COMPUTER PROGRAMS FOR UNSTEADY FLOW IN OPEN CHANNELS

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PROGRAM DYNA

1. INTRODUCTION

This program is intended for use in the computation of unsteady flow in open channels. The program is sufficiently general in scope, and is applicable to a wide range of routing problems. It is designed to be used primarily as a canned program, although maximum benefit can be obtained if the user has some familiarity with unsteady flow concepts.

The program is written in a modular structure, with a main program calling several subroutines to perform certain specific tasks. The modularity of the program provides for ease of modification, updating and improvement. The documentation given here is designed to help the user get familiar with the overall features of the program and its input-output requirements.

2. BRIEF DESCRIPTION OF THE MODEL

The unsteady flow model contained in program DYNA is a dynamic wave model, i.e., a model that uses the complete equations of motion and continuity. The numerical model is based on a finite difference formulation of these two equations, using the Preissmann four-point implicit scheme. A significant feature of this scheme is the provision of a weighting factor θ, which is used to control the stability and convergence properties of the model.

The nonlinear nature of the partial differential equation leads to a nonlinear system of algebraic equations. In order to solve directly, without iteration, the system is linearized by using a series expansion. The approximation inherent in the linearization is sufficiently accurate provided $\Delta f/f \ll 1$, where f is any function.

The system of linear algebraic equations is solved by the double sweep solution technique. This enables the calculation of the updated values of the dependent variables, i.e., discharge, flow area, stage. The computation then advances to the next time step.

The model enables the simulation of the variation in time of discharge, flow area, stage, etc. along a channel reach, given initial and boundary conditions. The several computational options available are explained in the following section.

3. PROGRAM FEATURES

DYNA has the following programming features:

(1) Maximum number of computational reaches = 100. Maximum number of time steps = 500. With these array sizes, the central memory requirements do not exceed 140,000 (octal).

(2) Twenty-two (22) subroutines, each performing a specific function. The flow of information from main program to subroutines and between subroutines is done primarily by labeled common blocks. Large array common blocks are labeled A through H, and single variable P through U.

(3) Eight (8) indicators for program capabilities. Each indicator can be either 0 or 1, depending on the user's choice. The choice of indicators determines the arrangement of the input file, as illustrated in the following section.

(4) For added convenience, the input-output is described in the source file by using comment cards.

A brief explanation on the use of the indicators is given below:

INB Downstream Boundary Type

If INB = 0, a kinematic wave boundary condition is specified at the downstream section by subroutine BOUN. This is essentially a single-valued rating curve. If INB = 1, the effect of the water surface slope on the rating curve is taken into account.

INC Calendar Time Capability

If INC = 0, there is no capability for the calculation of calendar time, and no need to enter related data on card D. If INC = 1, subroutine CALE will calculate the calendar time for each time step of the computation, given the initial date and time for $t = 0$, as read in card D.

IND Input Data Type

If IND = 0, the data corresponds to a natural channel case, while if IND = 1, a hypothetical case for a rectangular prismatic channel is being considered. This feature allows the user to run the program on a hypothetical channel mode, in order to test its performance and gain additional familiarity with it.

INL Lateral Inflow Option

If INL = 0, no lateral inflow can be included in the computation. If INL = 1, lateral inflow can be considered. The maximum number of reaches where lateral inflow can be specified is 8. (If necessary, this feature can be modified by increasing the size of labeled common I and reformatting cards P and Q.)

INP Plotted Output Capability

If INP = 0, no plotted output capability. If INP = 1, the discharge and stage hydrograph at the downstream section will be plotted using the MAPA library routine.

INR Printed Output Capability

If INR = 0, an extended printed output is given. This includes range, discharge, flow area, stage, mean velocity, wetted perimeter, top width, hydraulic radius, hydraulic depth and Froude number. If INR = 1, a condensed printed output is given: discharge, flow area and stage.

INS Cross-Sectional Data Input

If INS = 0, the cross-sectional data is given in terms of x-z coordinates, and the program calculates the cross-sectional hydraulic characteristics. If INS = 1, the cross-sectional hydraulic characteristics are given directly as input data.

INU System of Units

If INU = 0, the S.I. (Kg-m-sec) units are utilized throughout the program. If INU = 1, the U.S. customary system (lb-ft-sec) is used.

4. INPUT-OUTPUT EXAMPLES

Three examples are given to illustrate the use of program DYNA. The examples are detailed in Table 1.

Table 1
DYNA: ILLUSTRATIVE EXAMPLES

Example	INS	IND	INL	INPUT	OUTPUT
A	0	0	1	Fig. 1	Fig. 4
B	1	0	0	Fig. 2	Fig. 5
C	1	1	0	Fig. 3	Fig. 6

```
''''/'''''1''''/'''''2''''/'''''3''''/'''''4''''/'''''5''''/'''''6''''/'''''7''''/'''''8

UNSTEADY FLOW IN OPEN CHANNELS: PROGRAM DYNA/ EXAMPLE A                              A
JUNE 16-20, 1980                                                                     B
01010000                                                                             C
   10    48    4      6.000       0.60     0.0001        0.080 616   12.   0.0   0.0   D
         4
100.      105.      100.      100.      300.      100.      300.      105.
         4
100.      104.      100.      99.0      300.      99.0      300.      104.
         4
100.      103.      100.      98.0      300.      98.0      300.      103.
         4
100.      102.      100.      97.0      300.      97.0      300.      102.
         4
100.      101.      100.      96.0      300.      96.0      300.      101.
         4                                                                           E
100.      100.      100.      95.0      300.      95.0      300.      100.             &
         4                                                                           F
100.      99.0      100.      94.0      300.      94.0      300.      99.0
         4
100.      98.0      100.      93.0      300.      93.0      300.      98.0
         4
100.      97.0      100.      92.0      300.      92.0      300.      97.0
         4
100.      96.0      100.      91.0      300.      91.0      300.      96.0
         4
100.      95.0      100.      90.0      300.      90.0      300.      95.0
10000.    10000.    10000.    10000.    10000.    10000.    10000.    10000.         G
10000.    10000.
0.02374   0.02374   0.02374   0.02374   0.02374   0.02374   0.02374   0.02374        H
0.02374   0.02374   0.02374
91.6886   200.0     1.45      0.20                                                   I
213.63    253.59    317.157   400.      496.472   600.      703.528   800.
882.843   946.410   986.370   1000.     986.370   946.410   882.843   800.
703.527   600.      496.472   400.      317.157   253.59    213.63    200.           M
200.      200.      200.      200.      200.      200.      200.      200.
200.      200.      200.      200.      200.      200.      200.      200.
200.      200.      200.      200.      200.      200.      200.      200.
         2                                                                           O
         3         7                                                                 P
50.0      50.0      50.0      50.0      50.0      50.0      50.0      50.0
50.0      50.0      50.0      50.0      50.0      50.0      50.0      50.0
50.0      50.0      50.0      50.0      50.0      50.0      50.0      50.0
50.0      50.0      50.0      50.0      50.0      50.0      50.0      50.0
50.0      50.0      50.0      50.0      50.0      50.0      50.0      50.0
50.0      50.0      50.0      50.0      50.0      50.0      50.0      50.0
50.0                                                                                 Q
100.      100.      100.      100.      100.      100.      100.      100.
100.      100.      100.      100.      100.      100.      100.      100.
100.      100.      100.      100.      100.      100.      100.      100.
100.      100.      100.      100.      100.      100.      100.      100.
100.      100.      100.      100.      100.      100.      100.      100.
100.      100.      100.      100.      100.      100.      100.      100.
100.

''''/'''''1''''/'''''2''''/'''''3''''/'''''4''''/'''''5''''/'''''6''''/'''''7''''/'''''8
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Fig. 1 Program DYNA, Example A: Input

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''''/''''1''''/''''2''''/''''3''''/''''4''''/''''5''''/''''6''''/''''7''''/''''8
UNSTEADY FLOW IN OPEN CHANNELS: PROGRAM DYNA/ EXAMPLE B                          A
JUNE 16-20, 1980                                                                 B
10001110                                                                         C
   10   48    4       6.0      0.60     0.0001    5000.0                         D
89.5414   0.0218    179.0828  0.0218    200.0000  0.0000    0.0237    10000.
88.5496   0.0221    179.0828  0.0218    200.0000  0.0000    0.0237    10000.
87.5580   0.0223    179.0828  0.0218    200.0000  0.0000    0.0237    10000.
86.5665   0.0225    179.0828  0.0218    200.0000  0.0000    0.0237    10000.
85.5752   0.0229    179.0828  0.0218    200.0000  0.0000    0.0237    10000.
84.5840   0.0230    179.0828  0.0218    200.0000  0.0000    0.0237    10000.     J
83.5931   0.0232    179.0828  0.0218    200.0000  0.0000    0.0237    10000.
82.6023   0.0234    179.0828  0.0218    200.0000  0.0000    0.0237    10000.
81.6117   0.0237    179.0828  0.0218    200.0000  0.0000    0.0237    10000.
80.6213   0.0239    179.0828  0.0218    200.0000  0.0000    0.0237    10000.
79.6311   0.0242    179.0828  0.0218    200.0000  0.0000    0.0237    10000.
200.      337.716   200.      337.716   200.      337.716   200.      337.716
200.      337.716   200.      337.716   200.      337.716   200.      337.716    K
200.      337.716   200.      337.716   200.      337.716
213.63    253.59    317.157   400.      496.472   600.      703.528   800.
882.843   946.410   986.370   1000.     986.370   946.410   882.843   800.
703.527   600.      496.472   400.      317.157   253.59    213.63    200.       M
200.      200.      200.      200.      200.      200.      200.      200.
200.      200.      200.      200.      200.      200.      200.      200.
200.      200.      200.      200.      200.      200.      200.      200.
''''/''''1''''/''''2''''/''''3''''/''''4''''/''''5''''/''''6''''/''''7''''/''''8
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Fig. 2 Program DYNA, Example B: Input

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''''/''''1''''/''''2''''/''''3''''/''''4''''/''''5''''/''''6''''/''''7''''/''''8

UNSTEADY FLOW IN OPEN CHANNELS: PROGRAM DYNA/ EXAMPLE C                           A
JUNE 16-20, 1980                                                                  B
01100010                                                                          C
   10   96    8       6.0       0.60     0.0001    5000.080 616  12.  0.0  0.0    D
200.     337.716   200.      100.       179.0828  0.0218    200.0000  0.0000      L
0.0237   10000.    1.45      0.20
1000.    200.      72.0                                                           N

''''/''''1''''/''''2''''/''''3''''/''''4''''/''''5''''/''''6''''/''''7''''/''''8
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Fig. 3 Program DYNA, Example C: Input

DYNA----FLOOD ROUTING WITH A DYNAMIC WAVE MODEL

UNSTEADY FLOW IN OPEN CHANNELS: PROGRAM DYNA/ EXAMPLE A

JUNE 16-20, 1980

INB= 0 INDICATOR OF DOWNSTREAM BOUNDARY TYPE
INC= 1 INDICATOR OF CALENDAR CAPABILITY
IND= 0 INDICATOR OF INPUT DATA TYPE
INL= 1 INDICATOR OF LATERAL INFLOW
INP= 0 INDICATOR OF PLOTTED OUTPUT
INR= 0 INDICATOR OF TYPE OF PRINTED OUTPUT
INS= 0 INDICATOR OF CROSS SECTIONAL INPUT
INU= 0 INDICATOR OF SYSTEM OF UNITS

JR = 10 REACHES
JP = 11 CROSS SECTIONS
NT = 48 TIME STEPS
TST= 6.00 DAYS - TOTAL SIMULATION TIME
DTU= .13 DAYS - TIME INTERVAL
DT = 10800. SECONDS - TIME INTERVAL
THE= .60 WEIGHTING FACTOR OF IMPLICIT SCHEME
SLD= .000100 NORMAL WATER SURFACE SLOPE AT DOWNSTREAM SECTION FOR KINEMATIC BOUNDARY CONDITION

HYDRAULIC AND CROSS SECTIONAL PROPERTIES

J	XA	XB	A1	B1	A2	B2	XN	DX	J
1	89.5414	.0218	179.0828	.0218	200.0000	.0000	.0237	10000.	1
2	88.5496	.0221	179.0828	.0218	200.0000	.0000	.0237	10000.	2
3	87.5580	.0223	179.0828	.0218	200.0000	.0000	.0237	10000.	3
4	86.5665	.0225	179.0828	.0218	200.0000	.0000	.0237	10000.	4
5	85.5752	.0227	179.0828	.0218	200.0000	.0000	.0237	10000.	5
6	84.5840	.0230	179.0828	.0218	200.0000	.0000	.0237	10000.	6
7	83.5931	.0232	179.0828	.0218	200.0000	.0000	.0237	10000.	7
8	82.6023	.0234	179.0828	.0218	200.0000	.0000	.0237	10000.	8
9	81.6117	.0237	179.0828	.0218	200.0000	.0000	.0237	10000.	9
10	80.6213	.0239	179.0828	.0218	200.0000	.0000	.0237	10000.	10
11	79.6311	.0242	179.0828	.0218	200.0000	.0000	.0237	-R	11

TIME STEP 0 CALENDAR TIME 80/06/15 12:00:00

J	DISTANCE	DISCHARGE	AREA	STAGE	VELOCITY	W.PERIMETER	TOP WIDTH	HYD.RADIUS	HYD.DEPTH	FROUDE NO	J
1	0.0	200.000	337.716	101.6886	.5922	203.3772	200.0000	1.6605	1.6886	.15	1
2	10000.0	200.000	337.716	100.6886	.5922	203.3772	200.0000	1.6605	1.6886	.15	2
3	20000.0	200.000	337.716	99.6886	.5922	203.3772	200.0000	1.6605	1.6886	.15	3
4	30000.0	200.000	337.716	98.6886	.5922	203.3772	200.0000	1.6605	1.6886	.15	4
5	40000.0	200.000	337.716	97.6886	.5922	203.3772	200.0000	1.6605	1.6886	.15	5
6	50000.0	200.000	337.716	96.6886	.5922	203.3772	200.0000	1.6605	1.6886	.15	6
7	60000.0	200.000	337.716	95.6886	.5922	203.3772	200.0000	1.6605	1.6886	.15	7

Fig. 4 Program DYNA, Example A: Sample of Output

J	DISTANCE	DISCHARGE	AREA	STAGE	VELOCITY	W.PERIMETER	TOP WIDTH	HYD.RADIUS	HYD.DEPTH	FROUDE NO	J
8	70000.0	200.000	337.718	94.6886	.5922	203.3772	200.0000	1.6605	1.5886	.15	8
9	80000.0	200.000	337.717	93.6886	.5922	203.3772	200.0000	1.6605	1.5886	.15	9
10	90000.0	200.000	337.717	92.6886	.5922	203.3772	200.0000	1.6605	1.5886	.15	10
11	100000.0	200.000	337.720	91.6886	.5922	203.3772	200.0000	1.6606	1.5886	.15	11

TIME STEP 4 CALENDAR TIME 80/06/17 00:00:00

J	DISTANCE	DISCHARGE	AREA	STAGE	VELOCITY	W.PERIMETER	TOP WIDTH	HYD.RADIUS	HYD.DEPTH	FROUDE NO	J
1	0.0	400.000	490.384	102.5141	.8157	205.0282	200.0000	2.3918	2.4519	.17	1
2	10000.0	339.280	445.818	101.3010	.7610	204.6020	200.0000	2.1790	2.2291	.16	2
3	20000.0	290.942	430.063	100.2206	.6765	204.4413	200.0000	2.1036	2.1503	.15	3
4	30000.0	301.094	420.894	99.1725	.7154	204.3451	200.0000	2.0597	2.1045	.16	4
5	40000.0	276.986	399.468	98.0560	.6934	204.1120	200.0000	1.9571	1.9973	.16	5
6	50000.0	251.790	391.714	97.0123	.6428	204.0247	200.0000	1.9199	1.9586	.15	6
7	60000.0	238.023	424.879	96.1935	.5602	204.3871	200.0000	2.0788	2.1244	.12	7
8	70000.0	320.896	442.170	95.2825	.7257	204.5653	200.0000	2.1615	2.2109	.16	8
9	80000.0	307.934	428.105	94.2103	.7193	204.4209	200.0000	2.0942	2.1405	.16	9
10	90000.0	285.761	411.093	93.1198	.6951	204.2399	200.0000	2.0128	2.0555	.15	10
11	100000.0	269.179	405.669	92.0902	.6635	204.1807	200.0000	1.9868	2.0283	.15	11

TIME STEP 8 CALENDAR TIME 80/06/17 12:00:00

J	DISTANCE	DISCHARGE	AREA	STAGE	VELOCITY	W.PERIMETER	TOP WIDTH	HYD.RADIUS	HYD.DEPTH	FROUDE NO	J
1	0.0	800.000	762.275	103.5064	1.0495	207.0129	200.0000	3.6823	3.8114	.17	1
2	10000.0	743.156	727.425	102.4008	1.0216	206.8014	200.0000	3.5175	3.6371	.17	2
3	20000.0	680.954	704.755	101.3293	.9662	206.6585	200.0000	3.4102	3.5238	.16	3
4	30000.0	663.872	674.588	100.2306	.9841	206.4611	200.0000	3.2674	3.3729	.17	4
5	40000.0	594.508	628.468	99.0711	.9460	206.1421	200.0000	3.0487	3.1423	.17	5
6	50000.0	522.842	583.502	97.9041	.8960	205.8081	200.0000	2.8352	2.9175	.17	6
7	60000.0	456.952	578.456	96.8845	.7900	205.7691	200.0000	2.8112	2.8923	.15	7
8	70000.0	499.366	569.133	95.8480	.8774	205.6961	200.0000	2.7669	2.8457	.17	8
9	80000.0	451.512	536.651	94.7161	.8414	205.4323	200.0000	2.6123	2.6833	.16	9
10	90000.0	411.528	509.392	93.5991	.8079	205.1985	200.0000	2.4824	2.5470	.16	10
11	100000.0	378.012	499.491	92.5551	.7568	205.1106	200.0000	2.4352	2.4975	.15	11

TIME STEP 12 CALENDAR TIME 80/06/18 00:00:00

J	DISTANCE	DISCHARGE	AREA	STAGE	VELOCITY	W.PERIMETER	TOP WIDTH	HYD.RADIUS	HYD.DEPTH	FROUDE NO	J

Fig. 4 (continued)

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DYNA----FLOOD ROUTING WITH A DYNAMIC WAVE MODEL

UNSTEADY FLOW IN OPEN CHANNELS: PROGRAM DYNA/ EXAMPLE B

JUNE 16-20, 1980

INB= 1 INDICATOR OF DOWNSTREAM BOUNDARY TYPE
INC= 0 INDICATOR OF CALENDAR CAPABILITY
IND= 0 INDICATOR OF INPUT DATA TYPE
INL= 0 INDICATOR OF LATERAL INFLOW
INP= 1 INDICATOR OF PLOTTED OUTPUT
INR= 1 INDICATOR OF TYPE OF PRINTED OUTPUT
INS= 1 INDICATOR OF CROSS SECTIONAL INPUT
INU= 0 INDICATOR OF SYSTEM OF UNITS

JR  =        10 REACHES
JP  =        11 CROSS SECTIONS
NT  =        48 TIME STEPS
TST=       6.00 DAYS - TOTAL SIMULATION TIME
DTU=        .13 DAYS - TIME INTERVAL
DT  =    10800. SECONDS - TIME INTERVAL
THE=        .60 WEIGHTING FACTOR OF IMPLICIT SCHEME
SLD=    .000100 NORMAL WATER SURFACE SLOPE AT DOWNSTREAM SECTION FOR KINEMATIC BOUNDARY CONDITION
```

H Y D R A U L I C   A N D   C R O S S   S E C T I O N A L   P R O P E R T I E S

J	XA	XB	A1	B1	A2	B2	XN	DX	J
1	89.5414	.0218	179.0828	.0218	200.0000	0.0000	.0237	10000.	1
2	88.5496	.0221	179.0828	.0218	200.0000	0.0000	.0237	10000.	2
3	87.5580	.0223	179.0828	.0218	200.0000	0.0000	.0237	10000.	3
4	86.5665	.0225	179.0828	.0218	200.0000	0.0000	.0237	10000.	4
5	85.5752	.0227	179.0828	.0218	200.0000	0.0000	.0237	10000.	5
6	84.5840	.0230	179.0828	.0218	200.0000	0.0000	.0237	10000.	6
7	83.5931	.0232	179.0828	.0218	200.0000	0.0000	.0237	10000.	7
8	82.6023	.0234	179.0828	.0218	200.0000	0.0000	.0237	10000.	8
9	81.6117	.0237	179.0828	.0218	200.0000	0.0000	.0237	10000.	9
10	80.6213	.0239	179.0828	.0218	200.0000	0.0000	.0237	10000.	10
11	79.6311	.0242	179.0828	.0218	200.0000	0.0000	.0237	10000.	11

TIME STEP 0

J	DISCHARGE	AREA	STAGE	J	DISCHARGE	AREA	STAGE	J	DISCHARGE	AREA	STAGE
1	200.0000	337.7160	101.6591	6	200.0000	337.7160	96.7041	9	200.0000	337.7160	93.6869
2	200.0000	337.7160	100.7088	7	200.0000	337.7160	95.6826	10	200.0000	337.7160	92.6578
3	200.0000	337.7160	99.6971	8	200.0000	337.7160	94.6586	11	200.0000	337.7160	91.6798
4	200.0000	337.7160	98.6830								
5	200.0000	337.7160	97.6666								

Fig. 5 Program DYNA, Example B: Sample of Output

TIME STEP 4

J	DISCHARGE	AREA	STAGE	J	DISCHARGE	AREA	STAGE	J	DISCHARGE	AREA	STAGE
1	400.0000	497.0843	102.5194	6	215.4466	346.2029	96.7593	9	201.7914	337.0580	93.6826
2	339.5924	442.2626	101.3109	7	206.1979	341.2956	95.7060	10	200.4924	340.0428	92.6730
3	288.0708	402.4426	100.0877	8	204.2441	342.5082	94.6899	11	200.7208	338.4367	91.6845
4	251.6169	374.9066	98.9152								
5	228.8204	361.7675	97.8192								

TIME STEP 8

J	DISCHARGE	AREA	STAGE	J	DISCHARGE	AREA	STAGE	J	DISCHARGE	AREA	STAGE
1	800.0000	773.2719	103.5117	6	463.4402	532.8558	97.7238	9	283.4947	398.6947	94.0562
2	743.1131	723.1073	102.4177	7	391.0764	479.9379	96.4659	10	251.7853	379.0669	92.9140
3	680.8760	682.3695	101.2732	8	330.0818	440.4387	95.2487	11	229.2041	366.8884	91.8638
4	613.0089	636.6277	100.1007								
5	539.4408	595.8860	98.9337								

TIME STEP 12

J	DISCHARGE	AREA	STAGE	J	DISCHARGE	AREA	STAGE	J	DISCHARGE	AREA	STAGE
1	1000.0000	904.7885	103.8668	6	882.7426	807.5275	98.6627	9	716.1213	699.4021	95.3175
2	990.8596	880.0570	102.8633	7	836.3793	778.1631	97.5536	10	641.7489	660.6761	94.1559
3	974.9460	868.4184	101.8192	8	780.6478	754.0657	96.4547	11	557.3054	627.7896	93.0657
4	951.9039	853.8318	100.7641								
5	921.0953	846.9370	99.7264								

TIME STEP 16

J	DISCHARGE	AREA	STAGE	J	DISCHARGE	AREA	STAGE	J	DISCHARGE	AREA	STAGE

Fig. 5 (continued)

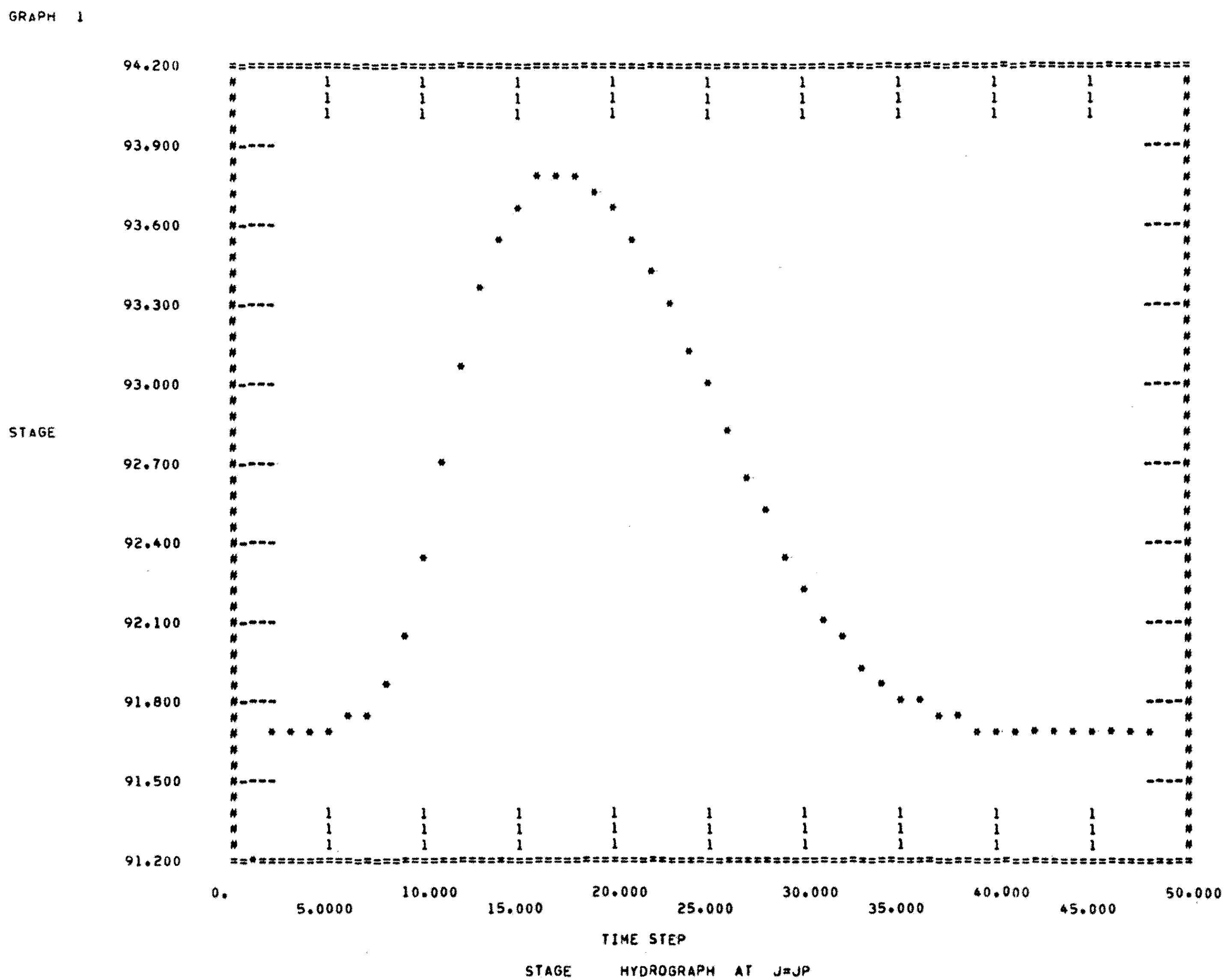

Fig. 5 (continued)

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****************************************************************************************************

                         DYNA----FLOOD ROUTING WITH A DYNAMIC WAVE MODEL

****************************************************************************************************

UNSTEADY FLOW IN OPEN CHANNELS: PROGRAM DYNA/ EXAMPLE C

JUNE 16-20, 1980

INB= 0 INDICATOR OF DOWNSTREAM BOUNDARY TYPE
INC= 1 INDICATOR OF CALENDAR CAPABILITY
IND= 1 INDICATOR OF INPUT DATA TYPE
INL= 0 INDICATOR OF LATERAL INFLOW
INP= 0 INDICATOR OF PLOTTED OUTPUT
INR= 0 INDICATOR OF TYPE OF PRINTED OUTPUT
INS= 1 INDICATOR OF CROSS SECTIONAL INPUT
INU= 0 INDICATOR OF SYSTEM OF UNITS

JR =        10 REACHES
JP =        11 CROSS SECTIONS
NT =        96 TIME STEPS
TST=      6.00 DAYS - TOTAL SIMULATION TIME
DTU=       .06 DAYS - TIME INTERVAL
DT =     5400. SECONDS - TIME INTERVAL
THE=       .60 WEIGHTING FACTOR OF IMPLICIT SCHEME
SLD=   .000100 NORMAL WATER SURFACE SLOPE AT DOWNSTREAM SECTION FOR KINEMATIC BOUNDARY CONDITION
```

H Y D R A U L I C   A N D   C R O S S   S E C T I O N A L   P R O P E R T I E S

J	XA	XB	A1	B1	A2	B2	XN	DX	J
1	89.5414	.0218	179.0828	.0218	200.0000	0.0000	.0237	10000.	1
2	88.5496	.0221	179.0828	.0218	200.0000	0.0000	.0237	10000.	2
3	87.5580	.0223	179.0828	.0218	200.0000	0.0000	.0237	10000.	3
4	86.5665	.0225	179.0828	.0218	200.0000	0.0000	.0237	10000.	4
5	85.5752	.0227	179.0828	.0218	200.0000	0.0000	.0237	10000.	5
6	84.5840	.0230	179.0828	.0218	200.0000	0.0000	.0237	10000.	6
7	83.5931	.0232	179.0828	.0218	200.0000	0.0000	.0237	10000.	7
8	82.6023	.0234	179.0828	.0218	200.0000	0.0000	.0237	10000.	8
9	81.6117	.0237	179.0828	.0218	200.0000	0.0000	.0237	10000.	9
10	80.6213	.0239	179.0828	.0218	200.0000	0.0000	.0237	10000.	10
11	79.6311	.0242	179.0828	.0218	200.0000	0.0000	.0237	10000.	11

TIME STEP 0 — CALENDAR TIME 80/06/16 12:00:00

J	DISTANCE	DISCHARGE	AREA	STAGE	VELOCITY	W.PERIMETER	TOP WIDTH	HYD.RADIUS	HYD.DEPTH	FROUDE NO	J
1	5000.0	200.000	337.716	101.6824	.5922	203.3182	200.0000	1.6610	1.5886	.15	1
2	15000.0	200.000	337.716	100.6824	.5922	203.3182	200.0000	1.6610	1.5886	.15	2
3	25000.0	200.000	337.716	99.6824	.5922	203.3182	200.0000	1.6610	1.5886	.15	3
4	35000.0	200.000	337.716	98.6824	.5922	203.3182	200.0000	1.6610	1.5886	.15	4
5	45000.0	200.000	337.716	97.6824	.5922	203.3182	200.0000	1.6610	1.5886	.15	5
6	55000.0	200.000	337.716	96.6824	.5922	203.3182	200.0000	1.6610	1.5886	.15	6
7	65000.0	200.000	337.716	95.6824	.5922	203.3182	200.0000	1.6610	1.5886	.15	7

Fig. 6 Program DYNA, Example C: Sample of Output

J	DISTANCE	DISCHARGE	AREA	STAGE	VELOCITY	W.PERIMETER	TOP WIDTH	HYD.RADIUS	HYD.DEPTH	FROUDE NO	J
9	85000.0	200.000	337.716	93.6824	.5922	203.3182	200.0000	1.6610	1.6886	.15	9
10	95000.0	200.000	337.716	92.6825	.5922	203.3182	200.0000	1.6610	1.6886	.15	10
11	105000.0	200.000	337.716	91.6825	.5922	203.3182	200.0000	1.6610	1.6886	.15	11

TIME STEP 8 CALENDAR TIME 80/06/17 00:00:00

J	DISTANCE	DISCHARGE	AREA	STAGE	VELOCITY	W.PERIMETER	TOP WIDTH	HYD.RADIUS	HYD.DEPTH	FROUDE NO	J
1	5000.0	400.000	488.663	102.5062	.8186	204.9624	200.0000	2.3842	2.4433	.17	1
2	15000.0	339.818	442.607	101.2848	.7678	204.5206	200.0000	2.1641	2.2130	.16	2
3	25000.0	288.396	402.886	100.0750	.7158	204.1018	200.0000	1.9739	2.0144	.16	3
4	35000.0	250.213	373.750	98.9078	.6695	203.7681	200.0000	1.8342	1.8687	.16	4
5	45000.0	225.701	355.588	97.7970	.6347	203.5469	200.0000	1.7470	1.7779	.15	5
6	55000.0	211.858	345.710	96.7344	.6128	203.4219	200.0000	1.6995	1.7285	.15	6
7	65000.0	204.878	340.936	95.7035	.6009	203.3603	200.0000	1.6765	1.7047	.15	7
8	75000.0	201.745	338.878	94.6901	.5953	203.3334	200.0000	1.6666	1.6944	.15	8
9	85000.0	200.495	338.090	93.6849	.5930	203.3231	200.0000	1.6628	1.6905	.15	9
10	95000.0	200.063	337.807	92.6831	.5922	203.3194	200.0000	1.6615	1.6890	.15	10
11	105000.0	199.918	337.632	91.6819	.5921	203.3171	200.0000	1.6606	1.6882	.15	11

TIME STEP 16 CALENDAR TIME 80/06/17 12:00:00

J	DISTANCE	DISCHARGE	AREA	STAGE	VELOCITY	W.PERIMETER	TOP WIDTH	HYD.RADIUS	HYD.DEPTH	FROUDE NO	J
1	5000.0	800.000	761.178	103.5032	1.0510	206.9523	200.0000	3.6780	3.8059	.17	1
2	15000.0	743.639	725.009	102.3932	1.0257	206.7328	200.0000	3.5070	3.6250	.17	2
3	25000.0	681.234	684.079	101.2621	.9958	206.4711	200.0000	3.3132	3.4204	.17	3
4	35000.0	613.100	638.273	100.1059	.9606	206.1593	200.0000	3.0960	3.1914	.17	4
5	45000.0	540.263	587.981	98.9213	.9188	205.7908	200.0000	2.8572	2.9399	.17	5
6	55000.0	465.145	534.659	97.7077	.8700	205.3648	200.0000	2.6035	2.6733	.17	6
7	65000.0	392.381	481.569	96.4734	.8148	204.8971	200.0000	2.3503	2.4078	.17	7
8	75000.0	328.657	433.970	95.2407	.7573	204.4328	200.0000	2.1228	2.1699	.16	8
9	85000.0	279.554	396.927	94.0417	.7043	204.0355	200.0000	1.9454	1.9846	.16	9
10	95000.0	246.185	371.298	92.8931	.6630	203.7388	200.0000	1.8224	1.8565	.16	10
11	105000.0	223.464	361.317	91.8325	.6185	203.6178	200.0000	1.7745	1.8066	.15	11

TIME STEP 24 CALENDAR TIME 80/06/18 00:00:00

J	DISTANCE	DISCHARGE	AREA	STAGE	VELOCITY	W.PERIMETER	TOP WIDTH	HYD.RADIUS	HYD.DEPTH	FROUDE NO	J

Fig. 6 (continued)

5. LIST OF SUBSCRIPTED VARIABLES

A	Flow area
A1	Coefficient a_1 in wetted perimeter-area ($p = a_1A^{b_1}$)
A2	Coefficient a_2 in top width-area ($w = a_2A^{b_2}$)
B1	Exponent b_1 in wetted perimeterarea ($p = a_1A^{b_1}$)
B2	Exponent b_2 in top width-area ($w = a_2A^{b_2}$)
CB	Matrix coefficient
CD	Matrix coefficient
CE	Matrix coefficient
CF	Matrix coefficient
CG	Matrix coefficient
CH	Matrix coefficient
CP	Right-hand side of continuity equation
CR	Right-hand side of momentum equation
CS	Internal array of double sweep algorithm
CT	Internal array of double sweep algorithm
DA	Change in flow area
DQ	Change in discharge
DX	Reach length
FR	Froude number
H	Auxiliary variable for backwater computations
HD	Hydraulic depth
HV	Auxiliary variable for backwater computations
KLI	Number of locations with lateral inflow
NP	Auxiliary variable for backwater computations
PE	Wetted perimeter

Q	Discharge
QI	Inflow discharge
QLI	Lateral inflow
RA	Hydraulic radius
RR	Range
SF	Friction slope
THEG	Auxiliary variable
TXA	Auxiliary variable
TXB	Auxiliary variable
TXC	Auxiliary variable
TXD	Auxiliary variable
TXE	Auxiliary variable
VE	Mean velocity
WD	Top width
XA	Coefficient a in stage-area ($y = aA^b$)
XB	Exponent b in stage-area ($y = aA^b$)
XC	Auxiliary variable
XD	Auxiliary variable
XN	Manning's n
XX	Abscissa of cross-section
XZ	Ordinate of cross-section
Y	Stage

6. PROGRAM LISTING

```
C*****************************************************************************
C*                                                                           *
C*                                                                           *
C*                              D  Y  N  A                                   *
C*                                                                           *
C*                                                                           *
C*****************************************************************************
C*                                                                           *
C*****DEVELOPED       ENGINEERING RESEARCH CENTER, COLORADO STATE            *
C*                    UNIVERSITY, FORT COLLINS, COLORADO 80523.              *
C*                                                                           *
C*****DESCRIPTION     DYNA IS A GENERALIZED COMPUTER PROGRAM FOR THE         *
C*                    COMPUTATION OF UNSTEADY FLOW IN OPEN CHANNELS USING    *
C*                    THE DYNAMIC WAVE MODEL.                                *
C*                                                                           *
C*****CORE USAGE      MAXIMUM NUMBER OF REACHES= 100                         *
C*                    MAXIMUM NUMBER OF TIME STEPS= 500                      *
C*                    CENTRAL MEMORY REQUIREMENTS= 120000 OCTAL.             *
C*                                                                           *
C*****VERSION         MK1, MAY 1980.                                         *
C*                                                                           *
C*****DISCLAIMER      THIS PROGRAM IS ACCEPTED AND USED BY THE RECIPIENT     *
C*                    UPON THE EXPRESS UNDERSTANDING THAT THE DEVELOPERS     *
C*                    MAKE NO WARRANTIES, EXPRESSED OR IMPLIED, CONCERNING   *
C*                    THE ACCURACY, COMPLETENESS, RELIABILITY OR SUITABILITY *
C*                    FOR ANY ONE PARTICULAR PURPOSE, AND THAT THE DEVELOPERS*
C*                    SHALL BE UNDER NO LIABILITY TO ANY PERSON BY REASON    *
C*                    OF ANY USE MADE THEREOF.                               *
C*                                                                           *
C*****SUBROUTINES     NAME  DESCRIPTION                                      *
C*                                                                           *
C*                    ARPE  HYDRAULIC VARIABLES AT A CROSS-SECTION           *
C*                    BACK  BACKWATER CURVE                                  *
C*                    BOUN  DOWNSTREAM BOUNDARY CONDITIONS                   *
C*                    CALE  CALENDAR TIME                                    *
C*                    COEF  MATRIX COEFFICIENTS                              *
C*                    COEL  LATERAL INFLOW                                   *
C*                    COME  HYDRAULIC CHARACTERISTICS AT A CROSS-SECTION     *
C*                    COMP  AUXILIARY COMPUTATION                            *
C*                    COOR  READS X-Z COORDINATES OF CROSS-SECTIONS          *
C*                    DOUB  DOUBLE SWEEP ALGORITHM                           *
C*                    HEAD  INPUT AND AUXILIARY CALCULATION                  *
C*                    HYCO  HYPOTHETICAL CONDITIONS                          *
C*                    INCO  INITIAL CONDITIONS                               *
C*                    PLOT  PLOTS OUTPUT                                     *
C*                    PRIC  PRINTS CROSS-SECTIONAL PROPERTIES                *
C*                    PRIN  PRINTS OUTPUT IN REDUCED FORM                    *
C*                    PRIX  PRINTS EXTENDED OUTPUT                           *
C*                    QTIM  READS INFLOW HYDROGRAPH AND LATERAL INFLOW DATA  *
C*                    REGR  LEAST SQUARE REGRESSION                          *
C*                    RELO  VARIABLE RELOCATION IN TIME                      *
C*                    VACE  AUXILIARY FOR BACKWATER COMPUTATIONS             *
C*                    VACO  AUXILIARY HYDRAULIC VARIABLE COMPUTATION         *
C*                                                                           *
C*****INDICATORS FOR PROGRAM CAPABILITIES                                    *
C*                                                                           *
C*                    NAME  DESCRIPTION                                      *
C*                                                                           *
C*                    INB   DOWNSTREAM BOUNDARY TYPE                         *
C*                            0= KINEMATIC WAVE BOUNDARY CONDITION           *
```

```
C*                    1= DIFFUSIVE WAVE BOUNDARY CONDITION                *
C*               INC    CALENDAR TIME CAPABILITY                          *
C*                        0= NO CALENDAR TIME                             *
C*                        1= CALENDAR TIME                                *
C*               IND    INPUT DATA TYPE                                   *
C*                        0= REAL CASE- NATURAL CHANNEL                   *
C*                        1= HYPOTHETICAL CASE- PRISMATIC CHANNEL         *
C*               INL    LATERAL INFLOW OPTION                             *
C*                        0= NO LATERAL INFLOW OPTION                     *
C*                        1= LATERAL INFLOW OPTION                        *
C*               INP    PLOTTED OUTPUT CAPABILITY                         *
C*                        0= NO PLOTTED OUTPUT OPTION                     *
C*                        1= PLOTTED OUTPUT OPTION                        *
C*               INR    PRINTED OUTPUT CAPABILITY                         *
C*                        0= EXTENDED PRINTED OUTPUT                      *
C*                        1= REDUCED PRINTED OUTPUT                       *
C*               INS    CROSS-SECTIONAL DATA INPUT                        *
C*                        0= INPUT OF CROSS-SECTIONAL X-Z COORDINATES     *
C*                        1= INPUT OF CROSS-SECTIONAL HYDRAULIC           *
C*                           CHARACTERISTICS                              *
C*               INU    SYSTEM OF UNITS                                   *
C*                        0= S.I. UNITS (METRIC)                          *
C*                        1= U.S. CUSTOMARY (LB-FT-SEC)                   *
C*                                                                        *
C*****INPUT DESCRIPTION                                                   *
C*                                                                        *
C*    CARD NUMBER   DESCRIPTION                                   FORMAT *
C*                                                                        *
C*    A     1       NAME OF RUN                                   40A2   *
C*                                                                        *
C*    B     1       DATE OF RUN                                   40A2   *
C*                                                                        *
C*    C     1       INPUT OF INDICATORS                           80I1   *
C*                                                                        *
C*    D     1       INPUT OF DISCRETIZATION DATA                         *
C*                  (IF(INC.EQ.0) NO NEED TO ENTER YEAR, MONTH, DAY,     *
C*                  HOUR, MIN, SEC)                                      *
C*                  JR,NT,NTP                                     3I5    *
C*                  TST,THE,SLD,RN                                4F10.0 *
C*                  YEAR,MONTH,DAY                                3I2    *
C*                  HOUR,MIN,SEC                                  3F5.0  *
C*                                                                        *
C*                  (IF(INS.EQ.0) READ CARDS E AND F, JP TIMES)(NOTE JP=JR+1) *
C*                                                                        *
C*    E     1       NUMBER OF POINTS DESCRIBING A CROSS SECTION   I10    *
C*                                                                        *
C*    F     NP/4    ABSCISSAS AND ORDINATES OF CROSS SECTION POINTS      *
C*                                                                        *
C*                  (IF(INS.EQ.0) READ CARDS G,H,AND I)                  *
C*                                                                        *
C*    G     JR/8    REACH LENGTH                                  8F10.0 *
C*                                                                        *
C*    H     JP/8    MANNING N                                     8F10.0 *
C*                                                                        *
C*    I     1       INITIAL VALUES FOR BACKWATER COMPUTATION      8F10.0 *
C*                                                                        *
C*                  (IF(INS.EQ.1 AND IND.EQ.0) READ CARD J)              *
C*                                                                        *
C*    J     JP      HYDRAULIC AND CROSS-SECTIONAL CHARACTERISTICS 8F10.0 *
C*                                                                        *
```

```
C*                 (IF(INS.EQ.1 AND IND.EQ.0) READ CARD K)                          *
C*                                                                                  *
C*    K      JP/4    INITIAL CONDITIONS                                    8F10.0   *
C*                                                                                  *
C*                 (IF(INS.EQ.1 AND IND.EQ.1) READ CARD L)                          *
C*                                                                                  *
C*    L       2      INPUT OF REFERENCE VALUES FOR HYPOTHETICAL PROBLEM    8F10.0   *
C*                                                                                  *
C*                 (IF(IND.EQ.0) READ CARD M)                                       *
C*                                                                                  *
C*    M      NT/8    UPSTREAM INFLOW DISCHARGE HYDROGRAPH                  8F10.0   *
C*                                                                                  *
C*                 (IF(IND.EQ.1) READ CARD N)                                       *
C*                                                                                  *
C*    N       1      CHARACTERISTICS OF HYPOTHETICAL INFLOW HYDROGRAPH     8F10.0   *
C*                                                                                  *
C*                 (IF(INL.EQ.1) READ CARD O)                                       *
C*                                                                                  *
C*    O       1      NUMBER OF REACHES WITH LATERAL INFLOW                 I10      *
C*                                                                                  *
C*                 (IF(INL.EQ.1) READ CARD P)                                       *
C*                                                                                  *
C*    P      NLI/8   REACH LOCATION WITH LATERAL INFLOW                    8I10     *
C*                                                                                  *
C*                 (IF(INL.EQ.1) READ CARD Q,NLI TIMES)                             *
C*                                                                                  *
C*    Q      NL/8    LATERAL INFLOW                                        8F10.0   *
C*                                                                                  *
C*****OUTPUT DESCRIPTION                                                            *
C*                                                                                  *
C*      IF(INR.EQ.0) CALL PRIX- EXTENDED OUTPUT                                     *
C*                              RANGE,DISCHARGE,FLOW AREA,STAGE,MEAN                *
C*                              VELOCITY,WETTED PERIMETER,TOP WIDTH,                *
C*                              HYDRAULIC RADIUS,HYDRAULIC DEPTH,                   *
C*                              FROUDE NUMBER.                                      *
C*                                                                                  *
C*      IF(INR.EQ.1) CALL PRIN- CONDENSED OUTPUT                                    *
C*                              DISCHARGE,FLOW AREA,STAGE.                          *
C*                                                                                  *
C***********************************************************************************
C
      PROGRAM DYNA (OUTPUT,TAPE6=OUTPUT,TAPE5)
      COMMON/A/ Q(101),DQ(101),A(101),DA(101),Y(101),QI(501)
      COMMON/B/ CA,CB(100),CC,CD(100),CE(100),CF(100),CG(100),CH(100)
      COMMON/C/ CP(100),CR(100),CS(101),CT(101)
      COMMON/D/ XA(101),XB(101),A1(101),B1(101),A2(101),B2(101)
      COMMON/E/ XN(101),DX(101),XC(101),XD(101),RR(101)
      COMMON/F/ VE(101),WD(101),HD(101),RA(101),PE(101),FR(101)
      COMMON/G/ XX(101,50),XZ(101,50)
      COMMON/H/ THEG(101),TXA(101),TXB(101),TXC(101),TXD(101),TXE(101)
      COMMON/I/ NLI,KLI(8),QLI(8,501)
      COMMON/J/ NP(101),HV(101),H(101),SF(101)
      COMMON/P/ INB,INC,IND,INL,INP,INR,INS,INJ
      COMMON/Q/ JR,JP,NT,NTP,TST,DTU,DT,THE,NL,SLD,RN
      COMMON/R/ GR,TMA,CMA,AL,BET,BES
      COMMON/S/ RUN(40),DATE(40)
      COMMON/T/ YEAR,MONTH,DAY,HOUR,MIN,SEC,IHOUR,IMIN,ISEC
      COMMON/U/ DIR,DDR
      COMMON/V/ PLN(500),QPL(500),QPLM,YPL(500),YPLM
      CALL HEAD
```

```
      CALL INCO                                                         DYNA 200
      CALL PRIC                                                         DYNA 210
      IF(INS.EQ.1) CALL VACO                                            DYNA 220
      CALL COMP                                                         DYNA 230
      IF(INR.EQ.0)CALL PRIX(0)                                          DYNA 240
      IF(INR.EQ.1)CALL PRIN(0)                                          DYNA 250
      CALL QTIM                                                         DYNA 260
      QPLM=0.                                                           DYNA 270
      YPLM=0.                                                           DYNA 280
      DO 10 N=1,NT                                                      DYNA 290
      IPR=MOD(N,NTP)                                                    DYNA 300
      IF(INC.EQ.1)CALL CALE(DT)                                         DYNA 310
      CALL COEF                                                         DYNA 320
      IF(INL.EQ.1)CALL COEL(N)                                          DYNA 330
      CALL DOUB(N)                                                      DYNA 340
      CALL RELO(N)                                                      DYNA 350
      IF(IPR.NE.0)GO TO 10                                              DYNA 360
      IF(INR.EQ.0)CALL PRIX(N)                                          DYNA 370
      IF(INR.EQ.1)CALL PRIN(N)                                          DYNA 380
   10 CONTINUE                                                          DYNA 390
      IF(INP.EQ.1) CALL PLOT(NT)                                        DYNA 400
      STOP                                                              DYNA 410
      END                                                               DYNA 420
```

```
C
      SUBROUTINE ARPE(L1,YT,AR,PR,WR)
      DIMENSION X(50),Z(50)
      COMMON/G/ XX(101,50),XZ(101,50)
      COMMON/J/ NP(101),HV(101),H(101),SF(101)
      N1=NP(L1)
      DO 10 K=1,N1
      X(K)=XX(L1,K)
   10 Z(K)=XZ(L1,K)
      DO 40 K=1,N1
      IF(Z(K)-YT)30,20,40
   20 N=K
      GO TO 50
   30 N=K-1
      X(N)=(Z(K-1)-YT)*(X(K)-X(K-1))/(Z(K-1)-Z(K))+X(K-1)
      Z(N)=YT
      GO TO 50
   40 CONTINUE
   50 CONTINUE
      DO 80 L=1,N1
      K=N1-L+1
      IF(Z(K)-YT)70,60,80
   60 M=K
      GO TO 90
   70 M=K+1
      X(M)=(YT-Z(K))*(X(K+1)-X(K))/(Z(K+1)-Z(K))+X(K)
      Z(M)=YT
      GO TO 90
   80 CONTINUE
   90 K=M-1
      AR=0.
      PR=0.
      DO 100 L=N,K
      AR=AR +((2.*Z(N)-Z(L+1)-Z(L))/2.0)*(X(L+1)-X(L))
  100 PR=PR +SQRT((Z(L)-Z(L+1))**2+(X(L+1)-X(L))**2)
      WR=X(M)-X(N)
      DO 110 K=1,N1
      X(K)=XX(L1,K)
  110 Z(K)=XZ(L1,K)
      RETURN
      END
```

```
C
      SUBROUTINE BACK
      COMMON/A/ Q(101),DQ(101),A(101),DA(101),Y(101),QI(501)
      COMMON/E/ XN(101),DX(101),XC(101),XD(101),RR(101)
      COMMON/F/ VE(101),WD(101),HD(101),RA(101),PE(101),FR(101)
      COMMON/G/ XX(101,50),XZ(101,50)
      COMMON/J/ NP(101),HV(101),H(101),SF(101)
      COMMON/Q/ JR,JP,NT,NTP,TST,DTJ,DT,THE,NL,SLD,RN
      COMMON/R/ GR,TMA,CMA,AL,BET,BES
      COMMON/U/ DIR,DDR
C
C**** CARD G- DX(J)= REACH LENGTH
C
      READ(5,100)(DX(J),J=1,JR)
C
C**** CARD H- XN(J)= MANNING  N
C
      READ(5,100)(XN(J),J=1,JP)
C
C**** CARD I- YT= DOWNSTREAM STAGE
C             QR= DOWNSTREAM DISCHARGE
C             DIR= INITIAL FLOW DEPTH FOR REGRESSION
C             DDR= FLOW DEPTH STEP INTERVAL
C
      READ(5,100)YT,QR,DIR,DDR
      DO 80 J=1,JP
      K=JP-J+1
      IF(J-1)20,20,30
   20 CALL ARPE(K,YT,AR,PR,WR)
      A(K)=AR
      PE(K)=PR
      WD(K)=WR
      CALL VACE(K,QR,YT)
      Y(K)=YT
      GO TO 80
   30 Y(K)=Y(K+1)+0.30
   40 YT=Y(K)
      CALL ARPE(K,YT,AR,PR,WR)
      A(K)=AR
      PE(K)=PR
      WD(K)=WR
      CALL VACE(K,QR,YT)
      SFM=(SF(K)+SF(K+1))/2.0
      HF=SFM*DX(K)
      HT=H(K+1)+HF
      IF(ABS(HT-H(K))-0.01)80,80,50
   50 HE=H(K)-HT
      FN=(2.0*HV(K))/RA(K)
      FA=(3.0*SF(K)*DX(K))/(2.0*RA(K))
      DY=ABS(HE/(1.0-FN+FA))
      IF(HT-H(K))60,80,70
   60 Y(K)=Y(K)-DY
      GO TO 40
   70 Y(K)=Y(K)+DY
      GO TO 40
   80 CONTINUE
      DO 90 J=1,JP
      HD(J)=A(J)/WD(J)
      FR(J)=VE(J)/(SQRT(GR*HD(J)))
      Q(J)=QR
   90 CONTINUE
  100 FORMAT(8F10.0)
      RETURN
      END
```

```
C
      SUBROUTINE BOUN
      COMMON/A/ Q(101),DQ(101),A(101),DA(101),Y(101),QI(501)
      COMMON/C/ CP(100),CR(100),CS(101),CT(101)
      COMMON/E/ XN(101),DX(101),XC(101),XD(101),RR(101)
      COMMON/P/ INB,INC,IND,INL,INP,INR,INS,INU
      COMMON/Q/ JR,JP,NT,NTP,TST,DTU,DT,THEW,NL,SLD,RN
      COMMON/R/ GR,TMA,CMA,AL,BET,BES
      SLOPE=SLD
      IF(INB.EQ.1)SLOPE=(ABS(Y(JR)-Y(JP))/DX(JR))
      ALP=AL*SQRT(SLOPE)
      DA(JP)=CT(JP)/(ALP*BET*A(JP)**BES-CS(JP))
      RETURN
      END
```

```
C
      SUBROUTINE CALE(TINT)
      COMMON/T/ YEAR,MONTH,DAY,HOUR,MIN,SEC,IHOUR,IMIN,ISEC
      INTEGER YEAR,MONTH,DAY,D,H,CHECK
      REAL HOUR,MIN,SEC
      ST= IHOUR*3600.+IMIN*60.+ISEC*1.+TINT
      H= ST/3600. +0.01
      D= H/24 +0.01
      IF(D.GT.0) GO TO 10
      IHOUR=H
      IMIN= (ST-H*3600.)/60.+0.01
      ISEC= ST-H*3600.-IMIN*60.+0.01
      RETURN
   10 DAY=DAY+D
      IF(DAY.GT.31 .AND. MONTH.EQ.1 .OR. DAY.GT.31 .AND. MONTH.EQ.3
     1.OR. DAY.GT.31 .AND. MONTH.EQ.5 .OR. DAY.GT.31 .AND. MONTH.EQ.7
     2.OR. DAY.GT.31 .AND. MONTH.EQ.8 .OR. DAY.GT.31 .AND. MONTH.EQ.10)
     3GO TO 30
      IF(DAY.GT.31 .AND. MONTH.EQ.12) GO TO 50
      IF(DAY.GT.30 .AND. MONTH.EQ.4 .OR. DAY.GT.30 .AND. MONTH.EQ.6 .OR.
     1DAY.GT.30 .AND. MONTH.EQ.9 .OR. DAY.GT.30 .AND. MONTH.EQ.11)GOTO60
      IF(DAY.GT.28 .AND. MONTH.EQ.2) GO TO 70
   20 IHOUR= (ST-D*86400.)/3600.+0.01
      IMIN= (ST-D*86400.-IHOUR*3600.)/60.+0.01
      ISEC= ST-D*86400.-IHOUR*3600.-IMIN*60.
      RETURN
   30 MONTH=MONTH+1
      IF(MONTH.GT.12) GO TO 50
      IF(MONTH.EQ.2) GO TO 40
      DAY=DAY-31
      IF(DAY.GT.31 .AND. MONTH.EQ.7) GO TO 30
      IF(DAY.GT.31 .AND. MONTH.NE.7) GO TO 60
      GO TO 20
   40 MONTH=MONTH-1
      GO TO 70
   50 YEAR=YEAR+1
      MONTH=1
      DAY=DAY-31
      IF(DAY.GT.31) GO TO 70
      GO TO 20
   60 MONTH=MONTH+1
      DAY=DAY-30
      IF(DAY.GT.30) GO TO 30
      GO TO 20
   70 CHECK=YEAR/4
      REST=FLOAT(YEAR)-CHECK*4.
      IF(REST.EQ.0.) GO TO 80
      MONTH=MONTH+1
      DAY=DAY-28
      GO TO 20
   80 IF(DAY.EQ.29) GO TO 20
      MONTH=MONTH+1
      DAY=DAY-29
      IF(DAY.GT.31) GO TO 60
      GO TO 20
      END
```

```
C
      SUBROUTINE COEF
      COMMON/A/ Q(101),DQ(101),A(101),DA(101),Y(101),QI(501)
      COMMON/B/ CA,CB(100),CC,CD(100),CE(100),CF(100),CG(100),CH(100)
      COMMON/C/ CP(100),CR(100),CS(101),CT(101)
      COMMON/D/ XA(101),XB(101),A1(101),B1(101),A2(101),32(101)
      COMMON/E/ XN(101),DX(101),XC(101),XD(101),RR(101)
      COMMON/H/ THEG(101),TXA(101),TXB(101),TXC(101),TXD(101),TXE(101)
      COMMON/Q/ JR,JP,NT,NTP,TST,DTU,DT,THE,NL,SLD,RN
      COMMON/R/ GR,TMA,CMA,AL,BET,BES
      DO 10 J=1,JR
      TAL=A(J)**XD(J)
      TAR=A(J+1)**XD(J+1)
      TEL=(1./A(J+1)+1./A(J))/(4.*GR*DT)
      TEF=Q(J+1)**2+Q(J)**2
      TEG=Q(J+1)**2-Q(J)**2
      TEH=1./A(J+1)**2+1./(A(J+1)*A(J))
      TEI=1./A(J)**2+1./(A(J+1)*A(J))
      CE(J)=0.25*TXE(J)*A(J)**TXD(J)*TEF-TXA(J)*A(J)**TX3(J)/DX(J)+THEG(
     1       J)*(2.*Q(J)**2/A(J)**3-TEG/(A(J)**2*A(J+1)))
      CF(J)=0.5*Q(J)*(TXC(J+1)*TAR+TXC(J)*TAL)-2.*THEG(J)*3(J)*TEI+TEL
      CG(J)=0.25*TXE(J+1)*A(J+1)**TXD(J+1)*TEF+TXA(J+1)*A(J+1)**TXB(J+1)
     1       /DX(J)+THEG(J)*(-2.*Q(J+1)**2/A(J+1)**3-TEG/(A(J+1)**2*A(J))
     2       )
      CH(J)=0.5*Q(J+1)*(TXC(J+1)*TAR+TXC(J)*TAL)+2.*THEG(J)*3(J+1)*TEH+T
     1       EL
      CP(J)=-DT/DX(J)*(Q(J+1)-Q(J))
      CR(J)=-0.25*TEF*(XC(J+1)*TAR+XC(J)*TAL)-(XA(J+1)*A(J+1)**XB(J+1)-X
     1       A(J)*A(J)**XB(J))/DX(J)-(THEG(J)/THE)*(Q(J+1)**2*TEH-Q(J)**2
     2       *TEI)
   10 CONTINUE
      RETURN
      END
```

```
C                                                                       DYNA2510
      SUBROUTINE COEL(N)                                                DYNA2520
      COMMON/C/ CP(100),CR(100),CS(101),CT(101)                         DYNA2530
      COMMON/E/ XN(101),DX(101),XC(101),XD(101),RR(101)                 DYNA2540
      COMMON/I/ NLI,KLI(8),QLI(8,501)                                   DYNA2550
      COMMON/Q/ JR,JP,NT,NTP,TST,DTU,DT,THE,NL,SLO,RN                   DYNA2560
      DO 30 J=1,JR                                                      DYNA2570
      DO 20 K=1,NLI                                                     DYNA2580
      IF(J-KLI(K))30,10,20                                              DYNA2590
   10 CP(J)=CP(J)+(DT/DX(J))*(QLI(K,N)+QLI(K,N+1))*0.5                  DYNA2600
   20 CONTINUE                                                          DYNA2610
   30 CONTINUE                                                          DYNA2620
      RETURN                                                            DYNA2630
      END                                                               DYNA2640
```

```
C
      SUBROUTINE COME
      DIMENSION YRF(10),ARF(10),PRF(10),WRF(10)
      COMMON/A/ Q(101),DQ(101),A(101),DA(101),Y(101),QI(501)
      COMMON/D/ XA(101),XB(101),A1(101),B1(101),A2(101),B2(101)
      COMMON/E/ XN(101),DX(101),XC(101),XD(101),RR(101)
      COMMON/F/ VE(101),WD(101),HD(101),RA(101),PE(101),FR(101)
      COMMON/G/ XX(101,50),XZ(101,50)
      COMMON/J/ NP(101),HV(101),H(101),SF(101)
      COMMON/Q/ JR,JP,NT,NTP,TST,DTU,DT,THE,NL,SLD,RN
      COMMON/R/ GR,TMA,CMA,AL,BET,BES
      COMMON/U/ DIR,DDR
      IF(DIR.EQ.0.) DIR=1.0
      IF(DDR.EQ.0.) DDR=1.0
      N=10
      DO 20 J=1,JP
      K=JP-J+1
      Z1=Y(K)-HD(K)
      D= DIR
      DO 10 L=1,N
      YT=Z1+D
      CALL ARPE(K,YT,AR,PR,WR)
      YRF(L)=YT
      ARF(L)=AR
      PRF(L)=PR
      WRF(L)=WR
      D= D+DDR
   10 CONTINUE
      CALL REGR(N,YRF,ARF,C1,C2)
      XA(K)=C1
      XB(K)=C2
      CALL REGR(N,PRF,ARF,C1,C2)
      A1(K)=C1
      B1(K)=C2
      CALL REGR(N,WRF,ARF,C1,C2)
      A2(K)=C1
      B2(K)=C2
      XC(K)=XN(K)**2*A1(K)**1.333/CMA
      XD(K)=(4.0*B1(K)-10.0)/3.0
   20 CONTINUE
  100 FORMAT(8F10.0)
      RETURN
      END
```

```
C                                                                   DYNA3080
      SUBROUTINE COMP                                               DYNA3090
      COMMON/B/ CA,CB(100),CC,CD(100),CE(100),CF(100),CG(100),CH(100) DYNA3100
      COMMON/D/ XA(101),XB(101),A1(101),B1(101),A2(101),B2(101)     DYNA3110
      COMMON/E/ XN(101),DX(101),XC(101),XD(101),RR(101)             DYNA3120
      COMMON/H/ THEG(101),TXA(101),TXB(101),TXC(101),TXD(101),TXE(101) DYNA3130
      COMMON/Q/ JR,JP,NT,NTP,TST,DTU,DT,THE,NL,SLD,RN               DYNA3140
      COMMON/R/ GR,TMA,CMA,AL,BET,BES                               DYNA3150
      CA=0.5                                                        DYNA3160
      CC=CA                                                         DYNA3170
      RR(1)=RN                                                      DYNA3180
      DO 10 J=1,JR                                                  DYNA3190
      CB(J)=-THE*DT/DX(J)                                           DYNA3200
      CD(J)=-CB(J)                                                  DYNA3210
      THEG(J)=THE/(2.*GR*DX(J))                                     DYNA3220
      K=J+1                                                         DYNA3230
      RR(K)=RR(J)+DX(J)                                             DYNA3240
   10 CONTINUE                                                      DYNA3250
      DO 20 J=1,JP                                                  DYNA3260
      TXA(J)=THE*XA(J)*XB(J)                                        DYNA3270
      TXB(J)=XB(J)-1                                                DYNA3280
      TXC(J)=THE*XC(J)                                              DYNA3290
      TXD(J)=XD(J)-1                                                DYNA3300
      TXE(J)=TXC(J)*XD(J)                                           DYNA3310
   20 CONTINUE                                                      DYNA3320
      AL=TMA/(XN(JP)*A1(JP)**0.666666)                              DYNA3330
      BET=(5.-2.*B1(JP))/3.0                                        DYNA3340
      BES=BET-1.                                                    DYNA3350
      RETURN                                                        DYNA3360
      END                                                           DYNA3370
```

```
C
      SUBROUTINE COOR
      COMMON/G/ XX(101,50),XZ(101,50)
      COMMON/J/ NP(101),HV(101),H(101),SF(101)
      COMMON/Q/ JR,JP,NT,NTP,TST,DTU,DT,THE,NL,SLO,RN
      DO 10 J=1,JP
C
C**** CARD E- NP= NUMBER OF POINTS DESCRIBING A CROSS SECTION.
C
      READ(5,100)NP(J)
      N1=NP(J)
C
C**** CARD F- XX(J,K)= ABSCISSA
C              XZ(J,K)= ORDINATE
C
   10 READ(5,200) ((XX(J,K),XZ(J,K)),K=1,N1)
  100 FORMAT(I10)
  200 FORMAT(8F10.0)
      RETURN
      END
```

```
C                                                                       DYNA3580
      SUBROUTINE DOUB(N)                                                DYNA3590
      COMMON/A/ Q(101),DQ(101),A(101),DA(101),Y(101),QI(501)            DYNA3600
      COMMON/B/ CA,CB(100),CC,CD(100),CE(100),CF(100),CG(100),CH(100)   DYNA3610
      COMMON/C/ CP(100),CR(100),CS(101),CT(101)                         DYNA3620
      COMMON/E/ XN(101),DX(101),XC(101),XD(101),RR(101)                 DYNA3630
      COMMON/P/ INB,INC,IND,INL,INP,INR,INS,INJ                         DYNA3640
      COMMON/Q/ JR,JP,NT,NTP,TST,DTU,DT,THE,NL,SLD,RN                   DYNA3650
      COMMON/R/ GR,TMA,CMA,AL,BET,BES                                   DYNA3660
      CS(1)=0.0                                                         DYNA3670
      CT(1)=QI(N)-Q(1)                                                  DYNA3680
      DO 10 J=1,JR                                                      DYNA3690
      U=(CE(J)+CF(J)*CS(J))/(CA+CB(J)*CS(J))                            DYNA3700
      T=1./(CH(J)-U*CD(J))                                              DYNA3710
      CS(J+1)=T*(U*CC-CG(J))                                            DYNA3720
      CT(J+1)=T*((CR(J)-CF(J)*CT(J))-U*(CP(J)-CB(J)*CT(J)))             DYNA3730
   10 CONTINUE                                                          DYNA3740
      CALL BOUN                                                         DYNA3750
      DQ(JP)=CS(JP)*DA(JP)+CT(JP)                                       DYNA3760
      DO 20 J=2,JP                                                      DYNA3770
      K=JP-J+1                                                          DYNA3780
      DA(K)=((CP(K)-CB(K)*CT(K))-(CC*DA(K+1)+CD(K)*DQ(K+1)))/(CA+CB(K)*CDYNA3790
     1S(K))                                                             DYNA3800
      DQ(K)=CS(K)*DA(K)+CT(K)                                           DYNA3810
   20 CONTINUE                                                          DYNA3820
      RETURN                                                            DYNA3830
      END                                                               DYNA3840
```

```
C
      SUBROUTINE HEAD
      COMMON/P/ INB,INC,IND,INL,INP,INR,INS,INU
      COMMON/Q/ JR,JP,NT,NTP,TST,DTU,DT,THE,NL,SLD,RN
      COMMON/R/ GR,TMA,CMA,AL,BET,BES
      COMMON/S/ RUN(40),DATE(40)
      COMMON/T/ YEAR,MONTH,DAY,HOUR,MIN,SEC,IHOUR,IMIN,ISEC
      INTEGER YEAR,MONTH,DAY
      REAL HOUR,MIN,SEC
      WRITE(6,100)
C
C**** CARD A- RUN(L)=NAME OF RUN
C
      READ(5,200)(RUN(L),L=1,40)
      WRITE(6,300)(RUN(L),L=1,40)
C
C**** CARD B- DATE(L)=DATE OF RUN
C
      READ(5,200)(DATE(L),L=1,40)
      WRITE(6,300)(DATE(L),L=1,40)
C
C**** CARD C- INDICATOR OPTIONS
C
      READ(5,400)INB,INC,IND,INL,INP,INR,INS,INU
      WRITE (6,500)INB,INC,IND,INL,INP,INR,INS,INU
      GR=9.81
      IF(INU.EQ.1)GR=32.17
      TMA=1.00
      IF(INU.EQ.1)TMA=1.486
      CMA=TMA*TMA
C
C**** CARD D- INPUT OF DISCRETIZATION DATA
C             JR=NUMBER OF REACHES
C             NT=NUMBER OF TIME STEPS
C             NTP=PRINTED OUTPUT EVERY NTP TIME STEPS
C             TST=TOTAL SIMULATION TIME,IN DAYS
C             THE=WEIGHTING FACTOR THETA
C             SLD=NORMAL WATER SURFACE SLOPE AT DOWNSTREAM SECTION FOR
C                 KINEMATIC BOUNDARY CONDITION
C             RN=RANGE
C             YEAR=YEAR OF CALENDAR DATA
C             MONTH=MONTH OF CALENDAR DATA
C             DAY=DAY OF CALENDAR DATA
C             HOUR=HOUR OF CALENDAR DATA
C             MIN=MINUTES OF CALENDAR DATA
C             SEC=SECONDS OF CALENDAR DATA
C
      READ(5,600)JR,NT,NTP,TST,THE,SLD,RN,YEAR,MONTH,DAY,HOUR,MIN,SEC
      IF(THE.LT.0.5) THE=0.6
      JP=JR+1
      NL=NT+1
      DTU=TST/FLOAT(NT)
      DT= DTU*86400.0
      IHOUR=HOUR
      IMIN=MIN
      ISEC=SEC
      WRITE(6,700)JR,JP,NT,TST,DTU,DT,THE,SLD
  100 FORMAT(1H1,2(/),132(1H*)//42X," DYNA----FLOOD ROUTING WITH A DYNAM
     1IC WAVE MODEL"//132(1H*)//)
  200 FORMAT(40A2)
  300 FORMAT(1X,40A2/)
  400 FORMAT(80I1)
  500 FORMAT(" INB=",I2," INDICATOR OF DOWNSTREAM BOUNDARY TYPE"/
     1       " INC=",I2," INDICATOR OF CALENDAR CAPABILITY"/
     2       " IND=",I2," INDICATOR OF INPUT DATA TYPE"/
     3       " INL=",I2," INDICATOR OF LATERAL INFLOW"/
     4       " INP=",I2," INDICATOR OF PLOTTED OUTPUT"/
     5       " INR=",I2," INDICATOR OF TYPE OF PRINTED OUTPUT"/
     6       " INS=",I2," INDICATOR OF CROSS SECTIONAL INPUT"/
     7       " INU=",I2," INDICATOR OF SYSTEM OF UNITS"/)
  600 FORMAT(3I5,4F10.0,3I2,3F5.0)
  700 FORMAT(" JR =",I10," REACHES"/
     1       " JP =",I10," CROSS SECTIONS"/
     2       " NT =",I10," TIME STEPS"/
     3       " TST=",F10.2," DAYS - TOTAL SIMULATION TIME"/
     4       " DTU=",F10.2," DAYS - TIME INTERVAL"/
     5       " DT =",F10.0," SECONDS - TIME INTERVAL"/
     6       " THE=",F10.2," WEIGHTING FACTOR OF IMPLICIT SCHEME"/
     7       " SLD=",F10.6," NORMAL WATER SURFACE SLOPE AT DOWNSTREAM SE
     8CTION FOR KINEMATIC BOUNDARY CONDITION"//)
      RETURN
      END
```

```
C                                                                       DYNA4670
      SUBROUTINE HYCO                                                   DYNA4680
      DIMENSION Y1(10),Z1(10)                                           DYNA4690
      COMMON/A/ Q(101),DQ(101),A(101),DA(101),Y(101),QI(501)            DYNA4700
      COMMON/D/ XA(101),XB(101),A1(101),B1(101),A2(101),B2(101)         DYNA4710
      COMMON/E/ XN(101),DX(101),XC(101),XD(101),RR(101)                 DYNA4720
      COMMON/F/ VE(101),WD(101),HD(101),RA(101),PE(101),FR(101)         DYNA4730
      COMMON/Q/ JR,JP,NT,NTP,TST,DTU,DT,THE,NL,SLD,RN                   DYNA4740
      COMMON/R/ GR,TMA,CMA,AL,BET,BES                                   DYNA4750
C                                                                       DYNA4760
C**** CARD L- INPUT OF REFERENCE VALUES FOR HYPOTHETICAL PROBLEM        DYNA4770
C              QRF= REFERENCE DISCHARGE                                 DYNA4780
C              ARF= REFERENCE FLOW AREA                                 DYNA4790
C              WRF= REFERENCE TOP WIDTH                                 DYNA4800
C              ZRF= BED ELEVATION OF UPSTREAM SECTION                   DYNA4810
C              A1RF= REFERENCE COEFFICIENT A1 IN WETTED PERIMETER-AREA  DYNA4820
C                    RELATION                                           DYNA4830
C              B1RF= REFERENCE EXPONENT B1 IN WETTED PERIMETER-AREA     DYNA4840
C                    RELATION                                           DYNA4850
C              A2RF= REFERENCE COEFFICIENT A2 IN TOP WIDTH-AREA RELATION DYNA4860
C              B2RF= REFERENCE EXPONENT IN TOPWIDTH-AREA RELATION       DYNA4870
C              XNRF= REFERENCE MANNING N                                DYNA4880
C              DXRF= REFERENCE CHANNEL REACH LENGTH                     DYNA4890
C               DIR= INITIAL FLOW DEPTH FOR REGRESSION                  DYNA4900
C               DDR= FLOW DEPTH STEP INTERVAL                           DYNA4910
C                                                                       DYNA4920
      READ(5,100)QRF,ARF,WRF,ZRF,A1RF,B1RF,A2RF,B2RF,XNRF,DXRF,DIR,DDR  DYNA4930
      DO 20 J=1,JP                                                      DYNA4940
      Q(J)=QRF                                                          DYNA4950
      A(J)=ARF                                                          DYNA4960
      WD(J)=WRF                                                         DYNA4970
      XN(J)=XNRF                                                        DYNA4980
      A1(J)=A1RF                                                        DYNA4990
      B1(J)=B1RF                                                        DYNA5000
      A2(J)=A2RF                                                        DYNA5010
      B2(J)=B2RF                                                        DYNA5020
      DX(J)=DXRF                                                        DYNA5030
   20 CONTINUE                                                          DYNA5040
      DO 30 J=1,JP                                                      DYNA5050
      XC(J)=XN(J)**2.*A1(J)**1.3333/CMA                                 DYNA5060
   30 XD(J)=(4.*B1(J)-10.0)/3.0                                         DYNA5070
      Z=ZRF                                                             DYNA5080
      N=10                                                              DYNA5090
      DO 50 J=1,JP                                                      DYNA5100
      D= DIR                                                            DYNA5110
      DO 40 K=1,N                                                       DYNA5120
      Y1(K)=Z+D                                                         DYNA5130
      Z1(K)=WRF*D                                                       DYNA5140
      D= D+DDR                                                          DYNA5150
   40 CONTINUE                                                          DYNA5160
      CALL REGR(N,Y1,Z1,C1,C2)                                          DYNA5170
      XA(J)=C1                                                          DYNA5180
      XB(J)=C2                                                          DYNA5190
      Y(J)=XA(J)*A(J)**XB(J)                                            DYNA5200
      Z=Z-SLD*DXRF                                                      DYNA5210
   50 CONTINUE                                                          DYNA5220
  100 FORMAT(8F10.0)                                                    DYNA5230
      RETURN                                                            DYNA5240
      END                                                               DYNA5250
```

```
C
      SUBROUTINE INCO
      COMMON/A/ Q(101),DQ(101),A(101),DA(101),Y(101),QI(501)
      COMMON/D/ XA(101),XB(101),A1(101),B1(101),A2(101),B2(101)
      COMMON/E/ XN(101),DX(101),XC(101),XD(101),RR(101)
      COMMON/F/ VE(101),WD(101),HD(101),RA(101),PE(101),FR(101)
      COMMON/G/ XX(101,50),XZ(101,50)
      COMMON/J/ NP(101),HV(101),H(101),SF(101)
      COMMON/P/ INB,INC,IND,INL,INP,INR,INS,INU
      COMMON/Q/ JR,JP,NT,NTP,TST,DTU,DT,THE,NL,SLD,RN
      COMMON/R/ GR,TMA,CMA,AL,BET,BES
      IF(INS.EQ.0)GO TO 30
      IF(IND.EQ.1)GO TO 40
C
C**** CARD J- HYDRAULIC AND CROSS SECTIONAL CHARACTERISTICS
C              XA(J)= COEFFICIENT A IN STAGE-AREA RELATION
C              XB(J)= EXPONENT B IN STAGE-AREA RELATION
C              A1(J)= COEFFICIENT A1 IN WETTED PERIMETER-AREA RELATION
C              B1(J)= EXPONENT B1 IN WETTED PERIMETER-AREA RELATION
C              A2(J)= COEFFICIENT A2 IN TOP WIDTH-AREA RELATION
C              B2(J)= EXPONENT B2 IN TOP WIDTH-AREA RELATION
C              XN(J)= MANNING  N
C              DX(J)= REACH LENGTH
C
      DO 10 J=1,JP
      READ(5,100)XA(J),XB(J),A1(J),B1(J),A2(J),B2(J),XN(J),DX(J)
      XC(J)=XN(J)**2*A1(J)**1.3333/CMA
      XD(J)=(4.0*B1(J)-10.0)/3.0
   10 CONTINUE
C
C**** CARD K- INITIAL CONDITIONS
C              Q(J)= DISCHARGE
C              A(J)= FLOW AREA
C
      READ(5,100)((Q(J),A(J),J=1,JP))
      DO 20 J=1,JP
   20 Y(J)=XA(J)*A(J)**XB(J)
      RETURN
   30 CONTINUE
      CALL COOR
      CALL BACK
      CALL COME
      RETURN
   40 CONTINUE
      CALL HYCO
  100 FORMAT(8F10.0)
      RETURN
      END
```

```
C                                                                       DYNA5740
      SUBROUTINE PLOT(NT)                                               DYNA5750
      COMMON/V/ PLN(500),QPL(500),QPLM,YPL(500),YPLM                    DYNA5760
      DIMENSION ITITLE(2),KTITLE(2),JTITLE(8),NTITLE(8)                 DYNA5770
      DATA ITITLE(1),ITITLE(2)/10HTIME STEP ,5HSTAGE/                   DYNA5780
      DATA KTITLE(1),KTITLE(2)/10HTIME STEP ,9HDISCHARGE/               DYNA5790
      DATA JTITLE/10HDISCHARGE ,10HHYDROGRAPH,10H  AT  J=JP,5*10H       DYNA5800
     1  /                                                               DYNA5810
      DATA NTITLE/10H  STAGE   ,10HHYDROGRAPH,10H  AT  J=JP,5*10H       DYNA5820
     1  /                                                               DYNA5830
      T=FLOAT(NT)                                                       DYNA5840
      CALL MAPA(5,PLN,YPL,1,NT,1.,T,YPL(1),YPLM,ITITLE(1),ITITLE(2),NTITDYNA5850
     1LE,1)                                                             DYNA5860
      CALL MAPA(5,PLN,QPL,1,NT,1.,T,QPL(1),QPLM,KTITLE(1),KTITLE(2),JTITDYNA5870
     1LE,1)                                                             DYNA5880
      RETURN                                                            DYNA5890
      END                                                               DYNA5900
```

```
C                                                                       DYNA5910
      SUBROUTINE PRIC                                                   DYNA5920
      COMMON/D/ XA(101),XB(101),A1(101),B1(101),A2(101),B2(101)         DYNA5930
      COMMON/E/ XN(101),DX(101),XC(101),XD(101),RR(101)                 DYNA5940
      COMMON/Q/ JR,JP,NT,NTP,TST,DTU,DT,THE,NL,SLO,RN                   DYNA5950
      WRITE(6,400)                                                      DYNA5960
      WRITE(6,100)                                                      DYNA5970
      DO 10 J=1,JP                                                      DYNA5980
      WRITE(6,200)J,XA(J),XB(J),A1(J),B1(J),A2(J),B2(J),XN(J),DX(J),J   DYNA5990
   10 CONTINUE                                                          DYNA6000
      WRITE(6,300)                                                      DYNA6010
  100 FORMAT(1X,116(1H-)/1X,"  J         XA            XB            A1 DYNA6020
     1       B1            A2           B2            XN           DX   DYNA6030
     2      J "/1X,116(1H-)/)                                           DYNA6040
  200 FORMAT(1X,I3,2F11.4,F15.4,F12.4,F16.4,2F13.4,F14.0,I7)            DYNA6050
  300 FORMAT(1X,116(1H-)/)                                              DYNA6060
  400 FORMAT(20X,"H Y D R A U L I C   A N D   C R O S S   S E C T I O N A LDYNA6070
     1 P R O P E R T I E S" /)                                          DYNA6080
      RETURN                                                            DYNA6090
      END                                                               DYNA6100
```

```
C
      SUBROUTINE PRIN(N)
      COMMON/A/ Q(101),DQ(101),A(101),DA(101),Y(101),QI(501)
      COMMON/B/ CA,CB(100),CC,CD(100),CE(100),CF(100),CG(100),CH(100)
      COMMON/P/ INB,INC,IND,INL,INP,INR,INS,INU
      COMMON/Q/ JR,JP,NT,NTP,TST,DTU,DT,THEW,NL,SLO,RN
      COMMON/T/ YEAR,MONTH,DAY,HOUR,MIN,SEC,IHOUR,IMIN,ISEC
      IF(INC.NE.1)GO TO 10
      WRITE(6,400)N,YEAR,MONTH,DAY,IHOUR,IMIN,ISEC
      GO TO 20
   10 WRITE(6,150)N
   20 I=0
      IF((JP/3*3)-JP)40,30,40
   30 K=0
      I=0
      GO TO 70
   40 IF(((JP-1)/3*3)-(JP-1))50,60,50
   50 I=-1
      K=2
      GO TO 70
   60 I=1
      K=1
   70 L1=JP/3
      J1=L1+K
      J2=2*L1+K
      DO 80 J=1,L1
      N1=J1+J
      N2=J2+J
      WRITE(6,200)J,Q(J),A(J),Y(J),N1,Q(N1),A(N1),Y(N1),N2,Q(N2),A(N2),Y
     1(N2)
   80 CONTINUE
      IF(I)90,130,100
   90 K=2
      GO TO 110
  100 K=1
  110 L2=L1+K
      L1=L1+1
      DO 120 K=L1,L2
  120 WRITE(6,200)K,Q(K),A(K),Y(K)
  130 WRITE(6,300)
  150 FORMAT(/"     TIME STEP  ",I3/1X,119(1H-)/"    J     DISCHARGE     A
     1REA      STAGE        J      DISCHARGE     AREA       STAGE       J
     2DISCHARGE     AREA       STAGE "/1X,119(1H-),//)
  200 FORMAT(3(I5,F14.4,2F10.4,1X))
  300 FORMAT(1X,119(1H-)/////)
  400 FORMAT(/"     TIME STEP  ",I3,65X,"CALENDAR TIME",2X,I2.2,"/",I2.2,
     1"/",I2.2,3X,I2.2,":",I2.2,":",I2.2/1X,119(1H-)/"      J     DISCHA
     2RGE     AREA       STAGE       J     DISCHARGE     AREA       STAGE
     3 J      DISCHARGE     AREA       STAGE "/1X,119(1H-),//)
      RETURN
      END
```

```
C
      SUBROUTINE PRIX(N)
      COMMON/A/ Q(101),DQ(101),A(101),DA(101),Y(101),QI(501)
      COMMON/E/ XN(101),DX(101),XC(101),XD(101),RR(101)
      COMMON/F/ VE(101),WD(101),HD(101),RA(101),PE(101),FR(101)
      COMMON/P/ INB,INC,IND,INL,INP,INR,INS,INU
      COMMON/Q/ JR,JP,NT,NTP,TST,DTU,DT,THE,NL,SLO,RN
      COMMON/T/ YEAR,MONTH,DAY,HOUR,MIN,SEC,IHOUR,IMIN,ISEC
      IF(INC.NE.1)GO TO 10
      WRITE(6,400)N,YEAR,MONTH,DAY,IHOUR,IMIN,ISEC
      GO TO 20
   10 WRITE(6,100)N
   20 CONTINUE
      DO 30 J=1,JP
      WRITE(6,200) J,RR(J),Q(J),A(J),Y(J),VE(J),PE(J),WD(J),RA(J),HD(J),
     1FR(J),J
   30 CONTINUE
      WRITE(6,300)
  100 FORMAT(/"     TIME STEP  ",I3/1X,131(1H-)/"    J    DISTANCE     DISCH
     1ARGE     AREA      STAGE     VELOCITY     W.PERIMETER     TOP WIDTH
     2 HYD.RADIUS     HYD.DEPTH     FROUDE NO     J"/1X,131(1H-),//)
  200 FORMAT(I4,F11.1,1X,2F11.3,F11.4,F9.4,4F14.4,F8.2,6X,I4)
  300 FORMAT(/1X,131(1H-),/////)
  400 FORMAT(/"     TIME STEP  ",I3,77X,"CALENDAR TIME",2X,I2.2,"/",I2.2,
     1"/",I2.2,3X,I2.2,":",I2.2,":",I2.2/1X,131(1H-)/  "    J    DISTANCE
     2  DISCHARGE      AREA       STAGE      VELOCITY     W.PERIMETER     TOP
     3WIDTH     HYD.RADIUS     HYD.DEPTH     FROUDE NO     J"/1X,131(1H-)//)
      RETURN
      END
```

```
C                                                                       DYNA6910
      SUBROUTINE QTIM                                                   DYNA6920
      COMMON/A/ Q(101),DQ(101),A(101),DA(101),Y(101),QI(501)            DYNA6930
      COMMON/I/ NLI,KLI(8),QLI(8,501)                                   DYNA6940
      COMMON/P/ INB,INC,IND,INL,INP,INR,INS,INU                         DYNA6950
      COMMON/Q/ JR,JP,NT,NTP,TST,DTU,DT,THE,NL,SLD,RN                   DYNA6960
      IF(IND.EQ.1)GO TO 20                                              DYNA6970
C                                                                       DYNA6980
C**** CARD M- UPSTREAM INFLOW DISCHARGE HYDROGRAPH (N=2,NL)              DYNA6990
C                                                                       DYNA7000
      READ(5,100)(QI(N),N=1,NT)                                         DYNA7010
      GO TO 60                                                          DYNA7020
C                                                                       DYNA7030
C**** CARD N- CHARACTERISTICS OF HYPOTHETICAL INFLOW HYDROGRAPH          DYNA7040
C             QP= PEAK DISCHARGE                                        DYNA7050
C             QB= BASE FLOW DISCHARGE                                   DYNA7060
C             TI= HYDROGRAPH DURATION,IN HOURS                          DYNA7070
C                                                                       DYNA7080
   20 READ(5,100)QP,QB,TI                                               DYNA7090
      C1=0.5*(QP+QB)                                                    DYNA7100
      C2=C1-QB                                                          DYNA7110
      DTH=DT/3600.                                                      DYNA7120
      TP=0.5*TI/DTH                                                     DYNA7130
      DO 50 N=1,NT                                                      DYNA7140
      COUNT=N                                                           DYNA7150
      VD=COUNT*DTH                                                      DYNA7160
      IF(VD-TI)30,30,40                                                 DYNA7170
   30 QI(N)=C1-C2*COS(N*3.1415930/TP)                                   DYNA7180
      GO TO 50                                                          DYNA7190
   40 QI(N)=QB                                                          DYNA7200
   50 CONTINUE                                                          DYNA7210
   60 CONTINUE                                                          DYNA7220
      IF(INL.EQ.0)RETURN                                                DYNA7230
C                                                                       DYNA7240
C**** CARD O- NUMBER OF REACHES WITH LATERAL INFLOW                      DYNA7250
C                                                                       DYNA7260
      READ(5,200)NLI                                                    DYNA7270
C                                                                       DYNA7280
C**** CARD P- REACH LOCATION WITH LATERAL INFLOW                         DYNA7290
C                                                                       DYNA7300
      READ(5,200)(KLI(K),K=1,NLI)                                       DYNA7310
C                                                                       DYNA7320
C**** CARD Q- LATERAL INFLOW                                             DYNA7330
C                                                                       DYNA7340
      DO 70 K=1,NLI                                                     DYNA7350
   70 READ(5,100)(QLI(K,N),N=1,NL)                                      DYNA7360
  100 FORMAT(8F10.0)                                                    DYNA7370
  200 FORMAT(8I10)                                                      DYNA7380
      RETURN                                                            DYNA7390
      END                                                               DYNA7400
```

```
C                                                                       DYNA7410
      SUBROUTINE REGR(N,X,Y,C1,C2)                                      DYNA7420
      DIMENSION X(10),Y(10)                                             DYNA7430
      SY=0.                                                             DYNA7440
      SA=0.                                                             DYNA7450
      S2=0.                                                             DYNA7460
      SP=0.                                                             DYNA7470
      DO 10 J=1,N                                                       DYNA7480
      YL=ALOG10(X(J))                                                   DYNA7490
      AR=ALOG10(Y(J))                                                   DYNA7500
      SY=SY+YL                                                          DYNA7510
      SA=SA+AR                                                          DYNA7520
      S2=S2+AR**2                                                       DYNA7530
      SP=SP+YL*AR                                                       DYNA7540
   10 CONTINUE                                                          DYNA7550
      C2=(N*SP-SY*SA)/(N*S2-SA**2)                                      DYNA7560
      YI=(SY-C2*SA)/FLOAT(N)                                            DYNA7570
      C1=10.0**YI                                                       DYNA7580
      RETURN                                                            DYNA7590
      END                                                               DYNA7600
```

```
C
      SUBROUTINE RELO(N)
      COMMON/A/ Q(101),DQ(101),A(101),DA(101),Y(101),QI(501)
      COMMON/D/ XA(101),XB(101),A1(101),B1(101),A2(101),B2(101)
      COMMON/F/ VE(101),WD(101),HD(101),RA(101),PE(101),FR(101)
      COMMON/P/ INB,INC,IND,INL,INP,INR,INS,INJ
      COMMON/Q/ JR,JP,NT,NTP,TST,DTU,DT,THE,NL,SLD,RN
      COMMON/R/ GR,TMA,CMA,AL,BET,BES
      COMMON/V/ PLN(500),QPL(500),QPLM,YPL(500),YPLM
      DO 20 J=1,JP
      Q(J)=Q(J)+DQ(J)
      A(J)=A(J)+DA(J)
      Y(J)=XA(J)*A(J)**XB(J)
   20 CONTINUE
      IF(INP.EQ.0) GO TO 30
      QPL(N)=Q(JP)
      YPL(N)=Y(JP)
      PLN(N)=FLOAT(N)
      IF(QPLM.LT.QPL(N)) QPLM=QPL(N)
      IF(YPLM.LT.YPL(N)) YPLM=YPL(N)
   30 CONTINUE
      IF(INR.EQ.1)RETURN
      CALL VACO
      RETURN
      END
```

```
C                                                                       DYNA7860
      SUBROUTINE VACE(J,QR,YT)                                          DYNA7870
      COMMON/A/ Q(101),DQ(101),A(101),DA(101),Y(101),QI(501)            DYNA7880
      COMMON/E/ XN(101),DX(101),XC(101),XD(101),RR(101)                 DYNA7890
      COMMON/F/ VE(101),WD(101),HD(101),RA(101),PE(101),FR(101)         DYNA7900
      COMMON/J/ NP(101),HV(101),H(101),SF(101)                          DYNA7910
      COMMON/R/ GR,TMA,CMA,AL,BET,BES                                   DYNA7920
      VE(J)=QR/A(J)                                                     DYNA7930
      HV(J)=VE(J)**2/(2.0*GR)                                           DYNA7940
      H(J)=HV(J)+YT                                                     DYNA7950
      RA(J)=A(J)/PE(J)                                                  DYNA7960
      SF(J)=(VE(J)**2*XN(J)**2)/(CMA*RA(J)**1.3333)                     DYNA7970
      RETURN                                                            DYNA7980
      END                                                               DYNA7990
```

```
C                                                                       DYNA8000
      SUBROUTINE VACO                                                   DYNA8010
      COMMON/A/ Q(101),DQ(101),A(101),DA(101),Y(101),QI(501)            DYNA8020
      COMMON/D/ XA(101),XB(101),A1(101),B1(101),A2(101),B2(101)         DYNA8030
      COMMON/F/ VE(101),WD(101),HD(101),RA(101),PE(101),FR(101)         DYNA8040
      COMMON/Q/ JR,JP,NT,NTP,TST,DTU,DT,THE,NL,SLD,RN                   DYNA8050
      COMMON/R/ GR,TMA,CMA,AL,BET,BES                                   DYNA8060
      DO 20 J=1,JP                                                      DYNA8070
      VE(J)=Q(J)/A(J)                                                   DYNA8080
      PE(J)=A1(J)*A(J)**B1(J)                                           DYNA8090
      WD(J)=A2(J)*A(J)**B2(J)                                           DYNA8100
      RA(J)=A(J)/PE(J)                                                  DYNA8110
      HD(J)=A(J)/WD(J)                                                  DYNA8120
      FR(J)=VE(J)/(SQRT(GR*HD(J)))                                      DYNA8130
   20 CONTINUE                                                          DYNA8140
      RETURN                                                            DYNA8150
      END                                                               DYNA8160
```

PROGRAM MUSK

1. INTRODUCTION

This program is intended for use in flood routing computations in natural and artificial channels. It is designed to be used primarily as a canned program, although maximum benefit can be obtained if the user has some familiarity with flood routing concepts.

The program is written in a modular structure, with a main program calling several subroutines to perform certain specific tasks. The modularity of the program provides for ease of modification, updating and improvement. The documentation given here is designed to help the user get familiar with the overall features of the program and its input-output requirements.

2. BRIEF DESCRIPTION OF THE MODEL

The unsteady flow model contained in program MUSK is a Muskingum-Cunge model, i.e., a model that uses the Muskingum method of flood routing in which the parameters K and X are calculated by using the formulas derived by Cunge. Program MUSK incorporates the feature of variable parameters, by using the three-point method of Ponce and Yevjevich. In this method, the parameters K and X (or C and D) are varied in time and space as a function of the flow variability. This enables an improved definition of the calculated discharge hydrograph.

3. PROGRAM FEATURES

MUSK has the following programming features:

(1) Maximum number of computational reaches = 100. Maximum number of time steps = 500. With these array sizes, the central memory requirements do not exceed 100,000 (octal).

(2) Seven (7) subroutines, each performing a specific function. The flow of information from main program to subroutines and between subroutines is done primarily by labeled common blocks. Large array common blocks are labeled A through E, and single variable P through S.

(3) Four (4) indicators for program capabilities. Each indicator can be either 0 or 1, depending on the user's choice. The choice of indicators determines the arrangement of the input file, as illustrated in the following section.

(5) For added convenience, the input-output is described in the source file by using comment cards.

(6) The input data can be given either in S.I. units (Kg-m-sec) or U.S. Customary (lb-ft-sec).

A brief explanation on the use of the indicators is given below:

INDC Calendar Time Capability

If INDC = 0, there is no capability for the calculation of calendar time, and no need to enter related data on card D. If INDC = 1, subroutine CALE will calculate the calendar time for each time step of the computation, given the initial data and time at t = 0, as read in card D.

INDL Lateral Inflow Option

If INDL = 0, no lateral inflow can be included in the computation. If INDL = 1, lateral inflow can be considered. The maximum number of reaches where lateral inflow can be specified is 8. (If necessary, this feature can be modified by increasing the size of labeled common block D and reformating cards J and K.)

INDP Plotted Output Capability

If INDP = 0, no plotted output capability. If INDP = 1 and INDS = 0, the discharge hydrograph at the downstream section will be plotted using the MAPA library routine. If INDP = 1 and INDS = 1, the discharge and stage hydrographs at the downstream section will be plotted.

INDS Stage Computation Capability

If INDS = 0, there is no stage computation capability. If INDS = 1, there is stage computation capability.

4. INPUT-OUTPUT EXAMPLES

Two examples are given to illustrate the use of program MUSK. The examples are detailed in Table 2.

Table 2
MUSK: ILLUSTRATIVE EXAMPLES

Example	INDC	INDL	INDP	INDS	INPUT	OUTPUT
A	0	0	0	0	Fig. 7	Fig. 9
B	1	1	1	1	Fig. 8	Fig. 10

5. LIST OF SUBSCRIPTED VARIABLES

AR Flow area

AL Coefficient α in discharge-area relation ($Q = \alpha A^{\beta}$)

A1 Coefficient a_1 in top width-area relation ($w = a_1 A^{b_1}$)

A2 Coefficient a_2 in stage-discharge relation ($y = a_2 Q^{b_2}$)

BE Exponent β in discharge-area relation ($Q = \alpha A^{\beta}$)

B1 Exponent b_1 in top width-area relation ($w = a_1 A^{b_1}$)

B2 Exponent b_2 in stage-discharge relation ($y = a_2 Q^{b_2}$)

```
''''/''''1''''/''''2''''/''''3''''/''''4''''/''''5''''/''''6''''/''''7''''/''''8

UNSTEADY FLOW IN OPEN CHANNELS: PROGRAM MUSK/ EXAMPLE A                      A
JUNE 16-20, 1980                                                             B
0000                                                                         C
   10   48    4      6.00                                                    D
0.01      1.67      200.      0.000     0.0001    10000.
0.01      1.67      200.      0.000     0.0001    10000.
0.01      1.67      200.      0.000     0.0001    10000.
0.01      1.67      200.      0.000     0.0001    10000.
0.01      1.67      200.      0.000     0.0001    10000.
0.01      1.67      200.      0.000     0.0001    10000.                       E
0.01      1.67      200.      0.000     0.0001    10000.
0.01      1.67      200.      0.000     0.0001    10000.
0.01      1.67      200.      0.000     0.0001    10000.
0.01      1.67      200.      0.000     0.0001    10000.
0.01      1.67      200.      0.000     0.0001    10000.
200.      200.      200.      200.      200.      200.      200.      200.     G
200.      200.      200.
213.63    253.59    317.157   400.      496.472   600.      703.528   800.
882.843   946.410   986.370   1000.     986.370   946.410   882.843   800.
703.527   600.      496.472   400.      317.157   253.59    213.63    200.     H
200.      200.      200.      200.      200.      200.      200.      200.
200.      200.      200.      200.      200.      200.      200.      200.
200.      200.      200.      200.      200.      200.      200.      200.

''''/''''1''''/''''2''''/''''3''''/''''4''''/''''5''''/''''6''''/''''7''''/''''8
```

Fig. 7 Program MUSK, Example A: Input

```
''''/''''1''''/''''2''''/''''3''''/''''4''''/''''5''''/''''6''''/''''7''''/''''8

UNSTEADY FLOW IN OPEN CHANNELS: PROGRAM MUSK/ EXAMPLE B                           A
JUNE 16-20, 1980                                                                  B
1111                                                                              C
   10    48    2      6.00   80    6    16        12.0      0.00      0.00        D
0.01      1.67      200.      0.000     0.0001    10000.    98.0      0.007
0.01      1.67      200.      0.000     0.0001    10000.    97.0      0.007
0.01      1.67      200.      0.000     0.0001    10000.    96.0      0.007
0.01      1.67      200.      0.000     0.0001    10000.    95.0      0.007
0.01      1.67      200.      0.000     0.0001    10000.    94.0      0.007
0.01      1.67      200.      0.000     0.0001    10000.    93.0      0.007       F
0.01      1.67      200.      0.000     0.0001    10000.    92.0      0.007
0.01      1.67      200.      0.000     0.0001    10000.    91.0      0.007
0.01      1.67      200.      0.000     0.0001    10000.    90.0      0.007
0.01      1.67      200.      0.000     0.0001    10000.    89.0      0.007
0.01      1.67      200.      0.000     0.0001    10000.    88.0      0.007
200.      200.      200.      200.      200.      200.      200.      200.0       G
200.      200.      200.
213.63    253.59    317.157   400.      496.472   600.      703.528   800.
882.843   946.410   986.370   1000.     986.370   946.410   882.843   800.
703.527   600.      496.472   400.      317.157   253.59    213.63    200.        H
200.      200.      200.      200.      200.      200.      200.      200.
200.      200.      200.      200.      200.      200.      200.      200.
200.      200.      200.      200.      200.      200.      200.      200.
         2                                                                        I
         3         7                                                              J
50.0      50.0      50.0      50.0      50.0      50.0      50.0      50.0
50.0      50.0      50.0      50.0      50.0      50.0      50.0      50.0
50.0      50.0      50.0      50.0      50.0      50.0      50.0      50.0
50.0      50.0      50.0      50.0      50.0      50.0      50.0      50.0
50.0      50.0      50.0      50.0      50.0      50.0      50.0      50.0
50.0      50.0      50.0      50.0      50.0      50.0      50.0      50.0        K
100.      100.      100.      100.      100.      100.      100.      100.
100.      100.      100.      100.      100.      100.      100.      100.
100.      100.      100.      100.      100.      100.      100.      100.
100.      100.      100.      100.      100.      100.      100.      100.
100.      100.      100.      100.      100.      100.      100.      100.
100.      100.      100.      100.      100.      100.      100.      100.

''''/''''1''''/''''2''''/''''3''''/''''4''''/''''5''''/''''6''''/''''7''''/''''8
```

Fig. 8 Program MUSK, Example B: Input

MUSK------MUSKINGUM-CUNGE FLOOD ROUTING METHOD WITH VARIABLE PARAMETERS

UNSTEADY FLOW IN OPEN CHANNELS: PROGRAM MUSK/ EXAMPLE A

JUNE 16-20, 1980

INDC= 0 INDICATOR CALENDAR TIME
INDL= 0 INDICATOR LATERAL INFLOW
INDP= 0 INDICATOR PLOTTED OUTPUT
INDS= 0 INDICATOR STAGE CALCULATION

JR = 10 REACHES
JP = 11 CROSS SECTIONS
NT = 48 TIME STEPS
NTP = 4 PRINTED OUTPUT EVERY NTP TIME STEPS
TST = 6.000 DAYS - TOTAL SIMULATION TIME
DT = .125 DAYS - TIME INTERVAL

HYDRAULIC AND CROSS SECTIONAL PROPERTIES

J	ALPHA	BETA	A1	B1	SLOPE	DX
1	.0100	1.6700	200.0000	0.0000	.0001	10000.0000
2	.0100	1.6700	200.0000	0.0000	.0001	10000.0000
3	.0100	1.6700	200.0000	0.0000	.0001	10000.0000
4	.0100	1.6700	200.0000	0.0000	.0001	10000.0000
5	.0100	1.6700	200.0000	0.0000	.0001	10000.0000
6	.0100	1.6700	200.0000	0.0000	.0001	10000.0000
7	.0100	1.6700	200.0000	0.0000	.0001	10000.0000
8	.0100	1.6700	200.0000	0.0000	.0001	10000.0000
9	.0100	1.6700	200.0000	0.0000	.0001	10000.0000
10	.0100	1.6700	200.0000	0.0000	.0001	10000.0000
11	.0100	1.6700	200.0000	0.0000	.0001	10000.0000

TIME STEP 0

J	DISCHARGE	AREA	T.WIDTH	J	DISCHARGE	AREA	T.WIDTH	J	DISCHARGE	AREA	T.WIDTH
1	200.0000	376.2418	200.0000	6	200.0000	376.2418	200.0000	9	200.0000	376.2418	200.0000
2	200.0000	376.2418	200.0000	7	200.0000	376.2418	200.0000	10	200.0000	376.2418	200.0000
3	200.0000	376.2418	200.0000	8	200.0000	376.2418	200.0000	11	200.0000	376.2418	200.0000
4	200.0000	376.2418	200.0000								
5	200.0000	376.2418	200.0000								

Fig. 9 Program MUSK, Example A: Sample of Output

TIME STEP 4

J	DISCHARGE	AREA	T.WIDTH	J	DISCHARGE	AREA	T.WIDTH	J	DISCHARGE	AREA	T.WIDTH
1	400.0000	569.8028	200.0000	6	213.3482	391.0830	200.0000	9	201.3608	377.7726	200.0000
2	337.5281	514.7102	200.0000	7	206.4257	383.4342	200.0000	10	200.6061	376.9241	200.0000
3	286.4379	466.5311	200.0000	8	202.9943	379.6047	200.0000	11	200.2655	376.5408	200.0000
4	249.7470	429.7676	200.0000								
5	226.5408	405.3892	200.0000								

TIME STEP 8

J	DISCHARGE	AREA	T.WIDTH	J	DISCHARGE	AREA	T.WIDTH	J	DISCHARGE	AREA	T.WIDTH
1	800.0000	862.9428	200.0000	6	442.3260	605.1761	200.0000	9	274.9274	455.2128	200.0000
2	735.8118	820.7891	200.0000	7	374.9213	548.1335	200.0000	10	244.7021	424.5480	200.0000
3	666.0820	773.2856	200.0000	8	318.2949	496.9415	200.0000	11	225.3706	404.1339	200.0000
4	592.0771	720.6287	200.0000								
5	516.2423	663.8470	200.0000								

TIME STEP 12

J	DISCHARGE	AREA	T.WIDTH	J	DISCHARGE	AREA	T.WIDTH	J	DISCHARGE	AREA	T.WIDTH
1	1000.0000	986.3067	200.0000	6	840.4220	888.7935	200.0000	9	647.7401	760.4634	200.0000
2	984.2331	976.9651	200.0000	7	783.6323	852.3269	200.0000	10	572.1998	706.0427	200.0000
3	960.5701	962.8316	200.0000	8	718.9855	809.4978	200.0000	11	495.8611	648.0266	200.0000
4	928.8435	943.6608	200.0000								
5	888.8456	919.1133	200.0000								

TIME STEP 16

J	DISCHARGE	AREA	T.WIDTH	J	DISCHARGE	AREA	T.WIDTH	J	DISCHARGE	AREA	T.WIDTH
1	800.0000	862.9428	200.0000	6	924.0241	940.7258	200.0000	9	902.7609	927.7027	200.0000
2	840.6098	888.9124	200.0000	7	925.2773	941.4896	200.0000	10	878.2286	912.5235	200.0000
3	873.1424	909.3552	200.0000	8	918.3098	937.2379	200.0000	11	844.3467	891.2765	200.0000
4	897.8504	924.6777	200.0000								

Fig. 9 (continued)

TIME STEP 20

J	DISCHARGE	AREA	T.WIDTH	J	DISCHARGE	AREA	T.WIDTH	J	DISCHARGE	AREA	T.WIDTH
1	400.0000	569.8028	200.0000	6	689.8073	789.6630	200.0000	9	797.7377	861.4808	200.0000
2	469.2448	626.9678	200.0000	7	731.3687	817.8177	200.0000	10	822.1285	877.1577	200.0000
3	532.6346	676.3901	200.0000	8	767.4029	841.7124	200.0000	11	840.2545	888.6874	200.0000
4	590.4464	719.4396	200.0000								
5	642.8223	757.0008	200.0000								

TIME STEP 24

J	DISCHARGE	AREA	T.WIDTH	J	DISCHARGE	AREA	T.WIDTH	J	DISCHARGE	AREA	T.WIDTH
1	200.0000	376.2418	200.0000	6	405.5321	574.5086	200.0000	9	543.7085	684.7761	200.0000
2	225.6975	404.4849	200.0000	7	453.1047	613.9639	200.0000	10	585.7863	716.0340	200.0000
3	264.6268	444.9218	200.0000	8	499.3406	650.7457	200.0000	11	625.2068	744.5099	200.0000
4	309.7404	488.9002	200.0000								
5	357.3626	532.6141	200.0000								

TIME STEP 28

J	DISCHARGE	AREA	T.WIDTH	J	DISCHARGE	AREA	T.WIDTH	J	DISCHARGE	AREA	T.WIDTH
1	200.0000	376.2418	200.0000	6	248.3112	428.2865	200.0000	9	339.9035	516.8762	200.0000
2	200.5248	376.8326	200.0000	7	275.3894	455.6706	200.0000	10	375.0437	548.2406	200.0000
3	203.4843	380.1532	200.0000	8	306.3503	485.6890	200.0000	11	411.0015	579.1359	200.0000
4	211.6189	389.1817	200.0000								
5	226.6206	405.4746	200.0000								

TIME STEP 32

J	DISCHARGE	AREA	T.WIDTH	J	DISCHARGE	AREA	T.WIDTH	J	DISCHARGE	AREA	T.WIDTH

Fig. 9 (continued)

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******************************************************************************************************************************

                          MUSK-------MUSKINGUM-CUNGE FLOOD ROUTING METHOD WITH VARIABLE PARAMETERS

******************************************************************************************************************************
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UNSTEADY FLOW IN OPEN CHANNELS: PROGRAM MUSK/ EXAMPLE B

JUNE 16-20, 1980

```
INDC= 1 INDICATOR CALENDAR TIME
INDL= 1 INDICATOR LATERAL INFLOW
INDP= 1 INDICATOR PLOTTED OUTPUT
INDS= 1 INDICATOR STAGE CALCULATION

JR  =        10 REACHES
JP  =        11 CROSS SECTIONS
NT  =        48 TIME STEPS
NTP =         2 PRINTED OUTPUT EVERY NTP TIME STEPS
TST =     6.000 DAYS - TOTAL SIMULATION TIME
DT  =      .125 DAYS - TIME INTERVAL
```

H Y D R A U L I C   A N D   C R O S S   S E C T I O N A L   P R O P E R T I E S

J	ALPHA	BETA	A1	B1	A2	B2	SLOPE	DX
1	.0100	1.6700	200.0000	0.0000	98.0000	.0070	.0001	10000.0000
2	.0100	1.6700	200.0000	0.0000	98.0000	.0070	.0001	10000.0000
3	.0100	1.6700	200.0000	0.0000	98.0000	.0070	.0001	10000.0000
4	.0100	1.6700	200.0000	0.0000	98.0000	.0070	.0001	10000.0000
5	.0100	1.6700	200.0000	0.0000	98.0000	.0070	.0001	10000.0000
6	.0100	1.6700	200.0000	0.0000	98.0000	.0070	.0001	10000.0000
7	.0100	1.6700	200.0000	0.0000	98.0000	.0070	.0001	10000.0000
8	.0100	1.6700	200.0000	0.0000	98.0000	.0070	.0001	10000.0000
9	.0100	1.6700	200.0000	0.0000	98.0000	.0070	.0001	10000.0000
10	.0100	1.6700	200.0000	0.0000	98.0000	.0070	.0001	10000.0000
11	.0100	1.6700	200.0000	0.0000	98.0000	.0070	.0001	10000.0000

TIME STEP 0 CALENDAR TIME 80/06/16 12:00:00

J	DISCHARGE	AREA	TOP WIDTH	STAGE	J	DISCHARGE	AREA	TOP WIDTH	STAGE
1	200.0000	376.2418	200.0000	101.7029	7	200.0000	376.2418	200.0000	101.7029
2	200.0000	376.2418	200.0000	101.7029	8	200.0000	376.2418	200.0000	101.7029
3	200.0000	376.2418	200.0000	101.7029	9	200.0000	376.2418	200.0000	101.7029
4	200.0000	376.2418	200.0000	101.7029	10	200.0000	376.2418	200.0000	101.7029
5	200.0000	376.2418	200.0000	101.7029	11	200.0000	376.2418	200.0000	101.7029
6	200.0000	376.2418	200.0000	101.7029					

TIME STEP 2 CALENDAR TIME 80/06/16 18:00:00

Fig. 10 Program MUSK, Example B: Sample of Output

J	DISCHARGE	AREA	TOP WIDTH	STAGE	J	DISCHARGE	AREA	TOP WIDTH	STAGE
1	253.5900	433.7154	200.0000	101.8720	7	207.2358	384.3346	200.0000	101.7282
2	225.3950	404.1601	200.0000	101.7880	8	289.0488	469.0728	200.0000	101.9654
3	211.1359	388.6495	200.0000	101.7415	9	258.8409	439.0709	200.0000	101.8867
4	247.6409	427.5938	200.0000	101.8551	10	231.3657	410.5373	200.0000	101.8067
5	230.2418	409.3421	200.0000	101.8032	11	214.8027	392.6773	200.0000	101.7537
6	215.6137	393.5643	200.0000	101.7564					

TIME STEP 4 CALENDAR TIME 80/06/17 00:00:00

J	DISCHARGE	AREA	TOP WIDTH	STAGE	J	DISCHARGE	AREA	TOP WIDTH	STAGE
1	400.0000	569.8028	200.0000	102.1976	7	234.7654	414.1390	200.0000	101.8171
2	337.5281	514.7102	200.0000	102.0761	8	319.9392	498.4770	200.0000	102.0379
3	286.4379	466.5311	200.0000	101.9589	9	304.0839	483.5342	200.0000	102.0016
4	299.6106	479.2622	200.0000	101.9910	10	283.5418	463.7007	200.0000	101.9517
5	273.5986	453.8939	200.0000	101.9262	11	260.5089	440.7630	200.0000	101.8912
6	252.3725	432.4673	200.0000	101.8686					

TIME STEP 6 CALENDAR TIME 80/06/17 06:00:00

J	DISCHARGE	AREA	TOP WIDTH	STAGE	J	DISCHARGE	AREA	TOP WIDTH	STAGE
1	600.0000	726.3876	200.0000	102.4880	7	295.7200	475.5258	200.0000	101.9817
2	526.8336	671.9692	200.0000	102.3948	8	367.6533	541.7457	200.0000	102.1372
3	453.8539	614.5716	200.0000	102.2880	9	346.4955	522.8556	200.0000	102.0949
4	436.5629	600.4421	200.0000	102.2601	10	327.0170	505.0514	200.0000	102.0535
5	379.8737	552.4576	200.0000	102.1606	11	307.0514	486.3543	200.0000	102.0085
6	333.0544	510.6143	200.0000	102.0666					

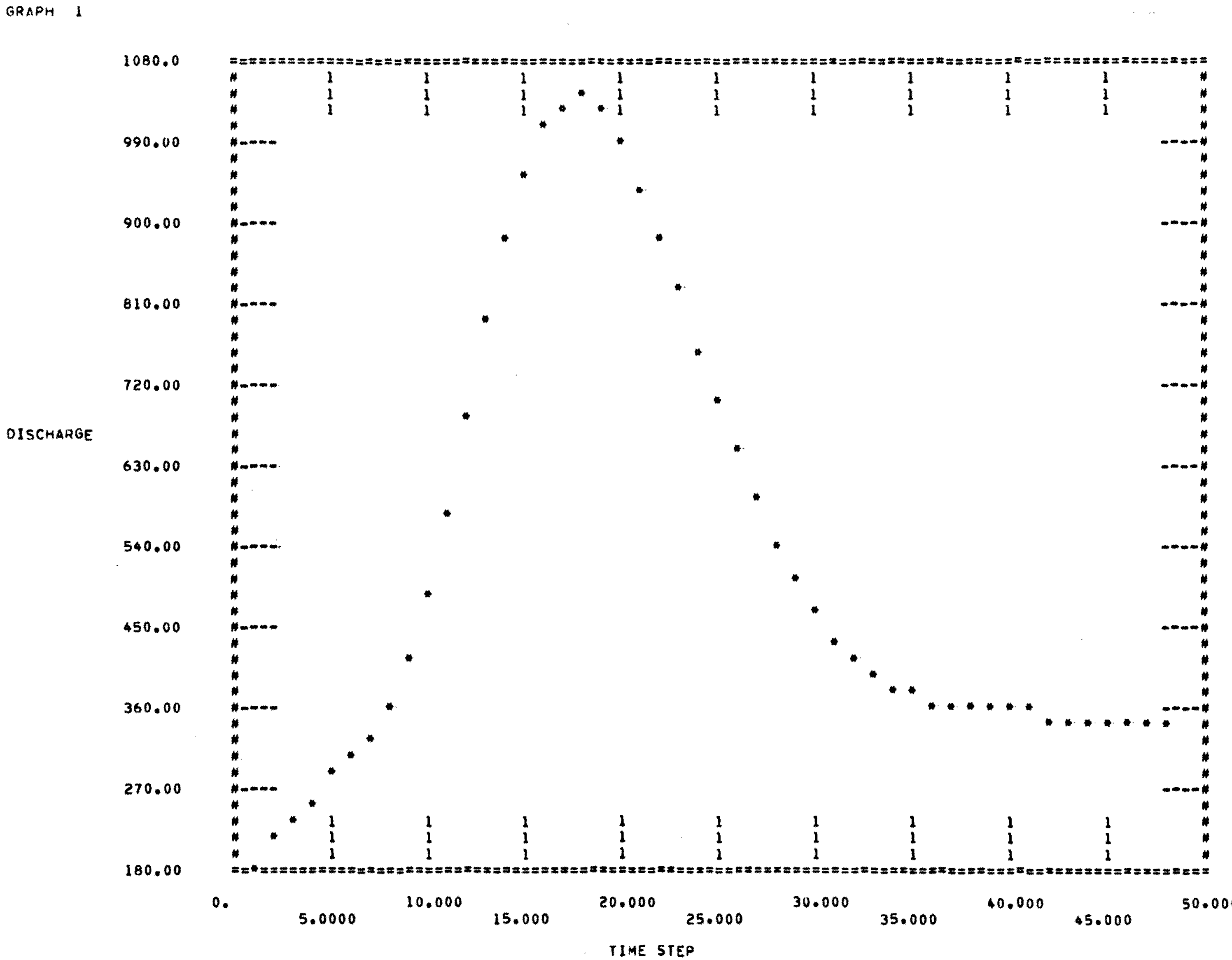
TIME STEP 8 CALENDAR TIME 80/06/17 12:00:00

J	DISCHARGE	AREA	TOP WIDTH	STAGE	J	DISCHARGE	AREA	TOP WIDTH	STAGE
1	800.0000	862.9428	200.0000	102.6946	7	434.3991	598.6583	200.0000	102.2566
2	735.8118	820.7891	200.0000	102.6345	8	478.6808	634.4871	200.0000	102.3261
3	666.0820	773.2856	200.0000	102.5630	9	434.8459	599.0269	200.0000	102.2573
4	643.1120	757.2051	200.0000	102.5378	10	398.4528	568.4820	200.0000	102.1948
5	570.5482	704.8217	200.0000	102.4519	11	367.8529	541.9218	200.0000	102.1376
6	499.9294	651.2051	200.0000	102.3572					

TIME STEP 10 CALENDAR TIME 80/06/17 18:00:00

J	DISCHARGE	AREA	TOP WIDTH	STAGE	J	DISCHARGE	AREA	TOP WIDTH	STAGE
1	946.4100	954.3072	200.0000	102.8155	7	642.3011	756.6333	200.0000	102.5369
2	903.2101	927.9791	200.0000	102.7819	8	671.1274	776.7878	200.0000	102.5684
3	852.6377	896.5068	200.0000	102.7404	9	605.4394	730.3237	200.0000	102.4945
4	845.2704	891.8602	200.0000	102.7342	10	544.4673	685.3481	200.0000	102.4184
5	782.3836	851.5134	200.0000	102.6786	11	489.7474	643.2304	200.0000	102.3425
6	714.1748	806.2501	200.0000	102.6131					

Fig. 10 (continued)



DISCHARGE HYDROGRAPH AT J=JP

Fig. 10 (continued)

DX	Reach length
KLI	Number of locations with lateral inflow
QD	Discharge
QI	Inflow discharge
PLN	Auxiliary array for plotting purposes
QLI	Lateral inflow discharge
QPL	Auxiliary array for plotting purposes
RBE	Auxiliary variable
SL	Average channel bed slope
ST	Stage
WT	Top width
YPL	Auxiliary array for plotting purposes

6. PROGRAM LISTING

```
C***********************************************************************
C*                                                                     *
C*                                                                     *
C*                              M  U  S  K                             *
C*                                                                     *
C*                                                                     *
C***********************************************************************
C*                                                                     *
C*****DEVELOPED       ENGINEERING RESEARCH CENTER, COLORADO STATE      *
C*                    UNIVERSITY, FORT COLLINS, COLORADO 80523.        *
C*                                                                     *
C*****DESCRIPTION     MUSK IS A GENERALIZED COMPUTER PROGRAM FOR THE   *
C*                    COMPUTATION OF FLOOD WAVES USING THE MUSKINGUM   *
C*                    METHOD. THE FLOOD ROUTING PARAMETERS ARE CALCULATED *
C*                    BY USING CUNGE"S FORMULAS.                       *
C*****CORE USAGE      CENTRAL MEMORY REQUIREMENTS= 100000 OCTAL        *
C*                                                                     *
C*                                                                     *
C*****VERSION         MK1, MAY 1980.                                   *
C*                                                                     *
C*****DISCLAIMER      THIS PROGRAM IS ACCEPTED AND USED BY THE RECIPIENT *
C*                    UPON THE EXPRESS UNDERSTANDING THAT THE DEVELOPERS *
C*                    MAKE NO WARRANTIES, EXPRESSED OR IMPLIED, CONCERNING *
C*                    THE ACCURACY, COMPLETENESS, RELIABILITY OR SUITABILITY *
C*                    FOR ANY ONE PARTICULAR PURPOSE, AND THAT THE DEVELOPERS *
C*                    SHALL BE UNDER NO LIABILITY TO ANY PERSON BY REASON *
C*                    OF ANY USE MADE THEREOF.                         *
C*                                                                     *
C*****SUBROUTINES     NAME  DESCRIPTION                                *
C*                                                                     *
C*                    CALE  CALENDAR TIME CALCULATION                  *
C*                    COMP  MAIN COMPUTATIONS                          *
C*                    INCO  INPUT OF INITIAL CONDITIONS                *
C*                    INDA  INPUT OF DATA                              *
C*                    PLOT  PLOTS OUTPUT                               *
C*                    PRIN  PRINT RESULTS WITHOUT STAGE CALCULATION    *
C*                    PRIX  PRINT RESULTS WITH STAGE CALCULATION       *
C*                                                                     *
C*****INDICATORS FOR PROGRAM OPTIONS                                   *
C*                                                                     *
C*                    NAME  DESCRIPTION                                *
C*                                                                     *
C*                    INDC  CALENDAR TIME OPTION                       *
C*                             0= NO CALENDAR TIME CAPABILITY          *
C*                             1= CALENDAR TIME CAPABILITY             *
C*                    INDL  LATERAL INFLOW OPTION                      *
C*                             0= NO LATERAL INFLOW CAPABILITY         *
C*                             1= LATERAL INFLOW CAPABILITY            *
C*                    INDP  PLOTTED OUTPUT OPTION                      *
C*                             0= NO PLOTTED OUTPUT CAPABILITY         *
C*                             1= PLOTTED OUTPUT CAPABILITY            *
C*                    INDS  STAGE COMPUTATION OPTION                   *
C*                             0= NO STAGE COMPUTATION CAPABILITY      *
C*                             1= STAGE COMPUTATION CAPABILITY         *
C*                                                                     *
C*****INPUT DESCRIPTION                                                *
C*                                                                     *
C*     CARD NUMBER    DESCRIPTION                               FORMAT *
C*                                                                     *
C*     A       1      NAME OF RUN                               40A2   *
```

```
C*                                                                            *
C*    B       1       DATE OF RUN                                     40A2    *
C*                                                                            *
C*    C       1       INPUT OF INDICATORS FOR PROGRAM OPTIONS         80I1    *
C*                                                                            *
C*    D       1       INPUT OF DISCRETIZATION DATA AND INITIAL TIME CALENDAR  *
C*                                                                            *
C*                    (IF(INDC.EQ.0) NO NEED TO ENTER YEAR,MONTH,DAY,         *
C*                    HOUR,MIN,SEC                                            *
C*                                                                            *
C*                    (JR,NT,NTP)                                     3I5     *
C*                    (TST)                                           F10.0   *
C*                    (YEAR,MONTH,DAY)                                3I5     *
C*                    (HOUR,MIN,SEC)                                  3F10.0  *
C*                                                                            *
C*                    (IF(INDS.EQ.0) READ CARD E, (JR+1) TIMES)               *
C*                                                                            *
C*    E      JR+1     HYDRAULIC AND CROSS-SECTIONAL CHARACTERISTICS   8F10.0  *
C*                    (AL(J),BE(J),A1(J),B1(J),SL(J),DX(J))                   *
C*                                                                            *
C*                    (IF(INDS.EQ.1) READ CARD F, (JR+1) TIMES)               *
C*                                                                            *
C*    F      JR+1     HYDRAULIC AND CROSS-SECTIONAL CHARACTERISTICS   8F10.0  *
C*                    AL(J),BE(J),A1(J),B1(J),SL(J),DX(J),A2(J),B2(J))        *
C*                                                                            *
C*    G   (JR+1)/8    INITIAL CONDITIONS                              8F10.0  *
C*                    (Q(J), J=1,(JR+1))                                      *
C*                                                                            *
C*    H      NT/8     BOUNDARY CONDITIONS                             8F10.0  *
C*                    (QI(N), N=1,NT)                                         *
C*                                                                            *
C*                    (IF(INDL.EQ.1) READ CARDS I,J, AND K                    *
C*                                                                            *
C*    I       1       NUMBER OF REACHES WITH LATERAL INFLOW, NLI      I10     *
C*                    (MAXIMUM NUMBER OF REACHES= 8)                          *
C*                                                                            *
C*    J       1       REACH LOCATION WITH LATERAL INFLOW              I10     *
C*                                                                            *
C*    K  NLI*(NT/8) LATERAL INFLOW                                    8F10.0  *
C*                                                                            *
C*****OUTPUT DESCRIPTION                                                      *
C*                                                                            *
C*    IF(INDS.EQ.0) CALL PRIN- DISCHARGE, FLOW AREA, TOP WIDTH                *
C*                                                                            *
C*    IF(INDS.EQ.1) CALL PRIS- DISCHARGE, FLOW AREA, TOP WIDTH, STAGE         *
C*                                                                            *
C*****NOTE            THIS PROGRAM CAN BE OPERATED IN S.I. UNITS(METRIC) OR   *
C*                    U.S. CUSTOMARY (LB-FT-SEC).                             *
C*                                                                            *
C******************************************************************************
C
      PROGRAM MUSK(OUTPUT,TAPE6=OUTPUT,TAPE5)
      COMMON/A/ QD(101,2),AR(101,2),WT(101,2)
      COMMON/B/ SL(101),DX(101),AL(101),BE(101),A1(101),B1(101),RBE(101)
      COMMON/C/ ST(101),A2(101),B2(101)
      COMMON/D/ QI(501),QLI(8,501),KLI(8)
      COMMON/E/ PLN(500),QPL(500),QPLM,YPL(500),YPLM
      COMMON/P/ INDL,INDS,INDP,INDC
      COMMON/Q/ JR,JP,NT,NL,DT,DTS,NLI,NN,NTP
      COMMON/R/ RUN(40),DATE(40)
```

```
      COMMON/S/ YEAR,MONTH,DAY,HOUR,MIN,SEC,IHOUR,IMIN,ISEC
      INTEGER YEAR,MONTH,DAY
      REAL MIN
      CALL INDA
      CALL INCO
      IF(INDS.EQ.0)CALL PRIN(0)
      IF(INDS.EQ.1)CALL PRIX(0)
      NN=2
      QPLM=0.0
      YPLM=0.0
      DO 10 N=1,NT
      IPR=MOD(N,NTP)
      CALL COMP(N)
      IF(INDC.EQ.1)CALL CALE(DTS)
      IF(IPR.NE.0)GO TO 10
      IF(INDS.EQ.0)CALL PRIN(N)
      IF(INDS.EQ.1)CALL PRIX(N)
   10 CONTINUE
      IF(INDP.EQ.1)CALL PLOT(NT)
      STOP
      END
```

```
C
      SUBROUTINE CALE(TINT)
      COMMON/S/ YEAR,MONTH,DAY,HOUR,MIN,SEC,IHOUR,IMIN,ISEC
      INTEGER YEAR,MONTH,DAY,D,H,CHECK
      REAL HOUR,MIN,SEC
      ST= IHOUR*3600.+IMIN*60.+ISEC*1.+TINT
      H= ST/3600. +0.01
      D= H/24 +0.01
      IF(D.GT.0) GO TO 10
      IHOUR=H
      IMIN= (ST-H*3600.)/60.+0.01
      ISEC= ST-H*3600.-IMIN*60.+0.01
      RETURN
   10 DAY=DAY+D
      IF(DAY.GT.31 .AND. MONTH.EQ.1 .OR. DAY.GT.31 .AND. MONTH.EQ.3
     1.OR. DAY.GT.31 .AND. MONTH.EQ.5 .OR. DAY.GT.31 .AND. MONTH.EQ.7
     2.OR. DAY.GT.31 .AND. MONTH.EQ.8 .OR. DAY.GT.31 .AND. MONTH.EQ.10)
     3GO TO 30
      IF(DAY.GT.31 .AND. MONTH.EQ.12) GO TO 50
      IF(DAY.GT.30 .AND. MONTH.EQ.4 .OR. DAY.GT.30 .AND. MONTH.EQ.6 .OR.
     1DAY.GT.30 .AND. MONTH.EQ.9 .OR. DAY.GT.30 .AND. MONTH.EQ.11)GOTO60
      IF(DAY.GT.28 .AND. MONTH.EQ.2) GO TO 70
   20 IHOUR= (ST-D*86400.)/3600.+0.01
      IMIN= (ST-D*86400.-IHOUR*3600.)/60.+0.01
      ISEC= ST-D*86400.-IHOUR*3600.-IMIN*60.
      RETURN
   30 MONTH=MONTH+1
      IF(MONTH.GT.12) GO TO 50
      IF(MONTH.EQ.2) GO TO 40
      DAY=DAY-31
      IF(DAY.GT.31 .AND. MONTH.EQ.7) GO TO 30
      IF(DAY.GT.31 .AND. MONTH.NE.7) GO TO 60
      GO TO 20
   40 MONTH=MONTH-1
      GO TO 70
   50 YEAR=YEAR+1
      MONTH=1
      DAY=DAY-31
      IF(DAY.GT.31) GO TO 70
      GO TO 20
   60 MONTH=MONTH+1
      DAY=DAY-30
      IF(DAY.GT.30) GO TO 30
      GO TO 20
   70 CHECK=YEAR/4
      REST=FLOAT(YEAR)-CHECK*4.
      IF(REST.EQ.0.) GO TO 80
      MONTH=MONTH+1
      DAY=DAY-28
      GO TO 20
   80 IF(DAY.EQ.29) GO TO 20
      MONTH=MONTH+1
      DAY=DAY-29
      IF(DAY.GT.31) GO TO 60
      GO TO 20
      END
```

```
C
      SUBROUTINE COMP(N)
      COMMON/A/ QD(101,2),AR(101,2),WT(101,2)
      COMMON/B/ SL(101),DX(101),AL(101),BE(101),A1(101),B1(101),RBE(101)
      COMMON/C/ ST(101),A2(101),B2(101)
      COMMON/D/ QI(501),QLI(8,501),KLI(8)
      COMMON/E/ PLN(500),QPL(500),QPLM,YPL(500),YPLM
      COMMON/P/ INDL,INDS,INDP,INDC
      COMMON/Q/ JR,JP,NT,NL,DT,DTS,NLI,NN,NTP
      QD(1,2)=QI(N)
      DO 30 J=1,JR
      AR(J,2)=(QD(J,2)/AL(J))**RBE(J)
      WT(J,2)=A1(J)*AR(J,2)**B1(J)
      QWAVE=0.3333*(QD(J,1)/WT(J,1)+QD(J+1,1)/WT(J+1,1)+QD(J,2)/WT(J,2))
      CEAVE=0.3333*(BE(J)*QD(J,1)/AR(J,1)+BE(J+1)*QD(J+1,1)/AR(J+1,1)
     1        +BE(J)*QD(J,2)/AR(J,2))
      C=CEAVE*DTS/DX(J)
      D=QWAVE/(SL(J)*CEAVE*DX(J))
      CD=1.+C+D
      C1=(1.+C-D)/CD
      C2=(-1.+C+D)/CD
      C3=(1.-C+D)/CD
      QD(J+1,2)=C1*QD(J,1)+C2*QD(J,2)+C3*QD(J+1,1)
      IF(INDL.EQ.0)GO TO 30
      DO 20 K=1,NLI
      IF(J-KLI(K))30,10,20
   10 QD(J+1,2)=QD(J+1,2)+(2.*C/CD)*QLI(K,N)
      GO TO 30
   20 CONTINUE
   30 CONTINUE
      IF(INDS.EQ.0)GO TO 50
      DO 40 J=1,JP
   40 ST(J)=A2(J)*QD(J,2)**B2(J)
   50 CONTINUE
      QPL(N)=QD(JP,2)
      IF(QPLM.LT.QPL(N))QPLM=QPL(N)
      IF(INDS.EQ.0)GO TO 60
      YPL(N)=ST(JP)
      IF(YPLM.LT.YPL(N))YPLM=YPL(N)
   60 CONTINUE
      PLN(N)=FLOAT(N)
      AR(JP,2)=(QD(JP,2)/AL(JP))**RBE(JP)
      WT(JP,2)=A1(JP)*AR(JP,2)**B1(JP)
      DO 70 J=1,JP
      QD(J,1)=QD(J,2)
      AR(J,1)=AR(J,2)
   70 WT(J,1)=WT(J,2)
      RETURN
      END
```

```
C
      SUBROUTINE INCO
      COMMON/A/ QD(101,2),AR(101,2),WT(101,2)
      COMMON/B/ SL(101),DX(101),AL(101),BE(101),A1(101),B1(101),RBE(101)
      COMMON/C/ ST(101),A2(101),B2(101)
      COMMON/D/ QI(501),QLI(8,501),KLI(8)
      COMMON/P/ INDL,INDS,INDP,INDC
      COMMON/Q/ JR,JP,NT,NL,DT,DTS,NLI,NN,NTP
      N=0
C
C**** CARD G- INITIAL CONDITIONS
C              (QD(J,1),J=1,JP)
C
      READ(5,100) (QD(J,1),J=1,JP)
C
C**** CARD H- BOUNDARY CONDITIONS
C              (QI(N),N=1,NT)
C
      READ(5,100) (QI(N),N=1,NT)
      IF(INDL.EQ.0)GO TO 20
C
C**** CARD I- NUMBER OF REACHES WITH LATERAL INFLOW
C
      READ(5,200)NLI
C
C**** CARD J- REACH LOCATION WITH LATERAL INFLOW
C
      READ(5,200) (KLI(K),K=1,NLI)
      DO 10 K=1,NLI
C
C**** CARD K- LATERAL INFLOW
C
   10 READ(5,100)  (QLI(K,N),N=1,NT)
   20 CONTINUE
      DO 30 J=1,JP
      RBE(J)=1./BE(J)
      AR(J,1)=(QD(J,1)/AL(J))**RBE(J)
   30 WT(J,1)=A1(J)*AR(J,1)**B1(J)
      IF(INDS.EQ.0)GO TO 50
      DO 40 J=1,JP
   40 ST(J)=A2(J)*QD(J,1)**B2(J)
   50 CONTINUE
  100 FORMAT(8F10.0)
  200 FORMAT(8I10)
      RETURN
      END
```

```
C
      SUBROUTINE INDA
      COMMON/B/ SL(101),DX(101),AL(101),BE(101),A1(101),B1(101),RBE(101)
      COMMON/C/ ST(101),A2(101),B2(101)
      COMMON/P/ INDL,INDS,INDP,INDC
      COMMON/Q/ JR,JP,NT,NL,DT,DTS,NLI,NN,NTP
      COMMON/R/ RUN(40),DATE(40)
      COMMON/S/ YEAR,MONTH,DAY,HOUR,MIN,SEC,IHOUR,IMIN,ISEC
      INTEGER YEAR,MONTH,DAY
      REAL MIN
C
C**** CARD A- RUN(L)= NAME OF RUN
C
      READ(5,100)(RUN(L),L=1,40)
C
C**** CARD B- DATE(L)= DATE OF RUN
C
      READ(5,100)(DATE(L),L=1,40)
      WRITE(6,300)(RUN(L),L=1,40),(DATE(L),L=1,40)
C
C**** CARD C- INPUT OF INDICATORS
C
      READ(5,200)INDC,INDL,INDP,INDS
C
C**** CARD D- INPUT OF DISCRETIZATION DATA
C              JR= NUMBER OF REACHES
C              NT= NUMBER OF TIME STEPS
C              NTP= PRINTED OUTPUT EVERY NTP TIME STEPS
C              TST= TOTAL SIMULATION TIME IN DAYS
C              YEAR= INITIAL YEAR FOR CALENDAR COMPUTATION
C              MONTH= INITIAL MONTH FOR CALENDAR COMPUTATION
C              DAY= INITIAL DAY FOR CALENDAR COMPUTATION
C              HOUR= INITIAL HOUR FOR CALENDAR COMPUTATION
C              MIN= INITIAL MINUTE FOR CALENDAR COMPUTATION
C              SEC= INITIAL SECOND FOR CALENDAR COMPUTATION
C
      READ(5,1100)JR,NT,NTP,TST,YEAR,MONTH,DAY,HOUR,MIN,SEC
      JP=JR+1
      DT=TST/FLOAT(NT)
      DTS=DT*86400.0
      WRITE(6,400)INDC,INDL,INDP,INDS,JR,JP,NT,NTP,TST,DT
      NL=NT+1
      IHOUR=HOUR
      IMIN=MIN
      ISEC=SEC
      IF(INDS.EQ.1)GO TO 20
      WRITE(6,500)
      DO 10 J=1,JP
C
C**** CARD E- HYDRAULIC AND CROSS SECTIONAL CHARACTERISTICS
C              AL(J)= COEFFICIENT ALPHA IN DISCHARGE-AREA RELATION
C              BE(J)= EXPONENT BETA IN DISCHARGE-AREA RELATION
C              A1(J)= COEFFICIENT A1 IN TOP WIDTH-AREA RELATION
C              B1(J)= EXPONENT B1 IN TOP WIDTH-AREA RELATION
C              SL(J)= AVERAGE CHANNEL BED SLOPE
C              DX(J)= REACH LENGTH
C
      READ(5,600)AL(J),BE(J),A1(J),B1(J),SL(J),DX(J)
   10 WRITE(6,700)J,AL(J),BE(J),A1(J),B1(J),SL(J),DX(J)
      WRITE(6,1000)
```

```
      GO TO 40
   20 WRITE(6,800)
      DO 30 J=1,JP
C
C**** CARD F- HYDRAULIC AND CROSS SECTIONAL CHARACTERISTICS
C             AL(J)= COEFFICIENT ALPHA IN DISCHARGE-AREA RELATION
C             BE(J)= EXPONENT BETA IN DISCHARGE-AREA RELATION
C             A1(J)= COEFFICIENT A1 IN TOP WIDTH-AREA RELATION
C             B1(J)= EXPONENT B1 IN TOP WIDTH-AREA RELATION
C             SL(J)= AVERAGE CHANNEL BED SLOPE
C             DX(J)= REACH LENGTH
C             A2(J)= COEFFICIENT A2 IN STAGE-DISCHARGE RELATION
C             B2(J)  EXPONENT B2 IN STAGE-DISCHARGE RELATION
C
      READ(5,600)AL(J),BE(J),A1(J),B1(J),SL(J),DX(J),A2(J),B2(J)
   30 WRITE(6,900)J,AL(J),BE(J),A1(J),B1(J),A2(J),B2(J),SL(J),DX(J)
      WRITE(6,1200)
   40 CONTINUE
  100 FORMAT(40A2)
  200 FORMAT(80I1)
  300 FORMAT(1H1,2(/),132(1H*)//30X" MUSK------MUSKINGUM-CUNGE FLOOD ROU
     1TING METHOD WITH VARIABLE PARAMETERS"//132(1H*)///1X40A2//1X40A2/)
  400 FORMAT(" INDC="I2" INDICATOR CALENDAR TIME"/
     1       " INDL="I2" INDICATOR LATERAL INFLOW"/
     2       " INDP="I2" INDICATOR PLOTTED OUTPUT"/
     3       " INDS="I2" INDICATOR STAGE CALCULATION"//
     4       " JR  ="I10" REACHES"/
     5       " JP  ="I10" CROSS SECTIONS"/
     6       " NT  ="I10" TIME STEPS"/
     7       " NTP ="I10" PRINTED OUTPUT EVERY NTP TIME STEPS"/
     8       " TST ="F10.3" DAYS - TOTAL SIMULATION TIME"/
     9       " DT  ="F10.3" DAYS - TIME INTERVAL"//)
  500 FORMAT(16X,"H Y D R A U L I C   A N D   C R O S S   S E C T I O N A L
     1 P R O P E R T I E S"//1X,123(1H-)/4X"J"18X"ALPHA"15X"BETA"16X"A1
     2"17X"B1"15X"SLOPE"15X"DX"/1X,123(1H-)/ )
  600 FORMAT(8F10.0)
  700 FORMAT(I5,3X,3F20.4,2F18.4,F19.4)
  800 FORMAT(23X,"H Y D R A U L I C   A N D   C R O S S   S E C T I O N A L
     1  P R O P E R T I E S"//1X,131(1H-)/4X"J"12X"ALPHA"11X"BETA"12X"A1
     2"13X"B1"13X"A2"13X"B2"11X"SLOPE"11X"DX"/1X,131(1H-)/ )
  900 FORMAT(I5,1X,3F16.4,F14.4,2F15.4,F14.4,F17.4)
 1000 FORMAT(1X,123(1H-)///)
 1100 FORMAT(3I5,F10.0,3I5,3F10.0)
 1200 FORMAT(1X,131(1H-)///)
      RETURN
      END
```

```
C
      SUBROUTINE PLOT(NT)
      COMMON/E/ PLN(500),QPL(500),QPLM,YPL(500),YPLM
      COMMON/P/ INDL,INDS,INDP,INDC
      DIMENSION ITITLE(2),KTITLE(2),JTITLE(8),NTITLE(8)
      DATA ITITLE(1),ITITLE(2)/10HTIME STEP ,5HSTAGE/
      DATA KTITLE(1),KTITLE(2)/10HTIME STEP ,9HDISCHARGE/
      DATA JTITLE/10HDISCHARGE ,10HHYDROGRAPH,10H   AT    J=JP,5*10H
     1   /
      DATA NTITLE/ 7HSTAGE    ,    10HHYDROGRAPH,10H   AT    J=JP,5*10H
     1   /
      T=FLOAT(NT)
      CALL MAPA(5,PLN,QPL,1,NT,1.,T,QPL(1),QPLM,KTITLE(1),KTITLE(2),JTIT
     1LE,1)
      IF(INDS.EQ.0)GO TO 10
      CALL MAPA(5,PLN,YPL,1,NT,1.,T,YPL(1),YPLM,ITITLE(1),ITITLE(2),NTIT
     1LE,1)
   10 RETURN
      END
```

```
C                                                                       MUSK3070
      SUBROUTINE PRIN(N)                                                MUSK3080
      COMMON/A/ QD(101,2),AR(101,2),WT(101,2)                           MUSK3090
      COMMON/P/ INDL,INDS,INDP,INDC                                     MUSK3100
      COMMON/Q/ JR,JP,NT,NL,DT,DTS,NLI,NN,NTP                           MUSK3110
      COMMON/S/ YEAR,MONTH,DAY,HOUR,MIN,SEC,IHOUR,IMIN,ISEC             MUSK3120
      INTEGER YEAR,MONTH,DAY                                            MUSK3130
      REAL MIN                                                          MUSK3140
      IF(INDC.NE.1)GO TO 10                                             MUSK3150
      WRITE(6,400)N,YEAR,MONTH,DAY,IHOUR,IMIN,ISEC                      MUSK3160
      GO TO 20                                                          MUSK3170
   10 WRITE(6,100)N                                                     MUSK3180
   20 I=0                                                               MUSK3190
      IF((JP/3*3)-JP)40,30,40                                           MUSK3200
   30 K=0                                                               MUSK3210
      I=0                                                               MUSK3220
      GO TO 70                                                          MUSK3230
   40 IF(((JP-1)/3*3)-(JP-1))50,60,50                                   MUSK3240
   50 I=-1                                                              MUSK3250
      K=2                                                               MUSK3260
      GO TO 70                                                          MUSK3270
   60 I=1                                                               MUSK3280
      K=1                                                               MUSK3290
   70 L1=JP/3                                                           MUSK3300
      J1=L1+K                                                           MUSK3310
      J2=2*L1+K                                                         MUSK3320
      DO 80 J=1,L1                                                      MUSK3330
      N1=J1+J                                                           MUSK3340
      N2=J2+J                                                           MUSK3350
      WRITE(6,200)J,QD(J,1),AR(J,1),WT(J,1),N1,QD(N1,1),AR(N1,1),WT(N1,1MUSK3360
     1),N2,QD(N2,1),AR(N2,1),WT(N2,1)                                   MUSK3370
   80 CONTINUE                                                          MUSK3380
      IF(I)90,140,110                                                   MUSK3390
   90 K=2                                                               MUSK3400
      GO TO 120                                                         MUSK3410
  110 K=1                                                               MUSK3420
  120 L2=L1+K                                                           MUSK3430
      L1=L1+1                                                           MUSK3440
      DO 130 K=L1,L2                                                    MUSK3450
  130 WRITE(6,200)K,QD(K,1),AR(K,1),WT(K,1)                             MUSK3460
  140 WRITE(6,300)                                                      MUSK3470
  100 FORMAT(/"     TIME STEP  ",I3/1X,119(1H-)/"     J     DISCHARGE    AMUSK3480
     1REA      T.WIDTH      J     DISCHARGE     AREA      T.WIDTH     J     MUSK3490
     2DISCHARGE     AREA      T.WIDTH"/1X,119(1H-),//)                  MUSK3500
  200 FORMAT(3(I5,F14.4,2F10.4,1X))                                     MUSK3510
  300 FORMAT(1X,119(1H-)//////)                                         MUSK3520
  400 FORMAT(/"     TIME STEP  ",I3,65X,"CALENDAR TIME"2X,I2.2,"/",I2.2,"MUSK3530
     1/",I2.2,3X,I2.2,":",I2.2,":",I2.2/1X,119(1H-)/"     J     DISCHARGEMUSK3540
     1     AREA      T.WIDTH      J     DISCHARGE     AREA      T.WIDTH_    JMUSK3550
     2     DISCHARGE     AREA      T.WIDTH"/1X,119(1H-),//)             MUSK3560
      RETURN                                                            MUSK3570
      END                                                               MUSK3580
```

```
C
      SUBROUTINE PRIX(N)
      COMMON/A/ QD(101,2),AR(101,2),WT(101,2)
      COMMON/C/ ST(101),A2(101),B2(101)
      COMMON/P/ INDL,INDS,INDP,INDC
      COMMON/Q/ JR,JP,NT,NL,DT,DTS,NLI,NN,NTP
      COMMON/S/ YEAR,MONTH,DAY,HOUR,MIN,SEC,IHOUR,IMIN,ISEC
      INTEGER YEAR,MONTH,DAY
      REAL MIN
      IF(INDC.NE.1)GO TO 10
      WRITE(6,400)N,YEAR,MONTH,DAY,IHOUR,IMIN,ISEC
      GO TO 20
   10 WRITE(6,100)N
   20 IF(JP/2*2-JP)30,40,40
   30 I=0
      L2=JP/2+1
      GO TO 50
   40 I=1
      L2=JP/2
   50 L1=JP/2
      DO 60 J=1,L1
      N1=L2+J
      WRITE(6,200)J,QD(J,1),AR(J,1),WT(J,1),ST(J),N1,QD(N1,1),AR(N1,1),W
     1T(N1,1),ST(N1)
   60 CONTINUE
      IF(I)70,70,80
   70 WRITE(6,200)L2,QD(L2,1),AR(L2,1),WT(L2,1),ST(L2)
   80 WRITE(6,300)
  100 FORMAT(4(/),4X,"TIME STEP ="I3/4X,117(1H-)/2X,2("     J      DISCHAR
     1GE       AREA        TOP WIDTH       STAGE     ")/4X,117(1H-),//)
  200 FORMAT(2X,2(I5,2X,2F12.4,F13.4,F14.4,2X))
  300 FORMAT(4X,117(1H-))
  400 FORMAT(/"     TIME STEP  ",I3,65X,"CALENDAR TIME"2X,I2.2,"/",I2.2,"
     1/",I2.2,3X,I2.2,":",I2.2,":",I2.2/4X,117(1H-)/2X,2("     J      DISC
     1HARGE       AREA        TOP WIDTH       STAGE     ")/4X,117(1H-),//)
      RETURN
      END
```