COMPUTER PROGRAM FOR THE COMPUTATION OF TOTAL SEDIMENT DISCHARGE BY THE MODIFIED EINSTEIN PROCEDURE

by Herbert H. Stevens, Jr.

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DONALD PAUL HODEL, Secretary

GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information
write to:

David W. Hubbell, Project Chief
U.S. Geological Survey
Box 25046, Mail Stop 413
Denver Federal Center
Lakewood, CO 80225

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CONVERSION FACTORS

Inch-pound units used in this report may be converted to SI (International System) units by the following conversion factors:

Multiply inch-pound units	By	To obtain SI units
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
foot (ft)	0.3048	meter (m)
foot per second (ft/s)	0.3048	meter per second (m/s)
pound per foot (lb/ft)	1.488	kilogram per meter (kg/m)
ton per day (t/d)	0.9078	metric ton per day (t/d)
square foot (ft^2)	0.0929	square meter (m^2)
square foot per second (ft^2/s)	0.0929	square meter per second (m^2/s)

To convert degree Celsius (°C) used in this report to degree Fahrenheit (°F), use the following equation:

$$°F = 9/5(°C + 32).$$

COMPUTER PROGRAM FOR THE COMPUTATION OF TOTAL SEDIMENT DISCHARGE BY THE MODIFIED EINSTEIN PROCEDURE

H. H. Stevens, Jr.

ABSTRACT

Two versions of a computer program to compute total sediment discharge by the modified Einstein procedure are presented. The FORTRAN 77 language version is for use on the PRIME computer, and the BASIC language version is for use on microcomputers. The program contains built-in limitations and input-output options that closely follow the original modified Einstein procedure. Program documentation and listings of both versions of the program are included.

INTRODUCTION

The modified Einstein procedure (Colby and Hembree, 1955) computes total sediment discharge at a cross section of an alluvial stream having primarily a sand bed from measured hydraulic variables, the concentration and particle-size distribution of the measured suspended sediment, and the particle-size distribution of the bed material. The computation involves the extrapolation of the measured suspended-sediment discharge to represent the total suspended-sediment discharge and the addition of a computed bedload discharge. The procedure is applicable only if measured data are available so it cannot be used directly for design or predictive purposes. It is intended to be used only at sites where all of the bed material is finer than about 16 millimeters, and it can be used only if a significant part of the measured suspended sediment is composed of particles of the same size as particles in the bed material.

Due to the wide-spread use of the modified Einstein procedure, a number of programs have been written to facilitate computer computations. Programs have been presented by Burkham and others (1977), Chen (1973), and U.S. Bureau of Reclamation (1968). The program presented in this report is designed to follow the computational sequence given by Hubbell and Matejka (1959) and retains limitations implicit in the original Colby and Hembree (1955) paper. As well as being more efficient, the program incorporates several features of the earlier programs. Proper use of the computer program and interpretation of computed results is contingent on knowledge of the modified Einstein procedure. Therefore, potential program users need to familiarize themselves with the historical development and application of the procedure (Einstein, 1950; and Colby and Hembree, 1955).

Two programs are presented. Program MEPDATA allows for keyboard entry of data and storage into a data file. Program MODEIN reads the data from the data file and computes the total sediment discharge by the modified Einstein procedure.

Program listings and examples of output for programs MEPDATA and MODEIN and flow chart for program MODEIN are included in the Supplemental Information Sections A through J at the back of the report.

PROGRAM MEPDATA INPUT

Data are entered by keyboard and stored in a file called MEP.DATA or a user-specified file. Input data are expressed in the foot-pound-second units except for water temperature which is in degrees Celsius, D_{35} and D_{65} which are in millimeters, and suspended-sediment concentration which is in milligrams per liter.

For each computation of total sediment discharge by the modified Einstein procedure the following variables are entered to form a data set:

LOC	- Measurement location (Maximum of 80 characters).
DATE	- Date of measurement (MM/DD/YY).
TIME	- Time of measurement (2400 hour).
DISCH	- Water discharge, in cubic feet per second.
WIDTH	- Top width of cross section, in feet.
DEPTH	- Mean depth in cross section, in feet.
TEMPER	- Water temperature, in degrees Celsius.
ZMEAS	- Variable that indicates whether z values for one or more size ranges will be entered (0 for no or 1 for yes). If one is entered, the program sets REFSIZE = 0 and skips the query for REFSIZE.
REFSIZE	- Reference size selection: 0 for program selection of a single size range. 1-9 for number of the single size range selected by user. -1 for program selection of all suitable size ranges.
PCTZ	- Minimum percentage of both suspended sediment and bed material in a size range for computation of a z value. This value is automatically set to 3 percent when REFSIZE is >=0. When REFSIZE = -1, user is prompted to enter minimum value.
D35	- Particle size at which 35 percent of the bed material by weight is finer, in millimeters. Enter zero for program determination.
D65	- Particle size at which 65 percent of the bed material by weight is finer, in millimeters. Enter zero for program determination.
CONC	- Concentration of measured suspended sediment, in milligrams per liter.
DS	- Average depth at the sampling verticals, in feet.
DN	- Distance between the bottom of the sampled zone and the streambed, in feet.
ZE(9)	- Entered z values for nine size ranges. Values entered when ZMEAS=1. Enter zero for no value.
PIS(9)	- Percent by weight of measured suspended sediment for nine size ranges. Enter zero for no value.

PIB(9) - Percent by weight of bed material for nine size ranges. Enter zero for no value.

Listing of a data file containing six data sets is shown in Section H of the Supplemental Data at the back of the report.

PROGRAM MODEIN OUTPUT

Output from the FORTRAN version of program MODEIN is stored on a file named MEP.OUT or a user-specified file and later printed using the line printer. The page width is 128 columns. The BASIC version directs the output directly to an 80-column line printer.

FORTRAN version outputs from six data sets are shown in Section I. Data for these runs are shown in Section H. The column headings in Section I are self-explanatory except the two columns under the heading "COMPUTATIONAL FACTORS." The heading F(J) is an abbreviation for the ratio $(PJ_1' + J_2')/(PJ_1' + J_2')$, and the heading F(I)+1 is an abbreviation for the quantity $(PI_1'' + I_2'' + 1)$. Entered z values are listed in both the ENTERED and COMP. columns under the heading Z-VALUES. However, values of z computed by trial, from multipliers, or from a regression equation are listed only in the COMP. column. Whenever the z value for a single reference size range is computed by trial, multipliers are listed in the MULT. column (see Section I, page I 1) When z values for more than one reference size range are computed by trial and z values for the other size ranges are determined from a regression equation, the multipliers are set to zero (see Section I, page I 3). Whenever one or more z values are entered, the MULT. column is replaced by an IBQB RATIO column which lists the $i_B Q_B$ adjustment ratios (see Section I, pages I 5 and I 6). Also when more than one z value is computed or entered, the reference size range is designated as "MULTIPLE" and "BY REGRESSION" is printed after the Z SLOPE value (see Section I, pages I 3 and I 5).

PROGRAM MEPDATA DESCRIPTION

The FORTRAN program is organized in the form of a main program called MEPDATA, five executable subroutines, and one BLOCK DATA subprogram (see Section C). The BASIC program (see Section E) contains minor variations from the FORTRAN program because of the differences between the two languages. FORTRAN and BASIC program variable definitions are presented in Section A. The main difference between the two versions is that the FORTRAN data file is random access so that data sets are read and stored individually and the maximum number of data sets in the file is not fixed; whereas, the BASIC data file is sequential access so that all of the data sets are read or stored in a single disk operation and the maximum number of data sets in a file is 30. The BASIC program automatically stores the data in memory after each addition of ten data sets to prevent loss of data.

The program is initiated by opening a data file called MEPDATA or user-named file. A program option code NC is entered which designates; (1) start a new data file, (2) add to an existing data file, (3) correct one or more data sets, (4) list data on screen, or (5) list data on printer. If NC>1 the number of data sets, NSET, is read from the data file, otherwise NSET is set to 0.

When NC=1 or 2, data sets are added as follows:

1. NSET is increased by 1.
2. Subroutine DAIN is called and one set of data is keyboard entered. Section "PROGRAM MEPDATA INPUT" (p. 2) describes the input variables.
3. Subroutine DALIST is called to list the data set on the screen. If the data set is correct, subroutine DAWRITE is called to write the data set on the data file. Program then goes back to step 1 for another data set. When the last data set is completed, the value of NSET is written on record 1 of the data file and the run is terminated.
4. An incorrect data set is either redone by calling subroutine DAIN or corrected by calling subroutine DACORR. In subroutine DACORR, an incorrect data value number from 1 to 24 is entered (see Section H), the current value is shown on the screen, and the correct value is entered. The program then goes back to step 3.

Correction of data sets (NC=3) is as follows:

1. The number of the data set to be corrected is entered. Subroutine DAREAD is called to input the data set from the data file, and subroutine DALIST is called to list the data set on the screen.
2. An incorrect data set is either redone by calling subroutine DAIN or corrected by calling subroutine DACORR.
3. Subroutine DALIST is called to list the corrected data set. If the data set is still not correct, step 2 is repeated. Otherwise, subroutine DAWRITE is called to write the data set on the data file. The program then goes back to step 1.

Listing of data sets on the screen (NC=4) is as follows:

1. The starting and ending numbers of the data sets to be listed are entered.
2. For each data set, subroutine DAREAD is called to input the data set from the data file, and subroutine DALIST is called to list the data set on the screen. The display is held on the screen until a number is entered.

Listing of data sets on the printer (NC=5) is as follows:

1. The starting and ending numbers of the data sets to be printed are entered.

2. For each data set, subroutine DAREAD is called to input the data set from the data file. The data set is then directed to an output file called MEPDATA.LIST in the FORTRAN version of the program, or to a line printer in the BASIC version. The file MEPDATA.LIST is printed using the line printer. The output from a MEPDATA.LIST file containing six data sets is shown in Section H.

PROGRAM MODEIN DESCRIPTION

In the following description, symbols originally used by Colby and Hembree (1955) for the various variables are utilized to facilitate the explanations of the program. If the program uses a variable for which no counterpart modified Einstein procedure symbol exists, the FORTRAN variable name is used in the description. Similarly, equations used in the descriptions are the original modified Einstein procedure equations from Colby and Hembree (1955) or Hubbell and Matejka (1959) unless the equation exists only in the program. In that case, the equation is expressed using the FORTRAN variable names. Definition of all FORTRAN and BASIC variable names, and counterpart modified Einstein procedure symbols, are presented in Section B. The FORTRAN program is organized in the form of a main program called MODEIN, nine executable subprograms, and one BLOCK DATA subprogram (see Section D). Section G presents a flow chart which illustrates the computation procedure. The BASIC program (see Section F) contains minor variations from the FORTRAN program because of the differences between the two languages; however, the FORTRAN program description can be used along with the BASIC variable definitions (Section B) to understand the BASIC program.

Main Program MODEIN

The main program first opens a data file created by program MEPDATA (see p. 3) called MEP.DATA or a user-specified file, reads the number of data sets (NCOMP1) in the file, and sets the data-set counter (NCOMP2) to 0.

The computation procedure for each data set is divided into six parts. Part 1 initializes the program variables, increases the data-set counter by one, sets NRSIZE equal to REFSIZE (-1, 0, or 1-9), and sets the computation flag MODE equal to 1. MODE is a code which directs the computational sequence and determines various output notes. Subroutine INPUT is called to read and check the data from the data file, and to compute several hydraulic variables.

Whenever one or more z values have been entered (ZMEAS=1), ZMEAS is reset to the number of entered z values. Then if ZMEAS=1, NRSIZE is reset to the size range number of the entered z. Otherwise NRSIZE is reset to - 1.

If NRSIZE<1 the program selects the reference size range number having the largest value of COMP2, where:

$$COMP2 = i_{sm} + i_b$$

Size ranges having i_{sm} or i_b values less than 3 percent are rejected in the determination of COMP2. This procedure gives a reference-size range number having the optimum combined percentage of suspended sediment and bed material. NRSIZE is then given the value of the selected size range number. If the previous value of NRSIZE was -1, it is given a negative size range number.

Part 2 calls subroutine SRCOMP to compute $(SR)_m$ with trial values of x. Whenever the number of x-value trials exceeds 15, the computation is terminated, an error message "counter for XBAL exceeded 15" is written, and the program returns to part 1 for the next data set. After a normal return to the main program, values of P, PCTQ, and Q''_{ts} are computed, where:

$$P = 2.303 \log_{10} \frac{30.2\ d\ x}{k_s}.$$

Fraction of flow sampled (PCTQ) $= 1 - A'' \left[\frac{P-1 + \ln A''}{P-1}\right]$ and

$$Q'_{ts} = (PCTQ)\ Q_{sm}.$$

Part 3 computes Q'_s, v_s, and $i_B Q_B$ values for each size range, where:

$$Q'_s = Q'_{ts}\ i_{sm}.$$

The settling velocity of the sediment particles, v_s, is computed by an equation developed by Rubey (1933). The equation has been modified to use kinematic viscosity, ν, rather than dynamic viscosity:

$$V_s = \frac{\sqrt{36.064\ D^3 + (6\nu)^2} - 6\nu}{D}.$$

Values of $i_B Q_B$ for each size range are computed as follows:

Ψ_m is computed from both equations

$$\Psi_m = \frac{1.65\ D_{35}}{(SR)_m} \quad \text{and}$$

$$\Psi_m = \frac{0.66\ D}{(SR)_m},$$

and the larger value of Ψ_m is used to call subroutine FIG10 which determines Φ_*. Then i_BQ_B is computed from:

$$i_Bq_B = 1200\ i_b\ D^{3/2}\ \Phi*/2 \quad \text{then}$$

$$i_BQ_B = i_Bq_B\ 43.2\ w.$$

Whenever the sum of i_BQ_B values for all size ranges is greater than zero, computation continues. Otherwise, computation is terminated, MODE is set to 2, and the program skips to part 6 to write the partially computed results and footnote "I_BQ_B values equal zero. Total discharge equal to measured suspended-sediment discharge" (see Section I, page I 2).

Part 4 determines z values for each size range from 1 or more computed or entered z values. When z values are not entered (ZMEAS=0) and a reference size is selected (NRSIZE=1 to 9), then subroutine COMPZ is called to compute one z value by trial for the indicated reference size range; or, if a reference size is not selected (NRSIZE=-1), then subroutine COMPZ is called to compute z values by trial for each size range for which both i_{sm} and i_b are equal to or greater than the percentage entered as the "z comp limit." If COMPZ returns an error MODE equal to 3, or if no z's are computed and MODE is set to 4, computation is terminated and the program skips to part 6 to write the partially computed results and an error message. The error message for 3 is "No convergence in z computation" and the message for 4 is "No overlap of bed and suspended material."

When ZMEAS>0, subroutine ZMIBQB is called to compute new i_BQ_B values for those size ranges having measured z values and to adjust i_BQ_B values for other size ranges that were computed under part 3.

Next, subroutine ZFIT is called to determine z's for the remaining size ranges. When ZFIT returns an error MODE equal to 5, computation is terminated and the program skips to part 6 to write the partially computed results and an error message "Not enough points for a fit of z values."

Part 5 computes the total sediment discharge (Q_t) for each size range. First Q_t is computed for size ranges smaller than the reference size range by the following steps:

A" and A' are determined from

$$A'' = \frac{2\ D}{d} \text{ and}$$

$$A' = d_n/d_s.$$

Subroutine POWER is called using A" and z to determine J_1'' and J_2''.

Subroutine POWER is called using A' and z to determine J_1' and J_2'.

First Q_t is computed from:

$$Q_t = FJDP\ Q'_s + i_B Q_B$$

where

$$FJDP = \frac{PJ''_1 + J''_2}{PJ'_1 + J'_2}.$$

Next, Q_t is computed for the reference size range and larger size ranges having i_b values greater than zero by these steps:

A" is determined from:

$$A'' = \frac{2\ D}{d}.$$

Subroutine POWER is called using A" and z to determine J''_1 and J''_2.

First I''_1 and I''_2 are computed from:

$$I''_1 = 0.216 \frac{A''^{(z-1)}}{(1-A'')^z} J''_1 \text{ and}$$

$$I''_2 = 0.216 \frac{A''^{(z-1)}}{(1-A'')^z} J''_2.$$

Then Q_t is computed from:

$$Q_t = FIDP\ i_B Q_B$$

where

$$FIDP = PI''_1 + I''_2 + 1.$$

Then, the Q_t value for each size range is compared with the value of $Q_{sm} i_{sm}$. Whenever $Q_{sm} i_{sm}$ is greater than Q_t, Q_t is set equal to $Q_{sm} i_{sm}$, a printing flag ITLD is set to 2, and MODE is set to 6 so that the footnote "Measured suspended-sediment discharge--which exceeds computed discharge (Review computation)" will be written (see Section I, page I 5).

Finally, part 6 writes the computed values. An "*" is printed after the Q_t value for each size range having ITLD = 2 (see Section I, page I 5) and, depending on the value of MODE, the appropriate, previously described footnotes are written. If the data-set counter (NCOMP2) is less than the number of data sets (NCOMP1), the program returns to part 1 for the next data set. The results of the execution of 6 data sets are shown in Section I.

Subroutine INPUT

Subroutine INPUT reads a set of input data from the file called MEP.DATA or a user-specified file. The section "PROGRAM MEPDATA INPUT" (p. 2) details the input data format. The program checks and rejects any data set which contains non-entry (zero values) of six input variables that would produce numeric overflow (∞ values) in latter steps of the program. Data sets also are rejected whenever the percent-in-class-size values for either the suspended sediment or the bed material do not total 100 percent. Whenever a data set is rejected, an error message is written, MODE is set to 10, and control is returned to the main program.

Whenever values for D_{35} or D_{65} are not specified (zero was entered), they are computed using the following procedure:

For D_{35}, values of i_b for each size range starting with the finest size range, are added until the sum (BM) is >=0.35.

Then, using values pertaining to the last included size range:
- X1 is set equal to the logarithm of the lower limit of the size range.
- X2 is set equal to the logarithm of the upper limit of the size range.
- Function subroutine ERRTAB is called using BM minus i_b to determine Y1, the value of ERRTAB for the lower limit of the size range.
- Function subroutine ERRTAB is called using BM to determine Y2, the value of ERRTAB for the upper limit of the size range,

then

$$D_{35} = \text{Antilog} \left[\frac{(-0.39 - Y1)(X2 - S1)}{(Y2 - Y1)} + X1 \right]$$

where

-0.39 is the value of ERRTAB for a probability value of 0.35.

For D_{65}, the same procedure is used except the i_b values are summed until BM is >=0.65, and the constant -0.39 is replaced by 0.39 (the value of ERRTAB for a probability value of 0.65).

Five hydraulic variables are computed as follows:

$$\nu = \frac{0.00002}{1.0334 + 0.03672\ T + 0.0002058\ T^2},$$

$$Q_{sm} = Q\ C_s\ 0.0027,$$

$$A_t = d\ w,$$

$\overline{U} = Q/A_t$, and

$A' = d_n/d_s$,

and the input data plus the five computed variables are written.

Finally, d_{35} and d_{65} are converted from millimeters to feet.

Subroutine SRCOMP

Subroutine SRCOMP sets an initial x value of 1.54 and computes the following three variables:

$$\sqrt{(SR)_m} = \frac{\bar{u}}{32.63 \log10 \dfrac{12.27\ d\ x}{k_s}}$$

$$u_m = \sqrt{(SR)_m}/5.68$$

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

Next, the ratio k_s/δ is used to call subroutine FIG4 to compute a new x value. Computation of the three variables is repeated using the newly computed x value. Control returns to the main program whenever the difference between the new computed x value and the previous x value is less than 0.05. Also, if the number of x-value trials exceeds 15, MODE is set to 10, an error message "counter for XBAL exceeded 15" is written, and control is returned to the main program.

Subroutine FIG4

Subroutine FIG4 uses a series of semilogarithmic equations to approximate Einstein's relation of k_s/δ versus x (Einstein, 1950, fig. 4; and Colby and Hembree, 1955, fig. 44). Based on the value of k_s/δ, the routine selects the appropriate parameters for the equation from arrays created by data statements, and computes the value of x.

Subroutine FIG10

Subroutine FIG10 uses a series of power functions to approximate Einstein's relation of Ψ_* versus Φ_* (Einstein, 1950, fig. 10; and Colby and Hembree, 1955, plate 2). Based on the value of Ψ_m, the routine selects the appropriate parameters from arrays created by data statements, and computes the value of ϕ_*. Ψ_m is the counterpart, in the modified Einstein procedure, of Ψ_*.

Subroutine COMPZ

Subroutine COMPZ determines z for a size range using trial values of z until the following equation is satisfied:

$$\text{Allowable error (TOL)} = 0.216 \frac{A''^{(z-1)}}{(1-A'')^{z}} (PJ_1'' + J_2'') - \frac{Q_s'}{i_B Q_B}.$$

First, the values of A'', $\frac{Q_s'}{i_B Q_B}$, and TOL are computed, where:

$$A'' = \frac{2\,D}{d} \quad \text{and}$$

$$TOL = \frac{Q_s'}{i_B Q_B}\,0.01.$$

An initial z value (ZA) is computed from an equation based on a relation of z versus $\frac{Q_s'}{i_B Q_B}$ (Colby and Hembree, 1955, fig. 46), where:

$$ZA = 1.08 - 0.33 \log 10 \frac{Q_s'}{i_B Q_B} \quad .$$

Next, subroutine POWER is called using A' and ZA to determine J_1' and J_2', then FZA and ERROR are computed from:

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

$$ERROR = FZA - \frac{Q_s'}{i_B Q_B}.$$

If the absolute value of ERROR is less than TOL, z = ZA and control is returned to the main program. Otherwise, ZB is set to ZA ± 0.01 (the sign is the same as the sign of ERROR), FZB is computed by the same procedure as FZA using ZB, and a new value of ZA is determined from:

ZA = ZA ± ZDIFF (The sign is the same as the sign of ERROR)

where

$$ZDIFF = \frac{\left(\frac{Q'_s}{i_B Q_B} - FZA\right)0.01}{FZB - FZA}.$$

Then, new values of FZA and ERROR are computed and ERROR is again compared to TOL. This process is repeated until ERROR<TOL, at which time, z = ZA and control returns to the main program. Whenever the number of ZA value trials exceeds 40, MODE is set to 3 and control reverts back to the main program.

Subroutine ZFIT

Subroutine ZFIT determines z values for size ranges that do not have computed or entered z values. For the usual computation when a single z value has been computed or entered for a reference size range (NRSIZE>0), ZSLOPE is set to 0.7. Then z values are obtained by proportioning the reference size z with multipliers that vary with the 0.7 power of fall velocity.

When z values for more than one size range have been computed or entered (NRSIZE<0), the remaining z values are determined from an equation that is defined by a least-squares regression of log z against log V_s using computed or entered Z values; ZSLOPE is set equal to the slope of the regression line. MODE is set to 5 whenever there is an inadequate number of z values to compute a regression line. Results of computations using the regression procedure for obtaining z values need to be reviewed. A flat slope can give erratic z values for the small and large size ranges. After the determination of z′s, either from multipliers or the regression equation, control is returned to the main program.

Subroutine ZMIBQB

Subroutine ZMIBQB computes revised $i_B Q_B$ values whenever one or more z values are entered. First $i_B Q_B$ values and ratios of $i_B Q_B$ values are computed, as follows, for each size range for which z values have been entered:

Subroutine POWER is called using A' and z to determine J_1' and J_2' and i_BQ_B (new) and ZMULT are computed from:

$$i_BQ_B\ (\text{new}) = \frac{Q_s'}{0.216\ \dfrac{A''(z-1)}{(1-A'')^z}\ (PJ_1' + J_2')} \quad \text{and}$$

$$\text{Ratio (ZMULT)} = \frac{i_BQ_B(\text{new})}{i_BQ_B(\text{old})}$$

where i_BQ_B(old) is the previous i_BQ_B value computed in part 3 of the main program.

Then old i_BQ_B values (computed in part 3) for the remaining size ranges are proportioned by multiplying each value by the appropriate ratio (ZMULT). When one z value is available (a single reference size range is used), ZMULT is the ratio for that size (see Section I, page I 6); when z values for more than one size range have been entered, size ranges finer than the size range for the first entered z are multiplied by the first ZMULT ratio and size ranges coarser than the size range for the last entered z are multiplied by the last ratio (see Section I, page I 5).

Subroutine POWER

Subroutine POWER evaluates the J_1 and J_2 integral functions by a procedure developed by Li (1974). The method, which is based on expanding the integral functions in the form of a power series, has several advantages over the Simpson's-rule method used in previous programs. First, with nearly the same accuracy, the new method requires only one-tenth of the computer time needed to apply Simpson's rule. Second, the desired degree of accuracy can be selected to satisfy the needs of a particular problem. A convergence factor of 0.001 was used in subroutine POWER.

Function Subroutine ERRTAB

Function subroutine ERRTAB determines the value of ERRTAB for a given percent finer value (BM), where ERRTAB is the dimensionless deviation from the mean, express as a multiple of the standard deviation, in the standardized normal probability distribution function.

If BM=0.5 — ERRTAB is set equal to zero and control is returned to the main program

If BM<0.5 BN=BM

If BM>0.5 BN=1.0-BM

then

$$T = \left\{ \mathrm{Log}_e \left[\frac{1.0}{BN^2} \right] \right\}^{1/2} \quad \text{and}$$

$$ERRTAB = T - \left[\frac{2.30753 + 0.27061\ T}{1.0 + 0.99229\ T + 0.04481\ T^2} \right].$$

If BM<0.5 ERRTAB is set to -ERRTAB.

Subprogram BLOCK DATA

BLOCK DATA is a nonexecutable subprogram used to enter the lower limit, upper limit and geometric mean of size ranges; limits are given in millimeters and means are expressed in feet.

REFERENCES CITED

Burkham, D. E., Kroll, C. G., and Porterfield, George, 1977, A guide for application of the computer program for the modified Einstein method of computing total sediment discharge (MODEIN): U.S. Geological Survey Computer Contribution, NTIS PB-262 429/AS, 143 p.

Chen, Y. H., 1973, Mathematical modeling of water and sediment routing in natural channels: Fort Collins, Colorado State University, unpublished Ph.D. dissertation, appendix 6.2, p. 225-230.

Colby, B. R., and Hembree, C. H., 1955, Computations of total sediment discharge, Niobrara River near Cody, Nebraska: U.S. Geological Survey Water-Supply Paper 1357, 187 p.

Einstein, H. A., 1950 [1951], The bed-load function for sediment transportation in open channel flows: U.S. Department of Agriculture Technical Bulletin 1026, 70 p.

Hubbell, D. W., and Matejka, D. Q., 1959, Investigations of sediment transportation Middle Loup River at Dunning, Nebraska: U.S. Geological Survey Water-Supply Paper 1476, 123 p.

Li, R. M., 1974, Mathematical modeling of response from small watersheds: Fort Collins, Colorado State University, unpublished Ph.D. dissertation, appendix A, p. 156-169.

Rubey, W. W., 1933, Settling velocities of gravel, sand, and silt particles: American Journal of Science, 5th series, v. 25, no. 148, p. 332.

U.S. Bureau of Reclamation, 1969, Guide for application of total sediment load computer program: Denver, 11 p.

SUPPLEMENTAL DATA--SECTION A.

DEFINITION OF PROGRAM MEPDATA VARIABLES

PROGRAM FORTRAN	PROGRAM BASIC	DEFINITION
		VARIABLES IN COMMON BLOCK /AA/
DATE	DATE$	Date of measurement (MM/DD/YY)
LOC	LO$	Location of measurement
NREC	--	Random file record number
SIZE	SIZE	Array of values for measured z values, percent suspended material, and percent bed material by size class
SIZEHI	SIZEHI	Upper limit of a particle-size range, in millimeters
SIZELO	SIZELO	Lower limit of a particle-size range, in millimeters
VAL	VAR	Array of values for 10 input variables
		VARIABLES IN MAIN PROGRAM NOT IN COMMON BLOCK /AA/
DFILE	DFILE$	Data file name
I	I	Loop counter
J	J	Loop counter
NC	NC	Program option flag
NR	NR	Variable number in data set (1-24)
NS	--	Data set counter
NS1	--	Start data set number to list or print
NS2	--	End data set number to list or print
NSET	NO	Number of data sets--maximum is 30 in BASIC program
--	N	Loop counter
--	ND	Data set counter to store data after each ten entered data sets
		VARIABLES IN SUBROUTINE DAIN NOT IN COMMON BLOCK /AA/
DA	I	Z computation limit option
I	I	Loop counter
ZI	ZI	Measured z input option
ZR	ZR	Reference size selection option
		VARIABLES IN SUBROUTINE DAWRITE NOT IN COMMON BLOCK /AA/
I	I	Loop counter
J	--	Loop counter
--	N	Data set counter
--	NO	Number of data sets

PROGRAM		DEFINITION
FORTRAN	BASIC	
		VARIABLES IN SUBROUTINE DAREAD NOT IN COMMON BLOCK /AA/
I	--	Loop counter
J	--	Loop counter
--	N	Data set counter
--	NO	Number of data sets
		VARIABLES IN SUBROUTINE DACORR NOT IN COMMON BLOCK /AA/
I	I	Loop counter
L	L	Loop counter
NSET	N	Data set number
--	NO	Number of data sets
		VARIABLES IN SUBROUTINE DALIST NOT IN COMMON BLOCK /AA/
I	I	Loop counter
J	--	Loop counter
L1	NR	Variable number in data set
L2	--	Variable number in data set
NSET	N	Data set number
--	NO	Number of data sets

SUPPLEMENTAL DATA--SECTION B.

DEFINITION OF PROGRAM MODEIN VARIABLES

PROGRAM FORTRAN	PROGRAM BASIC	MODIFIED EINSTEIN SYMBOL	DEFINITION
			VARIABLES IN COMMON BLOCK /AA/
APRIME	APRIME	A'	Value of d_n/d_s
AREA	AREA	--	Cross-sectional area, in square feet
CONC	CONC	C_S	Concentration of measured suspended sediment, milligrams per liter
D35	D35	D_{35}	Particle size at which 35 percent of the bed material by weight is finer, in feet (input and output is in millimeters)
D65	D65	D_{65} & k_s	Particle size at which 65 percent of the bed material by weight is finer, in feet (input and output is in millimeters)
DEPTH	DEPTH	d	Mean depth in cross section, in feet
DISCH	DISCH	Q	Water discharge, in cubic feet per second
MODE	MODE	--	Error indicating flag
PCTZ	PCTZ	--	Minimum percentage of both suspended sediment and bed material in a size range for computation of a z value
QSM	QSM	Q_{sm}	Measured suspended-sediment discharge of all size ranges, in tons per day
SUM	SUM	--	Array of sums of PIS, PIB, BIBQB, QPRIMS, and TOTALD of all sizes
UBAR	UBAR	$\bar{u}$	Average velocity of flow, in feet per second
VISC	VISC		Kinematic viscosity, in square feet per second
WIDTH	WIDTH	w	Top width of cross section, in feet
			VARIABLES IN COMMON BLOCK /BB/
BIBQB	BIBQB	I_BQ_B	Sediment discharge through the bed layer of particles of a size range, in tons per day
DIAM	DIAM	D	Geometric mean diameter of a size range, in feet
PIB	PIB	i_b	Fraction by weight of bed material in a size range (input is in percent)
PIS	PIS	i_{sm}	Fraction by weight of measured suspended sediment in a size range, (input is in percent)
PVALUE	PVALUE	P	A parameter

PROGRAM		MODIFIED EINSTEIN SYMBOL	DEFINITION
FORTRAN	BASIC		
			VARIABLES IN COMMON BLOCK /BB/--Continued
QPRIMS	QPRIMS	Q'_s	Suspended-sediment discharge of a size range in the sampled zone, in tons per day
SIZEHI	SIZEHI	--	Upper limit of a particle-size range, in millimeters
SIZELO	SIZELO	--	Lower limit of a particle-size range, in millimeters
			VARIABLES IN COMMON BLOCK /CC/
NRSIZE	NRSIZE	--	Reference size range number
NSR	NSR	--	Number of size ranges
VS	VS	V_s	Fall velocity of the geometric-mean particle size of a size range, in feet per second
ZC	ZC	z_2	Value of z for a size range computed by trial, from multipliers, or from a regression equation
ZE	ZE	z_2	Entered z value for a size range
MEAS	ZMEAS	--	Option to enter z's for one or more size ranges (0 for no, or 1 for yes)
ZMULT	ZMULT	MULT	Multipliers for computing z's for each size range from a reference size z value, or a factor for adjusting $i_B Q_B$ values when z values are entered
ZSLOPE	ZSLOPE	--	Slope of a linear relation between z's and the fall velocities of the geometric mean particle size of corresponding size ranges (normally is equal to 0.7)
			VARIABLES IN MAIN PROGRAM NOT IN COMMON BLOCKS /AA/, /BB/, /CC/
ADP	ADP	A"	Value of 2D/d
COEFF	COEFF	--	Coefficient to convert J values to I values
COMP1	COMP1	--	Temporary computation value
COMP2	COMP2	--	Temporary computation value
CONST	CONST	Q'_{ts}	Total suspended-sediment discharge through the sampled zone, in tons per day
DFILE	DFILE$	--	Data file name
FIDP	FIDP	--	Abbreviation for the value of $PI_1'' + I_2'' + 1$ for a size range

PROGRAM FORTRAN	PROGRAM BASIC	MODIFIED EINSTEIN SYMBOL	DEFINITION
VARIABLES IN MAIN PROGRAM NOT IN COMMON BLOCKS /AA/, /BB/, /CC/--Continued			
FJDP	FJDP	--	Abbreviation for the value of $(PJ_1'' + J_2'')$ / $(PJ_1' + J_2')$ for a size range
ITLD	ITLD	--	Total sediment discharge code (1 for computed or 2 for measured suspended sediment)
J	J	--	Temporary counter
K	K	--	Size range loop index
N1	N1	--	Reference size range number
NCOMP1	NCOMP1	--	Number of data sets
NCOMP2	NCOMP2	--	Counter for data sets
OFILE	--	--	Output file name
PCTQ	PCTQ	--	Fraction of flow in sampled zone
PHI	PHI	Φ_*	Intensity of bedload transport for a size range
PSI	PSI	Ψ_m	Function for correlating effect of flow with intensity of sediment transport for a size range. The greater of 1.65 $D_{35}/(SR)_m$ or 0.66 $D/(SR)_m$
QMEAS	QMEAS	Q_s	Suspended-sediment discharge of a size range, in tons per day
RSL	RSL	--	Lower limit of reference size range, in millimeters
RSH	RSH	--	Upper limit of reference size range, in millimeters
SHEAR	SHEAR	--	Value of 1.65 $D_{35}/(SR)_m$
SR	SR	$(SR)_m$	Quantity computed from velocity equation and measured average velocity in the cross section
TOTLD	TOTLD	Q_t	Total sediment discharge of a size range, in tons per day
UNITBD	UNITBD	i_Bq_B	Sediment discharge per unit width through the bed layer of particles of a size range, in pounds per foot of width
VALJ1	FJ1	J_1	Value of J_1' or J_1''
VALJ2	FJ2	J_2	Value of J_2' or J_2''
XR	XR	x	Dimensionless transition parameter
Z	Z	z_2	Value of z for a size range
ZS	ZS	--	Sum of computed z's for all size ranges
--	R$	--	Error message or footnote (formatted in FORTRAN program)

PROGRAM FORTRAN	PROGRAM BASIC	MODIFIED EINSTEIN SYMBOL	DEFINITION
			VARIABLES IN SUBROUTINE INPUT NOT IN COMMON BLOCKS /AA/, /BB/, /CC/
BM	BM	--	Equal to SUMBED
COMP1	COMP1	--	Temporary computation value
DATE	DATE$	--	Date of measurement (MM/DD/YY)
DN	DN	d_n	Distance between the bottom of the sampled zone and the streambed, in feet
DS	DS	d_s	Average depth at the sampling verticles, in feet
ERRTAB	ERRTAB	--	Function subroutine variable for the dimensionless deviation from the mean in the standardized normal probability distribution function
IND	IND	--	Indicating flag
ITIME	--	--	Integer value of TIME for printing
K	K	--	Size range loop index
LOC	LO$	--	Location of data set
PCT	PCT	--	Temporary value of D_{35} or D_{65}
REFSIZE	NRSIZE	--	Entered reference size range number (-1 for none, 0 for program determination, or 1-10 for designated reference size)
SUMBED	SUMBED	--	Sum of i_b values, starting with the finist size range
TEMPER	TEMPER	T	Water temperature, in degrees Celsius
TIME	TIME	--	Time of measurement (2400)
X1	X1	--	Log of lower limit of a particle-size range
X2	X2	--	Log of upper limit of a particle-size range
Y1	Y1	--	x value for lower limit of a particle-size range
Y2	Y2	--	x value for upper limit of a particle-size range
			VARIABLES IN SUBROUTINE SRCOMP NOT IN COMMON BLOCK /AA/
BSDELT	BSDELT	--	Value of D_{65}/δ
COMP1	COMP1	--	Temporary computation value
DELTA	DELTA	δ	Thickness of laminar sublayer
ERROR	ERROR	--	Absolute value of X-XCT
NUM	NUM	--	Iteration counter
SGRAD	SGRAD	$\sqrt{(SR)_m}$	Value of $\sqrt{(SR)_m}$

PROGRAM FORTRAN	PROGRAM BASIC	MODIFIED EINSTEIN SYMBOL	DEFINITION
			VARIABLES IN SUBROUTINE SRCOMP NOT IN COMMON BLOCK /AA/--Continued
SR	SR	$(SR)_m$	Quantity computed from velocity equation and measured average velocity in the cross section
UPRIME	UPRIME	u_m	Shear velocity, in feet per second
X	X	x	Dimensionless transition parameter
XCT	XCT	--	Previous value of x
			VARIABLES IN SUBROUTINE FIG4
I	--	--	Counter for values in array FX
--	I	--	Counter for values in array FIG4
FA	--	--	Intercept of a linear equation between FX values
FB	--	--	Slope of a linear equation between FX values
FX	--	--	Values of k_s/δ at endpoints of straight-line segment used to approximate Einstein's relation of k_s/δ versus x
--	FIG4	--	Array containing values of k_s/δ at endpoints, intercepts, and slopes of straight-line segments used to approximate Einstein's relation of k_s/δ versus x
X	BSDELT	k_s/δ	Value of D_{65}/δ
Y	X	x	Dimensionless transition parameter
			VARIABLES IN SUBROUTINE FIG10
I	--	--	Counter for values in array FX
--	I	--	Counter for values in array FIG10
FA	--	--	Intercept of a linear equation between FX values
FB	--	--	Slope of a linear equation between FX values
FX	--	--	Values of Ψ_m at endpoints of straight-line segment used to approximate Einstein's relation of Ψ_m versus $\Phi*$
--	FIG10	--	Array containing values of Ψ_m at endpoints, intercepts, and slopes of straight-line segments used to approximate Einstein's relation of Ψ_m versus $\Phi*$

PROGRAM FORTRAN	PROGRAM BASIC	MODIFIED EINSTEIN SYMBOL	DEFINITION
			VARIABLES IN SUBROUTINE FIG10--Continued
X	PSI	Ψ_m	Function for correlating effect of flow with intensity of sediment transport for a size range
Y	PHI	Φ_*	Intensity of bed-load transport for a size range
			VARIABLES IN SUBROUTINE COMPZ NOT IN COMMON BLOCKS /AA/, /BB/
ADP	ADP	A"	Value of 2D/d
COEFF	COEFF	--	Coefficient to convert J values to I values
CONST	CONST	--	Value of $Q_s'/i_B Q_B$
ERROR	ERROR	--	Value of FZA-CONST
FCTR	FCTR	--	The sign of ERROR times 1.0
FZA	FZA	--	Value of I_1''/J_1'' $(PJ_1' + J_2')$ for z value ZA
FZB	FZB	--	Value of I_1''/J_1'' $(PJ_1' + J_2')$ for z value ZB
KOUNT	KOUNT	--	Iteration counter
L	I9	--	Size-range loop index
TOL	TOL	--	Maximum allowable value of ERROR to stop z computation
VALJ1	FJ1	J_1	Value of J_1' or J_1''
VALJ2	FJ2	J_2	Value of J_2' or J_2''
Z	Z	z_2	Value of z for a size range
ZA	ZA	--	Value of first computed z
ZB	ZB	--	Value of second computed z
ZDIFF	ZDIFF	--	Value added or subtracted to the previous value of ZA to determine the new value of ZA
			VARIABLES IN SUBROUTINE ZFIT NOT IN COMMON BLOCKS /AA/, /CC/
AINT	AINT	--	Log of intercept in regression equation of the relation of z versus fall velocity
K	K	--	Size-range loop index
NUM	NUM	--	Number of size ranges that have computed z values
RS	RS	--	Fall velocity of geometric mean size for the reference size range, in feet per second
SE	SE	--	Value of z for reference size range
SMALA	SMALA	--	Antilog of AINT
SUMXY	SUMXY	--	Sum of XLN * YLN values

PROGRAM FORTRAN	PROGRAM BASIC	MODIFIED EINSTEIN SYMBOL	DEFINITION
			VARIABLES IN SUBROUTINE ZFIT NOT IN COMMON BLOCKS /AA/, /CC/--Continued
SUMXSQ	SUMXSQ	--	Sum squares of XLN values
XLN	XLN	--	Log of fall velocity of geometric mean size of a size range
XMEAN	XMEAN	--	Mean of XLM values
XZ	XZ	--	The 0.7 power of the ratio of the fall velocity for a size range to the fall velocity for the reference size range
YLN	YLN	--	Log of z of a size range
YMEAN	YMEAN	--	Mean of YLN values
			VARIABLES IN SUBROUTINE ZMIBQB NOT IN-COMMON BLOCKS /AA/, /BB/, /CC/
ADP	ADP	A"	Value of 2D/d
COEFF	COEFF	--	Coefficient to convert J values to I values
COMP1	COMP1	--	Temporary computation value
COMP2	COMP2	--	Temporary computation value
J	J	--	Temporary counter
K	K	--	Size-range loop index
NZ	NZ	--	Temporary counter
VALJ1	FJ1	J_1	Value of J_1' or J_1''
VALJ2	FJ2	J_2	Value of J_2' or J_2''
Z1	Z	z_2	Value of z for a size range
			VARIABLES IN SUBROUTINE POWER
A	A	A' or A"	Value of d_n/d_s or 2D/d
AEX	AEX	--	Value of A^E
ALG	ALG	--	Natural log of A
C	C	--	Series solution term
CJ1	CJ1	--	Absolute value of (1-XJ1/FJ1)
CJ2	CJ2	--	Absolute value of (1-XJ2/FJ2)
D	D	--	Series solution term
E	E	--	Series solution term
FJ1	FJ1	J_1	Value of J_1' or J_1''
FJ2	FJ2	J_2	Value of J_2' or J_2''
FN	NN	--	Real value of n
N	N	--	Iteration counter
XJ1	XJ1	--	Previous computed value of J_1' or J_1''
XJ2	XJ2	--	Previous computed value of J_2' or J_2''
Z	Z	z_2	Value of z for a size range

PROGRAM FORTRAN	PROGRAM BASIC	MODIFIED EINSTEIN SYMBOL	DEFINITION
			VARIABLES IN SUBROUTINE ERRTAB
BM	BM	--	Sum of bed material by size fraction
BN	BN	--	Equal to BM
ERRTAB	ERRTAB	--	Function subroutine variable for the dimensionless deviation from the mean in the standardized normal probability distribution function
T	T	--	Temporary computation value

SUPPLEMENTAL DATA--SECTION C.

FORTRAN PROGRAM MEPDATA LISTING

```
      PROGRAM MEPDATA
C
C     ENTER MODIFIED EINSTEIN PROCEDURE DATA TO INPUT FILE MEP.DATA
C              OR USER SPECIFIED FILE.
C
      COMMON /AA/ LOC,DATE,VAL(13),SIZE(9,3),SIZELO(9),SIZEHI(9),
     1 LABEL(15),NREC
      CHARACTER*80 LOC
      CHARACTER*10 DATE,DFILE
      CHARACTER*5 LABEL
    1 FORMAT (I3)
    2 FORMAT (1H1,'NUMBER DATA SETS = ',I3 //)
    3 FORMAT (1H ,2I4,4X,A5,4X,A80)
    4 FORMAT (1H ,2I4,4X,A5,4X,A10)
    5 FORMAT (1H ,2I4,4X,A5,4X,F10.3)
    6 FORMAT (1H ,2I4,4X,2F9.3,F10.3,2F6.0)
    7 FORMAT (A10)
    8 FORMAT (1H ,'DATA STORED ON FILE  ',A10 / )
    9 FORMAT ('ENTER SET NUMBER   MAX =',I4,'   0 TO END')
   10 FORMAT ('NUMBER DATA SETS =',I4)
   11 FORMAT ('ENTER START SET NUMBER   MAX =',I4)
   12 FORMAT ('ENTER END SET NUMBER   MAX =',I4)
      DFILE='MEP.DATA'
      WRITE (1,*) 'ENTER CODE FOR DATA FILE NAME:'
      WRITE (1,*) '      1 TO USE MEP.DATA'
      WRITE (1,*) '      2 TO ENTER FILE NAME'
      READ (1,*) I
      IF (I.LT.2) GO TO 50
      WRITE (1,*) 'ENTER FILE NAME'
      READ (1,7) DFILE
   50 WRITE (1,*) 'ENTER:  1-START  2-ADD  3-CORRECT  4-LIST  5-PRINT'
      READ (1,*) NC
      IF (NC.EQ.1) GO TO 100
      OPEN (10,FILE=DFILE,STATUS='OLD',ACCESS='DIRECT',RECL=40)
      READ (10,REC=1) NSET
      GO TO (100,70,200,300,400),NC
C     ADD DATA TO EXISTING FILE
   70 NREC=NSET*5+1
      GO TO 120
C     START NEW FILE
  100 NSET=0
      NREC=1
      OPEN (10,FILE=DFILE,STATUS='NEW',ACCESS='DIRECT',RECL=40)
      GO TO 120
  110 WRITE (1,*) 'INPUT MORE DATA:  1 FOR YES  2 FOR NO'
      READ (1,*) I
      IF (I.GT.1) GO TO 180
```

```
  120 NSET=NSET+1
  130 CALL DAIN
  140 CALL DALIST (NSET)
      WRITE (1,*) '                  '
      WRITE (1,*) '   1 FOR DATA OK'
      WRITE (1,*) '   2 TO RE-ENTER COMPLETE SET OF DATA'
      WRITE (1,*) '   3 TO CORRECT PART OF DATA SET'
        ITE (1,*) 'ENTER NUMBER'
      READ (1,*) I
      GO TO (160,130,150),I
  150 CALL DACORR (NSET)
      GO TO 140
  160 CALL DAWRITE
      GO TO 110
  180 WRITE (1,10) NSET
      WRITE (10,REC=1) NSET
  190 CLOSE (10)
      WRITE (1,*) '   END OF RUN'
      CALL EXIT
C     CORRECT DATA
  200 WRITE (1,9) NSET
      READ (1,*) NS
      IF (NS.EQ.0) GO TO 190
      IF (NS.GT.NSET) GO TO 200
      NREC=(NS-1)*5+1
      CALL DAREAD
      CALL DACORR (NS)
      NREC=(NS-1)*5+1
      CALL DAWRITE
      GOTO 200
C     LIST DATA ON SCREEN
  300 WRITE (1,11) NSET
      READ (1,*) NS1
      IF (NS1.GT.NSET) GO TO 300
      NREC=(NS1-1)*5+1
  310 WRITE (1,12) NSET
      READ (1,*) NS2
      IF (NS2.GT.NSET) GO TO 310
      DO 320 NS=NS1,NS2
      CALL DAREAD
      CALL DALIST (NS)
      WRITE (1,*) 'ENTER NUMBER TO CONTINUE'
      READ (1,*) I
  320 CONTINUE
      GO TO 190
C     LIST DATA ON PRINTER
C     OUTPUT IS ON FILE MEPDATA.LIST
  400 WRITE (1,11) NSET
      READ (1,*) NS1
```

```
      IF (NS1.GT.NSET) GO TO 400
      NREC=(NS1-1)*5+1
  410 WRITE (1,12) NSET
      READ (1,*) NS2
      IF (NS2.GT.NSET) GO TO 410
      OPEN (11,FILE='MEPDATA.LIST',STATUS='NEW')
      WRITE (11,2) NSET
      DO 480 NS=NS1,NS2
      CALL DAREAD
      NR=1
      WRITE (11,3) NS,NR,LABEL(1),LOC
      NR=2
      WRITE (11,4) NS,NR,LABEL(2),DATE
      DO 430 I=1,13
      NR=NR+1
      WRITE (11,5) NS,NR,LABEL(NR),VAL(I)
  430 CONTINUE
      DO 450 I=1,9
      NR=NR+1
      WRITE (11,6) NS,NR,SIZELO(I),SIZEHI(I),(SIZE(I,J),J=1,3)
  450 CONTINUE
  480 CONTINUE
      CLOSE (11)
      GO TO 190
      END
```

```
      BLOCK DATA
      COMMON /AA/ LOC,DATE,VAL(13),SIZE(9,3),SIZELO(9),SIZEHI(9),
     1 LABEL(15),NREC
      CHARACTER*80 LOC
      CHARACTER*10 DATE
      CHARACTER*5 LABEL
      DATA LABEL /'  LOC',' DATE',' TIME','DISCH','WIDTH','DEPTH',
     1' TEMP','ZMEAS',' REFZ',' PCTZ','  D35','  D65',' CONC','   DS',
     2'   DN'/
      DATA SIZELO /0.002,0.062,0.125,0.25,0.5,1.,2.,4.,8./
      DATA SIZEHI /0.062,0.125,0.25,0.5,1.,2.,4.,8.,16./
      END
```

```
      SUBROUTINE DAIN
C     INPUT ONE SET OF DATA
      COMMON /AA/ LOC,DATE,VAL(13),SIZE(9,3),SIZELO(9),SIZEHI(9),
     1 LABEL(15),NREC
      CHARACTER*80 LOC
      CHARACTER*10 DATE
```

```
      CHARACTER*5 LABEL
    1 FORMAT (A80)
    2 FORMAT (A10)
    3 FORMAT (F10.0)
    4 FORMAT ('ENTER Z VALUE FOR ',F6.3,' TO ',F6.3,'  (0 FOR NONE)')
    5 FORMAT ('ENTER % SUSP MATERIAL FOR ',F6.3,' TO ',F6.3,
     1 '   (0 FOR NONE)')
    6 FORMAT ('ENTER % BED MATERIAL FOR ',F6.3,' TO ',F6.3,
     1 '   (0 FOR NONE)')
      WRITE (1,*) 'ENTER LOCATION NAME (MAX 80 CHARACTERS)'
      READ (1,1,ERR=999) LOC
      WRITE (1,*) 'ENTER MEASUREMENT DATE (MM/DD/YY)'
      READ (1,2,ERR=999) DATE
      WRITE (1,*) 'ENTER MEASUREMENT TIME  (2400 HR)'
      READ (1,3,ERR=999) VAL(1)
      WRITE (1,*) 'ENTER WATER DISCHARGE (CFS)'
      READ (1,3,ERR=999) VAL(2)
      WRITE (1,*) 'ENTER TOP WIDTH (FEET)'
      READ (1,3,ERR=999) VAL(3)
      WRITE (1,*) 'ENTER AVERAGE DEPTH (FEET)'
      READ (1,3,ERR=999) VAL(4)
      WRITE (1,*) 'ENTER WATER TEMPERATURE (DEG C)'
      READ (1,3,ERR=999) VAL(5)
      WRITE (1,*) 'INPUT Z VALUES: ENTER 0 FOR NO OR 1 FOR YES'
      READ (1,3,ERR=999) ZI
      VAL(6)=ZI
      ZR=0
      IF (ZI.GT.0.0) GO TO 70
      WRITE (1,*) 'REFERENCE SIZE SELECTION.  ENTER:'
      WRITE(1,*)'     0 FOR PROGRAM SELECTION OF A SINGLE SIZE RANGE'
      WRITE (1,*) '   1-9 FOR NUMBER OF THE SELECTED SIZE RANGE'
      WRITE (1,*) '    -1 FOR PROGRAM SELECTION OF ALL SUITABLE SIZE RAN
     1GES'
      READ (1,3,ERR=999) ZR
   70 VAL(7)=ZR
      DA=3
      IF (ZR.GE.0.0) GO TO 80
      WRITE (1,*) 'ENTER Z COMP LIMIT (1-3%)'
      READ (1,3,ERR=999) DA
   80 VAL(8)=DA
      WRITE (1,*) 'ENTER D35 (MM) - 0 FOR PROGRAM DETERMINATION'
      READ (1,3,ERR=999) VAL(9)
      WRITE (1,*) 'ENTER D65 (MM) - 0 FOR PROGRAM DETERMINATION'
      READ (1,3,ERR=999) VAL(10)
      WRITE (1,*) 'ENTER SUSPENDED SEDIMENT CONC. (MG/L)'
      READ (1,3,ERR=999) VAL(11)
      WRITE (1,*) 'ENTER AVERAGE DEPTH AT SAMPLED VERTICALS (FT)'
      READ (1,3,ERR=999) VAL(12)
```

```
      WRITE (1,*) 'ENTER DISTANCE BETWEEN BOTTOM SAMPLED ZONE AND BED (F
     1T)'
      READ (1,3,ERR=999) VAL(13)
      DO 110 I=1,9
      SIZE(I,1)=0.0
      IF (ZI.EQ.0.0) GO TO 90
      WRITE (1,4) SIZELO(I),SIZEHI(I)
      READ (1,3,ERR=999) SIZE(I,1)
   90 WRITE (1,5) SIZELO(I),SIZEHI(I)
      READ (1,3,ERR=999) SIZE(I,2)
      WRITE (1,6) SIZELO(I),SIZEHI(I)
      READ (1,3,ERR=999) SIZE(I,3)
  110 CONTINUE
      RETURN
  999 WRITE (1,*) 'STOPPED ON INPUT ERROR'
      ENDFILE (10)
      CLOSE (10)
      CALL EXIT
      END


      SUBROUTINE DAWRITE
C     WRITE ONE SET OF DATA TO FILE
      COMMON /AA/ LOC,DATE,VAL(13),SIZE(9,3),SIZELO(9),SIZEHI(9),
     1 LABEL(15),NREC
      CHARACTER*80 LOC
      CHARACTER*10 DATE
      CHARACTER*5 LABEL
      NREC=NREC+1
      WRITE (10,REC=NREC) LOC
      NREC=NREC+1
      WRITE (10,REC=NREC) DATE
      NREC=NREC+1
      WRITE (10,REC=NREC) (VAL(I),I=1,13)
      NREC=NREC+1
      WRITE (10,REC=NREC) ((SIZE(I,J),J=1,3),I=1,5)
      NREC=NREC+1
      WRITE (10,REC=NREC) ((SIZE(I,J),J=1,3),I=6,9)
      RETURN
      END


      SUBROUTINE DAREAD
C     READ ONE SET OF DATA FROM FILE
      COMMON /AA/ LOC,DATE,VAL(13),SIZE(9,3),SIZELO(9),SIZEHI(9),
     1 LABEL(15),NREC
      CHARACTER*80 LOC
```

```
      CHARACTER*10 DATE
      CHARACTER*5 LABEL
      NREC=NREC+1
      READ (10,REC=NREC,ERR=100,END=200) LOC
      NREC=NREC+1
      READ (10,REC=NREC,ERR=100,END=200) DATE
      NREC=NREC+1
      READ (10,REC=NREC,ERR=100,END=200) (VAL(I),I=1,13)
      NREC=NREC+1
      READ (10,REC=NREC,ERR=100,END=200) ((SIZE(I,J),J=1,3),I=1,5)
      NREC=NREC+1
      READ (10,REC=NREC,ERR=100,END=200) ((SIZE(I,J),J=1,3),I=6,9)
      RETURN
  100 WRITE (1,*) 'ENDING WITH READ ERROR'
      CLOSE (10)
      CALL EXIT
  200 WRITE (1,*) 'STOPPED AT END-OF-FILE'
      CLOSE (10)
      CALL EXIT
      END


      SUBROUTINE DACORR (NSET)
C     CORRECT ONE SET OF DATA
      COMMON /AA/ LOC,DATE,VAL(13),SIZE(9,3),SIZELO(9),SIZEHI(9),
     1 LABEL(15),NREC
      CHARACTER*80 LOC
      CHARACTER*10 DATE
      CHARACTER*5 LABEL
    2 FORMAT (A80)
    3 FORMAT (A10)
    4 FORMAT (F10.3)
    5 FORMAT (F10.0)
  100 CALL DALIST (NSET)
      WRITE (1,*) 'ENTER VALUE NUMBER (1-24)  0 TO END'
      READ (1,*) L
      IF (L.EQ.0) RETURN
      IF (L.GT.24) GO TO 100
      IF (L.GT.1) GO TO 120
      WRITE (1,*) 'OLD LOCATION NAME IS '
      WRITE (1,2) LOC
      WRITE (1,*) 'ENTER NEW LOCATION NAME'
      READ (1,2) LOC
      GOTO 100
  120 IF (L.GT.2) GO TO 130
      WRITE (1,*) 'OLD MEASUREMENT DATE IS '
      WRITE (1,3) DATE
      WRITE (1,*) 'ENTER NEW MEASUREMENT DATE'
```

```
      READ (1,3) DATE
      GO TO 100
  130 IF (L.GT.15) GO TO 140
      I=L-2
      WRITE (1,*) 'OLD VALUE IS '
      WRITE (1,4) VAL(I)
      WRITE (1,*) 'ENTER NEW VALUE'
      READ (1,5) VAL(I)
      GO TO 100
  140 I=L-15
  150 WRITE (1,*) 'ENTER:  1-Z VAL  2-% SUSP  3-% BED  OR 0 TO END'
      READ (1,*) L
      IF (L.EQ.0) GO TO 100
      IF (L.GT.3) GO TO 150
      IF (L.GT.1) GO TO 160
      WRITE (1,*) 'OLD VALUE IS '
      WRITE (1,4) SIZE(I,L)
      WRITE (1,*) 'ENTER NEW VALUE'
      READ (1,5) SIZE(I,L)
      GO TO 150
  160 WRITE (1,*) 'OLD VALUE IS '
      WRITE (1,5) SIZE(I,L)
      WRITE (1,*) 'ENTER NEW VALUE'
      READ (1,5) SIZE(I,L)
      GOTO 150
      END


      SUBROUTINE DALIST (NSET)
C     LIST ONE SET OF DATA ON SCREEN
      COMMON /AA/ LOC,DATE,VAL(13),SIZE(9,3),SIZELO(9),SIZEHI(9),
     1 LABEL(15),NREC
      CHARACTER*80 LOC
      CHARACTER*10 DATE
      CHARACTER*5 LABEL
    1 FORMAT ('SET NUMBER',I4)
    2 FORMAT (I2,2X,A5,1X,A80)
    3 FORMAT (I2,2X,A5,4X,A10,6X,I2,2X,A5,F10.0)
    4 FORMAT (I2,2X,A5,F10.3,10X,I2,2X,A5,F10.3)
    5 FORMAT (I2,2F9.3,F8.2,2F6.0)
      WRITE (1,1) NSET
      L1=1
      WRITE (1,2) L1,LABEL(L1),LOC
      L1=2
      L2=3
      WRITE (1,3) L1,LABEL(L1),DATE,L2,LABEL(L2),VAL(1)
      DO 50 I=2,13,2
      L1=L1+2
```

```
      L2=L2+2                                                           LIST 210
      WRITE (1,4) L1,LABEL(L1),VAL(I),L2,LABEL(L2),VAL(I+1)             LIST 220
   50 CONTINUE                                                          LIST 230
      DO 60 I=1,9                                                       LIST 240
      L2=L2+1                                                           LIST 250
      WRITE (1,5) L2,SIZELO(I),SIZEHI(I),(SIZE(I,J),J=1,3)              LIST 260
   60 CONTINUE                                                          LIST 270
      RETURN                                                            LIST 280
      END                                                               LIST 290
```

SUPPLEMENTAL DATA--SECTION D.

FORTRAN PROGRAM MODEIN LISTING

```
C     PROGRAM MODEIN
C
C     COMPUTE TOTAL SEDIMENT DISCH BY THE MODIFIED EINSTEIN PROCEDURE
C
C     INPUT DATA IS READ FROM FILE MEP.DATA OR USER NAMED FILE
C     OUTPUT IS WRITTEN ON FILE MEP.OUT OR USER NAMED FILE
C
C     SUBPROGRAMS CALLED:
C          INPUT
C          SRCOMP
C          FIG4
C          FIG10
C          COMPZ
C          ZFIT
C          ZMIBQB
C          POWER
C          ERRTAB
C
      COMMON /AA/ APRIME,AREA,CONC,D35,D65,DEPTH,DISCH,MODE,PCTZ,QSM,
     1 SUM(5),UBAR,VISC,WIDTH
      COMMON /BB/ BIBQB(9),DIAM(9),PIB(9),PIS(9),PVALUE,QPRIMS(9),
     1 SIZEHI(9),SIZELO(9)
      COMMON /CC/ NRSIZE,NSR,VS(9),ZC(9),ZE(9),ZMEAS,ZMULT(9),ZSLOPE
      DIMENSION FIDP(9),FJDP(9),ITLD(9),TOTLD(9)
      CHARACTER*10 DFILE,OFILE
C
C     PROGRAM VARIABLES ARE INITIALIZED.
C
      DFILE='MEP.DATA'
      WRITE (1,*) 'ENTER CODE FOR DATA FILE NAME'
      WRITE (1,*) '      1 TO USE MEP.DATA'
      WRITE (1,*) '      2 TO ENTER FILE NAME'
      READ (1,*) I
      IF (I.LT.2) GO TO 2
      WRITE (1,*) 'ENTER DATA FILE NAME'
      READ (1,620) DFILE
    2 OPEN (5,FILE=DFILE,STATUS='OLD',FORM='UNFORMATTED')
      OFILE='MEP.OUT'
      WRITE (1,*) 'ENTER CODE FOR OUTPUT FILE NAME'
      WRITE (1,*) '      1 TO USE MEP.OUT'
      WRITE (1,*) '      2 TO ENTER FILE NAME'
      READ (1,*) I
      IF (I.LT.2) GO TO 5
      WRITE (1,*) 'ENTER OUTPUT FILE NAME'
      READ (1,620) OFILE
    5 OPEN (6,FILE=OFILE,STATUS='NEW')
      READ (5) NCOMP1
```

```
      NCOMP2=0
   10 NCOMP2=NCOMP2+1
      MODE = 1
      ZSLOPE = 0
      DO 20  K = 1,9
      BIBQB(K) = 0.0
      FIDP(K) = 0.0
      FJDP(K) = 0.0
      ITLD(K) = 1
      PIB(K) = 0.0
      PIS(K) = 0.0
      QPRIMS(K) = 0.0
      TOTLD (K) = 0.0
      VS(K) = 0.0
      ZC(K) = 0.0
      ZE(K) = 0.0
      ZMULT(K) = 0.0
   20 CONTINUE
      DO 30 I=1,5
      SUM(I) = 0.0
   30 CONTINUE
      CALL INPUT (DFILE)
      IF (MODE.EQ.10) GO TO 455
C
C     DETERMINE REFERENCE SIZE IF NOT SUPPLIED
C
      IF (ZMEAS.EQ.0.0) GO TO 50
      NRSIZE = -1
      ZMEAS = 0.0
      DO 40 K=1,NSR
      IF (ZE(K).EQ.0.0) GO TO 40
      ZC(K) = ZE(K)
      ZMEAS = ZMEAS + 1.0
      J = K
   40 CONTINUE
      IF (ZMEAS.LT.2.0) NRSIZE = J
   50 IF (NRSIZE) 70,60,90
   60 NRSIZE = 1
   70 COMP1 = 0
      DO 80 K=2,NSR
      IF (PIS(K).LT.3.0.OR.PIB(K).LT.3.0) GO TO 80
      COMP2 = PIS(K)+PIB(K)
      IF (COMP2.LT.COMP1) GO TO 80
      J = K
      COMP1 = COMP2
   80 CONTINUE
      NRSIZE = ISIGN(J,NRSIZE)
C
C     COMPUTE SRM BY ITERATION
```

```
C
   90 CALL SRCOMP (SR,XR)
      IF (MODE.EQ.10)  GO TO 455
      COMP1 = 30.2 * XR * DEPTH / D65
      PVALUE = 2.302594  * ALOG10 ( COMP1 )
      COMP1 =  PVALUE - 1.0
      PCTQ = 0.0
      IF (COMP1.EQ.0.0) GO TO 100
      PCTQ = 1.0 - APRIME * (COMP1 + ALOG (APRIME)) / COMP1
  100 CONST =  PCTQ  * QSM * 0.01
      SHEAR = 0.0
      IF (SR.LE.0.0) GO TO 110
      SHEAR   =  1.65 * D35 / SR
C
C     COMPUTE QPRIMS, IBQB, AND SED FALL VEL FOR EACH SIZE RANGE
C
  110 COMP2 = 6.0 * VISC
      DO 140 K=1,NSR
      QPRIMS (K) = CONST * PIS(K)
      SUM(4) = SUM(4) + QPRIMS(K)
      VS(K) = ((36.064*DIAM(K)**3 + COMP2**2)**0.5 - COMP2) / DIAM(K)
      IF (PIB(K).EQ.0.0) GO TO 140
      COMP1 = 0.66 * DIAM(K) / SR
      IF (COMP1.LT.SHEAR)  GO TO 120
      PSI = COMP1
      GO TO 130
  120 PSI = SHEAR
      IF ( PSI .GE. 25.0 )   GO TO 140
  130 CALL FIG10 (PSI,PHI)
      UNITBD = 12.0*DIAM(K)**1.5 * PIB(K) * PHI/2.0
      BIBQB(K) = AINT(UNITBD*43200.0*WIDTH) / 1000.0
      SUM(3) = SUM(3) + BIBQB(K)
  140 CONTINUE
      IF (SUM(3).GT.0.0) GO TO 190
      DO 170 K=1,NSR
      TOTLD(K) = QSM * PIS(K) * 0.01
      SUM(5) = SUM(5) + TOTLD(K)
  170 CONTINUE
      MODE = 2
  180 NRSIZE = 0
      GO TO 290
C
C     COMPUTE AND FIT Z VALUES
C
  190 IF (ZMEAS.GT.0.0) GO TO 220
      IF (NRSIZE.LE.0) GO TO 200
      CALL COMPZ (Z,NRSIZE)
      IF (MODE.EQ.3) GO TO 290
      ZC(NRSIZE) = Z
```

```
      GO TO 230
  200 ZS = 0.0
      DO 210 K=2,NSR
      J = K
      IF (BIBQB(K).EQ.0.0) GO TO 210
      IF (PIS(K).LT.PCTZ) GO TO 210
      IF (PIB(K).LT.PCTZ) GO TO 210
      CALL COMPZ (Z, J)
      IF (MODE.EQ.3) GO TO 290
      ZC(K) = Z
      ZS = ZS + Z
  210 CONTINUE
      IF (ZS.GT.0.0) GO TO 230
      MODE = 4
      GO TO 290
  220 CALL ZMIBQB
  230 CALL ZFIT
      IF (MODE.EQ.5) GO TO 290
C
C     COMPUTE TOTAL DISCHARGE FOR EACH SIZE RANGE
C
      N1 = IABS(NRSIZE)
      DO 270 K=1,NSR
      ADP = 2.0 * DIAM(K) / DEPTH
      Z = ZC(K)
      COMP1 = 0.0
      VALJ1 = 0.0
      VALJ2 = 0.0
      IF (PIS(K).EQ.0.0) GO TO 240
      CALL POWER ( APRIME , Z , VALJ1, VALJ2 )
      COMP1 = PVALUE * VALJ1 + VALJ2
      COMP2 = 0.0
      VALJ1 = 0.0
      VALJ2 = 0.0
      CALL POWER ( ADP , Z , VALJ1, VALJ2 )
      COMP2 = PVALUE * VALJ1 + VALJ2
      FJDP(K) =  COMP2 / COMP1
      IF (FJDP(K).LT.1.00) FJDP(K) = 1.00
  240 TOTLD(K) =  FJDP(K) * QPRIMS(K) + BIBQB(K)
      IF (K.LT.N1) GO TO 270
      IF (PIB(K).EQ.0.0) GO TO 270
      FIDP(K) = 1.00
      IF (Z.GE.10.0) GO TO 260
      COEFF = 0.216 * ADP **(Z- 1.0) / (1.0 - ADP) ** Z
      IF (VALJ1.GT.0.0) GO TO 250
      CALL POWER ( ADP , Z, VALJ1, VALJ2 )
  250 FIDP ( K ) = COEFF * ( PVALUE * VALJ1 + VALJ2 ) + 1.0
  260 TOTLD (K) = FIDP (K) * BIBQB (K)
  270 CONTINUE
```

```
      N1 = 0
      DO 280 K=1,NSR
      QMEAS = QSM * PIS(K) * 0.01
      IF (TOTLD(K).GE.QMEAS) GO TO 280
      N1 = N1 + 1
      TOTLD(K) = QMEAS
      ITLD(K) = 2
  280 SUM(5) = SUM(5) + TOTLD(K)
      IF (N1.GT.0) MODE = 6
C
C     PRINT RESULTS
C
  290 RSL = 0.0
      RSH = 0.0
      IF (NRSIZE) 320,310,300
  300 RSL = SIZELO(NRSIZE)
      RSH = SIZEHI(NRSIZE)
  310 WRITE (6,460) RSL,RSH,PVALUE
      GO TO 330
  320 WRITE (6,470) PVALUE
  330 COMP1 = DEPTH/D65
      PCTQ = PCTQ*100.0
      WRITE (6,480) PCTQ,XR,COMP1,ZSLOPE
      IF (NRSIZE.LT.0) WRITE (6,550)
      IF (ZMEAS.EQ.0.0) GO TO 340
      WRITE (6,490)
      GO TO 350
  340 WRITE (6,500)
  350 DO 380 K=1,NSR
      IF (ZE(K).EQ.0.0) GO TO 370
  360 WRITE (6,510) SIZELO(K),SIZEHI(K),PIS(K),PIB(K),BIBQB(K),
     1 QPRIMS(K),ZMULT(K),ZE(K),ZC(K),FJDP(K),FIDP(K),TOTLD(K)
      GO TO 375
  370 WRITE (6,520) SIZELO(K),SIZEHI(K),PIS(K),PIB(K),BIBQB(K),
     1 QPRIMS(K),ZMULT(K), ZC(K),FJDP(K),FIDP(K),TOTLD(K)
  375 IF (ITLD(K).EQ.2) WRITE (6,525)
  380 CONTINUE
      WRITE (6,530) (SUM(K) , K = 1,5)
      GO TO (455,390,420,430,440,450),MODE
  390 WRITE (6,540)
      GO TO 455
  420 WRITE (6,570)
      GO TO 455
  430 WRITE (6,580)
      GO TO 455
  440 WRITE (6,590)
      GO TO 455
  450 WRITE (6,600)
  455 IF (NCOMP2.LT.NCOMP1) GO TO 10
```

```
      ENDFILE (6)
      CLOSE (5)
      CLOSE (6)
      WRITE (1,630) OFILE
      WRITE (1,*) 'END OF RUN'
      CALL EXIT
C
C     FORMAT STATEMENTS
C
  460 FORMAT (' REFERENCE SIZE RANGE 'F8.4,' -',F8.4,' MM',11X,
     1 'P-FACTOR',7X,F7.2 )
  470 FORMAT (' REFERENCE SIZE RANGE - MULTIPLE',22X,'P-FACTOR',7X,F7.2)
  480 FORMAT (' PERCENT OF FLOW SAMPLED',F6.2,' %',22X,'X-FACTOR',F9.2 /
     1 ' DEPTH/KS ',F10.1,34X,'Z SLOPE',F8.2  )
  490 FORMAT (/'    SIZE RANGE         PERCENT IN RANGE      IBQB      QPRI
     1ME       IBQB         Z - VALUES       COMPUTATIONAL FACTORS    COMP T
     2OTAL     '/'  IN MILLIMETERS       SUSPENDED       BED        T/D      SUBS
     3(T/D)    RATIO      ENTERED      COMP.        F(J )      F(I )+1     DISCH
     4(T/D)    ' /)
  500 FORMAT (/'    SIZE RANGE         PERCENT IN RANGE      IBQB      QPRI
     1ME       MULT.        Z - VALUES       COMPUTATIONAL FACTORS    COMP T
     2OTAL     '/'  IN MILLIMETERS       SUSPENDED       BED        T/D      SUBS
     3(T/D)               ENTERED      COMP.        F(J )      F(I )+1     DISCH
     4(T/D)    ' /)
  510 FORMAT (F9.4,' -',F7.4,2F11.2,F9.2,F9.1,F12.2,F9.2,2F10.2,
     1 F13.2,F12.1 )
  520 FORMAT (F9.4,' -',F7.4,2F11.2,F9.2,F9.1,F12.2,9X,2F10.2,F13.2,
     1 F12.1 )
  525 FORMAT (1H+,125X,'*' )
  530 FORMAT (/7H TOTALS,11X,2F11.2,F9.2,F9.1,52X,F14.1 )
  540 FORMAT (// 1H0,'IBQB VALUES EQUAL ZERO.  TOTAL DISCHARGE EQUAL TO
     1MEASURED SUSPENDED-SEDIMENT DISCHARGE.')
  550 FORMAT (1H+,72X,'BY REGRESSION')
  570 FORMAT (// 46H0***** EXECUTION ABORTED FOR THIS JOB BECAUSE    /
     11H ,'  NO CONVERGENCE IN Z COMPUTATION')
  580 FORMAT (// 46H0***** EXECUTION ABORTED FOR THIS JOB BECAUSE    /
     11H ,'  NO OVERLAP OF BED AND SUSPENDED MATERIAL')
  590 FORMAT (// 46H0***** EXECUTION ABORTED FOR THIS JOB BECAUSE    /
     11H ,'  NOT ENOUGH POINTS FOR A FIT OF Z VALUES')
  600 FORMAT (// 1H0,'*  MEASURED SUSPENDED-SEDIMENT DISCHARGE -- WHICH
     1EXCEEDS COMPUTED DISCHARGE  (REVIEW COMPUTATION).')
  610 FORMAT (I3)
  620 FORMAT (A10)
  630 FORMAT (1H ,'OUTPUT ON FILE  ',A10 / )
      END
```

```
      BLOCK DATA
C
C     INPUT SIZE RANGE LIMITS IN MM AND GEOMETRIC MEAN DIAMETERS IN FT.
C
      COMMON /BB/ BIBQB(9),DIAM(9),PIB(9),PIS(9),PVALUE,QPRIMS(9),
     1 SIZEHI(9),SIZELO(9)
C
      DATA SIZELO  / 0.002, 0.0625, 0.125, 0.25, 0.5, 1., 2., 4., 8. /
      DATA SIZEHI  / 0.0625, 0.125, 0.25, 0.5, 1., 2., 4., 8., 16. /
      DATA DIAM / 0.000036, 0.00029, 0.00058, 0.00116, 0.00232, 0.00464,
     1  0.00928, 0.01856, 0.03712 /
      END


      SUBROUTINE INPUT (DFILE)
C
C     THIS SUBROUTINE READS DATA FROM INPUT FILE MEP.DATA
C
      COMMON /AA/ APRIME,AREA,CONC,D35,D65,DEPTH,DISCH,MODE,PCTZ,QSM,
     1 SUM(5),UBAR,VISC,WIDTH
      COMMON /BB/ BIBQB(9),DIAM(9),PIB(9),PIS(9),PVALUE,QPRIMS(9),
     1 SIZEHI(9),SIZELO(9)
      COMMON /CC/ NRSIZE,NSR,VS(9),ZC(9),ZE(9),ZMEAS,ZMULT(9),ZSLOPE
      CHARACTER*80 LOC
      CHARACTER*10 DATE,DFILE
C
      READ (5,ERR=80,END=90) LOC
      READ (5,ERR=90,END=90) DATE
      READ (5,ERR=80,END=90) TIME,DISCH,WIDTH,DEPTH,TEMPER,ZMEAS,
     1 REFSIZE,PCTZ,D35,D65,CONC,DS,DN
      READ (5,ERR=80,END=90) (ZE(K),PIS(K),PIB(K),K=1,5)
      READ (5,ERR=80,END=90) (ZE(K),PIS(K),PIB(K),K=6,9)
      WRITE (6,240) LOC
      ITIME=INT(TIME)
      WRITE (6,250) DATE, ITIME
      NRSIZE=INT(REFSIZE)
      NSR=0
      IF (DN.EQ.0.0.OR.DS.EQ.0.0) GO TO 120
      IF (DEPTH.EQ.0.0.OR.WIDTH.EQ.0.0) GO TO 140
      DO 20 K=1,9
      SUM(1) = SUM(1) + PIS(K)
      SUM(2) = SUM(2) + PIB(K)
      IF (SUM(2).GE.100.0) GO TO 30
   20 CONTINUE
   30 NSR = K
      IF (SUM(2).NE.100.0) GO TO 130
      IF (SUM(1).NE.100.0) GO TO 130
   50 IF (D35.GT.0.0) GO TO 68
```

```
      IND=1
      PCT=0.35
   52 SUMBED=0.0
      DO 66 K=1,NSR
      SUMBED=SUMBED+PIB(K)/100.0
      IF (SUMBED.EQ.PCT) GO TO 62
      IF (SUMBED.LT.PCT) GO TO 66
      X2=ALOG10(SIZEHI(K))
      X1=ALOG10(SIZELO(K))
   54 BM=SUMBED-PIB(K)/100.0
      IF (BM.LE.0.0) GO TO 64
      Y1=ERRTAB(BM)
   56 BM=SUMBED
      Y2=ERRTAB(BM)
      GO TO (58,60),IND
   58 D35=10**(((-.39-Y1)*(X2-X1)/(Y2-Y1))+X1)
      GO TO 68
   60 D65=10**((( .39-Y1)*(X2-X1)/(Y2-Y1))+X1)
      GO TO 70
   62 X2=ALOG10(SIZEHI(K))
      X1=ALOG10(SIZELO(K))
      IF (K.NE.1) GO TO 54
   64 Y1=-1.0
      GO TO 56
   66 CONTINUE
      GO TO 150
   68 IF (D65.GT.0.0) GO TO 70
      IND=2
      PCT=0.65
      GO TO 52
   70 COMP1 = 1.0334 + 0.03672*TEMPER + 0.0002058*TEMPER*TEMPER
      VISC  = 0.00002 / COMP1
      QSM = DISCH * CONC * 0.0027
      AREA = DEPTH * WIDTH
      UBAR = DISCH / AREA
      APRIME = DN/DS
      WRITE (6,320) DISCH,D65,AREA,D35,WIDTH,DN,UBAR,DS,DEPTH,CONC,
     1 TEMPER,QSM,VISC,APRIME
      D35 = D35 / 304.8
      D65 = D65 / 304.8
      RETURN
C
C     ERROR MESSAGES FOR THIS SUBROUTINE ARE GENERATED HERE
C
   80 WRITE (6,260) DFILE
      GO TO 110
   90 WRITE (6,270) DFILE
  110 ENDFILE 6
      CLOSE (5)
```

```
      CLOSE (6)
      WRITE (1,330) OFILE
      WRITE (1,*) 'END OF RUN'
      CALL EXIT
  120 WRITE (6,280)
      GO TO 160
  130 WRITE (6,290)
      GO TO 160
  140 WRITE (6,300)
      GO TO 160
  150 WRITE (6,310)
  160 MODE=10
      RETURN
C
C     FORMAT STATEMENTS
C
  200 FORMAT ( A80 )
  210 FORMAT ( A10 )
  220 FORMAT ( F10.3 )
  230 FORMAT ( F10.3,2F10.0)
  240 FORMAT (1H1,' U.S. GEOLOGICAL SURVEY, WATER RESOURCES DIVISION '//
     11H0,22X,'** DETERMINATION OF TOTAL SEDIMENT DISCHARGE BY THE MODIF
     2IED EINSTEIN PROCEDURE **' / 1H0,25X,A80 // )
  250 FORMAT (' DATE OF MEASUREMENT  ',A10,22X,'TIME OF MEASUREMENT  ',
     1 I5 )
  260 FORMAT (// 46H0***** EXECUTION ABORTED FOR THIS FOB BECAUSE   /
     11H ,'  OF READ ERROR ON INPUT FILE  ',A10 )
  270 FORMAT (// 46H0***** EXECUTION ABORTED FOR THIS JOB BECAUSE   /
     11H ,'  OF END-OF-FILE ON INPUT FILE  ',A10 )
  280 FORMAT (// 46H0***** EXECUTION ABORTED FOR THIS JOB BECAUSE   /
     11H ,'  EITHER DSUBS OR DSUBN IS EQUAL TO ZERO')
  290 FORMAT (// 46H0***** EXECUTION ABORTED FOR THIS JOB BECAUSE   /
     11H ,'  SUM OF MATERIAL IN BED OR SUSPENSION IS NOT 100')
  300 FORMAT (// 46H0***** EXECUTION ABORTED FOR THIS JOB BECAUSE   /
     11H ,'  EITHER DEPTH OR WIDTH ARE EQUAL ZERO')
  310 FORMAT (// 46H0***** EXECUTION ABORTED FOR THIS JOB BECAUSE   /
     11H ,'  CANNOT CALCULATE EITHER D35 OR D65')
  320 FORMAT (' WATER DISCHARGE ',F9.1,' CFS',24X,'D65 ',F8.3,' MM  '
     1     / ' AREA',8X,F10.2,' SQFT',26X,'D35 ',F8.3,' MM  '        /
     2 ' WIDTH ',10X,F7.1,' FT ',26X,'DISTANCE BETWEEN BOTTOM SAMPLED ZO
     3NE AND BED',F7.2,' FT ' / ' AVERAGE VELOCITY ',F6.2,' FT/SEC',23X,
     4'AVERAGE DEPTH AT SAMPLED VERTICALS ',F7.2,' FT ' / ' AVERAGE DEPT
     5H ',F10.2,' FT ',25X,'MEASURED SUSP-SED CONC    ',F9.0,' MG/L'/ '
     6WATER TEMPERATURE',F7.1,' C',27X,'MEASURED SUSP-SED DISCH  ',F12.1
     7,' T/D' / ' KINEMATIC VISCOSITY',F13.7,' SQFT/SEC',12X,'APRIME ',F
     89.3 )
  330 FORMAT (1H ,'OUTPUT ON FILE  ',A10 / )
      END
```

```
      SUBROUTINE SRCOMP (SR,X)
C
C     THIS SUBROUTINE COMPUTES X, SR, SHEAR VELOCITY, AND THICKNESS
C     OF LAMINAR SUBLAYER
C
C     SUBPROGRAMS CALLED:
C          FIG4
C
      COMMON /AA/ APRIME,AREA,CONC,D35,D65,DEPTH,DISCH,MODE,PCTZ,QSM,
     1 SUM(5),UBAR,VISC,WIDTH
C
      BSDELT = 0.0
      X = 1.54
      NUM  = 0
      XCK = 0.0
   10 IF ((12.27*X*DEPTH/D65).LE.0.000009) GO TO 60
      COMP1 = 32.63 * ALOG10 (12.27 * X * DEPTH / D65 )
      SGRAD =   UBAR / COMP1
      SR =  SGRAD * SGRAD
      UPRIME  =  SGRAD * 5.68
      IF ((UPRIME).EQ.0.0) GO TO 40
      DELTA  =  11.6 * VISC  / UPRIME
      IF ((DELTA) .EQ.0.0) GO TO 50
      BSDELT = D65 / DELTA
      XCK = X
      CALL FIG4 (BSDELT,X)
      ERROR = ABS (X - XCK)
      IF (ERROR.GT.0.05)  GO TO 20
      WRITE (6,110) DELTA, UPRIME
      RETURN
   20 NUM = NUM + 1
      IF (NUM.LT.15)  GO TO 10
C
C     ERROR MESSAGES FOR THIS SUBROUTINE ARE GENERATED HERE
C
      WRITE (6,70)
   30 MODE = 10
      RETURN
   40 WRITE (6,80)
      GO TO 30
   50 WRITE (6,90)
      GO TO 30
   60 WRITE (6,100)
      GO TO 30
C
C     FORMAT STATEMENTS
C
   70 FORMAT (// 46H0***** EXECUTION ABORTED FOR THIS JOB BECAUSE   /
     11H ,′  COUNTER FOR XBAL EXCEEDED 15′)
```

```
 80 FORMAT (// 46H0***** EXECUTION ABORTED FOR THIS JOB BECAUSE   /
   11H ,'  UPRIME EQUAL TO ZERO')
 90 FORMAT (// 46H0***** EXECUTION ABORTED FOR THIS JOB BECAUSE   /
   11H ,'   DELTA EQUAL TO ZERO')
100 FORMAT (// 46H0***** EXECUTION ABORTED FOR THIS JOB BECAUSE   /
   11H ,'  THE PRODUCT OF 12.27, X, DEPTH, AND 1/D65 IS ZERO')
110 FORMAT (' LAMINAR SUBLAYER THICKNESS',F10.7,' FT ', 13X,
   1 'SHEAR VELOCITY',F10.6,' FT/SEC'  )
    END
```

```
      SUBROUTINE FIG4 (X,Y)
C
C     THIS SUBROUTINE APPROXIMATES EINSTEINS FIGURE 4 WHERE;
C                    X = F (KS / DELTA)
C
      DIMENSION FX(8),FA(8),FB(8)
      DATA FX /0.5,0.65,0.9,1.15,1.4,3.2,5.0,8.4/
      DATA FA /1.9,1.75,1.62,1.61,1.63,1.72,1.42,1.25/
      DATA FB /1.72,1.23,0.57,0.0,-0.47,-1.11,-0.52,-0.27/
      I = 0
      Y = 0.4
      IF (X.LT.0.135) RETURN
      IF (X.LT.8.4) GO TO 10
      Y = 1.0
      RETURN
   10 I = I+1
      IF (X.GT.FX(I)) GO TO 10
      Y = FB(I)*ALOG10(X)+FA(I)
      RETURN
      END
```

```
      SUBROUTINE FIG10 (X,Y)
C
C     THIS SUBROUTINE APPROXIMATES EINSTEINS FIGURE 10 WHERE;
C                    PHI = F (PSI)
C
      DIMENSION FX(7),FA(7),FB(7)
      DATA FX /0.77,2.12,4.1,6.1,11.0,16.7,22.5/
      DATA FA /7.56,5.35,4.1,4.1,4.6,5.66,9.28/
      DATA FB /1.01,1.19,1.67,2.3,3.23,4.26,7.81/
      I = 0
      IF (X.LT.22.5) GO TO 10
      Y = (13.1/X)**12.66
      RETURN
   10 I = I+1
```

```
      IF (X.GT.FX(I)) GO TO 10
      Y = (FA(I)/X)**FB(I)
      RETURN
      END


      SUBROUTINE COMPZ (Z, L)
C
C     THIS SUBROUTINE COMPUTES Z BY TRIAL-AND-ERROR.
C
C     SUBPROGRAMS CALLED:
C          POWER
C
      COMMON /AA/ APRIME,AREA,CONC,D35,D65,DEPTH,DISCH,MODE,PCTZ,QSM,
     1 SUM(5),UBAR,VISC,WIDTH
      COMMON /BB/ BIBQB(9),DIAM(9),PIB(9),PIS(9),PVALUE,QPRIMS(9),
     1 SIZEHI(9),SIZELO(9)
C
      KOUNT = 0
      ADP = 2.0 * DIAM(L) / DEPTH
      CONST = QPRIMS(L) / BIBQB(L)
      TOL = 0.01 * CONST
      ZA = 1.08 - 0.33*ALOG10(CONST)
   10 KOUNT = KOUNT + 1
      IF (KOUNT.GE.40) GO TO 30
      COEFF = 0.216 * ADP **(ZA - 1.0) / (1.0 - ADP) ** ZA
      VALJ1 = 0.0
      VALJ2 = 0.0
      CALL POWER ( APRIME , ZA , VALJ1, VALJ2 )
      FZA = COEFF * ( PVALUE * VALJ1 + VALJ2 )
      ERROR = FZA-CONST
      IF (ABS(ERROR).LT.TOL) GO TO 20
      FCTR = SIGN(1.0,ERROR)
      ZB = ZA + 0.01*FCTR
      COEFF = 0.216 * ADP **(ZB - 1.0) / (1.0 - ADP) ** ZB
      VALJ1 = 0.0
      VALJ2 = 0.0
      CALL POWER ( APRIME , ZB , VALJ1, VALJ2 )
      FZB = COEFF * ( PVALUE * VALJ1 + VALJ2 )
      ZDIFF = (CONST-FZA)*0.01 / (FZB-FZA)
      ZA = ZA + ZDIFF*FCTR
      GO TO 10
   20 Z = ZA
      RETURN
C
C     ERROR MESSAGES FOR THIS SUBROUTINE ARE GENERATED HERE
C
   30 MODE = 3
```

```
      RETURN
      END


      SUBROUTINE  ZFIT
C
C     THIS SUBROUTINE COMPUTES Z-MULTIPLIERS OR FITS Z'S BY REG. LINE
C
      COMMON /AA/ APRIME,AREA,CONC,D35,D65,DEPTH,DISCH,MODE,PCTZ,QSM,
     1 SUM(5),UBAR,VISC,WIDTH
      COMMON /CC/ NRSIZE,NSR,VS(9),ZC(9),ZE(9),ZMEAS,ZMULT(9),ZSLOPE
      IF (NRSIZE) 10,40,40
C
   10 SUMXY = 0.0
      SUMXSQ = 0.0
      XMEAN = 0.0
      YMEAN = 0.0
      NUM = 0
      DO  20  K = 1, NSR
      IF (ZMEAS.EQ.0.0) ZMULT(K)=0.0
      IF (ZC(K).EQ.0.0) GO TO 20
      NUM = NUM + 1
      YLN = ALOG10 (ZC(K))
      XLN = ALOG10 (VS(K))
      YMEAN = YMEAN + YLN
      XMEAN = XMEAN + XLN
      SUMXY = SUMXY + YLN * XLN
      SUMXSQ = SUMXSQ + XLN * XLN
   20 CONTINUE
      IF (NUM.LE.1)  GO TO 60
      RNUM = NUM
      XMEAN = XMEAN / RNUM
      YMEAN  = YMEAN / RNUM
      ZSLOPE = SUMXY - RNUM * XMEAN * YMEAN
      ZSLOPE = ZSLOPE / (SUMXSQ - RNUM * XMEAN * XMEAN)
      AINT = YMEAN  - ZSLOPE * XMEAN
      SMALA = 10.0 ** AINT
      DO  30   K = 1, NSR
      IF (ZC(K).EQ.0.0) ZC(K)=SMALA*VS(K)**ZSLOPE
   30 CONTINUE
      RETURN
   40 ZSLOPE = 0.7
      RS = VS(NRSIZE)
      SE = ZC(NRSIZE)
      DO  50   K = 1, NSR
      XZ = (VS(K)/RS)**0.7
      IF (ZC(K).EQ.0.0) ZC(K)=SE*XZ
      IF (ZMEAS.EQ.0.0) ZMULT(K)=XZ
```

```
   50 CONTINUE
      RETURN
C
C     ERROR MESSAGES FOR THIS SUBROUTINE ARE GENERATED HERE
C
   60 MODE = 5
      RETURN
      END



      SUBROUTINE  ZMIBQB
C
C     THIS SUBROUTINE COMPUTES IBQB VALUES FOR SIZE RANGES THAT HAVE
C     MEASURED Z VALUES AND DETERMINES IBQB RATIOS TO ADJUST IBQB
C     VALUES FOR THE REMAINING SIZE RANGES.
C
C     SUBPROGRAMS CALLED:
C          POWER
C
      COMMON /AA/ APRIME,AREA,CONC,D35,D65,DEPTH,DISCH,MODE,PCTZ,QSM,
     1 SUM(5),UBAR,VISC,WIDTH
      COMMON /BB/ BIBQB(9),DIAM(9),PIB(9),PIS(9),PVALUE,QPRIMS(9),
     1 SIZEHI(9),SIZELO(9)
      COMMON /CC/ NRSIZE,NSR,VS(9),ZC(9),ZE(9),ZMEAS,ZMULT(9),ZSLOPE
C
      DO 10 K = 1,NSR
      IF (ZE(K).EQ.0.0) GO TO 10
      NZ = K
      Z1 = ZE(K)
      ADP = 2.0 * DIAM(K) / DEPTH
      COEFF = 0.216 * ADP **(Z1- 1.0) / (1.0 - ADP) ** Z1
      COMP1 = 0.0
      COMP2 = 0.0
      VALJ1 = 0.0
      VALJ2 = 0.0
      CALL POWER (APRIME, Z1, VALJ1, VALJ2)
      COMP2 = PVALUE * VALJ1 + VALJ2
      COMP1 = QPRIMS(K) / (COEFF * COMP2)
      ZMULT(K) = COMP1 / BIBQB(K)
      BIBQB(K) = COMP1
      GO TO 20
   10 CONTINUE
   20 J = NZ-1
      DO 30 K = 1,J
      IF (PIB(K).EQ.0.0) GO TO 30
      ZMULT(K) = ZMULT(NZ)
      BIBQB(K) = BIBQB(K) * ZMULT(NZ)
   30 CONTINUE
```

```
      J = NZ+1
      DO 40 K = J,NSR
      IF (ZE(K).EQ.0.0) GO TO 40
      NZ = K
      Z1 = ZE(K)
      ADP = 2.0 * DIAM(K) / DEPTH
      COEFF = 0.216 * ADP **(Z1- 1.0) / (1.0 - ADP) ** Z1
      COMP1 = 0.0
      COMP2 = 0.0
      VALJ1 = 0.0
      VALJ2 = 0.0
      CALL POWER (APRIME, Z1, VALJ1, VALJ2)
      COMP2 = PVALUE * VALJ1 + VALJ2
      COMP1 = QPRIMS(K) / (COEFF * COMP2)
      ZMULT(K) = COMP1 / BIBQB(K)
      BIBQB(K) = COMP1
   40 CONTINUE
      J = NZ+1
      DO 50 K = J,NSR
      IF (PIB(K).EQ.0.0) GO TO 50
      ZMULT(K) = ZMULT(NZ)
      BIBQB(K) = BIBQB(K) * ZMULT(NZ)
   50 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE POWER ( A, Z, FJ1 , FJ2 )
C
C     THIS SUBROUTINE EVALUATE J1 AND J2 INTEGRALS
C
      N=1
      FJ1=0.0
      FJ2=0.0
      ALG=ALOG(A)
      C=1.0
      D=-Z
      E=D+1.0
      FN=1.0
      AEX=A**E
      GO TO 20
   10 N=N+1
      C=C*D/FN
      D=E
      E=D+1.0
      FN=FLOAT(N)
      AEX=A**E
   20 IF (ABS(E).LE.0.001) GO TO 30
```

```
      FJ1=FJ1+C*(1.0-AEX)/E
      FJ2=FJ2+C*((AEX-1.0)/E**2-AEX*ALG/E)
      GO TO 40
   30 FJ1=FJ1-C*ALG
      FJ2=FJ2-0.5*C*ALG**2
   40 IF (N.EQ.1) GO TO 50
      CJ1=ABS(1.0-XJ1/FJ1)
      CJ2=ABS(1.0-XJ2/FJ2)
      IF (CJ1.LE.0.001.AND.CJ2.LE.0.001) RETURN
   50 XJ1=FJ1
      XJ2=FJ2
      GO TO 10
      END
```

```
      FUNCTION ERRTAB (BM)
      BN=BM
      IF (BM-0.50) 20, 30,10
   10 BN=1.0-BM
   20 T=SQRT(ALOG(1.0/BN**2))
      ERRTAB=T-((2.30753+0.27061*T)/(1.0+.99229*T+.04481*T*T))
      IF (BM.LT.0.50) ERRTAB=-ERRTAB
      RETURN
   30 ERRTAB=0.0
      RETURN
      END
```

SUPPLEMENTAL DATA--SECTION E.

BASIC PROGRAM MEPDATA LISTING

```
10 REM PROGRAM MEPDATA
20 REM ENTER MODIFIED EINSTEIN PROCEDURE DATA TO INPUT FILE
30 REM MAXIMUM NUMBER OF DATA SETS IN A FILE IS 30.
40 REM STORES DATA ON SEQUENTIAL FILE DFILE$ AFTER EACH 10 ENTERED DATA SETS
50 DIM VAR(30,13),SIZE(30,9,3),LO$(30),DATE$(30),SIZELO(9),SIZEHI(9)
60 LABEL$=" LOC DATE TIMEDISCHWIDTHDEPTH TEMPZMEAS REFZ PCTZ  D35  D65 CONC   D
S   DN"
70 DATA 0.002,0.062,0.062,0.125,0.125,0.25,0.25,0.5,0.5,1,1,2,2,4,4,8,8,16
80 FOR I=1 TO 9 : READ SIZELO(I),SIZEHI(I) : NEXT I
90 PRINT CHR$(27)"*" : PRINT : INPUT "ENTER DATA FILE NAME";DFILE$
100 PRINT : PRINT
110 INPUT "ENTER:  1-START  2-ADD  3-CORRECT  4-LIST  5 PRINT";NC
120 NO=0 : ND=0
130 IF NC=1 GOTO 280
140 REM LOAD DATA FROM DISK * * * * * * * * * * * * * * * * * * * * * * * * * * *
150 OPEN "I",#1,DFILE$
160 INPUT #1,NO
170 FOR N=1 TO NO
180 INPUT #1,LO$(N) : INPUT #1,DATE$(N)
190 FOR I=1 TO 13 : INPUT #1,VAR(N,I) : NEXT I
200 FOR I=1 TO 9 : INPUT #1,SIZE(N,I,1),SIZE(N,I,2),SIZE(N,I,3) : NEXT I
210 NEXT N
220 CLOSE
230 ON NC GOTO 280,280,910,1240,1300
240 REM ENTER DATA * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
250 IF NO=30 THEN 960
260 PRINT CHR$(27)"*" : PRINT : INPUT "ENTER MORE DATA  1 FOR YES  OR  2 FOR NO"
;I
270 IF I>1 THEN 960
280 NO=NO+1 : ND=ND+1
290 IF ND<11 THEN 320
300 GOSUB 800
310 ND=0
320 PRINT : PRINT "DATA SET NO. ";NO; : PRINT "    MAX = 30" : PRINT
330 PRINT : PRINT "ENTER LOCATION NAME  (MAX 80 CHARACTERS)"
340 LINE INPUT LO$(NO)
350 PRINT : INPUT "ENTER MEASUREMENT DATE  (MM/DD/YY)";DATE$(NO)
360 PRINT : INPUT "ENTER MEASUREMENT TIME  (2400 HR)";VAR(NO,1)
370 PRINT : INPUT "ENTER WATER DISCHARGE  (CFS)";VAR(NO,2)
380 PRINT : INPUT "ENTER TOP WIDTH  (FT)";VAR(NO,3)
390 PRINT : INPUT "ENTER AVERAGE DEPTH  (FT)";VAR(NO,4)
400 PRINT CHR$(27)"*"
410 PRINT : INPUT "ENTER WATER TEMPERATURE  (C)";VAR(NO,5)
420 PRINT : INPUT "ENTER Z VALUES:  ENTER 0 FOR NO  OR  1 FOR YES";ZI
430 VAR(NO,6)=ZI : ZR=0
440 IF ZI>0 THEN 500
450 PRINT : PRINT "REFERENCE SIZE SELECTION."
```

```
460 PRINT "      0 FOR PROGRAM SELECTION OF A SINGLE SIZE RANGE"
470 PRINT "    1-9 FOR NUMBER OF THE SELECTED SIZE RANGE"
480 PRINT "     -1 FOR PROGRAM SELECTION OF ALL SUITABLE SIZE RANGES"
490 PRINT : INPUT "ENTER NUMBER";ZR
500 VAR(NO,7)=ZR
510 I=3 : IF ZR>=0 THEN 530
520 PRINT : INPUT "ENTER Z COMP LIMIT  (1-3%)";I
530 VAR(NO,8)=I
540 PRINT : INPUT "ENTER D35  (MM)  0 FOR PROGRAM DETERMINATION";VAR(NO,9)
550 PRINT : INPUT "ENTER D65  (MM)  0 FOR PROGRAM DETERMINATION";VAR(NO,10)
560 PRINT : INPUT "ENTER SUSPENDED SEDIMENT CONC.  (MG/L)";VAR(NO,11)
570 PRINT : INPUT "ENTER AVERAGE DEPTH AT SAMPLED VERTICALS (FT)";VAR(NO,12)
580 PRINT : INPUT "ENTER DISTANCE BETWEEN BOTTOM SAMPLED ZONE ANDBED  (FT)";VAR
(NO,13)
590 PRINT CHR$(27)"*" : PRINT
600 FOR I=1 TO 9
610 FOR J=1 TO 3
620 SIZE(NO,I,J)=0
630 NEXT J
640 NEXT I
650 FOR I=1 TO 9
660 IF ZI=0 THEN 680
670 PRINT : PRINT USING "ENTER Z VALUE FOR ##.###  TO ##.###   (0 FOR NONE)";SIZ
ELO(I),SIZEHI(I) : INPUT SIZE(NO,I,1)
680 PRINT USING "ENTER % SUSP MATERIAL FOR ##.###  TO ##.###  (0 FOR NONE)";SIZE
LO(I),SIZEHI(I) : INPUT SIZE(NO,I,2)
690PRINT USING "ENTER % BED MATERIAL FOR ##.###  TO ##.###  (0 FOR NONE)";SIZEL
O(I),SIZEHI(I) : INPUT SIZE(NO,I,3)
700 IF I>3 AND SIZE(NO,I,3)=0 THEN 720
710 NEXT I
720 N=NO : GOSUB 1510
730 PRINT
740 PRINT "    1 FOR DATA SET OK"
750 PRINT "    2 TO RE-ENTER COMPLETE DATA SET"
760 PRINT "    3 TO CORRECT PART OF DATA SET"
770 PRINT : INPUT "ENTER NUMBER";I
780 IF I>3 THEN 720
790 ON I GOTO 250,330,1000
800 REM STORE DATA ON DISK * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
810 OPEN "O",#1,DFILE$
820 WRITE #1,NO
830 FOR N=1 TO NO
840 WRITE #1,LO$(N) : WRITE #1,DATE$(N)
850 FOR I=1 TO 13 : WRITE #1,VAR(N,I) : NEXT I
860 FOR I=1 TO 9 : WRITE #1,SIZE(N,I,1),SIZE(N,I,2),SIZE(N,I,3) : NEXT I
870 NEXT N
880 CLOSE
890 RETURN
900 END
```

```
910 REM CORRECT DATA * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
920 PRINT CHR$(27)"*" : PRINT
930 PRINT USING "ENTER SET NUMBER  MAX = ##";NO; : PRINT "   0 TO END RUN"; : IN
PUT N
940 IF N>NO THEN 920
950 IF N>0 THEN 1000
960 GOSUB 800
970 PRINT CHR$(27)"*" : PRINT : PRINT "DATA STORED ON FILE  ";DFILE$
980 PRINT : PRINT : PRINT "NO. DATA SETS = ";NO
990 PRINT : PRINT : PRINT "END OF RUN" : END
1000 GOSUB 1510
1010 PRINT : INPUT "ENTER VALUE NUMBER (1-24)  0 FOR NEW SET";L
1020 IF L>24 THEN 1000
1030 IF L>0 THEN 1060
1040 IF NC=3 THEN 920
1050 GOTO 720
1060 IF L>1 THEN 1110
1070 PRINT : PRINT "OLD NAME IS " : PRINT LO$(N)
1080 PRINT "ENTER NEW NAME  (MAX 80 CHARACTERS)"
1090 LINE INPUT LO$(N)
1100 GOTO 1000
1110 IF L>2 THEN 1140
1120 PRINT : PRINT "OLD MEASUREMENT DATE IS ";DATE$(N) : INPUT "ENTER NEW MEASUR
EMENT DATE";DATE$(N)
1130 GOTO 1000
1140 IF L>15 THEN 1180
1150 I=L-2
1160 PRINT : PRINT "OLD VALUE IS ";VAR(N,I) : INPUT "ENTER NEW VALUE";VAR(N,I)
1170 GOTO 1000
1180 I=L-15
1190 PRINT : INPUT "ENTER:  1-Z VAL  2-% SUSP  3-% BED  OR 0 TO END";L
1200 IF L=0 THEN 1000
1210 IF L>3 THEN 1190
1220 PRINT : PRINT "OLD VALUE IS ";SIZE(N,I,L) : INPUT "ENTER NEW VALUE";SIZE(N,
I,L)
1230 GOTO 1190
1240 REM LIST DATA ON SCREEN  * * * * * * * * * * * * * * * * * * * * * * * * *
1250 FOR N=1 TO NO
1260 GOSUB 1510
1270 PRINT : PRINT "PRESS ANY KEY TO CONTINUE"; : S$=INPUT$(1)
1280 NEXT N
1290 PRINT CHR$(27)"*" : PRINT : PRINT "END OF RUN" : END
1300 REM LIST DATA ON PRINTER * * * * * * * * * * * * * * * * * * * * * * * * *
1310 FOR N=1 TO NO
1320 LPRINT : LPRINT : LPRINT "SET NUMBER  "N
1330 LPRINT " 1    LOC ";LO$(N)
1340 L=9-LEN(DATE$(N))
1350 LPRINT " 2   DATE ";SPC(L);DATE$(N); : LPRINT SPC(10)" 3   TIME"; : LPRINT
USING "#########";VAR(N,1)
```

```
1360 NR=3 : NL=1
1370 FOR I=2 TO 13 STEP 2
1380 NR=NR+1 : NL=NL+5
1390 LPRINT USING "##  ";NR; : LPRINT MID$(LABEL$,NL,5); : LPRINT USING "######.
###";VAR(N,I);
1400 NR=NR+1 : NL=NL+5
1410 LPRINT SPC(10); : LPRINT USING "##  ";NR; : LPRINT MID$(LABEL$,NL,5); : LPR
INT USING "######.###";VAR(N,I+1)
1420 NEXT I
1430 FOR I=1 TO 9
1440 NR=NR+1
1450 LPRINT USING "##";NR; : LPRINT USING "#####.###";SIZELO(I),SIZEHI(I);
1460 LPRINT USING "####.##";SIZE(N,I,1);
1470 LPRINT USING "######";SIZE(N,I,2),SIZE(N,I,3)
1480 NEXT I
1490 NEXT N
1500 PRINT : PRINT : PRINT "END OF RUN" : END
1510 REM LIST ONE SET OF DATA ON SCREEN  * * * * * * * * * * * * * * * * * * *
1520 PRINT CHR$(27)"*" : PRINT "SET NUMBER  "N
1530 PRINT " 1    LOC ";LO$(N)
1540 L=9-LEN(DATE$(N))
1550 PRINT " 2   DATE ";SPC(L);DATE$(N); : PRINT SPC(10)" 3   TIME"; : PRINT USI
NG "##########";VAR(N,1)
1560 NR=3 : NL=11
1570 FOR I=2 TO 13 STEP 2
1580 NR=NR+1 : NL=NL+5
1590 PRINT USING "##  ";NR; : PRINT MID$(LABEL$,NL,5); : PRINT USING "######.###
";VAR(N,I);
1600 NR=NR+1 : NL=NL+5
1610 PRINT SPC(10); : PRINT USING "##  ";NR; : PRINT MID$(LABEL$,NL,5); : PRINT
USING "######.###";VAR(N,I+1)
1620 NEXT I
1630 FOR I=1 TO 9
1640 NR=NR+1
1650 PRINT USING "##";NR; : PRINT USING "#####.###";SIZELO(I),SIZEHI(I);
1660 PRINT USING "####.##";SIZE(N,I,1);
1670 PRINT USING "######";SIZE(N,I,2),SIZE(N,I,3)
1680 NEXT I
1690 RETURN
1700 END
```

SUPPLEMENTAL DATA--SECTION F.

BASIC PROGRAM MODEIN LISTING

```
10 REM PROGRAM MODEIN
20 REM COMPUTE TOTAL SEDIMENT DISCH BY THE MODIFIED EINSTEIN PROCEDURE
30 DIM SUM(5),BIBQB(9),DIAM(9),PIB(9),PIS(9),QPRIMS(9),SIZEHI(9),SIZELO(9),VS(9)
,ZC(9),ZE(9),ZMULT(9),FIDP(9),FJDP(9),ITLD(9),TOTLD(9),FG4(24),FG10(21)
40 DEF FNL(X)=LOG(X)/2.30259
50 P$="                                        "
60 DATA 0.000036,0.00029,0.00058,0.00116,0.00232,0.00464,0.00928,0.01856,0.03712
FOR I=1 TO 9 : READ DIAM(I) : NEXT I
80 DATA 0.002,0.0625,0.0625,0.125,0.125,0.25,0.25,0.5,0.5,1,1,2,2,4,4,8,8,16
90 FOR I=1 TO 9 : READ SIZELO(I),SIZEHI(I) : NEXT I
100 DATA 0.5,1.9,1.72,0.65,1.75,1.23,0.9,1.62,0.57,1.15,1.61,0,1.4,1.63,-0.47,3.
2,1.72,-1.11,5,1.42,-0.52,8.4,1.25,-0.27
110 FOR I=1 TO 24 : READ FG4(I) : NEXT I
120 DATA 0.77,7.56,1.01,2.12,5.35,1.19,4.1,4.1,1.67,6.1,4.1,2.3,11,4.6,3.23,16.7
,5.66,4.26,22.5,9.28,7.81
130 FOR I=1 TO 21 : READ FG10(I) : NEXT I
140 PRINT CHR$(27)"*" : PRINT : INPUT "ENTER DATA FILE NAME";DFILE$
150 REM LOAD DATA FROM DISK & INITIALIZE VARIABLES * * * * * * * * * * * * * *
160 OPEN "I",#1,DFILE$
170 INPUT #1,NCOMP1
180 NCOMP2=0
190 NCOMP2=NCOMP2+1
200 MODE=1 : ZSLOPE=0
210 FOR K=1 TO 9
220 BIBQB(K)=0 : FIDP(K)=0 : FJDP(K)=0 : ITLD(K)=1 : PIB(K)=0 : PIS(K)=0 : QPRIM
S(K)=0 : TOTLD(K)=0 : VS(K)=0 : ZC(K)=0 : ZE(K)=0 : ZMULT(K)=0
230 NEXT K
240 FOR I=1 TO 5 : SUM(I)=0 : NEXT I
250 INPUT #1,LO$ : INPUT#1,DATE$
260 INPUT#1,TIME,DISCH,WIDTH,DEPTH,TEMPER,ZMEAS,NRSIZE,PCTZ,D35,D65,CONC,DS,DN
270 FOR K=1 TO 9 : INPUT #1,ZE(K),PIS(K),PIB(K) : NEXT K
280 PRINT CHR$(27)"*" : PRINT LO$ : PRINT
290 L=LEN(DATE$)
300 PRINT "DATE OF MEASUREMENT   ";DATE$; : PRINT SPC(22-L)"TIME OF MEASUREMENT"
; : PRINT USING "#####";TIME
310 IF NCOMP2>1 THEN LPRINT CHR$(12)
320 LPRINT "TOTAL SEDIMENT DISCHARGE BY THE MODIFIED EINSTEIN PROCEDURE"
330 LPRINT : LPRINT LO$ : LPRINT
340 LPRINT "DATE OF MEASUREMENT   ";DATE$; : LPRINT SPC(22-L)"TIME OF MEASUREMEN
T"; : LPRINT USING "#####";TIME
350 IF DS>0 AND DN>0 THEN 380
360 R$="EITHER DSUBS OR DSUBN EQUAL ZERO"
370 GOTO 4520
380 IF DEPTH>0 AND WIDTH>0 THEN 410
390 R$="EITHER DEPTH OR WIDTH EQUAL ZERO"
400 GOTO 4520
410 FOR K=1 TO 9
```

```
420 SUM(1)=SUM(1)+PIS(K)
430 SUM(2)=SUM(2)+PIB(K)
440 IF SUM(2)>=100 THEN 460
450 NEXT K
460 NSR=K
470 IF SUM(1)=100 AND SUM(2)=100 THEN 500
480 R$="SUM OF MATERIAL IN BED OR SUSPENSION IS NOT 100"
490 GOTO 4520
500 IF D35>0 THEN 880
510 IND=1 : PCT=.35
520 SUMBED=0
530 FOR K=1 TO NSR
540 SUMBED=SUMBED+PIB(K)/100
550 IF SUMBED=PCT THEN 700
560 IF SUMBED<PCT THEN 740
570 X2=FNL(SIZEHI(K)) : X1=FNL(SIZELO(K))
580 BM=SUMBED-PIB(K)/100
590 IF BM<=0 THEN 720
600 GOSUB 770
610 Y1=ERRTAB
620 BM=SUMBED
630 GOSUB 770
640 Y2=ERRTAB
650 ON IND GOTO 660,680
660 D35=10^(((-.39-Y1)*(X2-X1)/(Y2-Y1))+X1)
670 GOTO 880
680 D65=10^(((.39-Y1)*(X2-X1)/(Y2-Y1))+X1)
690 GOTO 910
700 X2=FNL(SIZEHI(K)) : X1=FNL(SIZELO(K))
710 IF K<>1 THEN 580
720 Y1=-1
730 GOTO 620
740 NEXT K
750 R$="CANNOT CALCULATE EITHER D35 OR D65"
760 GOTO 4520
770 REM SUBROUTINE ERRTAB  * * * * * * * * * * * * * * * * * * * * * * * * * * *
780 BN=BM
790 ON SGN(BM-.5)+2 GOTO 810,850,800
800 BN=1-BM
810 T=SQR(LOG(1/BN^2))
820 ERRTAB=T-((2.30753+.27061*T)/(1+.99229*T+.04481*T*T))
830 IF BM<.5 THEN ERRTAB=-ERRTAB
840 RETURN
850 ERRTAB=0
860 RETURN
870 END
880 IF D65>0 THEN 910
890 IND=2 : PCT=.65
900 GOTO 520
```

```
910 COMP1=1.0334+.03672*TEMPER+.0002058*TEMPER*TEMPER
920 VISC=.00002/COMP1
930 QSM=DISCH*CONC*.0027
940 AREA=DEPTH*WIDTH
950 UBAR=DISCH/AREA
960 APRIME=DN/DS
970 L=LEN(DATE$)
980 PRINT USING "WATER DISCHARGE #######.# CFS";DISCH; : PRINT SPC(15); : PRINT
USING "D65 ####.### MM";D65
990 LPRINT USING "WATER DISCHARGE #######.# CFS";DISCH; : LPRINT SPC(15); : LPRI
NT USING "D65 ####.### MM";D65
1000 PRINT USING "AREA    ###########.## SQFT";AREA; : PRINT SPC(17); : PRINT US
ING "D35 ####.### MM";D35
1010 LPRINT USING "AREA    ###########.## SQFT";AREA; : LPRINT SPC(17); : LPRINT
 USING "D35 ####.### MM";D35
1020 PRINT USING "WIDTH      ##########.# FT";WIDTH; : PRINT SPC(18); : PRINT US
ING "DIST BOTTOM SAMP ZONE TO BED #.## FT";DN
1030 LPRINT USING "WIDTH      ##########.# FT";WIDTH; : LPRINT SPC(18); : LPRINT
 USING "DIST BOTTOM SAMP ZONE TO BED #.## FT";DN
1040 PRINT USING "AVERAGE VELOCITY ###.## FT/SEC";UBAR; : PRINT SPC(14); : PRINT
 USING "AVER. DEPTH AT SAMP. VERT. ###.## FT";DS
1050 LPRINT USING "AVERAGE VELOCITY ###.## FT/SEC";UBAR; : LPRINT SPC(14); : LPR
INT USING "AVER. DEPTH AT SAMP. VERT. ###.## FT";DS
1060 PRINT USING "AVERAGE DEPTH    ####.## FT";DEPTH; : PRINT SPC(16); : PRINT
USING "MEAS SUSP-SED CONC. ###### MG/L";CONC
1070 LPRINT USING "AVERAGE DEPTH    ####.## FT";DEPTH; : LPRINT SPC(16); : LPRI
NT USING "MEAS SUSP-SED CONC. ###### MG/L";CONC
1080 PRINT USING "WATER TEMPERATURE ####.# C";TEMPER; : PRINT SPC(18); : PRINT U
SING "MEAS SUSP-SED DISCH #########.# T/D";QSM
1090 LPRINT USING "WATER TEMPERATURE ####.# C";TEMPER; : LPRINT SPC(18); : LPRIN
T USING "MEAS SUSP-SED DISCH #########.# T/D";QSM
1100 PRINT USING "KIN. VISCOSITY ####.####### SQFT/SEC";VISC; : PRINT SPC(8); :
PRINT USING "APRIME #####.###";APRIME
1110 LPRINT USING "KIN. VISCOSITY ####.####### SQFT/SEC";VISC; : LPRINT SPC(8);
: LPRINT USING "APRIME #####.###";APRIME
1120 D35=D35/304.8
1130 D65=D65/304.8
1140 REM DETERMINE REF SIZE AND COMPUTE SRM BY ITERATION * * * * * * * * * * *
1150 IF ZMEAS=0 THEN 1240
1160 NRSIZE=-1 : ZMEAS=0
1170 FOR K=1 TO NSR
1180 IF ZE(K)=0 THEN 1220
1190 ZC(K)=ZE(K)
1200 ZMEAS=ZMEAS+1
1210 J=K
1220 NEXT K
1230 IF ZMEAS<2 THEN NRSIZE=J
1240 ON SGN(NRSIZE)+2 GOTO 1260,1250,1350
1250 NRSIZE=1
```

```
1260 COMP1=0
1270 FOR K=2 TO NSR
1280 IF PIS(K)<3 OR PIB(K)<3 THEN 1330
1290 COMP2=PIS(K)+PIB(K)
1300 IF COMP2<COMP1 THEN 1330
1310 J=K
1320 COMP1=COMP2
1330 NEXT K
1340 NRSIZE=SGN(NRSIZE)*J
1350 GOSUB 1920
1360 IF MODE=10 THEN 4520
1370 COMP1=30.2*XR*DEPTH/D65
1380 PVALUE=LOG(COMP1)
1390 COMP1=PVALUE-1
1400 PCTQ=0 : SHEAR=0
1410 IF COMP1=0 THEN 1430
1420 PCTQ=1-APRIME*(COMP1+LOG(APRIME))/COMP1
1430 CONST=PCTQ*QSM*.01
1440 IF SR<=0 THEN 1460
1450 SHEAR=1.65*D35/SR
1460 REM COMPUTE QPRIMS, IBQB, AND SED FALL VEL  * * * * * * * * * * * * * * *
1470 COMP2=6*VISC
1480 FOR K=1 TO NSR
1490 QPRIMS(K)=CONST*PIS(K)
1500 SUM(4)=SUM(4)+QPRIMS(K)
1510 VS(K)=((36.064*DIAM(K)^3+COMP2^2)^.5-COMP2)/DIAM(K)
1520 IF PIB(K)=0 THEN 1630
1530 COMP1=.66*DIAM(K)/SR
1540 IF COMP1<SHEAR THEN 1570
1550 PSI=COMP1
1560 GOTO 1590
1570 PSI=SHEAR
1580 IF PSI>=25 THEN 1630
1590 GOSUB 2330
1600 UNITBD=12*DIAM(K)^1.5*PIB(K)*PHI/2
1610 BIBQB(K)=INT(UNITBD*43200!*WIDTH)/1000
1620 SUM(3)=SUM(3)+BIBQB(K)
1630 NEXT K
1640 IF SUM(3)>0 THEN 1720
1650 FOR K=1 TO NSR
1660 TOTLD(K)=QSM*PIS(K)*.01
1670 SUM(5)=SUM(5)+TOTLD(K)
1680 NEXT K
1690 MODE=2 : NRSIZE=0
1700 R$="IBQB VALUES EQUAL ZERO.  TOTAL DISCH EQUAL TO MEAS SUSP-SED DISCH"
1710 GOTO 3930
1720 REM COMPUTE Z VALUES  * * * * * * * * * * * * * * * * * * * * * * * * * * *
1730 IF ZMEAS>0 THEN 2720
1740 IF NRSIZE<=0 THEN 1780
```

```
1750 I9=NRSIZE : GOSUB 2420
1760 PRINT P$; : PRINT CHR$(11)
1770 GOTO 3150
1780 ZS=0
1790 FOR I9=2 TO NSR
1800 IF BIBQB(I9)=0 THEN 1860
1810 IF PIS(I9)<PCTZ GOTO 1860
1820 IF PIB(I9)<PCTZ THEN 1860
1830 GOSUB 2420
1840 IF MODE=3 THEN 3930
1850 ZS=ZS+1
1860 NEXT I9
1870 PRINT P$; : PRINT CHR$(11)
1880 IF ZS>0 THEN 3150
1890 MODE=4
1900 R$="NO OVERLAP OF BED AND SUSPENDED MATERIAL"
1910 GOTO 3930
1920 REM SUBROUTINE SRCOMP * * * * * * * * * * * * * * * * * * * * * * * * * * *
1930 BSBDELT=0 : X=1.54 : NUM=0 : XCK=0
1940 COMP2=12.27*X*DEPTH/D65
1950 IF COMP2<=.000009 THEN 2200
1960 COMP1=32.63*FNL(COMP2)
1970 SGRAD=UBAR/COMP1
1980 SR=SGRAD*SGRAD
1990 UPRIME=SGRAD*5.68
2000 IF UPRIME=0 GOTO 2160
2010 DELTA=11.6*VISC/UPRIME
2020 IF DELTA=0 THEN 2180
2030 BSDELT=D65/DELTA
2040 XCK=X
2050 GOSUB 2230
2060 ERROR=ABS(X-XCK)
2070 IF ERROR>.05 THEN 2120
2080 XR=X
2090 PRINT USING "LAMINAR SUBLAYER THICK ##.####### FT";DELTA; : PRINT SPC(8); :
 PRINT USING "SHEAR VELOCITY ##.###### FT/SEC";UPRIME
2100 LPRINT USING "LAMINAR SUBLAYER THICK ##.####### FT";DELTA; : LPRINT SPC(8);
 : LPRINT USING "SHEAR VELOCITY ##.###### FT/SEC";UPRIME
2110 RETURN
2120 NUM=NUM+1
2130 IF NUM<15 THEN 1940
2140 R$="COUNTER FOR SRCOMP EXCEEDED 15"
2150 GOTO 2210
2160 R$="UPRIME EQUAL TO ZERO"
2170 GOTO 2210
2180 R$="DELTA EQUAL TO ZERO"
2190 GOTO 2210
2200 R$="THE PRODUCT OF 12.27, X, DEPTH, AND 1/D65 IS ZERO"
2210 MODE=10
```

```
2220 RETURN
2230 REM SUBROUTINE FIG4 * * * * * * * * * * * * * * * * * * * * * * * * * * *
2240 I=-2 : X=.4
2250 IF BSDELT<.135 THEN RETURN
2260 IF BSDELT<8.4 THEN 2290
2270 X=1
2280 RETURN
2290 I=I+3
2300 IF BSDELT>FG4(I) THEN 2290
2310 X=FG4(I+2)*FNL(BSDELT)+FG4(I+1)
2320 RETURN
2330 REM SUBROUTINE FIG10  * * * * * * * * * * * * * * * * * * * * * * * * * *
2340 I=-2
2350 IF PSI<22.5 THEN 2380
2360 PHI=(13.1/PSI)^12.66
2370 RETURN
2380 I=I+3
2390 IF PSI>FG10(I) THEN 2380
2400 PHI=(FG10(I+1)/PSI)^FG10(I+2)
2410 RETURN
2420 REM SUBROUTINE COMPZ  * * * * * * * * * * * * * * * * * * * * * * * * * *
2430 KOUNT=0
2440 ADP=2*DIAM(I9)/DEPTH
2450 CONST=QPRIMS(I9)/BIBQB(I9)
2460 TOL=.01*CONST
2470 ZA=1.08-.33*FNL(CONST)
2480 KOUNT=KOUNT+1
2490 IF KOUNT>=40 THEN 2690
2500 COEFF=.216*ADP^(ZA-1)/(1-ADP)^ZA
2510 A=APRIME : Z=ZA : FJ1=0 : FJ2=0
2520 PRINT "  COMPZ ";I9;"  GO POWER 1 ";KOUNT; : PRINT CHR$(11)
2530 GOSUB 4600
2540 FZA=COEFF*(PVALUE*FJ1+FJ2)
2550 ERROR=FZA-CONST
2560 IF ABS(ERROR)<TOL THEN 2670
2570 FCTR=1*SGN(ERROR)
2580 ZB=ZA+.01*FCTR
2590 COEFF=.216*ADP^(ZB-1)/(1-ADP)^ZB
2600 Z=ZB : FJ1=0 : FJ2=0
2610 PRINT "  COMPZ ";I9;"  GO POWER 2 ";KOUNT; : PRINT CHR$(11)
2620 GOSUB 4600
2630 FZB=COEFF*(PVALUE*FJ1+FJ2)
2640 ZDIFF=(CONST-FZA)*.01/(FZB-FZA)
2650 ZA=ZA+ZDIFF*FCTR
2660 GOTO 2480
2670 ZC(I9)=ZA
2680 RETURN
2690 MODE=3
2700 R$="NO CONVERGENCE IN Z COMPUTATION"
```

```
2710 RETURN
2720 REM SUBROUTINE ZMIBQB * * * * * * * * * * * * * * * * * * * * * * * * * * *
2730 PRINT "  ZMIBQB       "; : PRINT CHR$(11)
2740 FOR K=1 TO NSR
2750 IF ZE(K)=0 THEN 2870
2760 NZ=K : Z=ZE(K)
2770 ADP=2*DIAM(K)/DEPTH
2780 COEFF=.216*ADP^(Z-1)/(1-ADP)^Z
2790 A=APRIME : FJ1=0 : FJ2=0
2800 PRINT "  ZMIBQB  GO POWER ";K; : PRINT CHR$(11)
2810 GOSUB 4600
2820 COMP2=PVALUE*FJ1+FJ2
2830 COMP1=QPRIMS(K)/(COEFF*COMP2)
2840 ZMULT(K)=COMP1/BIBQB(K)
2850 BIBQB(K)=COMP1
2860 GOTO 2880
2870 NEXT K
2880 J=NZ-1
2890 FOR K=1 TO J
2900 IF PIB(K)=0 THEN 2930
2910 ZMULT(K)=ZMULT(NZ)
2920 BIBQB(K)=BIBQB(K)*ZMULT(NZ)
2930 NEXT K
2940 J=NZ+1
2950 FOR K=J TO NSR
2960 IF ZE(K)=0 THEN 3080
2970 NZ=K : Z=ZE(K)
2980 ADP=2*DIAM(K)/DEPTH
2990 COEFF=.216*ADP^(Z-1)/(1-ADP)^Z
3000 A=APRIME : FJ1=0 : FJ2=0
3010 PRINT "  ZMIBQB  GO POWER ";K; : PRINT CHR$(11)
3020 GOSUB 4600
3030 COMP2=PVALUE*FJ1+FJ2
3040 COMP1=QPRIMS(K)/(COEFF*COMP2)
3050 ZMULT(K)=COMP1/BIBQB(K)
3060 BIBQB(K)=COMP1
3070 PRINT P$; : PRINT CHR$(11)
3080 NEXT K
3090 J=NZ+1
3100 FOR K=J TO NSR
3110 IF PIB(K)=0 THEN 3140
3120 ZMULT(K)=ZMULT(NZ)
3130 BIBQB(K)=BIBQB(K)*ZMULT(NZ)
3140 NEXT K
3150 REM SUBROUTINE ZFIT * * * * * * * * * * * * * * * * * * * * * * * * * * * *
3160 PRINT "  ZFIT "; : PRINT CHR$(11)
3170 IF NRSIZE>=0 THEN 3440
3180 SUMXY=0 : SUMXSQ=0 : XMEAN=0 : YMEAN=0 : NUM=0
3190 FOR K=1 TO NSR
```

```
3200 IF ZMEAS=0 THEN ZMULT(K)=0
3210 IF ZC(K)=0 THEN 3290
3220 NUM=NUM+1
3230 YLN=FNL(ZC(K))
3240 XLN=FNL(VS(K))
3250 YMEAN=YMEAN+YLN
3260 XMEAN=XMEAN+XLN
3270 SUMXY=SUMXY+YLN*XLN
3280 SUMXSQ=SUMXSQ+XLN*XLN
3290 NEXT K
3300 IF NUM>1 THEN 3340
3310 MODE=5
3320 R$="NOT ENOUGH POINTS FOR A FIT OF Z VALUES"
3330 GOTO 3930
3340 XMEAN=XMEAN/NUM
3350 YMEAN=YMEAN/NUM
3360 ZSLOPE=SUMXY-NUM*XMEAN*YMEAN
3370 ZSLOPE=ZSLOPE/(SUMXSQ-NUM*XMEAN*XMEAN)
3380 AINT=YMEAN-ZSLOPE*XMEAN
3390 SMALA=10^AINT
3400 FOR K=1 TO NSR
3410 IF ZC(K)=0 THEN ZC(K)=SMALA*VS(K)^ZSLOPE
3420 NEXT K
3430 GOTO 3510
3440 ZSLOPE=.7
3450 RS=VS(NRSIZE) : SE=ZC(NRSIZE)
3460 FOR K=1 TO NSR
3470 XZ=(VS(K)/RS)^.7
3480 IF ZC(K)=0 THEN ZC(K)=SE*XZ
3490 IF ZMEAS=0 THEN ZMULT(K)=XZ
3500 NEXT K
3510 REM COMPUTE TOTAL SEDIMENT DISCHARGE * * * * * * * * * * * * * * * * * * * *
3520 N1=ABS(NRSIZE)
3530 FOR K=1 TO NSR
3540 ADP=2*DIAM(K)/DEPTH
3550 Z=ZC(K) : A=APRIME
3560 FJ1=0 : FJ2=0
3570 IF PIS(K)=0 THEN 3670
3580 PRINT "  TOTLD  GO POWER ";K; : PRINT CHR$(11)
3590 GOSUB 4600
3600 COMP1=PVALUE*FJ1+FJ2
3610 A=ADP : FJ1=0 : FJ2=0
3620 PRINT "  TOTLD  GO POWER ";K; : PRINT CHR$(11)
3630 GOSUB 4600
3640 COMP2=PVALUE*FJ1+FJ2
3650 FJDP(K)=COMP2/COMP1
3660 IF FJDP(K)<1 THEN FJDP(K)=1
3670 TOTLD(K)=FJDP(K)*QPRIMS(K)+BIBQB(K)
3680 IF K<N1 THEN 3790
```

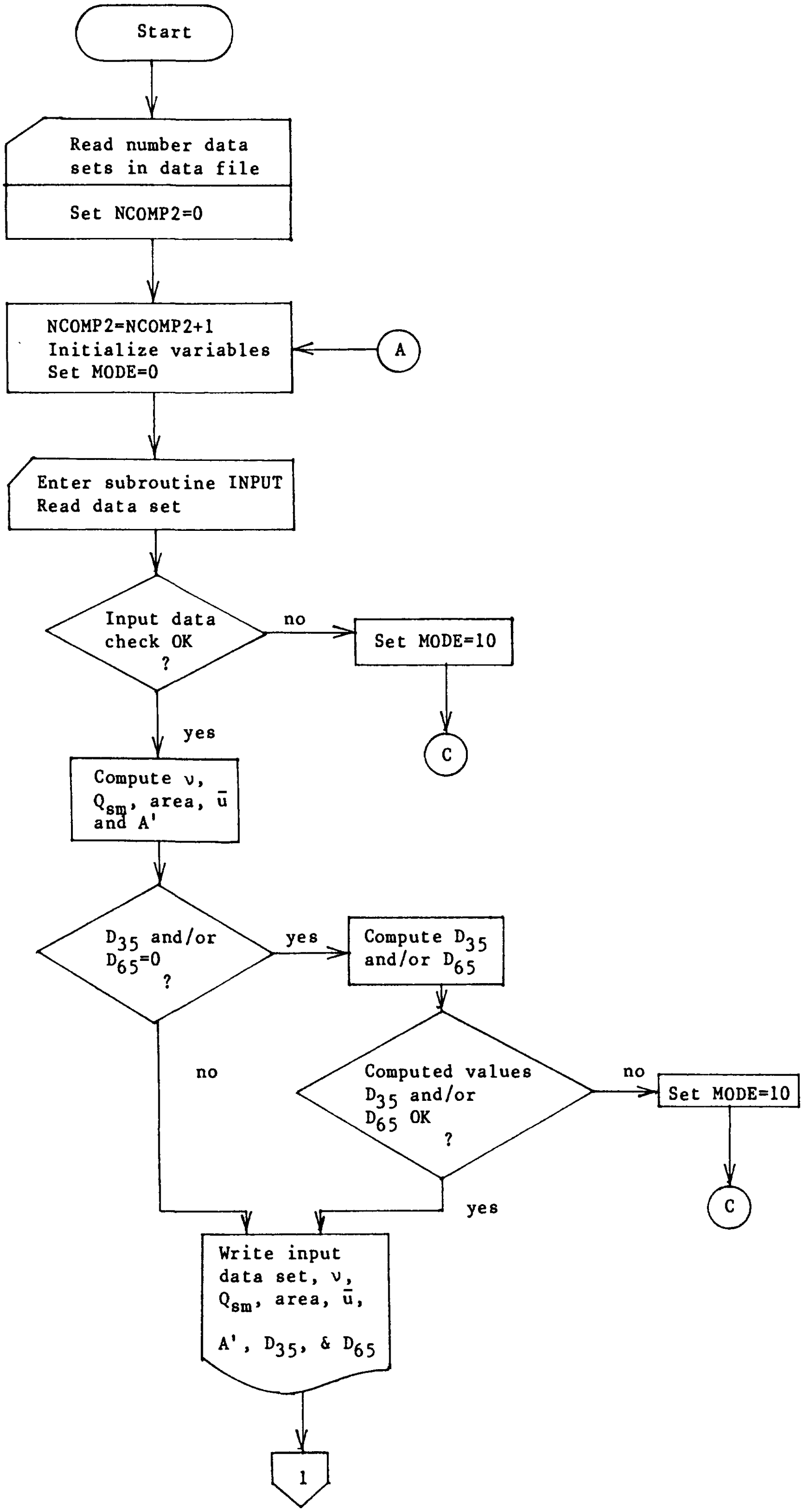
```
3690 IF PIB(K)=0 THEN 3790
3700 FIDP(K)=1
3710 IF Z>=10 THEN 3780
3720 A=ADP
3730 COEFF=.216*ADP^(Z-1)/(1-ADP)^Z
3740 IF FJ1>0 THEN 3770
3750 PRINT "  TOTLD  GO POWER ";K; : PRINT CHR$(11)
3760 GOSUB 4600
3770 FIDP(K)=COEFF*(PVALUE*FJ1+FJ2)+1
3780 TOTLD(K)=FIDP(K)*BIBQB(K)
3790 NEXT K
3800 PRINT P$; : PRINT CHR$(11)
3810 N1=0
3820 FOR K=1 TO NSR
3830 QMEAS=QSM*PIS(K)*.01
3840 IF TOTLD(K)>=QMEAS THEN 3880
3850 N1=N1+1
3860 TOTLD(K)=QMEAS
3870 ITLD(K)=2
3880 SUM(5)=SUM(5)+TOTLD(K)
3890 NEXT K
3900 IF N1=0 THEN 3930
3910 MODE=6
3920 R$="MEAS SUSP-SED DISCH -- WHICH EXCEEDS COMP DISCH  (REVIEW COMP)"
3930 REM PRINT RESULTS * * * * * * * * * * * * * * * * * * * * * * * * * * * *
3940 RSL=0 : RSH=0
3950 ON SGN(NRSIZE)+2 GOTO 4000,3970,3960
3960 RSL=SIZELO(NRSIZE) : RSH=SIZEHI(NRSIZE)
3970 PRINT USING "REFERENCE SIZE RANGE ##.#### - ##.#### MM";RSL,RSH; : PRINT US
ING "   P-FACTOR        ####.##";PVALUE
3980 LPRINT USING "REFERENCE SIZE RANGE ##.#### - ##.#### MM";RSL,RSH; : LPRINT
USING "   P-FACTOR        ####.##";PVALUE
3990 GOTO 4020
4000 PRINT "REFERENCE SIZE RANGE - MULTIPLE"; : PRINT SPC(13); : PRINT USING "P-
FACTOR        ####.##";PVALUE
4010 LPRINT "REFERENCE SIZE RANGE - MULTIPLE"; : LPRINT SPC(13); : LPRINT USING
'P-FACTOR        ####.##";PVALUE
4020 PRINT USING "PERCENT OF FLOW SAMPLED ###.## %";PCTQ*100; : PRINT SPC(12); :
 PRINT USING "X-FACTOR #######.##";XR
4030 LPRINT USING "PERCENT OF FLOW SAMPLED ###.## %";PCTQ*100; : LPRINT SPC(12);
 : LPRINT USING "X-FACTOR #######.##";XR
4040 PRINT USING "DEPTH/KS ########.#";DEPTH/D65; : PRINT SPC(25); : PRINT USING
 "Z SLOPE ####.##";ZSLOPE;
4050 LPRINT USING "DEPTH/KS ########.#";DEPTH/D65; : LPRINT SPC(25); : LPRINT US
ING "Z SLOPE ####.##";ZSLOPE;
4060 IF NRSIZE>=0 THEN 4080
4070 PRINT "   BY REGRESSION"; : LPRINT "   BY REGRESSION";
4080 PRINT : PRINT : PRINT : LPRINT : LPRINT : LPRINT
4090 PRINT "         SIZE RANGE       PERCENT IN RANGE      IBQB     QPRIME"
```

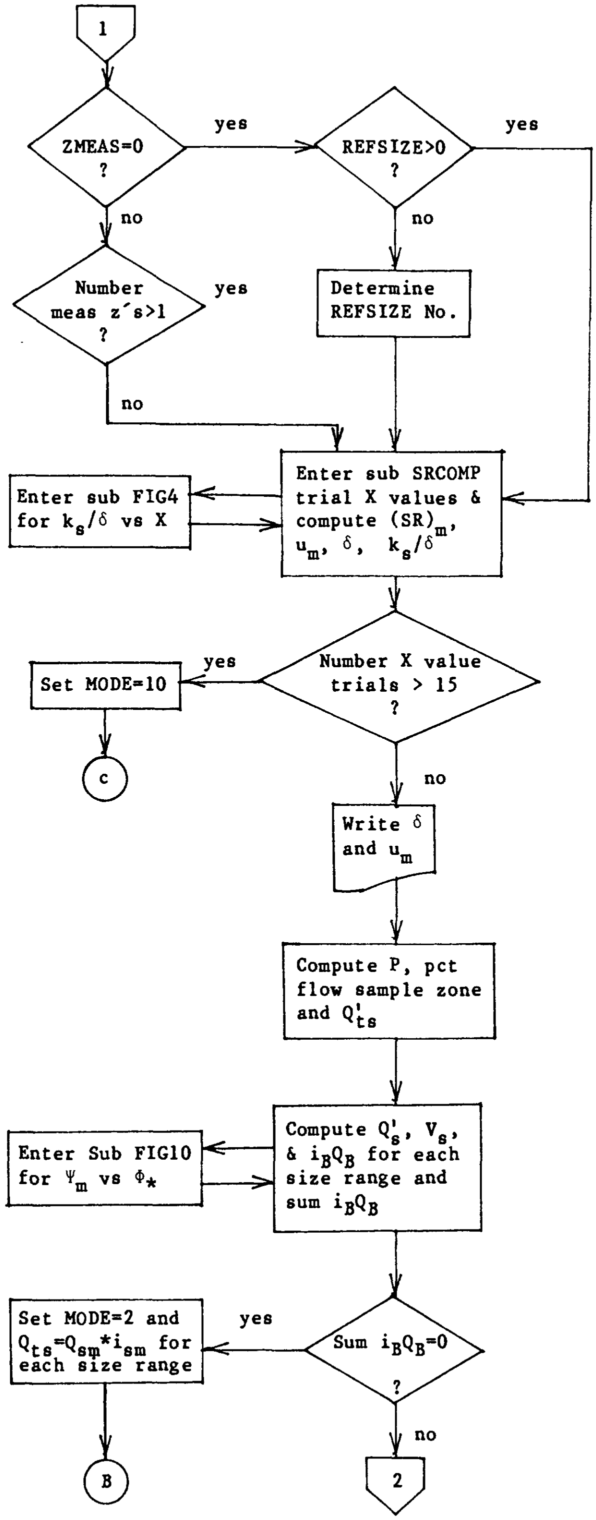
```
4100 LPRINT "        SIZE RANGE       PERCENT IN RANGE       IBQB     QPRIME"
4110 PRINT "      IN MILLIMETERS     SUSPENDED    BED        T/D      SUBS(T/D)"
4120 LPRINT "      IN MILLIMETERS     SUSPENDED    BED        T/D      SUBS(T/D)"
4130 PRINT : LPRINT
4140 FOR K=1 TO NSR
4150 PRINT USING "###";K; : PRINT USING "###.####";SIZELO(K); : PRINT USING "###
##.####";SIZEHI(K); : PRINT USING "#######.##";PIS(K),PIB(K); : PRINT USING "###
#####.##";BIBQB(K); : PRINT USING "#########.#";QPRIMS(K)
4160 LPRINT USING "###";K; : LPRINT USING "###.####";SIZELO(K); : LPRINT USING "
#####.####";SIZEHI(K); : LPRINT USING "#######.##";PIS(K),PIB(K); : LPRINT USING
 "########.##";BIBQB(K); : LPRINT USING "#########.#";QPRIMS(K)
4170 NEXT K
4180 PRINT : LPRINT
4190 PRINT "  TOTALS"; : PRINT SPC(13); : PRINT USING "#######.##";SUM(1),SUM(2)
; : PRINT USING "########.##";SUM(3); : PRINT USING "#########.#";SUM(4)
4200 LPRINT "  TOTALS"; : LPRINT SPC(13); : LPRINT USING "#######.##";SUM(1),SUM
(2); : LPRINT USING "########.##";SUM(3); : LPRINT USING "#########.#";SUM(4)
4210 PRINT : PRINT : LPRINT : LPRINT
4220 IF ZMEAS=0 THEN 4280
4230 PRINT "     IBQB     Z - VALUES     COMPUTATIONAL FACTORS   COMP TOTAL"
4240 LPRINT "     IBQB     Z - VALUES     COMPUTATIONAL FACTORS   COMP TOTAL"
4250 PRINT "     RATIO  ENTERED  COMP.      F(J)     F(I )+1     DISCH (T/D)"
4260 LPRINT "     RATIO  ENTERED  COMP.      F(J)     F(I )+1     DISCH (T/D)"
4270 GOTO 4320
4280 PRINT "     MULT     Z - VALUES     COMPUTATIONAL FACTORS   COMP TOTAL"
4290 LPRINT "     MULT     Z - VALUES     COMPUTATIONAL FACTORS   COMP TOTAL"
4300 PRINT "            ENTERED  COMP.     F(J)      F(I )+1     DISCH (T/D)"
4310 LPRINT "            ENTERED  COMP.     F(J)      F(I )+1     DISCH (T/D)"
4320 PRINT : LPRINT
4330 FOR K=1 TO NSR
4340 IF ZE(K)=0 THEN 4380
4350 PRINT USING "###";K; : PRINT USING "###.##";ZMULT(K); :  PRINT USING "#####
#.##";ZE(K);
4360 LPRINT USING "###";K; : LPRINT USING "###.##";ZMULT(K); : LPRINT USING "###
###.##";ZE(K);
4370 GOTO 4400
4380 PRINT USING "###";K; : PRINT USING "###.##";ZMULT(K); : PRINT SPC(9);
4390 LPRINT USING "###";K; : LPRINT USING "###.##";ZMULT(K); : LPRINT SPC(9);
4400 PRINT USING "#####.##";ZC(K); : PRINT USING "########.##";FJDP(K),FIDP(K);
: PRINT USING "############.#";TOTLD(K);
4410 LPRINT USING "#####.##";ZC(K); : LPRINT USING "########.##";FJDP(K),FIDP(K)
; : LPRINT USING "############.#";TOTLD(K);
4420 IF ITLD(K)=2 THEN 4450
4430 PRINT : LPRINT
4440 GOTO 4460
4450 PRINT " *" : LPRINT " *"
4460 NEXT K
4470 PRINT : LPRINT
4480 PRINT "  TOTAL"; : PRINT SPC(41); : PRINT USING "############.#";SUM(5)
```

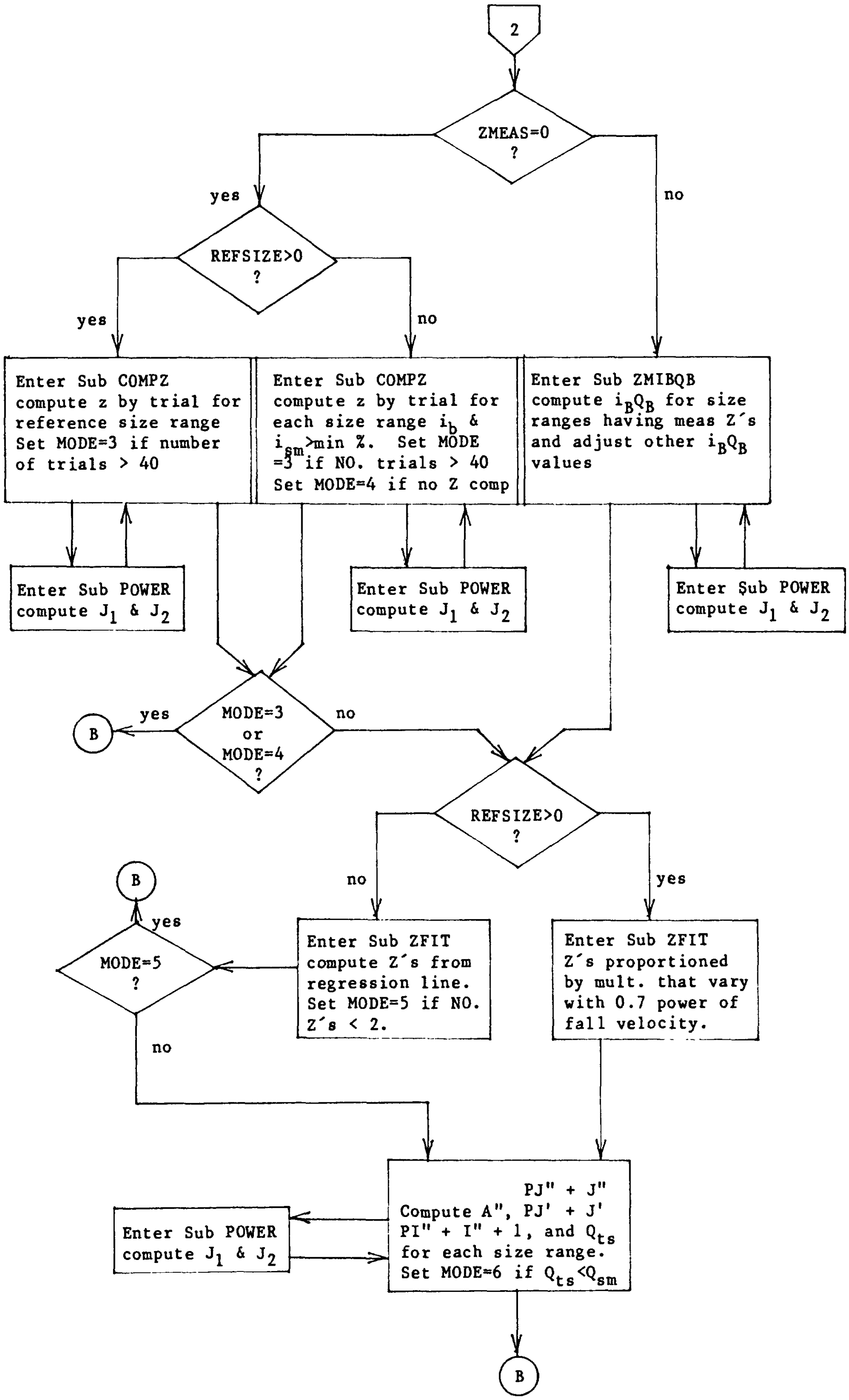
```
4490 LPRINT "  TOTAL"; : LPRINT SPC(41); : LPRINT USING "###########.#";SUM(5)
4500 PRINT : PRINT : LPRINT : LPRINT
4510 ON MODE GOTO 4560,4550,4520,4520,4520,4550
4520 PRINT : PRINT : LPRINT : LPRINT
4530 PRINT; : PRINT "**** EXECUTION ABORTED FOR THIS JOB BECAUSE"
4540 LPRINT; : LPRINT "**** EXECUTION ABORTED FOR THIS JOB BECAUSE "
4550 PRINT R$ : LPRINT R$
4560 PRINT : PRINT "PUSH KEY TO CONTINUE"; : S$=INPUT$(1)
4570 IF NCOMP2<NCOMP1 THEN 190
4580 PRINT CHR$(27)"*" : PRINT : PRINT "  END OF RUN"
4590 END
4600 REM SUBROUTINE POWER  * * * * * * * * * * * * * * * * * * * * * * * * * * *
4610 N=1 : FJ1=0 : FJ2=0
4620 ALG=LOG(A)
4630 C=1
4640 D=-Z
4650 E=D+1
4660 NN=1
4670 AEX=A^E
4680 GOTO 4750
4690 N=N+1
4700 C=C*D/NN
4710 D=E
4720 E=D+1
4730 NN=N
4740 AEX=A^E
4750 IF ABS(E)<=.001 THEN 4790
4760 FJ1=FJ1+C*(1-AEX)/E
4770 FJ2=FJ2+C*((AEX-1)/E^2-AEX*ALG/E)
4780 GOTO 4810
4790 FJ1=FJ1-C*ALG
4800 FJ2=FJ2-.5*C*ALG^2
4810 IF N=1 THEN 4850
4820 CJ1=ABS(1-XJ1/FJ1)
4830 CJ2=ABS(1-XJ2/FJ2)
4840 IF CJ1<=.001 AND CJ2<=.001 THEN RETURN
4850 XJ1=FJ1
4860 XJ2=FJ2
4870 GOTO 4690
4880 END
```

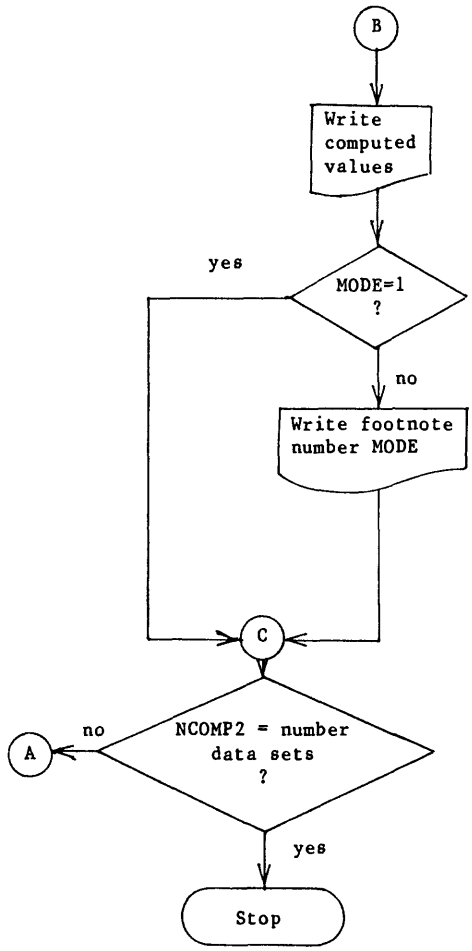
SUPPLEMENTAL DATA--SECTION G.

FLOW CHART OF PROGRAM MODEIN




1
ZMEAS=0 ?
yes
REFSIZE>0 ?
yes
no
no
Number meas z´s>1 ?
yes
Determine REFSIZE No.
no
Enter sub FIG4 for k_s/δ vs X
Enter sub SRCOMP trial X values & compute $(SR)_m$, u_m, δ, k_s/δ
Set MODE=10
yes
Number X value trials > 15 ?
c
no
Write δ and u_m
Compute P, pct flow sample zone and Q'_{ts}
Enter Sub FIG10 for Ψ_m vs Φ_*
Compute Q'_s, V_s, & i_BQ_B for each size range and sum i_BQ_B
Set MODE=2 and $Q_{ts}=Q_{sm}*i_{sm}$ for each size range
yes
Sum i_BQ_B=0 ?
no
B
2


2
ZMEAS=0 ?
yes
no
REFSIZE>0 ?
yes
no
Enter Sub COMPZ compute z by trial for reference size range Set MODE=3 if number of trials > 40
Enter Sub COMPZ compute z by trial for each size range i_b & i_sm>min %. Set MODE =3 if NO. trials > 40 Set MODE=4 if no Z comp
Enter Sub ZMIBQB compute i_BQ_B for size ranges having meas Z's and adjust other i_BQ_B values
Enter Sub POWER compute J1 & J2
Enter Sub POWER compute J1 & J2
Enter Sub POWER compute J1 & J2
B
yes
MODE=3 or MODE=4 ?
no
REFSIZE>0 ?
no
yes
B
yes
MODE=5 ?
no
Enter Sub ZFIT compute Z's from regression line. Set MODE=5 if NO. Z's < 2.
Enter Sub ZFIT Z's proportioned by mult. that vary with 0.7 power of fall velocity.
Enter Sub POWER compute J1 & J2
Compute A", PJ" + J" / PJ' + J' / PI" + I" + 1, and Q_ts for each size range. Set MODE=6 if Q_ts<Q_sm
B


B
Write computed values
MODE=1 ?
yes
no
Write footnote number MODE
C
NCOMP2 = number data sets ?
no
A
yes
Stop

SUPPLEMENTAL DATA--SECTION H.

EXAMPLES OF PROGRAM MEPDATA OUTPUT

NUMBER DATA SETS = 6

1	1	LOC	NIOBRARA RIVER NR CODY, NE - SECT C2				
1	2	DATE	6/19/52				
1	3	TIME	1200.000				
1	4	DISCH	239.000				
1	5	WIDTH	118.000				
1	6	DEPTH	0.980				
1	7	TEMP	17.800				
1	8	ZMEAS	0.000				
1	9	REFZ	0.000				
1	10	PCTZ	3.000				
1	11	D35	0.229				
1	12	D65	0.320				
1	13	CONC	262.000				
1	14	DS	1.220				
1	15	DN	0.300				
1	16	0.002	0.062	0.000	28.	1.	
1	17	0.062	0.125	0.000	24.	4.	
1	18	0.125	0.250	0.000	39.	38.	
1	19	0.250	0.500	0.000	9.	50.	
1	20	0.500	1.000	0.000	0.	5.	
1	21	1.000	2.000	0.000	0.	1.	
1	22	2.000	4.000	0.000	0.	1.	
1	23	4.000	8.000	0.000	0.	0.	
1	24	8.000	16.000	0.000	0.	0.	
2	1	LOC	FEATHER RIVER NR GRIDLEY, CA				
2	2	DATE	10/6/64				
2	3	TIME	1248.000				
2	4	DISCH	2030.000				
2	5	WIDTH	238.000				
2	6	DEPTH	12.390				
2	7	TEMP	19.400				
2	8	ZMEAS	0.000				
2	9	REFZ	0.000				
2	10	PCTZ	3.000				
2	11	D35	0.253				
2	12	D65	0.369				
2	13	CONC	3.000				
2	14	DS	13.720				
2	15	DN	0.300				
2	16	0.002	0.062	0.000	81.	4.	
2	17	0.062	0.125	0.000	8.	5.	
2	18	0.125	0.250	0.000	4.	25.	
2	19	0.250	0.500	0.000	7.	50.	
2	20	0.500	1.000	0.000	0.	16.	
2	21	1.000	2.000	0.000	0.	0.	
2	22	2.000	4.000	0.000	0.	0.	
2	23	4.000	8.000	0.000	0.	0.	
2	24	8.000	16.000	0.000	0.	0.	

3	1	LOC	COLUMBIA RIVER AT VANCOUVER, WA - MAIN CHANNEL				
3	2	DATE	6/8/64				
3	3	TIME	1045.000				
3	4	DISCH	447000.000				
3	5	WIDTH	2900.000				
3	6	DEPTH	39.000				
3	7	TEMP	13.300				
3	8	ZMEAS	0.000				
3	9	REFZ	-1.000				
3	10	PCTZ	3.000				
3	11	D35	0.000				
3	12	D65	0.000				
3	13	CONC	114.000				
3	14	DS	39.000				
3	15	DN	0.300				
3	16	0.002	0.062	0.000	55.	0.	
3	17	0.062	0.125	0.000	8.	1.	
3	18	0.125	0.250	0.000	27.	18.	
3	19	0.250	0.500	0.000	10.	43.	
3	20	0.500	1.000	0.000	0.	24.	
3	21	1.000	2.000	0.000	0.	10.	
3	22	2.000	4.000	0.000	0.	4.	
3	23	4.000	8.000	0.000	0.	0.	
3	24	8.000	16.000	0.000	0.	0.	
4	1	LOC	FEATHER RIVER NR GRIDLEY, CA				
4	2	DATE	2/2/65				
4	3	TIME	1203.000				
4	4	DISCH	11420.000				
4	5	WIDTH	304.000				
4	6	DEPTH	11.920				
4	7	TEMP	6.700				
4	8	ZMEAS	0.000				
4	9	REFZ	5.000				
4	10	PCTZ	3.000				
4	11	D35	0.505				
4	12	D65	0.740				
4	13	CONC	56.000				
4	14	DS	15.220				
4	15	DN	0.300				
4	16	0.002	0.062	0.000	43.	0.	
4	17	0.062	0.125	0.000	10.	0.	
4	18	0.125	0.250	0.000	11.	3.	
4	19	0.250	0.500	0.000	9.	31.	
4	20	0.500	1.000	0.000	27.	50.	
4	21	1.000	2.000	0.000	0.	14.	
4	22	2.000	4.000	0.000	0.	2.	
4	23	4.000	8.000	0.000	0.	0.	
4	24	8.000	16.000	0.000	0.	0.	

5	1	LOC	RIO GRANDE CONV. CHANNEL AT SAN ACACIA, NM			
5	2	DATE	12/15/76			
5	3	TIME	1125.000			
5	4	DISCH	767.000			
5	5	WIDTH	46.500			
5	6	DEPTH	3.430			
5	7	TEMP	3.300			
5	8	ZMEAS	1.000			
5	9	REFZ	0.000			
5	10	PCTZ	3.000			
5	11	D35	0.182			
5	12	D65	0.248			
5	13	CONC	3030.000			
5	14	DS	3.500			
5	15	DN	0.300			
5	16	0.002	0.062	0.000	37.	1.
5	17	0.062	0.125	0.130	27.	9.
5	18	0.125	0.250	0.430	31.	55.
5	19	0.250	0.500	0.000	5.	31.
5	20	0.500	1.000	0.000	0.	3.
5	21	1.000	2.000	0.000	0.	1.
5	22	2.000	4.000	0.000	0.	0.
5	23	4.000	8.000	0.000	0.	0.
5	24	8.000	16.000	0.000	0.	0.

6	1	LOC	NIOBRARA RIVER NR CODY, NE - SECT C2			
6	2	DATE	6/19/52			
6	3	TIME	1200.000			
6	4	DISCH	239.000			
6	5	WIDTH	118.000			
6	6	DEPTH	0.980			
6	7	TEMP	17.800			
6	8	ZMEAS	1.000			
6	9	REFZ	0.000			
6	10	PCTZ	3.000			
6	11	D35	0.000			
6	12	D65	0.000			
6	13	CONC	262.000			
6	14	DS	1.220			
6	15	DN	0.300			
6	16	0.002	0.062	0.000	28.	1.
6	17	0.062	0.125	0.000	24.	4.
6	18	0.125	0.250	0.690	39.	38.
6	19	0.250	0.500	0.000	9.	50.
6	20	0.500	1.000	0.000	0.	5.
6	21	1.000	2.000	0.000	0.	1.
6	22	2.000	4.000	0.000	0.	1.
6	23	4.000	8.000	0.000	0.	0.
6	24	8.000	16.000	0.000	0.	0.

EXAMPLES OF PROGRAM MODEIN OUTPUT

Run number 1. Reference size range selected by program and corresponding z value computed by trial. Z values for other size ranges computed from multipliers which vary with the 0.7 power of fall velocity.

U. S. GEOLOGICAL SURVEY, WATER RESOURCES DIVISION

** DETERMINATION OF TOTAL SEDIMENT DISCHARGE BY THE MODIFIED EINSTEIN PROCEDURE **

NIOBRARA RIVER NR CODY, NE - SECT C2

DATE OF MEASUREMENT	6/19/52	TIME OF MEASUREMENT	1200
WATER DISCHARGE	239.0 CFS	D65	0.320 MM
AREA	115.64 SQFT	D35	0.229 MM
WIDTH	118.0 FT	DISTANCE BETWEEN BOTTOM SAMPLED ZONE AND BED	0.30 FT
AVERAGE VELOCITY	2.07 FT/SEC	AVERAGE DEPTH AT SAMPLED VERTICALS	1.22 FT
AVERAGE DEPTH	0.98 FT	MEASURED SUSP-SED CONC	262. MG/L
WATER TEMPERATURE	17.8 C	MEASURED SUSP-SED DISCH	169.1 T/D
KINEMATIC VISCOSITY	0.0000114 SQFT/SEC	APRIME	0.246
LAMINAR SUBLAYER THICKNESS	0.0015628 FT	SHEAR VELOCITY	0.084722 FT/SEC
REFERENCE SIZE RANGE	0.1250 - 0.2500 MM	P-FACTOR	10.67
PERCENT OF FLOW SAMPLED	78.98 %	X-FACTOR	1.52
DEPTH/KS	933.4	Z SLOPE	0.70

SIZE RANGE	PERCENT IN RANGE		IBQB	QPRIME	MULT.	Z - VALUES		COMPUTATIONAL FACTORS		COMP TOTAL
IN MILLIMETERS	SUSPENDED	BED	T/D	SUBS(T/D)		ENTERED	COMP.	F(J)	F(I)+1	DISCH (T/D)
0.0020 - 0.0625	28.00	1.00	0.00	37.4	0.02		0.02	1.28	0.00	47.9
0.0625 - 0.1250	24.00	4.00	0.30	32.0	0.44		0.34	1.69	0.00	54.3
0.1250 - 0.2500	39.00	38.00	8.02	52.1	1.00		0.76	3.39	23.01	184.5
0.2500 - 0.5000	9.00	50.00	29.84	12.0	1.76		1.35	16.96	4.20	125.5
0.5000 - 1.0000	0.00	5.00	4.65	0.0	2.55		1.95	0.00	2.36	11.0
1.0000 - 2.0000	0.00	1.00	0.22	0.0	3.40		2.60	0.00	1.86	0.4
2.0000 - 4.0000	0.00	1.00	0.00	0.0	4.41		3.37	0.00	1.62	0.0
TOTALS	100.00	100.00	43.02	133.5						423.5

Run number 2. Sum of i_BQ_B values equal to zero.

U.S. GEOLOGICAL SURVEY, WATER RESOURCES DIVISION

** DETERMINATION OF TOTAL SEDIMENT DISCHARGE BY THE MODIFIED EINSTEIN PROCEDURE **

FEATHER RIVER NR GRIDLEY, CA

```
DATE OF MEASUREMENT  10/6/64                  TIME OF MEASUREMENT   1248
WATER DISCHARGE    2030.0 CFS                 D65    0.369 MM
AREA          2948.82 SQFT                    D35    0.253 MM
WIDTH            238.0 FT                     DISTANCE BETWEEN BOTTOM SAMPLED ZONE AND BED   0.30 FT
AVERAGE VELOCITY   0.69 FT/SEC                AVERAGE DEPTH AT SAMPLED VERTICALS   13.72 FT
AVERAGE DEPTH      12.39 FT                   MEASURED SUSP-SED CONC          3. MG/L
WATER TEMPERATURE   19.4 C                    MEASURED SUSP-SED DISCH         16.4 T/D
KINEMATIC VISCOSITY    0.0000110 SQFT/SEC     APRIME     0.022
LAMINAR SUBLAYER THICKNESS 0.0052842 FT       SHEAR VELOCITY  0.024081 FT/SEC
REFERENCE SIZE RANGE   0.0000 -  0.0000 MM    P-FACTOR        12.42
PERCENT OF FLOW SAMPLED 98.55 %               X-FACTOR     0.80
DEPTH/KS    10234.3                           Z SLOPE    0.00
```

SIZE RANGE IN MILLIMETERS	PERCENT IN RANGE SUSPENDED	PERCENT IN RANGE BED	IBQB T/D	QPRIME SUBS(T/D)	MULT.	Z - VALUES ENTERED	Z - VALUES COMP.	COMPUTATIONAL FACTORS F(J)	COMPUTATIONAL FACTORS F(I)+1	COMP TOTAL DISCH (T/D)
0.0020 - 0.0625	81.00	4.00	0.00	13.1	0.00		0.00	0.00	0.00	13.3
0.0625 - 0.1250	8.00	5.00	0.00	1.3	0.00		0.00	0.00	0.00	1.3
0.1250 - 0.2500	4.00	25.00	0.00	0.6	0.00		0.00	0.00	0.00	0.7
0.2500 - 0.5000	7.00	50.00	0.00	1.1	0.00		0.00	0.00	0.00	1.2
0.5000 - 1.0000	0.00	16.00	0.00	0.0	0.00		0.00	0.00	0.00	0.0
TOTALS	100.00	100.00	0.00	16.2						16.4

IBQB VALUES EQUAL ZERO. TOTAL DISCHARGE EQUAL TO MEASURED SUSPENDED-SEDIMENT DISCHARGE.

Run number 3. Three reference sizes selected by program and corresponding z values computed by trial. z values for other size ranges obtained from regression line defined by trial z's.

U.S. GEOLOGICAL SURVEY, WATER RESOURCES DIVISION

** DETERMINATION OF TOTAL SEDIMENT DISCHARGE BY THE MODIFIED EINSTEIN PROCEDURE **

COLUMBIA RIVER AT VANCOUVER, WA - MAIN CHANNEL

```
DATE OF MEASUREMENT  6/8/64                       TIME OF MEASUREMENT   1045
WATER DISCHARGE  447000.0 CFS                     D65    0.540 MM
AREA         113100.00 SQFT                       D35    0.333 MM
WIDTH             2900.0 FT                       DISTANCE BETWEEN BOTTOM SAMPLED ZONE AND BED   0.30 FT
AVERAGE VELOCITY   3.95 FT/SEC                    AVERAGE DEPTH AT SAMPLED VERTICALS   39.00 FT
AVERAGE DEPTH      39.00 FT                       MEASURED SUSP-SED CONC          114. MG/L
WATER TEMPERATURE   13.3 C                        MEASURED SUSP-SED DISCH      137586.6 T/D
KINEMATIC VISCOSITY    0.0000128 SQFT/SEC         APRIME      0.008
LAMINAR SUBLAYER THICKNESS 0.0012160 FT           SHEAR VELOCITY  0.122443 FT/SEC
REFERENCE SIZE RANGE - MULTIPLE                   P-FACTOR          13.84
PERCENT OF FLOW SAMPLED 99.52 %                   X-FACTOR     1.54
DEPTH/KS    21998.7                               Z SLOPE     0.50     BY REGRESSION
```

SIZE RANGE IN MILLIMETERS	PERCENT IN RANGE SUSPENDED	BED	IBQB T/D	QPRIME SUBS(T/D)	MULT.	Z - VALUES ENTERED	COMP.	COMPUTATIONAL FACTORS F(J)	F(I)+1	COMP TOTAL DISCH (T/D)
0.0020 - 0.0625	55.00	0.00	0.00	75311.2	0.00		0.04	1.01	0.00	75775.4
0.0625 - 0.1250	8.00	1.00	4.08	10954.4	0.00		0.35	1.03	0.00	11326.4
0.1250 - 0.2500	27.00	18.00	207.72	36971.0	0.00		0.65	1.15	0.00	42648.5
0.2500 - 0.5000	10.00	43.00	1403.51	13693.0	0.00		0.99	1.72	17.75	24913.1
0.5000 - 1.0000	0.00	24.00	2215.66	0.0	0.00		1.31	0.00	5.58	12373.2
1.0000 - 2.0000	0.00	10.00	743.89	0.0	0.00		1.62	0.00	3.40	2527.2
2.0000 - 4.0000	0.00	4.00	73.38	0.0	0.00		1.95	0.00	2.62	192.3
TOTALS	100.00	100.00	4648.23	136929.5						169756.0

Run number 4. Reference size range selected by user and corresponding z value computed by trial. Z values for other size ranges computed from multipliers which vary with the 0.7 power of fall velocity.

U.S. GEOLOGICAL SURVEY, WATER RESOURCES DIVISION

** DETERMINATION OF TOTAL SEDIMENT DISCHARGE BY THE MODIFIED EINSTEIN PROCEDURE **

FEATHER RIVER NR GRIDLEY, CA

```
DATE OF MEASUREMENT  2/2/65                     TIME OF MEASUREMENT   1203
WATER DISCHARGE   11420.0 CFS                   D65    0.740 MM
AREA          3623.68 SQFT                      D35    0.505 MM
WIDTH             304.0 FT                      DISTANCE BETWEEN BOTTOM SAMPLED ZONE AND BED   0.30 FT
AVERAGE VELOCITY   3.15 FT/SEC                  AVERAGE DEPTH AT SAMPLED VERTICALS   15.22 FT
AVERAGE DEPTH      11.92 FT                     MEASURED SUSP-SED CONC          56. MG/L
WATER TEMPERATURE    6.7 C                      MEASURED SUSP-SED DISCH       1726.7 T/D
KINEMATIC VISCOSITY    0.0000155 SQFT/SEC       APRIME     0.020
LAMINAR SUBLAYER THICKNESS 0.0016302 FT         SHEAR VELOCITY  0.110437 FT/SEC
REFERENCE SIZE RANGE   0.5000 -  1.0000 MM      P-FACTOR        12.33
PERCENT OF FLOW SAMPLED 98.71 %                 X-FACTOR     1.53
DEPTH/KS     4909.8                             Z SLOPE    0.70
```

SIZE RANGE IN MILLIMETERS	PERCENT IN RANGE SUSPENDED	BED	IBQB T/D	QPRIME SUBS(T/D)	MULT.	Z - VALUES ENTERED	COMP.	COMPUTATIONAL FACTORS F(J)	F(I)+1	COMP TOTAL DISCH (T/D)
0.0020 - 0.0625	43.00	0.00	0.00	732.9	0.01		0.01	1.01	0.00	742.9
0.0625 - 0.1250	10.00	0.00	0.00	170.4	0.14		0.15	1.03	0.00	175.1
0.1250 - 0.2500	11.00	3.00	0.76	187.5	0.35		0.37	1.07	0.00	201.7
0.2500 - 0.5000	9.00	31.00	22.38	153.4	0.66		0.70	1.29	0.00	219.8
0.5000 - 1.0000	27.00	50.00	102.12	460.2	1.00		1.06	2.06	10.30	1052.0
1.0000 - 2.0000	0.00	14.00	56.05	0.0	1.36		1.44	0.00	4.15	232.3
2.0000 - 4.0000	0.00	2.00	1.60	0.0	1.77		1.87	0.00	2.67	4.3
TOTALS	100.00	100.00	182.92	1704.5						2628.0

Run number 5. Z values entered for two size ranges. Z values for other size ranges obtained from regression line defined by entered z´s.

U.S. GEOLOGICAL SURVEY, WATER RESOURCES DIVISION

** DETERMINATION OF TOTAL SEDIMENT DISCHARGE BY THE MODIFIED EINSTEIN PROCEDURE **

RIO GRANDE CONV. CHANNEL AT SAN ACACIA, NM

DATE OF MEASUREMENT 12/15/76	TIME OF MEASUREMENT 1125
WATER DISCHARGE 767.0 CFS	D65 0.248 MM
AREA 159.49 SQFT	D35 0.182 MM
WIDTH 46.5 FT	DISTANCE BETWEEN BOTTOM SAMPLED ZONE AND BED 0.30 FT
AVERAGE VELOCITY 4.81 FT/SEC	AVERAGE DEPTH AT SAMPLED VERTICALS 3.50 FT
AVERAGE DEPTH 3.43 FT	MEASURED SUSP-SED CONC 3030. MG/L
WATER TEMPERATURE 3.3 C	MEASURED SUSP-SED DISCH 6274.8 T/D
KINEMATIC VISCOSITY 0.0000173 SQFT/SEC	APRIME 0.086
LAMINAR SUBLAYER THICKNESS 0.0011742 FT	SHEAR VELOCITY 0.170795 FT/SEC
REFERENCE SIZE RANGE - MULTIPLE	P-FACTOR 12.18
PERCENT OF FLOW SAMPLED 93.31 %	X-FACTOR 1.53
DEPTH/KS 4215.6	Z SLOPE 0.94 BY REGRESSION

SIZE RANGE IN MILLIMETERS	PERCENT IN RANGE SUSPENDED	BED	IBQB T/D	QPRIME SUBS(T/D)	IBQB RATIO	Z - VALUES ENTERED	COMP.	COMPUTATIONAL FACTORS F(J)	F(I)+1	COMP TOTAL DISCH (T/D)
0.0020 - 0.0625	37.00	1.00	0.00	2166.4	0.11		0.00	1.07	0.00	2323.0
0.0625 - 0.1250	27.00	9.00	0.38	1580.9	0.11	0.13	0.13	1.11	0.00	1762.0
0.1250 - 0.2500	31.00	55.00	8.28	1815.1	0.13	0.43	0.43	1.32	289.38	2397.1
0.2500 - 0.5000	5.00	31.00	13.21	292.8	0.13		1.06	3.62	9.79	313.7 *
0.5000 - 1.0000	0.00	3.00	2.14	0.0	0.13		1.90	0.00	2.56	5.5
1.0000 - 2.0000	0.00	1.00	0.71	0.0	0.13		2.88	0.00	1.77	1.3
TOTALS	100.00	100.00	184.27	5855.2						6802.6

* MEASURED SUSPENDED-SEDIMENT DISCHARGE -- WHICH EXCEEDS COMPUTED DISCHARGE (REVIEW COMPUTATION).

Run number 6. Z value entered for one size range. Z values for other size ranges computed from multipliers which vary with 0.7 power of fall velocity.

U.S. GEOLOGICAL SURVEY, WATER RESOURCES DIVISION

** DETERMINATION OF TOTAL SEDIMENT DISCHARGE BY THE MODIFIED EINSTEIN PROCEDURE **

NIOBRARA RIVER NR CODY, NE - SECT C2

DATE OF MEASUREMENT	6/19/52	TIME OF MEASUREMENT	1200
WATER DISCHARGE	239.0 CFS	D65	0.317 MM
AREA	115.64 SQFT	D35	0.226 MM
WIDTH	118.0 FT	DISTANCE BETWEEN BOTTOM SAMPLED ZONE AND BED	0.30 FT
AVERAGE VELOCITY	2.07 FT/SEC	AVERAGE DEPTH AT SAMPLED VERTICALS	1.22 FT
AVERAGE DEPTH	0.98 FT	MEASURED SUSP-SED CONC	262. MG/L
WATER TEMPERATURE	17.8 C	MEASURED SUSP-SED DISCH	169.1 T/D
KINEMATIC VISCOSITY	0.0000114 SQFT/SEC	APRIME	0.246
LAMINAR SUBLAYER THICKNESS	0.0015643 FT	SHEAR VELOCITY	0.084639 FT/SEC
REFERENCE SIZE RANGE	0.1250 - 0.2500 MM	P-FACTOR	10.67
PERCENT OF FLOW SAMPLED	78.98 %	X-FACTOR	1.52
DEPTH/KS	942.4	Z SLOPE	0.70

SIZE RANGE	PERCENT IN RANGE		IBQB	QPRIME	IBQB	Z - VALUES		COMPUTATIONAL FACTORS		COMP TOTAL
IN MILLIMETERS	SUSPENDED	BED	T/D	SUBS(T/D)	RATIO	ENTERED	COMP.	F(J)	F(I)+1	DISCH (T/D)
0.0020 - 0.0625	28.00	1.00	0.00	37.4	0.59		0.02	1.28	0.00	47.8
0.0625 - 0.1250	24.00	4.00	0.18	32.0	0.59		0.30	1.63	0.00	52.3
0.1250 - 0.2500	39.00	38.00	4.86	52.1	0.59	0.69	0.69	2.90	32.05	155.8
0.2500 - 0.5000	9.00	50.00	18.09	12.0	0.59		1.21	10.89	5.35	96.8
0.5000 - 1.0000	0.00	5.00	2.73	0.0	0.59		1.76	0.00	2.70	7.4
1.0000 - 2.0000	0.00	1.00	0.13	0.0	0.59		2.35	0.00	2.02	0.3
2.0000 - 4.0000	0.00	1.00	0.00	0.0	0.59		3.04	0.00	1.72	0.0
TOTALS	100.00	100.00	44.04	133.5						360.3

SUPPLEMENTAL DATA--SECTION J.

LOADING AND RUNNING THE PROGRAM ON THE PRIME COMPUTER

After the FORTRAN source code for the 2 programs (MEPDATA.F77 and MODEIN.F77) have been entered into the Prime computer, they must be compiled and loaded before they can be run.

Compiled programs MEPDATA.BIN and MODEIN.BIN are created by entering and executing in sequence, the commands F77 MEPDATA and F77 MODEIN.

The compiled programs are loaded by entering and executing the following command sequences:

```
SEG -LOAD            and        SEG -LOAD
$ LO MEPDATA                    $ LO MODEIN
$ LI                            $ LI
LOAD COMPLETE                   LOAD COMPLETE
$ Q                             $ Q
```

Files MEPDATA.SEG and MODEIN.SEG are created.

Lastly, the command SEG MEPDATA or SEG MODEIN is entered and executed to run the desired program.

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