Chapter 3

General Input Requirements

3.1 General Description of Data Input

Input data are grouped into the categories of geometry, sediment, hydrology, and special commands. A description of input records is contained in Appendix A. The alphanumerics in parentheses after each section heading in this chapter refer to the input records that control the discussed data.

3.2 Geometric Data

Geometric data includes cross sections, reach lengths and n values. In addition, the movable bed portion of each cross section and the depth of sediment material in the bed are defined. The **NC** to **H** records are used to define the model geometry. The format used for geometric data is similar to that of HEC-2.

3.2.1 Cross Sections (X1, X3, GR)

Cross sections are specified for the initial conditions. Calculations are made directly from coordinate points (stations, elevations), not from tables or curves of hydraulic elements. **GR** records are used to input elevation-station coordinates to provide a description of the shape of a cross section. Elevations may be positive, zero or negative. Cross section identification numbers, entered in field 1 of the **X1** record for each cross section, must be positive and should increase in the upstream direction. Corrections for skew (**X1**.8)[2] and changes in elevation (**X1.**9) can be made without re-entering coordinate points. If the water surface elevation exceeds the end elevations of a section, calculations continue by extending the end points vertically, neglecting the additional wetted perimeter.

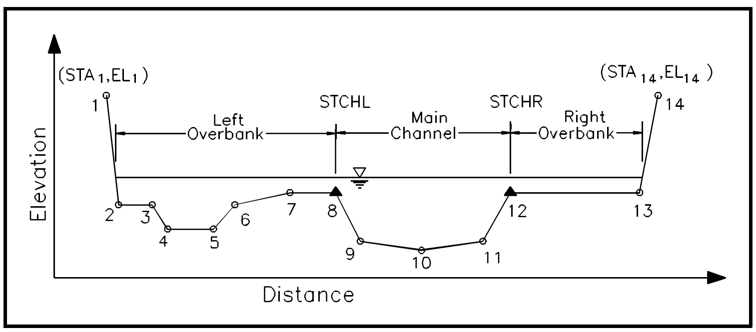


Figure 3-1
Cross Section Subsections

Each cross section may be subdivided into three parts called subsections - the left overbank, main channel and right overbank as shown in Figure 3-1. Each subsection must have a reach length. It extends from the previous (downstream) section to the present cross section. This enables the simulation of channel curves where the outer part of the bend, which is represented by an overbank area, has a reach length larger than the channel or the inside overbank area. For meandering rivers, the channel length is generally greater than the overbank reach lengths.

[2] The reference (**X1**.8) means that the variable being discussed, in this case, skew, can be entered in field 8 of the **X1** record).

3.2.2 Manning's *n* Values (NC, NV, $KL, $KI)

A Manning's *n* value is required for each subsection of a cross section. It is not possible to automatically change *n* values with respect to time. Static or fixed *n* values are entered using the **NC** record. The *n* values may vary with either discharge or elevation in the main channel and overbank areas by using **NV** records. When *n* varies with discharge, the first *n* on the **NV** record should be a negative value. An **NC** record must precede the first cross section even if an **NV** record immediately follows and overrides it.

Limerinos' (1970) relationship is available for the determination of Manning's *n* based upon bed gradation. This relationship is:

$$n = \frac{0.0926R^{1/6}}{1.16 + 2.0\ \log_{10}\left(\frac{R}{d_{84}}\right)} \tag{3-1}$$

where: d_{84} = particle size in the stream bed of which 84 percent of the bed is finer, in feet
R = hydraulic radius, in feet

To compute *n* values utilizing Limerinos' relationship, the **$KL** record is placed in the hydrologic data. To return to the input *n* values, a **$KI** record must be input.

The calculation of friction loss through the reach between cross sections is made by averaging the end areas of a subsection, averaging the end hydraulic radii and applying the subsection *n* value and reach length to get a length-weighted subsection conveyance. Subsection conveyances are summed to get a total value for the cross section reach which is used to calculate friction loss.

3.2.3 Movable Bed (H, HD)

Each cross section is divided into movable and fixed-bed portions. The **H** (or **HD**) record is used to define the movable bed limits, **XSM** and **XFM**, which can extend beyond the channel bank station. Scour and deposition will cause the movable bed to fall or rise by changing the cross section elevations within the movable bed at the end of each time step.

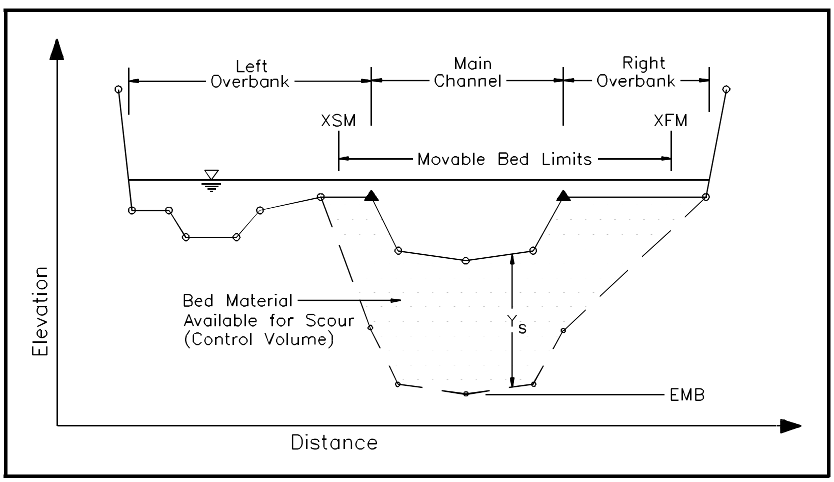


Figure 3-2
Sediment Material in the Stream Bed

The elevation of the model bottom is specified in field 2 of the **H** record. After determining the minimum channel elevation of each cross section, HEC-6 uses the model bottom elevation to compute the depth of sediment material available for scour. Optionally, the depth of sediment material, $\mathbf{Y_s}$, can be specified directly by using an **HD** record instead of an **H** record for each cross section.

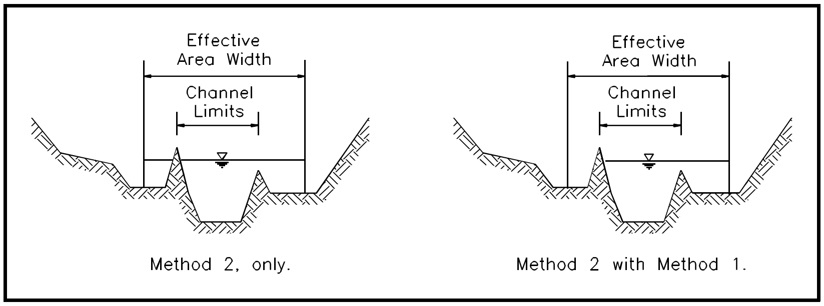
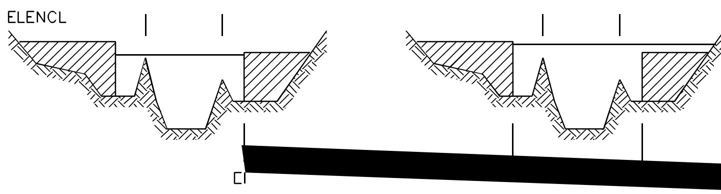


Figure 3-4
Examples of Ineffective Area, Method 2



3.3 Sediment Data

Sediment data is specified on records **I** through **PF**. This data includes fluid and sediment properties, the inflowing sediment load data, and the gradation of material in the stream bed. The transport capacity relationship(s) and unit weights of deposited material are also input in this section.

The grain sizes of sediment particles commonly transported by rivers may range over several orders of magnitude. Small sizes behave much differently from large sizes. Therefore, it is necessary to classify sediment material into groups for application of different transport theories. The three basic classes considered by HEC-6 are clay, silt, and sands-boulders. The groups are identified and subdivided based on the American Geophysical Union (AGU) classification scale (Table 2-1, Vanoni 1975) as shown in Table 3-1. HEC-6 accounts for 20 different sizes of material including one size for clay, four silt sizes, five sand sizes, five gravel, two cobble sizes, and three boulder sizes. The representative size of each class is the geometric mean size, which is the square root of the class ranges multiplied together. For example, the geometric mean size for medium silt is $(0.016 \cdot 0.032)^{1/2}$ or 0.023 mm.

Table 3-1
Grain Size Classification of Sediment Material

Class Size Number Used in HEC-6	Sediment Material	Grain Diameter (mm)
	Clay	
1	Clay	0.002 - 0.004
	Silt	
1	Very Fine Silt	0.004 - 0.008
2	Fine Silt	0.008 - 0.016
3	Medium Silt	0.016 - 0.032
4	Coarse Silt	0.032 - 0.0625
	Sands - Boulders	
1	Very Fine Sand (VFS)	0.0625 - 0.125
2	Fine Sand (FS)	0.125 - 0.250
3	Medium Sand (MS)	0.25 - 0.50
4	Coarse Sand (CS)	0.5 - 1.0
5	Very Coarse Sand (VCS)	1 - 2
6	Very Fine Gravel (VFG)	2 - 4
7	Fine Gravel (FG)	4 - 8
8	Medium Gravel (MG)	8 - 16
9	Coarse Gravel (CG)	16 - 32
10	Very Coarse Gravel (VCG)	32 - 64
11	Small Cobbles (SC)	64 - 128
12	Large Cobbles (LC)	128 - 256
13	Small Boulders (SB)	256 - 512
14	Medium Boulders (MB)	512 - 1024
15	Large Boulders (LB)	1024 - 2048

3.3.1 Inflowing Sediment Load (LQ, LT, LF)

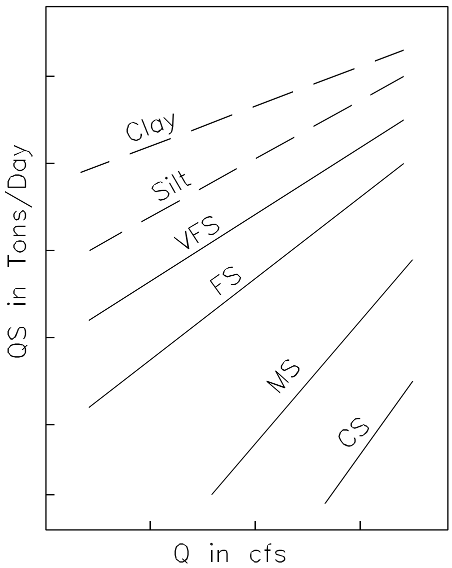


Figure 3-7
Water-Sediment Inflow Relationship

The aggradation or degradation of a stream bed profile depends upon the amount and size of sediment inflow relative to the transport capacity of the stream (see Section 2.3.1). The inflowing sediment supplies entering the upstream boundaries of the geometric model and at local inflow points are called inflowing sediment loads and are expressed in tons/day. The sediment load should include both bed and suspended load (total load) and is expressed as a log-log function of water discharge in cfs vs. sediment load in tons/day as depicted in Figure 3-7.

Data is entered on the **LT** and **LF** records as a table of sediment load by grain size class for a range of water discharges. The discharges entered on the **LQ** record should encompass the full range found in the computational hydrograph. A complete sediment load table is required for every inflow into the network. This includes the inflow to each stream segment as well as all local inflows.

In most projects, the sediment load table, once set, does not need to be modified. However, the option exists to modify or replace a sediment load table at any time during the simulation. This option is provide by the **$SED** option. See Appendix A for a description of this option.

If the inflowing sediment load is essentially of one grain size, that size should be located in Table 3-1, identified by its classification, and assigned the number of its grain size class. For instance, if the representative size is 0.035 mm, its classification is medium sand and its sand size number is 3. This number is then input for variables IGS and LGS on the **I4** record. But if the inflowing load is composed of a range of grain sizes, it is desirable to further subdivide sand and perhaps silts and clays into the classifications shown in Table 3-1. Use as many of these classifications as needed to describe the situation. It is not necessary to start with the smallest size nor is it necessary to go to the coarsest size, but once a range of sizes is selected, all grain sizes within that range must be included. The AGU classifications in Table 3-1 are stored internally in HEC-6 and cannot be modified.

3.3.2 Sediment Material in the Stream Bed (PF)

Transport theory for sand relates the total moving sand and coarser load to the gradation of sediment particles on the bed surface. Armor calculations require the gradation of material beneath the bed surface and knowledge about the depth to bedrock or some other material that might prevent degradation.

The gradation of sediment material in the stream bed (the subsurface gradation) is specified as a function of percent finer vs. grain size on the **PF** records. Cross section numbers are used in field 1 of the **PF** records to identify the subsurface gradation location within the geometric data set. Subsurface gradations are linearly interpolated for those cross sections for which **PF** records have not been specified.

The gradation of sediment particles on the stream bed (the bed surface gradation) and the distribution of sizes in the inflowing load are intimately related. One must complement the other in sediment transport theory. The significant depth for sediment transport calculations is two grain diameters and is difficult to sample. Therefore, in using HEC-6, it is customary to specify inflowing sediment load and the subsurface gradation and let HEC-6 calculate the bed surface gradation.

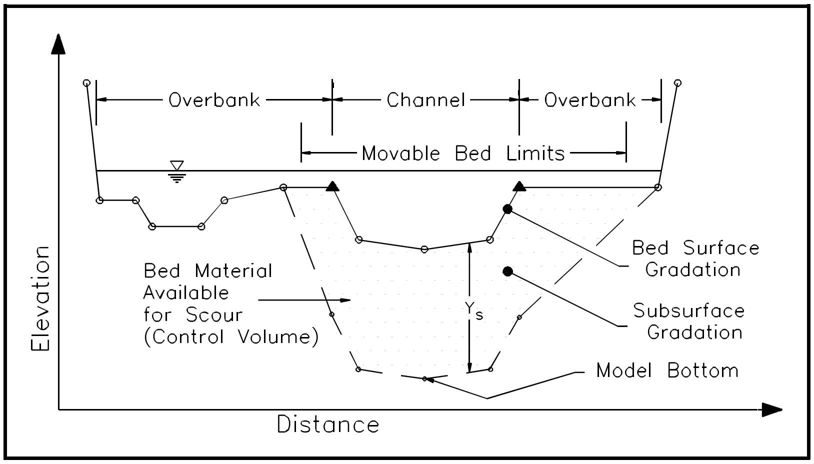


Figure 3-8
Bed Sediment Control Volume

3.3.3 Sediment Properties (I1, I2, I3, I4)

Five basic properties are considered: grain size, specific gravity, grain shape factor, unit weight of deposits and fall velocity. The grain size classifications shown in Table 3-1 are predefined in HEC-6. The specific gravity of bed material has a default value of 2.65 and the grain shape factor has a default value of 0.667. These values can be altered by providing the new values on the **I2**-**I4** records. The fall velocity method is input on the **I1** record.

3.3.4 Sediment Transport

3.3.4.1 Clay and Silt Transport (I2, I3)

Two methods for clay and silt transport are available in HEC-6. They are only applicable for flows with suspended sediment concentrations less than 300 mg/ℓ (Krone 1962). The first method (MTCL and MTSL = 1 in **I2** and **I3** records, respectively) allows the deposition of clays and silts but does not allow scour. The second method (MTCL and MTSL = 2) allows for both deposition and scour as described in Section 2.3.8. When this method is used, two additional **I2** records are required to provide information regarding critical shear stress thresholds for deposition and shear stress thresholds and erosion rates for both particle and mass erosion. Further details concerning these additional **I2** records are given in the **Special I2** record description in Appendix A.

3.3.4.2 Sand and Gravel Transport (I1, J, K)

There are several sand and gravel transport relationships available in HEC-6. The **I4** record is used to specify which of the following to use.

a. Toffaleti's (1966) transport function
b. Madden's (1963) modification of Laursen's (1958) relationship
c. Yang's (1973) stream power for sands
d. DuBoys' transport function (Vanoni 1975)

e. Ackers-White (1973) transport function
f. Colby (1964) transport function
g. Toffaleti (1966) and Schoklitsch (1930) combination
h. Meyer-Peter and Müller (1948)
i. Toffaleti and Meyer-Peter and Müller combination
j. Madden's (1985, unpublished) modification of Laursen's (1958) relationship
k. Copeland's (1990) modification of Laursen's relationship (Copeland and Thomas 1989)
l. User specification of transport coefficients based upon observed data

For the options involving two sediment transport relationships, the transport potential for each sediment size is computed using both methods and the largest transport potential is utilized.

If there is enough field data to develop a functional relationship between hydraulic parameters and sediment transport by grain size, the user-developed relationship using the **J** and **K** records should be considered. The functional relationship for each size class, **i**, is:

$$GP_i = \left[\frac{EFD \cdot SLO - C_i}{A_i}\right]^{B_i} \cdot EFW \cdot STO \qquad \textbf{(3-2)}$$

where:
EFD = effective depth
EFW = effective width
SLO = energy slope
STO = roughness correction factor, see Equation 3-3
A, B, C = sediment transport coefficients developed using data
GP = sediment transport potential

Often the transport potential is affected by variations in flow resistance. To account for this, the **K** record is used to define a factor, **STO**, which is multiplied by **GP** to determine the sediment transport potential. **STO** is defined by:

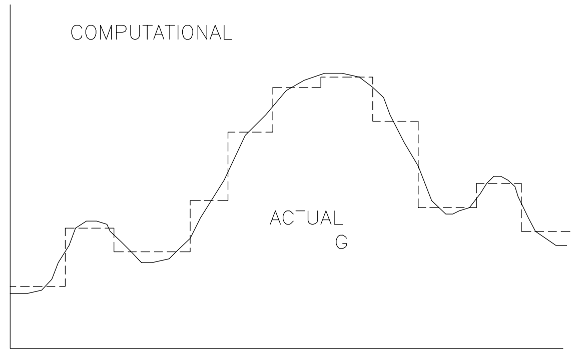
$$STO = 10^{-6} \cdot D \cdot n^{E} \qquad \textbf{(3-3)}$$

where:
D,E = sediment transport coefficients developed using data
n = Manning's roughness coefficient
STO = multiplying factor of GP

3.4 Hydrologic Data

Hydrologic data is specified on records **Q** through **W**. The hydrologic data includes water discharges, temperatures, downstream water surface elevations and flow duration.

Having specified the initial geometry (size, shape, and slope of the channel) and the sediment relationships for the stream, the final step in sediment calculations is to simulate the response of these data to hydrologic inputs and, perhaps, reservoir operation rules. A continuous simulation is needed for a water discharge hydrograph since both sediment transport and hydraulics of flow are nonlinear functions of water discharge. The lack of coincidence between main stem and tributary flood hydrographs makes it essential to enter flow from tributaries at their correct locations along the main stem.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3.4.2.2 Downstream Boundary Conditions ($RATING, RC, R, S)

A water surface elevation must be specified at the downstream boundary of the model for every time step. HEC-6 provides three options for prescribing this downstream boundary condition: (1) a rating curve, (2) **R** records, or (3) a combination of a rating curve and **R** records.

The first option involves the use of a rating curve which can be specified using a **$RATING** record followed by a set of **RC** records containing the water surface elevation data as a function of discharge (See Table 3-2). The rating curve need only be specified once at the start of the hydrologic data and a water surface elevation will be determined by interpolation using the discharge given on the **Q** record for each time step. The rating curve may be temporarily modified using the **S** record or replaced by entering a new set of **$RATING** and **RC** records before any Q record in the hydrologic data.

In the second option, **R** records can be used **instead** of a rating curve to define the water surface elevation. This option is often used with reservoirs where the water surface elevations are a function of time and not flow. To use this method, an **R** record is required for the first time step. The elevation entered in Field 1 of this record will be used for each succeeding time step until another **R** record is found with a non-zero value in Field 1 to change it. In this way, you only insert **R** records to change the water surface to a new value.

Option 3 is a combination of the first two options. This option makes it possible to use the rating curve most of the time to determine the downstream water surface elevation while still allowing the user to specify the elevation exactly at given time steps. In this option, the **R** record's non-zero Field 1 value for the downstream water surface elevation will override the rating curve for that time step. On the next time step, HEC-6 will go back to using the rating curve unless another **R** record is found with a non-zero value in Field 1.

3.4.2.3 Internal Boundary Conditions (QT, X5, R)

The **QT** record defines the location of a local inflow or tributary junction. The methods for prescribing the inflowing water and sediment discharge data are discussed in Section 3.4.2.1 (these are upstream boundary conditions). The water surface elevation of the downstream boundary of a tributary cannot be prescribed by the user; HEC-6 assigns the water surface of the cross section downstream of the junction to the downstream boundary of the tributary (this is a downstream boundary).

An **X5** record in the geometry data creates an internal boundary (or hydraulic control point) at which the water surface may be specified. The specified water surface at this internal boundary is called an internal boundary condition. Two options are available to specify the water surface at this internal boundary. A rule-curve type of option can be specified to establish a constant operating elevation of a navigation pool within the geometric data. This is accomplished by specifying a water surface elevation and a head loss on the **X5** record. When the tailwater elevation plus the head loss term is higher than the specified water surface elevation, the pool rises. This option was originally developed for hinged pool operations which usually had constant head losses for all discharges. The second option allows users to specify a rating curve at an internal boundary by using a combination of **X5** and **R** records. This is helpful in modeling weirs and drop structures.

3.4.2.4 Transmissive Boundary Condition ($B)

If a **$B** record is encountered in the hydrologic data, a transmissive boundary condition is defined at every downstream boundary in the system. This transmissive boundary condition will allow sediment reaching that boundary to pass without changing that cross section. This is useful for situations where the conditions at the downstream boundary are anomalous (such as at a bridge, weir, drop structure, etc.) and may cause upstream computations to be in error if incorporated into the sediment transport/bed change computations.

3.4.3 Example Hydrology Input

An example set of hydrologic data for several time steps is shown in Table 3-2.

The **$HYD** record indicates that the hydrologic data follows. The **$RATING** and **RC** records are used to input a discharge-elevation relationship. Every time step must have Q, **Q** and **W** (or **X**) records. The Q records contain user comments and also control the output level for each time step. The A in Column 5 and the B in Column 6 of the Q record for event number 1 will produce A-level output of the water surface profile computations and B-level output of the sediment transport computations.

The **Q** record contains the water discharge and its duration, in days, is on the **W** record. Because long time steps may cause computational oscillations, it may be desirable to divide long time steps into smaller increments. In time step 3, an **X** record is used to divide a long 10 day time step into 20 half day increments.

A water temperature (**T**) record is **always** required for the first time step. In this example, no **T** record is given in time step 2; therefore, the second time step will use the same temperature as time step 1 (60°F). The **T** record in time step number 3 changes the temperature (70°F).

Table 3-2
Example of Hydrologic Input for HEC-6

```
$HYD
  field1|field 2|field 3|field 4|field 5|field 6|field 7|...
$RATING
RC    3    100      0      0    520    525    528
Q   AB  Time Step 1, A/B Level Output
Q    100
T     60
W      1
Q       Time Step 2 - No Output
Q    200
W      2
Q    A  Time Step 3 - 10 days at 20 increments
Q    200
R    527
T     70
X           .5     10
  field1|field 2|field 3|field 4|field 5|field 6|field 7|...
$RATING
RC    3    100      0      0    520    525    528
Q   BB  TIME STEP NO. 4
Q    200
W      1
$$END
```

The water surface elevation in Field 1 on the **R** record in time step number 3 sets the stage for the downstream boundary to 527 ft. This value overrides the Stage-Discharge Rating curve entered before time step 1. The rating curve (**$RATING** and **RC** records) just before event number 4 is used to determine the starting water surface for time step number 4 and overrides elevation 527 from the **R** record in time step 3.

A **$$END** record marks the end the hydrologic data as well as the entire HEC-6 input file.

3.5 Special Command Records (EJ, $TRIB, $LOCAL, $HYD, $$END)

A command record structure was developed to enhance the flexibility of HEC-6. The **EJ**, **$HYD**, and **$$END** records are used to delineate the geometric, sediment and hydrologic data. These commands are **required** for all data sets. The **EJ** record identifies the end of geometric input. The **$HYD** record identifies the beginning of the hydrologic data. The **$$END** record identifies the end of the input. If tributaries or local inflow/outflow points are being modeled, **$TRIB** and **$LOCAL** records, respectively, are required. The **$TRIB** and **$LOCAL** records are used to distinguish tributary and local data from data for the primary stream segment in the geometric and sediment data sets.

3.6 Network Model

A network system in which sediment transport in tributaries is calculated can be simulated with HEC-6. This section describes the required data sequence.

The network option is designed so that individual segments of the stream network can be analyzed independently to calibrate and confirm the model. With only minor changes, the user will be able to link the data sets together and perform the final analysis on the entire stream network.

Correct methodology for labeling model segments is essential. HEC-6 saves information from the first title record in each geometric model as a label and prints it out as an identifier of the segment. Therefore, the stream's name and data model/test/run number code should be included on the **T1** record. The date of the data set is also useful information.

The following are presented to define the terms used in this section.

Control Point: The downstream boundary of the main stem and the junction point of each tributary.

Local Inflow/Outflow Point: Points along any river segment at which water and sediment enters or exits that segment.

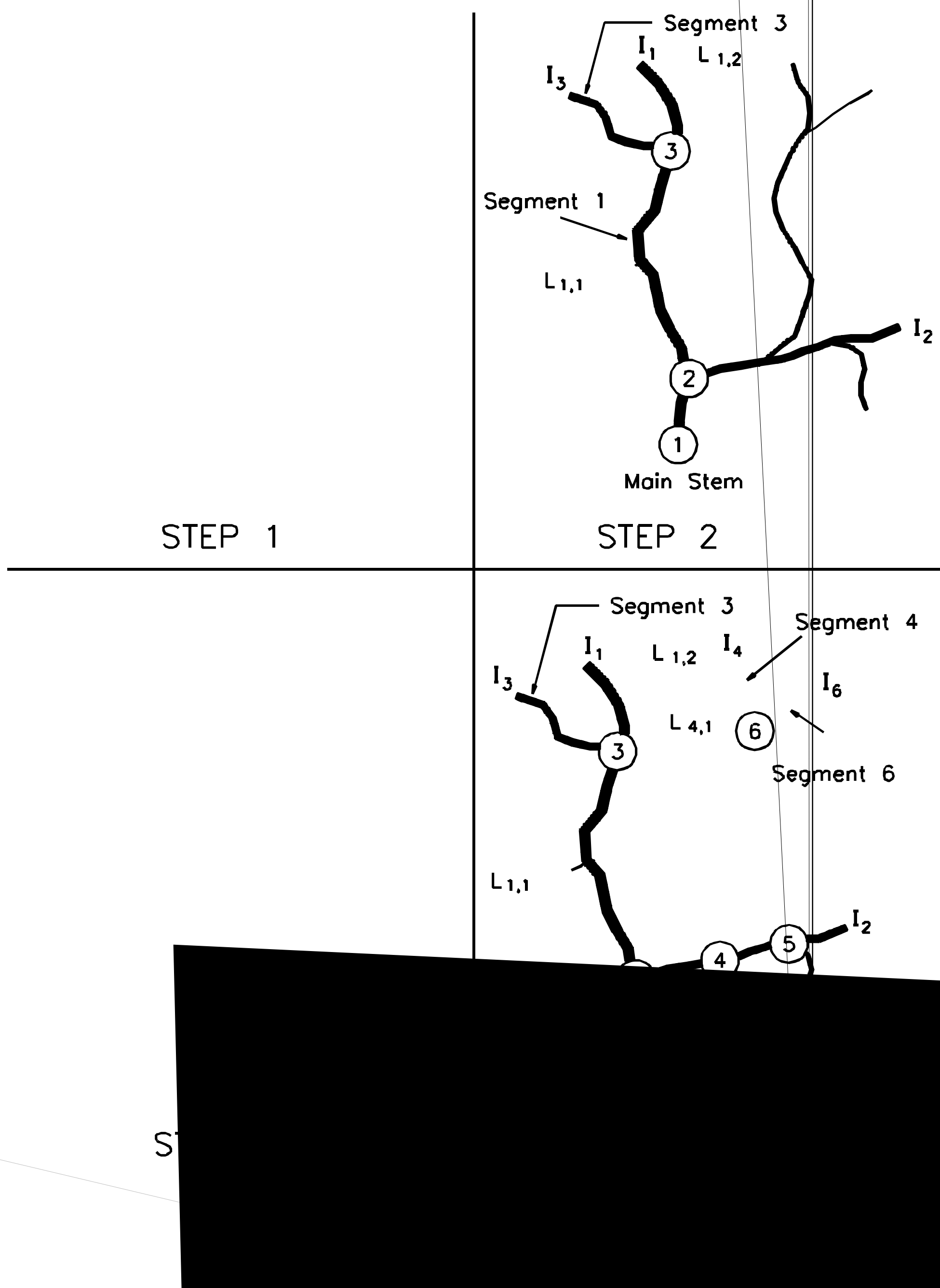
River Segment: A part of a river system which has an upstream water and sediment inflow point and has a downstream termination at a control point. Sediment transport is calculated along a segment.

Tributary: A river segment other than the main stem in which sediment transport is calculated.

Main Stem: The primary river segment with its outflow at the downstream end of the model.

3.6.1 Numbering Stream Segments

Stream segments and control points should not be numbered arbitrarily. To illustrate the numbering procedure, Figure 3-10 is used as an example and depicts a stream network. Each river segment's upstream-most inflow point is designated by I_k where k is the segment number. Local inflow/outflow points are marked with large arrows and labelled by $L_{i,j}$ where j is the sequence number (going upstream) of local inflow/outflow points along segment i. Control points are designated by a circled number. The numbering of segments, inflow/outflow points, and control points should follow these steps:


Segment 3
I1
L 1,2
I3
3
Segment 1
L 1,1
I2
2
1
Main Stem
STEP 1
STEP 2
Segment 3
I1
L 1,2
I4
Segment 4
I3
I6
L 4,1
6
3
Segment 6
L 1,1
I2
4
5

Step 4 - Starting from the downstream-most tributary of segment 2 (at control point 4), continue along segment 4, numbering control point 6, segment 6 and inflow point I_6. Since there are no tributaries on segment 6, check for tributaries on segment 5 (next upstream tributary of segment 4). Since there are no tributaries on segment 5 and all tributaries from control point 2 are accounted for, go to step 5.

Step 5 - Check the next upstream segment off the main stem, segment 3, for tributaries. If there were tributaries, the procedure would have continued as in steps 3 and 4 with the next control point being 7. Since there are no more tributaries, the numbering is complete.

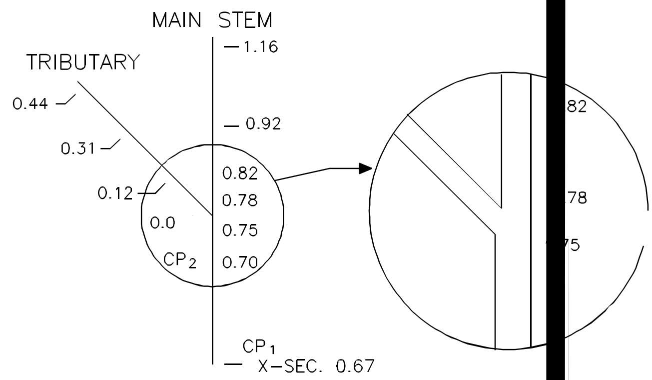
3.6.2 Cross Section Data Sets of Main Stem and Tributaries

HEC-6 identifies segments by the order in which cross section sets are assembled in forming the geometric model. When HEC-6 reads the main stem geometry and, eventually, reaches the first **EJ** record in the geometric data set, it will read one more record. If that record is a **$TRIB** record, HEC-6 will begin reading data for a segment in a stream network. This process is repeated until all geometric data sets representing river segments are read. The **CP** record following the **$TRIB** record identifies the control point number associated with the geometry information for each tributary segment data set. Table 3-3 illustrates these requirements for the network shown in Figure 3-10.

Table 3-3
Sequence of Geometry Data for a River Network

Record	Comments
T1	MAIN STEM GEOMETRY COMES FIRST, THEN TRIBUTARIES.
T2	EXAMPLE ILLUSTRATES GEOMETRIC SEQUENCE OF FIGURE 3-10
T3	THIS RECORD TO **EJ** RECORD CONTAINS GEOMETRIC INFO.
———	Main stem geometry, incl. **QT** records for $L_{1,1}$, $L_{1,2}$ and segments 2 & 3.
EJ	End of main stem (Segment 1)
$TRIB	Warns HEC-6 that geometry for a tributary segment follows.
CP 2	This stream segment enters the network at control point 2.
T1	SEGMENT 2 - THE FIRST TRIBUTARY UPSTREAM OF CONTROL POINT 1.
T2	AMERICAN RIVER
T3	SEDIMENTATION STUDY OF SACRAMENTO RIVER DELTA
———	Geometry of Segment 2, contains **QT** records for segment 4 and 5.
EJ	End of Segment 2.
$TRIB	Indicates that data for additional tributary segments follow.
CP 3	This stream segment enters the network at control point 3.
T1	SEGMENT 3 - SECOND TRIBUTARY - UPSTREAM ON SACRAMENTO RIVER
T2	DRY CREAK
T3	SEDIMENTATION STUDY OF SACRAMENTO RIVER DELTA
———	Geometry of Segment 3.
EJ	End of Segment 3.
$TRIB	Indicates that data for additional tributary segments follow.
CP 4	This stream segment enters the network at control point 4.
T1	SEGMENT 4 - FIRST TRIBUTARY ON SEGMENT 2
T2	ARDEN CREEK
T3	SEDIMENTATION STUDY OF SACRAMENTO RIVER DELTA AND ENDS AT **I4**.
———	Geometry of Segment 4, contains **QT** records for Segment 6 and $L_{4,1}$.
EJ	End of Segment 4.
T4	Sediment data follows.

Figure 3-11 shows how to position cross sections at a control point. The location of the junction (control) point is specified by inserting a **QT** record just prior to the **X1** record for the next cross section


MAIN STEM
TRIBUTARY
1.16
0.92
0.44
0.31
0.12
0.82
0.78
0.75
0.70
0.0
CP_2
CP_1
X-SEC. 0.67

3.6.6 Calculation Sequence of Network Systems

3.6.6.1 Hydraulic Computations for Network Systems

Water surface profiles are calculated for the main stem first and the elevation at each control point is saved. Each time the water discharge changes, the water discharges are mixed and new water temperatures are calculated for the main stem and tributaries. Upon reaching the upstream end of stream segment number 1, computations return to control point number 2, its starting water surface elevation is retrieved from storage, and the hydraulic computations are made for stream segment number 2. Like the main stem, a tributary can have local inflows/diversions and tributary junctions. These are handled like the main stem, as presented above. Hydraulic computations are continued for segment 3 in a similar fashion until all stream segments have been analyzed; then sediment movement computations begin.

3.6.6.2 Sediment Computations

Although data input and hydraulic computations proceed through network segments in the same order in which the data was read, sediment computations are made in the reverse order. It is necessary for HEC-6 to process the most remote tributary first (highest segment number) to determine its sediment contribution to the next stream segment. After all sediment computations for the tributary are completed and results are printed, computations proceed to the next lower numbered segment. After the main stem calculations, HEC-6 cycles back to read the next discharge. The process is repeated until all water discharges have been analyzed.

3.7 Input Requirements for Other Options

3.7.1 Fixed-Bed Calculations

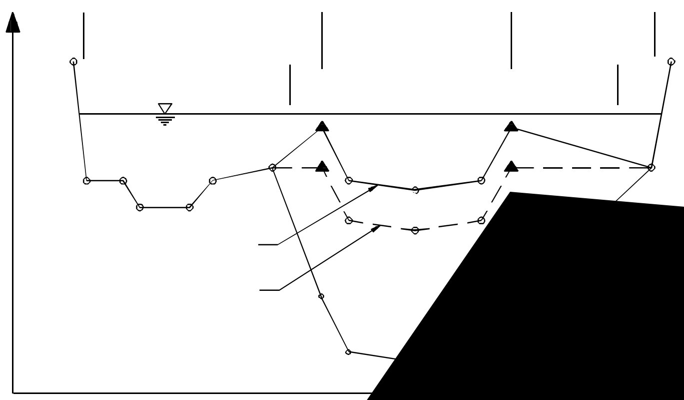
HEC-6 is capable of being executed as a "fixed bed" model similar to HEC-2. The minimum records required are: **T1-T3**, **NC**, **X1**, **GR**, **H**, **EJ**, **$HYD**, Q, **Q**, **R**, **T**, **W** and **$$END**. The **H** record can be left blank. Optional records are **NV**, **X3**, **X5**, **$RATING** and **RC**. Note that **T4** through **PF** records are not required; if these records are present, a fixed-bed run is achieved by moving the **$HYD** through **$$END** records to just after the **EJ** record of the geometry data set. Fixed-bed runs are used to identify and correct any errors in the geometric data and analyze the hydraulic behavior of the model for a full range of flows. Calibration and confirmation of the hydraulics are performed similar to procedures used for HEC-2 (HEC 1990).

3.7.2 Multiple Fixed-Bed Calculations

If there are no tributaries or local inflow/outflow points, up to ten profiles may be computed in one run. Table 3-6 contains an example of a time step using five discharges from 100 to 10,000 cfs with starting water surface elevations ranging from 510 to 518 ft. Multiple profile runs are preferred over single runs because the printout is more compact for the same number of discharges making it easier to make comparisons. If a **$RATING** record set has been entered, the **R** record is not needed.

Table 3-6
Example of Hydrologic Data Set for Multiple Fixed-Bed Calculations

```
$HYD
*      A   5 DISCHARGES FROM LOW TO HIGH
Q     100.      500.     1000.     5000.    10000.
R     510.      512.      513.      516.      518.
T      70.       70.       70.       70.       70.
W       1.        1.        1.        1.        1.
$$END
```



[redacted]