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

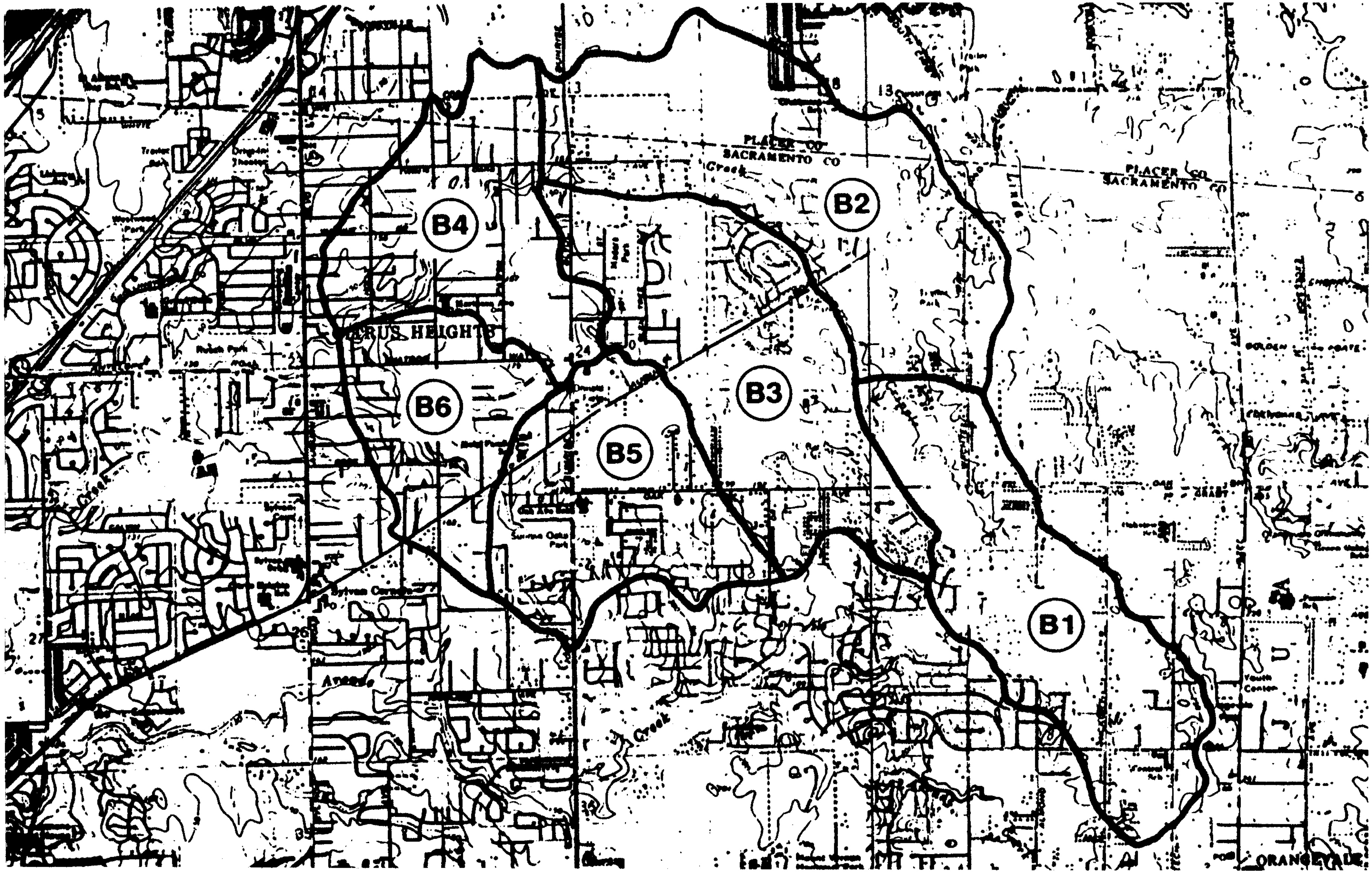
- parameters required to calculate the precipitation losses: percent impervious, and hydrologic soil types

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



Upper Arcade Creek Drainage Area

Date December 1996

Figure 10–1

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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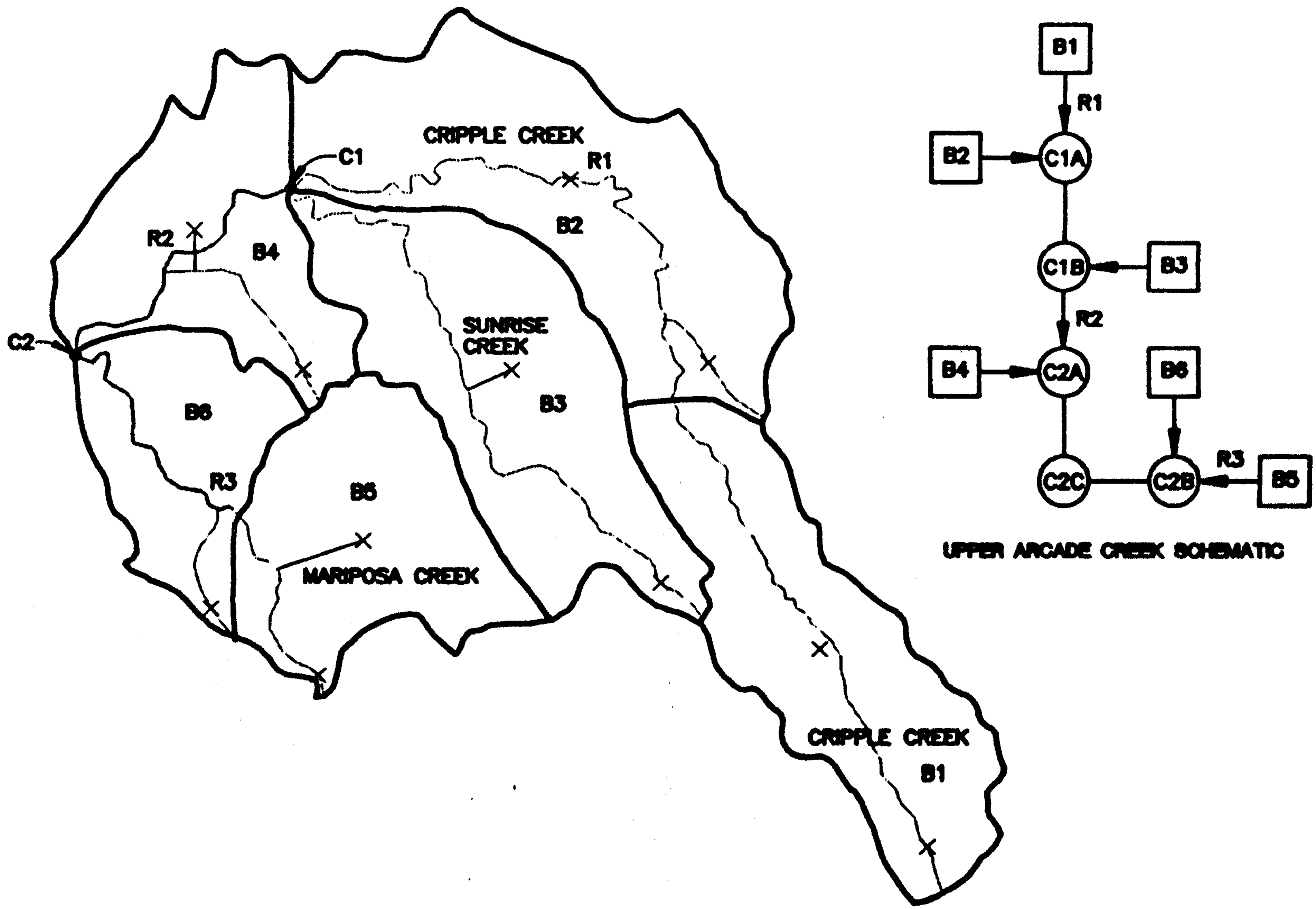

Upper Arcade Creek Drainage Schematic

Date December 1996

Figure 10–2

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 SACPRE 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, SACPRE 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
Model Timestep:               2-Minute(s)


            SUBBASIN DATA

  Operation    Area   %     i     Lag
 Type   I.D.   (ac)  Imp (in/hr) (min)
--------------------------------------

  A       B1    595   30    .09    56
  R       R1  Modified 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  Modified Puls Routing.
  A       B4    461   25    .09    37
  C      C2A  Combine previous  2 hydrographs.
  A       B5    454   40    .08    30
  R       R3  Modified Puls Routing.
  A       B6    333   30    .09    46
  C      C2B  Combine previous  2 hydrographs.
  C      C2C  Combine previous  2 hydrographs.
```

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

SACPRE Summary File (Cont.)

```
                    CONVEYANCE SYSTEM DATA

 Operation         Overland Flow       Gutter Flow          Channel/Pipe Flow
Type   I.D.       Land Use      S      L(ft)     S    T    n     L(ft)    S    D/W
-----------------------------------------------------------------------------------
 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
```

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

SACPRE Summary File (Cont.)

```
                LAND USE - SOIL TYPE - CHANNEL/FLOODPLAIN

 Operation                                              Soil Type/
Type   I.D.    %              Land Use                 Channelization
-----------------------------------------------------------------

 A       B1   100   Residential:   3-4 units/acre     DEVELOPED
                  100   Residential:   3-4 units/acre       D

 R       R1

 A       B2   100   Residential:   3-4 units/acre     DEVELOPED
                  100   Residential:   3-4 units/acre       D

 C      C1A

 A       B3   100   Residential:   3-4 units/acre     DEVELOPED
                  100   Residential:   3-4 units/acre       D

 C       C1

 R       R2

 A       B4   100   Residential:   2-3 units/acre     DEVELOPED
                  100   Residential:   2-3 units/acre       D


 C      C2A

 A       B5   100   Residential:   4-6 units/acre     DEVELOPED
                  100   Residential:   4-6 units/acre       D

 R       R3

 A       B6   100   Residential:   3-4 units/acre     DEVELOPED
                  100   Residential:   3-4 units/acre       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    .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
                        NMIN          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
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
HYDROGRAPH AT	B1	343.	6.73	129.	57.	57.	0.93
ROUTED TO	R1	189.	9.10	124.	57.	57.	0.93
HYDROGRAPH AT	B2	400.	6.87	163.	73.	73.	1.19
2 COMBINED AT	C1A	454.	6.90	278.	130.	130.	2.12
HYDROGRAPH AT	B3	367.	6.80	142.	64.	64.	1.03
2 COMBINED AT	C1B	816.	6.83	417.	194.	194.	3.15
ROUTED TO	R2	661.	7.97	413.	193.	193.	3.15
HYDROGRAPH AT	B4	340.	6.47	100.	43.	43.	0.72
2 COMBINED AT	C2A	756.	7.83	500.	236.	236.	3.87
HYDROGRAPH AT	B5	383.	6.37	108.	48.	48.	0.71
ROUTED TO	R3	252.	7.37	107.	48.	48.	0.71
HYDROGRAPH AT	B6	217.	6.60	73.	32.	32.	0.52
2 COMBINED AT	C2B	381.	6.83	179.	80.	80.	1.23
2 COMBINED AT	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.

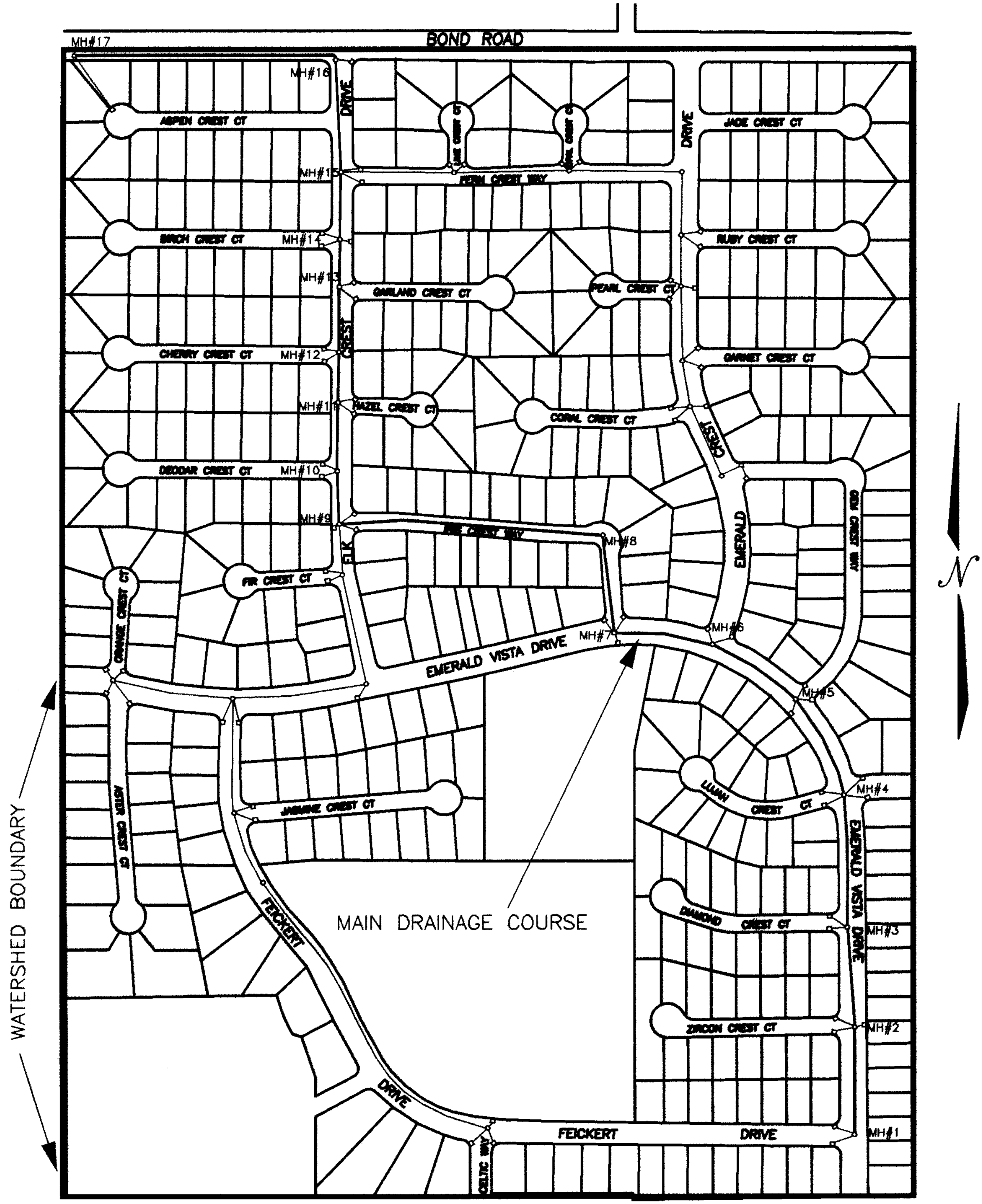
Hydrologic Parameters

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...



LEGEND:

○ MH#1 – MANHOLE

□ DROP INLET

Park Place Subdivision
Single Basin Analysis
of a Subdivision

Date **December 1996**

Figure **10–3**

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

CONVEYANCE SYSTEM DATA

	Overland Flow		Gutter Flow		Channel/Pipe Flow				
I.D.	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.
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
                  NMIN          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

                        PEAK   TIME OF   AVERAGE FLOW FOR MAXIMUM PERIOD   BASIN
OPERATION   STATION   FLOW     PEAK                                        AREA
                                          6-HOUR     24-HOUR     72-HOUR

HYDROGRAPH     BOND     84.    3.55        25.         19.         19.    0.19

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