THE REPUBLIC OF VENEZUELA

STUDY
ON
COMPREHENSIVE IMPROVEMENT
OF
THE APURE RIVER BASIN

USER'S MANUAL
OF
COMPUTER PROGRAM

RIVER BED FLUCTUATION CALCULATION

JANUARY 1993

JAPAN INTERNATIONAL COOPERATION AGENCY

USER'S MANUAL

RIVER BED FLUCTUATION MODEL: DVFLOW

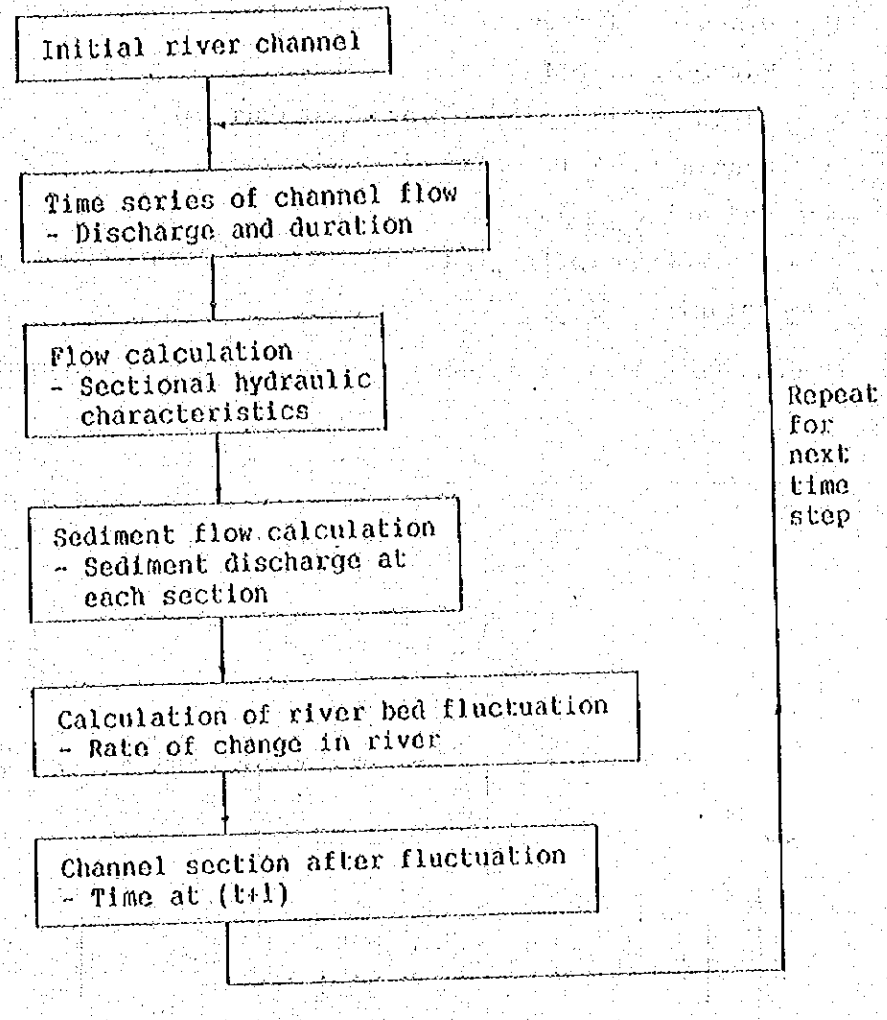
TABLE OF CONTENTS

USER'S MANUAL

RIVER BED FLUCTUATION MODEL: BVFLOW

I. METHOD OF CALCULATION

1.1 Overall Computation Scheme



1.2 Flow Calculation

$$H_i = H_{i-1} + \frac{\alpha Q^2}{2g}\left(\frac{1}{A_{i-1}^2} - \frac{1}{A_i^2}\right) + \frac{Q^2}{2}\left(\frac{n_{i-1}^2}{R_{i-1}^{4/3}A_{i-1}^2} + \frac{n_i^2}{R_i^{4/3}A_i^2}\right)\Delta X$$

where,

H = Elevation of water level (m)

g = Acceleration of gravity (m^3/sec^2)

Q = Discharge (m^3/sec)

A = Water area (m^2)

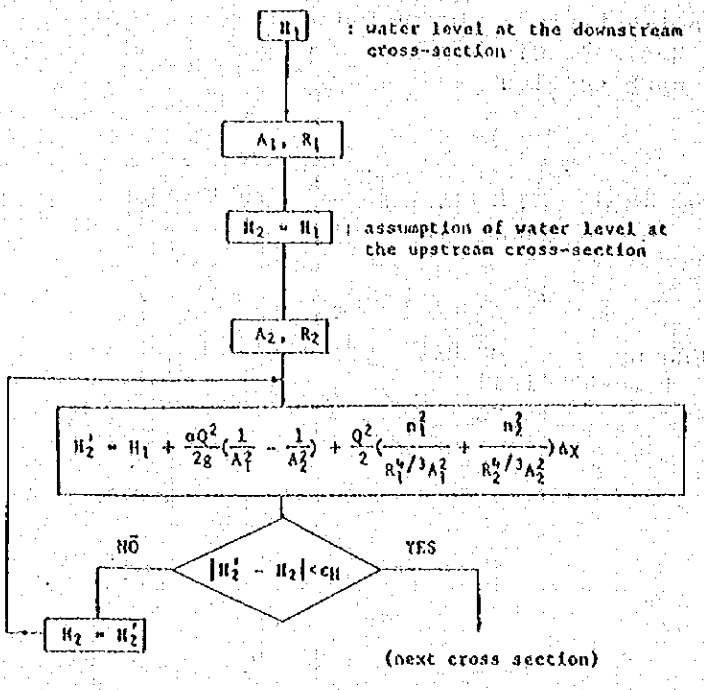
ΔX = Distance between two cross-sections (m)

n = Manning's coefficient of roughness

R = Hydraulic radius (m)

α = Correction coefficient for vertical distribution of velocity.

Suffix denotes number of a cross-section, from downstream to upstream.



ε_H : given tolerance in water level

1.3 Sediment Flow Calculation

1) Symbols

Major symbols and their units used for the sediment flow formulas are as follows:

g : Acceleration of gravity (=980 cm/s^2)
ρ' : Density of water (=1.0 g/cm^3)
σ : Density of bed materials (=2.65 g/cm^3)
ν : Kinematic viscosity (=0.009 cm^2/s for 24 deg.C)
$U*$: Friction velocity ($=\sqrt{gRIe} = \sqrt{\tau_0/\rho}$: cm/s)
τ_0 : Tractive force on river bed ($=\rho gRIe = \rho U*^2$: g/s^2/cm)
τ_c : Critical tractive force on river bed (g/s^2/cm)
$U*c$: Critical friction velocity ($=\sqrt{\tau_c/\rho}$: cm/s)
Ie : Gradient of energy ($=n^2v^2/R^{4/3}$: m,s)
n : Manning's coefficient of roughness (m,s)
v : Mean velocity (m/s)
R : Hydraulic mean depth (m)
h : Water depth (cm)
d_i : Grain size of bed material (cm)

2) Iwagaki's Formula for Critical Tractive Force

For the estimation of the critical tractive force, Iwagaki's formula is applied (see Fig.1).

for $671 \leq R_*$; $U_{*c}^2 = 0.05(\sigma/\rho - 1)gd$

for $162.7 \leq R_* \leq 671$; $U_{*c}^2 = \{0.01505(\sigma/\rho - 1)g\}^{25/22} \cdot \nu^{-3/11} \cdot d^{31/22}$

for $54.2 \leq R_* \leq 162.7$; $U_{*c}^2 = 0.034(\sigma/\rho - 1)gd$

for $2.14 \leq R_* \leq 54/2$; $U_{*c}^2 = \{0.1235(\sigma/\rho - 1)g\}^{25/32} \cdot \nu^{7/16} \cdot d^{11/32}$

for $R_* \leq 2.14$; $U_{*c}^2 = 0.14(\sigma/\rho - 1)gd$

where

$$R_* = \{(\sigma/\rho - 1)g\}^{1/2} \cdot d^{3/2} / \nu$$

3) Rubey's Formula for Fall Velocity of Particle

For the estimation of fall velocity of bed material in the water, Rubey's formula is applied (see Fig.2).

$$\frac{w_o}{\sqrt{sgd}} = \sqrt{\frac{2}{3} + \frac{36\nu^2}{sgd}} - \sqrt{\frac{36\nu^2}{sgd}}$$

where

$$s = (\sigma/\rho - 1)$$

4) Sato-Kikkawa-Ashida's Formula for Bed Load

$$qB = \frac{u_*^3}{\{(\sigma/\rho)-1\}g} \cdot \phi \cdot F(\tau_0/\tau_c)$$

$\phi = 0.623$ for $n \geq 0.025$

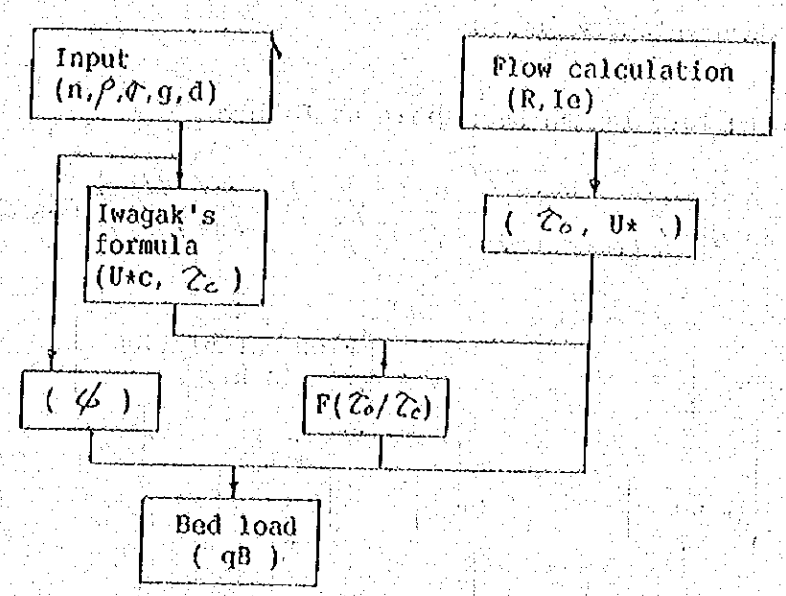
$\phi = 0.632*(40n)^{-3.5}$ for $n < 0.025$

where

qB : Bed load per unit width of channel river ($cm^3/s/cm$)

n : Manning's coefficient of roughness (m, sec)

$F(\tau_0/\tau_c)$: Function of τ_0/τ_c (see Fig.3)



5) Laursen's Formula for Total Sediment Load

$$C = \left(\frac{d}{h}\right)^{7/6} \cdot \left(\frac{\tau_e}{\tau_c} - 1\right) \cdot f\left(\frac{U_*}{w_o}\right)$$

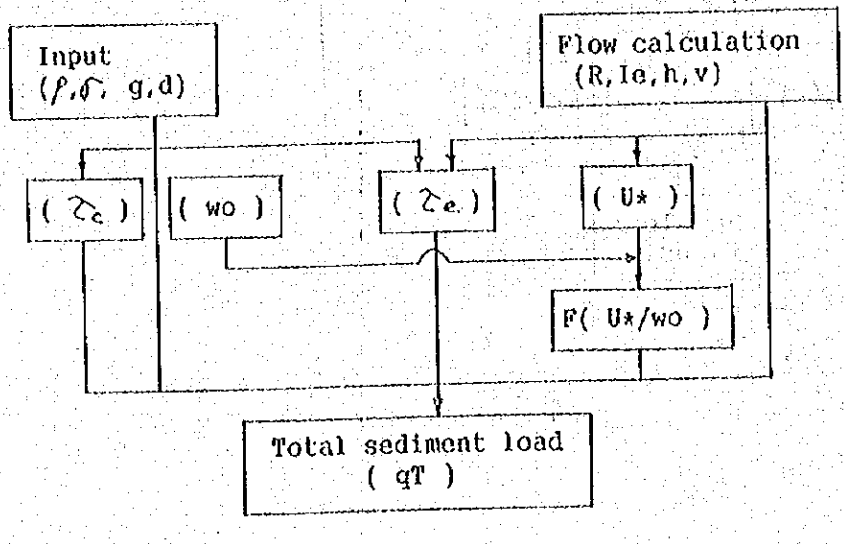
$$\tau_e = \rho \cdot \left(\frac{v}{7.66}\right)^2 \cdot \left(\frac{d}{h}\right)^{1/3}$$

where

C : Concentration of sediment load by weight (%)
(= 265*qT/q)
qT: Total sediment load ($m^3/s/m$)
q : Flow discharge (m^3/s)
τ_e: Effective tractive force
f(U*/wo): Function of U*/wo (see Fig.4)
v : Mean velocity (cm/s)

The preceding formula can be rewrite as follows:

$$qT = \frac{7.66}{265\phi_c} \left\{ \frac{\tau_e/\rho}{(\sigma/\rho - 1)gd} - \phi_c \right\} \cdot f\left(\frac{U_*}{w_o}\right) \cdot U_* e d$$



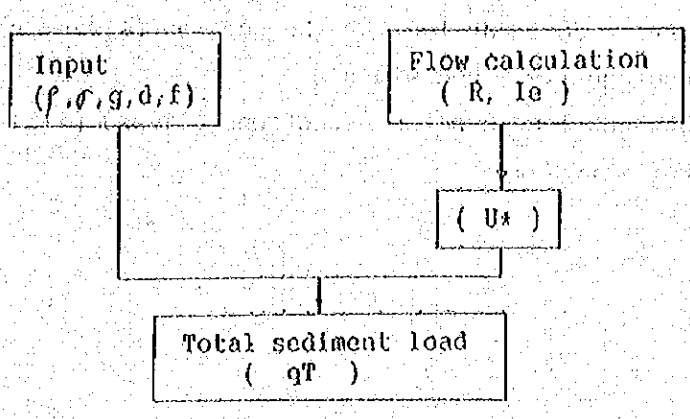
6) Kalinske-Brown's Formula for Total Sediment Load

$$qT = f \cdot \left\{ \frac{U_*^2}{(\sigma/\rho - 1) g d} \right\}^2 U_* d$$

where

qT : Total sediment load

f : Non-dimensional coefficient. f = 10 by Brown.



1.4 Calculation of River Bed Fluctuation

$$dz = Z_{t+1} - Z_t = \frac{1}{1-\lambda} \cdot \frac{QB_i - QB_{i+1}}{B \cdot dx} dt$$

where

dz : Fluctuation of river bed during the period of dt

dt : Period of time from (t) to (t+1)

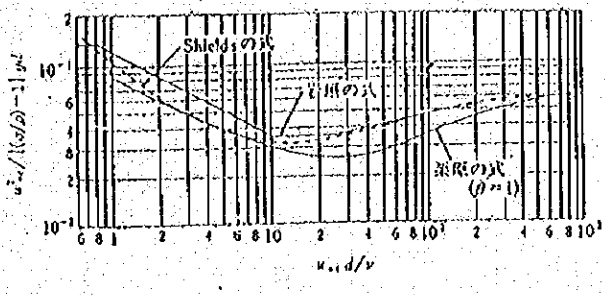
Z_t, Z_{t+1} : River bed elevation at the time of (t) and (t+1)

QB_i, QB_{i+1} : Sediment load at the section (i) and section (i+1)

B : Average river bed width

dx : Stretch length between sections (i) and (i+1)

λ : Porosity (%)



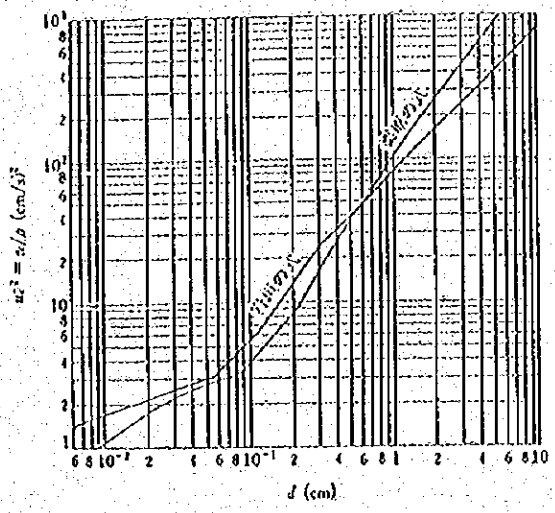


Fig. 1

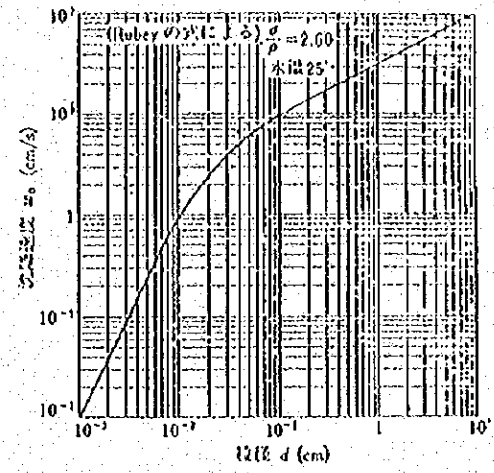


Fig. 2

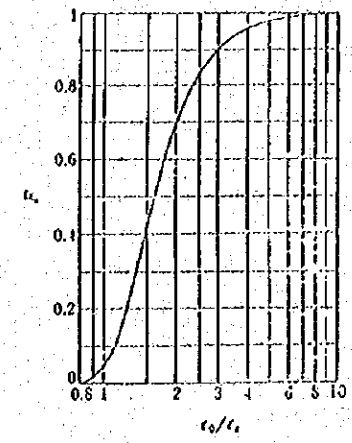


Fig. 3

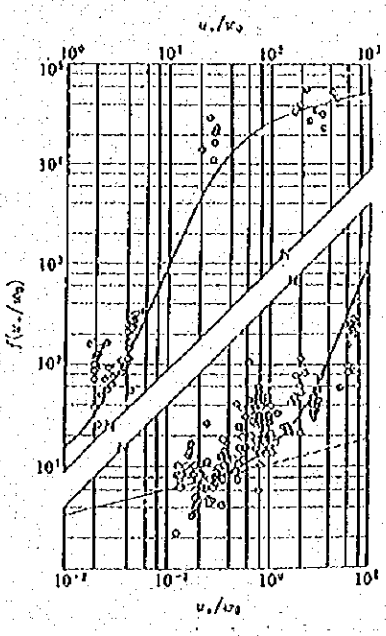


Fig. 4

II. FORMAT OF INPUT DATA

2.1 General

1) All the data shall be put within the specified column enclosed with thick solid line aligning to the right.
2) The input data shall be numerical value with or without decimal point and string of letters.
3) In case scaling factors (SF and SF1) accompany, the input value is to be converted as follows:

   SF x (input value) + SF1, in case (MC2) = 0

   SF x (input value + SF1), in case (MC2) = 1 .
4) Sectional data shall be arranged orderly from lower end to upstream.
5) Input values are of metric system as specified.
6) Left and right of river are always those facing toward downstream.

DATA SHEET

PROBLEM _____ WRITTEN BY _____ PAGE ____ OF ____

No	
1	
2	
3	KC KC1 KC2 --->
4	KC : Identification code for arrangement of input data
5	KC1 : Numerical codes to show kinds of data to be input.
6	Data shall be input in the order of KC-data.
7	0 or blank : No data and ignore
8	1: Input of title for output
9	2: Input of channel section data
10	3: Input of commands for output of sectional data
11	4: Input of flow configuration
12	5: Input of H(stage) vs. Q(discharge) relationship
13	6: Input of bed material data
14	8: Input of constants and factors for calculation
15	9: Input of boundary conditions and commands to execute the computation
16	10 or 99: Command to end the computation and return to DOS
17	
18	
19	D1 INPUT OF TITLE FOR OUTPUT (KC1=1)
20	
21	TITLE
22	
23	TITLE: Title to be put at the top of each output page; 80 letters at maximum.
24	
25	

DATA SHEET

PROBLEM _____ WRITTEN BY _____ PAGE _____ OF _____

No.	
1	
2	D2. INPUT OF CHANNEL SECTION DATA (KC1=2)
3	
4	N1 N2 KPR
5	
6	N1,N2 : Serial section No. starting from N1 (normally N1=1) to N2
7	(N2=100 at maximum) to show quantity of input sections.
8	KPR : Numerical code for output control.
9	0: No output
10	1: Output of section characteristic tables
11	2: Output of input data and section characteristics
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	

DATA SHEET

PROBLEM ______________ WRITTEN BY ______________ PAGE ____ OF ____

No												
1												
2	SC	MC1	SF →									
3	SC	MC2	SF1 →									
4	NAME(N1)		n	dx	mCd	Ibed	HIS	DHS	Ndiv	XBL	XBR	XL	XR
5	NAME(N1+1)											
6												

*) : When 0 or no data is input, value of the previous section will be used for these items.

**) : Value for the stretch between lower section shall be input. Therefore, the first (lowest) section shall be blank.

SC : Identification code for section data.

MC1 : MC1=0, if SF1=0 or will not be used. In this case, SF1-data row is not necessary.
MC1=1, if SF1 is adopted and the data are input in the next data row.

MC2 : MC2=0, if SF1-data will not be used as input.
MC2=1, if the input SF1-data will be multiplied by SF.

SF,SF1: Scaling factors to modify the input values.

NAME : Name of channel section; 10 letters at maximum. Data shall be input for all sections (N2-N1-1 rows).

n : Manning's coefficient of roughness. *),**)

dx : Distance between adjacent sections (m). *),**)

mCd : Drag coefficient of bridge piers, etc. **)

Ibed : Code No. of bed material. *)

HIS : Lowest elevation for output of section characteristics, in case KPR=1 or 2.

DHS : Interval of elevation for the above output (m). *)

Ndiv : Quantity of divisions of the lower stretch of the section under consideration for interpolation of river sections *)

XBL,XBR : Left and right boundaries of a river section subject to bed fluctuation in horizontal coordinate (m).

XL,XR : Left and right boundaries of a river section effective to water flow in horizontal coordinate (m).

SF×(入力値) + SF1

SF×(入力値 + SF1)

DATA SHEET

PROBLEM _____ WRITTEN BY _____ PAGE ___ OF _____

No									
1									
2	XY	KCK MC1 MC2		SFX	SFY	DXMAX	DYMAX	DXMIN	
3	XY			SFX1	SFY1				
4		NAME(N1)		Xn1,1	Yn1,1	Xn1,2	Yn1,2	---→	
5									
6									
7	X=Y=0 or blank denotes the end of data of a section.								
8		NAME(N1+1)		Xn1+1,1	Yn1+1,1	Xn1+1,2	Yn1+1,2	---→	
9									
10									
11									
12		END							
13									

14 XY : Identification code for sectional coordinate data.

15 KCK : Numerical code to specify method of checking NAME.

16 0: Check from 1st to 10th columns of NAME.

17 1: Check from 3rd to 10th columns of NAME.

18 2: Check from 6th to 10th columns of NAME.

19 3: No check.

20 MC1,MC2 : Control of scaling factor (Same function as data-2)

21 SFX,SFX1: Scaling factors for X (horizontal coordinate)

22 SFY,SFY1: Scaling factors for Y (vertical coordinate)

23 DXMAX : Critical max. interval of adjacent horizontal coordinates.
If (Xi,j - Xi,j-1) > DXMAX, the data includes error.

24 DXMAX=50 m, if no value is input.

25

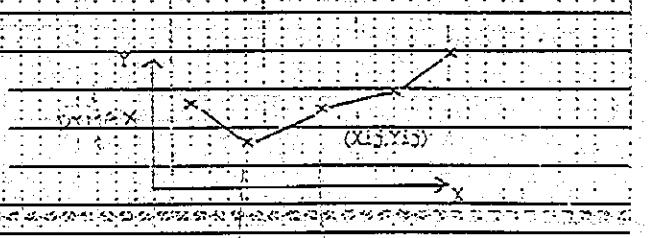
DYMAX : Critical max. interval of adjacent vertical coordinates.
If ABS(Yi,j -Yi,j-1) > DYMAX, the data includes error.
DYMAX=10 m, if no value is input.

DXMIN : Critical min. interval of adjacent horizontal coordinates.
If (Xi,j - Xi,j-1) < DXMAX, the data includes error.
DXMIN=0.0 m, if no value is input.

NAME : Name of channel section (same as data-2), which shall be put at the head of every data rows.

Xi,j and Yi,j: Horizontal and vertical coordinates (m).

END : Fixed code to denote end of channel section data.



DXMAX ≤ 50

DATA SHEET

PROBLEM _____ WRITTEN BY _____ PAGE ____ OF ____

D3. INPUT OF COMMAND FOR OUTPUT OF SECTIONAL DATA (KCi=3)

NN1 NN2

NN1,NN2: Number of the first and last sections to be output, i.e., from NN1-th to NN2-th sections. Serial numbers shall be put incorporating the interpolated sections.
In case NN2=0 or blank, all sections will be output.

D4. INPUT OF FLOW CONFIGURATION (KCi=4)

(1) In case KDX = 0 or blank

NQ (KDX) KPR

INQ1 INQ2 ---→ INQnq

NQ : Number of inflow points from tributaries; NQ≤30 at maximum.

KPR : Numerical code for output control.
0: Input data will not be ouput.
1: Input data will be output.

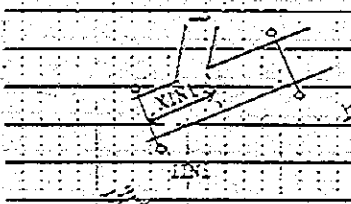
INQ : Section No. of nearest upstream section of the inflow point. The section number correspond to those of data-3.

(INQ1)

DATA SHEET

PROBLEM _____ WRITTEN BY _____ PAGE _____ OF _____

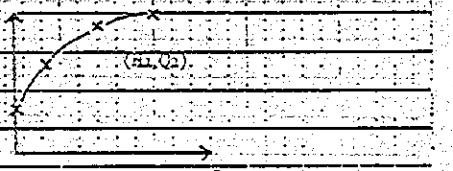
No.	
1	(2) In case KDX = 1.
2	NQ (KDX) KPR
3	IINI IIN2 ----→ IINnq
4	
5	XINI XIN2 ----→ XINnq
6	
7	
8	1) Place of inflow from tributary is specified by the number (IINi)
9	of the nearest lower section and distance (XINi in meter) from
10	the section IINi toward upstream. The section IINi corresponds
11	to N of data-2.
12	2) NQ and KPR are same with those of (1).
13	
14	(3) In case KDX = 2
15	NQ (KDX) KPR
16	XINI XIN2 ----→ XINnq
17	
18	
19	1) Place of inflow from tributary is specified by the distance (XINi
20	in meter) from the section at the lowest end.
21	2) NQ and KPR are same with those of (1).
22	
23	
24	
25	



DATA SHEET

PROBLEM _____ WRITTEN BY _____ PAGE ____ OF ____

No.	
1	
2	D5. INPUT OF H-Q RELATIONSHIP (KC=5)
3	
4	NN KPR SFH SFH1 SFQ SFQ1
5	H1 H2 H3 ←——→ Hnn
6	
7	
8	Q1 Q2 Q3 ←——→ Qnn
9	
10	
11	
12	NN : Number of points of H-Q relationship to be input for the
13	lowest section.
14	KPR : Numerical code for output control.
15	0: Input data will not be output.
16	1: Input data will be output.
17	SFH,SFH1: Scaling factor for H (water level).
18	SFQ,SFQ1: Scaling factors for Q (discharge).
19	H : Water level (m)
20	Q : Discharge (m³/s) corresponding to H.
21	
22	
23	
24	
25	



DATA SHEET

PROBLEM_____ WRITTEN BY_____ PAGE____ OF____

D6. INPUT OF BED MATERIAL DATA (KCi = 6)

NBM	KPR	SFDS	SFDI	KDS	KDI

NBM : Number of bed material data to be input; NBM = 50 at maximum.

KPR : Numerical code for output control.
0: Input data will not be output.
1: Input data will be output.

SFDS,SFDI: Scaling factors for DS (composition rate) and DI (mean diameter)

KDS : Numerical code for type of DS-data.
0 or blank: DS-data will be input for respective DI-data
1: DS-data will be common for all DI-data

KDI : Numerical code for place of DI-data.
0: Representative diameter will be input in the 76th to 80th columns of DI-data row.
1: Mean diameter or representative diameter will be input in the 11th to 15th columns of DI-data row.

DATA SHEET

PROBLEM _____ WRITTEN BY _____ PAGE _____ OF _____

No	
1	
2	D6.1 IN CASE KDF = 0
3	
4	DF NAMF1 DF1,1 DF1,2 DF1,3 ---→
5	DI NAMD1 DI1,1 DI1,2 DI1,3 ---→
6	DF NAMF2 DF2,1 DF2,2 DF2,3 ---→
7	
8	
9	
10	DF : Identification code for DF-data row.
11	DI : Identification code for DI-data row.
12	NAMEi : Name of i-th bed material.
13	Pair of DF and DI-data rows shall continue NBN times.
14	DFi,j : Composition rate (in %) of j-th size fraction of i-th bed
15	material.
16	DIi,j : Representative (or mean) diameter (in mm) of j-th size
17	fraction of i-th bed material.
18	DMi : Mean diameter of entire size fractions of i-th bed material.
19	If zero is input or kept blank,
20	
21	$DMi = \frac{1}{100} \sum (DFi,j \times DIi,j)$
22	
23	
24	
25	

DATA SHEET

PROBLEM _____ WRITTEN BY _____ PAGE _____ OF _____

例題 KDF=1

D6.2 IN CASE KDF = 1

DF	NAMF1	DF1	DF2	DF3		(DM1)
DI	NAMD1	DI1,1	DI1,2	DI1,3		
DI	NAMD2	DI2,1	DI2,2	DI2,3		

DF,DI : (Same as D6.1)

NAMDi : Name of i-th bed material. A DF-data row will be input followed by NDM-rows of DI-data

DFi,j : (Same as D6.1)

DIi,j : (Same as D6.1)

DMi : (Same as D6.1)

DATA SHEET

PROBLEM _____ WRITTEN BY _____ PAGE _____ OF _____

No.	1 2 3 4 5	6 7 8 9 10	11 12 13 14 15	16 17 18 19 20	21 22 23 24 25	26 27 28 29 30	31 32 33 34 35	36 37 38 39 40	41 42 43 44 45	46 47 48 49 50	51 52 53 54 55	56 57 58 59 60	61 62 63 64 65	66 67 68 69 70	71 72 73 74 75	76 77 78 79 80
1																
2	D8.-INPUT OF CONSTANTS AND FACTORS FOR CALCULATION (KCi=8)															
3																
4		ALPH		Frc		SIG		LAMB		eH		NU		GAMM		
5																
6																
7			ALPH : Correction factor for vertical velocity distribution													
8			(ALPH=1.0).													
9			Frc : Limit of Froude number for subcritical flow (Frc=0.9).													
10			SIG : Density of bed material (SIG=2.65 g/cm³).													
11			LAMB : Porosity which is defined as a percentage of porosity in a													
12			soil mass (LAMB=0 %).													
13			eH : Allowable error of water level calculations (eH=1E-4 m).													
14			NU : Kinematic viscosity (=0.009 cm²/s)													
15			GAMM : Adjustment factor of sediment volume (GAMM=1.0).													
16			Value in ( ) will be used, when no value is input.													
17																
18																
19																
20																
21																
22																
23																
24																
25																
	1 2 3 4 5	6 7 8 9 10	11 12 13 14 15	16 17 18 19 20	21 22 23 24 25	26 27 28 29 30	31 32 33 34 35	36 37 38 39 40	41 42 43 44 45	46 47 48 49 50	51 52 53 54 55	56 57 58 59 60	61 62 63 64 65	66 67 68 69 70	71 72 73 74 75	76 77 78 79 80

DATA SHEET

PROBLEM________ WRITTEN BY________ PAGE____ OF____

No	
1	
2	D9. INPUT OF BOUNDARY CONDITIONS AND EXECUTION OF CALCULATION (XCi=9)
3	
4	BC NT KPR KFM CLD
5	MC2 SFDT SFHO SFQN SFQI
6	HC2 SFDT1 SFHO1 SFQN1 SFQI1
7	TIME1 DT1 HO1 QN1 QI1.1 QI1.2 QI1.3 … QI1.nq
8	
9	
10	TIME2 DT2 HO2 QN2 QI2.1 QI2.2 QI2.3 … QI2.nq
11	
12	
13	
14	

15 BC : Identification code for boundary condition data.

16 NT : Number of time steps for calculation; NT=50 at maximum.

17 KPR : Numerical code for output control.

18 0: Input data will not be output.

19 1: Input data will be output.

20 KFM : Numerical code for sediment formula to be used

21 1: Sato-Kikkawa-Ashida's formula

22 2: Laursen's formula

23 3: Kalinske-Brown's formula

24 CLD : Adjustment factor of sediment volume.

25 When no value is input, CLD=1.0.

MC1,MC2: Control of scaling factors (Same function as data-2).

TIME : Code of time step for calculation; 10 letters at maximum.

DTi : Duration of i-th time step for calculation (sec). If zero is input or kept blank, only the sediment transport capacity will be calculated.

HO : Water level at the lowest section (m)

QN : Discharge (m^3/s) at the uppermost section.

QIi : Inflow (m^3/s) from tributaries in the same order as data-4.

III. SAMPLE INPUT DATA AND OUTPUT

3.1 Sample Input Data

```
KC  1
BED VARIATION CALCULATION OF APURE RIVER (SAMPLE)
KC  2
    1    7    1
SC  0       1E+0 1E+0       1E+0 1E+0 1E+0 1E+0                    1E-1 1E-1 1E-1 1E-1
     SAMAN .030    0          1   56    1                        -200 3556 -200 3556
     312-4      16120               58          6                    0 4000    0 4000
     296-7      16500               62          7                    0 3100    0 3100
     CHNAL      16330             2 66          7                    0 2180    0 2180
     258-8      15840               67          6                    0 4900    0 4900
     244-9 .03514160                71          6                    0 3650    0 3650
     BRZAL      15070               66          6                    0 3231    0 3231
XY2 0       1E-1 1E-2   75
XY  0SAMAN -200 6116  500 6001 1060 5969 1070 5905 1260 5771 1460 5549 1510 5660
XY  1SAMAN 1561 5705 1636 5727 1811 5693 1936 5727 2061 5649 2386 5669 2536 5582
XY  2SAMAN 2962 5638 3212 5969 3260 6034 3300 6120 3321 6247 3346 6437 3376 6510
XY  3SAMAN 3466 6497 3556 6557
XY  0312-4   00 6419  650 6409 1000 6419 1350 6369 1650 6249 2050 6259 2400 6229
XY  1312-4 2650 6079 3000 5939 3250 5849 3550 5789 3900 6839 4000 6419
XY  0296-7   00 6538  200 6538  500 6488  700 6438 1000 6398 1300 6348 1600 6288
XY  1296-7 1950 6268 2150 6248 2450 6188 2750 6208 3000 6438 3100 6538
XY  0CHNAL   00 7400   40 7395   65 7171   90 7066  100 6900  110 6765  262 6777
XY  1CHNAL  293 6650  445 6570  750 6673 1086 6754 1452 6788 1787 6823 1970 6880
XY  2CHNAL 2000 6900 2140 7064 2180 7367
XY  0258-8   00 7055   50 6985  200 6965  400 6955  650 7005 1050 7055 1450 7025
XY  1258-8 1800 7015 2250 6905 2700 6985 3100 6885 3500 6855 3850 6785 4200 6735
XY  2258-8 4500 6785 4600 6675 4700 6935 4900 7055
XY  0244-9   00 7358   50 7358  350 7048  600 7048  900 7048 1150 7078 1450 7108
XY  1244-9 1750 7148 2100 7128 2500 7148 2800 7088 3200 7058 3450 7068 3600 7148
XY  2244-9 3650 7358
XY  0BRZAL   00 7805   30 7613   35 7394   80 7303  170 7121  215 7189  230 7076
XY  1BRZAL  260 7098  290 6962  350 6848  471 6758  501 6553  606 6644  666 6712
XY  2BRZAL  711 6644  816 6780  996 6848 1191 6871 1251 6894 1357 6871 1522 6917
XY  3BRZAL 1657 6962 1822 7098 1897 7348 2182 7417 2333 7439 2483 7462 2618 7485
XY  4BRZAL 2620 7613 2890 7774 2980 7727 2992 7789 3006 7888 3021 8001 3030 7967
XY  5BRZAL 3156 7994 3226 8004 3231 8103
XY    END
KC  4
    1    1    0
              2
         6740
KC  5
    9    1 1E-158.02 1E+0
              16   18   22   28   36   46   58   73   80
             215  256  359  570  957 1610 2640 4308 5231
KC  6
    2    1 1E+0 1E+0    1    1
DF                100
DI    M- 7 0.25 0.25
DI    M- 6 0.30 0.30
KC  8
                0.3                 0.3
KC  9
BC        5    1    2  1.0
    0       1E+0 1E+0 1E+0 1E+0
12/15 12  86400       1062  244
12/16 12  86400       1005  209
12/17 12  86400        966  142
12/18 12  86400        944  128
12/19 12  86400        927  116
KC 99
```

BED VARIATION CALCULATION OF APURE RIVER (SAMPLE)

1	SAMAN			NDIV 1
ZS	N	DX	MCD	BEDM
55.490	.0300	.0	.0000	1

H	B	A	R
56.000	23.69	3.3	.137
57.000	132.27	82.5	.623
58.000	186.55	254.5	1.361
59.000	208.28	451.9	2.164
60.000	271.74	673.7	2.472
61.000	339.33	980.1	2.881
62.000	351.32	1329.8	3.773
63.000	352.80	1681.9	4.748
64.000	354.11	2035.3	5.719
65.000	359.72	2390.7	6.609
66.000	375.60	2763.5	7.318
67.000	375.60	3139.1	8.313
68.000	375.60	3514.7	9.307
69.000	375.60	3890.3	10.302

2	312-4			NDIV 6
ZS	N	DX	MCD	BEDM
57.890	.0300	16120.0	.0000	1

H	B	A	R
58.000	13.20	.7	.055
59.000	80.22	58.3	.726
60.000	108.03	152.8	1.408
61.000	133.00	274.0	2.048
62.000	151.39	416.2	2.730
63.000	245.70	613.8	2.485
64.000	286.37	875.0	3.038
65.000	400.00	1259.8	3.136
66.000	400.00	1659.8	4.132
67.000	400.00	2059.8	5.128
68.000	400.00	2459.8	6.124
69.000	400.00	2859.8	7.119
70.000	400.00	3259.8	8.115
71.000	400.00	3659.8	9.111

3	296-7			NDIV 7
ZS	N	DX	MCD	BEDM
61.280	.0300	16500.0	.0000	1

H	B	A	R
62.000	9.60	.6	.060
63.000	123.00	59.8	.486
64.000	195.17	217.5	1.114
65.000	263.40	450.6	1.710
66.000	310.00	748.0	2.412
67.000	310.00	1058.0	3.411
68.000	310.00	1368.0	4.411
69.000	310.00	1678.0	5.410
70.000	310.00	1988.0	6.410
71.000	310.00	2298.0	7.409
72.000	310.00	2608.0	8.409
73.000	310.00	2918.0	9.408
74.000	310.00	3228.0	10.408
75.000	310.00	3538.0	11.408

4	CHNAL			NDIV 7
ZS	N	DX	MCD	BEDM
65.700	.0300	16330.0	.0000	2

H	B	A	R
66.000	14.58	2.2	.150
67.000	58.12	39.4	.677
68.000	145.95	130.8	.893
69.000	190.00	305.8	1.601
70.000	199.14	500.4	2.492
71.000	206.28	703.7	3.375
72.000	209.62	911.8	4.292
73.000	212.06	1122.6	5.207
74.000	218.00	1335.9	6.015
75.000	218.00	1553.9	6.996
76.000	218.00	1771.9	7.977
77.000	218.00	1989.9	8.959
78.000	218.00	2207.9	9.940
79.000	218.00	2425.9	10.922

5	258-8			NDIV 6
ZS	N	DX	MCD	BEDM
66.750	.0300	15840.0	.0000	2

H	B	A	R
67.000	3.23	.4	.123
68.000	87.31	36.6	.418
69.000	164.65	158.2	.959
70.000	353.27	407.1	1.151
71.000	490.00	858.0	1.749
72.000	490.00	1348.0	2.748
73.000	490.00	1838.0	3.747
74.000	490.00	2328.0	4.746
75.000	490.00	2818.0	5.745
76.000	490.00	3308.0	6.744
77.000	490.00	3798.0	7.743
78.000	490.00	4288.0	8.741
79.000	490.00	4778.0	9.740
80.000	490.00	5268.0	10.739

6	244-9			NDIV 6
ZS	N	DX	MCD	BEDM
70.480	.0350	14160.0	.0000	2

H	B	A	R
71.000	184.03	62.9	.342
72.000	340.95	353.0	1.035
73.000	353.01	700.0	1.980
74.000	365.00	1060.1	2.899
75.000	365.00	1425.1	3.898
76.000	365.00	1790.1	4.896
77.000	365.00	2155.1	5.894
78.000	365.00	2520.1	6.893
79.000	365.00	2885.1	7.891
80.000	365.00	3250.1	8.889
81.000	365.00	3615.1	9.887
82.000	365.00	3980.1	10.886
83.000	365.00	4345.1	11.884
84.000	365.00	4710.1	12.882

BED VARIATION CALCULATION OF APURE RIVER (SAMPLE)

7	BRZAL			NDIV
				6

ZS	N	DX	MCD	BEDM
65.530	.0350	15070.0	.0000	2

H	S	A	R
66.000	6.11	1.4	.229
67.000	25.62	15.9	.605
68.000	45.44	49.3	1.064
69.000	113.84	122.3	1.065
70.000	142.15	253.2	1.767
71.000	159.58	402.9	2.502
72.000	172.17	568.2	3.261
73.000	180.11	744.3	4.080
74.000	207.69	933.6	4.441
75.000	258.57	1169.7	4.464
76.000	258.95	1428.5	5.409
77.000	274.95	1694.4	6.039
78.000	299.28	1982.9	6.492
79.000	300.76	2283.0	7.431

RED VARIATION CALCULATION OF APURE RIVER (SAMPLE)

32 CROSS SECTIONS ARE INSERTED.
NEW CROSSSECTION NUMBERS ARE 1 - 39.

INFLOW PNT. NQ = 1

NO	X		NO	SECT.			INQ
2	+6740.0	--->	2	312-4	(7)	+3 =	10

MAIN RIVER 1 - 39

INFLOW PNT. NQ = 1
10

H-Q CURVE

H	Q
59.620	215.0
59.820	256.0
60.220	359.0
60.820	570.0
61.620	957.0
62.620	1610.0
63.820	2640.0
65.320	4308.0
66.020	5231.0

1

DF	100.0	100.0
DI	.250	.250

2

DF	100.0	100.0
DI	.300	.300

ALPHA = 1.00000 CR FR = .30000 SIGMA = 2.65000 VOID = .30000
EPS H = .00010 NU = .00900 GAMMA = 1.00000 RHO = 1.00000

BOUNDARY CONDITIONS

		DT	HO	QN	DQ
1	12/15 12	86400.0	.000	1062.0	244.0
2	12/16 12	86400.0	.000	1005.0	209.0
3	12/17 12	86400.0	.000	966.0	142.0
4	12/18 12	86400.0	.000	944.0	128.0
5	12/19 12	86400.0	.000	927.0	116.0

BED VARIATION CALCULATION OF APURE RIVER (SAMPLE)

1

DF	100.0	100.0
DI	.250	.250
TC	2.25	2.25
WO	3.46	3.46

2

DF	100.0	100.0
DI	.300	.300
TC	2.39	2.39
WO	4.16	4.16

BED VARIATION CALCULATION OF APURE RIVER (SAMPLE)

LAURSEN 12/15 12

		Q	H	B	A	R	V	FR	TAU	U*	SQT	QT	B*
SAMAN	*	1306.0	60.586	312.2	845.2	2.700	1.545	.300	151.2	12.3	1.81	.053475	294.7
SAMAN	-1	1306.0	61.945	343.3	963.2	2.801	1.356	.259	115.0	10.7	.88	.027075	308.7
SAMAN	-2	1306.0	63.024	375.4	1031.5	2.745	1.266	.244	101.0	10.0	.62	.020607	331.4
SAMAN	-3	1306.0	63.913	384.9	1144.1	2.967	1.142	.212	80.0	8.9	.34	.011199	333.5
SAMAN	-4	1306.0	64.581	391.7	1240.9	3.160	1.052	.189	66.6	8.2	.21	.006915	335.7
SAMAN	-5	1306.0	65.103	395.9	1344.3	3.384	.971	.168	55.4	7.4	.13	.004243	337.8
312-4		1306.0	65.507	400.0	1462.6	3.641	.893	.149	45.7	6.8	.07	.002488	340.0
312-4	-1	1306.0	65.810	387.1	1437.4	3.700	.909	.151	47.1	6.9	.08	.002636	331.1
312-4	-2	1306.0	66.116	374.3	1412.1	3.762	.925	.152	48.5	7.0	.09	.002794	322.1
312-4	-3	1062.0	66.392	361.4	1373.7	3.793	.773	.127	33.8	5.8	.03	.000916	313.2
312-4	-4	1062.0	66.614	348.6	1315.9	3.769	.807	.133	36.9	6.1	.04	.001181	304.3
312-4	-5	1062.0	66.856	335.7	1265.3	3.765	.839	.138	39.9	6.3	.05	.001459	295.4
312-4	-6	1062.0	67.118	322.9	1220.7	3.778	.870	.143	42.9	6.5	.06	.001745	286.4
296-7		1062.0	67.396	310.0	1180.7	3.807	.899	.147	45.7	6.8	.07	.002035	277.5
296-7	-1	1062.0	67.754	296.9	1005.3	3.384	1.056	.183	65.6	8.1	.19	.004977	267.1
296-7	-2	1062.0	68.283	283.7	901.7	3.174	1.178	.211	83.2	9.1	.34	.008791	256.8
296-7	-3	1062.0	68.919	255.4	848.0	3.313	1.252	.220	92.8	9.6	.45	.010714	237.9
296-7	-4	1062.0	69.582	238.3	823.8	3.447	1.289	.221	97.0	9.9	.50	.011297	224.0
296-7	-5	1062.0	70.242	225.8	812.0	3.583	1.308	.220	98.6	9.9	.52	.011224	213.9
296-7	-6	1062.0	70.884	216.1	807.4	3.717	1.315	.217	98.5	9.9	.52	.010791	206.3
CHNAL		1062.0	71.502	208.1	807.8	3.835	1.315	.213	97.4	9.9	.51	.010128	200.0
CHNAL	-1	1062.0	72.060	253.6	1058.9	4.159	1.003	.157	55.2	7.4	.12	.002881	242.9
CHNAL	-2	1062.0	72.379	302.5	1263.9	4.168	.840	.131	38.7	6.2	.04	.001279	287.8
CHNAL	-3	1062.0	72.610	354.0	1448.0	4.084	.733	.116	29.7	5.4	.02	.000628	333.8
CHNAL	-4	1062.0	72.794	399.3	1611.6	4.031	.659	.105	24.1	4.9	.01	.000289	376.7
CHNAL	-5	1062.0	72.942	444.7	1754.7	3.942	.605	.097	20.5	4.5	.00	.000097	419.6
258-8		1062.0	73.083	490.0	1878.7	3.830	.565	.092	18.0	4.2	.00	.000000	462.5
258-8	-1	1062.0	73.252	469.2	1738.8	3.703	.611	.101	23.9	5.4	.00	.000173	443.8
258-8	-2	1062.0	73.455	448.3	1618.3	3.607	.656	.110	33.7	5.8	.01	.000437	425.0
258-8	-3	1062.0	73.696	427.5	1515.9	3.543	.701	.119	38.6	6.2	.02	.000759	406.3
258-8	-4	1062.0	73.974	406.7	1429.2	3.511	.743	.127	43.6	6.6	.03	.001125	387.5
258-8	-5	1062.0	74.286	385.8	1355.2	3.508	.784	.134	48.5	7.0	.04	.001522	368.8
244-9		1062.0	74.632	365.0	1290.7	3.530	.823	.140	53.4	7.3	.06	.001940	350.0
244-9	-1	1062.0	75.086	358.0	1161.6	3.234	.914	.162	67.8	8.2	.11	.003811	344.6
244-9	-2	1062.0	75.628	350.2	1144.7	3.254	.928	.164	69.7	8.4	.12	.004044	339.2
244-9	-3	1062.0	76.136	342.0	1196.7	3.479	.887	.152	62.4	7.9	.09	.002911	333.8
244-9	-4	1062.0	76.510	285.5	1299.4	4.510	.817	.122	48.5	7.0	.04	.001164	283.8
244-9	-5	1062.0	76.746	282.6	1468.8	5.136	.723	.101	36.4	6.0	.01	.000405	281.5
BRZAL		1062.0	76.901	273.1	1567.1	5.981	.637	.082	26.8	5.2	.00	.000039	272.5

BED VARIATION CALCULATION OF APURE RIVER (SAMPLE)

DZ	K =	1									
	0	-.004	-.001	-.001	-.001	-.000	-.000	.000	.000	-.000	.000
	1	.000	.000	.000	.001	.001	.000	.000	.000	-.000	-.000
	2	-.002	-.000	.000	.000	.000	.000	.000	.000	.000	.000
	3	.000	.000	.000	.000	-.000	-.000	-.000	.000	.000	

BED VARIATION CALCULATION OF APURE RIVER (SAMPLE)

LAURSEN 12/16 12

		Q	H	B	A	R	V	FR	TAU	U*	SQT	QT	B*
SAMAN	*	1214.0	60.421	301.6	795.8	2.632	1.526	.300	148.7	12.2	1.73	.050105	289.0
SAMAN	-1	1214.0	61.800	342.0	914.0	2.669	1.328	.260	112.2	10.6	.92	.026225	307.4
SAMAN	-2	1214.0	62.897	374.9	984.4	2.623	1.233	.243	97.3	9.9	.56	.018661	331.4
SAMAN	-3	1214.0	63.788	384.6	1096.2	2.846	1.107	.210	76.3	8.7	.30	.009894	333.5
SAMAN	-4	1214.0	64.452	391.4	1190.3	3.034	1.020	.187	63.4	8.0	.18	.006060	335.7
SAMAN	-5	1214.0	64.968	395.9	1291.0	3.250	.940	.166	52.7	7.3	.11	.003681	337.8
312-4		1214.0	65.367	400.0	1406.4	3.501	.863	.147	43.3	6.6	.06	.002125	340.0
312-4	-1	1214.0	65.665	387.1	1381.3	3.556	.879	.149	44.6	6.7	.07	.002254	331.1
312-4	-2	1214.0	65.968	374.3	1356.5	3.614	.895	.150	46.0	6.8	.07	.002408	322.1
312-4	-3	1005.0	66.242	361.4	1319.5	3.643	.762	.127	33.3	5.8	.03	.000667	313.2
312-4	-4	1005.0	66.469	348.6	1265.4	3.625	.794	.133	36.2	6.0	.04	.001112	304.3
312-4	-5	1005.0	66.716	335.7	1218.2	3.625	.825	.138	39.1	6.3	.05	.001366	295.4
312-4	-6	1005.0	66.981	322.9	1176.7	3.642	.854	.143	41.8	6.5	.06	.001623	286.4
296-7		1005.0	67.262	310.0	1139.2	3.673	.882	.147	44.5	6.7	.07	.001884	277.5
296-7	-1	1005.0	67.626	296.9	967.3	3.256	1.039	.184	64.2	8.0	.18	.004723	267.1
296-7	-2	1005.0	68.165	283.7	868.3	3.056	1.157	.211	81.4	9.0	.32	.008313	256.8
296-7	-3	1005.0	68.805	253.3	818.1	3.227	1.227	.218	89.9	9.5	.42	.009810	236.2
296-7	-4	1005.0	69.466	238.8	796.0	3.352	1.263	.220	93.9	9.7	.46	.010355	222.9
296-7	-5	1005.0	70.123	224.8	785.1	3.481	1.280	.219	95.4	9.8	.48	.010285	213.2
296-7	-6	1005.0	70.762	215.5	781.1	3.607	1.287	.216	95.2	9.8	.48	.009881	205.9
CHNAL		1005.0	71.377	207.7	782.1	3.722	1.285	.212	94.0	9.7	.46	.009239	199.7
CHNAL	-1	1005.0	71.930	253.0	1026.0	4.041	.980	.155	53.1	7.3	.11	.002605	242.6
CHNAL	-2	1005.0	72.245	301.4	1223.6	4.050	.821	.130	37.3	6.1	.04	.001146	287.2
CHNAL	-3	1005.0	72.476	354.0	1400.4	3.950	.718	.115	28.7	5.4	.02	.000557	333.8
CHNAL	-4	1005.0	72.659	399.3	1557.9	3.897	.645	.104	23.3	4.8	.01	.000243	376.7
CHNAL	-5	1005.0	72.813	444.7	1695.0	3.808	.593	.097	19.9	4.5	.00	.000065	419.6
258-8		1005.0	72.950	490.0	1813.3	3.697	.554	.092	17.5	4.2	.00	.000000	462.5
258-8	-1	1005.0	73.120	469.2	1677.0	3.571	.599	.101	20.2	5.3	.00	.000136	443.8
258-8	-2	1005.0	73.325	448.3	1560.3	3.478	.644	.110	32.9	5.7	.01	.000384	425.0
258-8	-3	1005.0	73.569	427.5	1461.8	3.417	.687	.119	37.7	6.1	.02	.000685	406.3
258-8	-4	1005.0	73.850	406.7	1379.0	3.388	.729	.126	42.5	6.5	.03	.001025	387.5
258-8	-5	1005.0	74.165	385.8	1308.5	3.388	.768	.133	47.2	6.9	.04	.001389	368.8
244-9		1005.0	74.513	365.0	1247.2	3.411	.806	.139	51.8	7.2	.05	.001769	350.0
244-9	-1	1005.0	74.971	358.0	1120.4	3.120	.897	.162	66.1	8.1	.10	.003545	344.6
244-9	-2	1005.0	75.517	349.9	1105.8	3.145	.909	.163	67.7	8.2	.11	.003721	339.2
244-9	-3	1005.0	76.025	341.8	1158.9	3.371	.867	.150	60.2	7.8	.08	.002630	333.8
244-9	-4	1005.0	76.393	282.9	1266.3	4.436	.794	.120	46.0	6.8	.03	.000872	281.3
244-9	-5	1005.0	76.620	277.8	1433.3	5.098	.701	.099	34.3	5.9	.01	.000305	276.8
BRZAL		1005.0	76.796	270.7	1630.7	5.904	.616	.080	25.2	5.0	.00	.000000	270.2

BED VARIATION CALCULATION OF APURE RIVER (SAMPLE)

DZ K = 2

0	-.008	-.002	-.003	-.001	-.001	-.000	.000	.000	-.001	.000
1	.000	.000	.000	.001	.001	.001	.000	.000	-.000	-.000
2	-.003	-.001	-.000	.000	.000	.000	.000	.000	.000	.000
3	.000	.000	.001	.000	-.000	-.001	-.000	-.000	-.000	

BED VARIATION CALCULATION OF APURE RIVER (SAMPLE)

LAURSEN 12/17 12

		Q	H	B	A	R	V	FR	TAU	U*	SQT	QT	B*
SAMAN	*	1108.0	60.220	288.3	737.6	2.551	1.502	.300	145.6	12.1	1.64	.046227	281.8
SAMAN	-1	1108.0	61.623	337.4	853.9	2.527	1.298	.261	109.0	10.4	.76	.023152	304.3
SAMAN	-2	1108.0	62.733	365.3	923.5	2.525	1.200	.241	93.2	9.7	.50	.016460	326.9
SAMAN	-3	1108.0	63.626	384.1	1033.9	2.688	1.072	.209	72.9	8.5	.26	.008743	333.5
SAMAN	-4	1108.0	64.292	391.0	1127.8	2.877	.982	.185	59.9	7.7	.15	.005194	335.7
SAMAN	-5	1108.0	64.804	396.9	1226.1	3.086	.904	.164	49.5	7.0	.09	.003094	337.8
312-4		1108.0	65.197	400.0	1338.5	3.332	.828	.145	40.5	6.4	.05	.001743	340.0
312-4	-1	1108.0	65.490	387.1	1313.7	3.382	.843	.146	41.8	6.5	.06	.001870	331.1
312-4	-2	1108.0	65.789	374.3	1289.6	3.436	.859	.148	43.1	6.6	.06	.001998	322.1
312-4	-3	966.0	66.066	361.4	1256.2	3.468	.769	.132	34.5	5.9	.03	.000975	313.2
312-4	-4	966.0	66.312	348.6	1210.7	3.468	.798	.137	37.1	6.1	.04	.001199	304.3
312-4	-5	966.0	66.575	335.7	1170.9	3.484	.825	.141	39.6	6.3	.05	.001422	295.4
312-4	-6	966.0	66.853	322.9	1135.3	3.514	.851	.145	42.0	6.5	.06	.001644	286.4
296-7		966.0	67.145	310.0	1102.6	3.555	.876	.148	44.4	6.7	.07	.001868	277.5
296-7	-1	966.0	67.521	286.9	935.7	3.149	1.032	.186	64.1	8.0	.18	.004702	267.1
296-7	-2	966.0	68.074	283.7	842.4	2.965	1.147	.213	80.7	9.0	.32	.008132	256.8
296-7	-3	966.0	68.722	251.7	798.0	3.164	1.210	.217	88.0	9.4	.39	.009268	235.0
296-7	-4	966.0	69.382	235.8	776.2	3.284	1.244	.219	91.9	9.6	.44	.009758	222.1
296-7	-5	966.0	70.038	224.1	766.2	3.407	1.261	.218	93.2	9.7	.45	.009877	212.7
296-7	-6	966.0	70.676	214.9	762.6	3.531	1.267	.215	92.9	9.6	.45	.009277	205.5
CHNAL		966.0	71.289	207.4	764.1	3.643	1.264	.210	91.6	9.6	.43	.008653	199.5
CHNAL	-1	966.0	71.838	252.5	1002.0	3.958	.963	.154	51.7	7.2	.10	.002423	242.4
CHNAL	-2	966.0	72.152	300.6	1195.5	3.967	.808	.129	36.4	6.0	.04	.001059	286.8
CHNAL	-3	966.0	72.381	354.0	1366.9	3.855	.707	.115	28.2	5.3	.02	.000511	333.8
CHNAL	-4	966.0	72.565	399.3	1520.3	3.803	.635	.104	22.8	4.8	.01	.000213	376.7
CHNAL	-5	966.0	72.719	444.7	1653.3	3.714	.584	.097	19.4	4.4	.00	.000045	419.6
258-8		966.0	72.856	490.0	1767.8	3.603	.547	.092	17.2	4.1	.00	.000000	462.5
258-8	-1	966.0	73.028	469.2	1633.8	3.479	.591	.101	27.7	5.3	.00	.000111	443.8
258-8	-2	966.0	73.236	448.3	1519.8	3.387	.636	.110	32.3	5.7	.01	.000349	425.0
258-8	-3	966.0	73.481	427.5	1424.1	3.329	.678	.119	37.0	6.1	.02	.000636	406.3
258-8	-4	966.0	73.764	406.7	1344.0	3.302	.719	.126	41.7	6.5	.02	.000957	387.5
258-8	-5	966.0	74.081	385.8	1276.0	3.304	.757	.133	46.2	6.8	.04	.001299	368.8
244-9		966.0	74.430	365.0	1216.9	3.328	.794	.139	50.7	7.1	.05	.001655	350.0
244-9	-1	966.0	74.891	358.0	1091.7	3.040	.885	.162	64.9	8.1	.10	.003365	344.6
244-9	-2	966.0	75.440	349.8	1078.8	3.071	.895	.163	66.2	8.1	.10	.003503	339.2
244-9	-3	966.0	75.948	341.6	1132.6	3.298	.853	.150	58.7	7.7	.07	.002441	333.8
244-9	-4	966.0	76.312	281.0	1243.4	4.384	.777	.118	44.3	6.7	.03	.000848	279.6
244-9	-5	966.0	76.531	273.1	1408.8	5.095	.686	.096	32.8	5.7	.01	.000239	272.3
BRZAL		966.0	76.672	268.9	1605.1	5.848	.602	.079	24.1	4.9	.00	.000000	268.5

BED VARIATION CALCULATION OF APURE RIVER (SAMPLE)

DZ K = 3

0	-.011	-.003	-.004	-.002	-.001	-.001	.000	.000	-.001	.000
1	.000	.000	.000	.002	.002	.001	.000	.000	-.000	-.001
2	-.004	-.001	-.000	-.000	.000	.000	.000	.000	.000	.000
3	.000	.000	.001	.000	-.000	-.001	-.000	-.000	-.000	

BED VARIATION CALCULATION OF APURE RIVER (SAMPLE)

LAURSEN 12/18 12

			Q	H	B	A	R	V	FR	TAU	U*	SQT	QT	B*
SAMAN		*	1072.0	60.146	283.5	717.5	2.523	1.494	.300	144.6	12.0	1.61	.044917	279.1
SAMAN	-1		1072.0	61.554	331.9	830.9	2.500	1.290	.260	108.2	10.4	.75	.022444	301.2
SAMAN	-2		1072.0	62.660	355.4	897.8	2.524	1.194	.240	92.4	9.6	.49	.015778	321.2
SAMAN	-3		1072.0	63.556	383.9	1007.4	2.620	1.064	.210	72.4	8.5	.26	.008613	333.5
SAMAN	-4		1072.0	64.231	390.9	1104.2	2.818	.971	.185	58.9	7.7	.15	.004962	335.7
SAMAN	-5		1072.0	64.744	395.9	1202.5	3.027	.891	.163	48.5	7.0	.09	.002920	337.8
312-4			1072.0	65.135	400.0	1314.1	3.271	.816	.144	39.5	6.3	.05	.001626	340.0
312-4	-1		1072.0	65.428	387.1	1289.6	3.320	.831	.145	40.9	6.4	.05	.001747	331.1
312-4	-2		1072.0	65.725	374.3	1265.9	3.373	.847	.147	42.2	6.5	.06	.001869	322.1
312-4	-3		944.0	66.003	361.4	1233.3	3.405	.765	.132	34.3	5.9	.03	.000965	313.2
312-4	-4		944.0	66.253	348.6	1189.9	3.408	.793	.137	36.9	6.1	.04	.001178	304.3
312-4	-5		944.0	66.518	335.7	1151.8	3.427	.820	.141	39.3	6.3	.05	.001390	295.4
312-4	-6		944.0	66.799	322.9	1117.6	3.459	.845	.145	41.6	6.5	.06	.001599	286.4
296-7			944.0	67.092	310.0	1086.0	3.502	.869	.148	43.9	6.6	.07	.001811	277.5
296-7	-1		944.0	67.470	296.9	920.6	3.099	1.025	.186	63.6	8.0	.17	.004605	267.1
296-7	-2		944.0	68.028	283.7	829.3	2.919	1.138	.213	80.0	8.9	.31	.007939	256.8
296-7	-3		944.0	68.677	250.9	786.8	3.129	1.200	.216	86.8	9.3	.38	.008919	234.4
296-7	-4		944.0	69.336	235.2	755.3	3.246	1.233	.218	90.6	9.5	.42	.009404	221.6
296-7	-5		944.0	69.991	223.7	755.5	3.368	1.249	.217	91.9	9.6	.44	.009327	212.5
296-7	-6		944.0	70.627	214.6	752.2	3.489	1.255	.214	91.6	9.6	.44	.008935	205.2
CHNAL			944.0	71.239	207.2	754.0	3.598	1.252	.210	90.2	9.5	.42	.008323	199.4
CHNAL	-1		944.0	71.786	252.3	989.8	3.910	.954	.154	50.9	7.1	.10	.002324	242.3
CHNAL	-2		944.0	72.098	300.2	1179.3	3.920	.800	.129	35.8	6.0	.04	.001011	286.6
CHNAL	-3		944.0	72.327	354.0	1347.8	3.801	.700	.115	27.7	5.3	.01	.000485	333.8
CHNAL	-4		944.0	72.511	399.3	1498.7	3.749	.630	.104	22.5	4.7	.01	.000196	376.7
CHNAL	-5		944.0	72.666	444.7	1629.3	3.660	.579	.097	19.2	4.4	.00	.000034	419.6
258-8			944.0	72.803	490.0	1741.4	3.550	.542	.092	17.0	4.1	.00	.000000	462.5
258-8	-1		944.0	72.975	469.2	1609.0	3.427	.587	.101	27.4	5.2	.00	.000098	443.8
258-8	-2		944.0	73.184	448.3	1496.7	3.336	.631	.110	32.0	5.7	.01	.000330	425.0
258-8	-3		944.0	73.431	427.5	1402.6	3.278	.673	.119	36.6	6.1	.01	.000609	406.3
258-8	-4		944.0	73.715	406.7	1324.0	3.253	.713	.126	41.2	6.4	.02	.000920	387.5
258-8	-5		944.0	74.034	385.8	1257.5	3.256	.751	.133	45.6	6.8	.03	.001249	368.8
244-9			944.0	74.383	365.0	1199.6	3.281	.787	.139	50.0	7.1	.05	.001591	350.0
244-9	-1		944.0	74.845	358.0	1075.4	2.994	.878	.162	64.2	8.0	.09	.003263	344.6
244-9	-2		944.0	75.396	349.7	1063.5	3.028	.888	.163	65.4	8.1	.10	.003380	339.2
244-9	-3		944.0	75.904	341.6	1117.6	3.254	.845	.149	57.8	7.6	.07	.002336	333.8
244-9	-4		944.0	76.265	280.0	1230.3	4.354	.767	.117	43.3	6.6	.03	.000782	278.5
244-9	-5		944.0	76.480	270.5	1394.9	5.095	.677	.095	32.0	5.7	.01	.000205	269.7
BRZAL			944.0	76.617	267.9	1590.6	5.817	.594	.078	23.5	4.8	.00	.000000	267.6

SED VARIATION CALCULATION OF APURE RIVER (SAMPLE)

D2 K = 4

0	-.015	-.004	-.005	-.002	-.001	-.001	.000	.000	-.001	.000
1	.000	.000	.000	.002	.003	.001	.000	.000	-.000	-.001
2	-.006	-.001	-.000	-.000	.000	.000	.000	.000	.000	.000
3	.000	.000	.001	.000	-.001	-.001	-.000	-.000	-.000	

BED VARIATION CALCULATION OF APURE RIVER (SAMPLE)

LAURSEN 12/19 12

		Q	H	B	A	R	V	FR	TAU	U*	SQT	QT	B*
SAMAN	*	1043.0	60.085	279.6	701.3	2.501	1.487	.300	143.7	12.0	1.58	.043861	276.9
SAMAN	-1	1043.0	61.496	327.3	812.3	2.478	1.284	.250	107.5	10.4	.73	.021881	298.7
SAMAN	-2	1043.0	62.607	353.2	879.4	2.487	1.186	.240	91.6	9.6	.48	.015323	319.0
SAMAN	-3	1043.0	63.508	383.7	989.2	2.574	1.054	.210	71.5	8.5	.25	.008331	333.5
SAMAN	-4	1043.0	64.185	390.8	1086.3	2.774	.960	.184	57.9	7.6	.14	.004740	335.7
SAMAN	-5	1043.0	64.697	395.9	1183.9	2.980	.881	.163	47.6	6.9	.08	.002771	337.8
312-4		1043.0	65.087	400.0	1294.6	3.223	.806	.143	38.8	6.2	.04	.001530	340.0
312-4	-1	1043.0	65.378	387.1	1270.2	3.270	.821	.145	40.1	6.3	.05	.001648	331.1
312-4	-2	1043.0	65.674	374.3	1246.8	3.322	.837	.146	41.4	6.4	.05	.001766	322.1
312-4	-3	927.0	65.952	361.4	1214.9	3.355	.763	.133	34.3	5.9	.03	.000961	313.2
312-4	-4	927.0	66.205	348.6	1173.2	3.361	.790	.138	36.8	6.1	.04	.001165	304.3
312-4	-5	927.0	66.473	335.7	1136.6	3.382	.816	.142	39.1	6.3	.05	.001367	295.4
312-4	-6	927.0	66.756	322.9	1103.7	3.416	.840	.145	41.3	6.4	.05	.001566	286.4
296-7		927.0	67.050	310.0	1072.9	3.459	.864	.148	43.5	6.6	.06	.001770	277.5
296-7	-1	927.0	67.431	296.9	908.7	3.058	1.020	.186	63.2	8.0	.17	.004533	267.1
296-7	-2	927.0	67.993	283.7	819.1	2.883	1.132	.213	79.4	8.9	.30	.007790	256.8
296-7	-3	927.0	68.642	250.3	778.0	3.103	1.191	.216	85.8	9.3	.37	.008652	233.8
296-7	-4	927.0	69.299	234.7	756.8	3.216	1.225	.218	89.6	9.5	.41	.009133	221.3
296-7	-5	927.0	69.954	223.4	747.2	3.334	1.241	.217	90.9	9.5	.43	.009060	212.2
296-7	-6	927.0	70.589	214.3	744.0	3.455	1.246	.214	90.6	9.5	.42	.008675	205.0
CHNAL		927.0	71.199	207.0	746.1	3.563	1.243	.209	89.2	9.4	.40	.008070	199.3
CHNAL	-1	927.0	71.744	252.1	979.5	3.872	.946	.153	50.3	7.1	.09	.002248	242.2
CHNAL	-2	927.0	72.056	299.9	1166.8	3.882	.795	.129	35.4	6.0	.03	.000974	286.4
CHNAL	-3	927.0	72.285	354.0	1332.8	3.759	.696	.115	27.4	5.2	.01	.000465	333.8
CHNAL	-4	927.0	72.469	399.3	1481.8	3.706	.626	.104	22.3	4.7	.00	.000184	376.7
CHNAL	-5	927.0	72.624	444.7	1610.6	3.618	.576	.097	19.0	4.4	.00	.000025	419.6
258-8		927.0	72.751	490.0	1721.0	3.508	.539	.092	16.8	4.1	.00	.000000	462.5
258-8	-1	927.0	72.934	469.2	1589.8	3.385	.583	.101	27.2	5.2	.00	.000087	443.8
258-8	-2	927.0	73.144	448.3	1478.6	3.295	.627	.110	31.7	5.6	.01	.000315	425.0
258-8	-3	927.0	73.392	427.5	1385.8	3.239	.669	.119	36.3	6.0	.01	.000588	406.3
258-8	-4	927.0	73.677	406.7	1308.4	3.215	.708	.126	40.8	6.4	.02	.000891	387.5
258-8	-5	927.0	73.996	385.8	1243.1	3.218	.746	.133	45.2	6.7	.03	.001210	368.8
244-9		927.0	74.346	365.0	1186.2	3.244	.782	.138	49.5	7.0	.04	.001541	350.0
244-9	-1	927.0	74.810	358.0	1062.7	2.959	.872	.162	63.6	8.0	.09	.003184	344.6
244-9	-2	927.0	75.362	349.6	1051.5	2.995	.882	.162	64.7	8.0	.10	.003285	339.2
244-9	-3	927.0	75.870	341.5	1105.9	3.220	.838	.149	57.1	7.6	.07	.002256	333.8
244-9	-4	927.0	76.229	279.2	1220.2	4.331	.760	.116	42.5	6.5	.03	.000732	277.8
244-9	-5	927.0	76.440	268.4	1384.3	5.094	.670	.094	31.3	5.6	.01	.000179	267.6
BRZAL		927.0	76.575	267.2	1579.3	5.792	.587	.077	23.0	4.8	.00	.000000	266.8

BED VARIATION CALCULATION OF APURE RIVER (SAMPLE)

DZ K = 5

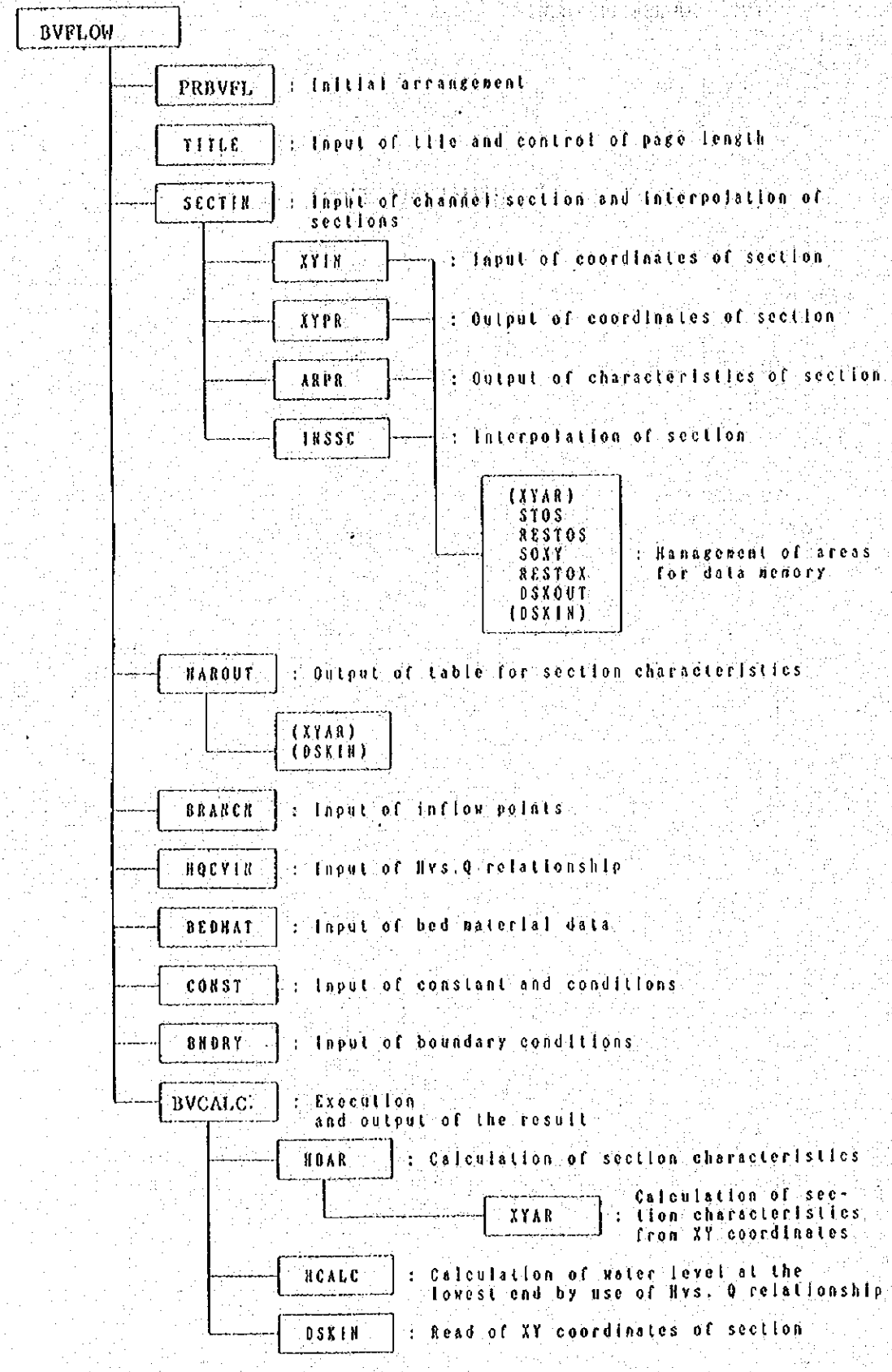
0	-.019	-.005	-.006	-.003	-.002	-.001	.000	.000	-.001	.000
1	.000	.000	.000	.003	.004	.001	.001	.000	-.001	-.001
2	-.007	-.001	-.000	-.000	-.000	.000	.000	.000	.000	.000
3	.000	.000	.001	.000	-.001	-.001	-.001	-.000	-.000	

BED VARIATION CALCULATION OF APURE RIVER (SAMPLE)

********** END OF CALCULATION.

IV. SOURCE PROGRAM

BVFLOW.FOR


BVFLOW
PRBVFL : Initial arrangement
TITLE : Input of title and control of page length
SECTIN : Input of channel section and interpolation of sections
XYIN : Input of coordinates of section
XYPR : Output of coordinates of section
ARPR : Output of characteristics of section
INSSC : Interpolation of section
(XYAR)
STOS
RESTOS
SOXY
RESTOX
DSXOUT
(DSXIN)
: Management of areas for data memory
HAROUT : Output of table for section characteristics
(XYAR)
(DSXIN)
BRANCH : Input of inflow points
HQCYIN : Input of Hvs.Q relationship
BEDMAT : Input of bed material data
CONST : Input of constant and conditions
BNDRY : Input of boundary conditions
BVCALC : Execution and output of the result
HOAR : Calculation of section characteristics
XYAR : Calculation of section characteristics from XY coordinates
HCALC : Calculation of water level at the lowest end by use of Hvs. Q relationship
DSXIN : Read of XY coordinates of section

SATODI : Calculation of Sato-Kikkawa-Ashida's formula
LAURSN : Calculation of Laursen's formula
KBROWN : Calculation of Kalinske-Brown's formula
TCCAL : Calculation of critical tractive force
FCAL : Calculation of "F" value of Sato-Kikkawa-Ashida's formula
ERF : Calculation of error function for "FCAL"
RUBEY : Calculation of fall velocity of particle by Rubey's formula

INDEX

```
      PROGRAM  DVFLOW                                                  DVFLOW.
C                        +-------------------------------------------+
C                        |  Computation of                           |
C                        |      Bed Variation in an Open Channel     |
C                        |                                           |
C                        |                    by M. Hamuro, 1992.11.10. |
C                        |                                           |
C                        |  Copyright (c) NIKKEN Consultants, Inc. 1992. |
C                        |  All rights reserved.                     |
C                        +-------------------------------------------+
C
      CALL  PRBVFL
      JC=0
      WRITE (*,'(1H )')                                                ******
C
  900 CALL  CONTRL(JC)
      IF ((JC-11)*JC.GE.0)    GOTO 900
      WRITE (*,'(13X,4HKC =,I2)') JC                                   ******
      GOTO  (1,2,3,4,5,6,7,8,9,10),JC
C
    1 CALL  TITLE(999)
                              GOTO 900
    2 CALL  SECTIN
                              GOTO 900
    3 CALL  HAROUT
                              GOTO 900
    4 CALL  BRANCH
                              GOTO 900
    5 CALL  HQCVIN
                              GOTO 900
    6 CALL  BEDMAT
                              GOTO 900
    7 CONTINUE
                              GOTO 900
    8 CALL  CONST(1)
                              GOTO 900
    9 CALL  BNDRY
      CALL  BVCALC
                              GOTO 900
   10 WRITE (6,2010)
 2010 FORMAT (1H1,4X,'END OF CALCULATION')
C     STOP
      END
```

```
      SUBROUTINE  PRBVFL                                    PRBVFL_    2
                                        CHARACTER*20  FILTMP
C
      COMMON /CBRC/ NQ,NQ1,INQ(31)
      COMMON /MISC/ NS1,NS2,NERR
      COMMON /CINS/ NDS1,NDS2,DL,IDIV
      COMMON /NQCV/ NNQ,N(50),Q(50)
      COMMON /CBED/ DF(14,100),DI(14,100),TC(14,100),WO(14,100),
     *              SDF(100),DM(100),TCM(100),WOM(100),NDF(100),NDM
      COMMON /CBND/ DT(500),NB(500),QB(31,500),QL(500),QSED(31,500),KSD,
     *              NT
      COMMON /CTMP/ DZ(1000)
      COMMON /FNAM/ FILTMP
C
      CALL  IOFILE('BVFLOW  ')
      CALL  TITLE(888)
      CALL  CONST(0)
      FILTMP='C:BVFLOW.TMP'
C
      NQ=1
      NQ1=0
      NS1=1
      NS2=0
      NDS1=1
      NDS2=0
      NNQ=0
      NBH=0
      NT =0
C
      DO 11 I=1,31
   11 INQ(I)=0
      DO 12 I=1,1000
   12 DZ(I)=0.0
C
      RETURN
      END
```

```
 80          SUBROUTINE  TITLE(LLP)                                  TITLE__    3
 81                                                CHARACTER*80  MTITLE
 82          COMMON /MTTL/ MTITLE
 83          COMMON /CTTL/ LP,LPSW
 84    C
 85          LPSW=0
 86          IF (LLP.EQ.999)  THEN
 87             READ (5,'(A80)') MTITLE
 88             LP=0
 89          ELSEIF (LLP.EQ.888)  THEN
 90             MTITLE =' '
 91             LP=0
 92          ELSE
 93             L=IABS(LLP)
 94             IF (LLP.EQ.0)  LP=0
 95             IF (LLP.LT.0.OR.LP.LT.L)  THEN
 96               LP=58
 97               WRITE (6,2000) MTITLE
 98    2000       FORMAT (1H1,4X,A80)
 99               LPSW=1
100             ENDIF
101             LP=LP-L
102          ENDIF
103    C
104          RETURN
105          END
```

```
106           SUBROUTINE  SECTIN                                          SECTIN_    4
107                                                 CHARACTER*10  NAME
108                                                 CHARACTER*2   MX
109           COMMON /MISC/ NS1,NS2,NERR
110           COMMON /SECT/ S(14),NAME
111           COMMON /NSCT/ ND1V,IBED,JBVL,JBVR
112     C
113           DIMENSION     SF(14),SFI(14),TS(14),SI(14)
114     C
115           NERR=0
116           READ (5,1000) N1,N2,KPR,ND1
117      1000 FORMAT (4I5)
118           IF (N1.GT.N2)  THEN
119              NN=N1
120              N1=N2
121              N2=NN
122           ENDIF
123           N1=MAXO(N1,1)
124           NS1=MINO(NS1,N1)
125           NS2=MAXO(NS2,N2)
126           ND1=MAXO(ND1,1)
127     C
128           READ (5,1010) MX,MC,SF
129      1010 FORMAT (A2,2X,I1,5X,14F5.0)
130           DO 11 J=1,14
131           IF (SF(J).EQ.0.0)  SF(J)=1.0
132           SFI(J)=0.0
133        11 S(J)=0.0
134           IF (MC.GT.0)  THEN
135              READ (5,1010) MXX,MC,SFI
136              IF (MC.GT.0)  THEN
137                 DO 12 J=1,14
138        12       SFI(J)=SFI(J)*SF(J)
139              ENDIF
140           ENDIF
141           IF (MX.NE.'SC')  THEN
142              NERR=NERR+1
143              WRITE (6,8010) 'SC',MX
144      8010    FORMAT (1H /10X,'LABEL MUST BE (',A2,') INSTEAD OF (',A2,').')
145           ENDIF
146     C
147           DO 23 I=N1,N2
148           READ (5,1020) NAME,TS
149      1020 FORMAT (A10,14F5.0)
150           DO 21 J=1,10
151           IF (TS(J).NE.0.0)  S(J)=TS(J)*SF(J)+SFI(J)
152        21 CONTINUE
153           S( 3)=TS( 3)*SF( 3)+SFI( 3)
154           S( 5)=TS( 5)*SF( 5)+SFI( 5)
155           DO 22 J=11,14
156        22 S(J)=TS(J)*SF(J)+SFI(J)
157           IF (S(4).NE.0.0)  IBED=S(4)
158           IF (S(7).NE.0.0)  ND1V=S(7)
159           ND1V=MAXO(ND1V,1)
160           S(4)=0.0
161           S(7)=0.0
162        23 CALL  STOS(I)
163     C
164           CALL  XYIN(N1,N2)
165     C
166           IF (KPR.GT.1)  CALL  XYPR(N1,N2)
167           IF (KPR.GT.0)  CALL  ARPR(N1,N2)
168     C
169           IF (NERR.GT.0)  THEN
170              CALL  TITLE(-1)
171              WRITE (6,8080) NERR
172      8080    FORMAT (1H /' ***** CROSS SECTION  ',I6,' ERROR(S).'//
173          *                                      28X,' CALCULATION SUSPENDED.')
174                                                    STOP
175           ENDIF
176     C
177           CALL  INSSC(N1,N2,ND1)
178     C
179           RETURN
180           END
```

```
181         SUBROUTINE  XYIN(N1,N2)                                    XYIN___      5
182                                          CHARACTER*10  NAME,NAMT,NAM
183                                          CHARACTER*2   MX
184   C
185         COMMON /MISC/ NS1,NS2,NERR
186         COMMON /CXY / X(100),Y(100),N
187         COMMON /SECT/ S(14),NAME
188         DIMENSION     TS(14)
189         EQUIVALENCE  (S(7),ZS),(S(13),XL),(S(14),XR)
190   C
191         READ (5,1000) MX,KCH,MC,SFX,SFY  ,DXMAX,DYMAX,DXMIN
192    1000 FORMAT (A2,I1,1X,I1,5X,6F6.0)
193         KCH=MAX0(MIN0(KCH,3),0)
194         IF (KCH.LT.3)  THEN
195            IF (KCH.EQ.0)  ICH=1
196            IF (KCH.EQ.1)  ICH=3
197            IF (KCH.EQ.2)  ICH=6
198         ELSE
199            ICH=1
200         ENDIF
201         IF (SFX.EQ.0.0)  SFX=1.0
202         IF (SFY.EQ.0.0)  SFY=1.0
203         SFX1=0.0
204         SFY1=0.0
205         IF (DXMAX.LE.0.0)  DXMAX=50.0
206         IF (DYMAX.LE.0.0)  DYMAX=10.0
207         IF (MX.NE.'XY')  THEN
208            NERR=NERR+1
209            WRITE (6,8000) 'XY',MX
210    8000    FORMAT (1H /10X,'LABEL MUST BE (',A2,') INSTEAD OF (',A2,').')
211         ENDIF
212         IF (MC.GT.0)  THEN
213            READ (5,1000) MX1,KCH1,MC,SFX1,SFY1
214            IF (MC.GT.0)  THEN
215               SFX1=SFX1*SFX
216               SFY1=SFY1*SFY
217            ENDIF
218         ENDIF
219   C
220         READ (5,1010) NAMT,TS
221    1010 FORMAT (A10,14F5.0)
222         I=N1
223   C
224      10 CALL  RESTOS(I)
225         K0=0
226         J=0
227   C
228      11 IF (NAMT(ICH:10).NE.NAME(ICH:10))  THEN
229            IF (KCH.LT.3)  NERR=NERR+1
230            WRITE (6,8010) NAMT(ICH:10),NAME,K0+1
231    8010    FORMAT (5X,'XY ERROR ---> (',A10,')''S DATA EXIST IN (',
232           *                                  A10,')''S (',I3,').')
233         ENDIF
234         NAM=NAMT
235   C
236      20 J0=K0*7
237         JE=0
238         DO 21 JJ=7,1,-1
239         J2=JJ*2
240         J1=J2-1
241         IF (TS(J1).NE.0.0.OR.TS(J2).NE.0.0)  THEN
242            JE=JJ
243                                  GOTO 22
244         ENDIF
245      21 CONTINUE
246      22 DO 23 JJ=1,JE
247         J2=JJ*2
248         J1=J2-1
249         J=JJ+J0
250         X(J)=TS(J1)*SFX+SFX1
251      23 Y(J)=TS(J2)*SFY+SFY1
252         K0=K0+1
253   C
254         READ (5,1010) NAMT,TS
255         IF (NAMT(ICH:10).NE.NAM(ICH:10))  GOTO 30
256         IF (J.GE.J0+7)            GOTO 11
257   C
258      30 IF (J.LT.1)               GOTO 90
259         N=J
260         XMAX=X(1)
```

```
261           XMIN=X(1)
262           ZS=Y(1)
263     C
264           DO 31 J=2,N
265           J1=J-1
266           XD=X(J)-X(J1)
267           YD=Y(J)-Y(J1)
268           IF (XD.LT.DXMIN.OR.XD.GT.DXMAX)  THEN
269              NERR=NERR+1
270              WRITE (0,8030) NAME,'X',J1,X(J1),'X',J,X(J),'DX',XD
271      8030    FORMAT (1H /10X,'XY  ',A10,2(5X,A1,'(',I3,')=',F10.2),
272                                                    5X,A2,'=',F10.2)
273          *
274           ENDIF
275           IF ((J-N)*(J-2).LT.0.AND.ABS(YD).GT.DYMAX)  THEN
276              NERR=NERR+1
277              WRITE (0,8030) NAME,'Y',J1,Y(J1),'Y',J,Y(J),'DY',YD
278           ENDIF
279           XMAX=AMAX1(X(J),XMAX)
280           XMIN=AMIN1(X(J),XMIN)
281        31 ZS=AMIN1(Y(J),ZS)
282           IF (XR.LE.XL)  THEN
283              XL=XMIN
284              XR=XMAX
285           ENDIF
286           CALL  STOS(I)
287           CALL  STOXY(I)
288           I=I+1
289           IF (I.LE.N2)            GOTO 10
290     C
291        90 RETURN
           END
```

```
292           SUBROUTINE  XYPR(N1,N2)                                  XYPR___
293                                                CHARACTER*10  NAME
294     C
295           COMMON /CXY / X(100),Y(100),N
296           COMMON /SECT/ S(14),NAME
297     C
298           CALL  TITLE(0)
299     C
300           DO 12 I=N1,N2
301           CALL  RESTOS(I)
302           CALL  RESTOX(I)
303           CALL  TITLE((N+0)/7+1)
304           WRITE (6,2010)
305      2010 FORMAT (1H )
306     C
307           DO 11 J1=1,N,7
308           J2=MIN0(J1+6,N)
309           JJ=(J1+6)/7
310           IF (J1.EQ.1)  THEN
311              WRITE (6,2011) I,NAME,JJ,(X(J),Y(J),J=J1,J2)
312      2011    FORMAT (1H ,I4,A10,I5,7(F9.1,',',F6.2))
313           ELSE
314              WRITE (6,2012) JJ,(X(J),Y(J),J=J1,J2)
315      2012    FORMAT (1H ,14X,I5,7(F9.1,',',F6.2))
316           ENDIF
317        11 CONTINUE
318        12 CONTINUE
319     C
320           RETURN
321           END
```

```
      SUBROUTINE  ARPR(N1,N2)                                  CHARACTER*10  NAM(3),NAME
                                                               CHARACTER*4   LOL(5,2)
C
      COMMON /SECT/ S(14),NAME
      COMMON /NSCT/ NDIV,IBEO,JDVL,JDVR
      DIMENSION     TS(14,3),TSS(14,5,3),NO(3),IBEOT(3),NDIVT(3)
      EQUIVALENCE  (S(5),HIS),(S(6),DHS)
      DATA          LOL /'  ZS','   N','  DX',' MCD','BEDM',
     *                   '   H','   D','   A','   R','  D*'/
C
      I2=N1-1
      KT=2
C
   10 KT=3-KT
      IF (KT.EQ.1)  CALL  TITLE(-1)
      I0=I2
      I2=MINO(I0+3,N2)
      I1= I+I0
      I3=I2-I0
C
      DO 15 L=1,I3
      I=L+I0
      CALL  RESTOS(I)
      CALL  RESTOX(I)
      NO(L)=I
      NAM(L)=NAME
      DO 12 J=1,14
   12 TS(J,L)=S(J)
      IBEOT(L)=IBEO
      NDIVT(L)=NDIV
      IF (DHS.LE.0.0)  DHS=1.0
      HH=HIS-DHS
C
      DO 14 J=1,14
   13 HH=HH+DHS
      CALL  XYAR(HH,0,A,R,P,RH,0V)
      IF (A.LE.0.0)            GOTO 13
      TSS(J,1,L)=HH
      TSS(J,2,L)=0
      TSS(J,3,L)=A
      TSS(J,4,L)=R
   14 CONTINUE
   15 CONTINUE
C
      WRITE (6,2021) (' ',NO(L),NAM(L),L=1,I3)
 2021 FORMAT (1H ///3(3X,A1,I4,A10,18X,'NDIV',3X))
      WRITE (6,2022) (NDIVT(L),L=1,I3)
 2022 FORMAT (3(34X,I6,3X))
      WRITE (6,2023) ((LOL(J,I),J=1,5),L=1,I3)
 2023 FORMAT (1H /3(5(4X,A4),3X))
      WRITE (6,2024) (TS(7,L),(TS(J,L),J=1,3),IBEOT(L),L=1,I3)
 2024 FORMAT (3(2X,F8.3,F8.4,F8.1,F8.4,I6,3X))
      WRITE (6,2025) ((LOL(J,2),J=1,4),L=1,I3)
 2025 FORMAT (1H /3(4(4X,A4),11X))
      DO 21 J=1,14
   21 WRITE (6,2026) ((TSS(J,K,L),K=1,4),L=1,I3)
 2026 FORMAT (3(2X,F8.3,F8.2,F8.1,F8.3,9X))
      IF (I2.LT.N2)            GOTO 10
      CALL  TITLE(0)
C
      RETURN
      END
```

```
      SUBROUTINE  INSSC(N1,N2,ND1)                                  INSSC__          9
                                          CHARACTER*10  NAME,NAME1,NAME2
C
      COMMON /SECT/ S(14),NAME
      COMMON /NSCT/ NDIV,IDED,JAVL,JBVR
      COMMON /CXY / X(100),Y(100),N
      COMMON /CINS/ NDS1,NDS2,DL,IDIV
      COMMON /BVAR/ BV,TAU,USTA,SQT,QT,EP,CLD,KFM
      COMMON /MISC/ NS1,NS2,NERR
      DIMENSION     S1(14),S2(14),X1(100),Y1(100),X2(100),Y2(100)
C
      CALL  DSKOUT(0)
      IF (ND1.LT.1)  ND1=1
      ID=ND1-1
C
      DO 33 I1=N1,N2
      CALL  RESTOS(I1)
      CALL  RESTOX(I1)
      NAME2=NAME
      DO 11 J=1,14
   11 S2(J)=S(J)
      NP2=N
      DO 12 J=1,N
      X2(J)=X(J)
   12 Y2(J)=Y(J)
      DL=0.0
      IDIV=0
      IF (I1.EQ.N1)            GOTO 30
C
      IF (NDIV.LE.1)           GOTO 30
      NPNT=MAX0(NP1,NP2)
      NPTH=(NPNT+1)/2
      NP1H=(NP1+1)/2
      NP2H=(NP2+1)/2
      N=NPNT
      NAME=NAME1
C
      DO 25 L=1,NDIV-1
      DO 21 J=1,10
   21 S(J)=S2(J)
      IDIV=L
      S(2)=S2(2)/NDIV
      DL=S(2)+DL
      DXX=DL/S2(2)
      S(3)=0.0
      S(5)=(S2(5)-S1(5))*DXX+S1(5)
      DO 22 J=11,14
   22 S(J)=(S2(J)-S1(J))*DXX+S1(J)
C
      DO 23 JL=1,NP1H
      J=JL
      J1=MINO(J,NP1H)
      J2=MINO(J,NP2H)
      X(J)=(X2(J2)-X1(J1))*DXX+X1(J1)
      Y(J)=(Y2(J2)-Y1(J1))*DXX+Y1(J1)
      J =N+1-JL
      J1=MAX0(NP1+1-JL,NP1H)
      J2=MAX0(NP2+1-JL,NP2H)
      X(J)=(X2(J2)-X1(J1))*DXX+X1(J1)
   23 Y(J)=(Y2(J2)-Y1(J1))*DXX+Y1(J1)
      S(7)=Y(1)
      DO 24 J=2,N
   24 S(7)=AMIN1(Y(J),S(7))
C
      ID=ID+1
   25 CALL  DSKOUT(ID)
C
      IDIV=0
      DL=0.0
      NAME=NAME2
      DO 26 J=1,14
   26 S(J)=S2(J)
      S(2)=S2(2)/NDIV
      N=NP2
      DO 27 J=1,N
      X(J)=X2(J)
   27 Y(J)=Y2(J)
C
   30 ID=ID+1
      CALL  DSKOUT(ID)
```

```
C                                                                       10
      NAME1=NAME2
      DO 31 J=1,14
   31 S1(J)=S2(J)
      NP1=NP2
      DO 32 J=1,N
      X1(J)=X2(J)
   32 Y1(J)=Y2(J)
C
   33 CONTINUE
C
      NDS1=MINO(ND1,NDS1)
      NDS2=MAXO(ID ,NDS2)
      CALL  OSKOUT(9999)
C
      CALL  TITLE(3)
      NINS=NDS2-NDS1-NS2+NS1
      WRITE (0,2090) NINS,NDS1,NDS2
 2090 FORMAT (1H //5X,I5,' CROSS SECTIONS ARE INSERTED.'/
     *               10X,' NEW CROSSSECTION NUMBERS ARE',I5,' -',I4,'.')
C
      RETURN
      END
```

```
      SUBROUTINE  HAROUT                                                HAROUT.          11
                                          CHARACTER*10  NAM(3),NAME
                                          CHARACTER*4   LBL(6,2),NOS(3)
C
      COMMON /SECT/ S(14),NAME
      COMMON /NSCT/ NDIV,IDEO,JOVL,JOVR
      COMMON /CINS/ NDS1,NDS2,DL,IDIV
      DIMENSION     TS(14,3),TSS(14,5,3),NO(3),IDEDT(3)
      EQUIVALENCE  (S(5),H1S),(S(6),DHS)
      DATA          LBL /'  2S','   N','  DX',' MCD','DEOM',
     *                   '   H','   D','   A','   R','  D*'/
C
      READ (5,1000) NN1,NN2
 1000 FORMAT (2I6)
      IF (NDS2.LT.NDS1)  THEN
         WRITE (6,8000)
 8000    FORMAT (1H /' ***** HAROUT (KC = 3)    NO DATA TO PRINT.')
                            GOTO 90
      ENDIF
      NN1=MAXO(NN1,NDS1)
      IF (NN2.LT.NN1)  NN2=NDS2
      I2=NN1-1
      KT=2
      CALL  DSKIN(0)
C
   10 KT=3-KT
      IF (KT.EQ.1)  CALL  TITLE(-1)
      I0=I2
      I2=MINO(I0+3,NN2)
      I1= 1+I0
      I3=I2-I0
C
      DO 15 L=1,I3
      I=L+I0
      CALL  DSKIN(I)
      NO(L)=I
      NAM(L)=NAME
      NOS(L)=' '
      IF (IDIV.GT.0)  WRITE (NOS(L),'(I4)') IDIV
      IDEDT(L)=IDED
      DO 12 J=1,14
   12 TS(J,L)=S(J)
      IF (DHS.LE.0.0)  DHS=1.0
      HH=H1S-DHS
C
      DO 14 J=1,14
   13 HH=HH+DHS
      CALL  XYAR(HH,B,A,R,P,RH,DV)
      IF (A.LE.0.0)            GOTO 13
      TSS(J,1,L)=HH
      TSS(J,2,L)=B
      TSS(J,3,L)=A
      TSS(J,4,L)=R
   14 CONTINUE
   15 CONTINUE
C
      WRITE (6,2021) (' ',NO(L),NAM(L),NOS(L),L=1,I3)
 2021 FORMAT (1H ///3(3X,A1,I4,A10,1X,A4,20X))
      WRITE (6,2022) ((LBL(J,I),J=1,6),L=1,I3)
 2022 FORMAT (1H //3(5(4X,A4),3X))
      WRITE (6,2023) (TS(1,L),(TS(J,L),J=1,3),IDEDT(L),L=1,I3)
 2023 FORMAT (3(2X,F8.3,F8.4,F8.1,F8.4,I6,3X))
      WRITE (6,2024) ((LBL(J,2),J=1,4),L=1,I3)
 2024 FORMAT (1H /3(4(4X,A4),11X))
      DO 21 J=1,14
   21 WRITE (6,2025) ((TSS(J,K,L),K=1,4),L=1,I3)
 2025 FORMAT (3(2X,F8.3,F8.2,F8.1,F8.3,9X))
      IF (I2.LT.NN2)           GOTO 10
      CALL  TITLE(0)
      CALL  DSKIN(9999)
C
   90 RETURN
      END
```

```
      SUBROUTINE  BRANCH                                                BRANCH_    12
C
                                          CHARACTER*10  NAMS
      COMMON /CORC/ NQ,NQ1,INQ(31)
      COMMON /CINS/ NDS1,NDS2,DL,IDIV
      COMMON /MISC/ NS1,NS2,NERR
      COMMON /DSKS/ SS(14,101),NDIVS(101),IDEOS(101)
      COMMON /DSKN/ NAMS(101)
      DIMENSION     XIN(31),IIN(31),SDX(101),ISS(101)
C
      READ (5,1010) NQ,KDX,KPR
 1010 FORMAT (3I5)
      NQ1=NQ+1
      IF (KDX.EQ.0)  THEN
         IF (NQ.GT.0)  THEN
            READ (5,1011) (INQ(J),J=1,16)
 1011       FORMAT (16I5)
            IF (NQ.GT.16)  THEN
               READ (5,1012) (INQ(J),J=17,31)
 1012          FORMAT (5X,15I5)
            ENDIF
         ENDIF
      ELSEIF (NQ.GT.0)  THEN
         IF (KDX.EQ.1)  READ (5,1012) (IIN(J),J=2,NQ1)
         READ (5,1013) (XIN(J),J=2,NQ1)
 1013    FORMAT (5X,15F5.0)
         IF (NS2.LT.NS1)  THEN
            WRITE (6,8010)
 8010       FORMAT (1H /' ***** BRANCH (KC = 4)    MISSING SECT. DATA.',
     *                                                    '(KC=2)')
            NERR=NERR+1
                                    GOTO 90
         ENDIF
C
         ISS(NS1)=NDS1
         SDX(NS1)=0.0
         DO 11 I=NS1+1,NS2
         ISS(I)=NDIVS(I)+ISS(I-1)
   11    SDX(I)=SS(2,I)+SDX(I-1)
         IF (KPR.LE.0)  THEN
            CALL  TITLE(NQ+4)
            WRITE (6,2010) NQ
 2010       FORMAT (1H /2X,'INFLOW PNT.    NQ =',I4//
     *                  23X,'NO',7X,'X',12X,'NO',5X,'SECT.',16X,'INQ')
         ENDIF
C
         DO 15 J=2,NQ1
         SXJ=XIN(J)
         IF (KDX.EQ.1)  SXJ=SXJ+SDX(IIN(J))
         IF (SXJ.LE.0.0.OR.SXJ.GT.SDX(NS2)+1E-2)  THEN
            INQ(J)=0
                                    GOTO 15
         ENDIF
         DO 12 I=NS1+1,NS2
         L=I
         IF (SDX(I).GE.SXJ)  GOTO 13
   12    CONTINUE
         L=NS2
         LI=L-1
         III=NDIVS(NS2)
                                    GOTO 14
   13    LI=L-1
         DXI=SS(2,L)/NDIVS(L)
         DDI=(SXJ-SDX(LI))/DXI
         III=DDI
         IF ((DDI-III).GT.1E-6)  III=III+1
   14    INQ(J)=III+ISS(LI)
         IF (KPR.LE.0)  THEN
            WRITE (6,2011) IIN(J),XIN(J),LI,NAMS(LI),ISS(LI),III,INQ(J)
 2011       FORMAT(18X,I7,SP,F9.1,'  --->',
     *                              S,I7,1X,A10,' (',I4,')',SP,I4,' =',S,I5)
         ENDIF
   15    CONTINUE
      ENDIF
C
      IF (KPR.LE.0)  THEN
         CALL  TITLE((NQ+14)/15+5)
         WRITE (6,2021) NDS1,NDS2,NQ
 2021    FORMAT (1H //2X,'MAIN RIVER',4X,I3,' -',I4//
     *                 2X,'INFLOW PNT.    NQ =',I4)
```

```
641           IF (NQ.GT.0)  WRITE (6,2022) (INQ(I),I=2,NQ1)                  13
642     2022    FORMAT (19X,1516)
643           ENDIF
644     C
645       90  RETURN
646           END
```

```
      SUBROUTINE  HQCVIN
C
      COMMON /HQCV/ NHQ,H(50),Q(50)
C
      READ (5,1000) NN,KPR,SFH,SFH1,SFQ,SFQ1
 1000 FORMAT (I5,I5,4F6.0)
      QNN=-100000.0
      HNN=-100000.0
C
      NHQ=NN
      READ (5,1010) (H(I),I=1,NHQ)
      READ (5,1010) (Q(I),I=1,NHQ)
 1010 FORMAT (10X,14F5.0)
      IF (SFH.EQ.0.0)  SFH=1.0
      IF (SFQ.EQ.0.0)  SFQ=1.0
      DO 11 I=1,NHQ
      H(I)=H(I)*SFH+SFH1
   11 Q(I)=Q(I)*SFQ+SFQ1
C
      DO 12 I=2,NHQ
      IF (H(I).LT.H(I-1))  THEN
         NERR=NERR+1
         WRITE (6,8011) I,I-1
 8011 FORMAT (' ***** H-Q CURVE     H(',I2,')  LOWER  THAN H(',I2,').')
      ENDIF
      IF (Q(I).LT.Q(I-1))  THEN
         NERR=NERR+1
         WRITE (6,8012) I,I-1
 8012 FORMAT (' ***** H-Q CURVE     Q(',I2,') SMALLER THAN Q(',I2,').')
      ENDIF
   12 CONTINUE
C
      IF (KPR.GT.0)  THEN
         CALL TITLE((NHQ+9)/10+NHQ+5)
         WRITE (6,2010) (H(I),Q(I),I=1,NHQ)
 2010    FORMAT (1H //10X,'H-Q CURVE'//10X,'H',11X,'Q'/
     *                                                  10(/10X,F10.3,F10.1))
      ENDIF
C
      IF (NERR.GT.0)  THEN
         WRITE (6,8080) NERR
 8080    FORMAT (1H /' ***** H-Q CURVE     ',I3,' ERROR(S).'//
     *                                    24X,' CALCULATION SUSPENDED.')
                                        STOP
      ENDIF
C
      RETURN
      END
```

```
695         SUBROUTINE  BEDMAT                                                  BEDMAT.      15
696                                              CHARACTER*8  NAMF,NAMD,NAMDM
697                                              CHARACTER*2  LBLF,LBLD
698   C
699         COMMON /CBED/ DF(14,100),DI(14,100),TC(14,100),WO(14,100),
700        *              SDF(100),DM(100),TCM(100),WDM(100),NDF(100),NBM
701         COMMON /NBED/ NAMDM(100)
702         DIMENSION     TF(14),TD(14)
703   C
704         READ (5,1000) NBM,KPR,SFF,SFD,KDF,KDM
705    1000 FORMAT (2I5,2F5.0,2I5)
706         IF (SFF.EQ.0.0)  SFF=1.0
707         IF (SFD.EQ.0.0)  SFD=1.0
708         SFF=SFF/100.0
709         SFD=SFD/10.0
710         IF (KDM.LE.0)  THEN
711            JO=0
712            JM=14
713         ELSE
714            JO=1
715            JM=1
716         ENDIF
717         NERR=0
718   C
719         DO 10 I=1,NBM
720         IF (I.EQ.1)  THEN
721            READ (5,1010) LBLF,NAMF,TF
722    1010    FORMAT (A2,A8,14F5.0)
723         ELSEIF (KDF.LT.1)  THEN
724            READ (6,1010) LBLF,NAMF,TF
725         ENDIF
726         NAMDM(I)=NAMF
727         IF (I.EQ.1.OR.KDF.LT.1)  THEN
728            IF (LBLF.NE.'DF')  THEN
729               NERR=NERR+1
730               WRITE (6,8010) 'DF',LBLF
731    8010       FORMAT (1H /' ***** BED MAT.        1,2 COLS. MUST BE (',A2,
732       *                                           ') INSTEAD OF (',A2,').')
733            ENDIF
734            SS=0.0
735            DO 11 J=1,13
736            JJ=J+JO
737            DF(J,I)=TF(JJ)*SFF
738      11    SS=DF(J,I)+SS
739            SDF(I)=SS
740         ELSE
741            DO 12 J=1,13
742      12    DF(J,I)=DF(J,1)
743            SDF(I)=SDF(1)
744         ENDIF
745   C
746         READ (5,1010) LBLD,NAMD,TD
747         IF (KDF.LT.1)  THEN
748            IF (NAMD.NE.NAMF)  THEN
749               NERR=NERR+1
750               WRITE (6,8011) NAMD,NAMF
751    8011       FORMAT (1H /' ***** BED MAT.       NAME OF DF = (',A8,
752       *                                          ')   NAME OF DI = (',A8,')')
753            ENDIF
754         ENDIF
755         IF (LBLD.NE.'DI')  THEN
756            NERR=NERR+1
757            WRITE (6,8010) 'DI',LBLD
758         ENDIF
759         DO 13 J=1,13
760         JJ=J+JO
761      13 DI(J,I)=TD(JJ)*SFD
762   C
763         DO 14 J=13,1,-1
764         ND=J
765         IF (DF(J,I).NE.0.0)  GOTO 15
766      14 CONTINUE
767      15 NDF(I)=ND
768   C
769         DM(I)=TD(JM)*SFD
770         IF (DM(I).LE.0.0)  THEN
771            SS=0.0
772            DO 16 J=1,ND
773      16    SS=DF(J,I)*DI(J,I)+SS
774            DM(I)=SS
```

```
775           ENDIF                                                          16
776     C
777           IF (KPR.GT.0)  THEN
778              CALL  TITLE(3)
779              WRITE (6,2010) I,NAMP,SOP(I),(DF(J,I),J=1,ND)
780      2010    FORMAT (1H /1X,I4,2X,A8/18X,'DF',2P16F7.1)
781              WRITE (6,2011) DM(I),(DI(J,I),J=1,ND)
782      2011    FORMAT (18X,'DI',1P16E7.3)
783           ENDIF
784     C
785        10 CONTINUE
786     C
787           RETURN
788           END
```

```
      SUBROUTINE  CONST(KSW)                                  CONST__    17
                                        CHARACTER*8  LBL(8)
C
      COMMON /CNST/ CONS(8),G,GO,SG
      DIMENSION     CON(8),S(8)
      DATA          CON / 1.0, 0.9, 2.66, 0.0, 1E-4,0.000, 1.0, 1.0/
      DATA          LBL / '  ALPHA ','  CR FR ','  SIGMA ','  VOID ',
     *                   '  EPS N ','  NU    ','  GAMMA ','  RHO   '/
C
      IF (KSW.GT.0)           GOTO 20
      DO 11 I=1,8
   11 CONS(I)=CON(I)
      G=9.8
      GO=G*100.0
                              GOTO 90
C
   20 READ (5,1020) S
 1020 FORMAT (8F10.0)
      DO 21 I=1,8
      IF (S(I).GT.0.0)  CONS(I)=S(I)
      IF (S(I).LT.0.0)  CONS(I)=CON(I)
   21 CONTINUE
C
      CALL  TITLE(4)
      WRITE (6,2020) (LBL(I),CONS(I),I=1,8)
 2020 FORMAT (1H //(5X,4(3X,A8,'=',F8.5)))
C
   90 SG=(CONS(3)/CONS(8)-1.0)*GO
      RETURN
      END
```

```
      SUBROUTINE  BNDRY                                                 BNDRY__   18
                                    CHARACTER*10  TIME,LBL*2
C
      COMMON /CBND/ DT(500),H8(500),QB(31,500),QL(500),QSED(31,500),KSD,
     *              NT
      COMMON /CTIM/ TIME(600)
      COMMON /CSRC/ NQ,NQ1,INQ(31)
      COMMON /CINS/ NDS1,NDS2,DL,IDIV
      COMMON /BVAR/ BV,TAU,USTA,SQT,QT,EP,CLD,KFM
      DIMENSION     SF(5),SF1(5)
C
      READ (5,1000) LBL,NT,KPR,KFM,CLD,KSD
 1000 FORMAT (A2,3X,3I5,F5.0,I5)
      IF (LBL.NE.'BC')  THEN
         WRITE (6,8000) 'BC',LBL
 8000    FORMAT (1H /' ***** BNDRY COND      1,2 COLS. MUST BE (',A2,
     *                                        ') INSTEAD OF (',A2,')')
      ENDIF
      IF (KFM.LT.1.OR.KFM.GT.3)  THEN
         KFM=0
         WRITE (6,8001) KFM
 8001    FORMAT (1H /' ***** BNDRY COND     SED. TRANS. FORMULA IS'
     *                                      ' UNKNOWN     KFM =',I2)
         KFM=0
      ENDIF
      IF (CLD.LE.0.0)  CLD=1.0
      NT=MAX0(NT,1)
      IF (NQ.LT.0)  THEN
         NQ=0
         NQ1=1
         CALL  TITLE(3)
         WRITE (6,8002)
 8002    FORMAT (1H /' ----- BNDRY (KC = 9)     MISSING FLOW-NET DATA.',
     *                                          '(KC=4)'/25X,'WARNING.')
      ENDIF
C
      READ (5,1010) MC,SF
 1010 FORMAT (4X,I1,5X,5F5.0)
      DO 11 L=1,5
      IF (SF(L).EQ.0.0)  SF(L)=1.0
   11 SF1(L)=0.0
      IF (MC.GT.0)  THEN
         READ (5,1010) MC,SF1
         IF (MC.GT.0)  THEN
            DO 12 L=1,5
   12       SF1(L)=SF1(L)*SF(L)
         ENDIF
      ENDIF
C
      DO 23 K=1,NT
      READ (5,1020) TIME(K),DT(K),H8(K),(QB(L,K),L=1,I1)
 1020 FORMAT (A10,10F5.0)
      IF (NQ).GT.11)  READ (5,1021) (QB(L,K),L=12,NQ1)
 1021 FORMAT (25X,10F5.0)
      DO 21 L=1,NQ1
   21 QSED(L,K)=0.0
      IF (KSD.EQ.1)  THEN
         READ (5,1022)  QSED(1,K)
      ELSEIF (KSD.EQ.2)  THEN
         READ (5,1022) (QSED(L,K),L=1,NQ1)
 1022    FORMAT (20X,11F5.0/(25X,10F5.0))
      ENDIF
      DT(K)=DT(K)*SF(1)+SF1(1)
      H8(K)=H8(K)*SF(2)+SF1(2)
      QB(1,K)=QB(1,K)*SF(3)+SF1(3)
      QSED(1,K)=QSED(1,K)*SF(5)+SF1(5)
      DO 22 L=2,NQ1
      QB(L,K)=QB(L,K)*SF(4)+SF1(4)
   22 QSED(L,K)=QSED(L,K)*SF(5)+SF1(5)
   23 CONTINUE
C
      DO 25 J=1,NT
      QL(J)=QB(1,J)
      DO 24 L=2,NQ1
      IF ((INQ(L)-NDS1+1)*(INQ(L)-NDS2).LE.0)  QL(J)=QL(J)+QB(L,J)
   24 CONTINUE
      IF (NHQ.GT.0.AND.H8(J).EQ.0.0)   CALL  HCALC(H8(J),QL(J))
   25 CONTINUE
C
      IF (KPR.GT.0)  THEN
```

```
899           CALL  TITLE(((NQ1+9)/10)*NT+5)                                  19
900           WRITE (6,2030)
901     2030 FORMAT (1H //
902          *       ' BOUNDARY CONDITIONS'/25X,'QT',8X,'HO',10X,'QH',8X,'DQ'/1X)
903           NP=MINO(NQ1,11)
904           DO 31 K=1,NT
905           WRITE (6,2031) K,TIME(K),QT(K),HO(K),(QO(L,K),L=1,NP)
906     2031  FORMAT (4X,I4,2X,A10,F10.1,F10.3,F10.1,10F8.1)
907           IF (NQ1.GT.11)  WRITE (6,2032) (QO(L,K),L=11,NQ1)
908     2032  FORMAT (50X,10F8.1)
909       31 CONTINUE
910          ENDIF
911   C
912          RETURN
913          END
```

```
914           SUBROUTINE  DVCALC                                          DVCALC.      20
915                                                 CHARACTER*10  NAME,TIME,FORMLA(4)
916                                                 CHARACTER*2   MCH,MFM(4),MDIV*4
917                                                 CHARACTER*8   NAMBM
918     C
919           COMMON /CINS/ NDS1,NDS2,DL,IDIV
920           COMMON /CDND/ DT(500),HB(500),QB(31,500),QL(500),QSED(31,500),KSD,
921          *              NT
922           COMMON /CTIM/ TIME(600)
923           COMMON /SECT/ S(14),NAME
924           COMMON /CBRC/ NQ,NQI,INQ(31)
925           COMMON /HQCV/ NHQ,HQ(50,2)
926           COMMON /CNST/ CONS(8),G,GO,SG
927           COMMON /CRES/ Q,H,O,A,R,V,FR,RH,GRAD,RF
928           COMMON /DVAR/ DV,TAU,USTA,SQT,QT,EF,CLD,KFM
929           COMMON /CBED/ DF(14,100),DI(14,100),TC(14,100),WO(14,100),
930          *              SOF(100),DM(100),TCM(100),WOM(100),NDF(100),NBM
931           COMMON /NBED/ NAMBM(100)
932           COMMON /CTMP/ DZ(1000)
933           EQUIVALENCE   (S(1),EN),(S(2),DX),(S(7),ZS)
934           EQUIVALENCE   (CONS(1),ALPHA),(CONS(2),FRCR),(CONS(3),SIGMA),
935          *              (CONS(4),VOID),  (CONS(5),EPSH),(CONS(7),GAMMA),
936          *              (CONS(8),RHO)
937           DATA          FOMLA/'    ','SATO ET AL.','LAURSEN    ','K-BROWN    '/
938           DATA          MFM  /'  ','QB'          ,'QT'         ,'QT'         /
939     C
940           NERR=0
941           IF (NDS2.LT.NDS1)  THEN
942              NERR=NERR+1
943              WRITE (6,8010) NDS1,NDS2
944       8010   FORMAT (' *****   NDS1 =',I4,'   NDS2 =',I4,
945          *                    ' MISSING  CROSS SECTIONAL DATA.')
946           ENDIF
947           IF (NQ.LT.0)  THEN
948              NQ=0
949              NQI=1
950              CALL  TITLE(3)
951              WRITE (6,8011)
952       8011   FORMAT (1H /' -----   MISSING FLOW-RET DATA.  (WARNING)')
953           ENDIF
954           IF (NT.LT.1)  THEN
955              NERR=NERR+1
956              WRITE (6,8012)
957       8012   FORMAT (' *****   MISSING  BOUNDARY CONDITIONS.')
958           ENDIF
959           IF (NERR.GT.0)  THEN
960              CALL  TITLE(3)
961              WRITE (6,8090)
962       8090   FORMAT (1H //' ********   CALCULATION  SUSPENDED.   *********')
963                                          STOP
964           ENDIF
965     C
966           IF (NBM.GT.0)  THEN
967              DO 13 I1=1,NBM,10
968              I2=MINO(I1+9,NBM)
969              CALL  TITLE(-1)
970              DO 12 I=I1,I2
971              ND=NDF(I)
972              DO 11 J=1,ND
973              TC(J,I)=TCCAL(DI(J,I))
974          11  WO(J,I)=RUBEY(DI(J,I))
975              TCM(I)=TCCAL(DM(I))
976              WOM(I)=RUBEY(DM(I))
977              WRITE (6,2010) I,NAMBM(I),SDF(I),(DF(J,I),J=1,ND)
978       2010   FORMAT (1H /1X,I4,2X,A8/18X,'DF',2P15F7.1)
979              WRITE (6,2011) DM(I),(DI(J,I),J=1,ND)
980       2011   FORMAT (18X,'DI',1P15F7.3)
981              WRITE (6,2012) TCM(I),(TC(J,I),J=1,ND)
982       2012   FORMAT (18X,'TC',15F7.2)
983              WRITE (6,2013) WOM(I),(WO(J,I),J=1,ND)
984       2013   FORMAT (18X,'WO',15F7.2)
985          12  CONTINUE
986          13  CONTINUE
987           ENDIF
988     C
989           CALL  TITLE(0)
990           CALL  DSKIN(0)
991           G2=G*2.0
992           DO 14 I=NDS1,NDS2
993          14 DZ(I)=0.0
```

```
C
C
      DO 69 J=1,NT
C
      DO 61 I=NDS1,NDS2
      CALL  DSKIN(I)
C
      MCH=' '
      IF (I.EQ.NDS1)  THEN
         H=HB(J)
         IF (H.LE.ZS)  H=ZS+1.0
         Q=QL(J)
         CALL  HBAR
         HA1=H
         HH1=H
                                  GOTO 40
      ENDIF
C
      Q=QQ1
      DO 22 L=2,NQ1
      IF (INQ(L).EQ.1)  Q=Q-QB(L,J)
   22 CONTINUE
      IF (I.EQ.NDS1+1)  THEN
         HA1=HH1+GRAD1*DX
      ELSE
         HA1=(HH1-HH2)*DX/DX1+HH1
      ENDIF
      IF (HA1.LT.ZS)  HA1=RH1+ZS
      HEE=HE1+RF1*EN*EN*DX*0.6+COM*VV1*VV1/G2
      HA =HA1
      DO 31 NU=1,50
      H =HA
      CALL  HBAR
      HH=HEE+RF*EN*EN*DX*0.5-(ALPHA-COM)*V*V/G2
      EPS=HH-H
      DH=EPS*0.1
      IF (ABS(EPS).LT.EPSH)          GOTO 40
      CALL  REGF1(H,EPS,DH,HA,ZS,NU,KNU)
      IF (ABS(HA-H).LT.EPSH*0.1)     GOTO 40
   31 CONTINUE
      IF (ABS(HA-H).GE.EPSH*0.5)  THEN
         MCH='- '
                                     GOTO 41
      ENDIF
C
   40 IF (FR.LE.FRCR)                GOTO 50
   41 MCH(2:2)='*'
      HA =HA1
      DO 42 NU=1,50
      H =HA
      CALL  HBAR
      EPS=FR-FRCR
      IF (ABS(EPS/FRCR).LT.1E-5)     GOTO 50
      DH=AMAX1(AMIN1(EPS*R/1.6/FRCR,0.5),-0.5)
      CALL  REGF1(H,EPS,DH,HA,ZS,NU,KNU)
      IF (ABS(HA-H).LT.EPSH*0.1)     GOTO 50
   42 CONTINUE
      MCH(2:2)='x'
C
   60 HE=H+ALPHA*V*V/G2
      GRAD=RF*EN*EN
      TAU =RHO*G0*R*GRAD*100.0
      USTA=SQRT(TAU/RHO)
C
      SQT=0.0
      IF (KFH.EQ.1)    CALL  SATODI
      IF (KFH.EQ.2)    CALL  LAURSH
      IF (KFH.EQ.3)    CALL  KBROWN
      QT=SQT*GAMMA*BV *0.0001
      IF (DT(J).GT.0.0)  THEN
         QTIN=0.0
         IF (KSD.GT.0.AND.I.EQ.NDS2)  QT=QSED(1,J)/CL0
         IF (KSD.EQ.2)  THEN
            DO 51 L=2,NQ1
            IF (INQ(L).EQ.1)  QTIN=QSED(L,J)+QTIN
   51       CONTINUE
         ENDIF
         IF (I.GT.NDS1)  THEN
            PP =(BV+BV1)*0.5*DX
            DDZ=((QT-QT1)*CL0+QTIN)*DT(J)/PP/(1.0-VOID)
```

```
1074                DZ(I-1)=DDZ+DZ(I-1)                                    22
1075                IF (I.EQ.NDS2)  DZ(I)=DZ(I-1)
1076              ENDIF
1077            ENDIF
1078    C
1079            HH2=HH1
1080            QQ1=Q
1081            HH1=H
1082            VV1=V
1083            HE1=HE
1084            RF1=RF
1085            RH1=RH
1086            GRAD1=GRAD
1087            ZS1=ZS
1088            DX1=DX
1089            DV1=DV
1090            QT1=QT
1091    C
1092            IF (MOD(I-NDS1,50).LE.0)  THEN
1093               CALL  TITLE(-1)
1094               WRITE (6,2060) FORMLA(KFM+1),TIME(J),MFM(KFM+1),MFM(KFM+1)
1095     2060      FORMAT (88X,A10,2X,A10//25X,'Q',7X,'H',9X,'B',7X,'A',6X,'R',
1096         *           6X,'V',6X,'FR',5X,'TAU',5X,'U*',5X,'S',A2,7X,A2,7X,'B*')
1097            ENDIF
1098            IF (MOD(I-NDS1,10).LE.0)  WRITE (6,2061)
1099            MDIV='    '
1100            IF (IDIV.GT.0)  WRITE (MDIV,'(I4)') IDIV
1101       61   WRITE (6,2061)  NAME,MDIV,HCH,Q,H,B,A,R,V,FR,TAU,USTA,SQT,QT,BV
1102     2061   FORMAT (1H ,A10,1X,A4,1X,A2,F9.1,F9.3,F9.1,F8.1,F7.3,F7.3,F7.3,
1103         *                                        F8.1,F7.1,F8.2,F10.6,F8.1)
1104    C
1105            IF (DT(J).GT.0.0)  THEN
1106               CALL  TITLE(-1)
1107               WRITE (6,2062)  J
1108     2062      FORMAT (1H /5X,'DZ      K =',I6)
1109               DO 62 I1=NDS1,NDS2,10
1110               I2=MIN0(I1+9,NDS2)
1111       62      WRITE (6,2063) (I/10,(DZ(I),I=I1,I2)
1112     2063      FORMAT (8X,I8,10F8.3)
1113            ENDIF
1114       69 CONTINUE
1115    C
1116            CALL  DSKIN(9999)
1117            RETURN
1118            END
```

```
      SUBROUTINE  HDAR
C
      COMMON /GRES/ Q,H,B,A,R,V,FR,RH,GRAD,RF
      COMMON /BVAR/ BV,TAU,USTA,SQT,QT,EF,CLD,KFH
      COMMON /CNST/ CONS(8),G,G0,SG
C
      CALL  XYAR(H,B,A,R,P,RH,BV)
      V =1E+9
      RF=1E+9
      FR=1E+9
      IF (A.GT.0.0)   V=Q/A
      IF (R.GT.0.0)   RF=ABS(R**(-1.333333)*V)*V
      IF (RH.GT.0.0)  FR=V/SQRT(G*RH)
C
      RETURN
      END
```

```
      SUBROUTINE  XYAR(H,B,A,R,P,RH,BV)                    XYAR___    24
                                        CHARACTER*10  NAME
C
      COMMON /CXY / X(100),Y(100),N
      COMMON /SECT/ S(14),NAME
      COMMON /NSCT/ NDIV,IBED,JBVL,JBVR
      EQUIVALENCE  (S(13),XL),(S(14),XR)
C
      B=0.0
      A=0.0
      P=0.0
      R=0.0
      RH=0.0
      BV=0.0
      IF (XR.LE.XL)              GOTO 90
C
      DO 30 J=2,N
      J1=J-1
      X1=AMAX1(X(J1),XL)
      X2=AMIN1(X(J ),XR)
      IF (J.LE.2.AND.X(J).GT.X(J1))  X1=XL
      IF (J.GE.N.AND.X(J).GT.X(J1))  X2=XR
      IF (X2.LT.X1)               GOTO 30
      IF (X(J)-X(J1))          30,10,20
C
   10 IF (X1.GE.X(J))  THEN
         Y2=AMIN1(Y(J1),H)
         Y1=AMIN1(Y(J ),H)
      ELSE
         IF (X2.LE.X(J))  THEN
            Y2=AMIN1(Y(J ),H)
            Y1=AMIN1(Y(J1),H)
         ELSE
            Y2=AMIN1(AMAX1(Y(J),Y(J1)),H)
            Y1=AMIN1(AMIN1(Y(J),Y(J1)),H)
         ENDIF
      ENDIF
      P=ABS(Y2-Y1)+P
                                  GOTO 30
C
   20 DD=(Y(J)-Y(J1))/(X(J)-X(J1))
      Y1=(X1-X(J1))*DD+Y(J1)
      Y2=(X2-X(J1))*DD+Y(J1)
      Z1=H-Y1
      Z2=H-Y2
      IF (Z1.LE.0.0.AND.Z2.LE.0.0)  GOTO 30
      IF (Z1.LT.0.0)  THEN
         X1=(X1-X2)*Z2/(Z2-Z1)+X2
         Z1=0.0
      ELSEIF (Z2.LT.0.0)  THEN
         X2=(X2-X1)*Z1/(Z1-Z2)+X1
         Z2=0.0
      ENDIF
      DB=X2-X1
      B=DB+B
      A=(Z1+Z2)*DB*0.5+A
      P=SQRT((Z2-Z1)**2+DB**2)+P
      IF (J.EQ.JBVL+1. OR.J.EQ.JBVR-1)  BV=DB*0.5+BV
      IF (J.GT.JBVL+1.AND.J.LT.JBVR-1)  BV=DB+BV
   30 CONTINUE
C
      IF (P.GT.0.0)  R =A/P
      IF (B.GT.0.0)  RH=A/B
C
   90 RETURN
      END
```

```
1201          SUBROUTINE  HCALC(WH,WQ)
1202    C
1203          COMMON /HQCV/ NHQ,H(50),Q(50)
1204    C
1205          DO 11 I=2,NHQ
1206          L2=I
1207          IF (WQ.LE.Q(I))          GOTO 12
1208       11 CONTINUE
1209       12 L1=L2-1
1210          WH=(H(L2)-H(L1))*(WQ-Q(L1))/(Q(L2)-Q(L1))+H(L1)
1211    C
1212       90 RETURN
1213          END
```

```
1214          SUBROUTINE  STOS(I)                                  STOS___      20
1215                                          CHARACTER*10  NAME,NAMS
1216    C
1217          COMMON /SECT/ S(14),NAME
1218          COMMON /NSCT/ NDIV,IBED,JBVL,JBVR
1219          COMMON /DSKS/ SS(14,101),NDIVS(101),IBEDS(101)
1220          COMMON /DSKN/ NAMS(101)
1221    C
1222          NAMS(I)=NAME
1223          NDIVS(I)=NDIV
1224          IBEDS(I)=IBED
1225          DO 11 J=1,14
1226       11 SS(J,I)=S(J)
1227    C
1228          RETURN
1229          END
```

```
1230        SUBROUTINE  RESTOS(I)                    CHARACTER*10  NAME,NAMS
1231
1232  C
1233        COMMON /SECT/ S(14),NAME
1234        COMMON /NSCT/ NDIV,IBED,JDVL,JDVR
1235        COMMON /DSKS/ SS(14,101),NDIVS(101),IBEDS(101)
1236        COMMON /DSKN/ NAMS(101)
1237  C
1238        NAME=NAMS(I)
1239        NDIV=NDIVS(I)
1240        IBED=IBEDS(I)
1241        DO 11 J=1,14
1242     11 S(J)=SS(J,I)
1243  C
1244        RETURN
1245        END
```

```
1246          SUBROUTINE  STOXY(I)                                    STOXY..      28
1247    C
1248          COMMON /CXY / X(100),Y(100),N
1249          COMMON /DSKX/ XX(100,101),YY(100,101),NXY(101)
1250    C
1251          NXY(I)=N
1252          DO 11 J=1,N
1253          XX(J,I)=X(J)
1254       11 YY(J,I)=Y(J)
1255    C
1256          RETURN
1257    .     END
```

```
1258          SUBROUTINE  RESTOX(I)                                    RESTOX.      20
1259    C
1260          COMMON /CXY / X(100),Y(100),N
1261          COMMON /DSKX/ XX(100,101),YY(100,101),NXY(101)
1262    C
1263          N=NXY(I)
1264          DO 11 J=1,N
1265          X(J)=XX(J,I)
1266       11 Y(J)=YY(J,I)
1267    C
1268          RETURN
1269          END
```

```
1270          SUBROUTINE  DSKOUT(ID)                                          DSKOUT.          30
1271                                                CHARACTER*10  NAME,FILTMP*20
1272    C
1273          COMMON /SECT/ S(14),NAME
1274          COMMON /CXY / X(100),Y(100),N
1275          COMMON /NSCY/ NDIV,IDED,JBVL,JBVR
1276          COMMON /CINS/ NDS1,NDS2,DL,IDIV
1277          COMMON /FNAM/ FILTMP
1278          EQUIVALENCE  (S(11),XBL),(S(12),XBR)
1279    C
1280          IF (ID.EQ.0)  THEN
1281             OPEN  (3,FILE=FILTMP,ACCESS='DIRECT',RECL=1024)
1282          ELSEIF (ID.EQ.9999)  THEN
1283             CLOSE (3)
1284          ELSEIF ((ID-1001)*ID.LT.0)  THEN
1285             JBVL=1
1286             JBVR=N
1287             IF (XBR.GT.XBL)  THEN
1288                DMXL=1E+9
1289                DMXR=1E+9
1290                DO 11 J=1,N
1291                DXL=ABS(X(J)-XBL)
1292                DXR=ABS(X(J)-XBR)
1293                IF (DXL.LT.DMXL)  THEN
1294                   DMXL=DXL
1295                   JBVL=J
1296                ENDIF
1297                IF (DXR.LT.DMXR)  THEN
1298                   DMXR=DXR
1299                   JBVR=J
1300                ENDIF
1301                IF (XBL.GT.X(JBVL))  JBVL=JBVL+1
1302                IF (XBR.GT.X(JBVR))  JBVR=JBVR-1
1303       11       CONTINUE
1304             ENDIF
1305             WRITE (3,REC=ID) N,S,DL,IDIV,NDIV,IDED,JBVL,JBVR,
1306          *                                    (X(J),J=1,N),(Y(J),J=1,N),NAME
1307          ENDIF
1308    C
1309          RETURN
1310          END
```

```
      SUBROUTINE  DSKIN(ID)                    CHARACTER*10  NAME,FILTMP*20

C
      COMMON /SECT/ S(14),NAME
      COMMON /CXY / X(100),Y(100),N
      COMMON /NSCT/ NDIV,IBED,JBVL,JBVR
      COMMON /CINS/ NDS1,NDS2,DL,IDIV
      COMMON /CTMP/ DZ(1000)
      COMMON /FNAM/ FILTMP
C
      IF (ID.EQ.0)  THEN
        OPEN  (3,FILE=FILTMP,ACCESS='DIRECT',RECL=1024)
      ELSEIF (ID.EQ.9999)  THEN
        CLOSE (3)
      ELSEIF ((ID-1001)*ID.LT.0)  THEN
        READ  (3,REC=ID) N,S,DL,IDIV,NDIV,IBED,JBVL,JBVR,
     *                                  (X(J),J=1,N),(Y(J),J=1,N),NAME
        DO 11 J=JBVL+1,JBVR-1
        Y(J)=Y(J)+DZ(ID)
   11   S(7)=S(7)+DZ(ID)
      ENDIF
C
      RETURN
      END
```

```
1335          SUBROUTINE  SATODI                                        SATODI_      32
1336                                          CHARACTER*10  NAME
1337    C
1338          COMMON /CUED/ DF(14,100),DI(14,100),TC(14,100),NO(14,100),
1339         *              SDF(100),DM(100),TCM(100),NOM(100),NDF(100),NDM
1340          COMMON /NSCT/ NDIV,IBED,JBVL,JBVR
1341          COMMON /CNST/ CONS(8),G,GO,SG
1342          COMMON /SECT/ S(14),NAME
1343          COMMON /DVAR/ DV,TAU,USTA,SQT,QT,EF,CLD,KFM
1344          EQUIVALENCE  (S(1),EN)
1345    C
1346          SS =0.0
1347          SQ1=0.0
1348          EF =0.0
1349          IF (TAU.LE.0.0)          GOTO 20
1350          L=IBED
1351          IF ((L-NDM-1)*L.GE.0)    GOTO 20
1352          M=NDF(L)
1353          IF (M.LE.0)              GOTO 20
1354    C
1355          IF (EN.GE.0.025.OR.EN.LE.0.0)  THEN
1356             PHI=0.623
1357          ELSE
1358             PHI=(EN*40.0)**(-3.5)*0.623
1359          ENDIF
1360          SQ1=USTA**3*PHI/SG
1361    C
1362          DO 11 J=1,M
1363          IF (TAU.LE.0.0.OR.TC(J,L).LE.0.0)  GOTO 11
1364          EF=FSCAL(TC(J,L)/TAU)
1365          SQT=SQ1*EF*DF(J,L)
1366          SS=SS+SQT
1367       11 CONTINUE
1368    C
1369       20 SQT=SS
1370          IF (SQ1.GT.0.0)  EF=SS/SQ1
1371    C
1372          RETURN
1373          END
```

```
1374          SUBROUTINE  LAURSN                                        LAURSN.  33
1375                                          CHARACTER*10  NAME
1376    C
1377          COMMON /CBED/ DF(14,100),DI(14,100),TC(14,100),W0(14,100),
1378         *              SDF(100),DM(100),TCM(100),W0M(100),NDF(100),NBM
1379          COMMON /NSCT/ NDIV,IBED,JBVL,JBVR
1380          COMMON /CNST/ CONS(8),G,GO,SO
1381          COMMON /SECT/ S(14),NAME
1382          COMMON /BVAR/ BV,TAU,USTA,SQT,QT,EF,CLD,KFM
1383          COMMON /CRES/ Q,H,B,A,R,V,FR,RH,GRAD,RP
1384          EQUIVALENCE  (CONS(3),SIGMA),(CONS(8),RHO)
1385    C
1386          SS=0.0
1387          S1=0.0
1388          IF (TAU.LE.0.0.OR.RH.LE.0.0) GOTO 20
1389          L=IBED
1390          IF ((L-NDM-1)*L.GE.0)    GOTO 20
1391          M=NDF(L)
1392          IF (M.LE.0)              GOTO 20
1393    C
1394          HH=RH*100.0
1395          VV=V *100.0
1396          TE=(DM(L)/HH)**0.3333333*(VV/7.66)**2*RHO
1397          SQ=VV*HH
1398    C
1399          DO 11 J=1,M
1400          DD=DI(J,L)
1401          IF (TC(J,L).LE.0.0.OR.W0(J,L).LE.0.0)  GOTO 11
1402          EF=FLCAL(USTA/W0(J,L))
1403          T2=AMAX1(TE/TC(J,L)-1.0,0.0)
1404          IF (T2.LE.0.0)  THEN
1405             T1=0.0
1406          ELSE
1407             T1=(DI(J,L)/HH)**1.166667
1408          ENDIF
1409          SQT=T1*T2*EF*DF(J,L)*SQ*RHO/SIGMA/100.0
1410          SS=SS+SQT
1411          S1=EF*DF(J,L)+S1
1412       11 CONTINUE
1413    C
1414       20 SQT=SS
1415          EF=S1
1416    C
1417          RETURN
1418          END
```

```
1430          SUBROUTINE  KBROWN                                    KBROWN.    34
1431                                        CHARACTER*10  NAME
1432    C
1433          COMMON /CBED/ DF(14,100),DI(14,100),TC(14,100),M0(14,100),
1434         *              SDF(100),DM(100),TCM(100),MOM(100),NDF(100),NBM
1435          COMMON /NSCT/ NDIV,IBED,JBVL,JBVR
1436          COMMON /CNST/ CONS(8),G,GO,SG
1437          COMMON /SECT/ S(14),NAME
1438          COMMON /BVAR/ BV,TAU,USTA,SQT,QT,EF,CLD,KFM
1439          COMMON /CRES/ Q,H,B,A,R,V,FR,RH,GRAD,RF
1440    C
1441          SS=0.0
1442          SI=0.0
1443          SSI=1.0
1444          L=IBED
1445          IF ((L-NBM-1)*L.GE.0)    GOTO 20
1446          M=NDF(L)
1447          IF (M.LE.0)              GOTO 20
1448          SGD=SG*DM(L)
1449          SSI=(USTA**2/SGD)**2*USTA*DM(L)*10.0
1450    C
1451          DO 11 J=1,M
1452          IF (DI(J,L).LE.0.0)      GOTO 11
1453          EF=DM(L)/DI(J,L)*DF(J,L)
1454          SQT=SSI*EF
1455          SS=SQT+SS
1456       11 CONTINUE
1457    C
1458       20 SQT=SS
1459          EF=SS/SSI
1460    C
1461          RETURN
1462          END
```

```
1463          FUNCTION  TCCAL(DD)
1464    C
1465          COMMON /CNST/ CONS(8),G,GD,SG
1466          EQUIVALENCE  (CONS(6),XNU),(CONS(8),RHO)
1467    C
1468          SGD =SG*DD
1469    C
1470          IF (SGD.LE.0.0)  THEN
1471             TCCAL=0.0
1472          ELSE
1473             DNU = DD/XNU
1474             RSTA= SQRT(SGD)*DNU
1475             IF (RSTA.LE.2.138000)  THEN
1476                UC2 = SGD*0.14
1477             ELSEIF (RSTA.LE.64.23201)  THEN
1478                UC2 =(SGD*0.1235440)**0.7811444*DNU**(-0.4077111)
1479             ELSEIF (RSTA.LE.102.6978)  THEN
1480                UC2 = SGD*0.034
1481             ELSEIF (RSTA.LE.870.8204)  THEN
1482                UC2 =(SGD*0.01504063)**1.136122*DNU**0.2722439
1483             ELSE
1484                UC2 = SGD*0.05
1485             ENDIF
1486             TCCAL=UC2*RHO
1487          ENDIF
1488    C
1489          RETURN
1490          END
```

```
1491          FUNCTION  RUBEY(DO)                                          RUBEY__          30
1492    C
1493          COMMON /CNST/ CONS(8),G,GO,SG
1494          EQUIVALENCE  (CONS(6),XNU),(CONS(8),RHO)
1495    C
1496          IF (DO.LE.0.0)  THEN
1497             WO=0.0
1498          ELSE
1499             SGD =SG*DO
1500             SQSGD=SQRT(SGD)
1501             B=(6.0*XNU/DO)**2/SGD
1502             A=2.0/3.0+B
1503             SQA=SQRT(A)
1504             SQB=SQRT(B)
1505             WO=(SQA-SQB)*SQSGD
1506          ENDIF
1507    C
1508          RUBEY=WO
1509          RETURN
1610          END
```

```
      FUNCTION  FSCAL(X)
C
      DATA          C1,C2,C3,C4/1.414214, 2.506628, 6.034640, 0.1621331/
C
      IF (X.LE.0.0)  THEN
         F = 1.0
      ELSEIF (X.GE.1.4)  THEN
         F = 0.0
      ELSEIF (X.LT.1.2)  THEN
         X0=(X*2.0-1.0)*2.0
         X1= X0**2/2.0
         X2= X0/1.414214
         WERFC=(1.0-ERF(X0))*2.0
         WEXP = EXP(-X1)
         F = (WERFC*2.506628*WEXP)/6.034640
      ELSE
         F =(1.4-X)**2*0.1621331
      ENDIF
C
      FSCAL=F
      RETURN
      END
```

```
1522          FUNCTION  ERF(X)                                        ERF____        38
1523    C
1524          AX=ABS(X)
1525          T = 1.0/(1.0+.2316410*AX)
1526          D = EXP(-X*X/2.0)*.3989423
1527          P = ((((1.330274*T -1.821256)*T +1.781478)*T
1528         *       -.3565638)*T +.3103815)*T*D
1529          IF (X.GT.0.0) P=1.0-P
1530    C
1531          ERF=P
1532          RETURN
1533          END
```

```
      FUNCTION  FLCAL(X)
C
      IF (X.LE.0.0)  THEN
         F=0.0
      ELSE
         Y1=X/7.91
         Y2=Y1**0.22
         Y1=ALOG10(Y1)
         Y3=(ABS(Y1)*0.08+1.0)*Y1*1.6
         Y4=TANH(Y3)*(1.545-0.01*Y1)
         Y5=10.0**Y4
         F=Y5*Y2*552.0
      ENDIF
C
      FLCAL=F
      RETURN
      END
```