APPENDIX C. RURAL HEC-1 EXAMPLE

GIVEN

In this example, flooding has occurred routinely at the Browns Valley Road crossing of Gibson Canyon Creek, north of the City of Vacaville (in actuality, flooding is not a problem at this location). During the flooding events, the capacity of the 48-inch corrugated metal pipe (CMP) culvert is exceeded (in actuality the culvert is not a 48-inch CMP). The creek water ponds upstream of the culvert until it is 5 feet above the top of the culvert inlet, overtops the road, and then drains back into the creek channel downstream of the road. Grade limitations at this site will allow up to a 6-foot tall culvert with up to 3 feet of surcharging.

The City of Vacaville maintains a stream gage and rain gage at the point that Gibson Canyon Creek crosses Browns Valley Road.

REQUIRED

Size a culvert for the Browns Valley Road crossing of Gibson Canyon Creek for a 50-year storm. Develop a HEC-1 model of the watershed upstream of Browns Valley Road. Verify the model based on actual storm events. Run the 50-year, 24-hour hypothetical storm with the verified model. Size the culvert for the 50-year, 24-hour storm peak flow.

SOLUTION

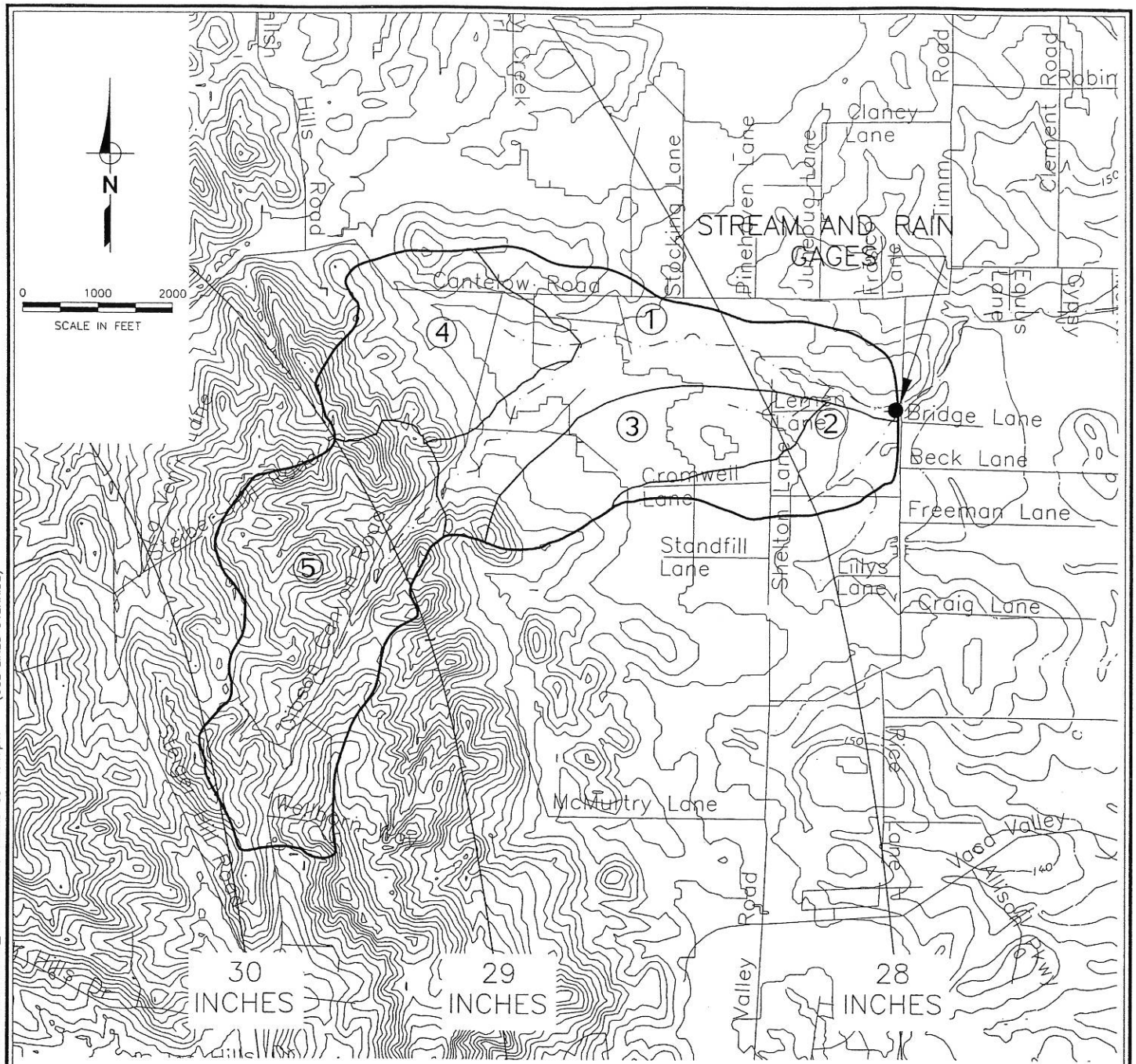
Watershed and subsheds delineated from USGS topographic mapping are shown on Figure C-1, as are the subshed characteristics. The total watershed area is 734 acres (greater than 200 acres), thus a HEC-1 analysis is appropriate, and the rational method should not be used (see Table 3-1).

The watershed upstream of the bridge includes rural residential areas and farmland in the flatter areas, and rural residential and undeveloped areas on the hillsides. These land uses were determined by a site visit and aerial photograph. The hydrologic soil groups for this watershed include Groups C and D.

Since a stream gage and rain gage exist at the analysis location, accurate precipitation data is available for the watershed, and the HEC-1 model can be verified by comparison with actual gaged flow data.

Model Development

The steps in developing the HEC-1 model are discussed below. The HEC-1 data input file for the February 1-3 storm event is presented at the end of this appendix.



SUBSHED	AREA (ACRES)	CREEK CHANNEL SLOPE	HYDROLOGIC SOIL GROUPS	LAND USE
1	168	0.0080	GROUP C=35% GROUP D=65%	NOTE 1
2	59	0.0080	GROUP C=20% GROUP D=80%	NOTE 1
3	114	0.0130	GROUP C=0% GROUP D=100%	NOTE 1
4	139	0.0150	GROUP C=10% GROUP D=90%	NOTE 2
5	254	0.0430	GROUP C=60% GROUP D=40%	NOTE 2

NOTES:
1.) LOW DENSITY RESIDENTIAL & GRASS FIELD
2.) LOW DENSITY RESIDENTIAL & WOODED

CAD FILE: I:/074/98-04/01/074C-01.dwg CFG FILE: WYA2500.PCP_MRG DATE: 06-23-99 1:47pm (USE LINES OVERRIDE)

LEGEND:

①	SUBSHED NUMBER
———	WATERSHED BOUNDARY
———	SUBSHED BOUNDARY
30———	MEAN ANNUAL PRECIPITATION

Figure C-1

Solano County Water Agency Hydrology Manual

GIBSON CANYON CREEK WATERSHED EXAMPLE

WEST YOST & ASSOCIATES

Rainfall and Losses. Hourly rainfall data for three actual storm events from February 1998 were obtained, including February 1-3, February 5-7, and February 19. These data are as presented in Figures C-2 through C-4.

As shown on Figure 2-2, mean annual precipitation (MAP) at the rain gage is about 28 inches/year. The MAP over this watershed ranges from 30 inches along the western edge to 28 inches over the eastern edge (near the rain gage). To account for the orographic effects of the hills, for each subshed the gaged storm precipitation was multiplied by the ratio of $MAP_{subshed}$ to MAP_{gage}. The MAP of each subshed is presented in Table C-1.

Table C-1. Precipitation and Losses

Subshed	Mean Annual Precipitation, inches	Terrain	Initial Loss for Pervious Areas, inches	Constant Loss		
				Percent Hydrologic Soil – Group C	Percent Hydrologic Soil – Group D	Avg. Constant Loss Rate, inches/hour
1	28	field	0.30	35	65	0.05
2	28	field	0.30	20	80	0.04
3	28	field	0.30	0	100	0.02
4	29	partly wooded	0.35	10	90	0.03
5	29	partly wooded	0.35	60	40	0.07

Initial and constant precipitation losses were estimated for the subsheds using the subshed land uses and Tables 3-5 and 3-6. These are summarized in Table C-1. The impervious area percentage was estimated to be about 5 percent for all subsheds. These data were entered on LU data records as shown in the model input files (at the end of this appendix).

Snyder's Method. Use of Snyder's Method was selected as recommended in Section 3-4. The coefficients for Snyder's method were calculated using Equations 3-5 and 3-6, and are summarized in Table C-2. The value of 0.45 was used for Snyder's peaking coefficient. The Snyder coefficients were entered into the model on US data records.

Routing. Hydrograph routing was performed using the Muskingum-Cunge routing method, as recommended in Section 3-4. The channel flow line slopes were measured from Figure C-1 and approximate dimensions and roughness (n = 0.034) were estimated from a site visit.

The HEC-1 model results (using the standard HEC modeling procedures recommended in this manual) for the February 1998 storm events at the gaging station are shown in Figures C-2 through C-4. Also shown in these figures are the gaged flows during each storm. The HEC-1 hydrographs generally agree with the gaged hydrographs. These hydrographs are presented in 1 hour increments. However, because the HEC-1 calculations were based on 10- to 15-minute

Table C-2. Development of Snyders Method Coefficients

Subshed	Lag Time				Snyder's Peaking Coefficient
	Area, acres	Urbanization, %	Slope, ft/ft	Snyder's Lag, hours	
1	167.9	10	0.008	1.03	0.45
2	59.3	10	0.008	0.84	0.45
3	113.9	10	0.013	0.91	0.45
4	139.0	10	0.015	0.93	0.45
5	254.2	10	0.043	0.95	0.45

increments, sometimes the peak flow does not occur on the even hour. The HEC and gaged peak flows are also listed on the figures and summarized in Table C-3.

Table C-3. Comparison of HEC-1 and Gaged Peak Flows

Figure	Date	Gaged Peak Flow, cfs	HEC-1 Peak Flow, cfs	Difference, cfs	Peak Flow Difference, %
C-2	February 1	97	133	36	37
	February 2	141	128	-13	-9
	February 3	124	117	-7	-6
C-3	February 5	49	56	7	14
	February 5	48	41	-7	-15
	February 6	60	57	-3	-5
	February 6	47	71	24	51
	February 6	77	74	-3	-4
	February 7	185	210	25	14
C-4	February 19	55	30	-25	-45
	February 19	95	71	-24	-25

For 4 out of 11 of these peak flows, the HEC-1 results are greater than the gaged flows. The percent differences range from +14 to as much as +51 percent, with the average being +29 percent. In 7 out of 11 cases, the HEC peak flows are lower than the gaged peak flows, with the difference ranging from –6 to –41 percent, and the average being –16 percent. The differences between the predicted and gaged peak flows is probably because the actual rainfall over the watershed was different (total amount and/or distribution) than the rainfall over the rain gage.

Figure C-2. Comparison of HEC-1 Results with Gaged Flow, February 1 - 3, 1998

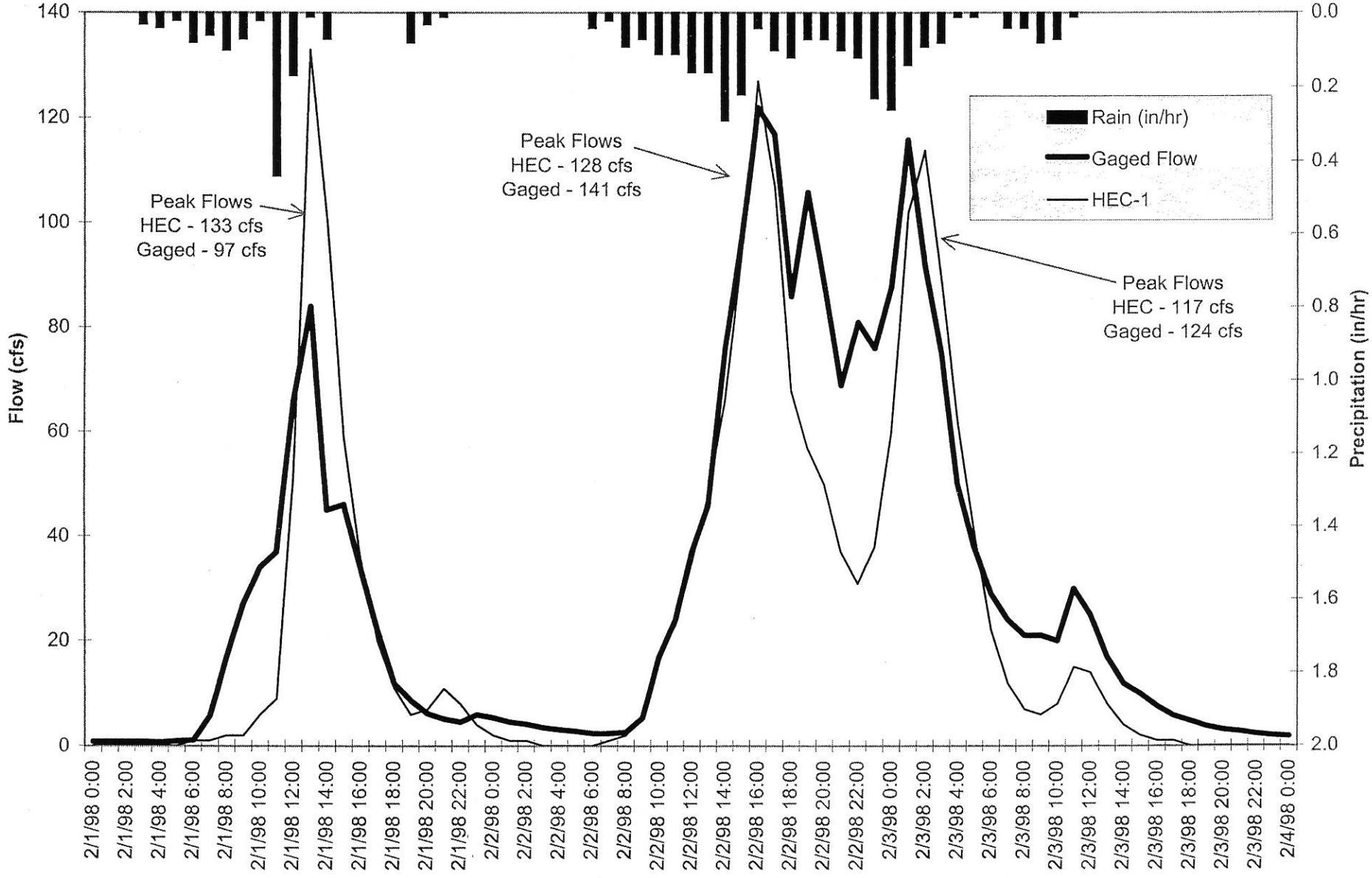


Figure C-3. Comparison of HEC-1 Results with Gaged Flow, February 5 - 7, 1998

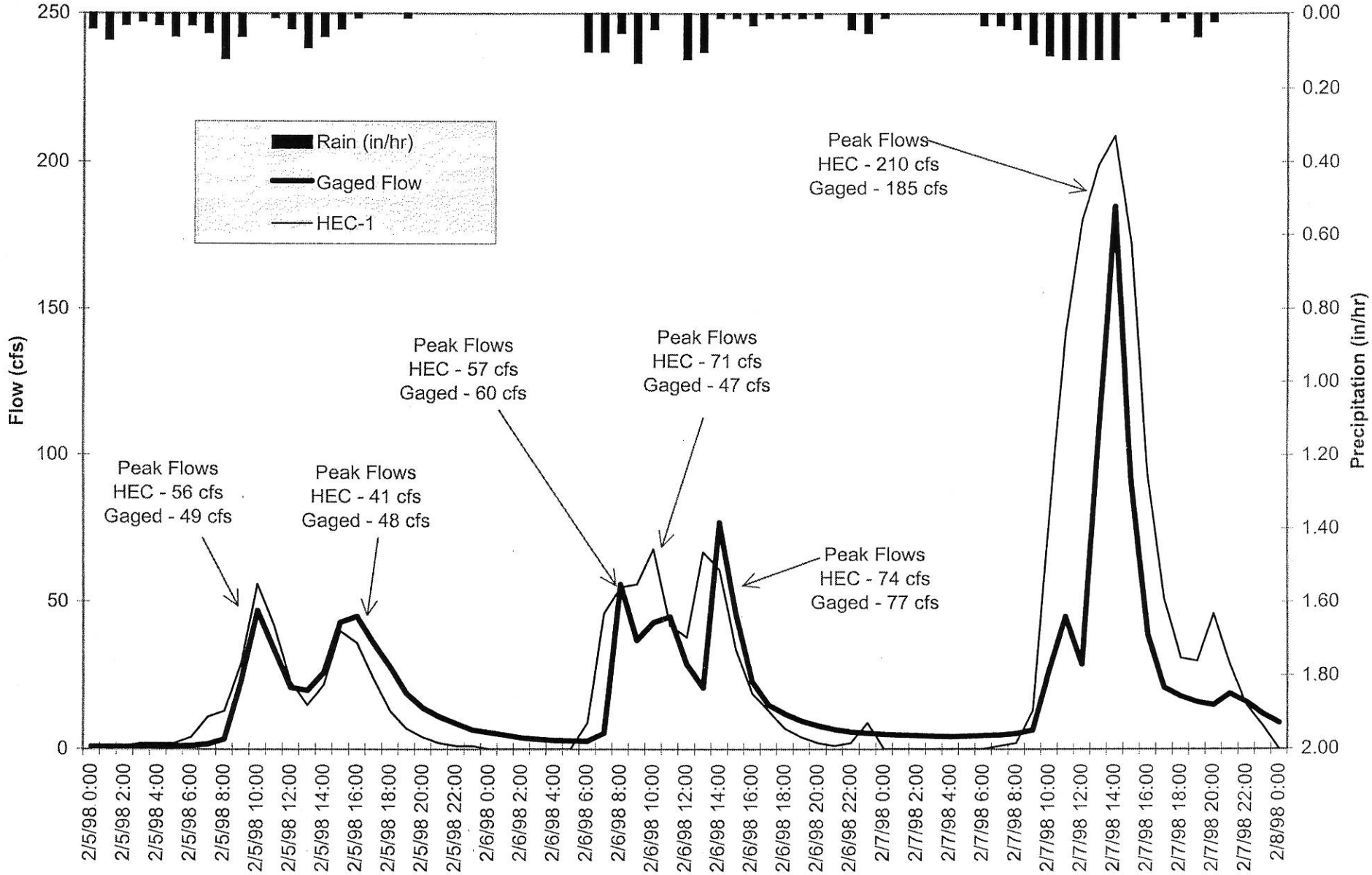
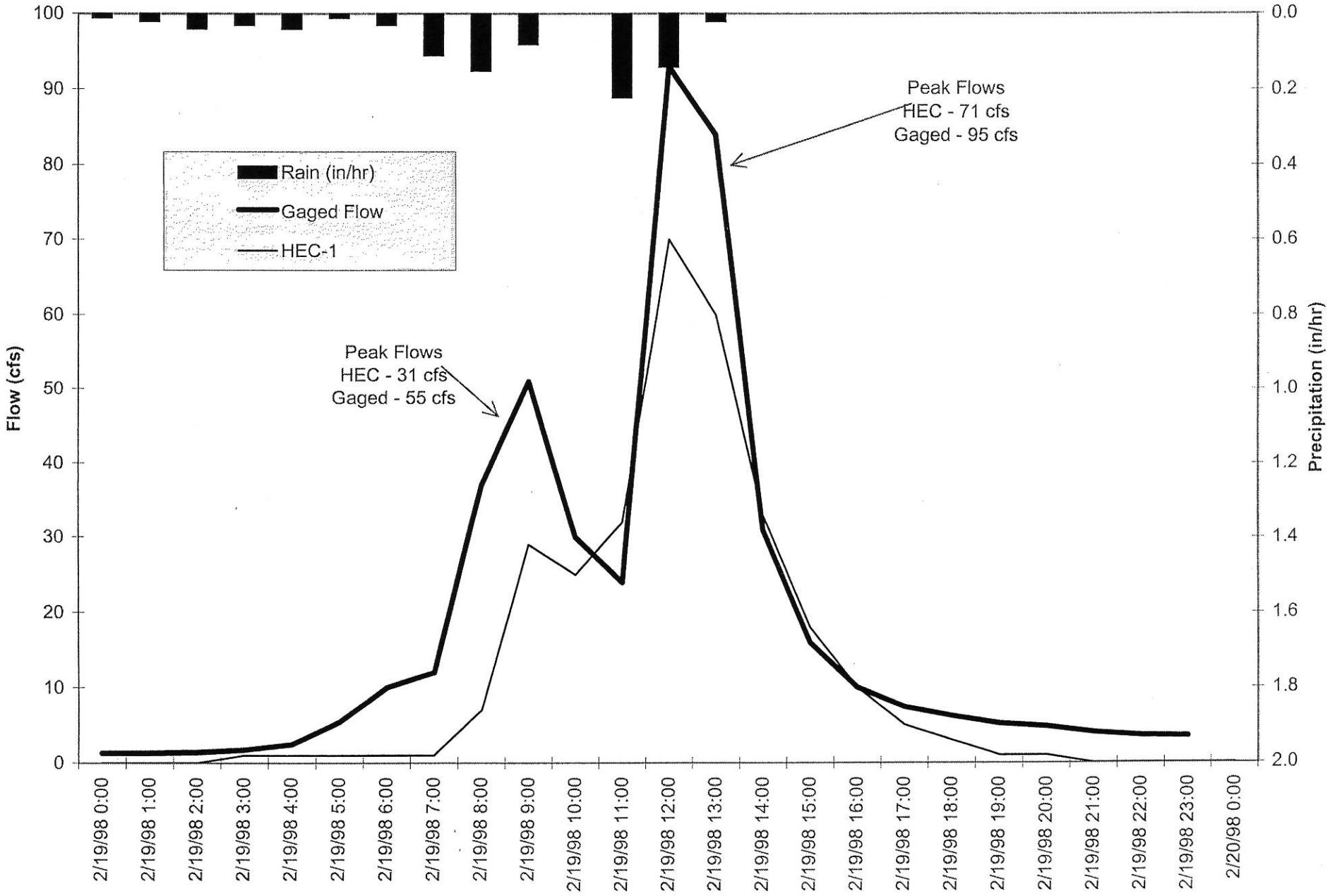


Figure C-4. Comparison of HEC-1 Results with Gaged Flow, February 19, 1998



Overall, (including all 11 peak flows) the average difference is +1 percent, which is a very close agreement between gaged and predicted flows. In conclusion, the modeling of these 3 actual storm events appears to verify that the HEC-1 model is reasonably accurate, on the average. Further adjustment or calibration of the model is not warranted. The model can be used to analyze the design storm with reasonable confidence in the results.

Design Storm

To run the design storm, the precipitation data were changed from actual hourly historical data to hypothetical data. The PB and PI records were replaced with PH records with the 50-year, 24-hour hypothetical storm distribution, and the IN record was deleted. The 50-year event precipitation depths are listed in Table C-4 (read/interpolated from Table 3-4B). The 50-year, 24-hour event HEC-1 input data file is presented at the end of this appendix.

Table C-4. 50-Year Storm Event
Hypothetical Precipitation (PH) Record Data

Duration	PH Record Data	
	28-Inch MAP	29-Inch MAP
5-minute	0.54	0.56
15-minute	0.87	0.90
1-hour	1.58	1.64
2-hour	2.12	2.20
3-hour	2.53	2.62
6-hour	3.40	3.52
12-hour	4.58	4.74
1-day	6.17	6.39

The HEC-1 output for the 50-year, 24-hour event is presented at the end of this appendix. The printed output was reduced by changing the IO record from a 1 (print all output) to a 5 (print summaries only).

The peak flow for the 50-year, 24-hour storm event at Browns Valley Road is listed in the model output (the CS12345 operation) as 581 cfs.

Culvert Sizing

A culvert with a capacity of 581 cfs must be selected, subject to the limitations of a height of 6 feet, and up to 3 feet of surcharging.

Given that ponding can occur up to 5 feet above the top of the existing 48-inch CMP before flooding occurs, the current culvert (with a headwall) has a capacity of about 160 cfs (based on reference to a capacity design chart for CMP culverts with inlet control). This culvert is significantly undersized.

The new culvert must have a capacity of at least 581 cfs. Using a typical design chart for box culverts, a 6-foot tall box culvert with 3 feet of surcharging has a capacity of 68 cfs per foot of width of the box culvert. The box culvert must be at least 8.6 feet wide (778/68 = 11.4), thus a 6-foot tall by 0-foot wide box culvert is an appropriate selection for this site.

ATTACHMENT C-1

February 1-3, 1998 Storm Event HEC-1 Input File

```
ID     SOLANO COUNTY WATER AGENCY GIBSON CANYON
ID     FEBRUARY 1-3, 1998 STORM EVENT
ID     EXISTING CONDITIONS
*
*FREE
*DIAGRAM
IT 15,01FEB99,0000,,04FEB99,0000
IN 60
IO 1
*
KK SHED5
KM (MAP=29 IN)
BA 0.3971
PB 4.33
PI 0.00,0.00,0.00,0.03,0.04,0.02,0.08,0.06,0.10,0.07
PI 0.02,0.44,0.17,0.01,0.07,0.00,0.00,0.00,0.00,0.08
PI 0.03,0.01,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
PI 0.04,0.02,0.09,0.07,0.11,0.11,0.16,0.16,0.29,0.22
PI 0.04,0.10,0.12,0.07,0.07,0.10,0.12,0.23,0.26,0.14
PI 0.09,0.08,0.01,0.01,0.00,0.04,0.04,0.08,0.07,0.01
PI 0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
PI 0.00,0.00
LU 0.35,0.07,5
US 0.95,0.45
*
KK RS1
RD 3000,0.023,0.034,,TRAP,8,2.5
*
KK SHED4
KM (MAP=29 IN)
BA 0.2172
PB 4.33
LU 0.35,0.03,5
US 0.93,0.45
*
KK CS5S4
KM COMBINE SHED5 WITH SHED4
HC2
*
KK RS4S5
RD 4000,0.010,0.034,,TRAP,10,2.5
*
KK SHED3
KM (MAP=28 IN)
BA 0.1779
PB 4.18
LU 0.30,0.02,5
US 0.91,0.45
*
KK SHED1
KM (MAP=28 IN)
BA 0.2624
PB 4.18
LU 0.35,0.05,5
US 1.03,0.45
*
KK CS1345
KM COMBINE SHEDS 1, 3, 4, 5
HC 3
*
KK RS1345
RD 1400,0.0071,0.034,,TRAP,10,2.5
*
KK SHED2
KM (MAP = 28 IN)
BA 0.09
PB 4.18
LU 0.30,0.04,5
US 0.84,0.45
*
KK CS12345
KM COMBINE SHEDS 1345 WITH SHED 2
HC 2
*
ZZ
```

ATTACHMENT C-2

50-Year, 24-Hour Storm Event HEC-1 Input File

```
ID     SOLANO COUNTY WATER AGENCY
ID     GIBSON CANYON CCREEK
ID     50-YEAR, 24-HOUR STORM EVENT
ID     EXISTING CONDITIONS
*
*FREE
*DIAGRAM
IT 05,07FEB99,0000,,08FEB99,0000
IO 5
*
KK SHED5
KM (MAP=29 IN)
BA 0.3971
PH 50,0,0.56,0.90,1.64,2.20,2.62,3.52,4.74,6.39
LU 0.35,0.07,5
US 0.95,0.45
*
KK RS1
RD 3000,0.023,0.034,,TRAP,8,2.5
*
KK SHED4
KM (MAP=29 IN)
BA 0.2172
PH 50,0,0.56,0.90,1.64,2.20,2.62,3.52,4.74,6.39
LU 0.35,0.03,5
US 0.93,0.45
*
KK CS5S4
KM COMBINE SHED5 WITH SHED4
HC2
*
KK RS4S5
RD 4000,0.010,0.034,,TRAP,10,2.5
*
KK SHED3
KM (MAP=28 IN)
BA 0.1779
PH 50,0,0.54,0.87,1.58,2.12,2.53,3.40,4.58,6.17
LU 0.30,0.02,5
US 0.91,0.45
*
KK SHED1
KM (MAP=28 IN)
BA 0.2624
PH 50,0,0.54,0.87,1.58,2.12,2.53,3.40,4.58,6.17
LU 0.35,0.05,5
US 1.03,0.45
*
KK CS1345
KM COMBINE SHEDS 1, 3, 4, 5
HC 3
*
KK RS1345
RD 1400,0.0071,0.034,,TRAP,10,2.5
*
KK SHED2
KM (MAP = 28 IN)
BA 0.09
PH 50,0,0.54,0.87,1.58,2.12,2.53,3.40,4.58,6.17
LU 0.30,0.04,5
US 0.849,0.45
*
KK CS12345
KM COMBINE SHEDS 1345 WITH SHED 2
KO 1
HC 2
*
ZZ
```

ATTACHMENT C-3

50-Year, 24-Hour Storm Event HEC-1 Output File

```
1****************************************
*                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
*            SEPTEMBER 1990            *
*             VERSION 4.0              *
*                                      *
*  RUN DATE  06/22/1999  TIME  10:01:25 *
*                                      *
****************************************
```

```
****************************************
*                                      *
*    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       SOLANO COUNTY WATER AGENCY
            2       ID       GIBSON CANYON CCREEK
            3       ID       50-YEAR, 24-HOUR STORM EVENT
            4       ID       EXISTING CONDITIONS
                    *
*** FREE ***
                    *DIAGRAM
            5       IT      05 07FEB99    0000         08FEB99    0000
            6       IO       5
                    *
            7       KK   SHED5
            8       KM   (MAP=29 IN)
            9       BA  0.3971
           10       PH      50       0    0.56    0.90    1.64    2.20    2.62    3.52    4.74    6.39
           11       LU    0.35    0.07       5
           12       US    0.95    0.45
                    *
           13       KK    RS1
           14       RD    3000   0.023   0.034           TRAP       8     2.5
                    *
           15       KK   SHED4
           16       KM   (MAP=29 IN)
           17       BA  0.2172
           18       PH      50       0    0.56    0.90    1.64    2.20    2.62    3.52    4.74    6.39
           19       LU    0.35    0.03       5
           20       US    0.93    0.45
                    *
           21       KK   CS5S4
           22       KM   COMBINE SHED5 WITH SHED4
           23       HC       2
                    *
           24       KK   RS4S5
           25       RD    4000   0.010   0.034           TRAP      10     2.5
                    *
           26       KK   SHED3
           27       KM   (MAP=28 IN)
           28       BA  0.1779
           29       PH      50       0    0.54    0.87    1.58    2.12    2.53    3.40    4.58    6.17
           30       LU    0.30    0.02       5
           31       US    0.91    0.45
                    *
           32       KK   SHED1
           33       KM   (MAP=28 IN)
           34       BA  0.2624
           35       PH      50       0    0.54    0.87    1.58    2.12    2.53    3.40    4.58    6.17
           36       LU    0.35    0.05       5
           37       US    1.03    0.45
                    *
```



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

           38       KK  CS1345
           39       KM   COMBINE SHEDS 1, 3, 4, 5
           40       HC       3
                    *
```

```
            41          KK  RS1345
            42          RD    1400  0.0071   0.034           TRAP      10     2.5
                        *

            43          KK   SHED2
            44          KM   (MAP = 28 IN)
            45          BA    0.09
            46          PH      50       0    0.54    0.87    1.58    2.12    2.53    3.40    4.58    6.17
            47          LU    0.30    0.04       5
            48          US   0.849    0.45
                        *

            49          KK CS12345
            50          KM   COMBINE SHEDS 1345 WITH SHED 2
            51          KO       1
            52          HC       2
                        *
            53          ZZ
1
                SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

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

     7      SHED5
              V
              V
    13        RS1
              .
              .
    15        .       SHED4
              .          .
              .          .
    21      CS5S4.............
              V
              V
    24      RS4S5
              .
              .
    26        .       SHED3
              .          .
              .          .
    32        .          .       SHED1
              .          .          .
              .          .          .
    38    CS1345.........................
              V
              V
    41    RS1345
              .
              .
    43        .       SHED2
              .          .
              .          .
    49   CS12345.............

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1****************************************
*                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
*             SEPTEMBER 1990           *
*              VERSION 4.0             *
*                                      *
*  RUN DATE  06/22/1999  TIME  10:01:25 *
*                                      *
****************************************

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

                            SOLANO COUNTY WATER AGENCY
                            GIBSON CANYON CCREEK
                            50-YEAR, 24-HOUR STORM EVENT
                            EXISTING CONDITIONS

    6 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      7FEB99  STARTING DATE
                        ITIME        0000  STARTING TIME
                           NQ         289  NUMBER OF HYDROGRAPH ORDINATES
                       NDDATE      8FEB99  ENDING DATE
                       NDTIME        0000  ENDING TIME
                        ICENT          19  CENTURY MARK

                    COMPUTATION INTERVAL      .08 HOURS
                         TOTAL TIME BASE    24.00 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
```

*** ***

```
          **************
          *            *
 49 KK    *   CS12345  *
          *            *
          **************

 51 KO          OUTPUT CONTROL VARIABLES
                      IPRNT           1  PRINT CONTROL
                      IPLOT           0  PLOT CONTROL
                      QSCAL           0.  HYDROGRAPH PLOT SCALE

 52 HC          HYDROGRAPH COMBINATION
                      ICOMP           2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                            ***

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

                                          HYDROGRAPH AT STATION  CS12345
                                            SUM OF  2 HYDROGRAPHS

*********************************************************************************************************
```

DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW	DA MON HRMN	ORD	FLOW
7 FEB 0000	1	0.	7 FEB 0605	74	49.	7 FEB 1210	147	225.	7 FEB 1815	220	125.
7 FEB 0005	2	0.	7 FEB 0610	75	50.	7 FEB 1215	148	247.	7 FEB 1820	221	122.
7 FEB 0010	3	0.	7 FEB 0615	76	51.	7 FEB 1220	149	275.	7 FEB 1825	222	120.
7 FEB 0015	4	0.	7 FEB 0620	77	52.	7 FEB 1225	150	310.	7 FEB 1830	223	118.
7 FEB 0020	5	0.	7 FEB 0625	78	53.	7 FEB 1230	151	350.	7 FEB 1835	224	115.
7 FEB 0025	6	0.	7 FEB 0630	79	54.	7 FEB 1235	152	395.	7 FEB 1840	225	113.
7 FEB 0030	7	0.	7 FEB 0635	80	55.	7 FEB 1240	153	439.	7 FEB 1845	226	111.
7 FEB 0035	8	0.	7 FEB 0640	81	56.	7 FEB 1245	154	481.	7 FEB 1850	227	109.
7 FEB 0040	9	0.	7 FEB 0645	82	57.	7 FEB 1250	155	517.	7 FEB 1855	228	107.
7 FEB 0045	10	0.	7 FEB 0650	83	58.	7 FEB 1255	156	546.	7 FEB 1900	229	106.
7 FEB 0050	11	0.	7 FEB 0655	84	59.	7 FEB 1300	157	567.	7 FEB 1905	230	104.
7 FEB 0055	12	0.	7 FEB 0700	85	60.	7 FEB 1305	158	578.	7 FEB 1910	231	102.
7 FEB 0100	13	0.	7 FEB 0705	86	61.	7 FEB 1310	159	581.	7 FEB 1915	232	100.
7 FEB 0105	14	1.	7 FEB 0710	87	62.	7 FEB 1315	160	577.	7 FEB 1920	233	99.
7 FEB 0110	15	1.	7 FEB 0715	88	63.	7 FEB 1320	161	568.	7 FEB 1925	234	97.
7 FEB 0115	16	1.	7 FEB 0720	89	64.	7 FEB 1325	162	557.	7 FEB 1930	235	95.
7 FEB 0120	17	1.	7 FEB 0725	90	65.	7 FEB 1330	163	544.	7 FEB 1935	236	94.
7 FEB 0125	18	1.	7 FEB 0730	91	66.	7 FEB 1335	164	531.	7 FEB 1940	237	92.
7 FEB 0130	19	1.	7 FEB 0735	92	67.	7 FEB 1340	165	518.	7 FEB 1945	238	91.
7 FEB 0135	20	1.	7 FEB 0740	93	68.	7 FEB 1345	166	504.	7 FEB 1950	239	89.
7 FEB 0140	21	1.	7 FEB 0745	94	69.	7 FEB 1350	167	491.	7 FEB 1955	240	88.
7 FEB 0145	22	2.	7 FEB 0750	95	70.	7 FEB 1355	168	478.	7 FEB 2000	241	87.
7 FEB 0150	23	2.	7 FEB 0755	96	71.	7 FEB 1400	169	464.	7 FEB 2005	242	85.
7 FEB 0155	24	2.	7 FEB 0800	97	72.	7 FEB 1405	170	452.	7 FEB 2010	243	84.
7 FEB 0200	25	2.	7 FEB 0805	98	73.	7 FEB 1410	171	439.	7 FEB 2015	244	83.
7 FEB 0205	26	2.	7 FEB 0810	99	74.	7 FEB 1415	172	426.	7 FEB 2020	245	82.
7 FEB 0210	27	2.	7 FEB 0815	100	75.	7 FEB 1420	173	414.	7 FEB 2025	246	80.
7 FEB 0215	28	2.	7 FEB 0820	101	76.	7 FEB 1425	174	402.	7 FEB 2030	247	79.
7 FEB 0220	29	2.	7 FEB 0825	102	77.	7 FEB 1430	175	391.	7 FEB 2035	248	78.
7 FEB 0225	30	2.	7 FEB 0830	103	79.	7 FEB 1435	176	379.	7 FEB 2040	249	77.
7 FEB 0230	31	3.	7 FEB 0835	104	80.	7 FEB 1440	177	368.	7 FEB 2045	250	76.
7 FEB 0235	32	3.	7 FEB 0840	105	81.	7 FEB 1445	178	357.	7 FEB 2050	251	75.
7 FEB 0240	33	3.	7 FEB 0845	106	82.	7 FEB 1450	179	347.	7 FEB 2055	252	73.
7 FEB 0245	34	3.	7 FEB 0850	107	83.	7 FEB 1455	180	337.	7 FEB 2100	253	72.
7 FEB 0250	35	3.	7 FEB 0855	108	85.	7 FEB 1500	181	327.	7 FEB 2105	254	71.
7 FEB 0255	36	3.	7 FEB 0900	109	86.	7 FEB 1505	182	318.	7 FEB 2110	255	70.
7 FEB 0300	37	3.	7 FEB 0905	110	87.	7 FEB 1510	183	309.	7 FEB 2115	256	69.
7 FEB 0305	38	3.	7 FEB 0910	111	88.	7 FEB 1515	184	300.	7 FEB 2120	257	68.
7 FEB 0310	39	3.	7 FEB 0915	112	90.	7 FEB 1520	185	292.	7 FEB 2125	258	67.
7 FEB 0315	40	3.	7 FEB 0920	113	91.	7 FEB 1525	186	283.	7 FEB 2130	259	67.
7 FEB 0320	41	4.	7 FEB 0925	114	93.	7 FEB 1530	187	275.	7 FEB 2135	260	66.
7 FEB 0325	42	4.	7 FEB 0930	115	94.	7 FEB 1535	188	268.	7 FEB 2140	261	65.
7 FEB 0330	43	5.	7 FEB 0935	116	96.	7 FEB 1540	189	260.	7 FEB 2145	262	64.
7 FEB 0335	44	5.	7 FEB 0940	117	97.	7 FEB 1545	190	253.	7 FEB 2150	263	64.
7 FEB 0340	45	6.	7 FEB 0945	118	99.	7 FEB 1550	191	246.	7 FEB 2155	264	63.
7 FEB 0345	46	7.	7 FEB 0950	119	101.	7 FEB 1555	192	240.	7 FEB 2200	265	62.
7 FEB 0350	47	8.	7 FEB 0955	120	102.	7 FEB 1600	193	233.	7 FEB 2205	266	62.
7 FEB 0355	48	9.	7 FEB 1000	121	104.	7 FEB 1605	194	227.	7 FEB 2210	267	61.
7 FEB 0400	49	10.	7 FEB 1005	122	106.	7 FEB 1610	195	221.	7 FEB 2215	268	61.
7 FEB 0405	50	11.	7 FEB 1010	123	108.	7 FEB 1615	196	216.	7 FEB 2220	269	60.
7 FEB 0410	51	13.	7 FEB 1015	124	110.	7 FEB 1620	197	210.	7 FEB 2225	270	59.
7 FEB 0415	52	14.	7 FEB 1020	125	112.	7 FEB 1625	198	205.	7 FEB 2230	271	59.
7 FEB 0420	53	16.	7 FEB 1025	126	114.	7 FEB 1630	199	200.	7 FEB 2235	272	58.
7 FEB 0425	54	18.	7 FEB 1030	127	116.	7 FEB 1635	200	195.	7 FEB 2240	273	58.
7 FEB 0430	55	20.	7 FEB 1035	128	119.	7 FEB 1640	201	190.	7 FEB 2245	274	57.
7 FEB 0435	56	22.	7 FEB 1040	129	121.	7 FEB 1645	202	185.	7 FEB 2250	275	57.
7 FEB 0440	57	24.	7 FEB 1045	130	124.	7 FEB 1650	203	181.	7 FEB 2255	276	56.
7 FEB 0445	58	26.	7 FEB 1050	131	127.	7 FEB 1655	204	177.	7 FEB 2300	277	56.
7 FEB 0450	59	28.	7 FEB 1055	132	130.	7 FEB 1700	205	172.	7 FEB 2305	278	55.
7 FEB 0455	60	29.	7 FEB 1100	133	133.	7 FEB 1705	206	168.	7 FEB 2310	279	55.
7 FEB 0500	61	31.	7 FEB 1105	134	136.	7 FEB 1710	207	165.	7 FEB 2315	280	54.
7 FEB 0505	62	33.	7 FEB 1110	135	140.	7 FEB 1715	208	161.	7 FEB 2320	281	54.
7 FEB 0510	63	34.	7 FEB 1115	136	143.	7 FEB 1720	209	157.	7 FEB 2325	282	53.
7 FEB 0515	64	36.	7 FEB 1120	137	148.	7 FEB 1725	210	154.	7 FEB 2330	283	53.
7 FEB 0520	65	37.	7 FEB 1125	138	152.	7 FEB 1730	211	150.	7 FEB 2335	284	52.
7 FEB 0525	66	39.	7 FEB 1130	139	157.	7 FEB 1735	212	147.	7 FEB 2340	285	52.
7 FEB 0530	67	40.	7 FEB 1135	140	162.	7 FEB 1740	213	144.	7 FEB 2345	286	51.
7 FEB 0535	68	41.	7 FEB 1140	141	167.	7 FEB 1745	214	141.	7 FEB 2350	287	51.
7 FEB 0540	69	43.	7 FEB 1145	142	173.	7 FEB 1750	215	138.	7 FEB 2355	288	50.
7 FEB 0545	70	44.	7 FEB 1150	143	180.	7 FEB 1755	216	135.	8 FEB 0000	289	50.
7 FEB 0550	71	45.	7 FEB 1155	144	188.	7 FEB 1800	217	132.			
7 FEB 0555	72	46.	7 FEB 1200	145	197.	7 FEB 1805	218	130.			
7 FEB 0600	73	47.	7 FEB 1205	146	209.	7 FEB 1810	219	127.			

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	24.00-HR
(CFS)	(HR)					
		(CFS)				
581.	13.17		323.	126.	126.	126.
		(INCHES)	2.626	4.105	4.105	4.105
		(AC-FT)	160.	251.	251.	251.

CUMULATIVE AREA = 1.14 SQ MI

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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	MAXIMUM STAGE	TIME OF MAX STAGE
				6-HOUR	24-HOUR	72-HOUR			
HYDROGRAPH AT	SHED5	202.	13.00	109.	41.	41.	.40		
ROUTED TO	RS1	202.	13.08	109.	40.	40.	.40		
HYDROGRAPH AT	SHED4	118.	13.00	65.	26.	26.	.22		
2 COMBINED AT	CS5S4	319.	13.08	174.	67.	67.	.61		
ROUTED TO	RS4S5	319.	13.17	174.	67.	67.	.61		
HYDROGRAPH AT	SHED3	94.	13.00	52.	22.	22.	.18		
HYDROGRAPH AT	SHED1	126.	13.08	72.	28.	28.	.26		
3 COMBINED AT	CS1345	535.	13.17	298.	116.	116.	1.05		
ROUTED TO	RS1345	534.	13.17	298.	116.	116.	1.05		
HYDROGRAPH AT	SHED2	49.	12.92	26.	10.	10.	.09		
2 COMBINED AT	CS12345	581.	13.17	323.	126.	126.	1.14		

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

ISTAQ	ELEMENT	DT	PEAK	TIME TO PEAK	VOLUME	INTERPOLATED TO COMPUTATION INTERVAL DT	PEAK	TIME TO PEAK	VOLUME
		(MIN)	(CFS)	(MIN)	(IN)	(MIN)	(CFS)	(MIN)	(IN)
RS1	MANE	5.00	202.17	785.00	3.79	5.00	202.17	785.00	3.79

CONTINUITY SUMMARY (AC-FT) - INFLOW= .8051E+02 EXCESS= .0000E+00 OUTFLOW= .8033E+02 BASIN STORAGE= .2449E+00 PERCENT ERROR= -.1

RS4S5	MANE	5.00	318.89	790.00	4.03	5.00	318.89	790.00	4.03

CONTINUITY SUMMARY (AC-FT) - INFLOW= .1327E+03 EXCESS= .0000E+00 OUTFLOW= .1322E+03 BASIN STORAGE= .7503E+00 PERCENT ERROR= -.1

RS1345	MANE	3.00	534.43	789.35	4.09	5.00	534.42	790.00	4.10

CONTINUITY SUMMARY (AC-FT) - INFLOW= .2307E+03 EXCESS= .0000E+00 OUTFLOW= .2304E+03 BASIN STORAGE= .4609E+00 PERCENT ERROR= .0

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