HYDROLOGIC ANALYSIS FOR A DISTRIBUTARY FLOW AREA: WASH 6a

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October 14, 1993

Prepared by:

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Registered Professional Engineer (Civil)
CERTIFICATE NO.
21680
DAVID W.
DUST
Date Signed 10-14-93
ARIZONA, U.S.A.

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CVL

Hydrologic Analysis
for a
Distributary Flow Area: Wash 6a

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1.0 Introduction

The purpose of this report is to present an approach for applying the HEC-1 computer model to a watershed with distributary-flow areas. The approach presented herein has been developed for a specific watershed located in northeast Phoenix and is not necessarily intended to be applicable to all watersheds with distributary-flow areas.

The watershed boundaries and HEC-1 schematic for Wash 6a are shown in Plate 1. Plate 1 shows the upper watershed area, which has strictly tributary flow patterns, and the lower watershed areas which exhibit both tributary and distributary flow patterns.

Plate 2 illustrates the lower portion of the watershed for Wash 6a, which was used to develop an approach for applying HEC-1 to distributary flow areas (DFAs). Wash 6a begins to exhibit significant distributary-flow characteristics approximately 4500 feet downstream of Scottsdale Road, as indicated in Plate 2. This distributary-flow pattern complicates the application HEC-1, since HEC-1 is typically applied to watersheds with a single main channel and strictly tributary flow patterns. Analysis of the numerous flow splits, within the distributary-flow network, with HEC-1 is impracticable. Yet, to delineate floodplains for the wash system it can be important to compute the runoff from the watershed areas within and adjacent to the distributary-flow network and to route these flows down the watershed.

2.0 Approach/Methodology

2.1 Summary

In general, the approach described herein for applying HEC-1 to watersheds with distributary-flow areas involves:

a) delineating watershed boundaries for a group of washes that emanate from a Primary Diffluence (PD as shown in Plates 1 and 2);

b) routing the hydrograph for the group of washes based on composite channel geometry; and

c) using critical depth and/or uniform flow analysis to evaluate flow splits within the channel system, flow splits for channels entering or exiting the group of washes, and water surface elevations in each of the washes.

Detailed discussion of item "C" is not presented in this report.

2.2 Watershed Boundary Delineation

Plate 2 shows schematically the flow network for Wash 6a, within the study reach. Plate 2 also shows watershed boundaries for Wash 6a consistent with the general approach described above. As shown in Plate 2, all of the washes emanating from the PDA for Wash 6a, and branches thereof, are included within the watershed boundaries. In the HEC-1 model, the group of washes emanating from the PDA are treated as a single channel in the hydrograph routings.

Identifying PDA's is an important aspect of this approach and not necessarily a simple task. In the report titled *Flood Hazards of Distributary-Flow Areas in Southwestern Arizona* (Hjalmarson and Kemna, 1991), the authors present a detailed procedure for identifying PDA's.

It is consistent with this approach to have isolated channels diverting flow into and out of the main watershed at specific locations. Within the study area, Plate 2 shows two locations where flow is diverted into Wash 6a from adjacent watersheds with distributary-flow patterns and one location where flow is diverted from Wash 6a. Hence, to compute hydrographs and peak discharge for Wash 6a, portions of the adjacent watersheds will also need to be evaluated with the same approach as Wash 6a, in order to compute the hydrographs for the flow diversions into Wash 6a.

It is also consistent with the approach presented herein to have significant tributary drainage basins. Within the study area, Wash 6a has two significant tributary basins that direct significant amounts of runoff to specific locations along Wash 6a.

2.3 Composite Channel Routings

The applicability of HEC-1 to a stable multi-channel system is dependent on the selected hydrograph routing methodology. The Normal Depth Hydrograph Routing option in HEC-1 is the methodology of choice by the local agencies and has therefore been selected for evaluation. The applicability of the Normal Depth Routing option to stable multi-channel systems was evaluated by comparing a computed hydrograph based on two individual channel routings with a single routing based on a "composite" channel section. The tests were performed using channel configurations based on detailed topographic mapping for Wash 6a.

The results of this analysis indicate that the "composite" channel routings can preserve the peak discharge, the time to peak, and the general hydrograph shape. However, it is important that the "composite" channel preserves the channel/overbank topwidths and the general flow depths of the individual channels. To preserve the multiple channel characteristics, it is important that the computed composite channel sections have: a) overbank and main channel topwidths equal to the sum of the overbank and main channel topwidths of the individual channel sections; and b) a main channel depth equal to the average main channel depth of the individual channel sections.

Two sets of HEC-1 output are given in Appendix A. One set of these output printouts presents the calculations corresponding to channel routings of two individual channels; while, the second presents the calculations corresponding to a composite

channel routing. As indicated in the HEC-1 printouts, the composite channel routing preserved the time to peak, the peak discharge, and the shape of the hydrograph.

2.4 Preliminary HEC-1 Model for Wash 6a

A preliminary HEC-1 model for Wash 6a is given in Appendix B. Plate 1 illustrates the HEC-1 schematic for the preliminary model for Wash 6a. The preliminary HEC-1 model has the following characteristics:

a) the upper watershed parameters (i.e., sub-basins 1430 and 1440) are identical to those submitted to FEMA by Water Resources and Associates (WRA) in February 1992 and were used by FEMA to generate the preliminary FIRM dated January 4, 1993;

b) the lower watershed parameters and routing parameters are consistent with those submitted by WRA in the aforementioned study;

c) composite channel configurations are used in normal depth routings R110 and R120; and

d) flow diversions into Wash 6a from Wash 5 and Washes 6b, c have not been evaluated.

3.0 Conclusions

The applicability of the approach, presented in this report, for using HEC-1 to compute hydrographs for watersheds with distributary channel patterns is dependent on the physical characteristics of the watercourse. The approach implicitly assumes that the distributary channel system is relatively stable. In addition, the use of composite channel geometry for hydrograph routings may only be adequate when:

a) the main channel depth, and consequently typical flow depths, of the individual channels do not vary significantly; and

b) the channel lengths, bed slopes, and appropriate roughness coefficients of the individual channels do not vary significantly.

The individual channels within Wash 6a are very similar in physical characteristics. Typical main channel depths vary from approximately 1.5 to 2.0 feet. The channel lengths, bed slopes, and roughness characteristics also do not vary significantly. Therefore, the study reach of Wash 6a does exhibit the physical characteristics required for the appropriate application of HEC-1 using composite channel routings.

4.0 References

Hjalmarson and Kemna, *Flood Hazards of Distributary-Flow Areas in Southwestern Area: U.S. Geological Survey: Water-Resources Investigation Report 91-4121*, U.S. Department of the Interior, December 1991.

APPENDIX A

COMPOSITE CHANNEL ROUTING TESTS

Summary of Test Results

	Left	Right	Composite	Comments
Bottom Width (BW)	20′	20′	40′	
Overbank Width (OBW)	150′	450′	600′	
Top Width (TW)	180	480′	650′	10′ narrow due to sideslopes
Depth (D)	2′	2′	2′	
Sideslope (z:1)	1	1	1	
Percent of Q_{100}	24%	76%	100%	
Station	R110		R110	
Q_{100} Peak	2683		2683	no difference
@ Time	4.42		4.42	no difference
Station	R110L	R110R	R110	
Q_{100}	626 cfs	2057	2683	
@ Time	4.42	4.42	4.42	
Max. Stage	2.69	3.07	2.97	
OB Depth	0.69	1.07	0.97	
Flow Areas in Channel	147.9 sf	526.6	666.9 sf	(7.6 sf short)
Q Before Routings				
Station	D110L	D110	C110	
Q_{100}	750	2376 cfs	3127 cfs	
@ Time	4.08	4.08	4.09	
Attenuation (cfs) (%)	124 cfs 16.5%	319 cfs 13.4%	444 cfs 14.2%	

```
****************************************
*                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
*            SEPTEMBER 1990            *
*             VERSION 4.0              *
*                                      *
*  RUN DATE  09/17/1993  TIME  09:18:31 *
*                                      *
****************************************
```

```
****************************************
*                                      *
*    U.S. ARMY CORPS OF ENGINEERS      *
*    HYDROLOGIC ENGINEERING CENTER     *
*          609 SECOND STREET           *
*       DAVIS, CALIFORNIA 95616        *
*           (916) 756-1104             *
*                                      *
****************************************
```

Composite Channel Routing

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X        XXXXX X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX         XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

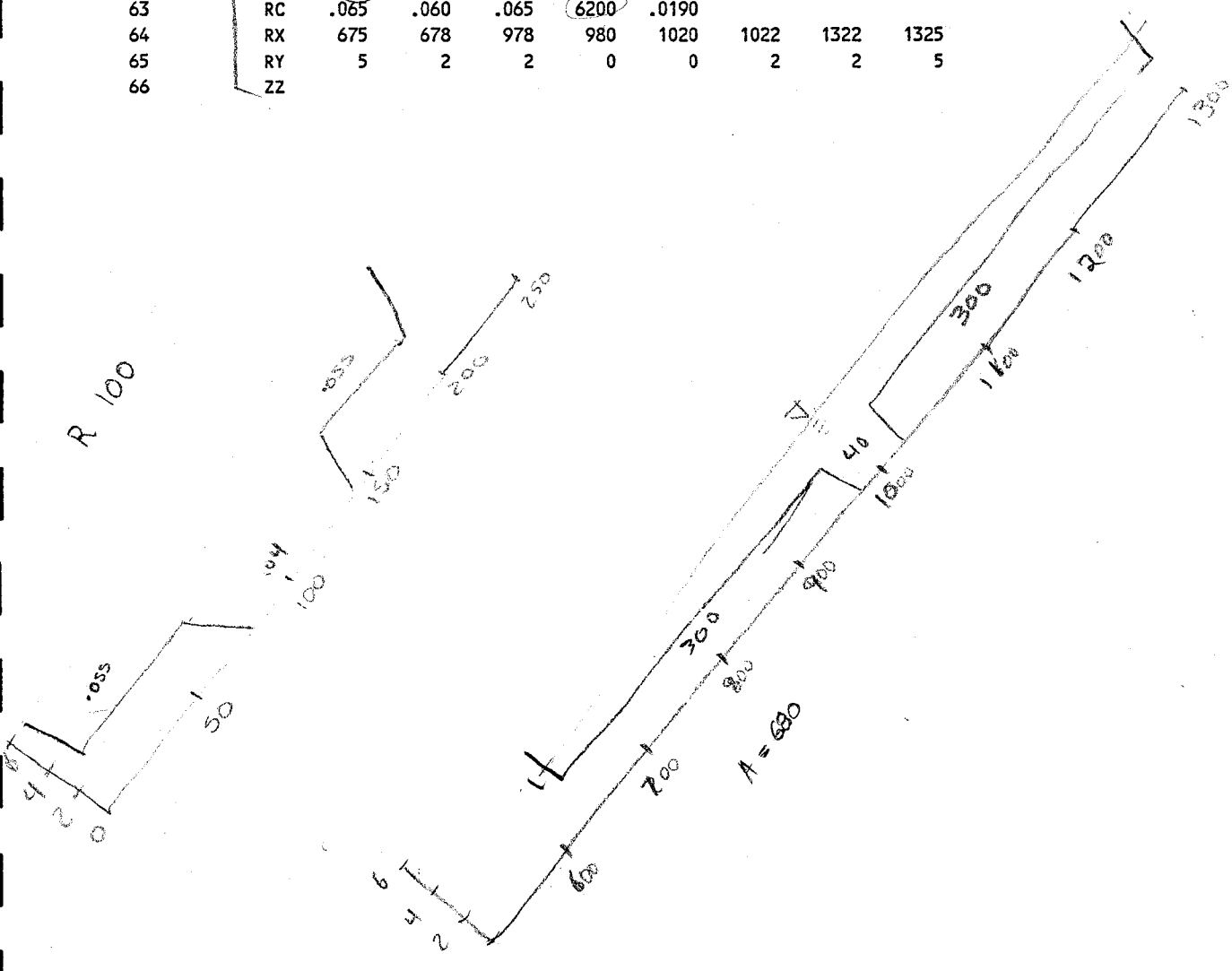
THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID        COMPOSITE CHANNEL TESTS
  2           ID        *************** COMPOSITE  CHANNEL ROUTING **********************
  3           ID        TEST 2 - 24/76 % SPLIT D/S BASIN 110
  4           ID        W6TST2C: CLOMR STUDY
  5           ID        ____________________________________________________________
  6           ID        NORTH SCOTTSDALE FLOOD INSURANCE STUDY, EXISTING CONDITIONS
  7           ID        100-YEAR, 6-HOUR STORM, USING HEC-1 HYPOTHETICAL DISTRIBUTION
  8           ID        RAINFALL FROM NOAA ATLAS
  9           ID
              *DIAGRAM
 10           IT       5               0     100
 11           IO       5       0

 12           KK    1430     SUB
 13           KM        RUNOFF FROM SUB 1430
 14           BA  1.4319
 15           PH            3.32     .71    1.39    2.44    2.81    3.05    3.52
 16           LS              81
 17           UK     240   .0555     .20     100
 18           RK   25800   .0271    .045            TRAP      30       3

 19           KK    1440     SUB
 20           KM        RUNOFF FROM SUB 1440
 21           BA  1.8882
 22           LS              81
 23           UK     240   .0555     .20     100
 24           RK   24800   .0258    .045            TRAP      30       3

 25           KK    1441      CP
 26           KM        COMBINE SUB 1430 & SUB 1440 - APEX
 27           HC       2

 28           KK   R1441
 29           KM        ROUTE SUB 1441 TO CP 100:BW=50' & OB = 50'
 30           RS       2    FLOW      -1
 31           RC    .055    .040    .055    4300   .0158
 32           RX       7      16      66      75     125     134     184     193
 33           RY       6       3       3       0       0       3       3       6

 34           KK     100     SUB
 35           KM        RUNOFF FROM SUB 100
 36           BA   .1060
 37           LS              81
 38           UK     240   .0555     .20     100
 39           RK    4300   .0158    .045            TRAP      50       3

 40           KK     100      CP
 41           KM        COMBINE
 42           HC       2
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  43          KK    R100
  44          KM        ROUTE BW=70' & OB = 50'
  45          RS        8    FLOW      -1
  46          RC     .055    .040    .055   15800    .0195
  47          RX        7      16      66      75      145     154     204     213
  48          RY        6       3       3       0        0       3       3       6

  49          KK      110     SUB
  50          KM        RUNOFF FROM SUB 110
  51          BA    .5780
  52          LS              81
  53          UK      240   .0555     .20     100
  54          RK    15800   .0195    .045            TRAP      70       3

  55          KK    C110      CP
  56          KM        COMBINE
  57          HC        2

  58          KK    R110
  59          KM        COMPOSITE CHANNEL ROUTING ************************************
  60          KM        ROUTE CHANNEL BW=40',D = 2', & OB = 600'
  61          KO        1       2     400
  62          RS        3    FLOW      -1
  63          RC     .065    .060    .065    6200    .0190
  64          RX      675     678     978     980    1020    1022    1322    1325
  65          RY        5       2       2       0       0       2       2       5
  66          ZZ
```

each side

each side



SCHEMATIC DIAGRAM OF STREAM NETWORK

```
INPUT
 LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

 NO.       (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

  12        1430
               .
               .
  19           .        1440
               .           .
               .           .
  25        1441............
               V
               V
  28       R1441
               .
               .
  34           .         100
               .           .
               .           .
  40         100............
               V
               V
  43        R100
               .
               .
  49           .         110
               .           .
               .           .
  55        C110............
               V
               V
  58        R110
```

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

```
****************************************
*                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
*            SEPTEMBER 1990            *
*             VERSION 4.0              *
*                                      *
*  RUN DATE  09/17/1993  TIME  09:18:31 *
*                                      *
****************************************
```

```
****************************************
*                                      *
*    U.S. ARMY CORPS OF ENGINEERS      *
*    HYDROLOGIC ENGINEERING CENTER     *
*          609 SECOND STREET           *
*       DAVIS, CALIFORNIA 95616        *
*           (916) 756-1104             *
*                                      *
****************************************
```

COMPOSITE CHANNEL TESTS
********** COMPOSITE CHANNEL ROUTING **********
TEST 2 - 24/76 % SPLIT D/S BASIN 110
W6TST2C: CLOMR STUDY

NORTH SCOTTSDALE FLOOD INSURANCE STUDY, EXISTING CONDITIONS
100-YEAR, 6-HOUR STORM, USING HEC-1 HYPOTHETICAL DISTRIBUTION
RAINFALL FROM NOAA ATLAS

```
 11 IO          OUTPUT CONTROL VARIABLES
                      IPRNT          5  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE

    IT          HYDROGRAPH TIME DATA
                       NMIN          5  MINUTES IN COMPUTATION INTERVAL
                      IDATE      1   0  STARTING DATE
                      ITIME       0000  STARTING TIME
                         NQ        100  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE      1   0  ENDING DATE
                     NDTIME       0815  ENDING TIME
                      ICENT         19  CENTURY MARK

                 COMPUTATION INTERVAL     .08 HOURS
                      TOTAL TIME BASE    8.25 HOURS

        ENGLISH UNITS
            DRAINAGE AREA          SQUARE MILES
            PRECIPITATION DEPTH    INCHES
            LENGTH, ELEVATION      FEET
            FLOW                   CUBIC FEET PER SECOND
            STORAGE VOLUME         ACRE-FEET
            SURFACE AREA           ACRES
            TEMPERATURE            DEGREES FAHRENHEIT


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


          **************
          *            *
 58 KK    *     R110   *
          *            *
          **************

 61 KO          OUTPUT CONTROL VARIABLES
                      IPRNT          1  PRINT CONTROL
                      IPLOT          2  PLOT CONTROL
                      QSCAL       400.  HYDROGRAPH PLOT SCALE
```

HYDROGRAPH ROUTING DATA

62 RS STORAGE ROUTING

NSTPS	3	NUMBER OF SUBREACHES
ITYP	FLOW	TYPE OF INITIAL CONDITION
RSVRIC	-1.00	INITIAL CONDITION
X	.00	WORKING R AND D COEFFICIENT

63 RC NORMAL DEPTH CHANNEL

ANL	.065	LEFT OVERBANK N-VALUE
ANCH	.060	MAIN CHANNEL N-VALUE
ANR	.065	RIGHT OVERBANK N-VALUE
RLNTH	6200.	REACH LENGTH
SEL	.0190	ENERGY SLOPE
ELMAX	.0	MAX. ELEV. FOR STORAGE/OUTFLOW CALCULATION

CROSS-SECTION DATA

		--- LEFT OVERBANK ---		+ ------ MAIN CHANNEL		------- +	--- RIGHT OVERBANK ---		
65 RY	ELEVATION	5.00	2.00	2.00	.00	.00	2.00	2.00	5.00
64 RX	DISTANCE	675.00	678.00	978.00	980.00	1020.00	1022.00	1322.00	1325.00

***

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	.00	1.51	3.04	4.58	6.15	7.74	9.34	10.97	21.61	45.75
OUTFLOW	.00	14.78	46.86	92.00	148.46	215.17	291.38	376.53	516.61	938.24
ELEVATION	.00	.26	.53	.79	1.05	1.32	1.58	1.84	2.11	2.37
STORAGE	69.90	94.08	118.28	142.50	166.74	191.00	215.27	239.57	263.89	288.22
OUTFLOW	1576.36	2393.78	3370.92	4494.81	5755.93	7146.88	8661.62	10295.12	12043.08	13901.77
ELEVATION	2.63	2.89	3.16	3.42	3.68	3.95	4.21	4.47	4.74	5.00

****

HYDROGRAPH AT STATION R110

****

DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE	DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE	DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE
1		0000	1	0.	.0	.0	1		0250	35	0.	.0	.0	1		0540	69	839.	13.4	2.3
1		0005	2	0.	.0	.0	1		0255	36	0.	.0	.0	1		0545	70	799.	12.6	2.3
1		0010	3	0.	.0	.0	1		0300	37	0.	.0	.0	1		0550	71	760.	11.9	2.3
1		0015	4	0.	.0	.0	1		0305	38	0.	.0	.0	1		0555	72	723.	11.1	2.2
1		0020	5	0.	.0	.0	1		0310	39	1.	.0	.0	1		0600	73	687.	10.4	2.2
1		0025	6	0.	.0	.0	1		0315	40	2.	.1	.0	1		0605	74	653.	9.8	2.2
1		0030	7	0.	.0	.0	1		0320	41	9.	.3	.2	1		0610	75	622.	9.2	2.2
1		0035	8	0.	.0	.0	1		0325	42	38.	.9	.5	1		0615	76	593.	8.7	2.2
1		0040	9	0.	.0	.0	1		0330	43	118.	1.8	.9	1		0620	77	567.	8.2	2.1
1		0045	10	0.	.0	.0	1		0335	44	229.	2.7	1.4	1		0625	78	544.	7.7	2.1
1		0050	11	0.	.0	.0	1		0340	45	323.	3.3	1.7	1		0630	79	524.	7.3	2.1
1		0055	12	0.	.0	.0	1		0345	46	382.	3.8	1.9	1		0635	80	507.	7.0	2.1
1		0100	13	0.	.0	.0	1		0350	47	424.	4.9	1.9	1		0640	81	493.	6.6	2.1
1		0105	14	0.	.0	.0	1		0355	48	530.	7.5	2.1	1		0645	82	479.	6.2	2.0
1		0110	15	0.	.0	.0	1		0400	49	782.	12.3	2.3	1		0650	83	464.	5.9	2.0
1		0115	16	0.	.0	.0	1		0405	50	1221.	18.8	2.5	1		0655	84	449.	5.5	2.0
1		0120	17	0.	.0	.0	1		0410	51	1783.	25.3	2.7	1		0700	85	432.	5.1	1.9
1		0125	18	0.	.0	.0	1		0415	52	2282.	30.3	2.9	1		0705	86	410.	4.5	1.9
1		0130	19	0.	.0	.0	1		0420	53	2594.	33.0	2.9	1		0710	87	385.	3.9	1.9
1		0135	20	0.	.0	.0	1		0425	54	2683.	33.7	3.0	1		0715	88	333.	3.4	1.7
1		0140	21	0.	.0	.0	1		0430	55	2588.	33.0	2.9	1		0720	89	290.	3.1	1.6
1		0145	22	0.	.0	.0	1		0435	56	2393.	31.4	2.9	1		0725	90	268.	3.0	1.5
1		0150	23	0.	.0	.0	1		0440	57	2188.	29.3	2.8	1		0730	91	252.	2.8	1.4
1		0155	24	0.	.0	.0	1		0445	58	1966.	27.1	2.8	1		0735	92	237.	2.7	1.4

1	0200	25	0.	.0	.0	*	1	0450	59	1760.	25.1	2.7	*	1	0740	93	224.	2.6	1.3
1	0205	26	0.	.0	.0	*	1	0455	60	1583.	23.4	2.6	*	1	0745	94	213.	2.6	1.3
1	0210	27	0.	.0	.0	*	1	0500	61	1455.	21.8	2.6	*	1	0750	95	203.	2.5	1.3
1	0215	28	0.	.0	.0	*	1	0505	62	1334.	20.2	2.5	*	1	0755	96	194.	2.4	1.2
1	0220	29	0.	.0	.0	*	1	0510	63	1221.	18.8	2.5	*	1	0800	97	186.	2.3	1.2
1	0225	30	0.	.0	.0	*	1	0515	64	1121.	17.6	2.4	*	1	0805	98	178.	2.3	1.2
1	0230	31	0.	.0	.0	*	1	0520	65	1038.	16.5	2.4	*	1	0810	99	169.	2.2	1.1
1	0235	32	0.	.0	.0	*	1	0525	66	970.	15.6	2.4	*	1	0815	100	161.	2.1	1.1
1	0240	33	0.	.0	.0	*	1	0530	67	919.	14.9	2.4	*						
1	0245	34	0.	.0	.0	*	1	0535	68	879.	14.1	2.3	*						
						*							*						

****

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	8.25-HR
+ (CFS)	(HR)					
		(CFS)				
+ 2683.	4.42		675.	491.	491.	491.
		(INCHES)	1.567	1.567	1.567	1.567
		(AC-FT)	335.	335.	335.	335.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
		6-HR	24-HR	72-HR	8.25-HR
+ (AC-FT)	(HR)				
34.	4.42	9.	7.	7.	7.

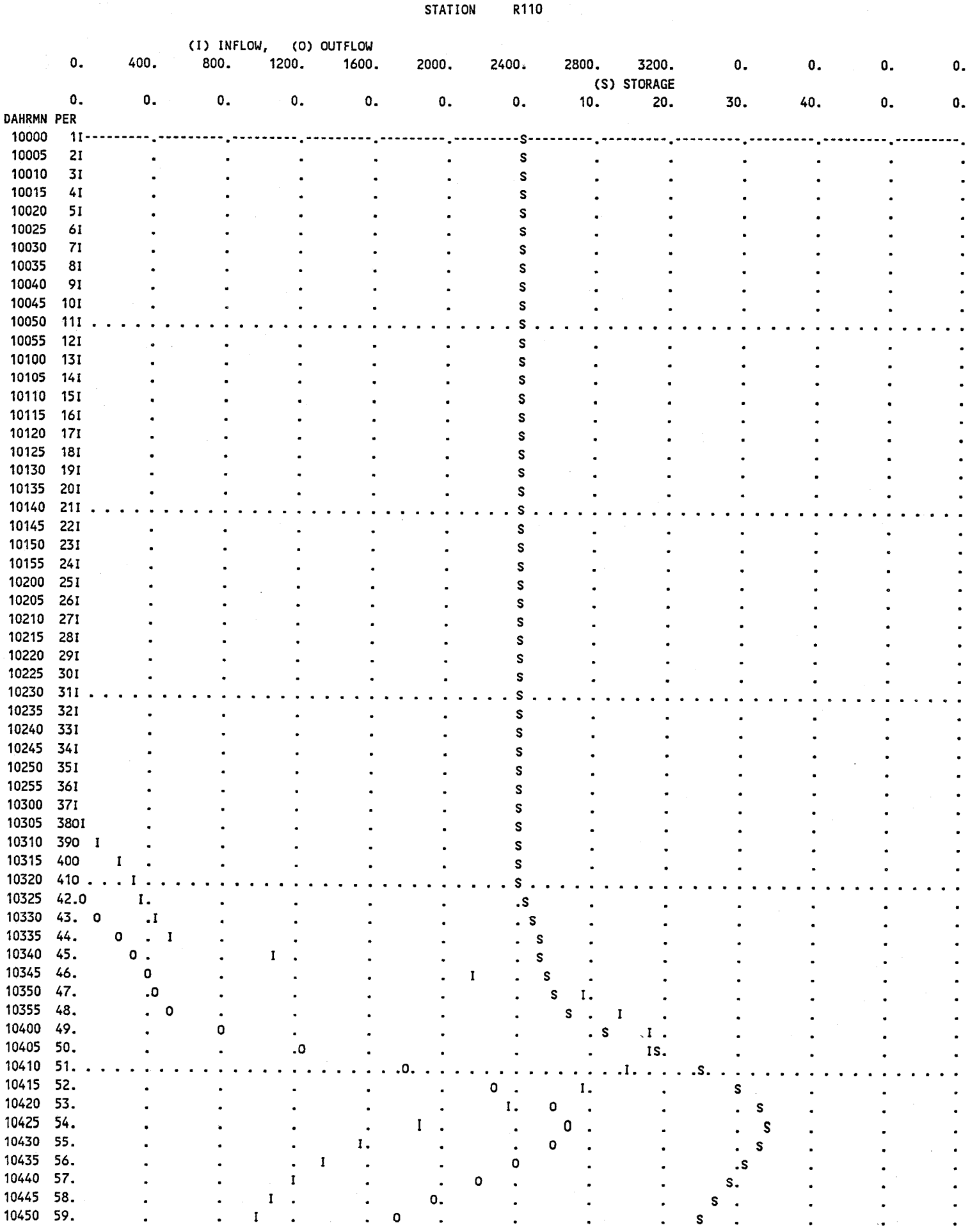
PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
		6-HR	24-HR	72-HR	8.25-HR
+ (FEET)	(HR)				
2.97	4.42	1.67	1.21	1.21	1.21

CUMULATIVE AREA = 4.00 SQ MI

STATION R110

(I) INFLOW, (O) OUTFLOW

(S) STORAGE



```
10455  60.         .         .  I      .         O         .         .         .         .  S      .         .         .         .
10500  61. . . . . . . . . . . . . . . . . . . . .I. . . . . . . . . . . . . . .O. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .S. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
10505  62.         .         I         .  O      .         .         .         .         S         .         .         .         .
10510  63.         .       I .         .O        .         .         .         .        S.         .         .         .         .
10515  64.         .      I  .       O .         .         .         .         .       S .         .         .         .         .
10520  65.         .     I   .     O   .         .         .         .         .      S  .         .         .         .         .
10525  66.         .    I    .   O     .         .         .         .         .     S   .         .         .         .         .
10530  67.         .    I    .  O      .         .         .         .         .    S    .         .         .         .         .
10535  68.         .   I     . O       .         .         .         .         .   S     .         .         .         .         .
10540  69.         .  I      .O        .         .         .         .         .  S      .         .         .         .         .
10545  70.         .  I      O         .         .         .         .         .  S      .         .         .         .         .
10550  71. . . . . . . . . . .I. . . . . .O. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .S. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
10555  72.         . I     O .         .         .         .         .         .S        .         .         .         .         .
10600  73.         .I     O  .         .         .         .         .         S         .         .         .         .         .
10605  74.         .I    O   .         .         .         .         .         S         .         .         .         .         .
10610  75.         I     O   .         .         .         .         .        S.         .         .         .         .         .
10615  76.         I    O    .         .         .         .         .        S.         .         .         .         .         .
10620  77.         I   O     .         .         .         .         .       S .         .         .         .         .         .
10625  78.        I.   O     .         .         .         .         .       S .         .         .         .         .         .
10630  79.        I.  O      .         .         .         .         .      S  .         .         .         .         .         .
10635  80.        I.  O      .         .         .         .         .      S  .         .         .         .         .         .
10640  81. . . . . . . . .I. .O. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .S. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
10645  82.       I . O       .         .         .         .         .     S   .         .         .         .         .         .
10650  83.       I . O       .         .         .         .         .     S   .         .         .         .         .         .
10655  84.       I .O        .         .         .         .         .    S    .         .         .         .         .         .
10700  85.      I  .O        .         .         .         .         .    S    .         .         .         .         .         .
10705  86.      I  O         .         .         .         .         .    S    .         .         .         .         .         .
10710  87.      I  O         .         .         .         .         .   S     .         .         .         .         .         .
10715  88.     I O .         .         .         .         .         .  S      .         .         .         .         .         .
10720  89.     IO  .         .         .         .         .         .  S      .         .         .         .         .         .
10725  90.     IO  .         .         .         .         .         .  S      .         .         .         .         .         .
10730  91. . . . .IO. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .S. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
10735  92.    IO   .         .         .         .         .         .  S      .         .         .         .         .         .
10740  93.    IO   .         .         .         .         .         .  S      .         .         .         .         .         .
10745  94.    I    .         .         .         .         .         .  S      .         .         .         .         .         .
10750  95.   IO    .         .         .         .         .         . S       .         .         .         .         .         .
10755  96.   IO    .         .         .         .         .         . S       .         .         .         .         .         .
10800  97.   IO    .         .         .         .         .         . S       .         .         .         .         .         .
10805  98.   I     .         .         .         .         .         . S       .         .         .         .         .         .
10810  99.  IO     .         .         .         .         .         . S       .         .         .         .         .         .
10815 100.--IO-----.---------.---------.---------.---------.---------.-S-------.---------.---------.---------.---------.---------.
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	1430	1423.	3.58	255.	185.	185.	1.43		
HYDROGRAPH AT	1440	2050.	3.50	337.	245.	245.	1.89		
2 COMBINED AT	1441	3382.	3.50	592.	430.	430.	3.32		
ROUTED TO	R1441	3192.	3.67	588.	428.	428.	3.32	4.10	3.67
HYDROGRAPH AT	100	153.	3.33	19.	14.	14.	.11		
2 COMBINED AT	100	3259.	3.67	607.	442.	442.	3.43		
ROUTED TO	R100	2875.	4.08	586.	426.	426.	3.43	3.29	4.08
HYDROGRAPH AT	110	501.	3.67	102.	74.	74.	.58		
2 COMBINED AT	C110	3127.	4.08	687.	500.	500.	4.00		
ROUTED TO	R110	2683.	4.42	675.	491.	491.	4.00	2.97	4.42

SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
(FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)

ISTAQ	ELEMENT	DT (MIN)	PEAK (CFS)	TIME TO PEAK (MIN)	VOLUME (IN)	INTERPOLATED TO COMPUTATION INTERVAL DT (MIN)	PEAK (CFS)	TIME TO PEAK (MIN)	VOLUME (IN)
1430	MANE	3.52	1431.76	216.06	1.65	5.00	1422.98	215.00	1.65

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .1299E+03 OUTFLOW= .1263E+03 BASIN STORAGE= .2746E+01 PERCENT ERROR= .7

1440	MANE	3.40	2084.02	211.40	1.66	5.00	2049.52	210.00	1.66

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .1713E+03 OUTFLOW= .1673E+03 BASIN STORAGE= .2899E+01 PERCENT ERROR= .7

100	MANE	3.14	156.22	198.37	1.67	5.00	152.92	200.00	1.67

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .9617E+01 OUTFLOW= .9442E+01 BASIN STORAGE= .9879E-01 PERCENT ERROR= .8

110	MANE	3.68	502.74	219.09	1.64	5.00	501.09	220.00	1.63

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .5244E+02 OUTFLOW= .5042E+02 BASIN STORAGE= .1658E+01 PERCENT ERROR= .7

*** NORMAL END OF HEC-1 ***

```
*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*            SEPTEMBER 1990             *
*             VERSION 4.0               *
*                                       *
*  RUN DATE  09/17/1993  TIME  09:19:52 *
*                                       *
*****************************************
```

```
*******************************
*                             *
*   U.S. ARMY CORPS OF ENGINEERS  *
*   HYDROLOGIC ENGINEERING CENTER *
*         609 SECOND STREET     *
*      DAVIS, CALIFORNIA 95616  *
*          (916) 756-1104       *
*                               *
*******************************
```

Individual Channel Routings

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X               X
XXXXXXX  XXXX     X        XXXXX  X
X     X  X        X               X
X     X  X        X     X         X
X     X  XXXXXXX   XXXXX         XXX
```

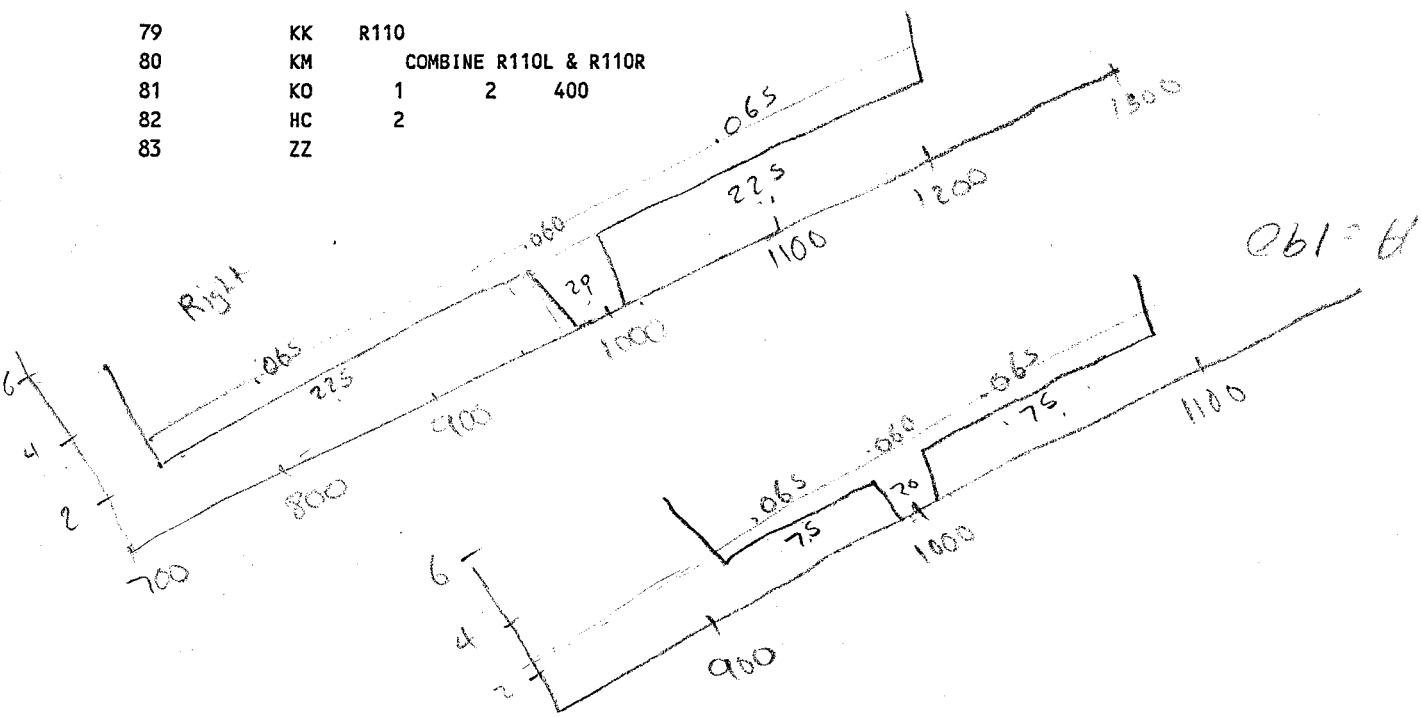
THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID        COMPOSITE CHANNEL TESTS
  2           ID        ************* TWO CHANNELS ROUTED **********************
  3           ID        TEST 2 - 24/76 % SPLIT D/S BASIN 110
  4           ID        ____________________________________________________________
  5           ID        NORTH SCOTTSDALE FLOOD INSURANCE STUDY, EXISTING CONDITIONS
  6           ID        100-YEAR, 6-HOUR STORM, USING HEC-1 HYPOTHETICAL DISTRIBUTION
  7           ID        RAINFALL FROM NOAA ATLAS
  8           ID
              *DIAGRAM
  9           IT      5              0     100
 10           IO      5      0

 11           KK    1430     SUB
 12           KM        RUNOFF FROM SUB 1430
 13           BA  1.4319
 14           PH           3.32     .71    1.39    2.44    2.81    3.05    3.52
 15           LS             81
 16           UK     240   .0555     .20     100
 17           RK   25800   .0271    .045            TRAP      30       3

 18           KK    1440     SUB
 19           KM        RUNOFF FROM SUB 1440
 20           BA  1.8882
 21           LS             81
 22           UK     240   .0555     .20     100
 23           RK   24800   .0258    .045            TRAP      30       3

 24           KK    1441      CP
 25           KM        COMBINE SUB 1430 & SUB 1440 - APEX
 26           HC       2

 27           KK   R1441
 28           KM        ROUTE SUB 1441 TO CP 100:BW=50' & OB = 50'
 29           RS       2    FLOW      -1
 30           RC    .055    .040    .055    4300   .0158
 31           RX       7      16      66      75     125     134     184     193
 32           RY       6       3       3       0       0       3       3       6

 33           KK     100     SUB
 34           KM        RUNOFF FROM SUB 100
 35           BA   .1060
 36           LS             81
 37           UK     240   .0555     .20     100
 38           RK    4300   .0158    .045            TRAP      50       3

 39           KK     100      CP
 40           KM        COMBINE
 41           HC       2

 42           KK    R100
 43           KM        ROUTE BW=70' & OB = 50'
 44           RS       8    FLOW      -1
 45           RC    .055    .040    .055   15800   .0195
 46           RX       7      16      66      75     145     154     204     213
 47           RY       6       3       3       0       0       3       3       6
```

No change

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  48          KK     110     SUB
  49          KM        RUNOFF FROM SUB 110
  50          BA   .5780
  51          LS              81
  52          UK     240   .0555     .20     100
  53          RK   15800   .0195    .045            TRAP      70       3

  54          KK    C110      CP
  55          KM        COMBINE
  56          HC       2

  57          KK    D110
  58          KM        DIVERT CHANNEL LEFT 24%
  59          DT   D110L
  60          DI       0     100    1000    2000    4000
  61          DQ       0      24     240     480     960

  62          KK   R110R
  63          KM        INDIVIDUAL CHANNEL ROUTING ********************
  64          KM        ROUTE CHANNEL RIGHT BW=20',D = 2', & OB = 450'
  65          RS       3    FLOW      -1
  66          RC    .065    .060    .065    6200   .0190
  67          RX     760     763     988     990    1010    1012    1237    1240
  68          RY       5       2       2       0       0       2       2       5

  69          KK      RL
  70          KM        RETRIEVE CHANNEL LEFT
  71          DR   D110L

  72          KK   R110L
  73          KM        INDIVIDUAL CHANNEL ROUTING *******************
  74          KM        ROUTE CHANNEL LEFT BW=20',D = 2', & OB = 150'
  75          RS       3    FLOW      -1
  76          RC    .065    .060    .065    6200   .0190
  77          RX     910     913     988     990    1010    1012    1087    1090
  78          RY       5       2       2       0       0       2       2       5

  79          KK    R110
  80          KM        COMBINE R110L & R110R
  81          KO       1       2     400
  82          HC       2
  83          ZZ
```



SCHEMATIC DIAGRAM OF STREAM NETWORK

```
INPUT
 LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   11        1430
                .
                .
   18           .        1440
                .           .
                .           .
   24        1441............
                V
                V
   27       R1441
                .
                .
   33           .         100
                .           .
                .           .
   39         100............
                V
                V
   42        R100
                .
                .
   48           .         110
                .           .
                .           .
   54        C110............
                .
                .
   59           .-------->   D110L
   57        D110
                V
                V
   62       R110R
                .
                .
   71           .           .<-------   D110L
   69           .          RL
                .           V
                .           V
   72           .       R110L
                .           .
                .           .
   79        R110............
```

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

```
****************************************                    ****************************************
*                                      *                    *                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                    *   U.S. ARMY CORPS OF ENGINEERS       *
*           SEPTEMBER 1990             *                    *   HYDROLOGIC ENGINEERING CENTER      *
*            VERSION 4.0               *                    *         609 SECOND STREET            *
*                                      *                    *      DAVIS, CALIFORNIA 95616         *
*  RUN DATE  09/17/1993  TIME  09:19:52 *                    *          (916) 756-1104              *
*                                      *                    *                                      *
****************************************                    ****************************************
```

COMPOSITE CHANNEL TESTS
********** TWO CHANNELS ROUTED **********
TEST 2 - 24/76 % SPLIT D/S BASIN 110

NORTH SCOTTSDALE FLOOD INSURANCE STUDY, EXISTING CONDITIONS
100-YEAR, 6-HOUR STORM, USING HEC-1 HYPOTHETICAL DISTRIBUTION
RAINFALL FROM NOAA ATLAS

```
 10 IO         OUTPUT CONTROL VARIABLES
                     IPRNT          5  PRINT CONTROL
                     IPLOT          0  PLOT CONTROL
                     QSCAL         0.  HYDROGRAPH PLOT SCALE

    IT         HYDROGRAPH TIME DATA
                      NMIN          5  MINUTES IN COMPUTATION INTERVAL
                     IDATE      1   0  STARTING DATE
                     ITIME       0000  STARTING TIME
                        NQ        100  NUMBER OF HYDROGRAPH ORDINATES
                    NDDATE      1   0  ENDING DATE
                    NDTIME       0815  ENDING TIME
                    ICENT         19  CENTURY MARK

                 COMPUTATION INTERVAL     .08 HOURS
                      TOTAL TIME BASE    8.25 HOURS

         ENGLISH UNITS
             DRAINAGE AREA         SQUARE MILES
             PRECIPITATION DEPTH   INCHES
             LENGTH, ELEVATION     FEET
             FLOW                  CUBIC FEET PER SECOND
             STORAGE VOLUME        ACRE-FEET
             SURFACE AREA          ACRES
             TEMPERATURE           DEGREES FAHRENHEIT


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


          **************
          *            *
 79 KK    *     R110   *
          *            *
          **************

 81 KO         OUTPUT CONTROL VARIABLES
                     IPRNT          1  PRINT CONTROL
                     IPLOT          2  PLOT CONTROL
                     QSCAL       400.  HYDROGRAPH PLOT SCALE

 82 HC         HYDROGRAPH COMBINATION
```

ICOMP 2 NUMBER OF HYDROGRAPHS TO COMBINE

***

HYDROGRAPH AT STATION R110
SUM OF 2 HYDROGRAPHS

DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW
1		0000	1	0.	1		0205	26	0.	1		0410	51	1829.	1		0615	76	555.
1		0005	2	0.	1		0210	27	0.	1		0415	52	2307.	1		0620	77	533.
1		0010	3	0.	1		0215	28	0.	1		0420	53	2597.	1		0625	78	512.
1		0015	4	0.	1		0220	29	0.	1		0425	54	2683.	1		0630	79	492.
1		0020	5	0.	1		0225	30	0.	1		0430	55	2596.	1		0635	80	473.
1		0025	6	0.	1		0230	31	0.	1		0435	56	2402.	1		0640	81	456.
1		0030	7	0.	1		0235	32	0.	1		0440	57	2176.	1		0645	82	439.
1		0035	8	0.	1		0240	33	0.	1		0445	58	1970.	1		0650	83	424.
1		0040	9	0.	1		0245	34	0.	1		0450	59	1773.	1		0655	84	409.
1		0045	10	0.	1		0250	35	0.	1		0455	60	1594.	1		0700	85	395.
1		0050	11	0.	1		0255	36	0.	1		0500	61	1445.	1		0705	86	382.
1		0055	12	0.	1		0300	37	0.	1		0505	62	1333.	1		0710	87	369.
1		0100	13	0.	1		0305	38	0.	1		0510	63	1237.	1		0715	88	357.
1		0105	14	0.	1		0310	39	1.	1		0515	64	1145.	1		0720	89	347.
1		0110	15	0.	1		0315	40	3.	1		0520	65	1058.	1		0725	90	336.
1		0115	16	0.	1		0320	41	11.	1		0525	66	979.	1		0730	91	328.
1		0120	17	0.	1		0325	42	48.	1		0530	67	909.	1		0735	92	318.
1		0125	18	0.	1		0330	43	116.	1		0535	68	846.	1		0740	93	309.
1		0130	19	0.	1		0335	44	185.	1		0540	69	790.	1		0745	94	298.
1		0135	20	0.	1		0340	45	242.	1		0545	70	735.	1		0750	95	287.
1		0140	21	0.	1		0345	46	298.	1		0550	71	689.	1		0755	96	275.
1		0145	22	0.	1		0350	47	392.	1		0555	72	657.	1		0800	97	260.
1		0150	23	0.	1		0355	48	539.	1		0600	73	629.	1		0805	98	243.
1		0155	24	0.	1		0400	49	797.	1		0605	74	603.	1		0810	99	218.
1		0200	25	0.	1		0405	50	1269.	1		0610	75	578.	1		0815	100	179.

PEAK FLOW (CFS)	TIME (HR)		MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	8.25-HR
		(CFS)				
+ 2683.	4.42		674.	491.	491.	491.
		(INCHES)	1.566	1.566	1.566	1.566
		(AC-FT)	334.	334.	334.	334.

CUMULATIVE AREA = 4.00 SQ MI

STATION R110

(O) OUTFLOW

DAHRMN	PER	0.	400.	800.	1200.	1600.	2000.	2400.	2800.	0.	0.	0.	0.	0.
10000	10													
10005	20													
10010	30													
10015	40													
10020	50													
10025	60													
10030	70													
10035	80													
10040	90													
10045	100													
10050	110													
10055	120													
10100	130													
10105	140													
10110	150													
10115	160													
10120	170													
10125	180													
10130	190													
10135	200													
10140	210													
10145	220													
10150	230													
10155	240													
10200	250													
10205	260													
10210	270													
10215	280													
10220	290													
10225	300													
10230	310													
10235	320													
10240	330													
10245	340													
10250	350													
10255	360													
10300	370													
10305	380													
10310	390													
10315	400													
10320	410													
10325	42.0													
10330	43.	O												
10335	44.		O											
10340	45.			O										
10345	46.				O									
10350	47.					O								
10355	48.						O							
10400	49.							O						
10405	50.								O					
10410	51.									O				
10415	52.										O			
10420	53.											O		
10425	54.												O	
10430	55.											O		
10435	56.										O			
10440	57.									O				
10445	58.								O					
10450	59.							O						
10455	60.						O							
10500	61.					O								

```
10505  62.        .        .        . 0      .        .        .        .        .        .        .        .        .
10510  63.        .        .        .0       .        .        .        .        .        .        .        .        .
10515  64.        .        .       0.        .        .        .        .        .        .        .        .        .
10520  65.        .        .    0   .        .        .        .        .        .        .        .        .        .
10525  66.        .        .  0     .        .        .        .        .        .        .        .        .        .
10530  67.        .        . 0      .        .        .        .        .        .        .        .        .        .
10535  68.        .        .0       .        .        .        .        .        .        .        .        .        .
10540  69.        .        0        .        .        .        .        .        .        .        .        .        .
10545  70.        .      0 .        .        .        .        .        .        .        .        .        .        .
10550  71. . . . . . . .0. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
10555  72.        .    0   .        .        .        .        .        .        .        .        .        .        .
10600  73.        .    0   .        .        .        .        .        .        .        .        .        .        .
10605  74.        .   0    .        .        .        .        .        .        .        .        .        .        .
10610  75.        .  0     .        .        .        .        .        .        .        .        .        .        .
10615  76.        .  0     .        .        .        .        .        .        .        .        .        .        .
10620  77.        . 0      .        .        .        .        .        .        .        .        .        .        .
10625  78.        . 0      .        .        .        .        .        .        .        .        .        .        .
10630  79.        .0       .        .        .        .        .        .        .        .        .        .        .
10635  80.        .0       .        .        .        .        .        .        .        .        .        .        .
10640  81. . . . .0. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
10645  82.        .o       .        .        .        .        .        .        .        .        .        .        .
10650  83.        .o       .        .        .        .        .        .        .        .        .        .        .
10655  84.        0        .        .        .        .        .        .        .        .        .        .        .
10700  85.        0        .        .        .        .        .        .        .        .        .        .        .
10705  86.        0        .        .        .        .        .        .        .        .        .        .        .
10710  87.       0.        .        .        .        .        .        .        .        .        .        .        .
10715  88.       0.        .        .        .        .        .        .        .        .        .        .        .
10720  89.       0.        .        .        .        .        .        .        .        .        .        .        .
10725  90.      0 .        .        .        .        .        .        .        .        .        .        .        .
10730  91. . . . 0 . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
10735  92.      0 .        .        .        .        .        .        .        .        .        .        .        .
10740  93.      0 .        .        .        .        .        .        .        .        .        .        .        .
10745  94.     0  .        .        .        .        .        .        .        .        .        .        .        .
10750  95.     0  .        .        .        .        .        .        .        .        .        .        .        .
10755  96.     0  .        .        .        .        .        .        .        .        .        .        .        .
10800  97.    0   .        .        .        .        .        .        .        .        .        .        .        .
10805  98.    0   .        .        .        .        .        .        .        .        .        .        .        .
10810  99.   0    .        .        .        .        .        .        .        .        .        .        .        .
10815 100.---0-----.--------.--------.--------.--------.--------.--------.--------.--------.--------.--------.--------.
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	1430	1423.	3.58	255.	185.	185.	1.43		
HYDROGRAPH AT	1440	2050.	3.50	337.	245.	245.	1.89		
2 COMBINED AT	1441	3382.	3.50	592.	430.	430.	3.32		
ROUTED TO	R1441	3192.	3.67	588.	428.	428.	3.32	4.10	3.67
HYDROGRAPH AT	100	153.	3.33	19.	14.	14.	.11		
2 COMBINED AT	100	3259.	3.67	607.	442.	442.	3.43		
ROUTED TO	R100	2875.	4.08	586.	426.	426.	3.43	3.29	4.08
HYDROGRAPH AT	110	501.	3.67	102.	74.	74.	.58		
2 COMBINED AT	C110	3127.	4.08	687.	500.	500.	4.00		
DIVERSION TO	D110L	750.	4.08	165.	120.	120.	4.00		
HYDROGRAPH AT	D110	2376.	4.08	522.	380.	380.	4.00		
ROUTED TO	R110R	2057.	4.42	514.	374.	374.	4.00	3.07	4.42
HYDROGRAPH AT	RL	750.	4.08	165.	120.	120.	.00		
ROUTED TO	R110L	626.	4.42	161.	117.	117.	.00	2.69	4.42
2 COMBINED AT	R110	2683.	4.42	674.	491.	491.	4.00		

SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
(FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)

ISTAQ	ELEMENT	DT (MIN)	PEAK (CFS)	TIME TO PEAK (MIN)	VOLUME (IN)	INTERPOLATED TO COMPUTATION INTERVAL DT (MIN)	PEAK (CFS)	TIME TO PEAK (MIN)	VOLUME (IN)
1430	MANE	3.52	1431.76	216.06	1.65	5.00	1422.98	215.00	1.65

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .1299E+03 OUTFLOW= .1263E+03 BASIN STORAGE= .2746E+01 PERCENT ERROR= .7

1440	MANE	3.40	2084.02	211.40	1.66	5.00	2049.52	210.00	1.66

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .1713E+03 OUTFLOW= .1673E+03 BASIN STORAGE= .2899E+01 PERCENT ERROR= .7

100	MANE	3.14	156.22	198.37	1.67	5.00	152.92	200.00	1.67

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .9617E+01 OUTFLOW= .9442E+01 BASIN STORAGE= .9879E-01 PERCENT ERROR= .8

110	MANE	3.68	502.74	219.09	1.64	5.00	501.09	220.00	1.63

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .5244E+02 OUTFLOW= .5042E+02 BASIN STORAGE= .1658E+01 PERCENT ERROR= .7

*** NORMAL END OF HEC-1 ***

APPENDIX B

PRELIMINARY HEC-1 MODEL FOR WASH 6A

```
****************************************
*                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
*            SEPTEMBER 1990            *
*             VERSION 4.0              *
*                                      *
*  RUN DATE  10/14/1993  TIME  09:43:23 *
*                                      *
****************************************
```

```
****************************************
*                                      *
*    U.S. ARMY CORPS OF ENGINEERS      *
*    HYDROLOGIC ENGINEERING CENTER     *
*          609 SECOND STREET           *
*       DAVIS, CALIFORNIA 95616        *
*           (916) 756-1104             *
*                                      *
****************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X               X
XXXXXXX  XXXX     X        XXXXX  X
X     X  X        X               X
X     X  X        X     X         X
X     X  XXXXXXX   XXXXX         XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID        PRELIMINARY HEC-1 MODEL FOR WASH 6A
  2           ID        CLOMR STUDY:
  3           ID        COMPOSITE CHANNELS R110 & R120
  4           ID        BASED ON THE FOLLOWING PREVIOUS STUDY:
  5           ID          NORTH SCOTTSDALE FLOOD INSURANCE STUDY, EXISTING CONDITIONS
  6           ID          1992 MODELING REVISIONS BASED ON REATA PASS SENSITIVITY ANALYSIS
  7           ID          MODEL FAN6R.6I -- SUB-BASINS 1380, 1390N, 1390S, 1430, & 1440
  8           ID          100-YEAR, 6-HOUR STORM, USING HEC-1 HYPOTHETICAL DISTRIBUTION
  9           ID          RAINFALL FROM NOAA ATLAS
 10           ID          CHANNEL GEOMETRY MODIFIED PER CVL MEASUREMENTS FOR 1391N & 1390N
 11           ID        FN =  W6ACVL
              *DIAGRAM
 12           IT       5              0     100
 13           IO       5       0

 14           KK    1430     SUB
 15           KM        RUNOFF FROM SUB 1430
 16           BA  1.4319
 17           PH            3.32     .71    1.39    2.44    2.81    3.05    3.52
 18           LS              81
 19           UK     240   .0555     .20     100
 20           RK   25800   .0271    .045            TRAP      30       3

 21           KK    1440     SUB
 22           KM        RUNOFF FROM SUB 1440
 23           BA  1.8882
 24           LS              81
 25           UK     240   .0555     .20     100
 26           RK   24800   .0258    .045            TRAP      30       3

 27           KK    1441      CP
 28           KM        COMBINE SUB 1430 & SUB 1440 - APEX
 29           HC       2

 30           KK   R1441
 31           KM        ROUTE SUB 1441 TO CP 100:BW=50' & OB = 50'
 32           RS       2    FLOW      -1
 33           RC    .055    .040    .055    4300   .0158
 34           RX       7      16      66      75     125     134     184     193
 35           RY       6       3       3       0       0       3       3       6

 36           KK     100     SUB
 37           KM        RUNOFF FROM SUB 100
 38           BA   .2046
 39           LS              81
 40           UK     240   .0555     .20     100
 41           RK    4300   .0158    .045            TRAP      50       3

 42           KK     100      CP
 43           KM        COMBINE
 44           HC       2
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  45          KK    D100
  46          KM        PRELIMINARY FLOW DIVERSION: ASSUMED TO BE 10 %
  47          KM        FINAL DIVERSION TO BE BASED ON UNIFORM FLOW OR CRITICAL DEPTH
  48          KM        COMPUTATIONS
  49          DT  TOW6BC
  50          DI       0     100    1000    2000    3000    4000
  51          DQ       0      10     100     200     300     400

  52          KK    R100
  53          KM        ROUTE BW=70' & OB = 50'
  54          RS       8    FLOW      -1
  55          RC    .055    .040    .055   18300   .0195
  56          RX       7      16      66      75     145     154     204     213
  57          RY       6       3       3       0       0       3       3       6

  58          KK     110     SUB
  59          KM        RUNOFF FROM SUB 110
  60          BA   .5780
  61          LS              81
  62          UK     240   .0555     .20     100
  63          RK   15800   .0195    .045            TRAP      70       3

  64          KK    C110      CP
  65          KM        COMBINE
  66          HC       2

  67          KK    R110
  68          KM        COMPOSITE CHANNEL
  69          KM        ROUTE SUB CHAN(60') OVERBANK(700') & DBAR = 1.80'(Z=1)
  70          RS       3    FLOW      -1
  71          RC    .065    .040    .065    6200   .0190
  72          RX     615     618     968     970    1030    1032    1382    1385
  73          RY     4.8     1.8     1.8       0       0     1.8     1.8     4.8

  74          KK     120     SUB
  75          KM        RUNOFF FROM SUB 120
  76          BA   .3598
  77          LS              81
  78          UK     240   .0555     .20     100
  79          RK    6200   .0190    .060            TRAP     800       3

  80          KK     T10     SUB
  81          KM        RUNOFF FROM SUB T10
  82          BA   .1933
  83          LS              81
  84          UK     240   .0555     .20     100
  85          RK    7100   .0180    .045            TRAP      20       3

  86          KK     T20     SUB
  87          KM        RUNOFF FROM SUB T20
  88          BA   .1198
  89          LS              81
  90          UK     240   .0555     .20     100
  91          RK    7400   .0180    .045            TRAP      20       3
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  92          KK    C120      CP
  93          KM        COMBINE
  94          HC       4

  95          KK    R120
  96          KM        COMPOSITE CHANNEL
  97          KM        ROUTE SUB CHAN(50') OVERBANK(980') & DBAR = 1.75'(Z=1)
  98          RS       3    FLOW      -1
  99          RC    .065    .040    .065    5800   .0185
 100          RX     480     483     973     975    1025    1027    1517    1520
 101          RY    4.75    1.75    1.75       0       0    1.75    1.75    4.75

 102          KK     130     SUB
 103          KM        RUNOFF FROM SUB 130
 104          BA   .5567
 105          LS              81
 106          UK     240   .0555     .20     100
 107          RK    5800   .0185    .060            TRAP     800       3

 108          KK    C130      CP
 109          KM        COMBINE
 110          HC       2
 111          ZZ
```

SCHEMATIC DIAGRAM OF STREAM NETWORK

```
INPUT
 LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   14        1430
                .
                .
   21           .        1440
                .           .
                .           .
   27        1441............
                V
                V
   30       R1441
                .
                .
   36           .         100
                .           .
                .           .
   42         100............
                .
                .
   49           .-------->  TOW6BC
   45        D100
                V
                V
   52        R100
                .
                .
   58           .         110
                .           .
                .           .
   64        C110............
                V
                V
   67        R110
                .
                .
   74           .         120
                .           .
                .           .
   80           .           .        T10
                .           .          .
                .           .          .
   86           .           .          .        T20
                .           .          .          .
                .           .          .          .
   92        C120.................................
                V
                V
   95        R120
                .
                .
  102           .         130
                .           .
                .           .
  108        C130............
```

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION

```
****************************************                                    ****************************************
*                                      *                                    *                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                    *   U.S. ARMY CORPS OF ENGINEERS       *
*           SEPTEMBER 1990             *                                    *   HYDROLOGIC ENGINEERING CENTER      *
*            VERSION 4.0               *                                    *         609 SECOND STREET            *
*                                      *                                    *      DAVIS, CALIFORNIA 95616         *
*  RUN DATE  10/14/1993  TIME  09:43:23 *                                    *          (916) 756-1104              *
*                                      *                                    *                                      *
****************************************                                    ****************************************
```

PRELIMINARY HEC-1 MODEL FOR WASH 6A
CLOMR STUDY:
COMPOSITE CHANNELS R110 & R120
BASED ON THE FOLLOWING PREVIOUS STUDY:
NORTH SCOTTSDALE FLOOD INSURANCE STUDY, EXISTING CONDITIONS
1992 MODELING REVISIONS BASED ON REATA PASS SENSITIVITY ANALYSIS
MODEL FAN6R.6I -- SUB-BASINS 1380, 1390N, 1390S, 1430, & 1440
100-YEAR, 6-HOUR STORM, USING HEC-1 HYPOTHETICAL DISTRIBUTION
RAINFALL FROM NOAA ATLAS
CHANNEL GEOMETRY MODIFIED PER CVL MEASUREMENTS FOR 1391N & 1390N
FN = W6ACVL

```
13 IO          OUTPUT CONTROL VARIABLES
                     IPRNT          5  PRINT CONTROL
                     IPLOT          0  PLOT CONTROL
                     QSCAL         0.  HYDROGRAPH PLOT SCALE

   IT          HYDROGRAPH TIME DATA
                      NMIN          5  MINUTES IN COMPUTATION INTERVAL
                     IDATE      1   0  STARTING DATE
                     ITIME       0000  STARTING TIME
                        NQ        100  NUMBER OF HYDROGRAPH ORDINATES
                    NDDATE      1   0  ENDING DATE
                    NDTIME       0815  ENDING TIME
                     ICENT         19  CENTURY MARK

               COMPUTATION INTERVAL     .08 HOURS
                    TOTAL TIME BASE    8.25 HOURS

        ENGLISH UNITS
             DRAINAGE AREA         SQUARE MILES
             PRECIPITATION DEPTH   INCHES
             LENGTH, ELEVATION     FEET
             FLOW                  CUBIC FEET PER SECOND
             STORAGE VOLUME        ACRE-FEET
             SURFACE AREA          ACRES
             TEMPERATURE           DEGREES FAHRENHEIT
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	1430	1423.	3.58	255.	185.	185.	1.43		
HYDROGRAPH AT	1440	2050.	3.50	337.	245.	245.	1.89		
2 COMBINED AT	1441	3382.	3.50	592.	430.	430.	3.32		
ROUTED TO	R1441	3192.	3.67	588.	428.	428.	3.32		
								4.10	3.67
HYDROGRAPH AT	100	330.	3.25	37.	27.	27.	.20		
2 COMBINED AT	100	3308.	3.67	625.	454.	454.	3.52		
DIVERSION TO	TOW6BC	331.	3.67	62.	45.	45.	3.52		
HYDROGRAPH AT	D100	2977.	3.67	562.	409.	409.	3.52		
ROUTED TO	R100	2587.	4.08	538.	391.	391.	3.52		
								3.13	4.08
HYDROGRAPH AT	110	501.	3.67	102.	74.	74.	.58		
2 COMBINED AT	C110	2839.	4.08	639.	465.	465.	4.10		
ROUTED TO	R110	2323.	4.50	628.	457.	457.	4.10		
								2.40	4.50
HYDROGRAPH AT	120	218.	4.00	61.	44.	44.	.36		
HYDROGRAPH AT	T10	280.	3.33	35.	25.	25.	.19		
HYDROGRAPH AT	T20	154.	3.42	21.	16.	16.	.12		
4 COMBINED AT	C120	2493.	4.50	745.	542.	542.	4.78		
ROUTED TO	R120	2089.	5.00	734.	534.	534.	4.78		
								2.28	5.00
HYDROGRAPH AT	130	431.	3.75	96.	70.	70.	.56		

2 COMBINED AT

+ C130	2187.	4.92	830.	604.	604.	5.33

SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
(FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)

ISTAQ	ELEMENT	DT (MIN)	PEAK (CFS)	TIME TO PEAK (MIN)	VOLUME (IN)	INTERPOLATED TO COMPUTATION INTERVAL DT (MIN)	PEAK (CFS)	TIME TO PEAK (MIN)	VOLUME (IN)
1430	MANE	3.52	1431.76	216.06	1.65	5.00	1422.98	215.00	1.65

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .1299E+03 OUTFLOW= .1263E+03 BASIN STORAGE= .2746E+01 PERCENT ERROR= .7

1440	MANE	3.40	2084.02	211.40	1.66	5.00	2049.52	210.00	1.66

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .1713E+03 OUTFLOW= .1673E+03 BASIN STORAGE= .2899E+01 PERCENT ERROR= .7

100	MANE	2.41	340.86	195.81	1.68	5.00	329.84	195.00	1.67

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .1856E+02 OUTFLOW= .1829E+02 BASIN STORAGE= .1417E+00 PERCENT ERROR= .7

110	MANE	3.68	502.74	219.09	1.64	5.00	501.09	220.00	1.63

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .5244E+02 OUTFLOW= .5042E+02 BASIN STORAGE= .1658E+01 PERCENT ERROR= .7

120	MANE	4.20	218.66	240.76	1.58	5.00	217.72	240.00	1.58

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .3264E+02 OUTFLOW= .3029E+02 BASIN STORAGE= .2119E+01 PERCENT ERROR= .7

T10	MANE	2.89	282.92	200.92	1.67	5.00	279.99	200.00	1.67

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .1754E+02 OUTFLOW= .1726E+02 BASIN STORAGE= .1625E+00 PERCENT ERROR= .7

T20	MANE	2.94	156.13	202.95	1.67	5.00	153.94	205.00	1.67

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .1087E+02 OUTFLOW= .1069E+02 BASIN STORAGE= .1104E+00 PERCENT ERROR= .6

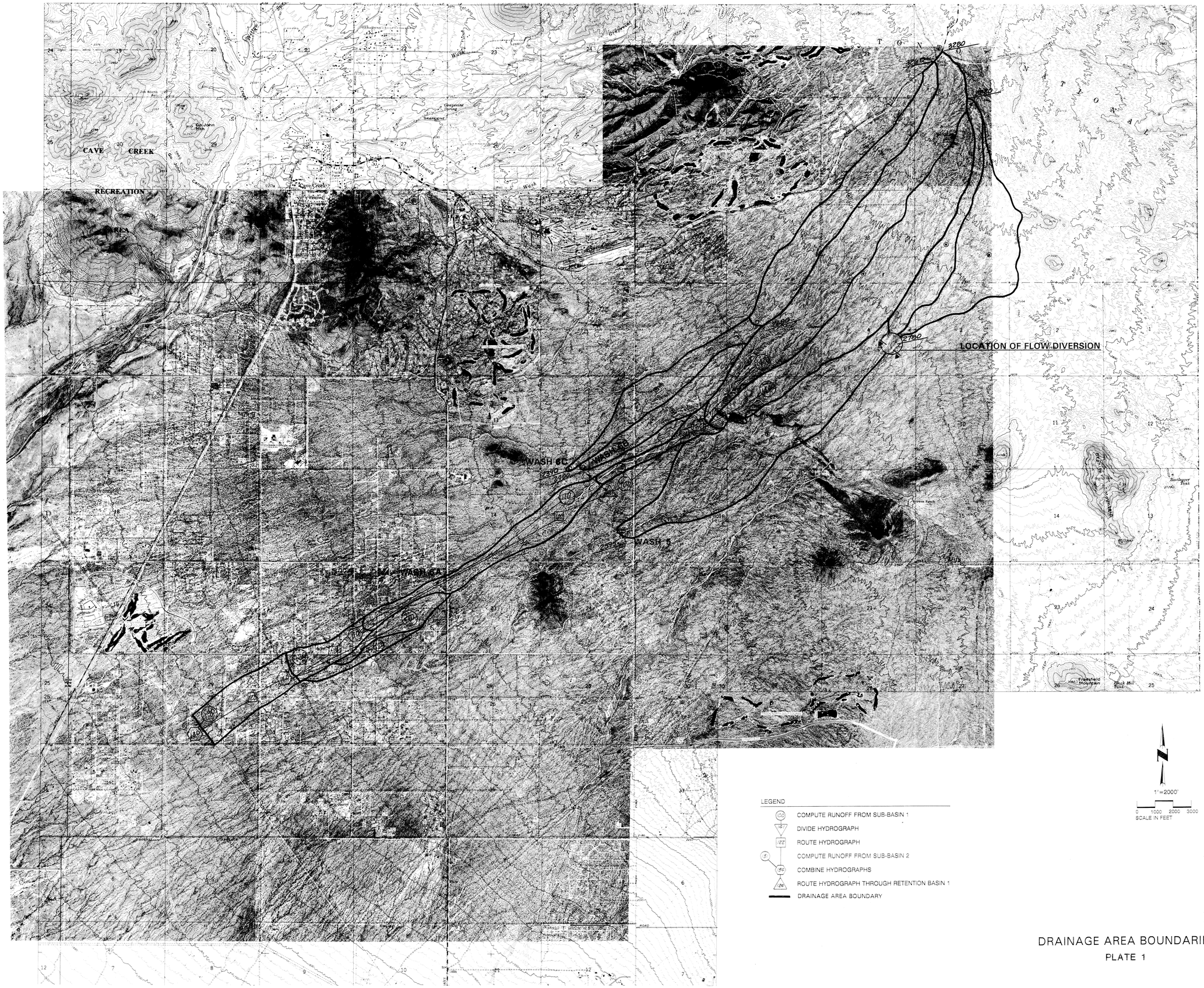
130	MANE	4.05	434.53	224.37	1.62	5.00	430.90	225.00	1.61

CONTINUITY SUMMARY (AC-FT) - INFLOW= .0000E+00 EXCESS= .5051E+02 OUTFLOW= .4798E+02 BASIN STORAGE= .2126E+01 PERCENT ERROR= .8

*** NORMAL END OF HEC-1 ***

APPENDIX C

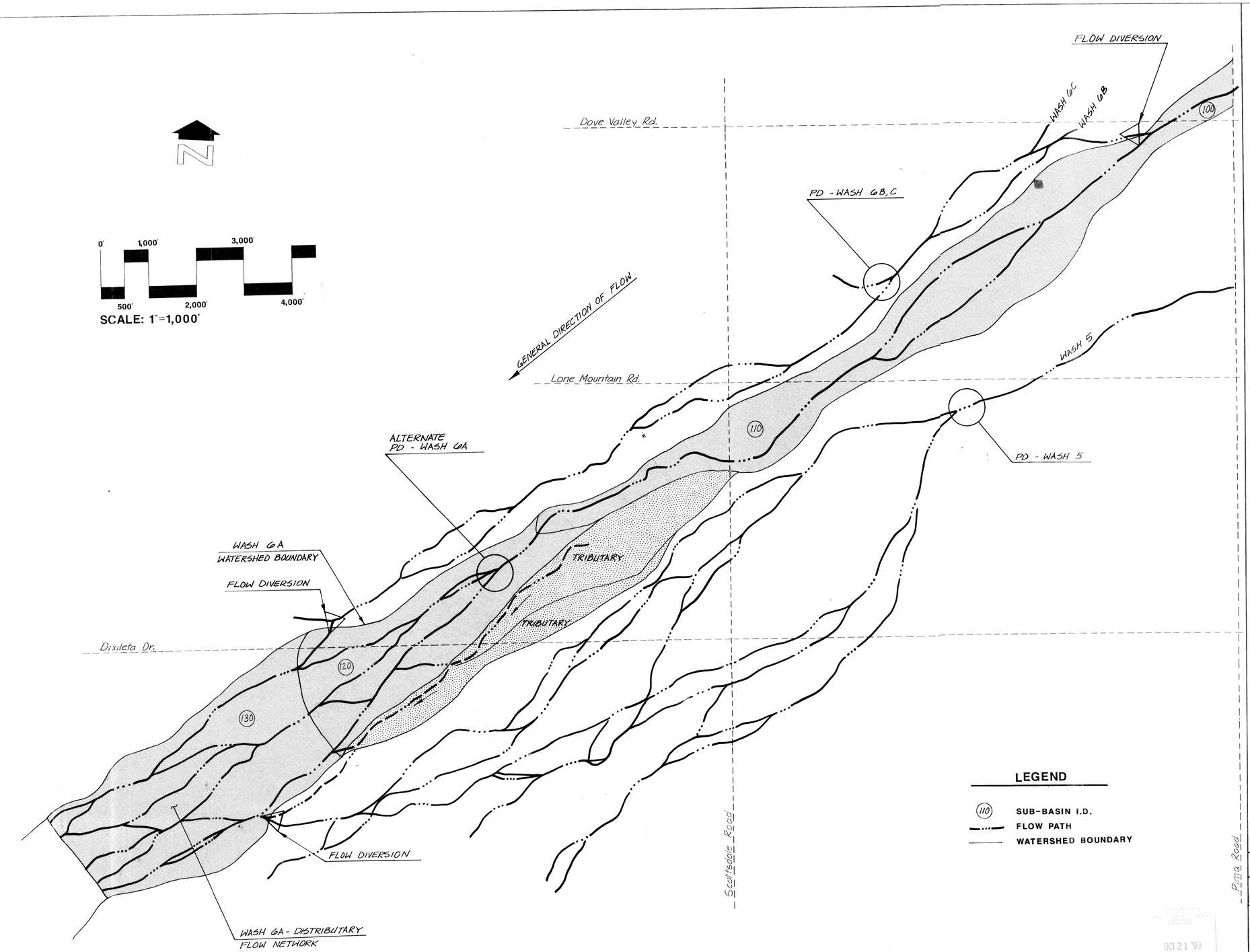
PLATES 1 AND 2



DRAINAGE AREA BOUNDARIES

PLATE 1

CVL



REVISION BY				
NO	DESCRIPTION	REV BY	CKD BY	DATE

REVISION BY				
NO	DESCRIPTION	REV BY	CKD BY	DATE

REVISION BY				
NO	DESCRIPTION	REV. BY	CKD BY	DATE

6303 19th Ave 866-5191 Tell Chuck

OCT 21 '93

COE & VAN LOO PHOENIX
CONSULTING ENGINEERS INC. ARIZONA

PLATE 2

APPLICATION OF HEC-1 TO WATERSHEDS WITH DISTRIBUTARY - FLOW AREAS

DES. DD	DR MGP	CK	SHEET NO.	TOTAL SHEETS	AS BUILT
DATE	DATE	DATE			
SCALE 1" = 20 HORIZONTAL / 2 VERTICAL					