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Hydrologic Engineering Center

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GEDA
Geometric Elements From Cross Section Coordinates

User's Manual

October 1981

CPD-15

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The purpose of this program is to prepare tables of hydraulic elements for use by the computer program "Gradually Varied Unsteady Flow Profiles". The program read data and produces tables of hydraulic elements for nodal points spaced a constant distance apart. The following hydraulic elements are calculated for each water surface elevation specified: cross sectional area, hydraulic radius to the 2/3 power, top width, average n-value, and velocity distribution factor.

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GEOMETRIC ELEMENTS FROM CROSS SECTION COORDINATES

INTRODUCTION

1. ORIGIN OF PROGRAM

This program was developed at the Hydrologic Engineering Center by William A. Thomas.

2. PURPOSE OF PROGRAM

The purpose of this program is to prepare tables of hydraulic elements for use by the computer program "Gradually Varied Unsteady Flow Profiles." It reads data coded in the standard format for "Water Surface Profiles, HEC-2" and produces tables of hydraulic elements for nodal points spaced a constant distance apart. The following hydraulic elements are calculated for each water surface elevation specified in the table: Cross sectional area, hydraulic radius to the 2/3 power, top width, average n-value, and velocity distribution factor. In addition to printing the hydraulic elements as each cross section is processed, the tables of hydraulic elements interpolated for each node are printed and the user may elect to have these tables also punched on cards.

PROGRAM DESIGN

1. CAPABILITY OF COMPUTER PROGRAM

In water surface profile calculations it is important to model conveyance. This sometimes results in cross sections which end at a flow boundary rather than extending all the way to the high ground, as illustrated in figure No. 1. In unsteady flow profile calculations it is necessary to also model the conveyance. However, there is the additional requirement that storage in the reach must be modeled also. This dual requirement is fulfilled by assigning limits of flow to any cross section which might not convey flow over its entire cross sectional area. The entire area is available for storage, however.

The elevations in the hydraulic elements table are specified at the downstream end of the study area. These may be projected section by section to the upstream end on a horizontal line, or a sloping line may be used. Oftentimes the number of elevations required to specify the geometric model can be reduced if a sloping computation grid is utilized. The slope may be changed at any cross section in the study area or may be based on the stream's channel bed slope.

Normally, the interpolation to establish computation nodes is done based on the main channel length. However, if another length would be more appropriate, these values may be specified for each cross section. This does not change the reach lengths used in computation of volume or accumulated surface area. Rather, the so-called "weighted" lengths are designed to be more along the center of the flow and are only used in locating nodes.

Ineffective area may be specified just as it is in the data for water surface profile calculations. This area is considered to be ineffective both for conveying and storing water until the water surface rises to a certain minimum elevation. Above this elevation the area is no longer considered to be ineffective. It is utilized both in conveyance and storage calculations.

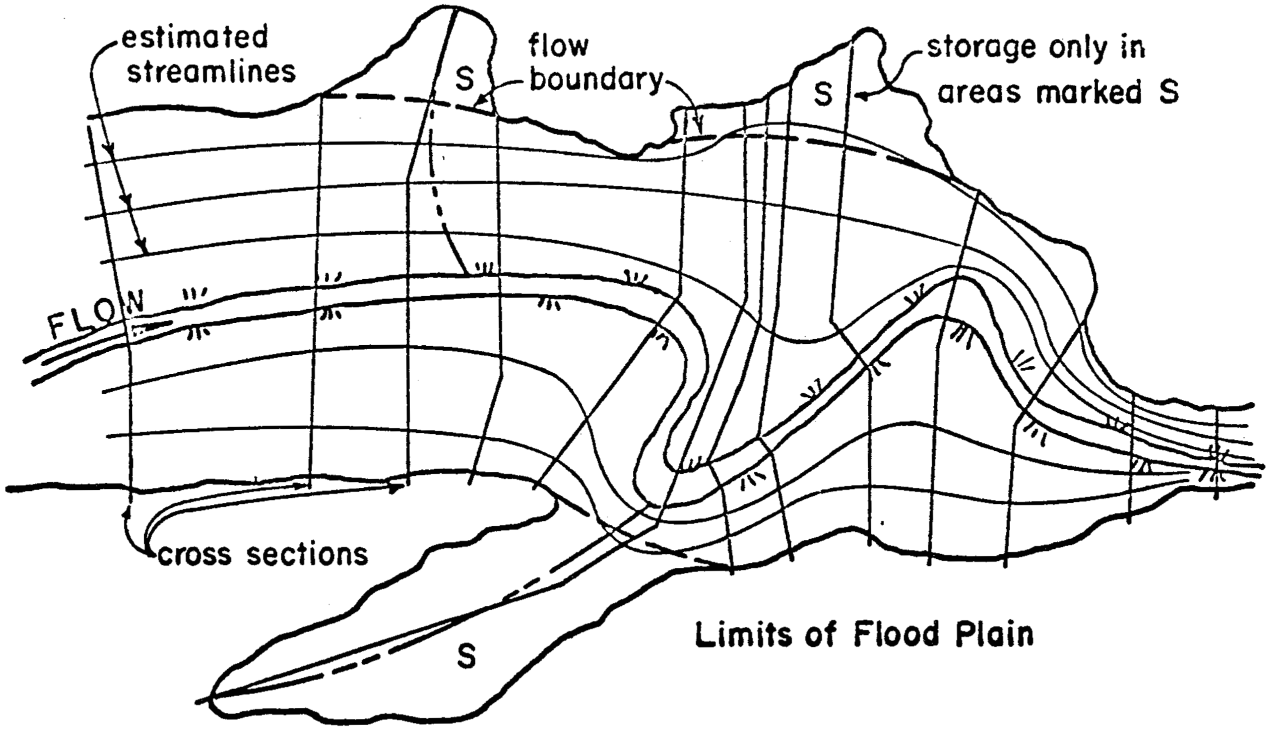


Fig. 1 Plan View of River and Flood Plain

The unsteady flow routing model permits n to vary with elevation but only one value may be specified for the entire cross section at each elevation. However, in most steady flow calculations for water surface profiles, different n-values may be used in the overbanks and main channel. This program accepts n-values specified in the normal way and calculates a composite n for each elevation based on conveyance.

The interpolated values for top width are calculated from accumulated volume in the study reach rather than the cross section width at the water surface. This insures that the correct volume is preserved in the geometric model.

2. PROGRAM ORGANIZATION

The functional and organizational flow chart is shown in figure 2. A two pass computation procedure is used. During the first pass, input data is read section by section, and hydraulic element tables of area, hydraulic radius to the 2/3 power, water surface width, composite n-value, the velocity distribution factor, surface area, and volume are calculated, stored and printed out for each cross section. The position of each cross section is located in terms of distance to the downstream boundary using either the channel length or weighted length - if those values are specified. After the final cross section has been processed, the second pass is made through the hydraulic element tables at which time the position of each nodal point is located and the interpolated values for the hydraulic element tables are calculated. All of the second pass calculations are performed in subroutine INTPL.

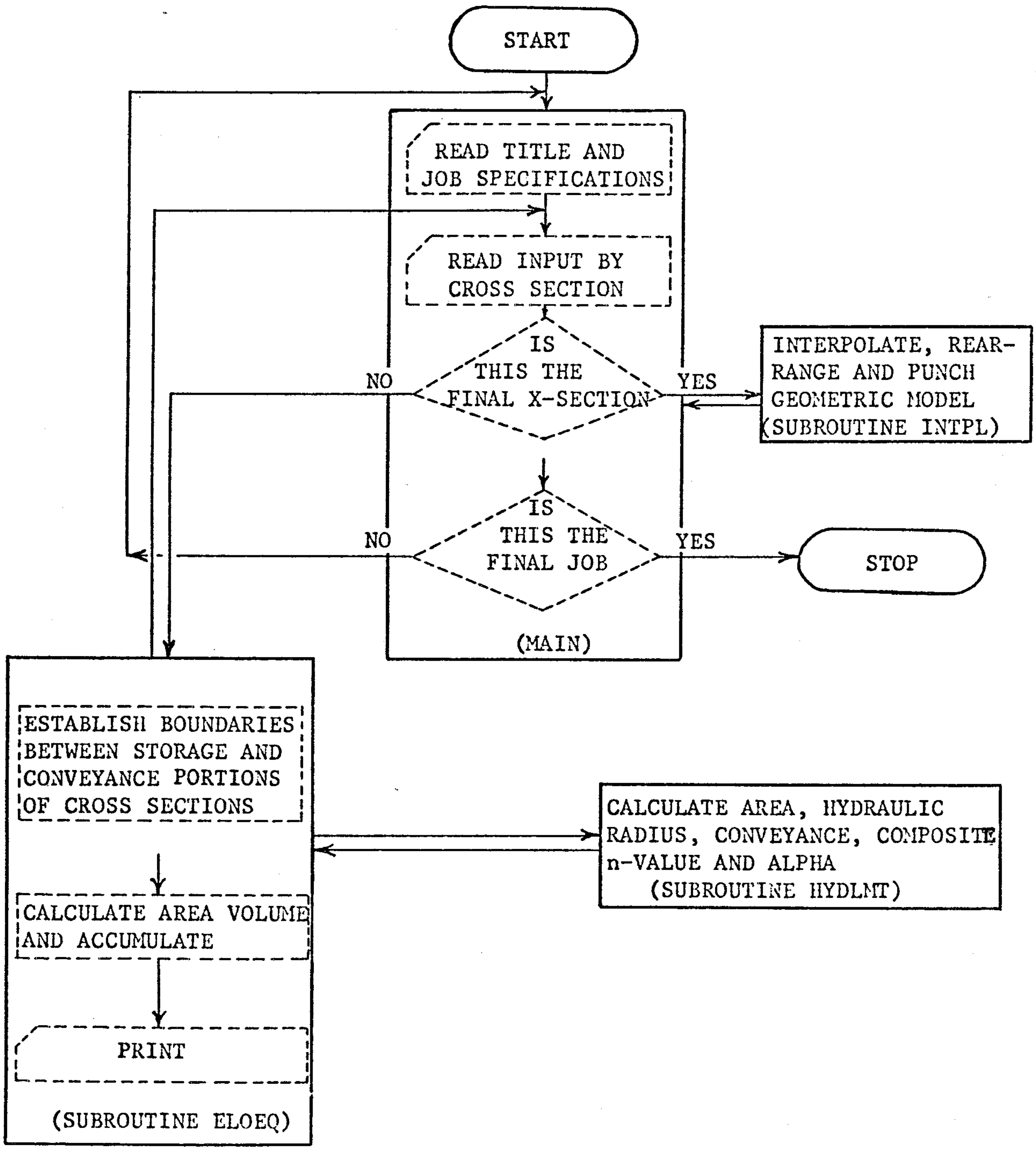
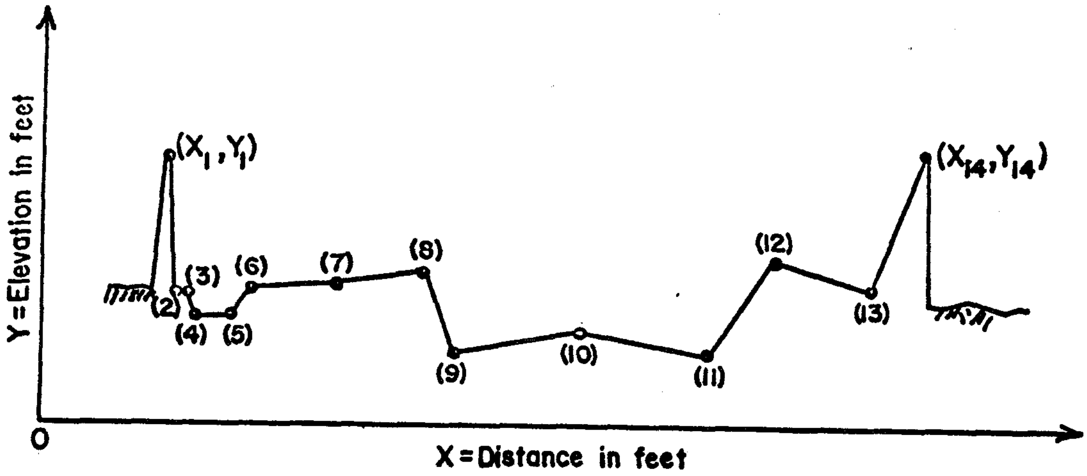


Figure 2. Functional and Organizational Flow Chart

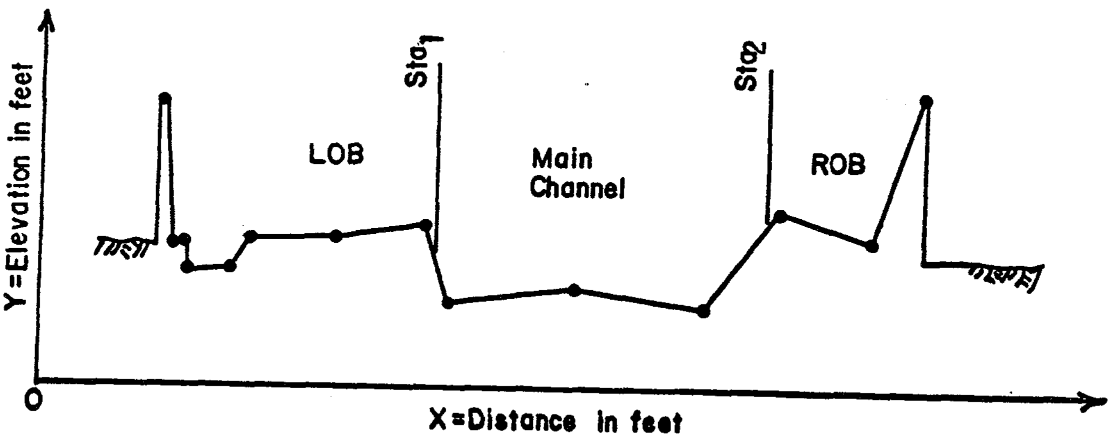
THEORETICAL BASIS

1. COMPUTATION OF GEOMETRIC ELEMENTS

Each cross section is defined by coordinate points, and for convenience of assigning n-values, reach lengths, etc., each cross section is divided into subsections.



a. Typical cross section



b. Subdivisions of typical cross section

Fig. 3. Typical Cross Section

The cross section is subdivided into left overbank, main channel, and right overbank, and hydraulic elements are computed for each of these subsections, as shown below.

a. Subsection area. The subsection area is computed by summing incremental areas between consecutive coordinates of the cross section. Fig. 4 illustrates the technique by using the Main Channel subsection (3) of the previous figure as an example.

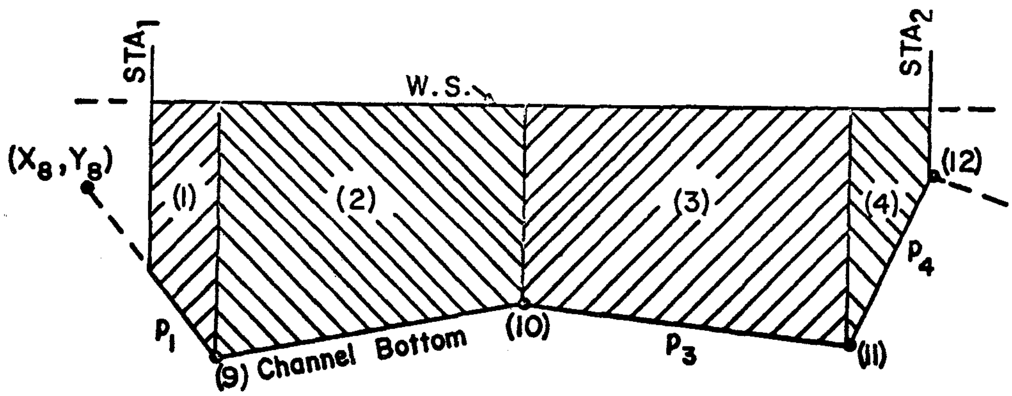


Fig. 4. Incremental Areas in Subsection

$$A_3 = a_1 + a_2 + a_3 + a_4$$

The equation for an incremental area is:

$$a = \frac{(A_1 + B_1)\ W_{avg}}{2}$$

Normally, where A_1, B_1 and W_{avg} are defined as shown in fig. 5, an incremental area is defined by two consecutive cross section coordinates. However, at the first and last increments in each subsection, a **subsection station** defines one side of the incremental area. If the subsection station does not coincide with an X coordinate, as below, straight line interpolation is used to compute the length of either A_1, B_1, or both.

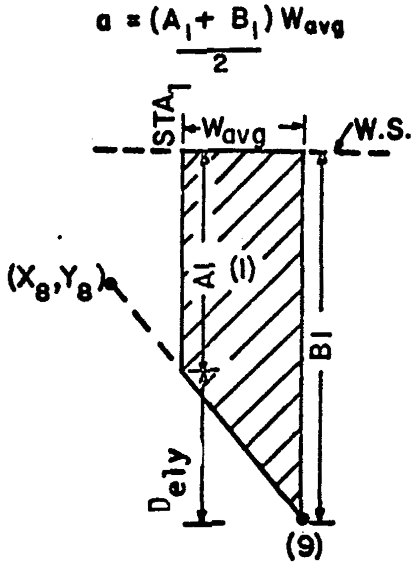


Fig. 5. An Incremental Area

b. Wetted perimeter. The wetted perimeter is computed as the length of cross section below the water surface. In the case of Fig. 4 this is:

$$P_3 = P_1 + P_2 + P_3 + P_4$$

The equation for wetted perimeter of each incremental area is:

$$p = \sqrt{\overline{D_{ely}}^2 + \overline{W_{avg}}^2}$$

where D_{ely} and W_{avg} are defined in fig. 5. Note that only the line between coordinate points and neither A_1 nor B_1 is considered in p. No energy is transferred between adjacent subsections.

c. Hydraulic radius. The hydraulic radius is calculated for each subsection:

$$R_j = \frac{A_j}{P_j}$$

2. CONVEYANCE

The conveyance is computed for each subsection by:

$$K_j = \frac{1.49}{n_j} A_j R_j^{2/3}$$

The total conveyance in the cross section is

$$K_t = \Sigma_{j=1}^{NSS} K_j$$

where NSS is total number of subsections.

3. ALPHA, THE VELOCITY DISTRIBUTION FACTOR

Alpha is a factor to account for the distribution of flow across the flood plain and not the vertical shape of the velocity profile. Large values (≥ 2) of Alpha may occur if the depth of flow on the overbanks is shallow, the conveyance small, and the area large. Alpha is computed as follows:

$$\alpha = \frac{\left(\frac{K_1}{A_1}\right)^2 K_1 + \left(\frac{K_2}{A_2}\right)^2 K_2 + \ldots + \left(\frac{K_j}{A_j}\right)^2 K_j + \ldots \left(\frac{K_{NSS}}{A_{NSS}}\right)^2 K_{NSS}}{\left(\frac{K_t}{A_t}\right)^2 K_t}$$

where A_t is the sum of the subsection areas and K_t is sum of conveyances.

4. COMPOSITE N-VALUE

The composite n-value is calculated as follows:

$$n = \frac{1.49 \times SUMA \times COMR^{2/3}}{SUMK}$$

SUMA = Total area of cross section (conveying flow)

COMR = Composite hydraulic radius = SUMA/SUMP

SUMK = Total conveyance of cross section (conveying flow)

SUMP = Total wetted perimeter of cross section (conveying flow)

5. VOLUME AND TOP WIDTH

Volume beneath the specified elevation is calculated by averaging each subsection end area and multiplying by the subsection reach length. These results are accumulated for each reach and with distance from the downstream end of the study area.

TOP WIDTH (not SUMW) is calculated for each nodal point using the interpolated values of accumulated volume.

$$V_{2DX} = V_o + B_w \times DH \times 2 \times DX$$

where

V_{2DX} = Volume of water that could be stored between nodal points located a distance of 2 x DX apart

V_o = Volume corresponding to the elevation 1DH below that elevation for V_{2DX}

B_w = TOP WIDTH at elevation DH/2 below that elevation for V_{2DX}

DH = Vertical distance between values in the elevation table

DX = Horizontal distance between nodal points

PROGRAM USAGE

1. COMPUTER EQUIPMENT REQUIREMENTS

This program requires 46000 decimal words of central processor memory on a CDC 7600. Punch file output, when requested, is written on Tape 7. A tape 95 is always generated for plotting results.

2. INPUT PREPARATION

The bulk of input data is required for pass I. Only the DX value (or the number of nodes) is utilized in subroutine INTPL.

a. Modeling the study reach. With the study reach located on a topographic map, mark the left (upstream) and right (downstream) boundaries and the lateral limits for the geometric model. Mark the location of each cross section in the study reach. Subdivide the flood plain into channel and overbank strips. Determine the reach length for each strip. This will be the distance between cross sections unless a strip ends before reaching the next cross section. Assign n-values to each strip.

It is important to correctly model both volume and conveyance. Therefore, delineate portions of a cross section conveying flow from that portion which just stores water. Special cross section controls are provided for this purpose (see subparagraph 2b (3) below). A sketch of the flow lines is usually sufficient to adequately separate conveyance of water from storage of water in the geometric model.

b. Coding input data. Code the data by starting at the downstream boundary and proceeding to the upstream boundary. A sample listing of the data cards for the problem presented in fig. 6 is shown on page 1, exhibit 1. A detailed description of input variables is given in exhibit 3 and a summary of required cards is shown in exhibit 4.

(1) Cross section coordinates. The station points which define the cross section geometry must be positive values in units of feet (actually, any consistent set of units may be used with this program if n-values are appropriately chosen) and must be entered in increasing order of magnitude. These are coded on GR-cards.

(2) Subsection stations. The left and right sides of the main channel subdivide the cross section into subsections. These do not have to coincide with a coordinate point, but they can.

(3) Conveyance limits. Computations for conveyance can be restricted to any portion of a cross section by specifying limits with either STS, ENST or both on the CL-card. None of these controls have to coincide with a subsection station, but they can. Volume computations are not restricted by these controls. The entire cross section is utilized to compute volume.

(4) Reach lengths. The reach length should be measured in feet and entered on the X1 card for the upstream end of each reach. A value is required for each strip in the reach. This length does not have to extend from one cross section to the next.

(5) n-values. Manning's n-values can either be a constant in each strip or they can vary vertically with either elevation or discharge in the main channel. They should be defined at the first cross section and be redefined only as necessary to change their value.

(6) Elevation table. This program will accept up to 30 different elevation values spaced at random. However, the "Gradually Varied Unsteady Flow Profiles" program will accept only 21 values of elevation and these may not be spaced at random intervals. Only three different intervals may be specified and these intervals must be integer numbers. The elevations may be real numbers but the interval between elevations must be integers.

It is recommended that larger increments be used at the top and bottom of the elevation table so that solutions generated by the unsteady flow program will always remain within the table.

(7) Section no. A cross section identification number is always assigned on the X1-card. River mile is recommended. However, this value is used for identification only -- not for distance between cross sections. Likewise, node numbers, which are interpolated from Section Numbers, are for identification only.

c. Computation grid. It is often desirable to project the values in the elevation table on a slope rather than horizontally. This is permitted by input variable ASEL (JP-card). It is also necessary to establish the distance between interpolated nodes. The routing program requires an odd number of nodes equal to or greater than 5. This can be produced by specifying NODE (JP-4) or DX (JP-3). The computation grid is different from the computation net in the unsteady flow program. This grid is in the (X,Y) plane whereas the computation net is in the (X,T) plane.

PROGRAM OUTPUT

1. PRINTED OUTPUT

Printed output is shown in exhibit 1. As each cross section is processed, Average Section Number, Reach Length (channel strip), Elevation, Area, R2/3, top width of conveyance portion of section, weighted n-value, Coriolis coefficient (alpha) for velocity distribution, accumulated surface area and accumulated volume beneath the water surface are printed.

After the final cross section has been processed, the geometric model being developed for the unsteady flow program is printed. Finally, a table of elevation versus volume is printed. These values are for comparison with the volumes printed at Section No. 3 of page 2, exhibit 1, as a check on the ability of the interpolated geometric data tables to reproduce the actual volume of the study reach.

2. PUNCHED CARD OUTPUT

The geometric elements will be punched on cards if that option is exercised (Card JP-10). The default option suppresses the punch. It is always advisable to review the printed results before punching the data.

EXAMPLE PROBLEM

The following figure shows boundary geometry for a prismatic channel on a slope of .0002.

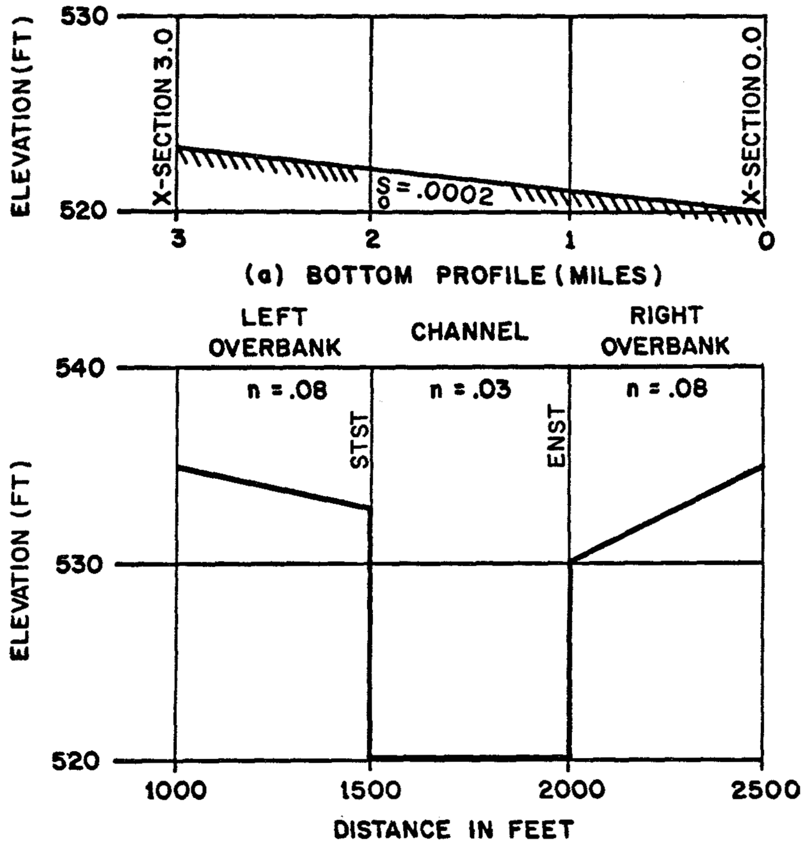


Figure 6 Annotated Boundary Geometry

The left overbank extends from cross section station 1000 to 1500. The channel extends from station 1500 to 2000, and the right overbank from 2000 to 2500. The n-values and reach lengths are shown on the figure. This example assumes that only the channel portion of the section conveys flow. The locations for STST and ENST are shown. These do not have to coincide with STA values.

The elevations specified for geometric data extend above elevation 535, the highest elevation of the cross section. The program assumes a vertical boundary at each end of the cross section, and it disregards any influence on wetted perimeter. Volume is important in the unsteady flow program; and it may be in error if the cross section coordinates do not extend above the elevation table range.

A listing of the input data is shown in exhibit 1. Only two cross sections are required, since the channel is prismatic, and the interpolation subroutine provides tables for seven nodal points equally spaced at 2640 feet apart.

3. TAPE 95 OUTPUT

The GEDA program produced a tape or file which contains 65 different output variables. The 65 variables are temporarily stored in an array called QVAR and written out to tape 95 as each section is processed. Tape 95 can then be used by HEC's Hydraulics Program to plot the variables interactively on a Tektronix 4014 computer display terminal or batch on a Calcomp drum plotter. A list and description of the 65 variables on tape 95 are given in Appendix I and II.

INSERT

MODIFICATIONS TO GEDA

(Version 4.2, Dec. 1987)

1. The computer program "Geometric Elements from Cross Section Coordinates" (GEDA) has been modified to operate interactively; that is, the user merely enters the name of the executable program file and responds to prompts from the program for various file names. GEDA also can now produce data files for direct input to the NWS DAMBRK computer program. The data that GEDA develop are input records 20-25 (distances, elevations, and top widths), and 28-30 (Manning's n-values). The former are written to default file name R2025 and the latter to R2830. The rest of the DAMBRK input data set will have to be prepared by the user and merged with the GEDA - produced data using either an editor or system commands.

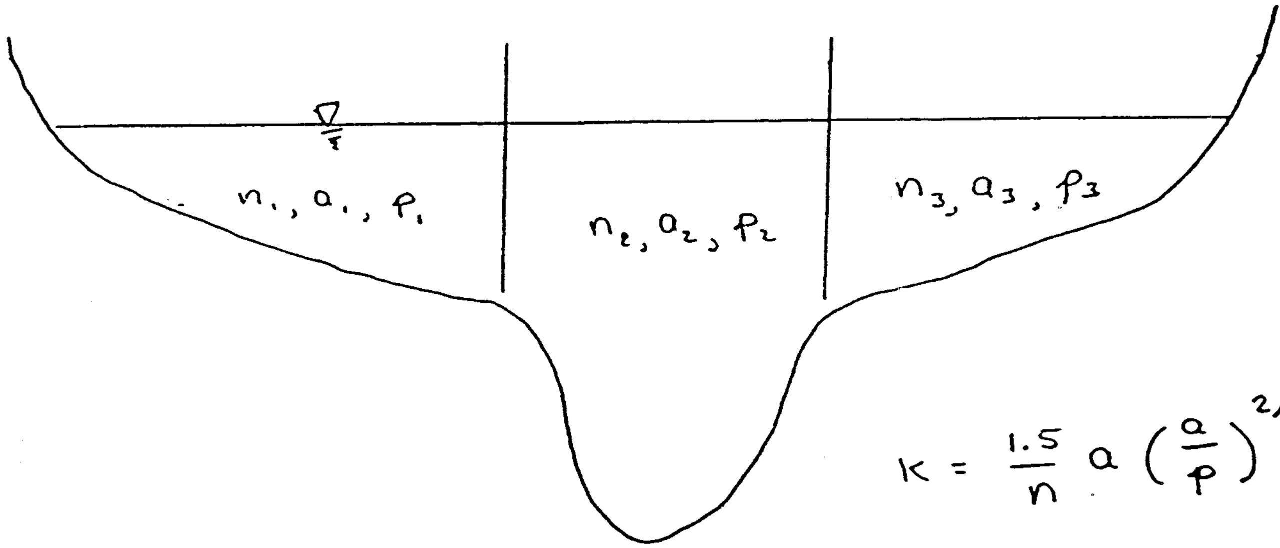
2. DAMBRK has two options for routing; the "standard" option and the special "flood plain" option. The cross section data are different for these two options. GEDA will prepare data for either option at the users request. For the standard option, DAMBRK top-width and n-value vs. elevation functions are computed using the same compositing approach as is used for preparation of input to DWOPER (please refer to "Documentation for the GEDA/DWOPER Interface", dated 17 April 85). For the flood plain option, the HEC-2 cross section is used directly; that is, the left overbank n-value and top width are transferred into the DAMBRK data for the left flood plain, and likewise for the other two subdivisions. Note, since DAMBRK uses n-values on a reach basis rather than on a section basis, the subdivision n-values are averaged for two successive sections to obtain a reach value.

3. At this time (Dec. 1987), these changes to GEDA have received minimal testing, particularly the flood plain option calculation. A potential problem area is that of one section having an overbank, followed or preceded by a section that does not. Users are advised to check BOTH the GEDA output AND the files developed for DAMBRK for errors or discrepancies. Please notify Michael Gee at HEC (FTS 460-1748 or (916) 551-1748) of any problems.

Documentation for the GEDA/DWOPER Interface

Background: Increasing use of the National Weather Service's dynamic routing model, "Dynamic Wave-Operational" (DWOPER), for unsteady flow analyses has highlighted the need for an improved means for describing hydraulic geometry for that program. Geometric input to DWOPER consists of tables of cross-section widths and composite Manning n values as functions of elevation. Development of these data has proven difficult for two reasons: (1) many users are familiar with the x-y coordinate method of describing cross sections and many data sets exist in that format (i.e., for the program HEC-2); and (2) composite n values for complex cross sections cannot be estimated directly from field observations. Experience has shown that use of estimated n values directly in DWOPER data can result in conveyance functions that decrease with elevation, which, in turn, leads to computational instabilities. Consequently the HEC has modified an existing program, "Geometric Elements from Cross Section Coordinates" (GEDA), to develop input geometric data for DWOPER which are consistent with HEC-2 data in both conveyance and volume (storage). It is emphasized that correct dynamic routing will be achieved only if the HEC-2 cross sections accurately describe both storage and conveyance of the river channel. The GEDA-produced data are in the appropriate sequence and format for DWOPER versions dated 2/22/80 to 7/18/84.

Theory: HEC-2 cross sections are subdivided to allow for transverse distribution of roughness. Given an HEC-2 cross section, GEDA computes the total conveyance and top width of that section for a sequence of elevations. The composite n vs. elevation function that provides the same conveyance at each elevation is then calculated. An example is shown below.



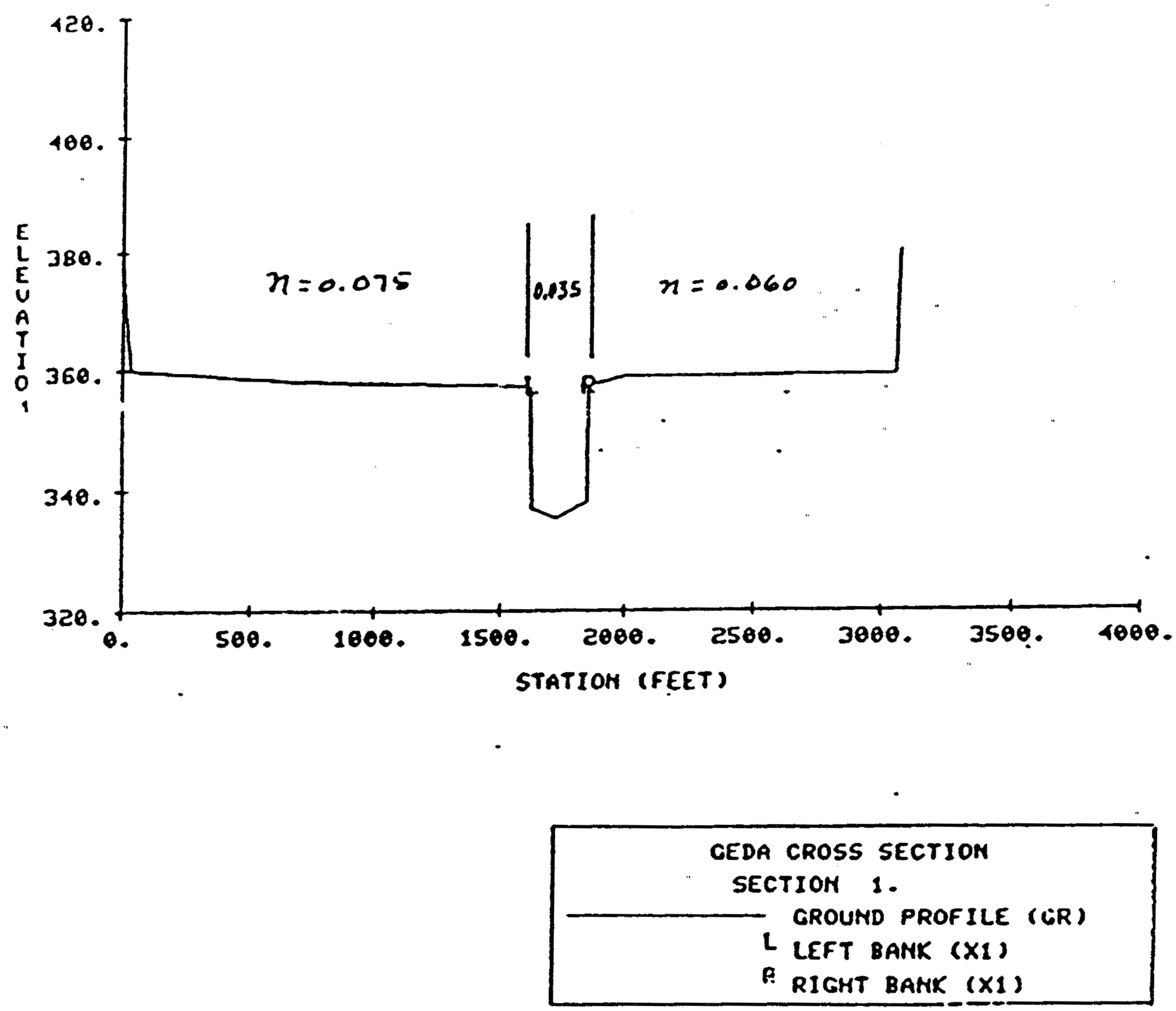
$$K = \frac{1.5}{n}\, a \left(\frac{a}{p}\right)^{2/3}$$

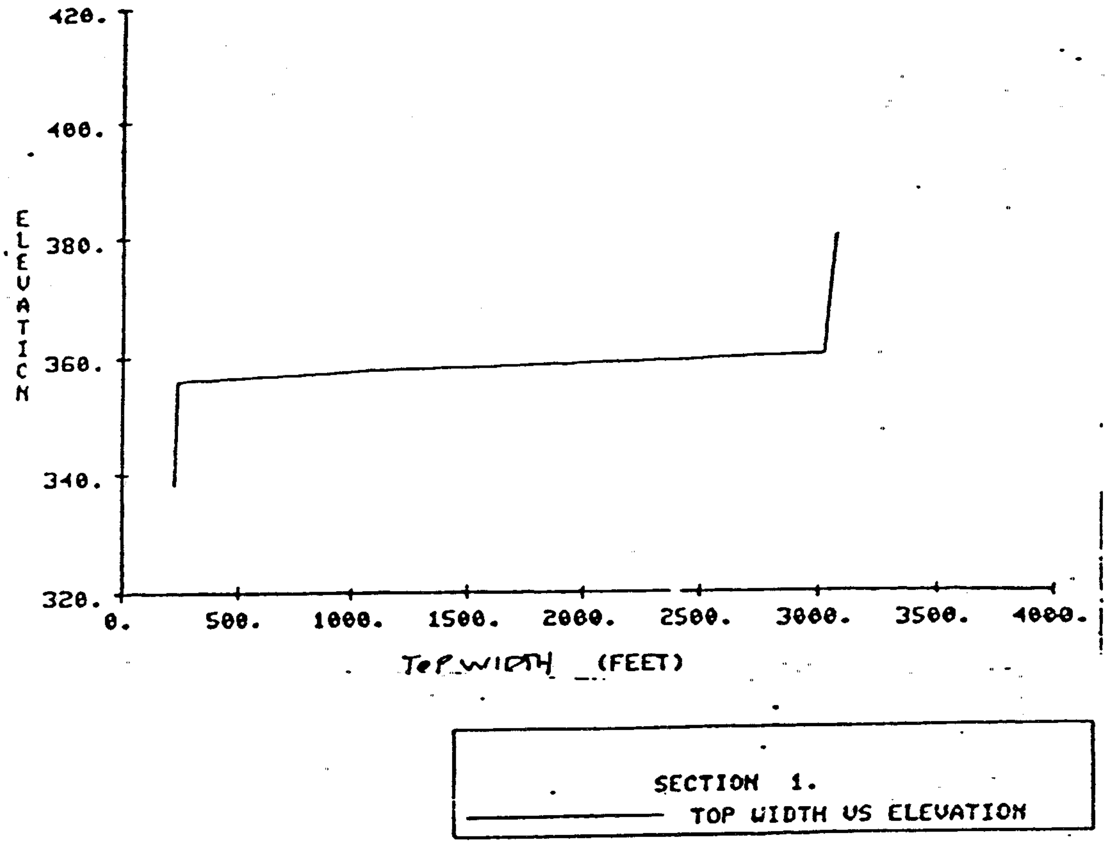
$$K_T = K_1 + K_2 + K_3$$

$$A_T = A_1 + A_2 + A_3$$

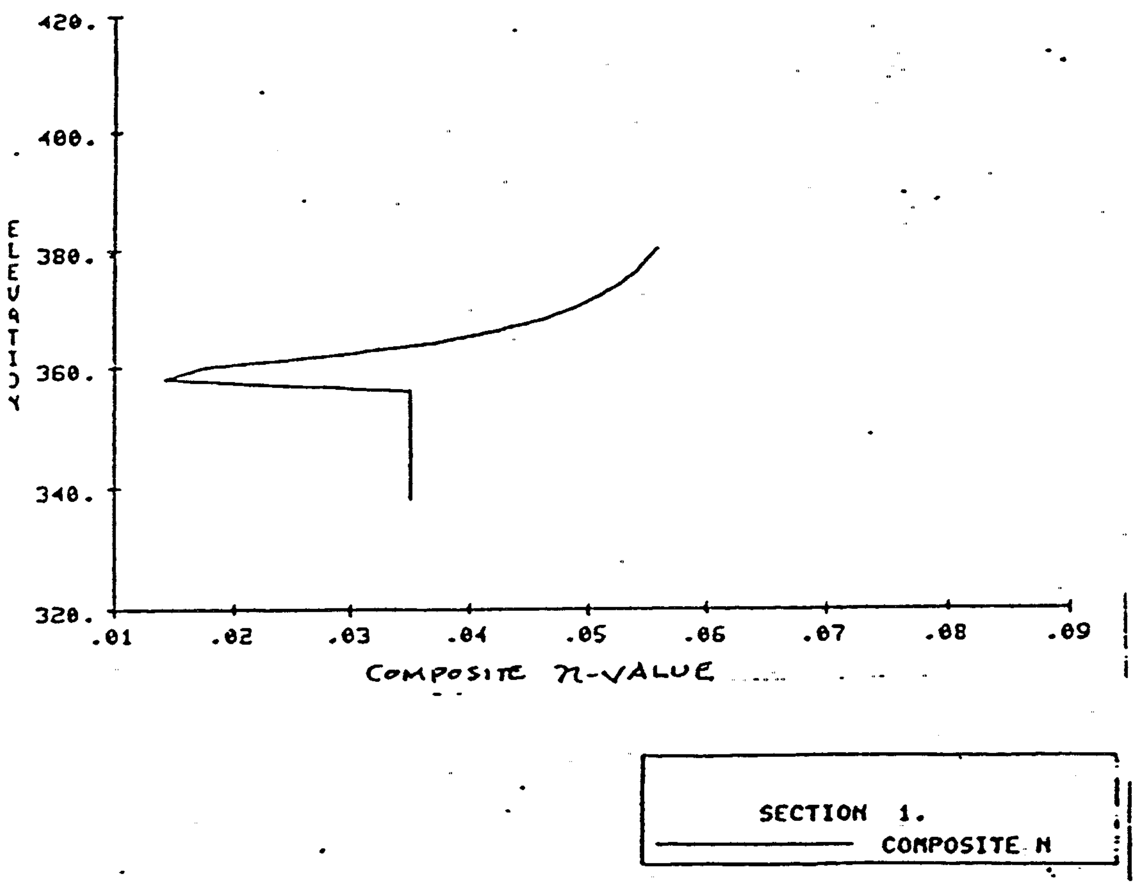
$$P_T \approx B_1 + B_2 + B_3$$

$$n_{\text{COMPOSITE}} = \frac{1.5\, A_T \left(\frac{A_T}{P_T}\right)^{2/3}}{K_T}$$


420.
400.
380.
360.
340.
320.
ELEVATION
n=0.075
0.035
n=0.060
L
R
0.
500.
1000.
1500.
2000.
2500.
3000.
3500.
4000.
STATION (FEET)
GEDA CROSS SECTION
SECTION 1.
GROUND PROFILE (GR)
L LEFT BANK (X1)
R RIGHT BANK (X1)



420.
400.
380.
360.
340.
320.
ELEVATION
0.
500.
1000.
1500.
2000.
2500.
3000.
3500.
4000.
TOP WIDTH (FEET)
SECTION 1.
TOP WIDTH VS ELEVATION



420.
400.
380.
360.
340.
320.
ELEVATION
.01
.02
.03
.04
.05
.06
.07
.08
.09
COMPOSITE n-VALUE
SECTION 1.
COMPOSITE N

Also, as DWOPER allows only a single distance between sections, the GEDA program calculates that distance to preserve the volume between each two successive sections using the HEC-2 channel and overbank distances. This computation is only performed for the highest elevation for which information is requested.

Operation: Upon execution of GEDA all geometric data are written to disk files* in the correct sequence (upstream to downstream) and format for DWOPER input if the variables NODE and DX (refer to the JP card description in the GEDA Users Manual) are set to zero. The data are computed for each HEC-2 section input. The interpolation feature of GEDA plays no role in the process and should not be used. Consequently, DWOPER computational points coincide with the HEC-2 sections.

The elevations for which widths and n values are calculated are controlled by the ET cards. Separation of sections into active and inactive widths is governed by KL cards. Refer to the GEDA Users Manual for descriptions of these cards.

The specific DWOPER input card images and the units to which they are written are shown in Table 1.

*Because geometric data appear at several locations in the DWOPER input stream, several files must be merged upon DWOPER execution.

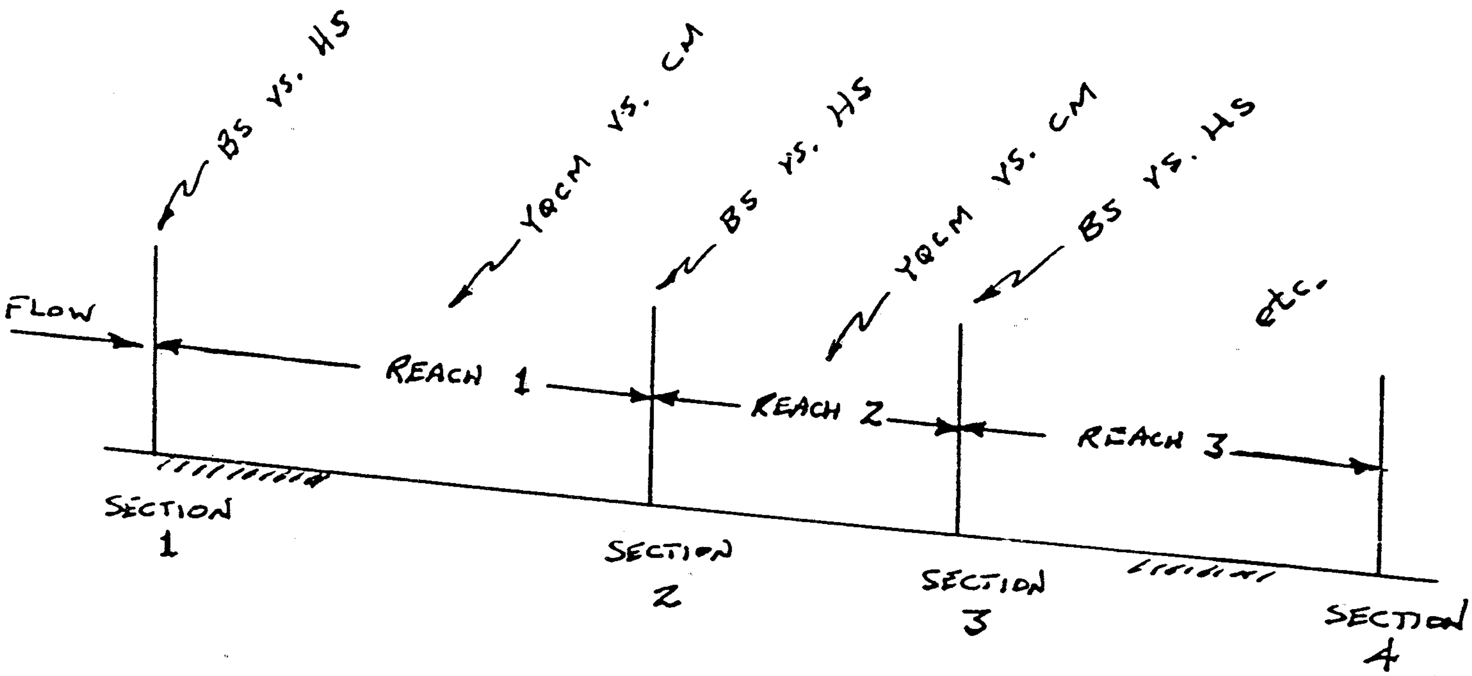
TABLE 1 DWOPER VARIABLES WRITTEN BY GEDA

DWOPER Variable Name	DWOPER Card Group No.	Description	Unit No.
BS	28	Table of top widths for all sections, upstream to downstream	11
HS	29	Table of elevations corresponding to the above	11
AS	30	Cross-sectional area below lowest elevation at each section	11
BSS	31	Table of storage widths	15*
HSS	32	Elevations corresponding to above (same as HS)	15
ASS	33	Storage area below lowest elevation (these are always zero)	15
X	36	Location of each computational section, units are feet from upstream boundary	14
YQCM	55	Table of elevations for which n values are provided, by reach** from upstream to downstream	12
CM	56	Manning n values corresponding to above	13

---

* The information on unit 15 is only written for those sections that have off-channel storage. This can be ascertained from GEDA output.

**NOTE: n values are associated with reaches rather than sections in the DWOPER computational scheme. Therefore, when using GEDA, an n value vs. elevation function is determined for every "reach" between two cross sections by averaging the n vs. elevation functions at the two cross sections bounding the reach. Hence, for DWOPER input the number of Manning n reaches (NRCM1, card 15) is one less than the number of cross sections and the station numbers defining those reaches (NCM, card 16) starts with 2 and goes to NB (the number of sections).



EXAMPLE STREAM PROFILE
SHOWING RELATIONSHIP BETWEEN
CROSS SECTIONS AND REACHES

Input Data

```
T1        TEST 1 PREPARED IN AUG74 ** DATA DECK IN HEC-2 FORMAT **
T2        GEOMETRIC ELEMENTS FROM CROSS SECTION COORDINATES, AUXILARY PROGRAM TO
T3        GRADUALLY VARIED UNSTEADY FLOW PROFILES.    W A THOMAS, HEC, DAVIS, CA.
JP           .0002          2640.
ET   521.     522.     523.     524.     525.     526.                           1
NC    .08      .08      .03
X1     0.       6.    1500.    2000.
GR   535.    1000.     533.    1500.     520.    1500.     520.    2000.     530.    2000.
GR   535.    2500.
X1    3.0       0.    1500.    2000.   15840.   15840.   15840.             3.168
EJ
```

```
VERSION 2.2 19SEPT1974
T1        TEST 1 PREPARED IN AUG74 ** DATA DECK IN HEC-2 FORMAT **
T2        GEOMETRIC ELEMENTS FROM CROSS SECTION COORDINATES, AUXILARY PROGRAM TO
T3        GRADUALLY VARIED UNSTEADY FLOW PROFILES.     W A THOMAS, HEC, DAVIS, CA.

HEADING DATA IN HEC-2 FORMAT.
ONLY CARDS NC,NV,X1,X3 AND GR CARDS ARE PERMITTED.

P-CARD        ASEL         JM        DX        KSW(1)    KSW(11)    KSW(12)
            .0002000        6    2640.00         1         -0          1

                                             ELEVATION TABLE
   521.000    522.000    523.000    524.000    525.000    526.000

              ELEV       AREA         R2/3      SUMW        ANV        ALFA   SURFACE    VOLUME

SEC NO.       0.000
INCREMENTAL AND ACCUMULATED CHANNEL LENGTHS =          0          0
INCREMENTAL AND ACCUMULATED WEIGHTED LENGTHS=          0          0 RATIO OF ACCUMULATED WEIGHT/CHANNEL=     0.0000
              521.00     500.00       1.00     500.00      .0300     1.0000        0          0
              522.00    1000.00       1.58     500.00      .0300     1.0000        0          0
              523.00    1500.00       2.06     500.00      .0300     1.0000        0          0.
              524.00    2000.00       2.49     500.00      .0300     1.0000        0          0
              525.00    2500.00       2.89     500.00      .0300     1.0000        0          0
              526.00    3000.00       3.25     500.00      .0300     1.0000        0          0

SEC NO.       3.000
INCREMENTAL AND ACCUMULATED CHANNEL LENGTHS =      15840      15840
INCREMENTAL AND ACCUMULATED WEIGHTED LENGTHS=      15840      15840 RATIO OF ACCUMULATED WEIGHT/CHANNEL=     1.0000
              524.17     500.00       1.00     500.00      .0300     1.0000      182        182
              525.17    1000.00       1.58     500.00      .0300     1.0000      182        364
              526.17    1500.00       2.06     500.00      .0300     1.0000      182        545
              527.17    2000.00       2.49     500.00      .0300     1.0000      182        727
              528.17    2500.00       2.89     500.00      .0300     1.0000      182        909
              529.17    3000.00       3.25     500.00      .0300     1.0000      182       1091
```

GEOMETRIC MODEL FOR UNSTEADY FLOW PROGRAM 8

SDM	ITM	JM	ASEL	DX	FORMAT
3.00	7	6	.00020	2640.0	8X,F8.0,8X,5F8.0,/(24X,5F8.0)

X-SEC NO	X	ELEV	AREA	R2/3	TOP WIDTH	AVG N-VALUE	ALPHA
3.000	0.000	524.17	500	1.00	500	.0300	1.0000
3.000	0.000	525.17	1000	1.58	500	.0300	1.0000
3.000	0.000	526.17	1500	2.06	500	.0300	1.0000
3.000	0.000	527.17	2000	2.49	500	.0300	1.0000
3.000	0.000	528.17	2500	2.89	500	.0300	1.0000
3.000	0.000	529.17	3000	3.25	500	.0300	1.0000
2.500	.500	523.64	500	1.00	500	.0300	1.0000
2.500	.500	524.64	1000	1.58	500	.0300	1.0000
2.500	.500	525.64	1500	2.06	500	.0300	1.0000
2.500	.500	526.64	2000	2.49	500	.0300	1.0000
2.500	.500	527.64	2500	2.89	500	.0300	1.0000
2.500	.500	528.64	3000	3.25	500	.0300	1.0000
2.000	1.000	523.11	500	1.00	500	.0300	1.0000
2.000	1.000	524.11	1000	1.58	500	.0300	1.0000
2.000	1.000	525.11	1500	2.06	500	.0300	1.0000
2.000	1.000	526.11	2000	2.49	500	.0300	1.0000
2.000	1.000	527.11	2500	2.89	500	.0300	1.0000
2.000	1.000	528.11	3000	3.25	500	.0300	1.0000
1.500	1.500	522.58	500	1.00	500	.0300	1.0000
1.500	1.500	523.58	1000	1.58	500	.0300	1.0000
1.500	1.500	524.58	1500	2.06	500	.0300	1.0000
1.500	1.500	525.58	2000	2.49	500	.0300	1.0000
1.500	1.500	526.58	2500	2.89	500	.0300	1.0000
1.500	1.500	527.58	3000	3.25	500	.0300	1.0000
1.000	2.000	522.06	500	1.00	500	.0300	1.0000
1.000	2.000	523.06	1000	1.58	500	.0300	1.0000
1.000	2.000	524.06	1500	2.06	500	.0300	1.0000
1.000	2.000	525.06	2000	2.49	500	.0300	1.0000
1.000	2.000	526.06	2500	2.89	500	.0300	1.0000
1.000	2.000	527.06	3000	3.25	500	.0300	1.0000
.500	2.500	521.53	500	1.00	500	.0300	1.0000
.500	2.500	522.53	1000	1.58	500	.0300	1.0000
.500	2.500	523.53	1500	2.06	500	.0300	1.0000
.500	2.500	524.53	2000	2.49	500	.0300	1.0000
.500	2.500	525.53	2500	2.89	500	.0300	1.0000
.500	2.500	526.53	3000	3.25	500	.0300	1.0000
.000	3.000	521.00	500	1.00	500	.0300	1.0000
.000	3.000	522.00	1000	1.58	500	.0300	1.0000
.000	3.000	523.00	1500	2.06	500	.0300	1.0000
.000	3.000	524.00	2000	2.49	500	.0300	1.0000
.000	3.000	525.00	2500	2.89	500	.0300	1.0000
.000	3.000	526.00	3000	3.25	500	.0300	1.0000

ELEVATION	AREA	VOLUME, *
524		182
525		364
526		545
527		727
528		909
529		1091

END OF RUN

*NOTE: The units of volume are acre-feet.

Input Data *

```
* TEST 2 PREPARED IN OCT69, MODIFIED MAR71, AUG74
* GEOMETRIC ELEMENTS FROM CROSS SECTION COORDINATES, AUXILARY PROGRAM TO
* GRADUALLY VARIED UNSTEADY FLOW PROFILES.      W A THOMAS, HEC, DAVIS, CALIF.
P         .0002                               6.      2640.                             1
R521.     522.     523.     524.     525.     526.
A0.       1.       6.                1.
B1500.    2000.    2500.                                      1500.   2000.   2000.
C1.       1.       1.
E0.08     .03      .08
G1000.    535.     1500.    533.     1500.    520.    2000.   520.    2000.   530.
G2500.     535.
A3.0      1.       6.
B1500.    2000.    2500.                                      1500.   2000.   2000.
C15840.   15840.   15840.
G1000.    538.168  1500.    536.168  1500.    523.168 2000.   523.168 2000.   533.168
G2500.    538.168
A         -1.
```

*NOTE: Test 2 is coded in an alternate input format which is not described in this manual.

```
VERSION 2.2 19SEPT1974
* TEST 2 PREPARED IN OCT69, MODIFIED MAR71, AUG74
* GEOMETRIC ELEMENTS FROM CROSS SECTION COORDINATES, AUXILARY PROGRAM TO
* GRADUALLY VARIED UNSTEADY FLOW PROFILES.      W A THOMAS, HEC, DAVIS, CALIF.

PROGRAM READING DATA IN ALTERNATE FORMAT.
ONLY CARDS R,W,A,B,C,D,E AND G OR GR ARE PERMITTED.

P-CARD       ASEL          JM       DX        KSW(1)   KSW(11)   KSW(12)
           .0002000         6    2640.00        -0        -0         1

R-CARD                                                  ELEVATIONS
  521.000   522.000   523.000   524.000   525.000   526.000

T-CARD                          INITIAL WATER SURFACE AREA IN ACRES
      0         0         0         0         0         0
U-CARD                                 INITIAL VOLUME IN ACRE-FEET
      0.0       0.0       0.0       0.0       0.0       0.0


             ELEV      AREA        R2/3     SUMW        ANV        ALFA  SURFACE   VOLUME


SEC NO.       0.000
INCREMENTAL AND ACCUMULATED CHANNEL LENGTHS =           0          0
INCREMENTAL AND ACCUMULATED WEIGHTED LENGTHS=           0          0 RATIO OF ACCUMULATED WEIGHT/CHANNEL=     0.0000
             521.00     500.00     1.00     500.00      .0300     1.0000        0         0
             522.00    1000.00     1.58     500.00      .0300     1.0000        0         0
             523.00    1500.00     2.06     500.00      .0300     1.0000        0         0
             524.00    2000.00     2.49     500.00      .0300     1.0000        0         0
             525.00    2500.00     2.89     500.00      .0300     1.0000        0         0
             526.00    3000.00     3.25     500.00      .0300     1.0000        0         0

SEC NO.       3.000
INCREMENTAL AND ACCUMULATED CHANNEL LENGTHS =       15840      15840
INCREMENTAL AND ACCUMULATED WEIGHTED LENGTHS=       15840      15840 RATIO OF ACCUMULATED WEIGHT/CHANNEL=     1.0000
             524.17     500.00     1.00     500.00      .0300     1.0000      182       182
             525.17    1000.00     1.58     500.00      .0300     1.0000      182       364
             526.17    1500.00     2.06     500.00      .0300     1.0000      182       545
             527.17    2000.00     2.49     500.00      .0300     1.0000      182       727
             528.17    2500.00     2.89     500.00      .0300     1.0000      182       909
             529.17    3000.00     3.25     500.00      .0300     1.0000      182      1091
```

GEOMETRIC MODEL FOR UNSTEADY FLOW PROGRAMS

SDM	ITM	JM	ASEL	DX	FORMAT
3.00	7	6	.00020	2640.0	8X,F8.0,8X,5F8.0,/(24X,5F8.0)

X-SEC NO	X	ELEV	AREA	R2/3	TOP WIDTH	AVG N-VALUE	ALPHA
3.000	0.000	524.17	500	1.00	500	.0300	1.0000
3.000	0.000	525.17	1000	1.58	500	.0300	1.0000
3.000	0.000	526.17	1500	2.06	500	.0300	1.0000
3.000	0.000	527.17	2000	2.49	500	.0300	1.0000
3.000	0.000	528.17	2500	2.89	500	.0300	1.0000
3.000	0.000	529.17	3000	3.25	500	.0300	1.0000
2.500	.500	523.64	500	1.00	500	.0300	1.0000
2.500	.500	524.64	1000	1.58	500	.0300	1.0000
2.500	.500	525.64	1500	2.06	500	.0300	1.0000
2.500	.500	526.64	2000	2.49	500	.0300	1.0000
2.500	.500	527.64	2500	2.89	500	.0300	1.0000
2.500	.500	528.64	3000	3.25	500	.0300	1.0000
2.000	1.000	523.11	500	1.00	500	.0300	1.0000
2.000	1.000	524.11	1000	1.58	500	.0300	1.0000
2.000	1.000	525.11	1500	2.06	500	.0300	1.0000
2.000	1.000	526.11	2000	2.49	500	.0300	1.0000
2.000	1.000	527.11	2500	2.89	500	.0300	1.0000
2.000	1.000	528.11	3000	3.25	500	.0300	1.0000
1.500	1.500	522.58	500	1.00	500	.0300	1.0000
1.500	1.500	523.58	1000	1.58	500	.0300	1.0000
1.500	1.500	524.58	1500	2.06	500	.0300	1.0000
1.500	1.500	525.58	2000	2.49	500	.0300	1.0000
1.500	1.500	526.58	2500	2.89	500	.0300	1.0000
1.500	1.500	527.58	3000	3.25	500	.0300	1.0000
1.000	2.000	522.06	500	1.00	500	.0300	1.0000
1.000	2.000	523.06	1000	1.58	500	.0300	1.0000
1.000	2.000	524.06	1500	2.06	500	.0300	1.0000
1.000	2.000	525.06	2000	2.49	500	.0300	1.0000
1.000	2.000	526.06	2500	2.89	500	.0300	1.0000
1.000	2.000	527.06	3000	3.25	500	.0300	1.0000
.500	2.500	521.53	500	1.00	500	.0300	1.0000
.500	2.500	522.53	1000	1.58	500	.0300	1.0000
.500	2.500	523.53	1500	2.06	500	.0300	1.0000
.500	2.500	524.53	2000	2.49	500	.0300	1.0000
.500	2.500	525.53	2500	2.89	500	.0300	1.0000
.500	2.500	526.53	3000	3.25	500	.0300	1.0000
.000	3.000	521.00	500	1.00	500	.0300	1.0000
.000	3.000	522.00	1000	1.58	500	.0300	1.0000
.000	3.000	523.00	1500	2.06	500	.0300	1.0000
.000	3.000	524.00	2000	2.49	500	.0300	1.0000
.000	3.000	525.00	2500	2.89	500	.0300	1.0000
.000	3.000	526.00	3000	3.25	500	.0300	1.0000

ELEVATION	AREA	VOLUME, *
524		182
525		364
526		545
527		727
528		909
529		1091

END OF JOB

*NOTE: The units of volume are acre-feet.

DESCRIPTION OF PAUSES

Pause No.	Cause	Action
0	End of job	
1	Negative value in input data.	Check Q(N), IDF, MEID, NCH, KXY, KQCH, n-values, NMD, ISXY.
2	one or more reach lengths either zero or blank. One or more STA(I) values are negative.	
3	Negative value in the n-value table.	
4	Logical error in program code.	Requires program debugging.
5	STA(I) is larger than the largest X coordinate on the GR cards.	
6	Sill length or sill elevation is negative.	Positive values required.
10	STST is negative	Positive value is required.
11	STST is larger than the largest X coordinate on the GR cards.	
12	STST is larger than the largest STA(I) value.	Change the data so at least 1 STA(I) value is greater than STST.
13	Logical error in subroutine HYDLMT.	Requires program debugging.
14	Either STST or the first STA(I) value is larger than the largest X coordinate on the GR card.	
15	An X coordinate is smaller than the previous one coded on the GR card.	

Pause No.	Cause	Action
16	Logical error in subroutine HYDLMT.	Requires program debugging.
17	Logical error in subroutine HYDLMT. Variable LOST is one and should not be.	Same as 16.
18	Similar to 17 except LOST = 2.	Same as 16.
19	Similar to 17 except LOST = 3.	Same as 16.
20	A bridge section has been entered, but there are not enough discharge coefficients.	Check data and eliminate bridge sections.
21	Starting water surface elevation is below critical depth.	This pause should be eliminated. Check the program logic.
22	Submerged flow exists at a weir and no submergence coefficients were provided.	Eliminate weir sections.
23	Submerged flow exists and 2 submergence coefficients are the same.	Same as 22.

GEOMETRIC ELEMENTS PROGRAM

INPUT DATA DESCRIPTION

Version 3.0 January 1976

This input description presents a "value" or "range of values" for each variable. The code "+" under the "Value" column means any positive number. Zeroes are not recommended except where indicated in the "Value" column. Avoid negative numbers unless that option is specifically stated as a value. Blanks are read as zero except where otherwise noted. Parentheses denote footnotes. All numeric variables are read as floating point numbers and integer variables are converted immediately after being read. Numbers may be coded either left or right justified.

HEC-2 Data Cards T1, T2, T3, NC, NV, X1, X3, X4 and GR are permitted. However, only a portion of the data on cards NC, X1, and X3 are utilized in this program (see pages for each card type).

INPUT DATA DESCRIPTION

TITLE CARDS - REQUIRED CARDS

CARDS T1, T2, T3

a. CARD T1

Title card for output title. This card is required for each job.

Field	Variable	Value	Description
0		T1	Card identification characters.
1-10	None		Numbers and alphabetical characters for title.

b. CARD T2

Title card for output title. This card is required for each job.

Field	Variable	Value	Description
0		T2	Card identification characters.
1-10	None		Numbers and alphabetical characters for title.

c. CARD T3

Title card for output title. This card is required for each job.

Field	Variable	Value	Description
0		T3	Card identification characters.
1-10	None		Numbers and alphabetical characters for title.

Note: Columns 9-32 on card T3 are not saved for subsequent use on plots, and this differs from the T3 card in HEC-2.

JOB PARAMETERS - REQUIRED CARD

CARD JP

The geometric elements may be calculated for the same elevation at each cross section or they may be calculated on a sloping grid. The latter usually results in fewer elevation points for jobs covering long distances of the river. In any case, using a sloping grid is only a matter of convenience and the slope does not impact on routing calculations in the unsteady flow model.

FIELD	VARIABLE	VALUE	DESCRIPTION
0	ICG	JP	Card identification characters.
1	AVGS	0,+,-	The downstream cross section identification (i"e., if cross section locations are identified by River Mile (X1-i), use the mile for the first sections here).
2	ASEL	+,-	The change in elevation between cross sections is calculated by multiplying the slope ASEL times the channel reach length.
		1000	ASEL will be based on the downstream channel slope.
		2000	ASEL will be based on the downstream minimum channel bank elevation slope.
3	NODE	0	The program will calculate the number of nodes from DX and the total model length.
		+	The program will calculate the distance between nodes from total model length and interpolate tables of geometric elements at those points.
4	DX	0	The value for NODE should be positive so the program will calculate DX and the resulting tables of geometric elements.

FIELD	VARIABLE	VALUE	DESCRIPTION
		+	Tables of geometric elements will be interpolated on the constant interval, DX, however, if both NODE and DX have been specified the value for NODE will override the value for DX.
5	LFA	0	Program calculates the velocity distribution factor ALPHA.
		1	The program assigns 1 to the velocity distribution factor.
6	NOSC	0	The largest identification number that can be printed or punched out by this program is 9999.999. The largest cross section area is 9,999,999. The program will test the size of section identification numbers and cross section areas and calculate a factor to scale down numbers which are too large. An appropriate note is printed giving the resulting scale factor.
		+	A scale factor of 1.0 is assigned.
7-8			Not used.
9	KSW(11)	0	Suppresses printout of subsection areas, wetted perimeters, conveyances, etc.
		1	Print the intermediate values of conveyance, area, hydraulic radius, n-value and reach length for each subsection in each cross section.
10	KSW(12)	0	The geometric elements are interpolated from adjacent input cross-sections and printed.
		1	Punch cards of the above geometric elements for subsequent use in the routing calculation.
		2	The geometric elements are interpolated by weighting the values at all input cross-sections within $\pm\frac{1}{2}$DX of the node and printed.
		3	Punch cards of the above geometric elements for subsequent use in the routing calculation.

ELEVATION TABLE - REQUIRED CARDS

CARD ET

The table of geometric elements may contain from 3 up to 21 values of elevation. The difference between two successive elevation values on this card, called the elevation interval, must be an integer amount for the routing program. Up to three different intervals may be utilized. Values must be entered from lowest to highest elevation for the routing program.

Field	Variable	Value	Description
0	ICG	ET	Card identification characters.
1 - 10	WS	0,+	Elevations may be zero or positive. Enter 10 values across the card and use as many cards as are required. The program will count the number of values internally using a zero or blank field to signify the end of elevations.

WEIGHTED REACH LENGTH - OPTIONAL CARDS

CARD WL

Frequently, the channel distance is not representative of the length of flow when extremely large flood events are to be analyzed. This card permits the user to enter a length between cross sections that reflects the flow length for the floods that he plans to analyze. The weighted reach length is not used in calculating area and volume, only in establishing the location of cross sections for subsequent calculations as the geometric elements are interpolated for each Node.

Field	Variable	Value	Description
0	ICG	WL	Card identification characters.
1-10	XRL	0	At the first cross section only.
		+	The weighted distance from the second to the first cross section is entered in field 2. Field 3 goes with the third cross section, ETC. Enter one value of weighted reach length for each cross section. The program will count the number of values entered using 0 or blank to identify the end.

REQUIRED CARD FOR FIRST CROSS SECTION

CARD NC

Manning's n-values are entered for starting each job, or for changing values previously specified. Manning's n-values apply at a cross section and halfway to the cross section on either side. The values on this NC card apply to the cross section described on the following X1 card and apply until changed by a future NC card.

Field	Variable	Value	Description
0	IA	NC	Card identification characters.
1	XNL	0	No change in Manning's "n" value for the left overbank.
		+	Manning's "n" value for the left overbank.
2	XNR	0	No change in Manning's "n" value for the right overbank.
		+	Manning's "n" value for the right overbank.
3	XNCH	0	No change in Manning's "n" value for the channel.
		+	Manning's "n" value for the channel.

Note: Other HEC-2 variables on NC-card are not used in this program.

OPTIONAL CARD FOR ROUGHNESS DESCRIPTION

CARD NV

Used to vary the channel n-values in the vertical based on water surface elevations. Straight line interpolation is used between points.

Field	Variable	Value	Description
0	IA	NV	Card identification characters.
1	NUMNV	+	Total number of Manning's "n" values entered on NV cards (maximum five). If more than one NV card is used, field 1 on the other cards would contain an ELN(N) value.
2,4,6..	VALN(N)	+	Manning's "n" coefficient for area below ELN(N). The overbank "n" values specified on CARD NC will be used for the overbank roughness regardless of the values in this table.
3,5,7..	ELN(N)	+	Elevation of the water surface corresponding to VALN(N) in increasing order.

Note: HEC-2 permits 20 n-value points. This program permits only 5.

SLOPE CHANGE - OPTIONAL CARD

CARD SC

The slope ASEL (JP-2) is changed at any cross section with this card. The slope will remain at this new slope until it is changed again. The specified set of closely spaced elevations follow approximately along the top bank elevation of the channel.

Field	Variable	Value	Description
0	ICG	SC	Card identification characters.
1	AVGS	0,+	The cross section identification number for the first cross section where the new slope was used.
2	ASEL	+,-	The change in elevation between cross sections is calculated by multiplying the slope ASEL times the channel reach length.
		1000	ASEL will be based on the downstream channel slope.
		2000	ASEL will be based on the downstream minimum channel bank elevation slope.

REQUIRED CARD FOR EACH CROSS SECTION

CARD X1

This card is required for each cross section, and is used to specify the cross section geometry and program options applicable to that cross section. This program differs from HEC-2 in that it does not read Field 10 and only 100 cross sections may be specified.

Field	Variable	Value	Description
0	IA	X1	Card identification characters.
1	SECNO	+	Cross section identification number
		-	(Tributaries in HEC-2). Not used in this program.
2	NUMST	0	Previous cross section is used for current section. Next GR cards are omitted.
		+	Total number of stations on the next GR cards.
3	STCHL	0	May be omitted if NUMST (X1.2) is 0.
		+	The station of the left bank of the channel.
4	STCHR	0	May be omitted if NUMST (X1.2) is 0.
		+	The station of the right bank of the channel. Must be equal to or greater than STCHL.
5	XLOBL	+	Length of reach between current cross section and next downstream cross section of the left overbank.
6	XLOBR	+	Length of reach between current cross section and next downstream cross section for the right overbank.
7	XLCH	+	Length of reach between current cross section and next downstream cross section for the channel.

CARD X1 (cont.)

Field	Variable	Value	Description
8	PXSECR	0	Cross section stations will not be changed by the factor PXSECR.
		+	A ratio which will be multiplied times all cross section stations, except the first station, to increase or decrease cross section width. The ratio can apply to a repeated cross section or a current one. A 1.1 would increase the width by 10 percent.
9	PXSECE	0	Cross section elevations will not be changed.
		+ -	Constant to be added (+) or subtracted (-) from all cross section elevations. A repeated cross section is handled in the same manner as one just entered. Elevation changes are permanent; therefore, changes accumulate with successive, repeated sections.

OPTIONAL PLOTS OF CROSS SECTION

Field	Variable	Value	Description
10	IPLOT	0	Not recognized by this program

SPECIFICATION OF INEFFECTIVE FLOW AREAS

CARD X3 - OPTIONAL CARD

Field	Variable	Value	Description
0	IA	X3	Card identification characters.
1	IEARA	0	Total area of cross section described on GR cards below the water surface elevation is used in the computations.
		10	Only the cross sectional area confined by levees below the water surface elevation is used in the computations, unless the water surface elevation is above the top of levee (elevations corresponding to STCH(X1.3) and STCHR (X1.4), in which case flow areas outside the levee will be included.
2	ELSED	0	NA
		+	NA
3	ENCFP	0	Width between encroachments is not changed or is not specified.
		+	Width between encroachments is centered in the channel, midway between the left and right overbanks. Flow areas outside this width are not included in the computations. This width will be used for all cross sections unless changed by a positive ENCFP on Card X3 of another cross section or unless over-ridden by the use of STENCL(X3.4).
4	STENCL	0	Encroachments by specifying station and/or elevation will not be used on the left overbank.
		+	Station of the left encroachment. Flow areas to the left of (less than) this station and below ELENCL are not included in the computations. This option will override the option using ENCFP when both are used.

CARD X3 (cont)

Field	Variable	Value	Description
5	ELENCL	0	An encroachment elevation on the left side is not applicable and is therefore assumed very high.
		+	Elevation of the left encroachment. Flow areas below this elevation and less than STENCL are not included in the computations.
6	STENCR	0	An encroachment station on the right is not used.
		+	Station of the right encroachment. Flow areas to the right of (greater than) this station and below ELENCR are not included in the computations.
7	ELENCR	0	An encroachment elevation on the right side is not applicable and is therefore assumed very high.
		+	Elevation of the right encroachment. Flow areas below this elevation and greater than STENCR are not included in the computations.
8	ELLEA	0	NA
		+	NA
9	ELREA	0	NA
		+	NA
10			NA

ADDITIONAL GROUND POINTS

CARD X4 - OPTIONAL CARD

An additional input card X4 may be inserted following cards X1, X2, or X3 in order to add additional points to describe the ground profile of the cross section. Stations of X4 data points must fall within the range of GR stations. The X4 data point is an added point and cannot be used to replace any GR data point. This option is useful when modifying data cards for a proposed obstruction as it allows points to be added anywhere in the cross section.

Field	Variable	Value	Description
0	IA	X4	Card identification characters.
1	NELT	+	Number of additional points to supplement the current set of GR cards read in describing the ground profile of the cross section. A maximum of 20 points may be used.
2	ELT(1)	+	Elevation of first additional ground point.
3	STAT(1)	+	Station of first additional ground point. All stations must be less than the maximum station on the GR cards. The pairs of elevations and stations do not have to be in any particular order.
4,5, etc.			Additional pairs of elevation and station values.

CONVEYANCE LIMITS - OPTIONAL CARD

CARD KL

The geometric model for unsteady flow calculations must describe both volume and conveyance. Satisfying the volume requirement often causes cross sections to extend up tributaries. This is an area that does not contribute to conveyance of the mainstem discharge, however, and conveyance limits can be established for affected cross sections.

Field	Variable	Value	Description
0	ICG	KL	Card identification characters.
1	AVGS	0,+	Cross section identification number.
2	STST	0	The entire cross section is used for both volume and conveyance on the left overbank.
		+	The cross section station separating storage from conveyance on the left overbank. This value does not have to coincide with a coordinate point.
3	ENST	0	The entire right overbank of the cross section is used to convey flow.
		+	The cross section station beyond which only volume is calculated.

GROUND PROFILE

CARD GR

This card specifies the elevation and station of each point in a cross section used to describe the ground profile, and is required for each X1 card unless NUMST (X1.2) is zero. The points outside of the channel determine the subdivision of the cross section which corrects for the nonuniform velocity distribution.

Field	Variable	Value	Description
0	IA	GR	Card identification characters.
1	EL(1)	+ -	Elevation of cross section point 1 at station STA(1). May be positive or negative.
2	STA(1)	+	Station of cross section point 1.
3	EL(2)	+ -	Elevation of cross section point 2 at STA(2).
4	STA(2)	+	Station of cross section point 2.

Continue with additional GR cards using up to 100 points to describe the cross section. Stations should be in increasing order and positive.

EJ

END OF JOB CARD

CARD EJ - REQUIRED

Required following the last cross section for each job. Each group of cards beginning with Card T1 is considered a job.

Field	Variable	Value	Description
0		EJ	Card identification characters.
1-10			Not used.

END OF RUN

CARD ER - REQUIRED CARD

Required at the end of a run consisting of one or more jobs in order to end computation on stop command. Three blank cards after the EJ card of the last job are optional.

Field	Variable	Value	Description
0	IA	ER	Card identification characters
1 - 10			Not used

APPENDIX I

Tape 95 Variable Description

TAPE95 VARIABLES

HEC2			GEDA	
Variable Name	Description	Code Number	Variable Name	Description
CWSEL	Computed water surface elevation.	1	ECOM	Water surface elevation.
CRIWS	Critical water surface elevation.	2	SCHL	Accumulated channel length.
EG	Energy gradient elevation for a cross section which is equal to the computed water surface elevation CWSEL plus the discharge-weighted velocity head HV.	3	XRL(NST)	Incremented weighted length.
TOPWID	Cross section width at the calculated water surface elevation.	4	SUMW	Total top width.
SLOPE (10K*S)	Slope of the energy grade line for the current section (times 10,000).	5	ASEL	Projection slope.
TIME	Travel time from the first cross section to the present cross section in hours.	6	SDM	Accumulated weighted length.
VOL	Cumulative volume of water in the stream from the first cross section (in acre-feet for English units or 1000 cubic meters in Metric units).	7	AV	Cumulative volume of water in the stream from the first cross section (in acre-feet).
DEPTH	Depth of flow.	8	QVAR	Depth of flow in the channel.
WSELK	Known water surface elevation.	9	RWC	Ratio of accumulated weight/channel.
HV	Mean velocity head across the entire cross section.	10	STST	Left overbank station separating storage from conveyance.
HL	Energy loss due to friction.	11	ENST	Right overbank station separating storage from conveyance.

TAPE95 VARIABLES

HEC2			GEDA	
Variable Name	Description	Code Number	Variable Name	Description
OLOSS	Energy loss due to expansion or contraction.	12	SUMP	Total wetted perimeter
QLOB	Amount of flow in the left overbank.	13	RTS	Hydraulic radius to the 2/3 power.
QCH	Amount of flow in the channel.	14	QVAR	Profile number.
QROB	Amount of flow in the right overbank.	15	QVAR	Cross section counter.
XNL (K*XNL)	Manning's 'n' for the left overbank area (times 1,000).	16	SUBK(1)*.01	Sub-conveyance value.
XNCH (K*XNCH)	Manning's 'n' for the channel area (times 1,000).	17	SUBK(2)*.01	Sub-conveyance value.
XNR (K*XNR)	Manning's 'n' for the right overbank area (times 1,000).	18	SUBK(3)*.01	Sub-conveyance value.
WTN (K*WTN)	Weighted value of Manning's 'n' for the channel based on the distance between cross sections and channel flow from the first cross section. Used when computing Manning's 'n' from high water marks (times 1,000).	19	ANV	Average 'n' value.
CASE	A variable indicating how the water surface elevation was computed. Values of -1, -2, -3, and 0 indicate assumptions of critical depth, minimum difference a fixed change (X5 card) or a balance between the computed and assumed water surface elevations.	20	SUBK(4)*.01	Sub-conveyance value.

TAPE95 VARIABLES

HEC2 Variable Name	HEC2 Description	Code Number	GEDA Variable Name	GEDA Description
STCHL	Station of the left bank	21	QVAR	Left bank station.
STCHR	Station of the right bank.	22	QVAR	Right bank station.
XLBEL	Left bank elevation.	23	QVAR	Left bank elevation.
RBEL	Right bank elevation.	24	QVAR	Right bank elevation.
AREA	Cross section area.	25	SUMA	Cross section area.
VCH	Mean velocity in the channel	26	SUBK(5)*.01	Sub-conveyance value.
STENCL	The station of the left encroachment.	27	STENCL	The station of the left encroachment.
STENCR	The station of the right encroachment.	28	STENCR	The station of the right encroachment
CLSTA	The centerline station of the trapezoidal excavation.	29	SUBK(6)*.01	Sub-conveyance value.
BW	The bottom width of the trapezoidal excavation.	30	SUBK(7)*.01	Sub-conveyance value.
ELENCL	Elevation of left encroachment.	31	ELENCL	Elevation of left encroachment.
ELENCR	Elevation of right encroachment.	32	ELENCR	Elevation of right encroachment.
CHSLOP (K*CHSL)	Channel slope (times 1,000).	33	QVAR	Channel slope.
.01K	The total discharge (index Q) carried with $S^{1/2}$ = .01 (equivalent to .01 times conveyance).	34	SUMK*.01	Total conveyance.
QLOB%	Percent of flow in the left overbank.	35	SA(1)	Sub-area value.

TAPE95 VARIABLES

HEC2 Variable Name	HEC2 Description	Code Number	GEDA Variable Name	GEDA Description
PERENC	The target of encroachment requested	36	SA(2)	Sub-area value.
TWA	The cumulative topwidth area (acres or 1000 square meters).	37	ASA	Cumulative topwidth area (in acres).
SECNO	The cross section identification number.	38	AVGS	The cross section identification number.
XLCH	Channel reach length.	39	CHL	Incremented channel length.
ELTRD	Minimum elevation for top of road profile.	40	SA(3)	Sub-area value.
ELLC	Maximum low chord elevation.	41	SA(4)	Sub-area value.
ELMIN	Minimum elevation in cross section.	42	QVAR	Minimum elevation in the channel strip.
Q	Discharge.	43	SA(5)	Sub-area value.
EGPRS	Energy elevation assuming pressure flow.	44	SA(6)	Sub-area value.
EGLWC	Energy elevation assuming low flow.	45	SA(7)	Sub-area value.
QWEIR	Total weir flow at the bridge.	46	R(1)	Sub-hydraulic radius value.
QPR	Total pressure or low flow at the bridge.	47	R(2)	Sub-hydraulic radius value.
H3	Change in water surface elevation from Yarnell's equation.	48	R(3)	Sub-hydraulic radius value.

TAPE95 VARIABLES

HEC2 Variable Name	HEC2 Description	Code Number	GEDA Variable Name	GEDA Description
CLASS	Controlling flow type for bridge solution.	49	R(4)	Sub-hydraulic radius value.
DIFWSP	Difference in water surface elevation for each profile.	50	R(5)	Sub-hydraulic radius value.
DIFWSX	Difference in water surface elevation between sections.	51	R(6)	Sub-hydraulic radius value.
DIFKWS	Difference between known and computed water surface elevations.	52	R(7)	Sub-hydraulic radius value.
SSTA	Starting station where the water-surface intersects the ground (on the left side of the cross section).	53	QVAR	Starting station where the water surface intersects the ground (on the left side of the cross section).
ENDST	Ending station where the water surface intersects the ground on the right side.	54	QVAR	Ending station where the water surface intersects the ground on the right side.
VLOB	Average velocity in the left overbank area.	55	XNV(1)	Sub-n value.
VROB	Average velocity in the right overbank area.	56	XNV(2)	Sub-n value.
ALPHA	Velocity head coefficient.	57	ALFA	Velocity head coefficient.
KRATIO	Ratio of the upstream to downstream conveyance.	58	XNV(3)	Sub-n value.
QROB%	Percent of flow in the right overbank.	59	XNV(4)	Sub-n value.
QCH%	Percent of flow in the channel.	60	XNV(5)	Sub-n value.

TAPE95 VARIABLES

HEC2 Variable Name	HEC2 Description	Code Number	GEDA Variable Name	GEDA Description
DIFEG	Difference in energy elevation for each profile.	61	XNV(6)	Sub-n value.
INLEQ	Friction loss equation index.	62	XNV(7)	Sub-n value.
TELMX	Elevation of the lower of the two end points of the cross section.	63	QVAR	Elevation of the lower of the two end points of the cross section.
NA		64	QVAR	Minimum channel bank slope.
NA		65	QVAR	Minimum channel bank elevation.

APPENDIX II

GEDA --Tape 95

TAPE 95

First record on tape 95:

Z ITAPE JM Z Z KVAR Z Z Z

Z - a zero value is used

ITAPE - This is set to 94 to identify it as a GEDA tape 95

JM - is set equal to the total number of profiles

KVAR - is set to 65, which is the number of variables written out to tape 95

Second record on tape 95:

TITLE(1) - TITLE (6)

TITLE - Title on title card based on A4 format

Third record on tape 95:

X(1) - X(100), Z, Z

X and Z - are set to zero

Fourth record on tape 95:

X(1) - X(100)

X - is set to zero

Fifth and all other records on tape 95:

QVAR(1) - QVAR(65)

Last record on tape 95:

QVAR(1) is set equal to -1.E + 0 5

QVAR(1) - QVAR(65)

Total records = 4 + total number sections X total number of profiles + 1