8 Input Requirements and Program Output for SAM.yld

Purpose

SAM.yld provides hydraulic design engineers a systematic method for rapidly calculating bed-material sediment yield. This chapter will address the input data requirements and discuss the associated output.

SAM.yld calculates sediment yield passing a cross-section during a specified period of time. The time period considered can be a single flood event or an entire year. In SAM.yld the flow can be specified by either a hydrograph or a flow duration curve. The sediment rating curve can be specified either as sediment discharge versus water discharge or as sediment concentration versus water discharge. Calculations are based on the flow-duration sediment-discharge rating curve method (EM 1110-2-4000 USACE 1989).

General

The SAM.yld module expects an input file designated as *xxxxxxxx*.**yi**, where *x* can be any DOS acceptable character, including a space (but no embedded spaces), i.e., acceptable file names could be *say.yi* or *ITSNEVER.YI*. SAM.yld will write a corresponding file *xxxxxxxx*.**yo**, which is the output file. There is no plot output. SAM.yld input screens are accessed as shown in Figure 8.1.

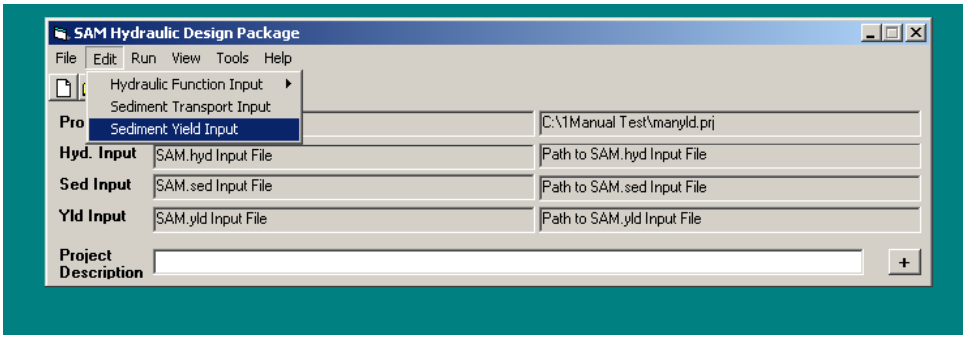

Figure 8.1. Accessing the Sediment Yield Input Screen

On the SAMwin main menu, clicking Edit/Sediment Yield Input brings up the screen in Figure 8-2. If there is an appropriate input file, a *.yi file, in the project directory, it's data will appear on the screen.

SAM.yld is designed to most easily run the data set made by SAM.sed, the *.yi file. SAM.sed writes the sediment concentration rating curve to a SAM.yld input file. If more than one sediment transport function was selected in SAM.sed, the SAM.yld input file will contain all sediment concentration rating curves, separated by a *$JOB* record. The flow duration curve or hydrograph, whichever is used, is not written into the *.yi file. This information can be added to a SAM.yld data set on the SAMwin Sediment Yield Input screen shown, Figure 8-2. Both the *.yi input file and the flow data file can be prepared with a system editor and read into the screen in Figure 8-2 using the File dropdown menu. The flow data file **MUST** be named CDFFIL and reside in the project directory.

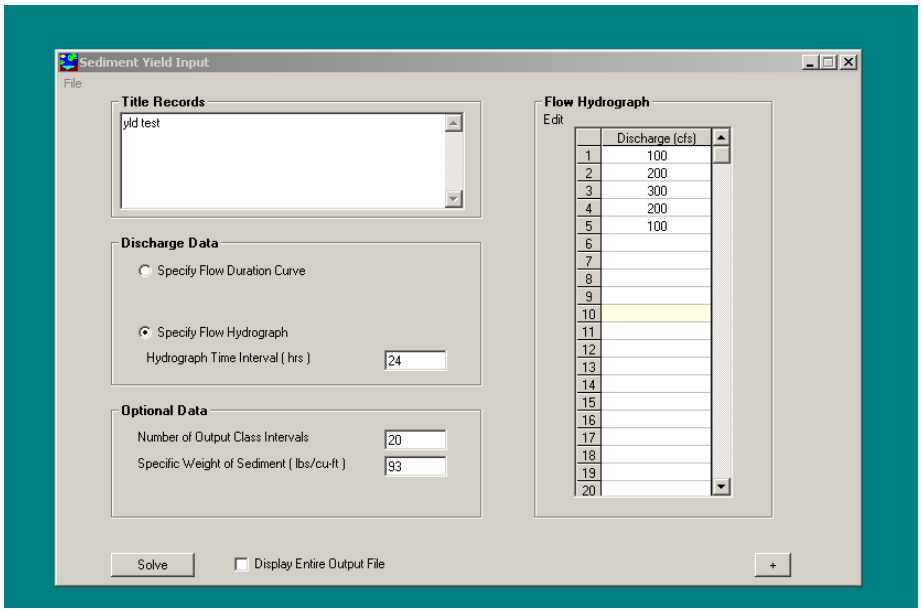

Figure 8-2. The Sediment Yield Input screen.

Title Records. This area allows the user to input descriptive strings, up to 78 characters long, for use in identifying data sets. These title records are written to the flow data file so should be used to describe the flow data, but the input is optional.

Discharge Data. The flow data may be input as a flow duration curve, the option shown in Figure 8.3, or as a flow hydrograph, Figure 8.4. Both options require the time interval to be input. Both the right hand side of the screen and the "Optional Data" area of the screen will request different data depending on the option selected here.

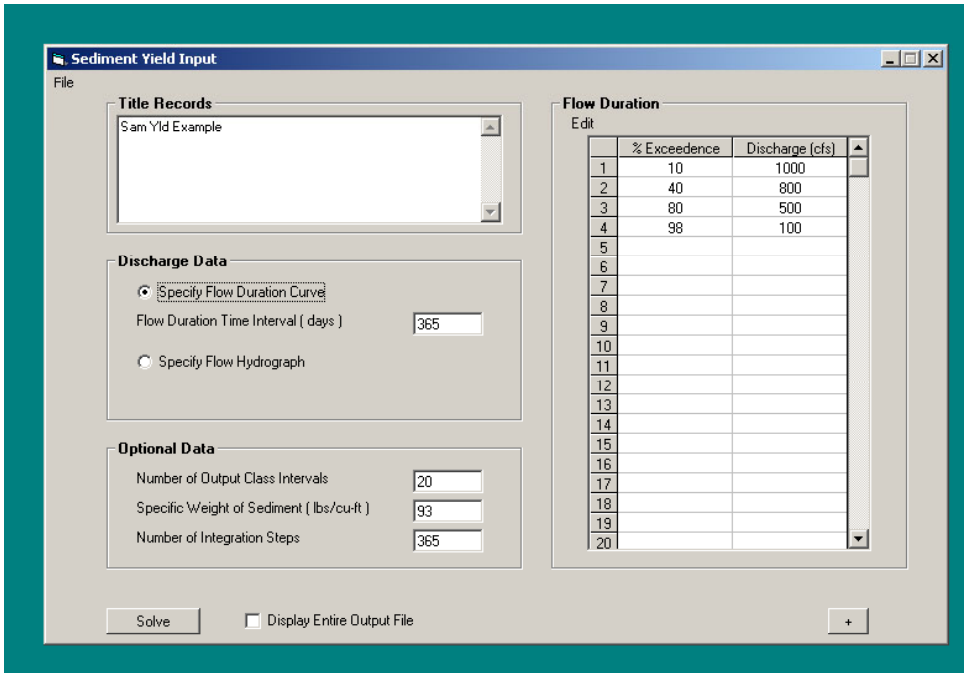

Figure 8.3. Example flow duration data input.

Flow Duration. This area allows the user to input the flow duration data. Data can be input in either increasing or decreasing percentage. **NOTE:** Do not use zero as the first or last discharge – use a very small number instead of zero, i.e., 0.0001. EM 1110-2-1415 (USACE) describes the procedure for calculating the flow duration curve. The time interval is input in days, and the default is 365. In the "Optional Data" section the "Number of Output Class Intervals" affects the Table 3.2 in the output file, a table useful for determining the effective discharge. The default for this value is 20. The "Specific Weight of Sediment (lbs/cu ft)" defaults to 93. The "Number of Integration Steps" refers to calculations internal to SAM.yld. The default is 365.

Flow Hydrograph. This area allows the user to input the flow hydrograph ordinate data. This hydrograph must have a uniform time-step. Zero can be used as a flow. The time interval is input in hours, and the default is 24. In the "Optional Data" section the "Number of Output Class Intervals" affects the Table 3.2 in the output file, a table useful for determining the effective discharge. The default for this value is 20. The "Specific Weight of Sediment (lbs/cu ft)" defaults to 93.

" + " Box. This button opens a small area below this window which will receive selected output. The output coming to this window cannot be selected by the user.

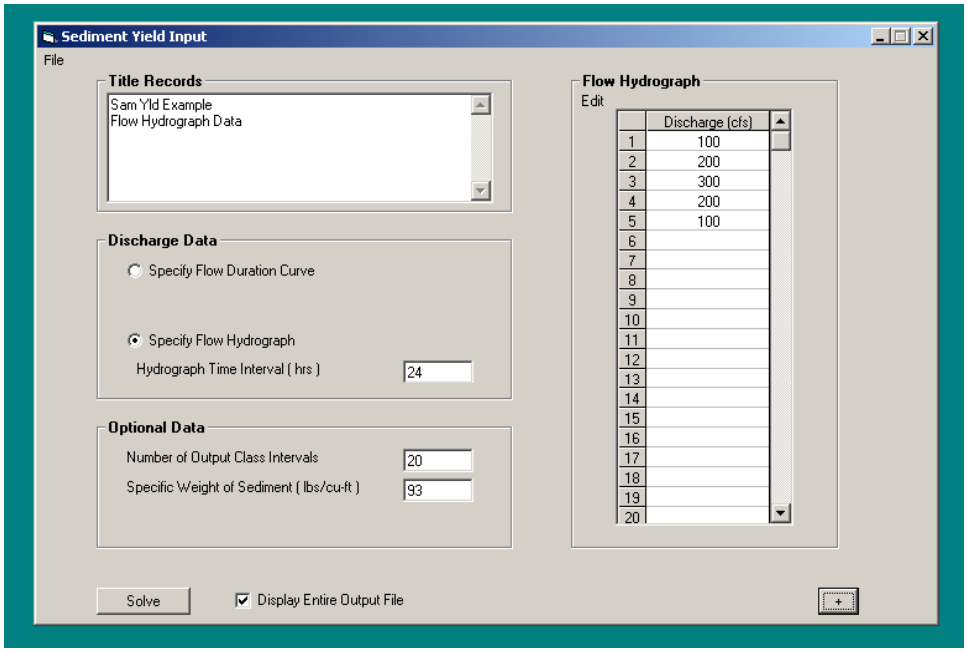

Figure 8.4. Example flow hydrograph data input.

Display Entire Output File. When this box is checked the output file will open in its own window (using Notepad) after calculations are complete. If this button is not checked, some input will echo to the screen in the area mentioned above. The entire output file can also be viewed by checking the View menu of the SAM main window and selecting "Sediment Yield Results."

Solve. This button causes SAM.yld to execute.

Program execution

The sediment yield calculations are made in SAMwin from the "Solve" button on the input screen, Figure 8.3 and 9.4, or from the "Run" dropdown menu. This second option is useful if a ready-to-run data set exists. This ready-to-run data set must contain the flow data, as described in the SAM Manual, or the flow data can be in a separate file that MUST be named "CDFFIL," no extension.

NOTE: If SAM.yld is run from the Run dropdown menu and it seems as though nothing happened, and there is no output file -- check to see if there is water data for the *.yi file being used, i.e., that there is a CDFFIL file in the directory.

Input Data Descriptions

The following example shows input data as created by running TEST 1C in SAM.sed. Notice that there is a separate input data set for each sediment transport function chosen in SAM.sed, with each data set ending with a *$JOB*, and a *$$END* record at the end. Also notice that no data set contains any flow-duration or hydrograph data.

```
TI      FILE WRITTEN BY SAM.sed
TF     LAURSEN(MADDEN),1985
QW   100    1000    5000   10000   20000
SC 9.225  55.792    243.    362.    512.
$JOB
TI      FILE WRITTEN BY SAM.sed
TF     ACKERS-WHITE,D50
QW   100    1000    5000   10000   20000
SC24.915    239.    684.   1076.   1615.
$JOB
TI      FILE WRITTEN BY SAM.sed
TF     VAN.RIJN
QW   100    1000    5000   10000   20000
SC16.999    101.    643.   1229.   2316.
$$END
```

In order to execute, the above data sets require flow information. This data is input through the "Sediment Yield Input" screen and automatically written to the *CDFFIL* file.

The flow information can also be in the ".yi" file, input using a system editor. Note that the information must be put in **each** "stacked" job, i.e., in each data set defined by a $JOB record. This format may be used to describe a flow-duration curve using discharge and percent of time exceeded, or a hydrograph, using QH records. See the Appendix E of this manual. The following examples show data sets containing the water data – the JP record, the QQ-QD record sets, and the QH records.

```
TI      FILE WRITTEN BY SAM.sed    VAN.RIJN
JP    25             500             730              89
QQ   100     140     160     180     200     250     300     350     400     450
QQ   500     550     600     650     700     750     800     850     900     950
QQ  1000    1100    1200    1300    1400    1500    1600    1700    1800    1920
QD 39.23   31.23   27.90   25.13   22.78   18.42   14.87   12.47   10.62    9.11
QD  7.89    7.05    6.44    5.69    5.19    4.69    4.16    3.90    3.55    3.30
QD  3.07    2.71    2.32    1.97    1.82    1.63    1.39    1.24    1.10    0.87
QW   100    1000    5000   10000   20000
SC20.354    107.    644.   1230.   2319.
$JOB

TI      FILE WRITTEN BY SAM.sed    LAURSEN(MADDEN),1985
F# 45678 2345678 2345678 2345678 2345678 2345678 2345678 2345678 2345678 2345678
JP    12                                      18      85
QW   100    1000    5000   10000   20000
SC 9.239  55.940    243.    363.    513.
QH   100     100     100     500     750    1000    1050    1100    1800    2500
QH  4000    5000    8000   13000   15000   18000   19850   17000   16000   13000
QH 11000   10000    8000    7000    4000    1000     800     500     200     100
QH   100
$$END
```

Sample Output Data

Selected results are printed to a window which opens below the input area as the program executes. The output coming to this window cannot be selected by the user. The complete output is saved in the appropriate default output file.

Output Data Sets

The following output files are from TEST 1C. The first output file shows that a flow duration curve data was input on the Sediment Yield Input screen. Note that the data set originally contained only the sediment discharge rating curves as output from SAM.sed and read the water data from the *CDFFIL* file. The output from only one sediment transport function is given here. The output from all sediment transport functions in the *.yi file are written to one file, the corresponding *.yo file.

```
*******************************************************************************
*                                                                             *
*      SAMwin   ---   HYDRAULIC DESIGN PACKAGE FOR FLOOD CONTROL CHANNELS     *
*                                                                             *
*                          SEDIMENT YIELD CALCULATIONS                        *
*                                                                             *
*                                  Version 1.0                                *
*                                                                             *
*           A Product of the Flood Control Channels Research Program          *
* Coastal & Hydraulics Laboratory, USAE Engineer Research & Development Center *
*                                                                             *
*                             in cooperation with                             *
*                                                                             *
*               Owen Ayres & Associates, Inc., Ft. Collins, CO                *
*                                                                             *
*******************************************************************************


 Msg 1:  YLD. READING INPUT DATA FROM FILE [  C:\Hold\hydtests.yi  ] THIS DIRECTORY.


 TABLE  1.  LIST INPUT DATA.

 TI      FILE WRITTEN BY SAM.sed
 TF     LAURSEN(MADDEN),1985
 QW   100    1000    5000   10000   20000
 SC 9.225  55.792    243.    362.    512.
 $JOB

 SAM.yld IS IMPORTING FLOWS FROM FILE = CDFFIL

 T1 yld test
 T1     using a flow duration curve
 T1     10 days
 T1
 JP    20             365             10              93
 QQ   100     700    1450    5600    8800   10300   16000   21000
 QD   100      98      95      80      67      34       2       0

 INPUT IS COMPLETE.


 TABLE 2.1  SEDIMENT DISCHARGE TABLE.

 Q,CFS       =      100.0    1000.0    5000.0   10000.0   20000.0
 QS,TONS/DAY =        2.5     150.6    3280.5    9774.0   27648.0
```

```
     MINIMUM Q IN Q-QS TABLE =  100.000
     MAXIMUM Q               =  20000.0

          TABLE 2.2  FLOW-DURATION TABLE
    #     CFS        %        #     CFS        %        #     CFS        %

    1    100.00    100.00     4   5600.00     80.00     7  16000.00      2.00
    2    700.00     98.00     5   8800.00     67.00     8  21000.00      0.00
    3   1450.00     95.00     6  10300.00     34.00

TABLE 2.3  INTEGRATION PARAMETERS FOR FLOW-DURATION OPTION
           MINIMUM FLOW, CFS           =       100.00
           MAXIMUM FLOW, CFS           =     21000.00
           INTEGRATION INTERVAL, CFS   =        57.26
           NUMBER OF INTEGRATION STEPS =       365

TABLE 2.7  DENSITY OF SEDIMENT DEPOSIT.
           IN LB/CUFT   =        93.00
           IN CY/TON    =         0.80

               TABLE 3.1  CALCULATED YIELDS

   SEDIMENT TRANSPORT FUNCTION USED -- LAURSEN(MADDEN),1985

    TIME PERIOD,    DAYS =      10.000
    WATER YIELD,    ACFT =     171691.,  Mean Daily Flow, CFS =      8656.07
    SEDIMENT YIELD, TONS =      84052.,  Mean Daily Load, T/D =        8405.
                    CUYD =      66947.,  Mean Daily Conc, mg/l=      359.636

TABLE 3.2  DISTRIBUTION OF YIELD BY WATER DISCHARGE CLASS INTERVAL.
           NO. OF CLASSES =        20   ,           CLASS INTERVAL =      1045.00
           MINIMUM Q, CFS =       100.00,           MAXIMUM Q, CFS =     21000.00

CLASS DISCHARGE     SEDIMENT   INCREMENT OF          INCREMENT OF SEDIMENT
        CFS         TONS/DAY    WATER, ACFT   %      %      TONS              CU YD

          100.           2.
   1                             272.   0.16   0.01          9.           7.
         1145.         195.
   2                            1835.   1.07   0.25        212.         169.
         2190.         676.
   3                            2314.   1.35   0.51        430.         343.
         3235.        1425.
   4                            2224.   1.30   0.67        562.         447.
         4280.        2436.
   5                            2157.   1.26   0.81        677.         539.
         5325.        3623.
   6                            5172.   3.01   2.22       1868.        1488.
         6370.        4804.
   7                            6025.   3.51   2.85       2393.        1906.
         7415.        6102.
   8                            5700.   3.32   2.92       2456.        1957.
         8460.        7511.
   9                           35692.  20.79  19.65      16520.       13158.
         9505.        9023.
  10                           37756.  21.99  22.11      18583.       14801.
        10550.       10591.
  11                           29234.  17.03  18.03      15151.       12067.
        11595.       12204.
  12                           16306.   9.50  10.52       8841.        7042.
        12640.       13890.
  13                            9551.   5.56   6.42       5398.        4299.
        13685.       15648.
  14                            5830.   3.40   4.07       3423.        2727.
        14730.       17474.
  15                            3686.   2.15   2.67       2243.        1787.
        15775.       19367.
  16                            1812.   1.06   1.36       1140.         908.
        16820.       21323.
  17                            1531.   0.89   1.18        993.         791.
        17865.       23341.
  18                            1531.   0.89   1.22       1023.         815.
        18910.       25419.
  19                            1531.   0.89   1.25       1052.         838.
```

```
        19955.       27555.
  20                            1531.   0.89   1.28       1080.        860.
        21000.       29748.
                                ________ ______ ______ __________ __________
                                171691. 100.00 100.00      84052.      66947.

 ...END OF JOB...     Printout is in FILE [  C:\Hold\hydtests.yo
```

The next output file shows the use of the hydrograph water data.

```
*********************************************************************************
*                                                                               *
*      SAMwin   ---   HYDRAULIC DESIGN PACKAGE FOR FLOOD CONTROL CHANNELS      *
*                                                                               *
*                          SEDIMENT YIELD CALCULATIONS                          *
*                                                                               *
*                                 Version 1.0                                   *
*                                                                               *
*           A Product of the Flood Control Channels Research Program            *
* Coastal & Hydraulics Laboratory, USAE Engineer Research & Development Center *
*                                                                               *
*                            in cooperation with                                *
*                                                                               *
*               Owen Ayres & Associates, Inc., Ft. Collins, CO                  *
*                                                                               *
*********************************************************************************

 Msg 1:  YLD. READING INPUT DATA FROM FILE [  C:\Hold\hydtests.yi  ] THIS
DIRECTORY.

 TABLE  1.  LIST INPUT DATA.

 TI      FILE WRITTEN BY SAM.sed
 TF     LAURSEN(MADDEN),1985
 QW   100    1000    5000   10000   20000
 SC 9.225  55.792    243.    362.    512.
 $JOB

 SAM.yld IS IMPORTING FLOWS FROM FILE = CDFFIL

 T1 yld test
 T1     using a hydrograph
 T1     24-hr interval
 T1
 JP    20                                      24      93
 QH   500     950    1300    2800    4850    6600    9825   13790   15980   14760
 QH 11030    7800    3550    1870     850     590     240

 INPUT IS COMPLETE.

 TABLE 2.1  SEDIMENT DISCHARGE TABLE.

 Q,CFS       =      100.0    1000.0    5000.0   10000.0   20000.0
 QS,TONS/DAY =        2.5     150.6    3280.5    9774.0   27648.0

      MINIMUM Q IN Q-QS TABLE =  100.000
      MAXIMUM Q               =  20000.0

 TABLE 2.4  DISCHARGE HYDROGRAPH POINTS, CFS
            TIME BETWEEN POINTS, HRS =    24.0000
      500.00      950.00     1300.00     2800.00     4850.00     6600.00
     9825.00    13790.00    15980.00    14760.00    11030.00     7800.00
     3550.00     1870.00      850.00      590.00      240.00

 TABLE 2.5  FLOW-DURATION TABLE FROM HYDROGRAPH POINTS
            CLASS VARIABLE =  DISCHARGE, CFS

 CLASS        CLASS INTERVAL       DURATION    %    EXCEEDENCE
   #       LIMIT       MIDPOINT      DAYS              %

    1       240.00                                    100.00
                      633.50          4.50  28.13
```

```
   2      1027.00                                        71.88
                    1420.50          1.00   6.25
   3      1814.00                                        65.63
                    2207.50          1.00   6.25
   4      2601.00                                        59.38
                    2994.50          1.00   6.25
   5      3388.00                                        53.13
                    3781.50          1.00   6.25
   6      4175.00                                        46.88
                    4568.50          1.00   6.25
   7      4962.00                                        40.63
                    5355.50          0.00   0.00
   8      5749.00                                        40.63
                    6142.50          0.00   0.00
   9      6536.00                                        40.63
                    6929.50          1.00   6.25
  10      7323.00                                        34.38
                    7716.50          1.00   6.25
  11      8110.00                                        28.13
                    8503.50          0.00   0.00
  12      8897.00                                        28.13
                    9290.50          0.00   0.00
  13      9684.00                                        28.13
                   10077.50          1.00   6.25
  14     10471.00                                        21.88
                   10864.50          1.00   6.25
  15     11258.00                                        15.63
                   11651.50          0.00   0.00
  16     12045.00                                        15.63
                   12438.50          0.00   0.00
  17     12832.00                                        15.63
                   13225.50          0.00   0.00
  18     13619.00                                        15.63
                   14012.50          1.00   6.25
  19     14406.00                                         9.38
                   14799.50          1.00   6.25
  20     15193.00                                         3.13
                   15586.50          0.50   3.13
  21     15980.00                                         0.00
                                  ___________
              TOTAL TIME    =         16.00    TOTAL EVENTS=         17
              MAXIMUM VALUE =      15980.00       EVENT NO.=          9
              MINIMUM VALUE =        240.00       EVENT NO.=         17
              % BELOW RANGE =        0.0000    ABOVE RANGE =     0.0000

TABLE 2.6  INTEGRATION PARAMETERS FOR HYDROGRAPH OPTION
           MINIMUM FLOW, CFS           =       240.00
           MAXIMUM FLOW, CFS           =     15980.00
           NUMBER OF INTEGRATION STEPS =       365

TABLE 2.7  DENSITY OF SEDIMENT DEPOSIT.
           IN LB/CUFT   =        93.00
           IN CY/TON    =         0.80

               TABLE 3.1  CALCULATED YIELDS
   SEDIMENT TRANSPORT FUNCTION USED -- LAURSEN(MADDEN),1985

    TIME PERIOD,    DAYS =      17.000
    WATER YIELD,    ACFT =     188757.,  Mean Daily Flow, CFS =      5597.94
    SEDIMENT YIELD, TONS =      89439.,  Mean Daily Load, T/D =        5261.
                    CUYD =      71237.,  Mean Daily Conc, mg/l=      348.084

TABLE 3.2  DISTRIBUTION OF YIELD BY WATER DISCHARGE CLASS INTERVAL.
           NO. OF CLASSES =        20   ,           CLASS INTERVAL =       787.00
           MINIMUM Q, CFS =       240.00,           MAXIMUM Q, CFS =     15980.00

CLASS DISCHARGE     SEDIMENT   INCREMENT OF         INCREMENT OF SEDIMENT
        CFS         TONS/DAY    WATER, ACFT   %     %      TONS             CU YD

          240.          12.
   1                             4728.   2.50   0.23        210.        167.
         1027.         159.
   2                             2888.   1.53   0.33        294.        234.
         1814.         471.
   3                             4597.   2.44   0.80        715.        570.
```

```
        2601.         939.
   4                          6282.   3.33   1.45       1300.       1036.
        3388.        1557.
   5                          7959.   4.22   2.29       2046.       1629.
        4175.        2323.
   6                          9632.   5.10   3.30       2947.       2347.
        4962.        3233.
   7                             0.   0.00   0.00          0.          0.
        5749.        4087.
   8                             0.   0.00   0.00          0.          0.
        6536.        5002.
   9                         14641.   7.76   6.58       5884.       4687.
        7323.        5983.
  10                         16308.   8.64   7.80       6974.       5555.
        8110.        7027.
  11                            0.   0.00   0.00          0.          0.
        8897.        8131.
  12                            0.   0.00   0.00          0.          0.
        9684.        9292.
  13                         21310.  11.29  11.86      10609.       8450.
       10471.       10473.
  14                         22976.  12.17  13.30      11892.       9472.
       11258.       11675.
  15                            0.   0.00   0.00          0.          0.
       12045.       12921.
  16                            0.   0.00   0.00          0.          0.
       12832.       14208.
  17                            0.   0.00   0.00          0.          0.
       13619.       15535.
  18                         29642.  15.70  19.48      17427.      13880.
       14406.       16901.
  19                         31308.  16.59  21.15      18917.      15067.
       15193.       18305.
  20                         16487.   8.73  11.43      10223.       8143.
       15980.       19746.
                  _________ ______ ______ __________ __________
                     188757. 100.00 100.00      89439.      71237.

...END OF JOB...     Printout is in FILE [  C:\Hold\hydtests.yo]
```

Output Data Description

Since the SAM.yld input file contained a *$$JOB* record, the use here of the term "output data set" refers to output from program banner to the "END OF JOB" tag. As in SAM.hyd and SAM.sed, Table 1 in every output data set is an echo of the input data set. However, in SAM.yld this table echoes the input from both the *.yi file and the *CDFFIL* water data file. Table 2.1 is the "Sediment Discharge Table" and shows the input sediment discharge rating curve in tons per day. The next several table numbers and the information displayed differ depending on whether the calculations were based on a flow duration curve or a hydrograph. If the input data included flow-duration information, the output includes tables 2.2 and 2.3. Table 2.2 simply echoes the input flow-duration curve. Table 2.3, "Integration Parameters for Flow-Duration Option," includes the number of integration steps, an input item on the Sediment Yield Input screen, and the integration interval in cfs. If the input data included QH records, the output includes tables 2.4, 2.5, and 2.6. Table 2.4 echoes the QH records and lists the time between points. Table 2.5 shows the hydrograph converted to a flow-duration table. Table 2.6 corresponds the Table 2.3, above, but is the "Integration Parameters for Hydrograph Option." The number of integration steps, echoed on this table, is an input parameter.

At this point the output table names and information specified become the same. Table 2.7 gives the density of the sediment deposit, another possible input variable. Table 3.1, "Calculated Yields," echoes to the screen in the drop down area of the Sediment Yield Input screen as well as printing to the output file. This table provides the "answers" for the SAM.yld option, giving the sediment yield in both tons and cubic yards, and echoing the time period, in days, as input on Figure 8.3 or 9.4. It also lists the sediment transport function used for that data set.

Table 3.2 is the "Distribution of Yield by Water Discharge Class Interval." The first column, "Class," is '20' in the example problems, because in the "Optional Data" area on the "Sediment Yield Input" screen, the "Number of Output Class Intervals" was left at the default of 20. The number of intervals into which the range of flows is divided can be changed with this input parameter. When a flow duration curve has been input, Table 3.2 can be used to determine the effective discharge – the discharge that moves the most sediment. The effective discharge can be determined by looking for the class that has the largest "increment of sediment." Copeland et al. (2001) has a discussion of effective discharge in chapter 3.

The end of the output for this data set is marked with "...END OF JOB..." and a note with the output filename. If the input file has stacked jobs, the next data set will begin with a new program banner.

If some discharges in the flow-duration or hydrograph information fall outside the range of discharges in the sediment discharge rating curve, the program will inform the user. These messages will print out in connection with the "Integration Parameters" table. The program will then assign a sediment discharge in tons per day to the water discharge value that is out of range, based on the existing sediment discharge table, Table 2.1. This is the "YOUT" value listed in the "INDEPENDENT VARIABLE XIN OUT OF TABLE BOUNDS" message if it appears.

Plotting

SAM.yld has no plotting capabilities at this time.