, Nebr.—Continued
[Duplicate samples collected with DH-48 sediment sampler having 3/16-in. nozzle. Method of analysis, visual accumulation tube]

Date	Time	Water temper-ature (°F)	Measured discharge[1] (cfs)	Sampling station	Total depth (ft)	Suspended sediment: Sampling point: Velocity[2] (ft/sec)	Nozzle velocity[3] (ft/sec)	Depth (ft)	Concen-tration (ppm)	Percent finer than indicated size, in millimeters: 0.062	0.125	0.250	0.500	1.000
Section R—Continued														
Oct. 3, 1956...	....	....	314	52	1.5	3.46	5.44	0.3	587	17	59	98	100	.....
	....	....	314	52	1.5	3.40	5.64	.6	683	15	55	97	100	.....
	....	....	314	52	1.5	3.32	5.63	.9	922	11	49	96	100	.....
	....	....	314	52	1.5	3.16	5.75	1.2	987	10	47	97	100	.....
	....	....	314	65	2.6	3.16	3.69	.3	312	32	76	100	......	.....
	....	....	314	65	2.6	3.34	3.70	1.0	446	24	67	99	100	.....
	....	....	314	65	2.6	3.02	3.96	1.7	448	24	68	99	100	.....
	....	....	314	65	2.6	1.63	3.88	2.3	850	12	44	95	100	.....
Nov. 29........	1:20 p.m.	4/ 35	330	12	2.0	2.67	2.63	.3	706	26	65	96	100	.....
	1:20 p.m.	4/ 35	330	12	2.0	2.71	2.29	.7	860	21	56	93	100	.....
	1:20 p.m.	4/ 35	330	12	2.0	2.59	2.63	1.2	1,180	16	45	90	100	.....
	1:20 p.m.	4/ 35	330	12	2.0	2.24	2.14	1.6	1,750	11	36	88	100	.....
	1:10 p.m.	4/ 35	330	28	1.1	4.10	3.32	.2	584	32	73	100	......	.....
	1:10 p.m.	4/ 35	330	28	1.1	4.01	3.70	.5	802	25	63	99	100	.....
	1:10 p.m.	4/ 35	330	28	1.1	3.54	3.21	.8	1,340	17	49	97	100	.....
	1:00 p.m.	4/ 35	330	43	1.5	4.59	3.94	.3	921	20	60	100	......	.....
	1:00 p.m.	4/ 35	330	43	1.5	4.59	3.82	.6	1,340	17	51	99	100	.....
	1:00 p.m.	4/ 35	330	43	1.5	4.01	3.83	.9	1,700	14	44	97	100	.....
	1:00 p.m.	4/ 35	330	43	1.5	3.68	3.35	1.2	2,460	10	37	93	100	.....
	12:50 p.m.	4/ 35	330	54	1.5	4.49	4.25	.3	645	32	75	100	......	.....
	12:50 p.m.	4/ 35	330	54	1.5	4.40	4.13	.6	969	23	67	100	......	.....
	12:50 p.m.	4/ 35	330	54	1.5	4.10	2.85	.9	1,560	16	51	100	......	.....
	12:50 p.m.	4/ 35	330	54	1.5	3.61	3.17	1.2	2,510	9	40	99	100	.....
	12:25 p.m.	4/ 34	330	64	1.9	3.68	2.68	.3	511	42	80	100	......	.....
	12:25 p.m.	4/ 34	330	64	1.9	3.47	2.94	.7	698	31	72	100	......	.....
	12:25 p.m.	4/ 34	330	64	1.9	3.24	2.71	1.2	1,020	22	62	98	100	.....
	12:25 p.m.	4/ 34	330	64	1.9	2.96	2.49	1.6	1,150	21	59	96	100	.....

See footnotes at end of table.

Table 2.--Particle-size analyses of suspended sediment, point-integrated samples, Middle Loup and Dismal Rivers near Dunning, Nebr.--Continued

[Duplicate samples collected with DH-48 sediment sampler having 3/16-in. nozzle. Method of analysis, visual accumulation tube]

Date	Time	Water temperature (°F)	Measured discharge[1] (cfs)	Sampling station	Total depth (ft)	Suspended sediment: Sampling point: Velocity[2] (ft/sec)	Nozzle velocity[3] (ft/sec)	Depth (ft)	Concentration (ppm)	Percent finer than indicated size, in millimeters: 0.062	0.125	0.250	0.500	1.000
Section S														
Oct. 3, 1956...	1:46 p.m.	64	724	190	0.9	2.88	2.57	0.2	317	21	68	100	......	......
	1:46 p.m.	64	724	190	.9	3.01	3.09	.4	446	17	62	100	......	......
	1:46 p.m.	64	724	190	.9	2.82	2.68	.6	726	10	50	99	100	......
	1:29 p.m.	4/ 63	724	230	1.1	....	2.49	.2	186	32	64	100	......	......
	1:29 p.m.	4/ 63	724	230	1.1	2.16	2.59	.4	287	22	59	100	......	......
	1:29 p.m.	4/ 63	724	230	1.1	2.06	2.36	.6	323	19	56	100	......	......
	1:29 p.m.	4/ 63	724	230	1.1	....	2.19	.8	386	20	55	99	100	......
	1:14 p.m.	62	724	295	2.2	1.89	2.24	.3	338	24	59	100	......	......
	1:14 p.m.	62	724	295	2.2	....	2.01	.6	488	16	53	100	......	......
	1:14 p.m.	62	724	295	2.2	....	2.17	1.0	694	12	44	100	......	......
	1:14 p.m.	62	724	295	2.2	....	1.78	1.5	782	11	43	100	......	......
	1:14 p.m.	62	724	295	2.2	1.77	1.76	1.9	1,170	9	38	99	100	......
	1:02 p.m.	62	724	365	1.2	....	2.65	.3	427	21	62	100	......	......
	1:02 p.m.	62	724	365	1.2	2.63	2.84	.5	292	27	68	100	......	......
	1:02 p.m.	62	724	365	1.2	1.67	2.71	.7	287	29	68	100	......	......
	1:02 p.m.	62	724	365	1.2	....	2.24	1.0	198	38	75	95	100	......
Nov. 29........	4:35 p.m.	41	773	23	1.1	2.89	2.35	.3	1,750	8	35	95	100	......
	4:35 p.m.	41	773	23	1.1	2.86	2.50	.6	2,120	6	40	93	100	......
	4:35 p.m.	41	773	23	1.1	2.71	2.63	.8	2,220	5	28	89	100	......
	4:50 p.m.	4/ 38	773	77	1.0	2.15	1.81	.3	503	30	72	100	......	......
	4:50 p.m.	4/ 38	773	77	1.0	2.12	1.87	.5	666	24	68	100	......	......
	4:50 p.m.	4/ 38	773	77	1.0	2.00	1.80	.6	774	21	64	100	......	......
	4:50 p.m.	4/ 38	773	77	1.0	1.39	1.69	.7	1,110	15	52	100	......	......
	5:00 p.m.	4/ 38	773	348	1.6	3.65	3.12	.3	734	19	52	93	100	......
	5:00 p.m.	4/ 38	773	348	1.6	3.89	4.17	.6	777	16	46	91	100	......
	5:00 p.m.	4/ 38	773	348	1.6	3.89	3.86	.9	1,000	13	40	90	100	......
	5:00 p.m.	4/ 38	773	348	1.6	3.80	3.96	1.3	1,130	11	35	87	100	......

See footnotes at end of table.

Table 2.—Particle-size analyses of suspended sediment, point-integrated samples, Middle Loup and Dismal Rivers near Dunning, Nebr.—Continued

[Duplicate samples collected with DH-48 sediment sampler having 3/16-in. nozzle. Method of analysis, visual accumulation tube]

Date	Time	Water temperature (°F)	Measured discharge [1] (cfs)	Sampling station	Total depth (ft)	Suspended sediment								
						Sampling point				Percent finer than indicated size, in millimeters				
						Velocity [2] (ft/sec)	Nozzle velocity [3] (ft/sec)	Depth (ft)	Concentration (ppm)	0.062	0.125	0.250	0.500	1.000
						Section S—Continued								
Nov. 29, 1956..	5:20 p.m.	4/ 38	773	365	2.5	5.02	4.43	0.5	556	25	62	100	......	.....
	5:20 p.m.	4/ 38	773	365	2.5	4.85	4.46	1.0	738	19	53	98	100	.....
	5:20 p.m.	4/ 38	773	365	2.5	4.46	4.54	1.5	926	13	44	98	100	.....
	5:20 p.m.	4/ 38	773	365	2.5	3.65	3.95	2.0	1,630	7	29	89	100	.....
	5:30 p.m.	4/ 38	773	379	2.5	4.16	3.15	.5	573	24	61	97	100	.....
	5:30 p.m.	4/ 38	773	379	2.5	3.89	2.90	1.0	1,010	14	41	80	99	100
	5:30 p.m.	4/ 38	773	379	2.5	3.43	2.97	1.5	1,120	13	38	74	98	100
	5:30 p.m.	4/ 38	773	379	2.5	3.37	3.03	2.0	868	17	50	82	100	.....
						Section T								
Oct. 3, 1956...	11:50 a.m.	61	746	16	2.6	3.16	2.89	0.3	515	14	42	97	100	.....
	11:50 a.m.	61	746	16	2.6	2.95	2.78	1.0	840	9	32	96	100	.....
	11:50 a.m.	61	746	16	2.6	2.89	3.01	1.7	855	8	31	94	100	.....
	11:50 a.m.	61	746	16	2.6	2.17	2.73	2.3	988	8	29	96	100	.....
	12:00 m.	61	746	37	1.8	3.84	3.23	.3	347	19	52	99	100	.....
	12:00 m.	61	746	37	1.8	3.92	3.02	.7	577	13	44	97	100	.....
	12:00 m.	61	746	37	1.8	3.53	2.93	1.1	764	10	37	95	100	.....
	12:00 m.	61	746	37	1.8	2.44	1.08	1.5	2,110	4	15	78	100	.....
	12:10 p.m.	61	746	64	1.5	3.09	2.83	.3	328	23	59	100	......	.....
	12:10 p.m.	61	746	64	1.5	3.09	2.71	.7	377	19	54	100	......	.....
	12:10 p.m.	61	746	64	1.5	2.83	2.77	1.0	458	17	53	99	100	.....
	12:10 p.m.	61	746	64	1.5	1.94	2.42	1.2	542	14	50	99	100	.....
	12:20 p.m.	4/ 62	746	250	1.0	1.98	2.33	.3	316	26	63	100	......	.....
	12:20 p.m.	4/ 62	746	250	1.0	1.78	2.33	.5	382	21	56	99	100	.....
	12:20 p.m.	4/ 62	746	250	1.0	1.86	2.47	.6	375	23	59	99	100	.....
	12:20 p.m.	4/ 62	746	250	1.0	1.63	2.45	.7	403	22	58	99	100	.....

See footnotes at end of table.

Table 2.—Particle-size analyses of suspended sediment, point-integrated samples, Middle Loup and Dismal Rivers near Dunning, Nebr.—Continued
[Duplicate samples collected with DH-48 sediment sampler having 3/16-in. nozzle. Method of analysis, visual accumulation tube]

Date	Time	Water temperature (°F)	Measured discharge[1] (cfs)	Sampling station	Total depth (ft)	Suspended sediment: Sampling point: Velocity[2] (ft/sec)	Nozzle velocity[3] (ft/sec)	Depth (ft)	Concentration (ppm)	Percent finer than indicated size, in millimeters: 0.062	0.125	0.250	0.500	1.000
						Section T—Continued								
Oct. 3, 1956...	12:30 p.m.	4/ 62	746	296	1.3	3.09	2.51	0.3	455	21	54	100	......	.....
	12:30 p.m.	4/ 62	746	296	1.3	2.95	2.56	.6	617	16	46	99	100	.....
	12:30 p.m.	4/ 62	746	296	1.3	2.64	2.33	.8	707	14	45	99	100	.....
	12:30 p.m.	4/ 62	746	296	1.3	2.36	1.94	1.0	903	10	39	98	100	.....
Nov. 29........	5:45 p.m.	4/ 37	821	17	2.0	2.58	2.44	.3	966	17	49	95	100	.....
	5:45 p.m.	4/ 37	821	17	2.0	2.95	2.08	.8	1,340	12	42	94	100	.....
	5:45 p.m.	4/ 37	821	17	2.0	2.71	2.56	1.3	1,350	13	43	94	100	.....
	5:45 p.m.	4/ 37	821	17	2.0	2.77	2.33	1.7	1,620	9	36	91	100	.....
	5:40 p.m.	4/ 37	821	44	1.8	3.69	2.68	.3	806	16	46	98	100	.....
	5:40 p.m.	4/ 37	821	44	1.8	3.53	2.14	.7	1,530	9	35	91	100	.....
	5:40 p.m.	4/ 37	821	44	1.8	2.95	2.32	1.1	2,020	6	26	85	100	.....
	5:40 p.m.	4/ 37	821	44	1.8	2.47	2.51	1.5	2,910	4	19	79	99	100
	....	....	821	71	2.0	4.05	3.21	.3	836	19	53	98	100	.....
	....	....	821	71	2.0	3.95	3.42	.7	1,060	14	48	98	100	.....
	....	....	821	71	2.0	2.05	3.23	1.2	1,440	9	37	90	100	.....
	....	....	821	71	2.0	.79	2.68	1.7	2,150	7	27	80	99	100
	....	....	821	101	1.5	3.12	2.59	.3	743	19	56	100	......	.....
	....	....	821	101	1.5	2.85	2.55	.6	1,060	14	47	97	100	.....
	....	....	821	101	1.5	2.58	2.16	.9	1,440	11	38	86	100	.....
	....	....	821	101	1.5	1.74	2.22	1.2	1,540	9	35	92	100	.....
	5:10 p.m.	38	821	200	.6	1.70	1.50	.1	202	62	91	100	......	......
	5:10 p.m.	38	821	200	.6	1.70	1.88	.2	230	60	85	100	......	......
	5:10 p.m.	38	821	200	.6	1.68	1.95	.3	259	54	75	100	......	......

1 For entire section.
2 Measured with Price current meter.
3 Computed from volume of sample, time of collection, and area of nozzle.
4 Estimated.

Table 3 .--Particle-size analyses of bed material, Middle Loup and Dismal Rivers near Dunning, Nebr.
[Methods of analysis: S, sieve; V, visual accumulation tube]

Date	Number of samples	Measured discharge (cfs)	Bed material: Percent finer than indicated size, in millimeters									Methods of analysis	Remarks
			0.062	0.125	0.250	0.500	1.000	2.000	4.000	8.000	16.000		
							Section E						
Aug. 6, 1956..	1	337	0	8	35	99	100	.....	.....	.....	......	V	Sta. 2.5, disk sample.
	1	337	0	1	15	90	99	100	.....	.....	......	V	Sta. 5.0, disk sample.
	1	337	.....	0	2	69	83	85	88	100	......	SV	Sta. 7.5, disk sample.
	1	337	0	1	10	57	66	69	70	70	100	SV	Sta. 10.0, disk sample.
	1	337	.....	0	11	54	75	82	90	100	......	SV	Sta. 12.5, disk sample.
	1	337	0	1	18	73	84	84	84	100	......	SV	Sta. 15.0, disk sample.
	1	337	0	1	21	90	100	.....	.....	.....	......	V	Sta. 17.5, disk sample.
	1	337	0	1	16	82	100	.....	.....	.....	......	V	Sta. 20.0, disk sample.
	1	337	.....	0	4	15	32	59	88	100	......	SV	Sta. 22.5, disk sample.
	1	337	0	1	30	96	100	.....	.....	.....	......	V	Sta. 25.0, disk sample.
	1	337	0	1	36	99	100	.....	.....	.....	......	V	Sta. 27.5, disk sample.
	1	337	.....	0	24	89	100	.....	.....	.....	......	V	Sta. 30.0, disk sample.
	1	337	0	1	28	85	98	100	.....	.....	......	V	Sta. 32.5, disk sample.
	1	337	0	1	9	30	46	55	69	81	100	SV	Sta. 35.0, disk sample.
	1	337	.....	0	21	92	100	.....	.....	.....	......	V	Sta. 37.5, disk sample.
	1	337	0	6	75	99	100	.....	.....	.....	......	V	Sta. 40.0, disk sample.
	1	337	.....	0	47	99	100	.....	.....	.....	......	V	Sta. 42.5, disk sample.
	1	337	0	1	30	98	100	.....	.....	.....	......	V	Sta. 45.0, disk sample.
	1	337	0	2	61	99	100	.....	.....	.....	......	V	Sta. 47.5, disk sample.
	1	337	0	1	10	32	58	72	83	100	......	SV	Sta. 50.0, disk sample.
	1	337	0	3	60	99	100	.....	.....	.....	......	V	Sta. 52.5, disk sample.
	1	337	0	3	45	92	100	.....	.....	.....	......	V	Sta. 55.0, disk sample.
	1	337	0	2	29	83	90	90	90	100	......	SV	Sta. 57.5, disk sample.
	1	337	0	2	30	80	98	100	.....	.....	......	V	Sta. 60.0, disk sample.
	1	337	0	2	46	95	100	.....	.....	.....	......	V	Sta. 62.5, disk sample.
	1	337	0	3	46	74	83	88	100	.....	......	SV	Sta. 65.0, disk sample.
	1	337	0	2	36	64	70	73	78	100	......	SV	Sta. 67.5, disk sample.
	1	337	0	2	51	85	100	.....	.....	.....	......	V	Sta. 70.0, disk sample.
	1	337	0	1	36	82	92	95	100	.....	......	SV	Sta. 72.5, disk sample.
	1	337	0	1	35	89	99	100	.....	.....	......	V	Sta. 75.0, disk sample.

Table 3.--Particle-size analyses of bed material, Middle Loup and Dismal Rivers near Dunning, Nebr.--Continued

Date	Number of samples	Measured discharge (cfs)	Bed material: Percent finer than indicated size, in millimeters									Methods of analysis	Remarks
			0.062	0.125	0.250	0.500	1.000	2.000	4.000	8.000	16.000		
Section E--Continued													
Aug. 6, 1956..	1	337	0	5	90	99	100	.....	.....	.....	......	V	Sta. 77.5, disk sample.
	1	337	0	5	53	92	100	.....	.....	.....	......	V	Sta. 80.0, disk sample.
	1	337	0	2	58	98	100	.....	.....	.....	......	V	Sta. 82.5, disk sample.
	1	337	0	1	29	73	88	94	100	.....	......	SV	Sta. 85.0, disk sample.
	1	337	0	4	78	100	.....	.....	.....	.....	......	V	Sta. 87.5, disk sample.
	1	337	.....	0	21	50	60	62	64	100	......	SV	Sta. 90.0, disk sample.
	1	337	0	4	61	99	100	.....	.....	.....	......	V	Sta. 92.5, disk sample.
	1	337	0	1	54	99	100	.....	.....	.....	......	V	Sta. 95.0, disk sample.
	1	337	0	2	42	95	96	96	100	.....	......	SV	Sta. 97.5, disk sample.
	1	337	0	3	51	92	100	.....	.....	.....	......	V	Sta. 100.0, disk sample.
	1	337	0	10	85	100	.....	.....	.....	.....	......	V	Sta. 102.5, disk sample.
	1	337	0	1	40	85	86	86	86	100	......	SV	Sta. 105.0, disk sample.
	1	337	0	4	52	99	100	.....	.....	.....	......	V	Sta. 107.5, disk sample.
	1	337	.....	0	9	32	40	42	45	66	100	SV	Sta. 110.0, disk sample.
	1	337	0	2	44	84	100	.....	.....	.....	......	V	Sta. 112.5, disk sample.
	1	337	0	2	43	88	97	100	.....	.....	......	SV	Sta. 115.0, disk sample.
	1	337	.....	0	19	91	100	.....	.....	.....	......	V	Sta. 117.5, disk sample.
	1	337	.....	0	10	67	87	96	100	.....	......	SV	Sta. 120.0, disk sample.
	1	337	0	4	69	99	100	.....	.....	.....	......	V	Sta. 122.5, disk sample.
	1	337	0	1	26	54	72	88	100	.....	......	SV	Sta. 125.0, disk sample.
	1	337	0	1	12	31	40	46	66	100	......	SV	Sta. 127.5, disk sample.
	1	337	0	1	13	39	69	77	85	100	......	SV	Sta. 130.0, disk sample.
	1	337	0	2	58	97	100	.....	.....	.....	......	V	Sta. 132.5, disk sample.
	1	337	0	4	69	99	100	.....	.....	.....	......	V	Sta. 135.0, disk sample.
	1	337	.....	0	8	46	73	82	96	100	......	SV	Sta. 137.5, disk sample.
	1	337	0	3	49	97	100	.....	.....	.....	......	V	Sta. 140.0, disk sample.
	1	337	.....	0	11	74	95	98	100	.....	......	SV	Sta. 142.5, disk sample.
	1	337	0	1	24	97	100	.....	.....	.....	......	V	Sta. 145.0, disk sample.
	1	337	0	2	34	98	100	.....	.....	.....	......	V	Sta. 147.5, disk sample.
	1	337	.....	0	9	91	100	.....	.....	.....	......	V	Sta. 150.0, disk sample.

Table 3.--Particle-size analyses of bed material, Middle Loup and Dismal Rivers near Dunning, Nebr.--Continued

Date	Number of samples	Measured discharge (cfs)	Bed material: Percent finer than indicated size, in millimeters 0.062	0.125	0.250	0.500	1.000	2.000	4.000	8.000	16.000	Methods of analysis	Remarks
						Section E--Continued							
Aug. 6, 1956..	1	337	.....	0	13	89	100	.....	.....	.....	......	V	Sta. 152.5, disk sample.
	1	337	0	2	40	96	100	.....	.....	.....	......	V	Sta. 155.0, disk sample.
	1	337	1	3	9	23	34	43	51	100	......	SV	Sta. 157.5, disk sample.
	1	337	3	23	67	100	.....	.....	.....	.....	......	V	Sta. 160.0, disk sample.
	64	337	0	2	35	81	89	92	94	99	100	SV	Average of stas. 2.5 to 160.
Aug. 7........	1	370	.....	0	23	96	99	100	.....	.....	......	SV	Sta. 4, core sample.
	1	370	.....	0	18	87	96	99	100	.....	......	SV	Sta. 8, core sample.
	1	370	.....	0	23	86	94	96	99	100	......	SV	Sta. 12, core sample.
	1	370	.....	0	14	50	70	82	97	100	......	SV	Sta. 16, core sample.
	1	370	.....	0	12	75	92	94	96	100	......	SV	Sta. 20, core sample.
	1	370	.....	0	7	26	51	71	93	100	......	SV	Sta. 24, core sample.
	1	370	.....	0	14	76	95	98	100	.....	......	SV	Sta. 28, core sample.
	1	370	.....	0	32	86	93	94	98	100	......	SV	Sta. 32, core sample.
	1	370	.....	0	25	94	99	100	.....	.....	......	SV	Sta. 36, core sample.
	1	370	.....	0	24	82	96	98	100	.....	......	SV	Sta. 40, core sample.
	1	370	.....	0	28	83	98	99	100	.....	......	SV	Sta. 44, core sample.
	1	370	.....	0	40	91	98	99	100	.....	......	SV	Sta. 48, core sample.
	1	370	.....	0	19	88	99	100	.....	.....	......	SV	Sta. 52, core sample.
	1	370	.....	0	22	66	84	92	98	100	......	SV	Sta. 56, core sample.
	1	370	.....	0	16	52	76	89	99	100	......	SV	Sta. 60, core sample.
	1	370	0	1	27	76	91	97	100	.....	......	SV	Sta. 64, core sample.
	1	370	.....	0	14	76	97	100	.....	.....	......	SV	Sta. 68, core sample.
	1	370	0	2	28	77	94	97	99	100	......	SV	Sta. 72, core sample.
	1	370	0	6	69	96	100	.....	.....	.....	......	V	Sta. 76, core sample.
	1	370	.....	0	16	66	90	96	99	100	......	SV	Sta. 80, core sample.
	1	370	.....	0	18	48	74	87	97	100	......	SV	Sta. 84, core sample.
	1	370	.....	0	21	52	79	90	99	100	......	SV	Sta. 88, core sample.
	1	370	.....	0	28	91	100	.....	.....	.....	......	V	Sta. 92, core sample.
	1	370	0	2	58	96	99	100	.....	.....	......	SV	Sta. 96, core sample.
	1	370	0	1	30	73	90	96	98	100	......	SV	Sta. 100, core sample.

Table 3.--Particle-size analyses of bed material, Middle Loup and Dismal Rivers near Dunning, Nebr.--Continued

Date	Number of samples	Measured discharge (cfs)	Bed material: Percent finer than indicated size, in millimeters									Methods of analysis	Remarks
			0.062	0.125	0.250	0.500	1.000	2.000	4.000	8.000	16.000		
Section E--Continued													
Aug. 7, 1956..	1	370	0	1	42	90	97	98	99	100	......	SV	Sta. 104, core sample.
	1	370	.....	0	19	76	91	96	100	.....	......	SV	Sta. 108, core sample.
	1	370	0	5	64	93	98	99	100	.....	......	SV	Sta. 112, core sample.
	1	370	0	4	53	83	90	95	99	100	......	SV	Sta. 116, core sample.
	1	370	0	1	43	94	100	.....	.....	.....	......	V	Sta. 120, core sample.
	1	370	0	2	55	96	100	.....	.....	.....	......	V	Sta. 124, core sample.
	1	370	0	4	61	96	100	.....	.....	.....	......	V	Sta. 128, core sample.
	1	370	0	2	36	88	98	99	100	.....	......	SV	Sta. 132, core sample.
	1	370	0	3	50	90	99	100	.....	.....	......	SV	Sta. 136, core sample.
	1	370	.....	0	15	66	91	97	100	.....	......	SV	Sta. 140, core sample.
	1	370	0	1	25	82	91	93	98	100	......	SV	Sta. 144, core sample.
	1	370	.....	0	16	69	83	88	94	97	100	SV	Sta. 148, core sample.
	1	370	.....	0	11	79	97	100	.....	.....	......	SV	Sta. 152, core sample.
	1	370	0	2	14	45	53	57	67	89	100	SV	Sta. 156, core sample.
	39	370	0	1	29	78	91	95	98	100	......	SV	Average of stas. 4 to 156.
Oct. 3........	31	375	0	1	30	80	94	97	99	100	......	SV	Composite of $\frac{1}{2}$-in. core samples collected at 5-ft intervals.
Oct. 4........	32	384	0	1	33	85	93	97	99	100	......	SV	Composite of $\frac{1}{2}$-in. core samples collected at 5-ft intervals. (Set no. 1).
	21	384	0	1	22	70	93	97	99	100	......	SV	Composite of $\frac{1}{2}$-in. core samples collected at 5-ft intervals from stas. 15 to 70 and 130 to 170. (Set no. 2).
	11	384	0	3	45	89	96	97	99	100	......	SV	Composite of $\frac{1}{2}$-in. core samples collected at 5-ft intervals from stas. 75 to 125. (Set no. 2).
Nov. 28.......	33	395	0	6	40	86	97	99	100	.....	......	SV	Composite of $\frac{1}{2}$-in. core samples collected at 5-ft intervals.
Nov. 29.......	31	416	0	4	36	85	97	99	100	.....	......	SV	Do.
Nov. 30.......	31	391	0	2	29	79	91	96	99	100	......	SV	Do.

Table 3.--Particle-size analyses of bed material, Middle Loup and Dismal Rivers near Dunning, Nebr.--Continued

Date	Number of samples	Measured discharge (cfs)	Bed material: Percent finer than indicated size, in millimeters									Methods of analysis	Remarks
			0.062	0.125	0.250	0.500	1.000	2.000	4.000	8.000	16.000		
Section R													
Aug. 6, 1956..	27	294	0	1	32	72	78	86	92	100	......	SV	Composite of disk samples collected at 2½-ft intervals.
Aug. 7........	31	335	1	6	53	88	94	96	98	99	100	SV	Composite of ½-in. core samples collected at 2½-ft intervals.
Oct. 3........	14	314	1	4	28	74	88	93	97	99	100	SV	Composite of ½-in. core samples collected at 5-ft intervals.
Oct. 4........	14	321	0	2	34	77	88	93	97	99	99	SV	Do.
Nov. 28.......	14	320	0	4	40	95	99	100	.....	.....	......	SV	Do.
Nov. 29.......	14	330	0	4	44	90	98	99	100	.....	......	SV	Do.
Nov. 30.......	12	331	0	1	34	84	93	96	99	100	......	SV	Do.
Section S													
Aug. 6, 1956..	83	645	0	3	45	88	96	98	99	100	......	SV	Composite of ½-in. core samples collected at 5-ft intervals.
Aug. 7........	15	719	0	4	46	88	96	98	100	.....	......	SV	Composite of ½-in. core samples collected at 10-ft intervals from stas. 10 to 150.
	8	719	0	2	36	90	98	99	99	100	......	SV	Composite of ½-in. core samples collected at 10-ft intervals from stas. 160 to 230.
	8	719	0	6	35	84	93	97	99	100	......	SV	Composite of ½-in. core samples collected at 10-ft intervals from stas. 240 to 310.
	6	719	0	2	34	88	98	99	100	.....	......	SV	Composite of ½-in. core samples collected at 10-ft intervals from stas. 320 to 350 and 380 to 390.
Oct. 3........	40	724	0	3	41	80	91	94	97	99	100	SV	Composite of ½-in. core samples collected at 10-ft intervals. (Set no. 1).
	40	724	0	3	38	77	93	95	98	100	......	SV	Composite of ½-in. core samples collected at 10-ft intervals (Set no. 2).
Oct. 4........	40	662	0	4	47	85	93	96	98	99	100	SV	Composite of ½-in. core samples collected at 10-ft intervals.

Table 3.--Particle-size analyses of bed material, Middle Loup and Dismal Rivers near Dunning, Nebr.--Continued

Date	Number of samples	Measured discharge (cfs)	Bed material: Percent finer than indicated size, in millimeters 0.062	0.125	0.250	0.500	1.000	2.000	4.000	8.000	16.000	Methods of analysis	Remarks
						Section S--Continued							
Nov. 28, 1956..	17	705	1	3	43	85	94	97	98	100	......	SV	Composite of ½-in. core samples collected at 5-ft intervals from stas. 5 to 85.
	11	705	4	33	83	96	98	100	.....	.....	......	SV	Composite of ½-in. core samples collected at 10-ft intervals from stas. 105 to 175 and 290 to 310.
	15	705	0	8	52	78	87	90	95	98	100	SV	Composite of ½-in. core samples collected at 5-ft intervals from stas. 320 to 390.
Nov. 29 a......	17	773	0	2	28	73	86	94	97	100	......	SV	Composite of ½-in. core samples collected at 5-ft intervals from stas. 5 to 85.
	12	773	5	38	88	97	100	.....	.....	.....	......	V	Composite of ½-in. core samples collected at 10-ft intervals from stas. 105 to 175 and 290 to 320.
	13	773	0	1	23	58	77	90	97	100	......	SV	Composite of ½-in. core samples collected at 5-ft intervals from stas. 330 to 390.
Nov. 30........	18	738	0	10	46	84	93	97	99	100	......	SV	Composite of ½-in. core samples collected at 5-ft intervals from stas. 5 to 90.
	12	738	6	36	84	96	100	.....	.....	.....	......	V	Composite of ½-in. core samples collected at 10-ft intervals from stas. 100 to 180 and 290 to 310.
	15	738	0	1	25	78	95	98	99	100	......	SV	Composite of ½-in. core samples collected at 5-ft intervals from stas. 320 to 390.
						Section T							
Aug. 6, 1956. a	14	696	7	34	77	96	100	.....	.....	.....	......	V	Composite of disk samples collected at 5-ft intervals from stas. 5 to 70.
	24	696	0	1	18	45	55	68	81	94	100	SV	Composite of disk samples collected at 5-ft intervals from stas. 75 to 190.
	28	696	0	1	20	42	50	57	67	67	74	SV	Composite of disk samples collected at 5-ft intervals from stas. 195 to 330.
Aug. 7.........	15	674	7	32	72	94	97	98	99	99	100	SV	Composite of ½-in. core samples collected at 5-ft intervals from stas. 5 to 75.

a Particle-size analyses probably not representative.

Table 3.--Particle-size analyses of bed material, Middle Loup and Dismal Rivers near Dunning, Nebr.--Continued

Date	Number of samples	Measured discharge (cfs)	Bed material: Percent finer than indicated size, in millimeters									Methods of analysis	Remarks
			0.062	0.125	0.250	0.500	1.000	2.000	4.000	8.000	16.000		
Section T--Continued													
Aug. 7, 1956..	21	674	0	1	29	80	92	96	99	100	......	SV	Composite of ½-in. core samples collected at 5-ft intervals from stas. 80 to 180.
	30	674	0	2	37	83	92	95	98	100	......	SV	Composite of ½-in. core samples collected at 5-ft intervals from stas. 185 to 330.
Oct. 3........	22	746	0	2	37	78	90	95	98	100	......	SV	Composite of ½-in. core samples collected at 5-ft intervals from stas. 5 to 110.
	20	746	8	37	73	93	99	100	.....	.....	......	SV	Composite of ½-in. core samples collected at 5-ft intervals from stas. 115 to 210.
	24	746	0	3	37	89	98	99	100	.....	......	SV	Composite of ½-in. core samples collected at 5-ft intervals from stas. 215 to 330.
Oct. 4........	23	737	0	3	40	83	94	97	99	100	......	SV	Composite of ½-in. core samples collected at 5-ft intervals from stas. 5 to 115.
	20	737	14	46	78	95	98	100	.....	.....	......	SV	Composite of ½-in. core samples collected at 5-ft intervals from stas. 120 to 215.
	23	737	0	2	51	90	95	97	99	100	......	SV	Composite of ½-in. core samples collected at 5-ft intervals from stas. 220 to 330.
Nov. 28.......	14	....	.....	0	24	76	90	94	97	98	100	SV	Composite of ½-in. core samples collected at 10-ft intervals from stas. 10 to 140.
	15	....	3	17	71	93	98	99	100	.....	......	SV	Composite of ½-in. core samples collected at 10-ft intervals from stas. 150 to 250 and 300 to 330.
Nov. 29.......	16	821	0	4	36	73	91	95	98	99	100	SV	Composite of ½-in. core samples collected at 10-ft intervals from stas. 10 to 160.

Table 3.--Particle-size analyses of bed material, Middle Loup and Dismal Rivers near Dunning, Nebr.--Continued

Date	Number of samples	Measured discharge (cfs)	Bed material: Percent finer than indicated size, in millimeters									Methods of analysis	Remarks
			0.062	0.125	0.250	0.500	1.000	2.000	4.000	8.000	16.000		
Section T--Continued													
Nov. 29, 1956..	18	821	4	23	70	92	98	99	100	.....	......	SV	Composite of $\frac{1}{2}$-in. core samples collected at 10-ft intervals from stas. 170 to 340.
Nov. 30........	10	700	0	1	29	75	90	93	96	98	100	SV	Composite of $\frac{1}{2}$-in. core samples collected at 10-ft intervals from stas. 10 to 100.
	11	700	2	20	64	92	98	99	100	.....	......	SV	Composite of $\frac{1}{2}$-in. core samples collected at 10-ft intervals from stas. 110 to 140, 200, 280, and 300 to 330.

Table 4.--Summary of hydraulic data

Date	Temperature (°F)	Measured discharge (cfs)	Effective area (sq ft)	Effective width (ft)	Mean depth (ft)	Mean velocity (fps)	Slope	n
Section E								
Aug. 6, 1956.	80	337	167	159	1.05	2.02	0.00144	0.0289
Aug. 7.......	70	370	185	159	1.16	2.00	.00136	.0303
Oct. 3.......	54	375	173	158	1.09	2.17	.00136	.0268
Oct. 4.......	52	384	161	156	1.03	2.39	.00132	.0230
Nov. 28......	32	395	136	157	.87	2.90	.00115	.0158
Nov. 29......	33	416	154	156	.99	2.70	.00113	.0184
Nov. 30......	34	391	140	157	.89	2.79	.00112	.0165
Section F								
Aug. 6, 1956.	a 80	337	156	95	1.64	2.16	0.00127	0.0341
Aug. 7.......	a 70	370	155	96	1.61	2.39	.00135	.0314
Oct. 3.......	a 54	375	158	93	1.70	2.37	.00127	.0318
Oct. 4.......	a 52	384	142	93	1.53	2.70	.00131	.0265
Nov. 28......	32	395	115	92	1.25	3.43	.00116	.0171
Nov. 29......	a 33	416	137	91	1.51	3.04	.00122	.0225
Nov. 30......	a 34	391	119	93	1.28	3.29	.00113	.0179
Section P								
Aug. 6, 1956.	a 80	294	128	83	1.54	2.30	0.00121	0.0300
Aug. 7.......	a 70	335	141	84	1.68	2.38	.00117	.0302
Oct. 3.......	55	314	125	83	1.51	2.51	.00123	.0273
Oct. 4.......	a 50	321	128	83	1.54	2.51	.00122	.0276
Nov. 28......	a 33	320	126	82	1.54	2.54	.00140	.0292
Nov. 29......	a 34	330	111	82	1.35	2.97	.00127	.0218
Nov. 30......	a 36	331	111	82	1.35	2.98	.00130	.0220
Section R								
Aug. 6, 1956.	80	294	126	75	1.68	2.33	0.00109	0.0297
Aug. 7.......	70	335	115	75	1.54	2.91	.00112	.0228
Oct. 3.......	a 54	314	118	73.5	1.61	2.66	.00104	.0248
Oct. 4.......	50	321	129	74	1.74	2.49	.00101	.0275
Nov. 28......	a 33	320	104	71	1.46	3.08	.00078	.0173
Nov. 29......	34	330	106	71	1.49	3.11	.00085	.0182
Nov. 30......	36	331	106	71	1.49	3.12	.00099	.0196
Section S								
Aug. 6, 1956.	77	645	337	356	0.95	1.91	0.00138	0.0279
Aug. 7.......	75	719	353	360	.98	2.04	.00134	.0263
Oct. 3.......	a 61	724	347	371	.94	2.09	.00122	.0244
Oct. 4.......	55	662	326	365	.89	2.03	.00120	.0234
Nov. 28......	32	705	273	270	1.01	2.58	.00133	.0212
Nov. 29......	37	773	286	274	1.04	2.70	.00135	.0208
Nov. 30......	39	738	291	271	1.07	2.54	.00128	.0219
Section T								
Aug. 6, 1956.	74	696	333	268	1.24	2.09	0.00118	0.0282
Aug. 7.......	80	674	320	278	1.15	2.10	.00113	.0261
Oct. 3.......	56	746	307	330	.93	2.43	.00107	.0191
Oct. 4.......	54	737	296	291	1.02	2.49	.00114	.0204
Nov. 28......	32	(b)	272	303	.90	(b)	.00085	......
Nov. 29......	a 38	821	314	329	.95	2.61	.00119	.0190
Nov. 30......	36	700	245	311	.79	2.85	.00118	.0153

a Estimated.
b Velocity determinations not reliable because of ice effect.

Table 4.--Summary of hydraulic data--Continued

Date	Temperature (°F)	Measured discharge (cfs)	Effective area (sq ft)	Effective width (ft)	Mean depth (ft)	Mean velocity (fps)	Slope	n
300 feet upstream from section S								
Aug. 7, 1956.	75	719	355	413	0.86	2.03	0.00112	0.0222
Oct. 3.......	61	724	345	473	.73	2.10	.00142	.0216
Oct. 4.......	55	662	359	451	.80	1.84	.00138	.0258
Nov. 29......	37	773	273	302	.90	2.83	.00162	.0197
Nov. 30......	39	738	290	385	.75	2.54	.00136	.0178
300 feet downstream from section S								
Aug. 7, 1956.	75	719	333	427	0.78	2.16	0.00157	0.0230
Oct. 3.......	61	724	346	403	.86	2.09	.00113	.0216
Oct. 4.......	55	662	310	435	.71	2.14	.00105	.0179
Nov. 29......	37	773	293	414	.71	2.64	.00108	.0147
Nov. 30......	39	738	297	412	.72	2.48	.00115	.0163
300 feet upstream from section T								
Aug. 7, 1956.	80	674	286	253	1.13	2.36	0.00095	0.0210
Oct. 3.......	56	746	293	259	1.13	2.55	.00098	.0198
Oct. 4.......	54	737	280	250	1.12	2.63	.00110	.0202
Nov. 30......	36	700	260	255	1.02	2.69	.00097	.0174
300 feet downstream from section T								
Aug. 7, 1956.	80	674	338	272	1.24	1.99	0.00132	0.0313
Oct. 3.......	56	746	355	276	1.29	2.10	.00115	.0284
Oct. 4.......	54	737	303	279	1.09	2.43	.00118	.0222
Nov. 30......	36	700	260	253	1.03	2.69	.00137	.0208

Date	Sediment discharge in tons per day									
	Finer 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 4.00 mm	Total	Measured at section D	Bed-material load
Section E										
Aug. 6, 1956.	61	85	228	160	28	2	0	a 564	470	418
Aug. 7.......	86	126	265	203	56	2	0	b 738	710	526
Oct. 3.......	58	202	391	248	77	3	0	b 979	887	719
Oct. 4.......	50	245	538	354	58	8	0	b 1,253	1,030	958
Nov. 28......	106	442	1,172	580	156	13	1	b 2,470	2,340	1,922
Nov. 29......	143	502	1,147	565	154	9	1	b 2,521	2,880	1,876
Nov. 30......	94	493	979	599	173	31	4	b 2,373	2,090	1,786
Section R										
Aug. 6, 1956.	113	108	193	111	18	5	0	a 548	....	327
Aug. 7.......	100	174	434	189	31	4	1	b 933	....	659
Oct. 3.......	78	286	366	252	84	9	1	b 1,076	....	712
Oct. 4.......	47	263	427	183	45	5	0	b 970	....	660
Nov. 28......	136	348	716	332	25	3	....	b 1,560	....	1,076
Nov. 29......	220	480	922	312	55	3	1	b 1,993	....	1,293
Nov. 30......	108	301	749	315	66	10	2	b 1,551	....	1,142
Section S										
Aug. 7, 1956.	168	215	538	414	55	2	0	b 1,392	....	1,009
Oct. 3.......	138	386	843	408	123	4	0	b 1,902	....	1,378
Oct. 4.......	124	338	1,040	420	58	4	0	b 1,984	....	1,522
Nov. 28......	237	759	2,791	655	166	30	11	b 4,649	....	3,653
Nov. 29......	310	812	2,249	753	237	38	13	cd 4,413	....	3,291
Nov. 30......	238	685	1,726	793	239	32	4	b 3,717	....	2,794
Section T										
Aug. 6, 1956.	181	218	549	373	77	5	0	e 1,403	....	1,004
Aug. 7.......	168	243	545	402	94	7	0	b 1,459	....	1,048
Oct. 3.......	80	393	1,334	679	156	18	2	b 2,662	....	2,189
Oct. 4.......	143	424	1,361	536	86	10	2	b 2,562	....	1,995
Nov. 29......	445	1,098	2,483	771	352	36	6	b 5,191	....	3,648
Nov. 30......	217	859	1,835	724	242	23	5	b 3,905	....	2,829

a Based on bed-material samples collected with disk sampler.
b Based on bed-material samples collected with core sampler.
c Based on average of bed-material samples collected with core sampler on Nov. 28 and 30, 1956.
d Includes 1 ton per day in 4.00 to 8.00 mm size.
e Based on bed-material samples collected with core sampler on Aug. 7, 1956.

Table 6.--Summation of z_1 and von Karman k values

Station	z for indicated size range[1]				k
	0-0.062	0.062-0.125	0.125-0.250	0.250-0.500	
Oct. 3, 1956, section R					
10	0.00	0.13	0.29	1.32	0.675
24	.03	.16	.33	....	.450
39	.02	.34	.58	....	.291
52	.00	.12	.25	.40	1.05
65	.00	.18	.32	1.19	.418
Mean...	0.01	0.18	0.35	0.97	0.577
Oct. 3, 1956, section S					
190	0.00	0.31	0.57	....	0.779
230	.14	.38	.41	....	.619
295	.08	.30	.46	....	4.64
365	.01	.32	.51	....	.077
Mean...	0.06	0.33	0.49	....	1.529
Oct. 3, 1956, section T					
16	0.03	0.06	0.12	0.21	0.583
37	.08	.26	.60	.80	.290
64	.00	.13	.24	.00	.317
250	.03	.17	.12	.00	.419
296	.01	.22	.39	.96	.353
Mean...	0.03	0.17	0.29	0.40	0.392
Nov. 29, 1956, section E					
62	Neg.	0.23	0.70	....	......
93	0.13	.29	.77	....	0.365
118	.06	.26	.62	2.18	.178
135	Neg.	.37	.71	1.65	.184
150	.05	.24	.80	2.25	.253
Mean...	0.08	0.28	0.72	2.03	0.245
Nov. 29, 1956, section R					
12	0.01	0.15	0.34	0.67	0.640
28	.04	.24	.53	1.30	.302
43	.13	.21	.44	1.41	.289
54	.05	.34	.74	....	.310
64	.05	.20	.38	.75	.547
Mean...	0.06	0.23	0.49	1.03	0.418
Nov. 29, 1956, section S					
23	Neg.	0.16	0.13	0.53	0.987
77	0.05	.33	.71	....	.239
348	Neg.	.04	.22	.34	......
365	Neg.	.19	.52	1.70	.331
379	.03	.13	.11	.68	.492
Mean...	0.04	0.17	0.34	0.82	0.512
Nov. 29, 1956, section T					
17	0.12	0.08	0.18	0.26	......
44	.04	.24	.98	1.08	0.352
71	.01	.13	.35	1.13	.139
101	.02	.12	.33	2.18	.239
200	.05	Neg.	.80	....	7.00
Mean...	0.05	0.14	0.53	1.16	1.932

1 Size range in millimeters.

Table 7.--Dimensionless parameters for various rivers

Section	Date	$\frac{W}{d}$	S	$\frac{k_s}{d}$	R_e	$\frac{V_s}{V}$	f	Computed f^1
Middle Loup River at Dunning, Nebr.								
	1956							
E	Aug. 6..	151	0.00144	0.00119	228,000	0.0524	0.0239	0.0240
	Aug. 7..	137	.00136	.00115	220,000	.0522	.0254	.0244
	Oct. 3..	145	.00136	.00135	179,000	.0429	.0202	.0178
	Oct. 4..	151	.00132	.00117	181,000	.0371	.0153	.0161
	Nov. 28.	180	.00115	.00132	131,000	.0255	.00765	.00875
	Nov. 29.	158	.00113	.00119	141,000	.0263	.00988	.00984
	Nov. 30.	176	.00112	.00151	134,000	.0302	.00825	.00935
S	Aug. 6..	375	.00138	.00114	187,000	......	.0231	....
	Aug. 7..	367	.00134	.00114	202,000	.0484	.0204	.0173
	Oct. 3..	395	.00128	.00135	161,000	.0421	.0177	.0130
	Oct. 4..	410	.00120	.00122	139,000	.0378	.0166	.0123
	Nov. 28.	267	.00133	.000987	142,000	.0242	.0131	.0104
	Nov. 29.	263	.00135	....	172,000	......	.0124	....
	Nov. 30.	253	.00128	.00101	160,000	.0313	.0137	.0131
T	Aug. 6..	216	.00118	....	259,000	......	.0215	....
	Aug. 7..	242	.00113	.000938	259,000	.0520	.0189	.0195
	Oct. 3..	355	.00107	.00113	176,000	.0396	.0109	.0119
	Oct. 4..	285	.00114	.000933	190,000	.0320	.0120	.0117
	Nov. 28.	337	.00085	.00120	....	......	....	....
	Nov. 29.	345	.00119	.00111	143,000	.0274	.0107	.00922
	Nov. 30.	395	.00118	.00140	126,000	.0253	.00737	.00688
Dismal River at Dunning, Nebr.								
	1956							
R	Aug. 6..	44.6	0.00109	0.000858	420,000	0.0372	0.0217	0.0178
	Aug. 7..	49.0	.00112	.000663	427,000	.0298	.0131	.0167
	Oct. 3..	45.7	.00104	.000894	324,000	.0348	.0152	.0167
	Oct. 4..	42.5	.00101	.000770	307,000	.0301	.0183	.0161
	Nov. 28.	48.5	.00078	.000719	238,000	.0181	.00773	.00766
	Nov. 29.	47.7	.00085	.000725	249,000	.0172	.00843	.00762
	Nov. 30.	47.7	.00099	.000812	250,000	.0215	.00975	.0105
Niobrara River near Cody, Nebr.								
	1951							
C-2	July 18.	94.2	0.00131	0.000861	274,000	0.0481	0.0225	0.0278
	Aug. 3..	84.6	.00123	.000808	311,000	.0444	.0184	.0246
	Sept. 6.	74.2	.00129	.000660	612,000	.0168	.00723	.00724

See footnote at end of table.

Table 7.--Dimensionless parameters for various rivers--Continued

Section	Date	$\frac{w}{d}$	S	$\frac{k_s}{d}$	R_e	$\frac{V_s}{V}$	f	Computed f[1]
Niobrara River near Cody, Nebr.--Continued								
	1952							
C-2	Apr. 1..	81.3	0.00133	0.000729	386,000	0.0164	0.00731	0.00778
	May 8...	93.5	.00134	.000840	280,000	.0279	.0140	.0147
	June 19.	121	.00138	.00107	179,000	.0411	.0200	.0220
	Sept. 26	121	.00138	.00112	163,000	.0371	.0180	.0194
North Loup River at Burwell, Nebr.								
	1955							
....	Mar. 29.	67.7	0.00157	0.000723	507,000	0.0279	0.0173	0.0166
	June 20.	141	.00108	.000892	435,000	.0417	.0179	.0140
	Aug. 22.	175	.00121	.00176	138,000	.0791	.0259	.0287
Middle Loup River at Arcadia, Nebr.								
	1955							
....	May 10..	162	0.00131	0.000857	230,000	0.0373	0.0217	0.0188
	June 7..	133	.00106	.000720	392,000	.0291	.0115	.0113
	June 21.	116	.00127	.000610	468,000	.0298	.0216	.0153
	July 26.	204	.00112	.00108	201,000	.0595	.0259	.0236

1 From regression equation.

Table 8.--Measured and computed widths and mean depths for different river sections

Date	Width		Depth	
	Measured	Computed[1]	Measured	Computed[1]
Section C-2, Niobrara River near Cody				
July 18, 1951.......	115	158	1.22	1.69
Aug. 3.............	110	175	1.30	2.09
Sept. 6............	118	118	1.59	1.59
Apr. 1, 1952........	117	129	1.44	1.59
May 8...............	117	126	1.25	1.35
June 19.............	118	136	.975	1.13
Sept. 26............	114	128	.938	1.05
Gaging section, North Loup River at Burwell				
Mar. 29, 1955.......	132	124	1.95	1.83
June 20.............	223	153	1.58	1.07
Aug. 22.............	140	164	.80	.94
Section A, Middle Loup River at Dunning				
Mar. 21, 1950.......	230	222	0.83	0.80
Apr. 12.............	229	170	.75	.55
May 9...............	325	270	.61	.50
Apr. 23.............	236	141	.72	.42
June 20.............	325	223	.66	.45

1 Computed with variation of regression equation.