A Study of Methods Used in

MEASUREMENT AND ANALYSIS OF SEDIMENT LOADS IN STREAMS

SPONSORED BY THE

SUBCOMMITTEE ON SEDIMENTATION

FEDERAL INTER-AGENCY RIVER BASIN COMMITTEE

REPORT H

INVESTIGATION OF INTAKE CHARACTERISTICS OF DEPTH-INTEGRATING SUSPENDED SEDIMENT SAMPLERS AT THE DAVID TAYLOR MODEL BASIN

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A Cooperative Project

Sponsored by the

Subcommittee on Sedimentation
Federal Inter-Agency River Basin Committee

Participating Agencies

Tennessee Valley Authority
Corps of Engineers ** Geological Survey
Soil Conservation Service ** Coast and Geodetic Survey
Bureau of Reclamation ** Forest Service
Federal Power Commission

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Published by
Project Offices of Cooperating Agencies
at
St. Anthony Falls Hydraulic Laboratory
Minneapolis, Minnesota

November 1954

The cooperative study of methods used in
MEASUREMENT AND ANALYSIS OF SEDIMENT LOADS IN STREAMS
covers phases indicated by the following report titles.

Report No. 1

FIELD PRACTICE AND EQUIPMENT USED IN SAMPLING SUSPENDED SEDIMENT

Report No. 2

EQUIPMENT USED FOR SAMPLING BED-LOAD AND BED MATERIAL

Report No. 3

ANALYTICAL STUDY OF METHODS OF SAMPLING SUSPENDED SEDIMENT

Report No. 4

METHODS OF ANALYZING SEDIMENT SAMPLES

Report No. 5

LABORATORY INVESTIGATIONS OF SUSPENDED SEDIMENT SAMPLERS

Report No. 6

THE DESIGN OF IMPROVED TYPES OF SUSPENDED SEDIMENT SAMPLERS

Report No. 7

A STUDY OF NEW METHODS FOR SIZE ANALYSIS OF SUSPENDED SEDIMENT SAMPLES

Report No. 8

MEASUREMENT OF THE SEDIMENT DISCHARGE OF STREAMS

Report No. 9

DENSITY OF SEDIMENTS DEPOSITED IN RESERVOIRS

Report No. 10

ACCURACY OF SEDIMENT SIZE ANALYSES MADE BY
THE BOTTOM WITHDRAWAL TUBE METHOD

Report A

PRELIMINARY FIELD TESTS OF THE US SEDIMENT-SAMPLING EQUIPMENT
IN THE COLORADO RIVER BASIN
APRIL 1944

Report B

FIELD CONFERENCES ON SUSPENDED SEDIMENT SAMPLING
SEPTEMBER 1944

Report C

COMPARATIVE FIELD TESTS ON SUSPENDED SEDIMENT SAMPLERS
PROGRESS REPORT--DECEMBER 1944

Report D

COMPARATIVE FIELD TESTS ON SUSPENDED SEDIMENT SAMPLERS
PROGRESS REPORT--AS OF JANUARY 1946 *

Report E

STUDY OF METHODS USED IN MEASUREMENT AND ANALYSIS
OF SEDIMENT LOADS IN STREAMS
(Paper presented at ASCE convention, Spokane, Washington)
JULY 1946

Report F

FIELD TESTS ON SUSPENDED SEDIMENT SAMPLERS, COLORADO RIVER
AT BRIGHT ANGEL CREEK NEAR GRAND CANYON, ARIZONA
JUNE 1950

Report G

PRELIMINARY REPORT ON US DH-48 (HAND) SUSPENDED SEDIMENT SAMPLER **
(Out of print--Superseded by material in Report No. 6)

Report H

INVESTIGATION OF INTAKE CHARACTERISTICS OF DEPTH-INTEGRATING
SUSPENDED SEDIMENT SAMPLERS AT THE DAVID TAYLOR MODEL BASIN **

Report I

OPERATION AND MAINTENANCE OF US P-46 SUSPENDED SEDIMENT SAMPLER

Report J

OPERATING INSTRUCTIONS--SUSPENDED SEDIMENT HAND SAMPLER, US DH-48

Report K

OPERATOR'S MANUAL (PRELIMINARY)
THE VISUAL TUBE METHOD FOR SEDIMENTATION ANALYSIS OF SANDS

- -

* In preparation for publication at a future date

** Very limited distribution

SYNOPSIS

The intake characteristics of the US D-43 and US P-46 suspended-sediment samplers were investigated at the David Taylor Model Basin in 1948. The investigation was confined to the effect of vertical motion of a sampler on the quantity of sample collected. Various flow velocities were simulated by towing the samplers through still water at speeds from one to twelve feet per second.

The Model Basin tests in which the samplers were towed through still water showed the same intake characteristics for the samplers as those indicated by laboratory tests for which the samplers were suspended at a fixed position in flowing water. The data that were collected established certain limitations on the maximum rate of vertical movement to which the samplers may be subjected without adversely affecting sampling accuracy. Because the factors that influence limitations on the vertical rates of sampler movement are different for upward and for downward motion, the allowable limits on upward and downward rates are different.

Limitations in the relationship between the vertical rate of movement of the sampler and the velocity of flow (stream velocity) are expressed as a function of the intake diameter of the sampler nozzle and the depth of the stream.

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INVESTIGATION OF INTAKE CHARACTERISTICS OF DEPTH-INTEGRATING SUSPENDED-SEDIMENT SAMPLERS AT THE DAVID TAYLOR MODEL BASIN

I. INTRODUCTION

1. Previous tests--Preliminary to the development of the US series of suspended-sediment samplers, the sampling characteristics of intake nozzles were investigated in the laboratory under various simulated stream conditions. These studies are described in Report No. 5, "Laboratory Investigations of Suspended-Sediment Samplers." In the subsequent development of the samplers, which is discussed in Report No. 6, "The Design of Improved Types of Suspended-Sediment Samplers," nozzle intake designs were based on these studies. The intake characteristics of these sampler nozzles have been the subject of other fairly comprehensive laboratory investigations. Some laboratory tests of the sampling action of the entire sampler have also been made, including the routine calibration of samplers. The laboratory investigations have been confined, almost exclusively, to a determination of the effect of various factors, such as velocity of flow and angle of approach, on the sampling characteristics of the instrument or nozzle, as indicated by the quantity of sample collected with the sampler or nozzle suspended at a fixed position in flowing water. The data obtained have a definite value in revealing various sampling features of the instruments but are not equivalent to data on sampling action under conditions of actual depth

integration in a stream.

During the spring of 1947, an investigation of the operation of the US P-46 suspended-sediment samplers under relatively rough field conditions was conducted in the Colorado River near the town of Grand Canyon, Arizona. Although some data of the most desirable type were obtained, the scope of the tests was not sufficient to define completely the basic factors that affect the accuracy of sampling. These data are presented in the progress report entitled "Field Tests on Suspended-Sediment Samplers, Colorado River at Bright Angel Creek near Grand Canyon, Arizona."

2. Scope of investigation--The test data available on the US D-43 and US P-46 samplers provided very little information to indicate the effect of the vertical movement of a depth-integrating sampler on its sampling characteristics. The information most urgently needed is precise data bearing on the accuracy of sediment samples collected from a stream under various conditions of vertical movement of the sampler. Because suitable conditions were not available to investigate this factor directly, a decision was made to approach the problem by a study of the intake action of the samplers as shown by the ratio of the velocity in the intake nozzle to that in the stream. The study of the problem was further simplified by substituting the towing of the sampler through still water for the operation of the sampler in flowing water. This was equivalent to sampling in a stream without turbulence and with a uniform velocity throughout the depth. Tests on this basis were run during April and May of 1948 in an attempt to determine the effect of the vertical movement of the samplers on their intake characteristics.

The original plans for the tests at the David Taylor Model Basin

contemplated a rigid suspension for the samplers. The horizontal speed of the samplers was to have been identical with that of the carriage from which they were suspended, and the nozzles were to have been horizontal and pointing in the direction of travel of the carriage at all times. Achievement of this ideal condition was found to be impossible within the period of time available for the investigation.

The sampling accuracy of an instrument with respect to the suspended sediment collected in a sample is believed to depend mainly on the relation of the velocity of flow in the nozzle to that in the stream. This relation may be called the intake ratio, which is defined as the mean velocity in the nozzle divided by that stream velocity vector that is coincident to the extended axis of the intake nozzle. If the sampler is oriented directly into the approaching stream flow, the intake ratio is the result obtained by dividing the velocity in the nozzle by the stream velocity at the sampling point. The theory of sampling and data presented in Report No. 5, indicate that the intake ratio for satisfactory sampling should approximate unity. The ratio of unity is based on the theory that the filament of flow entering the sampler nozzle should neither accelerate nor decelerate at the point of entrance. Therefore, the velocity of approach along the extended axis of the nozzle would be the important stream velocity to consider in determining the intake ratio. Departures from a ratio of unity are increasingly serious as the size of the sediment in suspension increases. Departures from a ratio of 1.00 are probably less serious at very low velocities because sediment particles in suspension at these velocities are very small.

In an attempt to evaluate the results of these tests, specifically

in the discussion of the data and in the conclusions, which follow, the assumption is made that if the intake ratio is near 1.00, the sampling will be satisfactory. If the deviation from a ratio of 1.00 exceeds 10 percent results may not be satisfactory. For reasons not relevant to this study, the smaller diameter nozzles (1/8-in.) are made to operate with intake ratios slightly above 1.00 in clear water such as that in the Model Basin.

Temperature also affects the intake ratio of a sampler nozzle. However, the range of temperatures during these tests was not sufficient to define any significant temperature effects.

3. Test facilities and personnel--The facilities of the David Taylor Model Basin of the Department of the Navy were used for these tests. The main testing channel and towing carriage were utilized. The tests were conducted by personnel of the Department of the Navy (R. A. Ebner and T. Gibbons) assisted by personnel of the U. S. Geological Survey (W. W. Hastings, B. C. Colby, and others) and of the Department of the Army (R. P. Christensen).

The report was prepared by Byrnon C. Colby, and was reviewed and edited by Russell P. Christensen, Martin E. Nelson, and Paul C. Benedict.

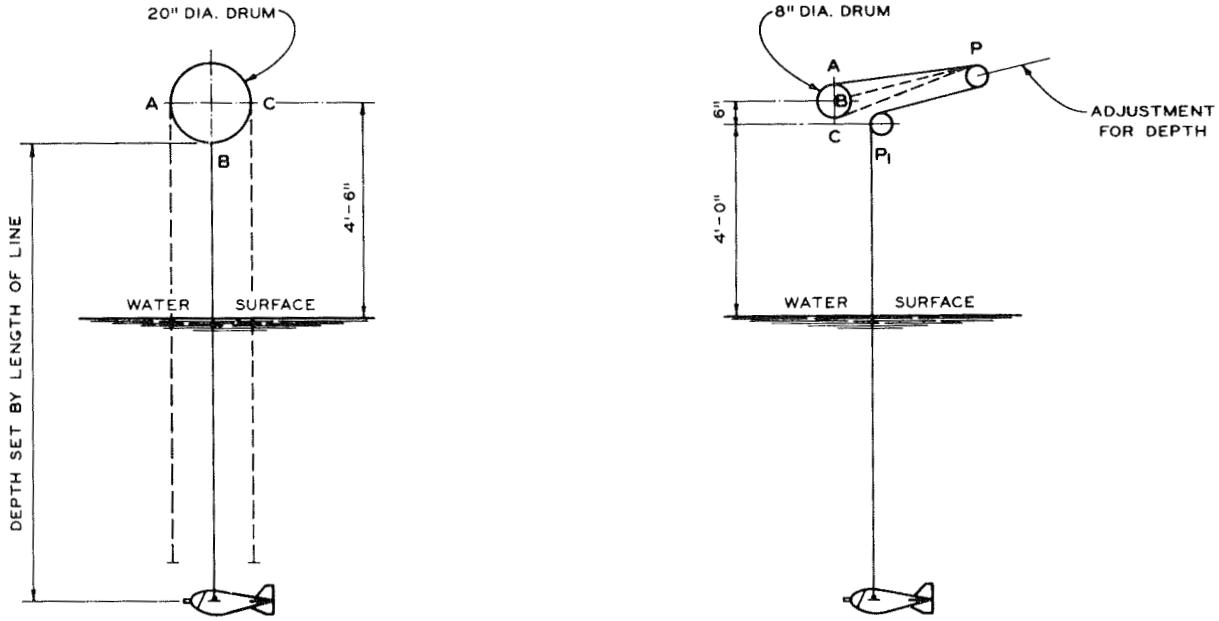
II. EQUIPMENT AND OPERATING PROCEDURE

4. Equipment--The suspended sediment samplers used in this investigation were of the D-43 and P-46 types which are described in Report No. 6. The P-46S used in these tests is identical to the regular P-46 sampler except that the simplified valve operating mechanism is adapted to a single operation which may be either opening or closing the sampler valve at any submerged depth. However, the sampling characteristics would be the same as for any P-46 sampler.

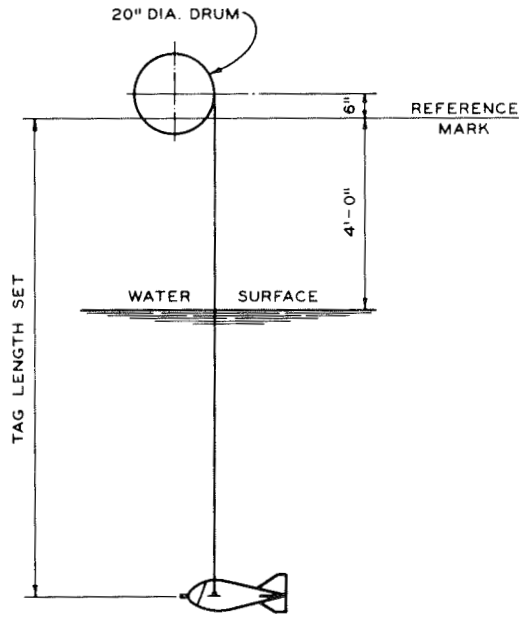
The sediment sampler to be tested was suspended from a carriage which towed the sampler through a long pool of still water at a predetermined rate of speed. Water temperatures ranged from 60.8° to 65.4°F. during the tests.

The mechanical arrangements for suspending the samplers from the carriage are shown diagramatically in Fig. 1. The 0.10-in. diameter suspension cable was wound on a drum the axis of which was horizontal and also perpendicular to the direction of movement of the carriage. Two drum sizes were used. An 8-in. diameter drum was used for vertical movement of the sampler up to rates of slightly over 1 ft. per sec. A 20-in. diameter drum was used for the higher rates of vertical movement. The center of the drum was 4.5 ft. above the water surface. The drum was driven by a reversible electric motor, whose speed could be varied.

Stop watches and 500 cc. graduates were available to determine respectively, the length of sampling time and the quantity of sample. Measuring tapes were available for the determination of depths and distances. Storage batteries, wire, and other electrical supplies were



SUSPENSIONS FOR US D-43 SAMPLER



SUSPENSION FOR US P-46S SAMPLER

FIG. 1 – MECHANICAL SUSPENSIONS FOR SAMPLER OPERATION

DAVID TAYLOR MODEL BASIN DATA

provided for construction of an electrical circuit for the operation of the P-46S sampler.

5. Operating procedures--The D-43 sampler accumulates a sample continuously while in transit from the water surface down to the desired depth and back to the surface again, thus requiring a reversal of direction of vertical travel during the time of sampling. This reversal was accomplished by allowing the entire amount of cable on the drum to unwind, then, as the point of attachment of the cable on the drum continued to rotate, the cable was rewound on the drum. The direction of rotation of the drum continued unchanged, and the speed of the drum varied only slightly during the sampling operation. At times there seemed to be a very small difference in the rate at which the sampler descended and ascended. This difference was much too small to be measured definitely, and certainly too minute to affect the results of the tests. The reversal of direction of transit was very smooth and the reversal occurred in a relatively short period of time. When the sampler was suspended directly from the drum, the sampling depth depended on the length of cable attached to the drum. The idler pulleys P and P_1 were used in order to adjust more readily for many of the shallower sampling depths. The sampling depth could be changed easily by moving the idler pulley P backward or forward. However, the principle of the reversal remained the same.

One feature of the direct suspension should be noted. Whenever the transit direction reversed during sampling, the point of suspension of the sampler was displaced laterally by an amount equal to the diameter of the drum. Also, the transit rate, or rate of lowering and raising the sampler, was governed directly by the speed of the drum except for about

one quarter turn of the drum prior to, and one quarter turn subsequent to a reversal of the transit direction.

In the mechanical arrangement for handling the P-46S sampler, enough cable was used on the drum to allow the sampler to be lowered to depths greater than any sampling depth included in the tests. A reference mark was set on the carriage 4.0 ft. above the water surface and adjacent to the suspension cable. The desired depths were indicated by setting a tag on the suspension cable at a distance, measured from the centerline of the sampler nozzle, which was equal to the desired depth plus 4.0 ft. During downward integration, samples were collected from the time the nozzle entered the water until the tag on the cable descended to the elevation of the reference mark. For upward integration, the sampler was first lowered to a point below the desired depth. Then, the direction of vertical movement was reversed. Sampling was begun when the tag on the cable passed the reference mark and continued until the nozzle emerged from the water.

The electrical circuit used to operate the valve of the P-46S sampler was the same as that for normal sampler operation. The suspension cable had an insulated center-core conductor wire. The electrical circuit was made from one battery terminal, through a switch, to a commutator on the suspension drum. This commutator was connected to the insulated center core of the suspension cable, which, in turn, was connected to the binding post on the head of the sampler. The return circuit was completed from the sampler body through the hanger bar and outer part of the suspension cable to the drum and drum frame, and then back to the other terminal of the battery.

6. Operating characteristics of sampling equipment--Both the D-43 and the P-46S samplers towed steadily and without weaving during the tests.

The D-43 sampler seemed to have a slight tendency to tilt upward when being raised and to nose downward when being lowered through the water. Under the conditions of these tests, the tilt of the D-43 sampler probably never exceeded 5 degs., and seldom approached that figure. The same amount of tilt applied to the P-46S when descending. However, when the P-46S sampler was raised it tended to tilt upward at angles as great as 20 degs. Probably the upward angle of tilt never exceeded the angle of the resultant velocity formed by the horizontal and vertical movement of the sampler. When the sampler is submerged water enters the compression chamber making the sampler tail-heavy, and as the sampler tail tilts downward the enclosed water shifts toward the rear of the compression chamber further increasing the tilt. Presumably, the tilt would be greater when the sampler is being raised from considerable depths than from shallow depths. However, the shape of the compression chamber indicates that after the chamber is about half full any additional water will cause a rapidly diminishing tendency toward tail-heavy tilting.

7. Observed data--The carriage velocity was observed in knots and is probably accurate to about 0.02 ft. per sec. This velocity corresponds to the stream velocity in ordinary sampling procedure. The test runs are directly comparable to measurements in a stream in which there is no turbulence and in which the velocity is the same at all depths.

Observed sampling depths were based on lengths of suspension cable and are believed to be accurate to 0.1 ft.

The time during which sampling continued was measured with a stop-watch by an observer who started the watch when the nozzle of the sampler entered the water and stopped the watch when the nozzle emerged; or when sampling was started or stopped by the valve on the P-46S, the instant at which the actuating switch was depressed was used for simultaneously starting or stopping the watch. The error in the observed time is probably about 0.1 sec. at each end of the sampling period. An error of 0.2 sec. in the observed time is possible, but the error is believed to be generally less than that amount.

The volume of sample collected was obtained by measuring the water sample in a 500 cc. graduate. These observations probably are accurate to within 3 cc.

The observed data for each sample, together with computations, are presented in Tables 1 to 4 in the Appendix.

III. TREATMENT OF DATA

8. Computation procedures--The following discussion of computation methods is based on the order of presentation of data in the Tables.

Observed horizontal velocity of the carriage in knots was converted to ft. per sec. by multiplying by 1.689 on the basis of 6080.2 ft. per nautical mile.

The drift of the sampler is the net longitudinal change of position of the sampler with respect to the position of the carriage during the sampling time, therefore it is the correction to apply to the travel of the towing carriage to obtain the longitudinal movement of the sampler during the sampling time. The drift was computed in feet and the rate of drift was obtained by dividing the drift in feet by the sampling time in seconds.

For the D-43 sampler the drift was determined from observations in inches as follows: When the sampler first entered the water, it was hanging almost directly under the point of suspension on the drum. When the sampler was removed from the water at the end of a sample run, it emerged at a point slightly "downstream" or back of a vertical projected downward from the suspension point. For this reason, the D-43 sampler did not travel quite as far during the sampling time as did the point from which it was suspended. Arbitrary travel corrections of 8 in. for a carriage velocity of 9 ft. per sec., 4 in. for 6 ft. per sec., and 1 in. for 3 ft. per sec. were made. Except for low transit rates (rates of movement of the sampler in an approximately vertical direction) for which a guide pulley P_1 (Fig. 1) was used, additional travel corrections were

required. At transit rates greater than about 1.0 ft. per sec., the suspension cable for the D-43 sampler had no guide pulley and the cable unwound from one side of a 20-in. drum and rewound on the other side. Consequently, during the sampling time the point of suspension of the sampler moved either forward or backward 20 in. with respect to the movement of the carriage. An advance of 20 in. is indicated by a (+) sign and a lag of 20 in. is indicated by a (-) sign before the sampling depth. Thus, the drift, or correction to carriage travel for the D-43 sampler, adjusts for the combined effect of a mechanical change in the position of the suspension point and the backward drag that results from the resistance of the water to the movement of the sampling equipment.

The above corrections do not take into account the fact that the actual velocity past the sampler nozzle, especially at higher horizontal velocities, was less than the average during integration downward and greater than the average during integration upward. This difference results from the backward drag of the sampler as it was lowered and the forward movement of the sampler as it was raised through the water. Also, at the time of reversal of the vertical movement of the sampler, velocities past the nozzle were abnormally fast or slow depending upon whether the point of suspension moved forward 20 in. or backward 20 in. with respect to the movement of the carriage.

The drift computations for the P-46S sampler did not involve any change in suspension point and were made on the basis of the observed backward drift of the sampler as it was lowered from the water surface to a depth of 15 ft. while the carriage was moving at a rate of 12 ft. per sec. and on the forward movement of the sampler while it was being

raised back to the surface at the same carriage speed. The backward drift, while lowering, was observed as 9 ft.; and the forward movement, while raising, was observed as 7 ft. Corrections for other conditions were computed or interpolated on the basis of very meager data. In comparison with data from other sources and according to the plotting of the figures in this report, these corrections appear slightly too large, but the magnitude of the corrections is such that any revisions that might be made would not alter the conclusions based on these data.

The adjusted horizontal velocity of the sampler was obtained by applying the drift correction in ft. per sec. to the observed carriage velocity in ft. per sec.

Because observed depths were based on lengths of suspension line, and the resistance of the water to the passage of the sampling equipment caused a deflection of the line from the vertical, the observed depths required correction. Corrections were computed in feet on the basis of data in the Geological Survey booklet entitled "Method for Correcting Soundings of Deep Swift Rivers." The total wet and dry line corrections were entered in the tables as a single depth correction. Dry line corrections and total corrections to depth, also corrections to horizontal velocity, would have been much greater for the same velocities if the samplers had been suspended from a point higher above the water surface. The adjusted sampling depth in feet was computed by applying the depth correction in feet to the observed depth, and represents the vertical distance the sampler nozzle was submerged.

The observed linear transit rate of the sampler was obtained by dividing the observed sampling depth by the sampling time for each sample.

The designation "linear" is used to contrast the dimensional distance divided by time relation with dimensionless "relative" rates which are ratios between velocities of sampler movement.

The adjusted linear transit rate of the sampler was computed as an average figure by dividing the adjusted depth by the average sampling time for a group of samples. (In this report transit rate refers to the vertical, or approximately vertical, velocity of the sampler. Adjusted transit rates are based on the adjusted, or vertical depth, and so represent the velocity of the sampler in a vertical direction only.)

The apparent relative transit rate was determined by dividing the average observed linear transit rate for a group of samples by the observed carriage velocity in ft. per sec.

The adjusted relative transit rate was obtained by dividing the adjusted linear transit rate by the average adjusted horizontal velocity of the sampler. The adjusted relative transit rate is the ratio of the vertical to the horizontal velocity of the sampler.

Rate of sample collection was determined by dividing the total measured sample volume in cubic centimeters by the corresponding sampling time in seconds.

The intake velocity is the mean velocity of flow through the nozzle of the sampler during the period of sampling. It was computed by multiplying the rate of sampling by the factor 0.18417 for the 3/16-in. nozzle and by 0.41438 for the 1/8-in. nozzle. These factors were derived by converting one cc. per sec. into cu. ft. per sec., then dividing by the internal cross-sectional area of the nozzles in sq. ft.

The apparent intake ratio was found by dividing the intake velocity

by the observed velocity of the carriage in ft. per sec.; and similarly, the adjusted intake ratio was computed by dividing the intake velocity by the adjusted horizontal velocity of the sampler.

9. Interpretation of data--A few pertinent items should be considered before the data from the investigation are studied in detail.

The intake ratio for upward integration has been computed on the basis of the horizontal velocity of the sampler as it was towed through the water. This treatment would be unquestionably correct if the sampler remained horizontal during upward transit. However, the sampler was found to tilt upward when being raised, as previously discussed in Section 6. If the sampler actually oriented directly on the resultant velocity, composed of both horizontal and vertical components of the sampler movement, then the resultant velocity approaching the sampler along the axis of the intake nozzle would determine the correct divisor for the true intake ratio. The intake ratios tabulated for upward integration with the P-46S would then be subject to the following corrections:

Relative transit rates	Reduction in tabulated intake ratios Percent
0.00	0.0
0.10	0.5
0.20	2.0
0.30	4.2
0.36	6.0
0.40	7.1
0.50	10.6

The tabulated corrections would be determined by the relative transit

rates as long as the sampler pointed directly along the resultant of the horizontal and vertical components of the sampler movement. However, the maximum angle of the sampler probably never exceeded 20 degs. The relative transit rate corresponding to 20 degs. is 0.36 and the indicated reduction in the tabulated intake ratios is about 6 percent.

The angle at which the P-46S sampler tilted while being operated upward was not adequately determined to establish precise corrections, and, consequently, the ratios based on the horizontal movement of the samplers have been shown throughout this report. In any case the correction for the upward angle of the sampler would not be great for the 1/8-in. nozzle except where the intake ratio was already unsatisfactory because of excessive transit rates. However, data such as those shown for the 3/16-in. nozzle on Fig. 2 B, would be seriously affected by corrections for tilt during upward movement. The apparent allowable maximum transit rate for upward integration with the 3/16-in. nozzle has been reduced somewhat because of the probable need for these corrections.

There is a definite theoretical limitation on the rate at which a sampler may be lowered through a stream without adversely affecting the intake characteristics of the instrument. The theoretical limits on relative transit rates for a sampler being operated downward are 0.39 for the 3/16-in. nozzle and 0.17 for the 1/8-in. nozzle. These limits are based on the rate of compression of the air in the one-pint sample bottle as the sampler is operated downward just beneath the surface of the water. The theoretical limits on downward transit rates vary with depth. As depth-integration is carried from the surface to greater depths, the relative transit rate based on the horizontal velocity at the point of

sampling may be rapidly increased without increasing the intake ratio. For example, when a sampler with a 3/16-in. nozzle has integrated down to a depth of 10 ft., a relative transit rate of 0.65 would not cause an excessive intake ratio. By the time the sampler reached a depth of 20 ft., the relative transit rate would have to exceed 0.97 before the intake ratio would be adversely affected. For proper sampling, the rate of lowering should remain constant. Hence, the relative downward transit rate is generally limited by the allowable relative transit rate at the water surface. These theoretical limiting lowering rates may be readily derived from the simple application of Boyle's law. A more formal treatment of these limits may be found in Report No. 6.

Except for very shallow streams the theoretical limit for integration near the water surface may be exceeded slightly without involving appreciable discrepancies in the size of the sample. This is true because the intake ratio is too high for only a very small fraction of the total integrated depth.

The effect of the angle at which the flow approaches an intake nozzle might be expected to impose certain limits on the allowable relative transit rates for sampler operation. Tests included in Report No. 5 and presented again in Report No. 6 (Fig. 3) indicate that the angle at which the flow approaches an isolated standard intake nozzle has little effect on the accuracy of sampling for angles less than 30 degs., but the tests imply that the effect of the angle of approach may start to appear at 30 degs. However, the effect of the angle at which the flow approaches the nozzle may be different when the nozzle is mounted in a sampler which is not entirely symmetrical.

The results of a few of the tests made on nozzles mounted in sediment samplers and held at definite vertical angles in flowing water are given in Report No. 6 (Fig. 42). A sampler held in place with the nozzle tilted upward in flowing water is essentially analogous to a sampler depth-integrating downward, and the data seem to show that there will be no very serious effect of the angle created by the downward transit rate unless an angle of 30 degs., corresponding to a relative transit rate of 0.58, is exceeded. Larger angles would tend to decrease the intake ratio of the sampler, whereas excessive downward transit rates tend to increase the intake ratio owing to the rapid compression of air within the sampler bottle. For downward integration at certain combinations of nozzle sizes and transit rates, these two effects might partly compensate. For the 3/16-in. and 1/8-in. diameter nozzles used in this investigation, the theoretical limitation on downward transit rates imposed by the compression of air in the sample bottle seems to be more restrictive than the angle of approach of the flow.

When the sampler nozzle is tilted downward, which is analogous to depth-integrating upward, the data of Report No. 6 show that the effect of the angle of approaching flow seems to begin before the angle reaches 10 degs., but the effect does not become serious until the angle exceeds 20 degs. For angles in excess of 20 degs., corresponding to a relative transit rate of 0.36, the effect of the approach angle becomes increasingly evident. Since there is no proof that the depth at which the sampler is operated has any effect on the limits imposed by the angle of approach, it seems reasonable to assume that this limitation would be equally operative at all depths. Because of the shape of the normal

vertical velocity curve in a stream, this limitation would be most restrictive in the zone of least velocity, that is at the bottom of the stream. Moreover, for a normal velocity distribution this limitation on the upward transit rate would define a much lower allowable relative transit rate than that determined on the basis of the allowable downward transit rate.

In this connection it should be remembered that "relative transit rate" as used in this investigation denotes the ratio of the vertical movement of the sampler to the horizontal movement of the sampler, which in stream sampling procedure corresponds to the ratio of the vertical movement of the sampler to the stream velocity. This is the basic relation using the velocity at the sampling point as the reference and should not be confused with similar concepts in other publications which relate a transit rate to the mean velocity in an assumed stream vertical.

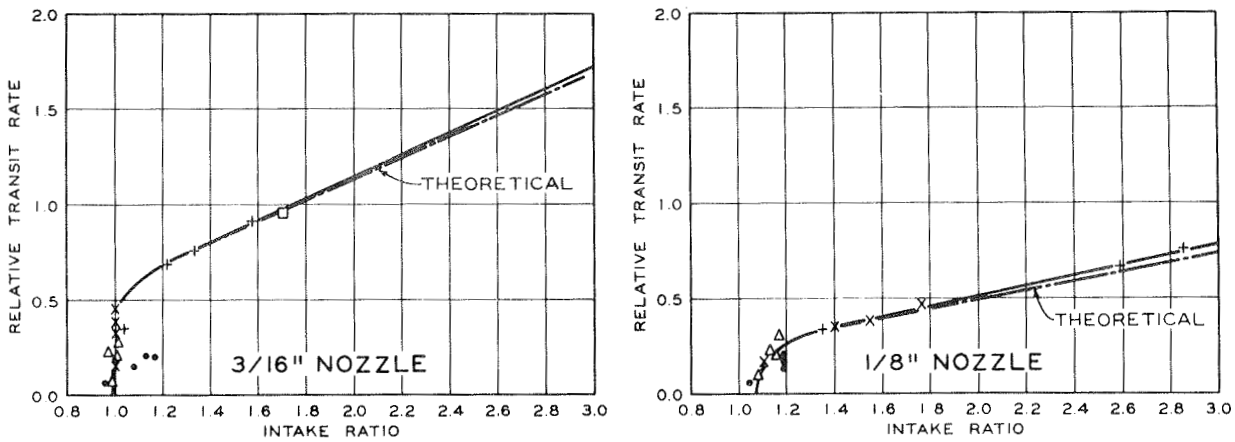
10. Discussion of plotted data--This discussion will be based upon the plotted data as shown in Figs. 2 to 6. All data plotted are the average adjusted values from Tables 1 to 4.

A. Relative transit rate--Fig. 2 A shows the relation between the intake ratio and the relative downward transit rate of the P-46S sampler. The curves break to the right at the higher relative transit rates, because the rate of compression of the air in the sample bottle reduces the volume of the air more rapidly than the normal filling rate would fill the bottle. This results in an accelerated filling rate. It is possible to compute the rate at which the volume of air in the sample bottle will be reduced by the increase in pressure as the sampler is lowered. A curve showing the relation of intake ratio to relative transit

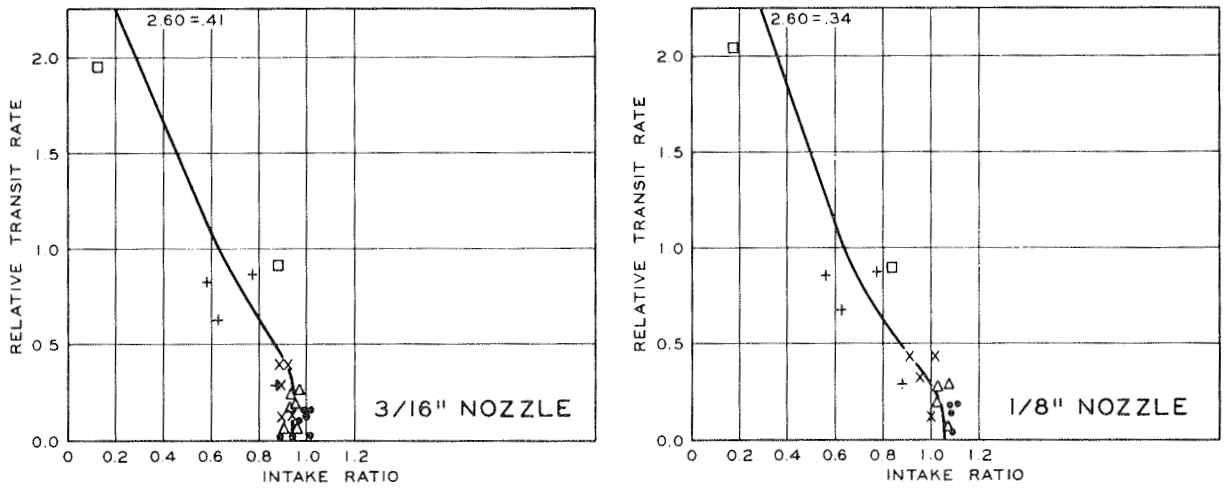
rate based entirely on the theoretical compression of the air in the sample bottle has been shown for each size of nozzle. This rate corresponds closely with the actual filling rate at relative transit rates above the break in the curve. At the higher nozzle velocities the filling rate lags slightly below the computed value. This lag is more pronounced for the 1/8-in. than for the 3/16-in. nozzle. According to equations 5 and 6 of Report No. 6, the break in the curve begins at a relative transit rate of 0.39 for a 3/16-in. and 0.17 for a 1/8-in. nozzle, provided the intake ratio is essentially unity at the lower transit rates. For integration of shallow depths, this break is very abrupt. For greater depths, the break is more rounded. In a stream, the characteristics of the break in the curve would depend somewhat on the shape of the vertical velocity curve.

Fig. 2 A shows that relative downward transit rates greater than 0.45 and 0.20 should not be used with the 3/16-in. and the 1/8-in. nozzles respectively. The allowable transit rate might be slightly less for integration of very shallow depths. In the portion of the curve where the break occurs, the plotted intake ratios are average values obtained from samples for which the intake ratios probably varied. During the sampling time the intake ratio near the surface of the stream may have been higher than the mean for the entire depth of integration.

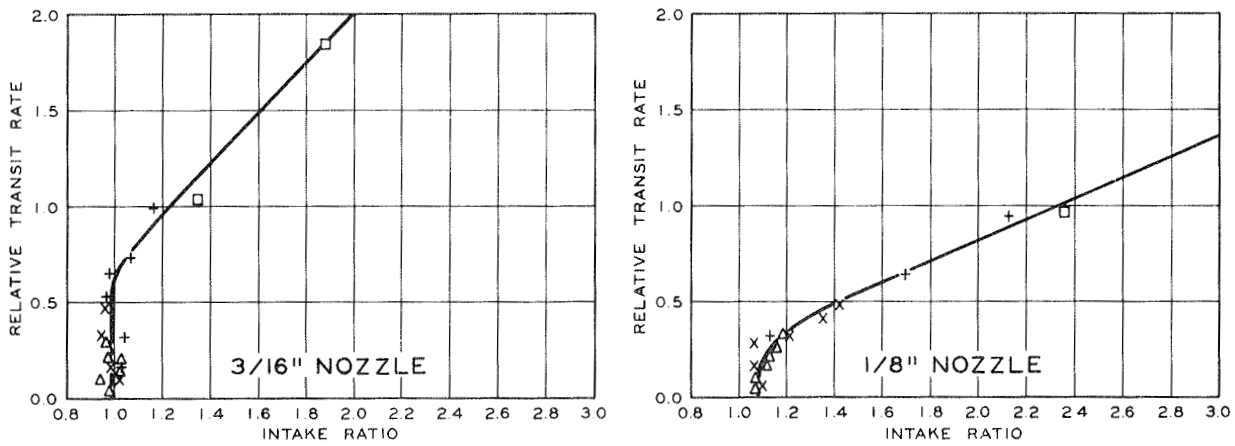
Fig. 2 B shows the relation between the intake ratio and the relative upward transit rate of the P-46S. A comparison of the allowable transit rates for upward integration with those for downward integration shows that for the 3/16-in. nozzle the allowable rate for upward integration is less than for downward integration, and that for the 1/8-in.



A. US P-46S SAMPLER - DEPTH INTEGRATING DOWNWARD



B. US P-46S SAMPLER - DEPTH INTEGRATING UPWARD



C. US D-43 SAMPLER

LEGEND

SYMBOL	HOR. VELOCITY FT./SEC.
□	1
+	3
X	6
Δ	9
●	12

FIG. 2 - EFFECT OF RELATIVE TRANSIT RATE ON INTAKE RATIO

DAVID TAYLOR MODEL BASIN DATA

nozzle the reverse is true. On the basis of Fig. 2 B and the upward tilt of the P-46S it was decided that relative upward transit rates should be limited to 0.35 for the 3/16-in. nozzle and 0.30 for the 1/8-in. nozzle. The break in the curve for upward integration is in the opposite direction from that for downward integration.

The break in the curves of Fig. 2 B is not as well defined, and the cause of the break is not as obvious as in the case of the downward transit of Fig. 2 A. At least three factors may tend to reduce the sampling rate. First, the rate at which the sampler is raised will govern the rate at which the volume of air in the sample bottle expands. The expanding air must escape through the air exhaust. The greater resistance to the discharge of this air at the higher relative transit rates may possibly cause a decrease from the normal sampling rate. However, this is not thought to be a major factor. Second, under the conditions of Fig. 2 B, the P-46S tilts upward. At low horizontal velocities there is some tendency for the water to enter the air exhaust and for the air to discharge from the point of the intake nozzle which is at a higher elevation. This is probably not an important factor in the reduction of the intake ratio. Third, there is also the effect of the angle at which the sampler points into the approaching water velocity. For small deviations from normal the effect is small; however, data determined in tests of a sampler held at an angle in flowing water indicated that for upward integration the maximum allowable relative transit rate should not exceed 0.35, equivalent to 20° in Fig. 42 of Report No. 6.

The curves of Fig. 2 B are not well defined above the point of the break. The points which plotted to the right of the curves above the

break were the results of observations of one crew at one time, those points which plotted to the left were observations of another crew at another time. The scattering of the high points may indicate that operating conditions for these high relative transit rates were rather unstable.

Fig. 2 C shows the relation between the intake ratio and the relative transit rate for the D-43 sampler. Each sample was accumulated throughout both directions of vertical travel. That is, each sample was a composite of both a downward sample and an upward sample. A comparison with the P-46S shows that the curve for the D-43 is very much like a combination of the upward and downward curves for the P-46S. Because the upward-integration curves of the P-46S inclined to the left and the downward ones to the right at about the same relative transit rates, a combination of the two tends to balance. The result is that the D-43 maintains a normal sampling ratio up to relative transit rates of about 0.7 for the 3/16-in. nozzle and up to about 0.3 for the 1/8-in. nozzle.

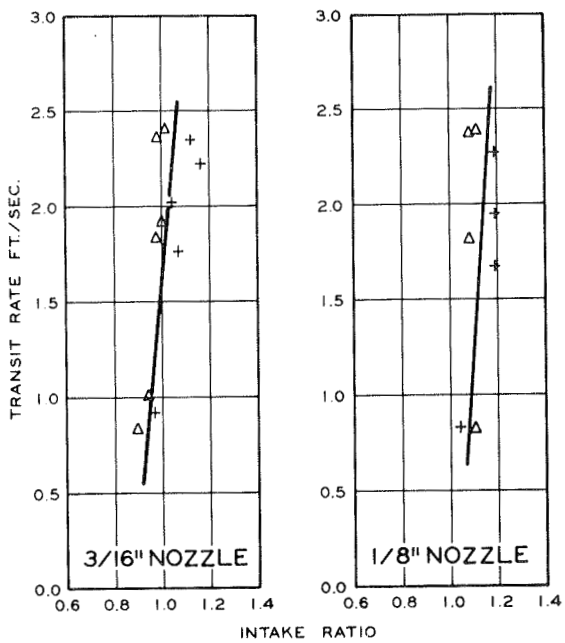
Although with the D-43 sampler the sampling ratio remains normal up to high relative transit rates, it is undoubtedly true that for some of the higher transit rates the over-all intake ratio is made up of a high downward intake ratio and a low upward intake ratio. Under similar conditions in routine sampling the portion of sample taken on the downward trip would be excessive in volume and deficient in sediment concentration. Conversely, the portion taken on the upward trip would be deficient in volume and excessive in sediment concentration. The composite made up of the downward and upward fractions would provide a mean sample in which the discrepancies tend to compensate. Because the degree to which the

upward and downward portions of the sample compensate is not known, the maximum allowable relative transit rates recommended are 0.50 and 0.25 for the 3/16-in. and 1/8-in. nozzles, respectively. Fig. 2 C seems to indicate that the D-43 sampler may be operated at higher relative transit rates for the same size nozzle than may the P-46S if the latter is operated in one direction only. The difference is more pronounced for the 3/16-in. nozzle.

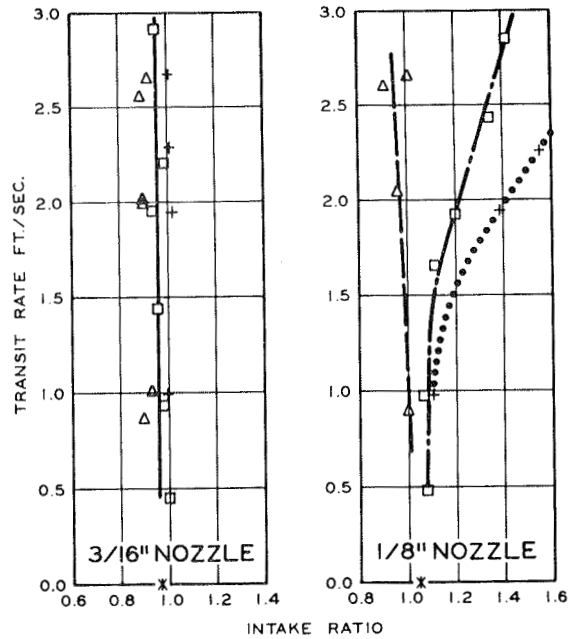
B. Transit rate--Fig. 3 A shows the relation of the intake ratio to the vertical (adjusted linear) transit rate at horizontal velocities of about 12 ft. per sec. The corrected velocities range up to about 13 ft. per sec. operating upward and down to about 10.5 ft. per sec. operating downward. There seems to be a tendency for the intake ratios to increase slightly with the transit rate. This is especially noticeable when the sampler operates downward.

Fig. 3 B shows the relation of the intake ratio to the vertical transit rate at horizontal velocities of about 9 ft. per sec. The corrected velocities range up to about 9.6 ft. per sec. operating upward and down to about 8.3 ft. per sec. operating downward. The ratios for 9 ft. per sec. are seen to be very similar to those for 12 ft. per sec., except that the curve for the 3/16-in. nozzle does not plot as far to the right at the higher transit rates. Data for the D-43 sampler approximate the average obtained by combining the figures for upward and downward travel of the P-46S sampler.

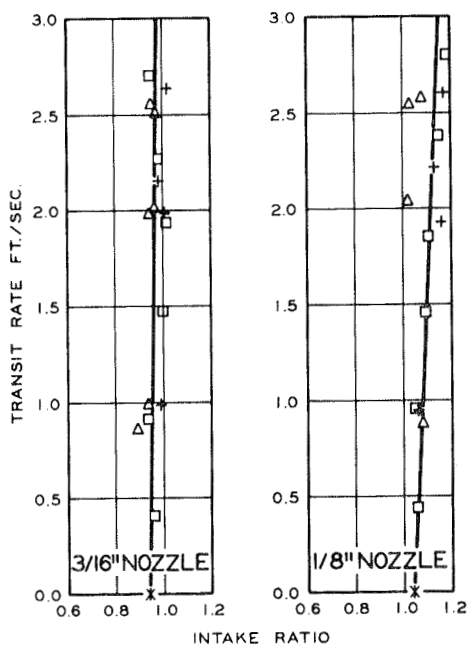
The points shown for the P-46S at 0.0 transit rates were determined in flowing water at about 70° F. These are not a part of the data from the David Taylor Model Basin, but are from tests made at the St. Anthony



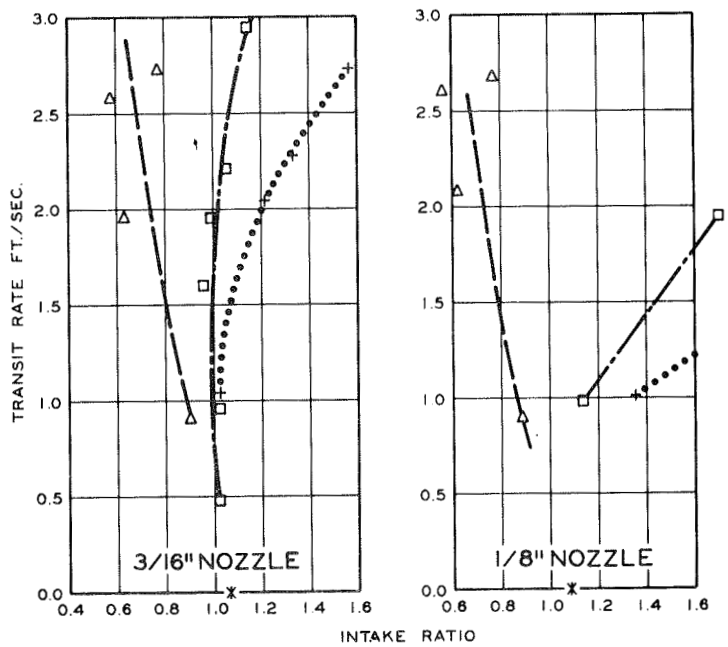
A. HORIZONTAL VELOCITY ABOUT 12 FT. PER. SEC.



C. HORIZONTAL VELOCITY ABOUT 6 FT. PER. SEC.



B. HORIZONTAL VELOCITY ABOUT 9 FT. PER. SEC.



D. HORIZONTAL VELOCITY ABOUT 3 FT. PER. SEC.

LEGEND

SYMBOL		
□ — — —	D-43	ROUND TRIP SAMPLING
△ — —	P-46S	OPERATING UPWARD
+ ••••••	P-46S	OPERATING DOWNWARD
✱	P-46S	IN FLOWING WATER

FIG. 3 – EFFECT OF TRANSIT RATE ON INTAKE RATIO

DAVID TAYLOR MODEL BASIN DATA

Falls Hydraulic Laboratory of the University of Minnesota, at Minneapolis, Minnesota. Similar data appear on the two following figures. There is close agreement between the data obtained in flowing water and that in still water.

Fig. 3 C shows the relation of the intake ratio to the vertical transit rate at horizontal velocities of about 6 ft. per sec. The corrected velocities range up to about 6.2 ft. per sec. operating upward and down to about 5.7 ft. per sec. operating downward. The ratios for the 3/16-in. nozzle are much like those at 9 and 12 ft. per sec. However, for the 1/8-in. nozzle the intake ratios of the P-46S when operating downward show a sharp break to the right slightly above a transit rate of 1.0 ft. per sec. The D-43 intake ratios are consistently about 2 percent higher than the average of the upward and downward travel of the P-46S, yet the D-43 ratios show a striking similarity to the average of the upward and downward ratios of the P-46S.

As in Fig. 3 B, the data collected in flowing water and in still water are in good agreement at the 0.0 transit rate.

Fig. 3 D shows the relation of the intake ratio to the vertical transit rate at horizontal velocities of about 3 ft. per sec. The velocity corrections on this figure are quite small. Statements concerning the 1/8-in. nozzle at horizontal velocities of 6 ft. per sec. apply about as well to the 3/16-in. nozzle at horizontal velocities of 3 ft. per sec. At 3 ft. per sec. a transit rate as low as 1.0 ft. per sec. is too high for the 1/8-in. nozzle.

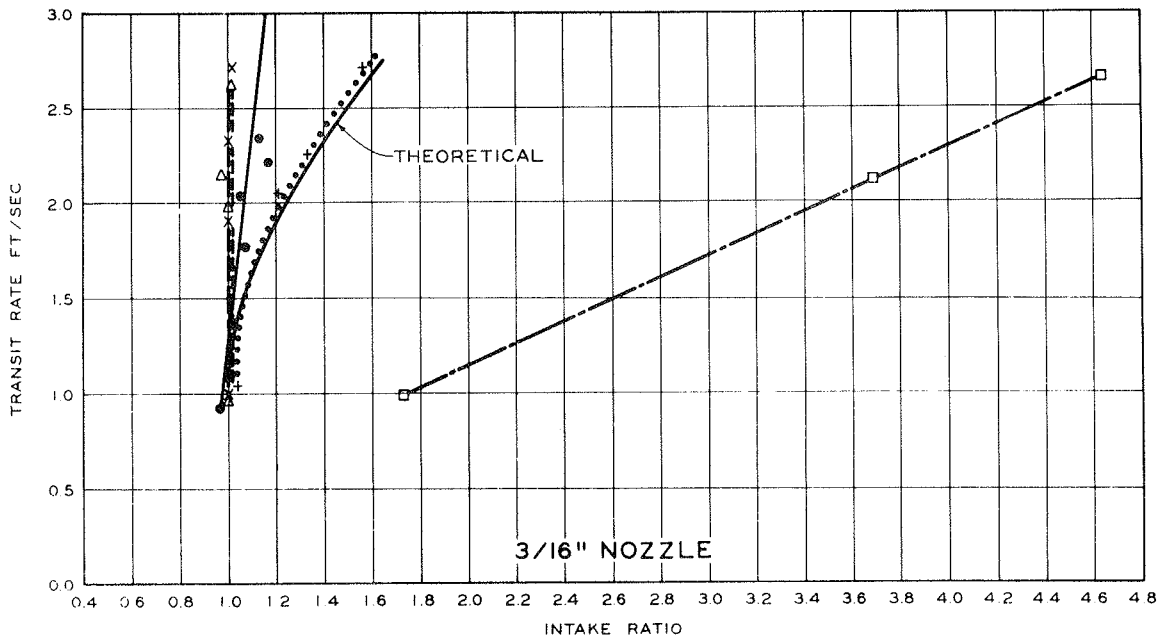
The intake ratios obtained in water flowing at 3 ft. per sec. are difficult to compare with those from the tests in still water at the

Model Basin. The curves based on the Model Basin data do not lend themselves to an accurate downward extension to a transit rate of 0.0. However, the comparison between the two types of data appears reasonable.

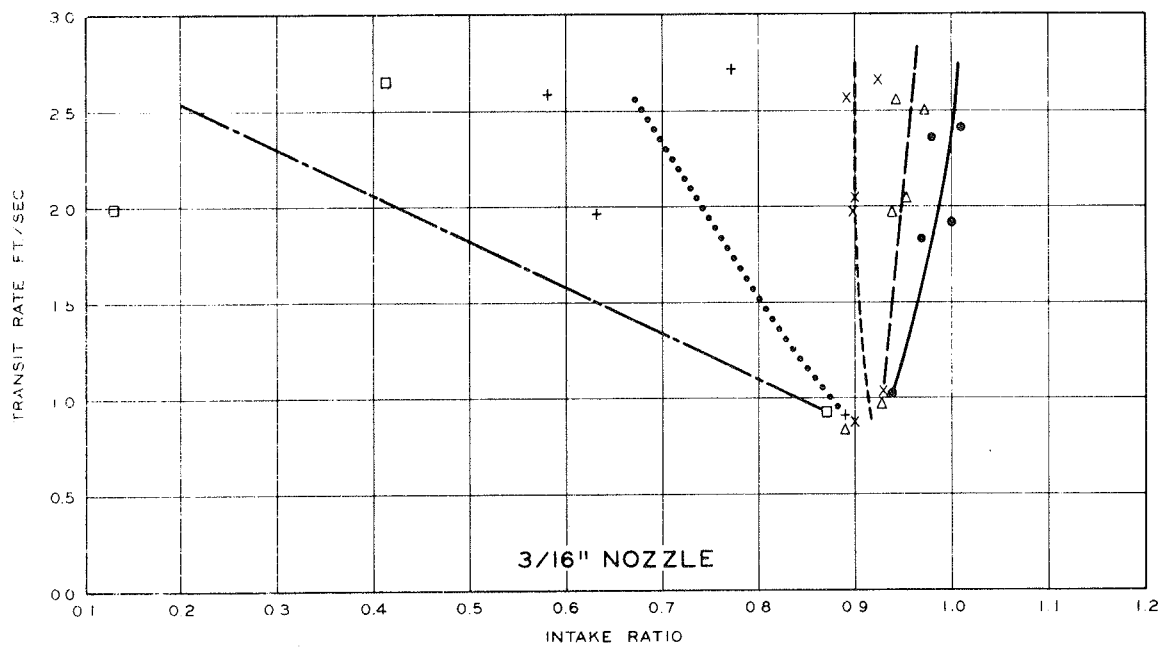
Figures illustrating relative transit rate effects for horizontal velocities of 1 ft. per sec. were not prepared as they would show only results from transit rates which exceeded allowable limits. A study of Figs. 4, 5, and 6 will verify this and again support the conclusions concerning allowable relative transit rates as presented under A of this section.

Fig. 4 A shows the relation of the intake ratio to the vertical transit rate as a separate curve for each group of horizontal velocities for the P-46S sampler with a 3/16-in. nozzle operating downward. The curves are in agreement with previous observations on relative transit rate limits below which the intake ratio remains essentially unity. The maximum corrections made to velocity and depth are shown on this figure and on Fig. 5 A. It appears that for horizontal velocities of 12 ft. per sec., the corrections were possibly too great.

Fig. 4 B shows the relation of the intake ratio to the vertical transit rate as a separate curve for each group of horizontal velocities for the P-46S sampler with a 3/16-in. nozzle operating upward. The effect of the higher transit rates is again apparent. There is a tendency for the intake ratios to increase when high horizontal velocities are combined with high transit rates. The most critical trend is toward extremely low intake ratios at certain combinations of transit rates and horizontal velocities. The information collected is neither sufficient in quantity nor consistent enough to clearly define basic relationships.



A. US P-46S SAMPLER - DEPTH INTEGRATING DOWNWARD



B. US P-46S SAMPLER - DEPTH INTEGRATING UPWARD

LEGEND

SYMBOL	HOR. VELOCITY FT/SEC.
□ — — —	1
+ ••••••	3
X — — — —	6
Δ — — —	9
● ———	12

FIG. 4 - EFFECT OF TRANSIT RATE AND STREAM VELOCITY ON INTAKE RATIO

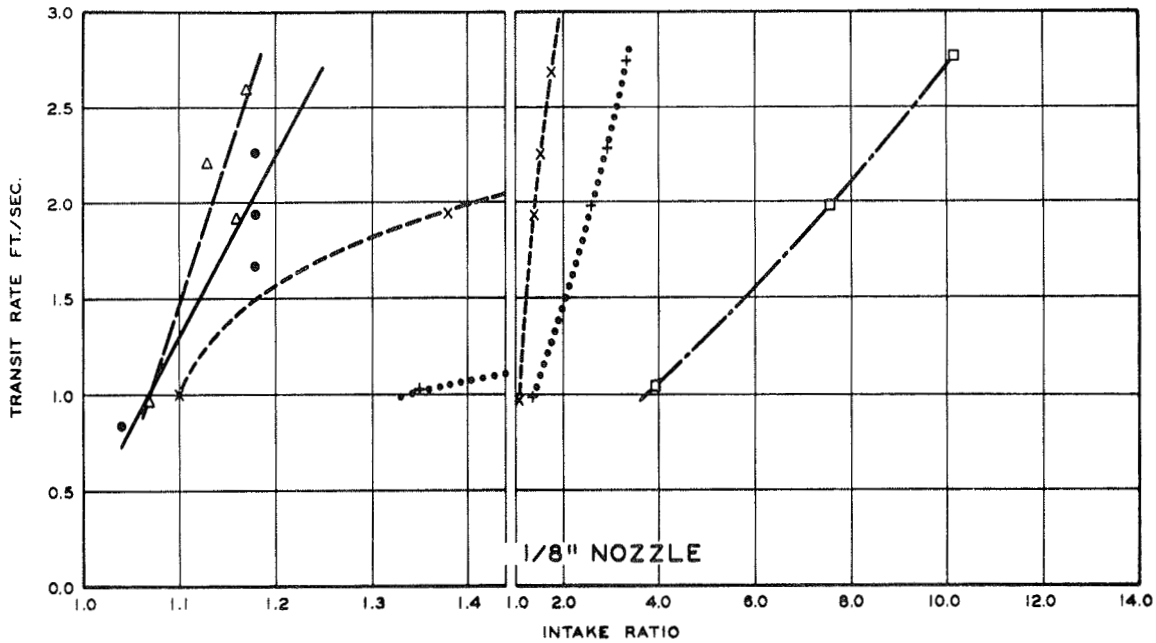
DAVID TAYLOR MODEL BASIN DATA

The relative transit rate may be the best index of the change in intake ratios for integration upward, but there is certainly some doubt on this point. The limits indicated under the discussion of Fig. 2 B are still applicable. However, there is a definite possibility that higher limits on the relative transit rate could be established for horizontal velocities of 6 ft. per sec. and over.

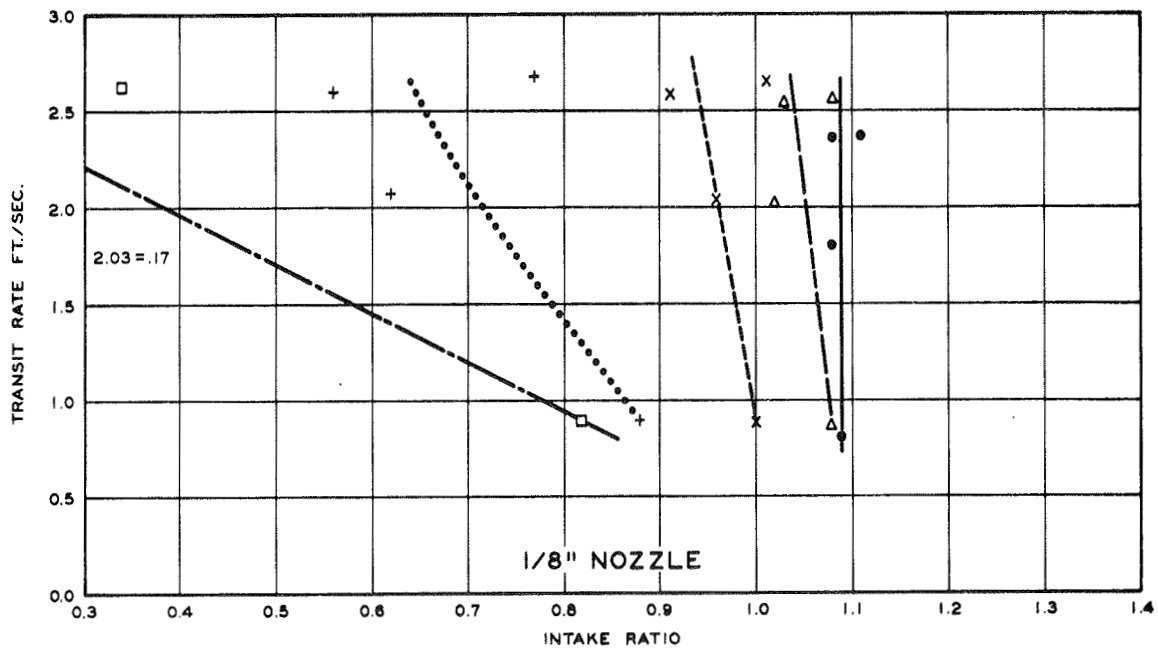
Fig. 5 A shows the relation of the intake ratio to the vertical transit rate as a separate curve for each group of horizontal velocities for the P-46S sampler with a 1/8-in. nozzle operating downward. This figure indicates that relative transit rates greater than about 0.20 should not be used for normal downward sampling with the 1/8-in. nozzle, which means maximum transit rates of 1.2, 1.8, and 2.4 ft. per sec. for horizontal velocities of 6, 9, and 12 ft. per sec., respectively. The intake ratios for horizontal velocities of 12 ft. per sec. are somewhat high and tend to be higher for the faster transit rates. The corrections to the observed data for 12 ft. per sec. may have been slightly too large.

Fig. 5 B shows the relation of the intake ratio to the vertical transit rate as a separate curve for each group of horizontal velocities for the P-46S sampler with a 1/8-in. nozzle operating upward. The data show that a transit rate of 1.0 ft. per sec. is too great for normal sampling at horizontal velocities of 1 and 3 ft. per sec. At horizontal velocities of 6 and 9 ft. per sec. the intake ratios of the 1/8-in. nozzle decrease with increasing transit rates.

Fig. 6 A shows the relation of the intake ratio to the vertical transit rate as a separate curve for each group of horizontal velocities



A. US P-46S SAMPLER - DEPTH INTEGRATING DOWNWARD



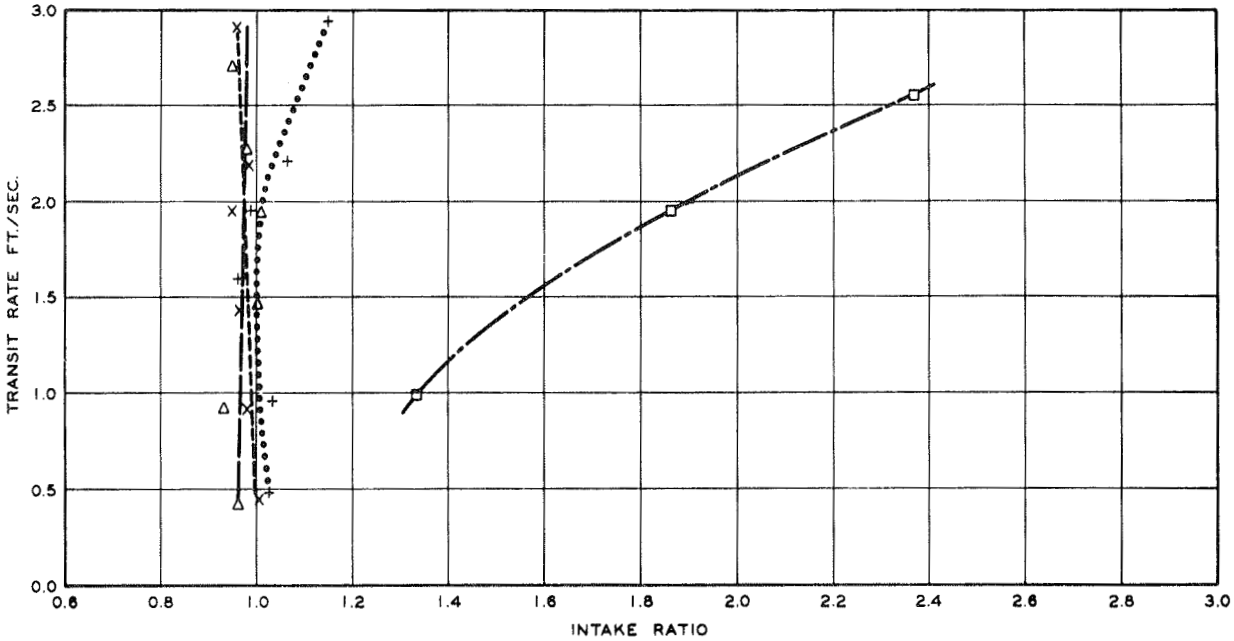
B. US P-46S SAMPLER - DEPTH INTEGRATING UPWARD

LEGEND

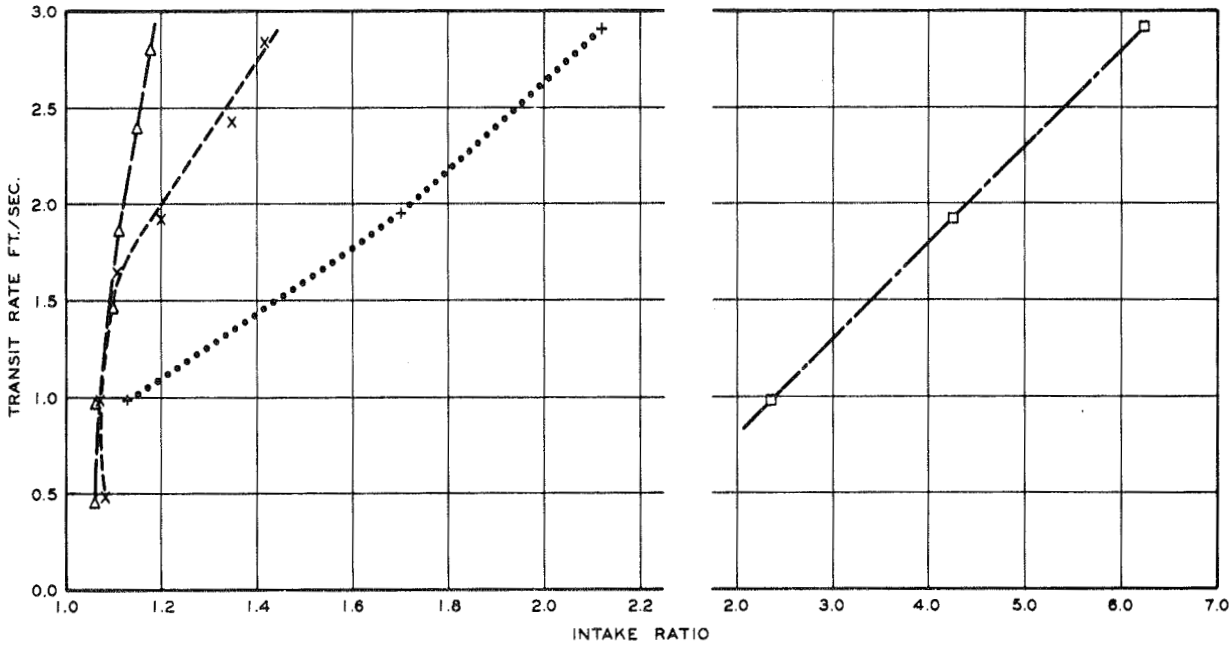
SYMBOL	HOR. VELOCITY FT./SEC.
□ ———	1
+ ••••••	3
X ———	6
Δ — —	9
● ———	12

FIG. 5 - EFFECT OF TRANSIT RATE AND STREAM VELOCITY ON INTAKE RATIO

DAVID TAYLOR MODEL BASIN DATA



A. US D-43 SAMPLER - 3/16" NOZZLE



B. US D-43 SAMPLER - 1/8" NOZZLE

LEGEND

SYMBOL	HOR. VELOCITY FT./SEC.
□ —·—	1
+ ·····	3
X — — —	6
Δ — —	9

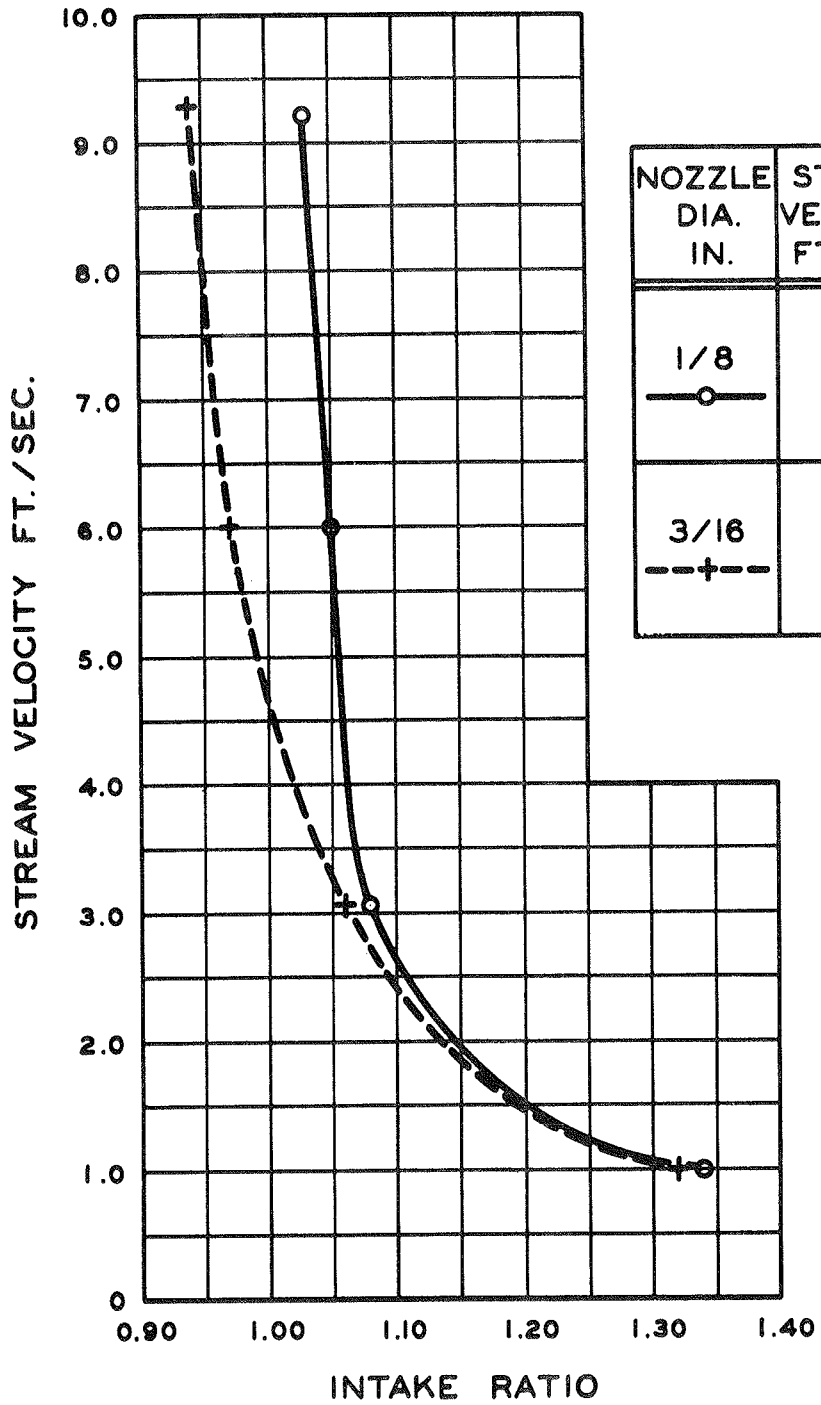
FIG. 6 - EFFECT OF TRANSIT RATE AND STREAM VELOCITY ON INTAKE RATIO

DAVID TAYLOR MODEL BASIN DATA

for the D-43 sampler with a 3/16-in. nozzle. Since the D-43 sampler integrates in both directions, each observation is a combination of the results of an upward and a downward integration at approximately uniform speed. The data support previous observations concerning the effect of transit rate on intake ratio.

Fig. 6 B shows the relation of the intake ratio to the vertical transit rate as a separate curve for each group of horizontal velocities for the D-43 sampler with a 1/8-in. nozzle. The relation between intake ratio and transit rate is clearly a function of the horizontal velocity.

Fig. 7 shows a check calibration of the P-46S sampler conducted at the St. Anthony Falls Hydraulic Laboratory of the University of Minnesota. This calibration was made subsequent to the tests at the Model Basin. The data were obtained in flowing water at a temperature of 70 to 71° F. If the temperature of the water had been the same as that at the Model Basin, both curves would have plotted very slightly to the left of their present positions.



NOZZLE DIA. IN.	STREAM VELOCITY FT./SEC.	INTAKE RATIO	WATER TEMP. F°
1/8 —o—	1.01 3.07 6.00 9.22	1.34 1.08 1.05 1.03	70 - 71
3/16 --+--	1.00 3.07 6.00 9.28	1.32 1.06 0.97 0.94	70 - 71

FIG. 7 - INTAKE RATIOS IN FLOWING WATER
US P-46S SAMPLER NO. 3
ST. ANTHONY FALLS HYDRAULIC LABORATORY

IV. CONCLUSIONS

11. Comparison of results in still and flowing water--The samplers used in these tests were calibrated in flowing water. The instruments were adjusted to give intake ratios of about 1.00 for the 3/16-in. nozzles and 1.05 for the 1/8-in. nozzles at the temperatures of these tests and in the velocity range between 3 and 6 ft. per sec. The intake ratios obtained by towing the samplers in still water agree closely with those expected from the calibration of the samplers. Also, the results in still and in flowing water, as shown in Fig. 3 B, C, and D, are in close agreement. Within the scope of these tests no apparent difference is indicated between the intake action of the samplers when towed through still water or suspended in flowing water.

12. Maximum allowable transit rates--If an intake ratio of unity indicates proper sampling action, the following relative transit rates are allowable for the conditions of the tests at the Model Basin.

Type of Instrument	Nozzle Size	Direction of Integration	Maximum Relative Transit Rate
P-46S	3/16"	downward	0.45
P-46S	3/16"	upward	0.35
P-46S	1/8"	downward	0.20
P-46S	1/8"	upward	0.30
D-43	3/16"	round-trip	0.50
D-43	1/8"	round-trip	0.25

The maximum relative transit rates allowable for downward integration as shown by the table are high enough to involve slight, but not

serious errors under general sampling conditions. For very shallow streams the theoretical figures of 0.39 and 0.17 for the 3/16-in. and 1/8-in. nozzles respectively, should be observed, and these theoretical limits are substantiated by the test data. For very turbulent streams the allowable transit rates for non-turbulent flow may be a few percent too large if based directly upon the average velocity of the turbulent flow. These limiting downward transit rates are determined by conditions just below the water surface. Greater relative transit rates are allowable at deeper depths.

The maximum relative transit rates allowable for upward integration are not as precisely defined as those for downward integration. The limits are determined by entirely different factors. There is no indication that the limits on upward integration vary with depth.

Because of the tendency of the two-way integration of the D-43 to compensate errors arising from one-way integration in either direction, a relative transit rate of 0.7 for the 3/16-in. nozzle and 0.3 for the 1/8-in. nozzle appeared allowable under the conditions of these tests. However, intake ratios of the D-43 at these higher relative transit rates are undoubtedly composed of a low ratio for upward integration and a high ratio for downward integration, so the recommended maximum transit rates for routine sampling are 0.5 and 0.25, respectively. The higher figures should only be used after an investigation of actual conditions indicates that the greater limits will introduce no serious errors under given circumstances.

13. Application of results--These tests indicate that round-trip sampling with the P-46S would give the same results as with the D-43.

The P-46S would be better adapted for use in high velocities because its greater weight tends to reduce the amount of downstream drift of the sampler. There is no evidence that data obtained with the P-46S are not representative of the action of the D-43 sampler under similar conditions of one-way integration.

All conclusions stated herein are based on the corrected relative transit rates, and should not be applied without regard to corrections necessitated by downstream drift of the sampler. In this investigation the relative transit rate represents the ratio between the vertical and horizontal movements of the sampling instrument in a vertical plane containing the point of suspension and the sampler. When correlated to stream sampling operations, the relative transit rate represents the ratio of the vertical movement of the sampler to the velocity of the stream at the sampling point.

Figs. 8, 9, and 10 are presented in an attempt to make this information on limiting transit rates more readily applicable. The shape of the vertical velocity curve in a stream has a major influence on the transit rates which may be used. In Fig. 8 two types of velocity distribution with depth are shown. One is a "normal" velocity distribution, the other is a uniform distribution in which the velocity is the same from the surface to the stream bed, corresponding to the test conditions at the Model Basin. Most streams will have a distribution approximating the normal distribution or somewhere between the two.

Limiting transit rates in terms of the relation to the mean velocity of the stream are presented in Figs. 9 and 10. These are shown as functions of the depth of the stream for two types of velocity distribution,

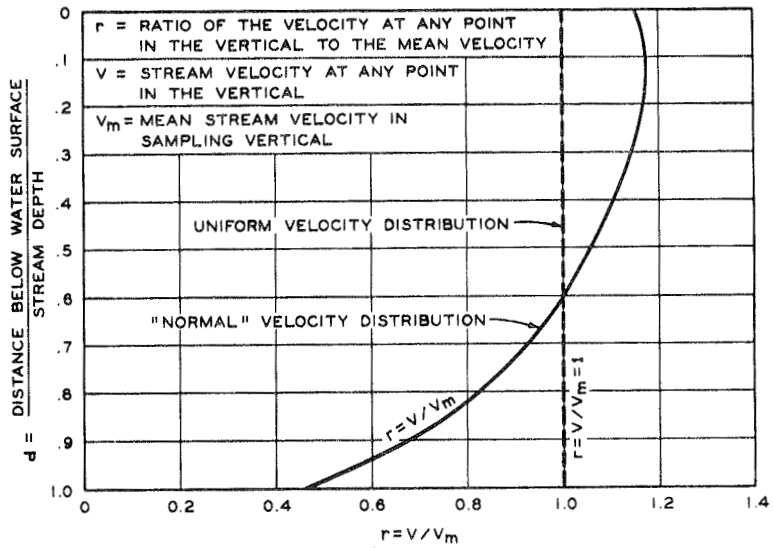


FIG. 8 – TWO TYPES OF VELOCITY DISTRIBUTION WITH DEPTH

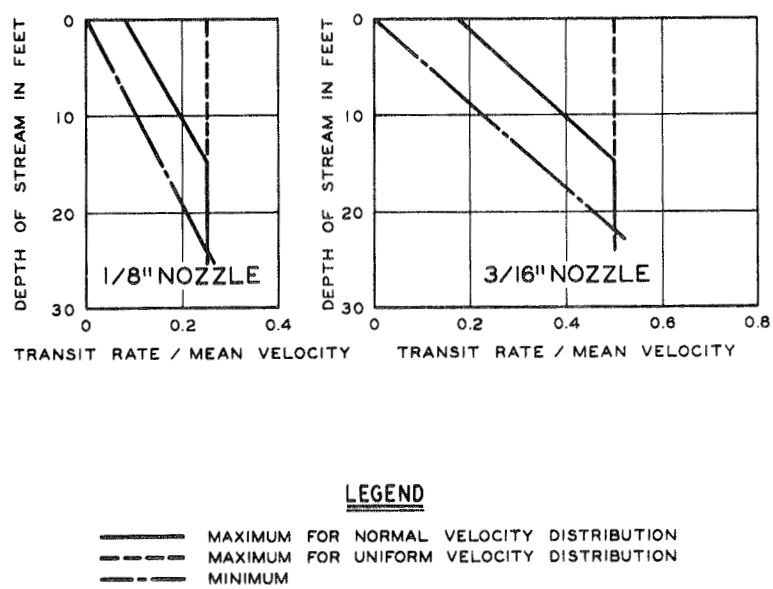
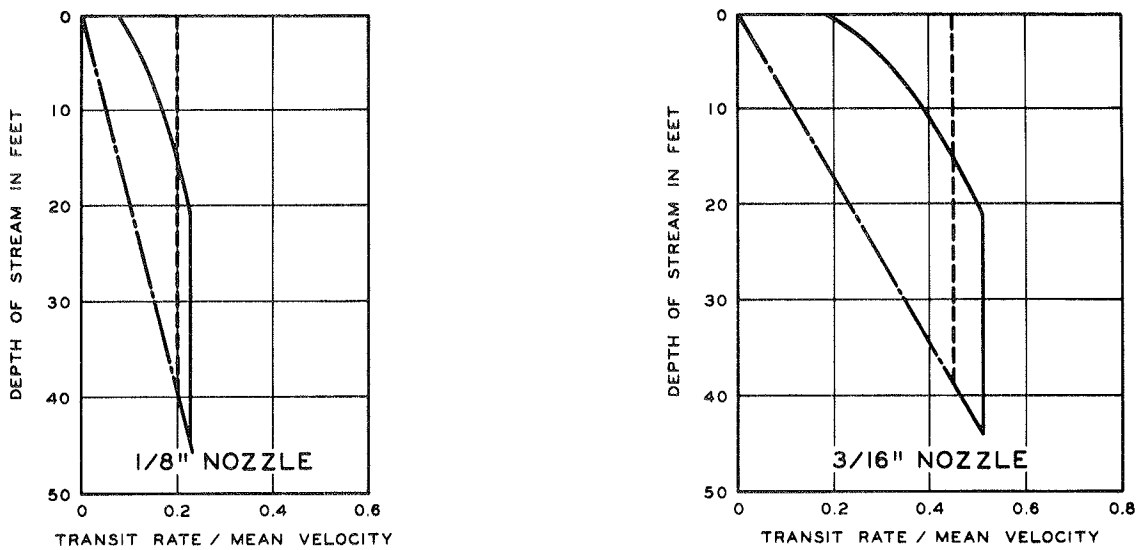
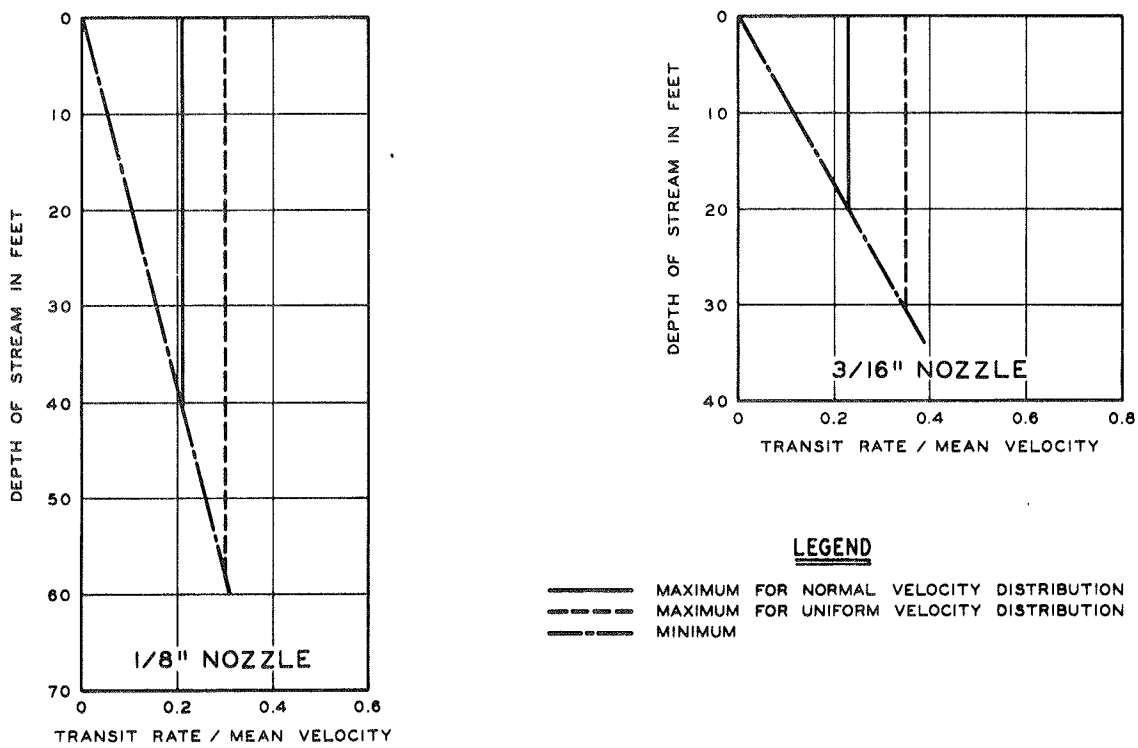


FIG. 9 – MAXIMUM AND MINIMUM VERTICAL TRANSIT RATES FOR ROUTINE SAMPLING. ROUND-TRIP DEPTH-INTEGRATION, CONTAINER CAPACITY ONE-PINT



DEPTH INTEGRATION DOWNWARD



DEPTH INTEGRATION UPWARD

FIG. 10 – MAXIMUM AND MINIMUM VERTICAL TRANSIT RATES FOR ROUTINE SAMPLING. DEPTH-INTEGRATING SAMPLER, CONTAINER CAPACITY ONE-PINT

APS StL 16466

and for both 3/16-in. and 1/8-in. nozzles. The minimum vertical transit rates were determined by basic sampling criteria and are the same as presented and explained in Report No. 6. The maximum transit rates listed in Section 12 were applied to obtain allowable downward transit rates for various stream depths. These maximum transit rates are not the theoretical limits beyond which errors may begin to appear, but are rather the rates beyond which the errors might become serious in routine sampling.

Fig. 9 presents the limiting transit rates for round-trip integration on the basis of the tests at the David Taylor Model Basin. Rates for round-trip integration are more liberal than for one-way integration due to compensation of errors. The limiting rate of half the mean stream velocity is for routine sampling with the 3/16-in. nozzle. In very precise work with a 3/16-in. nozzle, maximum round-trip transit rates greater than 0.35 of the mean stream velocity should not be used without prior investigation of the errors involved in any specific case.

Fig. 10 shows the limiting transit rates for upward and downward integration in one direction. For upward integration in a stream with normal vertical velocity distribution, the transit rates shown will be excessive for the lowest one-tenth of the depth, but in general this should not involve serious errors in routine sampling.

APPENDIX

14. Test data--The data collected and computed from the David Taylor Model Basin tests are shown in Tables 1 to 4. These data were discussed in Sections 7 and 8.

Explanation of tables--A bar over the top of letters designating a specific column indicates that only average figures were computed.

Superscript 1. Drift figures are the difference in feet between the horizontal distances traveled by the carriage and sampler during the sampling time.

Superscript 2. If the resistance of the water to the passage of the equipment deflects the suspension line from the vertical, the sampler will be submerged a lesser distance than indicated by the observed sampling depth. This reduction in depth of submergence for an observed sampling depth constitutes the sampling depth correction in feet.

Superscript 3. Column P was obtained by multiplying figures in column O by 0.18417 for the 3/16-in. nozzle and by 0.41438 for the 1/8-in. nozzle.

TABLE 1

DAVID TAYLOR MODEL BASIN TESTS

US P-46S SUSPENDED SEDIMENT SAMPLER NO. 3 WITH 3/16-IN. NOZZLE

HORIZONTAL VELOCITY					SAMPLING				TRANSIT RATE OF SAMPLER				SAMPLE		INTAKE	INTAKE RATIO	
CARRIAGE		SAMPLER			DEPTH			TIME	LINEAR		RELATIVE		COLLECTION		VELOCITY		
Observed		Drift		Adjusted	Observed	Correction	Adjusted		Observed	Adjusted	Apparent	Adjusted	Size	Rate		Apparent	Adjusted
knots	ft./sec.	ft.	ft./sec.	ft./sec.	ft.	ft.	ft.	sec.	ft./sec.	ft./sec.			cc.	cc./sec.	ft./sec.		
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Observed	Ax1.689	drift[1]	C / I	B + D	observed	computed[2]	F - G	observed	F / I	$\bar{H}$ / $\bar{I}$	$\bar{J}$ / $\bar{B}$	$\bar{K}$ / $\bar{E}$	observed	N / I	computed[3]	P / B	P / E
DEPTH-INTEGRATING DOWNWARD																	
0.6	1.01	0	0	1.01	15.8	0	15.8	16.08	0.98				151	9.39	1.73	1.71	1.71
0.6	1.01	0	0	1.01	15.8	0	15.8	15.92	0.99				151	9.48	1.75	1.73	1.73
0.6	1.01	0	0	1.01	15.8	0	15.8	16.03	0.98				151	9.39	1.73	1.71	1.71
				1.01				16.03	0.98	0.98	0.97	0.97		9.42	1.74	1.72	1.72
0.6	1.01	0	0	1.01	15.0	0	15.0	6.80	2.21				145	21.32	3.93	3.89	3.89
0.6	1.01	0	0	1.01	15.0	0	15.0	7.30	2.05				145	19.86	3.66	3.62	3.62
0.6	1.01	0	0	1.01	15.0	0	15.0	7.25	2.07				140	19.31	3.56	3.52	3.52
				1.01				7.12	2.11	2.11	2.09	2.09		20.16	3.72	3.68	3.68
0.6	1.01	0	0	1.01	15.0	0	15.0	5.55	2.70				145	26.13	4.81	4.76	4.76
0.6	1.01	0	0	1.01	15.0	0	15.0	5.60	2.68				143	25.54	4.70	4.65	4.65
0.6	1.01	0	0	1.01	15.0	0	15.0	5.75	2.61				143	24.87	4.58	4.53	4.53
				1.01				5.63	2.66	2.66	2.63	2.63		25.51	4.70	4.65	4.65
1.80	3.04	-0.4	-0.03	3.01	15.0	0	15.0	14.61	1.03				240	16.43	3.03	1.00	1.01
1.80	3.04	-0.4	-0.03	3.01	15.0	0	15.0	14.64	1.02				245	16.73	3.08	1.01	1.02
1.80	3.04	-0.4	-0.03	3.01	15.0	0	15.0	14.28	1.05				240	16.81	3.10	1.02	1.03
				3.01				14.45	1.03	1.03	0.34	0.34		16.66	3.07	1.01	1.02
1.80	3.04	-0.4	-0.06	2.98	15.0	0	15.0	7.00	2.14				145	20.71	3.81	1.25	1.28
1.80	3.04	-0.4	-0.05	2.99	15.0	0	15.0	7.62	1.97				145	19.03	3.50	1.15	1.17
1.80	3.04	-0.4	-0.05	2.99	15.0	0	15.0	7.60	1.97				145	19.08	3.51	1.15	1.17
				2.99				7.41	2.03	2.03	0.67	0.68		19.61	3.61	1.18	1.21
1.80	3.04	-0.4	-0.06	2.98	15.0	0	15.0	6.60	2.27				140	21.21	3.91	1.29	1.31
1.80	3.04	-0.4	-0.06	2.98	15.0	0	15.0	6.55	2.29				142	21.68	3.99	1.31	1.34
1.80	3.04	-0.4	-0.06	2.98	15.0	0	15.0	6.65	2.26				144	21.65	3.99	1.31	1.34
				2.98				6.60	2.27	2.27	0.75	0.76		21.51	3.96	1.30	1.33
1.81	3.06	-0.4	-0.07	2.99	15.0	0	15.0	5.60	2.68				142	25.36	4.67	1.53	1.56
1.81	3.06	-0.4	-0.07	2.99	15.0	0	15.0	5.46	2.75				140	25.64	4.72	1.54	1.58
1.81	3.06	-0.4	-0.07	2.99	15.0	0	15.0	5.50	2.73				140	25.45	4.69	1.53	1.57
				2.99				5.52	2.72	2.72	0.89	0.91		25.48	4.69	1.53	1.57
3.55	6.00	-1.3	-0.11	5.89	12.0	0.1	11.9	11.96	1.01				335	32.30	5.95	0.99	1.01
3.55	6.00	-1.3	-0.11	5.89	12.0	0.1	11.9	11.93	1.00				380	31.72	5.84	0.97	0.99
3.55	6.00	-1.3	-0.11	5.89	12.0	0.1	11.9	12.00	1.00				380	31.67	5.83	0.97	0.99
				5.89				11.97	1.00	0.99	0.17	0.17		31.90	5.87	0.98	1.00
3.55	6.00	-1.8	-0.23	5.77	15.0	0.1	14.9	7.72	1.94				245	31.74	5.85	0.98	1.01
3.55	6.00	-1.8	-0.23	5.77	15.0	0.1	14.9	7.70	1.95				245	31.82	5.86	0.98	1.02
3.55	6.00	-1.8	-0.24	5.76	15.0	0.1	14.9	7.62	1.97				245	32.15	5.92	0.99	1.03
				5.77				7.68	1.95	1.94	0.32	0.34		31.90	5.88	0.98	1.02
3.55	6.00	-1.8	-0.28	5.72	15.0	0.1	14.9	6.45	2.33				205	31.78	5.85	0.98	1.02
3.55	6.00	-1.8	-0.28	5.72	15.0	0.1	14.9	6.52	2.30				205	31.44	5.79	0.96	1.01
3.55	6.00	-1.8	-0.27	5.73	15.0	0.1	14.9	6.60	2.27				205	31.06	5.72	0.95	1.00
				5.72				6.52	2.30	2.28	0.38	0.40		31.43	5.79	0.96	1.01

3.56	6.02	-1.8	-0.33	5.69	15.0	0.1	14.9	5.44	2.76				165	30.33	5.59	0.93	0.98
3.56	6.02	-1.8	-0.32	5.70	15.0	0.1	14.9	5.62	2.67				175	31.14	5.74	0.96	1.01
3.56	6.02	-1.8	-0.32	5.70	15.0	0.1	14.9	5.70	2.63				182	31.93	5.88	0.98	1.03
				5.70				5.59	2.69	2.67	0.45	0.47		31.13	5.74	0.96	1.01
5.35	9.04	-1.6	-0.20	8.84	8.0	0.1	7.9	8.15	0.98				390	47.85	8.81	0.97	1.00
5.35	9.04	-1.6	-0.20	8.84	8.0	0.1	7.9	8.10	0.99				385	47.53	8.75	0.97	0.99
5.38	9.09	-1.6	-0.20	8.89	8.0	0.1	7.9	8.03	1.00				380	47.32	8.72	0.96	0.98
				8.86				8.09	0.99	0.98	0.11	0.11		47.57	8.76	0.97	0.99
5.35	9.04	-4.0	-0.53	8.51	15.0	0.5	14.5	7.52	1.99				345	45.88	8.45	0.93	0.99
5.35	9.04	-4.0	-0.56	8.48	15.0	0.5	14.5	7.20	2.08				340	47.22	8.70	0.96	1.03
5.35	9.04	-4.0	-0.55	8.49	15.0	0.5	14.5	7.30	2.05				345	47.26	8.70	0.96	1.02
				8.49				7.34	2.04	1.98	0.23	0.23		46.79	8.62	0.95	1.01
5.35	9.04	-4.0	-0.59	8.45	15.0	0.5	14.5	6.80	2.21				302	44.41	8.18	0.90	0.97
5.35	9.04	-4.0	-0.61	8.43	15.0	0.5	14.5	6.55	2.29				300	45.80	8.44	0.93	1.00
5.35	9.04	-4.0	-0.58	8.46	15.0	0.5	14.5	6.90	2.17				305	44.20	8.14	0.90	0.96
				8.45				6.75	2.22	2.15	0.25	0.25		44.80	8.25	0.91	0.98
5.36	9.06	-4.0	-0.72	8.34	15.0	0.5	14.5	5.53	2.71				250	45.21	8.33	0.92	1.00
5.36	9.06	-4.0	-0.72	8.34	15.0	0.5	14.5	5.53	2.71				255	46.11	8.49	0.94	1.02
5.36	9.06	-4.0	-0.73	8.33	15.0	0.5	14.5	5.50	2.73				255	46.36	8.54	0.94	1.03
				8.34				5.52	2.72	2.63	0.30	0.32		45.89	8.45	0.93	1.02
7.15	12.08	-2.7	-0.43	11.65	6.0	0.3	5.7	6.23	0.96				380	61.00	11.23	0.93	0.96
7.15	12.08	-2.7	-0.44	11.64	6.0	0.3	5.7	6.20	0.97				375	60.48	11.14	0.92	0.96
7.15	12.08	-2.7	-0.44	11.64	6.0	0.3	5.7	6.10	0.98				375	61.48	11.32	0.94	0.97
				11.64				6.18	0.97	0.92	0.08	0.08		60.99	11.23	0.93	0.96
7.15	12.08	-6.5	-1.05	11.03	12.0	1.4	10.6	6.20	1.94				380	61.29	11.29	0.93	1.02
7.15	12.08	-6.5	-1.10	10.98	12.0	1.4	10.6	5.90	2.04				395	66.95	12.33	1.02	1.12
7.15	12.08	-6.5	-1.10	10.98	12.0	1.4	10.6	5.92	2.03				380	64.19	11.82	0.98	1.08
				11.00				6.01	2.00	1.76	0.17	0.16		64.14	11.81	0.98	1.07
7.15	12.08	-9.0	-1.38	10.70	15.0	2.4	12.6	6.50	2.31				400	61.54	11.33	0.94	1.06
7.15	12.08	-9.0	-1.36	10.72	15.0	2.4	12.6	6.60	2.27				390	59.09	10.88	0.90	1.01
7.15	12.08	-9.0	-1.61	10.47	15.0	2.4	12.6	5.60	2.68				407				
				10.63				6.23	2.42	2.02	0.20	0.19		60.32	11.10	0.92	1.04
7.10	12.00	-9.0	-1.55	10.45	15.0	2.4	12.6	5.80	2.59				390	67.24	12.38	1.03	1.18
7.10	12.00	-9.0	-1.51	10.49	15.0	2.4	12.6	5.96	2.52				350	58.72	10.81	0.90	1.03
7.10	12.00	-9.0	-1.64	10.36	15.0	2.4	12.6	5.47	2.74				375	68.56	12.63	1.05	1.22
7.15	12.08	-9.0	-1.63	10.45	15.0	2.4	12.6	5.51	2.72				380	68.97	12.70	1.05	1.22
				10.44				5.68	2.64	2.22	0.22	0.21		65.87	12.13	1.01	1.16
7.10	12.00	-6.5	-1.41	10.59	12.0	1.4	10.6	4.60	2.61				290	63.04	11.61	0.97	1.10
7.10	12.00	-6.5	-1.48	10.52	12.0	1.4	10.6	4.40	2.73				290	65.91	12.14	1.01	1.15
7.10	12.00	-6.5	-1.41	10.59	12.0	1.4	10.6	4.60	2.61				290	63.04	11.61	0.97	1.10
				10.57				4.53	2.65	2.34	0.22	0.22		64.00	11.79	0.98	1.12

DEPTH-INTEGRATING UPWARD

0.59	1.00	0	0	1.00	15.0	0	15.0	16.50	0.91				80	4.35	0.89	0.89	0.89
0.59	1.00	0	0	1.00	15.0	0	15.0	16.10	0.93				76	4.72	0.87	0.87	0.87
0.59	1.00	0	0	1.00	15.0	0	15.0	16.10	0.93				75	4.66	0.86	0.86	0.86
				1.00				16.23	0.92	0.92	0.92	0.92		4.74	0.87	0.87	0.87
0.60	1.01	0	0	1.01	15.0	0	15.0	7.60	1.97				4	0.53	0.10	0.10	0.10
0.60	1.01	0	0	1.01	15.0	0	15.0	7.45	2.01				5	0.67	0.12	0.12	0.12
0.60	1.01	0	0	1.01	15.0	0	15.0	7.50	2.00				7	0.93	0.17	0.17	0.17
				1.01				7.52	1.99	1.99	1.97	1.97		0.71	0.13	0.13	0.13

TABLE 1 (Continued)

DAVID TAYLOR MODEL BASIN TESTS

US P-46S SUSPENDED SEDIMENT SAMPLER NO. 3 WITH 3/16-IN. NOZZLE

HORIZONTAL VELOCITY					SAMPLING				TRANSIT RATE OF SAMPLER				SAMPLE COLLECTION		INTAKE VELOCITY	INTAKE RATIO	
CARRIAGE		SAMPLER			DEPTH			TIME	LINEAR		RELATIVE						
Observed		Drift		Adjusted	Observed	Correction	Adjusted		Observed	Adjusted	Apparent	Adjusted	Size	Rate		Apparent	Adjusted
knots	ft./sec.	ft.	ft./sec.	ft./sec.	ft.	ft.	ft.	sec.	ft./sec.	ft./sec.			cc.	cc./sec.	ft./sec.		
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Observed	Ax1.689	drift[1]	C / I	B + D	observed	computed[2]	F - G	observed	F / I	$\bar{H}$ / $\bar{I}$	$\bar{J}$ / $\bar{B}$	$\bar{K}$ / $\bar{E}$	observed	N / I	computed[3]	P / B	P / E
DEPTH-INTEGRATING UPWARD																	
0.60	1.01	0	0	1.01	15.0	0	15.0	5.80	2.58				10	1.78	0.33	0.33	0.33
0.60	1.01	0	0	1.01	15.0	0	15.0	5.70	2.63				15	2.63	0.48	0.48	0.48
0.60	1.01	0	0	1.01	15.0	0	15.0	5.80	2.59				13	2.24	0.41	0.41	0.41
				1.01				5.70	2.63	2.63	2.60	2.60		2.22	0.41	0.41	0.41
1.80	3.04	+0.4	+0.02	3.06	15.0	0	15.0	17.10	0.88				255	14.91	2.75	0.90	0.90
1.80	3.04	+0.4	+0.02	3.06	15.0	0	15.0	16.60	0.90				242	14.58	2.69	0.88	0.88
1.80	3.04	+0.4	+0.02	3.06	15.0	0	15.0	16.36	0.92				240	14.67	2.70	0.89	0.88
				3.06				16.69	0.90	0.90	0.30	0.29		14.72	2.71	0.89	0.89
1.80	3.04	+0.4	+0.05	3.09	15.0	0	15.0	7.80	1.92				80	10.26	1.89	0.62	0.61
1.80	3.04	+0.4	+0.05	3.09	15.0	0	15.0	7.50	2.00				82	10.93	2.01	0.66	0.65
1.80	3.04	+0.4	+0.05	3.09	15.0	0	15.0	7.70	1.95				81	10.52	1.94	0.64	0.63
				3.09				7.66	1.96	1.96	0.64	0.63		10.57	1.95	0.64	0.63
1.80	3.04	+0.4	+0.07	3.11	15.0	0	15.0	5.80	2.59				54	9.31	1.71	0.56	0.55
1.80	3.04	+0.4	+0.07	3.11	15.0	0	15.0	6.05	2.48				55	9.09	1.67	0.55	0.54
1.80	3.04	+0.4	+0.07	3.11	15.0	0	15.0	5.65	2.65				61	10.80	1.99	0.65	0.64
				3.11				5.83	2.57	2.57	0.85	0.83		9.73	1.79	0.59	0.58
1.79	3.02	+0.4	+0.07	3.09	15.0	0	15.0	5.50	2.72				70	12.73	2.34	0.77	0.76
1.79	3.02	+0.4	+0.07	3.09	15.0	0	15.0	5.50	2.72				72	13.09	2.41	0.80	0.78
1.79	3.02	+0.4	+0.07	3.09	15.0	0	15.0	5.50	2.72				70	12.73	2.34	0.77	0.76
				3.09				5.50	2.72	2.72	0.90	0.88		12.85	2.36	0.78	0.77
3.56	6.02	+1.0	+0.07	6.09	11.5	0	11.5	13.34	0.86				403	30.21	5.56	0.92	0.91
3.56	6.02	+1.0	+0.07	6.09	11.5	0	11.5	13.46	0.85				400	29.72	5.47	0.91	0.90
3.56	6.02	+1.0	+0.07	6.09	11.5	0	11.5	13.50	0.85				402	29.78	5.48	0.91	0.90
				6.09				13.43	0.85	0.86	0.14	0.14		29.90	5.50	0.91	0.90
3.55	6.00	+1.0	+0.08	6.08	12.0	0	12.0	12.15	0.99				375	30.86	5.68	0.95	0.93
3.55	6.00	+1.0	+0.08	6.08	12.0	0	12.0	11.90	1.01				365	30.67	5.65	0.94	0.93
3.55	6.00	+1.0	+0.08	6.08	12.0	0	12.0	12.12	0.99				370	30.58	5.63	0.94	0.93
				6.08				12.05	1.00	1.00	0.17	0.16		30.70	5.65	0.94	0.93
3.55	6.00	+1.4	+0.18	6.18	14.9	0	14.9	[illegible]	[illegible]				230	30.26	5.57	0.93	0.90
3.55	6.00	+1.4	+0.19	6.19	15.0	0.1	14.9	[illegible]	[illegible]				227	30.88	5.69	0.95	0.92
3.55	6.00	+1.4	+0.19	6.19	15.0	0.1	14.9	[illegible]	[illegible]				225	30.00	5.53	0.92	0.89
				6.19				[illegible]	[illegible]	[illegible]	[illegible]	0.32		30.38	5.60	0.93	0.90
3.55	6.00	+1.4	+0.19	6.19	15.0	0.1	14.9	[illegible]	[illegible]				226	30.82	5.68	0.95	0.92
3.55	6.00	+1.4	+0.19	6.19	15.0	0.1	14.9	[illegible]	[illegible]				220	29.53	5.44	0.91	0.88
3.55	6.00	+1.4	+0.19	6.19	15.0	0.1	14.9	[illegible]	[illegible]				225	30.00	5.53	0.92	0.89
				6.19				[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		30.12	5.55	0.93	0.90
3.55	6.00	+1.4	+0.24	6.24	15.0	0.1	14.9	5.85	2.56				174	29.74	5.48	0.91	0.88
3.55	6.00	+1.4	+0.24	6.24	15.0	0.1	14.9	5.75	2.60				174	30.26	5.57	0.93	0.89
3.55	6.00	+1.4	+0.24	6.24	15.0	0.1	14.9	5.85	2.56				180	30.77	5.67	0.94	0.91
				6.24				5.82	2.57	2.56	0.43	0.41		30.26	5.57	0.93	0.89

3.55	6.00	+1.4	+0.24	6.24	15.0	0.1	14.9	5.80	2.59				170	29.31	5.40	0.90	0.87
3.55	6.00	+1.4	+0.25	6.25	15.0	0.1	14.9	5.60	2.68				175	31.25	5.76	0.96	0.92
3.55	6.00	+1.4	+0.25	6.25	15.0	0.1	14.9	5.50	2.73				180	32.73	6.03	1.00	0.96
				6.25				5.63	2.67	2.65	0.44	0.42		31.10	5.73	0.95	0.92
5.35	9.04	+1.1	+0.14	9.18	7.0	0.1	6.9	8.00	0.88				355	44.38	8.17	0.90	0.89
5.35	9.04	+1.1	+0.14	9.18	7.0	0.1	6.9	8.10	0.86				359	44.32	8.16	0.90	0.89
5.35	9.04	+1.1	+0.14	9.18	7.0	0.1	6.9	7.90	0.89				354	44.81	8.25	0.91	0.90
				9.18				8.00	0.88	0.86	0.10	0.09		44.50	8.19	0.90	0.89
5.35	9.04	+1.5	+0.16	9.20	9.0	0.1	8.9	9.10	0.99				420	46.15	8.50	0.94	0.92
5.35	9.04	+1.5	+0.17	9.21	9.0	0.1	8.9	9.00	1.00				420	46.67	8.60	0.95	0.93
5.35	9.04	+1.5	+0.16	9.20	9.0	0.1	8.9	9.10	0.99				425	46.70	8.60	0.95	0.93
				9.20				9.07	1.00	0.98	0.11	0.11		46.51	8.57	0.95	0.93
5.35	9.04	+3.2	+0.43	9.47	15.0	0.3	14.7	7.50	2.00				360	48.00	8.84	0.98	0.93
5.35	9.04	+3.2	+0.44	9.48	15.0	0.3	14.7	7.30	2.05				360	49.32	9.08	1.00	0.96
5.35	9.04	+3.2	+0.43	9.47	15.0	0.3	14.7	7.50	2.00				355	47.33	8.72	0.96	0.92
				9.47				7.43	2.02	1.98	0.22	0.21		48.22	8.88	0.98	0.94
5.35	9.04	+2.2	+0.38	9.42	12.0	0.2	11.8	5.80	2.07				280	48.28	8.89	0.98	0.94
5.35	9.04	+2.2	+0.37	9.41	12.0	0.2	11.8	5.90	2.03				290	49.15	9.05	1.00	0.96
5.35	9.04	+2.2	+0.38	9.42	12.0	0.2	11.8	5.80	2.07				280	48.28	8.89	0.98	0.94
				9.42				5.83	2.06	2.02	0.23	0.21		48.57	8.94	0.99	0.95
5.35	9.04	+3.2	+0.54	9.58	15.0	0.3	14.7	5.90	2.54				295	50.00	9.21	1.02	0.96
5.35	9.04	+3.2	+0.55	9.59	15.0	0.3	14.7	5.80	2.59				295	50.86	9.37	1.04	0.98
5.35	9.04	+3.2	+0.55	9.59	15.0	0.3	14.7	5.85	2.56				295	50.43	9.29	1.03	0.97
				9.59				5.85	2.56	2.51	0.28	0.26		50.43	9.29	1.03	0.97
5.35	9.04	+3.2	+0.55	9.59	15.0	0.3	14.7	5.80	2.59				277	47.76	8.80	0.97	0.92
5.35	9.04	+3.2	+0.55	9.59	15.0	0.3	14.7	5.80	2.59				285	49.14	9.05	1.00	0.94
5.35	9.04	+3.2	+0.56	9.60	15.0	0.3	14.7	5.75	2.61				285	49.57	9.13	1.01	0.95
				9.59				5.78	2.60	2.54	0.29	0.26		48.82	8.99	0.99	0.94
7.10	12.00	+1.7	+0.29	12.29	5.0	0.1	4.9	5.92	0.84				352	59.46	10.95	0.91	0.89
7.10	12.00	+1.7	+0.28	12.28	5.0	0.1	4.9	5.96	0.84				345	57.89	10.66	0.89	0.87
7.10	12.00	+1.7	+0.29	12.29	5.0	0.1	4.9	5.80	0.86				350	60.34	11.11	0.93	0.90
				12.29				5.89	0.85	0.83	0.07	0.07		59.23	10.91	0.91	0.89
7.10	12.00	+1.7	+0.35	12.35	5.0	0.1	4.9	4.80	1.04				305	63.54	11.70	0.98	0.95
7.10	12.00	+1.7	+0.34	12.34	5.0	0.1	4.9	4.95	1.01				310	62.63	11.53	0.96	0.93
7.10	12.00	+1.7	+0.36	12.36	5.0	0.1	4.9	4.75	1.05				295	62.11	11.44	0.95	0.93
				12.35				4.83	1.03	1.01	0.09	0.08		62.76	11.56	0.96	0.94
7.10	12.00	+5.1	+0.80	12.80	12.0	0.7	11.3	6.40	1.88				425	66.41	12.23	1.02	0.96
7.10	12.00	+5.1	+0.85	12.85	12.0	0.7	11.3	6.00	2.00				410	68.33	12.58	1.05	0.98
7.10	12.00	+5.1	+0.84	12.84	12.0	0.7	11.3	6.10	1.97				415	68.03	12.53	1.04	0.98
				12.83				6.17	1.95	1.83	0.16	0.14		67.59	12.45	1.04	0.97
7.10	12.00	+5.1	+0.88	12.88	12.0	0.9	11.1	5.80	2.07				405	69.82	12.86	1.07	1.00
7.10	12.00	+5.1	+0.87	12.87	12.0	0.9	11.1	5.85	2.05				405	69.23	12.75	1.06	0.99
7.10	12.00	+5.1	+0.89	12.89	12.0	0.9	11.1	5.75	2.09				405	70.44	12.97	1.08	1.01
				12.88				5.80	2.07	1.92	0.17	0.15		69.83	12.86	1.07	1.00
7.12	12.03	+7.0	+1.21	13.24	15.0	1.5	13.5	5.80	2.59				405	69.83	12.86	1.07	0.97
7.12	12.03	+7.0	+1.24	13.27	15.0	1.5	13.5	5.65	2.65				405	71.68	13.20	1.10	0.99
7.12	12.03	+7.0	+1.23	13.26	15.0	1.5	13.5	5.70	2.63				405	71.05	13.09	1.09	0.99
				13.26				5.72	2.62	2.36	0.22	0.18		70.85	13.05	1.09	0.98
7.13	12.05	+7.0	+1.27	13.32	15.0	1.5	13.5	5.50	2.73				400	72.73	13.39	1.11	1.01
7.13	12.05	+7.0	+1.23	13.28	15.0	1.5	13.5	5.70	2.63				405	71.05	13.09	1.09	0.99
7.13	12.05	+7.0	+1.25	13.30	15.0	1.5	13.5	5.60	2.68				412	73.57	13.55	1.12	1.02
				13.30				5.60	2.68	2.41	0.22	0.18		72.45	13.34	1.11	1.01

TABLE 2

DAVID TAYLOR MODEL BASIN TESTS
US P-46S SUSPENDED SEDIMENT SAMPLER NO. 3 WITH 1/8-IN. NOZZLE

HORIZONTAL VELOCITY					SAMPLING				TRANSIT RATE OF SAMPLER				SAMPLE		INTAKE	INTAKE RATIO	
CARRIAGE		SAMPLER			DEPTH			TIME	LINEAR		RELATIVE		COLLECTION		VELOCITY		
Observed		Drift		Adjusted	Observed	Correction	Adjusted		Observed	Adjusted	Apparent	Adjusted	Size	Rate		Apparent	Adjusted
knots	ft./sec.	ft.	ft./sec.	ft./sec.	ft.	ft.	ft.	sec.	ft./sec.	ft./sec.			cc.	cc./sec.	ft./sec.		
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Observed	Ax1.689	drift[1]	C / I	B + D	observed	computed[2]	F − G	observed	F / I	$\bar{H}$ / $\bar{I}$	$\bar{J}$ / $\bar{B}$	$\bar{K}$ / $\bar{E}$	observed	N / I	computed[3]	P / B	P / E
DEPTH-INTEGRATING DOWNWARD																	
0.61	1.03	0	0	1.03	15.0	0	15.0	14.80	1.01				145	9.80	4.06	3.94	3.94
0.61	1.03	0	0	1.03	15.0	0	15.0	14.60	1.03				145	9.93	4.11	3.99	3.99
0.61	1.03	0	0	1.03	15.0	0	15.0	14.46	1.04				145	10.03	4.16	4.04	4.04
				1.03				14.62	1.03	1.03	1.00	1.00		9.92	4.11	3.99	3.99
0.60	1.01	0	0	1.01	15.0	0	15.0	7.62	1.97				140	18.37	7.61	7.53	7.53
0.60	1.01	0	0	1.01	15.0	0	15.0	7.52	1.99				140	18.62	7.72	7.64	7.64
0.60	1.01	0	0	1.01	15.0	0	15.0	7.55	1.99				140	18.54	7.68	7.60	7.60
				1.01				7.56	1.98	1.96	1.96	1.96		18.51	7.67	7.59	7.59
0.60	1.01	0	0	1.01	15.0	0	15.0	5.41	2.77				135	24.95	10.34	10.24	10.24
0.60	1.01	0	0	1.01	15.0	0	15.0	5.40	2.78				133	24.63	10.21	10.11	10.11
0.60	1.01	0	0	1.01	15.0	0	15.0	5.42	2.77				135	24.91	10.32	10.22	10.22
				1.01				5.41	2.77	2.77	2.74	2.74		24.83	10.29	10.19	10.19
1.80	3.04	-0.4	-0.03	3.01	15.0	0	15.0	15.18	0.99				145	9.55	3.96	1.30	1.32
1.80	3.04	-0.4	-0.03	3.01	15.0	0	15.0	14.74	1.02				145	9.84	4.08	1.34	1.36
1.80	3.04	-0.4	-0.03	3.01	15.0	0	15.0	14.50	1.03				145	10.00	4.14	1.36	1.38
				3.01				14.81	1.01	1.01	0.33	0.34		9.80	4.06	1.33	1.35
1.80	3.04	-0.4	-0.05	2.99	15.0	0	15.0	7.52	1.99				145	19.27	7.99	2.63	2.67
1.80	3.04	-0.4	-0.05	2.99	15.0	0	15.0	7.58	1.98				140	18.47	7.65	2.52	2.56
1.80	3.04	-0.4	-0.05	2.99	15.0	0	15.0	7.60	1.97				140	18.42	7.63	2.51	2.55
				2.99				7.57	1.98	1.98	0.65	0.66		18.72	7.76	2.55	2.59
1.81	3.06	-0.4	-0.06	3.00	15.0	0	15.0	6.50	2.31				135	20.77	8.61	2.81	2.86
1.81	3.06	-0.4	-0.06	3.00	15.0	0	15.0	6.63	2.26				135	20.36	8.44	2.76	2.81
				3.00				6.56	2.28	2.28	0.75	0.76		20.56	8.52	2.78	2.84
1.80	3.04	-0.4	-0.07	2.97	15.0	0	15.0	5.44	2.76				134	24.63	10.21	3.36	3.44
1.80	3.04	-0.4	-0.07	2.97	15.0	0	15.0	5.51	2.72				133	24.14	10.00	3.29	3.37
1.80	3.04	-0.4	-0.07	2.97	15.0	0	15.0	5.47	2.74				130	23.77	9.85	3.24	3.32
				2.97				5.47	2.74	2.74	0.90	0.92		24.18	10.02	3.30	3.38
3.55	6.00	-1.8	-0.12	5.88	15.0	0.1	14.9	14.80	1.01				230	15.44	6.40	1.07	1.09
3.54	5.98	-1.8	-0.12	5.86	15.0	0.1	14.9	15.30	0.97				242	15.61	6.47	1.08	1.10
3.54	5.98	-1.8	-0.12	5.86	15.0	0.1	14.9	15.10	0.99				235	15.56	6.45	1.08	1.10
				5.87				15.17	0.99	0.98	0.16	0.17		15.54	6.44	1.08	1.10
3.55	6.00	-1.8	-0.23	5.77	15.0	0.1	14.9	7.80	1.92				150	19.23	7.97	1.33	1.38
3.55	6.00	-1.8	-0.24	5.76	15.0	0.1	14.9	7.60	1.97				145	19.08	7.91	1.32	1.37
3.55	6.00	-1.8	-0.23	5.77	15.0	0.1	14.9	7.70	1.94				150	19.48	8.07	1.34	1.40
				5.77				7.70	1.94	1.94	0.32	0.34		19.26	7.98	1.33	1.38
3.55	6.00	-1.8	-0.27	5.73	15.0	0.1	14.9	6.60	2.27				141	21.36	8.85	1.48	1.54
3.55	6.00	-1.8	-0.27	5.73	15.0	0.1	14.9	6.75	2.22				145	21.48	8.90	1.48	1.55
3.55	6.00	-1.8	-0.28	5.72	15.0	0.1	14.9	6.50	2.31				141	21.69	8.99	1.50	1.57
				5.73				6.62	2.27	2.25	0.38	0.39		21.51	8.91	1.49	1.55

3.55	6.00	-1.8	-0.32	5.68	15.0	0.1	14.9	5.60	2.68				132	23.57	9.77	1.63	1.72
3.55	6.00	-1.8	-0.32	5.68	15.0	0.1	14.9	5.60	2.68				135	24.11	9.99	1.66	1.76
3.55	6.00	-1.8	-0.33	5.67	15.0	0.1	14.9	5.51	2.72				135	24.50	10.15	1.69	1.79
				5.68				5.57	2.69	2.68	0.45	0.47		24.06	9.97	1.66	1.76
5.37	9.08	-4.0	-0.26	8.82	15.0	0.5	14.5	15.30	0.98				350	22.88	9.48	1.04	1.07
5.37	9.08	-4.0	-0.26	8.82	15.0	0.5	14.5	15.30	0.98				350	22.88	9.48	1.04	1.07
5.37	9.08	-4.0	-0.27	8.81	15.0	0.5	14.5	15.00	1.00				340	22.67	9.39	1.03	1.07
				8.82				15.20	0.99	0.95	0.11	0.11		22.81	9.45	1.04	1.07
5.35	9.04	-4.0	-0.52	8.52	15.0	0.5	14.5	7.65	1.96				180	23.53	9.75	1.08	1.14
5.35	9.04	-4.0	-0.53	8.51	15.0	0.5	14.5	7.55	1.98				180	23.84	9.88	1.09	1.16
5.35	9.04	-4.0	-0.53	8.51	15.0	0.5	14.5	7.52	1.99				180	23.94	9.92	1.10	1.17
				8.51				7.57	1.98	1.92	0.22	0.22		23.77	9.85	1.09	1.16
5.35	9.04	-4.0	-0.61	8.43	15.0	0.5	14.5	6.54	2.29				150	22.94	9.51	1.05	1.13
5.35	9.04	-4.0	-0.61	8.43	15.0	0.5	14.5	6.53	2.30				151	23.12	9.58	1.06	1.14
5.35	9.04	-4.0	-0.60	8.44	15.0	0.5	14.5	6.63	2.26				150	22.62	9.37	1.04	1.11
				8.43				6.57	2.28	2.21	0.25	0.26		22.89	9.49	1.05	1.13
5.35	9.04	-4.0	-0.71	8.33	15.0	0.5	14.5	5.60	2.67				130	23.21	9.62	1.06	1.15
5.35	9.04	-4.0	-0.71	8.33	15.0	0.5	14.5	5.60	2.67				134	23.93	9.92	1.10	1.19
5.35	9.04	-4.0	-0.71	8.33	15.0	0.5	14.5	5.61	2.67				133	23.71	9.82	1.09	1.18
				8.33				5.60	2.67	2.59	0.30	0.31		23.62	9.79	1.08	1.17
7.15	12.08	-6.5	-0.49	11.59	12.0	1.4	10.6	13.20	0.91				365	27.65	11.46	0.95	0.99
7.15	12.08	-6.5	-0.51	11.57	12.0	1.4	10.6	12.75	0.94				375	29.41	12.19	1.01	1.05
7.15	12.08	-6.5	-0.52	11.56	12.0	.4	10.6	12.40	0.97				375	30.24	12.53	1.04	1.08
				11.57				12.78	0.94	0.83	0.08	0.07		29.10	12.06	1.00	1.04
7.13	12.05	-9.0	-1.20	10.85	15.0	2.4	12.6	7.53	1.99				230	30.54	12.66	1.05	1.16
7.13	12.05	-9.0	-1.20	10.85	15.0	2.4	12.6	7.53	1.99				235	31.21	12.93	1.07	1.19
7.13	12.05	-9.0	-1.20	10.85	15.0	2.4	12.6	7.53	1.99				235	31.21	12.93	1.07	1.19
				10.85				7.53	1.99	1.67	0.17	0.15		30.99	12.84	1.06	1.18
7.10	12.00	-9.0	-1.41	10.59	15.0	2.4	12.6	6.37	2.35				190	29.83	12.36	1.03	1.17
7.10	12.00	-9.0	-1.36	10.64	15.0	2.4	12.6	6.60	2.27				195	29.55	12.24	1.02	1.15
7.10	12.00	-9.0	-1.39	10.61	15.0	2.4	12.6	6.46	2.32				200	30.96	12.83	1.07	1.21
				10.61				6.48	2.31	1.94	0.19	0.18		30.11	12.48	1.04	1.18
7.12	12.03	-9.0	-1.65	10.38	15.0	2.4	12.6	5.46	2.75				165	30.22	12.52	1.04	1.21
7.12	12.03	-9.0	-1.60	10.43	15.0	2.4	12.6	5.61	2.67				165	29.41	12.19	1.01	1.17
7.12	12.03	-9.0	-1.60	10.43	15.0	2.4	12.6	5.61	2.67				165	29.41	12.19	1.01	1.17
				10.41				5.56	2.70	2.27	0.22	0.22		29.68	12.30	1.02	1.18

TABLE 2 (Continued)

DAVID TAYLOR MODEL BASIN TESTS

US P-46S SUSPENDED SEDIMENT SAMPLER NO. 3 WITH 1/8-IN. NOZZLE

HORIZONTAL VELOCITY					SAMPLING				TRANSIT RATE OF SAMPLER				SAMPLE		INTAKE	INTAKE RATIO	
CARRIAGE		SAMPLER			DEPTH			TIME	LINEAR		RELATIVE		COLLECTION		VELOCITY		
Observed		Drift		Adjusted	Observed	Correction	Adjusted		Observed	Adjusted	Apparent	Adjusted	Size	Rate		Apparent	Adjusted
knots	ft./sec.	ft.	ft./sec.	ft./sec.	ft.	ft.	ft.	sec.	ft./sec.	ft./sec.			cc.	cc./sec.	ft./sec.		
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Observed	Ax1.689	drift[1]	C / I	B + D	observed	computed[2]	F − G	observed	F / I	$\bar{H}$ / $\bar{I}$	$\bar{J}$ / $\bar{B}$	$\bar{K}$ / $\bar{E}$	observed	N / I	computed[3]	P / B	P / E
DEPTH-INTEGRATING UPWARD																	
0.60	1.01	0	0	1.01	15.0	0	15.0	16.74	0.90				35	2.09	0.87	0.86	0.86
0.60	1.01	0	0	1.01	15.0	0	15.0	16.74	0.90				34	2.03	0.84	0.83	0.83
0.60	1.01	0	0	1.01	15.0	0	15.0	16.87	0.89				32	1.90	0.79	0.78	0.78
								16.78	0.90	0.90	0.89	0.89		2.01	0.83	0.82	0.82
0.60	1.01	0	0	1.01	15.0	0	15.0	7.55	1.99				3	0.40	0.17	0.17	0.17
0.60	1.01	0	0	1.01	15.0	0	15.0	7.30	2.05				3	0.41	0.17	0.17	0.17
0.60	1.01	0	0	1.01	15.0	0	15.0	7.30	2.05				3	0.41	0.17	0.17	0.17
								7.38	2.03	2.03	2.01	2.01		0.41	0.17	0.17	0.17
0.60	1.01	0	0	1.01	15.0	0	15.0	5.60	2.68				5	0.89	0.37	0.37	0.37
0.60	1.01	0	0	1.01	15.0	0	15.0	5.70	2.63				5	0.88	0.36	0.36	0.36
0.60	1.01	0	0	1.01	15.0	0	15.0	5.80	2.59				4	0.69	0.29	0.29	0.28
								5.70	2.63	2.63	2.60	2.60		0.82	0.34	0.34	0.34
1.82	3.08	+0.4	+0.02	3.10	15.0	0	15.0	16.90	0.89				110	6.51	2.70	0.88	0.87
1.80	3.04	+0.4	+0.02	3.06	15.0	0	15.0	16.50	0.91				110	6.67	2.76	0.91	0.90
1.80	3.04	+0.4	+0.02	3.06	15.0	0	15.0	16.42	0.91				107	6.52	2.70	0.89	0.88
				3.07				16.61	0.90	0.90	0.30	0.29		6.57	2.72	0.89	0.88
1.80	3.04	+0.4	+0.06	3.10	15.0	0	15.0	7.00	2.14				30	4.29	1.78	0.59	0.57
1.80	3.04	+0.4	+0.05	3.09	15.0	0	15.0	7.35	2.04				35	4.76	1.97	0.65	0.64
1.80	3.04	+0.4	+0.05	3.09	15.0	0	15.0	7.30	2.05				35	4.79	1.98	0.65	0.64
				3.09				7.32	2.08	2.08	0.68	0.67		4.61	1.91	0.63	0.62
1.80	3.04	+0.4	+0.07	3.11	15.0	0	15.0	5.90	2.54				24	4.07	1.69	0.56	0.54
1.80	3.04	+0.4	+0.07	3.11	15.0	0	15.0	5.72	2.62				25	4.37	1.81	0.60	0.58
1.80	3.04	+0.4	+0.07	3.11	15.0	0	15.0	5.65	2.65				24	4.25	1.76	0.58	0.57
				3.11				5.76	2.60	2.60	0.86	0.84		4.23	1.75	0.58	0.56
1.80	3.04	+0.4	+0.07	3.11	15.0	0	15.0	5.70	2.63				32	5.61	2.32	0.76	0.75
1.80	3.04	+0.4	+0.07	3.11	15.0	0	15.0	5.55	2.70				32	5.77	2.39	0.79	0.77
1.80	3.04	+0.4	+0.07	3.11	15.0	0	15.0	5.55	2.70				33	5.95	2.47	0.81	0.79
				3.11				5.62	2.68	2.68	0.88	0.86		5.78	2.39	0.79	0.77
3.55	6.00	+1.4	+0.08	6.08	15.0	0.1	14.9	16.90	0.89				246	14.56	6.03	1.00	0.99
3.55	6.00	+1.4	+0.08	6.08	15.0	0.1	14.9	16.90	0.89				245	14.50	6.01	1.00	0.99
3.55	6.00	+1.4	+0.08	6.08	15.0	0.1	14.9	16.50	0.91				244	14.79	6.13	1.02	1.01
				6.08				16.76	0.90	0.89	0.15	0.15		14.62	6.06	1.01	1.00
3.55	6.00	+1.4	+0.19	6.19	15.0	0.1	14.9	7.28	2.06				108	14.84	6.15	1.02	0.99
3.55	6.00	+1.4	+0.19	6.19	15.0	0.1	14.9	7.35	2.04				100	13.61	5.64	0.94	0.91
3.55	6.00	+1.4	+0.19	6.19	15.0	0.1	14.9	7.25	2.07				105	14.48	6.00	1.00	0.97
				6.19				7.29	2.06	2.04	0.34	0.33		14.31	5.93	0.99	0.96
3.55	6.00	+1.4	+0.24	6.24	15.0	0.1	14.9	5.72	2.62				75	13.29	5.51	0.92	0.88
3.55	6.00	+1.4	+0.25	6.25	15.0	0.1	14.9	5.68	2.64				78	13.73	5.69	0.95	0.91
3.55	6.00	+1.4	+0.24	6.24	15.0	0.1	14.9	5.80	2.59				82	14.14	5.86	0.98	0.94
				6.24				5.73	2.62	2.60	0.44	0.42		13.72	5.69	0.95	0.91

3.55	6.00	+1.4	+0.24	6.24	15.0	0.1	14.9	5.80	2.59				87	15.00	6.22	1.04	1.00
3.55	6.00	+1.4	+0.25	6.25	15.0	0.1	14.9	5.60	2.68				85	15.18	6.29	1.05	1.01
3.55	6.00	+1.4	+0.25	6.25	15.0	0.1	14.9	5.50	2.73				85	15.45	6.40	1.07	1.02
				6.25				5.63	2.67	2.65	0.44	0.42		15.21	6.30	1.05	1.01
5.35	9.04	+3.2	+0.19	9.23	15.0	0.3	14.7	17.20	0.87				410	23.84	9.88	1.09	1.07
5.35	9.04	+3.2	+0.19	9.23	15.0	0.3	14.7	16.88	0.89				397	23.52	9.75	1.08	1.06
5.35	9.04	+3.2	+0.20	9.24	15.0	0.3	14.7	16.40	0.91				406	24.76	10.26	1.13	1.11
				9.23				16.82	0.89	0.87	0.10	0.09		24.04	9.96	1.10	1.08
5.35	9.04	+3.2	+0.43	9.47	15.0	0.3	14.7	7.38	2.03				170	23.04	9.55	1.06	1.01
5.35	9.04	+3.2	+0.45	9.49	15.0	0.3	14.7	7.10	2.11				160	22.54	9.34	1.03	0.98
5.35	9.04	+3.2	+0.44	9.48	15.0	0.3	14.7	7.20	2.08				175	24.31	10.07	1.11	1.06
				9.48				7.23	2.07	2.03	0.23	0.21		23.30	9.65	1.07	1.02
5.35	9.04	+3.2	+0.56	9.60	15.0	0.3	14.7	5.70	2.63				135	23.68	9.81	1.09	1.02
5.35	9.04	+3.2	+0.55	9.59	15.0	0.3	14.7	5.80	2.59				138	23.79	9.86	1.09	1.03
5.35	9.04	+3.2	+0.55	9.59	15.0	0.3	14.7	5.85	2.56				140	23.93	9.92	1.10	1.03
				9.59				5.78	2.59	2.54	0.29	0.27		23.80	9.86	1.09	1.03
5.35	9.04	+3.2	+0.55	9.59	15.0	0.3	14.7	5.80	2.59				145	25.00	10.36	1.15	1.08
5.35	9.04	+3.2	+0.57	9.61	15.0	0.3	14.7	5.60	2.67				143	25.54	10.58	1.17	1.10
5.35	9.04	+3.2	+0.55	9.59	15.0	0.3	14.7	5.80	2.59				143	24.66	10.22	1.13	1.07
				9.60				5.73	2.62	2.57	0.29	0.27		25.07	10.39	1.15	1.08
7.10	12.00	+5.1	+0.38	12.38	12.0	0.9	11.1	13.28	0.90				435	32.76	13.58	1.13	1.10
7.10	12.00	+5.1	+0.38	12.38	12.0	0.9	11.1	13.34	0.90				439	32.91	13.64	1.14	1.10
7.10	12.00	+5.1	+0.37	12.37	12.0	0.9	11.1	13.97	0.86				445	31.85	13.20	1.10	1.07
				12.38				13.53	0.89	0.82	0.07	0.07		32.51	13.47	1.12	1.09
7.10	12.00	+7.0	+0.95	12.95	15.0	1.5	13.5	7.35	2.04				250	34.01	14.09	1.17	1.09
7.10	12.00	+7.0	+0.94	12.94	15.0	1.5	13.5	7.45	2.01				265	35.57	14.74	1.23	1.14
7.10	12.00	+7.0	+0.92	12.92	15.0	1.5	13.5	7.62	1.96				243	31.89	13.21	1.10	1.02
				12.94				7.47	2.00	1.81	0.17	0.14		33.82	14.01	1.17	1.08
7.10	12.00	+7.0	+1.23	13.23	15.0	1.5	13.5	5.70	2.63				196	34.39	14.25	1.19	1.08
7.10	12.00	+7.0	+1.23	13.23	15.0	1.5	13.5	5.68	2.64				200	35.21	14.59	1.22	1.10
7.10	12.00	+7.0	+1.23	13.23	15.0	1.5	13.5	5.72	2.62				196	34.27	14.20	1.18	1.07
				13.23				5.70	2.63	2.37	0.22	0.18		34.62	14.35	1.20	1.08
7.10	12.00	+7.0	+1.27	13.27	15.0	1.5	13.5	5.50	2.73				132	34.91	14.47	1.21	1.09
7.10	12.00	+7.0	+1.25	13.25	15.0	1.5	13.5	5.60	2.67				203	36.25	15.02	1.25	1.13
7.10	12.00	+7.0	+1.19	13.19	15.0	1.5	13.5	5.90	2.54				210	35.59	14.75	1.23	1.12
				13.24				5.67	2.65	2.38	0.22	0.18		35.58	14.75	1.23	1.11

TABLE 3

DAVID TAYLOR MODEL BASIN TESTS
US D-43 SUSPENDED SEDIMENT SAMPLER NO. 151 WITH 3/16-IN. NOZZLE

HORIZONTAL VELOCITY					SAMPLING				TRANSIT RATE OF SAMPLER				SAMPLE		INTAKE	INTAKE RATIO	
CARRIAGE		SAMPLER			DEPTH			TIME	LINEAR		RELATIVE		COLLECTION		VELOCITY		
Observed		Drift		Adjusted	Observed	Correction	Adjusted		Observed	Adjusted	Apparent	Adjusted	Size	Rate		Apparent	Adjusted
knots	ft./sec.	ft.	ft./sec.	ft./sec.	ft.	ft.	ft.	sec.	ft./sec.	ft./sec.			cc.	cc./sec.	ft./sec.		
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Observed	A x 1.689	drift[1]	C / I	B + D	observed	computed[2]	F + G	observed	F / I	$\bar{H}$ / $\bar{I}$	$\bar{J}$ / $\bar{B}$	$\bar{K}$ / $\bar{E}$	observed	N / I	computed[3]	P / B	P / E
0.58	0.98	0	0	0.98	14.5	0	14.5	29.3	0.99				208	7.10	1.31	1.34	1.34
0.58	0.98	0	0	0.98	14.5	0	14.5	29.4	0.99				210	7.14	1.31	1.34	1.34
0.58	0.98	0	0	0.98	14.5	0	14.5	29.5	0.98				207	6.99	1.29	1.32	1.32
				0.98				29.4	0.99	0.99	1.01	1.01		7.08	1.30	1.33	1.33
0.60	1.01	-1.7	+0.11	1.12	+15.0	0	15.0	15.55	1.93				160	10.29	1.90	1.88	1.69
0.60	1.01	-1.7	-0.11	0.90	+15.0	0	15.0	15.55	1.93				165	10.61	1.95	1.93	2.17
0.60	1.01	+1.7	+0.11	1.12	-15.0	0	15.0	15.20	1.97				160	10.53	1.94	1.92	1.73
				1.05				15.43	1.94	1.94	1.92	1.85		10.48	1.93	1.91	1.86
0.60	1.01	[illegible]	+0.14	1.15	+15.0	0	15.0	11.95	2.51				170	14.23	2.62	2.59	2.28
0.60	1.01	[illegible]	-0.14	0.87	-15.0	0	15.0	11.35	2.54				150	12.71	2.34	2.32	2.69
0.60	1.01	+1.7	+0.15	1.16	+15.0	0	15.0	11.50	2.61				155	13.43	2.48	2.46	2.14
				1.06				11.75	2.55	2.55	2.52	2.41		13.47	2.48	2.46	2.37
1.76	2.97	0	0	2.97	5.3	0	5.3	17.0	0.68				421	24.76	4.56	1.54)	N.G.
1.76	2.97	0	0	2.97	5.3	0	5.3	17.7	0.66				428	24.18	4.45	1.50)	
1.76	2.97	0	0	2.97	5.3	0	5.3	25.2	0.46				422	16.75	3.08	1.04	
				2.97													
1.79	3.02	0	0	3.02	12.0	0	12.0	25.0	0.96				420	16.80	3.09	1.02	1.02
1.79	3.02	0	0	3.02	12.0	0	12.0	25.0	0.96				423	16.92	3.12	1.03	1.03
1.79	3.02	0	0	3.02	12.0	0	12.0	25.0	0.96				421	16.84	3.10	1.03	1.03
				3.02				25.0	0.96	0.96	0.32	0.32		16.85	3.10	1.03	1.03
1.80	3.04	+1.6	+0.08	3.12	+15.0	0	15.0	13.90	1.59				305	16.14	2.97	0.98	0.95
1.80	3.04	-1.7	-0.09	2.95	-15.0	0	15.0	13.65	1.60				290	15.55	2.86	0.94	0.97
1.80	3.04	+1.6	+0.09	3.13	+15.0	0	15.0	13.60	1.61				300	16.13	2.97	0.98	0.95
				3.07				13.72	1.60	1.60	0.53	0.52		15.94	2.93	0.96	0.96
1.80	3.04	[illegible]	-0.11	2.93	-15.0	0	15.0	[illegible]	[illegible]				245	16.01	2.95	0.97	1.00
1.80	3.04	[illegible]	+0.10	3.14	+15.0	0	15.0	[illegible]	[illegible]				255	16.35	3.01	0.99	0.96
1.80	3.04	[illegible]	-0.11	2.93	-15.0	0	15.0	[illegible]	[illegible]				245	16.01	2.95	0.97	1.00
				3.00					[illegible]	[illegible]	0.64	0.65		16.12	2.97	0.98	0.99
1.80	3.04	[illegible]	-0.12	2.92	-15.0	0	15.0	[illegible]	[illegible]				225	16.42	3.02	0.99	1.03
1.80	3.04	[illegible]	+0.12	3.16	+15.0	0	15.0	[illegible]	[illegible]				250	13.45	3.40	1.12	1.07
1.80	3.04	[illegible]	-0.13	2.91	-15.0	0	15.0	[illegible]	[illegible]				230	17.16	3.16	1.04	1.08
				3.00					[illegible]	[illegible]	[illegible]	[illegible]		17.34	3.19	1.05	1.06
1.80	3.04	-1.7	-0.17	2.87	-15.0	0	15.0	[illegible]	3.00				190	19.00	3.50	1.15	1.22
1.80	3.04	+1.6	+0.15	3.19	+15.0	0	15.0	[illegible]	2.86				195	18.57	3.42	1.12	1.07
1.80	3.04	-1.7	-0.17	2.87	-15.0	0	15.0	[illegible]	[illegible]				185	18.23	3.36	1.11	1.17
				2.98				10.92	2.94	2.94	0.97	0.99		18.60	3.43	1.13	1.15

1.80	3.04	0	0	3.04	5.0	0	5.0	20.9	0.48				365	17.46	3.22	1.06	
1.80	3.04	0	0	3.04	5.0	0	5.0	20.9	0.48				345	16.51	3.04	1.00	
1.80	3.04	0	0	3.04	5.0	0	5.0	21.0	0.48				365	17.38	3.20	1.05	
1.80	3.04	0	0	3.04	5.0	0	5.0	21.4	0.47				350	16.36	3.01	0.99	
1.80	3.04	0	0	3.04	5.0	0	5.0	21.5	0.47				355	16.51	3.04	1.00	
				3.04				21.1	0.48	0.48	0.16	0.16		16.84	3.10	1.02	1.02
3.56	6.02	-0.33	-0.03	5.99	2.9	0	2.9	13.0	0.45				421	32.38	5.96	0.99	0.99
3.57	6.03	-0.33	-0.03	6.00	2.9	0	2.9	13.0	0.45				422	32.46			
3.56	6.02	-0.33	-0.03	5.99	2.9	0	2.9	13.0	0.45				423	32.54	5.99	1.00	1.00
				5.99				13.0	0.45	0.45	0.07	0.08		32.46	5.98	1.00	1.00
3.55	6.00	-0.33	-0.03	5.97	5.8	0	5.8	12.4	0.94				398	32.10	5.91	0.98	0.99
3.55	6.00	-0.33	-0.03	5.97	5.8	0	5.8	12.4	0.94				393	31.69	5.84	0.97	0.98
3.55	6.00	-0.33	-0.03	5.97	5.8	0	5.8	12.6	0.92				394	31.27	5.76	0.96	0.96
				5.97				12.5	0.93	0.93	0.16	0.16		31.69	5.84	0.97	0.98
3.55	6.00	-2.0	-0.21	5.79	-7.0	0	7.0	9.70	1.44				285	29.38	5.41	0.90	0.93
3.55	6.00	+1.3	+0.13	6.13	+7.0	0	7.0	9.90	1.41				325	32.83	6.05	1.01	0.99
3.55	6.00	-2.0	-0.21	5.79	-7.0	0	7.0	9.70	1.44				295	30.41	5.60	0.93	0.97
				5.90				9.76	1.43	1.43	0.24	0.24		30.87	5.69	0.95	0.96
3.55	6.00	+1.3	+0.13	6.13	+10.0	0.1	9.9	10.15	1.97				305	30.05	5.53	0.92	0.90
3.55	6.00	-2.0	-0.19	5.81	-10.0	0.1	9.9	10.30	1.94				330	32.04	5.90	0.98	1.02
3.55	6.00	+1.3	+0.13	6.13	+10.0	0.1	9.9	9.95	2.01				305	30.65	5.64	0.94	0.92
				6.02				10.13	1.97	1.95	0.33	0.32		30.91	5.69	0.95	0.95
3.55	6.00	-2.0	-0.15	5.85	-15.0	0.2	14.8	13.50	2.23				405	30.00	5.53	0.92	0.94
3.55	6.00	+1.3	+0.10	6.10	+15.0	0.2	14.8	13.65	2.19				450	32.97	6.07	1.01	1.00
3.55	6.00	-2.0	-0.15	5.85	-15.0	0.2	14.8	13.40	2.24				425	31.72	5.84	0.97	1.00
				5.93				13.52	2.22	2.19	0.37	0.37		31.56	5.81	0.97	0.98
3.55	6.00	+1.3	+0.13	6.13	+15.0	0.2	14.8	10.25	2.93				325	31.71	5.84	0.97	0.95
3.55	6.00	-2.0	-0.20	5.80	-15.0	0.2	14.8	10.05	2.99				310	30.85	5.68	0.95	0.98
3.55	6.00	+1.3	+0.13	6.13	+15.0	0.2	14.8	10.10	2.97				320	31.68	5.83	0.97	0.95
				6.02				10.13	2.96	2.92	0.49	0.49		31.41	5.78	0.96	0.96
5.34	9.02	-0.67	-0.08	8.94	1.75	0	1.75	8.5	0.41				391	46.00	8.47	0.94	0.95
5.35	9.04				1.75	0	1.75						395				
5.36	9.06	-0.67	-0.08	8.98	1.75	0	1.75	8.4	0.42				394	46.90	8.64	0.95	0.96
	9.04			8.96					0.41	0.41	0.05	0.05		46.45	8.56	0.95	0.96
5.35	9.04	-0.67	-0.08	8.96	3.9	0	3.9	8.6	0.91				389	45.23	8.33	0.92	0.93
5.35	9.04	-0.67	-0.08	8.96	3.9	0	3.9	8.3	0.94				385	46.39	8.54	0.94	0.95
5.35	9.04	-0.67	-0.08	8.96	3.9	0	3.9	8.8	0.89				390	44.32	8.16	0.90	0.91
				8.96					0.91	0.91	0.10	0.10		45.31	8.34	0.92	0.93
5.35	9.04	+1.0	+0.11	9.15	+7.0	0.2	6.8	9.30	1.50				455	48.92	9.01	1.00	0.98
5.35	9.04	-2.3	-0.25	8.79	-7.0	0.2	6.8	9.20	1.52				445	48.37	8.91	0.99	1.01
5.35	9.04	+1.0	+0.11	9.15	+7.0	0.2	6.8	9.20	1.52				455	49.46	9.11	1.01	1.00
				9.03				9.23	1.51	1.47	0.17	0.16		48.92	9.01	1.00	1.00
5.35	9.04	-2.3	-0.32	8.72	-7.0	0.2	6.8	7.10	1.97				345	48.59	8.95	0.99	1.03
5.35	9.04	+1.0	+0.15	9.19	+7.0	0.2	6.8	6.85	2.04				340	49.64	9.14	1.01	0.99
5.35	9.04	-2.3	-0.32	8.72	-7.0	0.2	6.8	7.20	1.94				340	47.22	8.70	0.96	1.00
				8.88				7.05	1.98	1.93	0.22	0.22		48.48	8.93	0.99	1.01
5.35	9.04	+1.0	+0.12	9.16	+10.0	0.4	9.6	8.70	2.30				425	48.85	9.00	1.00	0.98
5.35	9.04	-2.3	-0.28	8.76	-10.0	0.4	9.6	8.10	2.46				395	48.77	8.98	0.99	1.03
5.35	9.04	+1.0	+0.12	9.16	+10.0	0.4	9.6	8.60	2.33				400	46.51	8.57	0.95	0.94
				9.03				8.47	2.36	2.27	0.26	0.25		48.04	8.85	0.98	0.98
5.35	9.04	+1.0	+0.14	9.18	+10.0	0.4	9.6	7.10	2.81				330	46.48	8.56	0.95	0.93
5.35	9.04	-2.3	-0.34	8.70	-10.0	0.4	9.6	6.80	2.94				320	47.06	8.67	0.96	1.00
5.35	9.04	+1.0	+0.13	9.17	+10.0	0.4	9.6	7.45	2.68				340	45.64	8.41	0.93	0.92
				9.02				7.12	2.81	2.70	0.31	0.30		46.39	8.55	0.95	0.95

TABLE 4

DAVID TAYLOR MODEL BASIN TESTS
US D-43 SUSPENDED SEDIMENT SAMPLER NO. 151 WITH 1/8-IN. NOZZLE

HORIZONTAL VELOCITY					SAMPLING				TRANSIT RATE OF SAMPLER				SAMPLE COLLECTION		INTAKE VELOCITY	INTAKE RATIO	
CARRIAGE		SAMPLER			DEPTH			TIME	LINEAR		RELATIVE						
Observed		Drift		Adjusted	Observed	Correction	Adjusted		Observed	Adjusted	Apparent	Adjusted	Size	Rate		Apparent	Adjusted
knots	ft./sec.	ft.	ft./sec.	ft./sec.	ft.	ft.	ft.	sec.	ft./sec.	ft./sec.			cc.	cc./sec.	ft./sec.		
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
Observed	Axl.689	drift[1]	C / I	B + D	observed	computed[2]	F − G	observed	F / I	$\bar{H}$ / $\bar{I}$	$\bar{J}$ / $\bar{B}$	$\bar{K}$ / $\bar{E}$	observed	N / I	computed[3]	P / B	P / E
0.60	1.01	0	0	1.01	14.5	0	14.5	29.6	0.98				169	5.71	2.37	2.35	2.35
0.60	1.01	0	0	1.01	14.5	0	14.5	29.6	0.98				169	5.71	2.37	2.35	2.35
0.60	1.01	0	0	1.01	14.5	0	14.5	29.2	0.99				169	5.79	2.40	2.38	2.38
				1.01				29.5	0.98	0.98	0.97	0.97		5.74	2.38	2.36	2.36
0.60	1.01	-1.7	-0.11	0.90	-15.0	0	15.0	15.55	1.93				155	9.97	4.13	4.09	4.60
0.60	1.01	+1.7	+0.11	1.12	+15.0	0	15.0	15.35	1.89				155	9.78	4.05	4.01	3.62
0.60	1.01	-1.7	-0.11	0.90	-15.0	0	15.0	15.40	1.95				155	10.06	4.17	4.13	4.63
				0.97				15.60	1.92	1.92	1.90	1.98		9.94	4.12	4.08	4.28
0.60	1.01	-1.7	-0.16	0.85	-15.0	0	15.0	10.50	2.86				145	13.81	5.72	5.66	6.73
0.60	1.01	+1.7	+0.17	1.18	+15.0	0	15.0	10.05	2.99				150	14.93	6.19	6.13	5.25
0.60	1.01	-1.7	-0.16	0.85	-15.0	0	15.0	10.35	2.90				145	14.01	5.81	5.75	6.82
				0.96				10.30	2.92	2.92	2.89	3.04		14.25	5.91	5.85	6.27
1.80	3.04	0	0	3.04	14.5	0	14.5	29.6	0.98				246	8.31	3.44	1.13	1.13
1.80	3.04	0	0	3.04	14.5	0	14.5	29.5	0.98				242	8.20	3.40	1.12	1.13
1.80	3.04	0	0	3.04	14.5	0	14.5	29.7	0.98				244	8.22	3.41	1.12	1.12
				3.04				29.6	0.98	0.98	0.32	0.32		8.24	3.42	1.12	1.13
1.80	3.04	+1.6	+0.10	3.14	+15.0	0	15.0	15.25	1.97				195	12.79	5.30	1.74	1.69
1.80	3.04	-1.7	-0.11	2.93	-15.0	0	15.0	15.50	1.94				190	12.26	5.08	1.67	1.73
1.80	3.04	+1.6	+0.10	3.14	+15.0	0	15.0	15.40	1.95				195	12.66	5.25	1.73	1.67
				3.07				15.38	1.95	1.95	0.64	0.64		12.57	5.21	1.71	1.70
1.80	3.04	+1.6	+0.15	3.19	+15.0	0	15.0	10.50	2.86				165	15.71	6.51	2.14	2.04
1.80	3.04	-1.7	-0.16	2.88	-15.0	0	15.0	10.45	2.87				160	15.31	6.34	2.09	2.20
1.80	3.04	+1.6	+0.16	3.20	+15.0	0	15.0	10.15	2.96				165	16.26	6.74	2.22	2.11
				3.09				10.36	2.90	2.90	0.95	0.94		15.76	6.53	2.15	2.12
3.55	6.00	-0.33	-0.01	5.99	6.6	0	6.6	27.8	0.47				430	15.47	6.41	1.07	1.07
3.55	6.00	-0.33	-0.01	5.99	6.6	0	6.6	27.3	0.48				430	15.75	6.53	1.09	1.09
3.55	6.00	-0.33	-0.01	5.99	6.6	0	6.6	27.6	0.48				430	15.58	6.46	1.08	1.08
				5.99				27.6	0.48	0.48	0.08	0.08		15.60	6.47	1.08	1.08
3.56	6.02	-0.33	-0.01	6.01	12.0	0.1	11.9	24.7	0.97				380	15.38	6.37	1.06	1.06
3.56	6.02	-0.33	-0.01	6.01	12.0	0.1	11.9	24.6	0.98				381	15.49	6.42	1.07	1.07
3.56	6.02	-0.33	-0.01	6.01	12.0	0.1	11.9	24.6	0.98				381	15.49	6.42	1.07	1.07
				6.01				24.6	0.98	0.97	0.16	0.16		15.45	6.40	1.07	1.07
3.55	6.00	-2.0	-0.11	5.89	-15.0	0.2	14.8	18.00	1.67				285	15.83	6.56	1.09	1.11
3.55	6.00	+1.3	+0.07	6.07	+15.0	0.2	14.8	18.00	1.67				290	16.11	6.68	1.11	1.10
3.55	6.00	-2.0	-0.11	5.89	-15.0	0.2	14.8	17.90	1.68				285	15.92	6.60	1.10	1.12
				5.95				17.97	1.67	1.65	0.28	0.28		15.95	6.61	1.10	1.11
3.55	6.00	-2.0	-0.13	5.87	-15.0	0.2	14.8	15.50	1.94				260	16.77	6.95	1.16	1.18
3.55	6.00	+1.3	+0.08	6.08	+15.0	0.2	14.8	15.25	1.93				270	17.70	7.33	1.22	1.21
3.55	6.00	-2.0	-0.13	5.87	-15.0	0.2	14.8	15.45	1.94				265	17.15	7.11	1.19	1.21
				5.94				15.40	1.94	1.92	0.32	0.32		17.21	7.13	1.19	1.20

3.55	6.00	-2.0	-0.25	5.75	-10.0	0.1	9.9	8.15	2.45				155	19.02	7.88	1.31	1.37
3.55	6.00	+1.3	+0.16	6.16	+10.0	0.1	9.9	8.15	2.45				160	19.63	8.13	1.36	1.32
3.55	6.00	-2.0	-0.25	5.75	-10.0	0.1	9.9	8.15	2.45				155	19.02	7.88	1.31	1.37
				5.89				8.15	2.45	2.43	0.41	0.41		19.22	7.96	1.33	1.35
3.55	6.00	-2.0	-0.19	5.81	-15.0	0.2	14.8	10.50	2.86				205	19.52	8.09	1.35	1.39
3.55	6.00	+1.3	+0.13	6.13	+15.0	0.2	14.8	10.05	2.99				215	21.39	8.86	1.48	1.45
3.55	6.00	-2.0	-0.19	5.81	-15.0	0.2	14.8	10.70	2.80				215	20.09	8.32	1.39	1.43
				5.92				10.42	2.88	2.84	0.48	0.48		20.33	8.42	1.41	1.42
5.35	9.04	-0.67	-0.04	9.00	4.2	0	4.2	19.0	0.44				433	22.79	9.44	1.04	1.05
5.35	9.04	-0.67	-0.04	9.00	4.2	0	4.2	18.9	0.44				436	23.07	9.56	1.06	1.06
5.35	9.04	-0.67	-0.04	9.00	4.2	0	4.2	18.9	0.44				436	23.07	9.56	1.06	1.06
				9.00				18.9	0.44	0.44	0.05	0.05		22.98	9.52	1.05	1.06
5.35	9.04	-0.67	-0.04	9.00	8.4	0.3	8.1	16.0	1.05				386	24.12	9.99	1.11	1.11
5.35	9.04	-0.67	-0.04	9.00	8.4	0.3	8.1	17.4	0.97				388	22.30	9.24	1.02	1.03
5.35	9.04	-0.67	-0.04	9.00	8.4	0.3	8.1	17.3	0.97				394	22.77	9.44	1.04	1.05
				9.00				16.9	1.00	0.96	0.11	0.11		23.06	9.56	1.06	1.06
5.35	9.04	-2.3	-0.18	8.86	-10.0	0.4	9.6	13.10	1.53				310	23.66	9.80	1.08	1.11
5.35	9.04	+1.0	+0.08	9.12	+10.0	0.4	9.6	13.10	1.53				315	24.05	9.97	1.10	1.09
5.35	9.04	-2.3	-0.17	8.87	-10.0	0.4	9.6	13.15	1.52				310	23.57	9.77	1.08	1.10
				8.95				13.12	1.53	1.46	0.17	0.16		23.76	9.85	1.09	1.10
5.35	9.04	+1.0	+0.06	9.10	+15.0	0.8	14.2	15.50	1.94				375	24.19	10.02	1.11	1.10
5.35	9.04	-2.3	-0.15	8.89	-15.0	0.8	14.2	15.10	1.99				365	24.17	10.02	1.11	1.13
5.35	9.04	+1.0	+0.07	9.11	+15.0	0.8	14.2	15.15	1.98				370	24.42	10.12	1.12	1.11
				9.03				15.25	1.97	1.86	0.22	0.21		24.26	10.05	1.11	1.11
5.35	9.04	+1.0	+0.12	9.16	+10.0	0.4	9.6	8.10	2.47				205	25.31	10.49	1.16	1.15
5.35	9.04	-2.3	-0.28	8.76	-10.0	0.4	9.6	8.10	2.47				195	24.07	9.97	1.10	1.14
5.35	9.04	+1.0	+0.12	9.16	+10.0	0.4	9.6	8.00	2.50				205	25.62	10.62	1.17	1.16
				9.03				8.07	2.48	2.38	0.27	0.26		25.00	10.36	1.14	1.15
5.35	9.04	+1.0	+0.10	9.14	+15.0	0.8	14.2	10.00	3.00				255	25.50	10.57	1.17	1.16
5.35	9.04	-2.3	-0.22	8.82	-15.0	0.8	14.2	10.30	2.91				270	26.21	10.86	1.20	1.23
5.35	9.04	+1.0	+0.10	9.14	+15.0	0.8	14.2	10.25	2.93				260	25.37	10.51	1.16	1.15
				9.03				10.18	2.95	2.79	0.33	0.31		25.69	10.65	1.18	1.18