Analysis of Current-Meter Data at Columbia River Gaging Stations, Washington and Oregon

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By JOHN SAVINI *and* G. L. BODHAINE

RIVER HYDRAULICS

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ABSTRACT

The U.S. Geological Survey developed equipment to measure stream velocity simultaneously with 10 current meters arranged in a vertical and to measure velocity closer to the streambed than attainable with conventional equipment.

With the 10 current meters, synchronous velocities were recorded for a period of 66 minutes at 10 different depths in one vertical of one gaging-station cross section. In addition, with a current meter installed on a special bracket to allow measurements to 0.5 foot above streambed, data were obtained at two to four verticals in four gaging-station cross sections.

The mean velocity determined for the 66-minute period of record was 3.30 fps (feet per second). The graphic record of velocity was analyzed on a minute-by-minute basis. It was noted that the shape of the vertical velocity curves (plot of horizontal flow velocities measured in a vertical) changed from one minute to the next, but the change seemed to be random. Velocities obtained at different depths in the profile fluctuated significantly, with the 1-minute velocities obtained at 0.05 depth (5 percent of total depths measured from the surface at indicated vertical) showing the smallest range—0.66 fps—and those at 0.55 depth the largest range—1.22 fps.

The standard deviation, expressed in feet per second, of the velocity at each point in the vertical tended to increase with depth—from 0.16 fps at 0.05 depth to a maximum of 0.24 fps at 0.75 depth. The standard deviation, expressed as a percentage of the mean velocity, ranged from about 4 percent near the surface to 11 percent at 0.95 depth. In spite of the fluctuation in mean velocity that occurred during the 66 minutes, an observation period of 4 minutes yields a mean velocity that differs from the 66-minute mean by less than one-half of a percent.

Determining the mean velocity by averaging the 10-point observations of the 66-minute run proved to be as accurate as by plotting the vertical velocity curve (from the averaged 10 points) and then integrating the depth-velocity profile. In comparing the velocity obtained by integrating the depth-velocity profile with the 10-point mean velocity for other field data, collected beyond that obtained during the 66-minute run, the difference ranged from -1.3 to $+1.7$ percent and averaged -0.2 percent.

Extension of the curve below the 0.95 depth by use of a power function proved to be fairly accurate (when compared with actual measurements within this reach made

with the special current-meter bracket). However, the extension did not improve significantly the accuracy of the integrated-curve mean velocity.

Both the one- and two-point methods were found to agree with the 10-point velocity. In computing mean river velocity, values determined by the two-point method ranged from −1.4 to +1.6 percent when compared with the base integrated-curve mean river velocity. The one-point method yielded results that ranged from −1.9 to +4.4 percent and averaged +0.1 percent.

In determining river flow by use of the midsection and mean-section methods, the mean-section method uniformly yields lower flows for the same data. The range in difference is from −0.2 percent to −1.6 percent, with an average difference of −0.6 percent.

INTRODUCTION

PURPOSE AND SCOPE

The purpose of this report is to document a study of the changes in stream velocity that occur at various depths in a single vertical in a river cross section and to document the magnitude of change in velocity over a period of time. Such information is used as an evaluation of the relative accuracy of the several standard methods of determining velocity and an evaluation of the optimum time required to complete a series of flow measurements within a specific profile.

The investigation encompasses the development of the typical vertical velocity curve (plot of horizontal flow velocities measured in a vertical), and the use of the integrated-curve mean velocity in evaluating other methods of determining the mean velocity in a vertical section. During the investigation, data were collected at seven gaging stations on the Columbia River.

The variation of velocity with respect to time and depth was investigated by comparing 1-minute vertical velocity curves defined from simultaneous velocity data recorded from 10 Price current meters suspended at equal depth intervals in a vertical section and operating continuously for 66 minutes. The comparison of the 1-minute vertical velocity curves to the 66-minute mean vertical velocity curve demonstrates the velocity variation spectrum attributed to the effect of pulsation present in large rivers.

The relative merits of the mean-section and midsection methods of determining the mean velocity of the river at the gaging stations also were investigated.

DATA-COLLECTION PROGRAM

LOCATION OF COLLECTION SITES

Measurements of streamflow were made at five gaging stations in Washington and two in Oregon (fig. 1). Descriptions of the cross sections

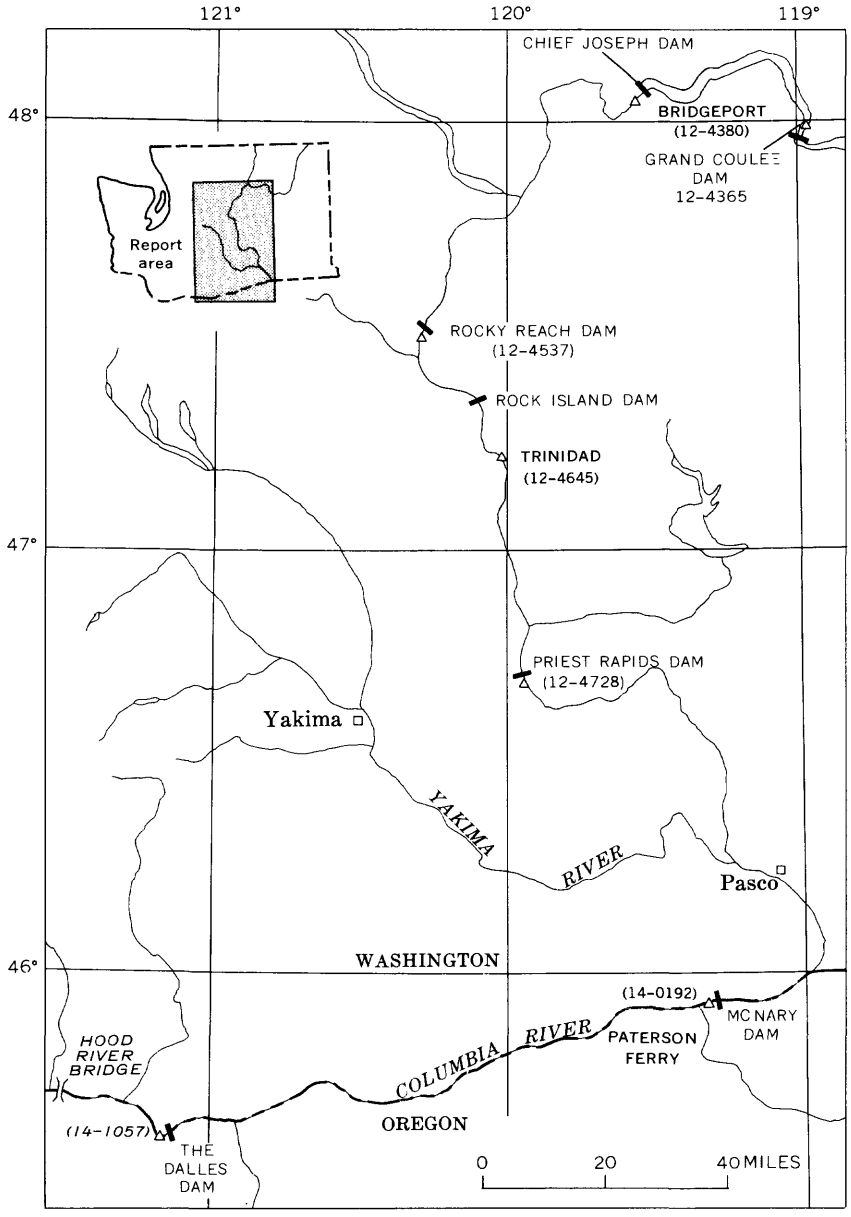

FIGURE 1.—Gaging stations on the Columbia River near which streamflow data were obtained for this report. Stations are numbered and are shown by open triangles.

and of their locations follow. Table 1 summarizes channel and flow characteristics at these sites.

Grand Coulee Dam.—The measuring cross section (at river mile 596.1) is about 4,500 feet downstream from Grand Coulee Dam and about 1,300 feet downstream from the recording gage (station 12–4365 at river mile 596.3) in the highway bridge pier. The channel between the dam and the cableway is straight. The cross section is deep and fairly uniform. At medium stages the flow becomes turbulent and velocities are high and variable. At high stages wave heights of several feet are present.

The distribution of discharge and the flow structure in the measuring cross section are affected by the following factors: (1) flow through each of the 800-foot-long powerhouses on either side of the spillway, (2) flow through numerous 8.5-foot outlet tunnels through the dam, and (3) flow through a combination of any of the 11 gates in the 1,650-foot long central spillway. Downstream, Chief Joseph Dam causes backwater at all stages and provides the control.

Bridgeport.—The measuring cross section is just above the recording gage (station 12–4380 at river mile 544.0) in a straight channel reach about 1.5 miles downstream from Chief Joseph Dam and about 0.6 mile downstream from a highway bridge. The measuring section is fairly uniform and velocities are high at all stages. The flow is somewhat disrupted by powerplant operations, highway bridge piers, and by a bedrock spur that extends several hundred feet streamward from the left bank, about 900 feet upstream from the cableway. The bed material is composed of well-rounded boulders that overlie bedrock.

Rocky Reach Dam.—The measuring cross section is in a straight channel reach at an auxiliary recording gage (at river mile 471.1), about 2.4 miles downstream from Rocky Reach Dam. It is 1.9 miles downstream from the gaging station (12–4537) at Rocky Reach Dam. The section is uniform and the bed material consists of well-rounded rocks.

Trinidad.—The measuring cross section (station 12–4645 at river mile 441.0) is in a straight channel about 12 miles downstream from Rock Island Dam. The cable section is now in backwater from Wanapum Dam and has been abandoned. The section is uniform and the bed material is well rounded to subangular.

Below Priest Rapids Dam.—The measuring cross section is in a straight channel reach at the recording gage (station 12–4728 at river mile 394.5), about 2.5 miles downstream from Priest Rapids Dam. The section is uniform and the bed material is well rounded.

Paterson Ferry.—The measuring cross section is in a straight stretch of channel at a former ferry crossing (at river mile 278.2), 13.8 miles downstream from McNary Dam. All discharge measurements are made from a tugboat positioned by triangulation from the banks; the measurements are referred to a recording gage (station 14–0192) located 1.2 miles

TABLE 1.—*Channel and flow characteristics of measuring cross sections at gaging stations on the Columbia River*

[For each locality the upper figure indicates data at highest stage; the lower figure, data at lowest stage]

Gaging station		Discharge (cfs)	Area (sq ft)	Width (ft)	Mean depth (ft)	Maximum depth (ft)	Mean velocity (fps)	Bank slope (degrees)		Bed material size (ft)	
Location	No.							Left	Right	Max	Median
At Grand Coulee Dam	12–4365	505,000	44,600	785	56.8	91.7	11.32	31	22	4.9	1.3
		75,600	22,100	560	39.5	56.8	3.42				
At Bridgeport	12–4380	488,000	43,000	1,100	39.1	52.1	11.36	18	12	4.3	.8
		64,800	13,600	850	16.0	23.7	4.76				
At Rocky Reach Dam	12–4537	506,500	53,000	1,270	41.7	61.6	9.56	7–14	15	1.6	.35
		59,800	25,800	910	28.4	36.4	2.35				
At Trinidad	12–4645	531,800	48,300	1,470	32.9	60.1	11.01	3.5–5	14	1.2	.4
		60,400	16,800	750	22.4	30.2	3.60				
Below Priest Rapids Dam	12–4728	505,900	54,200	1,305	41.5	53.5	9.33	14–4.5	13	.9	.3
		72,000	24,800	1,130	21.9	29.1	3.10				
Paterson Ferry, 13.8 miles downstream from McNary Dam	14–0192	604,100	85,200	2,490	34.2	46.5	7.00	10	3	1.5	
		84,500	44,000	2,210	19.9	27.0	1.92				
Hood River Bridge, 19.5 miles downstream from The Dalles	14–1057	648,500	192,000	4,150	65.7	46.1	3.39	24	18–3		
		194,800	137,000	3,910	52.0	35.1	1.42				

downstream from the dam. The cross section is fairly uniform, and the stream bottom contains subangular to rounded material and areas of coarse sand.

Hood River Bridge.—The measuring cross section is at the downstream side of the bridge (at river mile 169.8) in a straight stretch of channel, 19.5 miles downstream from the base recording gage (station 14–1057) at The Dalles and 300 feet downstream from the auxiliary recorder. Except for the shelf of bedrock and sand which extends from the right bank, the streambed is fairly uniform and is composed of small granular material.

There are eighteen 6-foot and two 10-foot piers at the measuring section. Although these piers do not quite extend into the measuring cross section, they cause a disturbance of the horizontal distribution of velocities. The verticals of each discharge measurement are distributed at random relative to the piers but are not nearer than 20 feet to any pier. The pier areas are subtracted from their respective subareas in the cross section. Constriction of flow by the piers causes higher than normal velocities above and below the bridge. Regulation of flow for power generation at The Dalles Dam, 21.7 miles upstream, causes the altitude of the river surface to fluctuate continuously over a range of about 0.3 foot.

TYPES OF DATA COLLECTED

The field data collected in this report were obtained at the seven described gaging sites on the Columbia River in Washington and Oregon. The types of data and methods used to collect the data are as follows:

1. Seventeen discharge measurements were made at the seven gaging sites on the Columbia River (fig. 1). At least two measurements were made at each site. Four measurements were made at Grand Coulee Dam, and three were made below Rocky Reach Dam. From 22 to 40 verticals were included in each discharge measurement. Velocities were observed at 10 points in each vertical and these velocity observation points were spaced at intervals of 0.10 depth beginning at 0.05 depth (5 percent of total depth measured from water surface at indicated vertical) and ending at 0.95 depth, except where the distance from the 0.95 depth to the streambed was less than the 1.5 foot distance between the current meter and the base of the sounding weight. (See table 2, footnote 1.) In addition to the 10 velocity observations, velocities were also observed at 0.20 and 0.80 depths. A predetermined sequence of measuring the velocities was not used for all measurements. The data collected for each discharge measurement is tabulated in table 2.
2. Ten-point velocity observations were made at selected verticals during regular discharge measurements at four of the gaging sites. At the

three sites in Washington, 10-point velocity observations were made at five verticals in the cross section, each vertical located at the same point for each measurement. These measurements were made three times at Grand Coulee Dam, four times at Bridgeport, and six times below Rocky Reach Dam. At Hood River Bridge, Oregon, 10-point velocity observations were made at three to six verticals in the cross section. Eight sets of observations were made at this site in Oregon. Table 3 lists the data collected during all observations.

3. Velocities were observed continuously for 4 minutes at each of 10 points in four or five selected verticals across the measuring section at three gaging sites—Grand Coulee Dam, Bridgeport, and Rocky Reach Dam. These observations were made once at Grand Coulee Dam. These observations were made once at Grand Coulee Dam, twice at Bridgeport, and three times below Rocky Reach Dam. These data were divided into intervals of 1, 2, and 4 minutes and are tabulated in table 4.
4. So that velocities could be observed as close to the streambed as possible, a special bracket (fig. 2) that permits the suspension of a

FIGURE 2.—Special bracket for suspending current meter to 0.5 foot above streambed.

current meter below the sounding weight was designed by the personnel of the Spokane subdistrict office, Washington district, U.S. Geological Survey. The bracket was designed to allow the measurement of velocities with the current meter to 0.5 foot above the streambed and also to protect the current meter from damage. The current meter was tested in the rating flume of the Bonneville Hydraulics Laboratory with the same suspension (a 150-pound Columbus-type sounding weight on top of the meter bracket) as that used to obtain velocites in the river. The current meter was rated using the specially designed bracket and the standard rod suspension. Practically no effect on the rating was introduced by the weight and bracket for velocities below 5 fps (feet per second). A slight underregistration in the current meter was noted for velocities between 6 and 7 fps (about 1.5 percent of the rod rating). No velocities above 7 fps were measured. Using the special meter bracket, velocities were observed continuously in selected verticals for about 3 minutes at each of 12 points at and above the 0.95-depth point and at several points below this depth. Velocity observations taken in two to four verticals across the measuring sections at Grand Coulee Dam, Bridgeport, Rocky Reach Dam, and below Priest Rapids Dam. Velocity observations were recorded to the nearest five revolutions of the current meter for intervals of 1, 2, and 3 minutes and coverted to feet per second. These data are presented in table 5.

5. Synchronous velocity observations at 10 points in a vertical were recorded continuously for 66 minutes. Ten current meters were suspended on a long hanger bar at 0.10-depth intervals beginning at 0.05 depth from the water surface. Figure 3 shows a photograph of the suspension and figure 4 shows a sample of the strip chart on which the record was made. The recorder was connected to each of the current meters, and every time that one of them made five revolutions, a blip was recorded on the strip chart. From the strip chart, velocities were determined for each 1-minute interval. The velocity data are tabulated in table 6.

An attempt was made to maintain a constant stage height during the 66-minute time span. Outflow from the Priest Rapids Dam was held as uniform as possible, and the stage recorder at station 12–4728 (p. F4) was checked frequently. In spite of this, however, it was not possible to avoid very slight fluctuations in stage. (See p. F10. fig. 5).

DEVELOPMENT OF THE VERTICAL VELOCITY CURVE

The shape of the vertical velocity curve is determined by plotting velocity measurements at several (usually 10) points well distributed in

FIGURE 3.—Hanger bar with 10 Price current meters spaced at 0.10-depth intervals and used to obtain data at vertical 280, Columbia River below Priest Rapids Dam, August 14, 1963. Depth to streambed at station was 21 feet.

the vertical section, from just below the water surface to just above the streambed. Then, by graphical integration of the curve, the mean velocity is obtained. The mean velocity so determined can be considered close enough to the true mean velocity that it can be used as a basis for comparing the accuracy of velocities obtained by other methods.

Past studies of vertical velocity curves show that their shape generally corresponds to a parabola, the axis of which is parallel to the water surface (Corbett and others, 1943, p. 35). The axis coincides with the maximum velocity in the vertical and is between the water surface and one-third of the depth. The velocity decreases upward from the axis to the water surface and downward to the streambed. The change in velocity

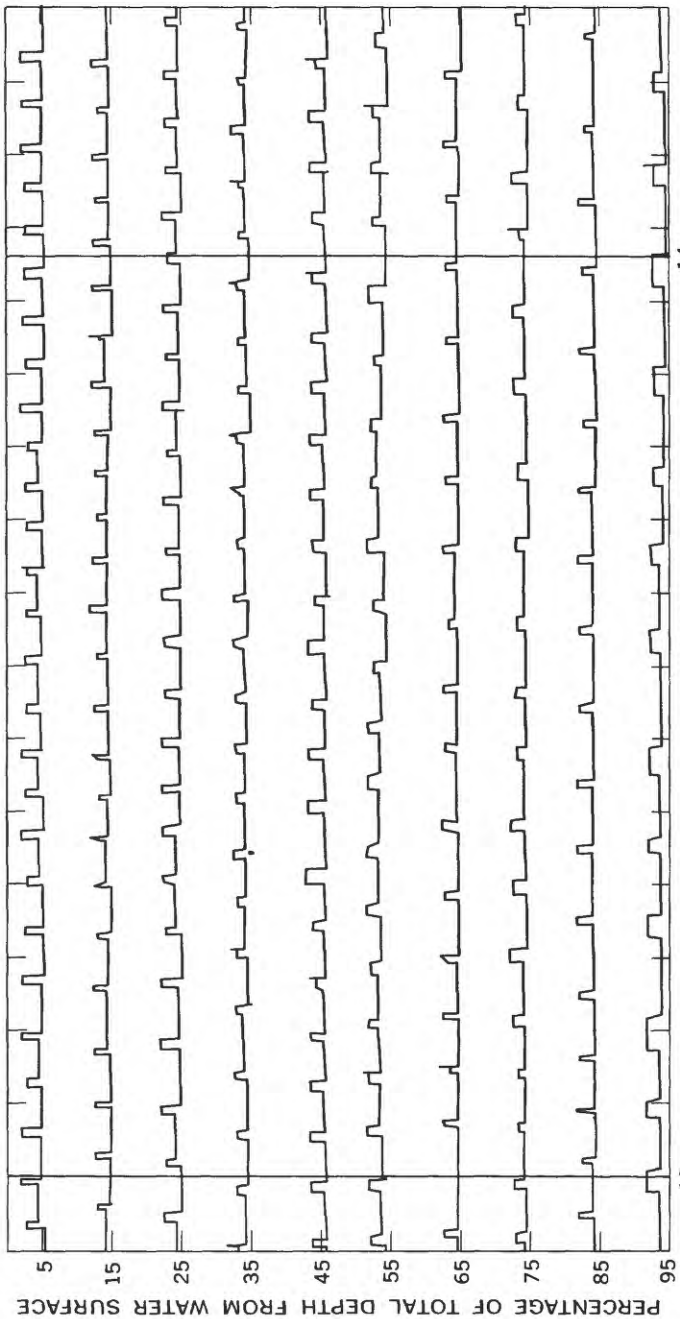

FIGURE 4.—Section of continuous-recorder chart showing simultaneous record from 10 Price current meters at vertical 280, at Columbia River below Priest Rapids Dam, August 14, 1963.

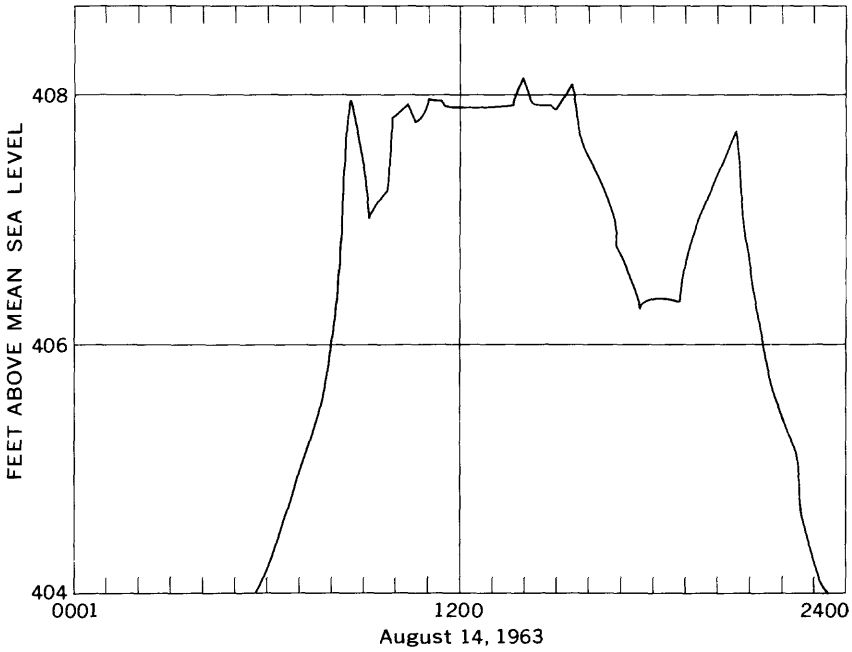

FIGURE 5.—Section of recorder chart from the gaging station Columbia River below Priest Rapids Dam for August 14, 1963, showing constant stage during test period from 1155 to 1301.

becomes more rapid close to the streambed because of the friction and turbulence produced by the bed materials.

The measurement of velocity in a vertical section is subject to two limitations. First, several minutes elapse between the first and last measurement, and second, the lowermost measurement can be made no closer than 1.5 feet above streambed (0.95 depth for sections 30 feet deep) for the larger and faster streams. These two limitations can produce errors that are manifested in the following two ways:

1. Because of the turbulence and pulsation in a large river, the mean temporal velocity in a vertical section varies with respect to time and depth. Velocity observations at points in the vertical frequently give erratic results owing to the effects of pulsation and surges upon the distribution of velocities. These pulsations and surges cause the velocity to vary in cycles lasting from a few seconds to several minutes, depending on the physical properties of the stream.
2. The method of determing the velocity curve between the lowermost velocity observation, usually 0.95 depth, and the streambed is not clearly defined, and the methods of estimation differ among

hydrologists. Some advocate extending the curve to the 0.98 or 0.99 depth and then assuming a straight line to zero velocity at the boundary. Others believe that the general curvature should be extended to the streambed as suggested by Corbett and others.[1] It can be assumed that the velocity varies as the logarithm of the distance from the streambed or that the distribution is parabolic. Both distributions are accepted in the literature (R. W. Carter, written commun., 1964). Because the rate of velocity change with depth within this segment usually is greater than within any other part of the velocity profile—from zero at the streambed to a significant fraction of the velocity at 0.95 depth— some error can be introduced into the mean velocity if this part of the profile is not properly constructed.

Some of the field data obtained during the course of this investigation provide a means of determining the nature of the velocity profile for the lowermost segment of depth—that is, the segment usually from the 0.95 depth to the streambed. Because the mean velocity as determined from the velocity profile cannot be determined precisely until the entire profile can be constructed, the characteristics of this lowermost 5-percent segment of the curve are discussed first.

DEVELOPMENT OF THE SEGMENT OF THE VERTICAL VELOCITY CURVE BELOW 0.95 DEPTH

Standard equipment used for determination of velocity in the Columbia River does not permit observations closer than 1.5 feet from the streambed. For example, when the depth is less than 30 feet, velocities in the segment from the 0.95 depth to the streambed must be determined indirectly.

Development of the velocity distribution curve below .95 depth by one method involves the construction of a velocity-depth graph on semilogarithmic paper. A straight line is fitted to the measured velocity points above the 0.95 depth and is extended to the streambed. The velocity at any point below the 0.95 depth can be read from the graph.

A second method, the parabolic method, involves the use of a power function, also called a parabolic function, which in this case takes the general form

$$V_y = K(y)^{\frac{1}{n}} \tag{1}$$

in which V_y is the velocity at any distance y from the streambed and n is a number which is about 5 for a rough streambed and about 7 for a smooth streambed (R. W. Carter, written commun., 1964). K is constant for any point in any given velocity profile.

[1] Corbett, Don M., and others, 1943, Steam-gaging procedure; a manual describing methods and practices of the Geological Survey: U.S. Geol. Survey Water-Supply Paper 888, 245 p.

Field data were obtained with the special bracket at several sites from 0.05 depth to as much as 0.99 depth in some instances (table 5). Figure 6 shows the results of one of the measurement runs, at station 660, Columbia River at Grand Coulee Dam. Regression equations for both the semilogarithmic and parabolic function curves shown in figure 6 were computed from the field measurements in the range 0.05–0.95 depth. The measurements below 0.95 depth were not used in the computation. The parabolic function follows the trend of the measured velocities below the 0.95 depth whereas the logarithmic extension (the straight line in fig. 6) yields values less than the measured velocities. This figure, together with analysis of data listed in table 5 for some of the other stations, justifies the use of the parabolic equation in computing velocities below the 0.95 depth.

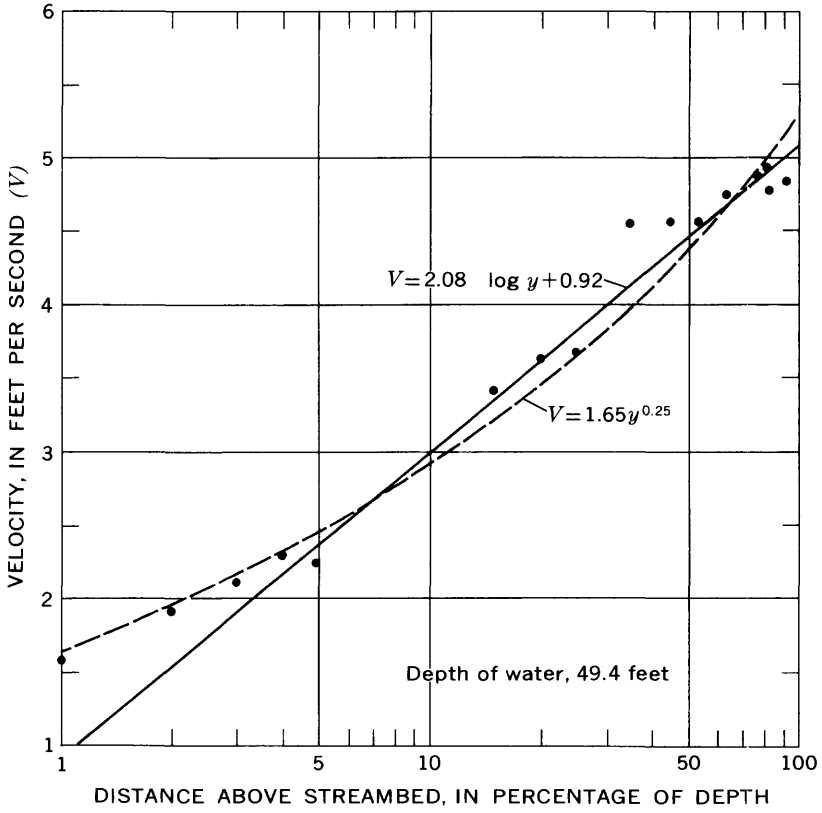

FIGURE 6.—Evaluation of velocity distribution in lower 5 percent of depth, the velocity being based on extension of curve for velocities in upper 95 percent of depth. Field data obtained March 24, 1964, at vertical 660 in measuring cross section at the gaging station Columbia River at Grand Coulee Dam.

It will be noted that in figure 6 the depth parameter is shown as percentage of depth above streambed, in contrast to percentage of depth below water surface as used elsewhere in the report. The reason for this seeming inconsistency is that the lowermost segment of the profile can then be shown in much greater detail on the logarithmic scale in figure 6. By slightly modifying equation 1 and using only the velocity at the deepest point measured, equation 1 can be used to determine the velocities in the lowermost segment of the velocity profile. For example, let us suppose that a is the distance from the streambed to the deepest point at which velocity was measured (usually the 0.90 or 0.95 depth) and y is some distance less than a. Then,

$$V_a = K(a)^{\frac{1}{n}}. \tag{2}$$

If K is assumed to remain constant throughout the distance a,

$$\frac{V_y}{y^{\frac{1}{n}}} = \frac{V_a}{a^{\frac{1}{n}}}$$

and

$$V_y = V_a \left(\frac{y}{a}\right)^{\frac{1}{n}} \tag{3}$$

Thus, if the velocity at 0.90 or 0.95 depth and the constant n are known for a particular velocity profile, equation 3 may be applied to extend the velocity profile to the streambed. The constant n need not be a whole number and may vary from station to station.

DEVELOPMENT OF THE UPPER 95-PERCENT SEGMENT OF THE VERTICAL VELOCITY CURVE

Synchronous velocity measurements were made at 10 points on the vertical at station 280, Columbia River below Priest Rapids Dam. During the period of measurement on August 14, 1963, the river was 21 feet deep and the current meter spacing was set at 10-percent intervals—from 0.05 to 0.95 depth. The simultaneous readings were continued for 66 minutes, during which time the stage remained constant, and computation of velocity (table 6) was made directly from the strip-chart record.

The simultaneous and continuous recording was made to determine the extent to which changes in velocity due to pulsations and turbulence—especially for short periods of meter exposure—can decrease the accuracy of a series of velocity measurements.The 66-minute mean vertical velocity is plotted in figure 7. As shown in the figure, the velocities at the 10 points define a smooth curve. To show the curve as it would look near the streambed, the lowermost five velocities have been computed and plotted on the graph. The curve can be extrapolated in such a manner that it will

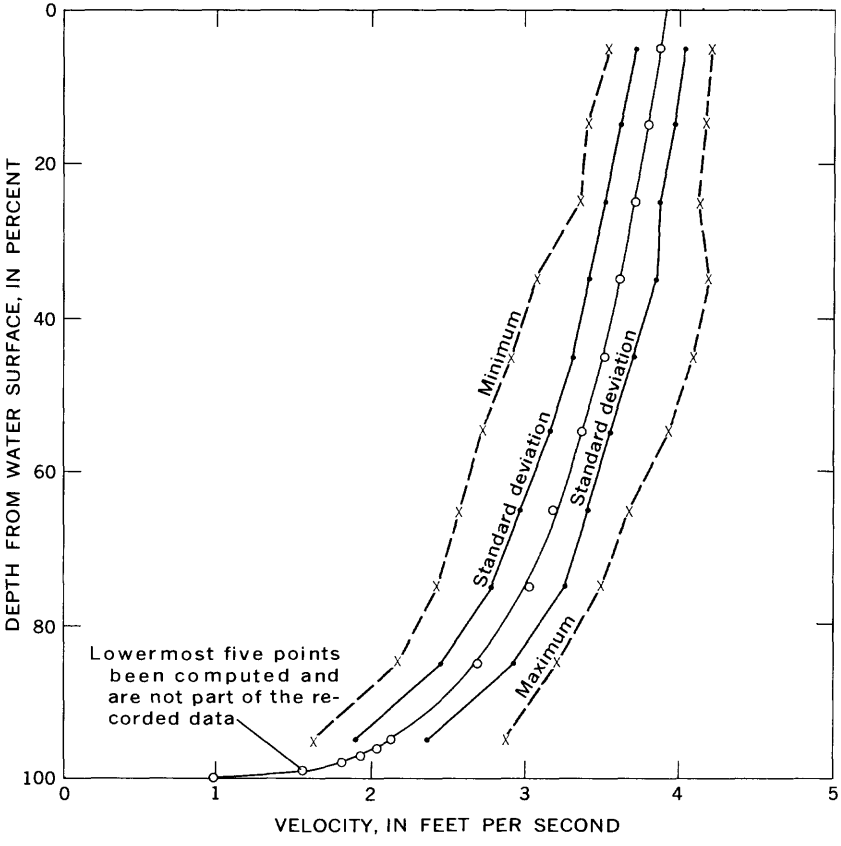

FIGURE 7.—The 66-minute mean vertical-velocity curve, vertical 280 in the measuring section at the gaging station Columbia River below Priest Rapids Dam, August 14, 1963.

pass through these points. The range between maximums and minimums indicates the extent to which velocities can fluctuate at given points in the vertical profile. At some points the fluctuation is ±20 percent.

The curve in figure 7 shows that the maximum velocity occurs near the water surface; that is, it indicates a velocity increase throughout the entire vertical from the streambed to near the water surface. In all but 10 of the sixty-six 1-minute profiles, the velocity was greater at 0.05 depth than at any other depth at which velocity measurements were made.

The pattern of maximum and minumum 1-minute velocities at each 0.10-depth during the 66-minute time span also is plotted in figure 7 and is shown by dashed lines. The mean velocity for the 10-point minimum profile is 2.79 fps, and the mean for the 10-point maximum profile is 3.73 fps. The standard deviation was computed for each tenth

depth in the vertical. These values, also plotted in feet per second, increase from 0.16 fps at 0.05 depth to 0.24 fps at 0.75 depth, then decrease to 0.236 fps at the 0.95 depth.

DETERMINATION OF MEAN VELOCITY

The mean velocity in the vertical was determined by integrating the vertical velocity curve. From the 66-minute data, the mean velocity was computed to be 3.30 fps, and this velocity was considered the base velocity, or the best computation of mean velocity that could be obtained from the 66 minutes of continuous record. This computed mean velocity is the same as that obtained by averaging the 10-point velocities. Therefore, the mean velocities for each 1-minute segment of the 66-minute run were determined by averaging the 10–point velocities. These means are listed in table 6.

To represent the mean velocity in the vertical in streams generally more than 2.5 feet deep, the Geological Survey normally uses the two-point velocity method, which provides the average of the velocities obtained at the 0.20 and 0.80 depths. The Survey occasionally uses the one-point velocity method, which takes the 0.60-depth velocity as representative of the average in the vertical. The velocities determined by the two methods for the Columbia River below Priest Rapids Dam, as read from the 66-minute mean vertical velocity 1 curve (fig. 7), are both 3.30 fps, or the same as the base velocity.

MAGNITUDE OF VELOCITY FLUCTUATIONS

Comparison of the velocity profiles obtained by plotting each set of successive 1-minute velocity readings shows that no two profiles are exactly alike. The extent to which successive curves can differ is shown in figure 8. In this figure, the curves for each of the first 6 minutes of the 66-minute run have been plotted. Of these the one for the third minute represents a drift in velocity of 3.9 percent below the mean and the one for the fourth minute represents a drift of 2.4 percent above the mean. The 6-minute average is 3.27 fps, 0.9 percent below the 66-minute mean.

In figure 9 are shown six additional velocity-distribution curves selected from among the 66 to illustrate the variations in shape that can occur. These, of course, show a greater variation in shape than those for consecutive minutes. The 18th-minute curve has a half-bell shape, and the velocities increase more rapidly near the water surface than in the middle part of the vertical—a comparatively unusual occurrence. Above the 0.65 depth for the 28th-minute curve, the velocities are almost constant. The 51st-minute curve shows a rapid increase in velocity from the streambed to about 0.40 depth and then becomes virutally constant to the water surface. The maximum velocity in the 63d-minute curve occurs

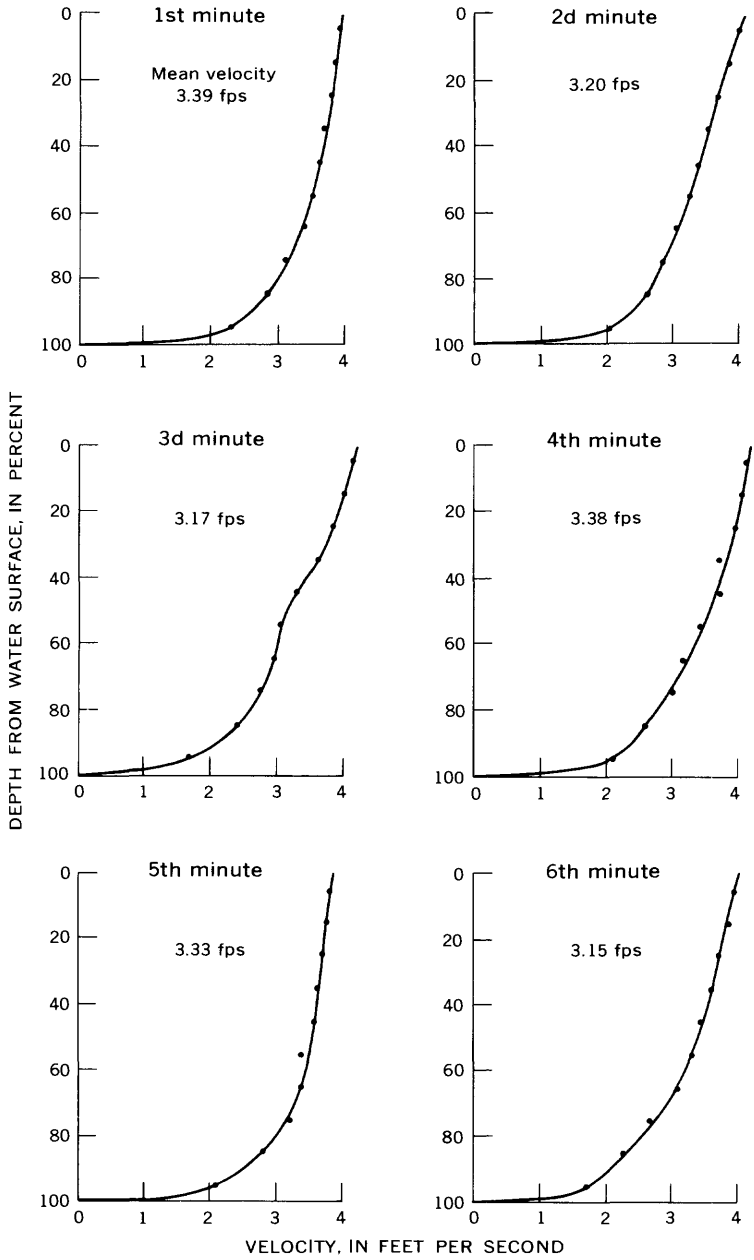

FIGURE 8.—One-minute vertical velocity curves showing variations in shape and velocity for 6 consecutive minutes at vertical 280 at the gaging station Columbia River below Priest Rapids Dam, August 14, 1963.

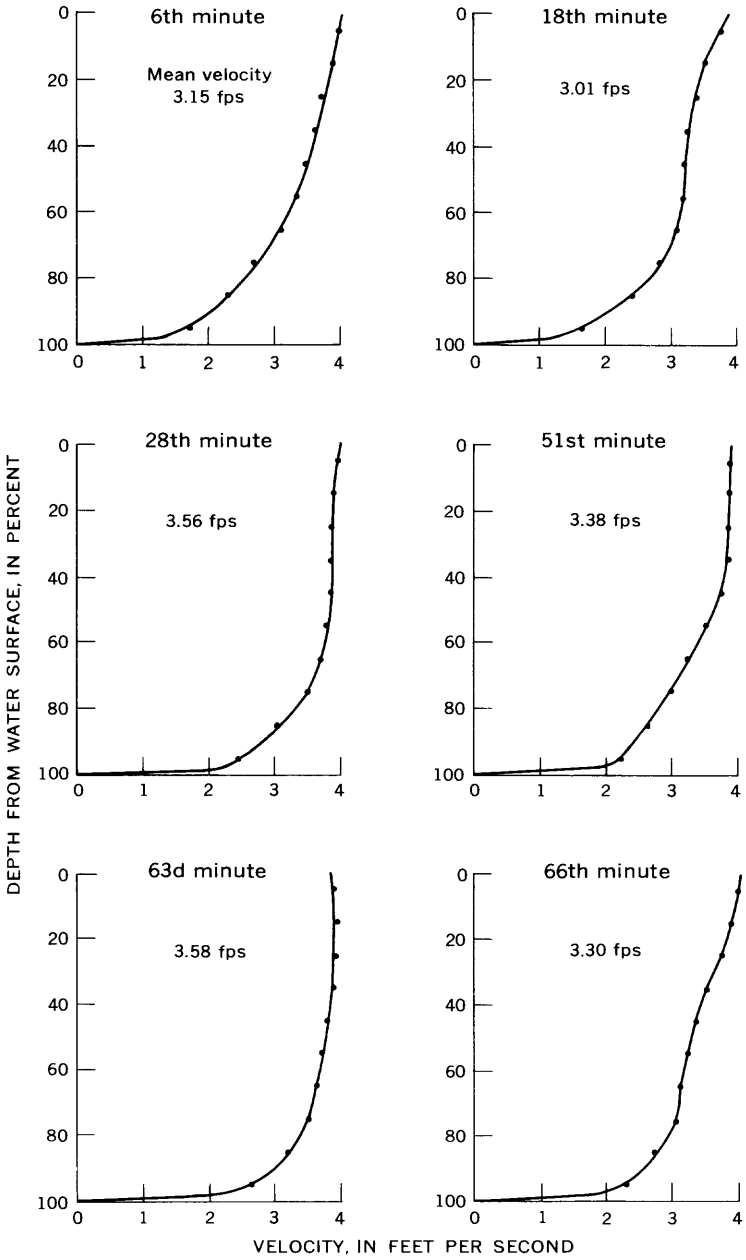

FIGURE 9.—Selected 1-minute vertical velocity curves showing variations in shape at different times at vertical 280 at the gaging station Columbia River below Priest Rapids Dam, August 14, 1963.

near the 0.20 depth and then decreases toward the water surface. The various shapes of the curves in figure 9 indicate that vertical velocity curves do not conform to any specific pattern.

Although the shapes of the 1-minute vertical velocity curves are different, the mean velocities are often the same for two or more 1-minute periods during the 66–minute run. Of the sixty-six 1-minute vertical velocity curves, 43 curves (19 sets) have mean velocities that are almost the same. Velocities during 31 of the sixty-six 1-minute periods are within 3 percent of the 66-minute mean.

Figure 10 shows a plot of 1-minute velocities (from table 6) at the 0.05, 0.35, 0.65, and 0.95 depths. As shown in figure 10, velocities obtained at different depths in the vertical profile fluctuate significantly. The summary of maximum and minimum 1-minute velocity measurements in table 6 shows that the velocities obtained at 0.05 depth had the smallest range—0.66 fps—and those at the 0.55 depth had the largest range—1.22 fps. The standard deviation, expressed in feet per second, of the velocity at each point in the vertical tended to increase with depth—from 0.16 fps at 0.05 depth to a maximum of 0.24 fps at 0.75 depth. The boundary conditions affected the velocities closer to the streambed and caused more turbulence and therefore relatively greater variations. The relation is shown in greater detail in figure 11. The standard deviation, expressed as a percentage of the mean velocity, ranged from about 4 percent near the surface to 11 percent at 0.95 depth, indicating the large variations that can occur close to the streambed.

Most of the discussion to this point has been concerned with vertical changes in velocity and changes in shape of the velocity-distribution curve. In addition to these variations, the mean velocity continually is changing—the velocity during the 66-minute period ranged from 2.79 fps to 3.73 fps (table 6). To determine whether this change occurred according to any pattern, the 1-minute mean velocities and their cumulative departure have been plotted (fig. 12). The standard deviation of the means was computed as 0.17 fps; that is, approximately two-thirds of the 1-minute means are within ± 0.17 fps (± 5.1 percent) of the 66-minute mean velocity. Although figure 10 shows that velocity appears to fluctuate randomly through time, figure 12 shows some significant "long term" trends. For the first 22 minutes of record (fig. 12, table 6), nine 1-minute mean velocities were above average and 13 were below; for the second 22 minutes, 13 were above average and nine were below; and for the final 22 minutes, 12 were above average and 10 were below. The occasional large deviations (see the 14th, 15th, and 42d minutes) are largely responsible for much of the departure from the 66-minute mean. As discussed earlier (p. F8), very minor fluctuations in stage occurred during the course of the 66-minute run.

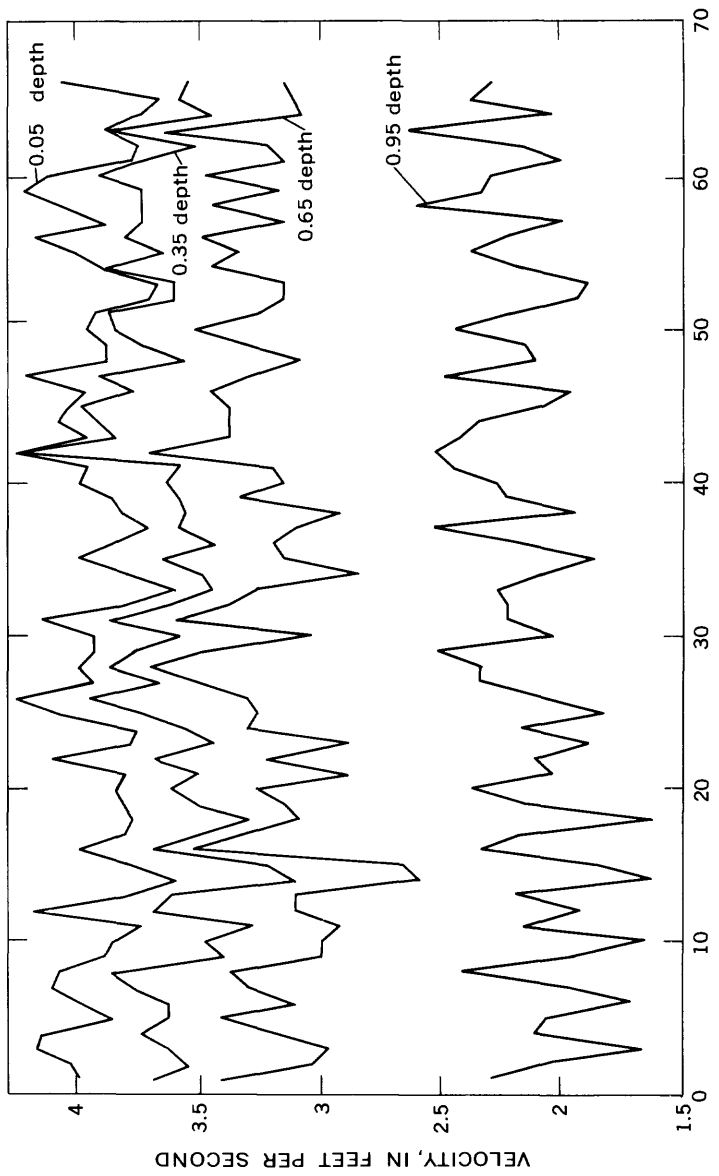

FIGURE 10.—Fluctuation of velocity at four different depths in vertical velocity profile at vertical 280 at the gaging station Columbia River below Priest Rapids Dam, August 14, 1963.

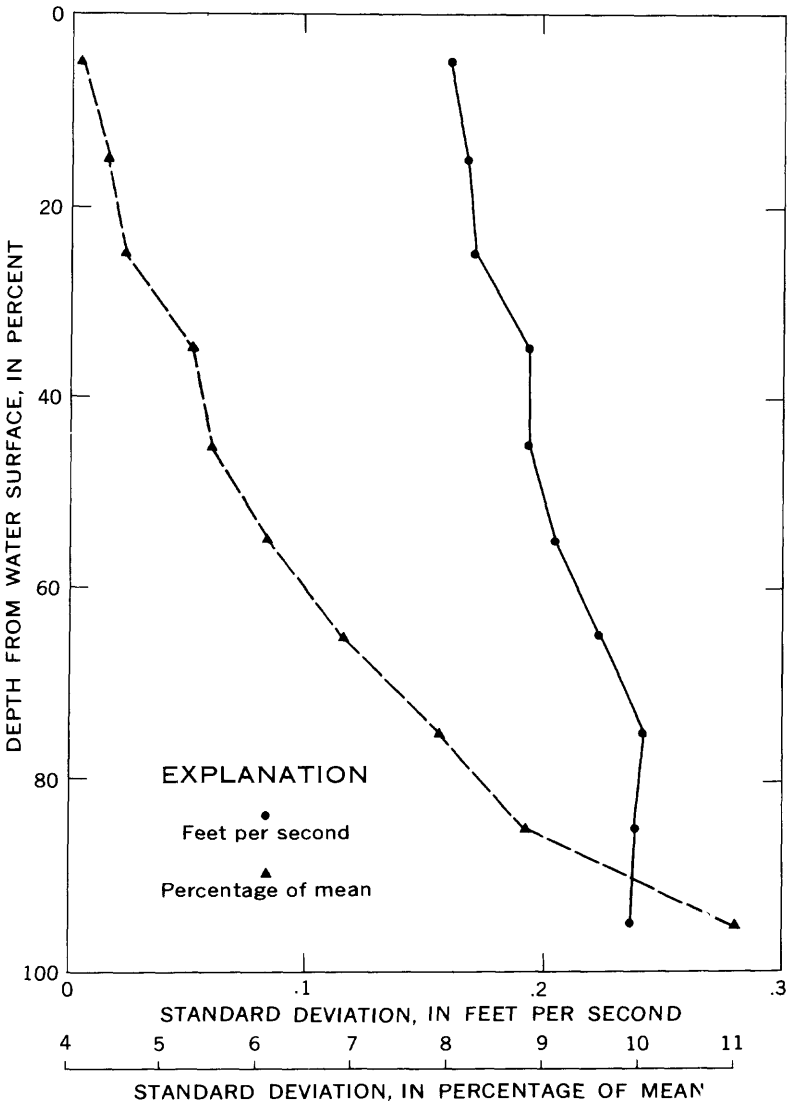

FIGURE 11.—Standard deviation from the 66-minute mean velocity at 10 different depths in vertical velocity profile at vertical 280 at the gaging station Columbia River below Priest Rapids Dam, August 14, 1963.

OPTIMUM TIME OF OBSERVATION

Because of the described fluctuations in mean velocity, it became necessary to determine the minimum length of time that the current meter could have been exposed at a specific point in the vertical to

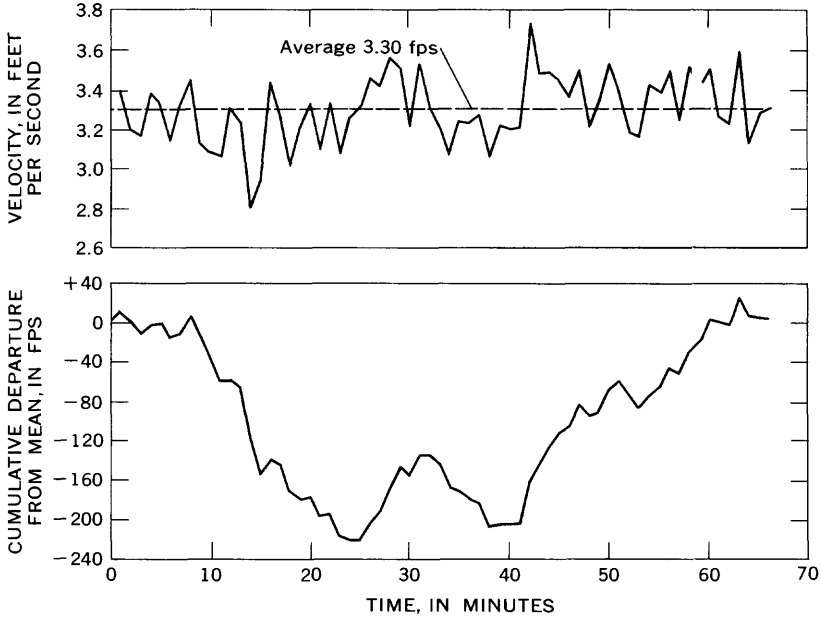

FIGURE 12.—Fluctuation of 1-minute mean velocities and cumulative departure from 66-minute mean at vertical 280 at gaging station Columbia River below Priest Rapids Dam, August 14, 1963.

obtain a mean velocity whose accuracy was reasonably close to that obtained during the entire 66-minute run. By using the 66-minute data the problem was approached as follows:

1. The highest and lowest individual 1-minute velocities were listed.
2. The 66-minute interval was divided into 2-minute intervals, beginning with the first minute. The highest average of two consecutive 1-minute velocities was listed.
3. The same procedure was followed to determine the lowest average of two consecutive 1-minute velocities.
4. The 66-minute interval was divided into 3-minute intervals, beginning with the first minute, and the highest and lowest averages were determined as described above; this procedure was followed for divisions of 4-minute intervals, and so on.

The list of average maximum and minimum velocities as developed in this fashion for each of the 10 depth intervals appears in table 7. In the table, for the 0.05-depth interval, the velocity alined in the 1-minute column opposite "Max," of 4.22 fps, is the highest individual velocity for that depth interval during the whole 66-minute run. The fact that the maximum velocity occurred during the 26th minute is not relevant.

The velocity of 4.13 fps, alined in the 2-minute column opposite "Max," is the average of the velocities for the 25th and 26th minutes. Similarly the highest 3-minute average, 4.08 fps, is for the second, third, and fourth, minutes and also for the 58th, 59th, and 60th minutes. The minimum 2-minute average for the 0.05 depth, 3.65, is for the 14th and 15th minutes, the 33d and 34th minutes and the 52d and 53d minutes. Table 7 and figure 13 show that, as the time intervals become longer, the range between the consecutive extremes becomes smaller; the largest variation occurs during the 1-minute time periods for each depth interval, and the smallest during the 30-minute period.

The fact that this relationship must exist is obvious from the mode of construction of table 7. The 1-minute maximum is, of course, the highest that occurred during the whole run. The 2-minute maximum is either (1) the average of two numbers of which one is the 1-minute maximum and the other is a number that is less than the maximum, or (2) the average of two numbers of which both are less than the maximum but whose average is larger than (1). For the 1-minute period the range is 0.66 fps at 0.05 depth and 1.22 fps at 0.55 depth. Significant to the problem is the fact that the ranges decrease rapidly to about the 4-minute time periods and then decrease at a much more gradual rate to 30 minutes. At each depth the 4-minute average velocity generally differed from the 30-minute average by less than 1 percent. The 4-minute mean velocity differed from the 66-minute mean by only 0.3 percent.

Consistently, the smallest ranges occur at 0.05 depth and the largest ranges occur between 0.35 and 0.75 depth— except for the 30-minute time period when the largest range occurs at 0.95 depth. Because of the effect of the streambed, discussed earlier, velocities near the boundary would be expected to show the greatest amount of variation. This analysis, however, indicates that at this specific site the velocities vary the most in the middle part of the vertical velocity profile.

The standard deviation of the velocities for a few time periods were also computed and are shown as dashed lines in figure 13. Similar to the range of velocity extremes, the standard deviation decreases fairly rapidly to the 4-minute periods, after which very little change occurs.

COMPARISON OF MEAN VELOCITIES DETERMINED BY VARIOUS METHODS

In this section, the relative adequacy of two methods of determining velocity will be discussed. They are the one-point method, where a lone velocity observation is obtained at 0.60 depth from the surface, and the two-point method, where two observations are obtained, one at 0.20 and the other at 0.80 depth. The velocities obtained by these methods are compared with those determined from the integrated vertical velocity profile.

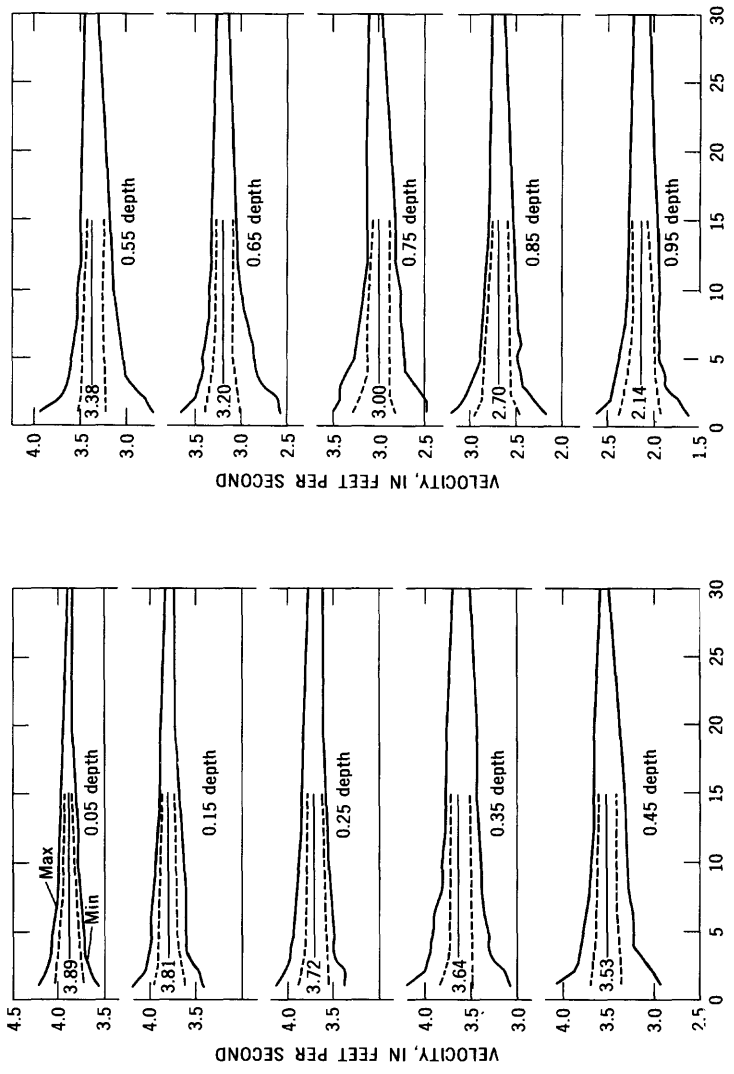

FIGURE 13.—Average maximum and minimum velocities during various time intervals at vertical 280 in the measuring cross section at the gaging station Columbia River below Priest Rapids Dam, August 14, 1963. Standard deviation is shown by dashed lines.

Data will be compared for each of many individual vertical velocity profiles and, in addition, will be compared for complete discharge measurements.

MEAN VELOCITY IN THE VERTICAL

The relations between the integrated mean velocities and the one- and two-point velocities for each of the 1-minute periods during the 66 minutes of continuous observations were analyzed. As part of the analysis, deviations of the two-point mean velocity from the integrated-curve mean velocity were computed. For the two-point mean velocity, the deviation from the curve mean velocity for each of the 66 minutes ranged from +0.07 to −0.04 fps. For the one-point velocity, the deviations had more scatter, ranging from +0.20 to −0.17 fps.

The foregoing data from the 66-minute run indicate that, at least for the one vertical velocity profile for which data were collected, the one- and two-point methods each would have yielded mean velocities of acceptable accuracy. To determine the consistency of this accuracy, the comparison was carried out for data from several other gaging stations and for all verticals in the measuring cross sections.

The two-point velocity measurements were compared with the integrated-curve mean velocity for each vertical profile, and the percentage differences between the two were listed. The frequency distribution of the 600 resultant values was compiled and is shown graphically in figure 14. On the basis of a graphical fit of the frequency curve, the velocities determined through the use of the two-point method are 0.7 percent higher than the integrated-curve mean. The average percentage differences computed for the 600 vertical velocity curves agree quite closely with the average obtained from the 66 minutes of continuous observations.

Similar to the two-point velocity measurements, the one-point determinations also were compared with the integrated-curve means for 600 vertical velocity curves. The frequency distribution of the percentage differences (fig. 15) shows that the velocities obtained by the one-point method are 0.7 percent higher, the same value as that for the two-point method. However, the average percentage differences are greater than the average for the 66-minute run.

An observation of the two frequency graphs shows that the slope and median deviation of the frequency curves for the two-point and one-point methods is approximately the same. This similarity indicates that both methods have about the same variability and that, at least for this group of vertical velocity curves, either method will give comparable results. It also is noted that the accuracy of of both the one- and two-point methods is at least as good as that of the 10-point method for the

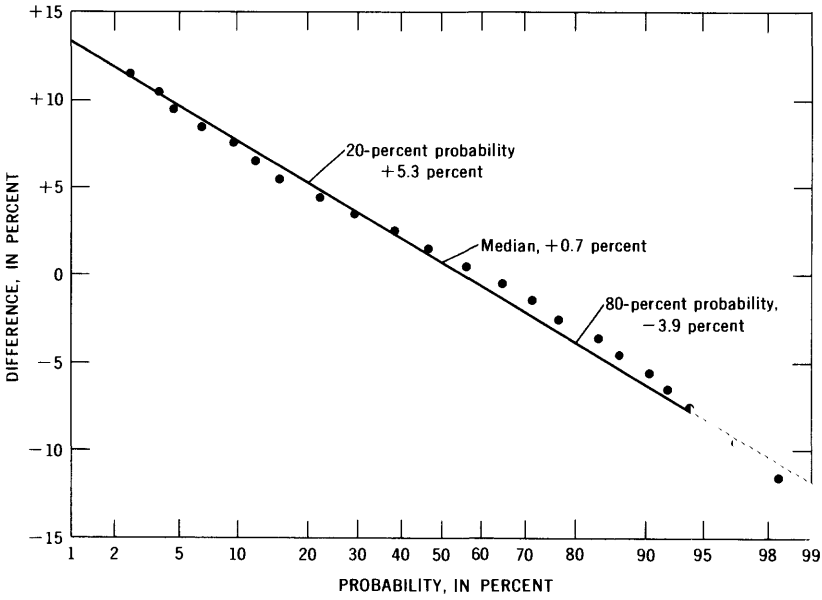

FIGURE 14.—Frequency distribution of percentage difference between two-point and integrated-curve mean velocities.

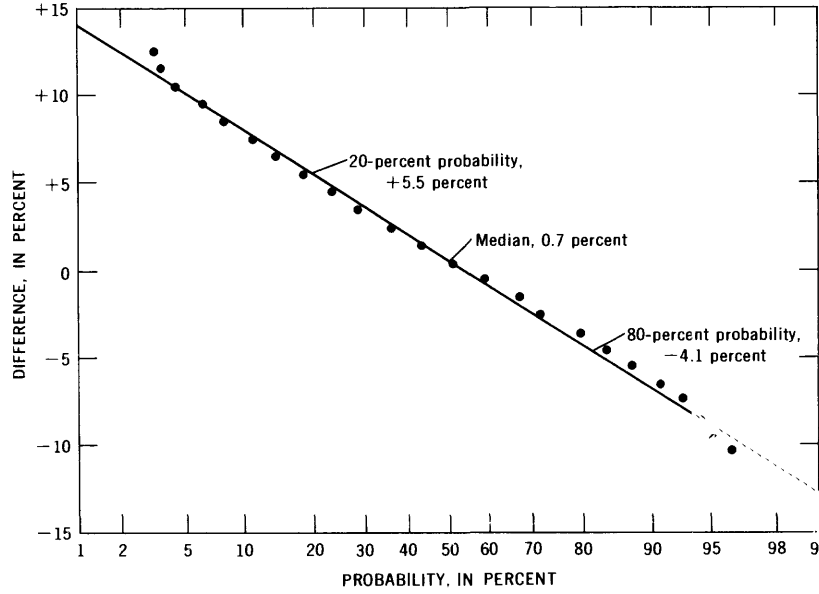

FIGURE 15.—Frequency distribution of percentage difference between one-point and integrated-curve mean velocities.

particular curves cited. The accuracies of all three methods are, of course, relative and are compared with the integrated-curve mean as a base.

MEAN RIVER VELOCITY

From the data listed in table 2, the mean velocity of the Columbia River was determined at seven gaging stations, by using the midsection method of computing discharge. In all, 17 mean velocities were computed. The means were determined through use of the one-, two-, and 10-point methods. Measurements for the two-point method were obtained at the 0.02 and 0.80 depths as part of the 10-point traverse, whereas the data for the one-point method (0.60 depth) were not obtained in the field but were interpolated from the measured velocities at 0.55 and 0.65 depth. These means were compared with the mean velocity obtained by integrating the depth-velocity profile at all verticals in the measuring cross section; this comparison is made on the assumption that the base river velocities, as determined by integrating the velocity curves, are the most accurate. All are listed in table 8, which also lists the base river velocities and the velocities obtained by the other three methods, along with the percentage of their deviations from the base velocities.

The deviation of the velocities obtained by the 10-point method ranged from −1.3 to +1.7 percent and averaged −0.2 percent, while that of the two-point method ranged from a −1.4 to +1.6 percent and averaged +0.3 percent. Although the ranges in deviations for the two methods were the same, the mean river velocity determined by the 10-point method was generally smaller than that obtained by the two-point method. When determined by the one-point method, the deviation ranged from −1.9 to +4.4 percent and averaged +0.1 percent.

Although the average percentage difference in the velocity for the one-point method is small for the 17 discharge measurements, the large range shows that there must be a significant difference at one or more of the individual stream-gaging sites. Inspection of the table shows large deviations at Grand Coulee Dam for four measurements and at Trinidad for two measurements (−1.6 percent and +4.3 percent, respectively). Only by chance did the positive percentages at the one station compensate for the negative values at the other.

EVALUATION OF METHODS OF COMPUTING RIVER DISCHARGE

From the 17 sets of velocity measurements at seven gaging stations on the Columbia River (table 2), discharges were computed by both the midsection and mean-section methods. Before discussing the results of the two computations, a brief outline of the two methods is given below.

MIDSECTION METHOD

The usual method of measuring discharge is to break the measuring cross section into at least several smaller sections, to explore the velocity-depth relationship in each, and then to combine these to obtain aggregate flow. The total discharge divided by the cross-sectional area then gives the mean river velocity. In the midsection method, the mean velocity and depth observations for a given velocity profile are assumed to be valid throughout an area that extends halfway to the preceding and following verticals. The midsection method was used in the early years of the Geological Survey's water-resources investigations, and in about 1944 it was adopted as the "standard method" in preference to the mean-section method. The chief advantage of the midsection method is that it saves time in computing a discharge measurement.

MEAN-SECTION METHOD

In computing discharge or mean river velocity by the mean-section method, a linear change in velocity and depth from vertical to vertical in the measuring cross section is assumed. Each vertical is the common boundary between adjacent subsections in the whole cross section. The area of the small section is the product of the width between the two verticals and the mean of their depths. The product of the mean velocity of each two verticals and the area between them is the discharge in the section, and the sum of the discharges in all the sections is the discharge of the stream.

STREAMFLOW COMPUTATION BY THE TWO METHODS

The mean-section method will produce a value of discharge slightly less than that obtained by the midsection method. The extent to which it will be less is a function of the difference in velocity and depth from section to section. This difference can be shown simply by assuming values for two adjacent verticals and computing flow. For example, if two verticals w distance apart were assigned velocity and depth of V, d and $V + \Delta V$, $d + \Delta d$, respectively, the quantity of water flowing in unit time would be

$$wVd+\frac{w}{2}(V\Delta d+d\Delta V)+\frac{w}{2}(\Delta V\Delta d)$$

for the midsection method, and

$$wVd+\frac{w}{2}(V\Delta d+d\Delta V)+\frac{w}{4}(\Delta V\Delta d)$$

for the mean-section method. The second is smaller, of course, by the factor, $\frac{w}{4}(\Delta V \Delta d)$.

This relationship is demonstrated further by means of an example (fig. 16, table 9). The heavy lines represent the bases on the two cross sections (fig. 16) and encompass areas that are the same as those produced by connecting the observed depths with straight lines (shown by the light lines in the figure). After assigning depth and mean-velocity values to each of the 11 verticals in the section, a simple computation (table 9) shows that the discharge computed by the mean-section method for this example is less by about 3 percent. Note, however, that the entire cross-

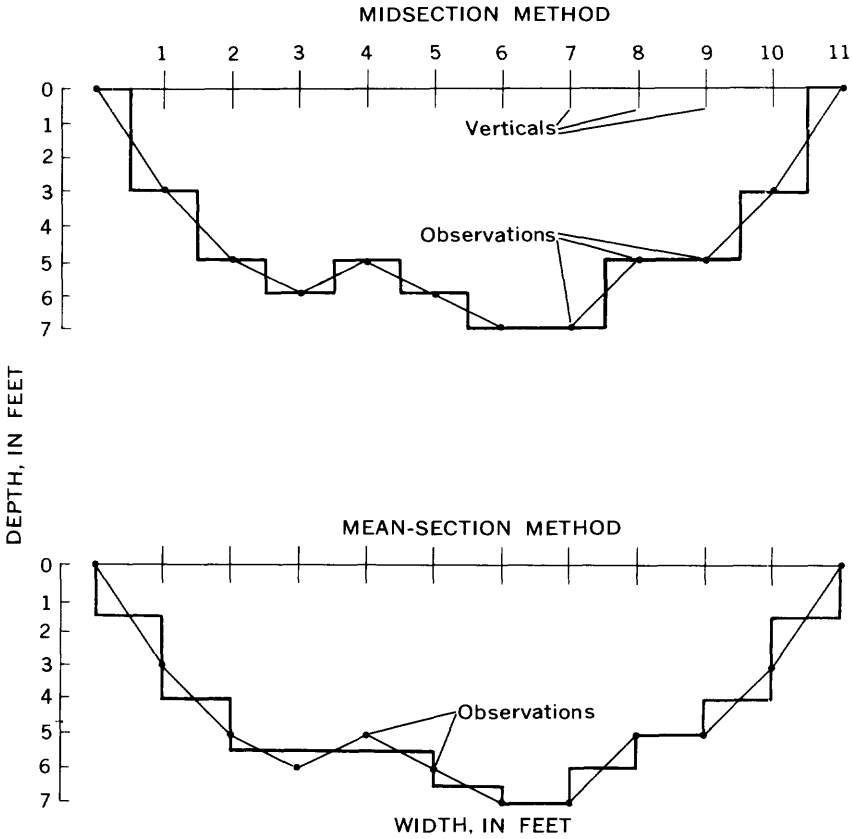

FIGURE 16.—Application of midsection and mean-section methods to a stream cross section. Heavy line represents area computed by the particular method. Note that by either method, the total area is the same as would be computed by connecting observed points with straight lines.

sectional area is the same by either method. Obviously, the mean stream velocity also would be 3 percent less by the mean-section method. For this example, then, the factor $\frac{w}{4}(\Delta w \Delta d)$ is equal to 3 percent.

To make a comparison of the two methods in computing flow from actual field data, 17 discharge measurements on the Columbia River were determined by each method (table 10). As expected, the mid-section method gives discharges that are greater than those obtained by the mean-section method.

The percentage difference in discharge obtained by the two methods ranges from -0.2 for the measurement of June 5, 1961, at Hood River Bridge, to -1.6 for the measurement of June 20, 1961, at Grand Coulee Dam. The average was 0.6 percent less by the mean-section method. The velocities at several verticals near the right bank at Hood River Bridge were notably low during the measuring period, and depths at either bank were relatively shallow. These channel and flow characteristics probably are a factor in the close agreement between the two methods. On the other hand, the banks at the Grand Coulee Dam measuring section are steep, the velocities are relatively high, and the first section from each bank was taken at two or three times the width of the remaining sections of the cross section. These differences in the near-bank conditions doubtless cause the greater difference between the two methods of measurement computation at Grand Coulee Dam.

In general, it is desirable to measure one or two extra stations near each bank in stream channels that have large differences in depths and velocities near the banks. For example, an attempt was made to increase the accuracy of the June 20 computation at Grand Coulee Dam by assuming two additional measuring stations near each bank. By estimating the depths and velocities (by linear interpolation) at these stations and by recomputing, the discharge is reduced 0.8 percent by the midsection method and is increased 0.4 percent by the mean-section methods. As a matter of interest, the difference in discharge computed by the two methods was reduced from 1.6 percent to 0.4 percent.

SUMMARY

The velocity data obtained for this study show that the shape of the vertical velocity curve differs significantly from the shape assumed in the past. The velocities generally increase continuously from the streambed to the water surface, the maximum occurring near the water surface.

Of the two methods for extending the vertical velocity curve below 0.95 depth, the logarithmic method showed no agreement at all between the log curve fitted to points plotted above and below that depth. The

power function, when applied to that part of the velocity curve below 0.95 depth, agrees with the plotted data although agreement with field data above the 0.95 depth is not good. In general, other data not specifically shown justify the use of the power function in extending the velocity curves below the 0.95 depth.

The averages of the continuous velocity observations for 66 minutes at 10 points constituted the basis for allowing construction of a smooth vertical velocity curve that increased continually from the streambed to the water surface. The 10-point mean was virtually identical to the integrated-curve mean.

Examination of the sixty-six 1-minute vertical velocity curves developed from data in the 66-minute run shows that no two curves are exactly alike in shape or in the vertical distribution of velocity. Although the shape and velocity distribution of the 66 curves differ, the mean velocity of one or more of these curves is often the same. There are 43 curves (19 sets) out of the sixty-six 1-minute curves that have mean velocities that are almost the same (table 6). Velocities at specific depths fluctuated considerably with no apparent relationship to changes in velocity above and below those depths. The largest variations in velocity occurred at the 55 percent depth; the smallest were near the stream surface.

Data obtained from the 66-minute run indicate that the ranges in velocities decrease rapidly between 1 and 4 minutes, then decrease at a gradual rate thereafter. Obviously, there is little need to extend a set of observations beyond about 4 minutes.

Both the integrated-curve and 10-point mean velocities were used as a basis for comparing the accuracy of mean velocities determined by other methods. The one- and two-point methods obtained velocities that were slightly greater than the mean velocity and yielded a mean velocity of acceptable accuracy.

For determining river discharge, the mean-section method yielded a value 0.6 percent less than that obtained by the midsection method. For one discharge measurement, the agreement between the two methods was improved by assuming two measuring stations near each bank. Additional stations to define any large difference in depth or velocity are necessary to obtain accurate results.

TABLES 2–10

TABLE 2.—*Velocities, in feet per second, in measuring cross sections at seven gaging stations on the Columbia River*

At Grand Coulee Dam, Wash.

[Gaging station 12–4365, April 24, 1961. Edge of water at left bank is station 930; at right bank, 360. Station number within measuring cross section (upper figure) and depth to streambed in feet (parentheses)]

Percent of depth	910 (13.2)	890 (22.9)	870 (39.6)	850 (44.1)	830 (50.0)	810 (50.5)	790 (52.4)	[1] 770 (45.0)
5	1.55	1.68	4.41	3.45	3.47	4.87	5.38	5.51
15	1.11	1.48	2.01	3.23	3.47	5.25	5.51	----
20	1.42	1.39	2.95	2.70	4.01	4.31	5.01	5.13
25	1.39	1.11	2.41	3.08	2.77	4.41	5.13	5.51
35	1.39	1.81	1.59	2.31	2.77	3.76	4.41	5.51
45	1.14	1.26	1.85	1.85	2.88	3.61	4.80	6.13
55	.91	1.33	1.85	1.85	2.70	3.34	4.41	5.13
65	.59	1.58	1.36	2.11	2.82	3.68	4.41	5.01
75	.59	1.85	1.85	1.77	2.57	2.63	4.31	----
80	.41	1.09	.70	2.01	2.41	2.88	4.33	4.90
85	.22	1.48	1.19	2.31	2.13	2.71	2.88	----
95	----	----	.80	1.55	1.59	1.62	2.26	[2] 5.04

Percent of depth	750 (57.9)	730 (57.2)	710 (55.9)	690 (56.2)	660 (56.9)	630 (55.5)	600 (53.1)
5	6.01	6.13	6.89	6.24	7.35	7.51	7.19
15	6.75	6.24	6.01	7.19	7.51	7.04	6.36
20	5.38	5.25	6.75	6.24	7.19	7.19	6.36
25	5.91	6.01	6.01	6.61	6.75	7.04	6.61
35	5.70	5.80	6.01	6.36	6.75	6.75	6.36
45	5.91	5.51	5.25	6.49	6.36	5.38	6.24
55	4.21	5.13	5.25	5.61	5.51	5.70	5.70
65	5.13	4.70	5.38	5.13	5.01	5.38	5.25
75	4.90	3.16	4.51	4.90	5.51	4.80	4.90
80	4.31	3.93	4.60	3.76	4.50	5.34	5.38
85	4.01	4.01	3.68	4.21	4.50	4.41	4.21
95	2.57	3.31	3.08	3.27	2.63	2.57	3.68

Percent of depth	570 (49.1)	540 (47.3)	510 (43.8)	480 (41.9)	450 (35.0)	420 (28.2)	390 (19.0)
5	7.19	7.51	6.75	6.49	5.51	4.01	2.88
15	6.75	6.89	6.75	6.36	5.13	3.93	3.16
20	6.36	7.35	6.89	6.61	4.90	3.76	3.23
25	7.04	7.51	6.61	6.36	4.90	3.68	2.82
35	6.61	7.35	7.19	5.91	4.90	3.40	2.81
45	6.01	6.61	6.75	5.51	4.70	3.61	2.63
55	5.64	5.51	6.36	5.13	4.70	3.61	2.63
65	5.35	6.24	5.91	5.80	4.80	3.08	2.51
75	4.41	5.51	5.80	4.90	4.80	3.45	2.46
80	4.50	5.25	5.38	5.38	4.60	2.70	2.36
85	5.38	5.01	5.38	5.13	4.31	2.65	2.06
95	4.01	4.21	4.25	3.84	4.11	2.31	----

[Gaging station 12–4365, June 20, 1962. Edge of water at left bank is station 940; at right bank, 330. Station number within measuring cross section (upper figure) and depth to streambed in feet (parentheses)]

Percent of depth	900 (28.2)	870 (50.0)	840 (57.0)	820 (60.4)	800 (61.1)	780 (64.1)	760 (65.2)	740 (66.6)	720 (66.2)
5	5.34	6.44	7.29	8.20	8.20	8.92	8.41	9.11	9.71
15	3.99	6.31	[1] 6.56	7.67	7.13	8.74	8.41	8.74	8.57
20	3.82	6.19	7.29	8.20	8.20	8.74	8.74	8.57	8.20
25	4.66	6.19	7.81	6.19	6.31	7.63	8.20	8.20	7.81
35	4.38	5.97	5.76	8.20	6.98	8.20	8.92	8.20	7.81
45	3.51	4.98	7.29	5.34	7.81	8.20	8.25	8.00	8.20
55	2.75	4.08	6.84	5.48	6.56	7.81	8.20	8.20	8.20
65	2.93	4.47	3.66	6.08	6.70	8.20	8.20	6.56	6.98
75	3.14	3.03	3.99	5.34	3.58	7.13	6.98	7.65	6.08
80	3.44	2.39	3.58	4.87	6.31	7.46	8.00	7.29	7.13
85	3.21	1.88	4.98	4.28	5.22	6.31	6.98	6.56	7.13
95	1.35	2.39	3.30	3.21	4.76	3.32	5.48	4.87	5.34

See footnotes at end of table.

TABLE 2.—*Velocities, in feet per second, in measuring cross sections at seven gaging stations on the Columbia River*—Continued

At Grand Coulee Dam, Wash.—Continued

Percent of depth	700 (65.2)	680 (67.3)	660 (64.8)	640 (66.8)	620 (64.6)	600 (62.7)	580 (59.5)	560 (58.6)	540 (55.8)
5	9.93	9.93	10.16	9.50	9.50	10.16	10.41	10.92	10.66
15	7.81	10.16	10.16	9.71	9.71	10.41	8.74	10.66	9.93
20	9.71	9.93	10.16	9.50	9.93	8.92	9.71	10.16	10.16
25	9.30	9.50	9.30	9.50	9.71	9.93	9.30	8.20	8.74
35	8.10	8.74	8.20	8.92	9.30	9.50	9.11	9.50	9.11
45	6.44	8.57	7.81	8.92	8.92	8.74	9.11	9.11	9.50
55	6.56	8.00	9.30	8.74	8.92	8.57	7.63	7.46	8.20
65	6.19	7.46	6.84	6.19	8.20	7.81	7.46	7.46	8.20
75	6.84	5.66	5.34	6.31	6.44	7.46	5.09	7.13	7.63
80	7.29	5.97	6.44	6.44	6.31	5.66	7.63	6.56	5.48
85	7.13	5.48	6.31	6.70	5.97	5.48	6.70	7.13	8.20
95	5.22	4.47	4.57	5.09	4.98	4.66	5.22	4.98	6.08

Percent of depth	520 (55.0)	500 (52.6)	480 (50.3)	460 (47.0)	450 (45.7)	430 (38.8)	410 (35.0)	390 (28.7)
5	10.41	10.41	8.74	9.71	9.50	7.63	6.56	5.97
15	10.92	9.93	8.92	8.41	8.00	7.46	6.84	5.97
20	10.41	10.16	9.30	8.20	8.74	7.46	6.56	5.34
25	10.16	9.71	9.30	8.41	8.20	7.63	6.56	5.34
35	9.93	9.50	9.30	8.74	8.74	7.81	6.19	5.76
45	9.93	9.71	9.11	8.20	7.13	6.70	7.20	6.08
55	7.46	9.50	8.57	8.20	8.20	6.70	5.34	5.66
65	7.81	8.74	7.46	7.81	6.56	6.31	5.22	5.76
75	9.11	8.74	6.56	7.63	6.98	6.19	5.34	3.99
80	7.63	8.41	7.67	8.20	7.29	5.48	5.22	4.08
85	7.13	6.84	6.31	7.63	5.97	5.86	4.38	4.47
95	5.48	5.09	6.70	6.84	5.22	5.22	3.30	2.68

[Gaging station 12–4365, July 9, 1962. Edge of water at left bank is station 943; at right bank, 330. Station number within measuring cross section (upper figure) and depth to streambed in feet (parentheses)]

Percent of depth	920 (16.4)	900 (21.3)	885 (39.3)	[1] 870 (47.9)	850 (55.7)	830 (59.4)	810 (61.5)	790 (63.8)	780 (62.3)	770 (55.4)
5	3.11	4.33	6.12	6.88	8.25	8.79	9.16	10.34	9.35	10.22
15	3.47	4.21	4.50	6.23	6.48	8.05	7.86	9.99	9.35	9.56
20	3.24	4.21	4.69	5.90	5.44	8.15	8.25	9.99	9.77	9.77
25	4.11	4.21	4.50	5.01	4.85	5.70	7.18	9.35	9.77	9.35
35	4.21	4.60	3.84	4.25	5.70	6.61	6.74	8.62	8.97	9.35
45	3.28	4.90	2.27	4.90	4.41	7.18	6.74	8.00	9.10	7.86
55	4.50	4.41	3.16	4.60	3.32	6.12	7.02	7.18	8.25	8.79
65	[1] 2.58	4.11	4.02	4.21	2.72	5.44	6.61	7.67	9.35	7.76
75	3.34	3.98	3.16	4.31	3.11	5.13	4.41	7.33	7.38	8.62
80	1.27	4.11	3.40	2.61	4.02	5.01	[1] 5.13	5.51	7.38	7.76
85	.92	2.36	2.12	1.56	3.32	[1] 4.69	4.21	6.01	6.74	8.46
95	[1] .66	2.95	.41	-------	1.49	2.47	4.02	4.41	3.84	5.25

Percent of depth	760 (67.3)	740 (68.0)	750 (67.8)	720 (67.4)	700 (66.6)	680 (66.4)	660 (66.2)	640 (66.1)	620 (64.8)	600 (63.0)
5	9.99	9.77	9.16	9.16	9.16	9.56	10.22	9.88	9.06	9.77
15	10.46	9.77	9.77	9.56	9.16	10.34	9.35	9.16	9.26	9.56
20	9.35	9.77	9.56	9.35	8.97	10.46	9.06	8.62	9.66	9.35
25	9.99	9.01	9.35	8.62	8.79	10.10	9.06	9.35	9.10	9.77
35	9.56	8.97	9.66	8.25	9.16	8.97	8.25	8.15	9.06	8.05
45	9.56	9.16	9.46	8.30	8.46	8.46	9.16	8.62	7.38	7.86
55	9.06	9.16	8.79	8.46	7.96	8.05	8.25	7.50	7.38	7.33
65	8.00	8.97	8.79	7.86	8.25	8.05	7.86	7.18	7.58	5.90
75	6.61	8.25	8.05	8.25	8.05	6.61	8.62	6.29	6.61	7.58
80	7.50	8.62	7.42	8.05	7.50	7.33	7.50	7.10	6.23	6.01
85	6.48	6.35	7.10	7.67	6.26	7.26	6.35	5.70	5.25	5.80
95	4.31	5.90	6.12	7.18	6.12	4.41	4.02	4.36	4.21	3.76

See footnotes at end of table.

TABLE 2.—*Velocities, in feet per second, in measuring cross sections at seven gaging stations on the Columbia River*—Continued

At Grand Coulee Dam, Wash.—Continued

Percent of depth	580 (60.7)	560 (58.9)	540 (57.2)	520 (56.2)	500 (54.0)	480 (51.5)	450 (46.5)	420 (38.0)	390 (27.4)	360 (11.5)
5	9.35	9.99	10.10	10.22	10.46	10.22	8.05	7.18	6.88	3.34
15	9.26	9.35	9.56	10.34	9.99	9.26	7.67	7.02	5.25	3.32
20	8.62	[1] 8.79	9.16	9.16	9.77	9.35	8.46	7.02	5.19	3.76
25	8.97	[1] 8.88	10.34	9.99	10.22	9.26	8.15	7.33	5.80	3.61
35	8.15	[1] 8.08	9.35	9.26	8.54	8.25	7.76	6.61	5.56	3.32
45	8.25	[1] 8.79	9.26	9.90	8.97	9.26	8.25	7.26	5.51	3.16
55	8.15	[1] 7.67	7.86	8.54	8.97	8.62	7.58	5.90	5.80	2.83
65	7.86	[1] 7.18	6.88	8.46	7.33	7.76	7.18	5.44	5.25	3.61
75	6.88	[1] 6.74	6.23	8.79	8.25	7.18	6.88	5.51	5.38	3.02
80	5.96	[1] 6.61	6.48	6.95	8.15	8.05	7.33	5.80	4.85	2.23
85	5.80	[1] 4.90	6.14	6.88	5.60	7.86	6.48	5.51	4.06	[1] 2.23
95	4.90	[1] 4.70	5.25	3.88	4.41	6.01	4.31	3.54	4.41	

[Gaging station 12–4365, June 19, 1963. Edge of water at left bank is station 945; at right bank, 325. Station number within measuring cross section (upper figure) and depth to streambed in feet (parentheses)]

Percent of depth	920 (20.8)	900 (31.2)	870 (50.4)	850 (60.3)	830 (63.0)	810 (63.8)	790 (65.8)	770 (69.0)	750 (72.8)
5	4.21	4.90	7.51	8.06	8.81	8.99	11.24	11.01	11.47
15	4.41	3.08	7.87	7.51	8.06	10.25	10.01	11.47	11.01
20	4.70	4.60	7.19	7.60	8.81	7.87	9.58	10.75	11.24
25	3.08	5.25	6.36	7.35	6.61	8.99	10.25	11.24	10.75
35	4.01	4.11	6.13	7.04	5.38	7.51	9.18	10.75	9.58
45	4.80	3.31	5.91	5.51	5.51	7.69	9.18	9.38	10.49
55	4.11	4.31	5.61	4.50	4.90	6.49	8.06	9.38	9.58
65	2.63	4.70	5.61	4.31	6.75	7.04	10.39	8.99	9.66
75	3.40	5.42	4.41	4.90	4.01	6.75	6.01	8.48	10.01
80	3.23	2.63	3.93	3.84	4.11	5.91	6.89	7.04	8.99
85	2.21	3.76	3.40	4.11	3.40	5.25	5.91	6.89	8.06
95	[1] .48	3.31	2.21	2.60	2.72	3.47	5.70	2.46	6.01

Percent of depth	730 (72.1)	710 (70.9)	690 (71.6)	660 (70.6)	640 (72.1)	620 (70.7)	600 (67.3)	580 (63.4)	560 (63.5)
5	11.72	12.24	11.72	10.49	9.58	10.49	10.75	11.97	11.72
15	10.75	11.47	11.97	10.75	10.49	10.01	9.79	11.30	11.47
20	11.01	11.97	11.01	10.01	10.01	9.38	9.58	11.47	11.97
25	10.75	11.72	11.01	10.25	10.49	10.01	9.38	11.01	11.72
35	10.75	10.01	10.49	10.20	9.79	9.79	9.18	10.59	11.01
45	9.68	9.58	11.01	8.64	9.34	9.58	8.99	11.01	9.58
55	10.01	9.38	9.58	9.38	8.99	9.38	8.32	10.20	9.79
65	8.99	8.99	8.06	9.18	8.64	8.64	8.64	9.38	9.18
75	9.18	8.64	7.51	8.06	8.64	8.64	8.06	9.38	8.06
80	9.28	8.81	7.69	7.87	8.32	8.64	7.51	7.69	7.19
85	8.06	8.27	7.19	7.69	7.51	6.36	6.49	6.89	4.90
95	8.64	7.35	6.36	7.19	5.01	4.87	5.70	4.90	6.36

Percent of depth	540 (62.2)	520 (60.1)	500 (58.5)	480 (56.3)	450 (49.7)	430 (44.2)	410 (38.3)	390 (31.8)	370 (19.5)
5	11.72	11.97	10.49	10.75	8.99	8.06	7.35	6.61	5.25
15	11.47	11.01	10.49	9.38	9.18	8.81	7.51	6.89	5.25
20	11.97	11.01	10.49	9.79	8.81	8.06	7.69	6.61	5.38
25	11.97	11.01	10.49	11.01	10.01	7.87	7.51	6.89	5.38
35	10.75	10.49	11.24	9.79	9.38	8.06	7.87	6.75	5.51
45	10.49	10.25	10.25	9.38	9.03	7.69	6.89	6.49	5.25
55	10.01	10.01	9.18	8.81	8.48	6.89	7.35	6.61	3.84
65	8.32	8.27	8.48	8.99	8.81	7.87	6.75	7.51	3.84
75	10.01	7.19	7.69	8.99	7.69	7.69	7.04	5.13	4.90
80	7.35	7.69	8.48	7.69	8.06	7.35	5.25	5.51	3.61
85	8.48	7.69	8.32	6.89	7.69	6.49	5.70	5.13	[1] 3.16
95	7.73	6.75	5.91	4.11	5.91	5.38	4.70	3.84	

See footnotes at end of table.

TABLE 2.—*Velocities, in feet per second, in measuring cross sections at seven gaging stations on the Columbia River*—Continued

At Bridgeport, Wash.

[Gaging station 12–4380, April 25, 1961. Edge of water at left bank is station 1175; at right bank, 285. Station number within measuring cross section (upper figure) and depth to streambed in feet (parentheses)]

Percent of depth	320 (8.0)	350 (14.5)	380 (18.1)	410 (20.9)	440 (22.4)	470 (22.9)	500 (23.9)	530 (24.0)	560 (24.0)	590 (23.1)
5	2.82	4.31	5.25	6.75	7.69	7.87	7.51	7.69	7.35	7.11
15	3.16	4.41	5.25	6.55	7.51	7.51	7.69	7.51	7.87	7.19
20	3.08	4.50	5.25	6.49	7.04	8.06	7.35	7.35	7.87	7.35
25	2.63	3.84	4.70	6.49	6.89	7.51	7.19	7.78	7.69	7.51
35	2.70	4.21	5.01	5.80	6.61	7.19	6.36	7.69	7.87	7.19
45	2.70	4.31	5.01	6.13	6.30	6.61	6.49	6.61	7.69	7.12
55	2.46	3.93	5.01	6.61	6.36	6.82	6.49	6.49	6.61	5.70
65	2.36	3.68	4.90	5.01	5.38	7.04	5.91	6.96	7.04	6.01
75	2.26	3.23	4.70	5.19	5.34	6.01	5.25	6.75	6.30	6.36
80	2.06	3.08	3.76	4.70	5.25	5.51	5.64	6.01	6.36	5.51
85		2.95	3.31	3.76	5.01	5.64	5.38	5.01	4.60	4.41
95		[1] 3.01	[1] 2.82	[1] 3.31	[1] 4.31	[1] 4.31	[1] 4.06	[1] 4.41	[1] 3.93	[1] 4.50

Percent of depth	620 (22.1)	650 (22.2)	680 (22.3)	710 (22.7)	740 (22.8)	770 (24.2)	800 (25.6)	830 (26.2)	860 (27.0)	890 (27.4)
5	7.69	6.89	7.35	7.51	7.87	7.51	7.51	7.35	7.35	7.04
15	7.19	7.19	7.04	7.87	7.69	7.51	6.89	7.19	7.04	7.04
20	7.04	6.89	7.19	7.87	7.35	7.51	7.04	7.87	7.35	7.04
25	7.19	6.49	7.19	7.69	7.35	7.51	6.61	7.35	7.04	7.04
35	6.96	6.75	7.19	7.51	7.43	7.69	6.24	7.23	6.49	6.61
45	6.68	6.75	6.75	7.51	6.75	7.19	6.49	7.19	6.49	6.89
55	6.36	6.49	6.89	7.19	6.75	7.04	6.01	6.89	5.70	5.91
65	6.36	5.38	6.49	7.35	5.51	6.89	5.91	6.75	5.44	5.51
75	6.61	6.01	5.01	5.91	3.87	6.75	5.25	5.13	5.13	5.13
80	6.36	4.60	4.50	4.46	5.70	5.25	5.25	5.25	4.90	5.38
85	5.70	4.70	4.90	5.80	5.25	5.58	5.61	5.38	4.41	5.01
95	[1] 5.13	[1] 3.84	[1] 4.70	[1] 5.13	[1] 3.84	[1] 4.70	[1] 4.50	[1] 4.60	[1] 4.11	[1] 3.93

Percent of depth	920 (28.3)	950 (28.9)	980 (28.8)	1010 (25.1)	1040 (23.9)	1070 (21.3)	1100 (16.2)	1130 (13.1)	1150 (8.6)
5	6.96	7.51	6.96	6.75	6.24	6.24	5.80	3.61	-------
15	7.19	7.19	7.04	6.24	6.49	6.01	5.64	3.87	-------
20	7.19	7.04	6.61	5.91	6.24	6.13	5.51	3.80	2.41
25	7.04	7.04	6.61	6.13	6.61	5.91	5.80	3.81	-------
35	6.49	6.24	6.49	6.18	6.01	5.64	5.91	3.84	-------
45	6.36	5.51	5.64	6.13	5.51	6.01	5.07	3.84	-------
55	6.13	5.38	6.24	5.91	5.25	5.01	5.01	3.93	-------
65	5.38	5.58	5.70	5.01	4.70	5.13	4.90	2.95	-------
75	4.80	4.41	3.68	4.01	4.41	4.31	4.31	3.01	-------
80	4.01	4.31	2.88	4.11	5.25	4.21	4.70	2.95	1.62
85	4.51	4.17	2.70	3.76	3.93	3.76	3.61	2.31	-------
95	4.11	2.95	1.14	[1] 3.23	[1] 2.06	[1] 2.88	[1] 2.70	[1] 1.93	-------

[Gaging station 12–4380, June 20, 1961. Edge of water at left bank is station 1240; at right bank, 180. Station number within measuring cross section (upper figure) and depth to streambed in feet (parentheses)]

Percent of depth	230 (8.7)	280 (21.4)	320 (30.1)	350 (36.8)	380 (40.9)	410 (43.9)	440 (45.2)	470 (46.1)	500 (46.6)	530 (46.3)	560 (47.3)
5		2.43	4.46	6.55	8.39	9.49	12.40	13.93	14.23	15.40	14.87
15		1.46	4.46	5.96	7.99	10.27	11.61	14.08	11.86	14.54	15.77
20	0.68	2.43	3.76	6.07	7.61	9.92	12.12	13.63	13.92	14.23	14.54
25		3.02	4.55	6.36	7.44	10.15	11.36	13.46	13.63	13.63	14.08
35		3.36	4.75	5.14	7.28	9.00	11.86	12.68	13.63	12.40	14.87
45		3.08	4.65	6.82	7.90	9.92	9.29	12.12	12.26	12.54	13.46
55		2.79	4.07	6.75	7.28	9.92	12.12	12.68	13.63	13.49	13.46
65		2.98	4.20	6.30	6.82	8.91	9.70	9.92	11.36	12.68	11.36
75		2.85	5.08	4.75	7.12	6.82	9.60	10.78	11.61	11.04	12.98
80	.48	2.43	3.64	4.48	6.07	8.19	8.91	8.19	10.15	9.70	10.04
85		1.38	3.36	5.46	5.46	7.44	9.49	8.29	8.82	8.91	9.49
95		[1] 1.50	2.61	4.55	4.37	4.75	6.68	5.46	7.80	6.55	7.44

See footnotes at end of table.

TABLE 2.—*Velocities, in feet per second, in measuring cross sections at seven gaging stations on the Columbia River*—Continued

At Bridgeport, Wash.—Continued

Percent of depth	590 (46.7)	620 (46.6)	650 (46.1)	680 (46.2)	710 (46.3)	740 (46.8)	770 (46.9)	800 (46.6)	830 (46.5)	860 (46.3)	890 (45.8)
5	15.58	14.54	13.58	14.52	14.84	13.26	13.75	14.52	14.28	13.92	13.92
15	15.58	14.23	13.10	13.26	13.36	12.95	14.52	14.52	12.95	15.01	13.92
20	14.70	13.63	12.66	12.95	13.58	14.52	13.75	13.36	13.58	14.28	14.52
25	13.78	15.22	13.92	13.58	13.58	13.58	13.36	13.26	12.11	13.75	13.10
35	14.54	11.74	13.26	13.26	12.95	13.58	13.26	13.26	13.26	13.92	12.80
45	13.09	12.71	13.26	12.38	13.92	13.58	12.11	12.95	11.14	12.66	13.26
55	13.92	12.12	12.38	12.66	13.10	11.14	11.85	12.24	11.98	11.43	13.58
65	11.36	12.12	10.62	13.26	11.14	12.24	12.38	12.95	9.49	11.43	12.95
75	12.98	12.26	10.87	11.85	10.02	13.10	11.14	12.38	8.92	10.37	11.14
80	11.99	9.70	8.58	10.02	11.14	10.62	11.14	10.62	10.87	9.49	11.14
85	9.49	7.44	8.37	8.75	10.14	9.30	11.14	11.14	9.30	11.14	8.58
95	7.70	7.99	6.21	6.45	8.42	6.57	7.61	9.91	9.30	7.97	8.58

Percent of depth	920 (46.2)	950 (47.2)	980 (49.2)	1010 (48.7)	1040 (46.8)	1070 (44.0)	1100 (38.7)	1130 (35.4)	1160 (28.1)	1200 (12.5)
5	13.92	13.36	13.36	13.36	12.95	12.61	12.11	10.87	1.062	------
15	13.92	13.92	14.84	13.36	11.37	12.15	10.72	10.96	9.91	------
20	12.95	13.36	12.50	13.58	10.62	12.38	11.14	11.26	9.11	6.51
25	13.92	11.98	13.26	13.30	12.80	12.73	11.85	11.61	9.70	------
35	13.26	12.38	11.43	12.85	11.61	12.15	11.14	11.14	10.37	------
45	12.66	12.11	12.85	12.24	11.85	11.85	11.85	10.62	8.58	------
55	11.14	10.62	10.14	12.15	10.37	10.14	10.62	10.87	8.58	------
65	11.14	10.87	8.92	12.38	9.61	9.60	10.62	9.70	7.84	------
75	11.61	9.49	9.30	12.11	10.02	8.92	10.14	9.91	9.30	------
80	12.11	8.17	7.97	9.70	7.79	9.30	9.02	9.11	7.20	4.27
85	6.70	10.62	8.37	10.14	6.98	8.92	8.92	7.88	5.99	------
95	6.70	7.21	7.97	8.58	4.48	7.13	5.60	5.53	5.60	------

At Rocky Reach Dam, Wash.

[Gaging station 12–4537, April 26, 1961. Edge of water at left bank is station 1210; at right bank, 280. Station number within measuring cross section (upper figure) and depth to streambed in feet (parentheses)]

Percent of depth	1180 (5.2)	1150 (9.8)	1120 (12.5)	1090 (19.7)	1060 (26.8)	1030 (35.1)	1000 (36.0)	960 (36.1)	920 (37.9)
5	1.45	2.29	2.65	3.47	3.84	3.93	4.33	4.90	5.01
15	1.48	2.95	2.88	3.23	3.61	4.17	4.41	4.90	5.01
20	1.48	2.31	2.88	3.34	3.34	4.25	4.41	5.01	5.25
25	1.45	2.36	2.82	3.23	3.76	3.84	4.41	4.70	5.25
35	1.42	2.11	2.60	3.34	3.47	3.68	4.33	4.80	5.51
45	1.48	2.21	2.70	3.05	3.61	3.68	4.21	4.80	5.64
55	1.32	2.21	2.82	2.88	3.21	3.27	4.25	4.80	5.51
65	1.24	2.01	2.16	2.77	3.08	3.27	3.53	4.41	5.25
75	[1]1.14	1.85	2.21	2.46	3.08	3.39	3.31	4.11	4.80
80	------	1.59	2.21	2.16	2.70	3.16	3.31	4.01	4.60
85	------	1.77	1.89	2.17	2.55	3.39	2.95	4.01	4.46
95	------	------	[1]1.72	[1]1.68	[1]1.68	1.59	2.46	3.23	3.31

Percent of depth	880 (38.0)	840 (38.4)	800 (38.8)	760 (39.2)	720 (39.4)	680 (38.7)	640 (37.1)	600 (36.5)	560 (38.0)
5	5.51	5.51	5.64	5.64	5.44	5.58	4.80	4.41	4.70
15	5.70	5.51	5.38	5.51	5.13	5.66	4.70	4.60	4.80
20	5.64	5.38	5.51	5.13	5.13	5.66	4.80	4.33	5.19
25	5.70	5.38	5.38	5.38	5.25	5.64	4.41	4.41	5.13
35	5.91	5.25	5.25	5.13	5.25	5.38	4.50	4.11	4.90
45	5.51	5.25	5.51	5.01	5.13	5.38	4.33	3.93	4.31
55	5.80	4.80	4.60	4.41	4.90	5.01	4.41	3.88	4.21
65	5.51	4.31	4.60	5.01	4.80	5.01	4.41	2.68	4.50
75	5.51	4.21	4.11	4.90	4.31	4.90	3.84	3.53	3.76
80	3.93	4.41	4.60	4.11	4.41	4.41	4.31	3.27	4.01
85	4.50	4.41	4.60	3.93	4.31	4.21	2.90	3.40	3.53
95	3.84	3.31	3.61	3.16	3.23	3.23	2.51	1.93	2.63

See footnotes at end of table.

TABLE 2.—*Velocities, in feet per second, in measuring cross sections at sever. gaging stations on the Columbia River*—Continued

At Rocky Reach Dam, Wash.—Continued

Percent of depth	520 (38.6)	480 (38.5)	440 (34.4)	400 (31.7)	370 (25.2)	340 (17.0)	310 (8.7)
5	5.32	4.96	3.53	2.63	2.31	1.64	1.48
15	5.25	4.90	3.34	2.84	2.26	1.62	1.48
20	5.25	4.70	3.68	2.88	2.82	1.85	1.36
25	5.25	4.70	3.61	3.08	2.71	1.48	1.36
35	5.25	4.41	3.93	2.88	2.66	1.51	1.29
45	4.80	4.41	3.93	2.82	2.41	1.59	1.48
55	4.31	4.31	3.61	3.01	2.63	1.93	1.14
65	3.68	4.16	3.31	2.57	2.36	1.59	1.06
75	4.21	4.16	2.95	1.93	1.97	1.74	.78
80	3.84	2.88	2.95	2.31	1.89	1.51	.95
85	2.82	3.34	2.21	1.81	1.97	1.48	----------
95	2.46	2.88	2.01	1.89	[1] 1.62	[1] 1.14	----------

[Gaging station 12–4537, June 21, 1961. Edge of water at left bank is station 1420; at right bank, 180. Station number within measuring cross section (upper figure) and depth to streambed in feet (parentheses)]

Percent of depth	1360 (5.0)	1300 (10.0)	1240 (16.0)	1180 (25.0)	1120 (32.7)	1070 (46.8)	1030 (55.6)	1000 (56.3)	970 (56.8)	940 (57.8)	910 (58.5)
5			4.48	7.13	7.28	8.58	9.40	10.37	11.14	11.43	11.73
15			4.87	5.99	7.70	8.92	9.91	10.37	10.87	11.73	11.28
20		4.31	4.67	5.89	7.79	9.30	9.70	10.14	11.14	11.61	12.52
25			5.21	6.10	7.44	8.37	9.91	10.14	10.87	11.43	10.87
35			5.21	6.84	7.36	8.48	9.30	10.37	11.00	11.14	11.14
45			5.09	6.57	7.44	8.37	9.30	10.74	9.70	9.91	10.50
55			4.43	6.10	6.98	8.17	9.02	9.91	10.14	11.14	10.50
65	[1] 1.93		4.87	6.21	6.70	6.98	8.37	9.60	9.91	11.43	11.28
75			4.18	5.60	6.70	6.84	6.98	9.30	9.49	10.37	9.11
80		2.41	3.74	4.87	6.21	6.33	6.98	8.17	8.58	10.26	10.14
85			3.29	4.98	6.33	5.67	6.98	7.28	8.37	7.97	9.20
95			[1] 3.29	3.91	5.09	4.48	4.48	6.84	7.28	6.84	8.37

Percent of depth	880 (58.7)	850 (58.7)	820 (58.6)	790 (58.8)	760 (59.3)	720 (59.2)	690 (59.0)	660 (58.4)	630 (57.3)	600 (56.5)
5	11.85	11.85	11.98	12.38	12.52	12.11	11.85	11.14	11.61	11.61
15	11.43	11.98	11.14	11.37	12.11	12.95	11.73	10.93	11.14	11.14
20	12.24	11.28	11.61	11.85	11.85	12.38	11.37	11.49	10.14	10.87
25	11.43	11.14	10.87	11.85	11.61	12.11	11.61	10.37	10.87	11.27
35	10.87	10.14	11.14	11.28	11.14	11.14	12.11	9.70	11.14	11.85
45	11.00	11.14	10.14	10.37	10.37	10.62	10.37	9.11	10.14	11.61
55	9.91	10.02	10.74	10.37	10.62	11.14	10.14	9.70	10.02	10.14
65	9.02	9.70	10.62	10.14	10.52	10.74	8.75	8.58	10.14	10.87
75	10.02	9.60	9.11	8.58	9.11	9.11	9.30	8.92	9.49	9.91
80	8.92	9.11	8.92	8.75	9.30	9.70	8.48	7.61	9.30	9.91
85	9.30	8.17	7.44	9.02	7.44	9.91	8.37	7.36	7.44	10.37
95	5.74	7.28	6.84	6.98	6.21	8.42	7.20	4.27	5.89	6.70

Percent of depth	560 (57.7)	520 (59.1)	490 (58.8)	460 (57.9)	430 (54.4)	400 (52.2)	360 (44.0)	320 (30.7)	280 (20.7)	240 (10.0)
5	11.43	11.61	11.14	10.32	8.92	8.58	7.44	6.33	5.79	----------
15	11.73	11.43	10.62	10.87	9.49	8.92	8.37	6.64	5.79	----------
20	11.73	11.14	11.28	10.87	9.91	9.49	8.42	6.33	5.99	3.14
25	11.85	11.14	11.14	10.32	9.70	8.92	7.97	6.45	6.10	----------
35	12.11	10.62	10.87	8.92	8.92	8.92	8.07	6.98	5.89	----------
45	11.43	10.62	10.26	9.91	8.92	8.75	7.44	6.84	5.89	----------
55	11.14	10.37	10.14	8.27	7.70	7.79	6.70	5.74	6.10	----------
65	10.62	9.30	8.58	7.97	6.91	7.97	7.13	5.60	5.60	----------
75	10.37	8.92	8.92	8.37	8.14	7.13	6.98	4.87	5.33	----------
80	8.92	9.91	8.17	8.27	6.84	6.21	6.57	6.27	4.3'	2.51
85	9.49	6.33	7.44	7.44	5.89	4.82	6.10	5.99	4.48	----------
95	6.33	5.46	5.60	6.10	5.89	4.31	5.89	4.31	[1] 3.67	----------

See footnotes at end of table.

TABLE 2.—*Velocities, in feet per second, in measuring cross sections at seven gaging stations on the Columbia River*—Continued

At Rocky Reach Dam, Wash.—Continued

[Gaging station 12–4537, November 20, 1962.[3] Edge of water at left bank is station 1185; at right bank, 280. Station number within measuring cross section (upper figure) and depth to streambed in feet (parentheses)]

Percent of depth	1150 (6.3)	1120 (10.2)	1090 (17.8)	1030 (33.1)	970 (33.9)	910 (35.2)	850 (35.7)	790 (35.8)	730 (36.4)	670 (35.4)	640 (33.8)
5		1.64	[1]1.68	2.71	2.68	2.84	2.90	3.00	3.10	2.78	2.68
15		[1]1.51	[1]1.56	[1]2.68	2.90	2.87	2.78	3.17	2.78	2.93	2.50
20		1.46									
25			[1]1.82	[1]2.65	2.90	3.17	2.87	2.93	3.00	2.93	2.47
35		[1]1.46	[1]1.83	[1]2.44	[1]2.71	[1]3.10	2.93	2.87	2.65	2.96	2.56
45		[2]1.57	[1]1.79	[1]2.53	[1]2.78	3.10	[1]2.84	2.62	2.65	2.96	2.62
55		[1]1.48	[1]1.75	[1]2.23	[1]2.56	[1]2.87	2.65	[1]2.87	2.93	2.65	2.74
65		[2]1.49	[1]1.49	[1]2.32	[1]2.44	2.90	2.65	3.14	2.30	1.98	2.42
75	[1]0.77	[1]1.40	[1]1.26	[1]2.23	[1]2.59	[1]2.78	[1]2.53	[1]2.47	2.96	2.26	1.98
80			[1]1.16								
85				[1]1.94	[1]2.25	[1]2.42	[1]2.40	[1]2.53	2.32	2.46	2.08
95						1.86	1.86	2.59	2.15	1.64	1.09

Percent of depth	610 (34.0)	580 (33.3)	550 (35.2)	520 (35.6)	490 (35.6)	460 (33.7)	430 (30.2)	400 (29.1)	370 (22.6)	340 (14.1)	310 (6.2)
5	2.20	2.59	2.81	2.87	2.56	2.23	1.75	1.79	1.34	1.17	0.70
15	2.32	2.37	2.84	2.90	2.65	2.65	2.00	1.58	1.49	1.09	.70
20											
25	2.23	2.53	2.71	2.74	2.71	2.42	2.18	1.75	1.38	.94	.58
35	2.23	2.59	2.78	2.37	2.44	2.71	2.03	1.90	1.32	1.02	.80
45	1.92	2.59	2.78	2.42	2.62	2.59	1.88	1.53	1.30	.85	.70
55	2.23	2.37	2.65	2.40	2.59	2.42	1.98	1.68	1.40	1.00	.66
65	1.82	2.42	2.53	2.53	2.37	2.15	2.23	1.43	1.02	.85	.72
75	1.66	2.03	2.34	2.32	2.23	1.60	1.94	1.54	1.06	.96	[1].51
80											
85	1.94	1.94	2.08	2.18	1.98	1.40	[1]1.49	1.30	.82	.97	
95	1.60	1.10	1.79	1.53	1.72	.99	1.46	.81	.89	[1]1.12	

At Trinidad, Wash.

[Gaging station 12–4645, June 21, 1961. Edge of water at left bank is station 100; at right bank, 1450. Station number within measuring cross section (upper figure) and depth to streambed in feet (parentheses)]

Percent of depth	160 (8.0)	220 (13.1)	280 (15.0)	340 (18.6)	400 (23.0)	450 (26.0)	500 (29.4)	550 (31.9)	610 (39.5)
5		[1]2.36		[1]7.87	[1]9.58	[1]11.01	11.60	12.81	13.43
15							11.72	12.24	13.77
20	0.38	2.21	5.01	7.51	9.68	10.01	11.84	12.38	12.51
25							11.47	12.24	12.66
35							11.01	11.97	12.24
45		[1]1.88	[1]4.80	[1]7.19	[1]8.48	[1]9.58	11.01	9.79	11.60
55							10.49	10.01	11.01
65		[1]1.48	[1]4.31	[1]5.91	[1]7.87	[1]8.64	10.80	9.79	10.62
75			[1]4.21	[1]4.70	[1]7.19	[1]8.90	10.37	8.24	10.01
80	0	.96	3.34	5.13	6.36	6.61	7.69	6.75	9.79
85		[1].70					7.69	9.18	9.38
95			[1]3.47	[1]3.31	[1]5.01	[1]6.01	4.90	6.24	7.00

Percent of depth	660 (48.6)	700 (52.3)	740 (54.1)	780 (55.9)	820 (56.7)	860 (57.6)	910 (57.9)	950 (58.0)	1000 (57.7)
5	15.36	14.68	14.52	14.36	14.36	13.77	13.77	13.77	13.43
15	14.68	14.68	14.52	14.68	14.36	14.21	14.36	13.77	12.71
20	14.36	14.84	14.36	14.06	14.21	13.77	13.77	13.43	13.77
25	14.68	14.06	13.77	14.36	13.77	14.06	13.60	13.77	13.43
35	14.06	14.68	13.77	12.38	13.77	13.77	13.60	13.43	13.43
45	12.51	13.43	14.06	11.72	13.77	13.77	13.11	13.11	12.96
55	12.51	13.11	13.43	13.11	13.43	13.11	13.43	12.81	12.81
65	11.47	13.43	13.11	11.72	11.97	13.11	12.66	13.11	12.81
75	10.25	11.72	11.36	11.84	12.24	11.72	11.24	13.11	12.38
80	8.27	10.80	10.25	10.01	11.01	11.01	11.24	10.49	11.01
85	6.75	11.47	9.18	9.58	10.75	10.75	10.75	10.25	8.27
95	7.04	6.89	7.35	7.35	5.70	10.01	7.69	8.99	[1]7.04

See footnotes at end of table.

TABLE 2.—*Velocities, in feet per second, in measuring cross sections at seven gaging stations on the Columbia River*—Continued

At Trinidad, Wash.—Continued

Percent of depth	1050 (57.6)	1100 (56.9)	1150 (51.3)	1200 (39.0)	1250 (19.8)	1300 (5.0)	1350 (5.3)	1400 (5.7)
5	12.24	11.60	7.96	7.87	[1]6.61			
15	11.24	11.84	8.99	8.06				
20	13.11	12.10	9.58	8.06	6.61			
25	12.66	11.97	9.79	8.99				
35	12.96	12.10	10.37	8.81				
45	12.96	12.24	11.30	9.18	[1]6.75			
55	12.51	12.81	11.72	8.99				
65	12.96	11.97	11.30	8.81	[1]6.36	[1]2.57	[1]1.77	[1]2.16
75	11.47	12.24	11.01	7.87	[1]6.49			
80	11.97	10.75	11.01	7.04	5.91			
85	8.99	11.01	9.79	5.25				
95	6.61	8.16	7.87	3.16	[1]4.33			

[Gaging station 12–4645, September 22, 1961. Edge of water at left bank is station 480; at right bank, 1230. Station number within measuring cross section (upper figure) and depth to streambed in feet (parentheses)]

Percent of depth	1200 (12.8)	1170 (22.8)	1140 (27.2)	1120 (28.4)	1100 (29.7)	1070 (30.0)	1040 (30.1)	1010 (30.0)	980 (30.0)
5	2.16	2.74	2.95	3.40	3.50	3.84	4.60	4.90	4.80
15	2.16	2.95	3.12	3.47	3.76	4.09	4.70	4.60	4.70
20	2.16	2.63	3.16	3.50	3.88	3.97	4.60	4.80	4.60
25	2.06	2.88	3.16	3.47	3.80	4.11	4.65	4.75	4.80
35	2.21	2.51	3.34	3.61	3.84	4.21	4.50	4.70	4.60
45	2.31	2.46	3.23	3.76	4.01	4.33	4.21	4.23	4.31
55	2.16	2.51	3.34	3.80	4.01	4.41	4.21	4.31	4.01
65	2.06	2.57	3.23	3.68	3.76	4.46	4.11	4.21	4.41
75	1.79	2.26	3.08	2.95	3.53	3.47	3.68	4.21	3.76
80	1.51	1.93	3.05	3.16	3.27	3.34	3.16	3.73	2.95
85	1.45	1.85	2.92	2.80	2.74	3.47	3.16	3.34	3.61
95	[1]1.16	1.68	[1]2.16	2.21	2.77	2.17	2.95	2.21	2.64

Percent of depth	950 (30.2)	930 (30.1)	910 (30.0)	880 (30.0)	850 (29.7)	820 (29.0)	790 (28.1)	760 (27.0)
5	4.80	5.13	4.80	4.90	4.90	4.60	4.70	4.80
15	4.75	4.85	4.96	4.90	4.90	4.90	4.25	4.80
20	4.80	4.80	4.90	4.70	4.96	4.90	4.21	4.60
25	4.60	4.70	4.80	4.80	4.80	4.80	4.60	4.70
35	4.70	4.60	4.94	4.80	4.60	4.41	4.16	4.41
45	4.90	4.60	4.80	4.55	4.21	4.36	4.31	4.21
55	4.21	4.50	4.31	4.50	4.21	4.37	4.41	4.21
65	4.01	3.93	3.68	3.68	3.84	3.57	4.01	4.21
75	3.61	4.01	4.01	3.68	3.93	3.57	3.40	3.76
80	3.68	3.76	3.47	3.53	3.31	3.72	3.08	3.16
85	3.47	3.12	3.53	3.44	3.16	2.88	3.16	3.16
95	2.63	2.82	2.85	2.88	2.48	2.60	2.63	[1]2.11

Percent of depth	730 (25.8)	700 (24.4)	670 (21.6)	640 (18.4)	610 (13.7)	580 (8.8)	550 (6.3)	520 (4.0)
5	4.80	4.21	3.76	3.20	2.70	[1]1.89		
15	4.90	4.31	3.84	3.16	2.53			
20	4.90	4.21	3.57	3.23	2.63	1.97		
25	4.50	4.50	3.72	2.95	2.70			
35	4.60	4.70	3.68	3.02	2.51			
45	4.36	4.60	3.47	2.98	2.41	[1]1.87		
55	4.21	3.68	3.47	2.70	2.16			
65	4.21	3.87	3.40	2.70	2.41	[1]1.67	[1]1.21	[1]0.75
75	3.76	3.40	3.04	2.51	2.34	[1]1.45		
80	3.16	3.40	2.57	2.16	2.01	1.55		
85	3.08	3.00	2.70	2.06	1.89			
95	[1]1.97	[1]2.38	[1]2.51	[1]1.55	[1]1.67			

See footnotes at end of table.

TABLE 2.—*Velocities, in feet per second, in measuring cross sections at seven gaging stations on the Columbia River*—Continued

Below Priest Rapids Dam, Wash.

[Gaging station 12–4728, April 28, 1961. Edge of water at left bank is station 130; at right bank, 1280. Station number within measuring cross section (upper figure) and depth to streambed in feet (parentheses)]

Percent of depth	1240 (10.3)	1200 (16.0)	1160 (25.0)	1120 (27.8)	1080 (28.6)	1040 (28.6)	1000 (29.3)	960 (30.6)	920 (31.8)	880 (31.9)
5	2.09	3.23	3.40	3.47	3.84	3.76	4.09	4.21	4.50	5.13
15	2.21	3.31	3.40	3.47	3.76	4.01	4.01	4.41	4.90	4.90
20	2.21	3.31	3.23	3.34	3.84	3.76	4.01	4.21	4.70	4.70
25	2.41	3.31	3.23	3.31	3.39	3.31	4.01	4.41	4.90	4.70
35	1.98	3.31	3.31	3.31	3.40	3.16	3.76	4.41	4.41	4.41
45	[1]1.97	3.31	3.40	3.47	3.08	3.47	3.64	4.01	4.50	4.21
55	1.93	3.23	3.23	3.27	3.21	3.23	3.76	4.01	4.11	4.11
65	2.16	2.95	3.08	2.77	3.16	3.39	3.68	3.39	3.76	3.93
75	1.77	3.08	2.65	[1]2.60	2.95	3.31	3.23	2.88	3.61	4.01
80	1.71	2.95	2.70	2.85	2.82	2.65	3.23	3.47	3.40	3.68
85	1.48	2.46	2.31	2.31	2.51	2.46	2.77	2.77	3.01	3.34
95		[1]2.16	[1]2.17	1.85	1.67	2.01	2.11	2.51	1.97	2.63

Percent of depth	840 (31.4)	800 (31.3)	760 (30.6)	720 (29.8)	680 (29.1)	640 (29.0)	600 (28.1)	560 (27.3)	520 (27.2)
5	5.32	5.13	5.38	5.01	5.13	5.38	5.01	5.13	5.13
15	5.01	5.25	5.13	5.25	5.25	5.64	5.25	5.13	4.60
20	4.90	4.90	4.41	5.25	5.01	5.25	5.13	4.90	4.51
25	5.13	4.90	5.13	5.51	5.42	5.38	4.70	4.90	4.60
35	4.60	5.25	5.38	3.01	5.42	5.25	5.13	4.51	4.50
45	4.80	4.90	5.38	5.01	5.38	5.13	5.32	5.01	4.25
55	4.21	4.50	4.51	4.90	5.01	4.90	4.70	4.25	4.06
65	4.50	4.80	4.31	4.31	5.51	4.90	4.11	4.51	4.25
75	4.01	4.41	4.50	3.93	4.21	4.70	4.41	4.41	3.76
80	3.61	4.21	3.53	4.80	4.31	4.41	4.01	4.01	3.23
85	3.23	3.76	3.68	3.40	4.21	3.84	4.50	4.01	3.68
95	2.63	3.01	3.08	3.08	3.53	3.01	3.53	4.31	[1]2.80

Percent of depth	480 (26.5)	440 (25.0)	400 (24.8)	360 (24.0)	320 (21.8)	280 (17.9)	240 (13.1)	200 (11.2)	160 (6.1)
5	4.51	4.11	4.21	3.47	3.35	2.82	[1]2.16	[1]1.72	-------
15	4.75	4.50	4.11	3.39	3.53	2.82	-------	-------	-------
20	4.60	3.88	4.33	3.61	3.68	2.51	2.51	1.81	-------
25	4.31	4.11	4.01	3.39	3.31	2.77	-------	-------	-------
35	4.41	4.21	4.11	3.34	2.95	2.70	-------	-------	-------
45	4.21	3.76	3.93	3.47	3.39	2.60	[1]2.11	[1]1.71	-------
55	4.31	3.84	3.31	2.71	3.23	2.54	-------	-------	-------
65	4.01	3.68	3.39	3.16	2.88	2.57	[1]2.17	[1]1.48	[1]0.64
75	3.76	3.53	2.95	3.16	2.88	2.11	-------	-------	-------
80	3.68	3.53	2.95	3.08	2.61	2.31	1.89	1.32	-------
85	3.61	3.53	2.41	2.71	2.82	1.97	[1]1.89	[1]1.31	-------
95	[1]2.82	[1]2.82	[1]2.16	[1]1.89	[1]2.26	[1]1.36	-------	-------	-------

[Gaging station 12–4728, June 20, 1961. Edge of water at left bank is station 55; at right bank, 1355. Station number within measuring cross section (upper figure) and depth to streambed in feet (parentheses)]

Percent of depth	1300 (15.2)	1250 (28.2)	1200 (36.6)	1160 (45.2)	1120 (49.1)	1080 (49.3)	1030 (49.7)	980 (50.6)	930 (52.2)
5	6.49	8.06	8.81	9.18	9.58	10.01	10.62	11.01	11.84
15	[1]6.30	[1]8.01	[1]8.06	9.38	[1]8.99	10.01	[1]10.62	11.01	11.47
20	[1]6.36	[1]8.16	[1]8.27	[1]8.06	[1]8.18	[1]10.25	[1]10.49	[1]11.24	[1]11.24
25	[1]6.75	[1]7.35	[1]8.81	[1]8.64	[1]9.58	[1]9.58	[1]10.01	[1]10.49	[1]11.24
35	[1]6.24	[1]6.82	[1]7.78	[1]8.16	[1]8.32	[1]9.38	[1]9.79	[1]10.49	[1]10.62
45	[2]5.63	[1]7.27	[1]7.96	[1]8.08	[1]8.16	[1]9.08	[1]10.01	[1]9.48	[1]11.01
55	[1]5.25	[1]7.27	[1]7.35	[1]8.27	[1]8.08	[1]8.48	[1]9.18	[1]9.90	[1]10.25
65	[1]5.38	[1]6.13	[1]7.19	[1]8.06	[1]8.16	[1]8.27	[1]9.38	[1]9.58	[1]10.01
75	[2]4.98	[2]5.96	[2]7.31	[2]6.82	[1]7.43	[1]7.69	[1]7.69	[1]8.81	[1]10.13
80	-------	4.90	[1]6.36	[1]7.04	[2]7.19	[2]7.69	[1]7.51	[2]9.09	[1]9.38
85	-------	-------	-------	-------	-------	-------	[1]8.16	-------	[1]7.43
95	[1]4.60	3.76	[1]5.38	[1]5.91	[1]6.36	[1]6.01	[1]6.89	[1]7.04	[1]7.19

See footnotes at end of table.

TABLE 2.—*Velocities, in feet per second, in measuring cross sections at seven gaging stations on the Columbia River*—Continued

Below Priest Rapids Dam, Wash.—Continued

Percent of depth	880 (52.5)	830 (52.0)	780 (51.5)	730 (50.6)	680 (49.6)	630 (49.0)	580 (48.7)	530 (48.1)
5	11.47	12.24	11.72	11.84	12.24	12.81	12.38	11.97
15	11.97	11.47	11.97	11.97	12.10	[1] 12.51	11.60	11.01
20	[1] 11.59	[1] 11.97	[1] 11.72	[1] 12.38	[1] 11.97	[1] 11.72	[1] 12.24	12.38
25	[1] 11.24	[1] 11.97	[1] 11.97	[1] 11.97	[1] 12.24	[1] 11.60	[1] 10.75	11.97
35	[1] 10.49	[1] 11.47	[1] 11.47	[1] 11.36	[1] 11.60	[1] 12.24	[1] 11.97	11.01
45	[1] 11.24	[1] 11.47	[1] 11.72	[1] 11.12	[1] 11.47	[1] 11.72	[1] 11.60	11.01
55	[1] 10.75	[1] 10.88	[1] 11.47	[1] 11.36	[1] 11.60	[1] 11.84	[1] 11.47	10.80
65	[1] 9.79	[1] 9.79	[1] 9.79	[1] 10.25	[1] 11.60	[1] 10.25	[1] 11.01	10.75
75	[1] 9.18	[1] 8.64	[1] 10.01	[1] 9.79	[1] 10.25	[1] 10.88	[1] 10.01	9.38
80	[1] 7.87	[1] 9.08	[1] 9.28	[1] 11.01	[1] 10.25	[1] 10.75	[1] 8.72	9.48
85	[1] 9.28	[1] 8.40	[1] 8.27	[1] 8.64	[1] 9.58	[1] 9.58	[1] 9.38	10.01
95	[1] 7.19	[1] 7.87	[1] 8.27	[1] 8.64	[1] 7.19	[1] 9.58	[1] 8.06	8.16

Percent of depth	480 (47.5)	430 (46.6)	380 (45.7)	330 (42.8)	280 (38.9)	230 (33.3)	180 (30.4)	120 (19.0)
5	11.01	11.36	10.49	9.90	9.18	8.64	7.69	[1] 5.01
15	10.88	10.75	10.37	10.25	8.90	8.64	7.87	----
20	11.24	10.88	10.13	10.25	9.18	8.06	8.06	4.50
25	11.24	10.75	9.90	8.90	8.90	8.06	7.19	----
35	11.47	10.01	10.25	9.28	8.64	7.69	[1] 6.89	----
45	10.75	9.68	10.13	8.81	8.48	7.51	6.24	[1] 4.11
55	10.88	9.28	9.08	9.28	8.40	6.68	7.27	----
65	10.13	9.38	8.27	9.48	8.64	6.68	6.01	[1] 4.33
75	9.28	10.37	8.48	7.51	7.35	6.61	5.66	[1] 4.50
80	8.99	9.08	7.96	7.35	7.78	5.91	5.51	2.77
85	9.18	9.18	7.04	6.30	7.12	5.25	[1] 4.50	----
95	7.35	7.51	6.07	7.04	4.55	3.84	[1] 4.65	[1] 2.11

Paterson Ferry, Oreg.

[Gaging station 14–0192, June 16, 1961. Edge of water at left bank is station 2; at right bank, 2494. Station number within measuring cross section (upper figure) and depth to streambed in feet (parentheses)]

Percent of depth	44 (11.7)	128 (26.5)	200 (36.0)	276 (38.6)	356 (39.5)	440 (41.4)	522 (41.6)	610 (41.6)	690 (42.3)
5	3.21	5.97	8.20	8.20	8.92	8.92	9.93	10.41	10.41
15	3.07	6.44	8.20	8.40	8.92	9.30	9.50	9.71	10.66
20	3.31	6.31	7.99	7.99	9.10	9.70	8.91	10.15	10.15
25	3.08	6.20	8.19	8.57	9.10	8.91	9.29	9.72	9.49
35	3.39	6.31	8.40	8.74	8.92	8.92	9.50	8.74	9.93
45	3.01	5.67	7.81	7.99	8.57	8.74	9.10	9.92	9.92
55	2.87	5.66	8.00	7.81	8.40	8.40	8.40	9.50	10.16
65	1.94	4.67	7.21	8.19	7.99	7.81	8.19	8.19	9.49
75	2.25	4.48	7.13	8.40	7.13	7.46	8.20	8.49	9.11
80	1.90	5.57	6.70	6.98	7.81	6.70	7.13	7.45	8.40
85	1.65	4.99	6.98	6.70	7.29	8.19	6.98	7.29	7.81
95	1.29	4.48	5.76	5.09	6.19	5.48	6.56	6.84	5.97

Percent of depth	772 (42.9)	850 (43.8)	930 (43.3)	1010 (46.5)	1126 (46.3)	1218 (46.2)	1312 (46.3)	1384 (45.8)
5	10.66	10.66	10.66	9.50	10.16	9.71	8.91	7.81
15	10.66	10.66	10.41	9.93	9.30	9.71	9.50	8.40
20	9.92	10.15	9.92	10.15	9.10	9.29	8.91	7.99
25	10.15	10.64	9.49	9.49	9.10	9.29	8.57	7.63
35	9.93	10.16	9.50	9.93	8.92	8.92	8.92	7.29
45	9.70	9.29	9.49	9.92	9.29	7.99	8.57	7.29
55	9.71	9.93	9.93	9.11	8.57	7.81	8.20	7.13
65	8.57	9.49	8.91	8.24	8.40	7.99	7.81	6.70
75	8.92	8.20	8.10	8.92	8.00	8.00	7.29	6.84
80	7.13	8.91	8.19	8.19	6.84	7.99	7.45	6.44
85	7.81	8.57	7.99	6.57	7.63	6.98	7.13	6.44
95	5.48	6.84	8.20	5.09	6.31	5.62	6.08	5.22

See footnotes at end of table.

TABLE 2.—*Velocities, in feet per second, in measuring cross sections at seven gaging stations on the Columbia River*—Continued

Paterson Ferry, Oreg.—Continued

Percent of depth	1492 (45.0)	1616 (41.5)	1730 (36.7)	1830 (36.1)	1904 (32.5)	2012 (29.9)	2122 (23.9)	2232 (14.0)
5	[1] 6.98	5.86	5.86	5.22	5.22	4.48	3.21	1.48
15	[2] 7.48	5.62	4.98	5.62	5.48	3.99	2.82	1.88
20	6.57	5.97	4.19	5.48	5.35	3.91	3.46	2.52
25	[1] 6.70	5.67	4.58	5.48	5.22	4.00	3.23	2.52
35	5.87	5.66	4.87	4.87	4.98	3.99	3.21	2.05
45	[1] 6.19	5.67	4.48	4.58	4.77	3.83	3.23	2.77
55	[2] 5.89	5.62	4.57	4.76	4.87	3.82	3.00	2.15
65	[2] 5.89	5.10	4.39	4.09	4.77	3.67	2.70	2.41
75	[1] 5.48	5.09	4.08	4.08	4.66	3.07	2.75	2.45
80		4.99	4.00	5.22	4.39	3.33	2.77	2.07
85		4.67	3.91	4.58	3.91	3.08	2.89	1.37
95		3.74	3.30	3.00	3.74	2.68	2.15	2.01

[Gaging station 14–0192, October 11, 1961. Edge of water at left bank is station 2406; at right bank, 200. Station number within measuring cross section (upper figure) and depth to streambed in feet (parentheses)]

Percent of depth	268 (3.7)	332 (5.9)	408 (8.6)	490 (13.7)	542 (13.8)	612 (13.1)	670 (17.1)	750 (19.6)	828 (23.1)
5		0.80					1.39	1.59	1.81
15		.71	0.85	0.88	1.24	1.22	1.39	1.67	1.74
20		.72	.99	.82	1.19	1.30	1.39	1.67	1.48
25		.84	.99	.85	1.22	1.45	1.48	1.65	1.67
35	0.45	.76	1.12	.76	1.14	1.31	1.42	1.48	1.78
45		.82	1.06	.90	1.24	1.55	1.36	1.55	1.55
55	.45	.87	1.02	.85	1.12	1.39	1.39	1.51	1.64
65	.43	.75	.99	1.12	1.27	1.24	1.21	1.55	1.50
75	[1] .35	.70	.94	1.00	1.07	1.30	1.33	1.36	1.45
80		.64	.85	.80	1.14	1.24	.98	1.39	1.48
85			.81	.66	.98	1.12	1.12	1.24	1.39
95			[1] .68	[1] .77	[1] .98	[1] .90	[1] .95	.95	.93

Percent of depth	920 (25.6)	1010 (26.9)	1100 (27.0)	1190 (26.7)	1290 (26.4)	1396 (25.6)	1468 (25.5)	1564 (24.8)
5	2.06	1.93	2.46	2.40	2.46	2.69	2.57	2.57
15	1.89	2.16	2.22	2.46	2.76	2.51	2.51	2.57
20	1.93	1.93	2.35	2 57	2.51	2.63	2.46	2.63
25	1.78	1.97	2.22	2.40	2.57	2.63	2.69	2.69
35	1.93	1.78	2.22	2.11	2.63	2.51	2.69	2.69
45	1.70	[1] 2.01	2.01	2.25	2.56	2.56	2.62	2.51
55	1.74	[1] 1.81	1.92	2.35	2.35	2.51	2.62	2.45
65	1.66	[1] 1.92	2.25	1.84	2.62	2.56	2.40	2.40
75	1.66	[1] 1.67	2.16	2.16	1.97	2.35	2.21	2.01
80	1.59	1.55	1.89	2.26	1.93	2.28	2.22	2.22
85	1.55	[1] 1.64	1.28	1.77	1.84	2.01	2.17	2.16
95	1.12	[1] 1.56	1.06	1.42	1.84	1.66	1.98	2.13

Percent of depth	1636 (24.3)	1728 (23.7)	1812 (23.1)	1900 (21.9)	1994 (22.0)	2070 (22.1)	2178 (20.7)	2252 (18.9)	2324 (15.4)
5	2.57	2.57	2.51	2.31	2.11	2.16	1.93	1.89	1.71
15	2.63	2.63	2.46	2.13	2.11	2.11	1.97	1.97	1.67
20	2.63	2.51	2.46	2.28	2.22	2.22	2.02	1.78	1.71
25	2.76	2.51	2.57	2.35	2.22	2.06	2.06	1.97	1.52
35	2.62	2.31	2.57	2.22	2.06	2.06	1.93	1.89	1.42
45	2.40	2.35	2.45	2.30	1.88	1.97	1.88	1.81	1.30
55	2.54	2.40	2.51	1.77	1.81	2.01	1.58	1.97	1.27
65	2.21	1.88	2.16	2.06	1.77	1.81	1.66	1.55	1.15
75	1.84	1.84	2.06	1.77	1.88	1.58	1.58	1.39	1.12
80	2.06	2.06	1.97	1.78	1.81	1.55	1.52	1.45	1.12
85	1.64	1.88	1.77	1.62	1.51	1.55	1.39	1.21	1.02
95	1.32	1.36	1.12	1.18	1.09	1.32	[1] .95	[1] 1.09	[1] .67

See footnotes at end of table.

TABLE 2.—*Velocities, in feet per second, in measuring cross sections at seven gaging stations on the Columbia River*—Continued

Hood River Bridge, Oreg.

[Gaging station 14–1057, May 3, 1961. Edge of water at left bank is station 4100; at right bank, 70. Station number within measuring cross section (upper figure) and depth to streambed in feet (parentheses)]

Percent of depth	4030 (34.5)	4000 (39.2)	3900 (40.2)	3800 (34.5)	3700 (41.7)	3600 (41.2)	3500 (43.0)	3400 (40.5)	3300 (40.0)	3200 (44.2)
5	1.55	0.92	1.24	1.68	1.71	1.59	1.55	1.59	1.52	1.59
15	1.59	1.12	1.30	1.70	1.67	1.63	1.61	1.71	1.58	1.59
20	1.45	1.21	1.33	1.65	1.71	1.63	1.67	1.74	1.67	1.74
25	1.59	1.04	1.36	1.67	1.68	1.63	1.59	1.67	1.63	1.54
35	1.63	1.02	1.45	1.67	1.52	1.55	1.59	1.67	1.55	1.52
45	1.63	1.04	1.42	1.73	1.55	1.59	1.63	1.71	1.65	1.59
55	1.55	1.02	1.48	1.81	1.44	1.45	1.52	1.67	1.21	1.67
65	1.52	1.07	1.48	1.67	1.48	1.45	1.48	1.67	1.19	1.45
75	1.45	.84	1.45	1.52	1.48	1.36	1.44	1.38	1.37	1.48
80	1.36	.98	1.19	1.07	1.65	1.42	1.17	1.39	1.33	1.55
85	1.21	.81	1.39	1.44	1.52	1.16	1.12	1.42	1.37	1.21
95	1.12	.77	1.30	1.42	1.47	1.04	.80	1.14	1.24	1.14

Percent of depth	3100 (43.5)	3000 (46.2)	2900 (43.7)	2780 (45.2)	2700 (43.3)	2580 (45.0)	2500 (44.2)	2410 (45.3)	2300 (44.8)
5	1.39	1.39	1.36	1.74	1.59	1.67	1.77	1.73	1.60
15	1.59	1.45	1.44	1.77	1.63	1.55	1.81	1.77	1.46
20	1.42	1.52	1.48	1.55	1.61	1.71	1.51	1.77	1.48
25	1.42	1.48	1.52	1.74	1.59	1.63	1.79	1.81	1.46
35	1.55	1.45	1.52	1.61	1.67	1.59	1.75	1.70	1.51
45	1.48	1.44	1.59	1.74	1.65	1.52	1.67	1.64	1.53
55	1.59	1.24	1.52	1.67	1.55	1.33	1.40	1.62	1.37
65	1.48	1.09	1.48	1.61	1.48	1.48	1.62	1.49	1.26
75	1.36	.41	1.52	1.24	1.48	1.32	1.45	1.37	1.19
80	1.32	.37	1.46	1.40	1.45	1.27	1.43	1.34	.83
85	1.24	.25	1.33	1.27	1.35	1.36	1.27	1.51	.85
95	.56	.25	1.04	1.00	1.18	.94	.98	.93	.79

Percent of depth	2200 (52.0)	2100 (45.4)	2000 (47.7)	1900 (49.0)	1800 (48.4)	1690 (45.8)	1600 (48.4)	1490 (50.2)	1400 (49.8)	1280 (38.0)
5	1.62	1.88	1.82	1.96	2.01	1.88	1.84	1.64	1.90	1.86
15	1.65	1.80	1.82	1.85	1.94	1.90	1.90	1.70	1.72	1.75
20	1.30	1.90	1.84	1.92	1.80	1.86	1.75	1.64	1.76	1.82
25	1.43	1.68	1.75	1.77	1.90	1.90	1.64	1.75	1.68	1.72
35	1.58	1.90	1.68	1.79	1.77	1.70	1.74	1.68	1.53	1.65
45	1.66	1.75	1.75	1.77	1.75	1.60	1.53	1.75	1.57	1.49
55	1.60	1.80	1.53	1.53	1.77	1.68	1.48	1.68	1.57	1.60
65	1.64	1.75	1.28	1.72	1.60	1.57	1.51	1.43	1.57	1.64
75	1.53	1.49	1.53	1.31	1.60	1.70	1.51	1.19	1.46	1.46
80	1.22	1.60	1.42	1.44	1.46	1.58	1.20	1.31	1.19	1.37
85	1.53	1.26	1.64	1.25	1.40	1.32	1.10	1.00	1.22	1.10
95	1.16	1.28	.92	.92	1.43	.77	.55	1.05	.83	.79

Percent of depth	1200 (37.6)	1110 (34.4)	1000 (28.0)	900 (24.5)	800 (10.6)	700 (6.8)	500 (6.1)	300 (5.8)	200 (4.0)
5	1.60	1.60	1.46	1.28	0.79	-------	0.60	0.74	-------
15	1.60	1.53	1.43	1.15	.69	0.52	.65	.53	-------
20	1.64	1.57	1.44	1.15	.63	.48	.53	.51	0.58
25	1.68	1.53	1.38	1.15	.53	.45	.58	.49	-------
35	1.64	1.57	1.34	.99	.49	.37	.47	.30	.48
45	1.68	1.49	1.40	1.00	.45	.26	.39	.28	-------
55	1.53	1.46	1.34	.87	.40	.22	.48	.25	-------
65	1.46	1.05	1.16	.81	.34	.20	.54	.24	-------
75	1.37	.76	1.32	.77	.36	.16	.25	.39	-------
80	1.34	.79	.99	.65	.26	.18	.24	.54	.27
85	1.37	.77	.83	.50	.22	.18	.24	.50	.26
95	.96	.63	.67	.53	[1].25	-------	-------	-------	-------

See footnotes at end of table.

TABLE 2.—*Velocities, in feet per second, in measuring cross sections at seven gaging stations on the Columbia River*—Continued

Hood River Bridge, Oreg.—Continued

[Gaging station 14-1057, June 5, 1961.[4] Edge of water at left bank is station 412C; at right bank, -30. Station number within measuring cross section (upper figure) and depth to streambed in feet (parentheses)]

Percent of depth	100 (15.4)	200 (17.7)	300 (19.5)	500 (19.5)	700 (20.3)	800 (24.2)	900 (38.6)	1000 (41.5)	1110 (48.5)	1200 (50.0)
5	0.38	0.40	0.46	0.76	1.82	1.75	1.79	2.85	3.35	3.87
15	.23	.30	.38	.40	1.68	1.64	2.03	2.43	3.35	3.63
20	.28	.42	.48	.71	1.64	1.82	1.68	2.85	3.27	3.71
25	.18	.20	.40	.48	1.68	1.79	2.03	2.48	3.27	3.63
35	.16	.18	.27	.29	1.46	1.79	1.99	2.91	3.19	3.27
45	.18	.11	.20	.19	1.60	1.79	1.53	2.54	3.11	3.19
55	.19	.06	.19	.29	1.60	1.79	2.03	2.80	2.97	3.11
65	.17	0	.29	.29	1.64	1.68	1.94	2.73	3.19	3.19
75	.18	0	.18	.26	1.34	1.53	1.82	2.37	2.28	3.04
80	.11	.25	.27	.42	1.10	1.31	1.57	2.43	1.68	3.11
85	.14	0	0	.47	.96	1.57	1.31	2.19	.80	2.85
95	0	0	0	.36	.35	1.10	.90	1.31	1.02	2.54

Percent of depth	1280 (51.3)	1400 (60.6)	1490 (62.1)	1600 (62.1)	1690 (63.5)	1800 (65.7)	1900 (61.8)	2000 (63.8)	2100 (59.8)	2200 (63.3)
5	3.96	3.71	4.54	4.36	4.63	4.36	4.36	4.73	4.35	4.84
15	3.63	3.87	4.36	4.36	4.36	4.15	4.47	4.15	4.35	4.44
20	3.56	3.79	4.36	4.36	4.63	4.36	4.15	4.54	4.25	4.54
25	3.04	3.79	4.05	4.15	4.36	4.25	4.05	4.25	4.25	4.47
35	3.42	3.71	4.05	3.87	4.15	4.05	4.15	4.25	4.15	3.96
45	3.49	3.71	3.96	3.63	4.05	3.71	4.05	4.15	4.05	3.71
55	3.35	3.29	3.87	3.56	3.96	3.49	3.71	3.79	3.56	3.42
65	2.97	3.35	3.63	3.12	3.71	3.12	3.79	3.71	3.56	3.56
75	2.91	3.27	3.04	3.35	3.56	3.12	3.56	3.71	3.71	3.27
80	2.24	2.91	3.27	3.63	3.27	3.17	3.56	3.71	2.97	3.27
85	2.60	3.04	2.91	3.04	2.43	2.73	3.27	3.19	3.19	2.91
95	2.19	2.19	2.48	2.73	1.86	2.03	2.79	2.48	2.60	2.54

Percent of depth	2300 (59.2)	2410 (59.8)	2500 (58.3)	2580 (59.0)	2700 (57.5)	2780 (59.0)	2900 (58.8)	3000 (60.8)	3100 (56.0)	3200 (57.5)
5	4.44	4.60	4.41	4.60	4.41	4.41	4.69	4.60	4.11	4.41
15	4.25	4.41	4.31	4.41	4.60	4.69	4.31	4.31	4.21	4.11
20	4.35	4.41	4.41	3.69	4.31	4.41	3.84	4.11	4.02	4.41
25	4.05	4.41	4.21	3.93	4.41	4.31	4.11	4.21	4.21	4.11
35	4.05	4.41	4.21	4.02	4.11	4.11	3.84	3.84	3.93	4.11
45	3.87	4.02	4.21	4.02	3.61	3.93	3.69	4.11	4.11	3.69
55	3.79	4.02	3.69	3.61	3.84	3.69	3.61	3.76	3.69	3.61
65	3.71	3.32	3.69	3.54	3.76	3.69	3.24	3.61	3.47	3.32
75	3.27	3.16	3.02	3.47	3.54	3.47	3.02	3.76	3.24	3.32
80	2.97	2.71	3.16	2.89	3.54	3.24	3.16	3.02	3.16	3.61
85	2.91	2.77	2.89	2.77	2.83	3.40	3.40	2.77	3.09	3.54
95	1.86	2.42	2.52	2.17	2.17	2.77	2.52	2.12	2.23	1.82

Percent of depth	3300 (57.2)	3400 (56.6)	3500 (54.7)	3600 (56.2)	3700 (55.0)	3800 (48.8)	3900 (54.3)	4000 (53.5)	4030 (49.2)	4100 (14.0)
5	4.02	4.11	4.31	4.31	4.31	4.41	4.21	3.09	4.11	1.82
15	4.11	4.11	4.21	4.41	4.31	4.21	4.41	3.54	3.84	1.94
20	4.11	4.11	4.11	4.31	4.60	4.11	4.41	3.69	4.31	2.77
25	3.93	4.21	4.11	4.69	4.21	4.21	4.11	3.76	4.02	2.42
35	4.02	4.41	4.50	4.33	4.11	4.31	3.84	4.02	3.69	2.83
45	3.84	4.11	4.41	4.31	4.21	4.69	3.93	3.93	3.93	2.95
55	3.47	4.11	4.02	3.93	3.76	4.50	4.41	4.21	4.02	2.83
65	3.76	3.84	3.76	3.84	3.76	4.02	4.11	4.21	4.11	2.64
75	3.34	3.61	3.34	3.47	3.54	3.93	3.09	4.11	4.21	2.58
80	3.32	3.02	3.69	3.16	3.84	3.69	2.71	3.28	3.93	2.77
85	2.89	2.89	2.47	3.16	3.47	3.69	3.32	4.02	3.93	2.36
95	2.42	2.36	2.77	2.52	3.54	3.16	3.09	3.61	2.77	2.17

[1] Measurement(s) made approximately at percentage of depth indicated.
[2] Average of measurements made just above and below percentage of depth listed.
[3] Additional current-meter measurements were made at about 60 percent depth, as follows: Station 970, 2.71 fps; 910, 2.59 fps; 850, 2.65 fps; 790, 2.87 fps; 730, 253 fps; 670, 2.65 fps; 640, 2.50 fps; 610, 2.23 fps; 580, 2.23 fps; 550, 2.23 fps; 520, 2.42 fps; 490, 2.50 fps; 460, 1.98 fps; 430, 1.94 fps; 400, 1.46 fps; 370, 1.22 fps; 340, 0.85 fps; 310, 0.70 fps.
[4] Additional current-meter measurements at about 98 percent depth as follows: Station 900, 0.65 fps; 1000, 0.77 fps; 1110, 0.74 fps; 1200, 2.37 fps; 1280, 1.68 fps; 1400, 2.28 fps; 1490, 1.94 fps; 1600, 2.03 fps; 1690, 2.03 fps; 1800, 2.43 fps; 1900, 2.19 fps; 2000, 1.34 fps; 2100, 2.03 fps; 2200, 2.32 fps; 2300, 1.75 fps.

TABLE 3.—*Velocities, in feet per second, in measuring cross sections at four gaging stations on the Columbia River*

At Grand Coulee Dam, Wash.

[Gaging station 12–4365. Station number within measuring cross section (upper figure) and depth to streambed in feet (in parentheses)]

Percent of depth	June 1, 1961 [1]					June 12, 1961				
	870 (57.6)	750 (77.0)	660 (80.5)	540 (70.0)	450 (57.0)	870 (66.5)	750 (87.4)	660 (91.0)	540 (81.7)	450 (65.9)
5	10.86	11.68	11.68	11.94	12.48	12.51	15.01	14.52	14.21	15.01
15	9.56	12.48	10.99	12.34	12.07	13.43	14.84	14.06	13.77	15.01
20							14.06	13.43	12.51	14.68
25	9.56	12.20	11.44	11.68	12.20	13.60	15.01	12.81	13.77	13.43
35	10.46	11.68	10.99	10.99	12.77	12.36	13.77	11.97	11.84	14.12
45	10.32	12.20	10.59	10.46	12.20	11.01	13.43	12.24	10.75	12.66
55	10.10	12.92	9.77	9.99	10.99	11.24	12.51	11.72	10.25	11.72
65	8.97	10.59	9.16	8.62	11.21	8.27	12.81	9.79	9.38	10.25
75	5.38	11.44	9.35	7.33	10.72	10.20	11.72	9.18	8.49	9.79
80							10.25	9.58	8.99	8.81
85	8.06	9.99	7.18	7.02	[2] 8.97	5.80	9.58	7.43	7.87	7.87
95	3.02	8.38	7.18	6.29	6.61	5.84	9.79	5.80	5.44	5.38

Percent of depth	September 15, 1961				
	870 (34.0)	750 (54.0)	660 (52.1)	540 (43.0)	450 (32.7)
5	1.63	4.60	5.80	4.50	3.76
15	1.31	4.01	5.19	4.50	3.16
20	1.21	4.01	5.13	4.90	3.61
25	1.21	3.84	5.13	4.41	3.34
35	1.89	3.64	4.80	4.80	3.53
45	1.48	3.53	4.80	4.50	3.31
55	1.11	3.47	4.75	4.41	2.95
65	.88	3.53	4.21	4.41	3.01
75	.56	3.01	4.41	3.31	2.88
80	.69	2.55	4.11	3.04	2.77
85	.60	2.71	3.53	3.37	2.26
95	.53	1.27	3.01	3.47	2.31

At Bridgeport, Wash.

[Gaging station 12–4380. Station number within measuring cross section (upper figure) and depth to streambed in feet (in parentheses)]

Percent of depth	June 2, 1961					June 9, 1961				
	950 (50.6)	800 (47.3)	710 (41.5)	560 (45.8)	500 (43.3)	950 (49.4)	800 (48.9)	710 (48.7)	560 (49.7)	500 (49.0)
5	13.86	12.77	14.07	14.63	13.23	13.77	15.01	14.84	15.18	15.36
15	14.07	13.07	13.90	14.32	12.48	13.60	15.01	15.36	15.72	15.01
20	12.20	14.01	13.44	13.39	12.20	13.43	14.68	15.73	15.73	14.68
25	12.77	12.48	12.48	13.90	13.07	13.27	14.68	15.34	15.73	14.06
35	10.99	12.77	12.77	13.07	13.39	13.47	14.52	14.68	14.69	13.77
45	10.99	12.48	12.92	12.20	12.77	13.77	13.77	13.77	14.33	13.11
55	11.94	12.92	11.68	11.21	13.23	12.24	12.81	12.81	13.77	12.38
65	8.62	9.56	12.20	11.94	11.27	11.24	12.51	13.21	13.77	12.81
75	7.86	10.22	10.46	11.68	10.22	11.01	11.30	12.81	12.51	11.01
80	6.35	9.16	10.72	9.35	10.46	10.25	11.84	12.38	13.11	11.01
85	6.88	8.46	10.34	8.79	10.46	10.80	11.24	9.58	11.72	10.25
95	4.26	7.02	8.46	6.48	7.02	8.06	8.32	7.69	7.35	6.75

Percent of depth	June 13, 1961					September 14, 1961 [2]				
	950 (49.5)	800 (48.9)	710 (48.6)	560 (49.6)	500 (48.7)	950 (23.7)	800 (19.0)	710 (15.1)	560 (16.4)	500 (18.1)
5	14.68	14.68	14.36	16.11	14.21	5.13	6.13	7.04	6.55	6.49
15	15.18	14.36	15.36	16.11	14.36	6.61	5.91	7.04	6.61	6.13
20	14.52	14.52	15.01	15.01	14.06	4.90	5.86	6.61	6.49	6.18
25	14.06	14.36	14.68	13.92	14.06	5.25	6.24	6.75	6.49	6.36
35	13.77	13.77	13.77	14.68	12.81	4.90	6.01	6.18	6.13	6.01
45	11.84	13.11	14.36	14.36	12.24	3.76	6.01	6.75	6.61	5.51
55	11.72	13.11	13.43	12.96	12.81	3.84	5.96	6.42	6.01	5.36
65	10.01	10.33	12.71	11.72	11.97	3.53	5.91	6.42	5.91	5.13
75	11.24	10.01	9.38	12.51	11.24	3.47	5.19	5.61	5.64	4.80
80	11.24	10.25	12.51	11.47	10.01	3.23	5.19	5.07	5.38	4.17
85	8.06	11.24	7.04	11.24	8.32	2.63	4.80	4.60	4.80	4.25
95	7.35	8.64	8.27	7.19	6.61	[3] 1.55	[3] 4.50	[3] 4.21	[3] 4.70	[3] 3.16

See footnotes at end of table.

TABLE 3.—*Velocities, in feet per second, in measuring cross sections at four gaging stations on the Columbia River*—Continued

At Rocky Reach Dam, Wash.

[Gaging station 12–4537. Station number within measuring cross section (upper figure) and depth to streambed in feet (in parentheses)]

Percent of depth	May 16, 1961					May 25, 1961				
	1030 (41.6)	880 (45.8)	720 (46.5)	600 (44.5)	520 (46.2)	1030 (47.1)	880 (51.1)	720 (51.7)	600 (50.0)	520 (51.8)
5	6.49	8.56	8.06	7.35	7.96	8.99	10.49	10.37	9.38	9.58
15	6.36	8.56	8.32	7.19	7.87	8.06	10.01	10.01	9.38	9.58
20	6.75	8.98	7.87	6.49	7.96	9.79	10.75	9.90	9.18	9.18
25	6.42	8.48	8.40	6.75	7.51	7.96	10.25	9.79	8.81	9.58
35	6.13	7.87	7.60	6.82	7.69	7.87	9.18	9.18	8.48	9.11
45	6.36	7.69	7.51	6.30	8.06	8.06	9.08	9.79	8.81	9.58
55	6.01	7.87	7.51	6.01	7.27	7.51	8.64	8.99	7.87	8.81
65	5.56	6.89	7.35	6.36	6.30	6.75	8.99	9.18	7.69	7.87
75	5.13	7.19	6.75	5.70	6.24	6.75	8.48	8.81	8.06	7.12
80	4.70	7.96	6.68	6.13	6.24	7.16	8.27	7.51	6.61	7.19
85	4.50	6.75	6.07	6.24	6.30	5.51	7.17	8.16	6.89	7.04
95	2.95	5.01	4.46	3.16	4.01	5.38	7.51	6.36	3.61	3.61

Percent of depth	June 7, 1961					June 16, 1961 [4]				
	1030 (59.2)	880 (61.0)	720 (61.5)	600 (59.0)	520 (61.4)	1030 (56.7)	880 (59.5)	720 (60.0)	600 (57.5)	520 (59.7)
5	8.81	12.96	13.27	12.24	12.24	9.58	12.24	13.11	11.47	12.10
15	9.38	12.51	12.71	12.24	12.38	9.79	12.24	12.51	10.75	12.24
20	8.81	12.47	12.24	12.51	12.51	8.99	11.97	11.84	11.97	11.97
25	8.99	12.24	13.11	12.10	12.10	9.79	11.72	12.24	10.37	11.97
35	8.99	10.75	12.24	12.24	12.51	9.58	11.97	11.47	11.01	11.60
45	10.01	10.75	12.24	12.51	12.51	8.99	10.75	11.72	11.01	11.84
55	8.81	10.25	9.79	11.84	11.01	8.81	8.99	11.24	11.47	10.49
65	9.58	10.25	10.49	10.49	10.75	8.48	9.38	9.90	10.25	9.90
75	9.58	10.25	9.79	10.49	10.25	7.87	9.18	9.18	10.01	9.18
80	8.81	9.38	9.79	10.13	9.58	8.16	8.32	10.25	8.48	9.38
85	7.69	9.38	8.48	11.01	9.51	7.87	8.81	8.27	9.68	9.38
95	5.38	7.69	9.58	6.61	7.35	5.25	7.19	6.75	7.35	7.19

Percent of depth	August 3, 1961 [5]					August 31, 1961 [6]				
	1030 (35.2)	880 (38.9)	720 (39.7)	600 (36.8)	520 (39.4)	1030 (33.0)	880 (36.5)	720 (37.1)	600 (34.4)	520 (36.8)
5	5.01	6.13	6.24	4.80	5.38	3.40	4.50	4.37	3.72	4.31
15	4.50	6.01	6.01	4.70	5.38	3.34	4.50	4.17	3.53	4.21
20	4.70	5.91	6.13	5.13	5.25	3.34	4.50	3.93	3.61	4.11
25	4.65	6.01	5.80	5.01	5.51	3.40	4.01	3.97	3.47	4.01
35	4.41	5.44	5.61	4.90	5.38	3.04	3.84	4.01	3.16	3.84
45	4.41	5.51	5.25	4.75	5.13	3.34	3.76	3.76	3.01	3.76
55	3.84	5.38	5.13	4.21	5.13	3.01	3.76	3.76	3.01	3.76
65	3.53	5.13	5.13	3.76	4.80	2.63	3.68	3.72	2.70	3.68
75	3.76	5.25	5.01	4.11	4.21	2.31	3.68	3.68	3.08	3.16
80	3.16	5.07	5.13	3.74	3.47	2.54	3.68	3.76	3.16	3.16
85	3.01	4.31	4.80	3.47	2.82	1.97	3.23	3.23	2.46	2.88
95	2.46	3.01	3.76	2.82	2.41	1.48	2.77	2.26	2.06	1.89

At Hood River Bridge, Oreg.

[Gaging station 14–1057. Station number within measuring cross section (upper figure) and depth to streambed in feet (in parentheses)]

Percent of depth	May 24, 1961						June 12, 1961			
	3950 (45.8)	3640 (37.6)	3300 (45.2)	2780 (51.0)	2300 (50.3)	1400 (54.0)	4090 (21.4)	3300 (55.4)	2300 (61.8)	1400 (63.0)
5	3.12	1.64	3.27	3.49	3.56	3.04	3.96	4.44	4.94	3.79
15	3.19	2.73	2.97	3.49	3.56	2.97	4.35	4.73	4.73	3.71
20		2.66					4.14	4.63	4.46	3.96
25	3.04	2.48	3.19	3.49	3.42	2.91	4.35	4.35	4.83	3.49
35	3.27	2.91	2.91	3.42	3.19	3.04	4.24	4.24	4.94	3.56
45	3.12	2.60	3.04	3.35	3.27	2.97	4.24	4.24	4.35	3.12
55	3.04	3.04	3.12	3.04	2.91	2.85	4.14	4.14	4.14	3.12
65	3.12	2.73	2.97	2.48	2.85	2.91	3.87	4.35	3.63	3.63
75	2.73	2.73	2.91	2.28	2.85	2.73	3.19	4.05	3.56	3.35
80		1.86					3.19	3.79	3.04	3.27
85	2.43	1.15	2.48	2.60	2.28	2.48	2.91	3.29	2.79	3.27
95	2.10	.39	2.48	2.19	1.82	2.19	1.72	3.04	1.25	2.85
98							2.33	.80	.91	2.09

See footnotes at end of table.

TABLE 3.—*Velocities, in feet per second, in measuring cross sections at four gaging stations on the Columbia River*—Continued

At Hood River Bridge—Continued

Percent of depth	July 13, 1961				August 16, 1961			
	4090 (7.3)	3300 (39.0)	2300 (46.0)	1400 (49.9)	4090 (6.7)	3300 (37.7)	2300 (44.0)	1400 (47.7)
5	0.92	2.34	2.05	2.05	0.76	1.40	1.30	1.46
15	1.09	2.34	2.01	1.88	.58	1.43	1.33	1.43
20	1.12	2.34	2.10	1.96				
25	1.21	2.20	1.84	1.77	.56	1.43	1.30	1.37
35	1.12	2.05	1.80	1.84	.64	1.46	1.30	1.40
45	1.18	1.96	1.84	1.80	.67	1.33	1.28	1.37
55	1.24	2.01	1.66	1.70	.81	1.33	1.10	1.30
65	1.39	2.01	1.39	1.48	.92	1.22	1.05	1.25
75	1.51	2.10	1.77	1.29	.87	1.12	.92	1.20
80	1.06	2.10	1.77	1.42				
85	1.04	1.84	1.43	1.32	.62	1.17	.92	1.07
95		1.55	1.26	1.09		.92	.78	.94
98		[3] 1.39	.93	.93		[3] .83	.73	.56

Percent of depth	December 5, 1961				May 1, 1962			
	4090 (5.9)	3300 (36.9)	2300 (43.5)	1400 (47.2)	4090 (7.9)	3300 (40.8)	2300 (47.8)	1400 (50.0)
5		0.85	1.07	0.94	0.99	2.30	2.56	2.26
15	0.38	.98	1.00	.90	.90	2.30	2.50	2.05
20								
25	.40	.94	1.00	.90	1.06	2.20	2.26	2.10
35	.37	.92	.74	.87	1.02	2.45	2.26	2.15
45	.42	.90	.96	.92	1.02	2.30	2.01	2.01
55	.45	.90	.90	.81	1.06	2.20	1.88	1.80
65	.51	.87	.84	.68	1.12	2.30	1.96	1.77
75	.52	.76	.77	.67	1.09	2.34	1.88	1.66
80								
85	.53	.81	.68	.64	.65	2.34	1.80	1.88
95		.58	.72	.55		1.66	1.48	1.51
98						1.55	.80	1.51

Percent of depth	May 22, 1962			June 4, 1962			
	3300 (40.7)	2300 (46.5)	1400 (49.5)	4090 (14.5)	3300 (47.8)	2300 (53.5)	1400 (56.8)
5	2.27	2.25	2.21	2.30	3.43	3.50	2.92
15	2.21	2.30	2.15	2.68	3.21	3.50	2.56
20		2.27		2.50	3.43	3.28	2.74
25	2.34	2.27	2.15	2.62	3.21	3.21	2.68
35	2.15	2.10	2.01	2.25	2.92	3.06	2.86
45	2.10	2.15	1.92	2.34	2.92	3.13	2.68
55	2.15	2.21	1.84	2.50	3.13	2.99	2.50
65	2.10	1.92	1.88	2.39	2.80	3.06	2.56
75	2.10	1.84	1.84	2.21	2.68	2.74	2.44
80		1.96		1.67	3.35	2.15	2.44
85	2.10	2.01	1.77	1.47	2.80	2.50	2.44
95	2.01	1.77	1.58	[3] 1.06	2.25	2.15	2.10
98	1.35	1.14	1.54		1.70	2.21	1.92

[1] Edge of water at left bank is station 925; right bank, 365.
[2] Edge of water at left bank is station 1160; right bank, 310.
[3] Measurements made approximately at percentage of depth indicated.
[4] Edge of water at left bank is station 1440; right bank, 180.
[5] Edge of water at left bank is station 1210; right bank, 280.
[6] Edge of water at left bank is station 1200; right bank, 290.

TABLE 4.—*One, 2-, and 4-minute velocities, in feet per second, at three gaging stations on the Columbia River*

At Grand Coulee Dam, Wash.

[Gaging station 12–4365, March 27, 1963. Station number within measuring cross section (left figure) and depth to streambed in feet (in parentheses)]

Percent of depth	450 (27.6)			540 (38.3)			660 (47.3)		
	1-min	2-min	4-min	1-min	2-min	4-min	1-min	2-min	4-min
5	3.40	3.50	3.46	5.38	5.25	5.26	5.30	5.38	5.06
15	3.59	3.34	3.44	4.98	5.08	5.04	6.13	5.92	5.97
20	3.18	3.04	3.20	5.09	4.97	5.01	5.34	5.34	5.40
25	3.62	3.36	3.21	4.70	4.72	4.87	5.91	5.97	5.97
35	2.95	2.99	3.00	5.01	5.09	4.97	5.80	5.70	5.61
45	3.03	3.01	2.92	4.73	4.50	4.44	5.42	5.61	5.42
55	3.00	2.90	3.01	4.76	4.60	4.54	5.70	5.56	5.08
65	2.77	2.79	2.80	4.38	4.28	4.14	4.87	4.67	4.85
75	2.90	2.81	2.61	4.17	4.07	4.02	4.68	4.84	4.93
80	2.83	2.52	2.91	3.86	3.74	3.62	4.68	4.90	5.04
85	2.41	2.23	2.33	3.27	3.68	3.89	4.18	4.13	3.92
95	1.79	1.84	1.79	2.72	2.94	2.99	2.64	2.72	2.92

Percent of depth	750 (49.0)		
	1-min	2-min	4-min
5	4.33	4.15	3.98
15	3.94	4.17	3.91
20	3.81	3.76	3.80
25	3.81	3.51	3.60
35	3.74	3.68	3.66
45	3.74	3.56	3.55
55	3.16	2.72	2.92
65	2.83	2.74	2.98
75	3.21	2.97	2.98
80	2.77	2.85	2.81
85	2.14	2.20	2.33
95	1.94	1.68	1.97

At Bridgeport, Wash.

[Gaging station 12–4380, May 11, 1963. Station number within measuring cross section (left figure) and depth to streambed in feet (in parentheses)]

Percent of depth	950 (30.4)			800 (25.3)			710 (21.6)		
	1-min	2-min	4-min	1-min	2-min	4-min	1-min	2-min	4-min
5	7.23	7.17	7.03	6.48	6.89	6.53	7.61	7.68	7.64
15	7.35	7.42	7.45	7.11	7.06	7.23	8.18	7.64	7.80
20	7.35	7.42	7.26	6.89	6.94	7.03	7.88	7.78	7.78
25	7.23	7.35	7.11	6.89	6.63	6.86	7.74	7.63	7.85
35	6.78	6.78	7.03	6.78	7.00	6.81	7.61	7.59	7.64
45	6.51	6.45	6.36	6.38	6.38	6.27	7.74	7.73	7.78
55	6.38	6.38	6.38	6.20	6.23	6.38	7.48	7.53	7.54
65	4.94	5.06	4.96	6.14	6.18	6.30	7.74	7.81	7.68
75	4.35	3.89	4.22	6.03	6.02	6.02	6.78	6.63	6.79
80	3.69	3.75	3.74	5.92	5.87	5.88	5.82	5.78	5.78
85	3.21	3.32	3.13	5.82	5.84	5.78	5.43	5.47	5.32
95	2.50	2.75	2.42	3.89	3.75	3.83	4.94	4.82	4.80

Percent of depth	560 (22.4)			500 (24.3)		
	1-min	2-min	4-min	1-min	2-min	4-min
5	8.03	7.93	7.99	7.61	7.48	7.46
15	8.03	7.98	7.91	7.61	7.51	7.43
20	7.88	7.96	8.16	7.48	7.41	7.34
25	8.03	8.06	7.98	7.48	7.35	7.49
35	8.03	7.93	7.81	7.48	7.48	7.42
45	7.74	7.80	7.71	6.51	6.46	6.46
55	7.48	7.29	7.51	6.26	6.18	6.20
65	6.78	6.65	6.91	5.92	5.87	5.79
75	6.78	6.75	6.70	5.71	5.78	5.62
80	6.51	6.48	6.63	5.26	5.26	5.26
85	6.26	6.13	6.07	4.94	5.13	5.24
95	4.77	5.01	4.90	4.03	3.75	3.69

TABLE 4.—*One-, 2-, and 4-minute velocities, in feet per second, at three gaging stations on the Columbia River*—Continued

At Bridgeport, Wash.—Continued

[Gaging station 12–4380, June 20, 1963. Station number within measuring cross section (left figure) and depth to streambed in feet (in parentheses)]

Percent of depth	950 (43.7)			800 (38.5)			710 (34.2)		
	1-min	2-min	4-min	1-min	2-min	4-min	1-min	2-min	4-min
5	10.92	10.57	10.92	10.92	11.11	11.30	11.11	11.60	11.45
15	10.92	11.02	10.75	11.30	11.30	11.30	10.92	11.11	11.06
20	10.57	10.16	10.53	10.75	11.20	11.20	11.11	11.11	11.11
25	10.75	10.63	10.53	12.14	11.70	11.45	10.75	11.02	10.79
35	10.75	10.49	10.20	10.24	10.57	10.66	11.11	11.20	11.11
45	9.42	9.50	9.26	9.59	9.76	10.12	10.32	10.65	10.70
55	7.81	8.54	8.34	9.93	9.86	10.02	10.84	10.50	10.88
65	8.82	8.22	8.10	8.82	9.42	9.03	10.75	10.75	10.50
75	7.54	7.29	7.03	8.68	8.96	8.64	10.09	9.86	10.09
80	6.19	6.12	6.23	8.68	9.03	8.68	8.82	8.28	8.82
85	6.95	6.25	6.02	7.29	7.54	7.57	8.41	8.28	8.57
95	3.46	3.49	4.38	5.97	5.86	6.18	8.41	7.98	7.14

Percent of depth	560 (36.0)			500 (35.8)		
	1-min	2-min	4-min	1-min	2-min	4-min
5	12.14	11.92	12.09	11.70	11.40	11.40
15	10.92	11.11	11.16	10.92	11.02	11.02
20	10.92	10.92	11.16	11.30	10.92	10.97
25	10.84	10.92	10.97	10.24	10.57	10.70
35	11.02	11.02	10.88	11.30	11.11	10.88
45	10.75	11.02	11.02	10.75	10.49	10.28
55	10.32	10.57	10.41	10.57	10.01	9.86
65	10.24	9.79	10.16	9.59	9.67	9.71
75	10.09	9.57	9.64	9.11	9.34	9.03
80	9.93	9.57	9.30	8.54	8.68	8.41
85	8.10	8.41	8.35	8.82	8.74	8.41
95	7.54	6.78	6.66	5.39	5.66	6.06

At Rocky Reach Dam, Wash.

[Gaging station 12–4537, May 13, 1963. Station number within measuring cross section (left figure) and depth to streambed in feet (in parentheses)]

Percent of depth	1030 (34.9)			880 (39.2)			720 (39.5)		
	1-min	2-min	4-min	1-min	2-min	4-min	1-min	2-min	4-min
5	4.46	4.24	4.31	5.76	5.80	5.75	5.39	5.34	5.50
15	4.09	4.24	4.25	5.94	5.98	5.86	5.23	5.25	5.27
20	4.46	4.35	4.24	5.39	5.43	5.53	5.01	5.07	5.30
25	3.96	4.15	4.07	5.48	5.25	5.46	5.12	5.16	5.16
35	3.91	3.88	3.89	5.48	5.53	5.20	5.02	5.03	5.14
45	3.72	3.90	3.86	5.39	5.39	5.30	5.02	5.07	5.01
55	3.72	3.88	3.77	5.30	5.25	5.14	4.94	4.80	4.78
65	3.19	3.39	3.51	5.35	5.34	5.32	4.68	4.84	4.75
75	2.99	3.00	3.18	4.75	4.75	4.53	4.03	4.12	4.08
80	3.02	2.87	3.10	4.14	4.17	4.39	4.68	4.30	4.21
85	2.21	2.21	2.54	4.85	4.62	4.60	4.14	4.08	4.08
95	1.96	1.92	2.00	3.36	3.72	3.72	2.94	2.91	2.78

Percent of depth	600 (36.7)			520 (39.0)		
	1-min	2-min	4-min	1-min	2-min	4-min
5	4.50	4.57	4.60	5.12	5.03	5.07
15	3.66	3.75	4.10	4.75	4.75	4.82
20	4.50	4.48	4.41	5.02	5.03	5.05
25	4.39	4.48	4.48	4.75	4.84	4.96
35	4.32	4.26	3.86	4.83	4.84	4.80
45	3.72	3.81	3.96	4.85	4.71	4.64
55	3.96	3.63	3.81	4.53	4.46	4.44
65	3.72	3.54	3.77	3.78	3.94	4.16
75	3.37	3.30	3.25	3.78	4.03	3.96
80	3.30	3.51	3.42	3.36	3.54	3.65
85	3.17	2.94	3.21	3.66	3.66	3.63
95	1.72	1.86	1.94	2.97	2.87	2.69

TABLE 4.—*One-, 2-, and 4-minute velocities, in feet per second, at three gaging stations on the Columbia River*—Continued

At Rocky Reach Dam, Wash.—Continued

[Gaging station 12–4537, June 14, 1963. Station number within measuring cross section (left figure) and depth to streambed in feet (in parentheses)]

Percent of depth	1030 (46.4)			880 (50.0)			720 (51.0)		
	1-min	2-min	4-min	1-min	2-min	4-min	1-min	2-min	4-min
5	7.84	7.96	7.97	9.86	9.93	9.89	9.64	9.66	9.52
15	8.02	7.75	7.75	9.48	9.29	9.35	9.50	9.57	9.61
20	8.02	7.93	7.72	9.66	9.40	9.43	9.50	9.29	9.57
25	7.71	7.66	7.71	9.66	9.66	9.16	9.29	9.40	9.66
35	7.66	7.82	7.76	9.66	9.46	9.26	9.48	9.40	9.29
45	6.39	6.84	7.21	9.66	9.01	8.89	9.11	8.84	8.80
55	7.12	7.02	7.25	8.93	8.75	8.72	8.53	8.84	8.21
65	7.30	7.02	6.93	8.06	8.20	8.26	8.39	8.11	8.11
75	6.70	6.30	6.05	7.42	7.75	7.80	8.34	8.39	8.21
80	6.03	5.66	5.75	7.71	7.57	7.83	7.79	8.37	7.78
85	5.57	5.66	5.53	7.71	7.36	7.22	7.42	6.97	7.10
95	3.48	3.63	3.68	6.64	5.93	6.34	5.12	5.30	5.63

Percent of depth	600 (48.4)			520 (37.0)		
	1-min	2-min	4-min	1-min	2-min	4-min
5	8.75	9.02	9.02	9.64	9.47	9.53
15	8.43	8.46	8.80	9.47	9.29	9.29
20	8.57	8.75	8.75	8.96	9.11	9.25
25	8.39	8.39	8.52	9.47	9.39	9.21
35	8.34	8.56	8.21	9.29	9.29	9.16
45	8.25	8.11	8.02	9.11	8.66	8.70
55	7.48	7.57	7.72	8.07	8.11	8.30
65	8.02	7.91	7.62	8.57	8.39	8.40
75	6.87	7.21	7.42	6.46	6.84	7.18
80	6.75	6.90	6.84	6.93	7.15	7.39
85	6.46	6.12	6.13	6.75	6.72	6.48
95	3.66	4.24	4.57	5.75	5.66	5.07

[Gaging station 12–4537, April 5, 1963. Station number within measuring cross section (left figure) and depth to streambed in feet (in parentheses)]

Percent of depth	1030 (33.2)			880 (36.9)			720 (37.4)		
	1-min	2-min	4-min	1-min	2-min	4-min	1-min	2-min	4-min
5	3.30	3.21	3.21	4.65	4.61	4.40	4.18	4.30	4.23
15	3.07	3.12	3.33	4.42	4.44	4.59	4.39	4.21	4.03
20	3.42	3.45	3.27	4.57	4.52	4.43	4.46	4.30	4.28
25	3.25	3.33	3.26	4.46	.453	4.50	3.96	4.13	4.13
35	3.35	3.07	3.14	4.28	4.28	4.01	3.96	3.90	3.89
45	2.35	2.28	2.57	4.32	4.35	4.39	3.85	4.03	4.09
55	2.89	2.91	2.76	4.14	4.33	4.19	4.14	3.99	3.84
65	2.57	2.69	2.70	3.96	3.97	3.91	3.78	3.72	3.85
75	1.72	2.04	2.25	3.78	3.79	3.75	3.48	3.60	3.51
80	2.06	2.00	1.96	3.18	3.48	3.60	3.91	3.88	3.63
85	2.29	2.39	2.10	2.99	3.14	3.30	3.66	3.66	3.66
95	1.16	1.34	1.43	2.35	2.57	2.74	2.89	3.00	2.65

Percent of depth	600 (34.9)			520 (37.0)		
	1-min	2-min	4-min	1-min	2-min	4-min
5	3.84	3.72	3.60	4.32	4.34	4.27
15	3.36	3.36	3.51	4.14	4.08	4.24
20	3.12	3.25	3.36	4.09	4.17	4.12
25	3.66	3.54	3.48	4.28	4.26	4.19
35	3.42	3.42	3.49	4.03	3.97	3.95
45	3.42	3.34	3.27	3.66	3.66	3.65
55	2.99	3.14	3.09	4.03	3.88	3.91
65	3.10	3.21	3.30	3.55	3.60	3.54
75	2.99	2.71	2.79	3.30	3.30	3.13
80	3.30	3.22	3.10	3.14	3.14	3.05
85	2.99	2.97	2.92	3.80	3.00	2.96
95	1.68	1.83	1.97	2.39	2.34	2.12

TABLE 5.—*Velocities, in feet per second, obtained with special current-meter bracket at four gaging stations on the Columbia River*

At Grand Coulee Dam, Wash.

[Gaging station 12-4365, March 24, 1964. Station number within measuring cross section (left figure) and depth to streambed in feet (in parentheses)]

Percent of depth	750 (50.5)				660 (49.4)			
	1st min	2d min	3d min	Mean	1st min	2d min	3d min	Mean
5	3.53	3.59	3.49	3.54	4.74	4.82	4.87	4.81
15	3.41	3.42	3.44	3.42	4.49	4.93	4.87	4.76
20	3.48	3.59	3.52	3.53	4.91	4.90	4.80	4.87
25	3.43	3.46	3.46	3.45	4.72	4.72	5.06	4.84
35	3.46	3.48	3.42	3.45	5.09	4.64	4.52	4.74
45	3.54	2.99	3.30	3.29	4.80	4.39	4.56	4.57
55	2.98	3.03	2.98	3.00	4.34	4.78	4.53	4.55
65	2.93	2.89	2.53	2.78	4.34	4.70	4.53	4.53
75	2.71	2.94	2.66	2.77	3.66	3.72	3.54	3.64
80	2.75	2.75	2.76	2.75	3.66	3.60	3.59	3.62
85	2.03	2.43	2.24	2.23	3.97	2.89	3.41	3.41
95	1.88	1.42	2.40	1.88	2.28	2.24	2.24	2.26
96					2.24	2.28	2.32	2.28
97	1.72	1.54	1.82	1.69	2.17	2.00	2.10	2.09
98	1.56	1.42	1.69	1.55	2.24	1.85	1.69	1.93
99	1.09	1.17	1.17	1.15	1.72	1.46	1.56	1.58

Percent of depth	540 (40.7)				450 (29.3)			
	1st min	2d min	3d min	Mean	1st min	2d min	3d min	Mean
5	4.20	4.64	4.09	4.31	2.71	2.80	2.89	2.80
15	3.78	3.83	3.85	3.82	3.30	2.80	2.84	2.98
20	3.91	3.44	4.09	3.80	3.14	3.05	2.98	3.05
25	4.16	4.09	4.18	4.12	3.03	2.98	2.89	2.97
35	3.49	3.45	3.42	3.45	2.80	2.80	2.84	2.81
45	3.41	3.35	3.41	3.39	2.89	2.75	2.98	2.87
55	3.19	2.99	3.22	3.14	2.67	2.71	2.40	2.60
65	3.33	3.44	3.35	3.37	2.24	2.32	2.21	2.26
75	3.44	2.85	2.93	3.09	2.14	2.17	2.40	2.23
80	2.80	3.02	2.93	2.92	2.17	2.40	2.71	2.44
85	2.47	2.71	2.57	2.59	2.21	2.24	2.13	2.20
95	2.03	2.61	2.35	2.33	2.00	1.32	2.21	1.85
96	2.43	2.32	2.34	2.36				
97					2.11	1.91	1.67	1.91
98	2.28	1.59	1.96	1.95	1.39	1.44	1.72	1.52
99	1.76	1.53	1.67	1.66				

At Bridgeport, Wash.

[Gaging station 12-4380, March 19, 1964. Station number within measuring cross section (left figure) and depth to streambed in feet (in parentheses)]

Percent of depth	500 (17.3)				560 (15.9)			
	1st min	2d min	3d min	Mean	1st min	2d min	3d min	Mean
5	6.48	5.92	6.35	6.24	6.22	6.22	6.19	6.21
15	6.30	5.93	6.51	6.24	6.11	6.11	6.40	6.21
20	6.19	5.94	6.08	6.07	6.01	6.22	6.30	6.17
25	5.65	6.38	6.17	6.07	6.32	6.11	5.91	6.11
35	6.09	6.40	6.30	6.26	6.22	5.82	6.00	6.01
45	5.83	5.56	5.46	5.62	6.11	5.79	5.78	5.90
55	5.38	5.37	5.83	5.53	5.75	5.47	5.83	5.68
65	5.65	5.47	5.47	5.53	5.58	5.30	5.76	5.53
75	4.56	4.80	4.93	4.76	5.47	5.19	5.65	5.44
80	4.82	4.38	5.01	4.74	5.82	4.72	5.09	5.22
85	4.27	4.82	4.46	4.52	4.56	5.18	5.03	4.92
95	3.35	3.46	3.54	3.45	2.80	3.37	2.70	2.89
96								
97	2.93	2.93	2.94	2.94	2.93	2.80	2.80	2.84

TABLE 5.—*Velocities, in feet per second, obtained with special current-meter bracket at four gaging stations on the Columbia River*—Continued

At Bridgeport, Wash.—Continued

Percent of depth	710 (14.4)				800 (18.5)			
	1st min	2d min	3d min	Mean	1st min	2d min	3d min	Mean
5	6.66	6.66	6.92	6.75	5.75	5.47	5.47	5.56
15	6.50	6.58	7.01	6.69	5.65	5.65	5.56	5.62
20	6.39	6.38	6.56	6.51	5.56	5.65	5.56	5.59
25	6.48	6.38	6.51	6.46	5.65	5.65	5.56	5.62
35	6.48	6.48	6.00	6.31	5.65	5.64	5.67	5.65
45	6.22	6.30	6.56	6.36	5.65	5.65	5.65	5.65
55	5.83	6.03	6.25	6.04	5.47	5.65	5.47	5.53
65	5.65	6.11	5.92	5.90	5.65	5.56	5.47	5.56
75	5.38	5.17	5.20	5.25	5.56	5.56	5.65	5.59
80	4.72	4.64	5.01	4.79	5.21	5.21	5.24	5.22
85	4.82	4.16	3.96	4.31	4.72	4.76	4.95	4.79
95	3.08	3.06	2.71	2.95	3.41	3.30	3.24	3.32
96	2.89	2.89	2.80	2.86				
97					2.75	2.17	2.36	2.43

At Rocky Reach Dam, Wash.

[Gaging station, 12–4537, February 20, 1964. Station number within measuring cross section (left figure) and depth to streambed in feet (in parentheses)]

Percent of depth	1030 (32.3)				880 (35.8)			
	1st min	2d min	3d min	Mean	1st min	2d min	3d min	Mean
5	3.41	3.63	3.55	3.53	4.47	4.39	4.43	4.43
15	2.94	3.36	3.22	3.17	4.36	4.32	4.46	4.38
20	3.49	3.79	3.41	3.56	4.39	4.53	4.47	4.47
25	3.52	3.12	3.55	3.41	4.16	4.19	3.84	4.04
35	2.96	3.52	3.70	3.40	3.64	3.76	3.79	3.75
45	3.44	2.99	3.82	3.41	3.93	3.95	4.25	4.04
55	3.36	3.15	3.14	3.21	4.07	4.09	4.10	4.09
65	2.82	2.55	3.01	2.80	3.90	3.79	4.21	3.97
75	2.76	2.66	2.30	2.60	3.36	4.03	3.76	3.72
80	2.18	2.66	2.42	2.41	3.82	4.06	4.35	4.07
85	1.86	1.78	2.17	1.93	3.55	3.61	2.93	3.37
90	2.03	1.63	1.57	1.74	3.55	3.04	3.28	3.29
95	1.69	1.68	1.55	1.64	2.99	2.67	2.80	2.82
97	1.17	1.07	1.58	1.28	1.82	2.60	2.41	2.27
98	1.00	1.09	1.26	1.11				
99					1.77	1.71	1.80	1.76

Percent of depth	720 (36.0)				600 (33.0)			
	1st min	2d min	3d min	Mean	1st min	2d min	3d min	Mean
5	3.76	3.96	3.96	3.90	3.17	3.08	3.46	3.26
15	3.58	3.67	3.86	3.70	3.39	3.22	3.41	3.34
20	3.52	3.66	3.85	3.68	3.48	3.46	2.99	3.31
25	3.88	3.96	3.91	3.92	3.41	3.00	3.02	3.16
35	3.76	3.37	3.73	3.62	3.25	3.23	2.97	3.15
45	4.03	3.64	3.44	3.71	3.07	2.92	2.73	2.91
55	3.67	3.46	3.67	3.60	2.82	2.64	3.12	2.86
65	3.58	3.36	3.36	3.43	2.71	3.06	3.12	2.96
75	3.47	3.25	3.44	3.39	2.71	2.65	2.62	2.66
80	3.51	3.28	2.92	3.23	2.69	2.85	2.58	2.70
85	2.51	3.40	1.07	2.43	2.00	2.60	2.97	2.53
90	3.12	2.90	2.32	2.77	2.73	2.41	2.58	2.58
95	2.76	2.58	2.47	2.60	1.62	1.47	1.77	1.62
97	2.08	1.78	1.80	1.88	1.89	1.66	1.54	1.69
98					1.48	1.19	.88	1.18
99	2.08	2.00	2.16	2.08				

TABLE 5.—*Velocities, in feet per second, obtained with special current-meter bracket at four gaging stations on the Columbia River*—Continued

Below Priest Rapids Dam, Wash.

[Gaging station 12-4728, February 18, 1964. Station number within measuring cross section (left figure) and depth to streambed in feet (in parentheses)]

Percent of depth	280 (16.1)				480 (24.7)			
	1st min	2d min	3d min	Mean	1st min	2d min	3d min	cean
3	2.62	2.55	2.43	2.54				
5	2.37	2.58	2.19	2.38	3.58	3.80	4.04	3.80
15	2.25	2.39	3.12	2.59	3.95	3.79	3.97	3.89
20	2.45	2.39	2.30	2.38	4.06	3.93	4.24	4.06
25	2.37	2.29	2.28	2.31	4.25	4.19	4.14	4.19
35	2.14	2.43	2.27	2.28	4.13	4.37	4.30	4.26
45	2.05	2.08	1.96	2.03	3.96	4.18	4.37	4.17
55	2.31	2.12	2.27	2.23	4.14	3.86	4.01	4.00
60					3.88	4.12	4.14	4.04
65	2.11	2.00	1.88	2.00	3.61	3.90	4.69	4.06
75	1.85	1.85	1.79	1.83	3.79	3.46	3.58	3.61
80	1.62	1.55	1.81	1.65	3.15	3.41	3.45	3.33
85	1.64	1.48	1.42	1.51	3.17	2.97	3.64	3.25
88	1.40	1.64	1.53	1.52				
90					3.06	2.83	2.86	2.92
91	1.48	1.46	1.54	1.49				
92					2.89	2.80	2.54	2.75
94	1.30	1.55	1.38	1.41	2.55	2.92	2.44	2.63
96					2.60	2.25	2.50	2.45
97	1.16	.86	1.09	1.03				
98					1.89	2.19	2.43	2.17

TABLE 6.—*One-minute simultaneous velocity measurements for 66 minutes at vertical 280 in the measuring cross section, Columbia River below Priest Rapids Dam, August 14, 1963*

[Gaging station 12-4728; maximum and minimum velocities italicized]

Percent of total depth	Velocities in feet per second for indicated time in minutes											
	1	2	3	4	5	6	7	8	9	10	11	12
5	3.96	4.00	4.14	4.11	3.82	3.96	4.07	4.04	3.85	3.82	3.71	4.14
15	3.85	3.85	4.00	4.04	3.78	3.85	3.96	3.96	3.78	3.71	3.60	4.04
25	3.78	3.66	3.85	3.96	3.70	3.70	3.88	3.88	3.63	3.63	3.44	3.88
35	3.66	3.52	3.59	3.70	3.59	3.59	3.74	3.84	3.37	3.45	3.26	3.66
45	3.60	3.35	3.31	3.70	3.56	3.45	3.60	3.78	3.28	3.35	3.13	3.53
55	3.50	3.24	3.06	3.42	3.39	3.31	3.46	3.57	3.13	3.20	3.02	3.31
65	3.38	3.01	2.94	3.16	3.38	3.08	3.27	3.34	2.97	2.97	2.90	3.08
75	3.10	2.81	2.74	2.99	3.21	2.63	2.96	3.03	2.77	2.70	2.81	2.96
85	2.80	2.58	2.37	2.58	2.80	2.26	2.55	2.77	2.58	2.29	2.58	2.55
95	2.28	2.03	1.66	2.10	2.06	1.70	1.95	2.39	1.95	1.66	2.14	1.92
Mean velocity	3.391	3.205	3.166	3.376	3.329	3.153	3.344	3.460	3.131	3.078	3.059	3.307

Percent of total depth	13	14	15	16	17	18	19	20	21	22	23	24
5	3.78	*3.56*	3.74	3.96	3.78	3.74	3.78	3.82	3.78	4.07	3.74	3.71
15	3.78	*3.41*	3.56	3.82	3.67	3.52	3.71	3.71	3.67	3.91	3.60	3.63
25	3.70	*3.37*	*3.37*	3.74	3.56	*3.37*	3.63	3.63	3.56	3.78	3.52	3.59
35	3.59	*3.08*	3.19	3.66	3.48	3.26	3.48	3.59	3.48	3.66	3.41	3.52
45	3.42	*2.92*	3.10	3.63	3.42	3.20	3.42	3.45	3.28	3.60	3.31	3.49
55	3.28	*2.72*	2.87	3.53	3.36	3.17	3.24	3.35	3.06	3.46	3.13	3.42
65	3.08	*2.57*	2.64	3.49	3.27	3.05	3.12	3.23	2.86	3.19	2.86	3.27
75	2.88	*2.48*	2.52	3.28	3.14	2.81	2.99	3.14	2.81	2.96	2.74	3.06
85	2.69	*2.18*	2.44	2.95	2.88	2.37	2.66	2.98	2.51	2.58	2.51	2.66
95	2.17	*1.62*	1.84	2.32	2.17	*1.62*	2.14	2.36	2.03	2.10	1.88	2.14
Mean velocity	3.237	2.791	2.927	3.438	3.273	3.011	3.217	3.326	3.104	3.331	3.070	3.249

TABLE 6.—*One-minute simultaneous velocity measurements for 66 minutes at vertical 280 in the measuring cross section, Columbia River below Priest Rapids Dam, August 14, 1963*—Continued

Percent of total depth	Velocities in feet per second for indicated time in minutes											
	25	26	27	28	29	30	31	32	33	34	35	36
5	4.04	*4.22*	3.89	3.96	3.89	3.89	4.11	3.78	*3.56*	3.74	3.96	3.82
15	3.93	*4.18*	3.74	3.89	3.82	3.74	4.00	3.71	3.45	3.63	3.89	3.67
25	3.74	4.03	3.63	3.85	3.74	3.66	3.88	3.63	3.41	3.52	3.70	3.48
35	3.70	3.92	3.63	3.84	3.74	3.55	3.84	3.59	3.41	3.45	3.62	3.41
45	3.67	3.67	3.60	3.81	3.70	3.49	3.81	3.56	3.38	3.28	3.53	3.38
55	3.50	3.39	3.57	3.76	3.64	3.28	3.68	3.46	3.31	3.02	3.35	3.35
65	3.23	3.27	3.45	*3.67*	3.45	3.01	3.56	3.34	3.23	2.83	3.12	3.19
75	2.99	3.10	3.39	3.47	3.39	2.77	3.36	3.03	3.14	2.70	2.85	3.14
85	2.48	2.77	2.98	2.98	3.09	2.58	2.80	2.73	2.88	2.44	2.51	2.69
95	1.81	2.06	2.32	2.32	2.50	2.03	2.21	2.21	2.25	2.06	1.84	2.17
Mean velocity	3.309	3.461	3.420	3.555	3.496	3.200	3.525	3.304	3.202	3.067	3.237	3.230

	37	38	39	40	41	42	43	44	45	46	47	48
5	3.67	3.78	3.82	3.96	3.93	4.18	3.93	4.04	4.00	3.93	4.18	3.85
15	3.63	3.67	3.67	3.89	3.85	4.15	3.91	3.96	4.00	3.78	*4.18*	3.78
25	3.59	3.56	3.66	3.74	3.66	*4.14*	3.88	3.88	4.00	3.74	4.00	3.66
35	3.55	3.52	3.55	3.59	3.55	*4.21*	3.81	3.88	3.95	3.74	3.88	3.52
45	3.53	3.35	3.49	3.42	3.42	*4.10*	3.67	3.70	3.78	3.63	3.67	3.45
55	3.31	3.17	3.42	3.28	3.28	*3.94*	3.50	3.50	3.50	3.53	3.46	3.24
65	3.08	2.90	3.30	3.12	3.16	*3.67*	3.34	3.34	3.34	3.41	3.27	3.05
75	2.99	2.52	3.21	2.96	3.03	3.43	3.32	3.17	3.10	3.17	3.14	2.77
85	2.88	2.22	2.91	2.77	2.77	2.98	3.09	2.98	2.62	2.69	2.88	2.51
95	2.50	1.95	2.21	2.25	2.43	2.50	2.39	2.32	2.06	1.95	2.47	2.10
Mean velocity	3.273	3.064	3.324	3.298	3.308	3.730	3.484	3.477	3.435	3.357	3.513	3.193

	49	50	51	52	53	54	55	56	57	58	59	60
5	3.85	3.93	3.89	3.67	3.63	3.85	3.96	4.14	3.85	4.00	4.18	4.07
15	3.85	3.91	3.85	3.67	3.63	3.85	3.85	4.00	3.71	3.91	4.00	4.04
25	3.81	3.85	3.85	3.63	3.63	3.85	3.74	3.88	3.74	3.78	3.85	3.96
35	3.70	3.81	3.84	3.59	3.59	3.84	3.62	3.77	3.70	3.70	3.70	3.88
45	3.56	3.74	3.74	3.53	3.45	3.70	3.56	3.70	3.60	3.60	3.56	3.67
55	3.50	3.61	3.50	3.35	3.28	3.57	3.42	3.61	3.35	3.53	3.31	3.50
65	3.30	3.49	3.23	3.12	3.12	3.41	3.30	3.45	3.12	3.41	3.16	3.45
75	2.99	3.43	2.99	2.85	2.92	3.25	3.14	3.28	2.96	3.39	3.06	3.28
85	2.73	3.13	2.66	2.44	2.44	2.69	2.88	2.88	2.51	*3.20*	2.91	2.91
95	2.14	2.43	2.21	1.92	1.88	2.14	2.36	2.21	1.99	2.58	2.32	2.28
Mean velocity	3.343	3.533	3.376	3.177	3.157	3.415	3.383	3.492	3.253	3.510	3.405	3.504

	61	62	63	64	65	66	Mean
5	3.74	3.71	3.85	3.71	3.63	4.00	3.89
15	3.78	3.63	3.89	3.67	3.63	3.89	3.81
25	3.74	3.59	3.88	3.56	3.56	3.74	3.72
35	3.70	3.48	3.84	3.41	3.55	3.52	3.62
45	3.60	3.49	3.74	3.42	3.49	3.38	3.52
55	3.35	3.35	3.68	3.24	3.35	3.24	3.37
65	3.12	3.19	3.60	3.05	3.08	3.12	3.20
75	2.96	3.03	*3.50*	2.74	3.10	3.06	3.02
85	2.58	2.73	3.17	2.44	2.98	2.73	2.70
95	1.99	2.14	*2.61*	2.03	2.39	2.28	2.14
Mean velocity	3.256	3.234	3.576	3.127	3.276	3.296	3.299

TABLE 6.—*One-minute simultaneous velocity measurements for 66 minutes at vertical 280 in the measuring cross section, Columbia River below Priest Rapids Dam August 14, 1963*—Continued

Percent of total depth	Standard deviation from mean		Range
	Fps	Percent	Fps
5	0.160	4.1	0.66
15	.167	4.4	.77
25	.170	4.6	.77
35	.193	5.3	1.13
45	.193	5.5	1.18
55	.204	6.1	1.22
65	.222	6.9	1.10
75	.240	7.9	1.02
85	.238	8.8	1.02
95	.236	11.0	.99
Mean	.169	5.1	.99

TABLE 7.—*Average maximum and minimum velocities for various time intervals vertical 280, Columbia River below Priest Rapids Dam, August 14, 1963*

[Based on simultaneous velocity measurements; gaging station 12–4728]

Percent of total depth		Velocities in feet per second for indicated time in minutes											
		1	2	3	4	5	6	8	10	12	15	20	30
5	Max	4.22	4.13	4.08	4.05	4.05	4.04	4.02	3.98	3.97	3.95	3.95	3.90
	Min	3.56	3.65	3.69	3.73	3.73	3.75	3.77	3.80	3.79	3.81	3.85	3.84
15	Max	4.18	4.06	4.01	4.00	3.97	4.00	3.96	3.94	3.93	3.88	3.89	3.84
	Min	3.41	3.48	3.58	3.62	3.60	3.62	3.63	3.66	3.67	3.69	3.74	3.73
25	Max	4.14	4.01	3.97	3.98	3.93	3.94	3.89	3.88	3.85	3.84	3.83	3.77
	Min	3.37	3.37	3.48	3.51	3.48	3.51	3.53	3.55	3.57	3.58	3.63	3.63
35	Max	4.21	4.01	3.96	3.96	3.92	3.91	3.84	3.83	3.79	3.78	3.77	3.70
	Min	3.08	3.14	3.29	3.33	3.32	3.35	3.39	3.40	3.42	3.44	3.44	3.53
45	Max	4.10	3.88	3.82	3.81	3.78	3.76	3.70	3.70	3.67	3.67	3.65	3.59
	Min	2.92	3.01	3.15	3.24	3.22	3.24	3.29	3.30	3.32	3.34	3.39	3.44
55	Max	3.94	3.72	3.65	3.61	3.59	3.57	3.52	3.53	3.49	3.50	3.48	3.45
	Min	2.72	2.80	2.96	3.05	3.04	3.07	3.13	3.16	3.18	3.19	3.23	3.31
65	Max	3.67	3.50	3.45	3.42	3.42	3.39	3.34	3.34	3.31	3.32	3.31	3.28
	Min	2.57	2.60	2.76	2.84	2.85	2.87	2.95	2.99	3.04	3.05	3.07	3.14
75	Max	3.50	3.43	3.42	3.34	3.27	3.25	3.21	3.17	3.12	3.13	3.12	3.10
	Min	2.48	2.50	2.62	2.71	2.73	2.73	2.77	2.77	2.83	2.84	2.89	2.96
85	Max	3.20	3.06	3.02	2.95	2.88	2.88	2.85	2.82	2.82	2.79	2.80	2.76
	Min	2.18	2.31	2.44	2.46	2.46	2.46	2.51	2.49	2.52	2.53	2.57	2.63
95	Max	2.61	2.46	2.44	2.41	2.38	2.35	2.32	2.28	2.27	2.26	2.23	2.23
	Min	1.62	1.73	1.88	1.89	1.90	1.89	1.96	1.93	1.96	1.96	2.00	2.04

TABLE 8.—*Comparison of mean velocities of the 17 discharge measurements of the Columbia River*

[Velocity, in feet per second; deviation, in percent. Base river velocity obtained by integrating the velocity curves]

Date	Base river velocity	10-point mean		2-point mean		1-point mean	
		Velocity	Deviation	Velocity	Deviation	Velocity	Deviation
At Grand Coulee Dam, Wash. (Gaging station 12–4365)							
April 24, 1961	4.81	4.81	0	4.84	+ .6	4.72	−1.9
June 20, 1962	7.29	7.22	−1.0	7.40	+1.5	7.18	−1.5
July 7, 1962	7.31	7.26	− .7	7.43	+1.6	7.18	−1.8
June 19, 1963	8.23	8.27	+ .5	8.32	+1.1	8.15	−1.0
At Bridgeport, Wash. (Gaging station 12–4380)							
April 25, 1961	5.82	5.81	− .2	5.80	− .3	5.83	+ .2
June 20, 1961	10.54	10.57	+ .3	10.47	− .7	10.58	+ .4
At Rocky Reach Dam, Wash. (Gaging station 12–4537)							
April 26, 1961	4.10	4.08	− .5	4.10	0	4.09	− .2
June 21, 1961	8.93	8.87	− .7	9.06	+1.4	8.93	0
November 20, 1962	2.35	2.32	−1.3	2.35	0	2.31	−1.7

TABLE 8.—*Comparison of mean velocities of the 17 discharge measurements of the Columbia River*—Continued

Date	Base river velocity	10-point mean		2-point mean		1-point mean	
		Velocity	Deviation	Velocity	Deviation	Velocity	Deviation
At Trinidad, Wash. (Gaging station 12–4645)							
June 21, 1961	10.54	10.52	− .2	10.50	− .4	11.01	+4.4
September 22, 1961	3.60	3.66	+1.7	3.60	0	3.75	+4.2
Below Priest Rapids Dam, Wash. (Gaging station 12–4728)							
April 28, 1961	3.78	3.77	− .3	3.77	− .3	3.77	− .3
June 20, 1961	9.29	9.28	− .1	9.29	0	9.25	− .4
At Paterson Ferry, Oreg. (Gaging station 14–0192)							
June 16, 1961	7.00	7.02	+ .3	7.00	0	7.02	+ .3
October 11, 1961	1.90	1.89	− .5	1.92	+1.0	1.92	+1.0
At Hood River Bridge, Oreg. (Gaging station 14–1057)							
May 5, 1961	1.44	1.43	− .7	1.42	−1.4	1.45	+ .7
June 5, 1961	3.37	3.36	− .3	3.39	+ .6	3.36	− .3
Average			− .2		+ .3		+ .1
Range			3.0		3.0		6.3

TABLE 9.—*Calculation of hypothetical stream discharge by midsection and mean-section method*

[Station numbers and depths are from fig. 16; velocity is assumed numerically equal to depth. Note that computed area is the same by the two methods, but discharge by mean-section method is 3.0 percent less than discharge by midsection method]

Station			Midsection method			Mean-section method			
No.	Velocity (fps)	Depth (feet)	Width of section (feet)	Area of section (sq ft)	Discharge (cfs)	Mean depth of section (feet)	Area of section (sq ft)	Mean velocity (fps)	Discharge (cfs)
0	0	0	0.5	0	0				
						1.5	1.5	1.5	2.25
1	3.0	3.0	1.0	3.0	9.0				
						4.0	4.0	4.0	16.00
2	5.0	5.0	1.0	5.0	25.0				
						5.5	5.5	5.5	30.25
3	6.0	6.0	1.0	6.0	36.0				
						5.5	5.5	5.5	30.25
4	5.0	5.0	1.0	5.0	25.0				
						5.5	5.5	5.5	30.25
5	6.0	6.0	1.0	6.0	36.0				
						6.5	6.5	6.5	42.25
6	7.0	7.0	1.0	7.0	49.0				
						7.0	7.0	7.0	49.00
7	7.0	7.0	1.0	7.0	49.0				
						6.0	6.0	6.0	36.00
8	5.0	5.0	1.0	5.0	25.0				
						5.0	5.0	5.0	25.00
9	5.0	5.0	1.0	5.0	25.0				
						4.0	4.0	4.0	16.00
10	3.0	3.0	1.0	3.0	9.0				
						1.5	1.5	1.5	2.25
11	0	0	.5	0	0				
Totals				52.0	288.0		52.0		279.50

TABLE 10.—*Comparison of Columbia River discharge computed by midsection and mean-section methods from mean velocities obtained from integrated vertical curves*

Date	Midsection discharge (cfs)	Mean-section discharge (cfs)	D'fference (percent)
At Grand Coulee Dam, Wash. (Gaging station 12–4365)			
April 24, 1961	115,700	115,100	−0.5
June 20, 1961	219,200	215,600	−1.6
July 7, 1962	219,500	218,500	− .5
June 19, 1963	267,300	265,400	− .7
At Bridgeport, Wash. (Gaging station 12–4380)			
April 25, 1961	110,800	110,400	− .4
June 20, 1961	427,000	424,800	− .5
Below Rocky Reach Dam, Wash. (Gaging station 12–4537)			
April 26, 1961	116,300	115,700	− .3
June 21, 1961	448,100	446,200	− .4
November 20, 1962	60,800	60,300	− .8
At Trinidad, Wash. (Gaging station 12–4645)			
June 21, 1961	473,100	470,700	− .5
September 22, 1961	60,400	60,100	− .5
Below Priest Rapids Dam, Wash. (Gaging station 12–4728)			
April 28, 1961	104,700	104,400	− .3
June 20, 1961	494,000	490,600	− .7
At Paterson Ferry, Oreg. (Gaging station 14–0192)			
June 16, 1961	596,900	593,900	− .5
October 11, 1961	83,400	83,000	− .5
At Hood River Bridge, Oreg. (Gaging station 14–1057)			
May 5, 1961	197,100	196,200	− .5
June 5, 1961	648,300	647,100	− .2
Average			− .6
Range			1.4

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