

Chapter 10

Sacramento Method Examples

Introduction

Overview

This chapter presents two example problems to demonstrate the use of the Sacramento method. These example problems use the SACPRE and HEC-1 computer programs to perform the hydrologic calculations.

Example 1 - Multi-Basin Planning Study

Example 1 summarizes the steps involved and the data required for a planning level drainage study of a large basin comprised of several smaller basins. This example uses the Basin "n" method to calculate basin lag time.

Example 2 - Single Basin Analysis of Subdivision

Example 2 summarizes the steps involved and the data required to determine runoff from a single small basin. This example uses the Travel Time Component method to calculate the basin lag time.

Example 1 - Multi-Basin Planning Study: Input Data

Overview

The upper portion of Arcade Creek Watershed in Sacramento County was chosen to demonstrate the procedure and the necessary information in the analysis of the existing condition multi-basin drainage system. This analysis is typical of a planning level effort, where detailed basin pipe/channel drainage information is not required.

Basin Delineation

The drainage area and subbasins boundaries for the Upper Arcade Creek basin were defined to have similar subbasin areas and lag times while considering the additional subbasin delineation parameters outlined in Chapter 9. The basin boundaries are shown in Figure 10-1.

Hydrologic Parameters

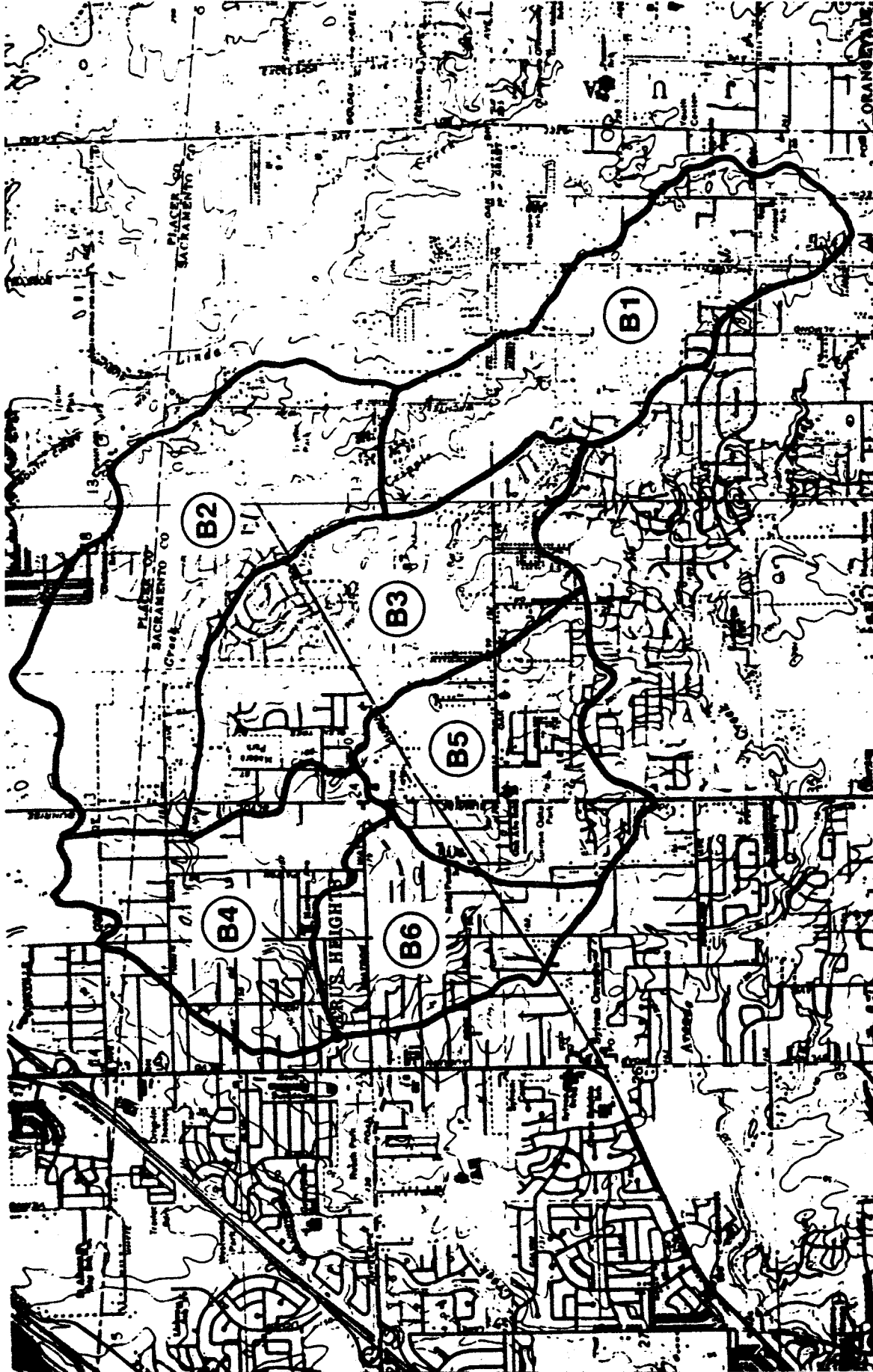
The following hydrologic parameters required to model the precipitation and the precipitation losses were derived from USGS topography maps, aerial photographs and SCS Soils maps.

- parameters required to calculate the precipitation: basin area, precipitation zone, and elevation
- parameters required to calculate the precipitation losses: percent impervious, and hydrologic soil types

The hydrologic parameters are summarized below.

Summary of Hydrologic Parameters for Upper Arcade Creek*			
Basin ID	Area mi ²	Elevation ft	Percent Impervious
1	0.93	220	31
2	1.19	170	31
3	1.03	190	29
4	0.72	150	24
5	0.71	180	36
6	0.52	150	27

* all basins are in rainfall zone 3 with a hydrologic soil type D



Date: December 1996

Figure 10-1

Upper Arcade Creek
Drainage Area

Example 1 - Multi-Basin Planning Study: Input Data (continued)

Lag Parameters

The lag time, which determines the shape of the basin runoff hydrographs, was determined by using the basin "n" lag method. This method requires the following parameters:

- length of the watercourse
- slope of the watercourse
- length to the centroid of the basin
- land use in the basin and the watercourse condition to determine the basin "n" value

The watercourse for each subbasin is shown on Figure 10-2. A "X" is placed at the point along the watercourse which is 90% of the distance between the concentration point and the headwater divide. This distance is used to calculate the slope of the drainage basin. A "X" is also placed at the centroid of each basin and a line is drawn perpendicular to the watercourse to show the length to the centroid of the basin. Table 7-1 was used to determine the basin "n" value according to the land use and conveyance systems in each basin. The lag parameters are summarized below.

Summary of Lag Parameters for Upper Arcade Creek				
Subbasin ID	Slope ft/mi	Length mi	Length to Centroid mi	Basin "n" Value*
1	24.6	2.09	1.13	0.046
2	19.1	2.65	1.25	0.046
3	29.7	2.52	1.24	0.046
4	34.7	1.33	0.63	0.050
5	40.5	1.10	0.55	0.042
6	34.0	1.42	1.05	0.046

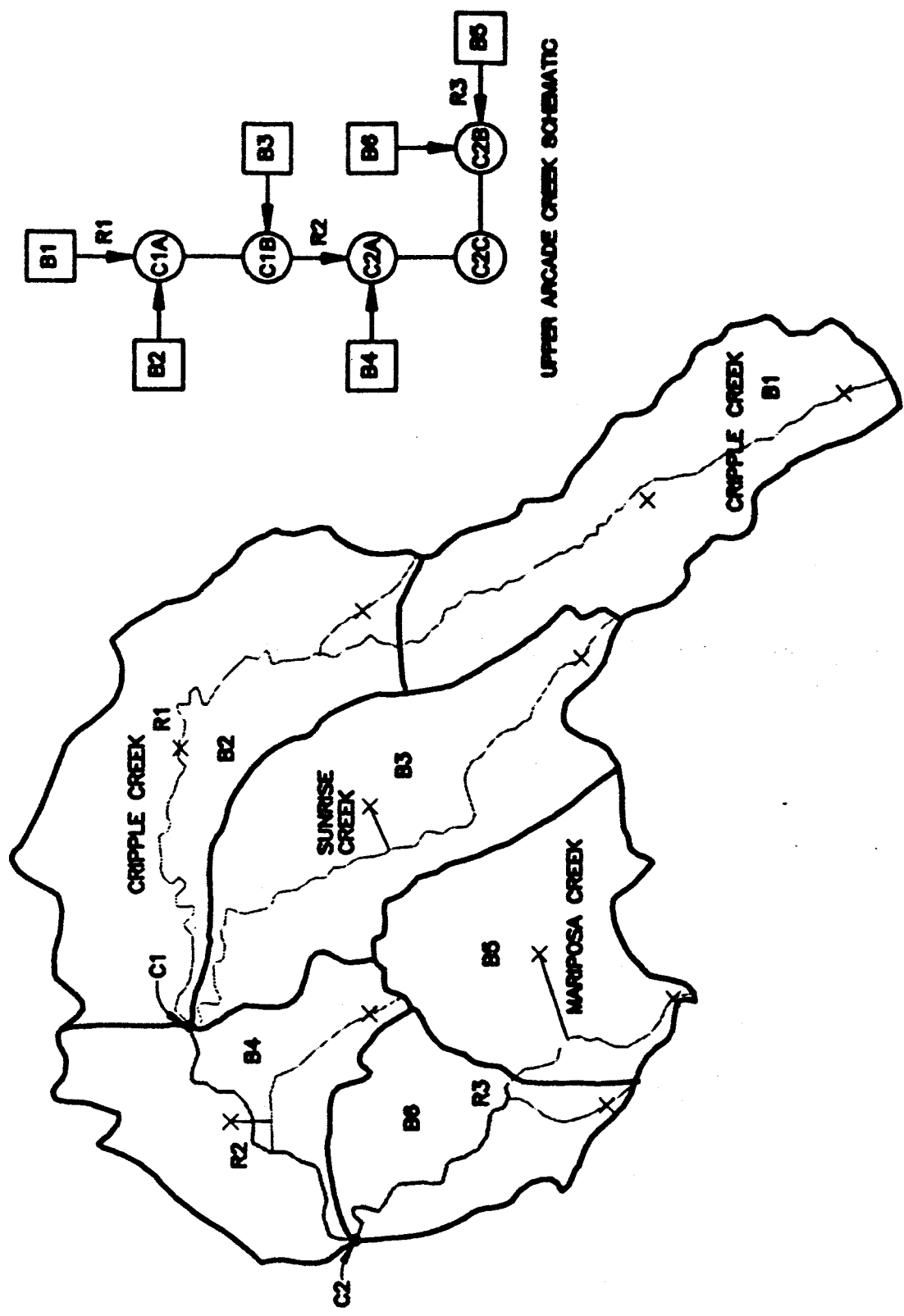
* developed channelization

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Figure 10-2

Upper Arcade Creek Drainage Schematic



UPPER ARCADE CREEK SCHEMATIC

Example 1 - Multi-Basin Planning Study: Input Data (continued)

Hydrograph Routing

Information on the main channel reaches is required to route hydrographs from the upper basins to the lower concentration points. HEC-2, the Corps of Engineer's Water Surface Profile Program was used to model the major tributaries in the Arcade Creek basin. Storage-discharge information was obtained from HEC-2 output and was used with the Modified Puls routing option in HEC-1. The storage-discharge information is summarized below.

Upper Arcade Creek Modified Puls Routing Data Storage Volume, ac-ft								
Reach	Discharge, cfs							
	0	100	200	300	400	500	600	700
1	0	20	40	60	81	106	130	149
2	0	8	12	24	30	34	44	53
3	0	9	15	24	32	41	48	54

Design Storm and Computation Interval

A 10-year design storm with a 12-hour duration is used in the 4.01e version of HEC-1 to model the basin. Based on this information, the computation interval of the HEC-1 program is 2 minutes and the lag time of the subbasins should be between 10 minutes and 3.0 hours to accurately define the runoff hydrographs.

Future Development

A future development model can be developed by changing the percent impervious, the basin roughness and the channel routing parameters to reflect increased development. The future model could then be modified to determine the effect of a project such as a detention basin on mitigating the increased peak flow due to development.

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Example 1 - Multi-Basin Planning Study: Input Data (continued)

Basin Network

The connectivity of stream network components in HEC-1 is implied by the order in which the components are arranged. The major components in this example are subbasin hydrograph calculations, hydrograph routing, and hydrograph addition. The structure must always begin in a branch of the stream network at the uppermost subbasin and proceed downstream until a confluence is reached. The flows are combined at the confluence and are routed downstream. The structure of the basin and stream network should always be outlined before the creation of an SACPRES intermediate file. A schematic showing the basin and stream network for this example is presented in Figure 10-2. An outline of the order of computation follows.

Upper Arcade Creek, SACPRES and HEC-1 Input File Order	
Station ID	Computation
B1	calculate subbasin hydrograph B1
R1	route hydrograph B1
B2	calculate subbasin hydrograph B2
C1A	add hydrographs R1 and B2
B3	calculate subbasin hydrograph B3
C1B	add hydrographs R1, B2, B3
R2	route hydrograph C1
B4	calculate subbasin hydrograph B4
C2A	add hydrographs R2 and B4
B5	calculate subbasin hydrograph B5
R3	route hydrograph B5
B6	calculate hydrograph B6
C2B	add hydrographs R3 and B6
C2C	add hydrographs R2, B4, R3, B6

Example 1 - Multi-Basin Planning Study: SACPRE Intermediate File

Introduction

SACPRE can be used to generate an intermediate file and ultimately a HEC-1 input file, once all of the pertinent data is collected and the structure of the drainage basin network is outlined. The intermediate file and the processed HEC-1 input file created in SACPRE and the HEC-1 output file for this example are shown on the following pages.

SACPRE Intermediate File

The SACPRE intermediate file for the multi-basin planning study example problem is shown below.

```

IDUPPER ARCADE CREEK
IDMULTIBASIN PLANNING LEVEL EXAMPLE
IDDRAINAGE MANUAL - HYDROLOGY STANDARDS
IT 2 12AUG94 1 500
IO 3 0 0
IN 5
*G 10-YEAR, 12-HOUR STORM 6-SUBBASINS 5.100-SQ MI LENGTHS IN MILES V-2
KK B1
*S ZONE =3, ELEV =220-FEET, LAG = -HOURS
*LN L = 2.090; LC = 1.130; SLOPE = .0047; BASIN "N" =
*LN LU = 7 (Residential: 3-4 units/acre); CF = 1 (DEV.); A = (100.0%) .930
*I LU = 7 (Residential: 3-4 units/acre); SOIL = D; A = .930 (100.0-%)
BA .930
LU .20 .09 30.00
KK R1
*RS REACH LENGTH = .000-MILES, AVG. VELOC. = .0-FPS, NO. OF STEPS = 5
SV 0. 20. 40. 60. 81. 106. 130. 149. 0. 0.
SQ 0. 100. 200. 300. 400. 500. 600. 700. 0. 0.
KK B2
*S ZONE =3, ELEV =170-FEET, LAG = -HOURS
*LN L = 2.650; LC = 1.250; SLOPE = .0036; BASIN "N" =
*LN LU = 7 (Residential: 3-4 units/acre); CF = 1 (DEV.); A = (100.0%) 1.190
*I LU = 7 (Residential: 3-4 units/acre); SOIL = D; A = 1.190 (100.0-%)
BA 1.190
LU .20 .09 30.00
KK C1A
HC 2
KK B3
*S ZONE =3, ELEV =190-FEET, LAG = -HOURS
*LN L = 2.520; LC = 1.240; SLOPE = .0056; BASIN "N" =
*LN LU = 7 (Residential: 3-4 units/acre); CF = 1 (DEV.); A = (100.0%) 1.030
*I LU = 7 (Residential: 3-4 units/acre); SOIL = D; A = 1.030 (100.0-%)
BA 1.030
LU .20 .09 30.00
KK C1A
HC 2
KK R2

```

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Example 1 - Multi-Basin Planning Study: SACPRE Intermediate File (con't)

SACPRE
Intermediate File
(continued)

```

*RS REACH LENGTH = .000-MILES, AVG. VELOC. = .0-FPS, NO. OF STEPS = 5
SV 0. 8. 12. 24. 30. 34. 44. 53. 0. 0.
SQ 0. 100. 200. 300. 400. 500. 600. 700. 0. 0.
KK B4
*S ZONE =3, ELEV =150-FEET, LAG = -HOURS
*LN L = 1.330; LC = .630; SLOPE = .0125; BASIN "N" =
*LN LU = 8 (Residential: 2-3 units/acre); CF = 1 (DEV.); A = (100.0%) .720
*I LU = 8 (Residential: 2-3 units/acre); SOIL = D; A = .720 (100.0-%)
BA .720
LU .20 .09 25.00
KK C2A
HC 2
KK B5
*S ZONE =3, ELEV =180-FEET, LAG = -HOURS
*LN L = 1.100; LC = .550; SLOPE = .0077; BASIN "N" =
*LN LU = 6 (Residential: 4-6 units/acre); CF = 1 (DEV.); A = (100.0%) .710
*I LU = 6 (Residential: 4-6 units/acre); SOIL = D; A = .710 (100.0-%)
BA .710
LU .20 .08 40.00
KK R3
*RS REACH LENGTH = .000-MILES, AVG. VELOC. = .0-FPS, NO. OF STEPS = 5
SV 0. 9. 15. 24. 32. 41. 48. 54. 0. 0.
SQ 0. 100. 200. 300. 400. 500. 600. 700. 0. 0.
KK B6
*S ZONE =3, ELEV =150-FEET, LAG = -HOURS
*LN L = 1.420; LC = 1.050; SLOPE = .0064; BASIN "N" =
*LN LU = 7 (Residential: 3-4 units/acre); CF = 1 (DEV.); A = (100.0%) .520
*I LU = 7 (Residential: 3-4 units/acre); SOIL = D; A = .520 (100.0-%)
BA .520
LU .20 .09 30.00
KK C2B
HC 2
KK C2C
HC 2
ZZ

```

Example 1 - Multi-Basin Planning Study: SACPRE Summary File

SACPRE Summary File

The SACPRE summary file for the multi-basin planning study example is shown below.

SACRAMENTO CITY AND COUNTY HEC-1 PREPROCESSOR
SUMMARY OUTPUT AUGUST 12, 1994 13:26

UPPER ARCADE CREEK
MULTIBASIN PLANNING LEVEL EXAMPLE
DRAINAGE MANUAL - HYDROLOGY STANDARDS

Storm Recurrence Interval: 10-Years
Storm Duration: 12-Hours
Mdel Timestep: 2-Minute(s)

SUBBASIN DATA

Operation Type	I. D.	Area (ac)	% Imp	i (in/hr)	Lag (min)
A	B1	595	30	.09	56
R	R1	Mdfied Puls Routing.			
A	B2	762	30	.09	66
C	C1A	Combine previous 2 hydrographs.			
A	B3	659	30	.09	60
C	C1B	Combine previous 2 hydrographs.			
R	R2	Mdfied Puls Routing.			
A	B4	461	25	.09	37
C	C2A	Combine previous 2 hydrographs.			
A	B5	454	40	.08	30
R	R3	Mdfied Puls Routing.			
A	B6	333	30	.09	46
C	C2B	Combine previous 2 hydrographs.			
C	C2C	Combine previous 2 hydrographs.			

Continued on next page...

Example 1 - Multi-Basin Planning Study: SACPRE Summary File (con't)

**SACPRE
Summary
File (Cont.)**

		CONVEYANCE SYSTEM DATA								
Operation Type	I. D.	Overland Flow			Gutter Flow			Channel/Pipe Flow		
		Land Use	S		L(ft)	S	T	n	L(ft)	S
A	B1	Subbasin 'n' Lag; L = 2.090-miles, Lc = 1.130-miles Slope = .0047, Basin n = .046								
R	R1	5-Steps. Reach Length = 0.-feet, Average Velocity = .0-fps Storage (ac-ft) Discharge (CFS)								
		20.			100.					
		40.			200.					
		60.			300.					
		81.			400.					
		106.			500.					
		130.			600.					
		149.			700.					
A	B2	Subbasin 'n' Lag; L = 2.650-miles, Lc = 1.250-miles Slope = .0036, Basin n = .046								
C	C1A									
A	B3	Subbasin 'n' Lag; L = 2.520-miles, Lc = 1.240-miles Slope = .0056, Basin n = .046								
C	C1B									
R	R2	5-Steps. Reach Length = 0.-feet, Average Velocity = .0-fps Storage (ac-ft) Discharge (CFS)								
		8.			100.					
		12.			200.					
		24.			300.					
		30.			400.					
		34.			500.					
		44.			600.					
		53.			700.					
A	B4	Subbasin 'n' Lag; L = 1.330-miles, Lc = .630-miles Slope = .0125, Basin n = .050								
C	C2A									
A	B5	Subbasin 'n' Lag; L = 1.100-miles, Lc = .550-miles Slope = .0077, Basin n = .042								
R	R3	5-Steps. Reach Length = 0.-feet, Average Velocity = .0-fps Storage (ac-ft) Discharge (CFS)								
		9.			100.					
		15.			200.					
		24.			300.					
		32.			400.					
		41.			500.					
		48.			600.					
		54.			700.					
A	B6	Subbasin 'n' Lag; L = 1.420-miles, Lc = 1.050-miles Slope = .0064, Basin n = .046								
C	C2B									
C	C2C									

Continued on next page...

Example 1 - Multi-Basin Planning Study: SACPRE Summary File (con't)

**SACPRE
Summary File
(Cont.)**

LAND USE - SOIL TYPE - CHANNEL/FLOODPLAIN					
Operation Type	I. D.	%	Land Use	Soil Type/ Channelization	
A	B1	100	Residential: 3-4 units/acre 100 Residential: 3-4 units/acre	DEVELOPED D	
R	R1				
A	B2	100	Residential: 3-4 units/acre 100 Residential: 3-4 units/acre	DEVELOPED D	
C	C1A				
A	B3	100	Residential: 3-4 units/acre 100 Residential: 3-4 units/acre	DEVELOPED D	
C	C1				
R	R2				
A	B4	100	Residential: 2-3 units/acre 100 Residential: 2-3 units/acre	DEVELOPED D	
C	C2A				
A	B5	100	Residential: 4-6 units/acre 100 Residential: 4-6 units/acre	DEVELOPED D	
R	R3				
A	B6	100	Residential: 3-4 units/acre 100 Residential: 3-4 units/acre	DEVELOPED D	
C	C2B				
C	C2C				

Example 1 - Multi-Basin Planning Study: HEC-1 Input File

HEC-1 Input File

The HEC-1 input file for the multi-basin planning study example is shown below.

```

IDUPPER ARCADE CREEK
IDMULTIBASIN PLANNING LEVEL EXAMPLE
IDDRAINAGE MANUAL - HYDROLOGY STANDARDS
IT      2 12AUG94      1      500

IO      3      0      0
IN      5
KK      B1
PB      0.00
PI      .009      .009      .009      .009      .009      .009      .009      .009      .009      .009
PI      .009      .009      .009      .009      .009      .009      .009      .009      .009      .009
PI      .009      .009      .009      .009      .009      .009      .009      .009      .009      .009
PI      .009      .009      .009      .009      .009      .009      .013      .013      .013      .013
PI      .013      .013      .013      .013      .013      .013      .013      .013      .013      .013
PI      .013      .013      .013      .013      .017      .017      .017      .017      .017      .017
PI      .023      .023      .023      .023      .023      .023      .034      .034      .034      .048
PI      .071      .243      .108      .048      .048      .034      .034      .034      .023      .023
PI      .023      .023      .023      .023      .017      .017      .017      .017      .017      .017
PI      .013      .013      .013      .013      .013      .013      .013      .013      .013      .013
PI      .013      .013      .013      .013      .013      .013      .013      .013      .009      .009
PI      .009      .009      .009      .009      .009      .009      .009      .009      .009      .009
PI      .009      .009      .009      .009      .009      .009      .009      .009      .009      .009
PI      .009      .009      .009      .009
BA      .930
LU      .20      .09      30.00
UI      17.      17.      41.      66.      94.      94.      115.      152.      152.      183.
UI      220.      220.      259.      303.      347.      347.      399.      455.      455.      506.
UI      519.      519.      526.      519.      506.      506.      466.      424.      424.      381.
UI      344.      344.      320.      297.      270.      270.      253.      235.      235.      217.
UI      204.      204.      190.      177.      165.      165.      156.      146.      146.      138.
UI      129.      129.      122.      115.      110.      110.      103.      98.      98.      93.
UI      89.      89.      85.      80.      77.      77.      72.      70.      70.      66.
UI      65.      65.      62.      60.      58.      58.      56.      54.      54.      52.
UI      50.      50.      48.      47.      45.      45.      43.      42.      42.      40.
UI      39.      39.      37.      37.      35.      35.      34.      32.      32.      31.
UI      30.      30.      29.      28.      27.      27.      26.      25.      25.      24.
UI      24.      24.      23.      22.      21.      21.      20.      20.      20.      19.
UI      18.      18.      18.      17.      16.      16.      16.      15.      15.      15.
UI      14.      14.      14.      13.      13.      13.      13.      12.      12.      12.
UI      11.      11.      11.      11.      10.      10.      10.      9.      9.      9.
UI      9.      9.      8.      8.      8.      8.      8.      7.      7.      7.
UI      7.      7.      7.      6.      6.      6.      6.      6.      6.      6.
UI      6.
KK      R1
RS      5      FLOW      -1
SV      0.      20.      40.      60.      81.      106.      130.      149.      0.      0.
SQ      0.      100.      200.      300.      400.      500.      600.      700.      0.      0.
    
```

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Example 1 - Multi-Basin Planning Study: HEC-1 Input File (continued)

HEC-1 Input File (Cont.)

KK	B2									
BA	1.190									
LU	.20	.09	30.00							
UI	18.	18.	45.	45.	73.	103.	103.	126.	126.	167.
UI	201.	201.	242.	242.	285.	332.	332.	381.	381.	438.
UI	500.	500.	556.	556.	570.	577.	577.	570.	570.	556.
UI	511.	511.	465.	465.	418.	377.	377.	352.	352.	326.
UI	296.	296.	278.	278.	259.	239.	239.	224.	224.	208.
UI	195.	195.	181.	181.	171.	160.	160.	151.	151.	142.
UI	134.	134.	127.	127.	121.	113.	113.	108.	108.	102.
UI	97.	97.	93.	93.	88.	85.	85.	79.	79.	77.
UI	73.	73.	71.	71.	68.	66.	66.	64.	61.	61.
UI	59.	59.	57.	55.	55.	53.	53.	51.	49.	49.
UI	47.	47.	46.	44.	44.	43.	43.	41.	40.	40.
UI	38.	38.	37.	35.	35.	34.	34.	33.	32.	32.
UI	31.	31.	30.	29.	29.	28.	28.	27.	26.	26.
UI	25.	25.	24.	23.	23.	23.	23.	22.	21.	21.
UI	20.	20.	19.	18.	18.	18.	18.	17.	17.	17.
UI	16.	16.	16.	15.	15.	14.	14.	14.	14.	14.
UI	13.	13.	13.	12.	12.	12.	12.	12.	11.	11.
UI	11.	11.	10.	10.	10.	10.	10.	9.	9.	9.
UI	9.	9.	8.	8.	8.	8.	8.	8.	7.	7.
UI	7.	7.	7.	7.	7.	6.	6.	6.	6.	6.
KK	C1A									
HC	2									
KK	B3									
BA	1.030									
LU	.20	.09	30.00							
UI	18.	18.	43.	69.	69.	98.	119.	119.	159.	190.
UI	190.	229.	270.	270.	315.	361.	361.	415.	474.	474.
UI	527.	527.	540.	547.	547.	540.	527.	527.	485.	441.
UI	441.	397.	358.	358.	333.	309.	309.	281.	263.	263.
UI	245.	226.	226.	212.	197.	197.	185.	171.	171.	162.
UI	152.	152.	143.	135.	135.	127.	120.	120.	114.	114.
UI	107.	102.	102.	97.	92.	92.	89.	83.	83.	80.
UI	75.	75.	73.	69.	69.	68.	65.	65.	63.	60.
UI	60.	58.	56.	56.	54.	52.	52.	50.	49.	49.
UI	47.	45.	45.	44.	42.	42.	41.	39.	39.	38.
UI	38.	36.	35.	35.	34.	33.	33.	31.	30.	30.
UI	29.	28.	28.	27.	27.	27.	25.	25.	25.	24.
UI	23.	23.	22.	21.	21.	21.	20.	20.	19.	18.
UI	18.	18.	17.	17.	16.	16.	16.	15.	15.	15.
UI	14.	14.	14.	13.	13.	13.	13.	13.	12.	12.
UI	12.	11.	11.	11.	11.	10.	10.	10.	9.	9.
UI	9.	9.	9.	8.	8.	8.	8.	8.	8.	7.
UI	7.	7.	7.	7.	7.	7.	6.	6.	6.	6.
UI	6.	6.	6.							
KK	C1B									
HC	2									
KK	R2									
RS	5	FLOW	-1							
SV	0.	8.	12.	24.	30.	34.	44.	53.	0.	0.
SQ	0.	100.	200.	300.	400.	500.	600.	700.	0.	0.

Example 1 - Multi-Basin Planning Study: HEC-1 Input File (continued)

*HEC1-Input
File (Cont.)*

KK	B4									
BA	.720									
LU	.20	.09	25.00							
UI	20.	48.	77.	110.	134.	178.	213.	257.	353.	405.
UI	466.	531.	591.	606.	614.	606.	591.	544.	495.	445.
UI	401.	374.	347.	315.	295.	275.	238.	222.	207.	192.
UI	182.	170.	161.	151.	142.	135.	128.	121.	114.	109.
UI	103.	99.	93.	90.	82.	78.	76.	73.	71.	68.
UI	65.	63.	61.	58.	56.	55.	52.	50.	49.	47.
UI	46.	43.	41.	39.	38.	37.	35.	34.	33.	32.
UI	31.	30.	29.	28.	27.	26.	25.	24.	23.	21.
UI	21.	20.	19.	18.	18.	17.	17.	16.	15.	15.
UI	15.	14.	14.	13.	13.	12.	12.	11.	10.	10.
UI	10.	10.	9.	9.	9.	8.	8.	8.	7.	7.
UI	7.	7.	6.	6.						
KK	C2A									
HC	2									
KK	B5									
BA	.710									
LU	.20	.08	40.00							
UI	24.	93.	131.	160.	213.	308.	363.	424.	559.	638.
UI	709.	727.	727.	709.	652.	534.	481.	449.	416.	354.
UI	330.	304.	266.	248.	231.	219.	193.	181.	170.	154.
UI	145.	137.	131.	119.	112.	108.	98.	93.	91.	87.
UI	81.	78.	75.	70.	67.	66.	63.	59.	56.	55.
UI	51.	49.	47.	45.	42.	41.	39.	37.	36.	34.
UI	33.	31.	30.	29.	27.	25.	25.	24.	22.	21.
UI	21.	19.	18.	18.	18.	17.	16.	15.	14.	14.
UI	13.	13.	12.	11.	11.	10.	10.	10.	9.	9.
UI	8.	8.	8.							
KK	R3									
RS	5	FLOW	-1							
SV	0.	9.	15.	24.	32.	41.	48.	54.	0.	0.
SQ	0.	100.	200.	300.	400.	500.	600.	700.	0.	0.
KK	B6									
BA	.520									
LU	.20	.09	30.00							
UI	11.	28.	45.	45.	64.	78.	104.	125.	150.	177.
UI	177.	207.	236.	272.	310.	345.	354.	354.	359.	354.
UI	345.	318.	289.	260.	260.	234.	219.	203.	184.	173.
UI	173.	161.	148.	139.	129.	121.	112.	112.	106.	99.
UI	94.	88.	83.	79.	79.	75.	70.	67.	64.	60.
UI	58.	58.	54.	53.	49.	48.	45.	44.	44.	42.
UI	41.	40.	38.	37.	35.	35.	34.	33.	32.	31.
UI	29.	29.	29.	27.	27.	25.	25.	24.	23.	23.
UI	22.	21.	21.	20.	19.	18.	18.	18.	17.	17.
UI	16.	16.	16.	15.	15.	14.	13.	13.	12.	12.
UI	12.	11.	11.	11.	10.	10.	10.	10.	9.	9.
UI	9.	9.	8.	8.	8.	8.	7.	7.	7.	7.
UI	7.	6.	6.	6.	6.	6.	5.	5.	5.	5.
UI	5.	5.	4.	4.	4.	4.	4.	4.	4.	4.
KK	C2B									
HC	2									
KK	C2C									
HC	2									
ZZ										

Example 1 - Multi-Basin Planning Study: HEC-1 Output File

HEC-1 Output File

The HEC-1 output file for the multi-basin planning study example is shown below.

```

UPPER ARCADE CREEK

MULTIBASIN PLANNING LEVEL EXAMPLE

DRAINAGE MANUAL - HYDROLOGY STANDARDS

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

IT      HYDROGRAPH TIME DATA
        NMN        2  MINUTES IN COMPUTATION INTERVAL
        IDATE      12AUG94  STARTING DATE
        ITIME      0001  STARTING TIME
        NQ         500  NUMBER OF HYDROGRAPH ORDINATES
        NDDATE     12AUG94  ENDING DATE
        NDTIME     1639  ENDING TIME
        ICENT      19  CENTURY MARK

        COMPUTATION INTERVAL  0.03 HOURS
        TOTAL TIME BASE      16.63 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

```

Continued on next page...

Example 1 - Multi-Basin Planning Study: HEC-1 Output File (continued)

HEC-1 Output File (Cont.)

		RUNOFF SUMMARY					BASIN AREA
		FLOW IN CUBIC FEET PER SECOND					
		TIME IN HOURS, AREA IN SQUARE MILES					
OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR 6-HOUR	24-HOUR	72-HOUR	
HYDROGRAPH AT	B1	343.	6.73	129.	57.	57.	0.93
ROUTED TO							
HYDROGRAPH AT	R1	189.	9.10	124.	57.	57.	0.93
2 COMBINED AT	B2	400.	6.87	163.	73.	73.	1.19
HYDROGRAPH AT	C1A	454.	6.90	278.	130.	130.	2.12
2 COMBINED AT	B3	367.	6.80	142.	64.	64.	1.03
ROUTED TO	C1B	816.	6.83	417.	194.	194.	3.15
HYDROGRAPH AT	R2	661.	7.97	413.	193.	193.	3.15
2 COMBINED AT	B4	340.	6.47	100.	43.	43.	0.72
HYDROGRAPH AT	C2A	756.	7.83	500.	236.	236.	3.87
ROUTED TO	B5	383.	6.37	108.	48.	48.	0.71
HYDROGRAPH AT	R3	252.	7.37	107.	48.	48.	0.71
2 COMBINED AT	B6	217.	6.60	73.	32.	32.	0.52
2 COMBINED AT	C2B	381.	6.83	179.	80.	80.	1.23
	C2C	1075.	7.57	673.	316.	316.	5.10

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

Example 2 - Single Basin Analysis of Subdivision: Input Data

Overview

This example demonstrates the development of a hydrograph for an existing subdivision modelled as a single basin. The Parkview Place subdivision was selected. The travel time component method is used to determine the lag time. This is the procedure to use when a detailed analysis of a developed basin is required.

Watershed Boundary

The study area is shown on Figure 10-3. Although the terminus for a developed basin would normally be a creek (or pump), the basin concentration point was chosen to be manhole #17, for ease of presentation.

Hydrologic Parameters

Values for drainage area, elevation, and soil type were determined from USGS topography maps and SCS Soils maps. The percent impervious was determined from aerial photographs and zoning maps. These values are summarized below.

Summary of Hydrologic Parameters				
Concentration Point	Area acres	Elevation feet	Percent Impervious	Soil Type
Bond Road and Stockton Blvd.	119.2	38	38.15	D

Continued on next page...

Example 2 - Single Basin Analysis of Subdivision: Input Data (continued)

Lag Parameters

The travel time method is more site specific than the basin "n" method, and requires the following parameters:

- ? land use of the most upstream portion of the longest watercourse.
- ? length and slope of the gutter between the overland flow path and the first drop inlet.
- ? length, slope and diameter of the various segments of drain pipe from the first manhole to the concentration point.

The lag time parameters are summarized below.

Travel Time Parameters of Pipe System						
Upstream Node		Downstream Node		Pipe Description		
Manhole #	Flowline feet	Manhole #	Flowline feet	Length feet	Slope feet/feet	Diam inches
MH#1	35.80	MH#2	35.08	257	0.0028	12
MH#2	34.83	MH#3	34.35	240	0.0020	15
MH#3	34.35	MH#4	33.75	299	0.0020	15
MH#4	33.75	MH#5	33.18	240	0.0024	15
MH#5	32.97	MH#6	32.57	233	0.0017	18
MH#6	32.57	MH#7	32.13	230	0.0019	18
MH#7	31.88	MH#8	31.48	368	0.0015	21
MH#8	30.73	MH#9	30.14	643	0.0009	30
MH#9	29.19	MH#10	29.13	120	0.0005	42
MH#10	29.13	MH#11	29.06	144	0.0005	42
MH#11	29.06	MH#12	29.00	126	0.0005	42
MH#12	29.00	MH#13	28.91	159	0.0006	42
MH#13	28.91	MH#14	28.85	111	0.0005	42
MH#14	28.85	MH#15	28.74	150	0.0007	42
MH#15	27.24	MH#16	27.16	257	0.0003	60
MH#16	27.16	MH#17	26.97	622	0.0003	60

Example 2 - Single Basin Analysis of Subdivision: SACPRE Intermediate File

Introduction

The intermediate, summary, processed (HEC-1 input), and output files are shown on the following pages.

SACPRE Intermediate File

The SACPRE intermediate file for the single basin analysis of a subdivision example problem is shown below.

```
IDPARKVIEW PLACE SUBDIVISION
IDSINGLE BASIN ANALYSIS OF A SUBDIVISION
IDVOLUME 2 - HYDROLOGY STANDARDS
IT 1 27JUL94 1 500
IO 3 0 0
IN 5
*G 10-YEAR, 6-HOUR STORM 1-SUBBASINS 119.200-ACRES LENGTHS IN FEET V-2
KK BOND
KM BOND ROAD AND STOCKTON BLVD
*S ZONE =2, ELEV = 38-FEET, LAG = .70-HOURS
*LC LU=R SO = .001 LG = 465.000 SG = .001 SS = .020
*LC 1 TYPE = C L = 257.000 S = .003 D/W = 12 Q = 0 n = .015
*LC 2 TYPE = C L = 240.000 S = .002 D/W = 15 Q = 0 n = .015
*LC 3 TYPE = C L = 299.000 S = .002 D/W = 15 Q = 0 n = .015
*LC 4 TYPE = C L = 240.000 S = .002 D/W = 15 Q = 0 n = .015
*LC 5 TYPE = C L = 233.000 S = .002 D/W = 18 Q = 0 n = .015
*LC 6 TYPE = C L = 230.000 S = .002 D/W = 18 Q = 0 n = .015
*LC 7 TYPE = C L = 268.000 S = .002 D/W = 21 Q = 0 n = .015
*LC 8 TYPE = C L = 643.000 S = .001 D/W = 30 Q = 0 n = .015
*LC 9 TYPE = C L = 120.000 S = .001 D/W = 42 Q = 0 n = .015
*LC 10 TYPE = C L = 144.000 S = .002 D/W = 42 Q = 0 n = .015
*LC 11 TYPE = C L = 126.000 S = .001 D/W = 42 Q = 0 n = .015
*LC 12 TYPE = C L = 159.000 S = .001 D/W = 42 Q = 0 n = .015
*LC 13 TYPE = C L = 111.000 S = .002 D/W = 42 Q = 0 n = .015
*LC 14 TYPE = C L = 150.000 S = .001 D/W = 42 Q = 0 n = .015
*LC 15 TYPE = C L = 257.000 S = .001 D/W = 60 Q = 0 n = .015
*LC 16 TYPE = C L = 622.000 S = .001 D/W = 60 Q = 0 n = .015
*I LU = 3 (Condominiums/Schools/Industry); SOIL = D; A = 5.300 ( 4.4-%)
*I LU = 6 (Residential: 4-6 units/acre); SOIL = D; A = 103.900 ( 87.2-%)
*I LU = 14 (Pasture/Mowed Grass ); SOIL = D; A = 10.000 ( 8.4-%)
BA .186
LU .20 .08 38.15
ZZ
```

Example 2 - Single Basin Analysis of Subdivision: SACPRE Summary File

SACPRE Summary File

The SACPRE summary file for the single basin analysis of a subdivision example is shown below.

SACRAMENTO CITY AND COUNTY HEC-1 PREPROCESSOR
SUMMARY OUTPUT AUGUST 27, 1994 14:47

PARKVIEW PLACE SUBDIVISION
SINGLE BASIN ANALYSIS OF A SUBDIVISION
VOLUME 2 - HYDROLOGY STANDARDS

Storm Recurrence Interval: 10-Years
Storm Duration: 6-Hours
Model Timestep: 1-Minute(s)

SUBBASIN DATA

Operation Type	I. D.	Area (ac)	% Imp	i (in/hr)	Lag (min)
A	BOND	119	38	.08	42

CONVEYANCE SYSTEM DATA

I. D.	Overland Flow		Gutter Flow			Channel/Pipe Flow			
	Land Use	S	L(ft)	S	T	n	L(ft)	S	D/W
BOND	RESIDENTIAL	.0010	465	.0010	C	.015	257	.003	12
					C	.015	240	.002	15
					C	.015	299	.002	15
					C	.015	240	.002	15
					C	.015	233	.002	18
					C	.015	230	.002	18
					C	.015	268	.002	21
					C	.015	643	.001	30
					C	.015	120	.001	42
					C	.015	144	.002	42
					C	.015	126	.001	42
					C	.015	159	.001	42
					C	.015	111	.002	42
					C	.015	150	.001	42
					C	.015	257	.001	60
					C	.015	622	.001	60

LAND USE - SOIL TYPE - CHANNEL/FLOODPLAIN

I. D.	%	Land Use	Soil Type/ Channelization
BOND	4	Condominiums/Schools/Industry	D
	87	Residential: 4-6 units/acre	D
	8	Pasture/Mowed Grass	D

Example 2 - Single Basin Analysis of Subdivision: HEC-1 Input File

HEC-1 Input File

The HEC-1 input file for the single basin analysis of a subdivision example problem is shown below.

```

ID PARKVIEW PLACE SUBDIVISION
ID SINGLE BASIN ANALYSIS OF A SUBDIVISION
ID VOLUME 2 - HYDROLOGY STANDARDS
IT 1 27JUL94 1 500
 IO 3 0 0
IN 5
KK BOND
PB 0.00
PI .012 .012 .012 .012 .012 .012 .012 .012 .012 .012
PI .012 .012 .012 .012 .012 .012 .012 .012 .016 .016
PI .016 .016 .016 .016 .022 .022 .022 .022 .022 .022
PI .033 .033 .033 .047 .070 .250 .110 .047 .047 .033
PI .033 .033 .022 .022 .022 .022 .022 .022 .016 .016
PI .016 .016 .016 .016 .012 .012 .012 .012 .012 .012
PI .012 .012 .012 .012 .012 .012 .012 .012 .012 .012
PI .012 .012
KM BOND ROAD AND STOCKTON BLVD
BA .186
LU .20 .08 38.15
UI 5. 5. 5. 11. 11. 18. 18. 25. 25. 31.
UI 31. 41. 41. 49. 49. 59. 59. 59. 69. 69.
UI 81. 81. 93. 93. 107. 107. 122. 122. 136. 136.
UI 139. 139. 139. 141. 141. 139. 139. 136. 136. 125.
UI 125. 113. 113. 102. 102. 92. 92. 86. 86. 86.
UI 80. 80. 72. 72. 68. 68. 63. 63. 58. 58.
UI 55. 55. 51. 51. 51. 47. 47. 44. 44. 42.
UI 42. 39. 39. 37. 37. 35. 35. 33. 33. 31.
UI 31. 31. 29. 29. 28. 28. 26. 26. 25. 25.
UI 24. 24. 23. 23. 21. 21. 21. 21. 21. 19.
UI 19. 19. 19. 18. 18. 17. 17. 17. 17. 16.
UI 16. 16. 16. 16. 15. 15. 14. 14. 14. 14.
UI 13. 13. 13. 13. 13. 13. 12. 12. 12. 12.
UI 12. 11. 11. 11. 11. 10. 10. 10. 10. 10.
UI 10. 9. 9. 9. 9. 9. 9. 9. 8. 8.
UI 8. 8. 8. 8. 8. 8. 7. 7. 7. 7.
UI 7. 7. 7. 7. 7. 6. 6. 6. 6. 6.
UI 6. 6. 6. 5. 5. 5. 5. 5. 5. 5.
UI 5. 5. 5. 5. 5. 5. 4. 4. 4. 4.
UI 4. 4. 4. 4. 4. 4. 4. 4. 4. 4.
UI 4. 3. 3. 3. 3. 3. 3. 3. 3. 3.
UI 3. 3. 3. 3. 3. 3. 3. 3. 3. 3.
UI 3. 3. 2. 2. 2. 2. 2. 2. 2. 2.
UI 2. 2. 2. 2. 2. 2. 2. 2. 2. 2.
UI 2. 2. 2. 2. 2. 2. 2. 2. 2. 2.
UI 2. 2. 1. 1. 1. 1. 1. 1. 1. 1.
ZZ
    
```

Example 2 - Single Basin Analysis of Subdivision: HEC-1 Output File

HEC-1 Output File

The HEC-1 output file for the single basin analysis of a subdivision example is given below.

```

PARKVIEW PLACE SUBDIVISION
SINGLE BASIN ANALYSIS OF A SUBDIVISION
VOLUME 2 - HYDROLOGY STANDARDS

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

IT      HYDROGRAPH TIME DATA
        NMN        1  MINUTES IN COMPUTATION INTERVAL
        IDATE      27JUL94  STARTING DATE
        ITIME      0001  STARTING TIME
        NQ         500  NUMBER OF HYDROGRAPH ORDINATES
        NDDATE     27JUL94  ENDING DATE
        NDTIME     0820  ENDING TIME
        ICENT      19  CENTURY MARK

        COMPUTATION INTERVAL  0.02 HOURS
        TOTAL TIME BASE      8.32 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  BASIN AREA
              6-HOUR   24-HOUR   72-HOUR
HYDROGRAPH  BOND     84.      3.55         25.          19.          19.        0.19

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

```