US Army Corps of Engineers
Hydrologic Engineering Center

HEC-HMS for the Sacramento and San Joaquin River Basins Comprehensive Study

Appendix D

August 2001

PR-46a

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From - To)*
August 2001	Project Report	

4. TITLE AND SUBTITLE
HEC-HMS Models for the Sacramento and San Joaquin River Basins Comprehensive Study

Appendix D

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Chris Dunn, Marilyn Hurst, Harry Dotson, Matt McPherson, James Doan, Tom Evans

5d. PROJECT NUMBER

5e. TASK NUMBER

5F. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
US Army Corps of Engineers
Institute for Water Resources
Hydrologic Engineering Center (HEC)
609 Second Street
Davis, CA 95616-4687

8. PERFORMING ORGANIZATION REPORT NUMBER
PR-46a

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
US Army Corps of Engineers
Sacramento District
1325 J Street
Sacramento, CA 95814

10. SPONSOR/ MONITOR'S ACRONYM(S)

11. SPONSOR/ MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT
The Sacramento District was directed by the U.S. House of Representatives to develop comprehensive flood control plans and develop hydrologic and hydraulic models of the Sacramento and San Joaquin Rivers after flooding that occurred during the 1980s and 1990s. The Hydrologic Engineering Center (HEC) helped to develop of the hydrologic models. HEC used the Hydrologic Modeling System (HEC-HMS) software and introduced the HEC-GeoHMS software to perform the hydrologic study. HEC developed and calibrated 33 individual HEC-HMS models for the major tributaries and portions of the valley floors of the Sacramento River and San Joaquin/Tulare Lake Bed Basins. The snowmelt portion of the study was performed by the Cold Regions Research and Engineering Laboratory (CRREL). CRREL used their Distributed Snow Process Model (DSPM) to create a gridded snowmelt/precipitation for the study.

Appendix D is a separate document (PR-46a) and contains the calibrated HEC-HMS models for thirty-three basins.

15. SUBJECT TERMS
HEC-HMS, calibration, basins, Sacramento River, San Joaquin River, Tulare Lake Bed, HEC-GeoHMS, DEM, subbasin, rivers, reservoirs, lakes, drainage area, events, 1995, 1997, modeling, gages, Clark, Muskingum, junction, flow lengths, slopes, basin shape factors

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			**19b. TELEPHONE NUMBER**
U	U	U	UU	404	

HEC-HMS Models for the Sacramento and San Joaquin River Basins Comprehensive Study

Appendix D

HEC-HMS Models (Calibration Results for Thirty-Three Basins)

August 2001

Prepared for:
US Army Corps of Engineers
Sacramento District
1325 J Street
Sacramento, CA 95814

Prepared by:
US Army Corps of Engineers
Institute for Water Resources
Hydrologic Engineering Center
609 Second Street
Davis, CA 95616

(530) 756-1104
(530) 756-8250 FAX
www.hec.usace.army.mil

PR-46a

Appendix D

HEC-HMS Models
(Calibration Results for 33 Basins)

Table of Contents

Description **Page**

Description **Page**

Overview of Appendix D:
Detailed HEC-HMS Model Descriptions and Results

This appendix provides the details for each of the HEC-HMS basin models developed for the Sacramento River, San Joaquin River and Tulare Lake Bed Basins. Model descriptions, figures, and results are given. The details and description of each basin model are provided in the following order:

1. A figure depicting each of the basins. The figure was captured from the HEC-GeoHMS results. Each figure includes the underlying DEM, basin and subbasin delineations as developed using HEC-GeoHMS, rivers, and significant reservoirs or lakes. The basin and subbasin delineations and subsequent subbasin and reach connectivity were then imported into HEC-HMS.

2. A written description for each basin model. The description includes a summary of the modeling decisions. It provides the drainage area and the number of subbasins and reaches for each basin. A brief comparison of the 1995 and 1997 events is made. The gages and the Clark TC and R values used for the modeling and calibration are provided. The description also indicates whether generic or basin specific criteria were used to compute the Muskingum K and X values. If HMS Sources and Sinks are used in the model, their purposes are described. Finally, a discussion of the 1995 and 1997 event calibrations is provided.

3. The HEC-HMS basin schematic displaying the subbasin, reach, and junction names.

4. Subbasin parameters are given in spreadsheet form. Drainage areas, flow lengths, slopes, the computed basin shape factors, and calculated TC and R values are given. The physical characteristics were developed in HEC-GeoHMS.

5. Reach parameters are given in spreadsheet form. Reach lengths, slopes, cumulative drainage areas, and calculated river reach parameters are provided. Estimates of the physical characteristics were calculated in GeoHMS. If the lag routing method was used instead of the Muskingum method, it is noted in the table and the lag time is given. The table also indicates whether generic routing criteria was used or if a river specific equation was used to compute the hydraulic radius for that reach. If a specific equation was used, the Manning's “n” value and channel velocity are also given.

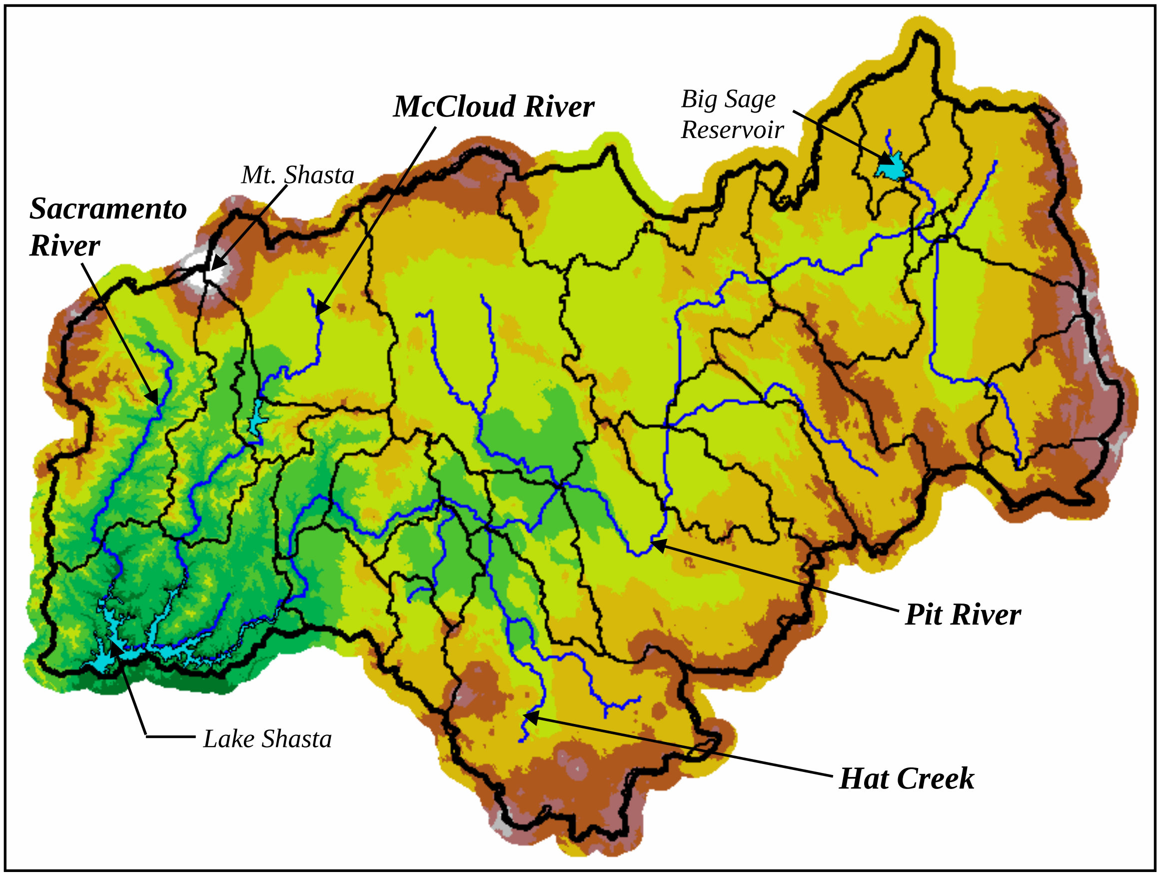
6. For the 1995 and 1997 events, the following information is provided:

    A. HEC-HMS Summary of Results Table. This table provides the computed peak discharge, time of peak, volume, and cumulative drainage area to each subbasin, reach and junction. The event modeling time window is also given.

    B. A comparison plot of the observed and computed hydrographs at all calibration points. If a calibration point was not used for a given basin, the computed hydrograph at the basin outlet is displayed. The figures start with the most downstream calibration point and proceed upstream. At times, two computed hydrographs overlap, and therefore only one of the two hydrographs is displayed in the hydrograph comparison plots.

C. A table which provides the baseflow and loss parameters for each of the subbasins that were used to calibrate the models.

Upper Sacramento River Basin



HEC-GeoHMS Subbasin Delineation

Upper Sacramento River

The Upper Sacramento River HMS Model consists of a 6,400 square mile basin above Shasta Dam, located in the northern-most portion of the Sacramento Watershed. The basin is divided into 27 subbasins and connected with 17 routing reaches. Diverse hydrologic features exist in the subbasins. Several existing studies (20-40 years old) were available for Hat Creek, Burney Creek, and North Fork Pit River at Alturas, but they were not used extensively. The HEC-HMS models produced computed peak inflows into Lake Shasta of 188,939 cfs for the 1997 event and 114,358 cfs for the 1995 event.

The subbasins in the Upper Sacramento River, McCloud River, Burney Creek, and Ash Creek followed the suggested parameter methodology for estimating TC and R. The Pit River, Hat Creek, and Fall River subbasins followed the guidelines also, but with one significant modification. Calibration along the Pit River using the generalized values proved impossible. The volcanic soils and frequent small lakes delayed the runoff for days. Several hourly gages are located on the mainstem of the Pit River. Therefore, the incremental contributions and timing could be identified, but the majority of the Pit River flow arrived much too late to substantially influence the peak inflow into the lake. Reasonable calibration of the 1997 event resulted from multiplying the TC values determined from the generalized procedure by a factor of 8. The value of R was set equal to 1.5TC.

The peaks of the inflow hydrograph at Shasta were driven by the Upper Sacramento and McCloud Rivers. Neither river exhibited the very slow, percolating drainage characteristics of the Pit River. Both are well-gaged basins, with historical flows measured at their confluence with Shasta. Unfortunately, several inconsistencies between the LWASS data and the observed hydrographs made calibration difficult (as described in the main report in “Section 5.2.4, Distributed Snow Process Model Operation”, and in “Section 6.6.1, Losses”). Therefore, HMS source elements were implemented for the Pit River, McCloud River, and Sacramento River to replace the inadequate computed runoff from the upstream basins.

For the 1997 event, initial baseflow values ranged between 0.7 and 5 cfs per square mile. Initial losses for the 1997 event were generally 1.5 inches, except for the Sacramento River and lower McCloud River, which were set to lower values. Constant loss rates were generally set to 0.05 inches/hour, except for the lava bed subbasins (0.25 inches/hour) and the Sacramento River and lower McCloud subbasins (0.001 inches/hour). All recession constants were set to 0.8, with 0.2 for the ratio-to-peak.

The 1995 event parameters were not modified from those in the detailed model for the 1997 event. The same tendencies arose: good calibration for the upper Sacramento River; mixed results on the McCloud and Pit Rivers; and, a huge volume of runoff required in the Shasta local drainage area (however, setting the loss rates to very low values for the Shasta local drainage area provided for a good fit with the observed hydrograph).

Specific modeling efforts for the 1997 and 1995 events are described in the following paragraphs:

US3R Tule Lake:

No reservoir information was found, but the behavior of the gage at Likely indicates no water was released during the 1997 event. Parameters were developed to store almost all of the water.

US5R West Valley Reservoir:

No reservoir information was found, but the behavior of the gage at Likely indicates no water was released during the 1997 event. A storage-outflow relationship was developed to generate flows that resembled those at the gage at Likely.

US11R Big Sage Reservoir:

No reservoir information was found. Assumed no water was released during the 1997 event because the other headwaters reservoirs had similar behavior. A storage-outflow relationship was developed to release a minimal flow.

US17 Pit River at Canby (and all subbasins upstream):

This subbasin represents the first calibration point on the Pit River. The areas upstream are volcanic with numerous hot springs. The river drops between a series of wide, flat valleys at 4000-5000 feet elevation, where it meanders in multiple shallow braids. The observed hydrograph for the 1997 event showed a highly attenuated peak arriving almost exactly three days after the rain ended. The generic loss rates (initial loss of 1.5 inches and constant loss ratesof 0.05 inches/hour) and baseflow parameters effectively modeled the response. Good calibration was achieved by multiplying Group 2 TC values for subbasins upstream of Canby by 8, and setting R equal to 1.5TC. As a recommendation, an excellent fit of the observed hydrograph could probably have been achieved by dividing the 740 square miles along the Pit River into more than two subbasins, and/or by revising the routing and recession parameters.

US18 Ash Creek above Adin:

This hourly gage shows a much faster response than in other parts of the basin. It is suspected that the LWASS hyetograph for the 1997 prevented an exact calibration, but an adequate fit was achieved using reasonable loss parameters with TC computed according to the Group 2 equation and R set equal to 4.0TC. The initial baseflow was set to 2 cfs per square mile.

US20 Ash Creek between Adin and Confluence with the Pit River:

The same parameters as US18 were used.

US17-US23 Pit River above Ash Creek and US23-US25 Pit River above Bieber:

The observed hydrographs at US17 (Canby) and US25 (Pit River at Muck Valley Diversion) had a substantial lag between them. The timing issues were resolved by: “disconnecting” the river at Canby (using the records from the observed gage as a source); reducing the runoff from the subbasins between US17 and US25 by using very high loss rates; and, adjusting water velocity in the spreadsheet until the routing parameters matched the peaks. A flow velocity of 1 foot per second provided a good fit between the observed hydrograph at

Bieber and the observed hydrograph routed from Canby. The river was “reconnected” and the source at Canby was removed.

US22 Pit River above Ash Creek and US24 Pit River at Muck Valley Diversion:
After determining the routing parameters, the Pit River basin parameters were set between Canby and Bieber using the generic losses and multiplier of 8 for the TC values.

US25-US29 Pit River above Fall River and US29-US31 Pit River above No 1 Powerplant:
The observed hydrographs at US25 (Bieber) and US31 (Pit River at No 1 Powerplant) have substantial lag between them. The timing issues were resolved by: “disconnecting” the river at Bieber (using the gage as a source); reducing the runoff from the subbasins between US25 and US31 by using very high loss rates; and, adjusting water velocity in the spreadsheet until the routing parameters matched the peaks. A flow velocity of 1.5 feet per second provided a good fit between the observed hydrograph at Powerplant No 1 and the observed hydrograph routed from Bieber. The river was “reconnected” and the source at Bieber was removed.

US26 Fall River, US28 Pit River above Fall River, US30 Hat Creek, and US32 Pit River above Hat Creek (above Powerhouse No 1):
After determining routing parameters as previously described, parameters for these areas were set using the multiplier of 8 for the TC value. Most of this area is lava beds so high constant loss rates of 0.25 inches/hour were chosen.

US34 Burney Creek above Burney and US36 Burney Creek above Confluence with Pit River:
The hourly gage showed a much faster response than in other parts of the basin. An adequate fit was achieved by using reasonable loss parameters with the TC computed according to the Group 2 equation and R set equal to 4.0TC.

US38 Pit River above Confluence with Burney Creek (Lake Britton) and US40 Pit River above Big Bend:
The runoff was no longer dominated by the lava beds, but the soils were still volcanic. Parameters were set for these subbasins using a multiplier of 8 for the TC, and the generic losses were used. Initial storage for Lake Britton was roughly estimated, but the reservoir had insufficient capacity to significantly influence the hydrograph. The model calibrated decently at US41 (Big Bend).

US42 Pit River above Dam No 6 and US44 Pit River above Dam No 7 (Montgomery Creek):
Parameters for these subbasins were set using a multiplier of 8 for the TC, and the generic losses were used. Initial storage for reservoirs at dams 6 and 7 were roughly estimated, but the reservoirs had insufficient capacity to significantly influence the hydrograph. The model calibrated well at US45 (Dam No 7), except that the observed hydrograph showed about 10,000 cfs of initial baseflow appearing somewhere between US41 and US45. Most of the 10,000 cfs was likely due to diversions from the McCloud River and upper Pit River returning to the basin.

US46 McCloud River at McCloud:

Parameters were set according to regression results (Group 2, with R = 4.0TC), but the LWASS data were not consistent with the timing of the observed flows. The closest fit to the observed data was found using losses of 1.5 inches of initial loss and 0.25 inches/hour of constant loss. This subbasin is adjacent to the lava-dominated Fall River basin. Available maps didn't show any lava beds in these headwaters, but the volume greatly exceeded the observed hydrograph; therefore, high loss values were used. Initial baseflow was set to 3 cfs per square mile.

Reach US47-US49 McCloud River above Ah-Di-Na and Reservoir US47R Lake McCloud:

The routing for this reach was converted from Muskingum (1.0/0.4/1) to the lag method (10 minutes) because most of reach is covered by Lake McCloud. Storage in this lake is insufficient to noticeably attenuate the 1997 event, so a node representing a simple junction (instead of a reservoir) was used. An elevation-storage-outflow curve (that delayed the flow routed from US46) was used. As a result, the modeled peak reservoir outflow occurred at approximately the same time as the observed. Losses of 1.5 inches and 0.05 inches/hour were used for the initial and constant losses, respectively, and the initial baseflow was set to 5 cfs per square mile.

US50 McCloud above Shasta:

This subbasin required a reduction of the initial loss to 0.5 inches and a minimization of the constant loss rate to 0.001 inches/hour. The initial baseflow was set to 5 cfs per square mile.

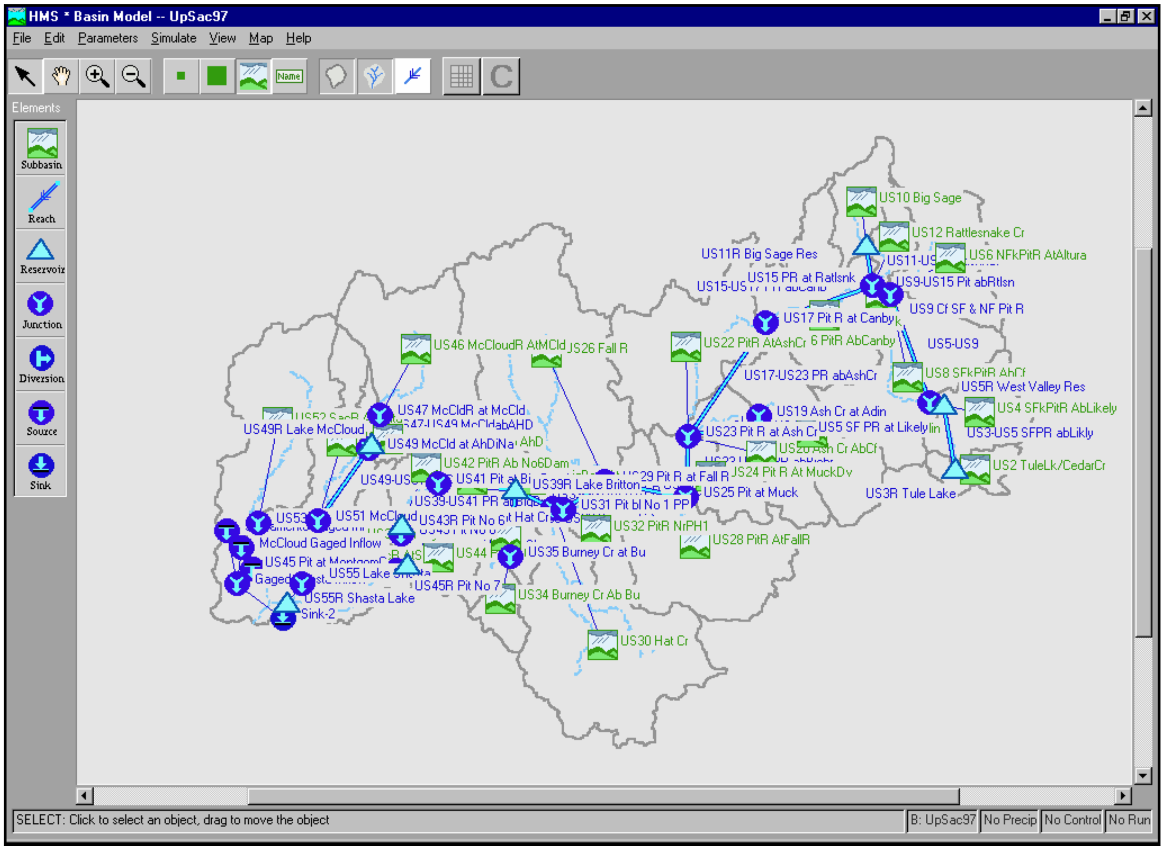
US52 Sacramento River at Delta (confluence with Shasta):

A good calibration was achieved by using the suggested Group 1 TC, with R set equal to 4.0TC. For this subbasin, minimal losses were used. The initial baseflow was set to 5 cfs per square mile.

US54 Shasta Lake Local Drainage:

Not enough water was available in the LWASS hyetograph to match the observed inflows. The timing appeared good, using suggested Group 1 TC, with R set equal to 4.0TC. Each of the tributaries to Shasta has observed flows available. The observed flows for the Pit River, McCloud River and Sacramento River were implemented as HMS source elements and a downstream sink element was established as a summation point. Even when these sources were combined, their flows were initially 20,000 cfs below the observed Shasta inflow at the beginning of the event and about 100,000 cfs at the peak. Therefore, to compensate for this difference in observed peaks and volumes, the losses for the local drainage area were reduced to nearly zero and the baseflows were set to 30 cfs per square mile to match the Shasta inflows. The same behavior occurred for the 1995 event.

Upper Sacramento River Basin HEC-HMS Model Schematic



Upper Sacramento River Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Initial TC $1.4(LL_{CA}/S^{1/2})^{.33}$ (Hr)	Initial R 1.5 TC (cfs/Hr)	Final TC $1.67(LL_{CA}/S^{1/2})^{.29}$ (Hr)	Final R 1.5TC (cfs/Hr)
US2 TuleLk/CedarCr	73.07	15.20	3.94	195.722	4.28	2.3	3.4	20.4	30.6
US4 SFkPitR AbLikely	174.77	24.60	10.67	164.099	20.49	3.8	5.7	32.1	48.1
US6 NFkPitR AtAltura	227.76	29.39	10.64	112.065	29.53	4.3	6.4	4.5	6.7
US8 SFkPitR AbCf	376.96	33.54	13.08	65.350	54.28	5.2	7.8	5.3	8.0
US10 Big Sage	117.46	23.78	9.10	14.898	56.08	5.3	7.9	42.9	64.4
US12 Rattlesnake Cr	71.60	24.82	12.85	38.197	51.62	5.1	7.7	41.9	62.9
US14 PitR AtRatlSnak	16.00	8.59	2.94	51.556	3.52	2.1	3.2	19.2	28.9
US16 PitR AbCanby	364.97	37.90	12.40	23.185	97.58	6.3	9.5	50.4	75.7
US18 Ash Cr AbAdin	259.49	34.58	12.22	82.357	46.57	5.0	7.5	5.1	20.3
US20 Ash Cr AbCf	207.58	36.96	18.34	70.839	80.53	6.0	8.9	6.0	23.9
US22 PitR AtAshCr	402.98	46.51	15.21	23.066	147.28	7.3	10.9	56.8	85.2
US24 Pit R At MuckDv	144.51	27.18	8.96	63.978	30.44	4.3	6.5	36.0	54.0
US26 Fall R	701.34	63.97	34.04	58.262	285.31	9.0	13.6	68.8	103.3
US28 PitR AtFallR	470.55	49.12	24.50	77.063	137.10	7.1	10.7	55.7	83.5
US30 Hat Cr	594.47	58.86	33.77	74.528	230.24	8.4	12.6	64.7	97.0
US32 PitR NrPH1	141.50	31.64	13.57	92.504	44.63	4.9	7.4	40.2	60.3
US34 Burney Cr Ab Bu	87.23	23.17	11.45	230.213	17.49	3.6	5.4	3.8	15.3
US36 Burney Cr AbCf	92.94	20.89	11.86	131.590	21.60	3.9	5.8	4.1	16.3
US38 PitR AtBurneyCr	46.96	12.71	10.76	182.001	10.14	3.0	4.5	26.2	39.2
US40 PitR At BigBend	127.64	33.68	13.94	114.683	43.85	4.9	7.3	40.0	60.0
US42 PitR Ab No6Dam	109.69	28.66	13.15	172.390	28.70	4.2	6.4	35.4	53.0
US44 PitR AtMontgmCr	128.08	23.27	8.40	221.337	13.15	3.3	4.9	28.2	42.3
US46 McCloudR AtMCld	363.16	46.28	21.26	245.900	62.75	5.5	8.2	5.5	22.2
US48 McCloudR Ab AhD	66.19	18.95	6.12	112.301	10.94	3.1	4.6	3.3	13.4
US50 McCloudR AbShas	184.47	43.21	18.99	232.861	53.77	5.2	7.8	5.3	21.2
US52 SacR AtDelta	424.21	52.54	22.09	211.127	79.90	5.9	8.9	5.1	20.4
US54 SacR AtShasta	438.23	44.82	12.57	100.856	56.08	5.3	7.9	4.3	17.3

Upper Sacramento River Reach Parameters

Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Ave Reach Vel $80\ S_R^{1/2}$ V_R (fps)	Initial K $1.47\ L_R / 1.5V_R$ K (Hr)	Musk X or LAG (Min)	N steps Time Step= 60
US49-US51 McClabSha	20.22	0.0098	7.92	2.5	0.4	2
US43-US45 PR ab Shas	8.57	0.0045	5.37	1.6	0.36	2
US3-US5 SFPR abLikly	13.75	0.0137	9.35	1.4	0.34	1
US15-US17 PR abCanb	24.85	0.0005	1.78	13.7	0.4	11
US35-US39 Burney Cr	14.19	0.0054	5.90	2.4	0.4	2
US33-US39 PR ab Burn	7.87	0.0006	1.88	4.1	0.4	4
US47-US49 McCldabAHD	9.36	0.0120	8.76	1.0	10	--
US23-US25 PR atBiebr	10.90	0.0006	1.00	10.7	0.4	9
US39-US41 PR abBigBn	21.78	0.0090	7.59	2.8	0.4	3
US41-US43 PR ab No6	11.05	0.0073	6.86	1.6	0.36	2
US11-US15 RtlsnkCr	10.49	0.0100	8.00	1.3	0.38	1
US9-US15 Pit abRtlsn	4.18	0.0009	2.39	1.7	0.4	2
US5-US9	23.40	0.0013	2.88	8.0	0.4	7
US17-US23 PR abAshCr	32.95	0.0009	1.00	32.3	0.4	26
US19-US21 Ash Cr	13.28	0.0010	1.00	13.0	0.4	11
US25-US29	24.45	0.0066	1.50	16.0	0.4	13
US29-31 PR ab No 1 PP	15.08	0.0061	1.50	9.8	0.4	8

HEC-HMS Summary of Results
Upper Sacramento River Basin: March 1995 Event

Project	: UpSac		Run Name	: March 1995 Event	
Start of Run	: 08Mar95	0100	Basin Model	:	UpSac95
End of Run	: 15Mar95	2400	Met. Model	:	1995 Event
Execution Time	: 31May00	1312	Control Specs.	:	1995 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
Sacramento Gaged Inf	34500	10 Mar 95 1700	225237	
McCloud Gaged Inflow	22746	10 Mar 95 2200	177630	
Pit Gaged Inflow	29300	14 Mar 95 0100	372776	
Gaged Shasta Inflow	77549	10 Mar 95 2100	775643	0.000
US52 SacR AtDelta	33387	10 Mar 95 2000	238686	424.213
US53 Sac R at Delta	33387	10 Mar 95 2000	238686	424.213
US46 McCloudR AtMCld	11373	09 Mar 95 1800	52648	363.160
US47 McCldR at McCld	11373	09 Mar 95 1800	52648	363.160
US47-US49 McCldabAHD	11352	09 Mar 95 1800	52637	363.160
US48 McCloudR Ab AhD	10231	09 Mar 95 1600	59286	66.185
US49R Lake McCloud	11046	11 Mar 95 0300	89918	429.345
US49 McCld at AhDiNa	11046	11 Mar 95 0300	89918	429.345
US49-US51 McCldabSha	11033	11 Mar 95 0500	88780	429.345
US50 McCloudR AbShas	11930	10 Mar 95 1900	85178	184.474
US51 McCloud abShast	21484	10 Mar 95 2200	173958	613.819
US34 Burney Cr Ab Bu	4076.1	14 Mar 95 2200	26442	87.230
US35 Burney Cr at Bu	4076.1	14 Mar 95 2200	26442	87.230
US35-US39 Burney Cr	4047.8	14 Mar 95 2400	26272	87.230
US18 Ash Cr AbAdin	786.53	11 Mar 95 2200	6248.5	259.495
US19 Ash Cr at Adin	786.53	11 Mar 95 2200	6248.5	259.495
US19-US21 Ash Cr	732.96	12 Mar 95 1200	6409.2	259.495
US10 Big Sage	82.219	08 Mar 95 0100	607.08	117.456
US11R Big Sage Res	1.1048	15 Mar 95 2400	17.407	117.456
US11-US15 RtlsnkCr	1.1048	15 Mar 95 2400	17.407	117.456
US2 TuleLk/CedarCr	51.150	08 Mar 95 0100	428.37	73.071
US3R Tule Lake	1.0041	15 Mar 95 2400	15.843	73.071
US3-US5 SFPR abLikly	1.0041	15 Mar 95 2400	15.843	73.071
US4 SFkPitR AbLikely	122.34	08 Mar 95 0100	1004.6	174.771
US5R West Valley Res	91.848	09 Mar 95 0900	1237.6	247.842
US5 SF PR at Likely	91.848	09 Mar 95 0900	1237.6	247.842
US5-US9	91.832	09 Mar 95 1700	1246.7	247.842
US8 SFkPitR AbCf	310.18	15 Mar 95 2400	2333.8	376.964
US6 NFkPitR AtAltura	159.43	08 Mar 95 0100	1252.6	227.762

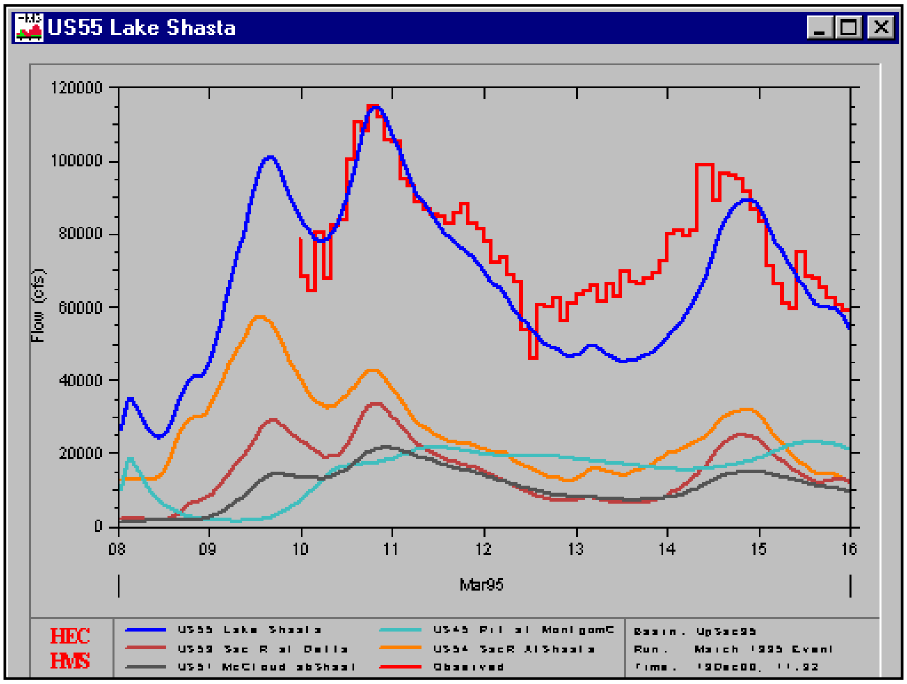
... Continued ...

HEC-HMS Summary of Results
Upper Sacramento River Basin: March 1995 Event
(Continued)

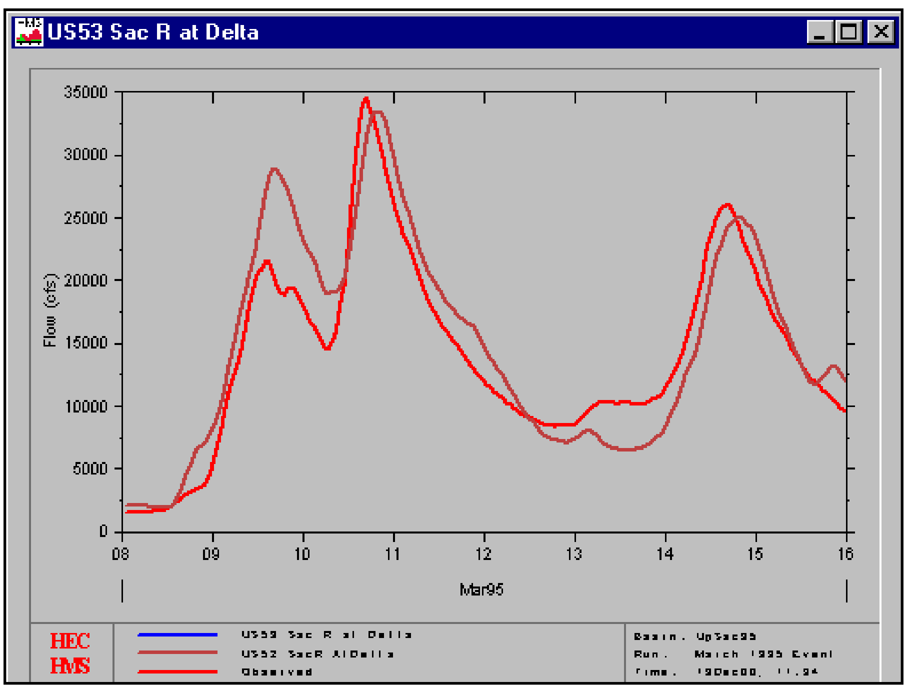
Project : UpSac Run Name : March 1995 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
US9 Cf SF & NF Pit R	503.34	08 Mar 95 0100	4833.1	852.568
US9-US15 Pit abRtlsn	503.34	08 Mar 95 0100	4841.3	852.568
US14 PitR AtRatlSnak	11.201	08 Mar 95 0100	83.288	16.001
US12 Rattlesnake Cr	50.120	08 Mar 95 0100	370.07	71.600
US15 PR at Ratlsnk	565.76	08 Mar 95 0100	5312.1	1057.625
US15-US17 PR abCanb	565.76	08 Mar 95 0100	5540.1	1057.625
US16 PitR AbCanby	255.48	08 Mar 95 0100	2142.6	364.972
US17 Pit R at Canby	821.24	08 Mar 95 0100	7682.7	1422.597
US17-US23 PR abAshCr	821.24	08 Mar 95 0100	8905.7	1422.597
US22 PitR AtAshCr	2117.9	15 Mar 95 2400	13332	402.978
US20 Ash Cr AbCf	1499.7	11 Mar 95 2400	8236.1	207.578
US23 Pit R at Ash Cr	3399.7	15 Mar 95 2400	36883	2292.648
US23-US25 PR abBiebr	3309.3	12 Mar 95 2200	35796	2292.648
US24 Pit R At MuckDv	101.15	08 Mar 95 0100	781.67	144.505
US25 Pit at Muck	3350.5	12 Mar 95 2200	36578	2437.153
US25-US29	3321.8	13 Mar 95 1400	35734	2437.153
US26 Fall R	1195.3	12 Mar 95 1700	10627	701.338
US28 PitR AtFallR	382.69	12 Mar 95 1100	3844.2	470.549
US29 Pit R at Fall R	4687.6	13 Mar 95 0400	50206	3609.040
US29-31 PR abNo 1 PP	4662.2	13 Mar 95 1500	50143	3609.040
US32 PitR NrPH1	637.92	12 Mar 95 2300	3555.5	141.503
US31 Pit bl No 1 PP	5180.5	13 Mar 95 1400	53699	3750.543
US30 Hat Cr	416.13	08 Mar 95 0100	3981.4	594.472
US33 Pit R at Hat Cr	5409.2	13 Mar 95 1400	57680	4345.015
US33-US39 PR ab Burn	5401.5	13 Mar 95 1800	57742	4345.015
US36 Burney Cr AbCf	3358.7	09 Mar 95 1700	23430	92.938
US38 PitR AtBurneyCr	1108.9	12 Mar 95 2000	7393.5	46.957
US39R Lake Britton	11016	15 Mar 95 0100	101941	4572.140
US39-US41 PR abBigBn	11000	15 Mar 95 0400	100464	4572.140
US40 PitR At BigBend	3912.1	12 Mar 95 0200	41118	127.642
US41 Pit at Big Bend	14420	15 Mar 95 0500	141583	4699.782
US41-US43 PR ab No6	14410	15 Mar 95 0600	140281	4699.782
US42 PitR Ab No6Dam	6098.7	11 Mar 95 2200	56916	109.694
US43R Pit No 6	30000	08 Mar 95 0100	198901	4809.476
US43 Pit No 6	30000	08 Mar 95 0100	198901	4809.476
US43-US45 PR ab Shas	30000	08 Mar 95 0100	200687	4809.476
US44 PitR AtMontgmCr	4501.7	15 Mar 95 1300	40095	128.081
US45R Pit No 7	23085	15 Mar 95 1300	237771	4937.557
US45 Pit at MontgomC	23085	15 Mar 95 1300	237771	4937.557
US54 SacR AtShasta	57084	09 Mar 95 1400	411089	438.231
US55 Lake Shasta	114358	10 Mar 95 2000	1061504	6413.820
US55R Shasta Lake	1.00000	08 Mar 95 0100	15.785	6413.820
Sink-2	77550	10 Mar 95 2100	775658	6413.820

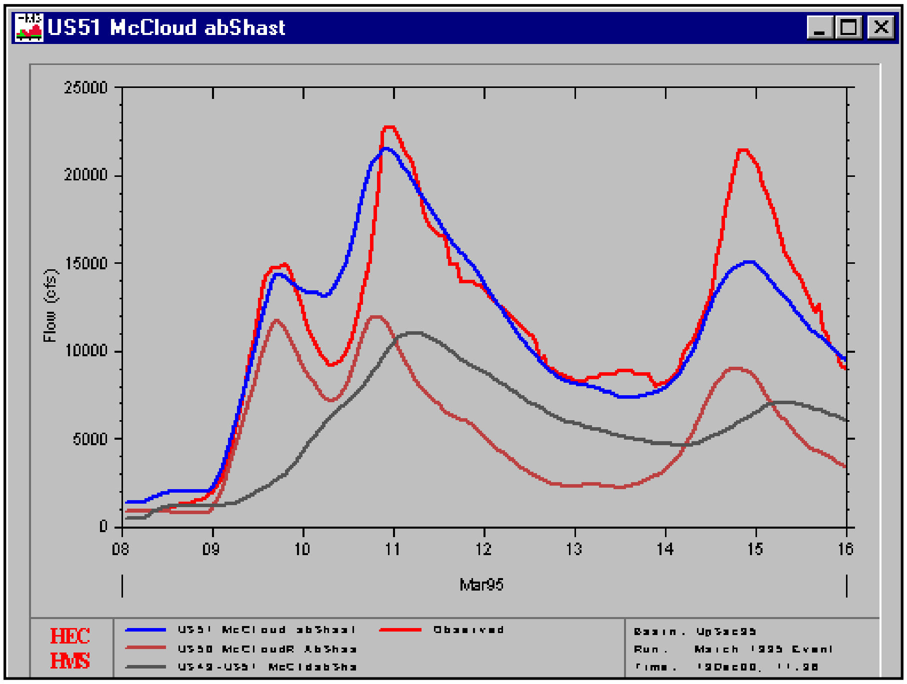
HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Upper Sacramento River Basin
March 1995 Event



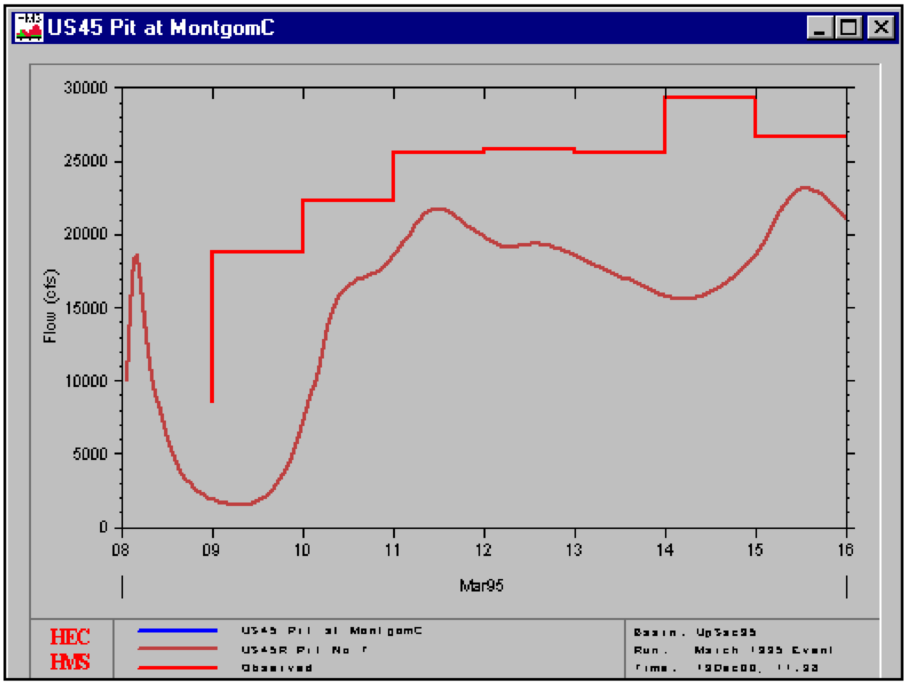
US55 – Lake Shasta



US53 – Sacramento River at Delta



US51 – McCloud RiverAbove Shasta



US45 – Pit River at Montgomery Creek

HEC-HMS Subbasin Parameters
Upper Sacramento River Basin: March 1995 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
US12 Rattlesnake Cr	0.7	0.8	0.2	1.5	0.05	0
US14 PitR AtRatlSnak	0.7	0.8	0.2	1.5	0.05	0
US16 PitR AbCanby	0.7	0.8	0.2	1.5	0.05	0
US26 Fall R	0.7	0.8	0.2	1.5	0.25	0
US22 PitR AtAshCr	0.7	0.8	0.2	1.5	0.05	0
US46 McCloudR AtMCld	3	0.8	0.2	1.5	0.25	0
US4 SFkPitR AbLikely	0.7	0.8	0.2	1.5	0.05	0
US28 PitR AtFallR	0.7	0.8	0.2	1.5	0.15	0
US50 McCloudR AbShas	5	0.8	0.2	1.5	0.05	0
US20 Ash Cr AbCf	2	0.8	0.2	1.5	0.05	0
US54 SacR AtShasta	30	0.8	0.2	0.01	0.001	50
US32 PitR NrPH1	0.7	0.8	0.2	1.5	0.25	0
US30 Hat Cr	0.7	0.8	0.2	1.5	0.25	0
US44 PitR AtMontgmCr	3	0.8	0.2	1.5	0.05	0
US52 SacR AtDelta	5	0.8	0.2	0.5	0.001	0
US10 Big Sage	0.7	0.8	0.2	1.5	0.05	0
US38 PitR AtBurneyCr	3	0.8	0.2	1.5	0.05	0
US36 Burney Cr AbCf	3	0.8	0.2	1.5	0.05	0
US6 NFkPitR AtAltura	0.7	0.8	0.2	1.5	0.05	0
US8 SFkPitR AbCf	0.7	0.8	0.2	1.5	0.05	0
US18 Ash Cr AbAdin	2	0.8	0.2	1.5	0.05	0
US48 McCloudR Ab AhD	5	0.8	0.2	1.5	0.05	0
US2 TuleLk/Cedar Cr	0.7	0.8	0.2	1.5	0.05	0
US24 Pit R At MuckDv	0.7	0.8	0.2	1.5	0.25	0
US34 Burney Cr Ab Bu	3	0.8	0.2	1.5	0.05	0
US40 PitR At BigBend	3	0.8	0.2	1.5	0.05	0
US42 PitR Ab No6Dam	3	0.8	0.2	1.5	0.05	0

HEC-HMS Summary of Results
Upper Sacramento River Basin: December 1996 - January 1997 Event

Project	: UpSac		Run Name	: Jan 1997 Event	
Start of Run	: 28Dec96	0100	Basin Model	:	UpSac97
End of Run	: 08Jan97	2400	Met. Model	:	1997 Event
Execution Time	: 31May00	1313	Control Specs.	:	1997 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
Sacramento Gaged Inf	61600	01 Jan 97 0100	339519	
McCloud Gaged Inflow	47423	01 Jan 97 0800	321888	
Pit Gaged Inflow	40200	03 Jan 97 0100	606871	
Gaged Shasta Inflow	142932	01 Jan 97 0300	1268278	0.000
US52 SacR AtDelta	54178	01 Jan 97 0500	391786	424.213
US53 Sac R at Delta	54178	01 Jan 97 0500	391786	424.213
US46 McCloudR AtMCld	17691	31 Dec 96 0300	99631	363.160
US47 McCldR at McCld	17691	31 Dec 96 0300	99631	363.160
US47-US49 McCldabAHD	17615	31 Dec 96 0300	99634	363.160
US48 McCloudR Ab AhD	13078	31 Dec 96 0200	85639	66.185
US49R Lake McCloud	23523	01 Jan 97 0900	175847	429.345
US49 McCld at AhDiNa	23523	01 Jan 97 0900	175847	429.345
US49-US51 McCldabSha	23480	01 Jan 97 1100	175364	429.345
US50 McCloudR AbShas	25754	01 Jan 97 0500	201178	184.474
US51 McCloud abShast	47722	01 Jan 97 0900	376541	613.819
US34 Burney Cr Ab Bu	5290.9	31 Dec 96 0200	33194	87.230
US35 Burney Cr at Bu	5290.9	31 Dec 96 0200	33194	87.230
US35-US39 Burney Cr	5242.1	31 Dec 96 0400	33193	87.230
US18 Ash Cr AbAdin	3300.5	31 Dec 96 0400	24382	259.495
US19 Ash Cr at Adin	3300.5	31 Dec 96 0400	24382	259.495
US19-US21 Ash Cr	3191.1	31 Dec 96 1700	24711	259.495
US10 Big Sage	379.69	03 Jan 97 0700	4058.2	117.456
US11R Big Sage Res	1.1389	08 Jan 97 2400	26.516	117.456
US11-US15 RtlsnkCr	1.1388	08 Jan 97 2400	26.511	117.456
US2 TuleLk/CedarCr	602.61	02 Jan 97 1600	3297.8	73.071
US3R Tule Lake	1.0124	08 Jan 97 2400	23.894	73.071
US3-US5 SFPR abLikly	1.0124	08 Jan 97 2400	23.893	73.071
US4 SFkPitR AbLikely	963.91	03 Jan 97 0300	6684.2	174.771
US5R West Valley Res	369.22	05 Jan 97 0600	5453.3	247.842
US5 SF PR at Likely	369.22	05 Jan 97 0600	5453.3	247.842
US5-US9	369.20	05 Jan 97 1400	5288.3	247.842
US8 SFkPitR AbCf	2242.2	03 Jan 97 1400	18262	376.964
US6 NFkPitR AtAltura	1180.1	03 Jan 97 0800	8225.0	227.762

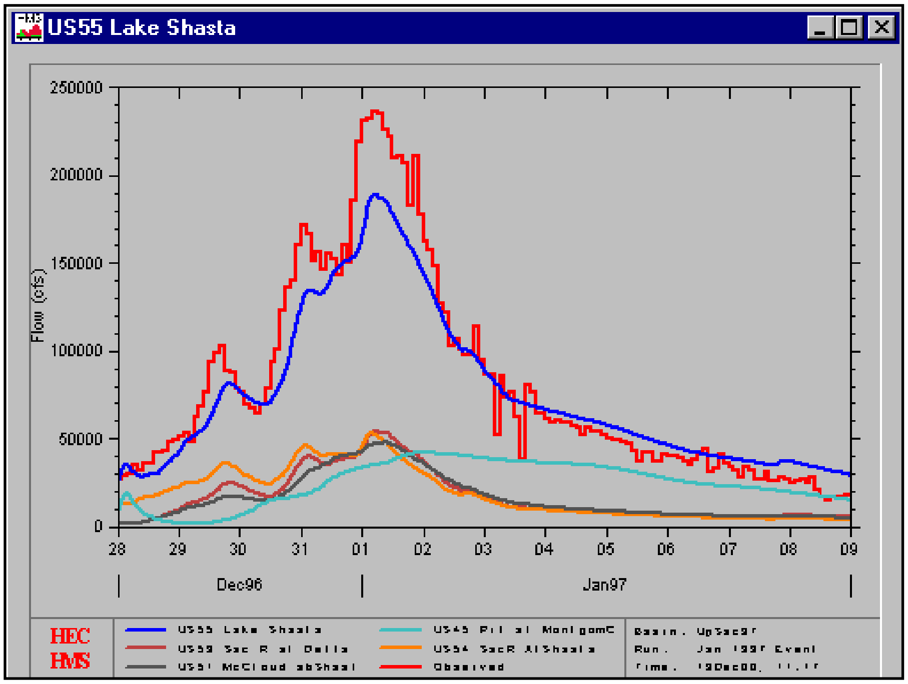
... Continued ...

HEC-HMS Summary of Results
Upper Sacramento River Basin: December 1996 - January 1997 Event
(Continued)

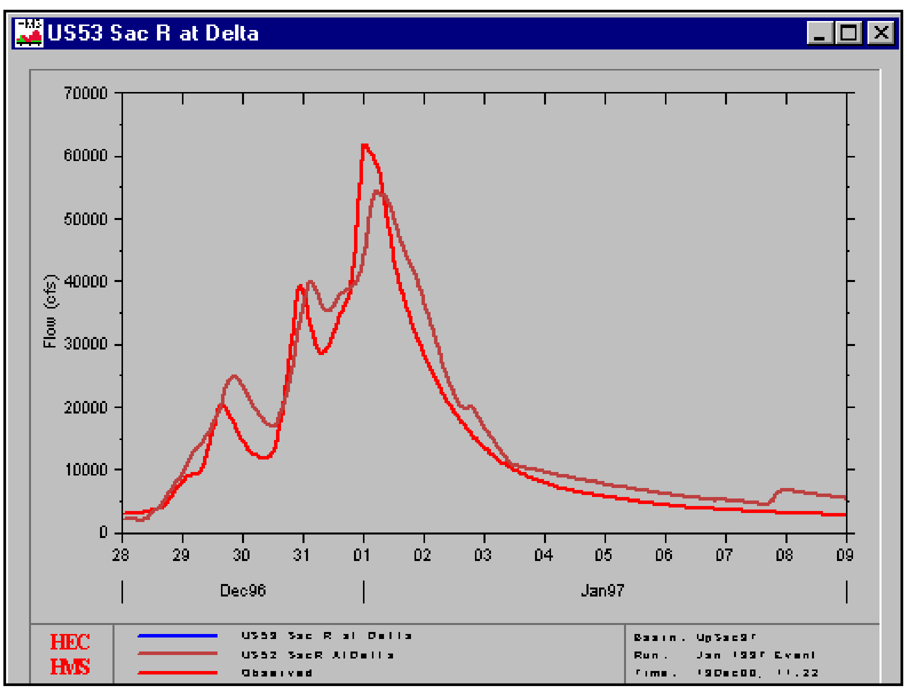
Project : UpSac Run Name : Jan 1997 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
US9 Cf SF & NF Pit R	3718.6	03 Jan 97 1100	31775	852.568
US9-US15 Pit abRtlsn	3717.9	03 Jan 97 1300	31724	852.568
US14 PitR AtRatlSnak	70.203	02 Jan 97 1900	465.14	16.001
US12 Rattlesnake Cr	165.37	03 Jan 97 1400	1515.9	71.600
US15 PR at Ratlsnk	3927.8	03 Jan 97 1300	33732	1057.625
US15-US17 PR abCanb	3912.1	04 Jan 97 0300	33295	1057.625
US16 PitR AbCanby	4634.0	02 Jan 97 0400	47362	364.972
US17 Pit R at Canby	7416.4	03 Jan 97 2300	80656	1422.597
US17-US23 PR abAshCr	7363.8	05 Jan 97 0800	77210	1422.597
US22 PitR AtAshCr	9777.4	02 Jan 97 1500	106237	402.978
US20 Ash Cr AbCf	2829.5	31 Dec 96 0300	22282	207.578
US23 Pit R at Ash Cr	18369	02 Jan 97 1700	230441	2292.648
US23-US25 PR abBiebr	18326	03 Jan 97 0400	227614	2292.648
US24 Pit R At MuckDv	101.15	28 Dec 96 0100	867.23	144.505
US25 Pit at Muck	18354	03 Jan 97 0400	228481	2437.153
US25-US29	18306	03 Jan 97 2000	223177	2437.153
US26 Fall R	3719.5	03 Jan 97 1800	41573	701.338
US28 PitR AtFallR	329.38	28 Dec 96 0100	2952.5	470.549
US29 Pit R at Fall R	22114	03 Jan 97 1900	267703	3609.040
US29-31 PR abNo 1 PP	22086	04 Jan 97 0500	263236	3609.040
US32 PitR NrPH1	99.052	28 Dec 96 0100	1089.4	141.503
US31 Pit bl No 1 PP	22130	04 Jan 97 0500	264326	3750.543
US30 Hat Cr	760.07	04 Jan 97 0800	9075.5	594.472
US33 Pit R at Hat Cr	22881	04 Jan 97 0500	273401	4345.015
US33-US39 PR ab Burn	22870	04 Jan 97 1000	271371	4345.015
US36 Burney Cr AbCf	5147.3	31 Dec 96 0300	35361	92.938
US38 PitR AtBurneyCr	1507.4	01 Jan 97 2400	14839	46.957
US39R Lake Britton	24897	04 Jan 97 1200	340064	4572.140
US39-US41 PR abBigBn	24891	04 Jan 97 1500	337613	4572.140
US40 PitR At BigBend	8566.4	01 Jan 97 1600	85420	127.642
US41 Pit at Big Bend	28795	04 Jan 97 1000	423034	4699.782
US41-US43 PR ab No6	28794	04 Jan 97 1200	421511	4699.782
US42 PitR Ab No6Dam	11354	01 Jan 97 1900	103143	109.694
US43R Pit No 6	35629	02 Jan 97 0400	526667	4809.476
US43 Pit No 6	35629	02 Jan 97 0400	526667	4809.476
US43-US45 PR ab Shas	35626	02 Jan 97 0600	528790	4809.476
US44 PitR AtMontgmCr	6729.9	01 Jan 97 1700	55253	128.081
US45R Pit No 7	41914	01 Jan 97 2400	582543	4937.557
US45 Pit at MontgomC	41914	01 Jan 97 2400	582543	4937.557
US54 SacR AtShasta	53082	01 Jan 97 0400	438969	438.231
US55 Lake Shasta	188939	01 Jan 97 0500	1789839	6413.820
US55R Shasta Lake	1.00000	28 Dec 96 0100	23.719	6413.820
Sink-2	142933	01 Jan 97 0300	1268302	6413.820

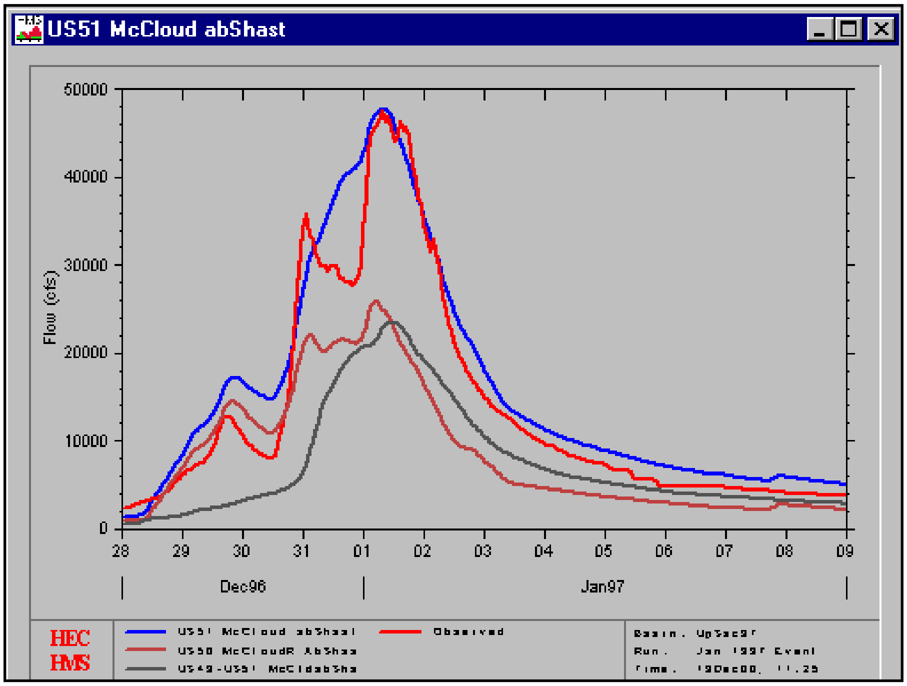
HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Upper Sacramento River Basin
December 1996 - January 1997 Event



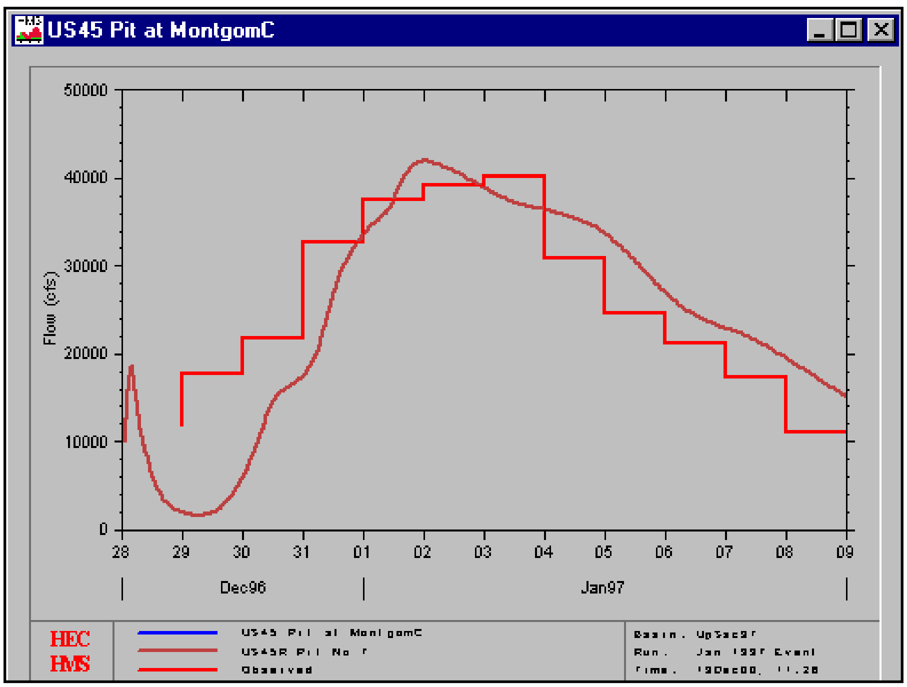
US55 – Lake Shasta



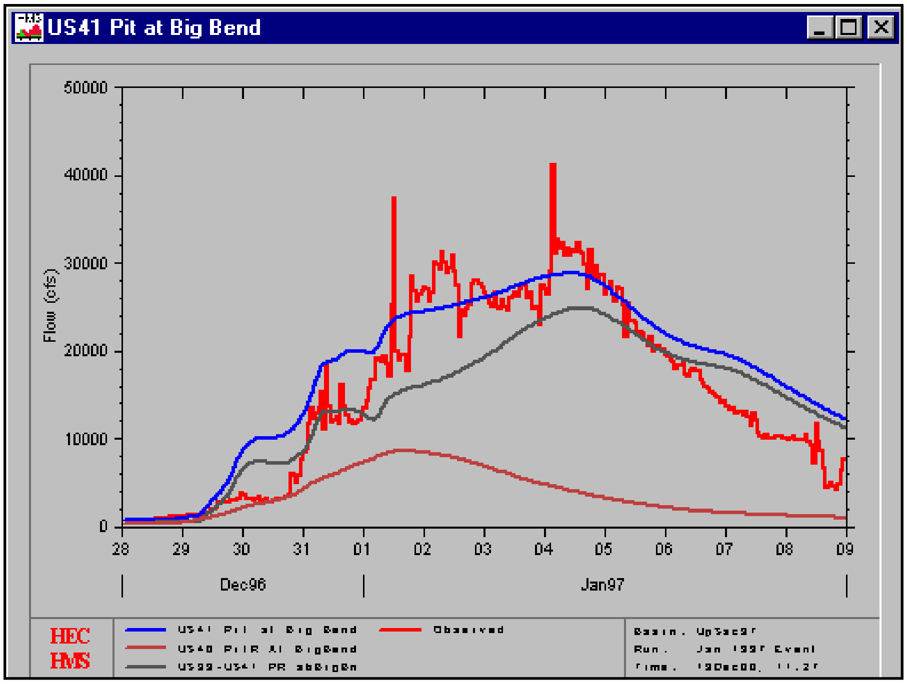
US53 – Sacramento River at Delta



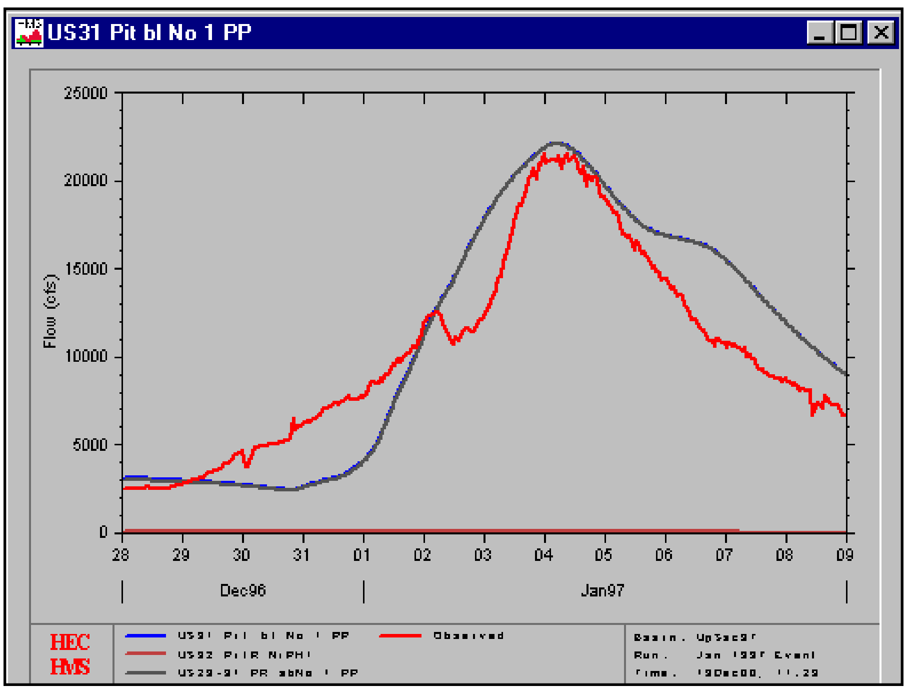
US51 – McCloud River Above Shasta



US45 – Pit River at Montgomery Creek



US41 – Pit River at Big Bend

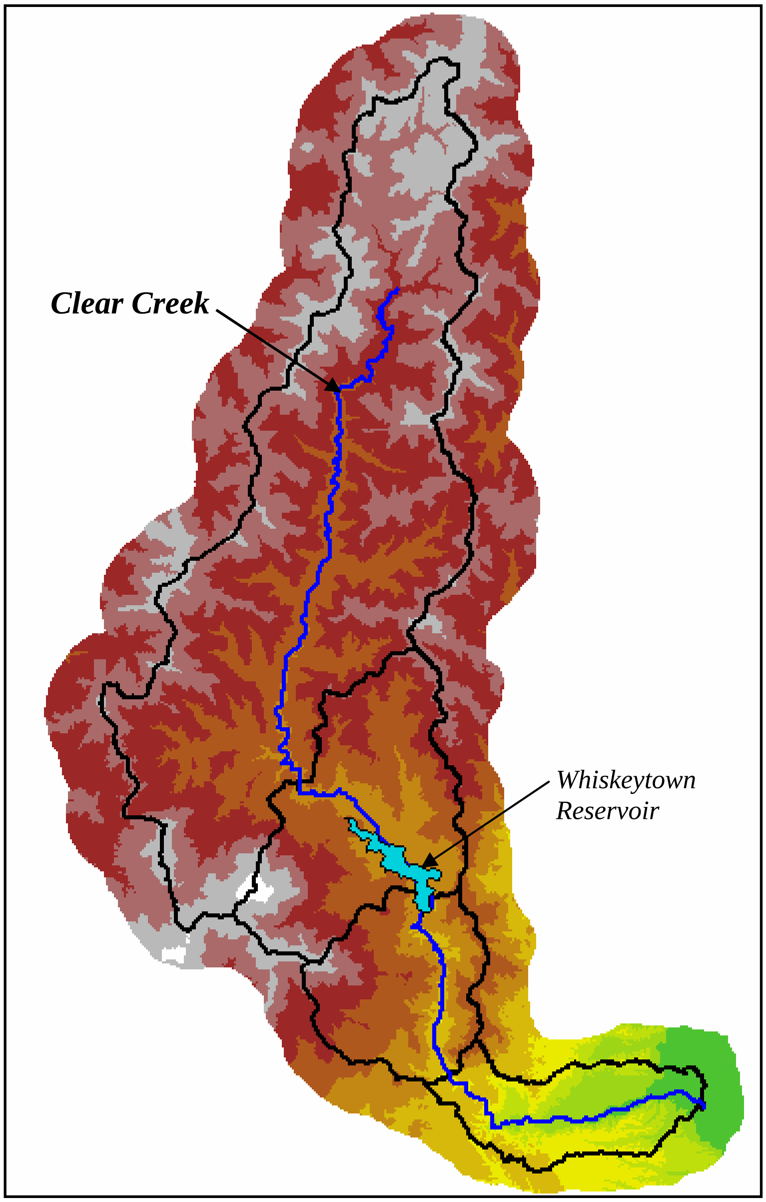


US31 – Pit River Below No. 1 Powerplant

HEC-HMS Subbasin Parameters
Upper Sacramento River Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
US12 Rattlesnake Cr	0.7	0.8	0.2	1.5	0.05	0
US14 PitR AtRatlSnak	0.7	0.8	0.2	1.5	0.05	0
US16 PitR AbCanby	0.7	0.8	0.2	1.5	0.05	0
US26 Fall R	0.7	0.8	0.2	1.5	0.25	0
US22 PitR AtAshCr	0.7	0.8	0.2	1.5	0.05	0
US46 McCloudR AtMCld	3	0.8	0.2	1.5	0.25	0
US4 SFkPitR AbLikely	0.7	0.8	0.2	1.5	0.05	0
US28 PitR AtFallR	0.7	0.8	0.2	1.5	0.25	0
US50 McCloudR AbShas	5	0.8	0.2	1.5	0.001	0
US20 Ash Cr AbCf	2	0.8	0.2	1.5	0.05	0
US54 SacR AtShasta	30	0.8	0.2	0.01	0.001	50
US32 PitR NrPH1	0.7	0.8	0.2	1.5	0.25	0
US30 Hat Cr	0.7	0.8	0.2	1.5	0.25	0
US44 PitR AtMontgmCr	3	0.8	0.2	1.5	0.05	0
US52 SacR AtDelta	5	0.8	0.2	0.5	0.001	0
US10 Big Sage	0.7	0.8	0.2	1.5	0.05	0
US38 PitR AtBurneyCr	3	0.8	0.2	1.5	0.05	0
US36 Burney Cr AbCf	3	0.8	0.2	1.5	0.05	0
US6 NFkPitR AtAltura	0.7	0.8	0.2	1.5	0.05	0
US8 SFkPitR AbCf	0.7	0.8	0.2	1.5	0.05	0
US18 Ash Cr AbAdin	2	0.8	0.2	1.5	0.05	0
US48 McCloudR Ab AhD	5	0.8	0.2	1.5	0.05	0
US2 TuleLk/Cedar Cr	0.7	0.8	0.2	1.5	0.05	0
US24 Pit R At MuckDv	0.7	0.8	0.2	1.5	0.25	0
US34 Burney Cr Ab Bu	3	0.8	0.2	1.5	0.05	0
US40 PitR At BigBend	3	0.8	0.2	1.5	0.05	0
US42 PitR Ab No6Dam	3	0.8	0.2	1.5	0.05	0

Clear Creek Basin



HEC-GeoHMS Subbasin Delineation

Clear Creek

The Clear Creek HMS model consists of a 251 square mile basin located in the northwest portion of the Sacramento Watershed above the confluence with the Sacramento River just south of Redding, CA. The model is included as part of the MidSac_West HMS Project and the basin is divided into 4 subbasins and connected with 3 routing reaches. The observed hydrographs are represented by the inflow into the Whiskeytown Reservoir (daily), and a hourly gage at Igo, CA (11372000) downstream of the reservoir. The computed peak inflow into Whiskeytown Reservoir for the 1997 event was larger than the 1995 event (13,920 cfs vs. 4,836 cfs).

Using the adopted TC and R (Group 1), the initial Muskingum routing parameters and the elevation-storage-outflow relationship provided by the district (for Whiskeytown Reservoir), the HMS model was calibrated. Because daily (not hourly) observed flows were available at the Whiskeytown Reservoir, the computed hydrographs (representing both the 1997 and 1995 events) were not as good as they were at Igo. The initial and constant loss values were lower for the 1997 event than they were for the 1995 event, but all of the loss values were in the normal modeling range.

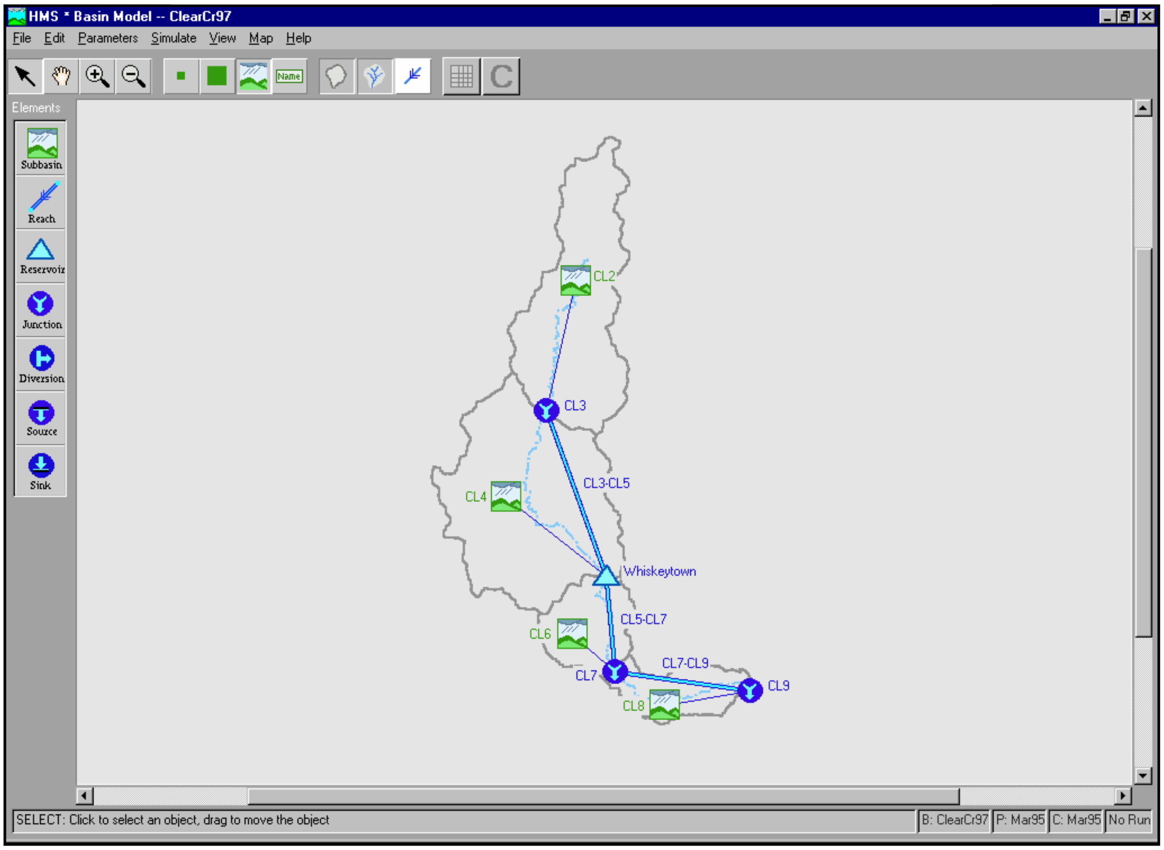
Calibration of the 1995 Event:

The initial observed spike at the Igo gage was matched well for the 1995 event; however, the subsequent spikes were not matched. Perhaps the actual reservoir operations varied from the elevation-storage-outflow relationship. The reservoir reduced the peak flow substantially for the 1995 event. The flow was reduced from approximately 22,000 cfs into the reservoir to about 5,500 cfs at the Igo gage. Initial and constant loss rates of 1.5 inches and 0.05 inches/hour, respectively, were used. The baseflow values of 2.0 cfs per square mile, 0.8 and 0.2 for the initial flow, recession ratio, and the threshold flow, respectively, were also used to calibrate the model.

Calibration of the 1997 Event:

The computed hydrograph for the 1997 event at the Igo gage matched the observed hydrograph very well. The reservoir appeared to have less of an influence on the 1997 event than it did for the 1995 event. The flow was reduced from 20,000 cfs at the reservoir to roughly 15,000 cfs at Igo. Initial and constant loss rates of 1.00 inch and 0.01 inches/hour, respectively, were used. The baseflow values of 2.0 cfs per square mile, 0.8 and 0.2 for the initial flow, recession ratio, and the threshold flow, respectively, were also used to calibrate the model.

Clear Creek Basin HEC-HMS Model Schematic



Clear Creek Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Initial TC $1.4(LL_{CA}/S^{1/2})^{.33}$ (Hr)	Initial R 1.5 TC (cfs/Hr)	Regression TC $0.68(LL_{CA}/S^{1/2})^{.46}$ (Hr)	Regression R 1.5TC (cfs/Hr)
CLR4 Whiskeytown Res	46.09	32.28	11.94	58.08	50.57	5.1	7.7	4.1	6.2
CL8 ClearCr Out	22.70	40.17	18.46	327.36	40.98	4.8	7.2	3.8	5.6
CL2 ClearCr Hdwtr	154.01	111.59	36.02	137.28	343.09	9.6	14.4	10.0	15.0
CL6	28.26	36.61	22.53	47.52	119.61	6.8	10.2	6.1	9.2

Clear Creek Reach Parameters

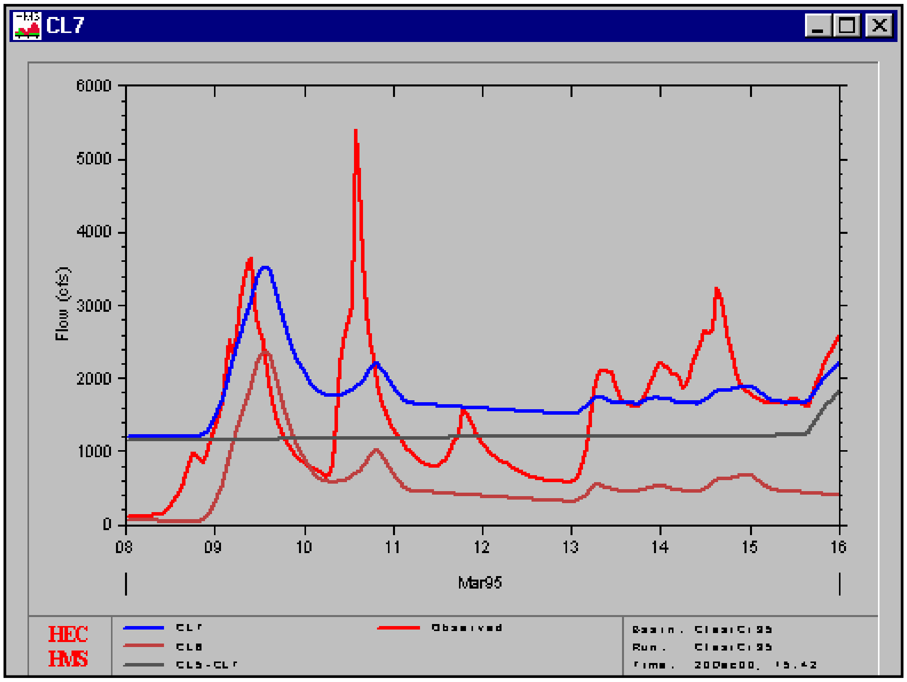
Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Ave Reach Vel $80\ S_R^{1/2}$ V_R (fps)	Initial K $1.47\ L_R / 1.5V_R$ K (Hr)	Musk X or LAG (Min)	N steps Time Step= 60
CL7-CL9	11.51	0.0044	5.31	2.1	0.4	3
CL3-CL5	6.72	0.0001	0.80	8.2	30	--
CL5-CL7	7.53	0.0135	9.30	1.0	0.4	2

HEC-HMS Summary of Results
Clear Creek Basin: March 1995 Event

Project	: MidSac_West	Run Name	: ClearCr95
Start of Run	: 08Mar95 0100	Basin Model	: ClearCr95
End of Run	: 15Mar95 2400	Met. Model	: Mar95
Execution Time	: 31May00 1305	Control Specs.	: Mar95

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
CL2	6485.9	09 Mar 95 1500	35355	85.700
CL3	6485.9	09 Mar 95 1500	35355	85.700
CL3-CL5	6481.6	09 Mar 95 1600	35307	85.700
CL4	15194	09 Mar 95 1300	58096	114.400
Whiskeytown	1868.2	15 Mar 95 2400	19056	200.100
CL5-CL7	1813.1	15 Mar 95 2400	18999	200.100
CL6	2350.0	09 Mar 95 1300	9051.7	28.300
CL7	3513.4	09 Mar 95 1400	28051	228.400
CL7-CL9	3510.4	09 Mar 95 1600	27888	228.400
CL8	1631.5	09 Mar 95 1200	6848.0	22.700
CL9	4835.9	09 Mar 95 1400	34736	251.100

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Clear Creek Basin
March 1995 Event



CL7 – Clear Creek at Igo

HEC-HMS Subbasin Parameters
Clear Creek Basin: March 1995 Event

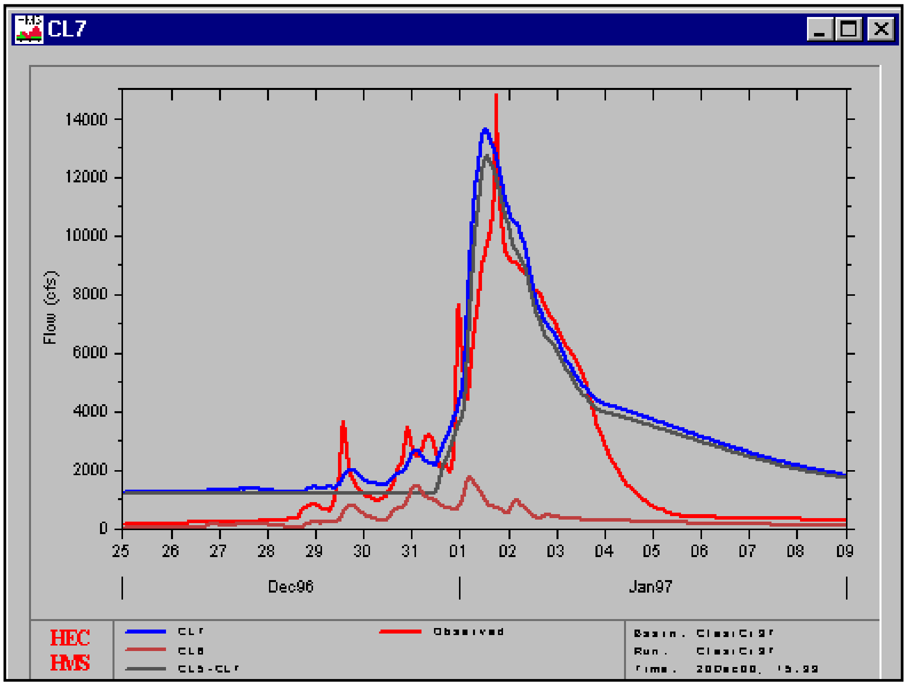
Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
CL4	2	0.8	0.2	1.5	.05	10
CL8	2	0.8	0.2	1.5	.05	0
CL2	2	0.8	0.2	1.5	.05	0
CL6	2	0.8	0.2	1.5	.05	0

HEC-HMS Summary of Results
Clear Creek Basin: December 1996 - January 1997 Event

Project	: MidSac_West	Run Name	: ClearCr97
Start of Run	: 25Dec96 0100	Basin Model	: ClearCr97
End of Run	: 08Jan97 2400	Met. Model	: Jan97
Execution Time	: 31May00 1305	Control Specs.	: Jan97

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
CL2	8695.7	01 Jan 97 0800	62669	85.700
CL3	8695.7	01 Jan 97 0800	62669	85.700
CL3-CL5	8690.7	01 Jan 97 0800	62652	85.700
CL4	11290	01 Jan 97 0400	60367	114.400
Whiskeytown	12699	01 Jan 97 1300	90332	200.100
CL5-CL7	12695	01 Jan 97 1400	90289	200.100
CL6	1716.4	01 Jan 97 0500	10067	28.300
CL7	13623	01 Jan 97 1300	100356	228.400
CL7-CL9	13604	01 Jan 97 1500	100256	228.400
CL8	1549.5	01 Jan 97 0300	7941.6	22.700
CL9	13920	01 Jan 97 1500	108198	251.100

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Clear Creek Basin
December 1996 - January 1997 Event

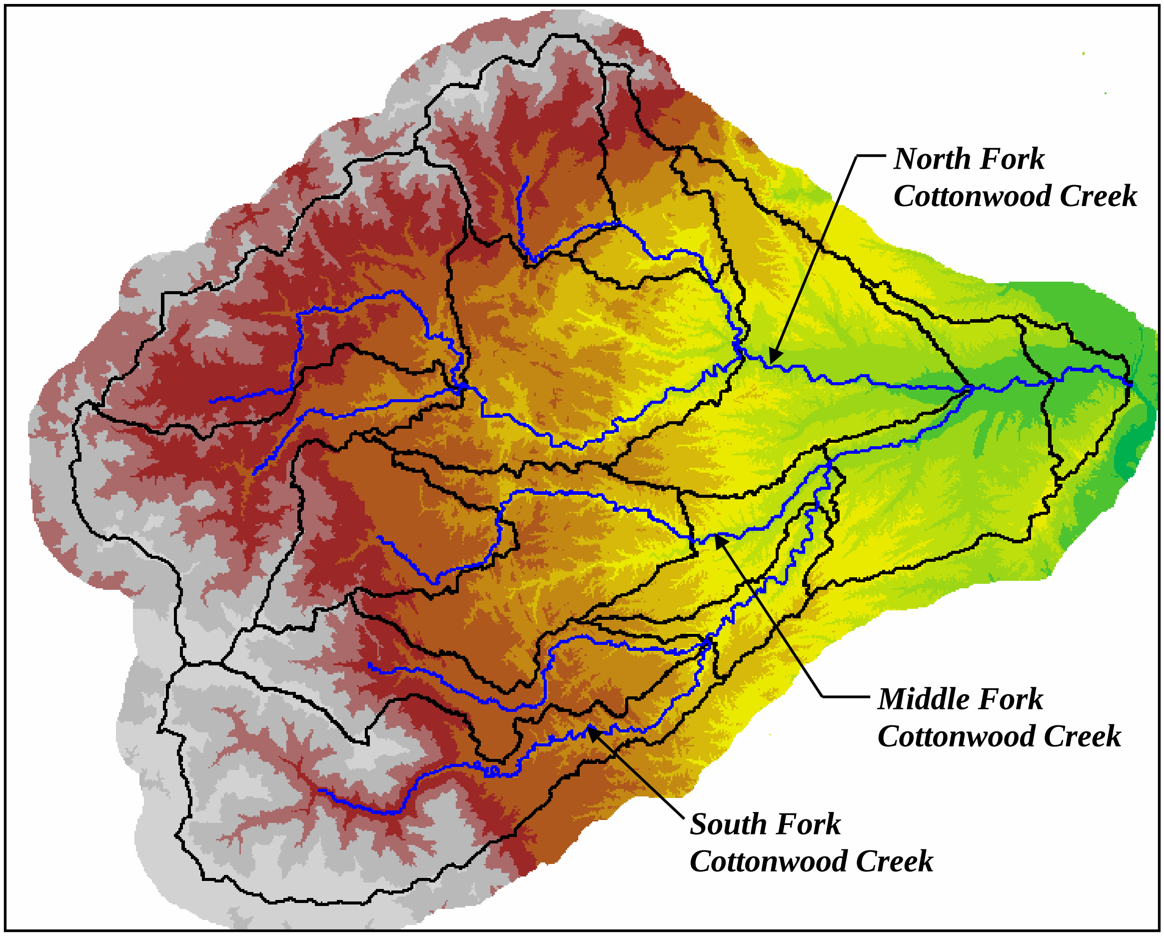


CL7 – Clear Creek at Igo

HEC-HMS Subbasin Parameters
Clear Creek Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
CL4	2	0.8	0.2	1.0	.01	0
CL8	2	0.8	0.2	1.0	.01	0
CL2	2	0.8	0.2	1.0	.01	0
CL6	2	0.8	0.2	1.0	.01	0

Cottonwood Creek Basin



HEC-GeoHMS Subbasin Delineation

Cottonwood Creek

The Cottonwood Creek HMS model consists of a 945 square mile basin located in the northwest portion of the Sacramento Watershed, south of the Clear Creek basin and just above the confluence with the Sacramento River near Cottonwood, CA. The model is included as part of the MidSac_West HMS Project and the basin is divided into 14 subbasins and connected with 11 routing reaches. The only observed hydrograph used for this model is located at Cottonwood, CA (11376000). The 1997 and 1995 events produced essentially identical peak flows at the basin outlet of 39,700 cfs for the 1997 event and 38,200 cfs for the 1995 event.

Using the adopted TC and R (Group 1) and the initial Muskingum parameters, the computed hydrographs for the 1997 and 1995 events matched the observed hydrographs reasonably well. The main peaks were matched; however, additional peaks were not. The initial and constant loss values were in the low end of the normal modeling range for both events.

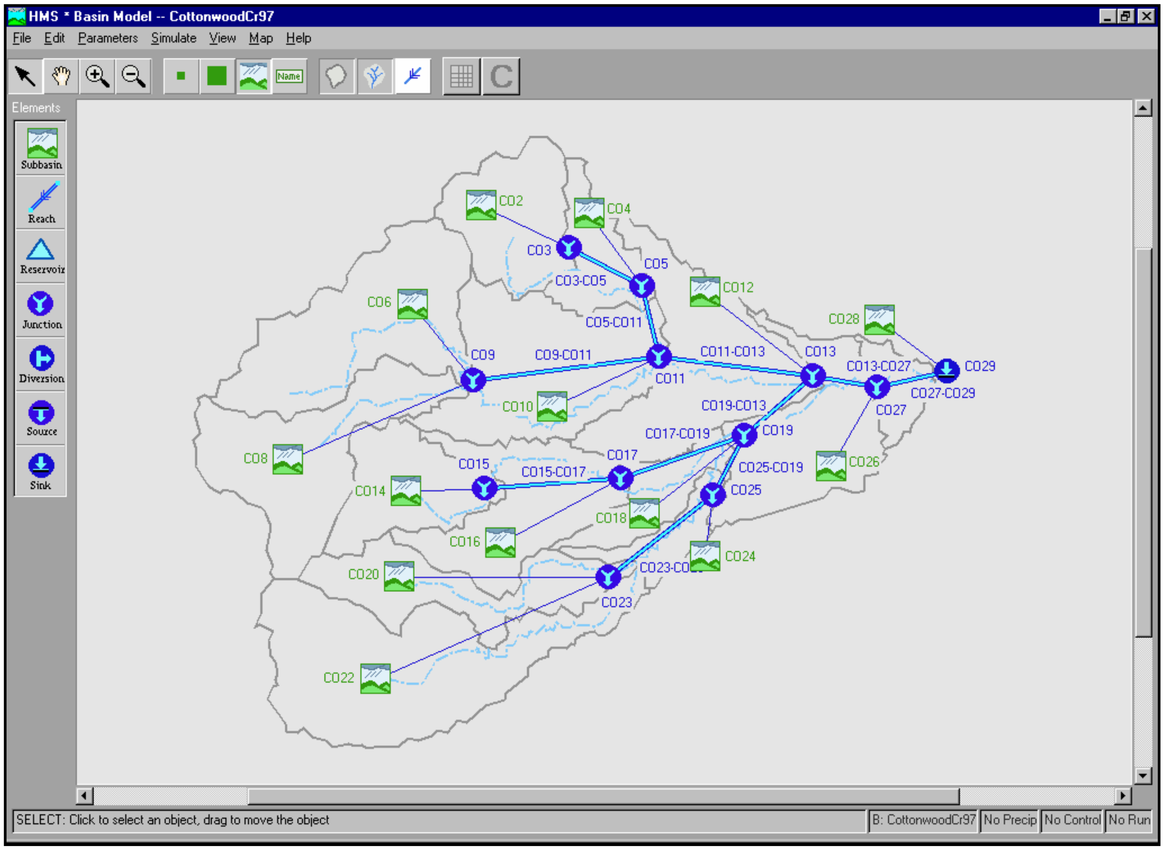
<u>Calibration of the 1995 Event:</u>

While the computed and observed peaks matched reasonably well, the observed hydrograph included several spikes after the peak flow that were not included with the computed hydrograph. The use of the constant loss rate probably precluded the computed hydrograph from developing the additional spikes in the hydrograph. Initial and constant loss rates of 0.8 inches and 0.08 inches/hour, respectively, were used. The baseflow values of 1.0 cfs per square mile, 0.8 and 0.2 for the initial flow, recession ratio, and the threshold flow, respectively, were also used to calibrate the model.

<u>Calibration of the 1997 Event:</u>

The computed peak matched the observed peak for the 1997 event very well. However, the computed hydrograph included several spikes preceding the peak which were not included with the observed hydrograph. Perhaps some of the precipitation actually fell as snowfall, was stored in the snowpack, and was not immediately converted to runoff. A thorough review of the snowmelt in this area could be performed. Initial and constant loss rates of 1.0 inch and 0.05 inches/hour, respectively, were used. The baseflow values of 1.0 cfs per square mile, 0.7 and 0.2 for the initial flow, recession ratio, and the threshold flow, respectively, were also used to calibrate the model.

Cottonwood Creek Basin HEC-HMS Model Schematic



Cottonwood Creek Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Initial TC $1.4(LL_{CA}/S^{1/2})^{.33}$ (Hr)	Initial R 1.5 TC (cfs/Hr)	Regression TC $0.68(LL_{CA}/S^{1/2})^{.46}$ (Hr)	Regression R 1.5TC (cfs/Hr)
CO10	102.75	23.77	14.48	58.080	45.16	4.9	7.4	3.9	5.9
CO4	32.18	14.61	8.61	327.360	6.95	2.7	4.0	1.7	2.5
CO6	104.73	27.92	13.57	137.280	32.33	4.4	6.6	3.4	5.0
CO12	94.26	20.96	9.55	47.520	29.05	4.3	6.4	3.2	4.8
CO26	75.30	17.86	5.87	26.400	20.41	3.8	5.7	2.7	4.1
CO8	89.45	25.62	15.16	253.440	24.40	4.0	6.0	3.0	4.4
CO28	17.61	9.57	4.50	42.240	6.63	2.6	3.9	1.6	2.4
CO14	53.04	17.97	9.56	285.120	10.17	3.0	4.5	2.0	3.0
CO16	72.08	20.47	9.68	179.520	14.78	3.4	5.1	2.3	3.5
CO18	29.76	16.61	8.25	58.080	17.99	3.6	5.4	2.6	3.9
CO20	61.39	29.48	16.24	221.760	32.14	4.4	6.6	3.4	5.0
CO22	135.57	39.70	22.03	158.400	69.49	5.7	8.5	4.8	7.2
CO2	56.48	18.39	11.20	242.880	13.21	3.3	4.9	2.2	3.3
CO24	20.04	17.72	7.06	52.800	17.23	3.6	5.4	2.5	3.8

Cottonwood Creek Reach Parameters

Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Ave Reach Vel $80\ S_R^{1/2}$ V_R (fps)	Initial K $1.47\ L_R / 1.5V_R$ K (Hr)	Musk X or LAG (Min)	N steps Time Step= 60
CO5-CO11	4.24	0.0037	4.87	1.0	0.4	1
CO11-CO13	12.80	0.0017	3.30	3.8	0.4	4
CO27-CO29	4.56	0.0018	3.39	1.3	0.4	2
CO9-CO11	18.86	0.0042	5.18	3.6	0.4	3
CO19-CO13	8.04	0.0022	3.75	2.1	0.4	2
CO15-CO17	11.49	0.0054	5.88	1.9	0.4	2
CO17-CO19	8.48	0.0028	4.23	2.0	0.4	2
CO3-CO5	6.38	0.0069	6.65	1.0	0.4	1
CO23-CO25	12.08	0.0029	4.31	2.7	0.4	3
CO25-CO19	2.63	0.0028	4.23	1.0	0.4	1
CO13-CO27	4.19	0.0018	3.39	1.2	0.4	1

HEC-HMS Summary of Results
Cottonwood Creek Basin: March 1995 Event

Project : MidSac_West   Run Name : CottonwoodCr95

Start of Run : 08Mar95 0100   Basin Model : CottonwoodCr95

End of Run : 15Mar95 2400   Met. Model : Mar95

Execution Time : 31May00 1304   Control Specs. : Mar95

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
CO8	5895.3	09 Mar 95 1200	19212	89.400
CO6	7214.0	09 Mar 95 1200	23240	104.700
CO9	13109	09 Mar 95 1200	42451	194.100
CO9-CO11	12533	09 Mar 95 1600	41869	194.100
CO2	4916.9	09 Mar 95 1100	16956	56.500
CO3	4916.9	09 Mar 95 1100	16956	56.500
CO3-CO5	4841.5	09 Mar 95 1300	16890	56.500
CO4	2769.4	09 Mar 95 1100	9522.1	32.200
CO5	7282.1	09 Mar 95 1100	26412	88.700
CO5-CO11	7195.9	09 Mar 95 1200	26311	88.700
CO10	4743.8	09 Mar 95 1200	15717	102.800
CO11	21842	09 Mar 95 1400	83897	385.600
CO11-CO13	21621	09 Mar 95 1700	82657	385.600
CO14	3282.9	09 Mar 95 1100	10110	53.000
CO15	3282.9	09 Mar 95 1100	10110	53.000
CO15-CO17	3072.4	09 Mar 95 1300	10036	53.000
CO16	3314.7	09 Mar 95 1100	10152	72.100
CO17	5927.5	09 Mar 95 1100	20188	125.100
CO17-CO19	5923.2	09 Mar 95 1400	20033	125.100
CO22	5970.7	09 Mar 95 1400	20979	135.600
CO20	2770.2	09 Mar 95 1300	9074.2	61.400
CO23	8466.8	09 Mar 95 1300	30053	197.000
CO23-CO25	8380.3	09 Mar 95 1600	29795	197.000
CO24	562.37	09 Mar 95 1100	1779.6	20.000
CO25	8579.5	09 Mar 95 1600	31575	217.000
CO25-CO19	8545.8	09 Mar 95 1700	31471	217.000
CO18	964.87	09 Mar 95 1100	3039.6	29.800
CO19	14183	09 Mar 95 1400	54544	371.900
CO19-CO13	14070	09 Mar 95 1600	54135	371.900
CO12	4422.8	09 Mar 95 1200	15567	94.300

... Continued ...

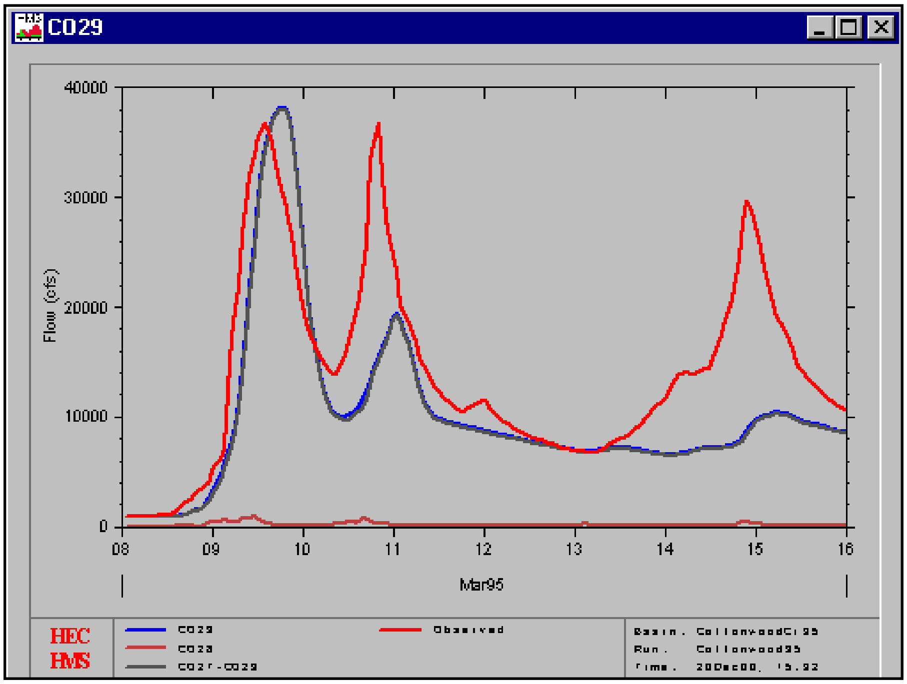
HEC-HMS Summary of Results
Cottonwood Creek Basin: March 1995 Event
(Continued)

Project : MidSac_West Run Name : CottonwoodCr95

Start of Run	: 08Mar95 0100	Basin Model	: CottonwoodCr95
End of Run	: 15Mar95 2400	Met. Model	: Mar95
Execution Time	: 31May00 1304	Control Specs.	: Mar95

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
CO13	37441	09 Mar 95 1700	152358	851.800
CO13-CO27	37410	09 Mar 95 1800	151658	851.800
CO26	2548.0	09 Mar 95 1100	8812.9	75.300
CO27	38038	09 Mar 95 1800	160471	927.100
CO27-CO29	38005	09 Mar 95 1900	159666	927.100
CO28	853.62	09 Mar 95 1100	2937.1	17.600
CO29	38170	09 Mar 95 1900	162603	944.700

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Cottonwood Creek Basin
March 1995 Event



CO29 – Cottonwood Creek Near Cottonwood

HEC-HMS Subbasin Parameters
Cottonwood Creek Basin: March 1995 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
CO10	1	0.8	0.2	0.8	.08	0
CO4	1	0.8	0.2	0.8	.08	0
CO6	1	0.8	0.2	0.8	.08	0
CO12	1	0.8	0.2	0.8	.08	0
CO26	1	0.8	0.2	0.8	.08	0
CO8	1	0.8	0.2	0.8	.08	0
CO28	1	0.8	0.2	0.8	.08	0
CO14	1	0.8	0.2	0.8	.08	0
CO16	1	0.8	0.2	0.8	.08	0
CO18	1	0.8	0.2	0.8	.08	0
CO20	1	0.8	0.2	0.8	.08	0
CO22	1	0.8	0.2	0.8	.08	0
CO2	1	0.8	0.2	0.8	.08	0
CO24	1	0.8	0.2	0.8	.08	0

HEC-HMS Summary of Results
Cottonwood Creek Basin: December 1996 - January 1997 Event

Project	: MidSac_West	Run Name	: CottonwoodCr97
Start of Run	: 25Dec96 0100	Basin Model	: CottonwoodCr97
End of Run	: 08Jan97 2400	Met. Model	: Jan97
Execution Time	: 31May00 1304	Control Specs.	: Jan97

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
CO8	6220.2	01 Jan 97 0300	27736	89.400
CO6	6846.6	01 Jan 97 0300	29339	104.700
CO9	13067	01 Jan 97 0300	57075	194.100
CO9-CO11	12653	01 Jan 97 0700	57010	194.100
CO2	5078.1	01 Jan 97 0200	18259	56.500
CO3	5078.1	01 Jan 97 0200	18259	56.500
CO3-CO5	5003.7	01 Jan 97 0300	18254	56.500
CO4	3133.5	01 Jan 97 0100	9947.7	32.200
CO5	7183.3	01 Jan 97 0300	28201	88.700
CO5-CO11	7099.4	01 Jan 97 0400	28192	88.700
CO10	4293.5	01 Jan 97 0300	15327	102.800
CO11	20808	01 Jan 97 0600	100529	385.600
CO11-CO13	20286	01 Jan 97 1000	100414	385.600
CO14	4141.9	01 Jan 97 0200	13634	53.000
CO15	4141.9	01 Jan 97 0200	13634	53.000
CO15-CO17	4032.1	01 Jan 97 0400	13629	53.000
CO16	4456.6	01 Jan 97 0200	13693	72.100
CO17	8017.3	01 Jan 97 0300	27322	125.100
CO17-CO19	7918.4	01 Jan 97 0500	27313	125.100
CO22	6614.5	01 Jan 97 0700	33322	135.600
CO20	3317.6	01 Jan 97 0300	12685	61.400
CO23	9705.6	01 Jan 97 0500	46007	197.000
CO23-CO25	9633.6	01 Jan 97 0800	45960	197.000
CO24	893.71	01 Jan 97 0200	2715.2	20.000
CO25	9987.9	01 Jan 97 0800	48675	217.000
CO25-CO19	9953.9	01 Jan 97 0900	48656	217.000
CO18	1418.9	01 Jan 97 0200	4427.9	29.800
CO19	16803	01 Jan 97 0700	80398	371.900
CO19-CO13	16672	01 Jan 97 0900	80346	371.900
CO12	4920.2	01 Jan 97 0300	17239	94.300

... Continued ...

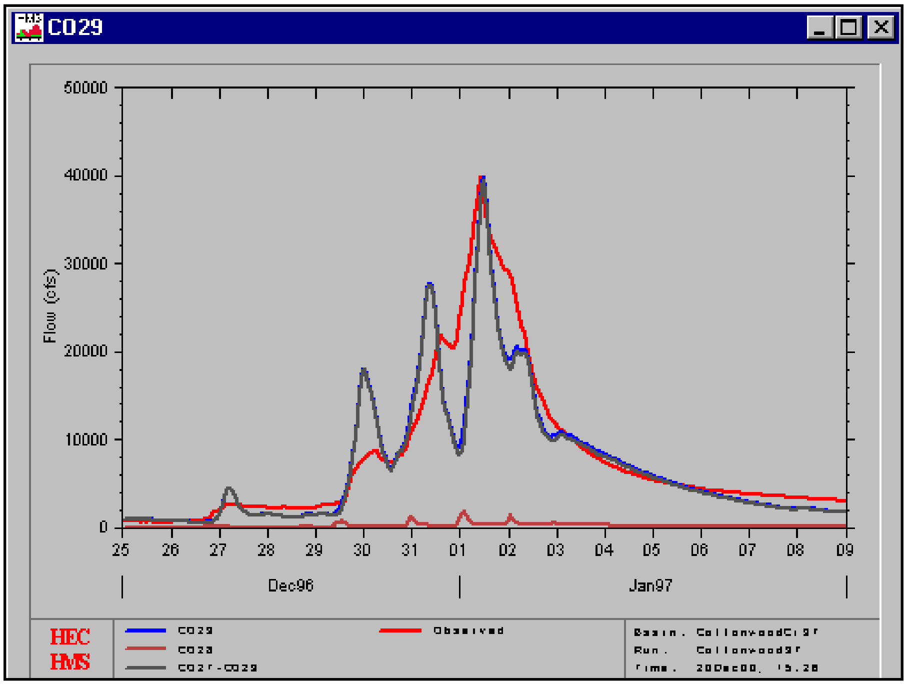
HEC-HMS Summary of Results
Cottonwood Creek Basin: December 1996 - January 1997 Event
(Continued)

Project : MidSac_West   Run Name : CottonwoodCr97

Start of Run : 25Dec96 0100   Basin Model : CottonwoodCr97
End of Run : 08Jan97 2400   Met. Model : Jan97
Execution Time : 31May00 1304   Control Specs. : Jan97

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
CO13	38633	01 Jan 97 0900	198000	851.800
CO13-CO27	38458	01 Jan 97 1100	197927	851.800
CO26	3884.8	01 Jan 97 0200	12631	75.300
CO27	39334	01 Jan 97 1100	210558	27.100
CO27-CO29	39375	01 Jan 97 1200	210475	927.100
CO28	1721.3	01 Jan 97 0200	5374.6	17.600
CO29	39698	01 Jan 97 1200	215850	944.700

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Cottonwood Creek Basin
December 1996 - January 1997 Event

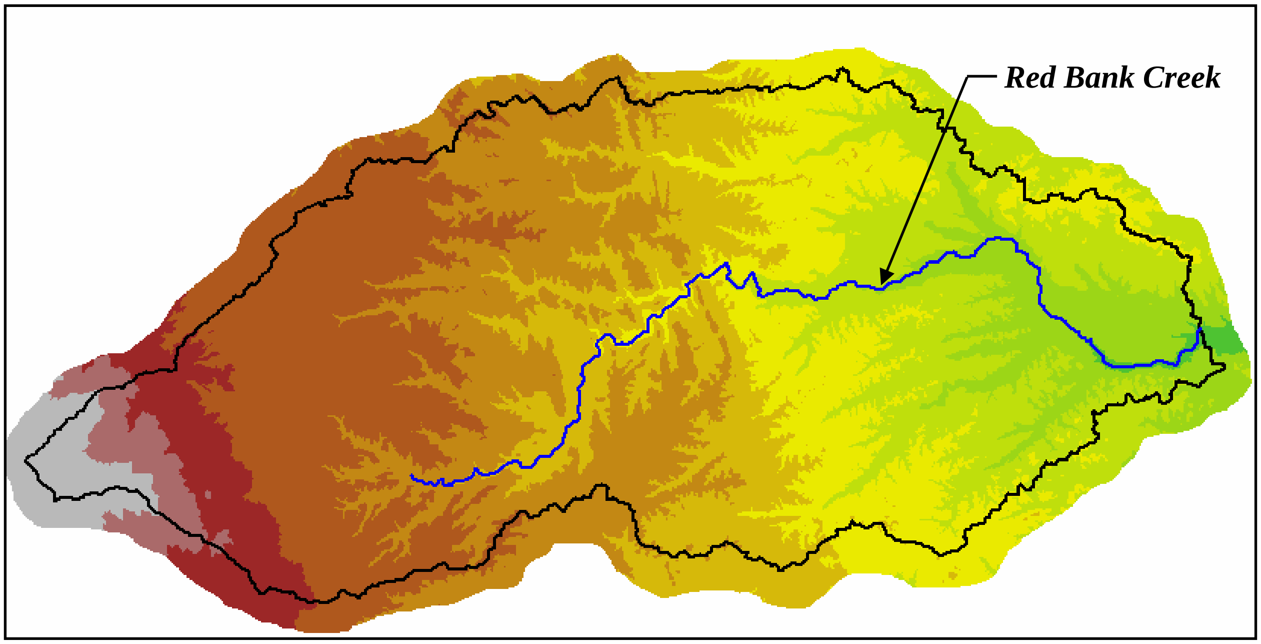


CO29 – Cottonwood Creek Near Cottonwood

HEC-HMS Subbasin Parameters
Cottonwood Creek Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
CO10	1	0.7	0.2	1.0	.05	0
CO4	1	0.7	0.2	1.0	.05	0
CO6	1	0.7	0.2	1.0	.05	0
CO12	1	0.7	0.2	1.0	.05	0
CO26	1	0.7	0.2	1.0	.05	0
CO8	1	0.7	0.2	1.0	.05	0
CO28	1	0.7	0.2	1.0	.05	0
CO14	1	0.7	0.2	1.0	.05	0
CO16	1	0.7	0.2	1.0	.05	0
CO18	1	0.7	0.2	1.0	.05	0
CO20	1	0.7	0.2	1.0	.05	0
CO22	1	0.7	0.2	1.0	.05	0
CO2	1	0.7	0.2	1.0	.05	0
CO24	1	0.7	0.2	1.0	.05	0

Red Bank Creek Basin



HEC-GeoHMS Subbasin Delineation

Red Bank Creek

The Red Bank Creek HMS model consists of a 94 square mile basin located in the mid-west portion of the Sacramento Watershed, south of the Cottonwood Creek basin and above the confluence with the Sacramento River near Red Bluff, CA. The model is included along with the Elder Creek and Thomes Creek basins as part of the MidSac_West HMS Project and SouthwestCr Basin Model. The Red Bank Creek basin model is comprised of 1 subbasin. No observed data were available for this basin. The computed peak flow at the HMS basin model outlet for the 1995 event was larger than the 1997 event (6,949 cfs vs. 5,994 cfs).

The initial and constant loss rates were set relatively low for both events to be consistent with the Elder Creek and Thomes Creek models. The baseflow parameters were in the normal range for this study.

<u>Calibration of the 1995 Event:</u>

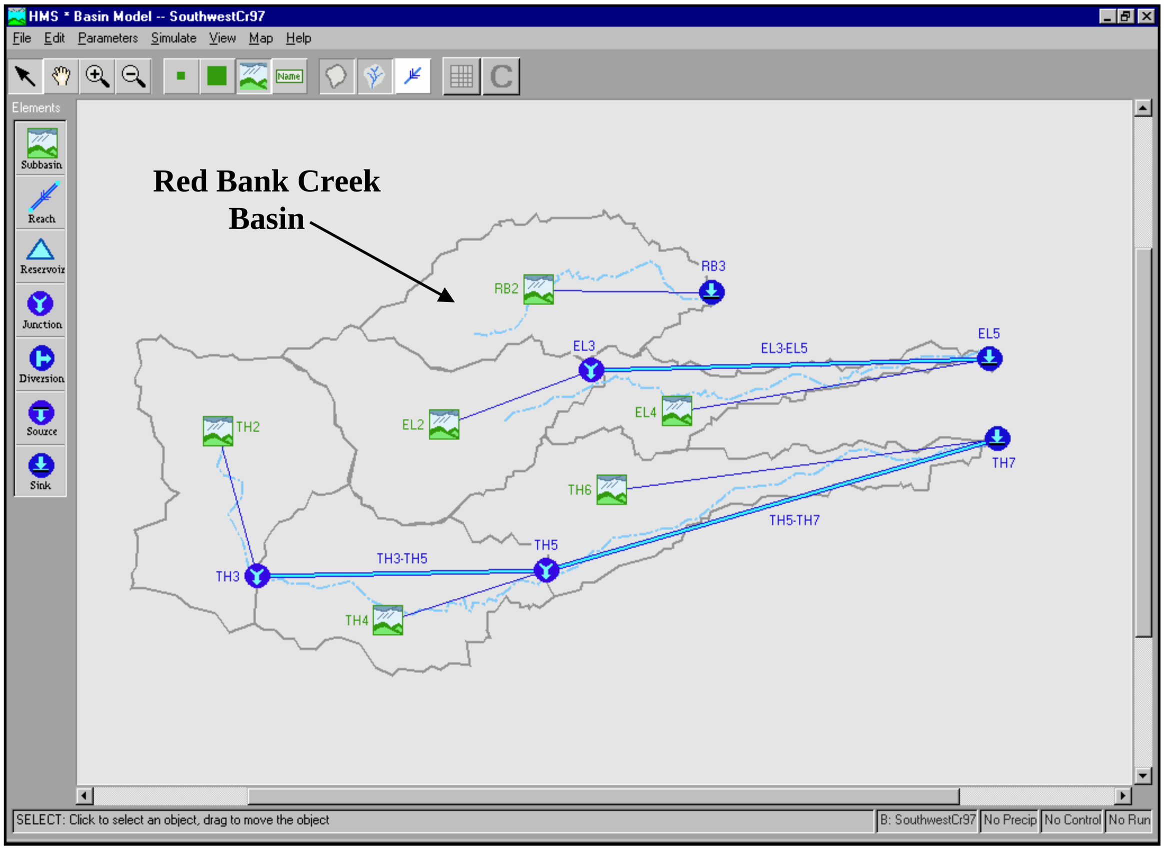
Initial and constant loss rates of 0.5 inches and 0.001 inches/hour, respectively, were used. The baseflow values of 2.0 cfs/square mile, 0.8, and 0.2 for the initial flow, recession ratio, and the threshold flow, respectively, were also used to develop a computed hydrograph.

<u>Calibration of the 1997 Event:</u>

Initial and constant loss rates of 1.0 inch and 0.005 inches/hour, respectively, were used. The baseflow values of 2.0 cfs per square mile, 0.7 and 0.2 for the initial flow, recession ratio, and the threshold flow, respectively, were also used to develop a computed hydrograph.

Red Bank Creek Basin HEC-HMS Model Schematic

Included in Southwest Creeks Basin Model (with Elder and Thomes Creeks) within MidSac_West HMS Project



Red Bank Creek (Mid-Sacramento Southwest Creeks) Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Initial TC $1.4(LL_{CA}/S^{1/2})^{.33}$ (Hr)	Initial R 1.5 TC (cfs/Hr)	Regression TC $0.68(LL_{CA}/S^{1/2})^{.46}$ (Hr)	Regression R 1.5 TC (cfs/Hr)
RB2	93.53	26.74	13.33	190.08	25.86	4.1	6.1	3.0	4.6

Red Bank Creek (Mid-Sacramento Southwest Creeks) Reach Parameters

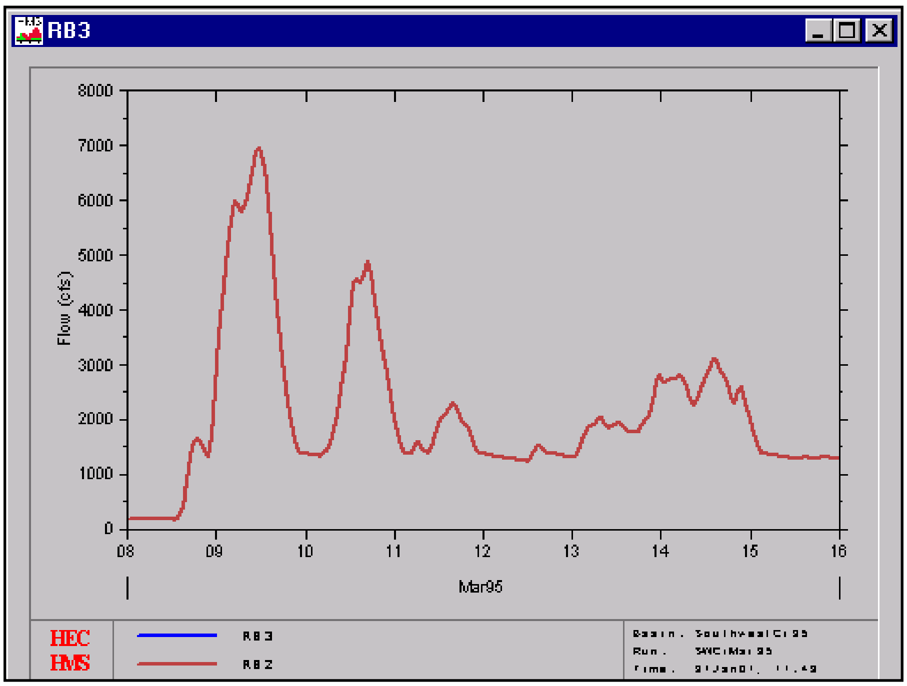
Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Ave Reach Vel $80\ S_R^{1/2}$ V_R (fps)	Initial K $1.47\ L_R / 1.5V_R$ K (Hr)	Musk X or LAG (Min)	N steps Time Step= 60

NO ROUTING REACHES

HEC-HMS Summary of Results
Red Bank Creek Basin: March 1995 Event

Project	: MidSac_West	Run Name	: SouthwestCr95
Start of Run	: 08Mar95 0100	Basin Model	: SouthwestCr95
End of Run	: 15Mar95 2400	Met. Model	: Mar95
Execution Time	: 31May00 1306	Control Specs.	: Mar95

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
RB2	6948.5	09 Mar 95 1200	33680	93.500
RB3	6948.5	09 Mar 95 1200	33680	93.500



RB3 Red Bank Creek at Outlet

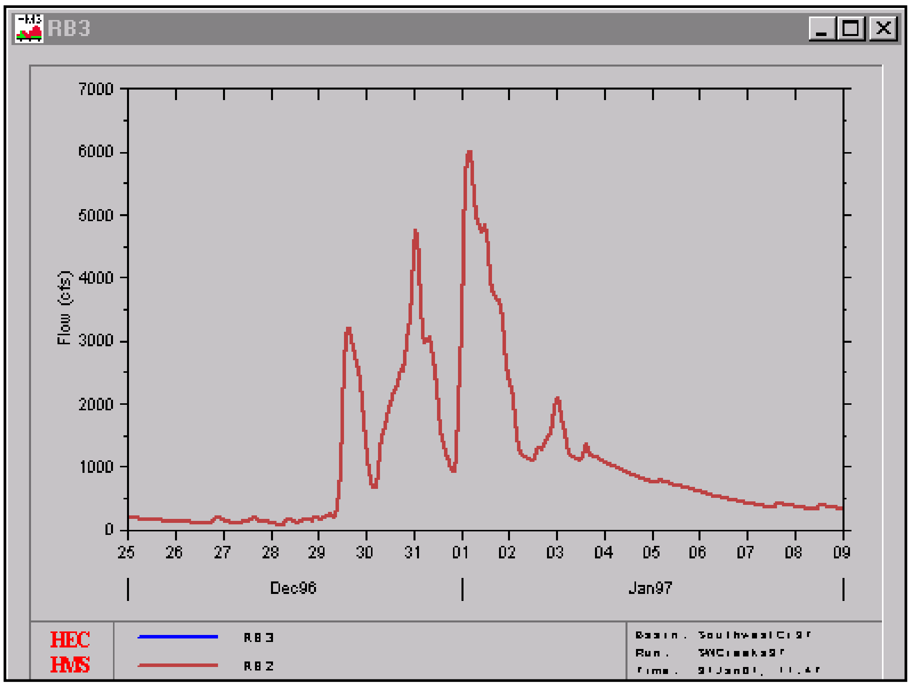
HEC-HMS Subbasin Parameters
Red Bank Creek Basin: March 1995 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
RB2	2	0.8	0.2	0.5	.001	0

HEC-HMS Summary of Results
Red Bank Creek Basin: December 1996 - January 1997 Event

Project	: MidSac_West	Run Name	: SouthwestCr97
Start of Run	: 25Dec96 0100	Basin Model	: SouthwestCr97
End of Run	: 08Jan97 2400	Met. Model	: Jan97
Execution Time	: 31May00 1306	Control Specs.	: Jan97

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
RB2	5993.8	01 Jan 97 0400	32506	93.500
RB3	5993.8	01 Jan 97 0400	32506	93.500

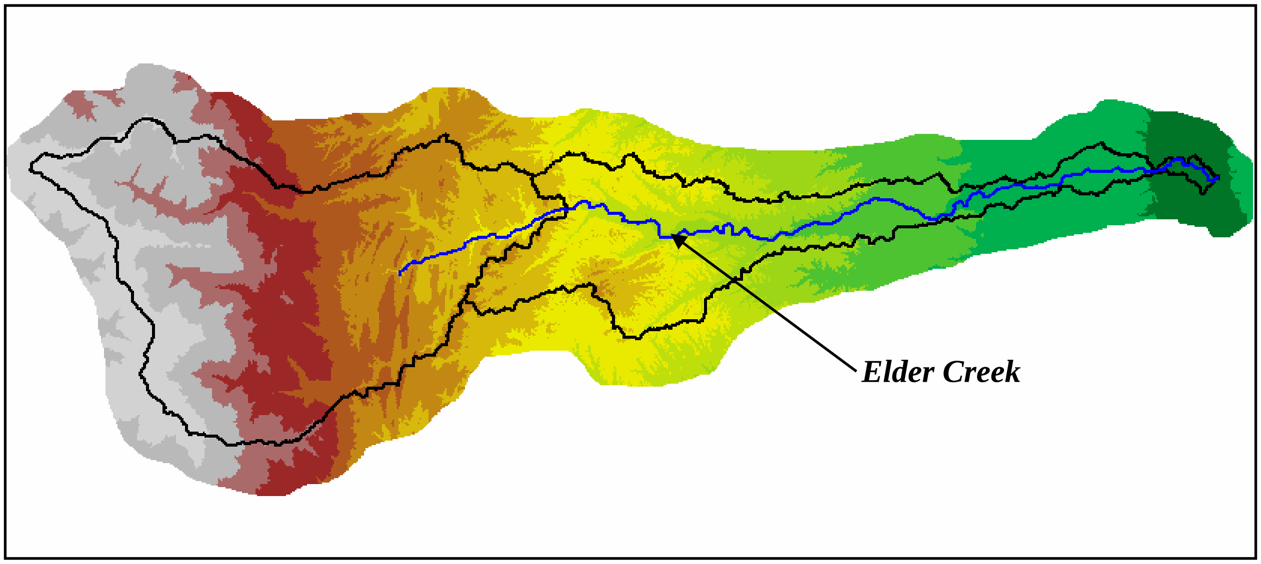


RB3 Red Bank Creek at Outlet

HEC-HMS Subbasin Parameters
Red Bank Creek Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
RB2	2	0.7	0.2	1.0	.005	0

Elder Creek Basin



HEC-GeoHMS Subbasin Delineation

Elder Creek

The Elder Creek HMS model consists of a 140 square mile basin located in the mid-west portion of the Sacramento Watershed, south of the Red Bank Creek basin and above the confluence with the Sacramento River near Gerber, CA. The model is included along with the Red Bank Creek and Thomes Creek basins as part of the MidSac_West HMS Project and SouthwestCr Basin Model. The Elder Creek basin model is divided into 2 subbasins and connected with 1 routing reach. One observed hydrograph, Elder Creek near Paskenta, CA (11379000), was used to calibrate this model. The computed peak flow at the basin outlet for the 1995 event was larger than the 1997 event (10,508 cfs vs. 9,453 cfs).

Using the adopted TC and R (Group 1) and Muskingum parameters, the computed hydrographs did a fair job of matching the observed hydrograph's shape and multiple peaks. The initial and constant loss rates were set relatively low for both events to be able to calibrate the model. The baseflow parameters were all in the normal range for this study.

Calibration of the 1995 Event:

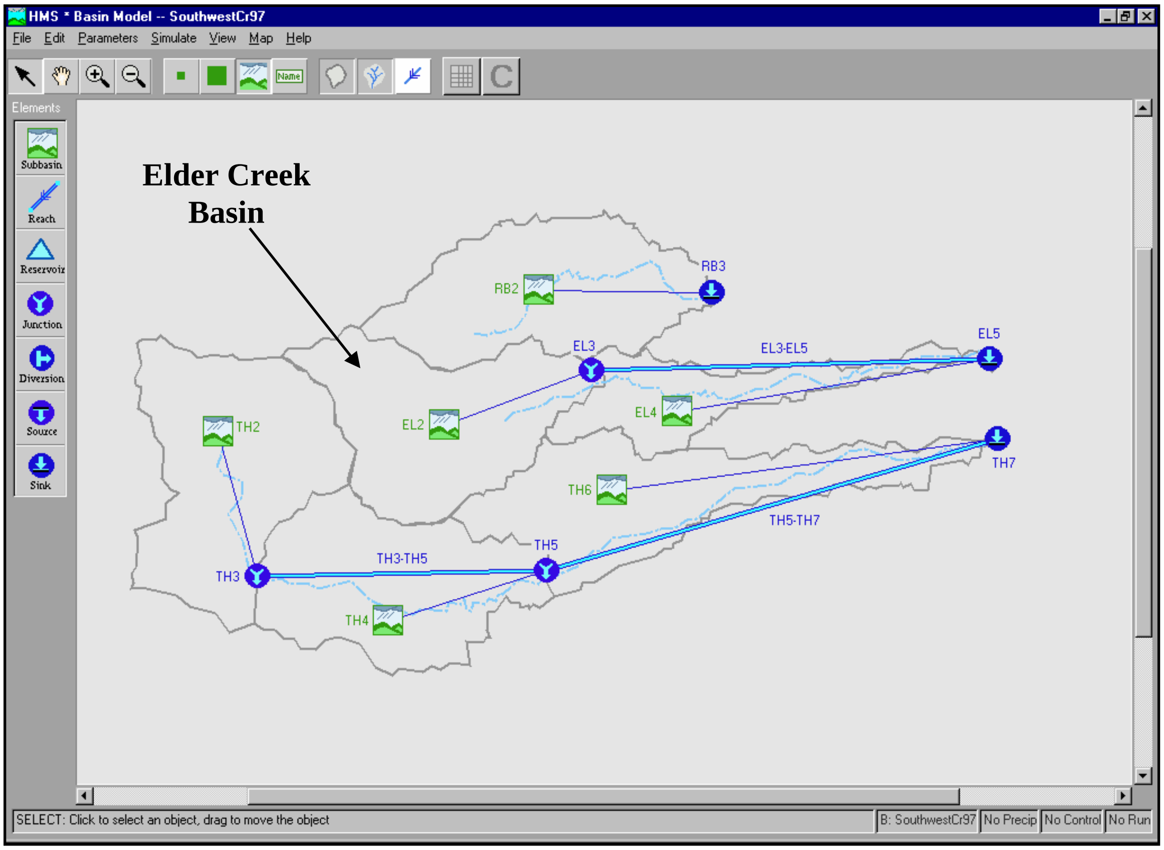
The computed and observed hydrographs had approximately the same shape even when the observed hydrograph appeared to switch from hourly data to daily data in the middle of the event. Multiple peaks were matched and the general trend of the daily values was approximated. Initial and constant loss rates of 0.5 inches and 0.001 inches/hour, respectively, were used. The baseflow values of 2.0 cfs per square mile, 0.8, and 0.2 for the initial flow, recession ratio, and the threshold flow, respectively, were also used to calibrate the model.

Calibration of the 1997 Event:

The computed hydrograph did a reasonable job in approximating the observed hydrograph. The peak of the observed hydrograph is a very sharp spike of minimal duration, which the computed hydrograph was unable to match. Otherwise, the general shapes of the two hydrographs were similar. Initial and constant loss rates of 1.0 inch and 0.005 inches/hour, respectively, were used. The baseflow values of 2.0 cfs per square mile, 0.7 and 0.2 for the initial flow, recession ratio, and the threshold flow, respectively, were also used to calibrate the model.

Elder Creek Basin HEC-HMS Model Schematic

Included in Southwest Creeks Basin Model (with Thomes and Red Bank Creeks) within MidSac_West HMS Project



Elder Creek (Mid-Sacramento Southwest Creeks) Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Initial TC $1.4(LL_{CA}/S^{1/2})^{.33}$ (Hr)	Initial R 1.5 TC (cfs/Hr)	Regression TC $0.68(LL_{CA}/S^{1/2})^{.46}$ (Hr)	Regression R 1.5 TC (cfs/Hr)
EL2	92.87	23.07	17.42	248.16	25.51	4.1	6.1	3.0	4.5
EL4	47.50	31.27	15.49	31.68	86.05	6.1	9.1	5.3	7.9

Elder Creek (Mid-Sacramento Southwest Creeks) Reach Parameters

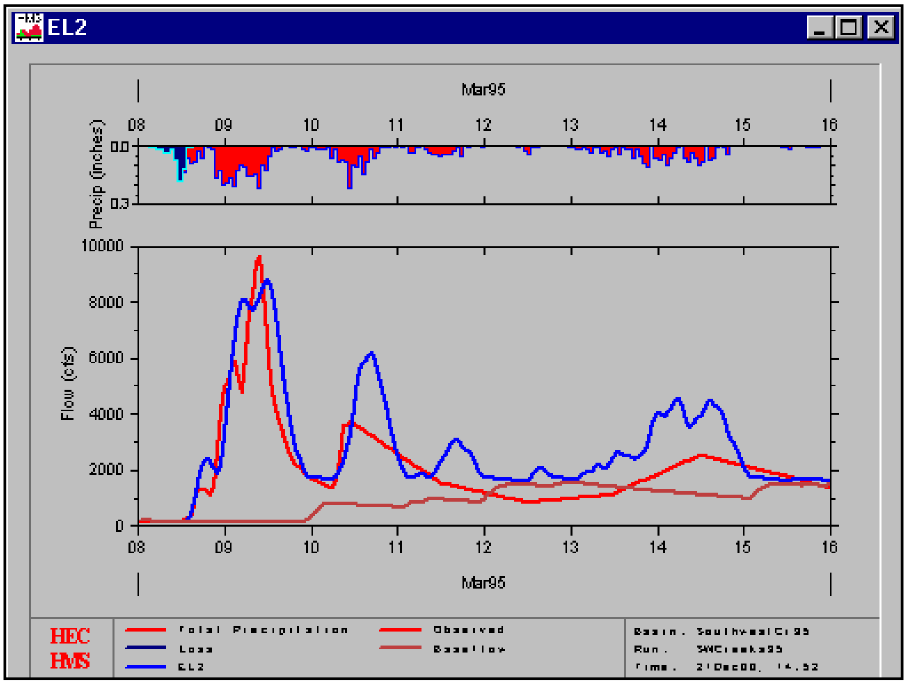
Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Ave Reach Vel $80\ S_R^{1/2}$ V_R (fps)	Initial K $1.47\ L_R / 1.5V_R$ K (Hr)	Musk X or LAG (Min)	N steps Time Step= 60
EL3-EL5	26.51	0.0032	4.53	5.7	0.4	5

HEC-HMS Summary of Results
Elder Creek Basin: March 1995 Event

Project	: MidSac_West	Run Name	: SouthwestCr95
Start of Run	: 08Mar95 0100	Basin Model	: SouthwestCr95
End of Run	: 15Mar95 2400	Met. Model	: Mar95
Execution Time	: 31May00 1306	Control Specs.	: Mar95

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
EL2	8788.5	09 Mar 95 1200	43956	92.900
EL3	8788.5	09 Mar 95 1200	43956	92.900
EL3-EL5	8558.5	09 Mar 95 1700	43270	92.900
EL4	2194.7	09 Mar 95 1400	11092	47.500
EL5	10508	09 Mar 95 1700	54362	140.400

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Elder Creek Basin
March 1995 Event



EL2 – Elder Creek Near Paskenta

HEC-HMS Subbasin Parameters
Elder Creek Basin: March 1995 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
EL2	2	0.8	0.2	0.5	.001	0
EL4	2	0.8	0.2	0.5	.001	0

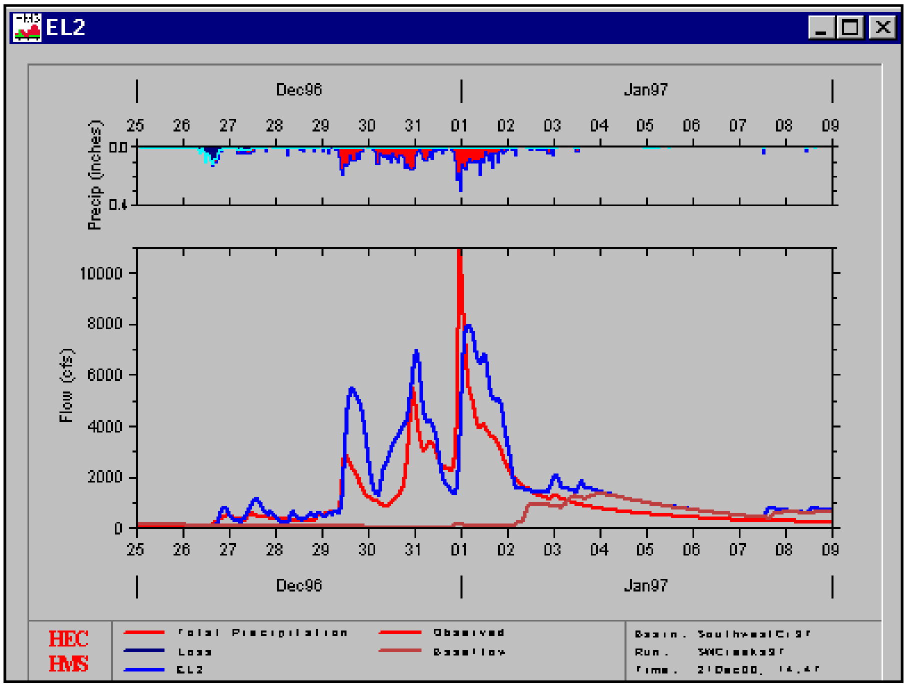
HEC-HMS Summary of Results
Elder Creek Basin: December 1996 - January 1997 Event

Project : MidSac_West   Run Name : SouthwestCr97

Start of Run	: 25Dec96	0100	Basin Model	: SouthwestCr97
End of Run	: 08Jan97	2400	Met. Model	: Jan97
Execution Time	: 31May00	1306	Control Specs.	: Jan97

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
EL2	7900.9	01 Jan 97 0500	47733	92.900
EL3	7900.9	01 Jan 97 0500	47733	92.900
EL3-EL5	7776.6	01 Jan 97 1000	47482	92.900
EL4	1747.1	01 Jan 97 0800	10189	47.500
EL5	9453.3	01 Jan 97 1000	57671	140.400

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Elder Creek Basin
December 1996 - January 1997 Event

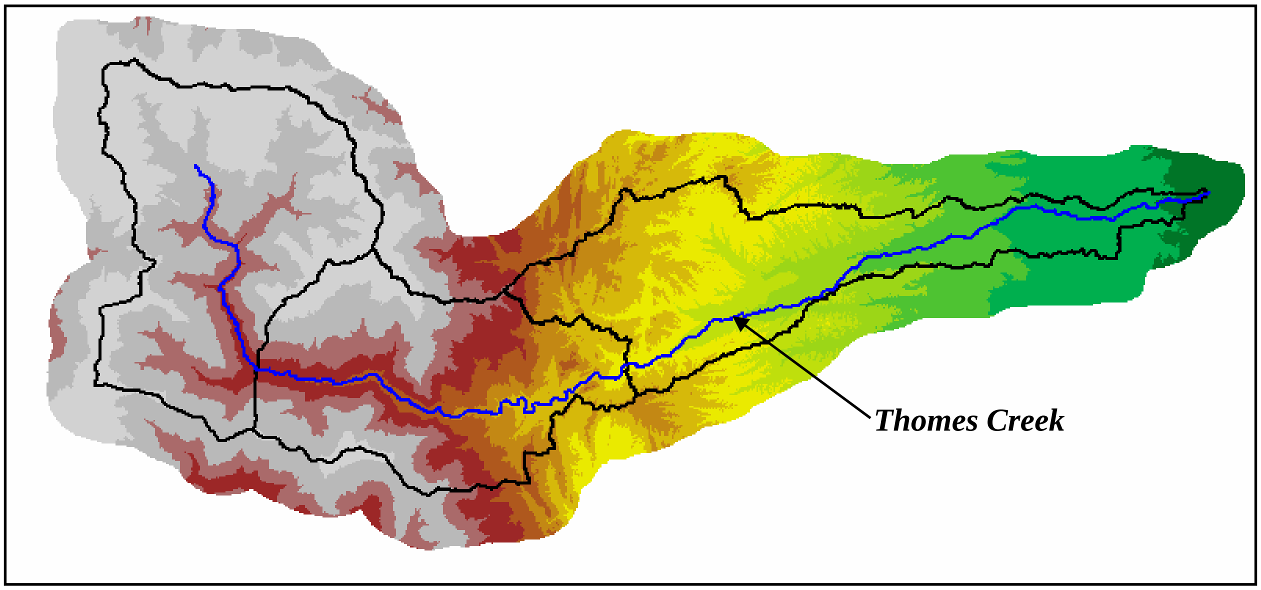


EL2 – Elder Creek Near Paskenta

HEC-HMS Subbasin Parameters
Elder Creek Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
EL2	2	0.7	0.2	1.0	.005	0
EL4	2	0.7	0.2	1.0	.005	0

Thomes Creek Basin



HEC-GeoHMS Subbasin Delineation

Thomes Creek

The Thomes Creek HMS model consists of a 297 square mile basin located in the mid-west portion of the Sacramento Watershed, south of the Elder Creek basin and above the confluence with the Sacramento River near Richfield, CA. The model is included along with the Red Bank Creek and Elder Creek basins as part of the MidSac_West HMS Project and SouthwestCr Basin Model. The Thomes Creek basin model is divided into 3 subbasins and connected with 2 routing reaches. One observed hydrograph, Thomes Creek at Paskenta, CA (11382000), was used to calibrate this model. The computed peak flow at the basin outlet for the 1997 event was larger than the 1995 event (29,872 cfs vs. 19,337 cfs).

Using the adopted TC and R (Group 1) and Muskingum parameters, the computed hydrographs did a good job of matching the 1997 observed hydrograph's shape and multiple peaks. The initial and constant loss rates were set relatively low for both events to be able to calibrate the model. The baseflow parameters were all in the normal range for this study.

<u>Calibration of the 1995 Event:</u>

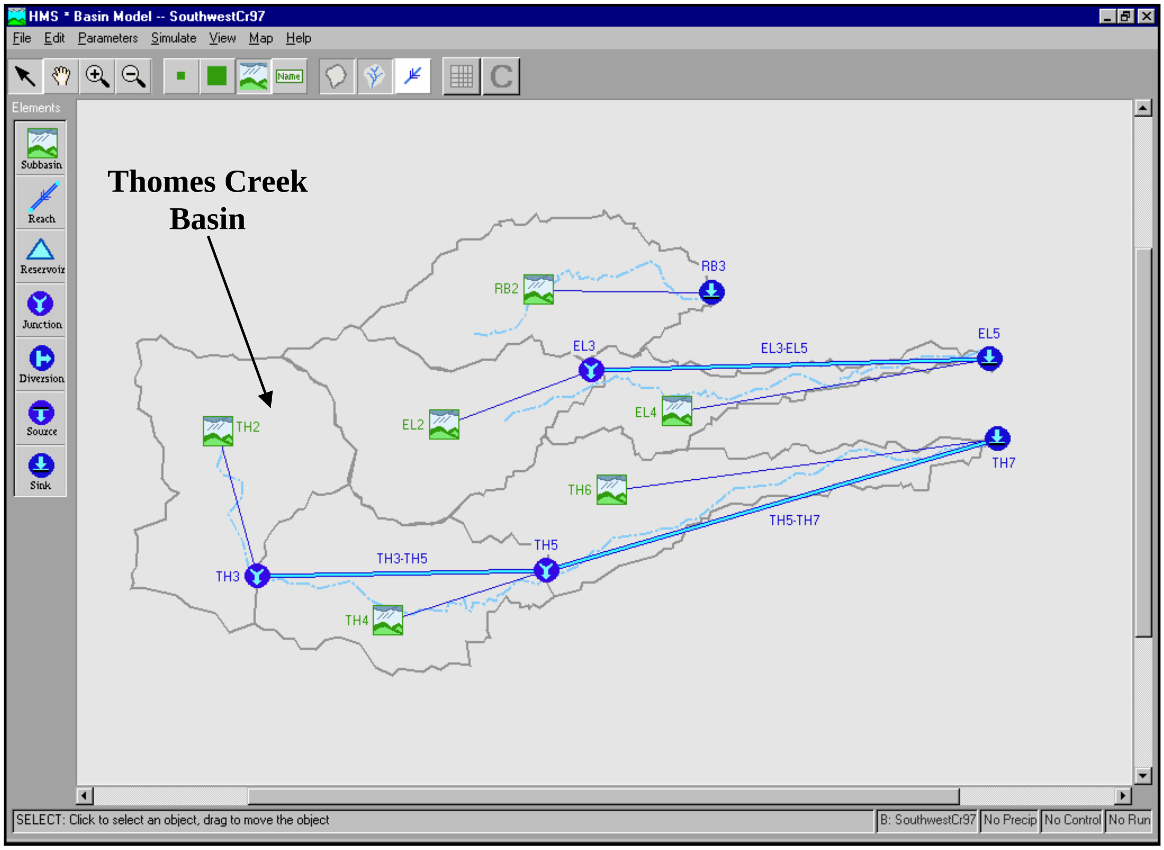
The observed peak for the 1995 event appeared to be missing; therefore, a cfs per square mile comparison was performed using the results from other models to calibrate the Thomes Creek model. Otherwise, the observed and computed hydrographs appeared to follow the same trend. Initial and constant loss rates of 0.6 inches and 0.08 inches/hour, respectively, were used. The baseflow values of 2.0 cfs per square mile, 0.8, and 0.2 for the initial flow, recession ratio, and the threshold flow, respectively, were also used to calibrate the model.

<u>Calibration of the 1997 Event:</u>

Even with multiple peaks, the computed hydrograph did a good job of representing the observed event. The initial computed spike was greater than the observed; therefore, additional losses may have reduced the computed spike. Initial and constant loss rates of 1.0 inch and 0.005 inches/hour, respectively, were used. The baseflow values of 2.0 cfs per square mile, 0.7 and 0.2 for the initial flow, recession ratio, and the threshold flow, respectively, were also used to calibrate the model.

Thomes Creek Basin HEC-HMS Model Schematic

Included in Southwest Creeks Basin Model (with Elder and Red Bank Creeks)
within MidSac_West HMS Project



Thomes Creek (Mid-Sacramento Southwest Creeks) Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Initial TC $1.4(LL_{CA}/S^{1/2})^{.33}$ (Hr)	Initial R 1.5 TC (cfs/Hr)	Regression TC $0.68(LL_{CA}/S^{1/2})^{.46}$ (Hr)	Regression R 1.5 TC (cfs/Hr)
TH2	107.52	17.52	6.00	285.12	6.23	2.6	3.8	1.6	2.4
TH6	96.09	35.39	26.69	100.32	94.30	6.3	9.4	5.5	8.3
TH4	93.72	22.46	11.30	232.32	16.66	3.5	5.3	2.5	3.7

Thomes Creek (Mid-Sacramento Southwest Creeks) Reach Parameters

Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Ave Reach Vel $80\ S_R^{1/2}$ V_R (fps)	Initial K $1.47\ L_R / 1.5V_R$ K (Hr)	Musk X or LAG (Min)	N steps Time Step= 60
TH5-TH7	29.20	0.0036	4.80	6.0	0.4	5
TH3-TH5	20.50	0.0160	10.12	2.0	0.4	2

HEC-HMS Summary of Results
Thomes Creek Basin: March 1995 Event

Project : MidSac_West Run Name : SouthwestCr95

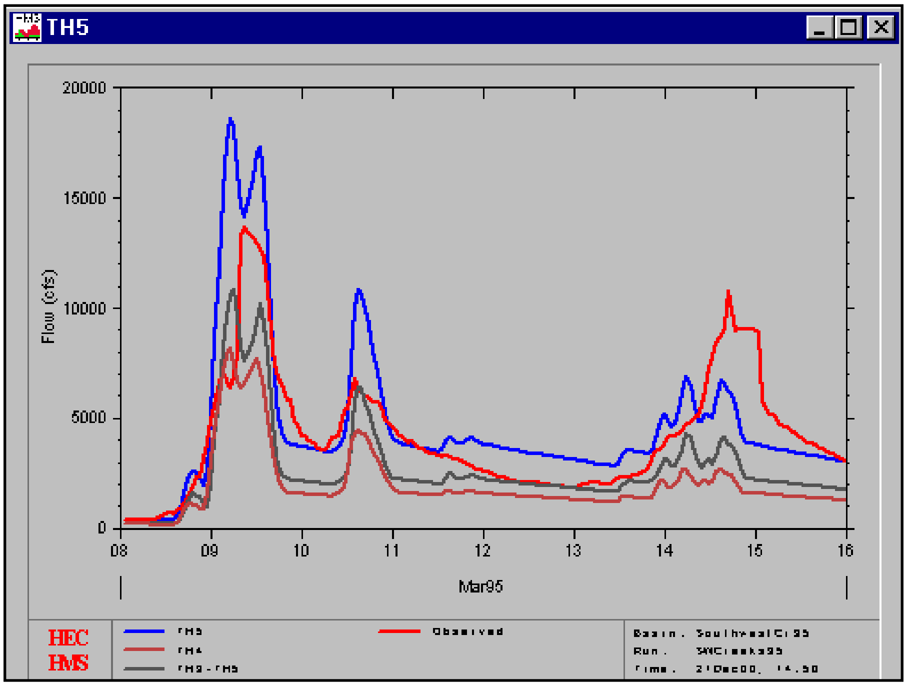
Start of Run : 08Mar95 0100 Basin Model : SouthwestCr95

End of Run : 15Mar95 2400 Met. Model : Mar95

Execution Time : 31May00 1306 Control Specs. : Mar95

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
TH2	11223	09 Mar 95 0400	42818	107.500
TH3	11223	09 Mar 95 0400	42818	107.500
TH3-TH5	10829	09 Mar 95 0600	42566	107.500
TH4	8135.1	09 Mar 95 0500	31545	93.700
TH5	18594	09 Mar 95 0500	74111	201.200
TH5-TH7	17744	09 Mar 95 1100	72767	201.200
TH6	1947.4	09 Mar 95 1400	7370.2	96.100
TH7	19337	09 Mar 95 1100	80137	297.300

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Thomes Creek Basin
March 1995 Event



TH5 – Thomas Creek at Paskenta

HEC-HMS Subbasin Parameters
Thomes Creek Basin: March 1995 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
TH2	2	0.8	0.2	0.6	.08	0
TH6	2	0.8	0.2	0.6	.08	0
TH4	2	0.8	0.2	0.6	.08	0

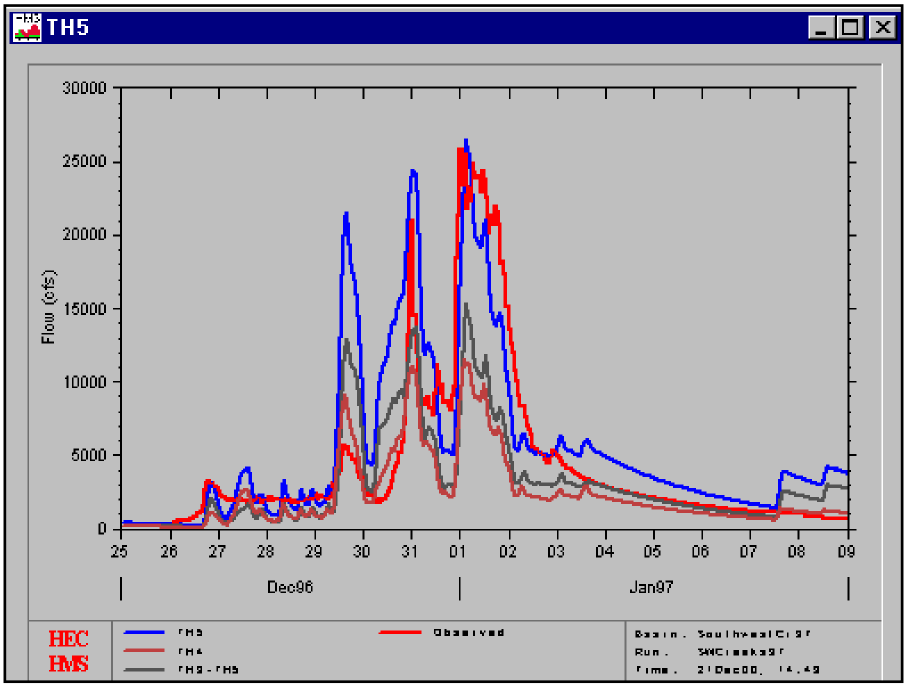
HEC-HMS Summary of Results
Thomes Creek Basin: December 1996 - January 1997 Event

Project : MidSac_West   Run Name : SouthwestCr97

Start of Run	: 25Dec96	0100	Basin Model	:	SouthwestCr97
End of Run	: 08Jan97	2400	Met. Model	:	Jan97
Execution Time	: 31May00	1306	Control Specs.	:	Jan97

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
TH2	15849	01 Jan 97 0100	94160	107.500
TH3	15849	01 Jan 97 0100	94160	107.500
TH3-TH5	15217	01 Jan 97 0300	93756	107.500
TH4	11468	01 Jan 97 0200	70282	93.700
TH5	26393	01 Jan 97 0300	164038	201.200
TH5-TH7	25437	01 Jan 97 1000	162295	201.200
TH6	4630.6	01 Jan 97 0800	26145	96.100
TH7	29872	01 Jan 97 1000	188440	297.300

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Thomes Creek River Basin
December 1996 - January 1997 Event

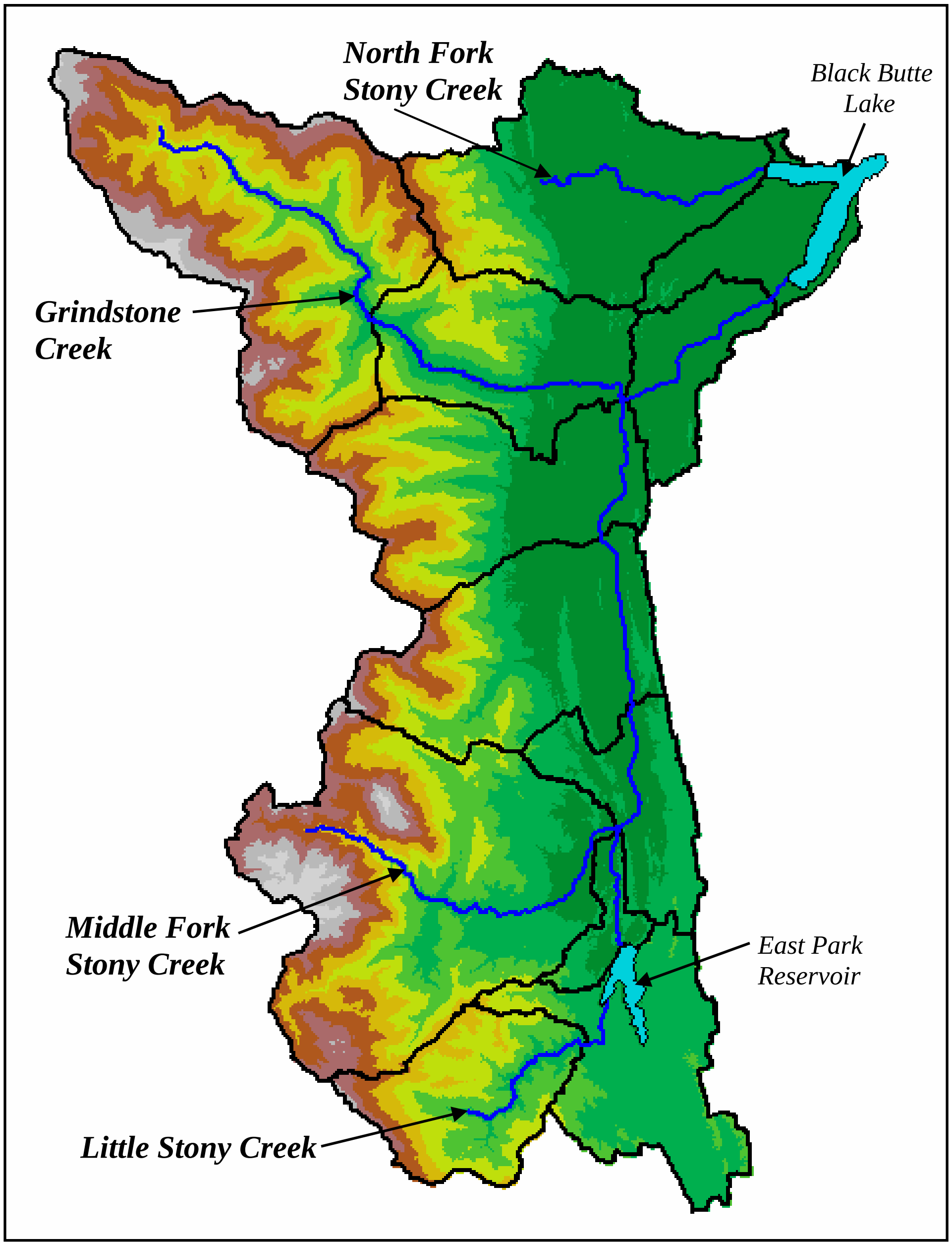


TH5 – Thomas Creek at Paskenta

HEC-HMS Subbasin Parameters
Thomes Creek Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
TH2	2	0.7	0.2	1.0	.005	0
TH6	2	0.7	0.2	1.0	.005	0
TH4	2	0.7	0.2	1.0	.005	0

Stony Creek Basin



HEC-GeoHMS Subbasin Delineation

Stony Creek

The Stony Creek HMS model consists of a 735 square mile basin above Black Butte Dam located in the southwest portion of the Sacramento Watershed, south of the Thomes Creek basin. The basin model is divided into 12 subbasins, connected with 9 routing reaches, and in addition to Black Butte Lake, it includes the Stony Gorge and East Park Reservoirs. The inflow into Black Butte Lake was the only observed hydrograph used for calibration. The computed peak inflow into Black Butte Lake for the 1995 event proved larger than the 1997 event (44,791 cfs vs. 35,977 cfs).

Using the adopted TC and R (Group 1) and initial Muskingum routing parameters, the computed hydrographs matched the observed hydrographs for both the 1995 and 1997 events. The peaks and the number of peaks matched well, although the timing of the computed peaks for the 1997 event arrived earlier than the observed peaks. The Muskingum K values for two routing reaches were reduced at the Black Butte Lake to match the observed inflows. Even though this basin has three reservoirs, it is a completely connected model with the elevation-storage-outflow relationships obtained from the Sacramento District for both the East Park and Stony Gorge reservoirs incorporated into the model. The relationships and starting conditions were used to calibrate the model. The loss and baseflow parameters varied between the two events but they stayed within reasonable bounds. The losses for the 1995 event were set lower than for the 1997 event in order to match the observed flows. Twenty-five percent imperviousness was used for the Black Butte Lake and East Park Reservoir subbasins and twenty percent imperviousness was used for the Stony Gorge Reservoir subbasin.

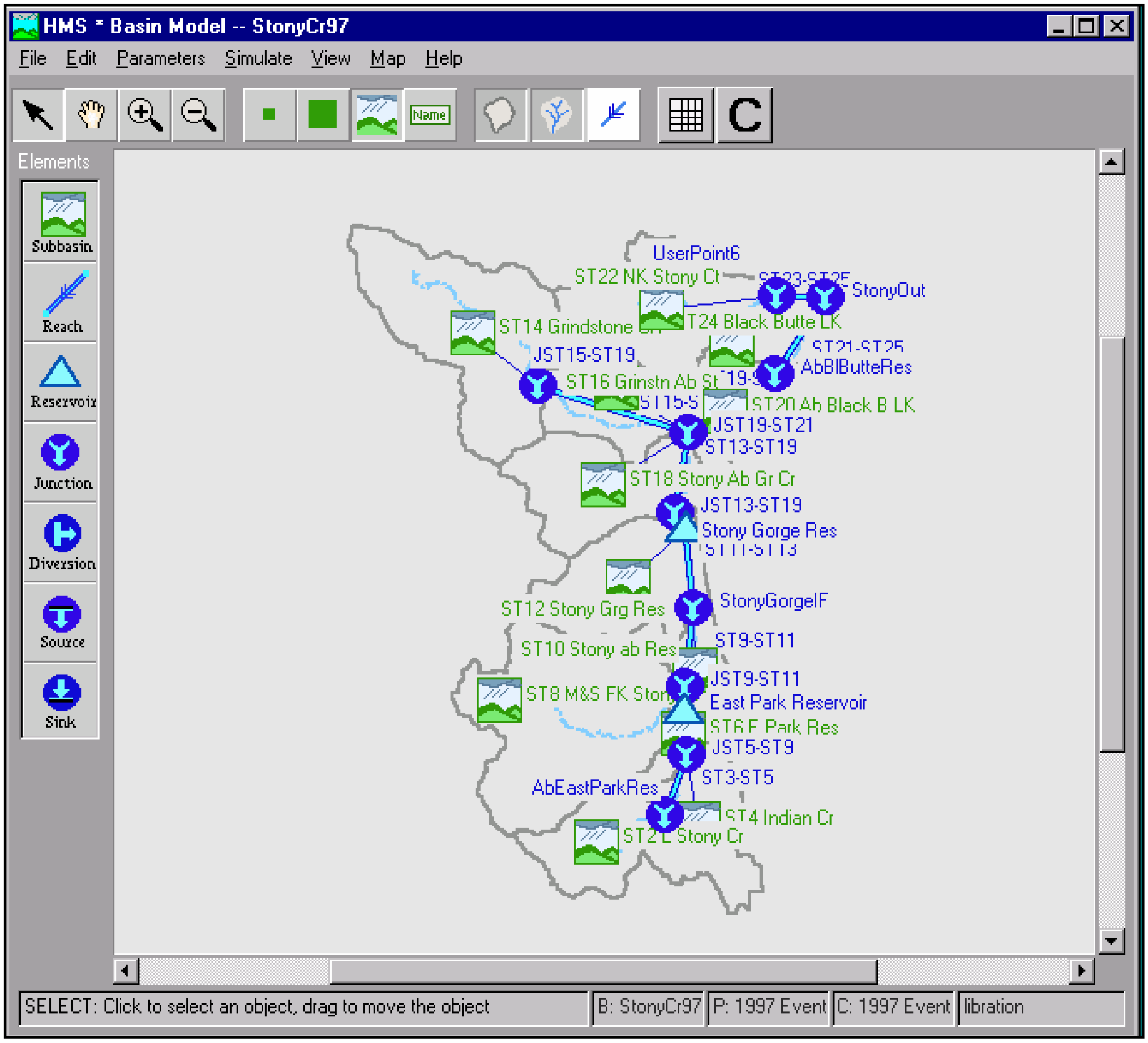
<u>Calibration of the 1995 Event:</u>

The peak, timing, and volume of the initial and dominant spike of the observed and computed hydrographs matched very well. Subsequent spikes did not match as well; however, with two reservoirs upstream, it is not surprising. Initial and constant loss rates of 0.5 inches and 0.045 inches/hour, respectively, were used for most of the basin. A constant loss rate of 0.1 inches/hour was used for a few of the lower subbasins. The baseflow values of 3.0 cfs per square mile, 0.7 and 0.15 for the initial flow, recession ratio, and the threshold flow, respectively, were also used to calibrate the model.

<u>Calibration of the 1997 Event:</u>

The peaks and volumes of the observed and computed hydrographs matched very well. Unfortunately the timing was off by several hours; however, again the flood must travel through two reservoirs first, so it is not surprising that they are not exact. Initial and constant loss rates of 1.0 inch and 0.083 inches/hour, respectively, were used. The baseflow values of 2.0 cfs per square mile, 0.7 and 0.15 for the initial flow, recession ratio, and the threshold flow, respectively, were also used to calibrate the model.

Stony Creek HEC-HMS Model Schematic



Stony Creek Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Initial TC $1.4(LL_{CA}/S^{1/2})^{.33}$ (Hr)	Initial R 1.5 TC (cfs/Hr)	Regression TC $0.68(LL_{CA}/S^{1/2})^{.46}$ (Hr)	Regression R 1.5 TC (cfs/Hr)
ST14 Grindstone CR	122.44	21.59	8.09	264.00	10.75	3.1	4.6	2.0	3.0
ST24 Black Butte LK	29.69	12.13	5.54	73.92	7.81	2.8	4.1	1.8	2.6
ST16 Grinstn Ab St	52.21	16.07	6.34	237.60	6.61	2.6	3.9	1.6	2.4
ST18 Stony Ab Gr Cr	71.06	18.44	8.61	279.84	9.49	2.9	4.4	1.9	2.9
ST12 Stony Grg Res	73.82	18.33	7.64	300.96	8.07	2.8	4.2	1.8	2.7
ST8 M&S FK Stony Cr	139.56	26.66	12.05	216.48	21.83	3.9	5.8	2.8	4.2
ST6 E Park Res	10.12	9.86	3.83	158.40	3.00	2.0	3.0	1.1	1.7
ST4 Indian Cr	54.86	14.71	5.61	73.92	9.60	3.0	4.4	1.9	2.9
ST10 Stony ab Res	31.93	12.58	4.79	95.04	6.18	2.6	3.8	1.6	2.4
ST2 L Stony Cr	42.54	14.16	7.82	311.52	6.27	2.6	3.8	1.6	2.4
ST20 Ab Black B LK	25.09	11.84	5.57	73.92	7.67	2.7	4.1	1.7	2.6
ST22 NF Stony Cr	81.81	19.66	10.66	227.04	13.91	3.3	5.0	2.3	3.4

Stony Creek Reach Parameters

Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Ave Reach Vel $80\ S_R^{1/2}$ V_R (fps)	Initial K $1.47\ L_R / 1.5V_R$ K (Hr)	K Used (Hr)	Musk X or LAG (Min)	N steps Time Step= 60
ST21-ST25	6.75	0.0006	1.96	3.4	1.0	0.4	3
ST23-ST25	3.31	0.0000	0.25	12.8	1.0	0.4	11
ST15-ST19	13.43	0.0085	7.38	1.8	1.8	0.4	2
ST13-ST19	6.58	0.0032	4.53	1.0	1.0	0.4	1
ST11-ST13	7.02	0.0037	4.87	1.0	1.0	0.4	1
ST5-ST9	5.29	0.0063	6.35	1.0	1.0	0.4	1
ST3-ST5	5.45	0.0038	4.93	1.1	1.1	0.4	1
ST9-ST11	6.45	0.0049	5.60	1.1	1.1	0.4	1
ST19-ST21	8.62	0.0024	3.92	2.2	2.2	0.4	2

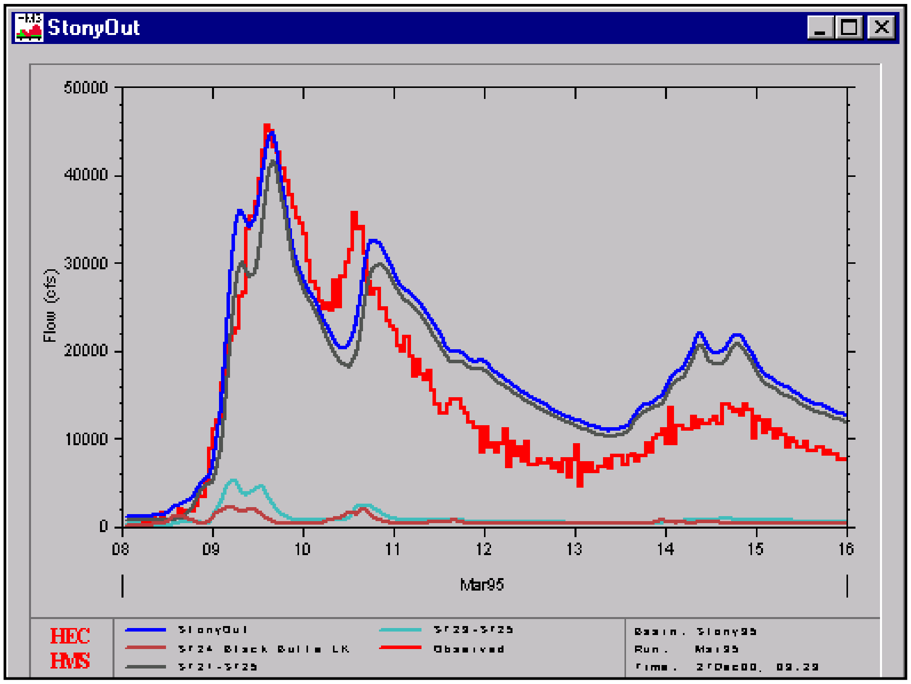
HEC-HMS Summary of Results
Stony Creek Basin: March 1995 Event

Project : StonyCr Run Name : Mar95 Calibration

Start of Run	: 08Mar95 0100	Basin Model	: StonyCr95
End of Run	: 15Mar95 2400	Met. Model	: 1995 Event
Execution Time	: 31May00 1309	Control Specs.	: 1995 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
ST14 Grindstone CR	15891	09 Mar 95 0400	52282	122.439
JST15-ST19	15891	09 Mar 95 0400	52282	122.439
ST15-ST19	15399	09 Mar 95 0600	52094	122.439
ST2 L Stony Cr	9790.9	09 Mar 95 0900	34807	42.540
AbEastParkRes	9790.9	09 Mar 95 0900	34807	42.540
ST3-ST5	9663.4	09 Mar 95 1000	34727	42.540
ST4 Indian Cr	9129.6	09 Mar 95 1000	31363	54.863
JST5-ST9	18793	09 Mar 95 1000	66090	97.403
ST5-ST9	18666	09 Mar 95 1100	65953	97.403
ST6 E Park Res	1884.2	09 Mar 95 0900	6710.5	10.116
East Park Reservoir	8847.5	10 Mar 95 2200	51168	107.519
ST8 M&S FK Stony Cr	3693	09 Mar 95 1100	82594	139.555
JST9-ST11	23698	09 Mar 95 1100	133762	247.074
ST9-ST11	23619	09 Mar 95 1200	133355	247.074
ST10 Stony ab Res	4400.0	09 Mar 95 1000	14551	31.933
StonyGorgeIF	27628	09 Mar 95 1100	147905	279.007
ST11-ST13	27475	09 Mar 95 1200	147499	279.007
ST12 Stony Grg Res	10850	09 Mar 95 1000	38836	73.815
Stony Gorge Res	23281	09 Mar 95 1700	163707	352.822
JST13-ST19	23281	09 Mar 95 1700	163707	352.822
ST13-ST19	23246	09 Mar 95 1800	163058	352.822
ST18 Stony Ab Gr Cr	8295.5	09 Mar 95 0400	25700	71.062
ST16 Grinstn Ab St	6520.8	09 Mar 95 0400	19537	52.209
JST19-ST21	41772	09 Mar 95 1300	260388	598.532
ST19-ST21	41033	09 Mar 95 1500	258478	598.532
ST20 Ab Black B LK	2613.5	09 Mar 95 0400	8471.2	25.091
AbBlButteRes	41913	09 Mar 95 1500	266950	623.623
ST21-ST25	41628	09 Mar 95 1600	266046	623.623
ST22 NK Stony Ct	5308.0	09 Mar 95 0500	14831	81.810
UserPoint6	5308.0	09 Mar 95 0500	14831	81.810
ST23-ST25	5235.9	09 Mar 95 0600	14809	81.810
ST24 Black Butte LK	2227.3	09 Mar 95 0400	8543.1	29.692
StonyOut	44791	09 Mar 95 1600	289398	735.125

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Stony Creek Basin
March 1995 Event



Stony Creek Inflow into the Black Butte Reservoir

HEC-HMS Subbasin Parameters
Stony Creek Basin: March 1995 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
ST14 Grindstone CR	3	0.7	0.15	0.5	.10	0
ST24 Black Butte LK	3	0.7	0.15	0.5	.045	25
ST16 Grinstn Ab St	3	0.7	0.15	0.5	.10	0
ST18 Stony Ab Gr Cr	3	0.7	0.15	0.5	.10	0
ST12 Stony Grg Res	3	0.7	0.15	0.5	.045	20
ST8 M&S FK Stony Cr	3	0.7	0.15	0.5	.045	0
ST6 E Park Res	3	0.7	0.15	0.5	.045	25
ST4 Indian Cr	3	0.7	0.15	0.5	.045	0
ST10 Stony ab Res	3	0.7	0.15	0.5	.045	0
ST2 L Stony Cr	3	0.7	0.15	0.5	.045	0
ST20 Ab Black B LK	3	0.7	0.15	0.5	.045	0
ST22 NK Stony Ct	3	0.7	0.15	0.5	.10	0

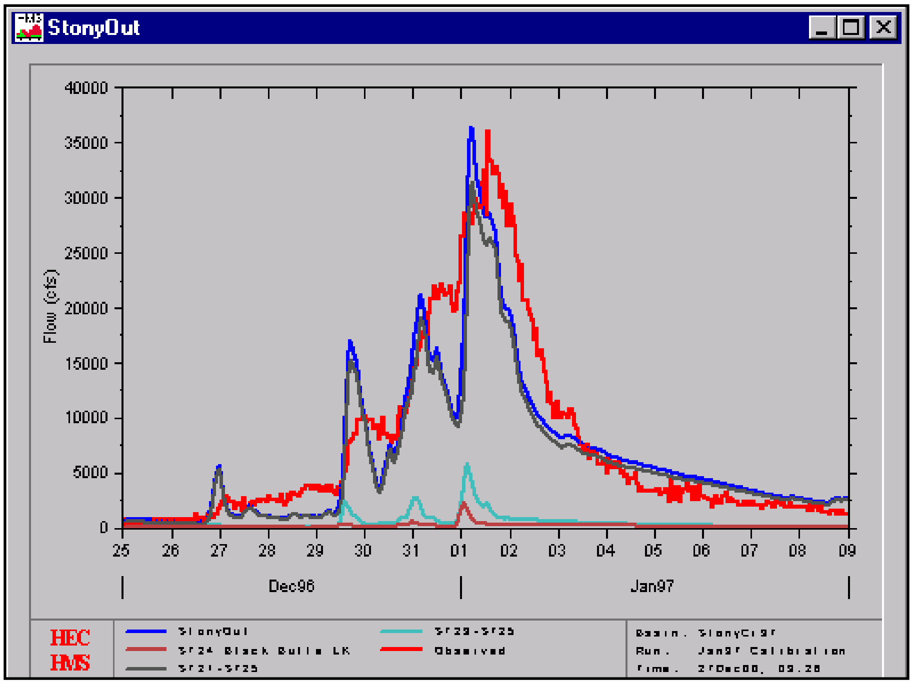
HEC-HMS Summary of Results
Stony Creek Basin: December 1996 - January 1997 Event

Project : StonyCr   Run Name : Jan97 Calibration

Start of Run	: 25Dec96 0100	Basin Model	: StonyCr97
End of Run	: 08Jan97 2400	Met. Model	: 1997 Event
Execution Time	: 31May00 1309	Control Specs.	: 1997 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
ST14 Grindstone CR	13071	01 Jan 97 0100	61394	122.439
JST15-ST19	13071	01 Jan 97 0100	61394	122.439
ST15-ST19	12699	01 Jan 97 0300	61282	122.439
ST2 L Stony Cr	8206.4	01 Jan 97 0100	28238	42.540
AbEastParkRes	8206.4	01 Jan 97 0100	28238	42.540
ST3-ST5	7881.1	01 Jan 97 0200	28236	42.540
ST4 Indian Cr	6329.1	01 Jan 97 0100	18396	54.863
JST5-ST9	14005	01 Jan 97 0200	46632	97.403
ST5-ST9	13804	01 Jan 97 0300	46633	97.403
ST6 E Park Res	1627.8	01 Jan 97 0100	5471.8	10.116
East Park Reservoir	999.63	04 Jan 97 1700	6625.9	107.519
ST8 M&S FK Stony Cr	14993	01 Jan 97 0300	56485	139.555
JST9-ST11	14998	01 Jan 97 0300	63111	247.074
ST9-ST11	14901	01 Jan 97 0400	63093	247.074
ST10 Stony ab Res	3124.7	01 Jan 97 0100	7117.2	31.933
StonyGorgeIF	16909	01 Jan 97 0400	70210	279.007
ST11-ST13	16833	01 Jan 97 0500	70196	279.007
ST12 Stony Grg Res	7364.2	01 Jan 97 0100	27977	73.815
Stony Gorge Res	13778	01 Jan 97 0900	73812	352.822
JST13-ST19	13778	01 Jan 97 0900	73812	352.822
ST13-ST19	13755	01 Jan 97 1000	73726	352.822
ST18 Stony Ab Gr Cr	7831.5	01 Jan 97 0100	24574	71.062
ST16 Grinstn Ab St	6867.5	01 Jan 97 0100	18864	52.209
JST19-ST21	30191	01 Jan 97 0300	178446	598.532
ST19-ST21	30562	01 Jan 97 0500	178107	598.532
ST20 Ab Black B LK	1773.9	01 Jan 97 0100	3282.7	25.091
AbBlButteRes	31318	01 Jan 97 0500	181390	623.623
ST21-ST25	31355	01 Jan 97 0600	181234	623.623
ST22 NK Stony Ct	5861.7	01 Jan 97 0200	14473	81.810
UserPoint6	5861.7	01 Jan 97 0200	14473	81.810
ST23-ST25	5809.7	01 Jan 97 0300	14481	81.810
ST24 Black Butte LK	2181.2	01 Jan 97 0100	5131.2	29.692
StonyOut	36407	01 Jan 97 0500	200846	735.125

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Stony Creek Basin
December 1996 - January 1997 Event

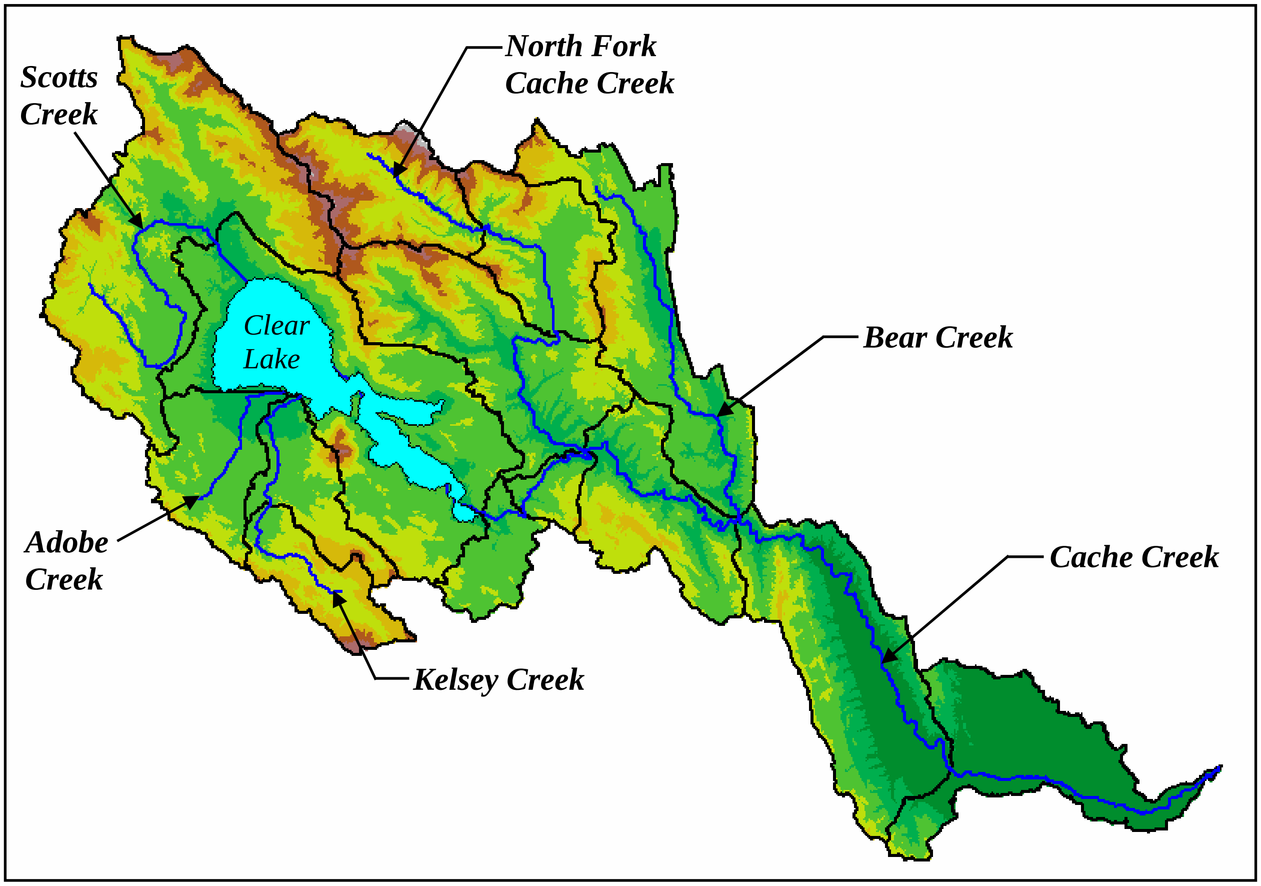


Stony Creek Inflow into the Black Butte Reservoir

HEC-HMS Subbasin Parameters
Stony Creek Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
ST14 Grindstone CR	2	0.7	0.15	1.0	.083	0
ST24 Black Butte LK	2	0.7	0.15	1.0	.083	25
ST16 Grinstn Ab St	2	0.7	0.15	1.0	.083	0
ST18 Stony Ab Gr Cr	2	0.7	0.15	1.0	.083	0
ST12 Stony Grg Res	2	0.7	0.15	1.0	.083	20
ST8 M&S FK Stony Cr	2	0.7	0.15	1.0	.083	0
ST6 E Park Res	2	0.7	0.15	1.0	.083	25
ST4 Indian Cr	2	0.7	0.15	1.0	.083	0
ST10 Stony ab Res	2	0.7	0.15	1.0	.083	0
ST2 L Stony Cr	2	0.7	0.15	1.0	.083	0
ST20 Ab Black B LK	2	0.7	0.15	1.0	.083	0
ST22 NK Stony Ct	2	0.7	0.15	1.0	.083	0

Cache Creek Basin



HEC-GeoHMS Subbasin Delineation

Cache Creek

The Cache Creek HMS model consists of a 1,145 square mile basin located in the southwest portion of the Sacramento Watershed, south of the Stony Creek basin and above Yolo, CA. The basin model is divided into 14 subbasins, connected with 11 routing reaches and includes the Indian Valley Reservoir, Clear Lake and the Grigsby Riffles (which is a natural control for Clear Lake). Six observed hydrographs were used to assist with the calibration: Kelsey Creek near Kelseyville (11449500); Cache Creek at Rumsey; Indian Valley Reservoir hourly inflow (11451300 Daily); Cache Creek at Yolo (11452500); Cache Creek near Lower Lake (11451000); and, North Fork Cache Creek at Hough Springs (11451100). Not all of the gages had records for both events, but if a gage had records for one of the events, it was still used for calibration purposes. Additionally, hourly records were not available at all gages; therefore, if daily gages were used, instantaneous peaks were collected, if possible, to assist with the calibration. Like other basins on the west side of the Sacramento valley, the 1995 event proved larger than the 1997 event (36,040 cfs vs. 25,442 cfs for the computed peak flow at the basin outlet).

Using the adopted TC and R (Group 1) and Muskingum parameters, the computed hydrograph at Yolo matched the observed hydrograph reasonably well for both events. The routing times for five of the reaches were reduced due to the fact that they traveled through lakes (Clear Lake and the Indian Valley Reservoir). The routing technique for these reaches was changed to the lag method due to their short routing times. Two other routing reaches, the two most downstream reaches, had their travel times reduced to calibrate the timing of the peak. Two gages were used as part of the optimization process: Kelsey Creek near Kelseyville (11449500) and North Fork Cache Creek at Hough Springs (11451100). The loss rates for both events were within the guidelines set for the study, with the losses for the 1995 event being higher than for the 1997 event. Impervious surfaces were used for the subbasins that included Clear Lake (40%) and the Indian Valley Reservoir (30%). The baseflow values used were also within the guidelines with the 1997 event baseflow values higher than those used for the 1995 event.

The model is connected through Clear Lake with an elevation-storage-outflow relationship used at the Grigsby Riffles. The reservoir relationship was obtained from the Sacramento District. The Grigsby Riffles is a natural constriction that has had a rating curve developed for it and controls the flows from Clear Lake. The Grigsby relationship and starting conditions were used to calibrate the model. For this modeling effort, rather than attempt to predict how the Indian Valley Reservoir was operated, the source and sink tools available in HMS were implemented. This technique allowed the observed hydrograph at the outlet of the Indian Valley Reservoir to be passed downstream. As pointed out in "Section 6.6.5, Reservoir Modeling" in the main report, HMS is fairly limited in how it models releases from reservoirs.

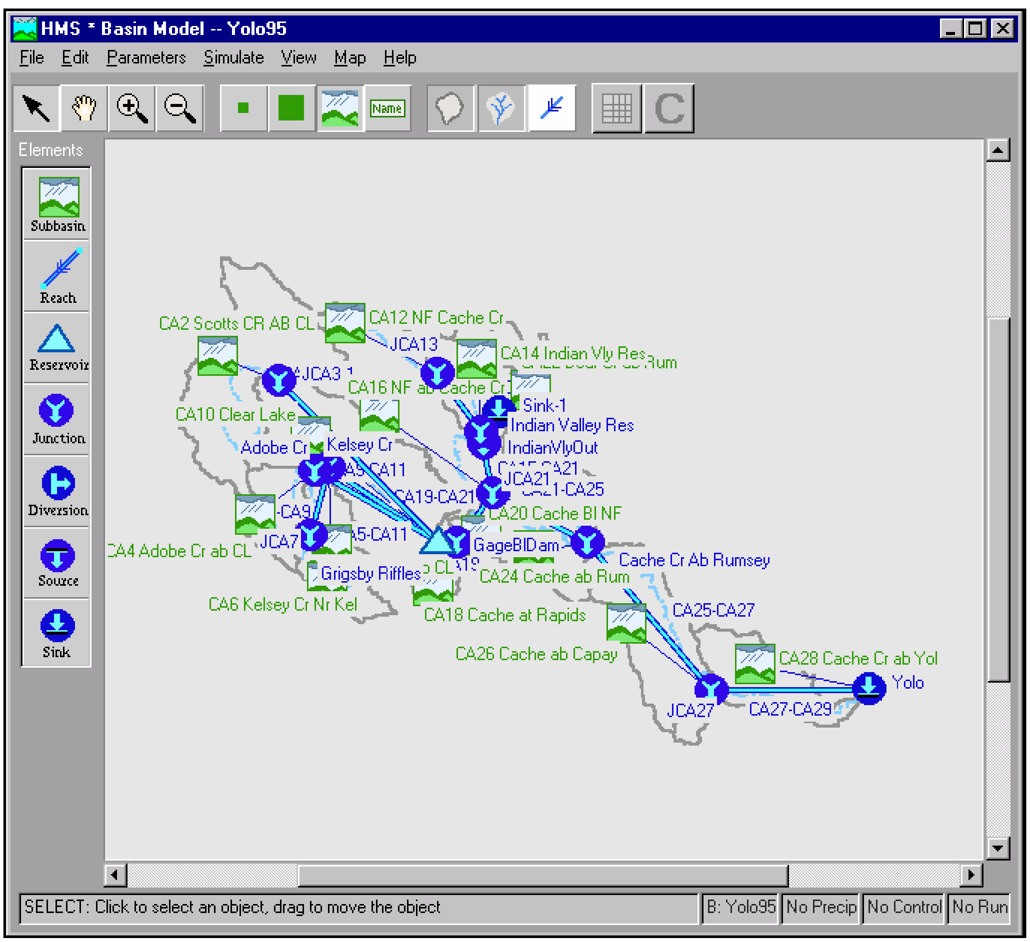
<u>Calibration of the 1995 Event:</u>

For the 1995 event, all of the observed hydrographs were reasonably matched by the computed hydrographs. Even the gages that only reported daily had their general trends reflected by the computed hydrographs. The initial loss varied between 1.0 and 3.0 with the majority of the values being set to 2.0 inches. The constant loss rates varied between 0.001 and 0.15 with the majority being set to 0.15 inches/hour. The baseflow values of 1.0 cfs per square mile, 0.8 and 0.2 for the initial flow, recession ratio, and the threshold flow, respectively, were also used to calibrate the model.

<u>Calibration of the 1997 Event:</u>

The computed hydrograph reasonably matched the observed hydrograph at Yolo, CA. The computed hydrograph had several smaller peaks preceding the main peak. While the observed hydrograph had several peaks as well, they were much smaller in magnitude. This discrepancy is difficult to explain given that the subbasins contributing to the hydrograph at Yolo all had similar spikes as the computed hydrograph, and the precipitation seems to validate the peaks. The other computed hydrographs, except the one below the Grigsby Riffles, matched the observed values reasonably well. The gage below the Grigsby Riffles provided daily records and, although the computed hydrograph resembled the observed hydrograph, neither came close to approximating the instantaneous peak. The initial loss varied between 1.0 and 3.0 with the majority being set to 1.5 inches. The constant loss rates varied between 0.001 and 0.07 with the majority being set to 0.05 inches/hour. The baseflow values of 3.0 cfs per square mile, 0.8 and 0.2 for the initial flow, recession ratio, and the threshold flow, respectively, were also used to calibrate the model.

Cache Creek HEC-HMS Model Schematic



Cache Creek Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Initial TC $1.4(LL_{CA}/S^{1/2})^{.33}$ (Hr)	Initial R 1.5 TC (cfs/Hr)	Regression TC $0.68(LL_{CA}/S^{1/2})^{.46}$ (Hr)	Regression R 1.5 TC (cfs/Hr)
CA2 Scotts CR AB CL	184.09	30.53	4.33	79.20	14.86	3.4	5.1	2.4	3.5
CA14 Indian Vly Res	60.50	15.35	5.52	205.92	5.90	2.5	3.8	1.5	2.3
CA12 NF Cache Cr	60.18	17.83	7.95	147.84	11.66	3.1	4.7	2.1	3.2
CA16 NF Ab Cache Cr	103.33	23.73	10.48	147.84	20.44	3.8	5.7	2.7	4.1
CA10 Clear Lake	192.26	27.27	12.00	36.96	53.84	5.2	7.8	4.3	6.4
CA22 Bear Cr Ab Rum	102.78	35.25	15.64	84.48	59.97	5.4	8.1	4.5	6.7
CA18 Cache at Rapids	26.04	11.10	4.97	73.92	6.41	2.6	3.9	1.6	2.4
CA24 Cache ab Rum	70.47	25.93	8.36	95.04	22.23	3.9	5.8	2.8	4.2
CA6 Kelsey Cr Nr Kel	36.76	16.77	8.65	132.00	12.62	3.2	4.8	2.2	3.3
CA20 Cache Bl NF	14.29	11.39	8.24	184.80	6.91	2.6	4.0	1.7	2.5
CA8 Kelsey Cr AB Lk	37.61	17.29	8.02	116.16	12.86	3.3	4.9	2.2	3.3
CA4 Adobe Cr AB Lk	49.98	15.77	7.76	89.76	12.92	3.3	4.9	2.2	3.3
CA26 Cache ab Capay	120.18	31.07	11.28	89.76	36.99	4.6	6.9	3.6	5.4
CA28 Cache Cr ab Yol	86.17	27.15	14.96	100.32	40.55	4.8	7.1	3.7	5.6

Cache Creek Reach Parameters

Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Ave Reach Vel $80\ S_R^{1/2}$ V_R (fps)	Initial K $1.47\ L_R / 1.5V_R$ K (Hr)	K Used (Hr)	Musk X or LAG (Min)	N steps Time Step= 60
CA3-CA11	23.31	0.00001	0.25	90.3	0.5	0.4	73
CA5-CA11	3.88	0.0002	1.13	3.4	0.3	0.4	3
CA9-CA11	3.05	0.0001	0.80	3.7	0.3	0.4	3
CA15-CA17	13.48	0.0042	5.18	2.5	2.5	0.4	3
CA19-CA21	8.31	0.0070	6.69	1.2	1.2	0.4	1
CA21-CA25	16.73	0.0043	5.25	3.1	3.1	0.4	3
CA13-CA15	9.60	0.0051	5.71	1.6	0.5	0.4	2
CA11-CA19	3.10	0.0019	3.49	1.0	0.5	0.4	1
CA7-CA9	9.09	0.0034	4.66	1.9	1.9	0.4	2
CA25-CA27	27.73	0.0027	4.16	6.5	3.5	0.4	3
CA27-CA29	19.88	0.0015	3.10	6.3	3.3	0.4	3

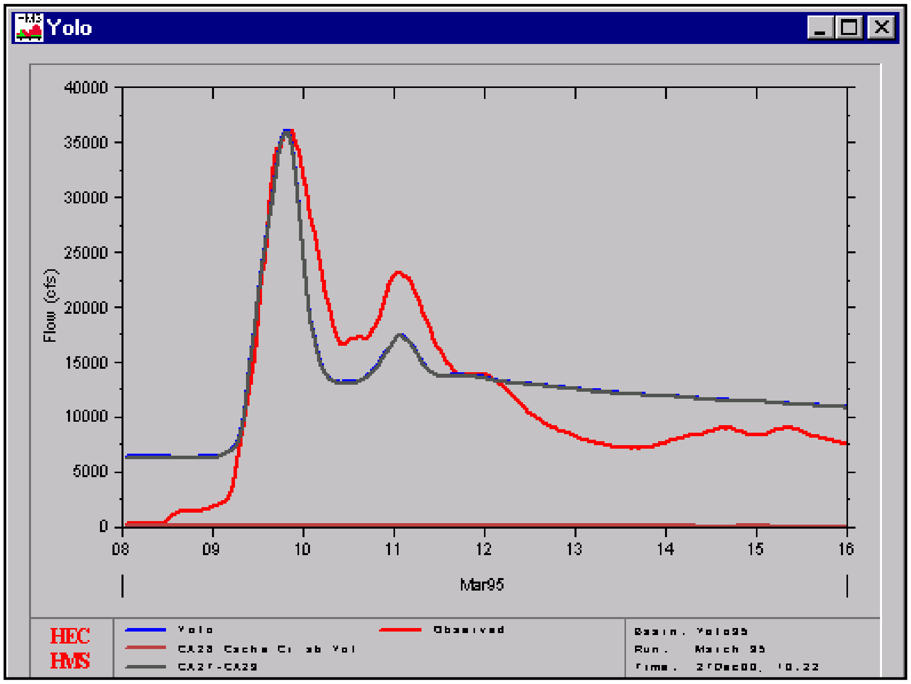
HEC-HMS Summary of Results
Cache Creek Basin: March 1995 Event

Project : CacheatYolo Run Name : March 95

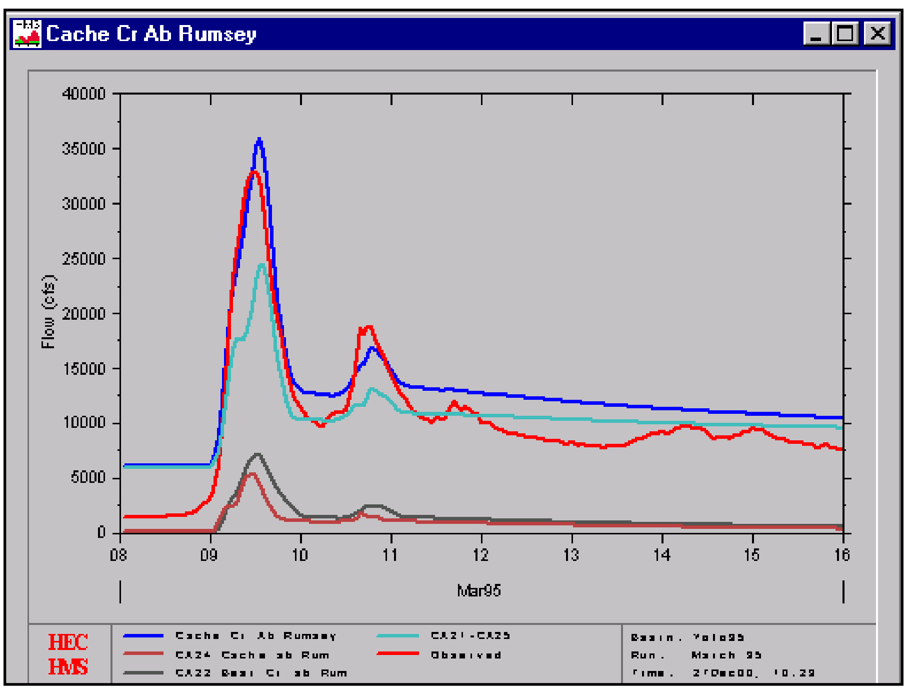
Start of Run	: 08Mar95 0100	Basin Model	: Yolo95
End of Run	: 15Mar95 2400	Met. Model	: March 1995
Execution Time	: 08Nov00 1136	Control Specs.	: Mar 95 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
CA12 NF Cache Cr	7535.6	09 Mar 95 1000	21361	60.080
JCA13	7535.6	09 Mar 95 1000	21361	60.080
CA13-CA15	7476.6	09 Mar 95 1000	21342	60.080
CA14 Indian Vly Res	8722.0	09 Mar 95 0900	32238	60.462
Indian Valley Res	15963	09 Mar 95 1000	53580	120.542
Sink-1	15963	09 Mar 95 1000	53580	120.542
CA2 Scotts CR AB CL	11130	09 Mar 95 1000	32737	184.085
JCA3	11130	09 Mar 95 1000	32737	184.085
CA3-CA11	11123	09 Mar 95 1000	32705	184.085
CA4 Adobe Cr ab CL	6111.9	09 Mar 95 1000	18087	49.894
Adobe Cr	6111.9	09 Mar 95 1000	18087	49.894
CA5-CA11	6009.3	09 Mar 95 1000	18078	49.894
CA6 Kelsey Cr Nr Kel	8995.8	09 Mar 95 1000	27981	36.747
JCA7	8995.8	09 Mar 95 1000	27981	36.747
CA7-CA9	8895.8	09 Mar 95 1200	27840	36.747
CA8 Kelsey Cr ab CL	7427.7	09 Mar 95 1000	22239	37.622
Kelsey Cr	15637	09 Mar 95 1100	50080	74.369
CA9-CA11	15615	09 Mar 95 1200	50048	74.369
CA10 Clear Lake	28252	09 Mar 95 1200	109386	192.348
Grigsby Riffles	5263.2	15 Mar 95 2400	67555	500.696
CA11-CA19	5261.5	15 Mar 95 2400	67455	500.696
CA18 Cache at Rapids	4908.2	09 Mar 95 1000	13996	26.043
GageBlDam	8089.0	09 Mar 95 1000	81451	526.739
CA19-CA21	8046.3	09 Mar 95 1100	81177	526.739
IndianVlyOut	3000.0	08 Mar 95 0100	47355	121.000
CA15-CA21	3000.0	08 Mar 95 0100	47355	121.000
CA16 NF ab Cache Cr	11873	09 Mar 95 1000	32437	103.461
CA20 Cache Bl NF	2046.3	09 Mar 95 1000	5349.5	14.291
JCA21	24803	09 Mar 95 1000	166320	765.491
CA21-CA25	24330	09 Mar 95 1400	165406	765.491
CA22 Bear Cr ab Rum	7136.2	09 Mar 95 1200	19953	102.778
CA24 Cache ab Rum	5322.9	09 Mar 95 1100	13538	70.463
Cache Cr Ab Rumsey	35799	09 Mar 95 1300	198897	938.732
CA25-CA27	34998	09 Mar 95 1600	197654	938.732
CA26 Cache ab Capay	1899.7	09 Mar 95 1300	8409.1	120.183
JCA27	36586	09 Mar 95 1600	206063	1058.915
CA27-CA29	35926	09 Mar 95 2000	204824	1058.915
CA28 Cache Cr ab Yol	140.24	09 Mar 95 1500	960.28	86.167
Yolo	36040	09 Mar 95 2000	205784	1145.082

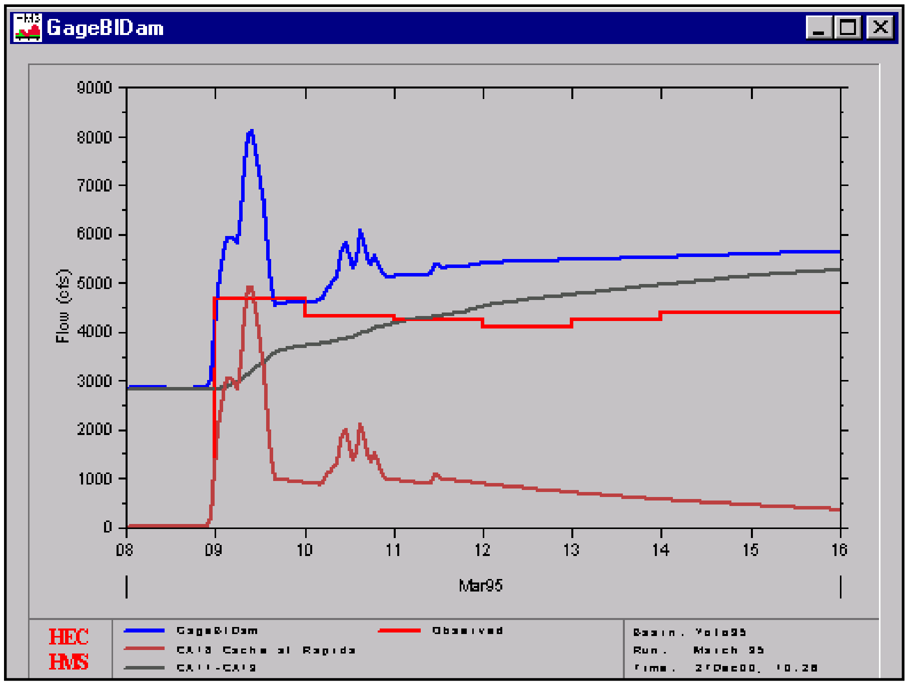
HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Cache Creek Basin
March 1995 Event



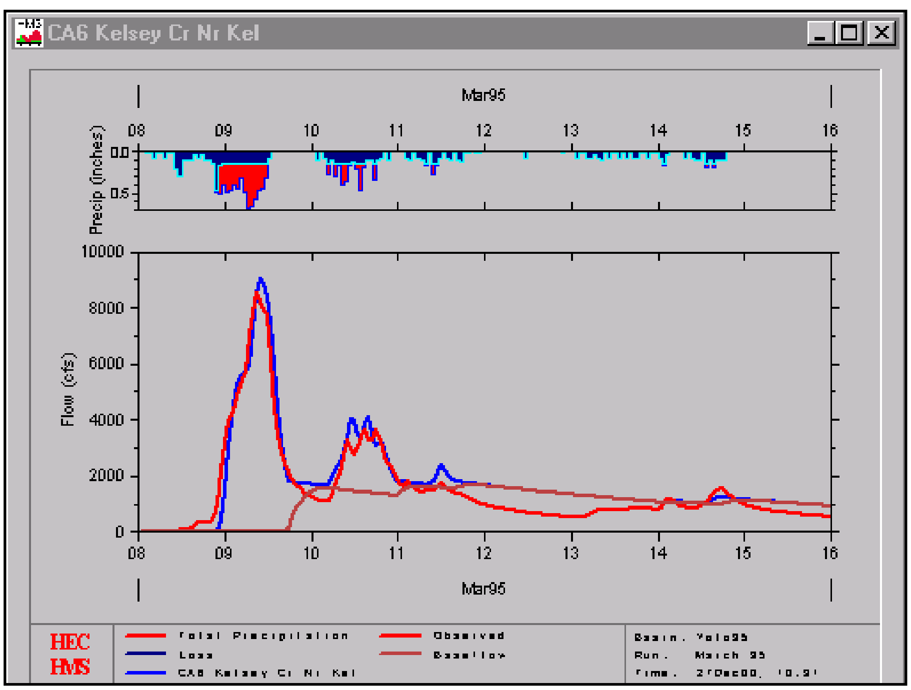
Cache Creek above Yolo, CA



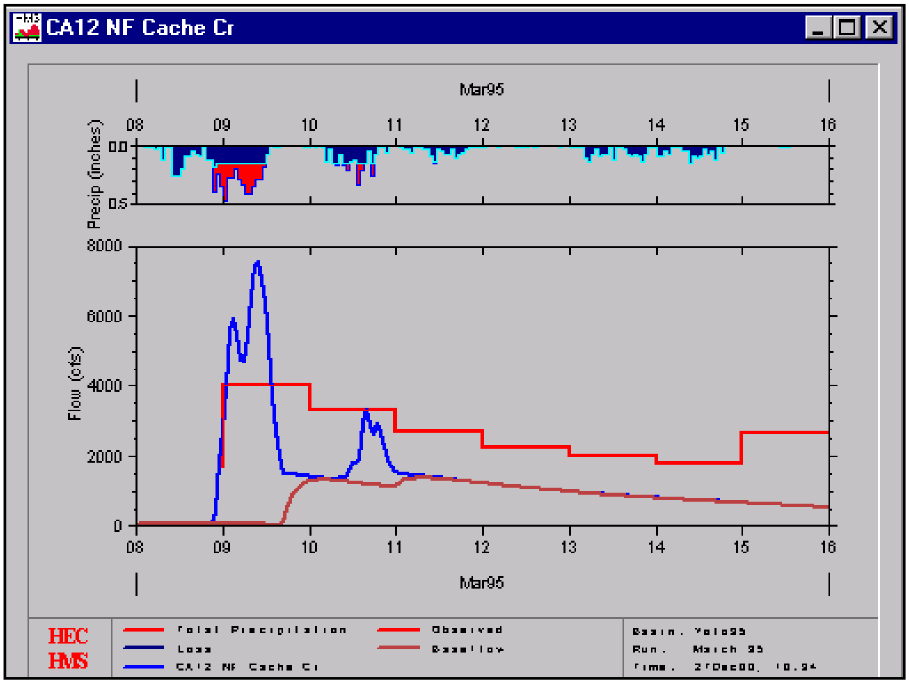
Cache Creek above Rumsey, CA



Cache Creek at gage below the Clear Lake Dam



CA6 Kelsey Creek near Kelseyville, CA



CA12 North Fork Cache Creek near Hough Springs, CA

HEC-HMS Subbasin Parameters
Cache Creek Basin: March 1995 Event

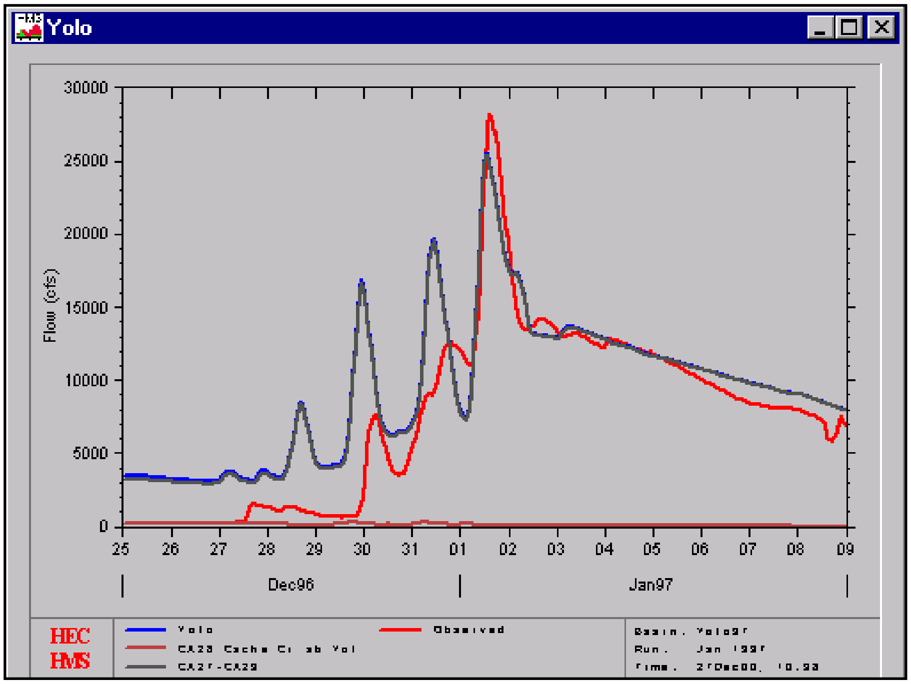
Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
CA2 Scotts CR AB CL	1	0.8	0.2	2.0	0.15	0
CA16 NF ab Cache Cr	1	0.8	0.2	1.5	0.15	0
CA18 Cache at Rapids	1	0.8	0.2	2.0	0.15	0
CA20 Cache Bl NF	1	0.8	0.2	2.0	0.15	0
CA24 Cache ab Rum	1	0.8	0.2	2.0	0.15	0
CA4 Adobe Cr ab CL	1	0.8	0.2	2.0	0.15	0
CA26 Cache ab Capay	1	0.8	0.2	1.0	0.001	0
CA22 Bear Cr ab Rum	1	0.8	0.2	2.0	0.12	0
CA8 Kelsey Cr ab CL	1	0.8	0.2	2.0	0.15	0
CA28 Cache Cr ab Yol	1	0.8	0.2	1.0	0.001	0
CA12 NF Cache Cr	1	0.8	0.2	1.5	0.15	0
CA14 Indian Vly Res	1	0.8	0.2	3.0	0.15	30
CA6 Kelsey Cr Nr Kel	1	0.8	0.2	2.0	0.15	0
CA10 Clear Lake	1	0.8	0.2	2.0	0.15	40

HEC-HMS Summary of Results
Cache Creek Basin: December 1996 - January 1997 Event

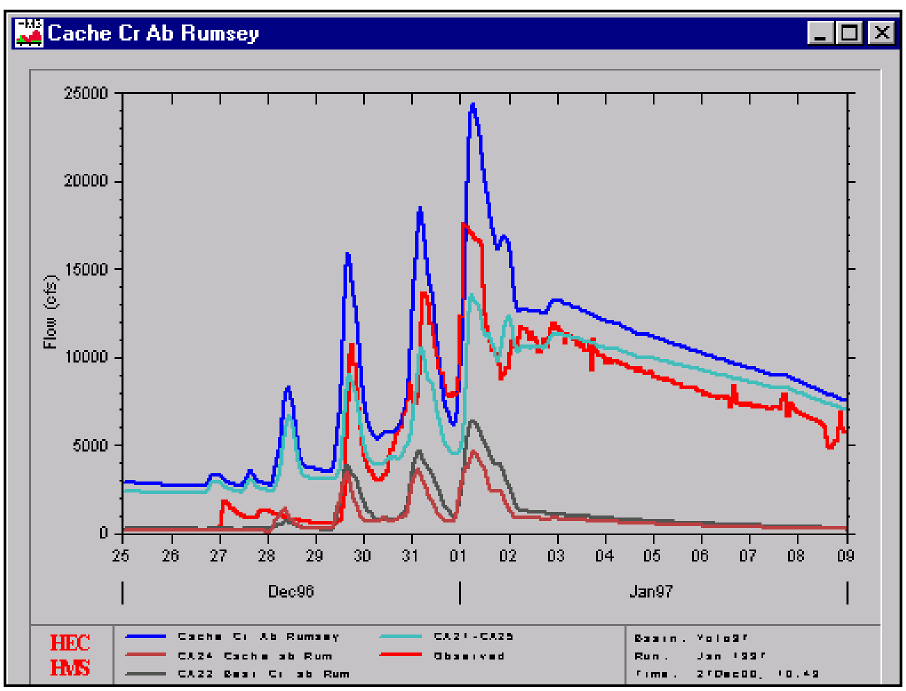
Project	: CacheatYolo	Run Name	: Jan 1997
Start of Run	: 25Dec96 0100	Basin Model	: Yolo97
End of Run	: 08Jan97 2400	Met. Model	: Jan 1997
Execution Time	: 28Nov00 1332	Control Specs.	: Jan 97 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
CA12 NF Cache Cr	10184	01 Jan 97 0200	60200	60.080
JCA13	10184	01 Jan 97 0200	60200	60.080
CA13-CA15	10144	01 Jan 97 0300	60172	60.080
CA14 Indian Vly Res	8879.9	01 Jan 97 0100	41698	60.462
Indain Valley Res	18294	01 Jan 97 0200	101871	120.542
Sink-1	18294	01 Jan 97 0200	101871	120.542
CA2 Scotts CR AB CL	15841	01 Jan 97 0100	73777	184.085
JCA3	15841	01 Jan 97 0100	73777	184.085
CA3-CA11	15294	01 Jan 97 0100	73763	184.085
CA4 Adobe Cr ab CL	2732.3	01 Jan 97 1200	14852	49.894
Adobe Cr	2732.3	01 Jan 97 1200	14852	49.894
CA5-CA11	2718.8	01 Jan 97 1200	14852	49.894
CA6 Kelsey Cr Nr Kel	5557.4	28 Dec 96 0800	22961	36.747
JCA7	5557.4	28 Dec 96 0800	22961	36.747
CA7-CA9	5445.0	28 Dec 96 1000	22932	36.747
CA8 Kelsey Cr ab CL	3839.6	28 Dec 96 0800	18507	37.622
Kelsey Cr	8782.6	28 Dec 96 0900	41439	74.369
CA9-CA11	8742.8	28 Dec 96 0900	41433	74.369
CA10 Clear Lake	11355	01 Jan 97 1300	83928	192.348
Grigsby Riffles	3742.0	06 Jan 97 2100	86687	500.696
CA11-CA19	3742.0	06 Jan 97 2100	86614	500.696
CA18 Cache at Rapids	2358.5	28 Dec 96 0800	12538	26.043
GageBlDam	4604.0	01 Jan 97 2000	99152	526.739
CA19-CA21	4563.4	01 Jan 97 2100	98972	526.739
IndianVlyOut	5693.0	02 Jan 97 1600	62661	121.000
CA15-CA21	5689.6	02 Jan 97 1900	62119	121.000
CA16 NF ab Cache Cr	8577.2	01 Jan 97 0300	42731	103.461
CA20 Cache Bl NF	996.95	01 Jan 97 0100	5429.3	14.291
JCA21	13605	01 Jan 97 0200	209251	765.491
CA21-CA25	13466	01 Jan 97 0600	208068	765.491
CA22 Bear Cr ab Rum	6383.4	01 Jan 97 0600	32258	102.778
CA24 Cache ab Rum	4638.6	01 Jan 97 0700	23498	70.463
Cache Cr Ab Rumsey	24360	01 Jan 97 0700	263824	938.732
CA25-CA27	24096	01 Jan 97 1000	262459	938.732
CA26 Cache ab Capay	1937.6	31 Dec 96 0500	14169	120.183
JCA27	25626	01 Jan 97 1000	276628	1058.915
CA27-CA29	25329	01 Jan 97 1400	275366	1058.915
CA28 Cache Cr ab Yol	303.68	29 Dec 96 1800	3164.6	86.167
Yolo	25442	01 Jan 97 1400	278531	1145.082

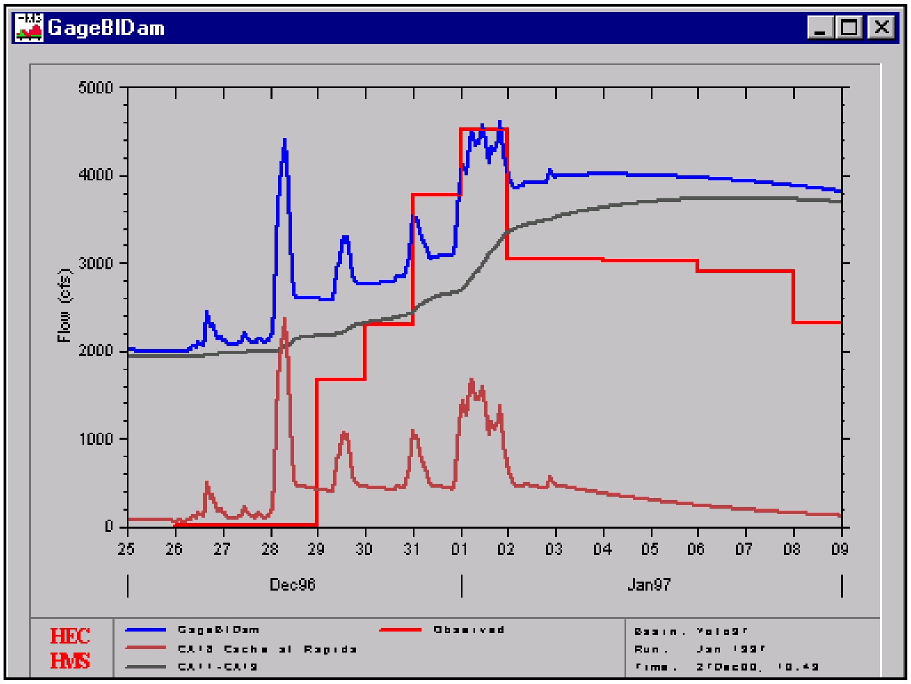
HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Cache Creek Basin
December 1996 - January 1997 Event



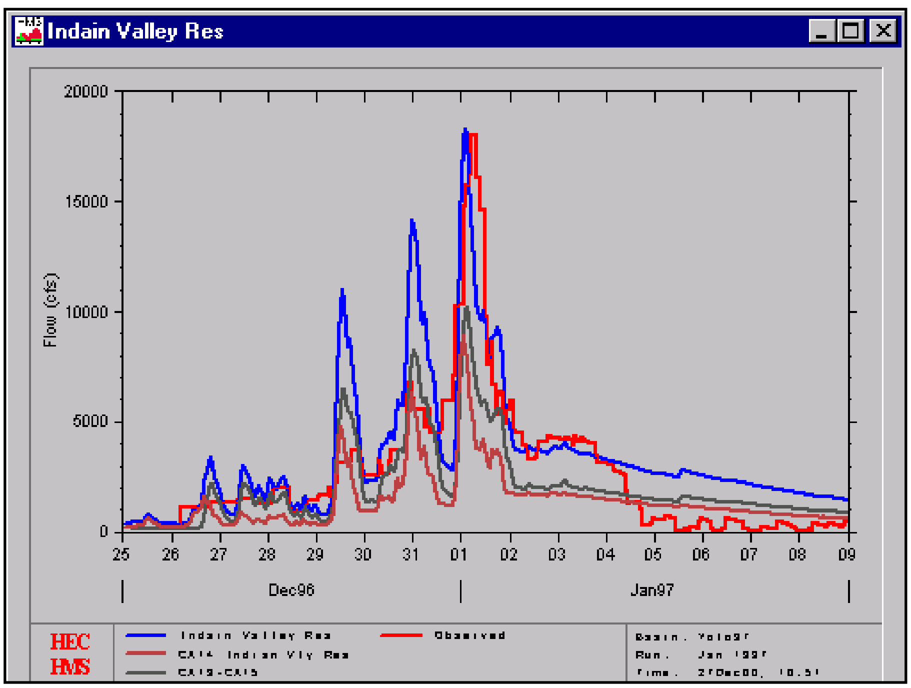
Cache Creek above Yolo, CA



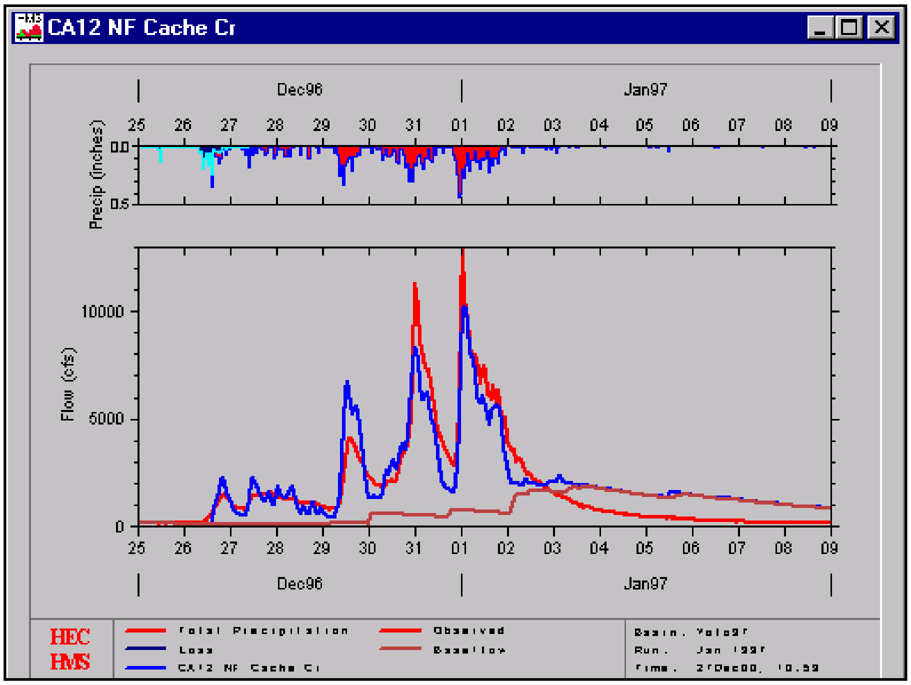
Cache Creek above Rumsey, CA



Cache Creek at gage below the Clear Lake Dam



North Fork Cache Creek Inflow into Indian Valley Reservoir

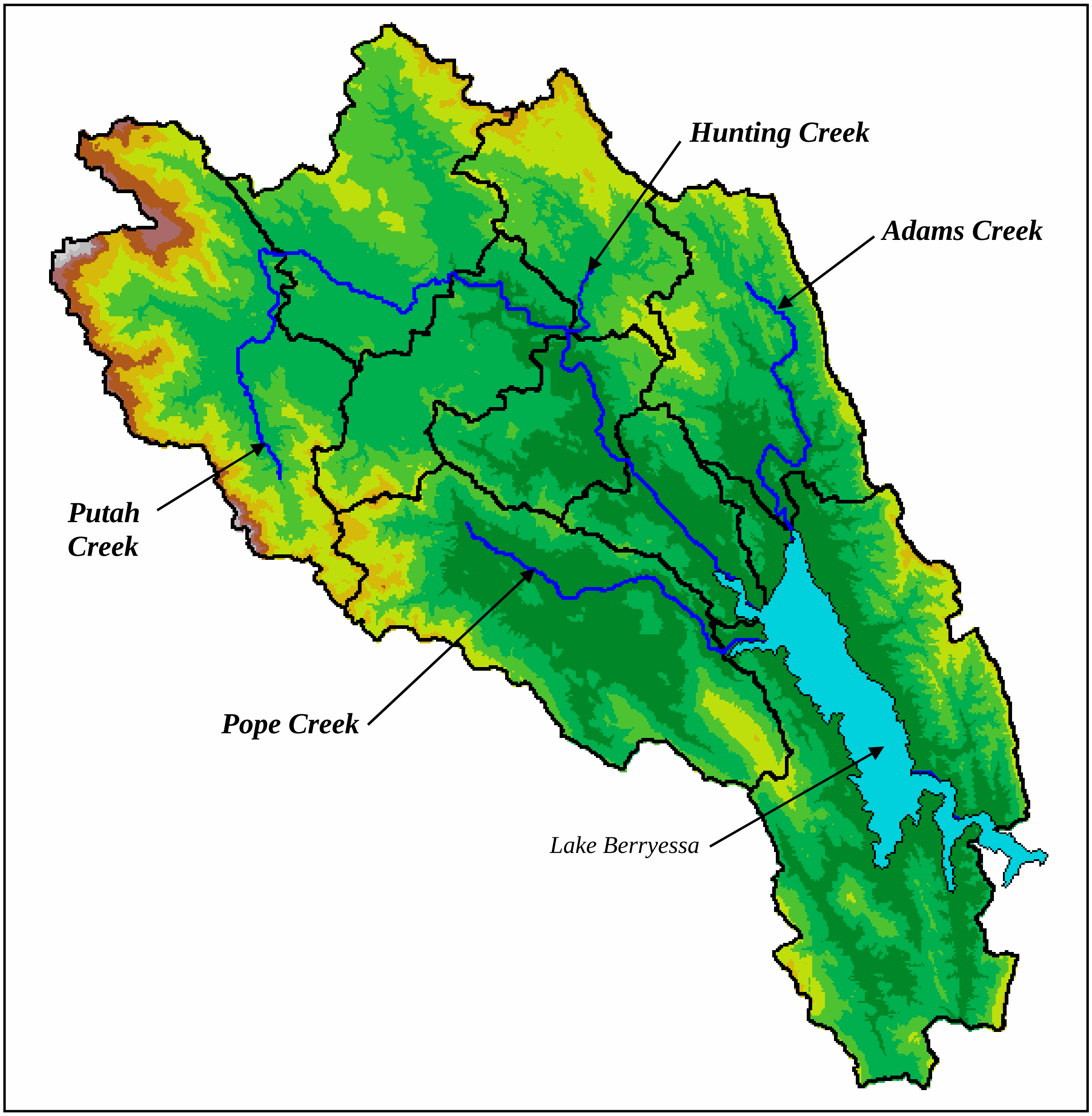


CA12 North Fork Cache Creek near Hough Springs, CA

HEC-HMS Subbasin Parameters
Cache Creek Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
CA2 Scotts CR AB CL	3	0.8	0.2	1.5	.05	0
CA16 NF ab Cache Cr	3	0.8	0.2	1.5	.05	0
CA18 Cache at Rapids	3	0.8	0.2	1.0	.05	0
CA20 Cache Bl NF	3	0.8	0.2	1.5	.05	0
CA24 Cache ab Rum	3	0.8	0.2	1.5	.05	0
CA4 Adobe Cr ab CL	3	0.8	0.2	1.5	.05	0
CA26 Cache ab Capay	3	0.8	0.2	1.5	.001	0
CA22 Bear Cr ab Rum	3	0.8	0.2	1.5	.05	0
CA8 Kelsey Cr ab CL	3	0.8	0.2	1.5	.05	0
CA28 Cache Cr ab Yol	3	0.8	0.2	1.5	.001	0
CA12 NF Cache Cr	3	0.8	0.2	1.5	.001	0
CA14 Indian Vly Res	3	0.8	0.2	3.0	.07	30
CA6 Kelsey Cr Nr Kel	3	0.8	0.2	1.5	.05	0
CA10 Clear Lake	3	0.8	0.2	1.5	.05	40

Putah Creek Basin



HEC-GeoHMS Subbasin Delineation

Putah Creek

The Putah Creek HMS model consists of a 560 square mile basin above Lake Berryessa located in the southwestern-most portion of the Sacramento Watershed, south of the Cache Creek basin. The basin model is divided into 9 subbasins and connected with 7 routing reaches. The inflow into Lake Berryessa was the only observed hydrograph used for calibration. Given that daily records were available and multiple peaks were witnessed, the calibrations did not do very well. The computed peak inflow into Lake Berryessa for the 1995 event proved larger than the 1997 event (63,288 cfs vs. 53,106 cfs).

Using the adopted TC (Group 1) and a R value equal to 2.33TC and Muskingum parameters, hydrographs were computed. The revision to the R value was made to approximate the values and shape of the observed hydrographs. The routing times for three of the reaches were reduced due to the fact that they traveled through Lake Berryessa. The routing technique for these reaches was changed to the lag method due to their short routing times. The loss rates for both events were nearly identical with the constant losses slightly smaller for the 1995 event. An impervious surface of 20 percent was used for the subbasin that included Lake Berryessa.

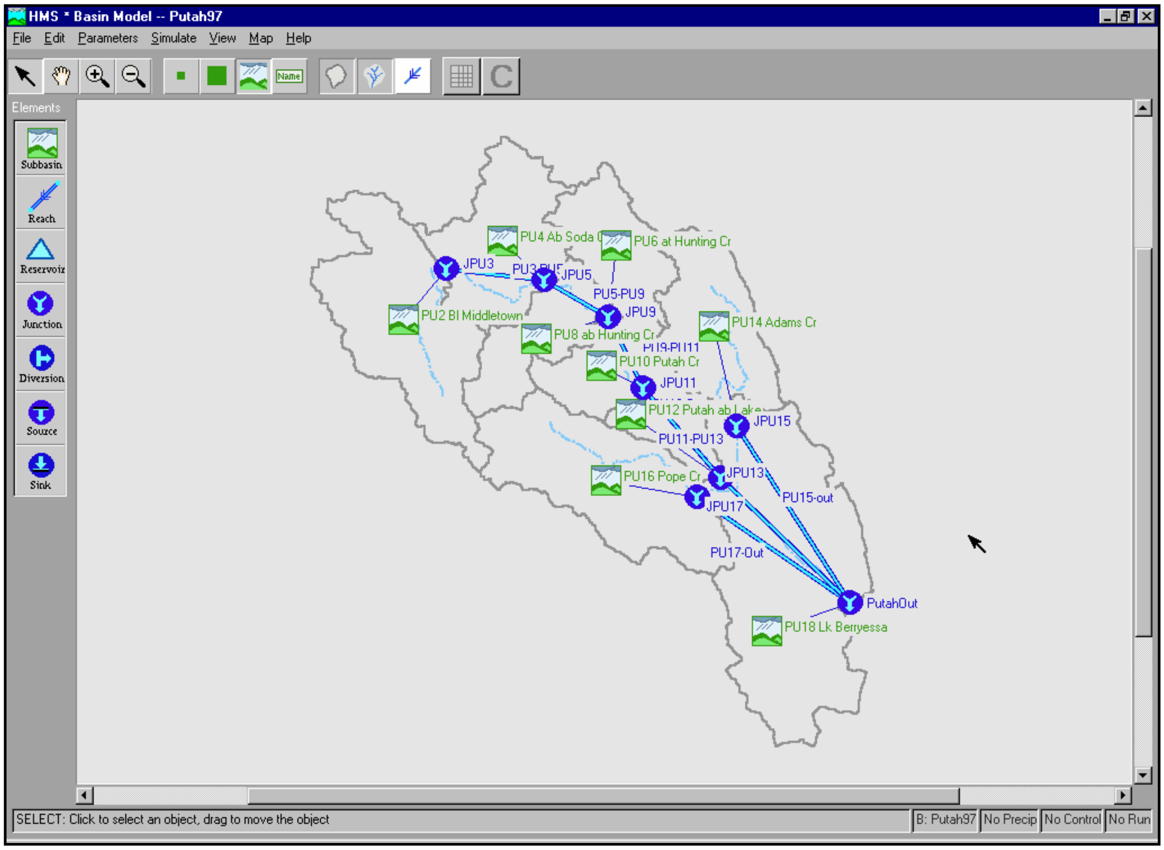
<u>Calibration of the 1995 Event:</u>

While the observed and computed hydrographs did not appear to line up very well, a possible cause could be that the observed hydrograph was the discharge from Lake Berryessa and the computed hydrograph was the inflow into the lake. Additionally, the observed records were daily values. The computed hydrograph followed the trend of the observed hydrograph. Initial and constant loss rates of 2.3 inches and 0.035 inches/hour, respectively, were used. The baseflow values of 3.0 cfs per square mile, 0.65 and 0.2 for the initial flow, recession ratio, and the threshold flow, respectively, were also used to calibrate the model.

<u>Calibration of the 1997 Event:</u>

While the observed and computed hydrographs did not appear to line up very well, a possible cause could be that the observed hydrograph was the discharge from Lake Berryessa and the computed hydrograph was the inflow into the lake. Additionally, the observed records were daily values. Initial and constant loss rates of 2.3 inches and 0.04 inches/hour, respectively, were used. The baseflow values of 1.0 cfs per square mile, 0.65 and 0.2 for the initial flow, recession ratio, and the threshold flow, respectively, were also used to calibrate the model.

Putah Creek Basin HEC-HMS Model Schematic



Putah Creek Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Initial TC $1.4(LL_{CA}/S^{1/2})^{.33}$ (Hr)	Initial R 1.5 TC (cfs/Hr)	Regression TC $0.68(LL_{CA}/S^{1/2})^{.46}$ (Hr)	Regression R 2.33 TC (cfs/Hr)
PU10 Putah Cr	29.62	9.22	3.13	158.400	2.30	1.8	2.8	1.0	2.3
PU4 Ab Soda Cr	60.78	12.16	6.98	110.880	8.06	2.8	4.2	1.8	4.1
PU18 Lk Berryessa	142.81	22.14	4.64	89.760	10.85	3.1	4.6	2.0	4.7
PU2 Bl Middletown	86.28	17.85	6.08	105.600	10.57	3.0	4.6	2.0	4.7
PU14 Adams Cr	55.14	19.89	9.90	84.480	21.43	3.8	5.8	2.8	6.5
PU16 Pope Cr	85.49	18.57	7.55	121.440	12.73	3.2	4.9	2.2	5.1
PU12 Putah ab Lake	24.55	11.86	5.04	84.480	6.51	2.6	3.9	1.6	3.8
PU8 ab Hunting Cr	37.14	16.83	7.15	126.720	10.69	3.1	4.6	2.0	4.7
PU6 at Hunting Cr	38.04	14.45	8.52	163.680	9.63	3.0	4.4	1.9	4.5

Putah Creek Reach Parameters

Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Ave Reach Vel $80\ S_R^{1/2}$ V_R (fps)	Initial K $1.47\ L_R / 1.5 V_R$ K (Hr)	Musk X or LAG (Min)	N steps Time Step= 60
PU3-PU5	8.39	0.0049	5.60	1.6	0.37	2
PU9-PU11	6.59	0.0054	5.88	1.1	0.4	1
PU11-PU13	7.67	0.0008	2.26	3.3	0.4	3
PU5-PU9	5.88	0.0051	5.71	1.0	0.4	1
PU13-Out	--	0.0000	0.0000	--	30	--
PU15-Out	--	0.0000	0.0000	--	30	--
PU17-Out	--	0.0000	0.0000	--	30	--

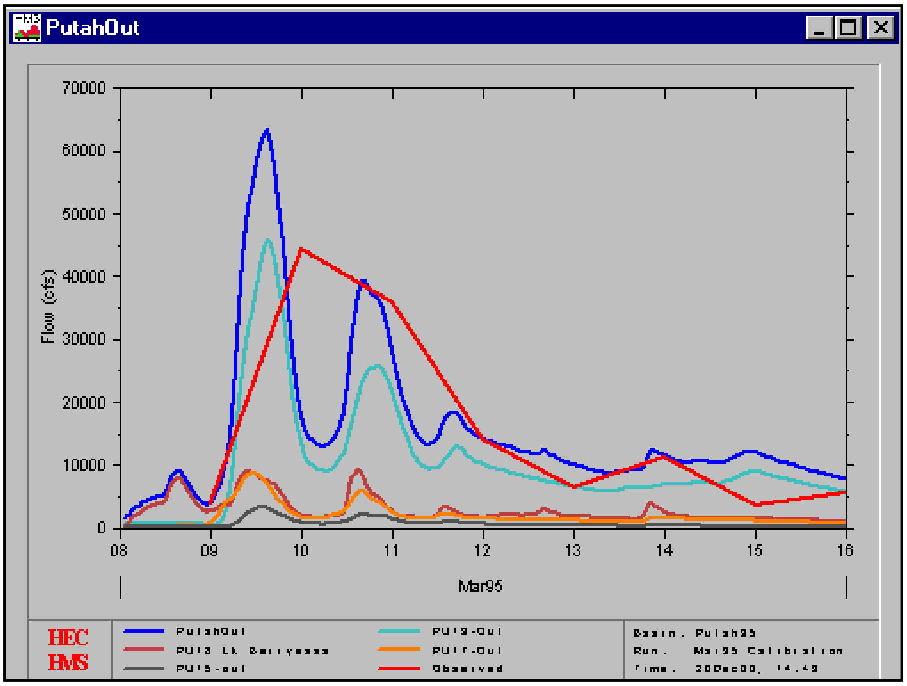
HEC-HMS Summary of Results
Putah Creek Basin: March 1995 Event

Project : PutahCr   Run Name : Mar95 Calibration

Start of Run	: 08Mar95 0100	Basin Model	: Putah95
End of Run	: 15Mar95 2400	Met. Model	: 1995 Event
Execution Time	: 31May00 1308	Control Specs.	: 1995 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
PU16 Pope Cr	8574.9	09 Mar 95 1100	29820	85.491
JPU17	8574.9	09 Mar 95 1100	29820	85.491
PU17-Out	8562.2	09 Mar 95 1100	29799	85.491
PU2 Bl Middletown	20475	09 Mar 95 1000	70478	86.278
JPU3	20475	09 Mar 95 1000	70478	86.278
PU3-PU5	20452	09 Mar 95 1200	70183	86.278
PU4 Ab Soda Cr	12112	09 Mar 95 1000	41105	60.776
JPU5	32074	09 Mar 95 1200	111288	147.054
PU5-PU9	31937	09 Mar 95 1300	110995	147.054
PU8 ab Hunting Cr	5821.1	09 Mar 95 1100	18910	37.136
PU6 at Hunting Cr	4762.3	09 Mar 95 1100	15054	38.043
JPU9	42230	09 Mar 95 1200	144959	222.233
PU9-PU11	41969	09 Mar 95 1300	144568	222.233
PU10 Putah Cr	4189.6	09 Mar 95 0900	13311	29.619
JPU11	44835	09 Mar 95 1300	157879	251.852
PU11-PU13	44657	09 Mar 95 1500	157099	251.852
PU12 Putah ab Lake	2096.4	09 Mar 95 1000	6870.9	24.553
JPU13	46025	09 Mar 95 1500	163970	276.405
PU13-Out	45693	09 Mar 95 1500	163765	276.405
PU14 Adams Cr	3244.9	09 Mar 95 1300	10167	55.142
JPU15	3244.9	09 Mar 95 1300	10167	55.142
PU15-out	3199.8	09 Mar 95 1300	10166	55.142
PU18 Lk Berryessa	9245.0	10 Mar 95 1500	44881	142.812
PutahOut	63310	09 Mar 95 1500	248611	559.850

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Putah Creek Basin
March 1995 Event



PutahOut – Lake Berryessa

HEC-HMS Subbasin Parameters
Putah Creek Basin: March 1995 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
PU10 Putah Cr	3	0.65	0.2	2.3	.035	0
PU4 Ab Soda Cr	3	0.65	0.2	2.3	.035	0
PU18 Lk Berryessa	3	0.65	0.2	2.3	.035	20
PU2 Bl Middletown	3	0.65	0.2	2.3	.035	0
PU14 Adams Cr	3	0.65	0.2	2.3	.035	0
PU16 Pope Cr	3	0.65	0.2	2.3	.035	0
PU12 Putah ab Lake	3	0.65	0.2	2.3	.035	0
PU8 ab Hunting Cr	3	0.65	0.2	2.3	.035	0
PU6 at Hunting Cr	3	0.65	0.2	2.3	.035	0

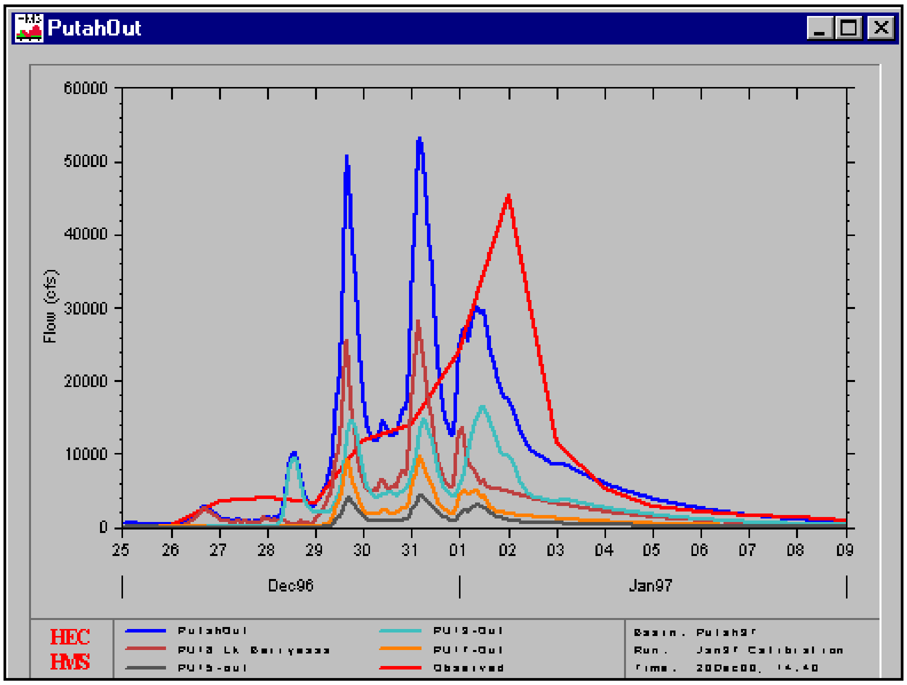
HEC-HMS Summary of Results
Putah Creek Basin: December 1996 - January 1997 Event

Project : PutahCr Run Name : Jan97 Calibration

Start of Run	: 25Dec96 0100	Basin Model	:	Putah97
End of Run	: 08Jan97 2400	Met. Model	:	1997 Event
Execution Time	: 31May00 1308	Control Specs.	:	1997 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
PU16 Pope Cr	9644.0	31 Dec 96 0300	36799	85.491
JPU17	9644.0	31 Dec 96 0300	36799	85.491
PU17-Out	9513.7	31 Dec 96 0400	36798	85.491
PU2 Bl Middletown	6855.1	28 Dec 96 0800	32679	86.278
JPU3	6855.1	28 Dec 96 0800	32679	86.278
PU3-PU5	6521.1	28 Dec 96 1000	32677	86.278
PU4 Ab Soda Cr	3804.6	01 Jan 97 0700	19391	60.776
JPU5	8910.9	28 Dec 96 0900	52068	147.054
PU5-PU9	8846.6	28 Dec 96 1000	52067	147.054
PU8 ab Hunting Cr	2503.6	01 Jan 97 0700	12138	37.136
PU6 at Hunting Cr	2699.0	01 Jan 97 0700	11884	38.043
JPU9	13510	01 Jan 97 0800	76089	222.233
PU9-PU11	13409	01 Jan 97 0900	76088	222.233
PU10 Putah Cr	3433.8	31 Dec 96 0200	13225	29.619
JPU11	15298	01 Jan 97 0900	89313	251.852
PU11-PU13	15270	01 Jan 97 1100	89309	251.852
PU12 Putah ab Lake	3362.6	31 Dec 96 0300	11902	24.553
JPU13	16538	01 Jan 97 1100	101211	276.405
PU13-Out	16442	01 Jan 97 1100	101210	276.405
PU14 Adams Cr	4269.1	31 Dec 96 0400	17693	55.142
JPU15	4269.1	31 Dec 96 0400	17693	55.142
PU15-out	4205.3	31 Dec 96 0400	17694	55.142
PU18 Lk Berryessa	28105	31 Dec 96 0300	101962	142.812
PutahOut	53106	31 Dec 96 0400	257664	559.850

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Putah Creek Basin
December 1996 - January 1997 Event

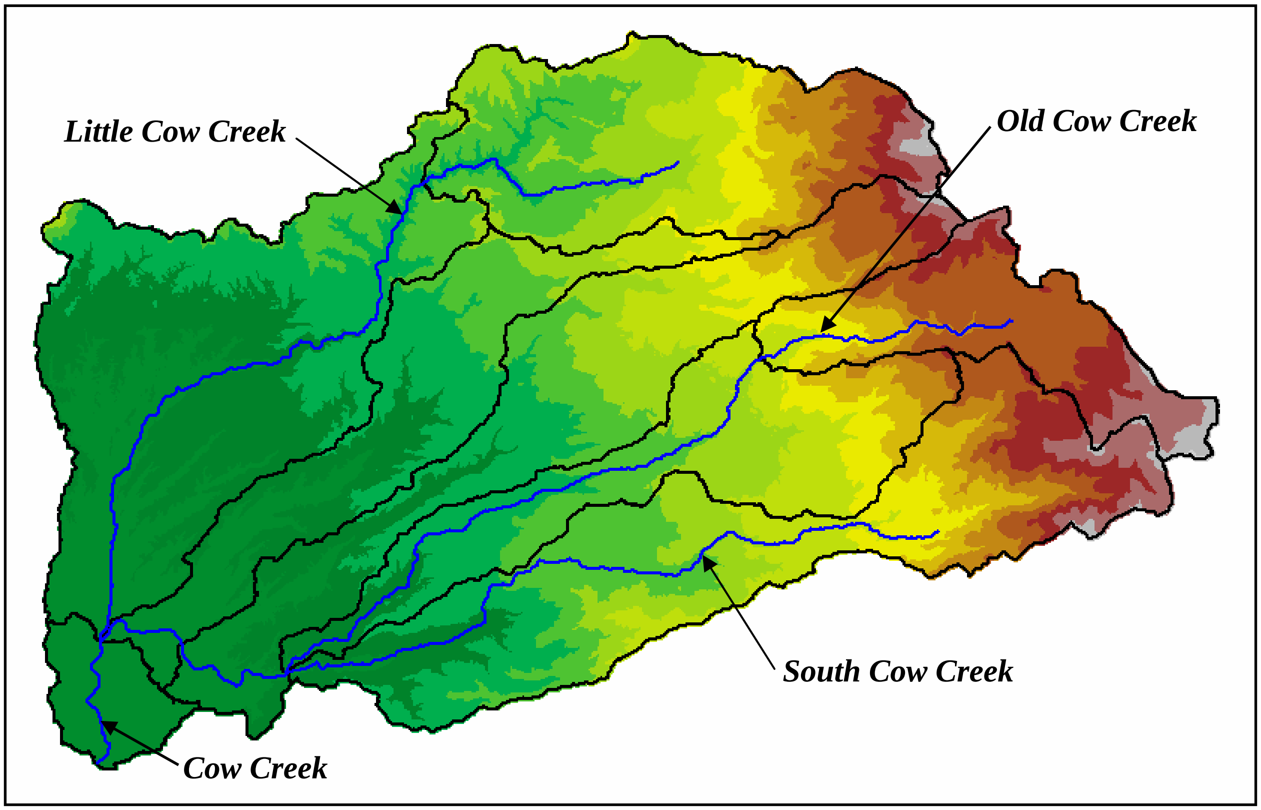


PutahOut – Lake Berryessa

HEC-HMS Subbasin Parameters
Putah Creek Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
PU10 Putah Cr	1	0.65	0.2	2.3	.04	0
PU4 Ab Soda Cr	1	0.65	0.2	2.3	.04	0
PU18 Lk Berryessa	1	0.65	0.2	2.3	.04	20
PU2 Bl Middletown	1	0.65	0.2	2.3	.04	0
PU14 Adams Cr	1	0.65	0.2	2.3	.04	0
PU16 Pope Cr	1	0.65	0.2	2.3	.04	0
PU12 Putah ab Lake	1	0.65	0.2	2.3	.04	0
PU8 ab Hunting Cr	1	0.65	0.2	2.3	.04	0
PU6 at Hunting Cr	1	0.65	0.2	2.3	.04	0

Cow Creek Basin



HEC-GeoHMS Subbasin Delineation

Cow Creek

The Cow Creek HMS model consists of a 425 square mile basin located in the northeast portion of the Sacramento Watershed above the confluence with the Sacramento River near Millville, CA. The model is included as part of the MidSac_East HMS Project and the basin is divided into 8 subbasins and connected with 5 routing reaches. One observed hydrograph, Cow Creek near Millville, CA (11374000), was used to calibrate this model. The computed peak flow at the basin outlet for the 1997 event was larger than the 1995 event (25,082 cfs vs. 22,008 cfs).

Using the adopted TC and R (Group 1) and Muskingum parameters, the computed hydrograph for the 1997 event matched the timing of the multiple peaked observed hydrograph. The initial losses for the 1995 and 1997 events were low, but the constant loss rates were close to or within the modeling guidelines. The baseflow parameters for both events were within the modeling guidelines.

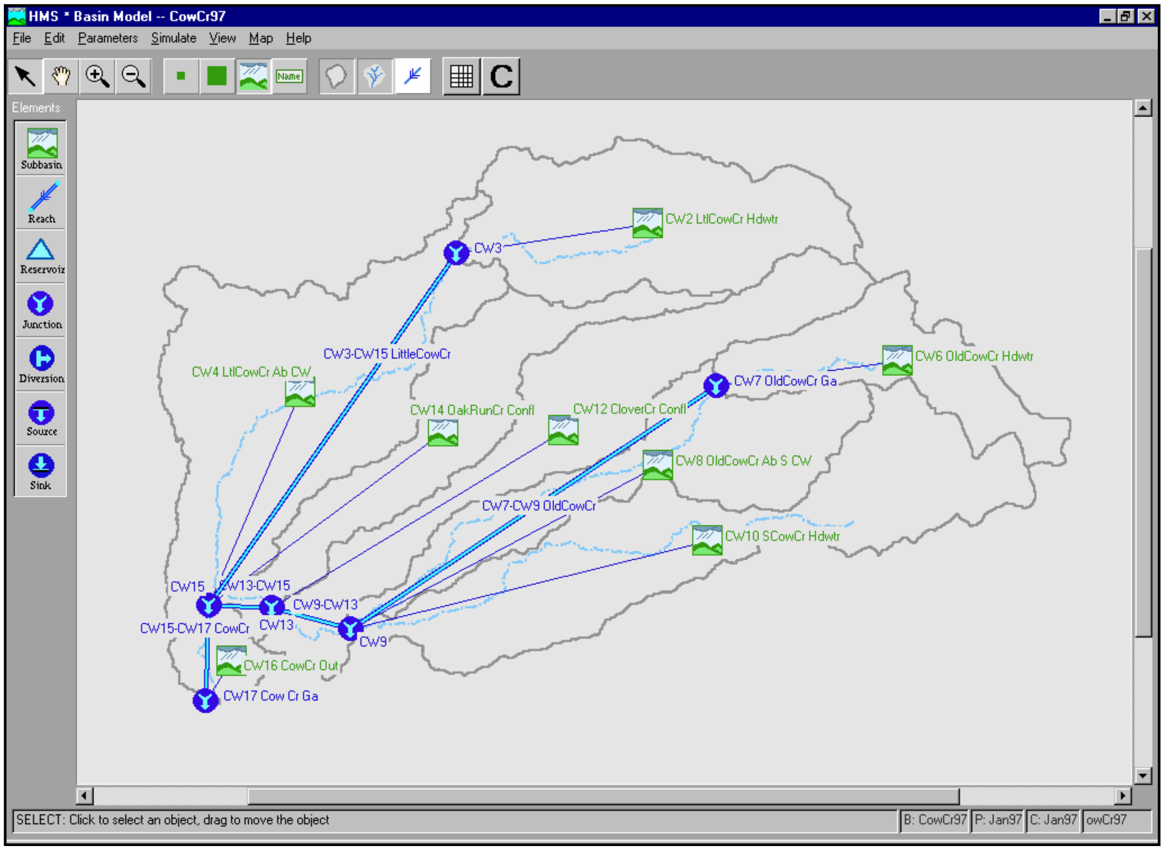
<u>Calibration of the 1995 Event:</u>

The calibration of the 1995 event was not without its challenges. While the initial computed peak matched the observed peak very closely, the observed hydrograph had a secondary peak on March 15, which was not matched by the computed hydrograph. In order to match the second peak, the modeling window should have been cropped around March 13th or 14th. Given that all the other basins had their peak flows reported around March 9th, the effort to calibrate to the peak on the 15th was not performed. Initial and constant loss rates of 0.075 inches and 0.12 inches/hour, respectively, were used. The baseflow values of 2.0 cfs per square mile, 0.8 and 0.2 for the initial flow, recession ratio, and the threshold flow, respectively, were also used to calibrate the model.

<u>Calibration of the 1997 Event:</u>

While the timing of the computed spikes match the timing of the observed spikes, the two hydrographs did not match. The initial spikes for the computed hydrograph were greater than the observed hydrograph, but the peak flow of the observed hydrograph far exceeded the peak of the computed hydrograph. Additionally, the peak of the observed hydrograph occurred on January 2, 1997 even though the peak precipitation fell on or before January 1, 1997. The computed hydrograph shows the main peak falling on January 1st which is consistent with the timing and amount of rainfall. Why the peak of the observed runoff is more than a day removed from the peak precipitation is unclear. The basin is not that large and the routing times are reasonable. One possible explanation may be that the initial precipitation fell as snowfall and was stored in the snowpack until the temperatures warmed enough to melt the snow and release the volume of runoff necessary to generate the peak flow witnessed by the observed gage. A thorough review of the snowmelt model would have to be performed to determine what might have happened. Initial and constant loss rates of 0.4 inches and 0.06 inches/hour, respectively, were used. The baseflow values of 2.0 cfs per square mile, 0.8 and 0.2 for the initial flow, recession ratio, and the threshold flow, respectively, were also used to calibrate the model.

Cow Creek Basin HEC-HMS Model Schematic



Cow Creek Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Initial TC $1.4(LL_{CA}/S^{1/2})^{.33}$ (Hr)	Initial R 1.5 TC (cfs/Hr)	Regression TC $0.68(LL_{CA}/S^{1/2})^{.46}$ (Hr)	Regression R 1.5 TC (cfs/Hr)
CW10 SCowCr Hdwtr	78.88	31.23	16.88	195.36	37.72	4.6	7.0	3.6	5.4
CW8 OldCowCr Ab S CW	48.03	25.26	15.02	174.24	28.74	4.2	6.4	3.2	4.8
CW12 CloverCr Confl	61.52	31.20	13.18	195.36	29.43	4.3	6.4	3.2	4.8
CW6 OldCowCr Hdwtr	32.59	16.79	7.82	269.28	8.00	2.8	4.2	1.8	2.7
CW2 LtlCowCr Hdwtr	60.79	19.00	9.35	290.40	10.43	3.0	4.6	2.0	3.0
CW14 OakRunCr Confl	44.42	28.08	12.73	142.56	29.95	4.3	6.4	3.2	4.9
CW4 LtlCowCr Ab CW	88.61	23.61	10.16	73.92	27.91	4.2	6.3	3.1	4.7
CW16 CowCr Out	10.57	5.95	2.74	36.96	2.69	1.9	2.9	1.1	1.6

Cow Creek Reach Parameters

Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Ave Reach Vel $80\ S_R^{1/2}$ V_R (fps)	Initial K $1.47\ L_R / 1.5V_R$ K (Hr)	Musk X or LAG (Min)	N steps Time Step= 60
CW3-CW15 LittleCowCr	20.38	0.0068	6.60	3.0	0.37	2
CW15-CW5	3.14	0.0025	4.00	1.0	0.4	1
CW7-CW9 OldCowCr	19.25	0.0188	10.97	1.7	0.4	2
CW9-CW13	4.38	0.0037	4.87	1.0	0.4	1
CW15-CW17 CowCr	4.35	0.0017	3.30	1.3	0.4	2

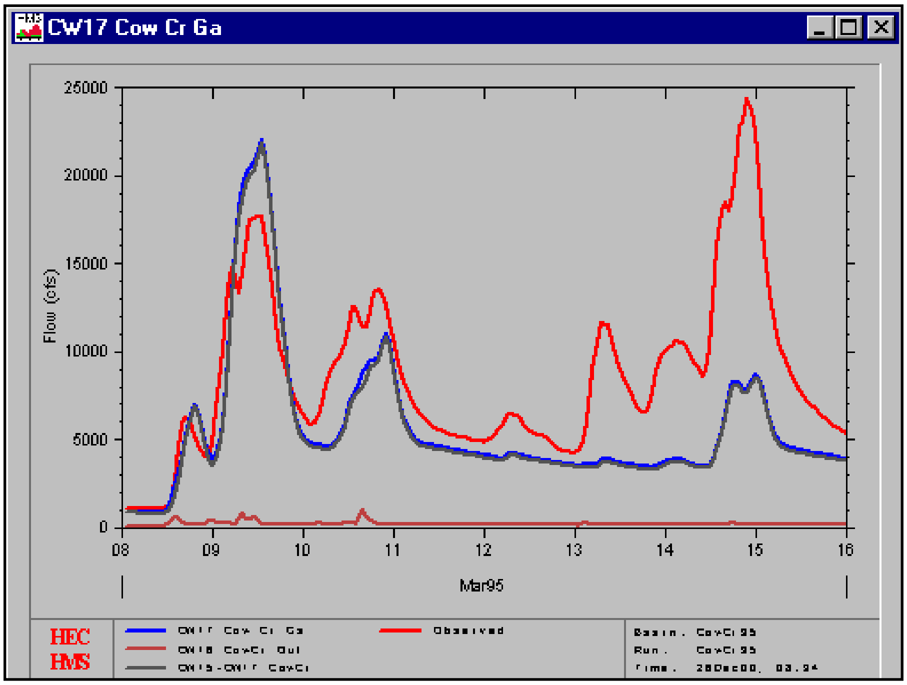
HEC-HMS Summary of Results
Cow Creek Basin: March 1995 Event

Project : MidSac_East   Run Name : CowCr95

Start of Run	: 08Mar95 0100	Basin Model	:	CowCr95
End of Run	: 15Mar95 2400	Met. Model	:	Mar95
Execution Time	: 31May00 1301	Control Specs.	:	Mar95

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
CW6 OldCowCr Hdwtr	2244.3	09 Mar 95 0900	8273.3	32.591
CW7 OldCowCr Ga	2244.3	09 Mar 95 0900	8273.3	32.591
CW7-CW9 OldCowCr	2181.0	09 Mar 95 1100	8231.3	32.591
CW8 OldCowCr Ab S CW	2218.7	09 Mar 95 1100	7916.5	48.026
CW10 SCowCr Hdwtr	3534.5	09 Mar 95 1100	11991	78.879
CW9	7934.2	09 Mar 95 1100	28139	159.496
CW9-CW13	7871.1	09 Mar 95 1200	28067	159.496
CW12 CloverCr Confl	3045.0	09 Mar 95 1000	12095	61.520
CW13	10604	09 Mar 95 1200	40162	221.016
CW13-CW15	10553	09 Mar 95 1300	40056	221.016
CW2 LtlCowCr Hdwtr	4415.5	09 Mar 95 0500	19946	60.792
CW3	4415.5	09 Mar 95 0500	19946	60.792
CW3-CW15 LittleCowCr	4296.9	09 Mar 95 0700	19792	60.792
CW4 LtlCowCr Ab CW	5889.8	09 Mar 95 1100	20299	88.610
CW14 OakRunCr Confl	2243.1	09 Mar 95 1100	8566.0	44.421
CW15	21808	09 Mar 95 1200	88712	414.839
CW15-CW17 CowCr	21791	09 Mar 95 1300	88398	414.839
CW16 CowCr Out	966.95	10 Mar 95 1600	2967.3	10.570
CW17 Cow Cr Ga	22008	09 Mar 95 1300	91366	425.409

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Cow Creek Basin
March 1995 Event



CW17 – Cow Creek Gage

HEC-HMS Subbasin Parameters
Cow Creek Basin: March 1995 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
CW10 SCowCr Hdwtr	2	0.8	0.2	.075	.12	0
CW8 OldCowCr Ab S CW	2	0.8	0.2	.075	.12	0
CW12 CloverCr Confl	2	0.8	0.2	.075	.12	0
CW6 OldCowCr Hdwtr	2	0.8	0.2	.075	.12	0
CW2 LtlCowCr Hdwtr	2	0.8	0.2	.075	.12	0
CW14 OakRunCr Confl	2	0.8	0.2	.075	.12	0
CW4 LtlCowCr Ab CW	2	0.8	0.2	.075	.12	0
CW16 CowCr Out	2	0.8	0.2	.075	.12	0

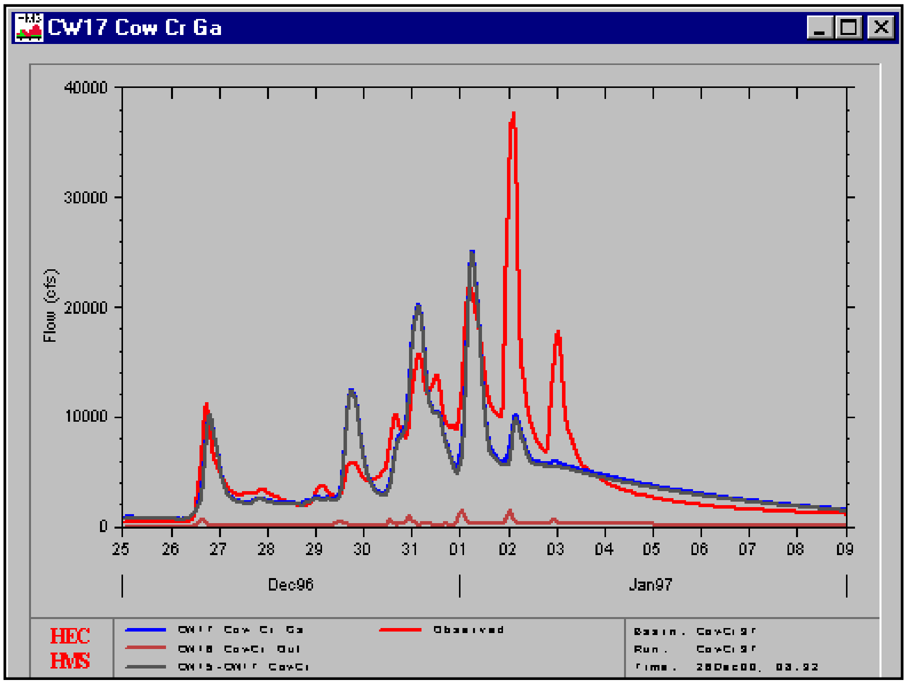
HEC-HMS Summary of Results
Cow Creek Basin: December 1996 - January 1997 Event

Project : MidSac_East   Run Name : CowCr97

Start of Run	: 25Dec96	0100	Basin Model	:	CowCr97
End of Run	: 08Jan97	2400	Met. Model	:	Jan97
Execution Time	: 31May00	1302	Control Specs.	:	Jan97

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
CW6 OldCowCr Hdwtr	3348.5	01 Jan 97 0200	14473	32.591
CW7 OldCowCr Ga	3348.5	01 Jan 97 0200	14473	32.591
CW7-CW9 OldCowCr	3215.8	01 Jan 97 0400	14461	32.591
CW8 OldCowCr Ab S CW	2562.2	01 Jan 97 0400	12819	48.026
CW10 SCowCr Hdwtr	3863.8	01 Jan 97 0400	20222	78.879
CW9	9641.9	01 Jan 97 0400	47502	159.496
CW9-CW13	9452.7	01 Jan 97 0500	47492	159.496
CW12 CloverCr Confl	3659.0	01 Jan 97 0300	17893	61.520
CW13	12662	01 Jan 97 0500	65384	221.016
CW13-CW15	12485	01 Jan 97 0600	65368	221.016
CW2 LtlCowCr Hdwtr	6903.7	01 Jan 97 0200	28828	60.792
CW3	6903.7	01 Jan 97 0200	28828	60.792
CW3-CW15 LittleCowCr	6144.6	01 Jan 97 0500	28779	60.792
CW4 LtlCowCr Ab CW	6221.8	01 Jan 97 0300	28449	88.610
CW14 OakRunCr Confl	2801.7	01 Jan 97 0300	13099	44.421
CW15	25258	01 Jan 97 0500	135695	414.839
CW15-CW17 CowCr	24800	01 Jan 97 0600	135629	414.839
CW16 CowCr Out	1458.8	02 Jan 97 0100	5734.0	10.570
CW17 Cow Cr Ga	25082	01 Jan 97 0600	141363	425.409

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Cow Creek River Basin
December 1996 - January 1997 Event

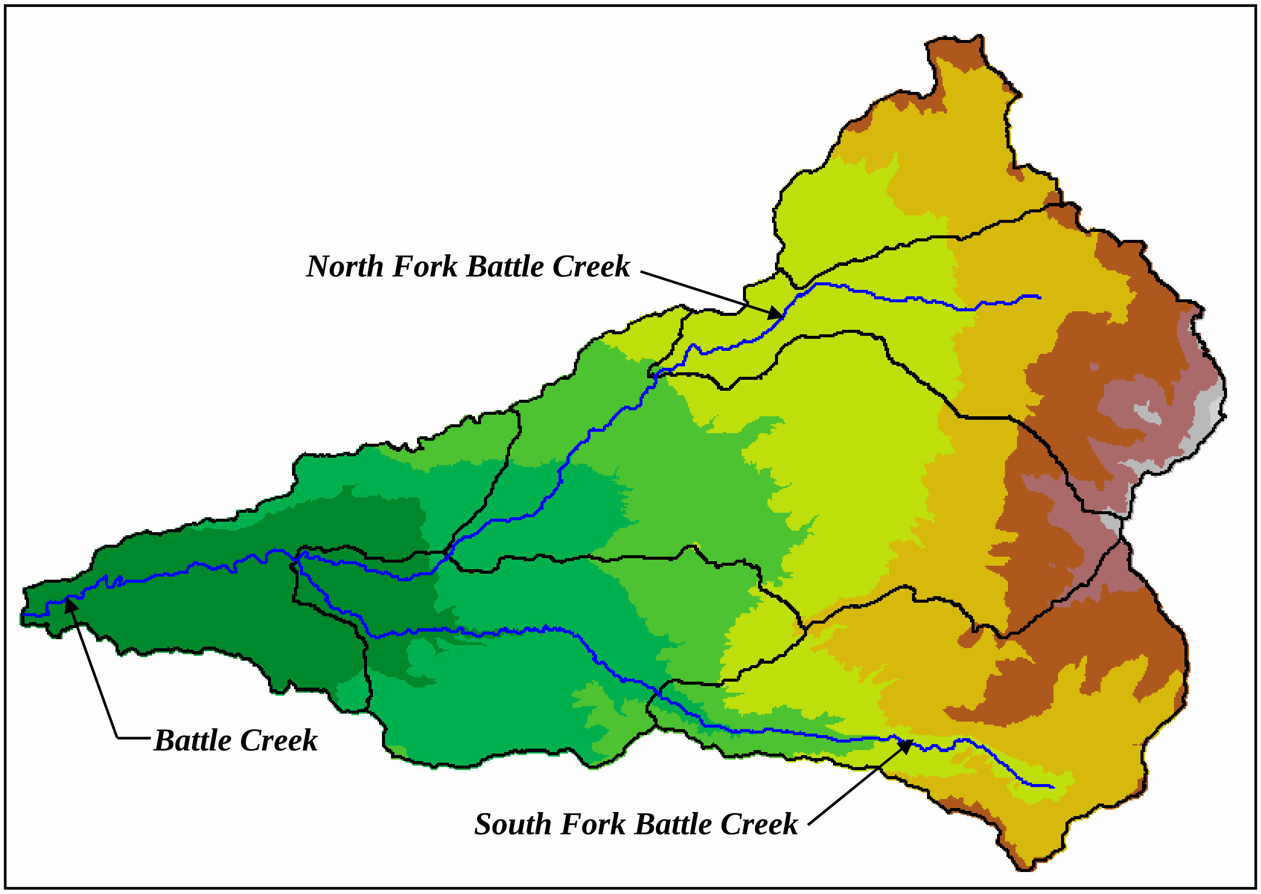


CW17 – Cow Creek Gage

HEC-HMS Subbasin Parameters
Cow Creek Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
CW10 SCowCr Hdwtr	2	0.8	0.2	0.4	.06	0
CW8 OldCowCr Ab S CW	2	0.8	0.2	0.4	.06	0
CW12 CloverCr Confl	2	0.8	0.2	0.4	.06	0
CW6 OldCowCr Hdwtr	2	0.8	0.2	0.4	.06	0
CW2 LtlCowCr Hdwtr	2	0.8	0.2	0.4	.06	0
CW14 OakRunCr Confl	2	0.8	0.2	0.4	.06	0
CW4 LtlCowCr Ab CW	2	0.8	0.2	0.4	.06	0
CW16 CowCr Out	2	0.8	0.2	0.4	.06	0

Battle Creek Basin



HEC-GeoHMS Subbasin Delineation

Battle Creek

The Battle Creek HMS model consists of a 362 square mile basin located in the northeast portion of the Sacramento Watershed, below the Cow Creek basin and above the confluence with the Sacramento River near Cottonwood, CA. The model is included as part of the MidSac_East HMS Project and the basin is divided into 6 subbasins and connected with 5 routing reaches. One observed hydrograph, Battle Creek below Coleman Fish Hatchery (11376550), was used to calibrate this model. The computed peak flow at the basin outlet for the 1997 event was larger than the 1995 event (17,474 cfs vs 10,762 cfs).

Using the adopted TC and R (Group 1) and Muskingum parameters, the computed hydrographs for both events matched the observed hydrographs very well. The initial loss for the 1997 event was somewhat low, but the constant loss rate was within the model guidance.

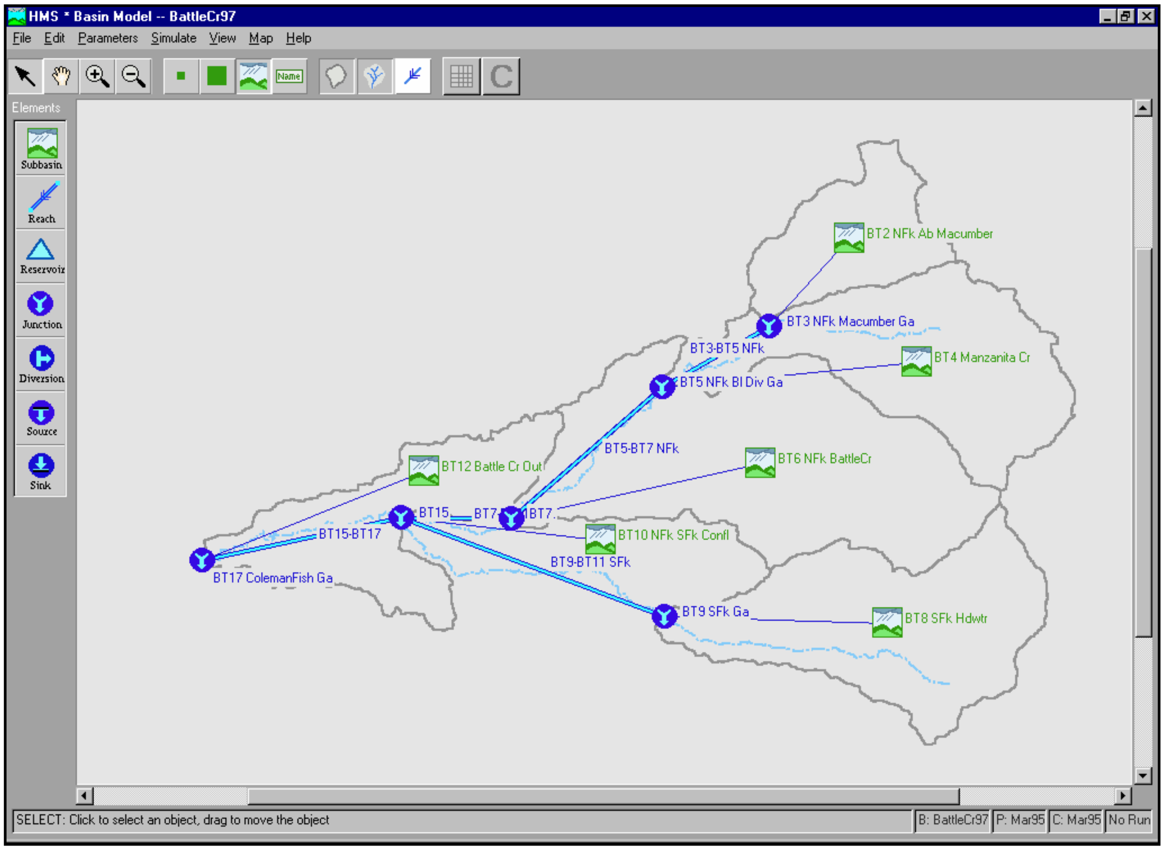
Calibration of the 1995 Event:

The observed and computed peak flows were very close; however, subsequent peaks were not. It appears that the constant loss rate may have been too great as the observed hydrograph exceeds the computed hydrograph for the period after the peak flow. Initial and constant loss rates of 2.5 inches and 0.165 inches/hour, respectively, were used. The baseflow parameters were in the normal range for this study: 2.0 cfs per square mile for the initial baseflow, 0.8 for the recession ratio and 0.15 for the threshold flow peak ratio.

Calibration of the 1997 Event:

The computed and observed volume, timing, and peaks of this multiple peaked event matched very closely. Initial and constant loss rates of 1.1 inches and 0.065 inches/hour, respectively, were used. The baseflow parameters were in the normal range for this study: 2.0 cfs per square mile for the initial baseflow, 0.8 for the recession ratio and 0.15 for the threshold flow peak ratio.

Battle Creek Basin HEC-HMS Model Schematic



Battle Creek Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Initial TC $1.4(LL_{CA}/S^{1/2})^{.33}$ (Hr)	Initial R 1.5 TC (cfs/Hr)	Regression TC $0.68(LL_{CA}/S^{1/2})^{.46}$ (Hr)	Regression R 4.0 TC (cfs/Hr)
BT6 NFk BattleCr	98.79	23.77	13.08	322.08	17.33	3.6	5.4	2.5	10.1
BT10 NFk SFk Confl	59.14	19.53	9.12	211.20	12.26	3.2	4.8	2.2	8.6
BT12 Battle Cr Out	45.38	21.23	9.60	147.84	16.76	3.5	5.3	2.5	9.9
BT2 NFk Ab Macumber	28.44	11.80	5.24	237.60	4.01	2.2	3.3	1.3	5.2
BT4 Manzanita Cr	63.30	22.15	12.44	290.40	16.17	3.5	5.3	2.4	9.8
BT8 SFk Hdwtr	66.71	22.43	10.47	285.12	13.91	3.3	5.0	2.3	9.1

Battle Creek Reach Parameters

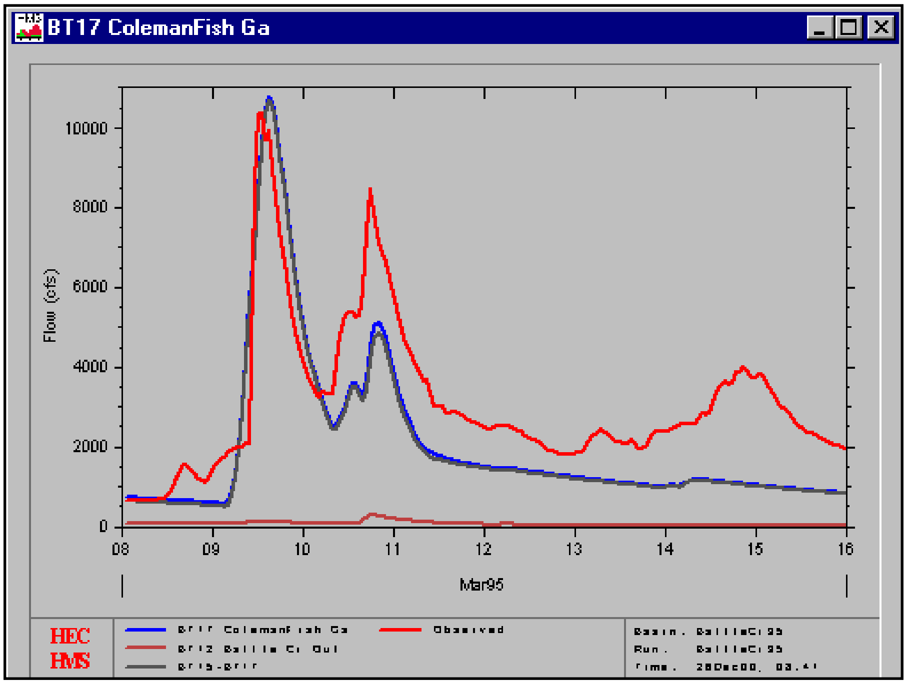
Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Ave Reach Vel $80\ S_R^{1/2}$ V_R (fps)	Initial K $1.47\ L_R / 1.5V_R$ K (Hr)	Musk X or LAG (Min)	N steps Time Step= 60
BT5-BT7 NFk	9.30	0.0432	16.63	1.0	0.4	1
BT7-BT11 NFk	5.41	0.0227	12.05	0.4	24	--
BT15-BT17	10.87	0.0073	6.84	1.6	0.4	1
BT9-BT11 SFk	14.07	0.0155	9.96	1.4	0.4	1
BT3-BT5 NFk	5.84	0.0140	9.47	1.0	0.4	1

HEC-HMS Summary of Results
Battle Creek Basin: March 1995 Event

Project	: MidSac_East		Run Name	: BattleCr95	
Start of Run	: 08Mar95	0100	Basin Model	:	BattleCr95
End of Run	: 15Mar95	2400	Met. Model	:	Mar95
Execution Time	: 31May00	1303	Control Specs.	:	Mar95

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
BT2 NFk Ab Macumber	749.77	09 Mar 95 1200	1748.6	28.443
BT3 NFk Macumber Ga	749.77	09 Mar 95 1200	1748.6	28.443
BT3-BT5 NFk	737.56	09 Mar 95 1300	1750.1	28.443
BT4 Manzanita Cr 1	336.0	09 Mar 95 1200	3629.1	63.300
BT5 NFk Bl Div Ga	2062.9	09 Mar 95 1300	5379.2	91.743
BT5-BT7 NFk	2043.5	09 Mar 95 1400	5385.4	91.743
BT6 NFk BattleCr	2522.8	09 Mar 95 1300	7483.3	98.792
BT7	4536.9	09 Mar 95 1300	12869	190.535
BT7-BT11 NFk	4476.3	09 Mar 95 1400	12873	190.535
BT8 SFk Hdwtr	5950.1	09 Mar 95 1200	16838	66.713
BT9 SFk Ga	5950.1	09 Mar 95 1200	16838	66.713
BT9-BT11 SFk	5851.6	09 Mar 95 1300	16796	66.713
BT10 NFk SFk Confl	595.06	10 Mar 95 1800	2002.1	59.143
BT15	10750	09 Mar 95 1300	31671	316.391
BT15-BT17	10645	09 Mar 95 1500	31648	316.391
BT12 Battle Cr Out	310.73	10 Mar 95 1800	1075.8	45.384
BT17 ColemanFish Ga	10762	09 Mar 95 1500	32724	361.775

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Battle Creek Basin
March 1995 Event



BT17 - Battle Creek Below Coleman Fish Hatchery Gage

HEC-HMS Subbasin Parameters
Battle Creek Basin: March 1995 Event

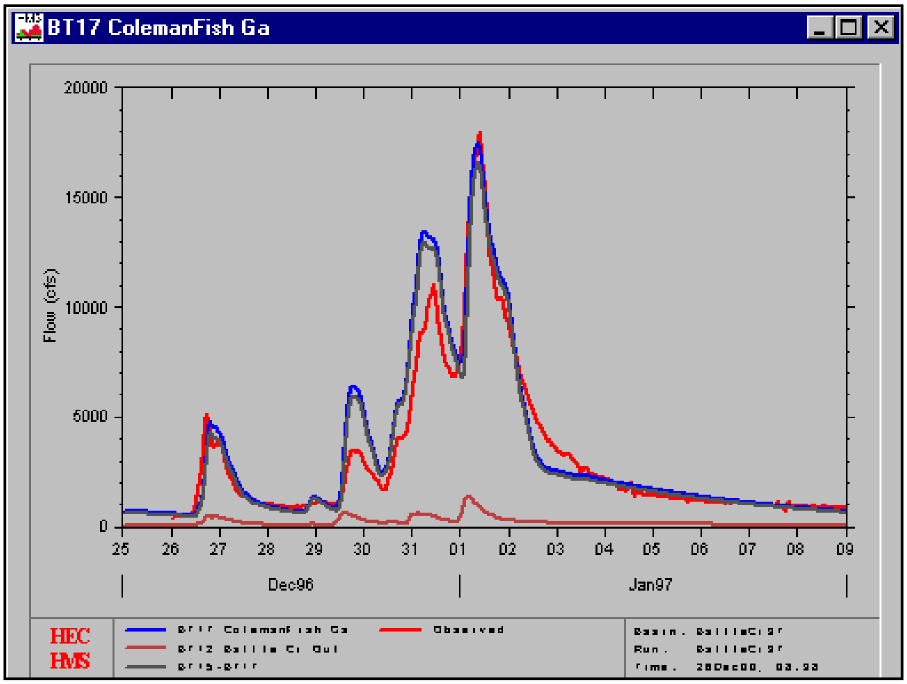
Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
BT6 NFk BattleCr	2	0.8	0.15	2.5	.165	0
BT10 NFk SFk Confl	2	0.8	0.15	2.5	.165	0
BT12 Battle Cr Out	2	0.8	0.15	2.5	.165	0
BT2 NFk Ab Macumber	2	0.8	0.15	2.5	.165	0
BT4 Manzanita Cr	2	0.8	0.15	2.5	.165	0
BT8 SFk Hdwtr	2	0.8	0.15	2.5	.165	0

HEC-HMS Summary of Results
Battle Creek Basin: December 1996 - January 1997 Event

Project	: MidSac_East		Run Name	: BattleCr97	
Start of Run	: 25Dec96	0100	Basin Model	:	BattleCr97
End of Run	: 08Jan97	2400	Met. Model	:	Jan97
Execution Time	: 31May00	1303	Control Specs.	:	Jan97

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
BT2 NFk Ab Macumber	1846.9	01 Jan 97 0200	8080.2	28.443
BT3 NFk Macumber Ga	1846.9	01 Jan 97 0200	8080.2	28.443
BT3-BT5 NFk	1817.1	01 Jan 97 0500	8080.1	28.443
BT4 Manzanita Cr	3706.5	01 Jan 97 0700	18758	63.300
BT5 NFk Bl Div Ga	5397.8	01 Jan 97 0700	26839	91.743
BT5-BT7 NFk	5367.6	01 Jan 97 0800	26838	91.743
BT6 NFk BattleCr	4209.1	01 Jan 97 0700	24732	98.792
BT7	9522.5	01 Jan 97 0700	51570	190.535
BT7-BT11 NFk	9465.4	01 Jan 97 0700	51571	190.535
BT8 SFk Hdwtr	5713.5	01 Jan 97 0800	32813	66.713
BT9 SFk Ga	5713.5	01 Jan 97 0800	32813	66.713
BT9-BT11 SFk	5687.6	01 Jan 97 0900	32805	66.713
BT10 NFk SFk Confl	1956.8	01 Jan 97 0500	9902.1	59.143
BT15	16645	01 Jan 97 0800	94278	316.391
BT15-BT17 1	6528	01 Jan 97 0900	94276	316.391
BT12 Battle Cr Out	1321.7	01 Jan 97 0400	5965.6	45.384
BT17 ColemanFish Ga	17474	01 Jan 97 0900	100242	361.775

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Battle Creek Basin
December 1996 - January 1997 Event

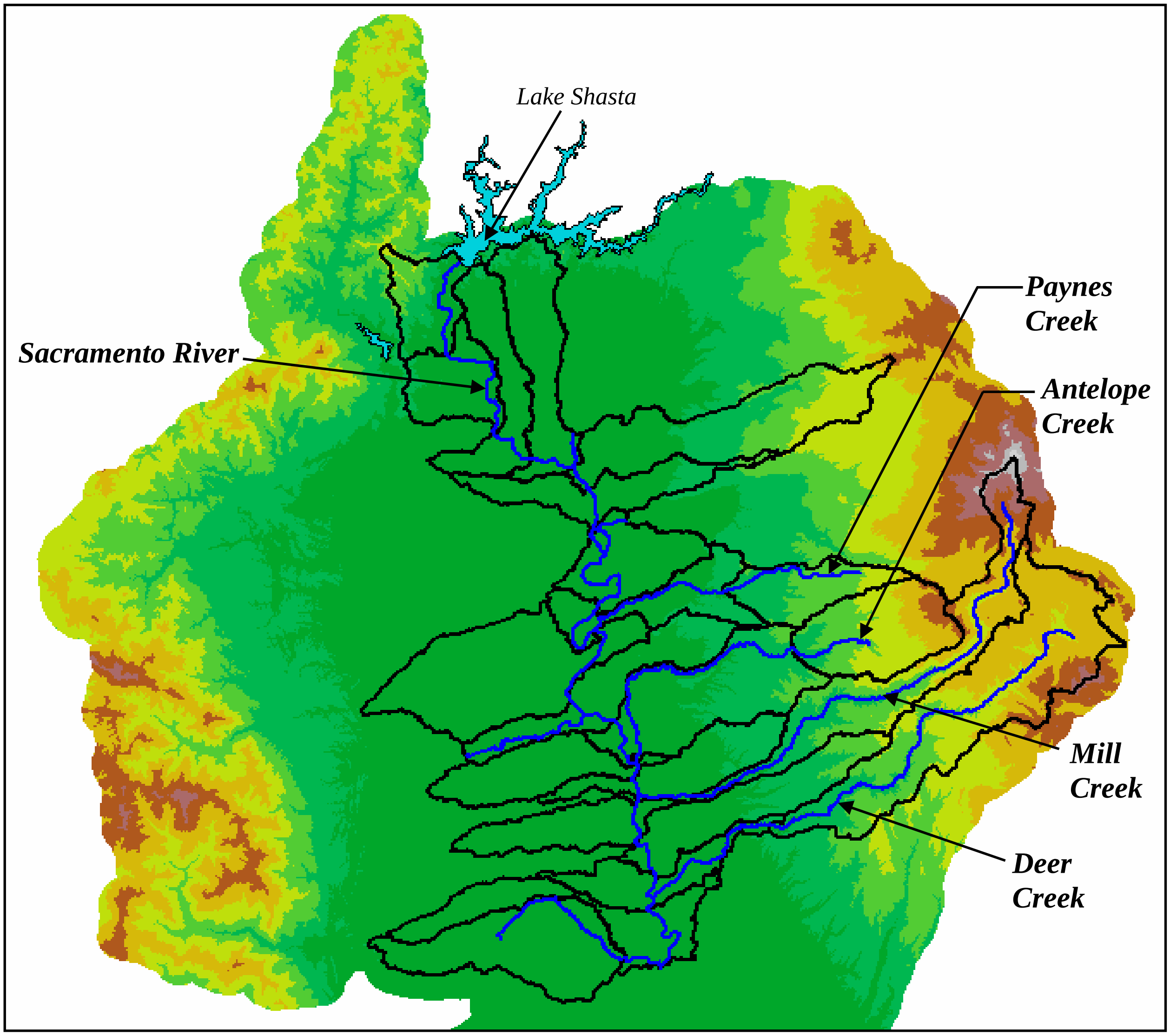


BT17 – Battle Creek Below Coleman Fish Hatchery Gage

HEC-HMS Subbasin Parameters
Battle Creek Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
BT6 NFk BattleCr	2	0.8	0.15	1.1	.065	0
BT10 NFk SFk Confl	2	0.8	0.15	1.1	.065	0
BT12 Battle Cr Out	2	0.8	0.15	1.1	.065	0
BT2 NFk Ab Macumber	2	0.8	0.15	1.1	.065	0
BT4 Manzanita Cr	2	0.8	0.15	1.1	.065	0
BT8 SFk Hdwtr	2	0.8	0.15	1.1	.065	0

Middle Sacramento River (Valley) Basin



HEC-GeoHMS Subbasin Delineation

Middle Sacramento River Valley

The Middle Sacramento River Valley HMS model consists of a 1,872 square mile basin located in the Sacramento Watershed and extends from the Shasta Reservoir outflow, below the Vina Bridge near Hamilton City, CA to the confluence with Burch Creek. Burch Creek enters the Sacramento River just above the Sacramento River and Stony Creek confluence. The basin model is divided into 22 subbasins and connected with 30 routing reaches. Eight sources are used to introduce upstream flows into the model. Since this model is a valley model, the results from the upstream HMS models, or gaged information, were used as inflow sources into the valley model. The eight sources were: 1.) Upper Sacramento below Shasta; 2.) Clear Creek; 3.) Cottonwood Creek; 4.) Red Bank Creek; 5.) Elder Creek; 6.) Thomes Creek; 7.) Cow Creek; and 8.) Battle Creek. The observed hydrographs used to calibrate this model were: Sacramento River at Keswick Reservoir (11370500); Sacramento River at Bend Bridge near Red Bluff (11377100); Sacramento River at Vina Bridge near Corning, CA (11383730); Mill Creek near Los Molinos (11381500); and Deer Creek near Vina (11383500). The computed peak flow at the downstream end of the basin model for the 1997 event was larger than the 1995 event (152,464 cfs vs. 123,318 cfs).

Using the adopted TC and R (Group 1) the computed hydrographs on the Sacramento River matched the observed hydrographs for the 1997 event reasonably well and the 1995 event adequately. However, for the headwater hydrographs (11381500 and 11383500) this was not true. Even with the losses reduced to minimal values, the computed volumes and peaks for the two events could not match the observed hydrographs.

The Muskingum routing approach was adjusted significantly for this model. Rather than use the general equation to compute the Muskingum routing values, the Sacramento District's Hydrology and Hydraulics group provided average velocities for the Sacramento River through the basin model. These velocities were used along with the routing reach lengths to develop the travel time (Muskingum K) for each reach. The Muskingum X was still set to 0.4, while the number of steps was approximated by dividing the Muskingum K by the one-hour time step. The timing of the observed and computed hydrographs matched well when using this method.

For this modeling effort, rather than attempt to predict how the Keswick Reservoir was operated, the source and sink tools available in HMS were implemented. This technique allowed the observed hydrograph at the outlet of the Keswick Reservoir to be passed downstream. As pointed out in "Section 6.6.5, Reservoir Modeling" of the main report, HMS is fairly limited in how it models releases from reservoirs. Of course, the computed hydrograph at Keswick matched the observed well because a source was used as the inflow to the subbasin.

The initial and constant losses were reasonable for the 1997 event. To approximate the shape and volume of the observed hydrographs, the losses for the 1995 event were set very low. Baseflow for both events was set within the modeling guidelines.

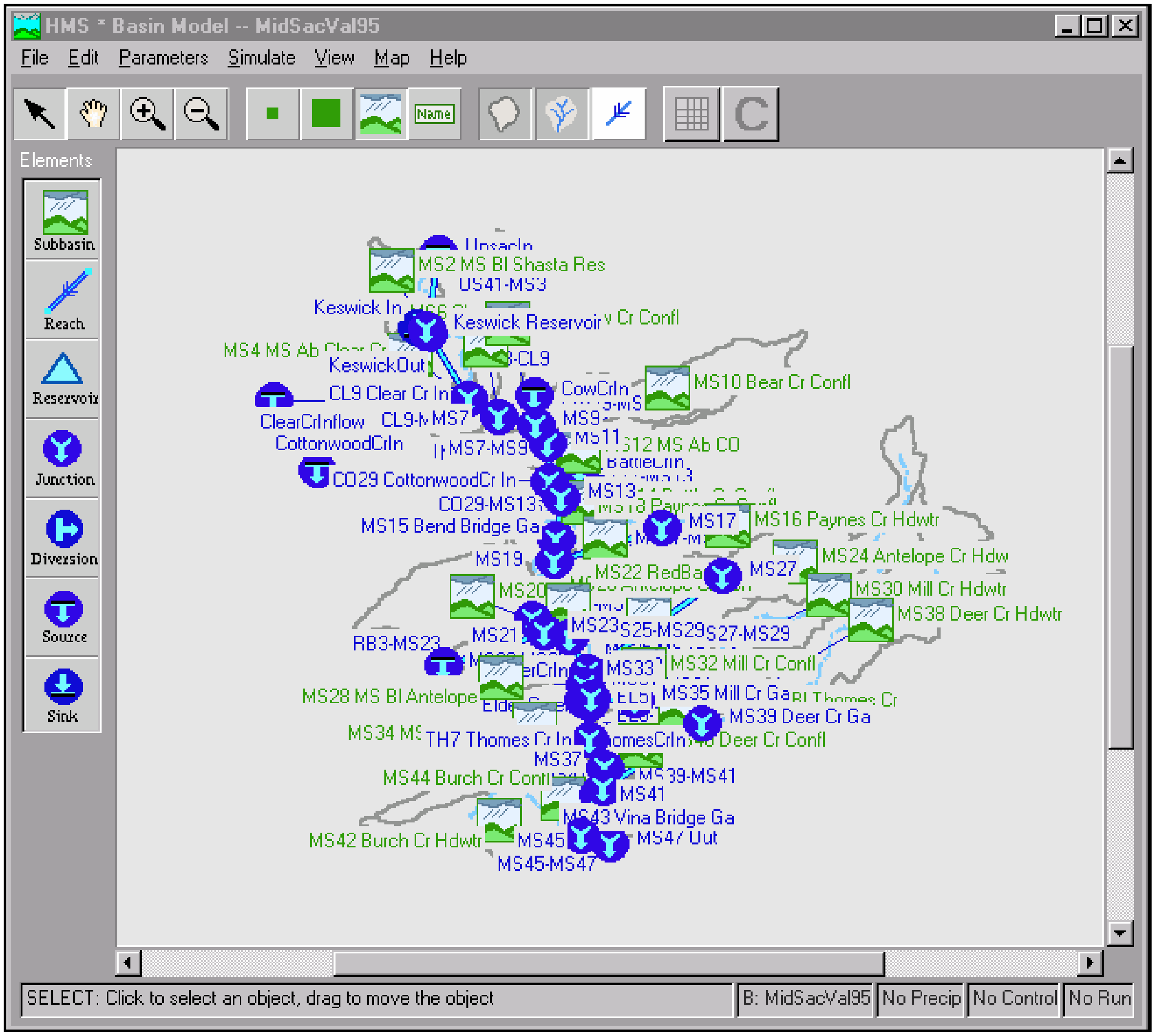
Calibration of the 1995 Event:

As expected, the observed and computed hydrographs for the Keswick Reservoir matched reasonably well. Since it is just downstream (one reach length from a source) it is a bit puzzling that the computed and observed volumes are not closer. The hydrograph at the Bend Bridge gage was also missing some volume. The multiple peaks, timing, and shape were all very close to the observed hydrograph, but some volume was missing. The missing volume would not have been due to the missing volume at the Keswick Reservoir gage because the observed outflow from Keswick was used as a source to route the outflow hydrograph downstream. The computed hydrograph at the Vina Bridge gage had the same shape as the observed hydrograph too, but, again, volume was missing as well. Part of the missing volume may be attributed to the fact that several of the major headwater streams, Mill Creek and Deer Creek, did not contribute as much flow as observed. For the headwater hydrographs (11381500 and 11383500), even with the losses reduced to minimal values, the computed volumes and peaks did not match the observed hydrographs. These reduced flows were then passed downstream, thus leading to the volume problem at the Vina Bridge. To check this theory, the two observed hydrographs were then inserted as sources into the model. The extra volume was noticeable at the Vina Bridge gage, but even this extra contribution was not sufficient. The thought was that the LWASS was not large enough to generate the observed volumes; not only for the two headwater hydrographs (Mill Creek and Deer Creek), but perhaps for some other headwater subbasins as well. The LWASS issue has been a problem in other basins as well. The timing at the Vina Bridge gage appeared to be consistent with the observed hydrograph, but the volume and peak were not. Initial and constant loss rates of 0.1 inches and 0.001 inches/hour, respectively, were used. The baseflow values of 2.0 cfs per square mile, 0.8 and 0.2 for the initial flow, recession ratio, and the threshold flow, respectively, were also used to calibrate the model.

Calibration of the 1997 Event:

As expected, the observed and computed hydrographs for the Keswick Reservoir matched very well. It is just downstream (one reach length from a source) so it was not difficult to match that hydrograph. The hydrograph at the Bend Bridge gage also matched very well. The multiple peaks, timing, shape and volume were all very close to the observed hydrograph. The computed hydrograph at the Vina Bridge gage was reasonably close to the observed values, but some of the volume was missing. It is suspected that the loss of volume can be attributed to the fact that several of the major headwater streams (Mill Creek and Deer Creek) did not contribute as much flow as observed. For the headwater hydrographs (11381500 and 11383500), even with the losses reduced to minimal values, the computed volumes and peaks did not match the observed hydrographs. These reduced flows were then passed downstream thus leading to the volume problem at the Vina Bridge. To check this theory, the two observed hydrographs were then inserted as sources into the model. The extra volume was noticeable at the Vina Bridge gage, but even this extra contribution was not sufficient. The thought was that the LWASS was not large enough to generate the observed volumes; not only for the two headwater hydrographs (Mill Creek and Deer Creek), but perhaps for some other headwater subbasins as well. The LWASS issue has been a problem in other basins as well. The timing at the Vina Bridge gage appeared to be consistent with the observed hydrograph, but the volume and peak were not. Initial and constant loss rates of 1.5 inches and 0.01 inches/hour, respectively, were used. The baseflow values of 2.0 cfs per square mile, 0.8 and 0.2 for the initial flow, recession ratio, and the threshold flow, respectively, were also used to calibrate the model.

Middle Sacramento River (Valley Floor) HEC-HMS Schematic



Middle Sacramento River (Valley Floor) Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Initial TC $1.4(LL_{CA}/S^{1/2})^{.33}$ (Hr)	Initial R 1.5 TC (cfs/Hr)	Regression TC $0.68(LL_{CA}/S^{1/2})^{.46}$ (Hr)	Regression R 4.0 TC (cfs/Hr)
MS10 Bear Cr Confl	126.13	40.07	19.79	158.400	63.00	5.5	8.2	4.6	18.3
MS4 MS Ab Clear Cr	51.64	16.76	11.37	95.040	19.54	3.7	5.6	2.7	10.7
MS6 Churn Cr Confl	64.49	22.02	9.06	73.920	23.22	4.0	5.9	2.9	11.6
MS8 Cow Cr Confl	82.21	27.02	13.70	68.640	44.69	4.9	7.4	3.9	15.6
MS12 MS Ab CO	60.49	25.71	4.82	121.440	11.24	3.1	4.7	2.1	8.3
MS40 Deer Cr Confl	48.31	19.52	2.86	89.760	5.89	2.5	3.8	1.5	6.2
MS14 Battle Cr Confl	62.89	18.18	4.38	26.400	15.49	3.5	5.2	2.4	9.6
MS18 Paynes Cr Confl	60.03	20.16	7.67	110.880	14.68	3.4	5.1	2.3	9.4
MS24 Antelope Cr Hdw	87.60	19.11	8.04	258.720	9.55	2.9	4.4	1.9	7.7
MS20 Reeds Cr Confl	144.27	21.74	6.88	42.240	23.01	3.9	5.9	2.9	11.5
MS32 Mill Cr Confl	61.92	20.18	9.66	110.880	18.52	3.7	5.5	2.6	10.4
MS26 Antelope Cr Con	120.96	34.51	18.87	84.480	70.86	5.7	8.6	4.8	19.3
MS22 RedBankCr Confl	78.46	22.99	5.82	89.760	14.12	3.4	5.0	2.3	9.2
MS28 MS Bl Antelope	62.71	22.02	10.56	26.400	45.27	4.9	7.4	3.9	15.7
MS34 MS Bl Elder Cr	54.38	23.18	10.05	26.400	45.34	4.9	7.4	3.9	15.7
MS36 MS Bl Thomes Cr	83.61	29.54	13.85	126.720	36.34	4.6	6.9	3.6	14.2
MS44 Burch Cr Confl	76.10	36.21	11.98	26.400	84.44	6.1	9.1	5.2	20.9
MS42 Burch Cr Hdwtr	108.32	30.56	13.70	36.960	68.86	5.7	8.5	4.8	19.1
MS2 MS Bl Shasta Res	46.31	14.96	7.68	274.560	6.93	2.7	4.0	1.7	6.6
MS16 Paynes Cr Hdwtr	52.52	20.27	8.96	237.600	11.79	3.2	4.7	2.1	8.5
MS30 Mill Cr Hdwtr	130.54	57.43	28.81	174.240	125.34	6.9	10.3	6.3	25.1
MS38 Deer Cr Hdwtr	208.50	55.76	27.27	95.040	155.94	7.4	11.1	6.9	27.8

Middle Sacramento River (Valley Floor) Reach Parameters

Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Ave Reach Vel $80\ S_R^{1/2}$ V_R (fps)	Initial K $1.47\ L_R / 1.5V_R$ K (Hr)	Musk X or LAG (Min)	N steps Time Step= 60
MS3-CL9	40.14	0.0013	2.88	13.6	0.4	11
CL9-MS7	15.29	0.0008	2.26	6.6	0.4	6
CW29-MS9	11.01	0.0010	2.53	4.3	0.4	4
MS7-MS9	14.68	0.0008	2.26	6.4	0.4	6
MS9-MS11	8.39	0.0008	2.26	3.6	0.4	3
MS11-CO29	14.68	0.0008	2.26	6.4	0.4	6
CO29-MS13	6.89	0.0004	1.60	4.2	0.4	4
BT17-MS13	19.89	0.0026	4.08	4.8	0.4	4
MS17-MS19	50.64	0.0097	7.88	6.3	0.4	6
MS15-MS19	25.86	0.0007	2.12	12.0	0.4	10
MS19-MS21	27.07	0.0000	0.25	104.8	0.4	84
MS21-MS23	5.98	0.0000	0.25	23.2	0.4	19
MS23-MS25	9.61	0.0015	3.10	3.0	0.4	3
RB3-MS23	48.69	0.0025	4.00	11.9	0.4	10
MS27-MS29	99.62	0.0074	6.88	14.2	0.4	12
MS25-MS29	17.84	0.0003	1.39	12.6	0.4	11
MS29-MS31	5.73	0.0014	2.99	1.9	0.4	2
MS31-MS33	5.20	0.0008	2.26	2.3	0.4	2
MS35-MS33	17.36	0.0077	7.02	2.4	0.4	2
Elder Creek	0.52	0.0000	0.25	2.0	0.4	2
MS33-EL5	1.94	0.0000	0.08	23.7	0.4	19
EL5-TH7	14.86	0.0011	2.65	5.5	0.4	5
TH7-MS37	13.33	0.0002	1.13	11.5	0.4	10
MS37-MS41	9.07	0.0004	1.60	5.6	0.4	5
MS39-MS41	54.63	0.0059	6.14	8.7	0.4	7
MS45-MS47	13.06	0.0016	3.20	4.0	0.4	4
MS43-MS47	28.92	0.0003	1.39	20.5	0.4	17
US41-MS3	35.03	0.0017	3.30	10.4	0.4	9
MS13-MS15	37.87	0.0008	2.26	16.4	0.4	14
MS41-MS43	3.53	0.0006	1.96	1.8	0.4	2

HEC-HMS Summary of Results
Middle Sacramento River (Valley) Basin: March 1995 Event

Project	: MidSac_Valley		Run Name	: MidSacVal95	
Start of Run	: 08Mar95	0100	Basin Model	: MidSacVal95	
End of Run	: 15Mar95	2400	Met. Model	: Mar95	
Execution Time	: 31May00	1307	Control Specs.	: Mar95	

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
UpsacIn	67953	15 Mar 95 1500	453212	6421.000
US41-MS3	67953	15 Mar 95 1600	450633	6421.000
MS2 MS Bl Shasta Res	10000.0	08 Mar 95 0100	81686	46.313
Keswick Reservoir	69867	15 Mar 95 1600	532320	6467.313
Keswick In	69867	15 Mar 95 1600	532320	6467.313
MS42 Burch Cr Hdwtr	584.84	09 Mar 95 1500	4155.7	108.320
MS45	584.84	09 Mar 95 1500	4155.7	108.320
MS45-MS47	582.35	09 Mar 95 1700	4167.7	108.320
ElderCrIn	10508	09 Mar 95 1700	54362	140.000
Elder Creek	10499	09 Mar 95 1700	54347	140.000
RedBankCrIn	6948.5	09 Mar 95 1200	33680	93.500
RB3-MS23	6788.2	09 Mar 95 1600	33241	93.500
KeswickOut	71559	15 Mar 95 1900	628281	6468.000
MS3-CL9	71263	15 Mar 95 2300	607243	6468.000
ClearCrInflow	5370.0	10 Mar 95 1400	23812	251.100
MS4 MS Ab Clear Cr	1005.8	09 Mar 95 1200	5534.4	51.639
CL9 Clear Cr In	73909	15 Mar 95 2300	636590	6770.739
CL9-MS7	73756	15 Mar 95 2400	628086	6770.739
MS6 Churn Cr Confl	889.74	09 Mar 95 1300	4904.2	64.493
MS7	73910	15 Mar 95 2400	632990	6835.232
MS7-MS9	73313	15 Mar 95 2400	625096	6835.232
CowCrIn	24320	14 Mar 95 2200	136197	425.000
CW29-MS9	24104	14 Mar 95 2300	135797	425.000
MS8 Cow Cr Confl	2572.4	09 Mar 95 1400	14392	82.206
MS9	82988	14 Mar 95 2300	775285	7342.438
MS9-MS11	82859	14 Mar 95 2400	770488	7342.438
MS10 Bear Cr Confl	2520.5	09 Mar 95 1500	16231	126.129
MS11	83994	14 Mar 95 2400	786719	7468.567
MS11-CO29	83805	15 Mar 95 0100	778345	7468.567
CottonwoodCrIn	36700	09 Mar 95 1400	222988	944.700
MS12 MS Ab CO	2091.3	09 Mar 95 1100	11141	60.492

... Continued ...

HEC-HMS Summary of Results
Middle Sacramento River (Valley) Basin: March 1995 Event
(Continued)

Project : MidSac_Valley Run Name : MidSacVal95

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
CO29 CottonwoodCr In	111944	14 Mar 95 2300	1012473	8473.759
CO29-MS13	111758	14 Mar 95 2400	1007734	8473.759
BattleCrIn	10348	09 Mar 95 1300	49112	357.000
BT17-MS13	10197	09 Mar 95 1500	48906	357.000
MS13	115631	14 Mar 95 2400	1056640	8830.759
MS13-MS15	114974	15 Mar 95 0400	1031604	8830.759
MS14 Battle Cr Confl	1069.7	09 Mar 95 1200	5772.2	62.885
MS15 Bend Bridge Ga	115263	15 Mar 95 0400	1037376	8893.644
MS15-MS19	114970	15 Mar 95 0600	1021087	8893.644
MS16 Paynes Cr Hdwtr	1379.7	09 Mar 95 1200	6831.5	52.517
MS17	1379.7	09 Mar 95 1200	6831.5	52.517
MS17-MS19	1359.5	09 Mar 95 1700	6777.2	52.517
MS18 Paynes Cr Confl	408.50	09 Mar 95 1300	2361.4	60.029
MS19	115415	15 Mar 95 0600	1030226	9006.190
MS19-MS21	115091	15 Mar 95 0900	1013681	9006.190
MS20 Reeds Cr Confl	1292.5	09 Mar 95 1300	7409.2	144.271
MS21	115360	15 Mar 95 0900	1021090	9150.461
MS21-MS23	115155	15 Mar 95 0900	1017290	9150.461
MS23	116546	15 Mar 95 0900	1050532	9243.961
MS23-MS25	116538	15 Mar 95 1000	1044732	9243.961
MS22 RedBankCr Confl	234.37	09 Mar 95 1200	1646.1	78.459
JMS25-MS29	116584	15 Mar 95 1000	1046378	9322.420
MS25-MS29	116494	15 Mar 95 1200	1035299	9322.420
MS24 Antelope Cr Hdw	971.41	09 Mar 95 1200	4079.6	87.596
MS27	971.41	09 Mar 95 1200	4079.6	87.596
MS27-MS29	946.36	09 Mar 95 2200	4087.6	87.596
MS26 Antelope Cr Con	241.91	08 Mar 95 0100	1786.2	120.956
MS29	116738	15 Mar 95 1200	1041173	9530.972
MS29-MS31	116554	15 Mar 95 1300	1037194	9530.972
MS28 MS Bl Antelope	522.92	09 Mar 95 1400	3302.9	62.708
MS31	116658	15 Mar 95 1300	1040497	9593.680
MS31-MS33	116599	15 Mar 95 1300	1037141	9593.680
MS30 Mill Cr Hdwtr	1351.2	09 Mar 95 1800	8136.8	130.542
MS35 Mill Cr Ga	1351.2	09 Mar 95 1800	8136.8	130.542
MS35-MS33	1344.2	09 Mar 95 2000	8135.5	130.542
MS33	116950	15 Mar 95 1300	1045277	9724.222
MS33-EL5	116831	15 Mar 95 1300	1043919	9724.222
MS32 Mill Cr Confl	185.40	09 Mar 95 1100	1326.1	61.921

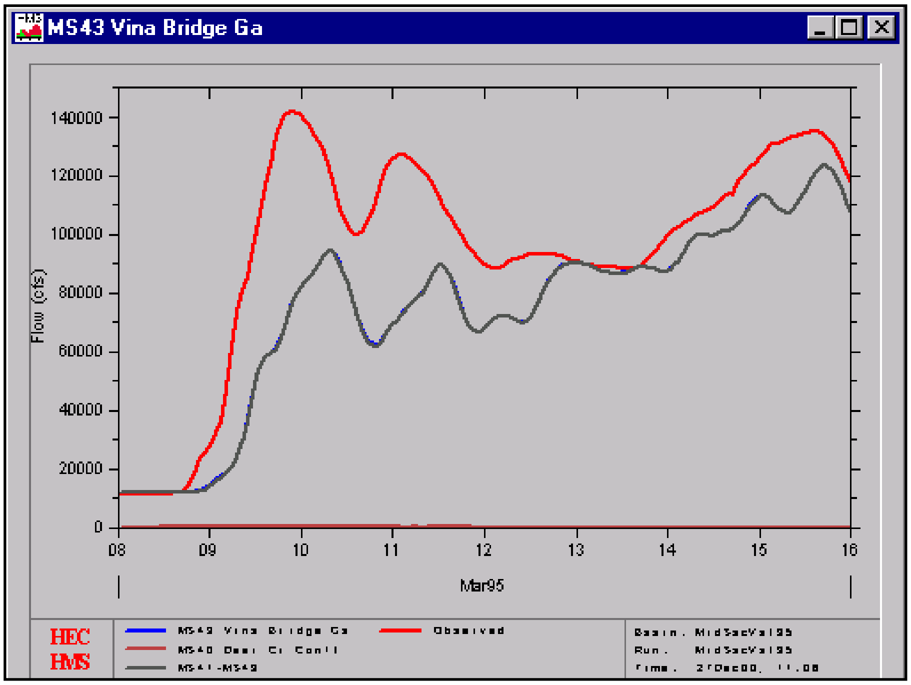
... Continued ...

HEC-HMS Summary of Results
Middle Sacramento River (Valley) Basin: March 1995 Event
(Continued)

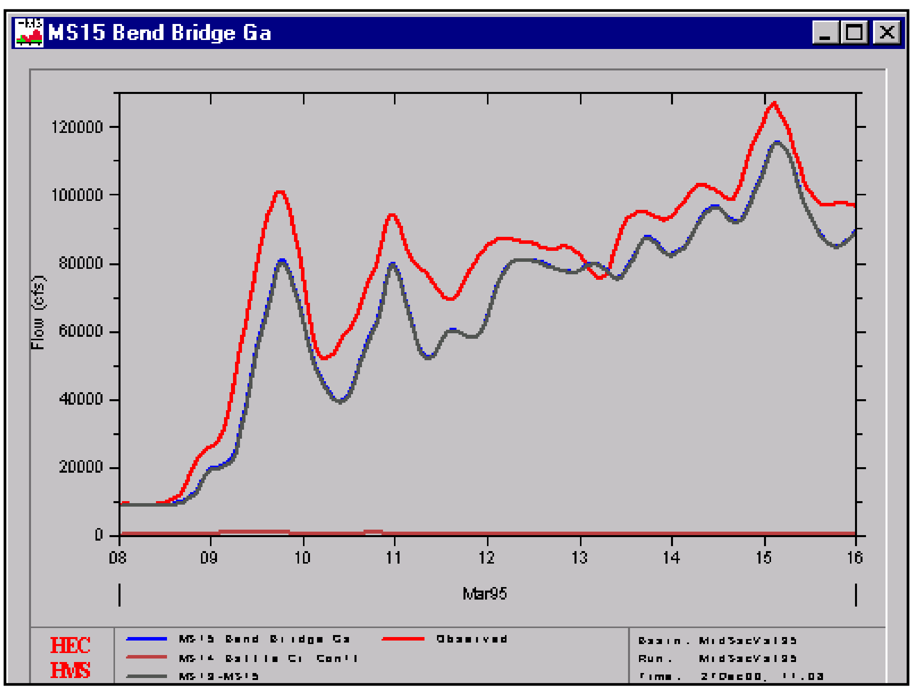
Project : MidSac_Valley Run Name : MidSacVal95

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
EL5	118961	15 Mar 95 1300	1099592	9926.143
EL5-TH7	118877	15 Mar 95 1500	1089063	9926.143
MS34 MS Bl Elder Cr	662.72	09 Mar 95 1400	4231.7	54.375
ThomesCrIn	19337	09 Mar 95 1100	80137	297.000
TH7 Thomes Cr In	122770	15 Mar 95 1500	1173432	10277.518
TH7-MS37	122640	15 Mar 95 1600	1163636	10277.518
MS36 MS Bl Thomes Cr	167.22	08 Mar 95 0100	1423.4	83.608
MS37	122673	15 Mar 95 1600	1165059	10361.126
MS37-MS41	122632	15 Mar 95 1700	1158087	10361.126
MS38 Deer Cr Hdwtr	2615.0	09 Mar 95 1900	17042	208.504
MS39 Deer Cr Ga	2615.0	09 Mar 95 1900	17042	208.504
MS39-MS41	2599.2	10 Mar 95 0100	16953	208.504
MS41	123383	15 Mar 95 1700	1175041	10569.630
MS41-MS43 1	23264	15 Mar 95 1700	1172647	10569.630
MS40 Deer Cr Confl	270.10	09 Mar 95 1100	1662.0	48.308
MS43 Vina Bridge Ga	123311	15 Mar 95 1700	1174309	10617.938
MS43-MS47	123098	15 Mar 95 2000	1151045	10617.938
MS44 Burch Cr Confl	581.00	09 Mar 95 1500	4209.5	76.097
MS47 Out	123318	15 Mar 95 2000	1159422	10802.355

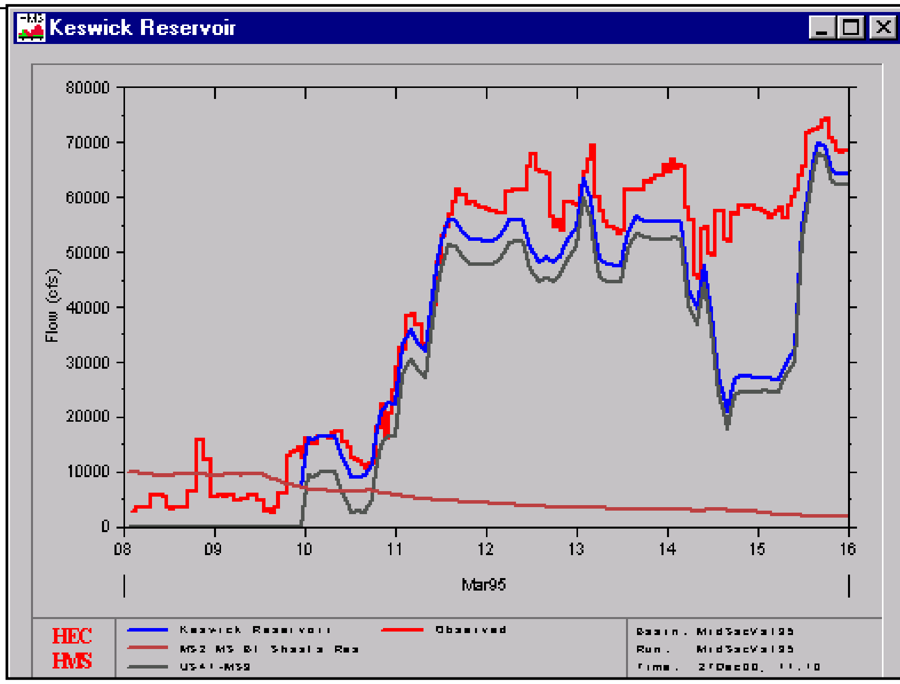
HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Middle Sacramento River (Valley) Basin
March 1995 Event



MS43 Sacramento River at the Vina Bridge Gage



MS15 Sacramento River at the Bend Bridge Gage



Sacramento River Inflow into the Keswick Reservoir

HEC-HMS Subbasin Parameters
Middle Sacramento River (Valley) Basin: March 1995 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
MS10 Bear Cr Confl	2	0.8	0.2	0.1	.001	0
MS4 MS Ab Clear Cr	2	0.8	0.2	0.1	.001	0
MS6 Churn Cr Confl	2	0.8	0.2	0.1	.001	0
MS8 Cow Cr Confl	2	0.8	0.2	0.1	.001	0
MS12 MS Ab CO	2	0.8	0.2	0.1	.001	0
MS40 Deer Cr Confl	2	0.8	0.2	0.1	.001	0
MS14 Battle Cr Confl	2	0.8	0.2	0.1	.001	0
MS18 Paynes Cr Confl	2	0.8	0.2	0.1	.001	0
MS24 Antelope Cr Hdw	2	0.8	0.2	0.1	.001	0
MS20 Reeds Cr Confl	2	0.8	0.2	0.1	.001	0
MS32 Mill Cr Confl	2	0.8	0.2	0.1	.001	0
MS26 Antelope Cr Con	2	0.8	0.2	0.1	.001	0
MS22 RedBankCr Confl	2	0.8	0.2	0.1	.001	0
MS28 MS Bl Antelope	2	0.8	0.2	0.1	.001	0
MS34 MS Bl Elder Cr	2	0.8	0.2	0.1	.001	0
MS36 MS Bl Thomes Cr	2	0.8	0.2	0.1	.001	0
MS44 Burch Cr Confl	2	0.8	0.2	0.1	.001	0
MS42 Burch Cr Hdwtr	2	0.8	0.2	0.1	.001	0
MS2 MS Bl Shasta Res	10000 cfs	0.8	0.2	0.1	.001	0
MS16 Paynes Cr Hdwtr	2	0.8	0.2	0.1	.001	0
MS30 Mill Cr Hdwtr	2	0.8	0.2	0.1	.001	0
MS38 Deer Cr Hdwtr	2	0.8	0.2	0.1	.001	0

HEC-HMS Summary of Results
Middle Sacramento River (Valley) Basin: December 1996 - January 1997 Event

Project : MidSac_Valley   Run Name : MidSacVal97

Start of Run	: 25Dec96 0100	Basin Model	: MidSacVal97
End of Run	: 08Jan97 2400	Met. Model	: Jan97
Execution Time	: 31May00 1307	Control Specs.	: Jan97

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
UpsacIn	76561	04 Jan 97 0900	1064356	6421.000
US41-MS3	76561	04 Jan 97 1000	1062386	6421.000
MS2 MS Bl Shasta Res	3000.0	25 Dec 96 0100	30878	46.313
Keswick Reservoir	76878	04 Jan 97 1000	1093264	6467.313
Keswick In	76878	04 Jan 97 1000	1093264	6467.313
MS42 Burch Cr Hdwtr	352.67	01 Jan 97 1500	3551.7	108.320
MS45	352.67	01 Jan 97 1500	3551.7	108.320
MS45-MS47	351.74	01 Jan 97 1000	3572.5	108.320
ElderCrIn	9453.3	01 Jan 97 1000	57671	140.000
Elder Creek	9443.7	01 Jan 97 1000	57666	140.000
RedBankCrIn	5993.8	01 Jan 97 0400	32506	93.500
RB3-MS23	5903.9	01 Jan 97 0900	32443	93.500
KeswickOut	78786	04 Jan 97 0200	1185238	6468.000
MS3-CL9	78607	04 Jan 97 0600	1169288	6468.000
ClearCrInflow	14800	01 Jan 97 1800	63842	251.100
MS4 MS Ab Clear Cr	13000	25 Dec 96 0100	113629	51.639
CL9 Clear Cr In	82759	03 Jan 97 2100	1346759	6770.739
CL9-MS7	82697	03 Jan 97 2300	1342147	6770.739
MS6 Churn Cr Confl	434.84	01 Jan 97 0400	3378.8	64.493
MS7	82771	03 Jan 97 2300	1345525	6835.232
MS7-MS9	82588	03 Jan 97 2400	1341208	6835.232
CowCrIn	37575	02 Jan 97 0300	160962	425.000
CW29-MS9	37273	02 Jan 97 0400	160856	425.000
MS8 Cow Cr Confl	1332.0	01 Jan 97 0400	9472.4	82.206
MS9	87003	03 Jan 97 2400	1511536	7342.438
MS9-MS11	86960	04 Jan 97 0100	1508986	7342.438
MS10 Bear Cr Confl	1460.3	01 Jan 97 0700	11790	126.129
MS11	87204	04 Jan 97 0100	1520776	7468.567
MS11-CO29	87029	04 Jan 97 0200	1516322	7468.567
CottonwoodCrIn	39800	01 Jan 97 1000	235046	944.700
MS12 MS Ab CO	1253.8	01 Jan 97 0300	6976.0	60.492

... Continued ...

HEC-HMS Summary of Results
Middle Sacramento River (Valley) Basin: December 1996 - January 1997 Event
(Continued)

Project : MidSac_Valley Run Name : MidSacVal97

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
CO29 CottonwoodCr In	101670	01 Jan 97 1000	1758344	8473.759
CO29-MS13	101602	01 Jan 97 1000	1755982	8473.759
BattleCrIn	17963	01 Jan 97 1000	89645	357.000
BT17-MS13	17712	01 Jan 97 1200	89512	357.000
MS13	118324	01 Jan 97 1000	1845494	8830.759
MS13-MS15	117710	01 Jan 97 1400	1832777	8830.759
MS14 Battle Cr Confl	678.52	01 Jan 97 0400	3981.0	62.885
MS15 Bend Bridge Ga	117992	01 Jan 97 1400	1836758	8893.644
MS15-MS19	117208	01 Jan 97 1600	1828250	8893.644
MS16 Paynes Cr Hdwtr	657.50	01 Jan 97 0700	5161.2	52.517
MS17	657.50	01 Jan 97 0700	5161.2	52.517
MS17-MS19	641.56	01 Jan 97 1100	5188.6	52.517
MS18 Paynes Cr Confl	209.72	01 Jan 97 0500	1883.0	60.029
MS19	117863	01 Jan 97 1600	1835322	9006.190
MS19-MS21	117301	01 Jan 97 1900	1826567	9006.190
MS20 Reeds Cr Confl	765.97	01 Jan 97 0600	6122.5	144.271
MS21	117878	01 Jan 97 1900	1832690	9150.461
MS21-MS23	117453	01 Jan 97 1900	1830687	9150.461
MS23	121721	01 Jan 97 1900	1863130	9243.961
MS23-MS25	121680	01 Jan 97 2000	1860114	9243.961
MS22 RedBankCr Confl	156.92	25 Dec 96 0100	1682.4	78.459
JMS25-MS29	121769	01 Jan 97 2000	1861796	9322.420
MS25-MS29	121515	01 Jan 97 2200	1856119	9322.420
MS24 Antelope Cr Hdw	597.33	01 Jan 97 0800	4758.7	87.596
MS27	597.33	01 Jan 97 0800	4758.7	87.596
MS27-MS29	590.34	02 Jan 97 0400	4874.7	87.596
MS26 Antelope Cr Con	241.91	25 Dec 96 0100	2074.0	120.956
MS29	122139	01 Jan 97 2200	1863068	9530.972
MS29-MS31	121721	01 Jan 97 2200	1861080	9530.972
MS28 MS Bl Antelope	316.45	01 Jan 97 1400	2668.5	62.708
MS31	122015	01 Jan 97 2200	1863749	9593.680
MS31-MS33	121991	01 Jan 97 2300	1862096	9593.680
MS30 Mill Cr Hdwtr	2589.7	02 Jan 97 0100	19342	130.542
MS35 Mill Cr Ga	2589.7	02 Jan 97 0100	19342	130.542
MS35-MS33	2588.1	02 Jan 97 0200	19353	130.542
MS33	124489	01 Jan 97 2300	1881449	9724.222
MS33-EL5	124319	01 Jan 97 2300	1880788	9724.222
MS32 Mill Cr Confl	134.99	02 Jan 97 2300	1388.0	61.921

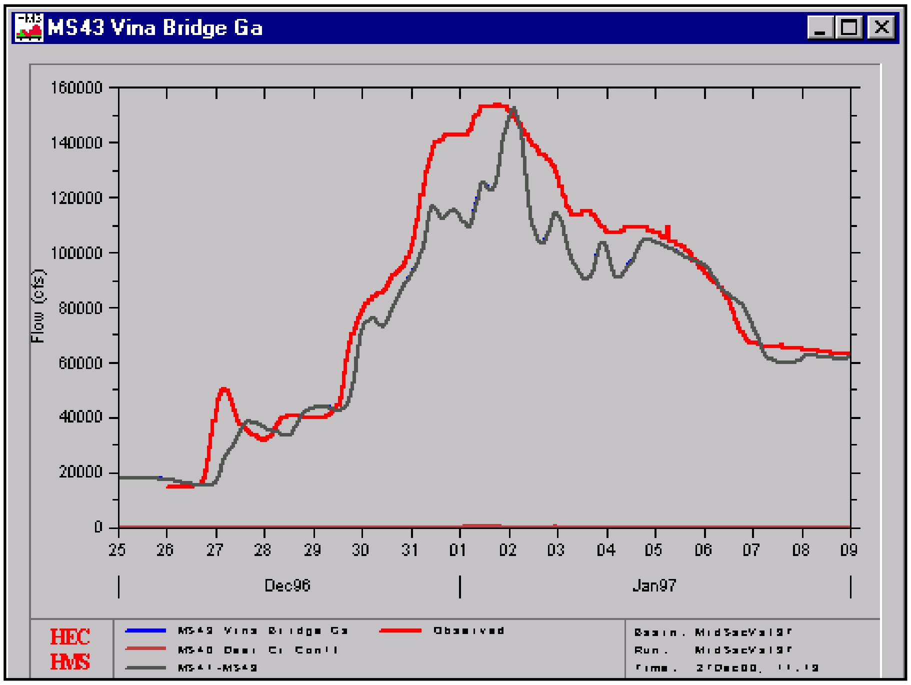
... Continued ...

HEC-HMS Summary of Results
Middle Sacramento River (Valley) Basin: December 1996 - January 1997 Event
(Continued)

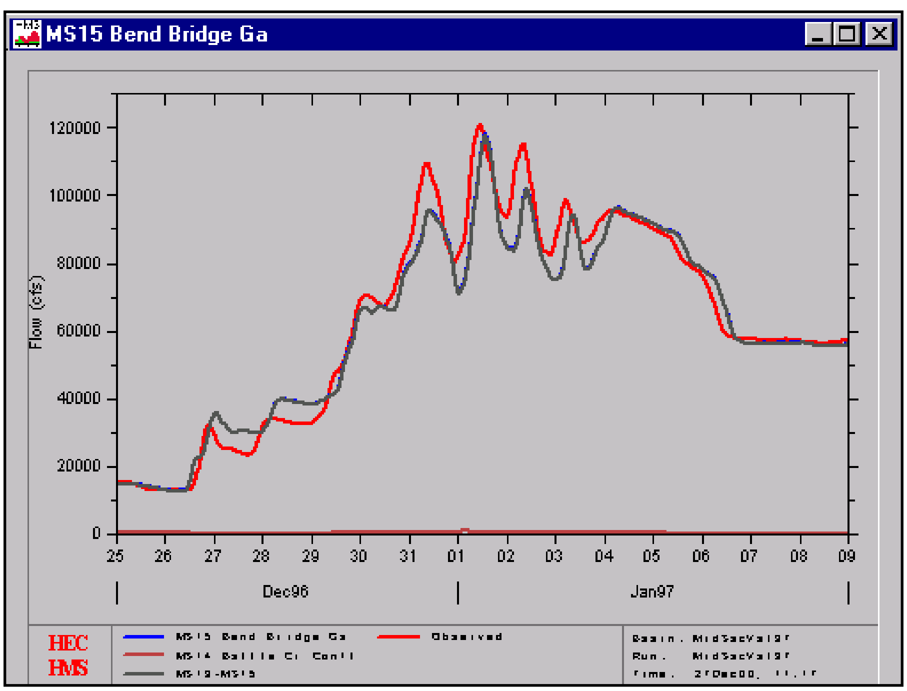
Project : MidSac_Valley Run Name : MidSacVal97

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
EL5	130790	01 Jan 97 2300	1939843	9926.143
EL5-TH7	130453	02 Jan 97 0100	1934833	9926.143
MS34 MS Bl Elder Cr	348.81	03 Jan 97 0100	2956.2	54.375
ThomesCrIn	29872	01 Jan 97 1000	188440	297.000
TH7 Thomes Cr In	148030	01 Jan 97 2400	2126229	10277.518
TH7-MS37	147950	02 Jan 97 0200	2121501	10277.518
MS36 MS Bl Thomes Cr	167.22	25 Dec 96 0100	1531.1	83.608
MS37	147993	02 Jan 97 0200	2123032	10361.126
MS37-MS41	147866	02 Jan 97 0300	2119769	10361.126
MS38 Deer Cr Hdwtr	4738.3	02 Jan 97 0100	38982	208.504
MS39 Deer Cr Ga	4738.3	02 Jan 97 0100	38982	208.504
MS39-MS41	4709.8	02 Jan 97 0700	39008	208.504
MS41	152386	02 Jan 97 0300	2158777	10569.630
MS41-MS43	152330	02 Jan 97 0300	2157692	10569.630
MS40 Deer Cr Confl	147.97	01 Jan 97 0600	1363.5	48.308
MS43 Vina Bridge Ga	152386	02 Jan 97 0300	2159056	10617.938
MS43-MS47	151941	02 Jan 97 0600	2148999	10617.938
MS44 Burch Cr Confl	371.29	01 Jan 97 1500	3129.4	76.097
MS47 Out	152464	02 Jan 97 0600	2155701	10802.355

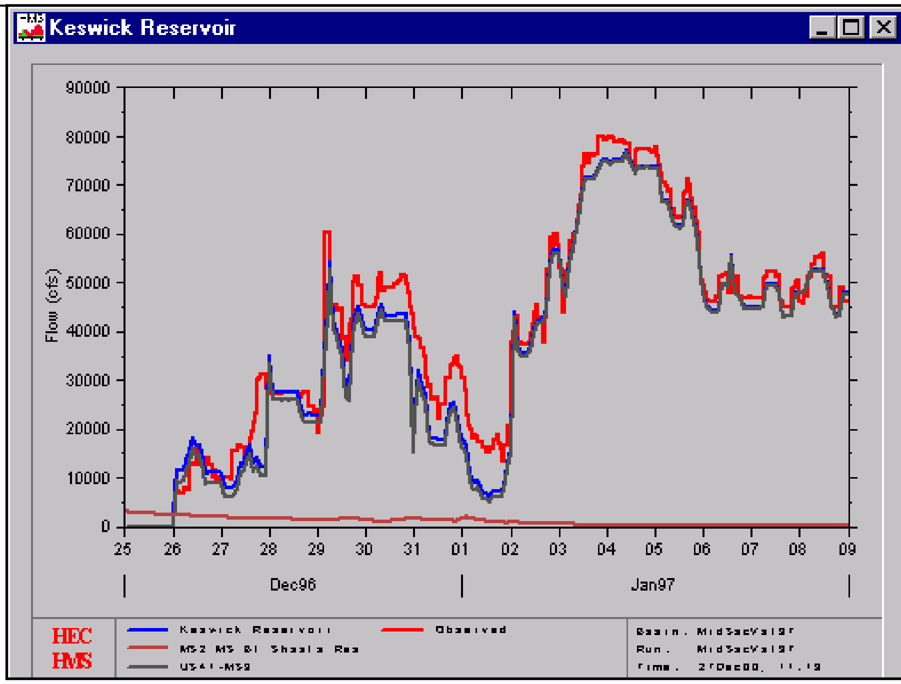
HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Middle Sacramento (Valley) River Basin
December 1996 - January 1997 Event



MS43 Sacramento River at the Vina Bridge Gage



MS15 Sacramento River at the Bend Bridge Gage

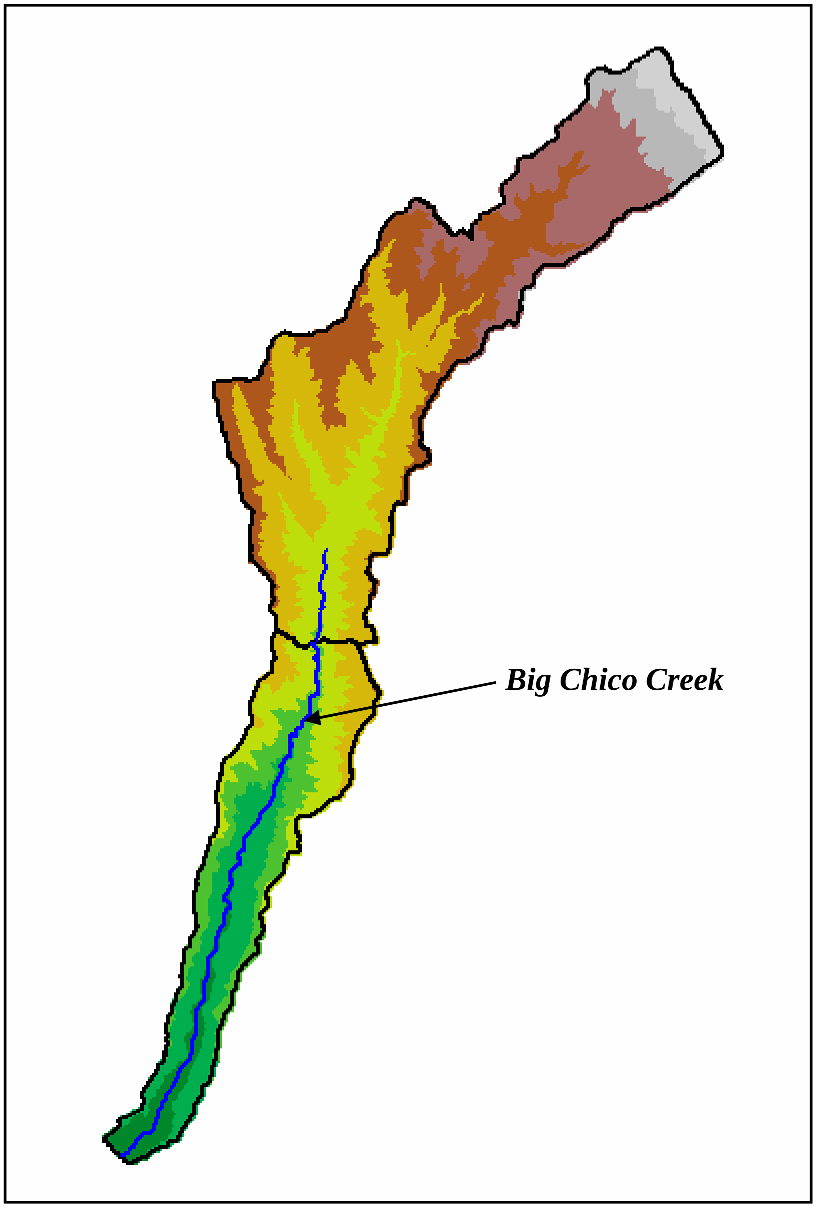


Sacramento River Inflow into the Keswick Reservoir

HEC-HMS Subbasin Parameters
Middle Sacramento River (Valley) Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
MS10 Bear Cr Confl	2	0.8	0.2	1.5	.01	0
MS4 MS Ab Clear Cr	13000 cfs	0.8	0.2	1.5	.01	0
MS6 Churn Cr Confl	2	0.8	0.2	1.5	.01	0
MS8 Cow Cr Confl	2	0.8	0.2	1.5	.01	0
MS12 MS Ab CO	2	0.8	0.2	1.5	.01	0
MS40 Deer Cr Confl	2	0.8	0.2	1.5	.01	0
MS14 Battle Cr Confl	2	0.8	0.2	1.5	.01	0
MS18 Paynes Cr Confl	2	0.8	0.2	1.5	.01	0
MS24 Antelope Cr Hdw	2	0.8	0.2	1.5	.01	0
MS20 Reeds Cr Confl	2	0.8	0.2	1.5	.01	0
MS32 Mill Cr Confl	2	0.8	0.2	1.5	.01	0
MS26 Antelope Cr Con	2	0.8	0.2	1.5	.01	0
MS22 RedBankCr Confl	2	0.8	0.2	1.5	.01	0
MS28 MS Bl Antelope	2	0.8	0.2	1.5	.01	0
MS34 MS Bl Elder Cr	2	0.8	0.2	1.5	.01	0
MS36 MS Bl Thomes Cr	2	0.8	0.2	1.5	.01	0
MS44 Burch Cr Confl	2	0.8	0.2	1.5	.01	0
MS42 Burch Cr Hdwtr	2	0.8	0.2	1.5	.01	0
MS2 MS Bl Shasta Res	3000 cfs	0.8	0.2	1.5	.01	0
MS16 Paynes Cr Hdwtr	2	0.8	0.2	1.5	.01	0
MS30 Mill Cr Hdwtr	2	0.8	0.2	0.1	.001	0
MS38 Deer Cr Hdwtr	2	0.8	0.2	0.1	.001	0

Big Chico Creek Basin



HEC-GeoHMS Subbasin Delineation

Big Chico Creek

The Big Chico Creek HMS model consists of a 72.4 square mile basin located in the mid-east portion of the Sacramento Watershed. The basin model is divided into 2 subbasins and connected with 1 routing reach. There was no observed hydrograph available for either the 1995 or 1997 event; however, the computed peak flow at the basin outlet for the 1997 event was larger than the 1995 event (14,500 cfs vs. 3,890 cfs).

Using the adopted TC and R (Group 1) and Muskingum parameters, a hydrograph was computed using parameters based on the Butte Creek HMS model. To validate the model, the average peak flow rate per square mile of the Butte Creek basin was used to approximate an appropriate average peak flow rate per square mile of the Big Chico Creek basin (since the basins are adjoining and have similar land use and precipitation).

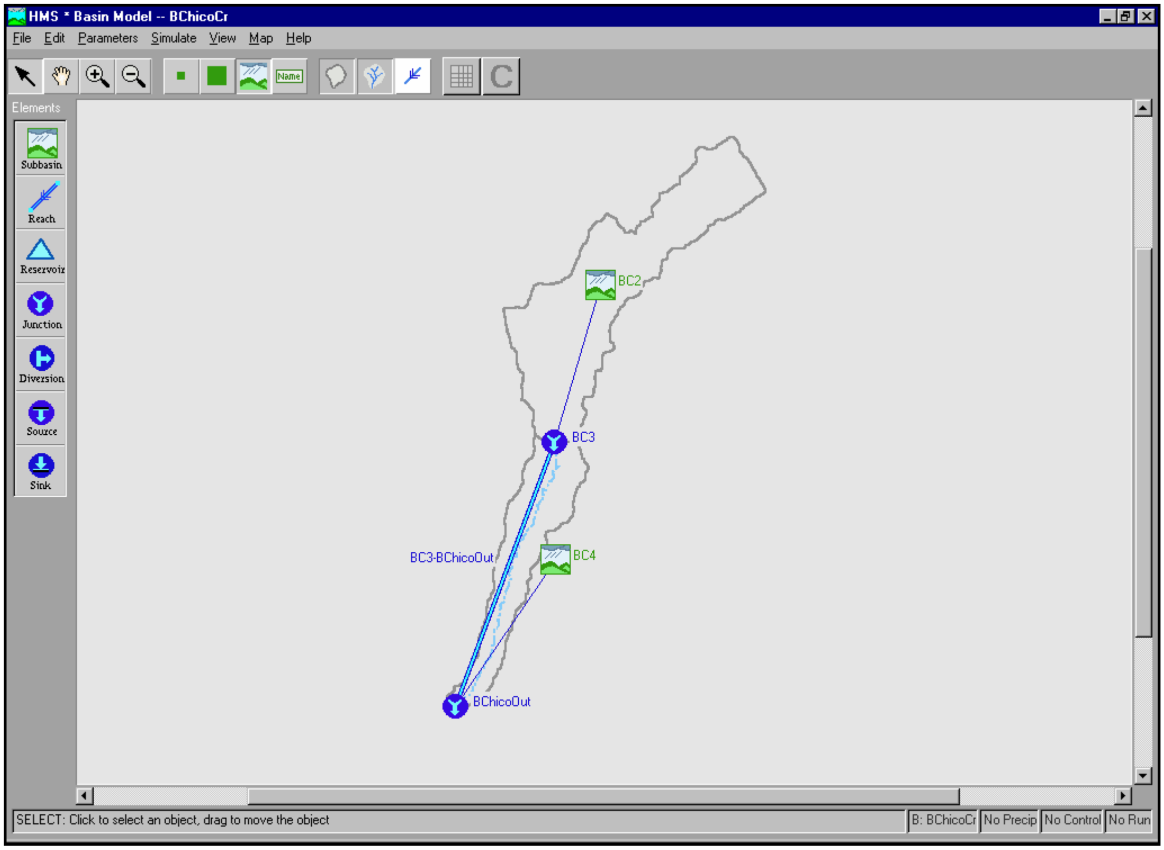
<u>Calibration of the 1995 Event:</u>

By using a constant loss rate of 0.085 inches/hour and a high initial loss of 4.2 inches, the model produced a peak flow consistent with the average peak flow rate per square mile of the Butte Creek basin. A recession ratio of 0.8 and a peak ratio of 0.2 defined the recession limb of the hydrograph. An initial baseflow of 3 cfs per square mile was used.

<u>Calibration of the 1997 Event:</u>

By using a constant loss rate of 0.02 inches/hour and an initial loss of 2.2 inches, the model produced a peak flow consistent with the average peak flow rate per square mile of the Butte Creek basin. A recession ratio of 0.8 and a peak ratio of 0.2 defined the recession limb of the hydrograph. An initial baseflow of 3 cfs per square mile was used.

Big Chico Creek Basin HEC-HMS Model Schematic



Big Chico Creek Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Inital TC $1.4(LL_{CA}/S^{1/2})^{0.33}$ (Hr)	Initial R 1.5 TC (cfs/Hr)	Regression TC $0.68(LL_{CA}/S^{1/2})^{0.46}$ (Hr)	Regression R 1.5TC (cfs/Hr)
BC2	50.02	19.29	8.20	200.64	11.16	3.1	12.4	2.1	8.3
BC4	22.51	15.86	8.41	190.08	9.68	3.0	11.8	1.9	7.7

Big Chico Creek Reach Parameters

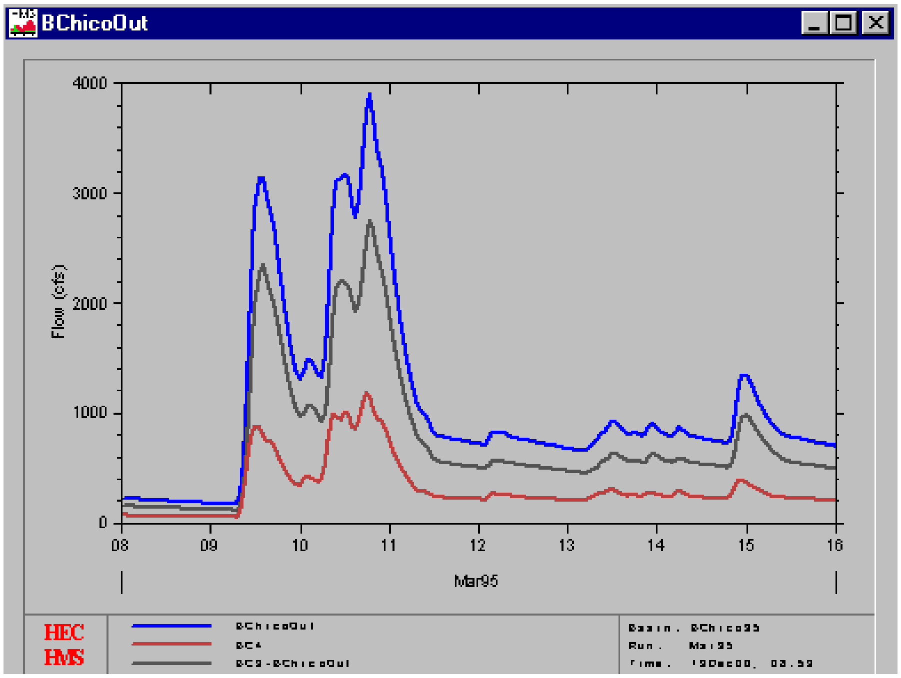
Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Ave Reach Vel $80\ S_R^{1/2}$ V_R (fps)	Initial K $1.47\ L_R / 1.5V_R$ K (Hr)	Musk X or LAG (Min)	N steps Time Step= 60
BC3-OUT	14.80	0.0226	12.03	1.2	0.4	1

HEC-HMS Summary of Results
Big Chico Creek Basin: March 1995 Event

Project	: BChicoCr	Run Name	: Mar95
Start of Run	: 08Mar95 0100	Basin Model	: BChico95
End of Run	: 15Mar95 2400	Met. Model	: Mar95
Execution Time	: 13Dec00 0853	Control Specs.	: Mar95

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
BC2	2788.2	10 Mar 95 1800	12024	50.020
BC3	2788.2	10 Mar 95 1800	12024	50.020
BC3-BChicoOut	2743.6	10 Mar 95 1900	11990	50.020
BC4	1181.5	10 Mar 95 1800	5040.6	22.510
BChicoOut	3889.6	10 Mar 95 1900	17031	72.530

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Big Chico Creek Basin
March 1995 Event



Big ChicoCreek Outlet (No Gage at Location)

HEC-HMS Subbasin Parameters
Big Chico Creek Basin: March 1995 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
BC4	3	0.8	0.2	4.2	0.085	0
BC2	3	0.8	0.2	4.2	0.085	0

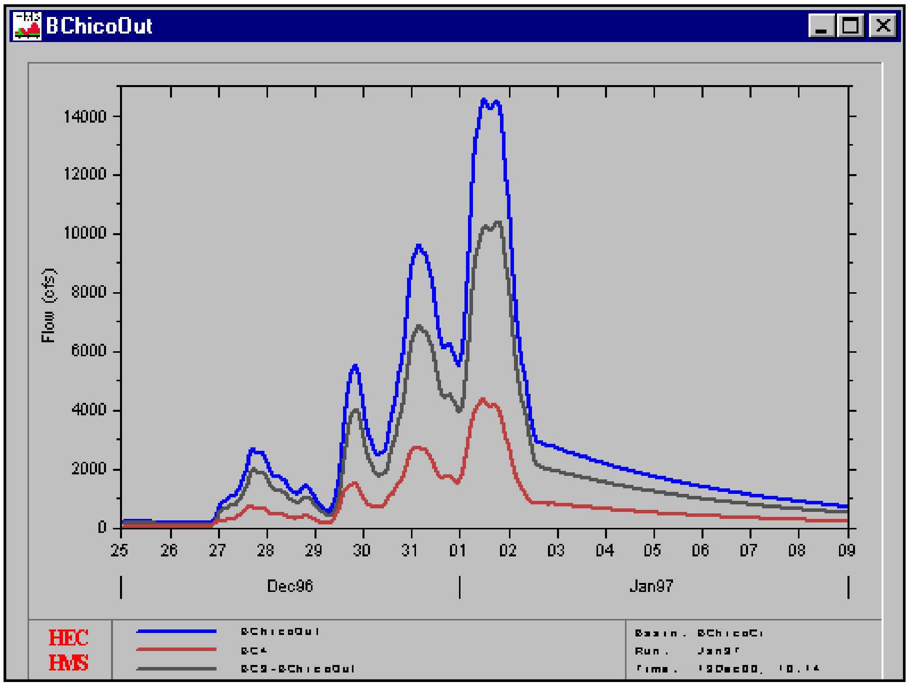
HEC-HMS Summary of Results
Big Chico Creek Basin: December 1996 - January 1997 Event

Project : BChicoCr Run Name : Jan97

Start of Run	: 25Dec96	0100	Basin Model	:	BChicoCr97
End of Run	: 08Jan97	2400	Met. Model	:	Jan97
Execution Time	: 11Dec00	1113	Control Specs.	:	Jan97

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
BC2	10388	01 Jan 97 1800	62330	50.020
BC3	10388	01 Jan 97 1800	62330	50.020
BC3-BChicoOut	10378	01 Jan 97 1900	62296	50.020
BC4	4339.9	01 Jan 97 1100	24654	22.510
BChicoOut	14523	01 Jan 97 1200	86950	72.530

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Big Chico Creek Basin
December 1996 - January 1997 Event

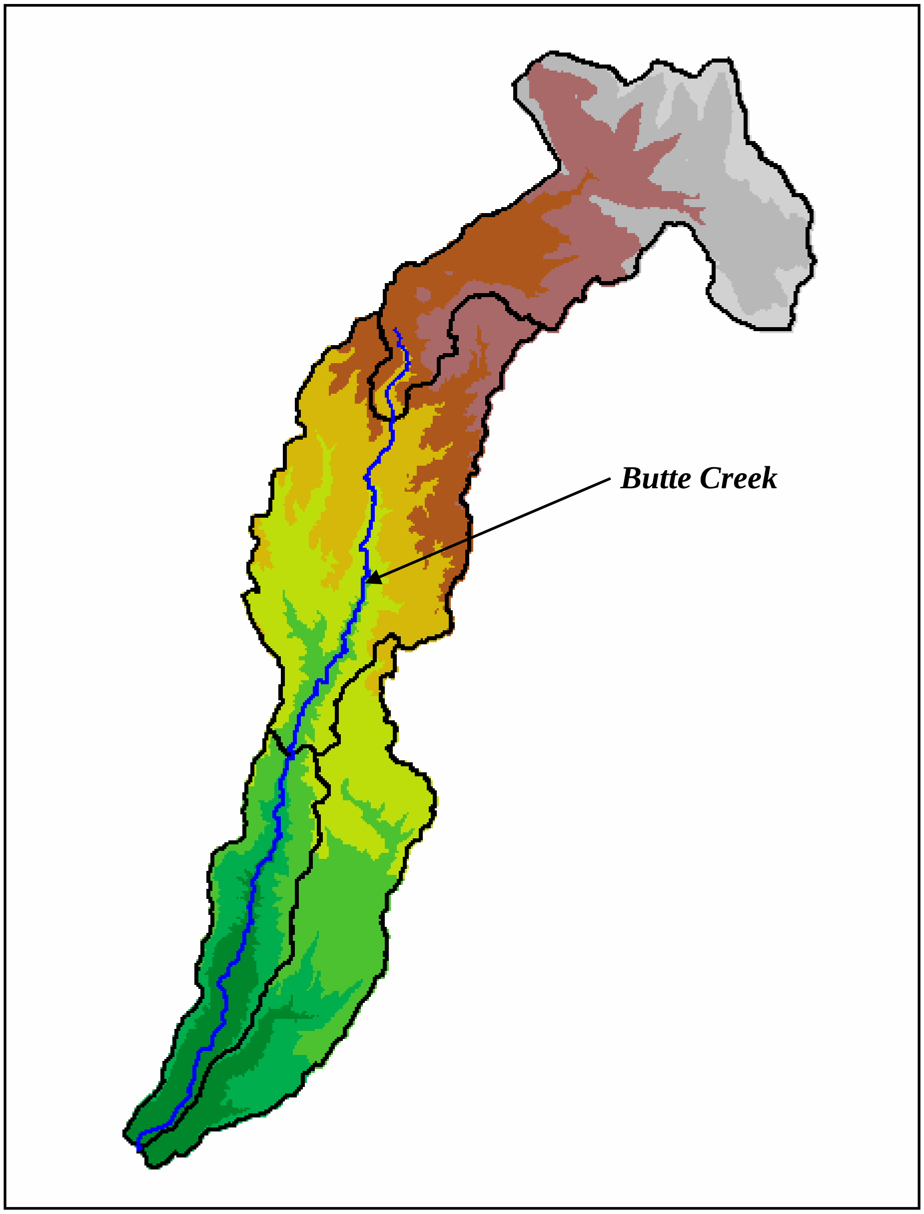


Big ChicoCreek Outlet (No Gage at Location)

HEC-HMS Subbasin Parameters
Big Chico Creek Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
BC4	3	0.8	0.2	2.2	0.02	0
BC2	3	0.8	0.2	2.2	0.02	0

Butte Creek Basin



HEC-GeoHMS Subbasin Delineation

Butte Creek

The Butte Creek HMS model consists of a 147 square mile basin located in the mid-east portion of the Sacramento Watershed above the gage near Chico, CA (11390000). The basin model is divided into 5 subbasins and connected with 2 routing reaches. Although subbasin BU10 is only one grid cell in area (0.01 square miles), it was included to add in the drainage area below the confluence of the streams from BU6 and BU8. There is one observed hydrograph at the gage near Chico. The computed peak flow at the Chico gage for the 1997 event was larger than the 1995 event (33,390 cfs vs. 9,390 cfs).

Using the adopted TC and R (Group 1) and Muskingum parameters for the two longest reaches, the computed hydrograph matched the observed hydrograph well. Since the travel time was less than an hour for the third very short reach, the lag method was used with a lag time of 1 minute.

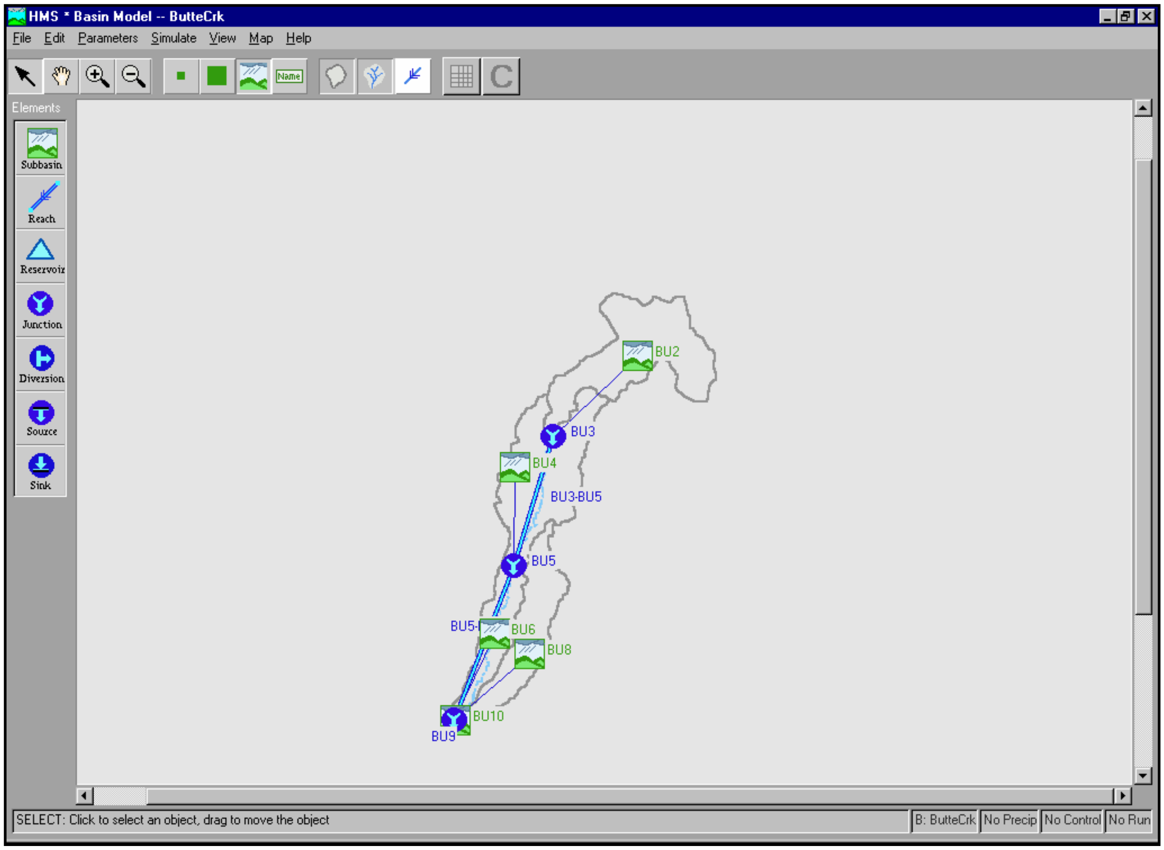
Calibration of the 1995 Event:

By using a constant loss rate of 0.085 inches/hour and a high initial loss of 4.2 inches, the model calibrated well to the observed hydrograph. A recession ratio of 0.8 and a peak ratio of 0.2 defined the recession limb of the hydrograph. An initial baseflow of 3.5 cfs per square mile was used.

Calibration of the 1997 Event:

By using a constant loss rate of 0.02 inches/hour and an initial loss of 2.2 inches, the model calibrated well to the observed hydrograph. A recession ratio of 0.8 and a peak ratio of 0.2 defined the recession limb of the hydrograph. An initial baseflow of 3 cfs per square mile was used.

Butte Creek Basin HEC-HMS Model Schematic



Butte Creek Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Inital TC $1.4(LL_{CA}/S^{1/2})^{0.33}$ (Hr)	Initial R 1.5 TC (cfs/Hr)	Regression TC $0.68(LL_{CA}/S^{1/2})^{0.46}$ (Hr)	Regression R 4.0TC (cfs/Hr)
BU2	50.01	19.99	13.16	179.52	19.63	3.7	15.0	2.7	10.7
BU4	47.28	18.50	8.34	190.08	11.20	3.1	12.4	2.1	8.3
BU8	30.14	20.89	10.86	168.96	17.45	3.6	14.4	2.5	10.1
BU6	19.55	14.30	7.87	174.24	8.52	2.8	11.4	1.8	7.3
BU10	0.01	0.18	0.09	818.40	0.00	0.1	0.5	0.0	0.1

Butte Creek Reach Parameters

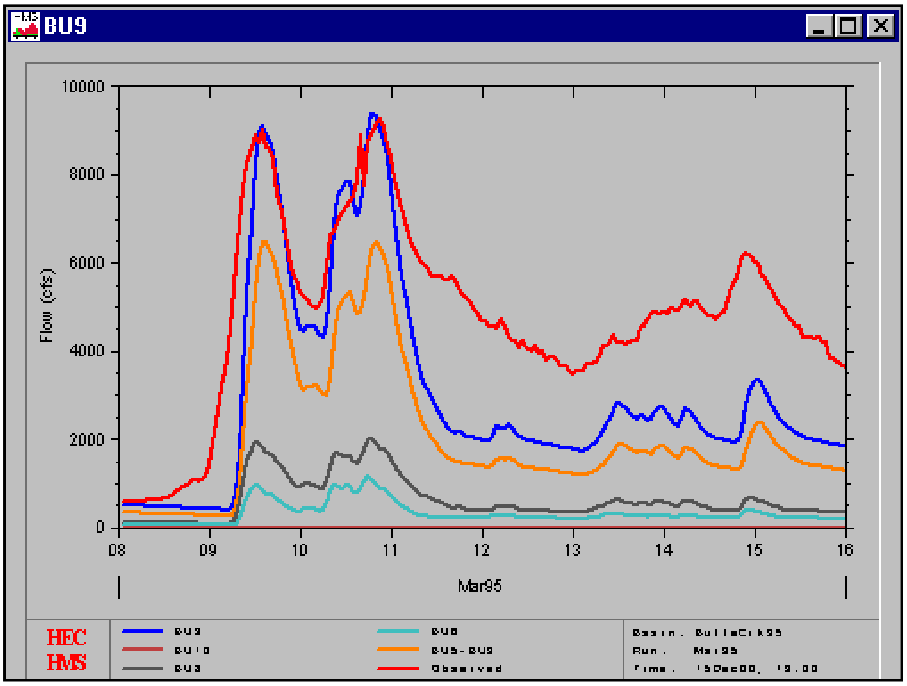
Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Ave Reach Vel $80\ S_R^{1/2}$ V_R (fps)	Initial K $1.47\ L_R / 1.5V_R$ K (Hr)	Musk X or LAG (Min)	N steps Time Step= 60
BU3-BU5	11.58	0.0275	13.27	1.0	0.4	1
BU5-BU9	13.64	0.0202	11.37	1.2	0.4	1

HEC-HMS Summary of Results
Butte Creek Basin: March 1995 Event

Project	: ButteCrk	Run Name	: Mar95
Start of Run	: 08Mar95 0100	Basin Model	: ButteCrk95
End of Run	: 15Mar95 2400	Met. Model	: Mar95
Execution Time	: 15Dec00 1300	Control Specs.	: Mar95

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
BU2	2934.1	10 Mar 95 1900	13405	50.010
BU3	2934.1	10 Mar 95 1900	13405	50.010
BU3-BU5	2909.3	10 Mar 95 2000	13376	50.010
BU4	4358.7	09 Mar 95 1200	19963	47.280
BU5	6542.4	09 Mar 95 1300	33339	97.290
BU5-BU9	6463.6	10 Mar 95 2000	33245	97.290
BU10	1.5241	10 Mar 95 1100	1.6039	0.010
BU6	1140.9	10 Mar 95 1800	5032.8	19.550
BU8	1995.7	10 Mar 95 1900	9955.9	30.140
BU9	9385.6	10 Mar 95 1900	48236	146.990

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Butte Creek Basin
March 1995 Event



BU9 – Butte Creek Near Chico

HEC-HMS Subbasin Parameters
Butte Creek Basin: March 1995 Event

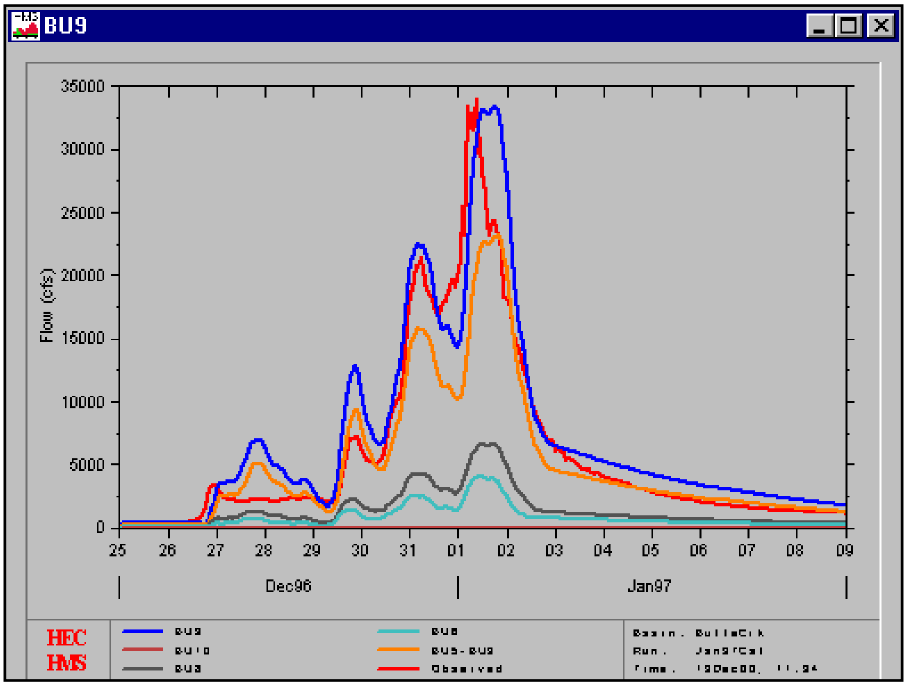
Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
BU10	3.5	0.8	0.2	4.2	0.085	0
BU2	3.5	0.8	0.2	4.2	0.085	0
BU4	3.5	0.8	0.2	4.2	0.085	0
BU8	3.5	0.8	0.2	4.2	0.085	0
BU6	3.5	0.8	0.2	4.2	0.085	0

HEC-HMS Summary of Results
Butte Creek Basin: December 1996 - January 1997 Event

Project	: ButteCrk		Run Name	: Jan97Cal	
Start of Run	: 25Dec96	0100	Basin Model	:	ButteCrk
End of Run	: 08Jan97	2400	Met. Model	:	Jan97
Execution Time	: 11Dec00	1108	Control Specs.	:	Jan97

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
BU2	11760	01 Jan 97 2000	75160	50.010
BU3	11760	01 Jan 97 2000	75160	50.010
BU3-BU5	11726	01 Jan 97 2100	75119	50.010
BU4	12024	01 Jan 97 1100	75354	47.280
BU5	23127	01 Jan 97 1900	150473	97.290
BU5-BU9	23118	01 Jan 97 2000	150378	97.290
BU10	1.8395	01 Jan 97 0300	6.1430	0.010
BU6	4080.5	01 Jan 97 1100	22987	19.550
BU8	6594.3	01 Jan 97 1200	40650	30.140
BU9	33390	01 Jan 97 1800	214022	146.990

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Butte Creek Basin
December 1996 - January 1997 Event

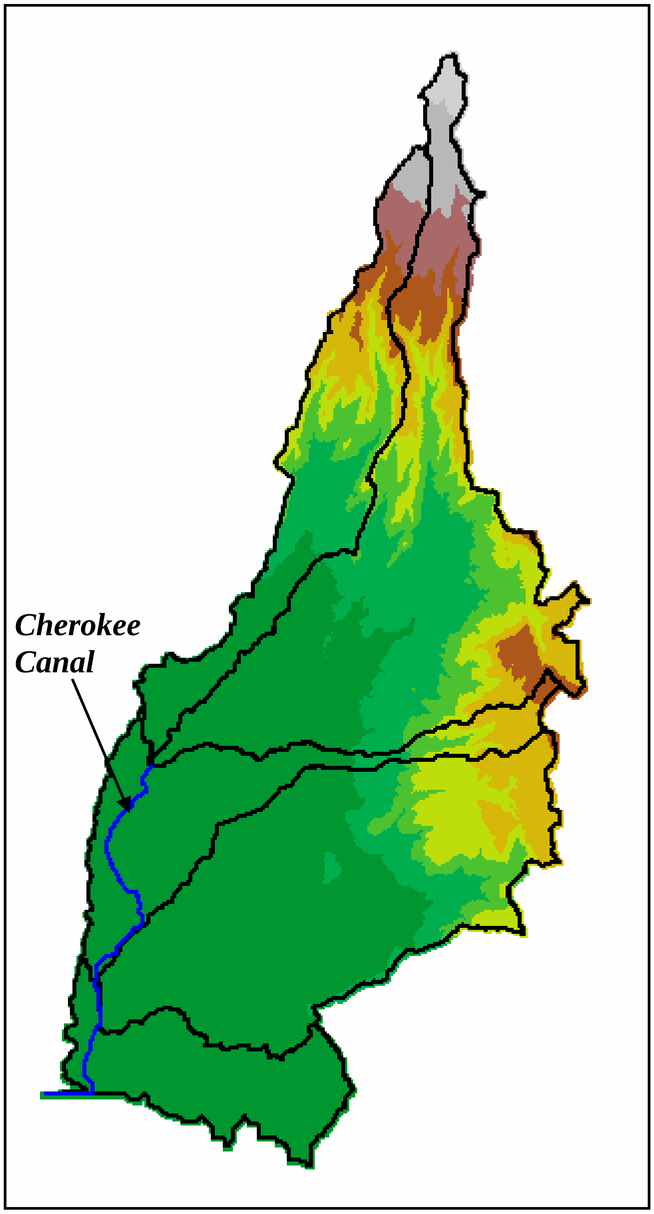


BU9 – Butte Creek Near Chico

HEC-HMS Subbasin Parameters
Butte Creek Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
BU10	3	0.8	0.2	2.2	0.02	0
BU2	3	0.8	0.2	2.2	0.02	0
BU4	3	0.8	0.2	2.2	0.02	0
BU8	3	0.8	0.2	2.2	0.02	0
BU6	3	0.8	0.2	2.2	0.02	0

Cherokee Canal Basin



HEC-GeoHMS Subbasin Delineation

Cherokee Canal

The Cherokee Canal HMS model consists of a 104 square mile basin located in the mid-east portion of the Sacramento Watershed above the gage near Richvale, CA (11390225). The basin model is divided into 5 subbasins and connected with 2 routing reaches. There is one observed hydrograph at the gage at Richvale. The computed peak flow at the Richvale gage for the 1997 event was larger than the 1995 event (8,200 cfs vs. 7,350 cfs).

Using the adopted TC and R (Group 1) and Muskingum parameters, the computed hydrograph matched the observed hydrograph well.

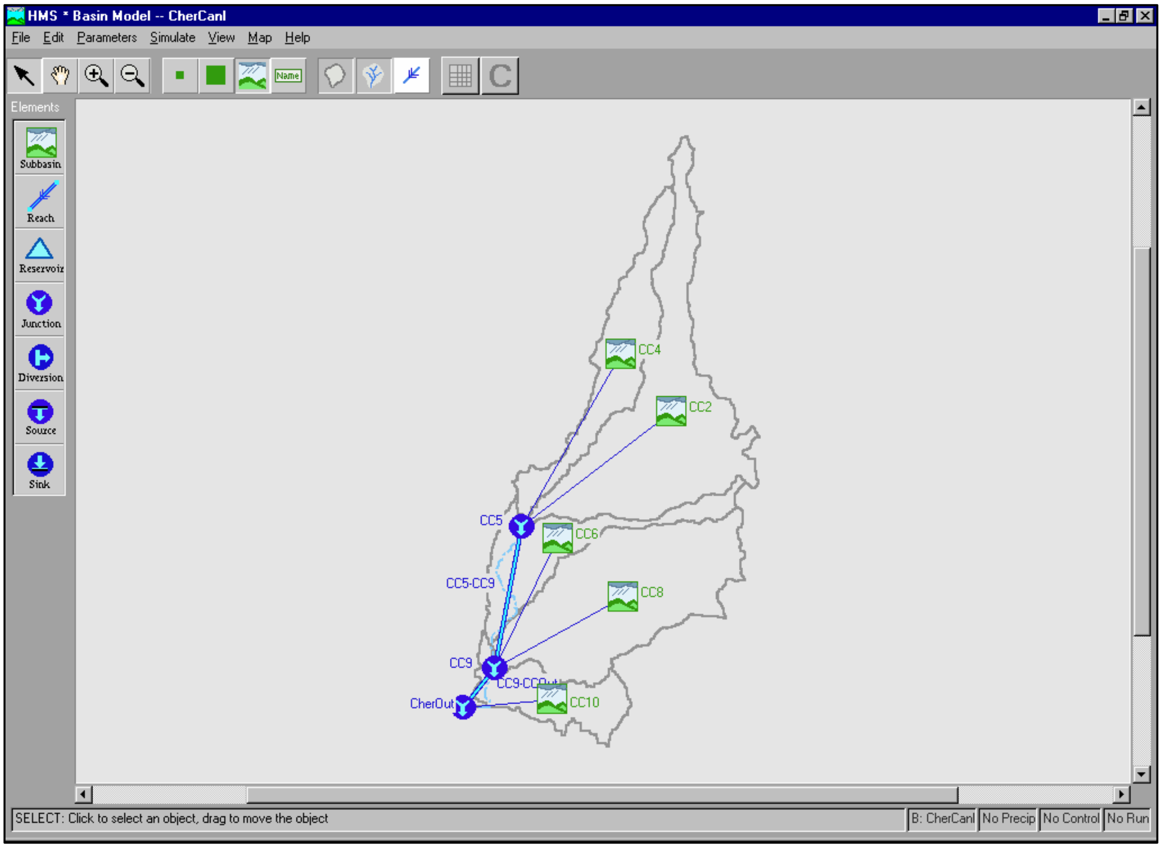
<u>Calibration of the 1995 Event:</u>

By using a constant loss rate of 0.05 inches/hour and an initial loss of 0.8 inches, the model calibrated well to the observed hydrograph. A recession ratio of 0.8 and a peak ratio of 0.2 defined the recession limb of the hydrograph. An initial baseflow of 0.9 cfs per square mile was used.

<u>Calibration of the 1997 Event:</u>

By using a constant loss rate of 0.06 inches/hour and an initial loss of 0.05 inches, the model calibrated well to the observed hydrograph. A recession ratio of 0.6 and a peak ratio of 0.2 defined the recession limb of the hydrograph. An initial baseflow of 1 cfs per square mile was used.

Cherokee Canal Basin HEC-HMS Model Schematic



Cherokee Canal Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Inital TC $1.4(LL_{CA}/S^{1/2})^{0.33}$ (Hr)	Initial R 4.0 TC (cfs/Hr)	Regression TC $0.68(LL_{CA}/S^{1/2})^{0.46}$ (Hr)	Regression R 4.0TC (cfs/Hr)
CC10	9.73	7.11	3.49	36.96	4.08	2.2	8.9	1.3	5.2
CC2	35.15	20.20	9.22	110.88	17.68	3.6	14.5	2.5	10.2
CC4	14.79	16.23	8.63	121.44	12.71	3.2	13.0	2.2	8.8
CC6	12.58	16.42	7.52	84.48	13.43	3.3	13.2	2.2	9.0
CC8	32.15	14.12	8.08	95.04	11.70	3.2	12.6	2.1	8.4

Cherokee Canal Reach Parameters

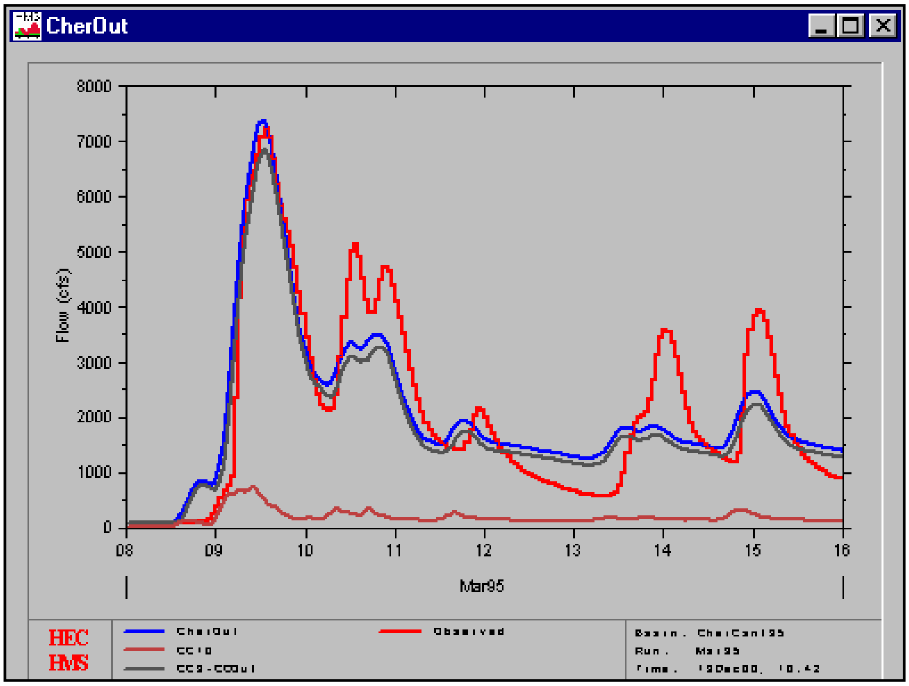
Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Ave Reach Vel $80\ S_R^{1/2}$ V_R (fps)	Initial K $1.47\ L_R / 1.5V_R$ K (Hr)	Musk X or LAG (Min)	N steps Time Step= 60
CC5-7	6.61	0.0014	2.99	2.2	0.4	2
CC7-9	2.52	0.0005	1.79	1.4	0.36	1

HEC-HMS Summary of Results
Cherokee Canal Basin: March 1995 Event

Project	: CherCanl		Run Name	: Mar95	
Start of Run	: 08Mar95	0100	Basin Model	:	CherCanl95
End of Run	: 15Mar95	2400	Met. Model	:	Mar95
Execution Time	: 11Dec00	1112	Control Specs.	:	Mar95

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
CC4	1249.7	09 Mar 95 1100	5185.6	14.790
CC2	2882.3	09 Mar 95 1100	12367	35.150
CC5	4132.0	09 Mar 95 1100	17553	49.940
CC5-CC9	4091.8	09 Mar 95 1300	17430	49.940
CC6	717.47	09 Mar 95 1100	2924.7	12.580
CC8	2322.6	09 Mar 95 1100	9805.2	32.150
CC9	6890.3	09 Mar 95 1200	30160	94.670
CC9-CCOut	6837.3	09 Mar 95 1300	30024	94.670
CC10	720.99	09 Mar 95 1000	2923.8	9.730
CherOut	7350.7	09 Mar 95 1300	32948	104.400

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Cherokee Canal Basin
March 1995 Event



CherOut – Cherokee Canal Outlet

HEC-HMS Subbasin Parameters
Cherokee Canal Basin: March 1995 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
CC10	0.9	0.8	0.2	0.08	0.05	0
CC2	0.9	0.8	0.2	0.08	0.05	0
CC4	0.9	0.8	0.2	0.08	0.05	0
CC8	0.9	0.8	0.2	0.08	0.05	0
CC6	0.9	0.8	0.2	0.08	0.05	0

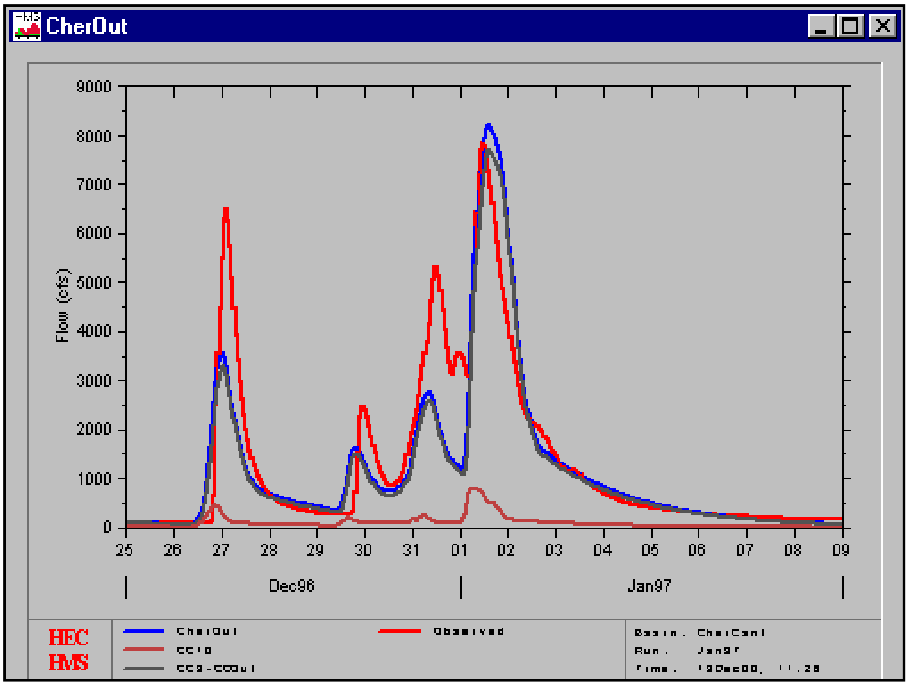
HEC-HMS Summary of Results
Cherokee Canal Basin: December 1996 - January 1997 Event

Project : CherCanl   Run Name : Jan97

Start of Run	: 25Dec96	0100	Basin Model	: CherCanl
End of Run	: 08Jan97	2400	Met. Model	: Jan97
Execution Time	: 11Dec00	1111	Control Specs.	: Jan97

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
CC4	1460.4	01 Jan 97 1200	5983.1	14.790
CC2	3421.1	01 Jan 97 1200	14440	35.150
CC5	4881.5	01 Jan 97 1200	20423	49.940
CC5-CC9	4842.0	01 Jan 97 1400	20425	49.940
CC6	699.68	01 Jan 97 1100	2698.7	12.580
CC8	2425.2	01 Jan 97 1100	9948.9	32.150
CC9	7713.8	01 Jan 97 1300	33073	94.670
CC9-CCOut	7687.2	01 Jan 97 1500	33077	94.670
CC10	778.74	01 Jan 97 0700	2830.3	9.730
CherOut	8201.2	01 Jan 97 1500	35907	104.400

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Cherokee Canal Basin
December 1996 - January 1997 Event

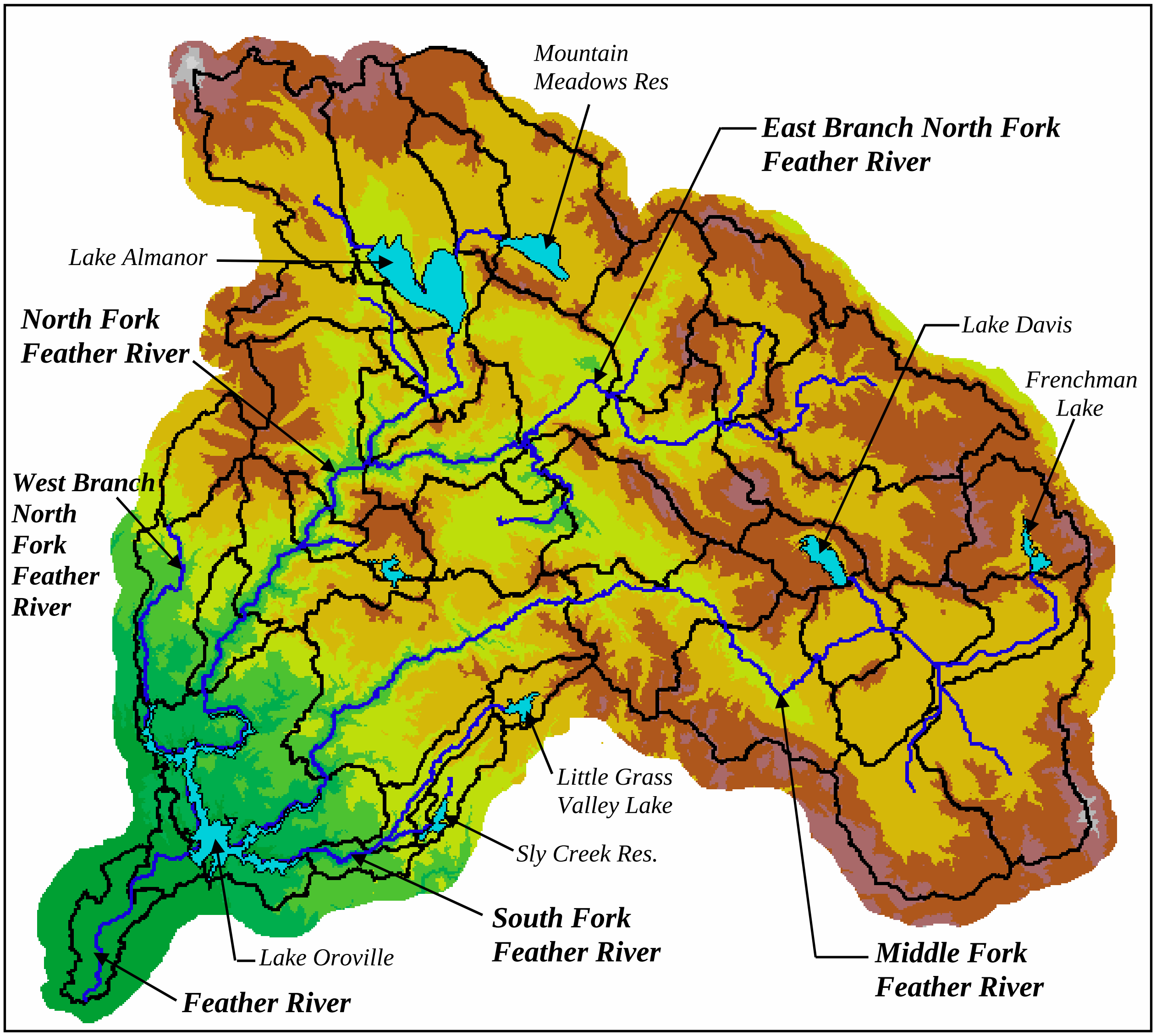


CherOut – Cherokee Canal Outlet

HEC-HMS Subbasin Parameters
Cherokee Canal Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
CC10	1	0.6	0.2	0.05	0.06	0
CC2	1	0.6	0.2	0.05	0.06	0
CC4	1	0.6	0.2	0.05	0.06	0
CC8	1	0.6	0.2	0.05	0.06	0
CC6	1	0.6	0.2	0.05	0.06	0

Feather River Basin



HEC-GeoHMS Subbasin Delineation

Feather River

The Feather River HMS model consists of a 3,665 square mile basin located in the eastern portion of the Sacramento Watershed above the gage near Gridley, CA. The basin model is divided into 44 subbasins and connected with 40 routing reaches. The observed hydrographs are the computed inflow into Lake Oroville, a gage on the North Fork at Grizzly, and a gage on the North Fork at Rock Creek. The computed peak inflow into Lake Oroville for the 1997 event was larger than the 1995 event (160,000 cfs vs. 86,000 cfs).

The adopted TC and R (Group 1) values were used. The generic equation to compute the reach travel time (Muskingum K) was not used because the reach travel times were too short; thus, causing the computed peaks to occur too early. Instead, the reach travel time (K) was computed knowing the reach length and average velocity. The average velocity was computed using Manning's equation. The Manning's "n" value was estimated with Jarrett's equation, and the hydraulic radius was estimated from the Feather River equation, which was developed from a regression of field data. Of the 40 routing reaches, 13 reaches used the Muskingum routing technique. The other 27 reaches used the lag method since the travel time within each of those reaches was less than the one-hour time step used by the Muskingum method. For this modeling effort, rather than attempt to predict how the Oroville, Little Grass Valley, Lake Almanor, and Bucks Lake reservoirs were operated, the source and sink tools available in HMS were implemented. This technique allowed the observed hydrograph at the outlet of each of the reservoirs to be passed downstream. As pointed out in "Section 6.6.5, Reservoir Modeling" of the main report, HMS is fairly limited in how it models releases from reservoirs. Calibration efforts required different loss and baseflow parameters for different subbasins. Ten to fifteen percent impervious area was assumed for the subbasins that included lakes.

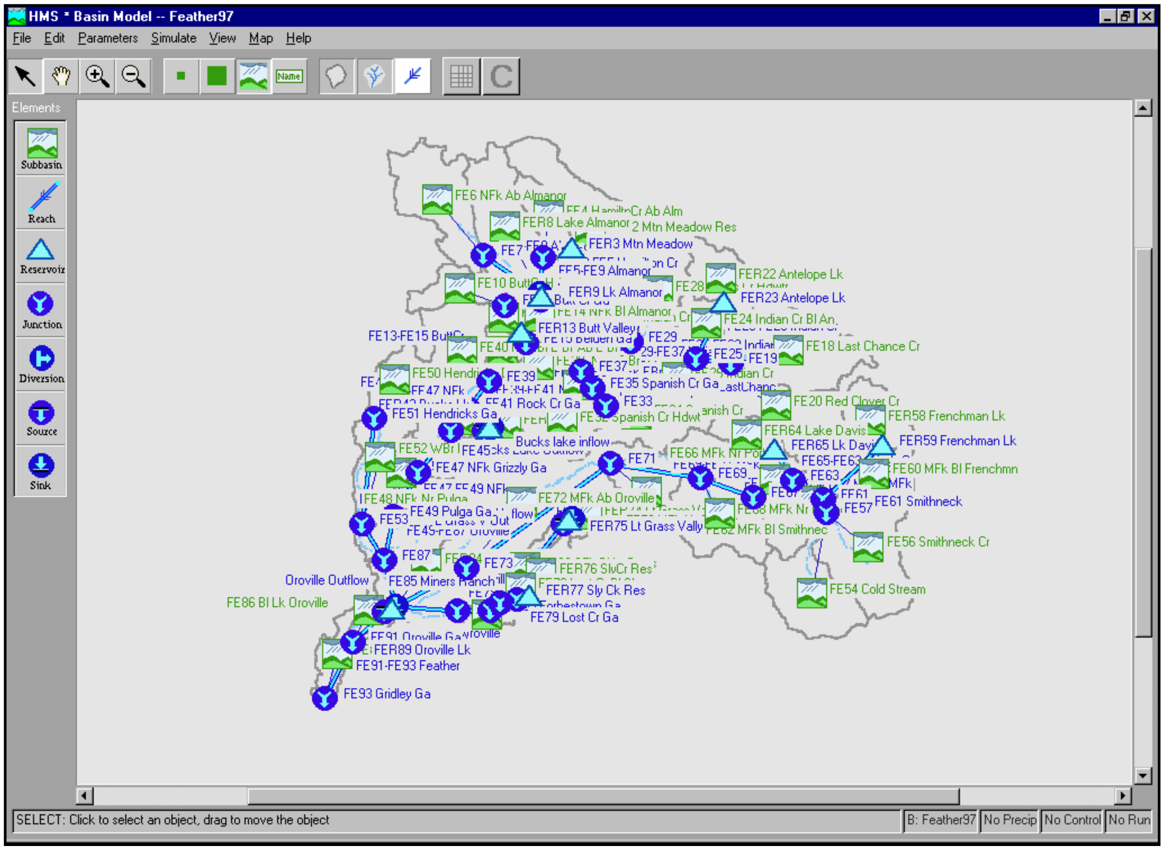
<u>Calibration of the 1995 Event:</u>

Calibration was not performed for the North Fork at Rock Creek gage (due to insufficient data) but was performed for the Lake Oroville inflow and the North Fork at Grizzly gage. By using constant loss rates between 0.03 and 1.0 inches/hour and high initial losses between 2.0 and 8.0 inches (most subbasins about 5 inches), the model calibrated well to observed hydrographs at Grizzly and Lake Oroville. A recession ratio of 0.7 and a peak ratio of 0.35 defined the recession limb of the hydrograph. An initial baseflow of 3 cfs per square mile was assumed. The event featured two peaks, with the second peak being the highest. The model calibrated well to both peaks.

<u>Calibration of the 1997 Event:</u>

The model calibrated well for the North Fork at Grizzly gage, the North Fork at Rock Creek gage, and inflow into Lake Oroville. The event featured two peaks, with the second peak being highest. The generalized parameters for TC and R (Group 1) fit the observed hydrograph. The baseflow recession parameters of 0.7 for the constant and 0.35 for the peak ratio worked best. The subbasins used constant loss rates between 0.01 and 0.33 inches/hour, and initial losses between 0.5 and 3.5 inches, with most initial losses set to 1.0 inch.

Feather River Basin HEC-HMS Model Schematic



Feather River Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Initial TC $1.4(LL_{CA}/S^{1/2})^{.33}$ (Hr)	Initial R 2.33 TC	Final TC $0.68(LL_{CA}/S^{1/2})^{.46}$ (Hr)	Final R 4.0 TC (Hr)
FE30 Indian Cr	102.21	27.35	14.85	163.68	31.74	4.4	10.2	3.3	13.3
FE28 Lights Cr Hdwtr	105.03	21.15	9.71	174.24	15.57	3.5	8.1	2.4	9.6
FE24 Indian Cr Bl An	42.81	14.52	7.38	248.16	6.80	2.6	6.1	1.6	6.6
FE38 NFk E Br	76.51	21.37	8.61	163.68	14.39	3.4	7.9	2.3	9.3
FE16 NFk Ab E Br	31.87	13.17	5.27	221.76	4.66	2.3	5.4	1.4	5.5
FE20 Red Clover Cr	128.36	33.88	17.86	132.00	52.67	5.2	12.1	4.2	16.8
FE40 NFk Bl E Br	118.43	30.36	12.46	168.96	29.10	4.3	9.9	3.2	12.8
FE36 Spanish Cr	19.32	10.35	4.88	153.12	4.08	2.2	5.2	1.3	5.2
FE26 Indian Cr	102.26	25.11	11.43	163.68	22.43	3.9	9.1	2.8	11.4
FE60 MFk Bl Frenchmn	60.95	20.70	8.49	158.40	13.96	3.3	7.8	2.3	9.1
FER84 Lake Oroville	249.02	29.89	13.91	142.56	34.82	4.5	10.5	3.5	13.9
FE56 Smithneck Cr	170.82	23.03	8.30	132.00	16.63	3.5	8.2	2.5	9.9
FE54 Cold Stream	121.19	25.05	13.78	84.48	37.54	4.6	10.8	3.6	14.4
FE88 Feather Out	46.51	20.07	8.26	52.80	22.82	3.9	9.2	2.9	11.5
FE50 Hendricks Div D	46.03	18.76	10.19	195.36	13.67	3.3	7.7	2.3	9.1
FE34 Spanish Cr	96.18	23.16	10.98	179.52	18.97	3.7	8.6	2.6	10.5
FER2 Mtn Meadow Res	165.45	30.06	6.50	84.48	21.26	3.8	8.9	2.8	11.1
FE48 NFk Nr Pulga	39.11	15.86	6.66	248.16	6.70	2.6	6.1	1.6	6.5
FER74 Lt Grass Valle	26.00	11.14	3.97	248.16	2.80	2.0	4.6	1.1	4.4
FE80 SFk Bl Lt Grass	31.88	20.91	9.28	205.92	13.52	3.3	7.7	2.3	9.0
FE82 SFk Bl Lost Cr	19.56	12.87	6.24	232.32	5.27	2.4	5.6	1.5	5.8
FER42 Bucks Lake	28.44	10.23	4.57	269.28	2.85	2.0	4.6	1.1	4.4
FE66 MFk Nr Portola	53.16	14.49	5.26	168.96	5.87	2.5	5.8	1.5	6.1
FE70 MFk Nr Quincy	128.95	22.47	9.81	158.40	17.52	3.6	8.4	2.5	10.2
FE72 MFk Ab Oroville	255.06	40.68	19.48	142.56	66.37	5.6	13.0	4.7	18.7
FE86 Bl Lk Oroville	25.05	15.14	6.46	105.60	9.52	2.9	6.9	1.9	7.7
FE44 Bucks Cr	25.03	9.28	2.37	522.72	0.96	1.4	3.2	0.7	2.7
FE46 NFk Bl Storrie	87.70	23.98	5.71	184.80	10.08	3.0	7.0	2.0	7.9
FE52 WBr Bl Hendrick	96.67	30.58	14.52	195.36	31.76	4.4	10.2	3.3	13.3
FER58 Frenchman Lk	77.82	13.69	3.98	121.44	4.94	2.4	5.5	1.4	5.7
FER64 Lake Davis	44.21	12.66	4.15	100.32	5.25	2.4	5.6	1.5	5.8
FE62 MFk Bl Smithnec	91.48	23.81	4.12	73.92	11.42	3.1	7.3	2.1	8.3
FER22 Antelope Lk	71.20	12.14	3.60	221.76	2.94	2.0	4.7	1.1	4.5
FER76 SlyCr Res	24.06	13.71	6.87	190.08	6.83	2.6	6.1	1.6	6.6
FE78 Lost Cr Bl Sly	5.94	4.99	1.06	248.16	0.33	1.0	2.3	0.4	1.6
FE6 NFk Ab Almanor	133.00	26.91	12.68	179.52	25.46	4.1	9.5	3.0	12.1
FE10 ButtCr Hdwtr	54.42	19.67	10.82	147.84	17.50	3.6	8.4	2.5	10.1
FER12 ButtValley Res	12.11	6.57	2.86	216.48	1.28	1.5	3.5	0.8	3.0
FE4 HamiltnCr Ab Alm	56.22	15.79	5.45	137.28	7.35	2.7	6.3	1.7	6.8
FER8 Lake Almanor	147.57	29.88	14.79	110.88	41.99	4.8	11.2	3.8	15.2
FE14 NFk Bl Almanor	45.00	18.14	7.06	195.36	9.17	2.9	6.8	1.9	7.5
FE18 Last Chance Cr	177.88	33.11	16.48	52.80	75.09	5.8	13.6	5.0	19.8
FE32 Spanish Cr Hdwt	86.78	18.59	9.01	168.96	12.89	3.3	7.6	2.2	8.8
FE68 MFk Nr Blairsdn	135.90	21.17	7.91	158.40	13.30	3.3	7.7	2.2	8.9

Feather River Reach Parameters

Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Cum Drainage Area (from GeoHms) A (Sq. Mi.)	Feather River Field Reg. Eqa $R = 0.0043A + 6.0561$	Jarrett's Equation $n = .39S^{.38}R^{-.16}$	Manning's Velocity $v\ (ft/s) = 1.49R^{2/3}S^{1/2}/n$	Travel Time K Hrs	Lag (Min)
FE11-FE13 Butt Val R	4.87	0.0023	66	6.34	0.029	8.48	0.84	51
FE13-FE15 ButtCr	1.90	0.0898	69	6.35	0.116	13.19	0.21	13
FE15-FE39 NFk Ab EBr	9.94	0.0161	646	8.83	0.057	14.10	1.03	
FE19-FE25 LastChanc	6.94	0.0424	306	7.37	0.085	13.63	0.75	45
FE23-FE25 Indian Cr	10.89	0.0208	114	6.55	0.066	11.35	1.41	
FE25-FE29 Indian Cr	14.16	0.0026	518	8.28	0.029	10.74	1.93	
FE29-FE37 Indian Cr	12.35	0.0093	730	9.20	0.046	13.64	1.33	
FE33-FE35 Spanish Cr	5.57	0.0077	183	6.84	0.045	10.45	0.78	47
FE35-FE37 Spanish Cr	5.92	0.0076	202	6.92	0.045	10.53	0.82	49
FE37-FE39 NFk EBr	17.59	0.0063	1009	10.39	0.039	14.41	1.79	
FE39-FE41 NFk	6.98	0.0085	1773	13.68	0.042	18.74	0.55	33
FE3-FE5 Hamilton Cr	5.91	0.0173	222	7.01	0.061	11.74	0.74	44
FE41-FE45 NFk	4.69	0.0113	1787	13.74	0.047	19.46	0.35	21
FE43-FE45 Bucks Cr	6.09	0.0802	39	6.22	0.112	12.80	0.70	42
FE45-FE47 NFk	9.10	0.0065	1914	14.29	0.038	18.81	0.71	43
FE47-FE49 NFk	8.80	0.0108	1953	14.45	0.046	20.19	0.64	38
FE49-FE87 Oroville	14.24	0.0004	2044	14.85	0.013	13.90	1.70	Use 30 min
FE51-FE53 WBr	21.93	0.0199	119	6.57	0.065	11.32	2.84	
FE53-FE87 Oroville	8.22	0.0002	168	6.78	0.011	6.69	1.80	Use 10 min
FE57-FE61 Smithneck	2.08	0.0006	298	7.34	0.030	4.59	0.66	40
FE59-FE61 MFk	18.21	0.0064	133	6.63	0.042	9.95	2.68	
FE5-FE9 Almanor	6.10	0.0001	222	7.01	0.009	6.33	1.41	Use 10 min
FE61-FE63 MFk	5.45	0.0001	522	8.30	0.030	2.04	3.92	
FE63-FE67 MFk	7.87	0.0020	620	8.72	0.026	10.86	1.06	
FE65-FE63 Grizzly C	6.05	0.0236	54	6.29	0.070	11.14	0.80	48
FE67-FE69 MFk	14.99	0.0070	727	9.18	0.042	13.17	1.67	
FE69-FE71 MFk	17.31	0.0055	884	9.86	0.037	13.57	1.87	
FE71-FE73 MFk	37.45	0.0142	1105	10.81	0.053	16.40	3.35	
FE73-FE89 Oroville	14.73	0.0003	1178	11.12	0.012	10.57	2.04	Use 30 min
FE75-FE81 SFk	18.14	0.0284	52	6.28	0.075	11.38	2.34	
FE77-FE79 Lost Cr	1.89	0.0130	30	6.19	0.056	10.23	0.27	16
FE79-FE81 Lost Cr	3.04	0.0753	33	6.20	0.109	12.66	0.35	21
FE7-FE9 Almanor	11.13	0.0002	280	7.26	0.011	7.08	2.31	Use 10 min
FE81-FE83 SFk	1.89	0.0321	88	6.43	0.078	11.78	0.23	14
FE83-FE85 SFk	6.91	0.0203	107	6.52	0.066	11.27	0.90	54
FE85-FE89 Oroville	10.77	0.0001	162	6.75	0.009	6.14	2.57	Use 30 min
FE87-FE89 Oroville	7.27	0.0001	2249	15.73	0.008	12.34	0.86	Use 30 min
FE89-FE91 Feather*	8.73	0.0025	3617	21.61	0.035	16.51	0.78	47
FE91-FE93 Feather*	11.37	0.0010	3663	21.81	0.030	12.26	1.36	
FE9-FE15 NFk Ab Butt	10.14	0.0247	545	8.40	0.068	14.23	1.05	

Routing parameters based on field observations and regression analysis. (Dec 1996 Event)

HEC-HMS Summary of Results
Feather River Basin: March 1995 Event

Project	: Feather River	Run Name	: Mar 1995 Event
Start of Run	: 07Mar95 2400	Basin Model	: Feather95
End of Run	: 15Mar95 2400	Met. Model	: Mar 95 Event
Execution Time	: 15Feb01 0959	Control Specs.	: Mar 95 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
Oroville Outflow	86461	11 Mar 95 1500	980561	3593.340
FE89-FE91 Feather	86461	11 Mar 95 1600	976485	3593.340
FE86 Bl Lk Oroville	294.76	10 Mar 95 1900	1363.4	25.047
FE91 Oroville Ga	86660	11 Mar 95 1600	977848	3618.387
FE91-FE93 Feather	86523	11 Mar 95 2100	970773	3618.387
FE88 Feather Out	282.67	11 Mar 95 1800	1541.3	46.506
FE93 Gridley Ga	86783	11 Mar 95 1800	972314	3664.893
FE50 Hendricks Div D	3726.8	10 Mar 95 1800	22048	46.031
FE51 Hendricks Ga	3726.8	10 Mar 95 1800	22048	46.031
FE51-FE53 WBr	3669.4	10 Mar 95 2100	21844	46.031
FE52 WBr Bl Hendrick	8757.1	10 Mar 95 2000	54055	96.669
FE53	12394	10 Mar 95 2000	75899	142.700
FE53-FE87 Oroville	12281	10 Mar 95 2100	75774	142.700
FE10 ButtCr Hdwtr	2969.2	10 Mar 95 1900	12777	54.423
FE11 Butt Cr Ga	2969.2	10 Mar 95 1900	12777	54.423
FE11-FE13 Butt Val R	2943.2	10 Mar 95 2000	12753	54.423
FER12 ButtValley Res	1786.6	10 Mar 95 1800	9327.9	12.111
FER13 Butt Valley	19.707	15 Mar 95 2400	238.14	66.534
FE13-FE15 ButtCr	19.674	15 Mar 95 2400	237.47	66.534
L Almanor Out	44.000	10 Mar 95 1800	617.15	503.000
FE9-FE15 NFk Ab Butt	44.000	10 Mar 95 2300	616.89	503.000
FE14 NFk Bl Almanor	2643.8	10 Mar 95 1900	8455.9	44.996
FE15 Belden Ga	2701.3	10 Mar 95 1900	9310.3	614.530
FE15-FE39 NFk Ab EBr	2678.3	10 Mar 95 2000	9287.7	614.530
FE32 Spanish Cr Hdwt	9340.8	09 Mar 95 1600	49272	86.778
FE33	9340.8	09 Mar 95 1600	49272	86.778
FE33-FE35 Spanish Cr	9318.3	09 Mar 95 1600	49123	86.778
FE34 Spanish Cr	4933.3	09 Mar 95 1900	25424	96.183
FE35 Spanish Cr Ga	13930	09 Mar 95 1800	74548	182.961
FE35-FE37 Spanish Cr	13928	09 Mar 95 1900	74336	182.961
FER22 Antelope Lk	2320.6	10 Mar 95 1400	10249	71.203
FER23 Antelope Lk	2320.6	10 Mar 95 1400	10249	71.203
FE23-FE25 Indian Cr	2254.8	10 Mar 95 1600	10131	71.203

... Continued ...

HEC-HMS Summary of Results
Feather River Basin: March 1995 Event
(Continued)

Project : Feather River Run Name : Mar 95 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
FE18 Last Chance Cr	2446.5	10 Mar 95 1900	11184	177.878
FE19	2446.5	10 Mar 95 1900	11184	177.878
FE19-FE25 LastChanc	2440.5	10 Mar 95 1900	11176	177.878
FE24 Indian Cr Bl An	1455.5	15 Mar 95 2000	6148.8	42.805
FE20 Red Clover Cr	2955.7	10 Mar 95 2000	12956	128.363
FE25	8259.9	10 Mar 95 1800	40412	420.249
FE25-FE29 Indian Cr	8237.2	10 Mar 95 1900	40211	420.249
FE28 Lights Cr Hdwtr	4007.9	10 Mar 95 1500	19602	105.032
FE26 Indian Cr	2569.6	10 Mar 95 1800	12706	102.263
FE29	14677	10 Mar 95 1900	72519	627.544
FE29-FE37 Indian Cr	14635	10 Mar 95 2000	71951	627.544
FE36 Spanish Cr	1892.9	10 Mar 95 1900	9971.7	19.322
FE30 Indian Cr	8217.7	10 Mar 95 2000	39834	102.211
FE37	35423	10 Mar 95 2000	196091	932.038
FE37-FE39 NFk EBr	35299	10 Mar 95 2100	195143	932.038
FE16 NFk Ab E Br	4292.7	09 Mar 95 1300	21698	31.873
FE38 NFk E Br	7705.8	09 Mar 95 1500	40837	76.512
FE39	47556	10 Mar 95 2000	266966	1654.953
FE39-FE41 NFk	47345	10 Mar 95 2100	266282	1654.953
FE40 NFk Bl E Br	10046	09 Mar 95 1600	54165	118.426
FE41 Rock Cr Ga	55645	10 Mar 95 2000	320447	1773.379
FE41-FE45 NFk	55398	10 Mar 95 2100	319945	1773.379
Bucks Lake Outflow	140.00	15 Mar 95 2400	366.74	29.500
FE43-FE45 Bucks Cr	138.60	15 Mar 95 2400	358.76	29.500
FE44 Bucks Cr	5091.7	09 Mar 95 1200	23978	25.033
FE45	57540	10 Mar 95 2000	344282	1827.912
FE45-FE47 NFk	57458	10 Mar 95 2100	343177	1827.912
FE46 NFk Bl Storrie	12124	09 Mar 95 1300	56717	87.701
FE47 NFk Grizzly Ga	62683	10 Mar 95 2000	399894	1915.613
FE47-FE49 NFk	62619	10 Mar 95 2100	398777	1915.613
FE48 NFk Nr Pulga	4032.6	10 Mar 95 1900	24819	39.113
FE49 Pulga Ga	66077	10 Mar 95 2000	423597	1954.726
FE49-FE87 Oroville	66066	10 Mar 95 2100	422687	1954.726
FE87	78347	10 Mar 95 2100	498462	2097.426
FE87-FE89 Oroville	78186	10 Mar 95 2100	497951	2097.426
FER76 SlyCr Res	1862.0	10 Mar 95 1800	10591	24.055
FER77 Sly Ck Res	841.89	15 Mar 95 0400	6044.9	24.055
FE77-FE79 Lost Cr	840.84	15 Mar 95 0400	6030.1	24.055
FE78 Lost Cr Bl Sly	1033.3	09 Mar 95 1200	5885.9	5.941

... Continued ...

HEC-HMS Summary of Results
Feather River Basin: March 1995 Event
(Continued)

Project : Feather River   Run Name : Mar 95 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
FE79 Lost Cr Ga	1408.4	14 Mar 95 2300	11916	29.996
FE79-FE81 Lost Cr	1384.5	14 Mar 95 2300	11890	29.996
L Grass V Out	1840.0	11 Mar 95 0100	15665	25.900
FE75-FE81 SFk	1829.2	11 Mar 95 0300	15575	25.900
FE80 SFk Bl Lt Grass	3482.0	09 Mar 95 1600	20767	31.883
FE81	4890.4	10 Mar 95 1900	48232	87.779
FE81-FE83 SFk	4865.0	10 Mar 95 1900	48188	87.779
FE83 Forbestown Ga	4865.0	10 Mar 95 1900	48188	87.779
FE83-FE85 SFk	4834.2	10 Mar 95 2000	48001	87.779
FE82 SFk Bl Lost Cr	1426.5	10 Mar 95 1900	6894.2	19.561
FE85 Miners Ranch	6111.7	10 Mar 95 2000	54895	107.340
FE85-FE89 Oroville	6108.4	10 Mar 95 2000	54841	107.340
FER64 Lake Davis	1566.2	10 Mar 95 1500	5673.7	44.214
FER65 Lk Davis	227.37	15 Mar 95 2200	2888.4	44.214
FE65-FE63 Grizzly C	227.36	15 Mar 95 2300	2882.2	44.214
FE54 Cold Stream	2744.4	10 Mar 95 2300	12689	121.186
FE56 Smithneck Cr	5127.9	10 Mar 95 2100	21851	170.822
FE57	7785.5	10 Mar 95 2200	34540	292.008
FE57-FE61 Smithneck	7725.2	10 Mar 95 2200	34473	292.008
FER58 Frenchman Lk	1749.0	10 Mar 95 1500	6160.7	77.823
FER59 Frenchman Lk	513.21	12 Mar 95 0300	5667.6	77.823
FE59-FE61 MFk	513.19	12 Mar 95 0400	5660.4	77.823
FE60 MFk Bl Frenchmn	2235.5	10 Mar 95 2100	9504.5	60.953
FE61	10342	10 Mar 95 2200	49638	430.784
FE61-FE63 MFk	10226	10 Mar 95 2400	49354	430.784
FE62 MFk Bl Smithnec	4330.6	10 Mar 95 1800	19604	91.483
FE63	14316	10 Mar 95 2200	71840	566.481
FE63-FE67 MFk	14297	10 Mar 95 2300	71603	566.481
FE66 MFk Nr Portola	3067.4	10 Mar 95 1800	14754	53.162
FE67	16495	10 Mar 95 2200	86357	619.643
FE67-FE69 MFk	16471	10 Mar 95 2300	85889	619.643
FE68 MFk Nr Blairsdn	6062.7	10 Mar 95 1800	32056	135.896
FE69	21551	10 Mar 95 2200	117945	755.539
FE69-FE71 MFk	21478	10 Mar 95 2400	117305	755.539
FE70 MFk Nr Quincy	7008.4	09 Mar 95 2000	37958	128.953
FE71	25561	10 Mar 95 2300	155263	884.492
FE71-FE73 MFk	25412	11 Mar 95 0300	153520	884.492
FE72 MFk Ab Oroville	34587	09 Mar 95 1400	192119	255.057
FE73	41090	10 Mar 95 1900	345639	1139.549
FE73-FE89 Oroville	40797	10 Mar 95 1900	345003	1139.549

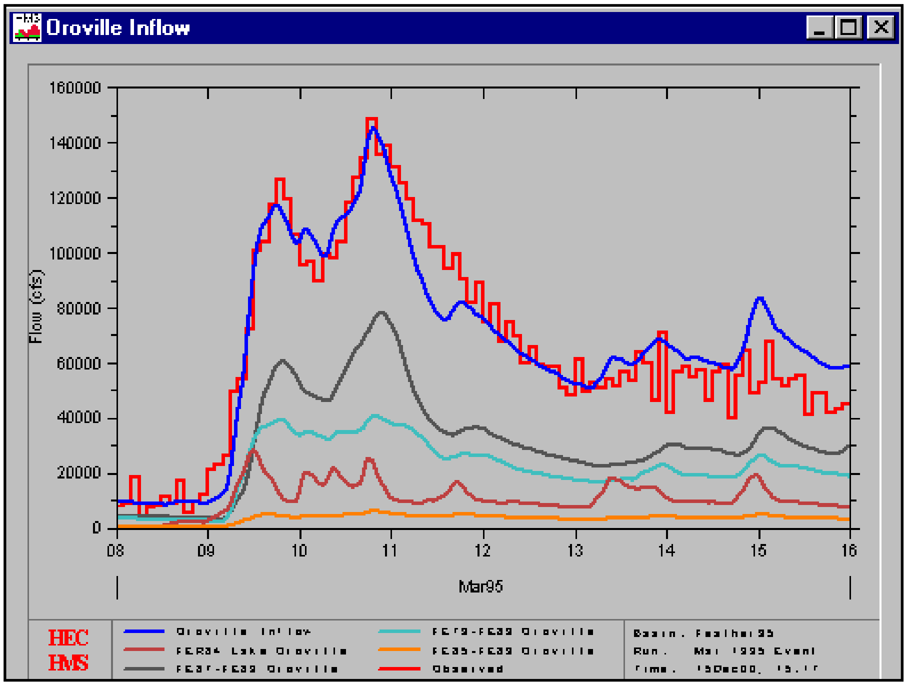
... Continued ...

HEC-HMS Summary of Results
Feather River Basin: March 1995 Event
(Continued)

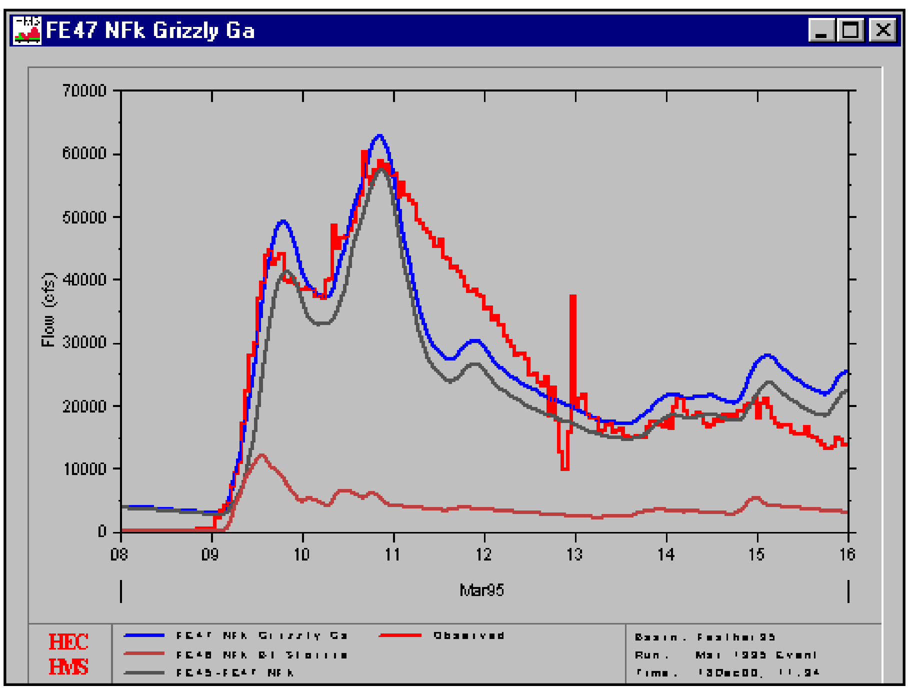
Project : Feather River Run Name : Mar 95 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
FER84 Lake Oroville	28364	09 Mar 95 1200	172581	249.023
Oroville Inflow	145587	10 Mar 95 1900	1070376	3593.338
FE6 NFk Ab Almanor	7645.8	10 Mar 95 1800	38637	133.004
FE7	7645.8	10 Mar 95 1800	38637	133.004
FE7-FE9 Almanor	7620.7	10 Mar 95 1800	38612	133.004
FER2 Mtn Meadow Res	9451.5	10 Mar 95 1800	44524	165.451
FER3 Mtn Meadow	9451.5	10 Mar 95 1800	44524	165.451
FE3-FE5 Hamilton Cr	9396.7	10 Mar 95 1800	44361	165.451
FE4 HamiltnCr Ab Alm	4830.9	10 Mar 95 1700	23998	56.219
FE5	14217	10 Mar 95 1800	68359	221.670
FE5-FE9 Almanor	14183	10 Mar 95 1800	68301	221.670
FER8 Lake Almanor	10450	10 Mar 95 1900	57548	147.569
L Almanor Inflow	31867	10 Mar 95 1800	164461	502.243
FER74 Lt Grass Valle	4321.1	09 Mar 95 1600	21260	25.998
L Grass V Inflow	4321.1	09 Mar 95 1600	21260	25.998
FER42 Bucks Lake	5054.1	09 Mar 95 1300	25521	28.440
Bucks lake inflow	5054.1	09 Mar 95 1300	25521	28.440
FER75 Lt Grass Vally	36.339	07 Mar 95 2400	448.87	0.000
FER9 Lk Almanor	0.0	07 Mar 95 2400	0.0	0.000
FER43 Bucks Lk	0.0	07 Mar 95 2400	0.0	0.000
FER89 Oroville Lk	0.0	07 Mar 95 2400	0.0	0.000

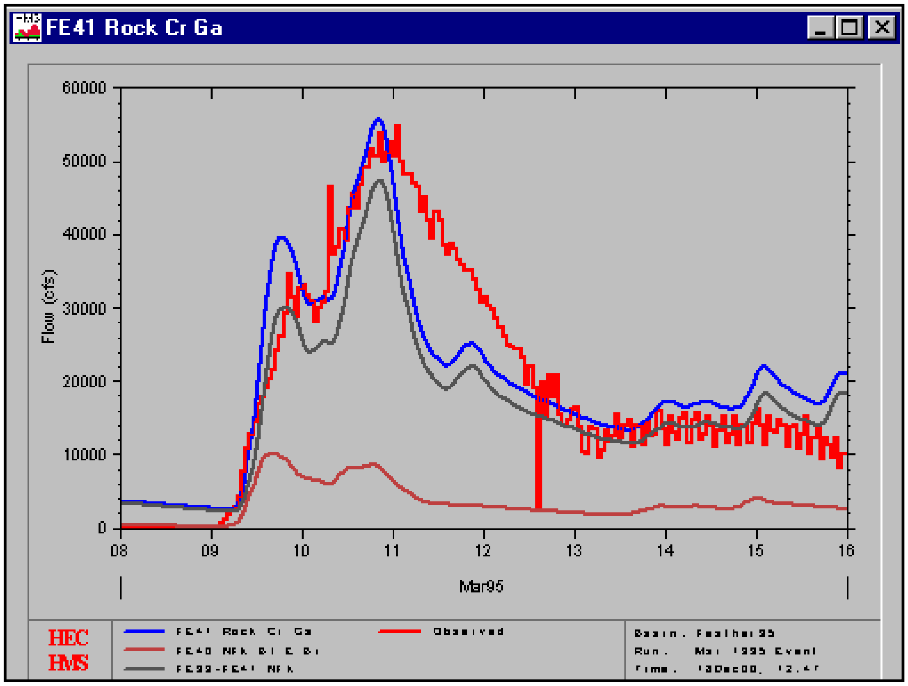
HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Feather River Basin
March 1995 Event



Oroville Inflow – Lake Oroville Inflow



FE47 – North Fork Below Grizzly Creek Gage



FE41 – Rock Creek Gage

HEC-HMS Subbasin Parameters
Feather River Basin: March 1995 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
FE30 Indian Cr	3	0.7	0.35	5.0	.05	0
FE28 Lights Cr Hdwtr	3	0.7	0.35	5.0	.05	0
FE24 Indian Cr Bl An	3	0.7	0.35	5.0	.05	0
FE38 NFk E Br	3	0.7	0.35	4.0	.07	0
FE16 NFk Ab E Br	3	0.7	0.35	4.0	.07	0
FE20 Red Clover Cr	3	0.7	0.35	5.0	.05	0
FE40 NFk Bl E Br	3	0.7	0.35	4.0	.07	0
FE36 Spanish Cr	3	0.7	0.35	5.0	.05	0
FE26 Indian Cr	3	0.7	0.35	5.0	.05	0
FE60 MFk Bl Frenchmn	3	0.7	0.35	5.0	.05	0
FER84 Lake Oroville	3	0.7	0.35	3.0	.05	15
FE56 Smithneck Cr	3	0.7	0.35	5.0	.05	0
FE54 Cold Stream	3	0.7	0.35	5.0	.05	0
FE88 Feather Out	3	0.7	0.35	5.0	.10	0
FE50 Hendricks Div D	3	0.7	0.35	5.0	.05	0
FE34 Spanish Cr	3	0.7	0.35	4.0	.07	0
FER2 Mtn Meadow Res	3	0.7	0.35	5.0	.05	0
FE48 NFk Nr Pulga	3	0.7	0.35	5.0	.05	0
FER74 Lt Grass Valle	3	0.7	0.35	5.0	.05	12
FE80 SFk Bl Lt Grass	3	0.7	0.35	2.5	.03	0
FE82 SFk Bl Lost Cr	3	0.7	0.35	5.0	.05	0
FER42 Bucks Lake	3	0.7	0.35	5.0	.05	0
FE66 MFk Nr Portola	3	0.7	0.35	5.0	.05	0
FE70 MFk Nr Quincy	3	0.7	0.35	5.0	.05	0
FE72 MFk Ab Oroville	3	0.7	0.35	5.0	.05	0
FE86 Bl Lk Oroville	3	0.7	0.35	3.0	.12	0
FE44 Bucks Cr	3	0.7	0.35	5.0	.12	0
FE46 NFk Bl Storrie	3	0.7	0.35	3.0	.12	0
FE52 WBr Bl Hendrick	3	0.7	0.35	3.0	.05	0
FER58 Frenchman Lk	3	0.7	0.35	5.0	.05	0
FER64 Lake Davis	3	0.7	0.35	5.0	.05	0
FE62 MFk Bl Smithnec	3	0.7	0.35	5.0	.05	0
FER22 Antelope Lk	3	0.7	0.35	5.0	.05	0
FER76 SlyCr Res	3	0.7	0.35	5.0	.05	0
FE78 Lost Cr Bl Sly	3	0.7	0.35	2.0	.03	0
FE6 NFk Ab Almanor	3	0.7	0.35	5.0	.05	0
FE10 ButtCr Hdwtr	3	0.7	0.35	5.5	.12	0
FER12 ButtValley Res	3	0.7	0.35	5.0	.05	0
FE4 HamiltnCr Ab Alm	3	0.7	0.35	5.0	.05	0
FER8 Lake Almanor	3	0.7	0.35	5.0	.05	10
FE14 NFk Bl Almanor	3	0.7	0.35	8.0	.15	0
FE18 Last Chance Cr	3	0.7	0.35	5.0	.05	0
FE32 Spanish Cr Hdwt	3	0.7	0.35	4.0	.07	0
FE68 MFk Nr Blairsdn	3	0.7	0.35	5.0	.05	0

HEC-HMS Summary of Results
Feather River Basin: December 1996 - January 1997 Event

Project	: Feather River		Run Name	: Jan 97 Event	
Start of Run	: 25Dec96	2400	Basin Model	:	Feather97
End of Run	: 08Jan97	2400	Met. Model	:	Jan 97 Event
Execution Time	: 15Feb01	0958	Control Specs.	:	Jan 97 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
Oroville Outflow	160917	01 Jan 97 1900	2021660	3593.340
FE89-FE91 Feather	160917	01 Jan 97 2000	2018747	3593.340
FE86 Bl Lk Oroville	3125.6	01 Jan 97 1300	17671	25.047
FE91 Oroville Ga	163867	01 Jan 97 2000	2036418	3618.387
FE91-FE93 Feather	163656	01 Jan 97 2100	2031357	3618.387
FE88 Feather Out	3879.9	01 Jan 97 1300	22885	46.506
FE93 Gridley Ga	167166	01 Jan 97 2100	2054242	3664.893
FE50 Hendricks Div D	13275	01 Jan 97 2000	94969	46.031
FE51 Hendricks Ga	13275	01 Jan 97 2000	94969	46.031
FE51-FE53 WBr	13262	01 Jan 97 2000	94941	46.031
FE52 WBr Bl Hendrick	25065	01 Jan 97 1900	189824	96.669
FE53	38280	01 Jan 97 1900	284765	142.700
FE53-FE87 Oroville	38255	01 Jan 97 1900	284758	142.700
FE10 ButtCr Hdwtr	4356.4	01 Jan 97 2000	18427	54.423
FE11 Butt Cr Ga	4356.4	01 Jan 97 2000	18427	54.423
FE11-FE13 Butt Val R	4345.4	01 Jan 97 2100	18428	54.423
FER12 ButtValley Res	1028.1	01 Jan 97 0800	3418.5	12.111
FER13 Butt Valley	19.533	08 Jan 97 2400	403.40	66.534
FE13-FE15 ButtCr	19.528	08 Jan 97 2400	402.74	66.534
L Almanor Out	2160.0	05 Jan 97 0900	25716	503.000
FE9-FE15 NFk Ab Butt	2159.0	05 Jan 97 1100	25536	503.000
FE14 NFk Bl Almanor	3077.0	01 Jan 97 1900	12241	44.996
FE15 Belden Ga	3422.8	01 Jan 97 1900	38180	614.530
FE15-FE39 NFk Ab EBr	3407.3	01 Jan 97 2000	38006	614.530
FE32 Spanish Cr Hdwt	15426	01 Jan 97 2000	73985	86.778
FE33	15426	01 Jan 97 2000	73985	86.778
FE33-FE35 Spanish Cr	15419	01 Jan 97 2100	73969	86.778
FE34 Spanish Cr	9465.1	01 Jan 97 2100	40686	96.183
FE35 Spanish Cr Ga	24885	01 Jan 97 2100	114655	182.961
FE35-FE37 Spanish Cr	24860	01 Jan 97 2200	114635	182.961
FER22 Antelope Lk	9010.2	01 Jan 97 2000	62378	71.203
FER23 Antelope Lk	9010.2	01 Jan 97 2000	62378	71.203
FE23-FE25 Indian Cr	8960.8	01 Jan 97 2100	62230	71.203

... Continued ...

HEC-HMS Summary of Results
Feather River Basin: December 1996 - January 1997 Event
(Continued)

Project : Feather River Run Name : Jan 97 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
FE18 Last Chance Cr	1481.1	01 Jan 97 1500	10482	177.878
FE19	1481.1	01 Jan 97 1500	10482	177.878
FE19-FE25 LastChanc	1475.2	01 Jan 97 1600	10511	177.878
FE24 Indian Cr Bl An	1416.9	01 Jan 97 1200	6192.9	42.805
FE20 Red Clover Cr	1691.7	01 Jan 97 2300	8990.2	128.363
FE25	13177	01 Jan 97 2100	87924	420.249
FE25-FE29 Indian Cr	13148	01 Jan 97 2200	87889	420.249
FE28 Lights Cr Hdwtr	4294.6	01 Jan 97 2000	18034	105.032
FE26 Indian Cr	4632.8	01 Jan 97 2000	19120	102.263
FE29	21958	01 Jan 97 2100	125043	627.544
FE29-FE37 Indian Cr	21862	01 Jan 97 2200	125028	627.544
FE36 Spanish Cr	2726.3	01 Jan 97 1900	10790	19.322
FE30 Indian Cr	8272.1	01 Jan 97 2100	37498	102.211
FE37	57360	01 Jan 97 2200	287950	932.038
FE37-FE39 NFk EBr	57267	01 Jan 97 2300	287909	932.038
FE16 NFk Ab E Br	5436.3	01 Jan 97 1900	25647	31.873
FE38 NFk E Br	11504	01 Jan 97 2000	52516	76.512
FE39	76178	01 Jan 97 2100	404078	1654.953
FE39-FE41 NFk	76084	01 Jan 97 2200	403951	1654.953
FE40 NFk Bl E Br	25870	01 Jan 97 2100	154943	118.426
FE41 Rock Cr Ga	101616	01 Jan 97 2200	558894	1773.379
FE41-FE45 NFk	101600	01 Jan 97 2200	558796	1773.379
Bucks Lake Outflow	402.00	05 Jan 97 2400	3454.6	29.500
FE43-FE45 Bucks Cr	400.29	06 Jan 97 0100	3454.5	29.500
FE44 Bucks Cr	7471.7	01 Jan 97 0900	35024	25.033
FE45	106299	01 Jan 97 2100	597274	1827.912
FE45-FE47 NFk	106279	01 Jan 97 2200	597062	1827.912
FE46 NFk Bl Storrie	21318	01 Jan 97 1800	125456	87.701
FE47 NFk Grizzly Ga	125649	01 Jan 97 2100	722518	1915.613
FE47-FE49 NFk	125590	01 Jan 97 2200	722306	1915.613
FE48 NFk Nr Pulga	9223.3	01 Jan 97 1300	48298	39.113
FE49 Pulga Ga	133105	01 Jan 97 2200	770604	1954.726
FE49-FE87 Oroville	133089	01 Jan 97 2200	770574	1954.726
FE87	170829	01 Jan 97 2100	1055332	2097.426
FE87-FE89 Oroville	170829	01 Jan 97 2100	1055332	2097.426
FER76 SlyCr Res	5870.9	01 Jan 97 1900	38364	24.055
FER77 Sly Ck Res	5006.8	01 Jan 97 2400	38125	24.055
FE77-FE79 Lost Cr	5002.2	01 Jan 97 2400	38121	24.055
FE78 Lost Cr Bl Sly	1727.6	01 Jan 97 1000	11442	5.941

... Continued ...

HEC-HMS Summary of Results
Feather River Basin: December 1996 - January 1997 Event
(Continued)

Project : Feather River Run Name : Jan 97 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
FE79 Lost Cr Ga	6059.2	01 Jan 97 2100	49563	29.996
FE79-FE81 Lost Cr	6048.3	01 Jan 97 2200	49556	29.996
L Grass V Out	8603.0	01 Jan 97 2100	42841	25.900
FE75-FE81 SFk	8170.5	01 Jan 97 2200	42812	25.900
FE80 SFk Bl Lt Grass	6968.9	01 Jan 97 2000	46257	31.883
FE81	21076	01 Jan 97 2200	138625	87.779
FE81-FE83 SFk	20904	01 Jan 97 2200	138610	87.779
FE83 Forbestown Ga	20904	01 Jan 97 2200	138610	87.779
FE83-FE85 SFk	20627	01 Jan 97 2200	138579	87.779
FE82 SFk Bl Lost Cr	3847.4	01 Jan 97 1800	23266	19.561
FE85 Miners Ranch	24078	01 Jan 97 2200	161844	107.340
FE85-FE89 Oroville	24078	01 Jan 97 2200	161844	107.340
FER64 Lake Davis	6546.6	01 Jan 97 1400	44501	44.214
FER65 Lk Davis	1452.4	04 Jan 97 0100	23245	44.214
FE65-FE63 Grizzly C	1452.4	04 Jan 97 0200	23181	44.214
FE54 Cold Stream	3404.9	02 Jan 97 0100	13731	121.186
FE56 Smithneck Cr	1507.1	01 Jan 97 2300	7074.2	170.822
FE57	4820.0	01 Jan 97 2400	20805	292.008
FE57-FE61 Smithneck	4785.7	02 Jan 97 0100	20843	292.008
FER58 Frenchman Lk	3380.2	01 Jan 97 2100	14684	77.823
FER59 Frenchman Lk	1417.5	02 Jan 97 0500	14424	77.823
FE59-FE61 MFk	1417.0	02 Jan 97 0600	14420	77.823
FE60 MFk Bl Frenchmn	192.69	01 Jan 97 2200	1468.0	60.953
FE61	6277.5	02 Jan 97 0100	36731	430.784
FE61-FE63 MFk	6227.1	02 Jan 97 0300	36865	430.784
FE62 MFk Bl Smithnec	1501.5	01 Jan 97 2300	5626.5	91.483
FE63	8565.2	02 Jan 97 0200	65672	566.481
FE63-FE67 MFk	8543.2	02 Jan 97 0300	65677	566.481
FE66 MFk Nr Portola	2113.2	01 Jan 97 2100	7138.1	53.162
FE67	9715.7	02 Jan 97 0200	72815	619.643
FE67-FE69 MFk	9701.5	02 Jan 97 0300	72820	619.643
FE68 MFk Nr Blairsdn	11238	01 Jan 97 2300	45414	135.896
FE69	20389	02 Jan 97 0100	118234	755.539
FE69-FE71 MFk	20389	02 Jan 97 0100	118239	755.539
FE70 MFk Nr Quincy	23143	01 Jan 97 2200	137529	128.953
FE71	42496	01 Jan 97 2400	255767	884.492
FE71-FE73 MFk	42407	02 Jan 97 0100	255732	884.492
FE72 MFk Ab Oroville	63671	01 Jan 97 1900	377721	255.057
FE73	100220	01 Jan 97 2200	633453	1139.549
FE73-FE89 Oroville	100198	01 Jan 97 2200	633440	1139.549

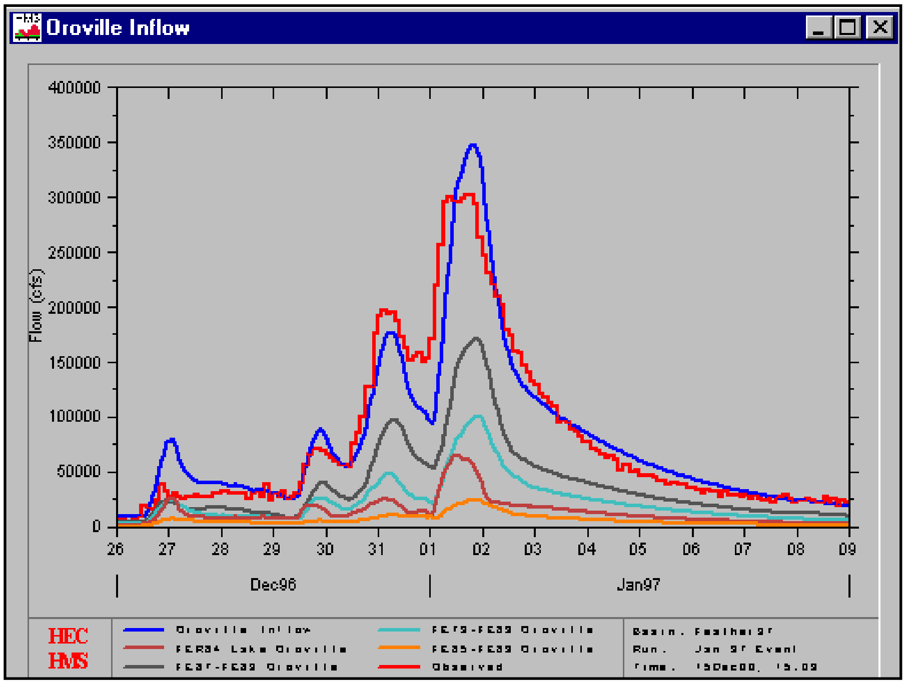
... Continued ...

HEC-HMS Summary of Results
Feather River Basin: December 1996 - January 1997 Event
(Continued)

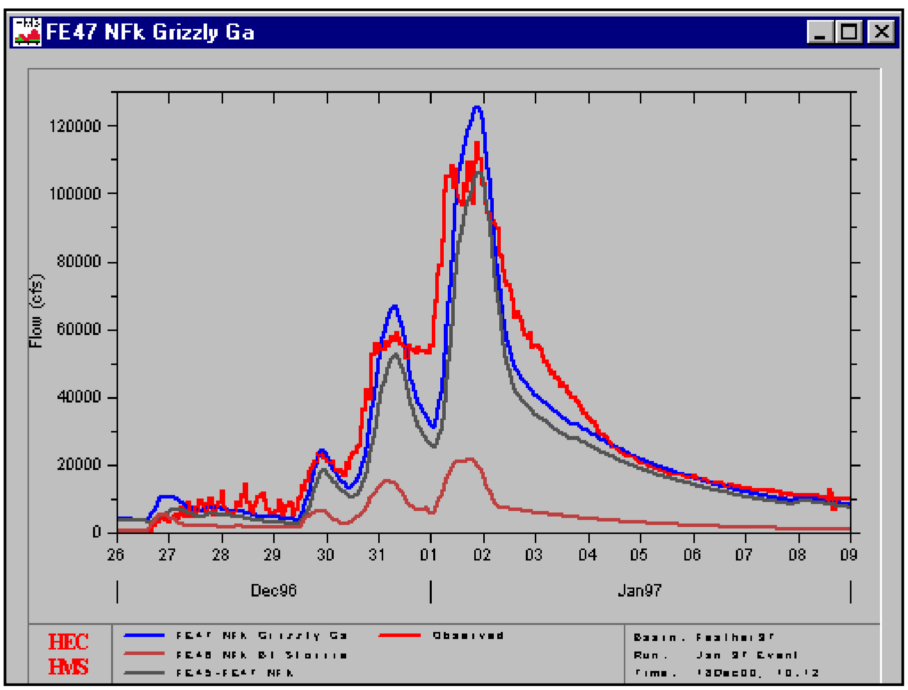
Project : Feather River Run Name : Jan 97 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
FER84 Lake Oroville	64706	01 Jan 97 1200	365246	249.023
Oroville Inflow	347733	01 Jan 97 2000	2215863	3593.338
FE6 NFk Ab Almanor	26676	01 Jan 97 2000	178725	133.004
FE7	26676	01 Jan 97 2000	178725	133.004
FE7-FE9 Almanor	26629	01 Jan 97 2000	178717	133.004
FER2 Mtn Meadow Res	26641	01 Jan 97 2000	186259	165.451
FER3 Mtn Meadow	26641	01 Jan 97 2000	186259	165.451
FE3-FE5 Hamilton Cr	26611	01 Jan 97 2100	186205	165.451
FE4 HamiltnCr Ab Alm	11643	01 Jan 97 1900	78437	56.219
FE5	37994	01 Jan 97 2000	264642	221.670
FE5-FE9 Almanor	37919	01 Jan 97 2000	264626	221.670
FER8 Lake Almanor	28913	01 Jan 97 2100	209894	147.569
L Almanor Inflow	93298	01 Jan 97 2100	653237	502.243
FER74 Lt Grass Valle	7859.7	01 Jan 97 1800	49560	25.998
L Grass V Inflow	7859.7	01 Jan 97 1800	49560	25.998
FER42 Bucks Lake	8320.8	01 Jan 97 1000	43902	28.440
Bucks lake inflow	8320.8	01 Jan 97 1000	43902	28.440
FER75 Lt Grass Vally	36.339	25 Dec 96 2400	660.72	0.000
FER9 Lk Almanor	0.0	25 Dec 96 2400	0.0	0.000
FER43 Bucks Lk	0.0	25 Dec 96 2400	0.0	0.000
FER89 Oroville Lk	0.0	25 Dec 96 2400	0.0	0.000

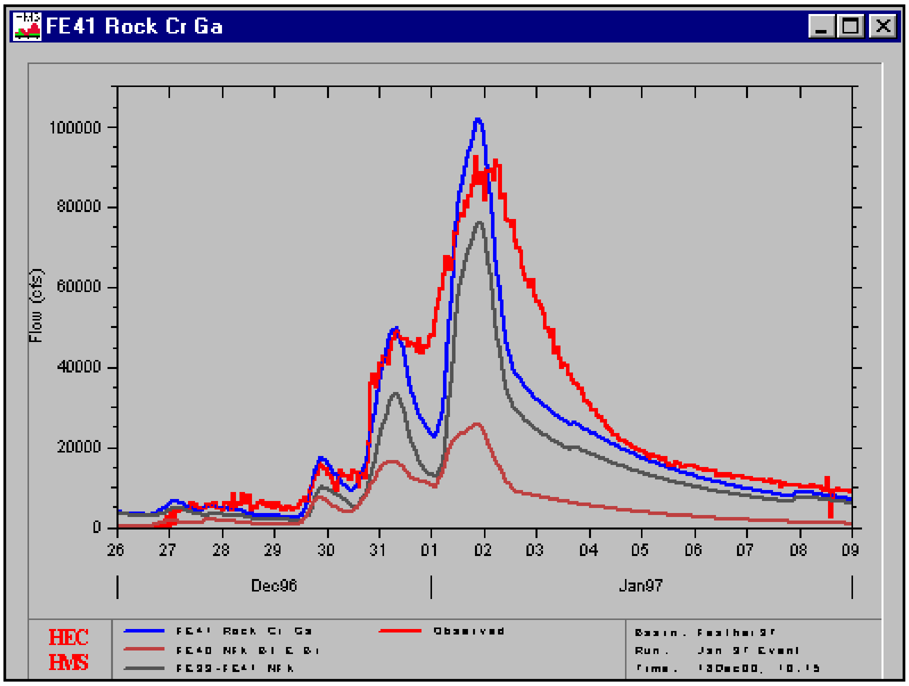
HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Feather River Basin
December 1996 - January 1997 Event



Oroville Inflow – Lake Oroville Inflow



FE47 – North Fork Below Grizzly Creek Gage

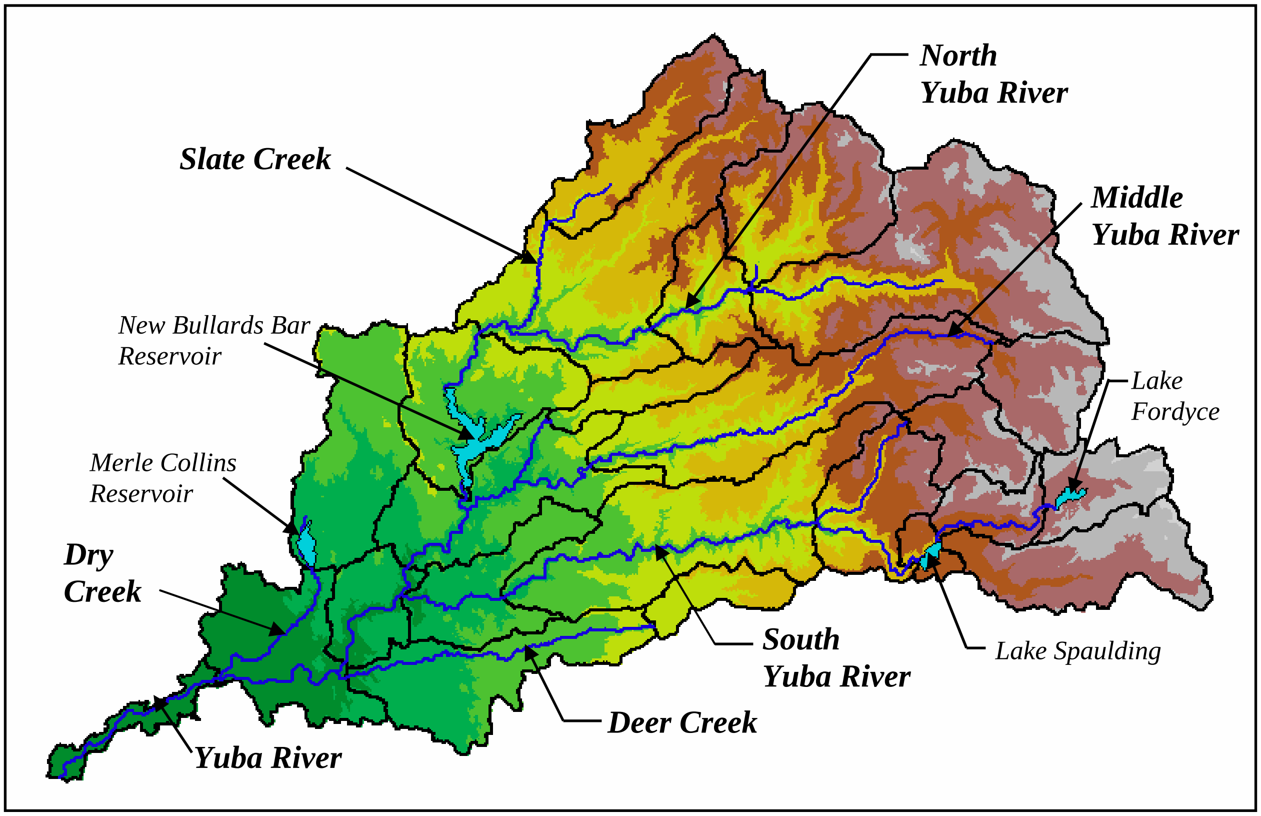


FE41 – Rock Creek Gage

HEC-HMS Subbasin Parameters
Feather River Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
FE30 Indian Cr	3	0.7	0.35	2.5	.20	0
FE28 Lights Cr Hdwtr	3	0.7	0.35	2.5	.20	0
FE24 Indian Cr Bl An	3	0.7	0.35	2.2	.20	0
FE38 NFk E Br	3	0.7	0.35	2.5	.20	0
FE16 NFk Ab E Br	3	0.7	0.35	1.0	.20	0
FE20 Red Clover Cr	3	0.7	0.35	2.5	.20	0
FE40 NFk Bl E Br	3	0.7	0.35	2.0	.10	0
FE36 Spanish Cr	3	0.7	0.35	2.5	.20	0
FE26 Indian Cr	3	0.7	0.35	2.5	.20	0
FE60 MFk Bl Frenchmn	3	0.7	0.35	1.0	.25	0
FER84 Lake Oroville	3	0.7	0.35	1.5	.01	15
FE56 Smithneck Cr	3	0.7	0.35	1.0	.25	0
FE54 Cold Stream	3	0.7	0.35	1.0	.25	0
FE88 Feather Out	3	0.7	0.35	1.0	.02	0
FE50 Hendricks Div D	3	0.7	0.35	0.5	.01	0
FE34 Spanish Cr	3	0.7	0.35	2.0	.17	0
FER2 Mtn Meadow Res	3	0.7	0.35	1.0	.02	0
FE48 NFk Nr Pulga	3	0.7	0.35	1.0	.15	0
FER74 Lt Grass Valle	3	0.7	0.35	1.0	.02	12
FE80 SFk Bl Lt Grass	3	0.7	0.35	1.0	.02	0
FE82 SFk Bl Lost Cr	3	0.7	0.35	1.0	.02	0
FER42 Bucks Lake	3	0.7	0.35	2.5	.20	0
FE66 MFk Nr Portola	3	0.7	0.35	1.0	.20	0
FE70 MFk Nr Quincy	3	0.7	0.35	1.0	.05	0
FE72 MFk Ab Oroville	3	0.7	0.35	1.0	.08	0
FE86 Bl Lk Oroville	3	0.7	0.35	1.0	.02	0
FE44 Bucks Cr	3	0.7	0.35	2.5	.20	0
FE46 NFk Bl Storrie	3	0.7	0.35	1.0	.15	0
FE52 WBr Bl Hendrick	3	0.7	0.35	0.5	.01	0
FER58 Frenchman Lk	3	0.7	0.35	1.0	.15	0
FER64 Lake Davis	3	0.7	0.35	1.0	.02	0
FE62 MFk Bl Smithnec	3	0.7	0.35	1.0	.25	0
FER22 Antelope Lk	3	0.7	0.35	1.0	.02	0
FER76 SlyCr Res	3	0.7	0.35	1.0	.02	0
FE78 Lost Cr Bl Sly	3	0.7	0.35	1.0	.02	0
FE6 NFk Ab Almanor	3	0.7	0.35	1.0	.02	0
FE10 ButtCr Hdwtr	3	0.7	0.35	3.5	.33	0
FER12 ButtValley Res	3	0.7	0.35	2.5	.33	0
FE4 HamiltnCr Ab Alm	3	0.7	0.35	1.0	.02	0
FER8 Lake Almanor	3	0.7	0.35	1.0	.02	10
FE14 NFk Bl Almanor	3	0.7	0.35	2.5	.30	0
FE18 Last Chance Cr	3	0.7	0.35	1.0	.20	0
FE32 Spanish Cr Hdwt	3	0.7	0.35	2.0	.17	0
FE68 MFk Nr Blairsdn	3	0.7	0.35	1.0	.20	0

Yuba River Basin



HEC-GeoHMS Subbasin Delineation

Yuba River

The Yuba River HMS model consists of a 1,339 square mile basin located in the southeast portion of the Sacramento Watershed above the gage near Marysville, CA. The basin model is divided into 24 subbasins and connected with 24 routing reaches. The observed hydrographs are computed inflows into the Engelbright and New Bullards Bar Reservoirs and at gages at Jones Bar and on the Middle Fork near Our House. The computed peak inflow into Engelbright Reservoir for the 1997 event was larger than the 1995 event (133,391 cfs vs. 38,626 cfs).

The adopted TC and R (Group 1) values were used. The generic equation to compute the reach travel time (Muskingum K) was not used because the reach travel times were too short; thus, causing the computed peaks to occur too early. Instead, the reach travel time (K) was computed knowing the reach length and average velocity. The average velocity was computed using Manning’s equation. The Manning’s “n” value was estimated with Jarrett’s equation, and the hydraulic radius was estimated from the Yuba River equation, which was developed from a regression of field data. Of the 24 routing reaches, 7 reaches used the Muskingum routing technique. The other 17 reaches used the lag method since the travel time within each of those reaches was less than the one-hour time step used by the Muskingum method.

For this modeling effort, rather than attempt to predict how the Jackson Meadows, Bowman, Spaulding, New Bullards Bar, and Englebright reservoirs were operated, the source and sink tools available in HMS were implemented. This technique allowed the observed hydrograph at the outlet of each of the reservoirs to be passed downstream. As pointed out in “Section 6.6.5, Reservoir Modeling” of the main report, HMS is fairly limited in how it models releases from reservoirs. Calibration efforts required different loss and baseflow parameters for different subbasins. Another reason the observed reservoir outflows were used as sources was to replace the inadequate computed runoff from the upstream basins. Even with the losses reduced to minimal values, the computed volumes and peaks for the 1997 event could not match the observed hydrographs. The thought was that the LWASS was not large enough to generate the observed volumes. The timing appears consistent with the observed hydrograph, but the volume and peak are not. This has been a problem in other basins as well. For the 1995 event, the observed and computed hydrographs matched very well. Ten percent impervious area was assumed for the New Bullards Bar Reservoir subbasin.

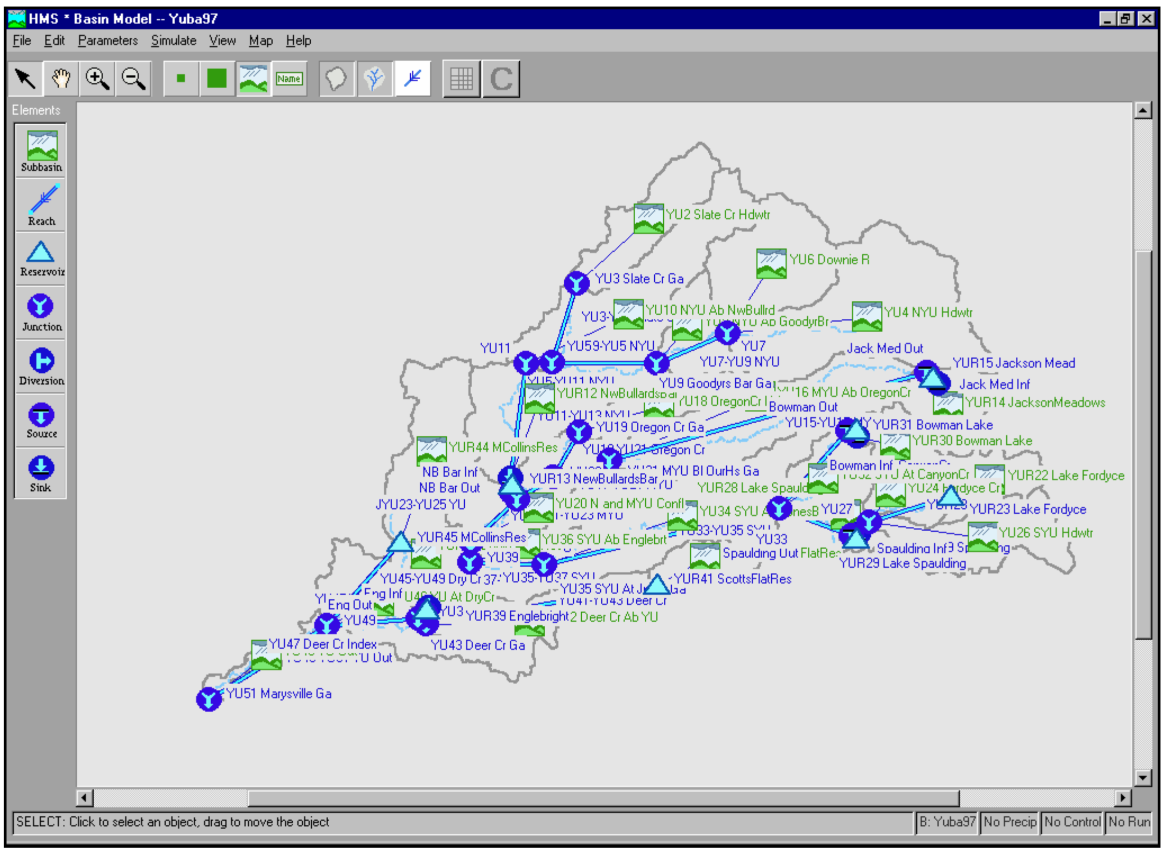
<u>Calibration of the 1995 Event:</u>

By using constant loss rates between 0.02 and 0.1 inches/hour and initial losses between 2 and 4 inches (most subbasins about 3 inches), the model calibrated well to observed hydrographs. A recession ratio of 0.8 and a peak ratio of 0.15 defined the recession limb of the hydrograph. An initial baseflow of 6 cfs per square mile was assumed. The event featured two peaks, with the second peak being the highest. The model calibrated well to both peaks.

<u>Calibration of the 1997 Event:</u>

The model calibrated well for the computed inflows into the Engelbright and New Bullards Bar Reservoirs, but gage data were not available at the two other gages for calibration. The baseflow recession parameters of 0.8 for the constant and 0.15 for the peak ratio worked best. The subbasins used low constant loss rates between 0.001 and 0.01 inches/hour, and an initial loss of 1.0 inch (except for 1.5 inches in the Oregon Creek headwater subbasin). An initial baseflow of 3 cfs per square mile was assumed.

Yuba River Basin HEC-HMS Model Schematic



Yuba River Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Initial TC $1.4(LL_{CA}/S^{1/2})^{.33}$ (Hr)	Initial R 2.33TC (cfs/Hr)	Final TC $0.68(LL_{CA}/S^{1/2})^{.46}$ (Hr)	Final R 4.0 TC (Hr)
YU10 NYU Ab NwBullrd	124.52	31.62	12.74	179.52	30.08	4.3	10.0	3.3	13.0
YU16 MYU Ab OregonCr	107.36	35.67	16.98	142.56	50.74	5.1	11.9	4.1	16.6
YU18 OregonCr Hdwtr	23.16	16.80	8.70	205.92	10.18	3.0	7.0	2.0	7.9
YU2 Slate Cr Hdwtr	49.43	20.06	10.22	174.24	15.52	3.5	8.1	2.4	9.6
YU20 N and MYU Confl	71.52	24.69	10.48	153.12	20.90	3.8	8.9	2.8	11.0
YU24 Fordyce Cr	21.87	13.67	4.91	200.64	4.74	2.3	5.4	1.4	5.6
YU26 SYU Hdwtr	59.47	21.55	11.44	174.24	18.68	3.7	8.6	2.6	10.5
YU32 SYU At CanyonCr	48.12	11.80	4.48	343.20	2.85	2.0	4.6	1.1	4.4
YU34 SYU Ab JonesBar	111.56	35.58	16.46	153.12	47.33	5.0	11.6	4.0	16.0
YU36 SYU Ab Englebrt	41.95	17.75	6.50	137.28	9.85	3.0	6.9	1.9	7.8
YU4 NYU Hdwtr	141.75	29.34	14.95	168.96	33.73	4.5	10.4	3.4	13.7
YU42 Deer Cr Ab YU	64.54	23.43	10.41	132.00	21.24	3.8	8.9	2.8	11.1
YU46 YU At DryCr	59.82	16.09	6.40	116.16	9.55	2.9	6.9	1.9	7.7
YU48 YU Out	14.67	14.85	7.29	42.24	16.66	3.5	8.3	2.5	9.9
YU6 Downie R	72.76	16.75	8.81	258.72	9.18	2.9	6.8	1.9	7.5
YU8 NYU Ab GoodyrBr	35.25	11.03	4.65	311.52	2.91	2.0	4.6	1.1	4.4
YUR12 NwBullardsBar	66.45	14.81	5.80	205.92	5.99	2.5	5.9	1.5	6.2
YUR14 JacksonMeadows	37.45	9.74	5.84	232.32	3.73	2.2	5.0	1.2	5.0
YUR22 Lake Fordyce	30.94	9.48	3.91	274.56	2.24	1.8	4.3	1.0	3.9
YUR28 Lake Spaulding	9.15	5.34	1.94	311.52	0.59	1.2	2.7	0.5	2.1
YUR30 Bowman Lake	28.32	11.06	5.23	232.32	3.79	2.2	5.1	1.3	5.0
YUR38 EnglebrightRes	27.87	11.16	4.32	179.52	3.60	2.1	5.0	1.2	4.9
YUR40 ScottsFlatRes	20.10	11.03	4.91	179.52	4.04	2.2	5.2	1.3	5.2
YUR44 MCollinsRes	72.12	21.78	10.86	116.16	21.94	3.9	9.0	2.8	11.3

Yuba River Reach Parameters

Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Cum Drainage Area (from GeoHms) A (Sq. Mi.)	Yuba River Field Reg. Eqa R = 4.13Ln(A) - 6.3926	Jarrett's Equation $n = .39S^{.38}R^{-.16}$	Manning's Velocity $v\ (ft/s) = 1.49R^{2/3}S^{1/2}/n$	Travel Time K Hrs	Lag (Min)
YU21-YU23 MYU	4.70	0.0121	206	15.61	0.047	21.81	0.32	19
YU25-YU37 YU	2.08	0.0006	733	20.85	0.035	7.90	0.39	23
YU35-YU37 SYU	7.94	0.0142	336	17.63	0.049	24.59	0.47	28
YU39-YU47 YU	0.83	0.0012	1109	22.56	0.035	11.78	0.10	6
YU43-YU47 Deer Cr	0.97	0.0685	89.8	12.18	0.094	21.87	0.06	4
YU45-YU49 Dry Cr	12.23	0.0135	82.3	11.82	0.051	17.56	1.02	
YU47-YU49 YU	10.14	0.0029	1204	22.90	0.026	25.22	0.59	35
YU49-YU51 YU Out	13.29	0.0014	1329	23.31	0.035	13.00	1.50	
YU27-YU29 Spaulding	2.68	0.0349	116	13.24	0.072	21.61	0.18	11
YUR23-YU27	9.78	0.0226	39.6	8.80	0.065	14.64	0.98	
YU29-YU33 SYU	8.30	0.0385	127	13.61	0.074	22.38	0.54	33
YU31-YU33 CanyonCr	10.46	0.0471	41.1	8.95	0.086	16.21	0.95	
YU7-YU9 NYU	7.78	0.0100	222	15.92	0.044	21.66	0.53	32
YU9-YU5 NYU	11.79	0.0079	259	16.56	0.040	21.75	0.80	48
YU3-YU5 Slate Cr	8.69	0.0330	54.8	10.14	0.074	17.22	0.74	44
YU5-YU11 NYU	2.52	0.0052	420	18.55	0.033	22.73	0.16	10
YU15-YU17 MYU	33.99	0.0213	81.5	11.78	0.061	18.50	2.70	
YU17-YU21 MYU	7.41	0.0126	156	14.46	0.048	20.57	0.53	32
YU19-YU21 Oregon Cr	5.66	0.0269	31	7.79	0.071	13.51	0.61	37
YU11-YU13 NYU	12.74	0.0096	430	18.65	0.042	24.57	0.76	46
YU33-YU35 SYU	25.96	0.0124	252	16.44	0.047	22.83	1.67	
YU41-YU43 Deer Cr	22.96	0.0198	40.2	8.86	0.062	14.49	2.32	
YU37-YU39 Englebrt	6.72	0.0063	1094	22.51	0.035	27.29	0.36	22
YU23-YU25 YU	7.25	0.0159	711	20.73	0.050	28.49	0.37	22

Final routing parameters based on field observations and regression analysis. (Dec 1996

HEC-HMS Summary of Results
Yuba River Basin: March 1995 Event

Project	: Yuba River	Run Name	: Mar 95 Event
Start of Run	: 06Mar95 2400	Basin Model	: Yuba95
End of Run	: 15Mar95 2400	Met. Model	: Mar 95 Event
Execution Time	: 31May00 1313	Control Specs.	: Mar 95 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
YUR44 MCollinsRes	3409.8	10 Mar 95 2000	18374	72.118
YUR45 MCollinsRes	3409.8	10 Mar 95 2000	18374	72.118
YU45-YU49 Dry Cr	3389.9	10 Mar 95 2100	18362	72.118
Eng Out	34348	10 Mar 95 0200	336521	1108.000
YU39-YU47 YU	34318	10 Mar 95 0200	336353	1108.000
YUR40 ScottsFlatRes	1961.4	09 Mar 95 2200	9653.9	20.103
YUR41 ScottsFlatRes	1558.8	09 Mar 95 2400	9327.0	20.103
YU41-YU43 Deer Cr	1547.6	10 Mar 95 0200	9266.5	20.103
YU42 Deer Cr Ab YU	3468.1	10 Mar 95 2000	20429	64.543
YU43 Deer Cr Ga	4718.6	10 Mar 95 2000	29696	84.646
YU43-YU47 Deer Cr	4702.9	10 Mar 95 2000	29693	84.646
YU47 Deer Cr Index	38392	10 Mar 95 0200	366046	1192.646
YU47-YU49 YU	38262	10 Mar 95 0300	365041	1192.646
YU46 YU At DryCr	2339.7	11 Mar 95 1700	9157.5	59.817
YU49	42193	10 Mar 95 2300	392560	1324.581
YU49-YU51 YU Out	42157	11 Mar 95 0100	389516	1324.581
YU48 YU Out	346.81	11 Mar 95 1800	1644.5	14.673
YU51 Marysville Ga	42325	11 Mar 95 0100	391160	1339.254
YUR22 Lake Fordyce	575.25	09 Mar 95 1700	2421.6	30.940
YUR23 Lake Fordyce	9.5641	15 Mar 95 2400	164.31	30.940
YUR23-YU27	9.5622	15 Mar 95 2400	164.25	30.940
YU24 Fordyce Cr	1165.4	09 Mar 95 1900	4762.7	21.865
YU26 SYU Hdwtr	2220.4	09 Mar 95 1900	10072	59.474
YU27	3394.8	09 Mar 95 1900	14999	112.279
YU27-YU29 Spaulding	3372.8	09 Mar 95 1900	14999	112.279
YUR28 Lake Spaulding	1543.0	09 Mar 95 1500	5554.6	9.147
Spaulding Inf	4347.7	09 Mar 95 1900	20553	121.426
YU2 Slate Cr Hdwtr	7008.0	09 Mar 95 1700	29663	49.427
YU3 Slate Cr Ga	7008.0	09 Mar 95 1700	29663	49.427
YU3-YU5 Slate Cr	6998.4	09 Mar 95 1800	29617	49.427
YU6 Downie R	8162.5	09 Mar 95 1600	32587	72.761
YU4 NYU Hdwtr	6974.0	09 Mar 95 2400	37074	141.747

... Continued ...

HEC-HMS Summary of Results
Yuba River Basin: March 1995 Event
(Continued)

Project : Yuba River   Run Name : Mar 95 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
YU7	14280	09 Mar 95 2000	69662	214.508
YU7-YU9 NYU	14225	09 Mar 95 2000	69626	214.508
YU8 NYU Ab GoodyrBr	5791.4	09 Mar 95 1500	23248	35.251
YU9 Goodyrs Bar Ga	18255	09 Mar 95 1700	92874	249.759
YU9-YU5 NYU	18231	09 Mar 95 1800	92783	249.759
YU5	25230	09 Mar 95 1800	122400	299.186
YU5-YU11 NYU	25188	09 Mar 95 1800	122370	299.186
YU10 NYU Ab NwBullrd	10307	09 Mar 95 1800	58925	124.516
YU11	35495	09 Mar 95 1800	181295	423.702
YU11-YU13 NYU	35395	09 Mar 95 1800	181254	423.702
YUR12 NwBullardsBar	5670.9	10 Mar 95 1900	28337	66.447
NB Bar Inf	39795	09 Mar 95 1800	209592	490.149
YU18 OregonCr Hdwtr	1474.0	10 Mar 95 1900	6917.6	23.162
YU19 Oregon Cr Ga	1474.0	10 Mar 95 1900	6917.6	23.162
YU19-YU21 Oregon Cr	1452.0	10 Mar 95 1900	6914.2	23.162
Jack Med Out	0.0	06 Mar 95 2400	0.0	37.100
YU15-YU17 MYU	0.0	06 Mar 95 2400	0.0	37.100
YU16 MYU Ab OregonCr	7280.5	10 Mar 95 1900	43037	107.362
YU21 MYU Bl OurHs Ga	7280.5	10 Mar 95 1900	43037	144.462
YU17-YU21 MYU	7247.7	10 Mar 95 2000	43017	144.462
YU23	8693.9	10 Mar 95 2000	49931	167.624
YU21-YU23 MYU	8676.8	10 Mar 95 2000	49917	167.624
NB Bar Out	15888	10 Mar 95 1800	197703	490.000
JYU23-YU25 YU	24565	10 Mar 95 2000	247620	657.624
YU23-YU25 YU	24520	10 Mar 95 2100	247159	657.624
YU20 N and MYU Confl	2533.7	09 Mar 95 1600	11503	71.515
YU25	26699	10 Mar 95 2000	258662	729.139
YU25-YU37 YU	26612	10 Mar 95 2100	258183	729.139
Bowman Out	0.0	06 Mar 95 2400	0.0	28.900
YU31-YU33 CanyonCr	0.0	06 Mar 95 2400	0.0	28.900
Spaulding Out	435.00	09 Mar 95 1600	1795.9	120.000
YU29-YU33 SYU	431.15	09 Mar 95 1600	1794.2	120.000
YU32 SYU At CanyonCr	6754.6	09 Mar 95 1600	27494	48.119
YU33	7185.8	09 Mar 95 1600	29288	197.019
YU33-YU35 SYU	7054.7	09 Mar 95 1700	29189	197.019
YU34 SYU Ab JonesBar	6959.4	10 Mar 95 2000	40604	111.560
YU35 SYU At JnsBr Ga	11169	10 Mar 95 1900	69794	308.579
YU35-YU37 SYU	11124	10 Mar 95 2000	69752	308.579
YU36 SYU Ab Englebrt	1214.4	10 Mar 95 1900	5457.3	41.951

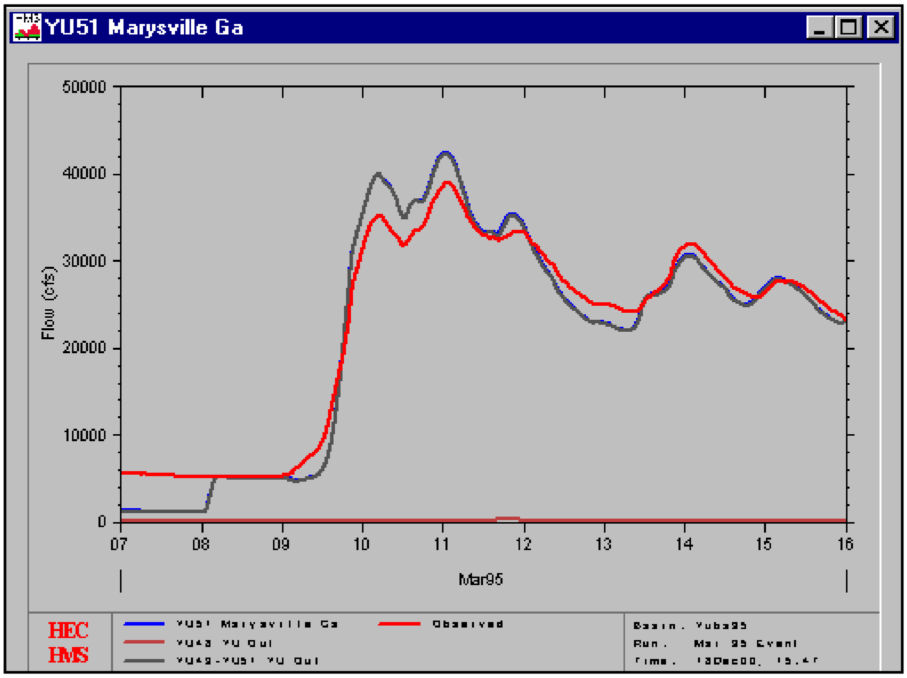
... Continued ...

HEC-HMS Summary of Results
Yuba River Basin: March 1995 Event
(Continued)

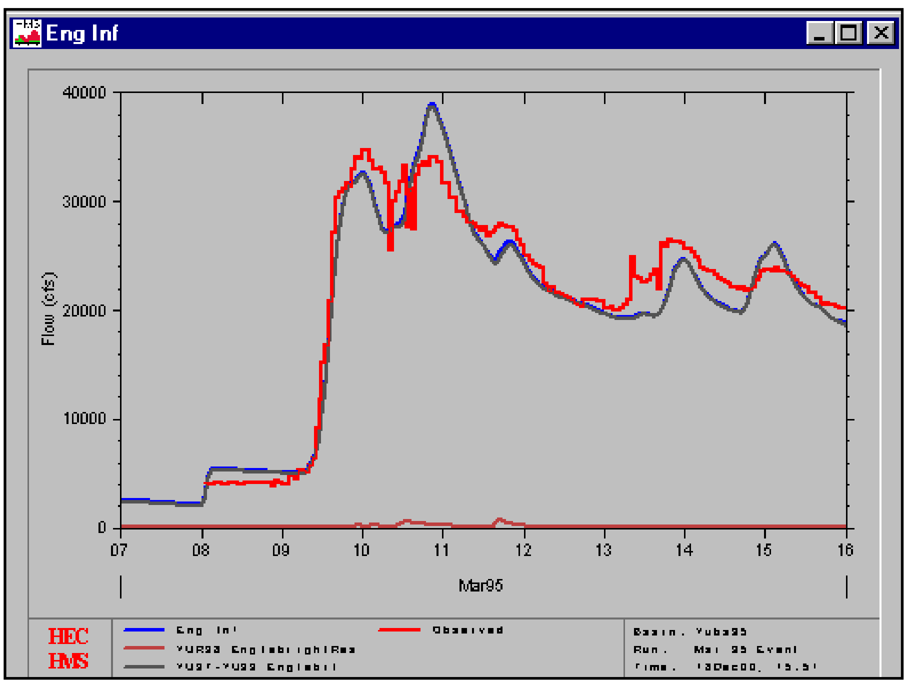
Project : Yuba River Run Name : Mar 95 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
YU39	38845	10 Mar 95 2000	333391	1079.669
YU37-YU39 Englebrt	38626	10 Mar 95 2100	332902	1079.669
YUR38 EnglebrightRes	701.01	11 Mar 95 1700	2508.0	27.867
Eng Inf	38872	10 Mar 95 2100	335410	1107.536
YUR14 JacksonMeadows	2065.6	09 Mar 95 1700	6551.2	37.448
Jack Med Inf	2065.6	09 Mar 95 1700	6551.2	37.448
YUR30 Bowman Lake	1734.7	09 Mar 95 1800	6437.9	28.320
Bowman Inf	1734.7	09 Mar 95 1800	6437.9	28.320
YUR15 JcksonMeadows	20.000	06 Mar 95 2400	17.143	0.000
YUR31 Bowman Lake	0.0	06 Mar 95 2400	0.0	0.000
YUR29 Lake Spaulding	0.0	06 Mar 95 2400	0.0	0.000
YUR13 NewBullardsBar	0.0	06 Mar 95 2400	0.0	0.000
YUR39 Englebright	0.0	06 Mar 95 2400	0.0	0.000

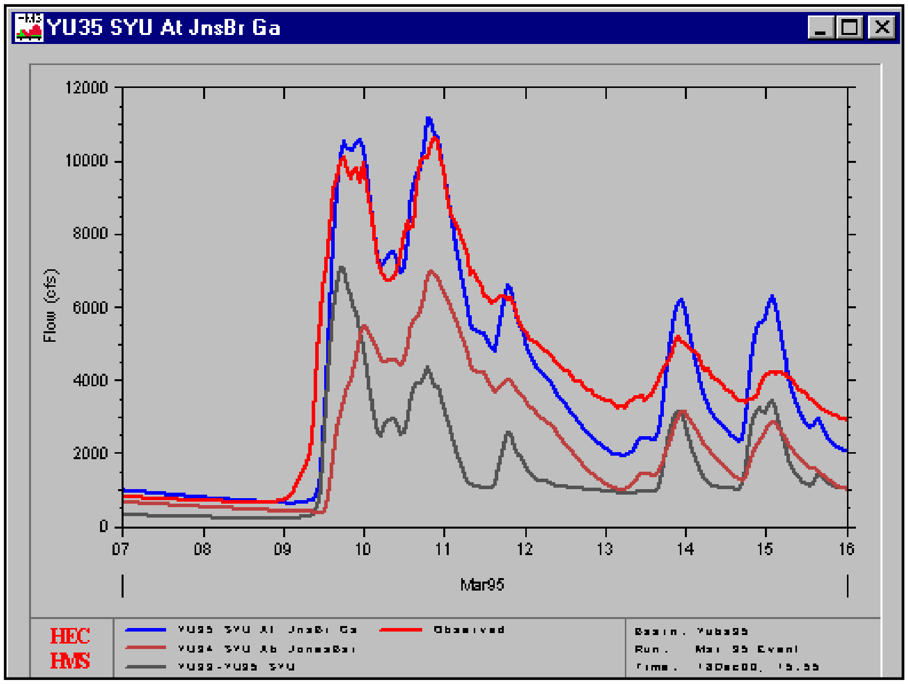
HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Yuba River Basin
March 1995 Event



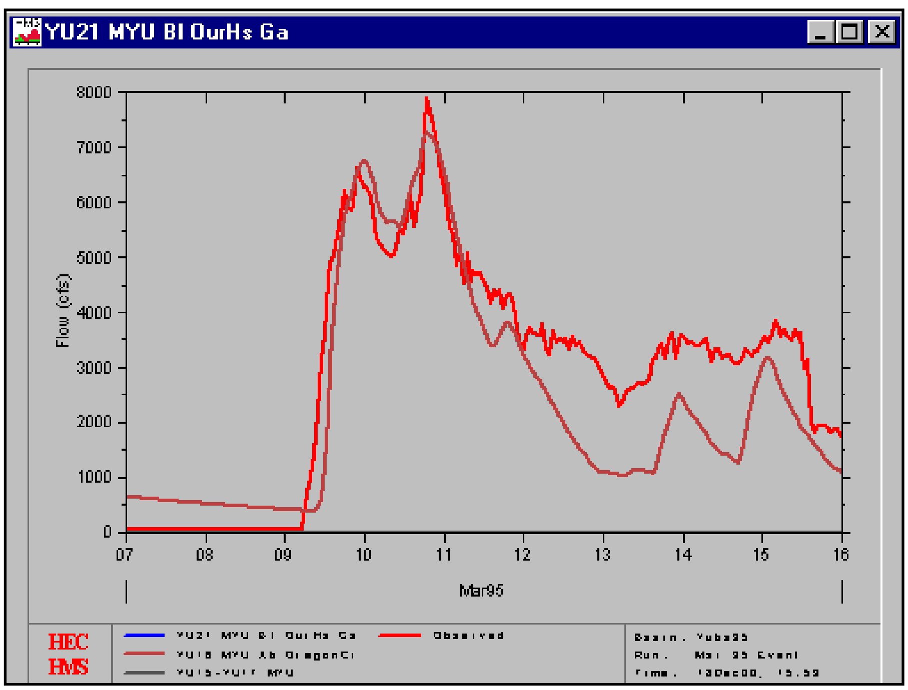
YU51 – Marysville Gage



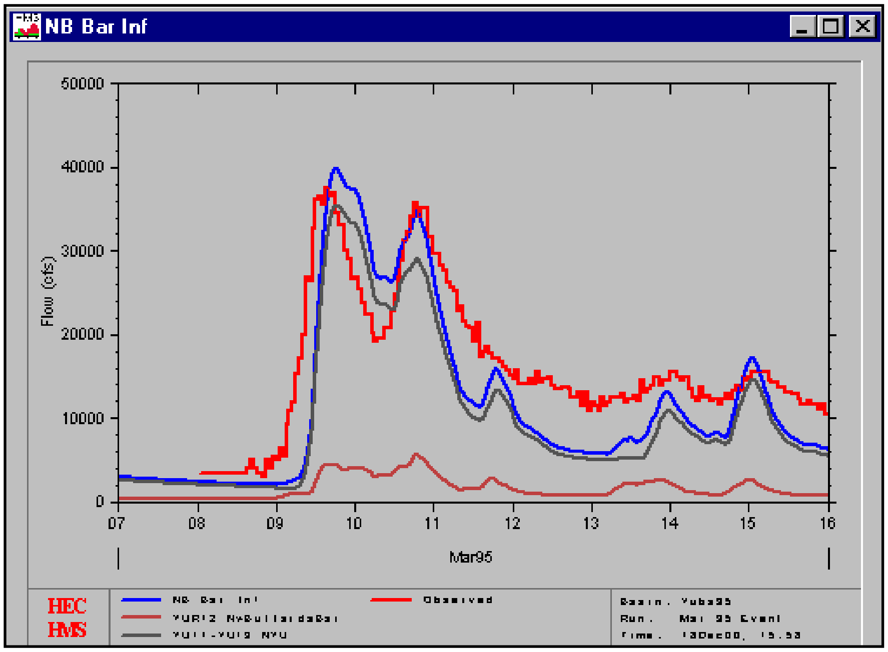
Englebright Reservoir Inflow



YU35 – South Yuba At Jones Bar Gage



YU21 – Middle Yuba Below Our House Gage



New Bullards Bar Inflow

HEC-HMS Subbasin Parameters
Yuba River Basin: March 1995 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
YU6 Downie R	6	0.8	0.15	3.0	.03	0
YU4 NYU Hdwtr	6	0.8	0.15	3.0	.03	0
YUR38 EnglebrightRes	6	0.8	0.15	2.0	.10	0
YU46 YU At DryCr	6	0.8	0.15	3.0	.03	0
YU36 SYU Ab Englebrt	6	0.8	0.15	2.0	.10	0
YU48 YU Out	6	0.8	0.15	3.0	.03	0
YUR14 JacksonMeadows	6	0.8	0.15	3.0	.03	0
YUR28 Lake Spaulding	6	0.8	0.15	3.0	.03	0
YUR22 Lake Fordyce	6	0.8	0.15	3.0	.03	0
YU24 Fordyce Cr	6	0.8	0.15	3.0	.03	0
YU26 SYU Hdwtr	6	0.8	0.15	3.0	.03	0
YUR30 Bowman Lake	6	0.8	0.15	3.0	.03	0
YU8 NYU Ab GoodyBr	6	0.8	0.15	3.0	.03	0
YU2 Slate Cr Hdwtr	6	0.8	0.15	3.0	.03	0
YU10 NYU Ab NwBullrd	6	0.8	0.15	3.0	.03	0
YU16 MY Ab OregonCr	6	0.8	0.15	3.0	.03	0
YU18 OregonCr Hdwtr	6	0.8	0.15	4.0	.07	0
YUR12 NwBullardsBar	6	0.8	0.15	3.0	.03	10
YUR40 ScottsFlatRes	6	0.8	0.15	2.5	.04	0
YUR44 McollinsRes	6	0.8	0.15	3.0	.03	0
YU42 Deer Cr Ab YU	6	0.8	0.15	2.2	.02	0
YU34 SYU Ab JonesBar	6	0.8	0.15	3.3	.04	0
YU32 SYU At CanyonCr	6	0.8	0.15	2.5	.02	0
YU20 N and MY Confl	6	0.8	0.15	2.0	.10	0

HEC-HMS Summary of Results
Yuba River Basin: December 1996 - January 1997 Event

Project : Yuba River Run Name : Jan 97 Event

Start of Run : 25Dec96 2400 Basin Model : Yuba97

End of Run : 08Jan97 2400 Met. Model : Jan 97 Event

Execution Time : 04Dec00 2203 Control Specs. : Jan 97 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
YUR44 MCollinsRes	7018.5	01 Jan 97 1500	41325	72.118
YUR45 MCollinsRes	7018.5	01 Jan 97 1500	41325	72.118
YU45-YU49 Dry Cr	7014.7	01 Jan 97 1600	41311	72.118
Eng Out	149622	02 Jan 97 1000	1225993	1108.000
YU39-YU47 YU	149593	02 Jan 97 1000	1225893	1108.000
YUR40 ScottsFlatRes	2429.3	01 Jan 97 1300	18004	20.103
YUR41 ScottsFlatRes	2146.3	01 Jan 97 2200	17938	20.103
YU41-YU43 Deer Cr	2143.6	01 Jan 97 2400	17922	20.103
YU42 Deer Cr Ab YU	5081.0	01 Jan 97 1400	33623	64.543
YU43 Deer Cr Ga	6817.5	01 Jan 97 2000	51545	84.646
YU43-YU47 Deer Cr	6812.9	01 Jan 97 2000	51544	84.646
YU47 Deer Cr Index	155451	02 Jan 97 1000	1277438	1192.646
YU47-YU49 YU	155219	02 Jan 97 1000	1276848	1192.646
YU46 YU At DryCr	5547.9	01 Jan 97 1100	24840	59.817
YU49	161707	02 Jan 97 1000	1342999	1324.581
YU49-YU51 YU Out	161377	02 Jan 97 1200	1341209	1324.581
YU48 YU Out	974.31	01 Jan 97 1200	4588.5	14.673
YU51 Marysville Ga	161827	02 Jan 97 1200	1345797	1339.254
YUR22 Lake Fordyce	6004.4	01 Jan 97 2100	30214	30.940
YUR23 Lake Fordyce	963.41	02 Jan 97 2100	8907.1	30.940
YUR23-YU27	962.97	02 Jan 97 2200	8867.6	30.940
YU24 Fordyce Cr	4007.1	01 Jan 97 2200	23442	21.865
YU26 SYU Hdwtr	9016.4	02 Jan 97 0800	55575	59.474
YU27	12809	02 Jan 97 0800	87885	112.279
YU27-YU29 Spaulding	12802	02 Jan 97 0800	87866	112.279
YUR28 Lake Spaulding	1403.1	01 Jan 97 1200	9838.7	9.147
Spaulding Inf	13971	02 Jan 97 0700	97704	121.426
YU2 Slate Cr Hdwtr	12436	01 Jan 97 2200	77593	49.427
YU3 Slate Cr Ga	12436	01 Jan 97 2200	77593	49.427
YU3-YU5 Slate Cr	12430	01 Jan 97 2200	77559	49.427
YU6 Downie R	16509	01 Jan 97 2300	100274	72.761
YU4 NYU Hdwtr	27238	02 Jan 97 0500	184061	141.747

... Continued ...

HEC-HMS Summary of Results
Yuba River Basin: December 1996 - January 1997 Event
(Continued)

Project : Yuba River Run Name : Jan 97 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
YU7	42674	02 Jan 97 0100	284335	214.508
YU7-YU9 NYU	42623	02 Jan 97 0200	284129	214.508
YU8 NYU Ab GoodyrBr	8083.3	01 Jan 97 1900	49393	35.251
YU9 Goodyrs Bar Ga	49375	01 Jan 97 2400	333521	249.759
YU9-YU5 NYU	49329	02 Jan 97 0100	333180	249.759
YU5	61402	01 Jan 97 2400	410740	299.186
YU5-YU11 NYU	61316	01 Jan 97 2400	410661	299.186
YU10 NYU Ab NwBullrd	23518	01 Jan 97 2300	157637	124.516
YU11	84575	01 Jan 97 2400	568297	423.702
YU11-YU13 NYU	84514	01 Jan 97 2400	568205	423.702
YUR12 NwBullardsBar	10133	01 Jan 97 1300	60591	66.447
NB Bar Inf	93055	01 Jan 97 2300	628796	490.149
YU18 OregonCr Hdwtr	3960.1	01 Jan 97 2100	25947	23.162
YU19 Oregon Cr Ga	3960.1	01 Jan 97 2100	25947	23.162
YU19-YU21 Oregon Cr	3955.7	01 Jan 97 2200	25939	23.162
Jack Med Out	9197.5	02 Jan 97 0800	31272	37.100
YU15-YU17 MYU	9167.2	02 Jan 97 1000	31245	37.100
YU16 MYU Ab OregonCr	14961	02 Jan 97 0100	116600	107.362
YU21 MYU Bl OurHs Ga	23675	02 Jan 97 0800	147844	144.462
YU17-YU21 MYU	23652	02 Jan 97 0900	147812	144.462
YU23	26606	02 Jan 97 0600	173751	167.624
YU21-YU23 MYU	26602	02 Jan 97 0600	173728	167.624
NB Bar Out	55005	02 Jan 97 1500	699492	490.000
JYU23-YU25 YU	80595	02 Jan 97 0700	873220	657.624
YU23-YU25 YU	80575	02 Jan 97 0800	872899	657.624
YU20 N and MYU Confl	7042.4	01 Jan 97 2000	47324	71.515
YU25	86025	02 Jan 97 0800	920223	729.139
YU25-YU37 YU	85993	02 Jan 97 0800	919881	729.139
Bowman Out	84.560	30 Dec 96 2300	640.71	28.900
YU31-YU33 CanyonCr	84.454	30 Dec 96 2400	643.52	28.900
Spaulding Out	33900	01 Jan 97 1100	131774	120.000
YU29-YU33 SYU	33675	01 Jan 97 1200	131741	120.000
YU32 SYU At CanyonCr	7926.4	01 Jan 97 2000	53939	48.119
YU33	41062	01 Jan 97 1200	186324	197.019
YU33-YU35 SYU	40971	01 Jan 97 1400	186183	197.019
YU34 SYU Ab JonesBar	10749	01 Jan 97 2400	88671	111.560
YU35 SYU At JnsBr Ga	49724	01 Jan 97 1400	274853	308.579
YU35-YU37 SYU	49721	01 Jan 97 1500	274804	308.579
YU36 SYU Ab Englebrt	4100.8	01 Jan 97 1300	24496	41.951

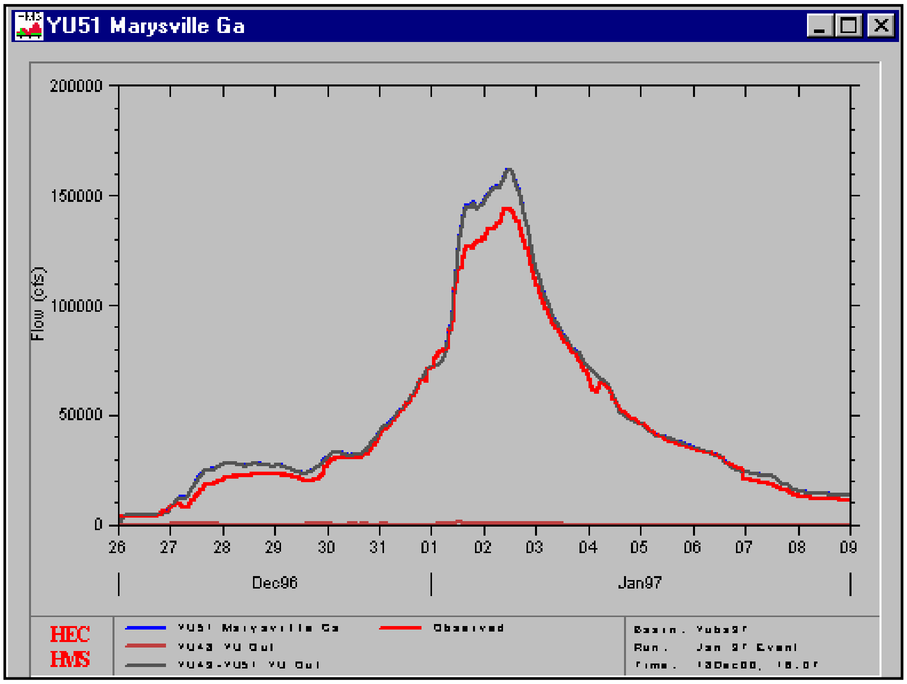
... Continued ...

HEC-HMS Summary of Results
Yuba River Basin: December 1996 - January 1997 Event
(Continued)

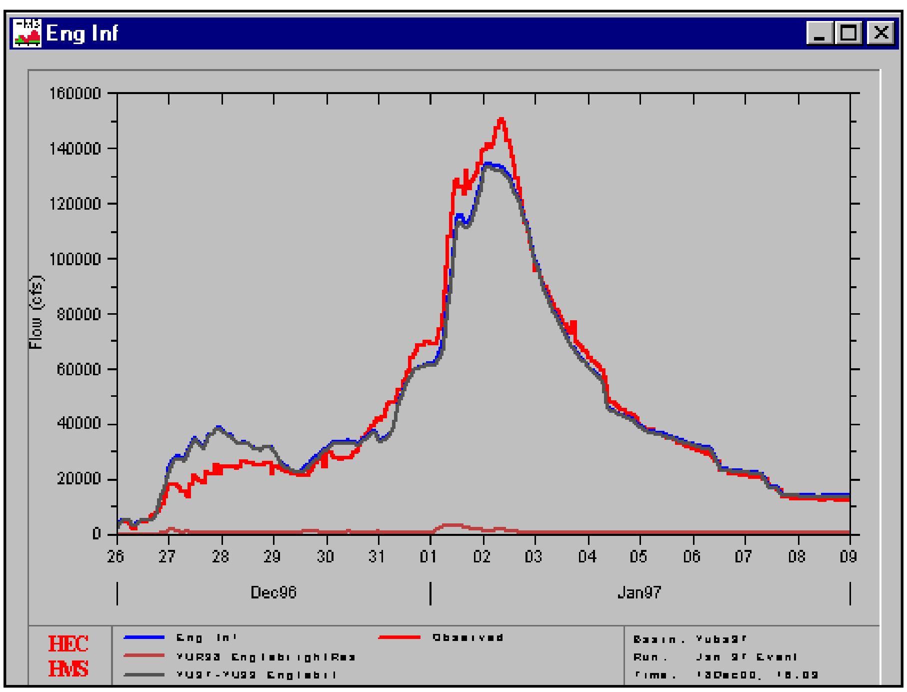
Project : Yuba River Run Name : Jan 97 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
YU39	133434	02 Jan 97 0200	1219181	1079.669
YU37-YU39 Englebrt	133391	02 Jan 97 0200	1218812	1079.669
YUR38 EnglebrightRes	3238.7	01 Jan 97 1100	15992	27.867
Eng Inf	134421	02 Jan 97 0200	1234804	1107.536
YUR14 JacksonMeadows	8164.2	01 Jan 97 2200	40690	37.448
Jack Med Inf	8164.2	01 Jan 97 2200	40690	37.448
YUR30 Bowman Lake	6030.4	01 Jan 97 2200	33413	28.320
Bowman Inf	6030.4	01 Jan 97 2200	33413	28.320
YUR29 Lake Spaulding	0.0	25 Dec 96 2400	0.0	0.000
YUR13 NewBullardsBar	0.0	25 Dec 96 2400	0.0	0.000
YUR39 Englebright	0.0	25 Dec 96 2400	0.0	0.000
YUR31 Bowman Lake	0.0	25 Dec 96 2400	0.0	0.000
YUR15 Jackson Mead	20.000	25 Dec 96 2400	17.143	0.000

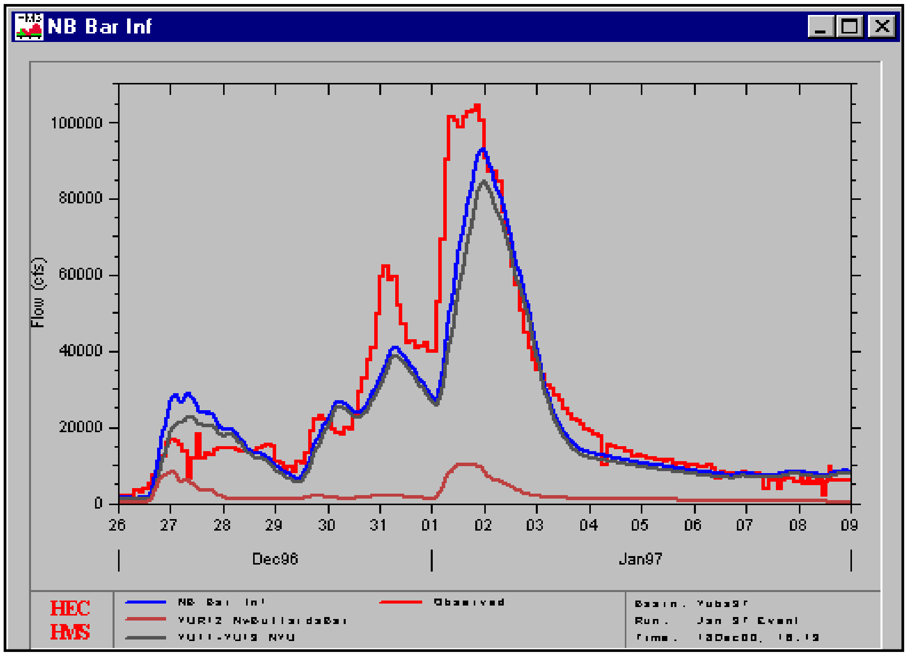
HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Yuba River Basin
December 1996 - January 1997 Event



YU51 – Marysville Gage



Englebright Reservoir Inflow

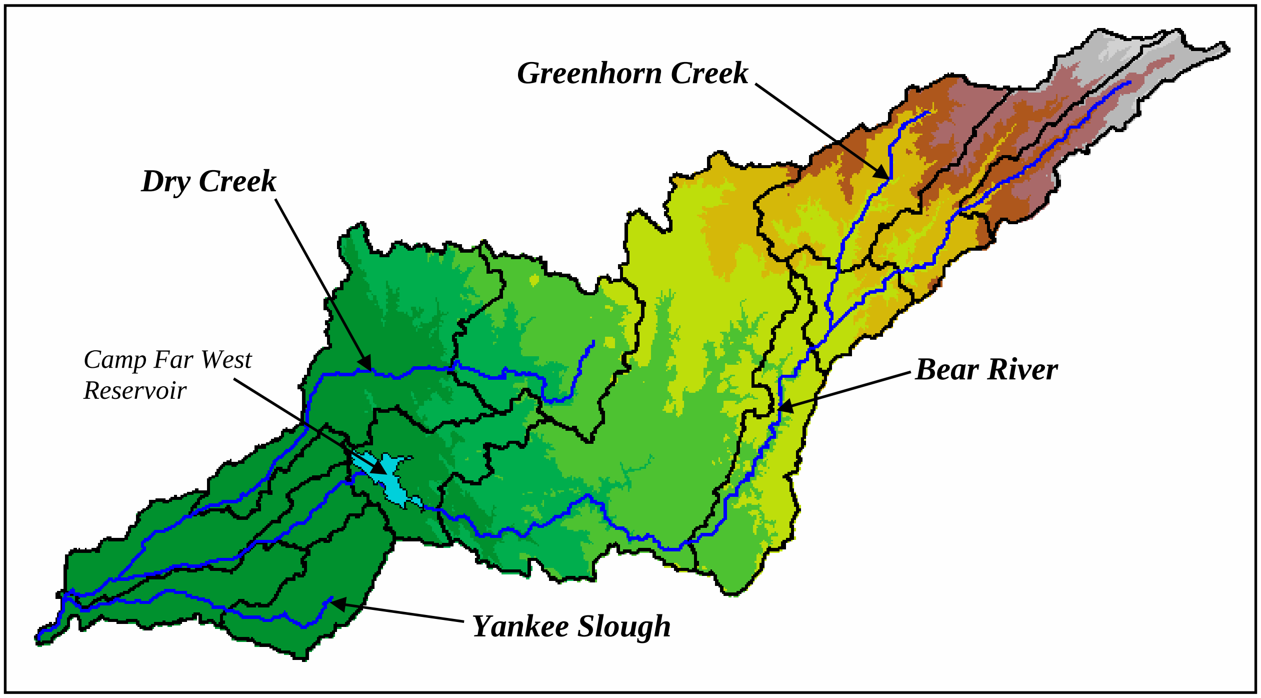


New Bullards Bar Inflow

HEC-HMS Subbasin Parameters
Yuba River Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
YU6 Downie R	3	0.8	0.15	1.0	.001	0
YU4 NYU Hdwtr	3	0.8	0.15	1.0	.001	0
YUR38 EnglebrightRes	3	0.8	0.15	1.0	.001	0
YU46 YU At DryCr	3	0.8	0.15	1.0	.010	0
YU36 SYU Ab Englebrt	3	0.8	0.15	1.0	.001	0
YU48 YU Out	3	0.8	0.15	1.0	.010	0
YUR14 JacksonMeadows	3	0.8	0.15	1.0	.001	0
YUR28 Lake Spaulding	3	0.8	0.15	1.0	.001	0
YUR22 Lake Fordyce	3	0.8	0.15	1.0	.001	0
YU24 Fordyce Cr	3	0.8	0.15	1.0	.001	0
YU26 SYU Hdwtr	3	0.8	0.15	1.0	.001	0
YUR30 Bowman Lake	3	0.8	0.15	1.0	.001	0
YU8 NYU Ab GoodyBr	3	0.8	0.15	1.0	.001	0
YU2 Slate Cr Hdwtr	3	0.8	0.15	1.0	.001	0
YU10 NYU Ab NwBullrd	3	0.8	0.15	1.0	.001	0
YU16 MY Ab OregonCr	3	0.8	0.15	1.0	.001	0
YU18 OregonCr Hdwtr	3	0.8	0.15	1.5	.001	0
YUR12 NwBullardsBar	3	0.8	0.15	1.0	.001	10
YUR40 ScottsFlatRes	3	0.8	0.15	1.0	.001	0
YUR44 McollinsRes	3	0.8	0.15	1.0	.010	0
YU42 Deer Cr Ab YU	3	0.8	0.15	1.0	.001	0
YU34 SYU Ab JonesBar	3	0.8	0.15	1.0	.001	0
YU32 SYU At CanyonCr	3	0.8	0.15	1.0	.001	0
YU20 N and MY Confl	3	0.8	0.15	1.0	.001	0

Bear River Basin



HEC-GeoHMS Subbasin Delineation

Bear River

The Bear River HMS model consists of a 451 square mile basin located in the southeast portion of the Sacramento Watershed, south of the Yuba River basin and above the confluence with the Feather River near Wheatland, CA. The basin model is divided into 13 subbasins and connected with 14 routing reaches. Three observed hydrographs were used to calibrate this model: Bear River near Wheatland, CA (11424000); Bear River below the Dutch Flat Afterbay (11421790); and, the outflow from Rollins Reservoir (11422500). The computed peak flow at the HMS basin model outlet for the 1997 event was nearly twice as large as the 1995 event (37,383 cfs vs. 18,943 cfs).

Using the adopted TC and R (Group 1) and Muskingum parameters, the computed hydrograph at the Wheatland gage matched the observed hydrograph reasonably well for the 1997 event and very well for the 1995 event. For this modeling effort, rather than attempt to predict how the Rollins Reservoir was operated, the source and sink tools available in HMS were implemented. This technique allowed the observed hydrograph at the outlet of the Rollins Reservoir to be passed downstream. As pointed out in "Section 6.6.5, Reservoir Modeling" of the main report, HMS is fairly limited in how it models releases from reservoirs. The gage at the Dutch Flats Afterbay only provided daily records that were difficult to simulate with the hourly model. The initial losses were reasonable for the two events. To approximate the volume in the observed hydrographs, the constant loss rates were set fairly low. Imperviousness was set at ten percent for the two subbasins that included the larger reservoirs: BER8 (Rollins Reservoir) and BER14 (Camp Far West). The baseflow values were within the modeling guidelines.

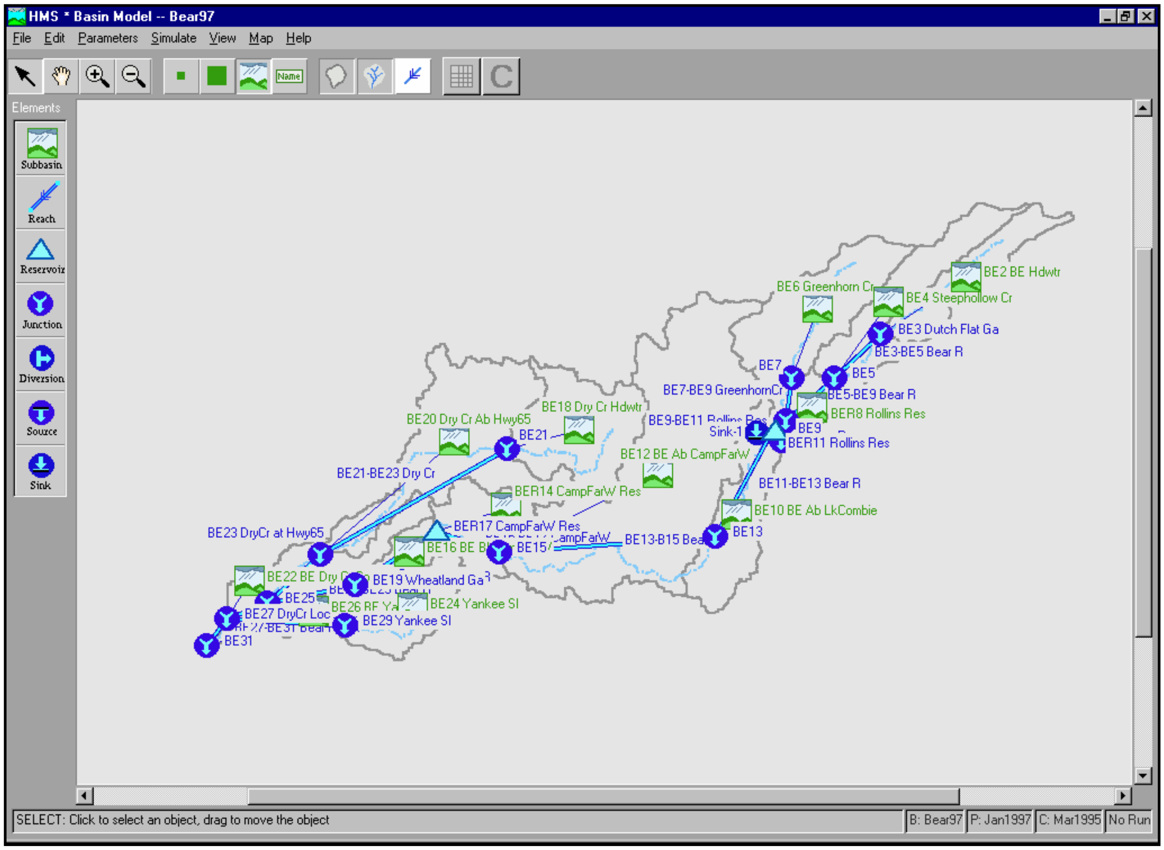
<u>Calibration of the 1995 Event:</u>

The observed and computed hydrographs at the Wheatland gage were almost coincident. They matched volumes, peaks, shape and timing. The gage at the headwaters (11421790) reported only daily information, but its general trend was similar to the computed hydrograph. Initial and constant loss rates of 1.0 inch and 0.02 inches/hour, respectively, were used. The baseflow values of 6.0 cfs per square mile, 0.8 and 0.2 for the initial flow, recession ratio, and the threshold flow, respectively, were also used to calibrate the model.

<u>Calibration of the 1997 Event:</u>

The observed and computed hydrographs at the Wheatland gage followed the same general shape. The constant losses were set to 0.001 inches; however, the observed peak was still not duplicated. Given the shape of the observed and computed hydrographs, it appeared that a different R/(TC + R) ratio could have been used to better approximate the shape of the observed hydrograph. The gage at the headwaters (11421790) reported only daily information, but its general trend was approximated by the computed hydrograph. However, even with the losses set to a minimal value, the volume of the computed hydrograph was below the observed hydrograph. Initial and constant loss rates of 1.5 inches and 0.001 inches/hour, respectively, were used. The baseflow values of 3.0 cfs per square mile, 0.8 and 0.2 for the initial flow, recession ratio, and the threshold flow, respectively, were also used to calibrate the model.

Bear River Basin HEC-HMS Model Schematic



Bear River Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Initial TC $1.4(LL_{CA}/S^{1/2})^{.33}$ (Hr)	Initial R 1.5 TC (cfs/Hr)	Regression TC $0.68(LL_{CA}/S^{1/2})^{.46}$ (Hr)	Regression R 4.0 TC (cfs/Hr)
BER8 Rollins Res	14.1	6.05	1.97	190.08	0.87	1.3	2.0	0.6	2.5
BE6 Greenhorn Cr	38.7	13.75	4.80	174.24	5.00	2.4	3.6	1.4	5.7
BE4 Steephollow Cr	30.6	18.82	7.14	190.08	9.74	3.0	4.5	1.9	7.8
BE20 Dry Cr Ab Hwy65	56.5	21.97	11.78	79.20	29.08	4.3	6.4	3.2	12.8
BE12 BE Ab CampFarW	122.9	32.92	17.42	95.04	58.82	5.4	8.1	4.4	17.7
BE16 BE Bl CampFarW	8.7	6.88	3.95	63.36	3.42	2.1	3.2	1.2	4.8
BE22 BE Dry Cr Confl	25.7	16.73	5.94	21.12	21.60	3.9	5.8	2.8	11.2
BE26 BE Yankee Confl	17.9	15.32	8.10	10.56	38.18	4.7	7.0	3.6	14.5
BE24 Yankee Sl	20.3	11.36	6.29	36.96	11.75	3.2	4.7	2.1	8.4
BE18 Dry Cr Hdwtr	38.9	14.50	5.00	137.28	6.19	2.6	3.8	1.6	6.3
BE10 BE Ab LkCombie	30.7	15.63	5.87	73.92	10.67	3.1	4.6	2.0	8.1
BER14 CampFarW Res	24.5	11.26	4.15	132.00	4.07	2.2	3.3	1.3	5.2
BE2 BE Hdwtr	21.5	15.67	7.01	195.36	7.86	2.8	4.1	1.8	7.0

Bear River Reach Parameters

Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Ave Reach Vel $80\ S_R^{1/2}$ V_R (fps)	Initial K $1.47\ L_R / 1.5V_R$ K (Hr)	Musk X or LAG (Min)	N steps Time Step= 60
BE3-BE5 Bear R	4.97	0.0144	9.60	1.0	0.4	1
BE7-BE9 GreenhornCr	2.77	0.0001	0.80	3.4	0.4	3
BE5-BE9 Bear R	4.32	0.0018	3.39	1.2	0.4	1
BE23-BE25 Dry Cr	4.61	0.0008	2.26	2.0	0.4	2
BE19-BE25 Bear R	5.56	0.0011	2.65	2.1	0.4	2
BE29-BE27 Yankee Sl	8.02	0.0009	2.40	3.3	0.4	3
BE27-BE31 Bear R Out	2.21	0.0008	2.26	1.0	0.4	1
BE9-BE11 Rollins Res	1.27	0.0401	16.02	0.1	0.4	1
BE15-BE17 CampFarW	4.67	0.0060	6.20	1.0	0.4	1
BE13-B15 Bear R	15.27	0.0159	10.09	1.5	0.4	2
BE21-BE23 Dry Cr	15.64	0.0045	5.37	2.9	0.4	3
BE17-BE19 Bear R	6.16	0.0014	2.99	2.0	0.4	2
BE25-BE27 Bear R	2.68	0.0007	2.12	1.2	0.4	1
BE11-BE13 Bear R	12.35	0.0053	5.82	2.1	0.4	2

HEC-HMS Summary of Results
Bear River Basin: March 1995 Event

Project : Bear River Run Name : Mar95

Start of Run : 08Mar95 0100 Basin Model : Bear95

End of Run : 15Mar95 2400 Met. Model : Mar1995

Execution Time : 31May00 1240 Control Specs. : Mar1995

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
BE18 Dry Cr Hdwtr	2418.8	10 Mar 95 1900	13536	38.861
BE21	2418.8	10 Mar 95 1900	13536	38.861
BE21-BE23 Dry Cr	2338.3	10 Mar 95 2200	13482	38.861
BE20 Dry Cr Ab Hwy65	2322.1	10 Mar 95 2000	13178	56.467
BE23 DryCr at Hwy65	4447.3	10 Mar 95 2100	26660	95.328
BE23-BE25 Dry Cr	4418.6	10 Mar 95 2300	26606	95.328
Rollins Res	6050.0	11 Mar 95 0100	55532	105.000
BE11-BE13 Bear R	6023.7	11 Mar 95 0300	55338	105.000
BE10 BE Ab LkCombie	1955.3	10 Mar 95 1900	11016	30.687
BE13	7587.2	10 Mar 95 2000	66354	135.687
BE13-B15 Bear R	7586.4	10 Mar 95 2100	66187	135.687
BE12 BE Ab CampFarW	5892.6	10 Mar 95 2200	39241	122.916
BE15	13458	10 Mar 95 2100	105427	258.603
BE15-BE17 CampFarW	13435	10 Mar 95 2300	105284	258.603
BER14 CampFarW Res	1607.2	10 Mar 95 1800	7135.2	24.455
BER17 CampFarW Res	13668	11 Mar 95 0100	104640	283.058
BE17-BE19 Bear R	13647	11 Mar 95 0300	103905	283.058
BE16 BE Bl CampFarW	717.88	10 Mar 95 1800	2636.2	8.667
BE19 Wheatland Ga	13790	11 Mar 95 0300	106541	291.725
BE19-BE25 Bear R	13773	11 Mar 95 0500	105733	291.725
BE25	17344	11 Mar 95 0100	132339	387.053
BE25-BE27 Bear R	17331	11 Mar 95 0300	131834	387.053
BE24 Yankee Sl	1006.3	10 Mar 95 1800	4182.9	20.298
BE29 Yankee Sl	1006.3	10 Mar 95 1800	4182.9	20.298
BE29-BE27 Yankee Sl	957.98	10 Mar 95 2200	4166.5	20.298
BE22 BE Dry Cr Confl	1013.2	10 Mar 95 1900	4705.4	25.667
BE27 DryCr Loc	18587	11 Mar 95 0100	140706	433.018
BE27-BE31 Bear R Out	18570	11 Mar 95 0200	140269	433.018
BE26 BE Yankee Confl	513.67	10 Mar 95 2000	2751.1	17.868
BE31	18930	11 Mar 95 0200	143020	450.886
BE6Greenhorn Cr	4363.5	09 Mar 95 1400	22070	38.741

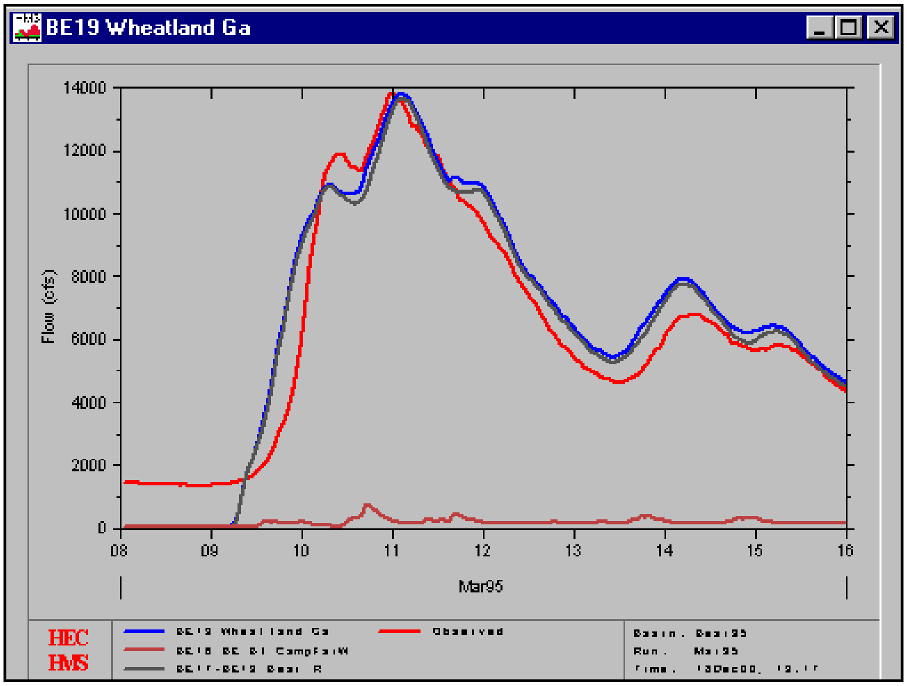
... Continued ...

HEC-HMS Summary of Results
Bear River Basin: March 1995 Event
(Continued)

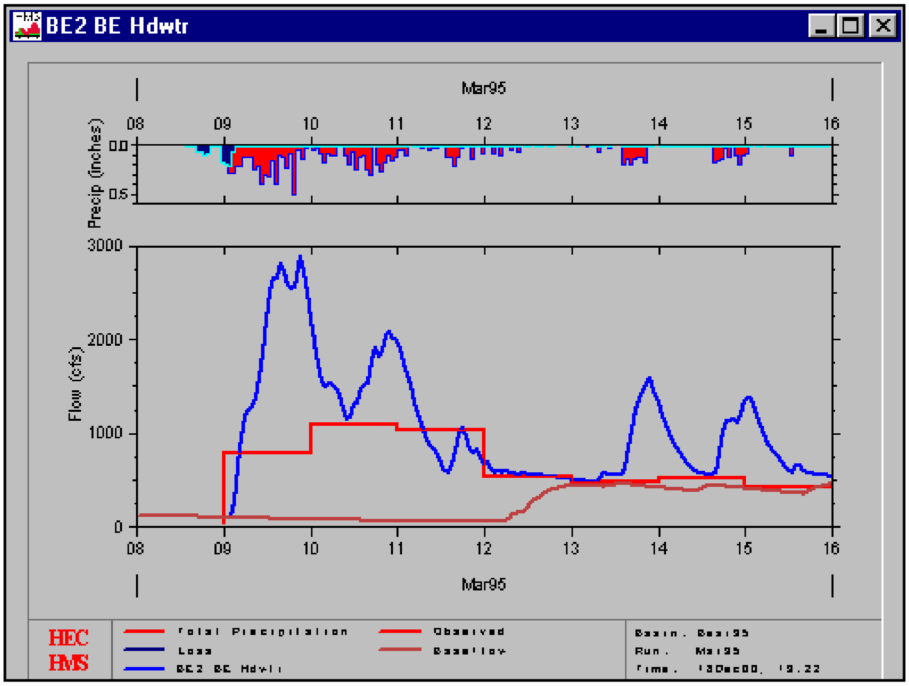
Project : Bear River Run Name : Mar95

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
BE7	4363.5	09 Mar 95 1400	22070	38.741
BE7-BE9 GreenhornCr	4281.2	09 Mar 95 1800	21918	38.741
BE2 BE Hdwtr	2885.7	09 Mar 95 2100	14994	21.509
BE3 Dutch Flat Ga	2885.7	09 Mar 95 2100	14994	21.509
BE3-BE5 Bear R	2843.1	09 Mar 95 2200	14960	21.509
BE4 Steephollow Cr	3337.4	09 Mar 95 1600	18370	30.564
BE5	6138.5	09 Mar 95 2200	33330	52.073
BE5-BE9 Bear R	6081.6	09 Mar 95 2300	33245	52.073
BE9	10336	09 Mar 95 1800	55162	90.814
BE9-BE11 Rollins Res	10335	09 Mar 95 1800	55151	90.814
BER8 Rollins Res	1758.5	09 Mar 95 1400	8076.0	14.122
BER11 Rollins Res	7464.9	11 Mar 95 0200	52069	104.936
Sink-1	7464.9	11 Mar 95 0200	52069	104.936

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Bear River Basin
March 1995 Event



BE19 – Wheatland Gage



BE2 – Bear River Headwater

HEC-HMS Subbasin Parameters
Bear River Basin: March 1995 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
BER8 Rollins Res	6	0.8	0.2	1.0	.025	10
BE6 Greenhorn Cr	6	0.8	0.2	1.0	.02	0
BE4 Steephollow Cr	6	0.8	0.2	1.0	.02	0
BE20 Dry Cr Ab Hwy65	6	0.8	0.2	1.0	.02	0
BE12 BE Ab CampFarW	6	0.8	0.2	1.0	.02	0
BE16 BE Bl CampFarW	6	0.8	0.2	1.0	.02	0
BE22 BE Dry Cr Confl	6	0.8	0.2	1.0	.02	0
BE26 BE Yankee Confl	6	0.8	0.2	1.0	.02	0
BE24 Yankee Sl	6	0.8	0.2	1.0	.02	0
BE18 Dry Cr Hdwtr	6	0.8	0.2	1.0	.02	0
BE10 BE Ab LkCombie	6	0.8	0.2	1.0	.02	0
BER14 CampFarW Res	6	0.8	0.2	1.0	.02	10
BE2 BE Hdwtr	6	0.8	0.2	1.0	.02	0

HEC-HMS Summary of Results
Bear River Basin: December 1996 - January 1997 Event

Project : Bear River Run Name : Jan97

Start of Run : 25Dec96 0100 Basin Model : Bear97

End of Run : 08Jan97 2400 Met. Model : Jan1997

Execution Time : 31May00 1251 Control Specs. : Jan1997

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
BE18 Dry Cr Hdwtr	3418.2	01 Jan 97 1200	17251	38.861
BE21	3418.2	01 Jan 97 1200	17251	38.861
BE21-BE23 Dry Cr	3381.6	01 Jan 97 1500	17219	38.861
BE20 Dry Cr Ab Hwy65	3474.5	01 Jan 97 1400	20709	56.467
BE23 DryCr at Hwy65	6813.5	01 Jan 97 1500	37928	95.328
BE23-BE25 Dry Cr	6776.6	01 Jan 97 1700	37887	95.328
Rollins Res	22800	02 Jan 97 0100	146368	105.000
BE11-BE13 Bear R	22658	02 Jan 97 0300	146478	105.000
BE10 BE Ab LkCombie	2256.6	01 Jan 97 1300	12709	30.687
BE13	24294	02 Jan 97 0200	159186	135.687
BE13-B15 Bear R	24270	02 Jan 97 0400	159257	135.687
BE12 BE Ab CampFarW	6368.0	01 Jan 97 2200	45235	122.916
BE15	30343	02 Jan 97 0300	204492	258.603
BE15-BE17 CampFarW	30333	02 Jan 97 0300	204532	258.603
BER14 CampFarW Res	2141.6	01 Jan 97 1200	10156	24.455
BER17 CampFarW Res	30103	02 Jan 97 0700	214113	283.058
BE17-BE19 Bear R	30089	02 Jan 97 0900	213857	283.058
BE16 BE Bl CampFarW	752.69	01 Jan 97 1200	3348.0	8.667
BE19 Wheatland Ga	30459	02 Jan 97 0900	217205	291.725
BE19-BE25 Bear R	30440	02 Jan 97 1100	216928	291.725
BE25	35074	02 Jan 97 1200	254816	387.053
BE25-BE27 Bear R	35052	02 Jan 97 1300	254630	387.053
BE24 Yankee Sl	1338.4	01 Jan 97 1300	6644.3	20.298
BE29 Yankee Sl	1338.4	01 Jan 97 1300	6644.3	20.298
BE29-BE27 Yankee Sl	1316.1	01 Jan 97 1600	6638.4	20.298
BE22 BE Dry Cr Confl	1410.4	01 Jan 97 1300	7613.2	25.667
BE27 DryCr Loc	36781	02 Jan 97 1300	268882	433.018
BE27-BE31 Bear R Out	36765	02 Jan 97 1400	268722	433.018
BE26 BE Yankee Confl	821.08	01 Jan 97 1400	4861.1	17.868
BE31	37368	02 Jan 97 1400	273583	450.886
BE6 Greenhorn Cr	4122.8	01 Jan 97 1200	28534	38.741

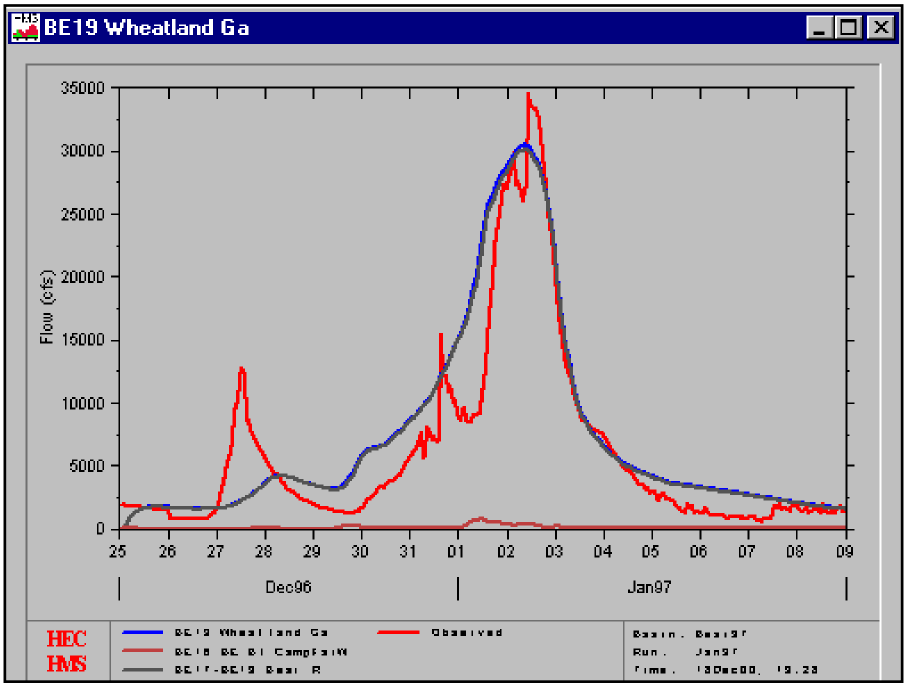
... Continued ...

HEC-HMS Summary of Results
Bear River Basin: December 1996 - January 1997 Event
(Continued)

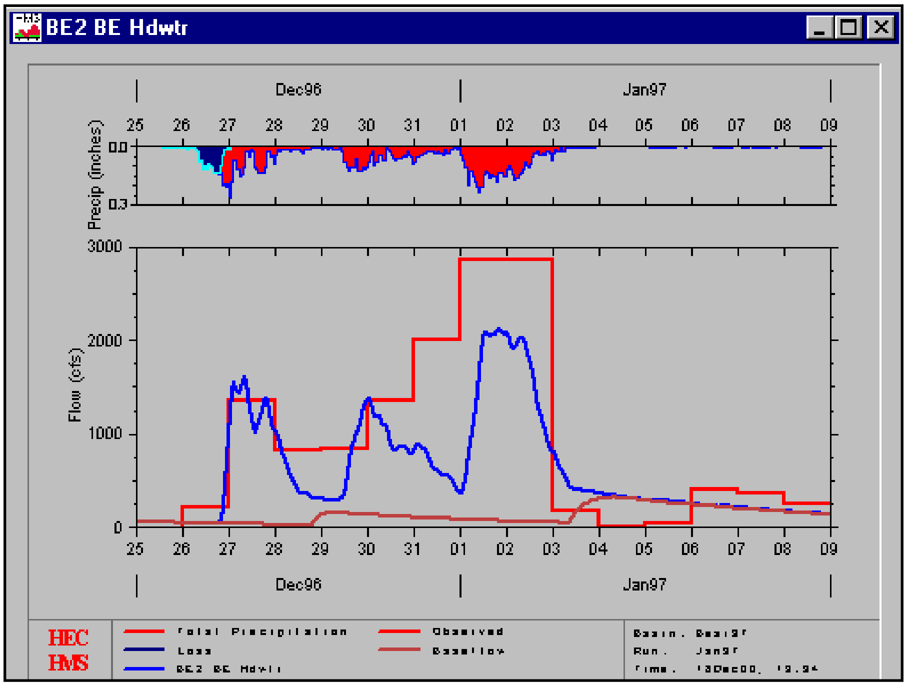
Project : Bear River Run Name : Jan97

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
BE7	4122.8	01 Jan 97 1200	28534	38.741
BE7-BE9 GreenhornCr	4079.2	01 Jan 97 1600	28489	38.741
BE2 BE Hdwtr	2114.2	01 Jan 97 2000	18045	21.509
BE3 Dutch Flat Ga	2114.2	01 Jan 97 2000	18045	21.509
BE3-BE5 Bear R	2110.4	01 Jan 97 2100	18038	21.509
BE4 Steephollow Cr	2809.7	01 Jan 97 2000	22952	30.564
BE5	4900.1	01 Jan 97 2000	40990	52.073
BE5-BE9 Bear R	4890.4	01 Jan 97 2100	40973	52.073
BE9	8908.2	01 Jan 97 1600	69462	90.814
BE9-BE11 Rollins Res	8915.3	01 Jan 97 1600	69459	90.814
BER8 Rollins Res	1668.1	01 Jan 97 1100	9110.5	14.122
BER11 Rollins Res	9454.8	01 Jan 97 2300	68216	104.936
Sink-1	9454.8	01 Jan 97 2300	68216	104.936

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Bear River Basin
December 1996 - January 1997 Event



BE19 – Wheatland Gage

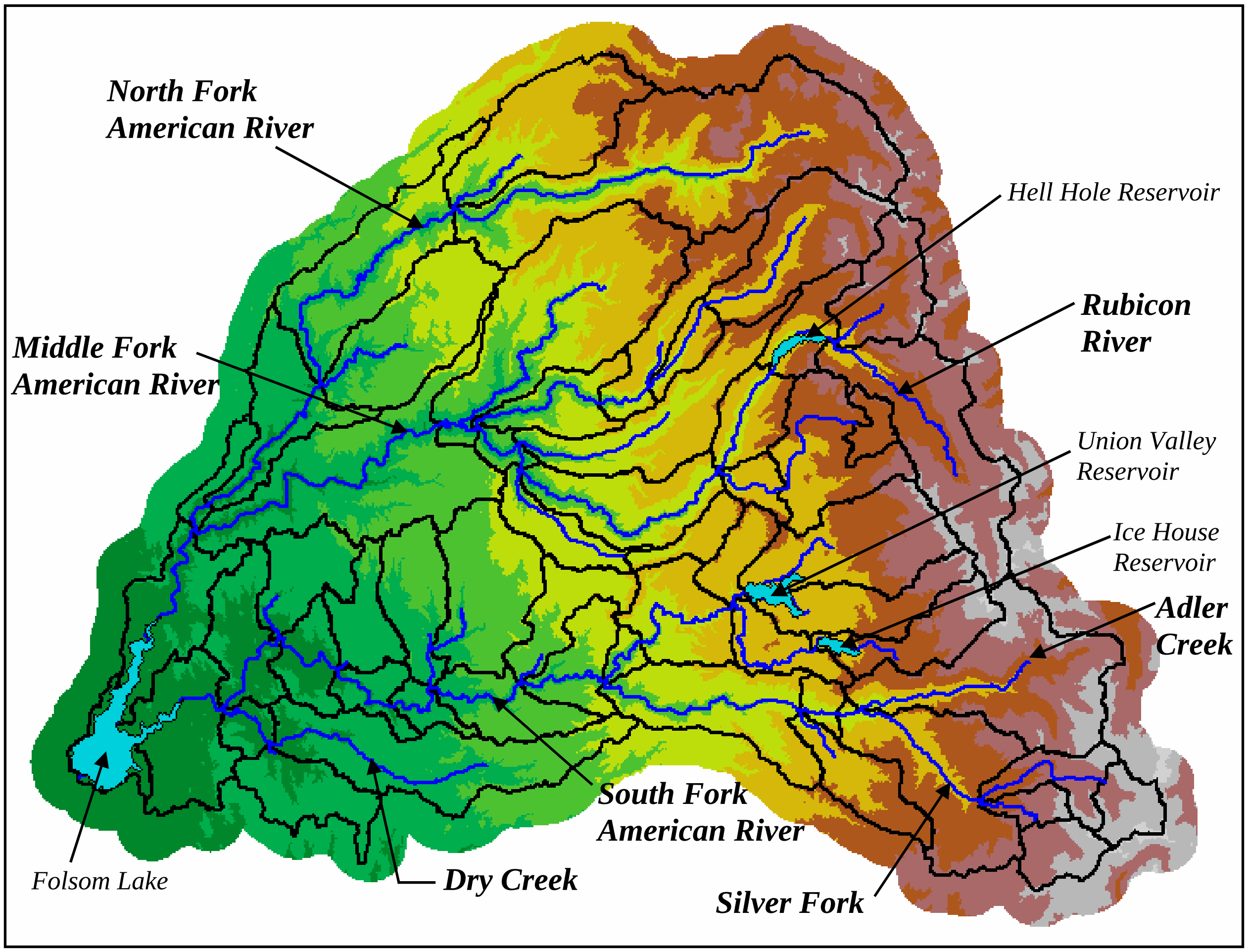


BE2 – Bear River Headwater

HEC-HMS Subbasin Parameters
Bear River Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
BER8 Rollins Res	3	0.8	0.2	1.5	.001	10
BE6 Greenhorn Cr	3	0.8	0.2	1.5	.001	0
BE4 Steephollow Cr	3	0.8	0.2	1.5	.001	0
BE20 Dry Cr Ab Hwy65	3	0.8	0.2	1.5	.001	0
BE12 BE Ab CampFarW	3	0.8	0.2	1.5	.001	0
BE16 BE Bl CampFarW	3	0.8	0.2	1.5	.001	0
BE22 BE Dry Cr Confl	3	0.8	0.2	1.5	.001	0
BE26 BE Yankee Confl	3	0.8	0.2	1.5	.001	0
BE24 Yankee Sl	3	0.8	0.2	1.5	.001	0
BE18 Dry Cr Hdwtr	3	0.8	0.2	1.5	.001	0
BE10 BE Ab LkCombie	3	0.8	0.2	1.5	.001	0
BER14 CampFarW Res	3	0.8	0.2	1.5	.001	10
BE2 BE Hdwtr	3	0.8	0.2	1.5	.001	0

American River Basin



HEC-GeoHMS Subbasin Delineation

American River

The American River HMS model consists of a 1,861 square mile basin above Folsom Reservoir located in the southeastern-most portion of the Sacramento Watershed. It is divided into 57 subbasins and connected with 38 routing reaches. The observed hydrographs are the computed inflow into Folsom Reservoir and at gages on the South Fork near Placerville and near Lotus and on the Middle Fork near Forest Hill. The computed peak inflow into Folsom Reservoir for the 1997 event was larger than the 1995 event (275,000 cfs vs. 75,000 cfs).

The adopted TC and R (Group 1) values were used. The generic equation to compute the reach travel time (Muskingum K) was not used because the reach travel times were too short; thus, causing the computed peaks to occur too early. Instead, the reach travel time (K) was computed knowing the reach length and average velocity. The average velocity was computed using Manning's equation. The Manning's "n" value was estimated with Jarrett's equation, and the hydraulic radius was estimated from the American River equation, which was developed from a regression of field data. Of the 38 routing reaches, 13 reaches used the Muskingum routing technique. The other 25 reaches used the lag method since the travel time within each of those reaches was less than the one-hour time step used by the Muskingum method.

For this modeling effort, rather than attempt to predict how the French Meadows, Hell Hole, North Fork, and Loon Lake reservoirs were operated, the source and sink tools available in HMS were implemented. This technique allowed the observed hydrograph at the outlet of each of the reservoirs to be passed downstream. As pointed out in "Section 6.6.5, Reservoir Modeling" of the main report, HMS is fairly limited in how it models releases from reservoirs. Calibration efforts required different loss and baseflow parameters for different subbasins. Another reason the observed reservoir outflows were used as sources was to replace the inadequate computed runoff from the upstream basins. Even with the losses reduced to minimal values, the computed volumes and peaks for the 1997 event could not match the observed hydrographs. The thought was that the LWASS was not large enough to generate the observed volumes. The timing appears consistent with the observed hydrograph, but the volume and peak are not. This has been a problem in other basins as well. For the 1995 event, the observed and computed hydrographs matched very well. Ten percent impervious area was used for the Folsom Lake subbasin, and twelve percent impervious area was used for the Loon Lake subbasin.

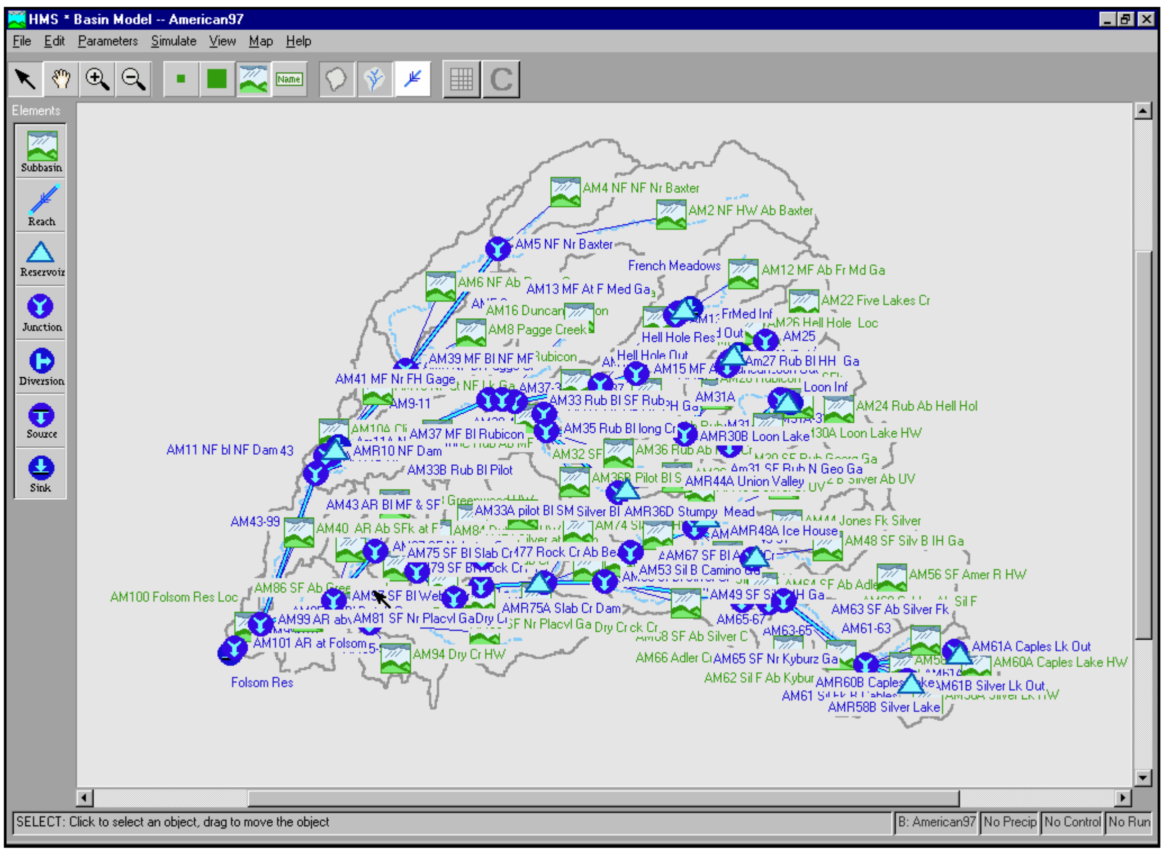
<u>Calibration of the 1995 Event:</u>

Calibration was not performed for the Middle Fork near Forest Hill (due to insufficient data) but was performed for the other locations listed above. By using constant loss rates between 0.01 and 0.05 inches/hour and initial losses between 1.5 and 2.75 inches (most subbasins about 2 inches), the model calibrated well to observed hydrographs. A recession ratio of 0.8 and a peak ratio of 0.15 defined the recession limb of the hydrographs. An initial baseflow of 5 to 8 cfs per square mile was assumed (most initial baseflows were set to 5 cfs per square mile).

Calibration of the 1997 Event:

Calibration was not performed for the gages on the South Fork near Placerville and near Lotus (due to insufficient data) but was performed for the other locations listed above. By using a constant loss rate of 0.001 inches/hour and an initial loss of 2.0 inches, the model calibrated well to the observed hydrograph (the inflow to Folsom Reservoir). Only daily data were available at the gage on the Middle Fork near Forest Hill, so the model was calibrated to fit an observed peak and the daily data reasonably well. The baseflow recession parameters of 0.8 for the constant and 0.15 for the peak ratio worked best. An initial baseflow of 5 cfs per square mile was used.

American River Basin HEC-HMS Model Schematic



American River Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Ave Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Initial TC $1.4(LL_{CA}/S^{1/2})^{.33}$ (Hr)	Initial R 1.5 TC (cfs/Hr)	Final TC $0.68(LL_{CA}/S^{1/2})^{.46}$ (Hr)	Final R 4.0 TC (Hr)
AM10 NF at NF Lk Ga	33.89	19.21	9.06	105.60	16.94	3.6	5.3	2.5	10.0
AM12 MF Ab Fr Md Ga	48.06	17.24	7.86	205.92	9.44	2.9	4.4	1.9	7.6
AM18 MF Ab Rubicon	22.79	12.72	5.71	348.48	3.89	2.2	3.3	1.3	5.1
AM26 Hell Hole Loc	19.04	9.84	4.61	422.40	2.21	1.8	2.7	1.0	3.9
AM30 SF Rub Georg Ga	40.55	11.41	4.87	337.92	3.02	2.0	3.0	1.1	4.5
AM30A Loon Lake HW	7.95	5.33	1.61	253.44	0.54	1.1	1.7	0.5	2.0
AM36 Rub Ab Pilot Cr	38.64	19.32	7.48	205.92	10.07	3.0	4.5	2.0	7.9
AM36A Pilot Ab SM Ga	11.61	9.31	5.04	190.08	3.40	2.1	3.1	1.2	4.8
AM36B Pilot Bl SM	18.55	12.47	6.16	253.44	4.82	2.4	3.5	1.4	5.6
AM36C Rub Ab MF	6.05	5.84	2.37	443.52	0.66	1.2	1.8	0.6	2.2
AM48 SF Silv B IH Ga	27.54	15.85	8.87	258.72	8.75	2.9	4.3	1.8	7.4
AM52 Sil B Camino Ga	29.80	12.46	5.48	200.64	4.82	2.4	3.5	1.4	5.6
AM58A Silver Lk HW	15.10	6.14	2.55	417.12	0.77	1.3	1.9	0.6	2.4
AM60A Caples Lake HW	13.49	5.68	1.70	348.48	0.52	1.1	1.7	0.5	2.0
AM80 SF Nr Placvl Ga	7.87	6.95	3.04	274.56	1.27	1.5	2.3	0.8	3.0
AM6 NF Ab Pagge Cr	57.45	26.13	12.81	158.40	26.59	4.1	6.2	3.1	12.3
AM4 NF NF Nr Baxter	54.61	19.38	9.12	248.16	11.21	3.1	4.7	2.1	8.3
AM2 NF HW Ab Baxter	141.44	34.67	17.67	200.64	43.25	4.9	7.3	3.8	15.4
AM22 Five Lakes Cr	29.06	11.31	5.46	359.04	3.26	2.1	3.1	1.2	4.7
AM16 Duncan Canyon	29.68	18.65	9.69	258.72	11.24	3.1	4.7	2.1	8.3
AM14 MF Ab Ducan Cr	10.43	7.43	3.68	390.72	1.38	1.6	2.3	0.8	3.2
AM20 NF MF at FH Ga	97.21	28.29	16.46	216.48	31.65	4.4	6.6	3.3	13.3
AM8 Pagge Creek	54.59	20.09	9.73	190.08	14.17	3.4	5.0	2.3	9.2
AM24 Rub Ab Hell Hol	65.81	22.10	10.23	264.00	13.91	3.3	5.0	2.3	9.1
AM28 Rubicon Ab SFk	19.82	9.31	3.96	327.36	2.04	1.8	2.7	0.9	3.8
AM34 Long Cr Ab Rub	48.92	22.92	10.80	253.44	15.55	3.5	5.2	2.4	9.6
AM10A Clipper Cr HW	8.13	9.74	4.66	168.96	3.49	2.1	3.2	1.2	4.8
AM32 SF Rub Ab Rub	9.34	6.74	3.18	427.68	1.04	1.4	2.1	0.7	2.8
AM38 MF at Mouth	91.04	32.85	14.89	121.44	44.39	4.9	7.3	3.9	15.6
AM42 B Silver Ab UV	51.77	17.60	9.10	269.28	9.76	3.0	4.5	1.9	7.8
AM46 L Silver Bl UV	13.34	7.46	3.58	285.12	1.58	1.6	2.4	0.8	3.4
AM88 Greenwood HW	25.53	11.57	6.55	142.56	6.35	2.6	3.9	1.6	6.4
AM44 Jones Fk Silver	31.37	20.93	9.67	211.20	13.92	3.3	5.0	2.3	9.1
AM78 Bear Cr HW	28.13	13.35	7.00	158.40	7.43	2.7	4.1	1.7	6.8
AM84 Dutch Cr HW	19.73	10.47	4.50	190.08	3.42	2.1	3.2	1.2	4.8
AM76 Rock Cr Ab Bear	46.53	13.74	6.49	200.64	6.29	2.6	3.9	1.6	6.3
AM54 Silver at Mouth	5.16	6.16	2.96	443.52	0.86	1.3	2.0	0.6	2.5
AM74 Slab Cr HW	22.38	13.24	6.20	248.16	5.21	2.4	3.6	1.5	5.8
AM50 SF Silver At Mo	17.24	14.89	8.12	142.56	10.13	3.0	4.5	2.0	7.9
AM90 SF Ab Weber Cr	28.17	13.51	7.02	100.32	9.46	2.9	4.4	1.9	7.6
AM68 SF Ab Silver C	47.75	16.43	9.77	211.20	11.05	3.1	4.6	2.1	8.2
AM86 SF Ab Greenwood	17.56	8.58	3.35	158.40	2.28	1.8	2.8	1.0	4.0
AM70 SF Bb Slab Cr	21.19	9.85	4.69	322.08	2.58	1.9	2.9	1.1	4.2
AM82 SF Above Dutch	11.93	8.51	2.84	190.08	1.75	1.7	2.5	0.9	3.5
AM40 AR Ab SFk at F	38.32	17.91	9.53	79.20	19.19	3.7	5.6	2.6	10.6
AM72 SF Ab Rock Cr	24.23	13.02	6.13	216.48	5.42	2.4	3.7	1.5	5.9
AM62 Sil F Ab Kyburz	60.10	13.86	5.86	253.44	5.10	2.4	3.6	1.4	5.8
AM64 SF Ab Adler Cr	6.44	4.37	2.00	691.68	0.33	1.0	1.5	0.4	1.6
AM56 SF Amer R HW	77.62	20.47	10.64	232.32	14.29	3.4	5.1	2.3	9.2
AM96 Weber Bl Dry C	8.35	6.63	2.73	205.92	1.26	1.5	2.3	0.8	3.0
AM58 Sil Fk Ab Cable	8.28	6.93	3.89	501.60	1.20	1.5	2.2	0.7	3.0
AM100 Folsom Res Loc	15.40	7.32	2.31	84.48	1.84	1.7	2.6	0.9	3.6
AM98 SF at Folsom Re	41.73	12.27	5.41	121.44	6.02	2.5	3.8	1.6	6.2
AM92 Weber Ab Dry Cr	66.77	27.03	12.58	132.00	29.60	4.3	6.4	3.2	12.9
AM60 Cables Ab Sil F	18.34	12.26	6.91	311.52	4.80	2.3	3.5	1.4	5.6
AM66 Adler Cr HW	23.41	13.47	6.45	285.12	5.15	2.4	3.6	1.4	5.8
AM94 Dry Cr HW	25.42	12.16	5.67	89.76	7.28	2.7	4.0	1.7	6.8

American River Reach Parameters

Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Cum Drainage Area (from GeoHms) A (Sq. Mi.)	American River Field Reg. Eqa $R = 0.0136A + 7.5649$	Jarrett's Equation $n = .39S^{.38}R^{-.16}$	Manning's Velocity v (ft/s)	Travel Time K Hrs	Lag (Min)
AM11-43	2.35	0.0143	349	12.31	0.052	18.28	0.19	11
AM17-37	10.43	0.0255	100	8.92	0.068	15.02	1.02	
AM31-33	4.97	0.0551	53.8	8.30	0.092	15.51	0.47	28
AM41-43	22.44	0.0039	569	15.30	0.031	18.72	1.76	
AM37-39	1.90	0.0061	427	13.37	0.037	17.67	0.16	9
AM35-37	3.75	0.0123	313	11.82	0.049	17.36	0.32	19
AM43-99	16.31	0.0008	986	20.97	0.016	20.09	1.19	
AM45-51	1.30	0.0072	83.5	8.70	0.042	12.64	0.15	9
AM53-69	5.02	0.0221	174	9.93	0.063	16.13	0.46	27
AM49-51	11.49	0.0137	36.6	8.06	0.055	12.82	1.31	
AM87-97	6.82	0.0041	690	16.95	0.031	20.50	0.49	29
AM77-79	2.73	0.0260	72.6	8.55	0.069	14.53	0.28	17
AM85-87	5.84	0.0028	641	16.28	0.027	18.94	0.45	27
AM69-75	6.86	0.0060	450	13.68	0.037	17.98	0.56	34
AM75-79	7.46	0.0190	505	14.43	0.056	21.57	0.51	30
AM97-99	8.25	0.0013	812	18.61	0.020	19.29	0.63	Use 20 min
AM67-69	14.82	0.0183	251	10.98	0.058	17.13	1.27	
AM81-85	5.09	0.0081	605	15.79	0.040	20.98	0.36	21
AM95-97	5.08	0.0100	97.9	8.90	0.048	13.39	0.56	33
AM63-65	2.60	0.0190	197	10.24	0.060	16.25	0.23	14
AM61-63	10.21	0.0353	94.8	8.85	0.077	15.52	0.96	
AM5-9	19.84	0.0097	219	10.54	0.046	15.35	1.90	
AM99-101	2.90	0.0206	1851	32.74	0.051	42.87	0.10	Use 0 min
AM9-11	12.68	0.0027	334	12.11	0.028	14.76	1.26	
AM13-15	6.77	0.0427	52.1	8.27	0.084	15.01	0.66	40
AM65-67	1.42	0.0224	190	10.15	0.064	16.45	0.13	8
AM51-53	10.68	0.0313	148	9.58	0.073	16.32	0.96	
AM79-81	4.99	0.0049	594	15.64	0.033	19.60	0.37	22
AM15-17	4.04	0.0378	84.9	8.72	0.079	15.45	0.38	23
AM39-41	2.24	0.0067	521	14.65	0.038	19.27	0.17	10
AM25-27	5.35	0.0157	106	9.01	0.057	14.28	0.55	33
AM27-33	7.57	0.0165	122	9.22	0.057	14.65	0.76	45
AM33-35	17.88	0.0210	207	10.38	0.062	16.63	1.58	
AM33A-33B	10.49	0.0491	18.7	7.82	0.089	14.57	1.06	
AM33B-35	1.64	0.0195	261	11.11	0.059	17.44	0.14	8
AM61A-61	10.09	0.0145	24.9	7.90	0.056	12.69	1.17	
AM61B-61	4.63	0.0552	21.2	7.85	0.093	14.83	0.46	28
AM31A-31	8.95	0.0245	20.7	7.85	0.069	13.44	0.98	

Routing parameters based on field observations and regression analysis. (Dec 1996 Event)

HEC-HMS Summary of Results
American River Basin: March 1995 Event

Project : American River   Run Name : Mar 1995 Event

Start of Run : 06Mar95 1200   Basin Model : American95

End of Run : 17Mar95 2400   Met. Model : Mar 95 Event

Execution Time : 31May00 1238   Control Specs. : Mar 95 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
AM4 NF NF Nr Baxter	6048.7	09 Mar 95 2100	31634	54.612
AM2 NF HW Ab Baxter	8567.4	09 Mar 95 2100	48477	141.437
AM5 NF Nr Baxter	14616	09 Mar 95 2100	80110	196.049
AM5-9	14444	09 Mar 95 2300	80040	196.049
AM6 NF Ab Pagge Cr	3994.5	10 Mar 95 2200	27115	57.452
AM8 Pagge Creek	3775.4	10 Mar 95 2200	23967	54.589
AM9 NF Bl Pagge Cr	21732	09 Mar 95 2300	131121	308.090
AM9-11	21607	09 Mar 95 2400	131057	308.090
AM10 NF at NF Lk Ga	1959.9	10 Mar 95 2000	11546	33.893
AMR10 NF Dam	22817	09 Mar 95 2400	142495	341.983
AM11 NF bl NF Dam	22817	09 Mar 95 2400	142495	341.983
AM11-43	22723	09 Mar 95 2400	142485	341.983
AM36A Pilot Ab SM Ga	1136.4	09 Mar 95 1600	5434.8	11.600
AMR36D Stumpy Mead	910.45	10 Mar 95 2300	5399.3	11.600
AM33A pilot Bl SM	910.45	10 Mar 95 2300	5399.3	11.600
AM33A-33B	908.28	10 Mar 95 2400	5392.9	11.600
Hell Hole Out	90.000	10 Mar 95 1900	713.01	114.000
Am27 Rub Bl HH Ga	90.000	10 Mar 95 1900	713.01	114.000
AM27-33	90.000	10 Mar 95 2000	712.57	114.000
Loon Out	470.00	07 Mar 95 0100	2876.9	8.000
AM31A	470.00	07 Mar 95 0100	2876.9	8.000
AM31A-31	470.00	07 Mar 95 0800	2910.0	8.000
AM30 SF Rub Georg Ga	3424.0	09 Mar 95 1500	14301	40.600
Am31 SF Rub N Geo Ga	3435.5	09 Mar 95 1500	17211	48.600
AM31-33	3422.3	09 Mar 95 1600	17219	48.600
AM32 SF Rub Ab Rub	1486.8	09 Mar 95 1500	6034.3	9.344
AM28 Rubicon Ab SFk	2367.1	09 Mar 95 1500	10278	19.825
AM33 Rub Bl SF Rub	7157.3	09 Mar 95 1500	34244	191.769
AM33-35	7100.0	09 Mar 95 1700	34236	191.769
AM36B Pilot Bl SM	1135.2	10 Mar 95 2100	5255.3	18.600
AM36 Rub Ab Pilot Cr	2893.6	10 Mar 95 2200	15212	38.600
AM33B Rub Bl Pilot	9833.6	10 Mar 95 1700	60096	260.569
AM33B-35	9823.9	10 Mar 95 1700	60095	260.569
AM34 Long Cr Ab Rub	3198.9	10 Mar 95 2200	17967	48.919

... Continued ...

HEC-HMS Summary of Results
American River Basin: March 1995 Event
(Continued)

Project : American River Run Name : Mar 1995 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
AM35 Rub Bl long Cr	12814	10 Mar 95 1700	78062	309.488
AM35-37	12769	10 Mar 95 1800	78055	309.488
FM Outflow	94.000	10 Mar 95 1800	559.38	47.200
AM13 MF At F Med Ga	94.000	10 Mar 95 1800	559.38	47.200
AM13-15	93.333	10 Mar 95 1900	559.19	47.200
AM14 MF Ab Duncan Cr	709.91	10 Mar 95 1500	3401.2	10.429
AM15 MF Ab Duncan	769.22	10 Mar 95 1700	3960.4	57.629
AM15-17	756.78	10 Mar 95 1500	3961.1	57.629
AM16 Duncan Canyon	1213.6	10 Mar 95 1800	7301.8	29.678
AM17 MF Ab MF PH Ga	1957.8	10 Mar 95 1800	11263	87.307
AM17-37	1947.5	10 Mar 95 1800	11275	87.307
AM36C Rub Ab MF	486.26	10 Mar 95 2000	2070.4	6.100
AM18 MF Ab Rubicon	1661.3	10 Mar 95 2100	8319.9	22.789
AM37 MF Bl Rubicon	16685	10 Mar 95 1800	99720	425.684
AM37-39	16678	10 Mar 95 1800	99718	425.684
AM20 NF MF Ab FH Ga	5880.8	10 Mar 95 2200	36533	97.214
AM39 MF Bl NF MF	22228	10 Mar 95 2200	136251	522.898
AM39-41	22185	10 Mar 95 2200	136248	522.898
AM41 MF Nr FH Gage	22185	10 Mar 95 2200	136248	522.898
AM41-43	22063	11 Mar 95 0100	136188	522.898
AM10A Clipper Cr HW	548.61	10 Mar 95 1900	2289.2	8.126
AM38 MF at Mouth	4019.7	10 Mar 95 2300	24679	91.038
AM43 AR Bl MF & SF	46452	10 Mar 95 2200	305641	964.045
AM43-99	46424	10 Mar 95 2300	305573	964.045
AM94 Dry Cr HW	1828.7	10 Mar 95 1900	7670.0	25.422
AM92 Weber Ab Dry Cr	1965.3	10 Mar 95 1900	12108	66.773
AM95 Weber Bl Dry Cr	3794.0	10 Mar 95 1900	19778	92.195
AM95-97	3729.2	10 Mar 95 2100	19796	92.195
AM76 Rock Cr Ab Bear	1777.0	10 Mar 95 2200	8776.2	46.525
AM77 Rock Cr Ab Bear	1777.0	10 Mar 95 2200	8776.2	46.525
AM77-79	1770.2	10 Mar 95 2200	8778.0	46.525
Union Val Out	1441.8	07 Mar 95 0900	8716.7	84.000
AM45 Silver Bl U Val	1441.8	07 Mar 95 0900	8716.7	84.000
AM45-51	1440.3	07 Mar 95 0900	8723.0	84.000
AM48 SF Silv B IH Ga	745.14	09 Mar 95 1800	4293.4	27.541
AMR48A Ice House	402.94	10 Mar 95 2400	4330.6	27.541
AM49 SF Sil Bl IH Ga	402.94	10 Mar 95 2400	4330.6	27.541
AM49-51	402.27	11 Mar 95 0200	4332.6	27.541
AM46 L Silver Bl UV	2033.6	09 Mar 95 1500	8447.5	13.340
AM50 SF Silver At Mo	1408.8	10 Mar 95 2200	7156.2	17.244

... Continued ...

HEC-HMS Summary of Results
American River Basin: March 1995 Event
(Continued)

Project : American River Run Name : Mar 1995 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
AM51 Sil Bl SF	3423.4	10 Mar 95 1500	28659	142.125
AM51-53	3397.6	10 Mar 95 1600	28683	142.125
AM52 Sil B Camino Ga	2292.3	10 Mar 95 2200	11543	29.796
AM53 Sil B Camino Ga	5531.7	10 Mar 95 1600	40227	171.921
AM53-69	5470.5	10 Mar 95 1700	40235	171.921
AM58A Silver Lk HW	88.540	15 Mar 95 1700	670.78	15.100
AMR58B Silver Lake	75.500	06 Mar 95 1200	1092.4	15.100
AM61B Silver Lk Out	75.500	06 Mar 95 1200	1092.4	15.100
AM61B-61	75.500	06 Mar 95 1200	1094.3	15.100
AM60A Caples Lake HW	67.450	06 Mar 95 1200	553.49	13.490
AMR60B Caples Lake	16.180	12 Mar 95 2200	350.19	13.490
AM61A Caples Lk Out	16.180	12 Mar 95 2200	350.19	13.490
AM61A-61	16.180	12 Mar 95 2300	349.87	13.490
AM58 Sil Fk Ab Cable	337.65	15 Mar 95 1700	995.00	8.280
AM60 Cables Ab Sil F	340.29	09 Mar 95 1700	1880.0	18.340
AM61 Sil Fk B Cables	685.88	15 Mar 95 1700	4319.2	55.210
AM61-63	667.99	15 Mar 95 1800	4326.8	55.210
AM62 Sil F Ab Kyburz	3236.0	09 Mar 95 1800	17262	60.103
AM56 SF Amer R HW	1574.4	09 Mar 95 1800	10693	77.625
AM63 SF Ab Silver Fk	5373.4	09 Mar 95 1700	32281	192.938
AM63-65	5368.7	09 Mar 95 1800	32280	192.938
AM65 SF Nr Kyburz Ga	5368.7	09 Mar 95 1800	32280	192.938
AM65-67	5362.7	09 Mar 95 1800	32280	192.938
AM64 SF Ab Adler Cr	726.61	10 Mar 95 1300	3358.4	6.438
AM66 Adler Cr HW	1480.6	09 Mar 95 1700	8026.9	23.414
AM67 SF Bl Adler Cr	7195.8	09 Mar 95 1700	43665	222.790
AM67-69	7072.7	09 Mar 95 1900	43644	222.790
AM54 Silver at Mouth	362.10	10 Mar 95 2100	1472.9	5.164
AM68 SF Ab Silver C	3144.6	10 Mar 95 2200	15518	47.749
AM69 Sf Bl Silver Cr	13831	10 Mar 95 2200	100870	447.623
AM69-75	13831	10 Mar 95 2300	100863	447.623
AM74 Slab Cr HW	1057.0	10 Mar 95 2200	5119.2	22.383
AM70 SF Ab Slab Cr	898.63	10 Mar 95 2100	3716.7	21.194
AM75 SF Bl Slab Cr	15601	10 Mar 95 2300	109699	491.200
AMR75A Slab Cr Dam	15420	10 Mar 95 2400	109603	491.200
AM75-79	15420	11 Mar 95 0100	109496	491.200
AM78 Bear Cr HW	1093.5	10 Mar 95 2100	5401.4	28.128
AM72 SF Ab Rock Cr	121.13	06 Mar 95 1200	1274.5	24.226
AM79 SF Bl Rock Cr	17976	10 Mar 95 2400	124950	590.079
AM79-81	17875	11 Mar 95 0100	124913	590.079
AM80 SF Nr Placvl Ga	217.77	11 Mar 95 1900	922.86	7.867

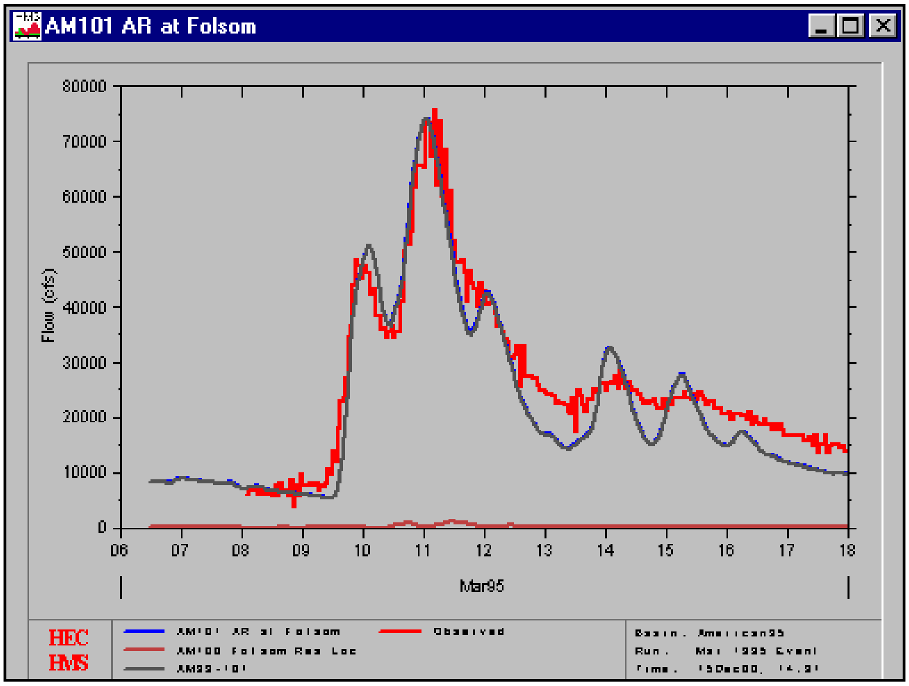
... Continued ...

HEC-HMS Summary of Results
American River Basin: March 1995 Event
(Continued)

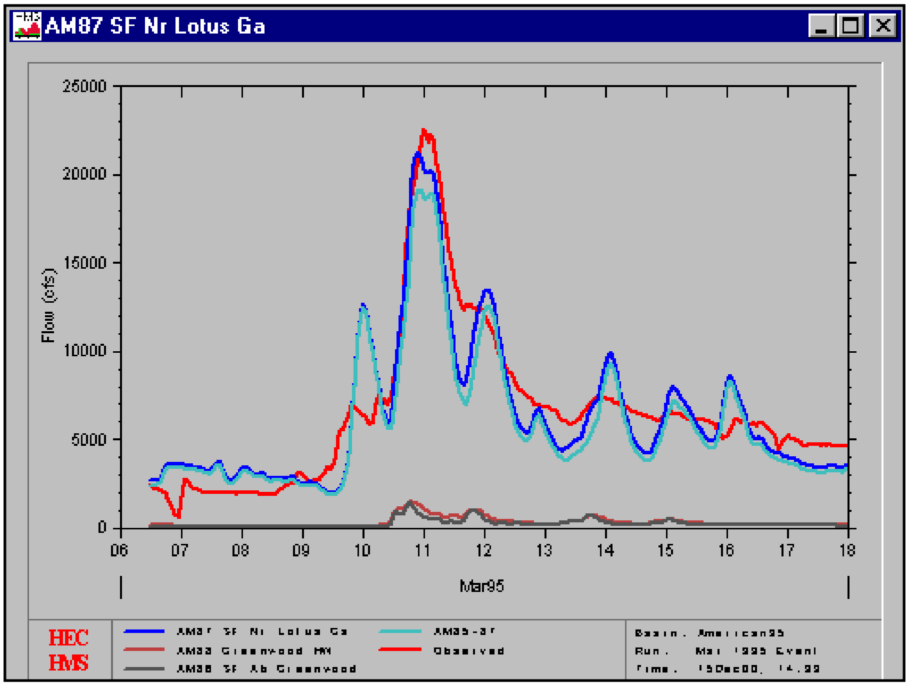
Project : American River Run Name : Mar 1995 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
AM81 SF Nr Placvl Ga	17974	11 Mar 95 0100	125836	597.947
AM81-85	17942	11 Mar 95 0200	125721	597.947
AM84 Dutch Cr HW	1042.9	10 Mar 95 2100	4584.5	19.726
AM82 SF Above Dutch	870.02	10 Mar 95 1800	3377.7	11.931
AM85 SF Bl Dutch Cr	19147	10 Mar 95 2100	133683	629.603
AM85-87	19093	10 Mar 95 2200	133543	629.603
AM88 Greenwood HW	1504.2	10 Mar 95 1900	6705.6	25.526
AM86 SF Ab Greenwood	1365.3	10 Mar 95 1800	5079.0	17.564
AM87 SF Nr Lotus Ga	21192	10 Mar 95 2200	145328	672.692
AM87-97	21112	10 Mar 95 2300	145218	672.692
AM90 SF Ab Weber Cr	1535.9	10 Mar 95 1900	6514.7	28.166
AM96 Weber Bl Dry C	655.47	10 Mar 95 1800	2199.9	8.348
AM97 SF Bl Weber Cr	25819	10 Mar 95 2300	173728	801.402
AM97-99	25653	11 Mar 95 0200	173566	801.402
AM40 AR Ab SFk at F	1604.0	10 Mar 95 2000	7744.5	38.320
AM98 SF at Folsom Re	2294.6	10 Mar 95 1900	9270.3	41.735
AM99 AR abv Folsom	73947	11 Mar 95 0100	496154	1845.502
AM99-101	73947	11 Mar 95 0100	496154	1845.502
AM100 Folsom Res Loc	1192.8	11 Mar 95 1100	4089.2	15.398
AM101 AR at Folsom	74127	11 Mar 95 0100	500243	1860.900
Folsom Res	74127	11 Mar 95 0100	500243	1860.900
AM22 Five Lakes Cr	1224.3	09 Mar 95 1600	4960.2	29.062
AM24 Rub Ab Hell Hol	957.66	09 Mar 95 1800	6538.6	65.814
AM25	2089.9	09 Mar 95 1600	11499	94.876
AM25-27	2088.4	09 Mar 95 1700	11510	94.876
AM26 Hell Hole Loc	1928.2	09 Mar 95 1500	7430.5	19.038
Hell Hole Inflow	3864.3	09 Mar 95 1600	18941	113.915
AM42 B Silver Ab UV	2910.7	09 Mar 95 1600	14263	51.773
AM44 Jones Fk Silver	1846.8	09 Mar 95 1700	10195	31.372
Union val inf	4732.2	09 Mar 95 1600	24458	83.145
AM12 MF Ab Fr Md Ga	2634.7	09 Mar 95 1800	12955	48.061
FM Inflow	2634.7	09 Mar 95 1800	12955	48.061
French Meadows	8.0000	06 Mar 95 1200	182.48	0.000
Hell Hole Res	0.000477	06 Mar 95 1200	0.01086	0.000
AM30A Loon Lake HW	429.59	09 Mar 95 1700	1750.5	8.000
Loon Inf	429.59	09 Mar 95 1700	1750.5	8.000
AMR44A Union Valley	0.0	06 Mar 95 1200	0.0	0.000
AMR30B Loon Lake	0.0	06 Mar 95 1200	0.0	0.000

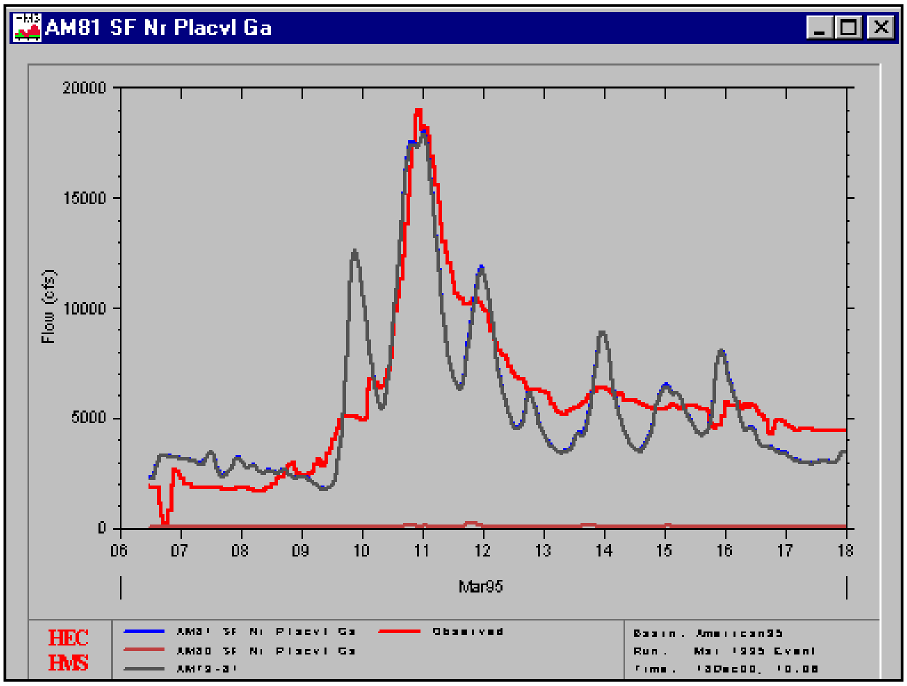
HEC-HMS: Comparison of Observed vs. Computed Hydrographs
American River Basin
March 1995 Event



AM101 – American River at Folsom



AM87 – South Fork Near Lotus Gage



AM81 – South Fork Near Placerville Gage

HEC-HMS Subbasin Parameters
American River Basin: March 1995 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
AM6 NF Ab Pagge Cr	5	0.8	0.15	1.5	.01	0
AM4 NF Nr Baxter	5	0.8	0.15	2.0	.02	0
AM2 NF NF HW Ab Baxter	5	0.8	0.15	2.0	.02	0
AM22 Five Lakes Cr	5	0.8	0.15	2.0	.02	0
AM16 Duncan Canyon	8	0.8	0.15	2.75	.05	0
AM14 MF Ab Duncan Cr	8	0.8	0.15	2.75	.05	0
AM20 NF MF Ab FH Ga	5	0.8	0.15	2.0	.02	0
AM8 Pagge Cr	5	0.8	0.15	1.5	.01	0
AM24 Rub Ab Hell Hol	5	0.8	0.15	2.0	.02	0
AM28 Rubicon Ab SFk	5	0.8	0.15	2.0	.02	0
AM34 Long Cr Ab Rub	5	0.8	0.15	2.0	.02	0
AM10A Clipper Cr HW	5	0.8	0.15	2.0	.02	0
AM32 SF Rub Ab Rub	5	0.8	0.15	2.0	.02	0
AM38 MF at Mouth	5	0.8	0.15	2.0	.01	0
AM42 B Silver Ab UV	5	0.8	0.15	2.0	.02	0
AM46 L Silver Bl UV	5	0.8	0.15	2.0	.02	0
AM88 Greenwood HW	5	0.8	0.15	2.0	.01	0
AM44 Jones Fk Silver	5	0.8	0.15	2.0	.02	0
AM78 Bear Cr HW	5	0.8	0.15	2.0	.01	0
AM84 Dutch Cr HW	5	0.8	0.15	2.0	.01	0
AM76 Rock Cr Ab Bear	5	0.8	0.15	2.0	.01	0
AM54 Silver at Mouth	5	0.8	0.15	2.0	.02	0
AM74 Slab Cr HW	5	0.8	0.15	2.0	.01	0
AM50 SF Silver At Mo	5	0.8	0.15	2.0	.02	0
AM90 SF Ab Weber Cr	5	0.8	0.15	1.5	.02	0
AM68 SF Ab Silver C	5	0.8	0.15	2.0	.02	0
AM86 SF Ab Greenwood	5	0.8	0.15	2.0	.01	0
AM70 SF Ab Slab Cr	5	0.8	0.15	2.0	.02	0
AM82 SF Above Dutch	5	0.8	0.15	2.0	.01	0
AM40 AR Ab SFk at F	5	0.8	0.15	1.5	.02	0
AM72 SF Ab Rock Cr	5	0.8	0.15	2.0	.01	0
AM62 Sil F Ab Kyburz	5	0.8	0.15	2.0	.02	0
AM64 SF Ab Adler Cr	5	0.8	0.15	2.0	.02	0
AM56 SF Amer R HW	5	0.8	0.15	2.0	.02	0
AM96 Weber Bl Dry C	5	0.8	0.15	2.0	.02	0
AM58 Sil Fk Ab Cable	5	0.8	0.15	2.0	.02	0
AM100 Folsom Res Loc	5	0.8	0.15	1.5	.02	10
AM98 SF at Folsom	5	0.8	0.15	1.5	.02	0
AM92 Weber Ab Dry Cr	5	0.8	0.15	1.5	.01	0
AM60 Cables Ab Sil F	5	0.8	0.15	2.0	.02	0
AM66 Adler Cr HW	5	0.8	0.15	2.0	.02	0
AM94 Dry Cr HW	5	0.8	0.15	1.5	.01	0
AM10 NF at NF Lk Ga	5	0.8	0.15	1.5	.01	0
AM52 Sil B Camino Ga	5	0.8	0.15	2.0	.02	0
AM80 SF Nr Placvl Ga	5	0.8	0.15	2.0	.01	0
AM48 SF Silv B IH Ga	5	0.8	0.15	2.0	.02	0

… Continued …

HEC-HMS Subbasin Parameters
American River Basin: March 1995 Event
(Continued)

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
AM30 SF Rub Georg Ga	5	0.8	0.15	2.0	.02	0
AM12 MF Ab Fr Md Ga	5	0.8	0.15	2.5	.02	0
AM26 Hell Hole Loc	5	0.8	0.15	2.0	.02	0
AM18 MF Ab Rubicon	5	0.8	0.15	2.0	.02	0
AM36 Rub Ab Pilot Cr	5	0.8	0.15	2.0	.01	0
AM60A Caples Lake HW	5	0.8	0.15	2.0	.02	0
AM58A Silver Lk HW	5	0.8	0.15	2.0	.02	0
AM30A Loon Lake HW	5	0.8	0.15	2.0	.02	12.5
AM36A Pilot Ab SM Ga	5	0.8	0.15	2.3	.02	0
AM36B Pilot Bl SM	5	0.8	0.15	2.0	.02	0
AM36C Rub Ab MF	5	0.8	0.15	2.0	.02	0

HEC-HMS Summary of Results
American River Basin: December 1996 - January 1997 Event

Project : American River   Run Name : Jan 1997 Event

Start of Run : 25Dec96 1200   Basin Model : American97

End of Run : 10Jan97 1200   Met. Model : Jan 97 Event

Execution Time : 31May00 1239   Control Specs. : Jan 97 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
AM11B NF Out	64200	01 Jan 97 1500	401522	342.000
AM11 NF bl NF Dam	64200	01 Jan 97 1500	401522	342.000
AM11-43	64127	01 Jan 97 1500	401509	342.000
AM36A Pilot Ab SM Ga	2585.1	01 Jan 97 1300	14782	11.600
AMR36D Stumpy Mead	2401.0	01 Jan 97 1800	14727	11.600
AM33A pilot Bl SM	2401.0	01 Jan 97 1800	14727	11.600
AM33A-33B	2395.1	01 Jan 97 1900	14717	11.600
Hell Hole Out	28761	02 Jan 97 1100	69543	114.000
Am27 Rub Bl HH Ga	28761	02 Jan 97 1100	69543	114.000
AM27-33	28587	02 Jan 97 1200	69456	114.000
Loon Out	4428.0	02 Jan 97 1600	13784	8.000
AM31A	4428.0	02 Jan 97 1600	13784	8.000
AM31A-31	4424.2	02 Jan 97 1700	13781	8.000
AM30 SF Rub Georg Ga	7522.5	02 Jan 97 0700	61175	40.600
Am31 SF Rub N Geo Ga	9675.9	02 Jan 97 0900	74956	48.600
AM31-33	9619.4	02 Jan 97 1000	74941	48.600
AM32 SF Rub Ab Rub	2353.4	01 Jan 97 1200	13411	9.344
AM28 Rubicon Ab SFk	3151.3	02 Jan 97 0700	22921	19.825
AM33 Rub Bl SF Rub	41740	02 Jan 97 1100	180730	191.769
AM33-35	41692	02 Jan 97 1300	180453	191.769
AM36B Pilot Bl SM	5334.6	02 Jan 97 0100	31087	18.600
AM36 Rub Ab Pilot Cr	6627.2	02 Jan 97 0800	47696	38.600
AM33B Rub Bl Pilot	53712	02 Jan 97 1200	273952	260.569
AM33B-35	53649	02 Jan 97 1200	273933	260.569
AM34 Long Cr Ab Rub	6655.3	02 Jan 97 0800	50817	48.919
AM35 Rub Bl long Cr	59826	02 Jan 97 1200	324750	309.488
AM35-37	59638	02 Jan 97 1200	324688	309.488
Fr Med Out	4556.0	02 Jan 97 1500	17862	48.000
AM13 MF At F Med Ga	4556.0	02 Jan 97 1500	17862	48.000
AM13-15	4536.0	02 Jan 97 1600	17862	48.000
AM14 MF Ab Duncan Cr	1500.5	01 Jan 97 1300	10824	10.429
AM15 MF Ab Duncan	5533.5	02 Jan 97 1300	28686	58.429
AM15-17	5501.6	02 Jan 97 1300	28686	58.429
AM16 Duncan Canyon	3764.4	02 Jan 97 0800	28284	29.678

... Continued ...

HEC-HMS Summary of Results
American River Basin: December 1996-January 1997 Event
(Continued)

Project : American River Run Name : Jan 97 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
AM17 MF Ab MF PH Ga	8910.6	02 Jan 97 1000	56970	88.107
AM17-37	8898.2	02 Jan 97 1100	56965	88.107
AM36C Rub Ab MF	1201.3	01 Jan 97 1200	6571.0	6.100
AM18 MF Ab Rubicon	3179.8	02 Jan 97 0800	23962	22.789
AM37 MF Bl Rubicon	71942	02 Jan 97 1200	412186	426.484
AM37-39	71804	02 Jan 97 1200	412154	426.484
AM20 NF MF Ab FH Ga	9787.0	02 Jan 97 1000	79561	97.214
AM39 MF Bl NF MF	81361	02 Jan 97 1200	491714	523.698
AM39-41	81190	02 Jan 97 1200	491680	523.698
AM41 MF Nr FH Gage	81190	02 Jan 97 1200	491680	523.698
AM41-43	81077	02 Jan 97 1400	491302	523.698
AM10A Clipper Cr HW	711.71	01 Jan 97 1200	3106.2	8.126
AM38 MF at Mouth	7152.8	02 Jan 97 1000	51156	91.038
AM43 AR Bl MF & SF	143611	02 Jan 97 1200	947074	964.862
AM43-99	143437	02 Jan 97 1300	946935	964.862
AM94 Dry Cr HW	1764.8	01 Jan 97 1300	8151.6	25.422
AM92 Weber Ab Dry Cr	2668.6	01 Jan 97 2000	17603	66.773
AM95 Weber Bl Dry Cr	4305.9	01 Jan 97 1300	25755	92.195
AM95-97	4273.8	01 Jan 97 1400	25765	92.195
AM76 Rock Cr Ab Bear	7078.6	02 Jan 97 0200	47743	46.525
AM77 Rock Cr Ab Bear	7078.6	02 Jan 97 0200	47743	46.525
AM77-79	7070.0	02 Jan 97 0200	47739	46.525
AM42 B Silver Ab UV	11087	02 Jan 97 0800	73348	51.773
AM44 Jones Fk Silver	6594.2	02 Jan 97 0900	38169	31.372
AMR44A Union Valley	12704	02 Jan 97 1600	106652	83.145
AM45 Silver Bl U Val	12704	02 Jan 97 1600	106652	83.145
AM45-51	12700	02 Jan 97 1600	106637	83.145
AM48 SF Silv B IH Ga	4739.4	02 Jan 97 1000	20769	27.541
AMR48A Ice House	4132.1	02 Jan 97 1400	19944	27.541
AM49 SF Sil Bl IH Ga	4132.1	02 Jan 97 1400	19944	27.541
AM49-51	4123.5	02 Jan 97 1500	19891	27.541
AM46 L Silver Bl UV	3444.4	02 Jan 97 0700	18331	13.340
AM50 SF Silver At Mo	3414.8	02 Jan 97 0800	20387	17.244
AM51 Sil Bl SF	21907	02 Jan 97 0900	165247	141.270
AM51-53	21886	02 Jan 97 1000	165076	141.270
AM52 Sil B Camino Ga	5167.5	01 Jan 97 1300	33382	29.796
AM53 Sil B Camino Ga	26043	02 Jan 97 0900	198458	171.065
AM53-69	26037	02 Jan 97 1000	198377	171.065
AM58A Silver Lk HW	2352.0	02 Jan 97 1200	8264.0	15.100
AMR58B Silver Lake	1478.8	02 Jan 97 1600	8189.7	15.100

... Continued ...

HEC-HMS Summary of Results
American River Basin: December 1996 - January 1997 Event
(Continued)

Project : American River Run Name : Jan 97 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
AM61B Silver Lk Out	1478.8	02 Jan 97 1600	8189.7	15.100
AM61B-61	1477.5	02 Jan 97 1600	8188.9	15.100
AM60A Caples Lake HW	2235.7	01 Jan 97 1800	6822.3	13.490
AMR60B Caples Lake	52.950	10 Jan 97 1200	1074.3	13.490
AM61A Caples Lk Out	52.950	10 Jan 97 1200	1074.3	13.490
AM61A-61	52.948	10 Jan 97 1200	1070.3	13.490
AM58 Sil Fk Ab Cable	1331.9	02 Jan 97 1200	5609.7	8.280
AM60 Cables Ab Sil F	2789.2	02 Jan 97 1100	12709	18.340
AM61 Sil Fk B Cables	5433.6	02 Jan 97 1100	27578	55.210
AM61-63	5384.3	02 Jan 97 1200	27563	55.210
AM62 Sil F Ab Kyburz	9587.9	01 Jan 97 1500	57625	60.103
AM56 SF Amer R HW	12019	02 Jan 97 1200	64360	77.625
AM63 SF Ab Silver Fk	26108	02 Jan 97 1200	149548	192.938
AM63-65	26061	02 Jan 97 1300	149526	192.938
AM65 SF Nr Kyburz Ga	26061	02 Jan 97 1300	149526	192.938
AM65-67	26041	02 Jan 97 1300	149513	192.938
AM64 SF Ab Adler Cr	1257.4	01 Jan 97 1200	8410.8	6.438
AM66 Adler Cr HW	3806.0	01 Jan 97 1500	23464	23.414
AM67 SF Bl Adler Cr	30071	02 Jan 97 1300	181388	222.790
AM67-69	29937	02 Jan 97 1400	181237	222.790
AM54 Silver at Mouth	723.84	01 Jan 97 1200	5011.9	5.164
AM68 SF Ab Silver C	5180.3	02 Jan 97 0900	43750	47.749
AM69 Sf Bl Silver Cr	60836	02 Jan 97 0900	428376	446.768
AM69-75	60805	02 Jan 97 1000	428200	446.768
AM74 Slab Cr HW	3730.3	01 Jan 97 1600	24608	22.383
AM70 SF Ab Slab Cr	2441.3	01 Jan 97 1300	16924	21.194
AM75 SF Bl Slab Cr	65897	02 Jan 97 1000	469732	490.344
AMR75A Slab Cr Dam	65918	02 Jan 97 1000	469491	490.344
AM75-79	65826	02 Jan 97 1000	469328	490.344
AM78 Bear Cr HW	2380.6	01 Jan 97 1300	15561	28.128
AM72 SF Ab Rock Cr	862.97	01 Jan 97 1300	5462.9	24.226
AM79 SF Bl Rock Cr	75380	02 Jan 97 1000	538091	589.224
AM79-81	75314	02 Jan 97 1000	537966	589.224
AM80 SF Nr Placvl Ga	334.23	01 Jan 97 1100	1573.1	7.867
AM81 SF Nr Placvl Ga	75492	02 Jan 97 1000	539540	597.091
AM81-85	75374	02 Jan 97 1000	539421	597.091
AM84 Dutch Cr HW	1713.7	01 Jan 97 1200	8598.2	19.726
AM82 SF Above Dutch	935.26	01 Jan 97 1100	4238.2	11.931
AM85 SF Bl Dutch Cr	77090	02 Jan 97 1000	552257	628.748
AM85-87	77015	02 Jan 97 1100	552102	628.748
AM88 Greenwood HW	2008.2	01 Jan 97 1300	10145	25.526

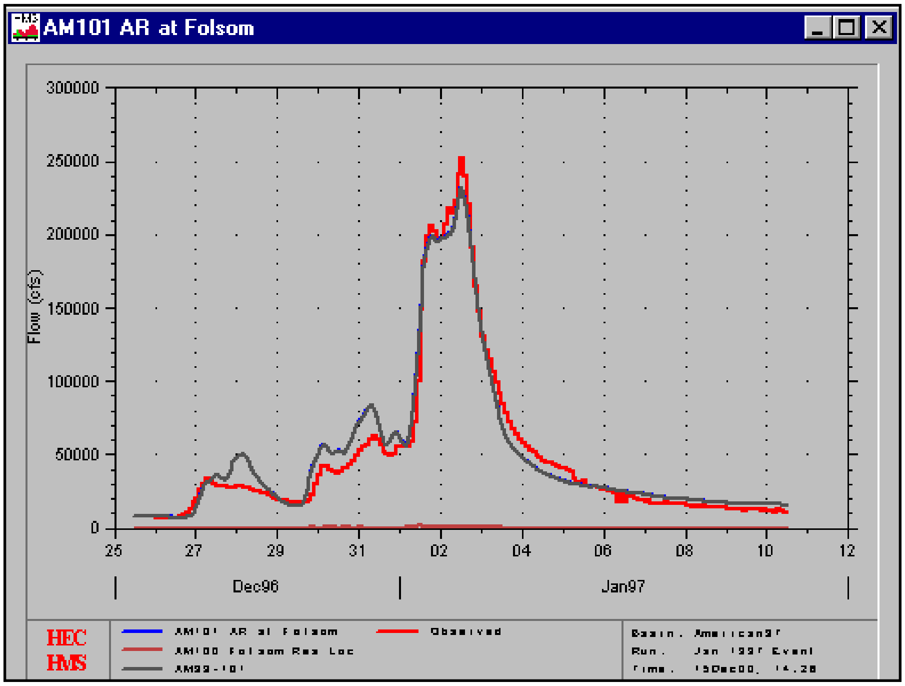
... Continued ...

HEC-HMS Summary of Results
American River Basin: December 1996 - January 1997 Event
(Continued)

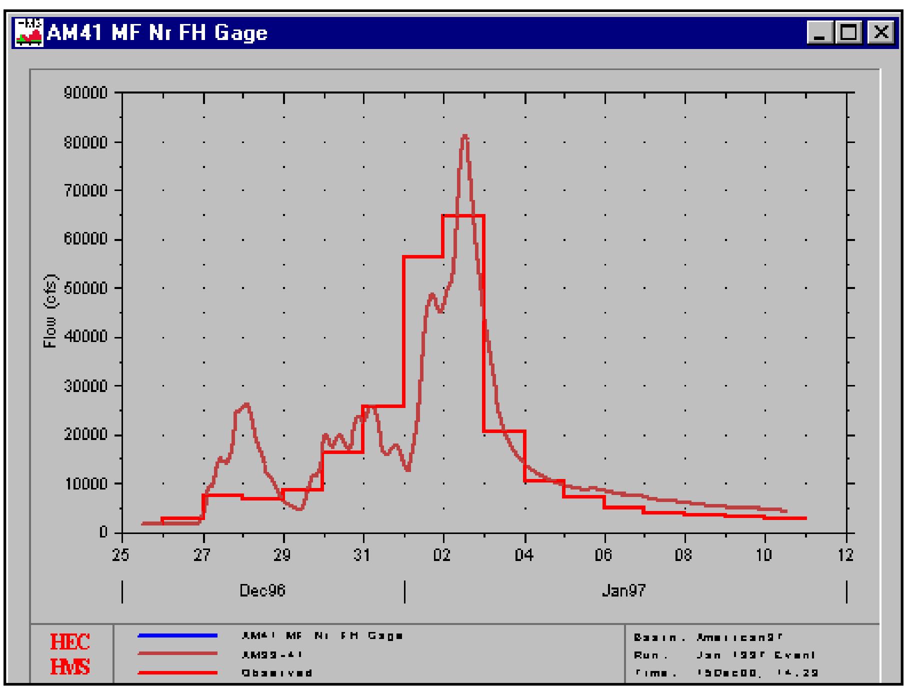
Project : American River Run Name : Jan 97 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
AM86 SF Ab Greenwood	1544.7	01 Jan 97 1200	6786.4	17.564
AM87 SF Nr Lotus Ga	79318	02 Jan 97 1100	569034	671.837
AM87-97	79302	02 Jan 97 1100	568867	671.837
AM90 SF Ab Weber Cr	1935.1	01 Jan 97 1300	9259.6	28.166
AM96 Weber Bl Dry C	790.12	01 Jan 97 1200	3082.5	8.348
AM97 SF Bl Weber Cr	84657	02 Jan 97 1100	606974	800.547
AM97-99	84587	02 Jan 97 1100	606867	800.547
AM40 AR Ab SFk at F	2137.1	01 Jan 97 2100	11642	38.320
AM98 SF at Folsom Re	3135.7	01 Jan 97 1300	13382	41.735
AM99 AR abv Folsom	230780	02 Jan 97 1300	1578827	1845.463
AM99-101	230780	02 Jan 97 1300	1578827	1845.463
AM100 Folsom Res Loc	1501.1	01 Jan 97 1200	5773.2	15.398
AM101 AR at Folsom	231369	02 Jan 97 1300	1584600	1860.862
Folsom Res	231369	02 Jan 97 1300	1584600	1860.862
AM4 NF NF Nr Baxter	5960.5	02 Jan 97 0100	46276	54.612
AM2 NF HW Ab Baxter	16430	02 Jan 97 1000	120741	141.437
AM5 NF Nr Baxter	22293	02 Jan 97 0900	167017	196.049
AM5-9	22252	02 Jan 97 1100	166933	196.049
AM6 NF Ab Pagge Cr	4152.4	02 Jan 97 0900	30788	57.452
AM8 Pagge Creek	4568.2	02 Jan 97 0900	35590	54.589
AM9 NF Bl Pagge Cr	30847	02 Jan 97 1000	233312	308.090
AM9-11	30783	02 Jan 97 1100	233268	308.090
AM10 NF at NF Lk Ga	2137.4	01 Jan 97 1400	12681	33.893
Am11A NF Dam Inf	32709	02 Jan 97 1100	245949	341.983
AM22 Five Lakes Cr	4854.1	01 Jan 97 1400	32615	29.062
AM24 Rub Ab Hell Hol	10886	02 Jan 97 0900	80626	65.814
AM25	15419	02 Jan 97 0800	113241	94.876
AM25-27	15401	02 Jan 97 0900	113154	94.876
AM26 Hell Hole Loc	2937.8	01 Jan 97 1400	20697	19.038
Hell Hole Inf	18201	02 Jan 97 0800	133851	113.915
AM12 MF Ab Fr Md Ga	6801.5	02 Jan 97 0800	47264	48.061
FrMed Inf	6801.5	02 Jan 97 0800	47264	48.061
French Meadows	0.0	25 Dec 96 1200	0.0	0.000
Hell Hole Res	0.0	25 Dec 96 1200	0.0	0.000
AM30A Loon Lake HW	1922.8	27 Dec 96 1700	14428	8.000
Loon Inf	1922.8	27 Dec 96 1700	14428	8.000
AMR30B Loon Lake	0.0	25 Dec 96 1200	0.0	0.000
AMR10 NF Dam	0.0	25 Dec 96 1200	0.0	0.000

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
American River Basin
December 1996 - January 1997 Event



AM101 – American River at Folsom



AM41 – Middle Fork Near Forest Hill Gage

HEC-HMS Subbasin Parameters
American River Basin: December 1996 - January 1997 Event

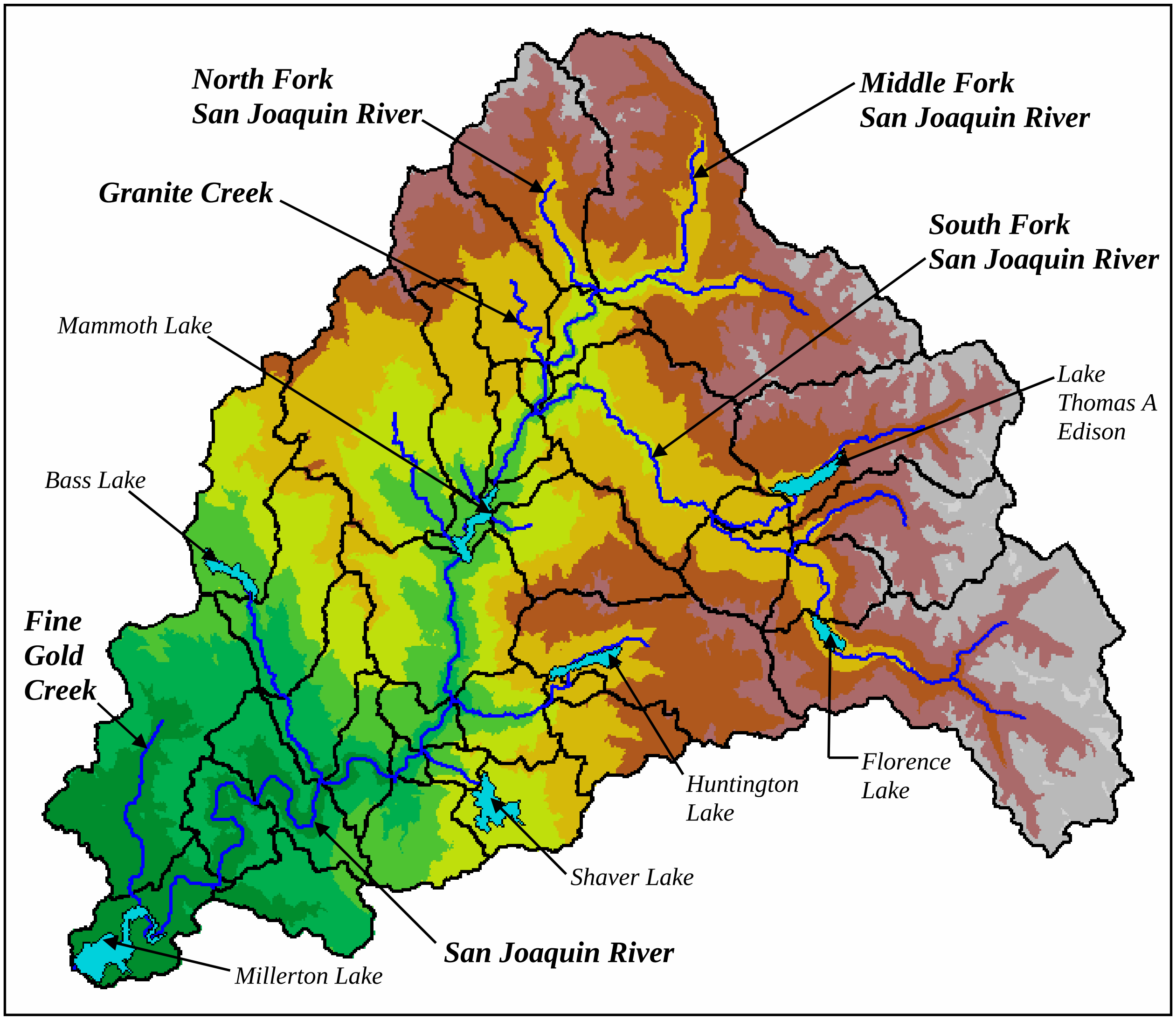
Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
AM6 NF Ab Pagge Cr	5	0.8	0.15	2.0	.001	0
AM4 NF Nr Baxter	5	0.8	0.15	2.0	.001	0
AM2 NF NF HW Ab Baxter	5	0.8	0.15	2.0	.001	0
AM22 Five Lakes Cr	5	0.8	0.15	2.0	.001	0
AM16 Duncan Canyon	5	0.8	0.15	2.0	.001	0
AM14 MF Ab Duncan Cr	5	0.8	0.15	2.0	.001	0
AM20 NF MF Ab FH Ga	5	0.8	0.15	2.0	.001	0
AM8 Pagge Cr	5	0.8	0.15	2.0	.001	0
AM24 Rub Ab Hell Hol	5	0.8	0.15	2.0	.001	0
AM28 Rubicon Ab SFk	5	0.8	0.15	2.0	.001	0
AM34 Long Cr Ab Rub	5	0.8	0.15	2.0	.001	0
AM10A Clipper Cr HW	5	0.8	0.15	2.0	.001	0
AM32 SF Rub Ab Rub	5	0.8	0.15	2.0	.001	0
AM38 MF at Mouth	5	0.8	0.15	2.0	.001	0
AM42 B Silver Ab UV	5	0.8	0.15	2.0	.001	0
AM46 L Silver Bl UV	5	0.8	0.15	2.0	.001	0
AM88 Greenwood HW	5	0.8	0.15	2.0	.001	0
AM44 Jones Fk Silver	5	0.8	0.15	2.0	.001	0
AM78 Bear Cr HW	5	0.8	0.15	2.0	.001	0
AM84 Dutch Cr HW	5	0.8	0.15	2.0	.001	0
AM76 Rock Cr Ab Bear	5	0.8	0.15	2.0	.001	0
AM54 Silver at Mouth	5	0.8	0.15	2.0	.001	0
AM74 Slab Cr HW	5	0.8	0.15	2.0	.001	0
AM50 SF Silver At Mo	5	0.8	0.15	2.0	.001	0
AM90 SF Ab Weber Cr	5	0.8	0.15	2.0	.001	0
AM68 SF Ab Silver C	5	0.8	0.15	2.0	.001	0
AM86 SF Ab Greenwood	5	0.8	0.15	2.0	.001	0
AM70 SF Ab Slab Cr	5	0.8	0.15	2.0	.001	0
AM82 SF Above Dutch	5	0.8	0.15	2.0	.001	0
AM40 AR Ab SFk at F	5	0.8	0.15	2.0	.001	0
AM72 SF Ab Rock Cr	5	0.8	0.15	2.0	.001	0
AM62 Sil F Ab Kyburz	5	0.8	0.15	2.0	.001	0
AM64 SF Ab Adler Cr	5	0.8	0.15	2.0	.001	0
AM56 SF Amer R HW	5	0.8	0.15	2.0	.001	0
AM96 Weber Bl Dry C	5	0.8	0.15	2.0	.001	0
AM58 Sil Fk Ab Cable	5	0.8	0.15	2.0	.001	0
AM100 Folsom Res Loc	5	0.8	0.15	2.0	.001	10
AM98 SF at Folsom	5	0.8	0.15	2.0	.001	0
AM92 Weber Ab Dry Cr	5	0.8	0.15	2.0	.001	0
AM60 Cables Ab Sil F	5	0.8	0.15	2.0	.001	0
AM66 Adler Cr HW	5	0.8	0.15	2.0	.001	0
AM94 Dry Cr HW	5	0.8	0.15	2.0	.001	0
AM10 NF at NF Lk Ga	5	0.8	0.15	2.0	.001	0
AM52 Sil B Camino Ga	5	0.8	0.15	2.0	.001	0
AM80 SF Nr Placvl Ga	5	0.8	0.15	2.0	.001	0
AM48 SF Silv B IH Ga	5	0.8	0.15	6.5	.001	0

… Continued …

HEC-HMS Subbasin Parameters
American River Basin: December 1996 - January 1997 Event
(Continued)

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
AM30 SF Rub Georg Ga	5	0.8	0.15	2.0	.001	0
AM12 MF Ab Fr Md Ga	5	0.8	0.15	2.0	.001	0
AM26 Hell Hole Loc	5	0.8	0.15	2.0	.001	0
AM18 MF Ab Rubicon	5	0.8	0.15	2.0	.001	0
AM36 Rub Ab Pilot Cr	5	0.8	0.15	2.0	.001	0
AM60A Caples Lake HW	5	0.8	0.15	2.0	.001	0
AM58A Silver Lk HW	5	0.8	0.15	2.0	.001	0
AM30A Loon Lake HW	5	0.8	0.15	2.0	.001	12.5
AM36A Pilot Ab SM Ga	5	0.8	0.15	2.0	.001	0
AM36B Pilot Bl SM	5	0.8	0.15	2.0	.001	0
AM36C Rub Ab MF	5	0.8	0.15	2.0	.001	0

Upper San Joaquin River Basin



HEC-GeoHMS Subbasin Delineation

Upper San Joaquin River

The Upper San Joaquin River HMS model consists of a 1,638 square mile basin above Millerton Lake (Friant Dam) located in the southeastern-most portion of the San Joaquin Watershed. The basin model is divided into 36 subbasins and connected with 18 routing reaches. The computed peak inflow into Millerton Lake was approximately 83,600 cfs for the 1997 event and approximately 39,700 cfs for the 1995 event.

Calibration of the 1995 Event:

As noted for other basins, the observed discharge at the headwater reservoirs was difficult to match because of insufficient LWASS. The LWASS hyetographs allowed for a better match of the observed hydrographs in the lower reaches; however, only one good calibration resulted in the upper area (at the mouth of Willow Creek). The other observed hydrographs in the lower reaches were along the mainstem of the San Joaquin River where storage capacity in the chain of dams above Millerton Lake was sufficient to make them difficult to calibrate to without substantial knowledge of the regulation of the individual reservoirs. No releases were made at Mammoth Pool, while the hydrographs at Kerckhoff and Redinger consisted of a sequence of large, abrupt changes. Although revising the loss rates allowed a match of the observed flood volume, calibrating to the peak inflow to Millerton Lake required successful calibrations at Redinger and Kerckhoff, (which wasn't possible with the limited knowledge of the reservoir regulations).

Calibration of the 1997 Event:

The 1997 event completely overwhelmed the San Joaquin River reservoirs above Millerton Lake and provided good calibrations at Bear Creek, Mammoth Pool, and Millerton Lake. Insufficient LWASS led to discrepancies between the computed and observed hydrographs at Willow Creek and Pitman/Big Creek. These subbasins had little effect on downstream flows.

The simulation period was set to begin 01Jan1997, rather than 29Dec1996, so that the small burst of rainfall a few days prior to the main event was ignored. Using the earlier simulation date made it difficult to reconcile the observed initial level of the Mammoth Pool reservoir with realistic loss rates. Achieving a good calibration at Millerton Lake required a good calibration at the Mammoth Pool Dam.

All subbasins used the generalized TC and R parameters (Group 2) derived from regression analysis. Good calibrations resulted at Bear Creek, Mammoth Pool, and Millerton Lake, although revising the parameters for a slightly sharper response could improve results somewhat. Calibrations at Pitman Creek, and Big Creek were limited by inconsistencies between the observed hydrographs and the shape and timing of the LWASS hyetographs. Lack of runoff volume seemed to be the main problem for calibration at Willow Creek and other (mostly headwater) subbasins.

Losses were assigned according to how far upstream the subbasin was located (which generally coincided with elevation). The three “elevation zones” that were used were as follows:

1. Florence Lake, Bear Creek, Lake T. A. Edison, Mono Creek had the highest losses (1.5 inches initial, 0.85 inches/hour constant). These values were determined by calibration at Bear Creek.

2. The area between South Fork San Joaquin River at Mono Creek to Mammoth Dam used smaller losses (1.0 inches initial, 0.44 inches/hour constant). These values were determined by calibration at the Mammoth Pool Dam.

3. The area between Friant Dam and the Mammoth Pool Dam used the smallest losses (0.75 inches initial, 0.01 inches/hour constant). These values were determined by calibration at Friant Dam.

Specific modeling efforts for the 1997 and 1995 events are described in the following paragraphs:

SJ5R Florence Lake:

The drainage area to this location is approximately 173 square miles. Reservoir levels for Florence Lake are given at gage 11229600. One diversion, Ward Tunnel (gage 11229500), diverts 1000-2000 cfs from Florence Lake to Huntington Lake. Hourly flows below the reservoir were available for the 1995 event at gage 11230215. This gage includes 13 square miles of area below the reservoir. It appeared that the peak flows were likely the result of the local drainage rather than reservoir releases. Gage records implied that the reservoir filled during the 1995 and 1997 events. Southern California Edison (SCE) provided elevation-storage-outflow data, but it’s not clear how the datums related. Since it doesn’t appear the reservoir releases much water, an artificial outflow curve ranging from 40-50 cfs was used. Calibrated outflow data does not exist.

SJ13R Lake Thomas A. Edison:

The drainage area to this location is approximately 92 square miles. Reservoir levels for the lake are given at gage 11231500. A diversion below the lake at Mono Diversion Dam sends small amounts of flow to Ward tunnel, which in turn goes to Huntington Lake. Gage records imply that the reservoir reduced outflow from 200-300 cfs to about 25 cfs during the 1995 and 1997 events. SCE provided elevation-storage-outflow data, but since it doesn’t appear the reservoir releases much water, an artificial outflow curve ranging from 20-25 cfs was used.

SJ8 Bear Creek:

This 52 square mile subbasin served as an optimization point, and fit the 1997 observed data extremely well (no hourly data were available for 1995). By adjusting the losses slightly and using the generalized values, the calibration provided an acceptable fit with only a slight difference in timing.

SJ4 Florence Lake, SJ6 South Fork San Joaquin above Bear Creek, SJ10 South Fork San Joaquin above Mono Creek, SJ12 Lake Thomas A. Edison, and SJ14 Mono Creek:

The losses used for Bear Creek were also applied to the other subbasins in the vicinity. The two lakes (Florence and Thomas A. Edison) released almost no water during the two events, while the three other subbasins were very small (totaling 56 square miles).

SJ43R Mammoth Pool Reservoir:

The drainage area to this location is approximately 1000 square miles. The reservoir levels are given at gage 11234700. One diversion, Ward Tunnel (gage 11229500), diverts 1000-2000 cfs from Florence Lake to Huntington Lake. This reservoir is the most upstream of a chain of reservoirs along the mainstem San Joaquin above Millerton. The drainage area above the reservoir consists of many subbasins and routing reaches. About 30% of the area is gaged, but most of this area occurs at outflows from Lake TA Edison and Florence Lake. These lakes released little water during the flood events. Only the 52 square miles of Bear Creek above gage 11230500 provided any indication of the hydrologic response in the drainage area above Mammoth Pool. In addition to being sparsely gaged, the valleys above Mammoth Pool vary greatly regarding elevation and orientation.

Mammoth Pool is the first point along the mainstem San Joaquin offering calibration data. Hourly flow data below the reservoir is available at gage 11234760, although the 1997 flood overwhelmed the gage. Therefore, the data for this flood consists of most of the rising limb and an estimated peak (80,000 cfs). Flow to Mammoth Pool Powerhouse (gage 11235100) bypasses the outflow gage for reservoir. Daily averages for these flows seem to remain steady at about 1100 cfs for the March 1995 event. They generally fluctuate between 1000-2500 cfs for the 1997 event with a daily mean on Jan 2nd of 1420 cfs. SCE provided elevation-storage-outflow data; starting storage is published online.

Calibration issues for the 1997 event: According to the SCE data, a recorded peak reservoir level of 3,338 feet on 02Jan97 should have yielded less than 30,000 cfs outflow. However, an instantaneous peak of 80,000 cfs was observed at the gage downstream of dam. So, the storage-outflow relationship was extended. Little is known for sure about the actual peak. The shape of the partial observed hydrograph implies that the highest hourly outflow could be substantially less than this instantaneous value, possibly around 60,000-65,000 cfs. Additionally, calibration to the observed hourly inflows at Millerton Lake was sensitive to the shape and timing of the hydrograph coming out of Mammoth Pool. Adjusting the initial losses to an intermediate value (between those used for the lower subbasins close to Millerton and those used for the most upstream subbasins around Florence and T.A. Edison Lakes) resulted in a modeled peak hourly flow of around 70,000 cfs. This reasonably matched available observed data at the outlet of Mammoth Pool and provided a good fit to the observed data at Millerton.

SJ47R Huntington Lake:

The drainage area to Huntington Lake is about 80 square miles. Reservoir levels are given at gage 11236000. Observed outflows are given at gage 11237000. Diversions from the South Fork San Joaquin River and Ward Tunnel come into the reservoir. A diversion to Shaver Lake leaves Huntington (Shaver conduit seems to remain within 500-700 cfs). Gage records show that little water left Huntington Lake during the 1995 and 1997 events. The SCE provided elevation-storage-outflow data, but since it doesn't appear the reservoir releases much water, an artificial outflow curve ranging from 2-30 cfs was used.

SJ50 Pitman Creek below Tamarack Creek (11237500):

The drainage area for this subbasin is about 23 square miles. Partial hourly data were available, but it didn't include the peak flow of 5500 cfs on 02Jan97. LWASS data favors a two-peak hydrograph, but the observed data shows only one. There appears to be a possible problem with the LWASS data.

SJ53G Big Creek near Mouth, above San Joaquin River (11238500):

The drainage area to this location is about 131 square miles, although most of it is behind Huntington Lake (which released little water during the events). The hourly data reflects the same problem as seen at SJ50: Observed hydrograph is a single sharp spike that modeled data can't replicate. There appears to be a problem in the LWASS data.

SJ65R Crane Valley Storage Reservoir (Bass Lake):

The drainage area is about 50 square miles. Reservoir levels are given at gage 11243400. Observed hourly flow data below the reservoir is available at gage 11244000. During the winter months, Soquel Ditch diverts up to 50 cfs above the reservoir into the Fresno River basin. Brown's Creek Canal (gage 11243300) diverts up to 80 cfs from South Fork Willow Creek into Bass Lake (but cut back diversion flows to only 1-2 cfs during a flood event). Conduit #3 (gage 11243500) diverts 100-200 cfs from Bass Lake to the Kerckhoff Reservoir, bypassing the gage at the outlet. Pacific Gas & Electric (PG&E) provided elevation-storage-outflow data adequate for modeling.

Calibration issues for 1997 event: The drainage area above the reservoir consists of a single subbasin (SJ64). The elevation-storage-outflow relationship and initial storage data closely matched initial observed flows downstream of dam. After routing through the reservoir, the shape and timing of the modeled hydrograph resembled observed data, but the volume was too low (even with loss parameters reduced to almost zero).

SJ69 Willow Creek at Mouth, near Auberry (Gage 11246500):

The drainage area is about 130 square miles. Observed flows are given at gage 11243400. During the winter months, Soquel Ditch diverts up to 50 cfs above Bass Lake into the Fresno River basin. Conduit #3 (gage 11243500) diverts 100-200 cfs from Bass Lake to the Kerckhoff Reservoir, bypassing the gage at the outlet.

Calibration issues for 1997 event: The gage data were unusable since the gage was inundated by backwater from the San Joaquin River. Also, outflow from Bass Lake accounted for almost all of the pre-storm flow at this station, making it necessary to set initial baseflow to 0.01 cfs per square mile for subbasins SJ66 and SJ68.

SJ63-SJ71 Redinger Lake:

Because this entire routing reach is covered by the lake, the lag method was used and the time was set to one minute. Because little storage exists in this lake, a junction was used instead of a reservoir.

SJ71-SJ73 Kerckhoff Lake:

Because most of this reach is covered by the lake, the Muskingum routing method (K=1.8 hr; X=0.4; subreaches=2) was changed to the lag method (24 minutes). Because little storage exists in this lake, a junction was used instead of a reservoir.

SJ73-SJ75 Millerton Lake:

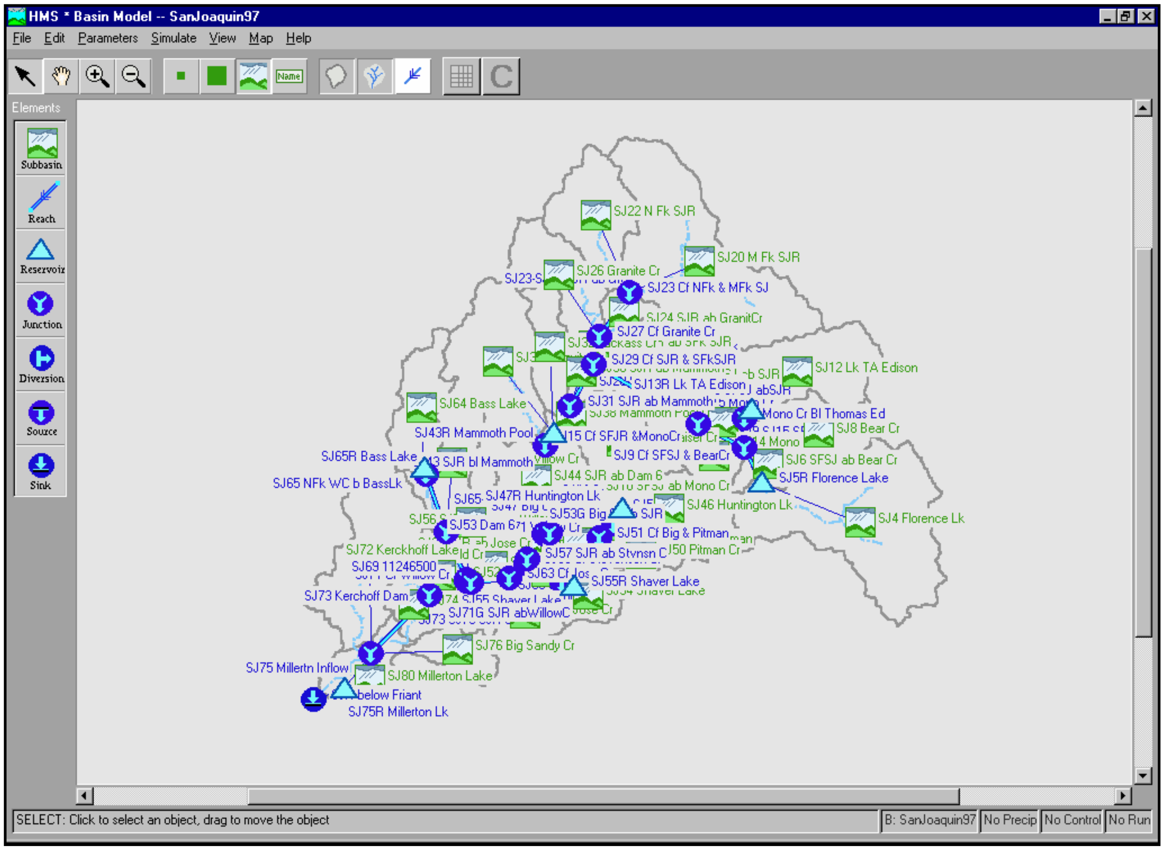
Because most of this reach is covered by the lake, the routing technique was changed from the Muskingum method (K=1.5; X=0.4; subreaches=2) to the lag method (18 minutes).

SJ75 Inflow to Millerton Lake:

Reservoir inflows computed from change-in-storage were provided from DSS pathname: /SJ R @ HILLS FERRY/FRIANT/FLOW-RES IN//1HOUR/PHASE1/.

Calibration issues for 1997 event: Reduced initial losses to 0.5 inches for the subbasins close to Millerton Lake (below Mammoth Pool Dam) to reproduce the small rise in the hydrograph that occurred late on 01Jan97. The sharp spikes likely reflect precipitation on or close to the water surface in the chain of lakes. Smaller initial losses in the lower reaches of the overall basin were used to generate the high baseflows occurring prior to the 1997 event. Runoff from a smaller antecedent storm was still influencing the system. Additionally, the calibration to the observed hourly inflows at Millerton Lake was very sensitive to the shape and timing of the hydrograph coming out of Mammoth Pool. Adjusting the initial losses to an intermediate value (a value between that used for the lower subbasins close to Millerton and those used for the most upstream subbasins around Florence and T.A. Edison Lakes) resulted in a modeled peak hourly flow of approximately 70,000 cfs. This reasonably matched available observed data at the outlet of Mammoth Pool and provided a good fit to the observed data at Millerton.

Upper San Joaquin River Basin HEC-HMS Model Schematic



Upper San Joaquin River Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Slope LFP S (ft/ft)	Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Initial TC $1.4(LL_{CA}/S^{1/2})^{.33}$ (Hr)	Initial R 1.5 TC (cfs/Hr)	Final TC $1.67(LL_{CA}/S^{1/2})^{.29}$ (Hr)	Final R 4.0TC (cfs/Hr)
SJ4 Florence Lk	172.67	25.78	11.84	0.040	213.508	20.89	3.8	5.7	4.0	16.1
SJ6 SFSJ ab Bear Cr	23.11	8.13	3.21	0.115	609.152	1.06	1.4	2.1	1.7	6.8
SJ8 Bear Cr	53.78	18.04	10.36	0.074	388.395	9.48	2.9	4.4	3.2	12.8
SJ10 SFSJ ab Mono Cr	24.83	8.94	4.48	0.091	478.361	1.83	1.7	2.6	2.0	8.0
SJ12 Lk TA Edison	93.52	19.10	7.50	0.060	315.482	8.07	2.8	4.2	3.1	12.2
SJ14 Mono Cr	8.18	6.51	3.31	0.044	234.435	1.40	1.6	2.3	1.8	7.4
SJ16 SFSJ ab SJR	86.36	21.16	9.64	0.047	250.532	12.88	3.3	4.9	3.5	14.0
SJ20 M Fk SJR	188.13	26.71	7.66	0.051	270.738	12.44	3.2	4.8	3.5	13.9
SJ22 N Fk SJR	66.77	18.51	10.21	0.082	432.615	9.09	2.9	4.3	3.2	12.7
SJ24 SJR ab GranitCr	15.18	10.05	5.08	0.089	467.608	2.36	1.9	2.8	2.1	8.6
SJ26 Granite Cr	54.43	18.31	10.41	0.078	412.601	9.38	2.9	4.4	3.2	12.8
SJ28 SJR ab SFk SJR	4.16	4.62	2.05	0.164	864.682	0.32	1.0	1.4	1.2	4.8
SJ30 SJR ab Mammoth	14.52	9.25	3.68	0.089	470.674	1.57	1.6	2.4	1.9	7.6
SJ32 Jackass Cr	33.44	18.90	8.50	0.056	295.463	9.34	2.9	4.4	3.2	12.8
SJ34 Chiquito Cr	96.38	21.62	9.80	0.055	289.593	12.46	3.2	4.8	3.5	13.9
SJ36 Kaiser Cr	46.18	16.83	8.05	0.069	362.122	7.12	2.7	4.0	3.0	11.8
SJ38 Mammoth Pool LD	13.70	10.73	4.94	0.062	325.472	2.94	2.0	3.0	2.3	9.1
SJ44 SJR ab Big Cr	66.72	15.87	5.89	0.084	442.750	4.44	2.3	3.4	2.6	10.3
SJ46 Huntington Lk	80.75	18.99	6.68	0.034	178.415	9.50	2.9	4.4	3.2	12.8
SJ48 Big C ab Pitman	4.10	5.06	2.79	0.120	635.899	0.56	1.2	1.7	1.4	5.6
SJ50 Pitman Cr	25.44	10.38	5.26	0.084	442.297	2.60	1.9	2.9	2.2	8.8
SJ52 Big Cr at SJR	23.14	9.41	3.96	0.114	603.203	1.52	1.6	2.4	1.9	7.5
SJ56 SJR ab Stvnson	11.25	5.71	2.25	0.147	775.895	0.46	1.1	1.6	1.3	5.3
SJ54 Shaver Lake	29.38	9.07	2.65	0.049	261.082	1.49	1.6	2.4	1.9	7.5
SJ58 Stevenson Cr	6.25	5.15	2.32	0.183	968.438	0.38	1.0	1.5	1.3	5.1
SJ60 Jose Cr	30.20	11.13	6.49	0.077	404.447	3.59	2.1	3.2	2.4	9.7
SJ62 SJR ab Jose Cr	4.04	3.42	1.29	0.176	928.579	0.14	0.7	1.1	1.0	3.8
SJ70 Redinger Lk	19.59	9.48	3.58	0.104	548.466	1.45	1.6	2.4	1.9	7.4
SJ64 Bass Lake	49.60	20.28	8.97	0.055	288.820	10.70	3.1	4.6	3.3	13.3
SJ66 N Fk Willow Cr	47.89	16.00	7.56	0.067	351.502	6.45	2.6	3.9	2.9	11.5
SJ68 Willow Cr ab SJ	32.04	15.55	7.78	0.069	365.755	6.33	2.6	3.9	2.9	11.4
SJ72 Kerchoff Lake	33.48	12.42	3.05	0.057	302.346	2.18	1.8	2.7	2.1	8.4
SJ74 SJR ab Millerto	22.79	12.95	4.79	0.032	170.514	4.76	2.3	3.5	2.6	10.5
SJ76 Big Sandy Cr	28.71	13.26	7.06	0.058	307.644	5.34	2.4	3.6	2.7	10.9
SJ78 Fine Gold Cr	94.16	25.89	10.75	0.031	163.721	21.75	3.9	5.8	4.1	16.3
SJ80 Millerton Lake	33.41	15.63	6.59	0.024	127.619	9.12	2.9	4.4	3.2	12.7

Upper San Joaquin River Reach Parameters

Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Ave Reach Vel $80\ S_R^{1/2}$ V_R (fps)	Initial K $1.47\ L_R / 1.5V_R$ K (Hr)	Musk X or LAG (Min)	N steps Time Step= 60
SJ5-SJ9 SFSJ ab Bear	5.27	0.0194	11.15	0.5	30	--
SJ9-SJ15 SFSJ abMono	5.82	0.0116	8.62	1.0	0.4	1
SJ13-SJ15 Mono Cr	6.05	0.0339	14.72	0.4	24	--
SJ15-SJ29 SFSJ ab SJ	17.11	0.0287	13.54	1.2	0.4	1
SJ23-SJ27 SJR ab Gra	7.40	0.0207	11.50	1.0	0.4	1
SJ27-SJ29 SJR ab Sfk	3.09	0.0192	11.09	0.3	18	--
SJ29-SJ31 SJR ab Mam	5.09	0.0145	9.62	1.0	0.4	1
SJ47-SJ51 Big ab Pit	2.62	0.1304	28.89	0.1	6	--
SJ51-SJ53 Big ab SJR	6.33	0.0783	22.39	0.3	18	--
SJ43-SJ53 SJR ab Dam6	9.80	0.0212	11.64	1.0	0.4	1
SJ55-SJ59 Stvnsn Cr	4.40	0.1604	32.04	0.1	6	--
SJ53-SJ59 SJR ab Stv	3.75	0.0286	13.54	0.3	18	--
SJ59-SJ63 SJR abJose	2.65	0.0159	10.08	0.3	18	--
SJ65-SJ67 NF Willow	7.06	0.0218	11.81	1.0	0.4	1
SJ67-SJ69 Willow Cr	6.49	0.0357	15.11	1.0	0.4	1
SJ63-SJ71 Redinger L	5.56	0.0088	7.51	1.0	1	--
SJ71-SJ73 Kerchoff L	9.16	0.0038	4.96	1.8	24	--
SJ73-SJ75 SJR ab Mil	10.34	0.0076	6.99	1.5	18	--

HEC-HMS Summary of Results
Upper San Joaquin River Basin: March 1995 Event

Project : SanJoaquin   Run Name : March95

Start of Run	: 08Mar95 0100	Basin Model	:	SanJoaquin95
End of Run	: 15Mar95 2400	Met. Model	:	1995 Event
Execution Time	: 31May00 1351	Control Specs.	:	1995 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
SJ64 Bass Lake	4330.3	10 Mar 95 2400	15935	49.602
SJ65R Bass Lake	3187.4	11 Mar 95 0500	14921	49.602
SJ65 NFk WC b BassLk	3187.4	11 Mar 95 0500	14921	49.602
SJ65-SJ67 NF Willow	3184.9	11 Mar 95 0600	14899	49.602
SJ66 N Fk Willow Cr	3841.9	10 Mar 95 2400	13180	47.887
JSJ67-SJ71 Willow Cr	6442.5	10 Mar 95 2400	28079	97.489
SJ67-SJ69 Willow Cr	6419.4	11 Mar 95 0100	28025	97.489
SJ68 Willow Cr ab SJ	2076.2	10 Mar 95 2400	6813.5	32.044
SJ69 11246500	8389.5	11 Mar 95 0100	34838	129.533
SJ22 N Fk SJR	1140.4	09 Mar 95 2300	6156.5	66.766
SJ20 M Fk SJR	2406.0	09 Mar 95 2300	13727	188.133
SJ23 Cf NFk & MFk SJ	3546.4	09 Mar 95 2300	19884	254.899
SJ23-SJ27 SJR ab Gra	3519.2	09 Mar 95 2400	19959	254.899
SJ26 Granite Cr	2599.1	09 Mar 95 2200	10555	54.427
SJ24 SJR ab GranitCr	1668.0	09 Mar 95 2200	7818.7	15.178
SJ27 Cf Granite Cr	7569.0	09 Mar 95 2300	38333	324.504
SJ27-SJ29 SJR ab SFk	7510.8	09 Mar 95 2300	38341	324.504
SJ4 Florence Lk	1036.0	08 Mar 95 0100	6881.9	172.669
SJ5R Florence Lake	31.678	15 Mar 95 2400	493.70	172.669
SJ5-SJ9 SFSJ ab Bear	31.677	15 Mar 95 2400	493.65	172.669
SJ6 SFSJ ab Bear Cr	618.94	10 Mar 95 0300	2306.1	23.114
SJ8 Bear Cr	322.68	08 Mar 95 0100	2201.2	53.780
SJ9 Cf SFSJ & BearCr	918.10	10 Mar 95 0300	5000.9	249.563
SJ9-SJ15 SFSJ abMono	912.14	10 Mar 95 0400	5030.0	249.563
SJ12 Lk TA Edison	561.10	08 Mar 95 0100	3779.4	93.516
SJ13R Lk TA Edison	20.517	15 Mar 95 2400	323.78	93.516
Mono Cr Bl Thomas Ed	20.517	15 Mar 95 2400	323.78	93.516
SJ13-SJ15 Mono Cr	20.517	15 Mar 95 2400	323.78	93.516
SJ10 SFSJ ab Mono Cr	1278.9	10 Mar 95 0300	4854.9	24.825
SJ14 Mono Cr	752.79	10 Mar 95 0300	2664.1	8.177
SJ15 Cf SFJR &MonoCr	2947.7	10 Mar 95 0400	12873	376.081
SJ15-SJ29 SFSJ abSJR	2936.4	10 Mar 95 0500	12903	376.081
SJ28 SJR ab SFk SJR	629.85	09 Mar 95 2100	2702.6	4.156
SJ16 SFSJ ab SJR	5265.2	10 Mar 95 0500	24774	86.359

… Continued …

HEC-HMS Summary of Results
Upper San Joaquin River Basin: March 1995 Event
(Continued)

Project : SanJoaquin Run Name : March95

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
SJ29 Cf SJR & SFkSJR	15468	09 Mar 95 2300	78721	791.100
SJ29-SJ31 SJR ab Mam	15374	09 Mar 95 2400	78740	791.100
SJ30 SJR ab Mammoth	1853.1	10 Mar 95 2200	8146.4	14.521
SJ31 SJR ab Mammoth	16759	09 Mar 95 2400	86887	805.621
SJ34 Chiquito Cr	8670.9	10 Mar 95 2200	39881	96.376
SJ32 Jackass Cr	2630.4	09 Mar 95 2300	13206	33.444
SJ38 Mammoth Pool LD	1595.4	10 Mar 95 2200	6794.6	13.701
SJ36 Kaiser Cr	2635.3	10 Mar 95 0500	12512	46.184
SJ43R Mammoth Pool	4345.6	15 Mar 95 2400	19388	995.326
SJ43 SJR bl Mammoth	4345.6	15 Mar 95 2400	19388	995.326
SJ43-SJ53 SJR abDam6	4268.2	15 Mar 95 2400	19033	995.326
SJ46 Huntington Lk	1957.2	10 Mar 95 0400	8717.2	80.751
SJ47R Huntington Lk	8.6298	15 Mar 95 2400	93.826	80.751
SJ47 Big Cr bl Hntng	8.6298	15 Mar 95 2400	93.826	80.751
SJ47-SJ51 Big ab Pit	8.6282	15 Mar 95 2400	93.772	80.751
SJ48 Big C ab Pitman	564.58	09 Mar 95 2200	2068.9	4.101
SJ50 Pitman Cr	1517.4	10 Mar 95 0400	5547.8	25.439
SJ51 Cf Big & Pitman	2016.7	09 Mar 95 2200	7710.5	110.291
SJ51-SJ53 Big ab SJ	1999.8	10 Mar 95 0500	7708.2	110.291
SJ52 Big Cr at SJR	2568.5	09 Mar 95 2200	10942	23.141
SJ53G Big Cr ab SJR	4535.1	10 Mar 95 0500	18650	133.432
SJ44 SJR ab Dam 6	7132.5	10 Mar 95 2300	31167	66.724
SJ53 Dam 6	10901	10 Mar 95 2200	68850	1195.482
SJ53-SJ59 ab Stevnsn	10835	10 Mar 95 2200	68726	1195.482
SJ56 SJR ab Stvnson	1280.5	10 Mar 95 2200	5226.0	11.248
SJ57 SJR ab Stvnsn C	12116	10 Mar 95 2200	73952	1206.730
SJ54 Shaver Lake	3144.1	10 Mar 95 0500	13457	29.375
SJ55R Shaver Lake	2.2177	15 Mar 95 2400	26.575	29.375
SJ55 Shaver Lake	2.2177	15 Mar 95 2400	26.575	29.375
SJ55-SJ59 Stvnsn Cr	2.2174	15 Mar 95 2400	26.565	29.375
SJ58 Stevenson Cr	673.51	09 Mar 95 2100	2809.2	6.254
SJ59 Cf Stevenson Cr	12762	10 Mar 95 2200	76788	1242.359
SJ59-SJ63 SJ ab Jose	12690	10 Mar 95 2300	76661	1242.359
SJ62 SJR ab Jose Cr	464.24	10 Mar 95 2200	1824.0	4.037
SJ60 Jose Cr	2470.2	10 Mar 95 2300	10241	30.199
SJ63 Cf Jose Cr	15588	10 Mar 95 2300	88725	1276.595
SJ63-SJ71 RedingerLk	15588	10 Mar 95 2300	88718	1276.595
SJ70 Redinger Lk	1973.3	10 Mar 95 2300	7457.8	19.593
SJ71G SJR abWillowC	17561	10 Mar 95 2300	96176	1296.188
SJ71 Cf Willow Cr	25445	10 Mar 95 2300	131014	1425.721

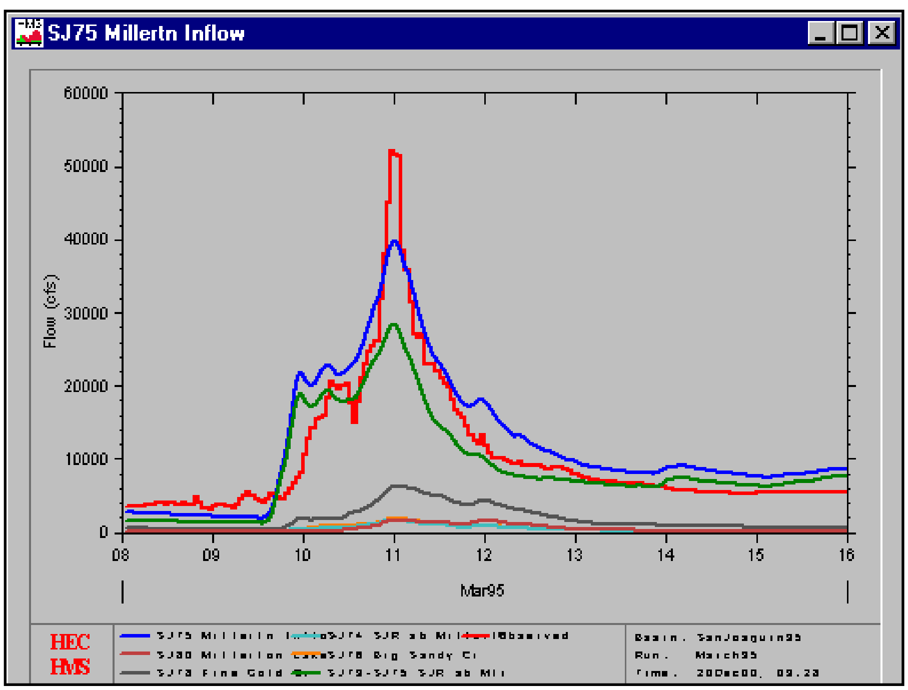
… Continued …

HEC-HMS Summary of Results
Upper San Joaquin River Basin: March 1995 Event
(Continued)

Project : SanJoaquin   Run Name : March95

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
SJ71-SJ73 Kerckhoff	25424	10 Mar 95 2400	130813	1425.721
SJ72 Kerckhoff Lake	3072.0	10 Mar 95 2300	11200	33.480
SJ73 Kerchoff Dam	28426	10 Mar 95 2400	142014	1459.201
SJ73-SJ75 SJR ab Mlr	28375	10 Mar 95 2400	141863	1459.201
SJ78 Fine Gold Cr	6334.3	11 Mar 95 0200	28582	94.160
SJ80 Millerton Lake	1613.1	12 Mar 95 0100	7739.6	33.410
SJ74 SJR ab Millerto	1669.6	10 Mar 95 2300	6564.9	22.790
SJ76 Big Sandy Cr	1865.9	10 Mar 95 2400	7512.4	28.705
SJ75 Millertn Inflow	39677	10 Mar 95 2400	192262	1638.266
SJ75R Millerton Lk	1.00000	08 Mar 95 0100	15.785	1638.266
SJR below Friant	1.00000	08 Mar 95 0100	15.785	1638.266

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Upper San Joaquin River Basin
March 1995 Event



SJ75 – Millerton Lake Inflow

HEC-HMS Subbasin Parameters
Upper San Joaquin River Basin: March 1995 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousnes s (%)
SJ20 M Fk SJR	6	0.75	0.2	0.75	0.02	0
SJ22 N Fk SJR	6	0.75	0.2	0.75	0.02	0
SJ24 SJR ab GranitCr	6	0.75	0.2	0.75	0.02	0
SJ26 Granite Cr	6	0.75	0.2	0.75	0.02	0
SJ28 SJR ab SFk SJR	6	0.75	0.2	0.75	0.02	0
SJ38 Mammoth Pool LD	6	0.75	0.2	0.75	0.02	0
SJ10 SFSJ ab Mono Cr	6	0.75	0.2	0.75	0.02	0
SJ14 Mono Cr	6	0.75	0.2	0.75	0.02	0
SJ16 SFSJ ab SJR	6	0.75	0.2	0.75	0.02	0
SJ36 Kaiser Cr	6	0.75	0.2	0.75	0.02	0
SJ8 Bear Cr	6	0.75	0.2	0.75	0.02	0
SJ66 N Fk Willow Cr	0.12	0.75	0.2	0.90	0.086	0
SJ4 Florence Lk	6	0.75	0.2	0.75	0.02	0
SJ56 SJR ab Stvnson	6	0.75	0.2	0.75	0.02	0
SJ6 SFSJ ab Bear Cr	6	0.75	0.2	0.75	0.02	0
SJ62 SJR ab jose Cr	6	0.75	0.2	0.75	0.02	0
SJ58 Stevenson Cr	6	0.75	0.2	0.75	0.02	0
SJ68 Willow Cr ab SJ	0.12	0.75	0.2	0.90	0.086	0
SJ70 Redinger Lk	6	0.75	0.2	0.75	0.02	0
SJ60 Jose Cr	6	0.75	0.2	0.75	0.02	0
SJ80 Millerton Lake	6	0.75	0.2	0.75	0.02	0
SJ12 Lk TA Edison	6	0.75	0.2	0.75	0.02	0
SJ34 Chiquito Cr	6	0.75	0.2	0.75	0.02	0
SJ32 Jackass Cr	6	0.75	0.2	0.75	0.02	0
SJ30 SJR ab Mammoth	6	0.75	0.2	0.75	0.02	0
SJ64 Bass Lake	0.12	0.75	0.2	0.90	0.086	0
SJ78 Fine Gold Cr	6	0.75	0.2	0.75	0.02	0
SJ74 SJR ab Millerto	6	0.75	0.2	0.75	0.02	0
SJ76 Big Sandy Cr	6	0.75	0.2	0.75	0.02	0
SJ46 Huntington Lk	6	0.75	0.2	0.75	0.02	0
SJ44 SJR ab Dam 6	6	0.75	0.2	0.75	0.02	0
SJ48 Big C ab Pitman	6	0.75	0.2	0.75	0.02	0
SJ50 pitman Cr	6	0.75	0.2	0.75	0.02	0
SJ52 Big Cr at SJR	6	0.75	0.2	0.75	0.02	0
SJ54 Shaver Lake	6	0.75	0.2	0.75	0.02	0
SJ72 Kerckhoff Lake	6	0.75	0.2	0.75	0.02	0

HEC-HMS Summary of Results
Upper San Joaquin River Basin: December 1996 - January 1997 Event

Project : SanJoaquin Run Name : Jan97

Start of Run : 31Dec96 2400 Basin Model : SanJoaquin97

End of Run : 04Jan97 2400 Met. Model : Jan97

Execution Time : 31May00 1351 Control Specs. : Jan97

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
SJ64 Bass Lake	3899.0	01 Jan 97 2400	15063	49.602
SJ65R Bass Lake	3009.0	03 Jan 97 0100	13645	49.602
SJ65 NFk WC b BassLk	3009.0	03 Jan 97 0100	13645	49.602
SJ65-SJ67 NF Willow	3006.8	03 Jan 97 0200	13608	49.602
SJ66 N Fk Willow Cr	2701.1	02 Jan 97 2200	9033.6	47.887
JSJ67-SJ71 Willow Cr	5536.7	02 Jan 97 2300	22642	97.489
SJ67-SJ69 Willow Cr	5527.1	02 Jan 97 2400	22572	97.489
SJ68 Willow Cr ab SJ	1461.5	02 Jan 97 2200	4451.1	32.044
SJ69 11246500	6958.6	02 Jan 97 2300	27023	129.533
SJ22 N Fk SJR	6109.9	02 Jan 97 2300	18194	66.766
SJ20 M Fk SJR	17569	02 Jan 97 2200	48925	188.133
SJ23 Cf NFk & MFk SJ	23636	02 Jan 97 2200	67119	254.899
SJ23-SJ27 SJR ab Gra	23573	02 Jan 97 2400	67037	254.899
SJ26 Granite Cr	5513.9	02 Jan 97 2100	18236	54.427
SJ24 SJR ab GranitCr	1640.7	02 Jan 97 2300	5105.8	15.178
SJ27 Cf Granite Cr	30493	02 Jan 97 2300	90379	324.504
SJ27-SJ29 SJR ab SFk	30375	02 Jan 97 2300	90351	324.504
SJ4 Florence Lk	5670.1	02 Jan 97 1700	19327	172.669
SJ5R Florence Lake	34.214	04 Jan 97 2400	257.73	172.669
SJ5-SJ9 SFSJ ab Bear	34.206	04 Jan 97 2400	257.58	172.669
SJ6 SFSJ ab Bear Cr	2673.3	02 Jan 97 1600	6206.1	23.114
SJ8 Bear Cr	1741.1	02 Jan 97 1700	4040.0	53.780
SJ9 Cf SFSJ & BearCr	4432.8	02 Jan 97 1600	10504	249.563
SJ9-SJ15 SFSJ abMono	4402.2	02 Jan 97 1700	10481	249.563
SJ12 Lk TA Edison	5322.7	02 Jan 97 1800	14562	93.516
SJ13R Lk TA Edison	20.572	04 Jan 97 2400	162.95	93.516
Mono Cr Bl Thomas Ed	20.572	04 Jan 97 2400	162.95	93.516
SJ13-SJ15 Mono Cr	20.572	04 Jan 97 2400	162.95	93.516
SJ10 SFSJ ab Mono Cr	3278.5	02 Jan 97 1800	8256.1	24.825
SJ14 Mono Cr	1254.9	02 Jan 97 1800	3180.1	8.177
SJ15 Cf SFJR &MonoCr	8951.4	02 Jan 97 1800	22081	376.081
SJ15-SJ29 SFSJ abSJR	8922.6	02 Jan 97 1900	22031	376.081
SJ28 SJR ab SFk SJR	420.93	02 Jan 97 1800	1301.2	4.156
SJ16 SFSJ ab SJR	10376	02 Jan 97 2000	33010	86.359

… Continued …

HEC-HMS Summary of Results
Upper San Joaquin River Basin: December 1996 - January 1997 Event
(Continued)

Project : SanJoaquin Run Name : Jan97

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
SJ29 Cf SJR & SFkSJR	48131	02 Jan 97 2200	146693	791.100
SJ29-SJ31 SJR ab Mam	48053	02 Jan 97 2300	146501	791.100
SJ30 SJR ab Mammoth	1395.2	02 Jan 97 2100	4509.6	14.521
SJ31 SJR ab Mammoth	49364	02 Jan 97 2300	151011	805.621
SJ34 Chiquito Cr	7595.5	02 Jan 97 2200	28702	96.376
SJ32 Jackass Cr	3078.8	02 Jan 97 2200	11149	33.444
SJ38 Mammoth Pool LD	1031.2	02 Jan 97 2100	3361.4	13.701
SJ36 Kaiser Cr	5020.1	02 Jan 97 1900	16165	46.184
SJ43R Mammoth Pool	61542	03 Jan 97 0100	121815	995.326
SJ43 SJR bl Mammoth	61542	03 Jan 97 0100	121815	995.326
SJ43-SJ53 SJR abDam6	61404	03 Jan 97 0200	120924	995.326
SJ46 Huntington Lk	10478	02 Jan 97 1800	31336	80.751
SJ47R Huntington Lk	25.801	04 Jan 97 2400	118.40	80.751
SJ47 Big Cr bl Hntng	25.801	04 Jan 97 2400	118.40	80.751
SJ47-SJ51 Big ab Pit	25.792	04 Jan 97 2400	118.21	80.751
SJ48 Big C ab Pitman	660.88	02 Jan 97 1600	2019.7	4.101
SJ50 Pitman Cr	3491.9	02 Jan 97 1800	10617	25.439
SJ51 Cf Big & Pitman	4149.0	02 Jan 97 1800	12755	110.291
SJ51-SJ53 Big ab SJ	4145.5	02 Jan 97 1800	12749	110.291
SJ52 Big Cr at SJR	2272.9	01 Jan 97 2300	7930.0	23.141
SJ53G Big Cr ab SJR	6156.9	02 Jan 97 1800	20679	133.432
SJ44 SJR ab Dam 6	5265.6	02 Jan 97 2100	19871	66.724
SJ53 Dam 6	69786	03 Jan 97 0200	161474	1195.482
SJ53-SJ59 ab Stevnsn	69677	03 Jan 97 0200	161195	1195.482
SJ56 SJR ab Stvnson	763.96	02 Jan 97 2100	2074.4	11.248
SJ57 SJR ab Stvnsn C	70113	03 Jan 97 0200	163269	1206.730
SJ54 Shaver Lake	2535.9	01 Jan 97 2200	9153.8	29.375
SJ55R Shaver Lake	9.2857	04 Jan 97 2400	47.321	29.375
SJ55 Shaver Lake	9.2857	04 Jan 97 2400	47.321	29.375
SJ55-SJ59 Stvnsn Cr	9.2832	04 Jan 97 2400	47.254	29.375
SJ58 Stevenson Cr	427.40	02 Jan 97 2100	1359.2	6.254
SJ59 Cf Stevenson Cr	70369	03 Jan 97 0200	164675	1242.359
SJ59-SJ63 SJ ab Jose	70134	03 Jan 97 0200	164395	1242.359
SJ62 SJR ab Jose Cr	271.97	02 Jan 97 2100	644.39	4.037
SJ60 Jose Cr	1324.5	02 Jan 97 2200	3884.7	30.199
SJ63 Cf Jose Cr	71338	03 Jan 97 0200	168925	1276.595
SJ63-SJ71 RedingerLk	71317	03 Jan 97 0200	168909	1276.595
SJ70 Redinger Lk	1012.4	02 Jan 97 2200	2832.7	19.593
SJ71G SJR abWillowC	72029	03 Jan 97 0200	171742	1296.188
SJ71 Cf Willow Cr	78490	03 Jan 97 0200	198765	1425.721

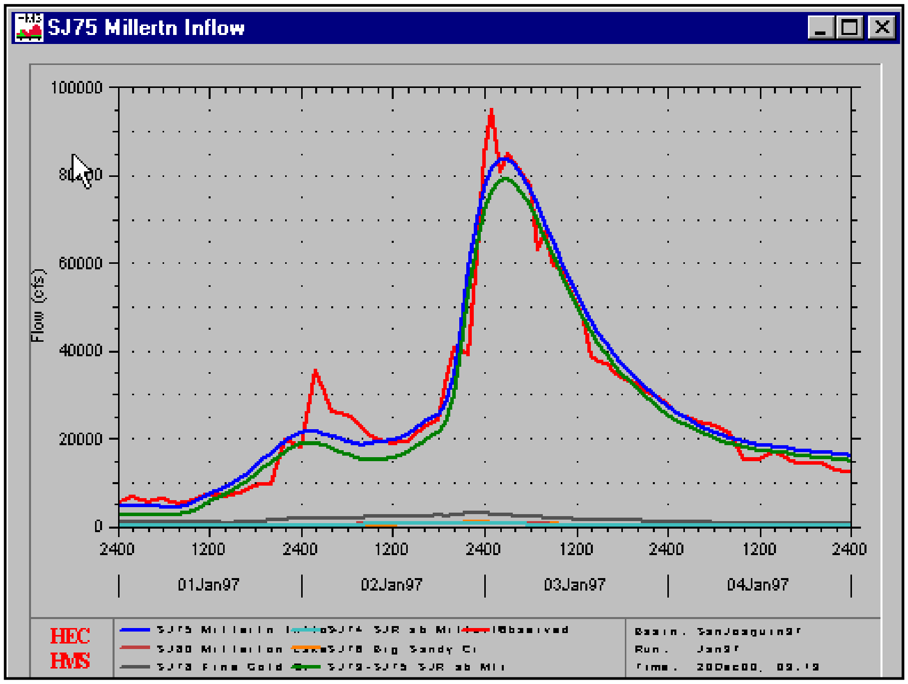
… Continued …

HEC-HMS Summary of Results
Upper San Joaquin River Basin: December 1996 - January 1997 Event
(Continued)

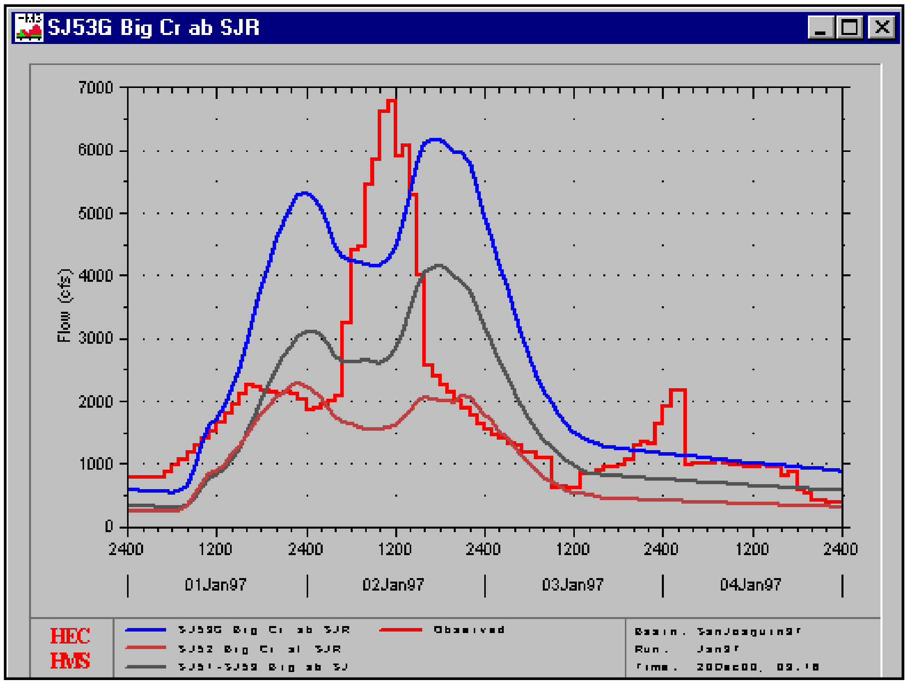
Project : SanJoaquin Run Name : Jan97

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
SJ71-SJ73 Kerckhoff	78123	03 Jan 97 0300	198360	1425.721
SJ72 Kerckhoff Lake	1437.0	02 Jan 97 2200	4144.4	33.480
SJ73 Kerchoff Dam	79153	03 Jan 97 0200	202505	1459.201
SJ73-SJ75 SJR ab Mlr	79094	03 Jan 97 0300	202203	1459.201
SJ78 Fine Gold Cr	3005.8	02 Jan 97 2300	11823	94.160
SJ80 Millerton Lake	820.89	02 Jan 97 2300	3109.7	33.410
SJ74 SJR ab Millerto	762.54	02 Jan 97 2200	2465.8	22.790
SJ76 Big Sandy Cr	944.12	02 Jan 97 2300	2797.3	28.705
SJ75 Millertn Inflow	83614	03 Jan 97 0300	222399	1638.266
SJ75R Millerton Lk	1.00000	31 Dec 96 2400	7.9339	1638.266
SJR below Friant	1.00000	31 Dec 96 2400	7.9339	1638.266

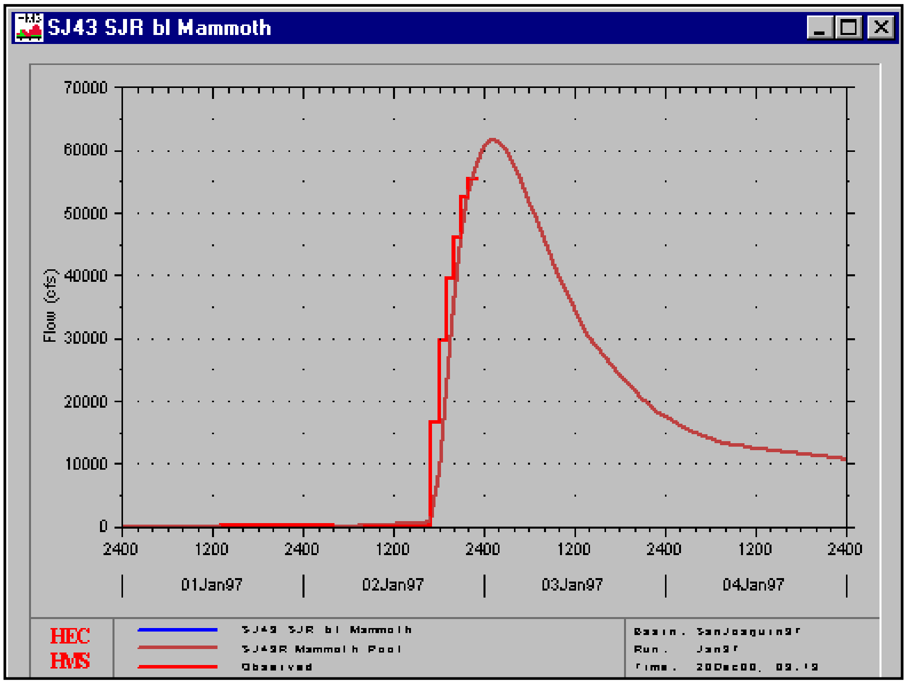
HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Upper San Joaquin River Basin
December 1996 - January 1997 Event



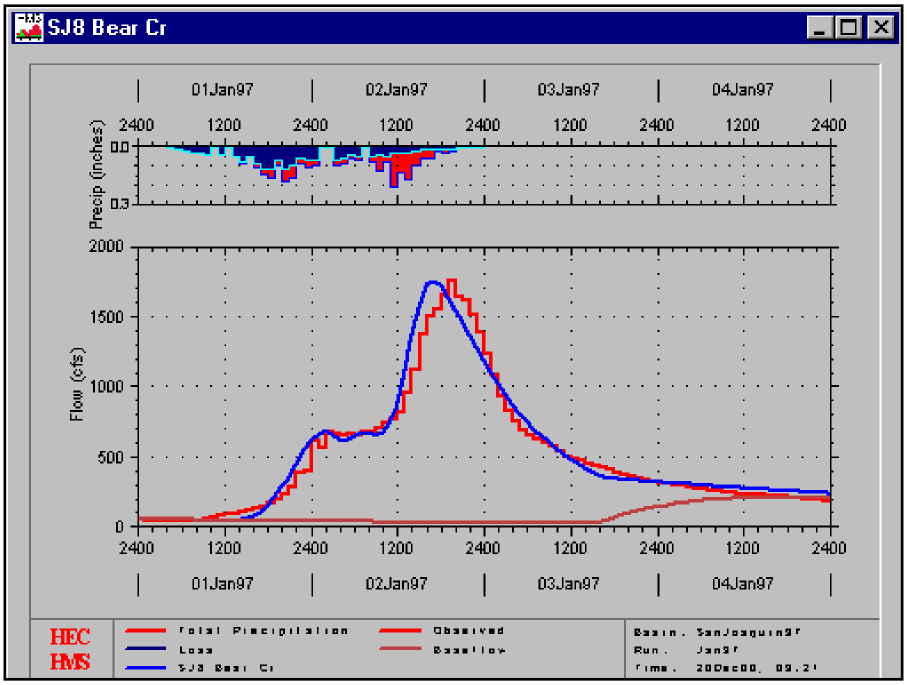
SJ75 – Millerton Lake Inflow



SJ53G – Big Creek Above San Joaquin River



SJ43 – San Joaquin River Below Mammoth

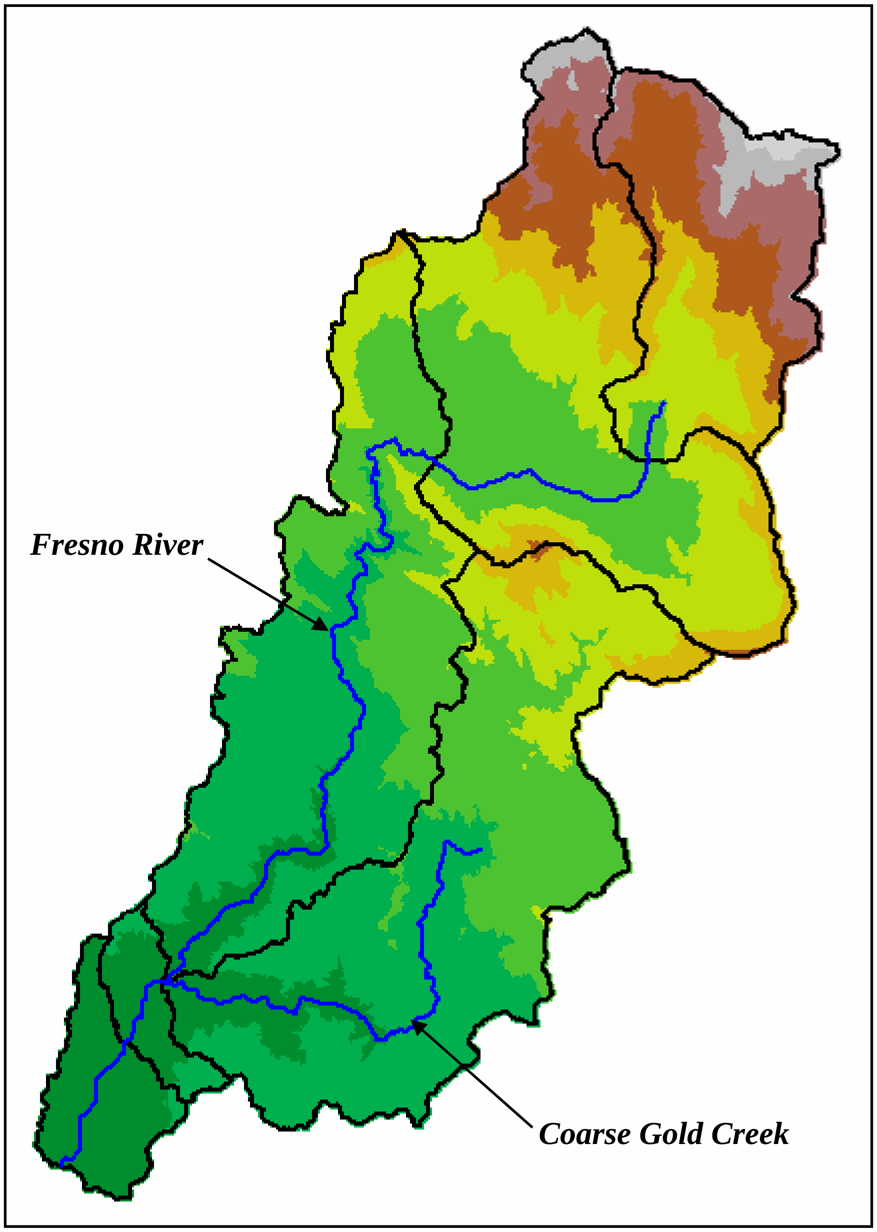


SJ8 – Gage 11230500, Bear Creek

HEC-HMS Subbasin Parameters
Upper San Joaquin River Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
SJ20 M Fk SJR	11	0.75	0.2	1.0	0.044	0
SJ22 N Fk SJR	11	0.75	0.2	1.0	0.044	0
SJ24 SJR ab GranitCr	11	0.75	0.2	1.0	0.044	0
SJ26 Granite Cr	11	0.75	0.2	1.0	0.044	0
SJ28 SJR ab SFk SJR	11	0.75	0.2	1.0	0.044	0
SJ38 Mammoth Pool LD	11	0.75	0.2	1.0	0.044	0
SJ10 SFSJ ab Mono Cr	11	0.75	0.2	1.5	0.085	0
SJ14 Mono Cr	11	0.75	0.2	1.5	0.085	0
SJ16 SFSJ ab SJR	11	0.75	0.2	1.0	0.044	0
SJ36 Kaiser Cr	11	0.75	0.2	1.0	0.044	0
SJ8 Bear Cr	11	0.75	0.2	1.5	0.085	0
SJ66 N Fk Willow Cr	0.01	0.75	0.2	0.75	0.01	0
SJ4 Florence Lk	11	0.75	0.2	1.5	0.085	0
SJ56 SJR ab Stvnson	11	0.75	0.2	0.75	0.01	0
SJ6 SFSJ ab Bear Cr	11	0.75	0.2	1.5	0.085	0
SJ62 SJR ab jose Cr	11	0.75	0.2	0.75	0.01	0
SJ58 Stevenson Cr	11	0.75	0.2	0.75	0.01	0
SJ68 Willow Cr ab SJ	0.01	0.75	0.2	0.75	0.01	0
SJ70 Redinger Lk	11	0.75	0.2	0.75	0.01	0
SJ60 Jose Cr	11	0.75	0.2	0.75	0.01	0
SJ80 Millerton Lake	11	0.75	0.2	0.75	0.01	0
SJ12 Lk TA Edison	11	0.75	0.2	1.5	0.085	0
SJ34 Chiquito Cr	11	0.75	0.2	1.0	0.044	0
SJ32 Jackass Cr	11	0.75	0.2	1.0	0.044	0
SJ30 SJR ab Mammoth	11	0.75	0.2	1.0	0.044	0
SJ64 Bass Lake	11	0.75	0.2	0.01	0.01	0
SJ78 Fine Gold Cr	11	0.75	0.2	0.75	0.01	0
SJ74 SJR ab Millerto	11	0.75	0.2	0.75	0.01	0
SJ76 Big Sandy Cr	11	0.75	0.2	0.75	0.01	0
SJ46 Huntington Lk	11	0.75	0.2	0.75	0.01	0
SJ44 SJR ab Dam 6	11	0.75	0.2	0.75	0.01	0
SJ48 Big C ab Pitman	11	0.75	0.2	0.75	0.01	0
SJ50 pitman Cr	11	0.75	0.2	0.75	0.01	0
SJ52 Big Cr at SJR	11	0.75	0.2	0.75	0.01	0
SJ54 Shaver Lake	11	0.75	0.2	0.75	0.01	0
SJ72 Kerckhoff Lake	11	0.75	0.2	0.75	0.01	0

Fresno River Basin



HEC-GeoHMS Subbasin Delineation

Fresno River

The Fresno River HMS model consists of a 236 square mile basin above Hensley Lake (Hidden Dam) located in the southeast portion of the San Joaquin Watershed. The basin model is divided into 6 subbasins and connected with 3 routing reaches. The observed hydrographs include computed inflow into Hensley Lake and a gage in the headwaters at Oakhurst (33 square miles). The computed peak flow at the HMS basin model outlet for the 1995 event was larger than the 1997 event (22,000 cfs vs. 14,000 cfs).

Using the adopted TC and R (Group 2) and Muskingum parameters, the computed hydrograph matched the observed hydrograph. The gage at Oakhurst was used as one of optimization models. The 1995 hydrograph comparison (observed vs. computed) suggests that a gage malfunction must have taken place. One-hour duration spikes provide the peaks for the 1997 hydrograph. Calibration efforts at Oakhurst required loss and baseflow parameters that differed from the other Fresno River subbasins. The flow from the Oakhurst subbasin had little effect at Hensley Lake.

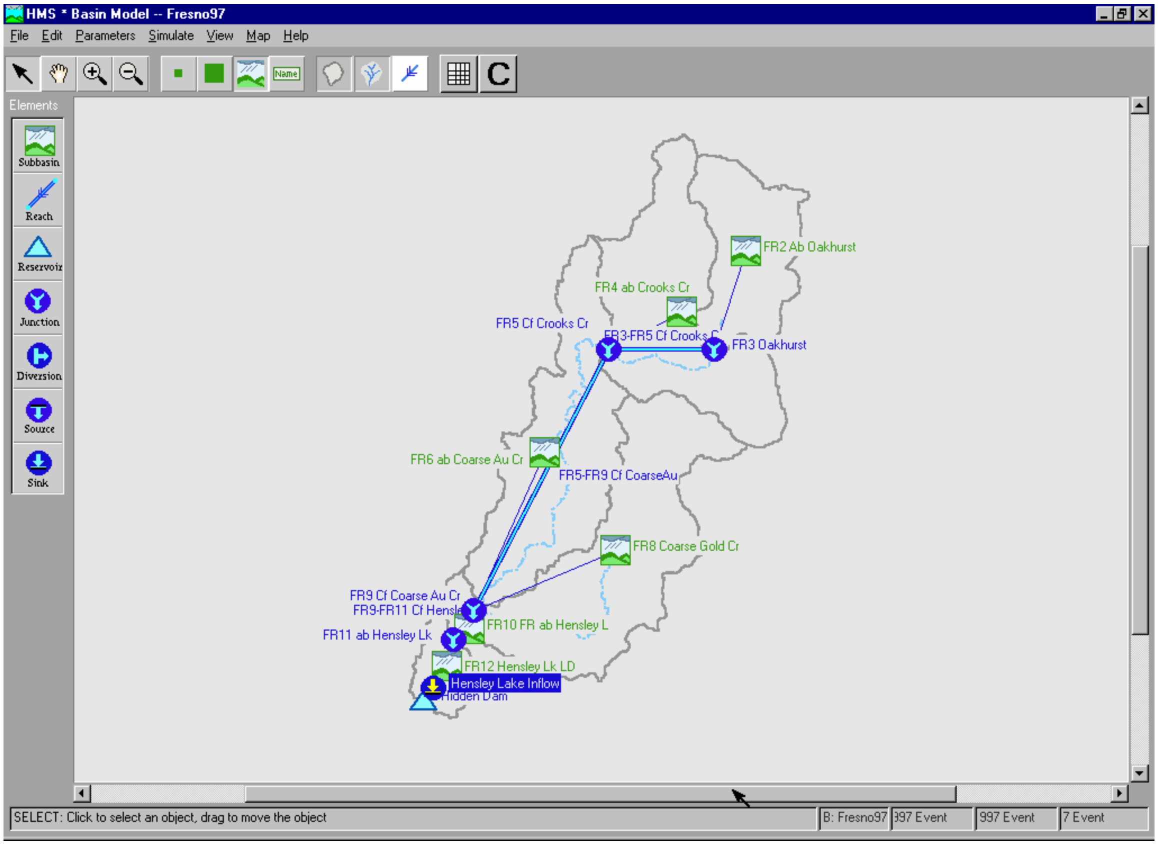
<u>Calibration of the 1995 Event:</u>

By using a constant loss rate of 0.06 inches/hour and initial losses of 1.9 inches (in the upper subbasins) and 1.5 inches (in the lower subbasins), the model calibrated well to the observed hydrograph at Hensley Lake. A recession ratio of 0.7 and a peak ratio of 0.1 defined the recession limb of the hydrograph. All the parameters for the area upstream of Oakhurst retained the values from optimization analysis.

<u>Calibration of the 1997 Event:</u>

As noted for other basins, the observed discharge for this event was difficult to match because of insufficient LWASS. The event featured three peaks, with the third peak being highest. The generalized parameters for TC and R (Group 2) fit the observed hydrograph. The baseflow recession parameters of 0.8 for the constant and 0.1 for the peak ratio worked best. All of the subbasins (except that above Oakhurst) used a constant loss rate of 0.001 inches/hour, and an initial loss of 2.1 inches.

Fresno River Basin HEC-HMS Model Schematic



Fresno River Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Initial TC $1.4(LL_{CA}/S^{1/2})^{.33}$ (Hr)	Initial R 1.5 TC (cfs/Hr)	Final TC $1.67(LL_{CA}/S^{1/2})^{.29}$ (Hr)	Final R 1.5TC (cfs/Hr)
FR2 Ab Oakhurst	33.04	11.68	5.68	389.881	3.36	2.1	3.1	2.4	3.6
FR4 Crooks Cr	59.42	15.91	5.17	259.541	5.11	2.4	3.6	2.7	4.0
FR6 ab Coarse Au Cr	60.29	25.23	11.44	143.731	24.07	4.0	6.0	4.2	6.3
FR8 Coarse Gold Cr	67.90	25.39	12.60	143.459	26.70	4.1	6.2	4.3	6.5
FR12 Hensley Lk LD	10.09	6.82	2.12	131.326	1.26	1.5	2.3	1.8	2.7
FR10 FR ab Hensley L	5.53	4.41	1.16	235.636	0.33	1.0	1.5	1.2	1.8

Fresno River Reach Parameters

Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Ave Reach Vel $80\ S_R^{1/2}$ V_R (fps)	Initial K $1.47\ L_R / 1.5V_R$ K (Hr)	Musk X or LAG (Min)	N steps Time Step= 60
FR3-FR5 Cf Crooks Cr	6.46	0.0074	6.90	1.0	0.4	1
FR5-FR9 Cf Coarse Au	20.87	0.0121	8.78	2.3	0.4	2
FR9-FR11 Cf Hensley L	2.10	0.0139	9.42	0.2	1.2	--

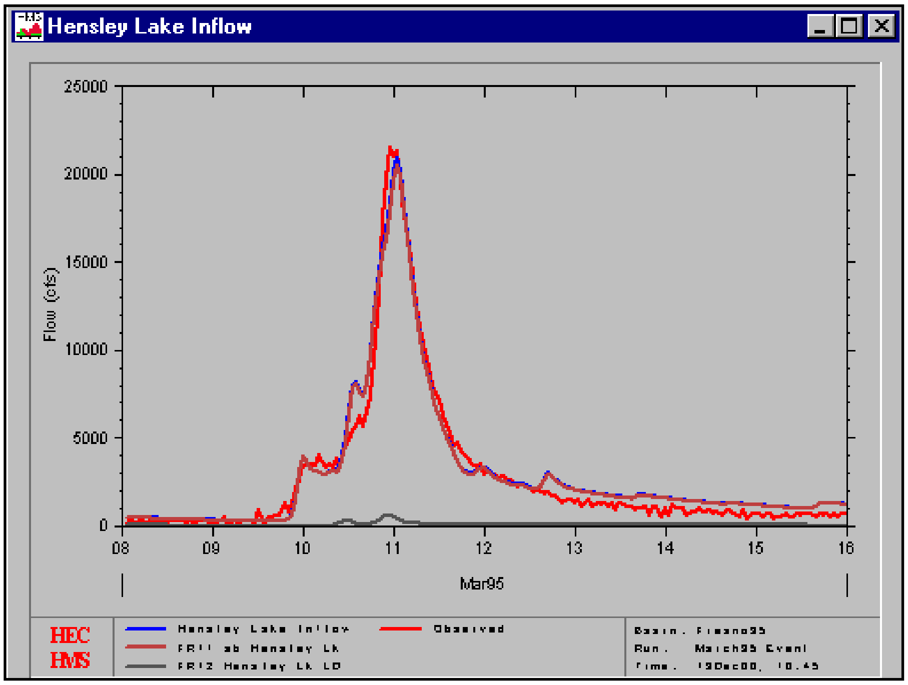
HEC-HMS Summary of Results
Fresno River Basin: March 1995 Event

Project : Fresno   Run Name : March95 Event

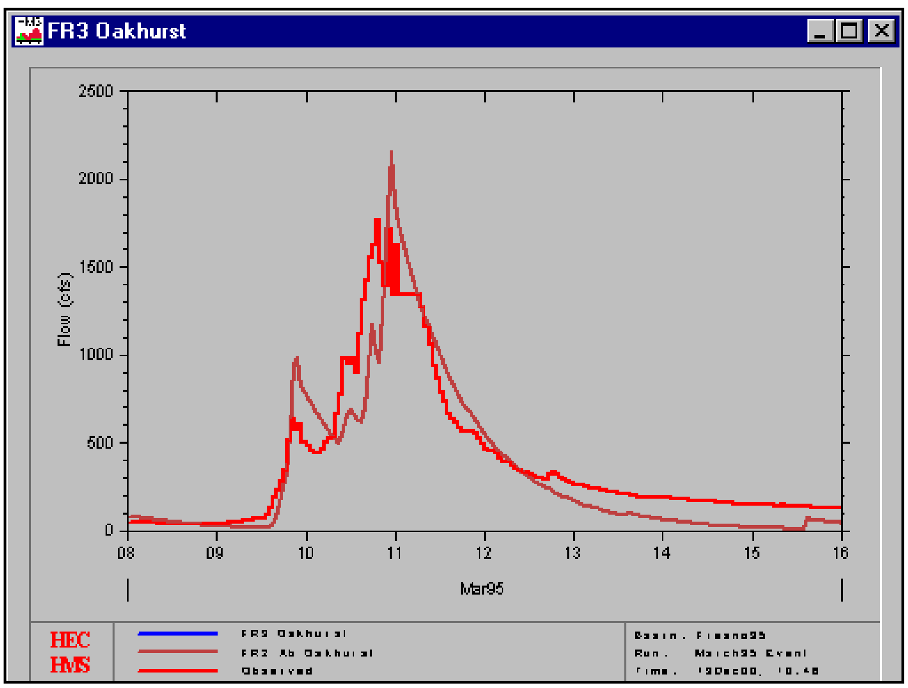
Start of Run	: 08Mar95 0100	Basin Model	: Fresno95
End of Run	: 15Mar95 2400	Met. Model	: 1995 Event
Execution Time	: 31May00 1345	Control Specs.	: 1995 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
FR2 Ab Oakhurst	2153.2	10 Mar 95 2300	5265.4	33.041
FR3 Oakhurst	2153.2	10 Mar 95 2300	5265.4	33.041
FR3-FR5 Cf Crooks C	2093.5	10 Mar 95 2400	5268.8	33.041
FR4 ab Crooks Cr	9043.2	10 Mar 95 2300	20610	59.423
FR5 Cf Crooks Cr	10837	10 Mar 95 2300	25879	92.464
FR5-FR9 Cf CoarseAu	10505	11 Mar 95 0200	25752	92.464
FR6 ab Coarse Au Cr	5083.0	10 Mar 95 2400	9893.1	60.295
FR8 Coarse Gold Cr	4919.5	11 Mar 95 0100	10022	67.897
FR9 Cf Coarse Au Cr	20393	11 Mar 95 0100	45668	220.656
FR9-FR11 Cf Hensley	20377	11 Mar 95 0100	45667	220.656
FR10 FR ab Hensley L	392.68	10 Mar 95 2200	521.62	5.533
FR11 ab Hensley Lk	20528	11 Mar 95 0100	46188	226.189
FR12 Hensley Lk LD	575.23	10 Mar 95 2300	834.49	10.089
Hensley Lake Inflow	20871	11 Mar 95 0100	47023	236.278
Hidden Dam	1.00000	08 Mar 95 0100	15.785	0.000

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Fresno River Basin
March 1995 Event



Hensley Lake Inflow



FR3 - Fresno River at Oakhurst

HEC-HMS Subbasin Parameters
Fresno River Basin: March 1995 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
FR4 ab Crooks Cr	2	0.7	0.1	1.9	0.06	0
FR6 ab Coarse Au Cr	2	0.7	0.1	1.9	0.06	0
FR8 Coarse Gold Cr	2	0.7	0.1	1.9	0.06	0
FR12 Hensley Lk LD	2	0.7	0.1	1.5	0.06	0
FR10 FR ab Hensley L	2	0.7	0.1	1.5	0.06	0
FR2 Ab Oakhurst	2.5	0.3	0.85	1.5	0.25	0

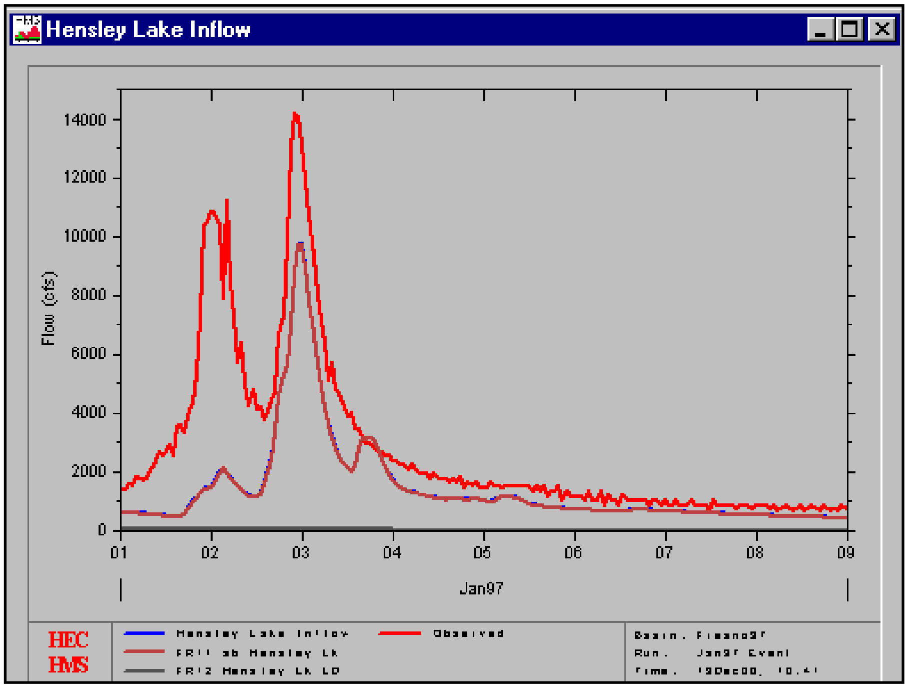
HEC-HMS Summary of Results
Fresno River Basin: December 1996 - January 1997 Event

Project : Fresno   Run Name : Jan97 Event

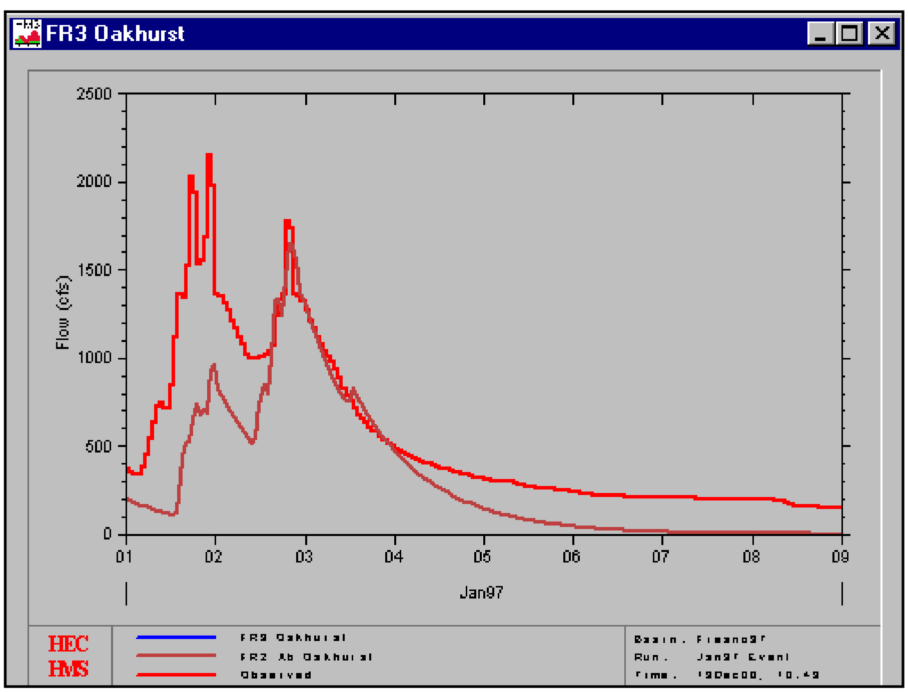
Start of Run	: 31Dec96	2400	Basin Model	:	Fresno97
End of Run	: 08Jan97	2400	Met. Model	:	1997 Event
Execution Time	: 31May00	1346	Control Specs.	:	1997 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
FR2 Ab Oakhurst	1642.6	02 Jan 97 2000	5005.1	33.041
FR3 Oakhurst	1642.6	02 Jan 97 2000	5005.1	33.041
FR3-FR5 Cf Crooks C	1626.3	02 Jan 97 2200	5021.4	33.041
FR4 ab Crooks Cr	4728.5	02 Jan 97 2100	9213.1	59.423
FR5 Cf Crooks Cr	6352.3	02 Jan 97 2100	14235	92.464
FR5-FR9 Cf CoarseAu	6173.9	02 Jan 97 2300	14257	92.464
FR6 ab Coarse Au Cr	2126.6	02 Jan 97 2300	4628.6	60.295
FR8 Coarse Gold Cr	1476.4	02 Jan 97 2400	3416.7	67.897
FR9 Cf Coarse Au Cr	9702.5	02 Jan 97 2400	22302	220.656
FR9-FR11 Cf Hensley	9702.4	02 Jan 97 2400	22302	220.656
FR10 FR ab Hensley L	14.561	05 Jan 97 0700	85.661	5.533
FR11 ab Hensley Lk	9709.5	02 Jan 97 2400	22388	226.189
FR12 Hensley Lk LD	20.178	31 Dec 96 2400	149.62	10.089
Hensley Lake Inflow	9722.4	02 Jan 97 2400	22537	236.278
Hidden Dam	1.00000	31 Dec 96 2400	15.868	0.000

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Fresno River Basin
December 1996 - January 1997 Event



Hensley Lake Inflow

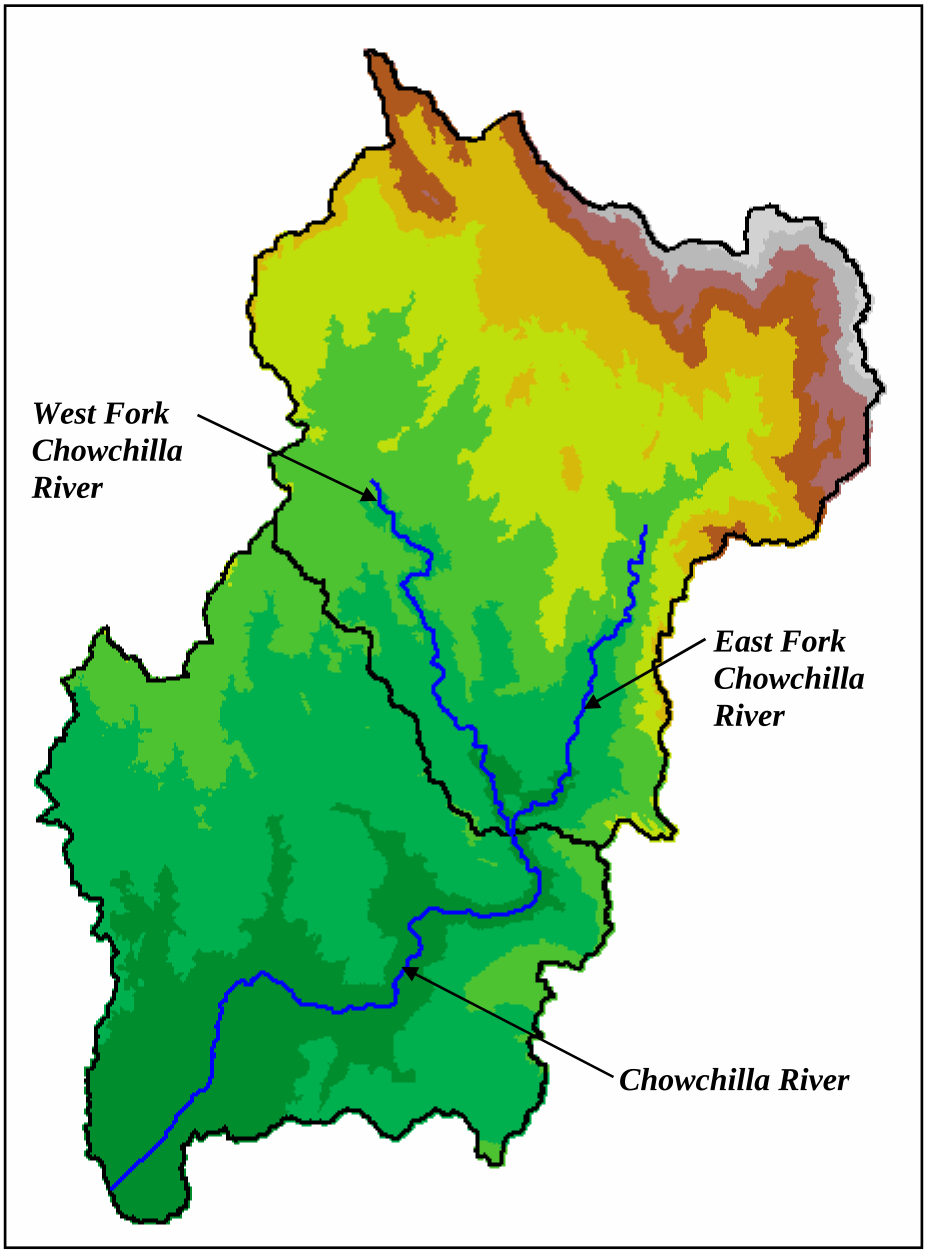


FR3 – Fresno River at Oakhurst

HEC-HMS Subbasin Parameters
Fresno River Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
FR4 ab Crooks Cr	2	0.8	0.1	2.1	.001	0
FR6 ab Coarse Au Cr	2	0.8	0.1	2.1	.001	0
FR8 Coarse Gold Cr	2	0.8	0.1	2.1	.001	0
FR12 Hensley Lk LD	2	0.8	0.1	2.1	.001	0
FR10 FR ab Hensley L	2	0.8	0.1	2.1	.001	0
FR2 Ab Oakhurst	6	0.3	0.85	1.9	.08	0

Chowchilla River Basin



HEC-GeoHMS Subbasin Delineation

Chowchilla River

The Chowchilla River HMS model consists of a 235 square mile basin above H. V. Eastman Lake (Buchanan Dam) located in the southeast portion of the San Joaquin Watershed. The basin is divided into 2 subbasins and connected with 1 routing reach. The subbasin delineation was based on an existing model obtained from the Sacramento District. The only observed hydrograph is the computed inflow into Eastman Lake. The computed peak inflow into Eastman Lake for the 1995 event was larger than the 1997 event (20,000 cfs vs. 15,000 cfs).

When using the study's adopted values for the Muskingum routing method (K=3.3; X=0.4, subreaches=3), the computed peak arrived two hours after the observed peak. However, when the Muskingum values from the Sacramento District's existing model were used (K=1.0; X=0.5; subreaches=2), the timing of the two hydrographs coincided. Therefore, the values from the District's model were used.

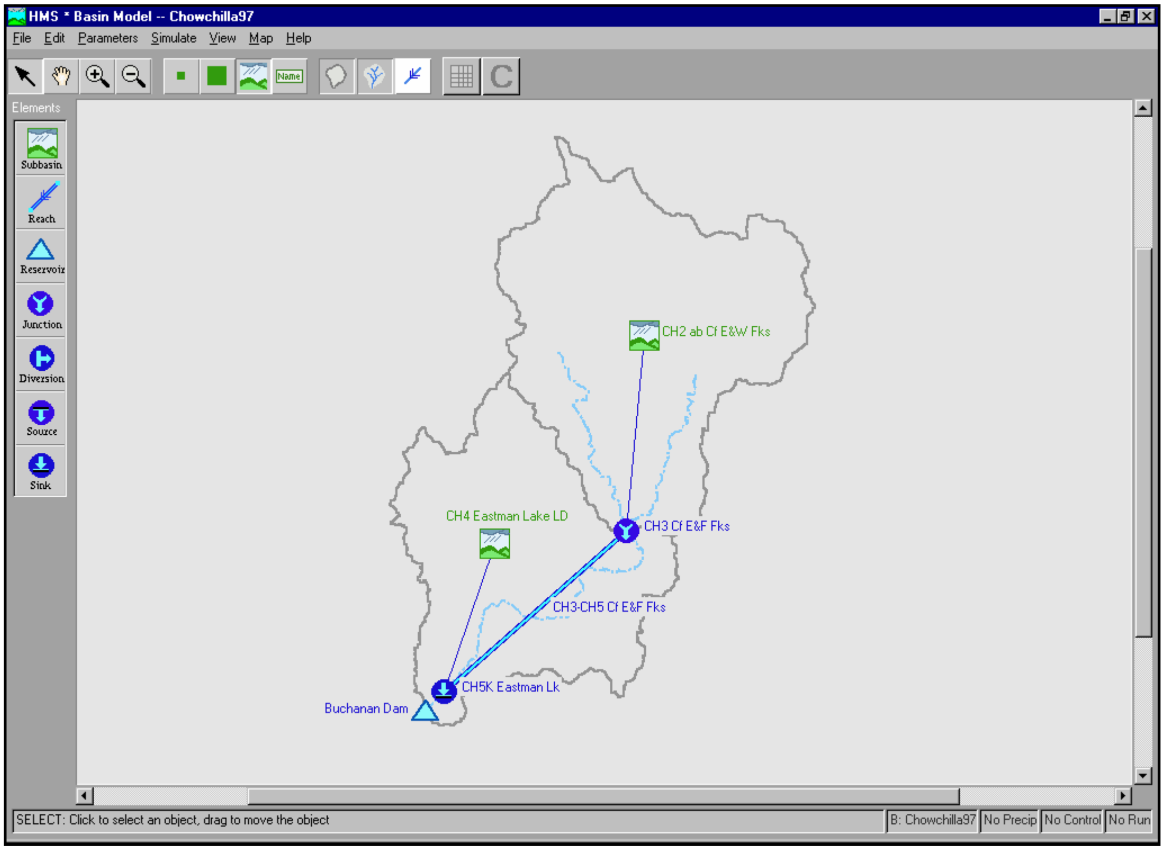
<u>Calibration of the 1995 Event:</u>

The generalized parameters for TC and R (Group 2) fit the observed hydrograph well, with the loss rates and initial baseflow value within the recommended ranges. A recession ratio of 0.7 and a peak ratio of 0.1 defined the recession limb of the hydrograph.

<u>Calibration of the 1997 Event:</u>

As noted for other basins, the observed discharge for this event was difficult to match because of insufficient LWASS. The event featured three peaks, with the third peak being highest. Beginning the simulation at midnight on New Year's Eve helped match the peaks. To model the third peak, the computation window was shortened so the rainfall for 29-30 December was ignored. Additionally, the initial baseflow rates were raised and the initial losses reduced to compensate for the different antecedent conditions. Whether starting the simulation on 29Dec96 or 01Jan97, loss rates between the upper and lower subbasins were revised to achieve calibration. The generalized parameters for TC and R (Group 2) fit the observed hydrograph. The observed hydrograph (computed from storage change) tended toward sharper peaks than the computed hydrograph. A recession ratio of 0.7 and a peak ratio of 0.2 defined the recession limb of the hydrograph.

Chowchilla River Basin HEC-HMS Model Schematic



Chowchilla River Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Initial TC $1.4(LL_{CA}/S^{1/2})^{.33}$ (Hr)	Initial R 1.5 TC (cfs/Hr)	Final TC $1.67(LL_{CA}/S^{1/2})^{.29}$ (Hr)	Final R 1.5TC (cfs/Hr)
CH2 ab Cf E&W Fk	132.88	23.95	8.52	152.278	16.53	3.5	5.3	3.8	5.7
CH4 Eastman Lake	102.07	24.56	6.59	89.905	17.08	3.6	5.4	3.8	5.7

Chowchilla River Reach Parameters

Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Ave Reach Vel $80\ S_R^{1/2}$ V_R (fps)	Initial K $1.47\ L_R / 1.5V_R$ K (Hr)	Musk X or LAG (Min)	N steps Time Step= 60
CH2-CHR5 Cf West Fk	17.03	0.0040	5.04	3.3	0.4	3

HEC-HMS Summary of Results
Chowchilla River Basin: March 1995 Event

Project : Chowchilla Run Name : March 95 Event

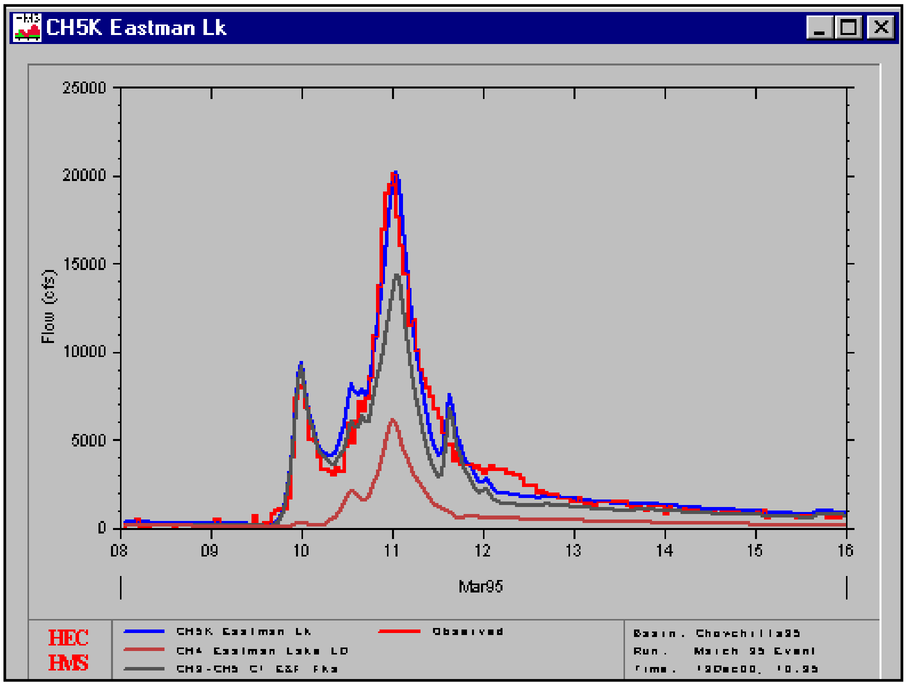
Start of Run : 08Mar95 0100 Basin Model : Chowchilla95

End of Run : 15Mar95 2400 Met. Model : 1995 Event

Execution Time : 13May00 1343 Control Specs. : 1995 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
CH2 ab Cf E&W Fks	14390	10 Mar 95 2400	35187	132.884
CH3 Cf E&F Fks	14390	10 Mar 95 2400	35187	132.884
CH3-CH5 Cf E&F Fks	14286	11 Mar 95 0100	35144	132.884
CH4 Eastman Lake LD	6112.2	10 Mar 95 2400	10390	102.072
CH5K Eastman Lk	20220	11 Mar 95 0100	45535	234.956
Buchanan Dam	1.00000	08 Mar 95 0100	15.785	0.000

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Chowchilla River Basin
March 1995 Event



CH5K – Eastman Lake

HEC-HMS Subbasin Parameters
Chowchilla River Basin: March 1995 Event

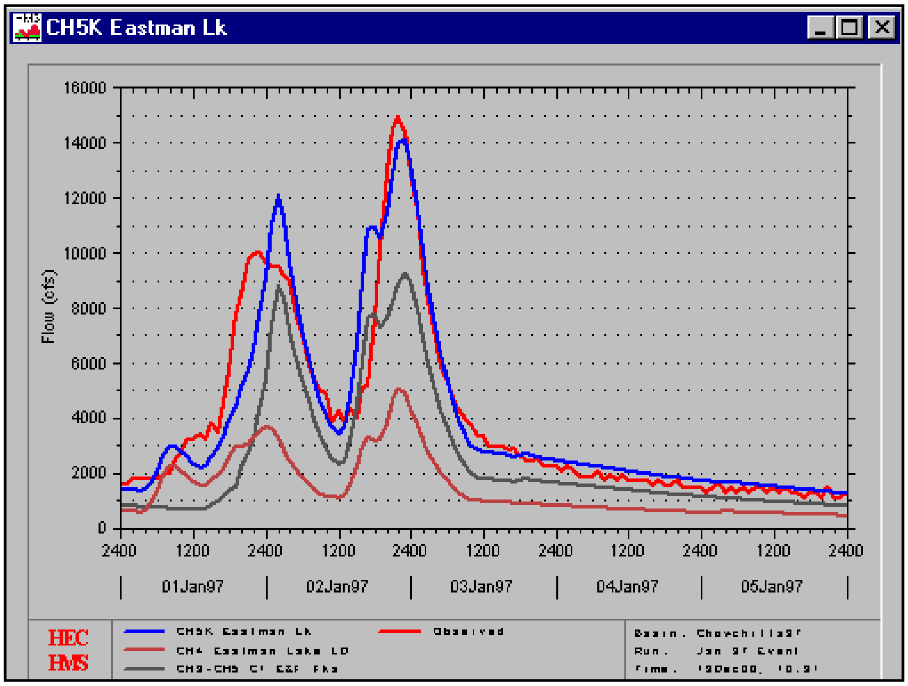
Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
CH2 ab Cf E&W Fks	1.5	0.7	0.1	1.5	0.075	0
CH4 Eastman Lake LD	1.5	0.7	0.1	1.5	0.075	0

HEC-HMS Summary of Results
Chowchilla River Basin: December 1996 - January 1997 Event

Project	: Chowchilla	Run Name	: Jan 97 Event
Start of Run	: 31Dec96 2400	Basin Model	: Chowchilla97
End of Run	: 05Jan97 2400	Met. Model	: 1997 Event
Execution Time	: 31May00 1343	Control Specs.	: 1997 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
CH2 ab Cf E&W Fks	9279.3	02 Jan 97 2200	24962	132.884
CH3 Cf E&F Fks	9279.3	02 Jan 97 2200	24962	132.884
CH3-CH5 Cf E&F Fks	9212.1	02 Jan 97 2300	24962	132.884
CH4 Eastman Lake LD	5049.0	02 Jan 97 2200	14353	102.072
CH5K Eastman Lk	14078	02 Jan 97 2300	39315	234.956
Buchanan Dam	1.00000	31 Dec 96 2400	9.9174	0.000

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Chowchilla River Basin
December 1996 - January 1997 Event

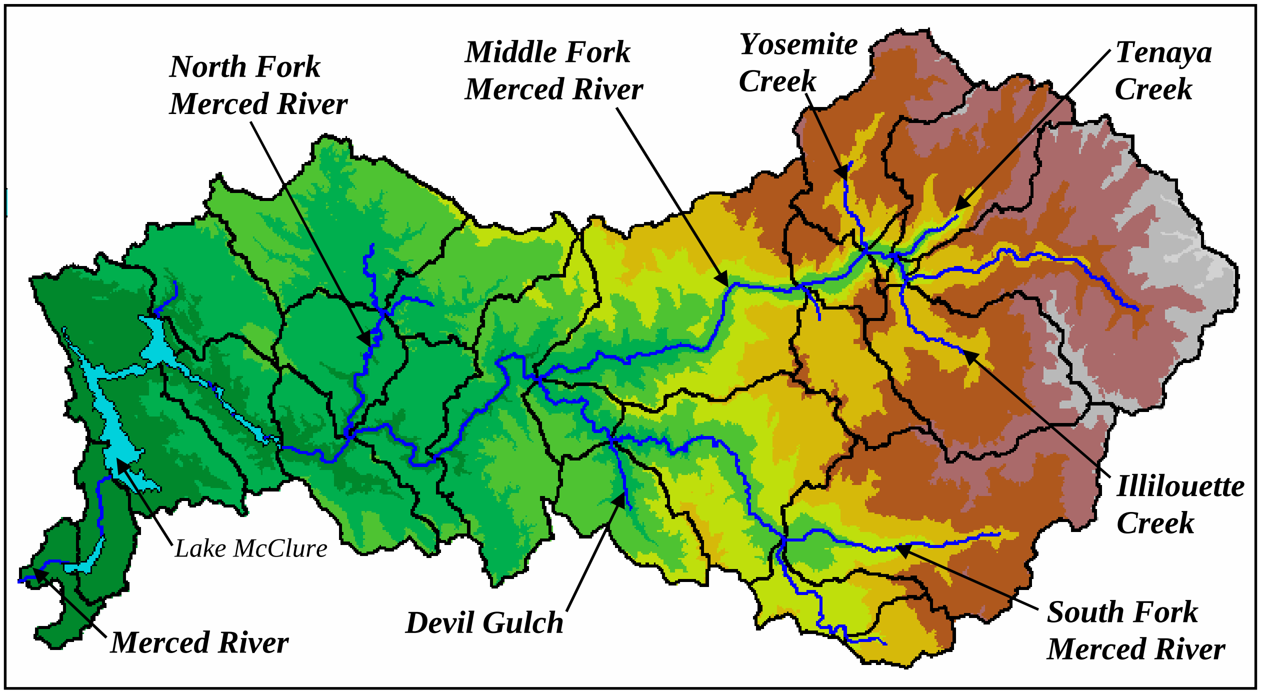


CH5K – Eastman Lake

HEC-HMS Subbasin Parameters
Chowchilla River Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
CH2 ab Cf E&W Fks	6	0.7	0.2	1.6	0.04	0
CH4 Eastman Lake LD	6	0.7	0.2	0.02	0.02	0

Merced River Basin



HEC-GeoHMS Subbasin Delineation

Merced River

The Merced River HMS model consists of a 1,036 square mile basin above Lake McClure (New Exchequer Dam) located in the mid-east portion of the San Joaquin Watershed. The basin model is divided into 24 subbasins and connected with 11 routing reaches. The observed hydrographs are the computed inflow into Lake McClure and at gages at the confluence of Illilouette Creek and Bridalveil Creek. The computed peak inflow into Lake McClure for the 1997 event was larger than the 1995 event (95,700 cfs vs. 74,100 cfs).

While the adopted value for TC was computed using the Group 2 equations, the value of R was set to 3.1TC. This revision was made so the shape of the computed hydrograph would better resemble the observed hydrograph. The generic equation to compute the reach travel time (Muskingum K) was not used because the reach travel times were too short; thus, causing the computed peaks to occur too early. Instead, the reach travel time (K) was computed knowing the reach length and average velocity. The average velocity was computed using Manning's equation. The Manning's "n" value was estimated with Jarrett's equation, and the hydraulic radius was estimated from the Yuba River equation, which was developed from a regression of field data (the Yuba River equation was used because it was felt that it would represent the Merced system the best). Of the 15 routing reaches, 11 reaches used the Muskingum routing technique. The other 4 reaches used the lag method since the travel time within each of those reaches was less than the one-hour time step used by the Muskingum method. Twenty-five percent impervious area was used for the Exchequer subbasin, and five percent impervious area was used for the subbasin containing the upstream end of the reservoir.

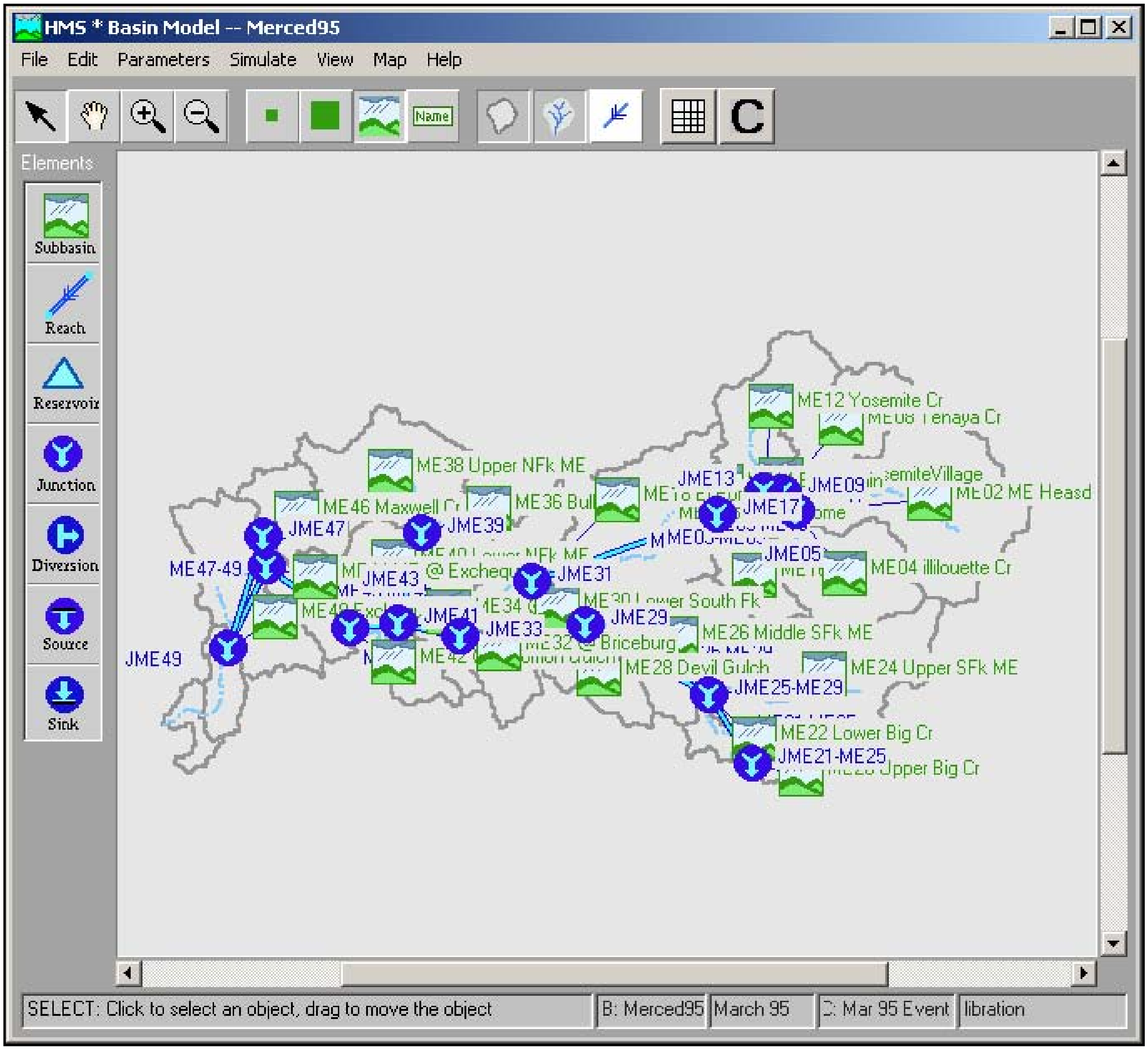
<u>Calibration of the 1995 Event:</u>

By using constant loss rates between 0.02 and 0.05 inches/hour and an initial loss of 2 inches, the model calibrated reasonably well to the observed hydrographs. A recession ratio of 0.6 and a peak ratio of 0.25 defined the recession limb of the hydrographs. An initial baseflow of 1.8 cfs per square mile was assumed.

<u>Calibration of the 1997 Event:</u>

By using constant loss rates between 0.02 and 0.05 inches/hour and initial losses of 2-3 inches, the model calibrated reasonably well to the observed hydrographs at Illilouette Creek and Bridalveil Creek and very well to the observed hydrograph at Exchequer. The baseflow recession parameters of 0.6 for the constant and 0.25 for the peak ratio worked best. Initial baseflows of 12 cfs per square mile were used to fit a smaller time window around the peak, with 3 cfs per square mile in the headwater subbasins.

Merced River Basin HEC-HMS Model Schematic



Merced River Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Ave Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Initial TC $1.4(LL_{CA}/S^{1/2})^{.33}$ (Hr)	Initial R 1.5 TC (cfs/Hr)	Final TC $1.67(LL_{CA}/S^{1/2})^{.29}$ (Hr)	Final R 3.1 TC (Hr)
ME08 Tenaya Cr	47.30	15.18	8.54	422.40	6.30	2.6	3.9	2.8	8.8
ME02 ME Heasdwaters	119.40	22.35	11.12	380.16	12.74	3.2	4.9	3.5	10.8
ME12 Yosemite Cr	47.04	15.81	7.40	422.40	5.69	2.5	3.7	2.8	8.6
ME10 YosemiteVillage	2.89	4.07	1.79	1034.88	0.23	0.9	1.3	1.1	3.4
ME16 Bridalveil Cr	25.09	12.24	6.47	454.08	3.72	2.2	3.2	2.4	7.6
ME06 Sentinel Dome	1.75	3.21	1.45	1235.52	0.13	0.7	1.1	0.9	2.9
ME40 Lower NFk ME	27.64	14.59	5.76	163.68	6.57	2.6	3.9	2.9	8.9
ME38 Upper NFk ME	63.37	15.42	5.68	142.56	7.33	2.7	4.1	3.0	9.2
ME14 El Capitain	15.02	6.70	2.09	649.44	0.55	1.1	1.7	1.4	4.4
ME34 @ Halls Gulch	29.08	11.53	3.88	253.44	2.81	2.0	3.0	2.3	7.0
ME36 Bull Cr	33.06	14.27	7.07	290.40	5.92	2.5	3.8	2.8	8.7
ME48 Exchequer Bsn	65.60	15.27	4.13	153.12	5.09	2.4	3.6	2.7	8.3
ME18 El Portal	100.36	23.41	13.32	306.24	17.83	3.6	5.4	3.9	11.9
ME04 illilouette Cr	60.87	15.50	7.58	480.48	5.36	2.4	3.7	2.7	8.4
ME30 Lower South Fk	13.37	8.40	4.54	480.48	1.74	1.7	2.5	2.0	6.1
ME22 Lower Big Cr	18.86	14.08	4.91	332.64	3.79	2.2	3.3	2.5	7.6
ME44 ME @ Exchequer	27.55	11.79	4.87	227.04	3.81	2.2	3.3	2.5	7.6
ME26 Middle SFk ME	67.21	20.14	10.06	258.72	12.59	3.2	4.8	3.5	10.8
ME28 Devil Gulch	28.67	10.59	4.42	480.48	2.14	1.8	2.7	2.1	6.5
ME24 Upper SFk ME	100.18	23.49	9.42	322.08	12.33	3.2	4.8	3.5	10.7
ME42 @ Salomon Gulch	33.62	12.18	4.54	216.48	3.76	2.2	3.3	2.5	7.6
ME46 Maxwell Cr	32.63	13.48	5.84	216.48	5.35	2.4	3.7	2.7	8.4
ME32 @ Briceburg	63.73	17.63	4.69	279.84	4.94	2.4	3.6	2.7	8.2
ME20 Upper Big Cr	12.06	7.68	2.91	422.40	1.09	1.4	2.2	1.7	5.3

Merced River Reach Parameters

Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Cum Drainage Area (from GeoHms) A (Sq. Mi.)	Yuba River Field Reg. Eqa R = 4.13*LN(A)-6.4	Jarret's Equation $n = .39S^{.38}R^{-.16}$	Manning's Velocity v (ft/s)	Travel Time K Hrs	Lag (Min)	Remarks
ME05-ME09	1.70	0.0251	181	15.07	0.062	23.12	0.11	6	
ME09-ME13	1.47	0.0017	231	16.08	0.022	17.65	0.12	7	
ME13-ME17	4.01	0.0026	285	16.94	0.026	19.40	0.30	18	
ME17-ME31	18.18	0.0262	363	17.94	0.062	26.84	0.99	--	Musk K=1hr
ME21-ME25	3.71	0.0421	23	6.55	0.087	12.35	0.44	26	
ME25-ME29	15.83	0.0256	178	15.00	0.063	23.08	1.01	--	Musk K=1hr
ME29-ME31	7.20	0.0107	236	16.17	0.045	22.11	0.48	29	
ME31-ME33	10.47	0.0044	697	20.64	0.031	24.32	0.63	38	
ME33-ME41	6.57	0.007	735	20.86	0.036	25.94	0.37	22	
ME39-ME41	9.99	0.0153	109	12.98	0.053	19.25	0.76	46	
ME41-43	4.94	0.0026	900	21.69	0.025	23.80	0.30	18	

Routing parameters based on field observations and regression analysis.

HEC-HMS Summary of Results
Merced River Basin: March 1995 Event

Project : Merced   Run Name : Mar95 Calibration

Start of Run : 09Mar95 0000   Basin Model : Merced95

End of Run : 13Mar95 2400   Met. Model : March 95

Execution Time : 16Feb01 0922   Control Specs. : Mar 95 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
ME38 Upper NFk ME	6788.7	10 Mar 95 2400	20282	63.366
ME36 Bull Cr	4249.4	10 Mar 95 2400	13234	33.060
JME39	11038	10 Mar 95 2400	33516	96.426
ME39-ME41	10960	11 Mar 95 0100	33414	96.426
ME20 Upper Big Cr	1668.5	10 Mar 95 2200	5056.1	12.056
JME21-ME25	1668.5	10 Mar 95 2200	5056.1	12.056
ME21-ME25	1660.1	10 Mar 95 2200	5044.0	12.056
ME22 Lower Big Cr	3406.0	10 Mar 95 2300	9940.5	18.855
ME24 Upper SFk ME	4614.6	10 Mar 95 2200	18292	100.181
JME25-ME29	9629.7	10 Mar 95 2200	33277	131.092
ME25-ME29	9629.7	10 Mar 95 2300	33116	131.092
ME28 Devil Gulch	4525.1	10 Mar 95 2300	12124	28.665
ME26 Middle SFk ME	9537.5	10 Mar 95 2400	30612	67.207
JME29	23570	10 Mar 95 2300	75853	226.964
ME29-ME31	23494	10 Mar 95 2400	75703	226.964
ME04 illilouette Cr	1931.0	09 Mar 95 2200	5327.0	60.866
ME02 ME Heasdwaters	574.89	09 Mar 95 2300	2840.2	119.396
JME05	2503.4	09 Mar 95 2300	8167.1	180.262
ME05-ME09	2502.4	09 Mar 95 2300	8161.8	180.262
ME06 Sentinel Dome	269.35	09 Mar 95 2100	633.32	1.751
ME08 Tenaya Cr	1016.9	09 Mar 95 2200	3331.9	47.298
JME09	3665.0	09 Mar 95 2200	12127	229.311
ME09-ME13	3602.3	09 Mar 95 2200	12119	229.311
ME12 Yosemite Cr	947.38	09 Mar 95 2200	2115.6	47.036
ME10 YosemiteVillage	443.93	09 Mar 95 2100	1069.6	2.890
JME13	4915.3	09 Mar 95 2200	15304	279.237
ME13-ME17	4772.7	09 Mar 95 2300	15276	279.237
ME14 El Capitain	1836.2	09 Mar 95 2100	4585.7	15.024
ME16 Bridalveil Cr	2124.9	09 Mar 95 2200	5130.2	25.091
JME17	8539.2	09 Mar 95 2200	24992	319.352
ME17-ME31	8539.2	09 Mar 95 2300	24810	319.352
ME30 Lower South Fk	1988.2	10 Mar 95 2400	5277.8	13.369
ME18 El Portal	9300.6	10 Mar 95 2400	33541	100.363
JME31	38334	10 Mar 95 2400	139332	660.048

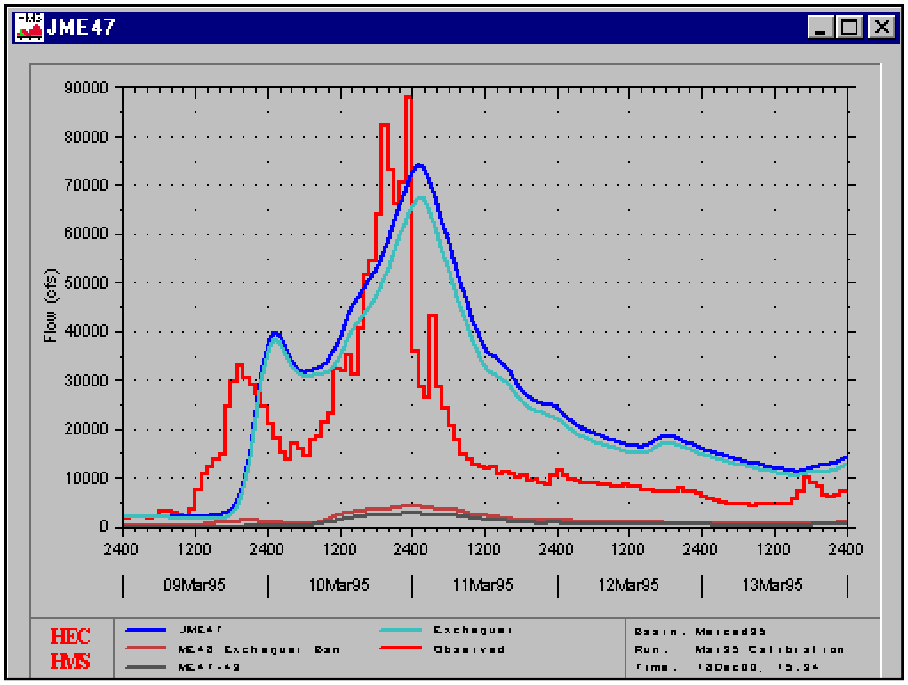
... Continued ...

HEC-HMS Summary of Results
Merced River Basin: March 1995 Event
(Continued)

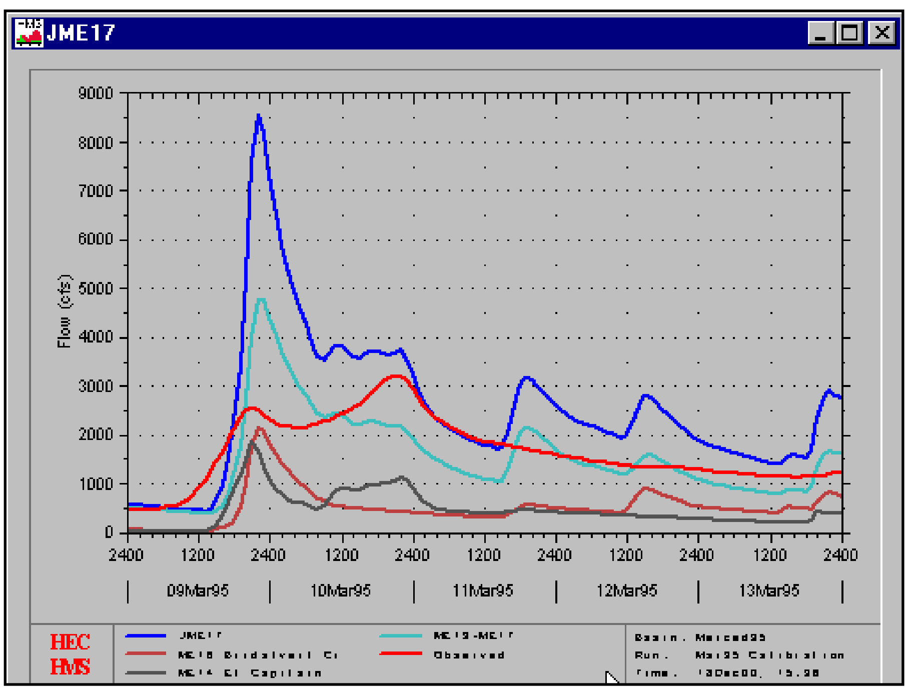
Project : Merced Run Name : Mar95 Calibration

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
ME31-ME33	37912	10 Mar 95 2400	138922	660.048
ME32 @ Briceburg	8253.9	10 Mar 95 2400	23668	63.734
JME33	46166	10 Mar 95 2400	162590	723.782
ME33-ME41	45780	11 Mar 95 0100	162324	723.782
ME40 Lower NFk ME	2821.8	10 Mar 95 2400	7933.9	27.643
ME34 @ Halls Gulch	3624.7	10 Mar 95 2400	10433	29.077
JME41	62859	11 Mar 95 0100	214104	876.928
ME41-43	62809	11 Mar 95 0100	213845	876.928
ME42 @ Salomon Gulch	3242.4	10 Mar 95 2400	8183.7	33.616
JME43	65853	11 Mar 95 0100	222028	910.544
ME43-ME45	65529	11 Mar 95 0100	221593	910.544
ME44 ME @ Exchequer	2258.6	10 Mar 95 2400	5971.5	27.552
JME45	67691	11 Mar 95 0100	227565	938.096
Exchequer	67308	11 Mar 95 0100	227349	938.096
ME46 Maxwell Cr	2783.8	10 Mar 95 2400	8043.3	32.630
JME47	2783.8	10 Mar 95 2400	8043.3	32.630
ME47-49	2759.0	10 Mar 95 2400	8020.4	32.630
ME48 Exchequer Bsn	4279.2	10 Mar 95 2400	13339	65.600
JME49	74118	11 Mar 95 0100	248708	1036.326

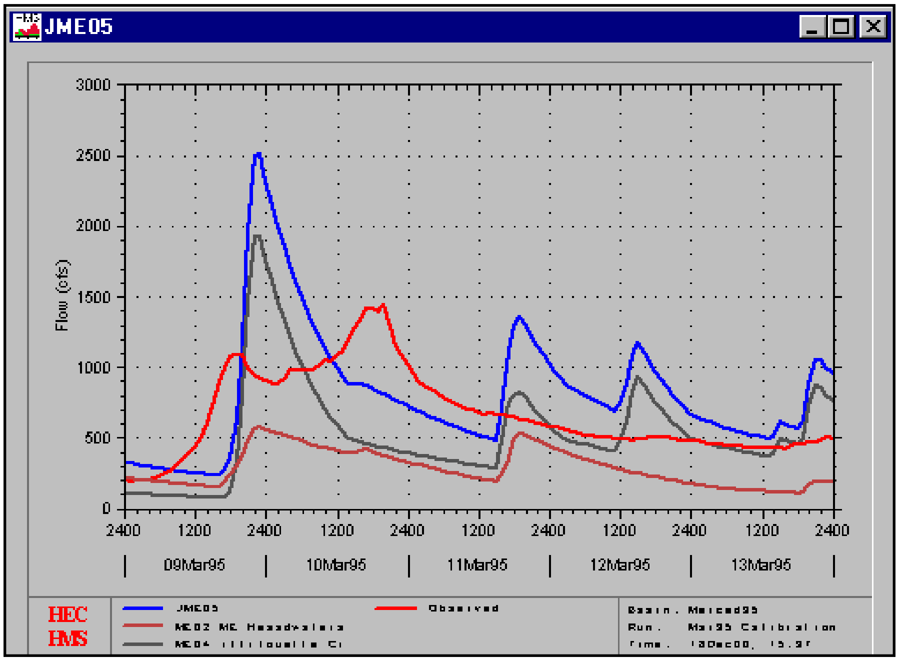
HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Merced River Basin
March 1995 Event



JME47 – Exchequer



JME17 – Bridalveil Creek



JME05 – Below Illilouette Creek

HEC-HMS Subbasin Parameters
Merced River Basin: March 1995 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
ME08 Tenaya Cr	1.8	0.6	0.25	2	0.03	0
ME02 ME Headswaters	1.8	0.6	0.25	2	0.05	0
ME12 Yosemite Cr	1.8	0.6	0.25	2	0.03	0
ME10 YosemiteVillage	1.8	0.6	0.25	2	0.03	0
ME16 Bridalveil Cr	1.8	0.6	0.25	2	0.03	0
ME06 Sentinel Dome	1.8	0.6	0.25	2	0.03	0
ME40 Lower NFk ME	1.8	0.6	0.25	2	0.02	0
ME38 Upper NFk ME	1.8	0.6	0.25	2	0.02	0
ME14 El Capitain	1.8	0.6	0.25	2	0.03	0
ME34 @ Halls Gulch	14.8	0.6	0.25	2	0.02	0
ME36 Bull Cr	1.8	0.6	0.25	2	0.02	0
ME48 Exchequer Bsn	1.8	0.6	0.25	2	0.02	25
ME18 El Portal	1.8	0.6	0.25	2	0.02	0
ME04 illilouette Cr	1.8	0.6	0.25	2	0.05	0
ME30 Lower South Fk	1.8	0.6	0.25	2	0.03	0
ME22 Lower Big Cr	1.8	0.6	0.25	2	0.03	0
ME44 ME @ Exchequer	1.8	0.6	0.25	2	0.02	5
ME26 Middle SFk ME	1.8	0.6	0.25	2	0.03	0
ME28 Devil Gulch	1.8	0.6	0.25	2	0.03	0
ME24 Upper SFk ME	1.8	0.6	0.25	2	0.03	0
ME42 @ Salomon Gulch	1.8	0.6	0.25	2	0.02	0
ME46 Maxwell Cr	1.8	0.6	0.25	2	0.02	0
ME32 @ Briceburg	1.8	0.6	0.25	2	0.02	0
ME20 Upper Big Cr	1.8	0.6	0.25	2	0.03	0

HEC-HMS Summary of Results
Merced River Basin: December 1996 - January 1997 Event

Project	: Merced	Run Name	: Jan97 Calibration
Start of Run	: 31Dec96 0000	Basin Model	: Merced97
End of Run	: 09Jan97 2400	Met. Model	: Jan 97
Execution Time	: 16Feb01 0927	Control Specs.	: Jan 97 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
ME38 Upper NFk ME	6376.2	02 Jan 97 1800	23203	63.366
ME36 Bull Cr	4468.9	02 Jan 97 1800	17748	33.060
JME39	10845	02 Jan 97 1800	40951	96.426
ME39-ME41	10823	02 Jan 97 1900	41004	96.426
ME20 Upper Big Cr	1517.7	01 Jan 97 2300	4410.0	12.056
JME21-ME25	1517.7	01 Jan 97 2300	4410.0	12.056
ME21-ME25	1485.6	01 Jan 97 2400	4411.7	12.056
ME22 Lower Big Cr	2063.8	01 Jan 97 2300	6658.2	18.855
ME24 Upper SFk ME	8031.3	02 Jan 97 2200	27801	100.181
JME25-ME29	10769	02 Jan 97 2200	38871	131.092
ME25-ME29	10769	02 Jan 97 2300	38928	131.092
ME28 Devil Gulch	2558.6	01 Jan 97 2400	8485.8	28.665
ME26 Middle SFk ME	6466.1	02 Jan 97 0100	24835	67.207
JME29	19541	02 Jan 97 0100	72249	226.964
ME29-ME31	19362	02 Jan 97 0100	72315	226.964
ME04 illilouette Cr	5722.0	02 Jan 97 1800	20296	60.866
ME02 ME Heasdwaters	6847.5	02 Jan 97 2100	28501	119.396
JME05	12380	02 Jan 97 2100	48797	180.262
ME05-ME09	12378	02 Jan 97 2100	48801	180.262
ME06 Sentinel Dome	362.76	02 Jan 97 1600	1228.6	1.751
ME08 Tenaya Cr	7364.4	02 Jan 97 1800	24866	47.298
JME09	19431	02 Jan 97 1900	74896	229.311
ME09-ME13	19421	02 Jan 97 1900	74900	229.311
ME12 Yosemite Cr	8518.9	02 Jan 97 1700	29223	47.036
ME10 YosemiteVillage	615.77	02 Jan 97 1600	2122.7	2.890
JME13	28277	02 Jan 97 1800	106246	279.237
ME13-ME17	28087	02 Jan 97 1800	106260	279.237
ME14 El Capitain	3035.6	01 Jan 97 1900	10677	15.024
ME16 Bridalveil Cr	3501.8	01 Jan 97 2400	12618	25.091
JME17	34317	02 Jan 97 1800	129555	319.352
ME17-ME31	34317	02 Jan 97 1900	129634	319.352
ME30 Lower South Fk	1231.7	02 Jan 97 2100	4268.8	13.369
ME18 El Portal	16836	02 Jan 97 1900	70989	100.363
JME31	69862	02 Jan 97 1900	277206	660.048

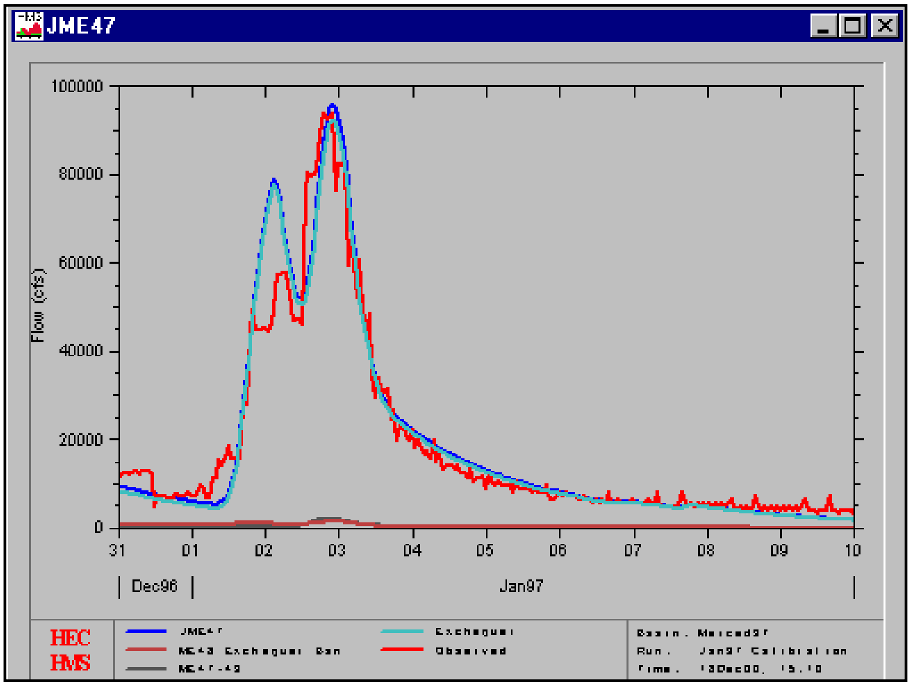
... Continued ...

HEC-HMS Summary of Results
Merced River Basin: December 1996 - January 1997 Event
(Continued)

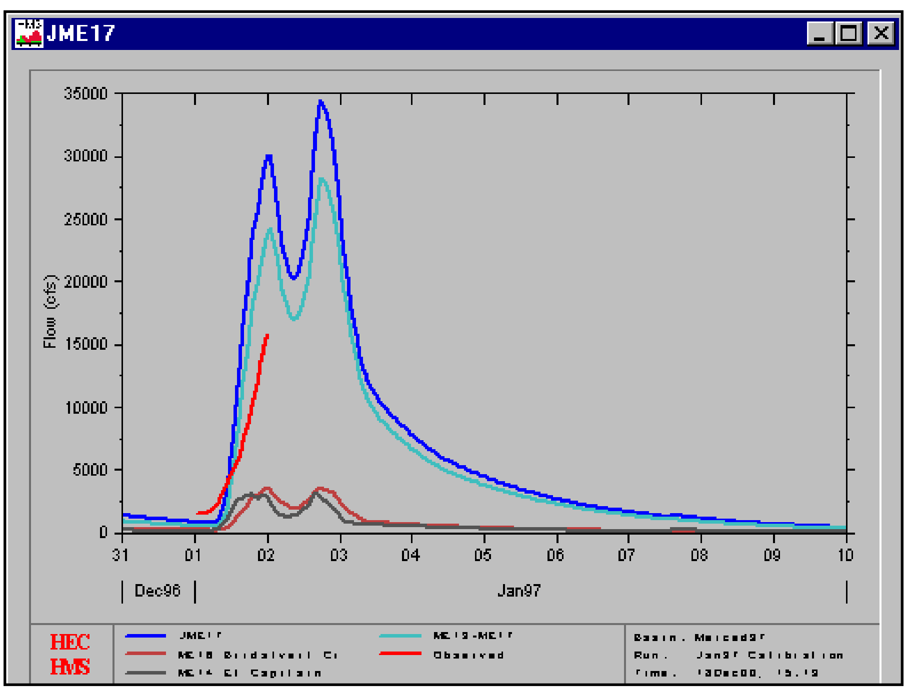
Project : Merced Run Name : Jan97 Calibration

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
ME31-ME33	69750	02 Jan 97 2000	277389	660.048
ME32 @ Briceburg	5998.9	02 Jan 97 2100	21268	63.734
JME33	75632	02 Jan 97 2000	298657	723.782
ME33-ME41	75431	02 Jan 97 2100	298784	723.782
ME40 Lower NFk ME	1903.4	02 Jan 97 2200	5979.8	27.643
ME34 @ Halls Gulch	2196.3	02 Jan 97 2100	6459.9	29.077
JME41	90039	02 Jan 97 2100	352228	876.928
ME41-43	89983	02 Jan 97 2100	352369	876.928
ME42 @ Salomon Gulch	1599.4	02 Jan 97 2200	4368.1	33.616
JME43	91538	02 Jan 97 2100	356737	910.544
ME43-ME45	91329	02 Jan 97 2200	356986	910.544
ME44 ME @ Exchequer	979.44	02 Jan 97 2200	3118.3	27.552
JME45	92309	02 Jan 97 2200	360104	938.096
Exchequer	92229	02 Jan 97 2200	360235	938.096
ME46 Maxwell Cr	1919.4	02 Jan 97 2100	5695.5	32.630
JME47	1919.4	02 Jan 97 2100	5695.5	32.630
ME47-49	1911.9	02 Jan 97 2200	5710.6	32.630
ME48 Exchequer Bsn	1581.8	02 Jan 97 2200	7668.1	65.600
JME49	95723	02 Jan 97 2200	373614	1036.326

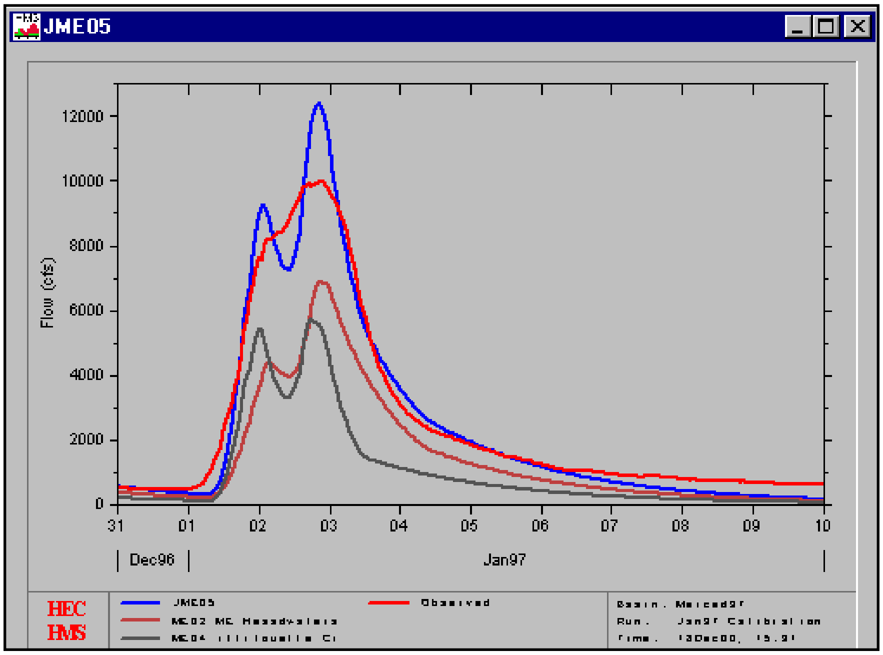
HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Merced River Basin
December 1996 - January 1997 Event



JME47 – Exchequer



JME17 – Bridalveil Creek

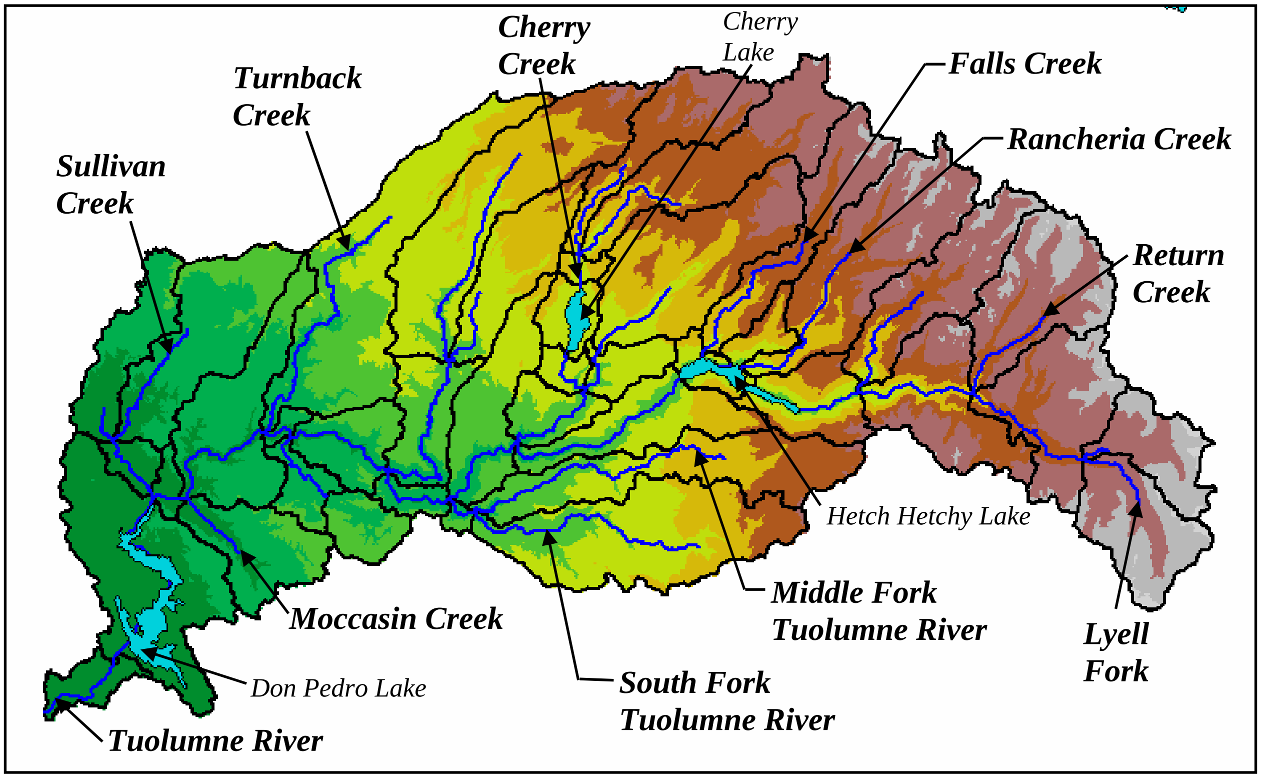


JME05 – Below Illilouette Creek

HEC-HMS Subbasin Parameters
Merced River Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
ME08 Tenaya Cr	3	0.6	0.25	2.5	0.03	0
ME02 ME Headswaters	3	0.6	0.25	2.0	0.05	0
ME12 Yosemite Cr	3	0.6	0.25	2.5	0.03	0
ME10 YosemiteVillage	12	0.6	0.25	2.5	0.03	0
ME16 Bridalveil Cr	12	0.6	0.25	2.5	0.03	0
ME06 Sentinel Dome	12	0.6	0.25	2.5	0.03	0
ME40 Lower NFk ME	12	0.6	0.25	3.0	0.02	0
ME38 Upper NFk ME	12	0.6	0.25	3.0	0.02	0
ME14 El Capitain	12	0.6	0.25	2.5	0.03	0
ME34 @ Halls Gulch	12	0.6	0.25	3.0	0.02	0
ME36 Bull Cr	12	0.6	0.25	3.0	0.02	0
ME48 Exchequer Bsn	12	0.6	0.25	3.0	0.02	25
ME18 El Portal	12	0.6	0.25	3.0	0.02	0
ME04 illilouette Cr	3	0.6	0.25	2.0	0.05	0
ME30 Lower South Fk	12	0.6	0.25	2.5	0.03	0
ME22 Lower Big Cr	12	0.6	0.25	2.5	0.03	0
ME44 ME @ Exchequer	12	0.6	0.25	3.0	0.02	5
ME26 Middle SFk ME	12	0.6	0.25	2.5	0.03	0
ME28 Devil Gulch	12	0.6	0.25	2.5	0.03	0
ME24 Upper SFk ME	5	0.6	0.25	2.5	0.03	0
ME42 @ Salomon Gulch	12	0.6	0.25	3.0	0.02	0
ME46 Maxwell Cr	12	0.6	0.25	3.0	0.02	0
ME32 @ Briceburg	12	0.6	0.25	3.0	0.02	0
ME20 Upper Big Cr	5	0.6	0.25	2.5	0.03	0

Tuolumne River Basin



HEC-GeoHMS Subbasin Delineation

Tuolumne River

The Tuolumne River HMS model consists of a 1,534 square mile basin above Don Pedro Lake located in the mid-east portion of the San Joaquin Watershed. The basin model is divided into 40 subbasins and connected with 15 routing reaches. The observed hydrographs are the computed inflows into Cherry Lake, Lake Eleanor, and Don Pedro Lake and at gages at Mather and at the confluences with Upper Big Creek and Cherry Creek. The computed peak inflow into Don Pedro Lake for the 1997 event was larger than the 1995 event (120,000 cfs vs. 90,000 cfs).

While the adopted value for TC was computed using the Group 1 equations, the value of R was set to 2.3TC. This revision was made so the shape of the computed hydrograph would better resemble the observed hydrograph. The generic equation to compute the reach travel time (Muskingum K) was not used because the reach travel times were too short; thus, causing the computed peaks to occur too early. Instead, the reach travel time (K) was computed knowing the reach length and average velocity. The average velocity was computed using Manning's equation. The Manning's "n" value was estimated with Jarrett's equation, and the hydraulic radius was estimated from the American River equation, which was developed from a regression of field data (the American River equation was used because it was felt that it would represent the Tuolumne system the best). Of the 15 routing reaches, only 2 reaches used the Muskingum routing technique. The other 13 reaches used the lag method since the travel time within each of those reaches was less than the one-hour time step used by the Muskingum method.

For this modeling effort, rather than attempt to predict how the Hetch Hetchy, Lake Eleanor, and Cherry Lake reservoirs were operated, the source and sink tools available in HMS were implemented. This technique allowed the observed hydrograph at the outlet of each of the reservoirs to be passed downstream. As pointed out in "Section 6.6.5, Reservoir Modeling" of the main report, HMS is fairly limited in how it models releases from reservoirs. Calibration efforts required different loss and baseflow parameters for different subbasins. Thirty-five percent impervious area was used for the Hetch Hetchy subbasin, thirty percent impervious area was used for the Cherry Lake subbasin, twenty-five percent impervious area was used for the Don Pedro Lake subbasin, and ten percent impervious area was used for the Tuolumne Canyon subbasin.

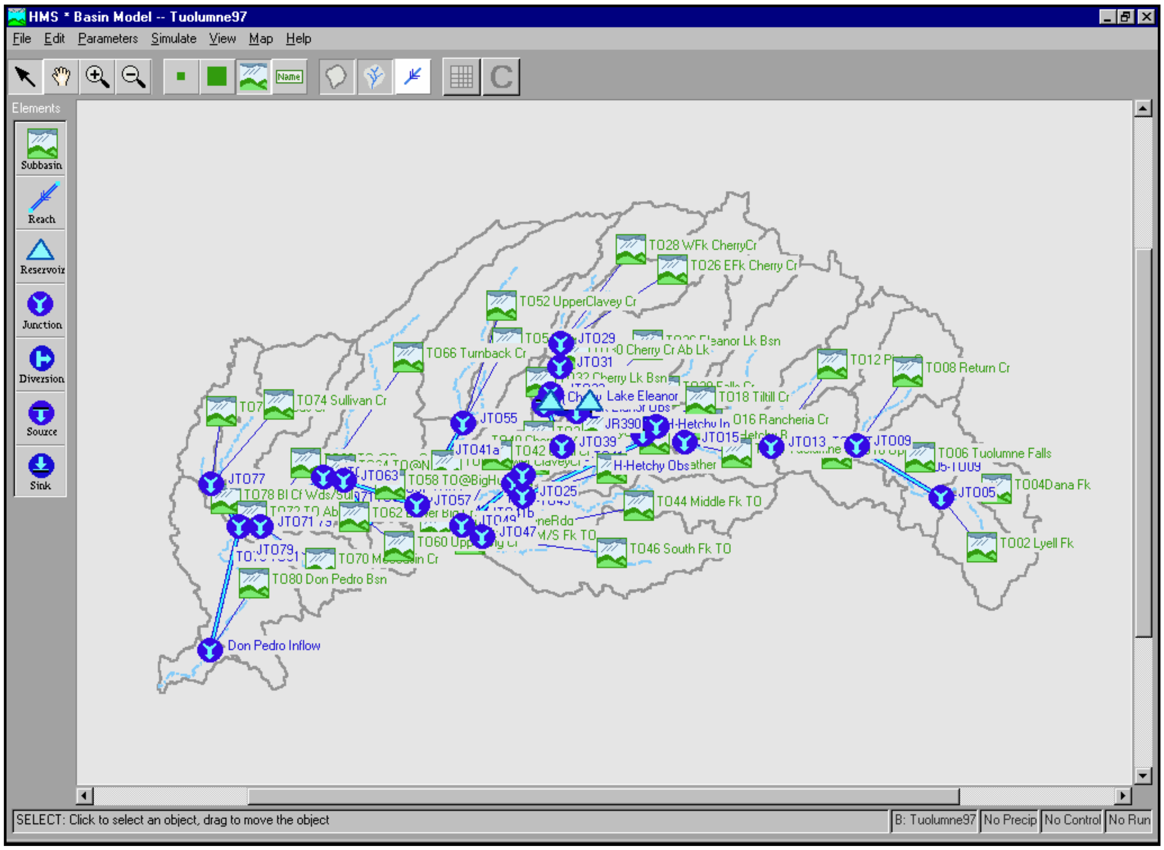
<u>Calibration of the 1995 Event:</u>

Calibration was performed on all six gages listed above. By using constant loss rates between 0.03 and 0.10 inches/hour and initial losses between 1.5 and 2.5 inches, the model calibrated reasonably well to the observed hydrographs. A recession ratio of 0.6 and a peak ratio of 0.27 defined the recession limb of the hydrographs. An initial baseflow of 3 cfs per square mile was used for the entire basin.

<u>Calibration of the 1997 Event:</u>

Calibration was performed on all six gages listed above. By using low constant loss rates between 0.001 and 0.04 inches/hour and initial losses between 0.5 and 2.5 inches, the model calibrated reasonably well to observed hydrographs. The model calibrated the best at the inflow to Don Pedro Lake. The baseflow recession parameters of 0.6 for the constant and 0.27 for the peak ratio worked best. An initial baseflow of 15 cfs per square mile was assumed to fit a smaller time window around the peak; 2 cfs per square mile baseflows were used in the headwater subbasins.

Tuolumne River Basin HEC-HMS Model Schematic



Tuolumne River Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Ave Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Initial TC $1.4(LL_{CA}/S^{1/2})^{.33}$ (Hr)	Initial R 1.5 TC (cfs/Hr)	Final TC $0.68(LL_{CA}/S^{1/2})^{.46}$ (Hr)	Final R 2.33 TC (Hr)
TO76 Woods Cr	31.24	16.90	7.68	168.96	9.99	3.0	4.5	2.0	4.6
TO28 WFk CherryCr	39.22	19.91	11.48	248.16	14.51	3.4	5.1	2.3	5.4
TO26 EFk Cherry Cr	62.08	25.49	13.96	221.76	23.90	4.0	6.0	2.9	6.8
TO24 @ Mather	39.73	19.60	9.85	290.40	11.33	3.1	4.7	2.1	4.8
TO12 Piute Cr	49.00	20.17	10.16	385.44	10.44	3.0	4.6	2.0	4.7
TO52 UpperClavey Cr	90.78	28.71	12.80	200.64	25.95	4.1	6.1	3.0	7.1
TO22 HetchHetchy Bsn	10.67	6.06	2.24	464.64	0.63	1.2	1.8	0.5	1.3
TO54 Reed Cr	39.26	18.67	8.95	264.00	10.29	3.0	4.5	2.0	4.6
TO08 Return Cr	56.80	15.39	8.09	390.72	6.30	2.6	3.9	1.6	3.7
TO34 CherryCr Bl Lk	6.85	5.55	2.59	390.72	0.73	1.3	1.9	0.6	1.4
TO38 Eleanor Cr	13.63	8.29	3.74	374.88	1.60	1.6	2.5	0.8	2.0
TO68 TO @Deer Cr	55.27	22.03	9.36	168.96	15.87	3.5	5.2	2.4	5.7
TO66 Turnback Cr	99.61	37.07	17.07	195.36	45.28	4.9	7.4	3.9	9.2
TO64 TO@NFk Hunter	3.41	3.76	1.89	686.40	0.27	0.9	1.4	0.4	0.9
TO40 CherryCr @ TO	17.14	8.71	4.18	359.04	1.92	1.7	2.6	0.9	2.1
TO74 Sullivan Cr	61.96	21.48	10.15	174.24	16.51	3.5	5.3	2.5	5.8
TO10 Upper TO Cyn	51.55	17.41	7.17	364.32	6.54	2.6	3.9	1.6	3.8
TO56 Lower ClaveyCr	27.85	16.77	10.15	258.72	10.58	3.0	4.6	2.0	4.7
TO58 TO@BigHumbug	24.40	9.50	4.35	237.60	2.68	1.9	2.9	1.1	2.5
TO78 Bl Cf Wds/Sul	8.52	5.57	2.64	89.76	1.55	1.6	2.4	0.8	1.9
TO42 Coral Cr	40.18	20.03	9.09	274.56	10.99	3.1	4.6	2.0	4.8
TO06 Tuolumne Falls	55.52	16.23	5.79	327.36	5.19	2.4	3.6	1.5	3.4
TO50 @ JawboneRdg	8.28	6.86	2.96	290.40	1.19	1.5	2.2	0.7	1.7
TO72 TO Ab DonPedro	5.56	5.29	1.83	311.52	0.55	1.1	1.7	0.5	1.2
TO04Dana Fk	29.12	11.83	5.56	274.56	3.97	2.2	3.3	1.3	3.0
TO44 Middle Fk TO	64.23	32.66	15.81	216.48	35.10	4.5	6.8	3.5	8.1
TO48 N/M/S Fk TO	2.70	3.37	1.30	834.24	0.15	0.8	1.1	0.3	0.7
TO62 Lower Big Cr	13.23	8.50	5.32	332.64	2.48	1.9	2.8	1.0	2.4
TO46 South Fk TO	87.58	27.78	13.95	242.88	24.86	4.0	6.1	3.0	6.9
TO02 Lyell Fk	42.69	13.48	6.58	327.36	4.91	2.4	3.5	1.4	3.3
TO70 Moccasin Cr	35.93	15.89	7.60	195.36	8.64	2.9	4.3	1.8	4.3
TO60 Upper Big Cr	15.99	7.92	3.81	110.88	2.86	2.0	3.0	1.1	2.6
TO20 Falls Cr	44.07	23.30	13.43	311.52	17.73	3.6	5.4	2.6	5.9
TO16 Rancheria Cr	75.55	25.25	13.74	290.40	20.36	3.8	5.7	2.7	6.3
TO18 Tiltill Cr	10.19	7.43	3.40	538.56	1.09	1.4	2.2	0.7	1.6
TO14 Tuolumne Cyn	28.93	11.81	5.08	501.60	2.68	1.9	2.9	1.1	2.5
TO32 Cherry Lk Bsn	14.20	5.76	2.86	401.28	0.82	1.3	2.0	0.6	1.4
TO36 Eleanor Lk Bsn	77.43	20.90	12.10	258.72	15.72	3.5	5.2	2.4	5.6
TO30 Cherry Cr Ab Lk	4.38	4.21	1.04	612.48	0.18	0.8	1.2	0.3	0.7
TO80 Don Pedro Bsn	88.86	20.13	8.12	58.08	21.44	3.8	5.8	2.8	6.5

Tuolumne River Reach Parameters

Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Cum Drainage Area (from GeoHms) A (Sq. Mi.)	American River Field Reg. Eqa R = 0.0136A + 7.5649	Jarret's Equation $n = .39S^{.38}R^{-.16}$	Manning's Velocity v (ft/s)	Travel Time K Hrs	Lag (Min)
TO05-TO09	10.46	0.0439	210	10.42	0.082	18.22	0.84	51
TO09-TO13	8.69	0.0402	297	11.60	0.078	19.71	0.65	39
TO23-TO41	13.97	0.0185	478	14.07	0.056	21.05	0.97	
TO29-TO31	2.48	0.0323	103	8.97	0.074	15.51	0.23	14
TO33-TO39	3.77	0.0416	123	9.24	0.082	16.39	0.34	20
TO37-TO39	3.05	0.059	85	8.72	0.094	16.30	0.27	16
TO39-TO41	7.36	0.0358	225	10.62	0.075	18.07	0.60	36
TO41-TO49	7.19	0.0195	760	17.90	0.055	25.86	0.41	24
TO47-TO49	2.42	0.0791	153	9.65	0.103	18.35	0.19	12
TO49-TO57	6.02	0.008	927	20.17	0.039	25.64	0.34	21
TO55-TO57	15.05	0.0239	145	9.54	0.066	15.74	1.40	
TO57-TO63	7.70	0.0061	1107	22.62	0.034	27.29	0.41	25
TO61-TO63	6.01	0.0525	26	7.92	0.091	14.84	0.59	36
TO63-TO67	2.36	0.0065	1145	23.14	0.035	28.02	0.12	7
TO67-TO71	9.06	0.0007	1276	24.92	0.015	22.80	0.58	35

Routing parameters based on field observations and regression

HEC-HMS Summary of Results
Tuolumne River Basin: March 1995 Event

Project	: Tuolumne		Run Name	: Mar95 Calibration	
Start of Run	: 08Mar95	0000	Basin Model	:	Tuolumne95
End of Run	: 13Mar95	1200	Met. Model	:	Mar95
Execution Time	: 31May00	1353	Control Specs.	:	Mar95

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
TO76 Woods Cr	3009.5	11 Mar 95 0200	7888.4	31.237
TO74 Sullivan Cr	5374.9	11 Mar 95 0200	15620	61.959
JTO77	8384.4	11 Mar 95 0200	23508	93.196
TO77-TO79	8131.7	11 Mar 95 0200	23470	93.196
TO60 Upper Big Cr	1767.2	10 Mar 95 1500	4443.8	15.993
TO61-TO63	1662.0	10 Mar 95 1600	4433.2	15.993
TO46 South Fk TO	6456.0	09 Mar 95 2300	20636	87.580
TO44 Middle Fk TO	2812.8	10 Mar 95 2300	8983.7	64.235
JTO47	9126.3	09 Mar 95 2200	29620	151.815
TO47-TO49	9092.9	09 Mar 95 2300	29605	151.815
H-Hetchy Obs	308.00	10 Mar 95 1900	2060.0	454.100
TO23-TO41	308.00	10 Mar 95 2000	2057.6	454.100
TO24 @ Mather	2773.2	10 Mar 95 2100	6842.5	39.729
JTO25	3081.2	10 Mar 95 2100	8900.2	493.829
Cherry Lk Obs	48.000	10 Mar 95 2000	196.11	119.900
TO33-TO39	47.600	10 Mar 95 2000	195.96	119.900
Lk Elanor Obs	48.000	09 Mar 95 1800	150.96	77.400
TO37-TO39	45.300	09 Mar 95 1800	150.90	77.400
TO34 CherryCr Bl Lk	766.44	10 Mar 95 1900	1905.9	6.846
TO38 Eleanor Cr	1484.6	10 Mar 95 1900	3471.8	13.628
JTO39	2333.9	10 Mar 95 1900	5724.6	217.774
TO39-TO41	2288.4	10 Mar 95 2000	5710.8	217.774
TO40 CherryCr @ TO	1942.2	10 Mar 95 1900	5164.3	17.136
JTO41a	4185.8	10 Mar 95 1900	10875	234.910
JTO41b	7213.6	10 Mar 95 2000	19775	728.739
TO41-TO49	7182.0	10 Mar 95 2000	19753	728.739
TO48 N/M/S Fk TO	592.85	10 Mar 95 2200	1615.2	2.703
TO42 Coral Cr	4648.6	10 Mar 95 2300	14294	40.181
JTO49	20386	10 Mar 95 2300	65268	923.438
TO49-TO57	20371	10 Mar 95 2300	65214	923.438
TO52 UpperClavey Cr	4200.4	10 Mar 95 2000	12813	90.776
TO54 Reed Cr	2357.5	10 Mar 95 1500	7145.2	39.259
JTO55	6501.4	10 Mar 95 1500	19958	130.035
TO55-TO57	6455.2	10 Mar 95 1600	19898	130.035

… Continued …

HEC-HMS Summary of Results
Tuolumne River Basin: March 1995 Event
(Continued)

Project : Tuolumne Run Name : Mar95 Calibration

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
TO50 @ JawboneRdg	1210.8	10 Mar 95 2200	3590.8	8.279
TO56 Lower ClaveyCr	3027.5	10 Mar 95 2300	9258.8	27.852
JTO57	30411	10 Mar 95 2300	97962	1089.604
TO57-TO63	30410	10 Mar 95 2300	97856	1089.604
TO62 Lower Big Cr	1992.7	10 Mar 95 1500	5287.5	13.229
TO58 TO @ BigHumbug	3338.9	10 Mar 95 1500	9189.1	24.401
JTO63	36082	10 Mar 95 2300	116766	1143.227
TO63-TO67	36027	10 Mar 95 2300	116732	1143.227
TO64 TO@NFk Hunter	623.44	10 Mar 95 1400	1626.7	3.407
TO66 Turnback Cr	7091.0	10 Mar 95 2300	20732	99.607
JTO67	43417	10 Mar 95 2300	139091	1246.241
TO67-TO71	43095	10 Mar 95 2300	138854	1246.241
TO68 TO @Deer Cr	5159.3	10 Mar 95 1500	15627	55.267
TO70 Moccasin Cr	3886.4	10 Mar 95 1500	11301	35.926
JTO71	51660	10 Mar 95 2300	165782	1337.434
TO71-TO79	51042	10 Mar 95 2400	165541	1337.434
TO78 Bl Cf Wds/Sul	936.44	10 Mar 95 1200	2468.2	8.522
TO72 TO Ab DonPedro	815.00	10 Mar 95 1400	2140.2	5.563
JTO79	59173	10 Mar 95 2400	193619	1444.715
TO79-TO81	59023	10 Mar 95 2400	193327	1444.715
TO80 Don Pedro Bsn	6601.0	10 Mar 95 1600	21472	88.857
Don Pedro Inflow	65121	10 Mar 95 2400	214800	1533.572
TO28 WFk CherryCr	152.77	09 Mar 95 2000	634.82	39.224
TO26 EFk Cherry Cr	241.19	09 Mar 95 2000	1135.6	62.076
JTO29	393.96	09 Mar 95 2000	1770.4	101.300
TO29-TO31	393.96	09 Mar 95 2100	1792.3	101.300
TO30 Cherry Cr Ab Lk	384.79	09 Mar 95 1900	736.12	4.378
JTO31	667.19	09 Mar 95 1900	2528.4	105.678
TO31-TO33	616.88	09 Mar 95 2000	2534.6	105.678
TO32 Cherry Lk Bsn	1578.5	10 Mar 95 1200	5072.1	14.200
JTO33	2149.0	09 Mar 95 2000	7606.7	119.878
Cherry Lake	1455.4	10 Mar 95 2200	7025.5	119.878
Sink-2	1455.4	10 Mar 95 2200	7025.5	119.878
TO02 Lyell Fk	128.07	07 Mar 95 2400	530.23	42.689
TO04Dana Fk	124.39	11 Mar 95 1500	400.22	29.122
JTO05	241.12	11 Mar 95 1500	930.44	71.811
TO05-TO09	238.41	11 Mar 95 1600	942.77	71.811
TO08 Return Cr	170.39	07 Mar 95 2400	653.33	56.798
TO06 Tuolumne Falls	518.82	11 Mar 95 1600	1001.4	55.522

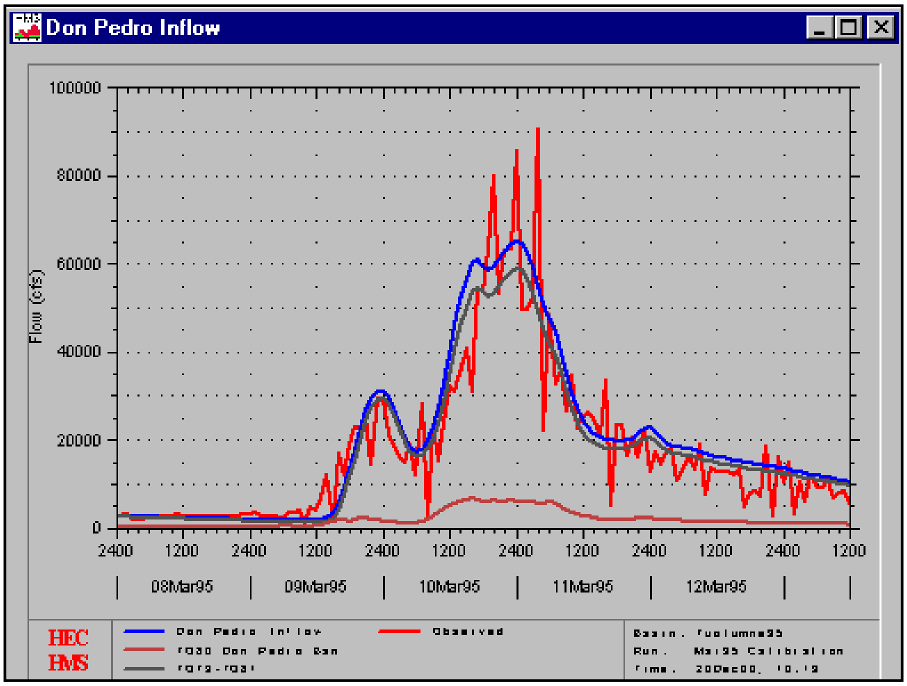
… Continued …

HEC-HMS Summary of Results
Tuolumne River Basin: March 1995 Event
(Continued)

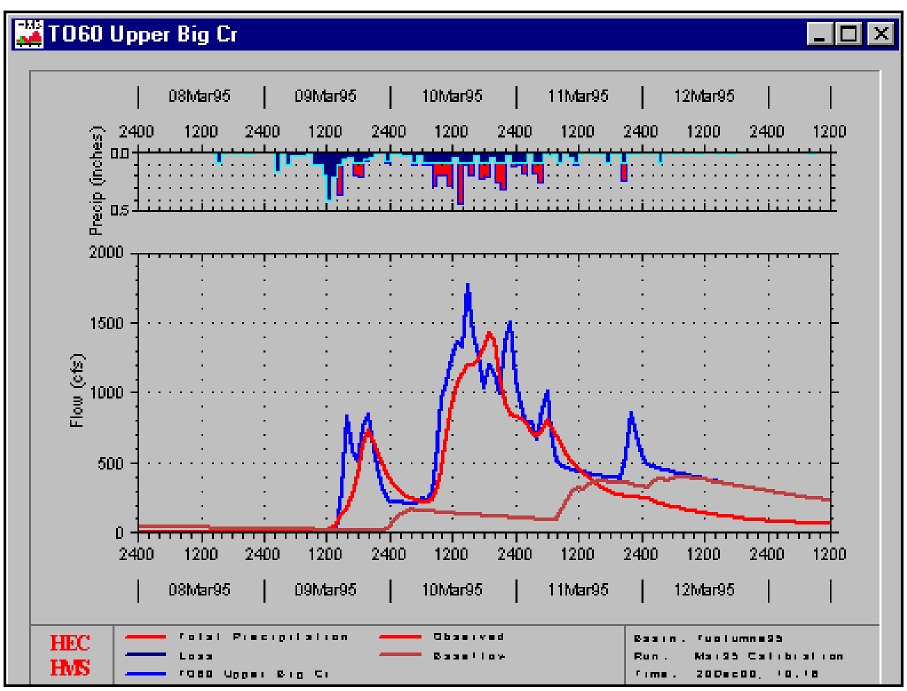
Project : Tuolumne Run Name : Mar95 Calibration

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
JTO09	833.39	11 Mar 95 1600	2597.5	184.131
TO09-TO13	770.96	11 Mar 95 1700	2619.8	184.131
TO12 Piute Cr	374.12	11 Mar 95 1600	1235.9	49.001
TO10 Upper TO Cyn	916.73	11 Mar 95 2200	2347.4	51.548
JTO13	1452.0	11 Mar 95 1700	6203.1	284.680
TO13-TO15	1452.0	11 Mar 95 1800	6250.2	284.680
TO14 Tuolumne Cyn	1598.6	09 Mar 95 2100	4578.3	28.929
JTO15	2278.5	09 Mar 95 2100	10828	313.609
TO22 HetchHetchy Bsn	1433.4	10 Mar 95 1800	4294.8	10.674
TO20 Falls Cr	157.29	10 Mar 95 1800	734.68	44.066
TO18 Tiltill Cr	365.87	09 Mar 95 2000	1011.5	10.188
TO16 Rancheria Cr	250.53	09 Mar 95 2100	1254.2	75.550
JR390	4052.8	09 Mar 95 2000	18124	454.087
H-Hetchy In	4052.8	09 Mar 95 2000	18124	454.087
TO36 Eleanor Lk Bsn	922.70	10 Mar 95 1900	2947.4	77.429
Lake Eleanor	230.55	11 Mar 95 2100	2161.8	77.429
Sink-1	230.55	11 Mar 95 2100	2161.8	77.429

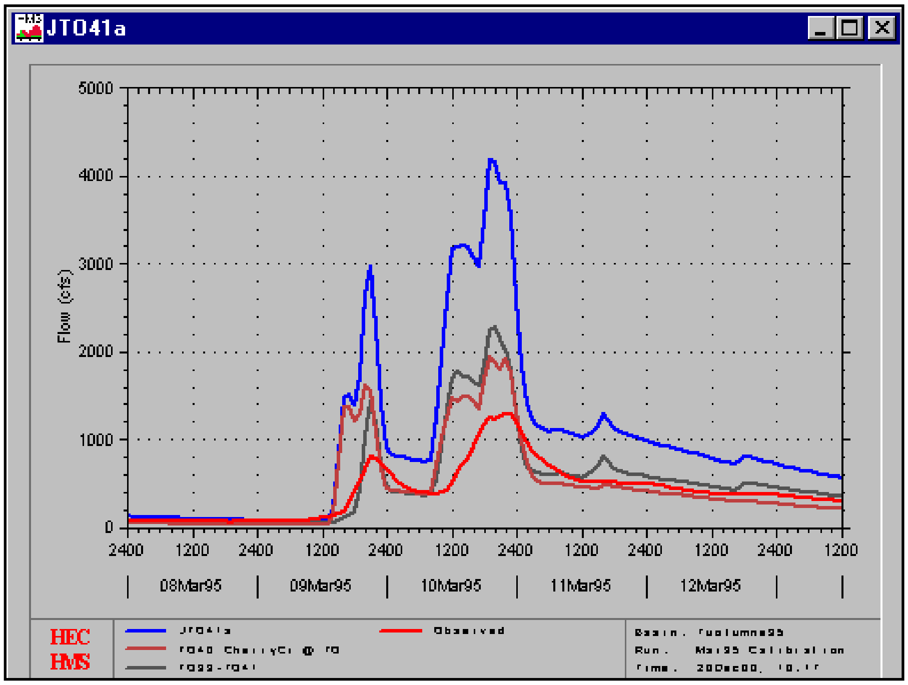
HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Tuolumne River Basin
March 1995 Event



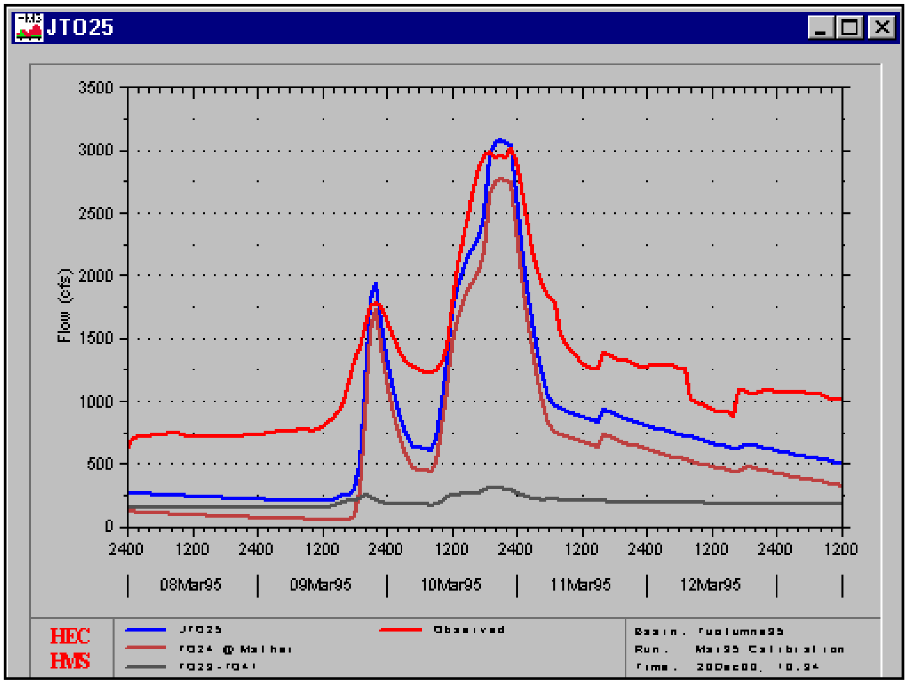
Don Pedro Reservoir Inflow



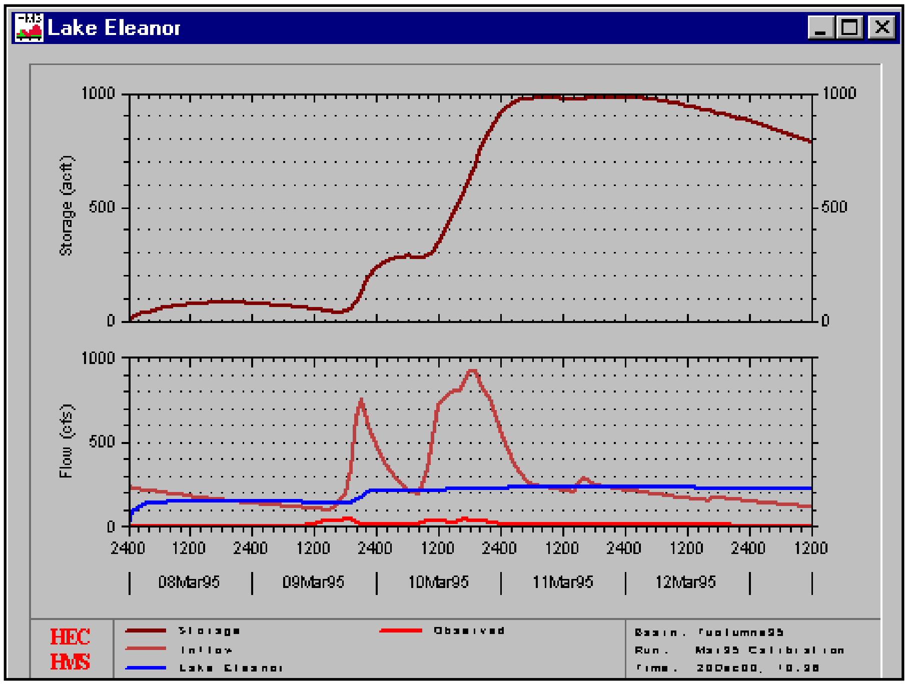
TO60 – Upper Big Creek



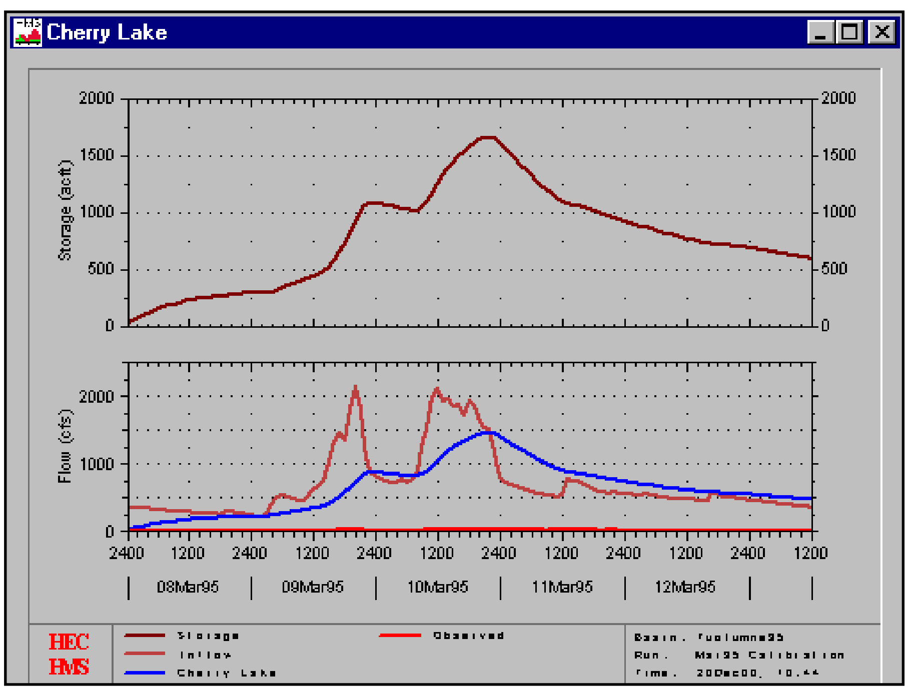
JT041a – Gage 11278300, Cherry Creek Near Early Intake



JT025 – Gage 11276900, Tuolumne River Below Early Intake Near Mather, CA



Lake Eleanor



Cherry Lake

HEC-HMS Subbasin Parameters
Tuolumne River Basin: March 1995 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
TO76 Woods Cr	3	0.6	0.27	1.5	.03	0
TO28 WFk CherryCr	3	0.6	0.27	2.5	.10	0
TO26 EFk Cherry Cr	3	0.6	0.27	2.5	.10	0
TO24 @ Mather	3	0.6	0.27	2.5	.10	0
TO12 Piute Cr	3	0.6	0.27	2.5	.10	0
TO52 UpperClavey Cr	3	0.6	0.27	2.0	.04	0
TO22 HetchHetchy Bsn	3	0.6	0.27	2.5	.10	35
TO54 Reed Cr	3	0.6	0.27	2.0	.04	0
TO08 Return Cr	3	0.6	0.27	2.5	.10	0
TO34 CherryCr Bl Lk	3	0.6	0.27	2.5	.10	0
TO38 Eleanor Cr	3	0.6	0.27	2.5	.10	0
TO68 TO @Deer Cr	3	0.6	0.27	1.5	.03	0
TO66 Turnback Cr	3	0.6	0.27	2.0	.04	0
TO64 TO @NFk Hunter	3	0.6	0.27	1.5	.03	0
TO40 CherryCr @ TO	3	0.6	0.27	1.5	.10	0
TO74 Sullivan Cr	3	0.6	0.27	2.5	.03	0
TO10 Upper TO Cyn	3	0.6	0.27	1.5	.10	0
TO56 Lower ClaveyCr	3	0.6	0.27	1.5	.03	0
TO58 TO @BigHumbug	3	0.6	0.27	1.5	.03	0
TO78 Bl Cf Wds/Sul	3	0.6	0.27	1.5	.03	0
TO42 Coral Cr	3	0.6	0.27	1.5	.03	0
TO06 Tuolumne Falls	3	0.6	0.27	2.5	.10	0
TO50 @ JawboneRdg	3	0.6	0.27	1.5	.03	0
TO72 TO Ab DonPedro	3	0.6	0.27	1.5	.03	0
TO04 Dana Fk	3	0.6	0.27	2.5	.10	0
TO44 Middle Fk TO	3	0.6	0.27	2.0	.08	0
TO48 N/M/S Fk TO	3	0.6	0.27	1.5	.03	0
TO62 Lower Big Cr	3	0.6	0.27	1.5	.03	0
TO46 South Fk TO	3	0.6	0.27	2.0	.08	0
TO02 Lyell Fk	3	0.6	0.27	2.5	.10	0
TO70 Moccasin Cr	3	0.6	0.27	1.5	.03	0
TO60 Upper Big Cr	3	0.6	0.27	1.5	.08	0
TO20 Falls Cr	3	0.6	0.27	2.5	.10	0
TO16 Rancheria Cr	3	0.6	0.27	2.5	.10	0
TO18 Tiltill Cr	3	0.6	0.27	2.5	.10	0
TO14 Tuolumne Cyn	3	0.6	0.27	2.5	.10	10
TO32 Cherry Lk Bsn	3	0.6	0.27	2.5	.10	30
TO36 Eleanor Lk Bsn	3	0.6	0.27	2.5	.10	0
TO30 Cherry Cr Ab Lk	3	0.6	0.27	2.5	.10	0
TO80 Don Pedro Bsn	3	0.6	0.27	1.5	.03	25

HEC-HMS Summary of Results
Tuolumne River Basin: December 1996 - January 1997 Event

Project	: Tuolumne		Run Name	: Jan97 Calibration	
Start of Run	: 31Dec96	0000	Basin Model	:	Tuolumne97
End of Run	: 08Jan97	2400	Met. Model	:	Jan97
Execution Time	: 14Jan01	0955	Control Specs.	:	Jan97

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
TO76 Woods Cr	1418.8	02 Jan 97 1500	4485.4	31.237
TO74 Sullivan Cr	3001.0	02 Jan 97 1500	9729.4	61.959
JTO77	4419.8	02 Jan 97 1500	14215	93.196
TO77-TO79	4315.6	02 Jan 97 1600	14268	93.196
TO60 Upper Big Cr	2480.9	02 Jan 97 1600	7374.9	15.993
TO61-TO63	2441.9	02 Jan 97 1700	7384.5	15.993
TO46 South Fk TO	19118	01 Jan 97 2000	77404	87.580
TO44 Middle Fk TO	12198	01 Jan 97 2000	50285	64.235
JTO47	31316	01 Jan 97 2000	127689	151.815
TO47-TO49	31292	01 Jan 97 2000	127707	151.815
H-Hetchy Obs	16000	03 Jan 97 1400	107529	454.100
TO23-TO41	16000	03 Jan 97 1500	108064	454.100
TO24 @ Mather	4429.3	01 Jan 97 1900	13900	39.729
JTO25	16912	03 Jan 97 1500	121963	493.829
Cherry Lk Obs	2430.0	02 Jan 97 1900	12031	119.900
TO33-TO39	2426.0	02 Jan 97 1900	12007	119.900
Lk Elanor Obs	19500	02 Jan 97 1200	67381	77.400
TO37-TO39	19370	02 Jan 97 1400	67377	77.400
TO34 CherryCr Bl Lk	2013.7	02 Jan 97 1600	7780.3	6.846
TO38 Eleanor Cr	4166.8	01 Jan 97 1400	14607	13.628
JTO39	24855	02 Jan 97 1500	101771	217.774
TO39-TO41	24695	02 Jan 97 1600	101729	217.774
TO40 CherryCr @ TO	4555.7	02 Jan 97 1600	17258	17.136
JTO41a	29251	02 Jan 97 1600	118987	234.910
JTO41b	40555	02 Jan 97 1700	240951	728.739
TO41-TO49	39887	02 Jan 97 1700	241152	728.739
TO48 N/M/S Fk TO	798.79	02 Jan 97 1500	2357.0	2.703
TO42 Coral Cr	6729.2	02 Jan 97 1700	25789	40.181
JTO49	76210	02 Jan 97 1800	397005	923.438
TO49-TO57	76093	02 Jan 97 1800	397193	923.438
TO52 UpperClavey Cr	12098	01 Jan 97 1900	47839	90.776
TO54 Reed Cr	6628.3	01 Jan 97 1700	24218	39.259
JTO55	18656	01 Jan 97 1900	72057	130.035
TO55-TO57	18707	01 Jan 97 2000	72264	130.035

… Continued …

HEC-HMS Summary of Results
Tuolumne River Basin: December 1996 - January 1997 Event
(Continued)

Project : Tuolumne   Run Name : Jan97 Calibration

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
TO50 @ JawboneRdg	1842.5	02 Jan 97 1600	5413.4	8.279
TO56 Lower ClaveyCr	4175.6	02 Jan 97 1700	13751	27.852
JTO57	97868	02 Jan 97 1800	488622	1089.604
TO57-TO63	97121	02 Jan 97 1800	488941	1089.604
TO62 Lower Big Cr	1537.4	02 Jan 97 1600	4226.4	13.229
TO58 TO @ BigHumbug	3227.8	02 Jan 97 1600	9209.6	24.401
JTO63	103348	02 Jan 97 1800	509761	1143.227
TO63-TO67	103063	02 Jan 97 1800	509846	1143.227
TO64 TO@NFk Hunter	411.33	02 Jan 97 1500	1327.3	3.407
TO66 Turnback Cr	7724.5	02 Jan 97 1700	34403	99.607
JTO67	111016	02 Jan 97 1800	545576	1246.241
TO67-TO71	110513	02 Jan 97 1900	546154	1246.241
TO68 TO @Deer Cr	3508.0	02 Jan 97 1700	11276	55.267
TO70 Moccasin Cr	2556.7	02 Jan 97 1600	7609.7	35.926
JTO71	116108	02 Jan 97 1900	565040	1337.434
TO71-TO79	115503	02 Jan 97 1900	565572	1337.434
TO78 Bl Cf Wds/Sul	465.80	02 Jan 97 1100	1295.4	8.522
TO72 TO Ab DonPedro	388.47	02 Jan 97 0900	1031.6	5.563
JTO79	119452	02 Jan 97 1900	582167	1444.715
TO79-TO81	118793	02 Jan 97 2000	582759	1444.715
TO80 Don Pedro Bsn	3558.6	02 Jan 97 1500	15706	88.857
Don Pedro Inflow	122003	02 Jan 97 2000	598465	1533.572
TO28 WFk CherryCr	6990.4	01 Jan 97 1900	23728	39.224
TO26 EFk Cherry Cr	9997.0	01 Jan 97 1900	36105	62.076
JTO29	16987	01 Jan 97 1900	59834	101.300
TO29-TO31	16987	01 Jan 97 2000	59837	101.300
TO30 Cherry Cr Ab Lk	1504.7	01 Jan 97 1300	4862.7	4.378
JTO31	17745	01 Jan 97 2000	64700	105.678
TO31-TO33	17658	01 Jan 97 2000	64700	105.678
TO32 Cherry Lk Bsn	4173.8	01 Jan 97 1400	15426	14.200
JTO33	20250	01 Jan 97 1900	80125	119.878
Cherry Lake	2864.9	04 Jan 97 1500	43493	119.878
Sink-2	2864.9	04 Jan 97 1500	43493	119.878
TO02 Lyell Fk	4815.8	02 Jan 97 1600	9857.9	42.689
TO04Dana Fk	4053.4	02 Jan 97 1600	7373.1	29.122
JTO05	8869.1	02 Jan 97 1600	17231	71.811
TO05-TO09	8726.2	02 Jan 97 1700	17233	71.811
TO08 Return Cr	5180.0	02 Jan 97 1500	13845	56.798
TO06 Tuolumne Falls	8717.5	02 Jan 97 1600	22072	55.522

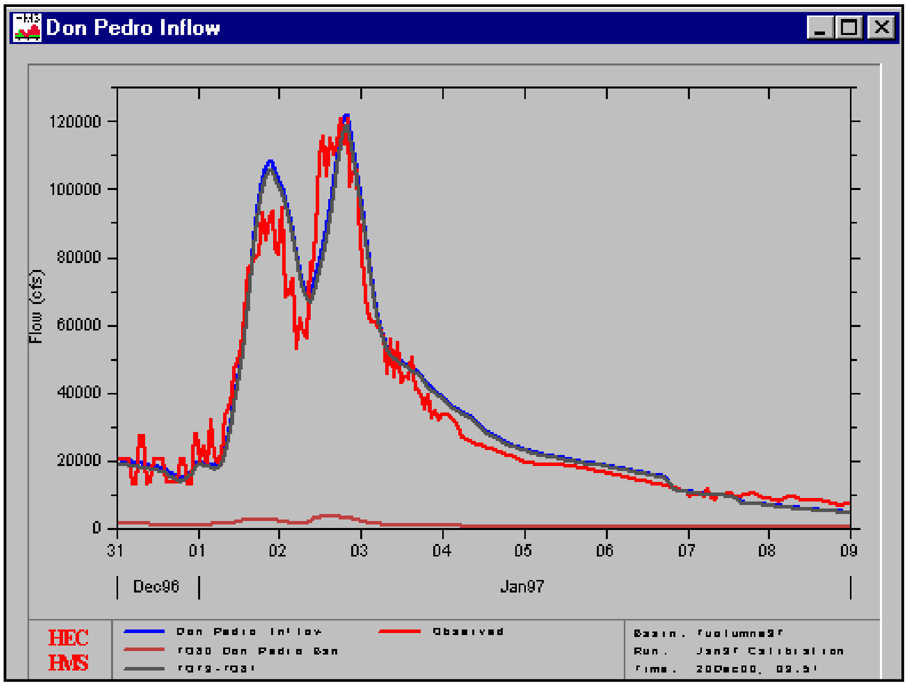
… Continued …

HEC-HMS Summary of Results
Tuolumne River Basin: December 1996 - January 1997 Event
(Continued)

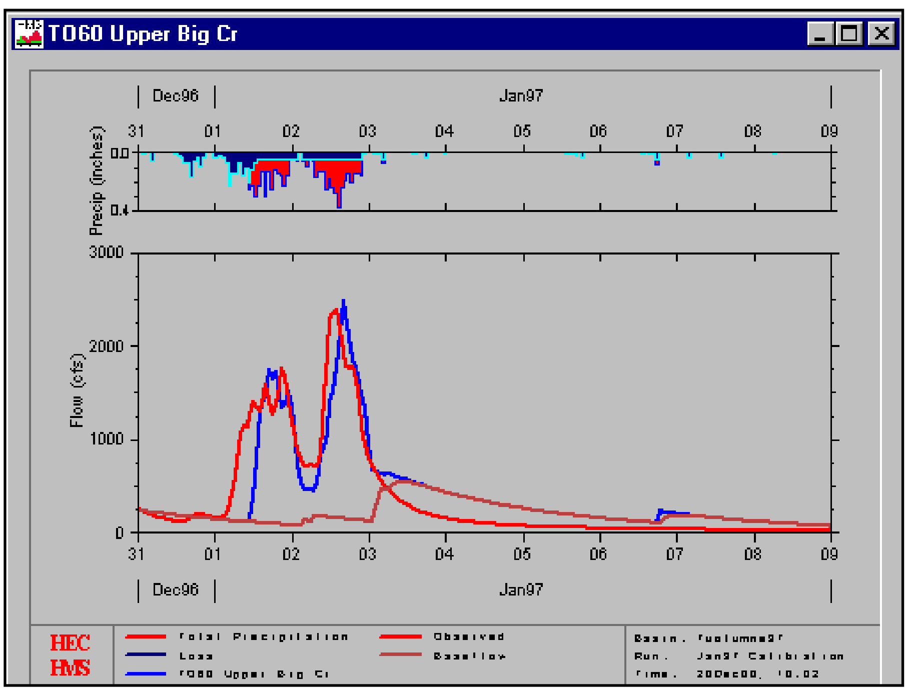
Project : Tuolumne Run Name : Jan97 Calibration

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
JTO09	21649	02 Jan 97 1700	53151	184.131
TO09-TO13	21595	02 Jan 97 1700	53155	184.131
TO12 Piute Cr	6154.3	02 Jan 97 1600	17803	49.001
TO10 Upper TO Cyn	6715.7	02 Jan 97 2300	24294	51.548
JTO13	32383	02 Jan 97 1700	95251	284.680
TO13-TO15	32383	02 Jan 97 1800	95256	284.680
TO14 Tuolumne Cyn	6742.7	02 Jan 97 1600	20844	28.929
JTO15	37395	02 Jan 97 1800	116099	313.609
TO22 HetchHetchy Bsn	3231.7	02 Jan 97 1500	10273	10.674
TO20 Falls Cr	5796.1	02 Jan 97 1600	17829	44.066
TO18 Tiltill Cr	2495.0	01 Jan 97 1400	7288.7	10.188
TO16 Rancheria Cr	9185.9	02 Jan 97 1600	28080	75.550
JR390	55973	02 Jan 97 1700	179570	454.087
H-Hetchy In	55973	02 Jan 97 1700	179570	454.087
TO36 Eleanor Lk Bsn	15909	01 Jan 97 1900	55915	77.429
Lake Eleanor	13962	01 Jan 97 2300	58049	77.429
Sink-1	13962	01 Jan 97 2300	58049	77.429

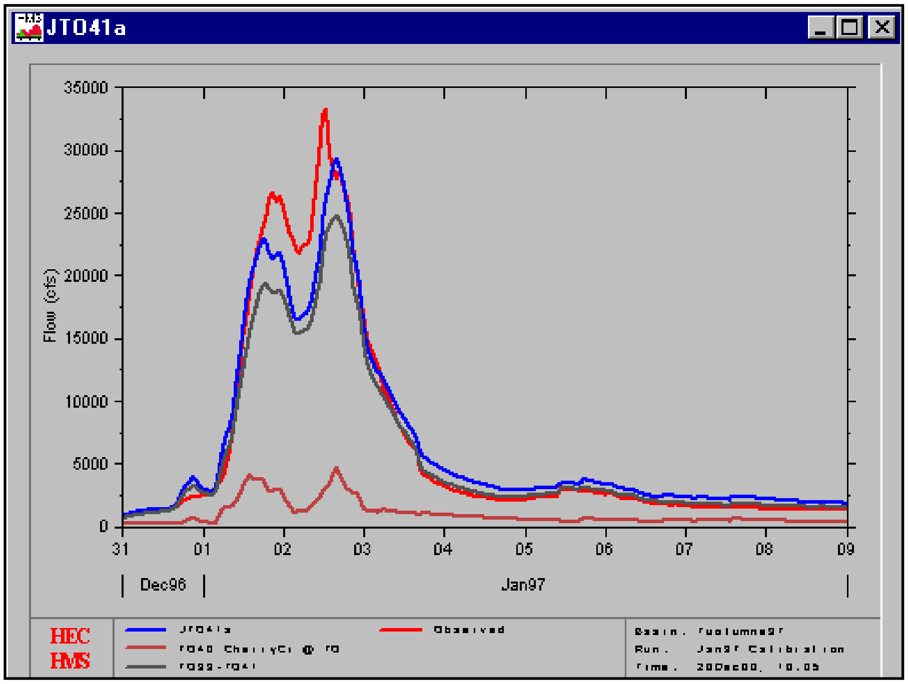
HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Tuolumne River Basin
December 1996 - January 1997 Event



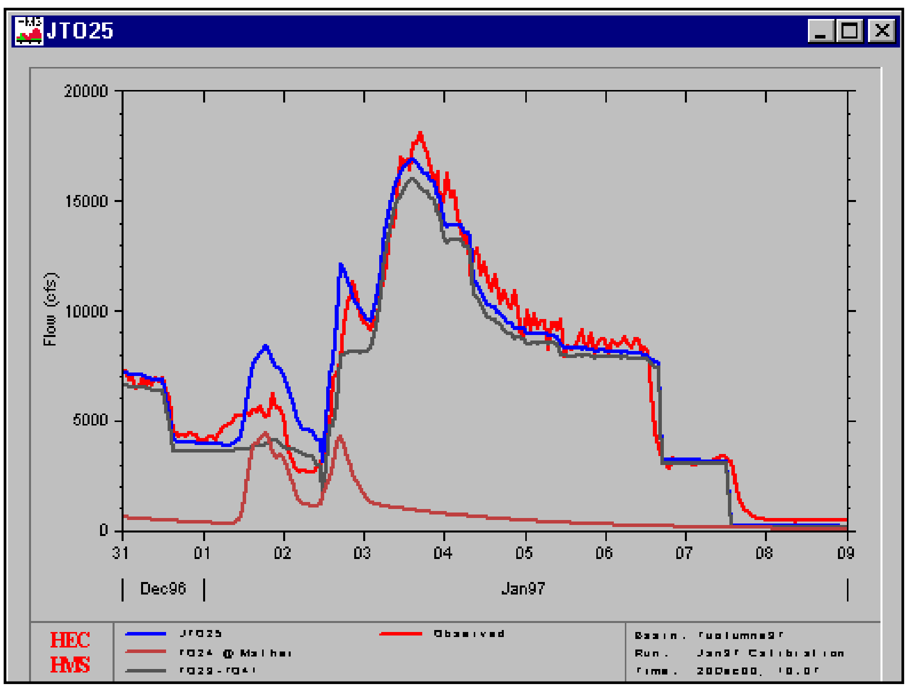
Don Pedro Reservoir Inflow



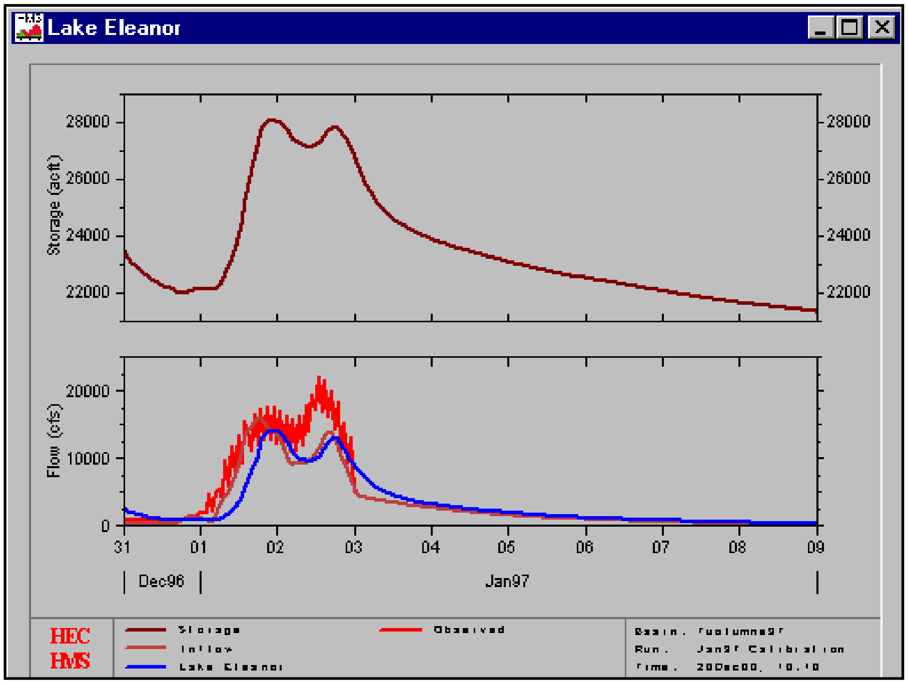
TO60 – Upper Big Creek



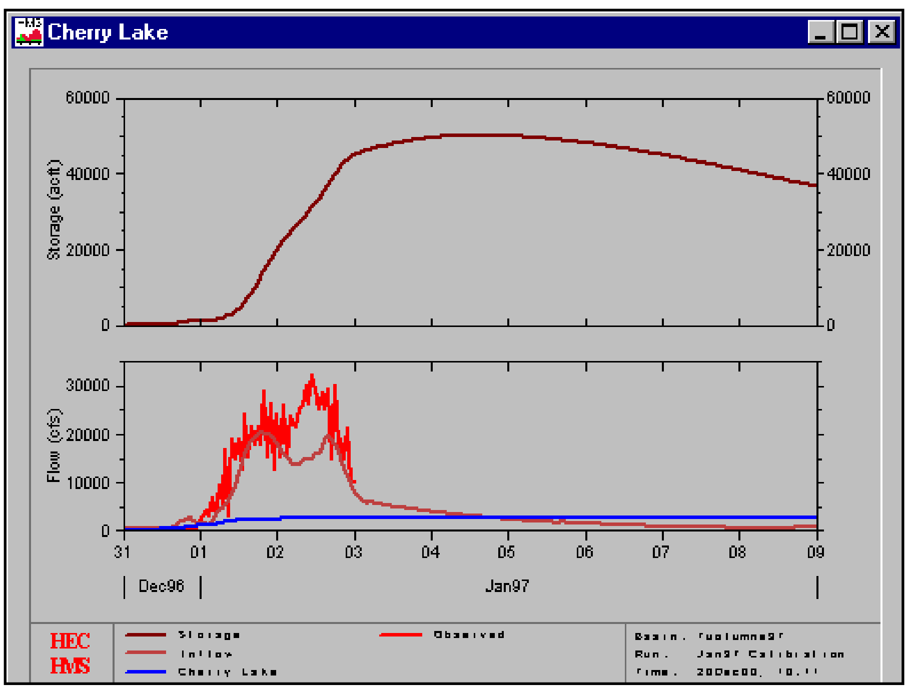
JT041a – Gage 11278300, Cherry Creek Near Early Intake



JT025 – Gage 11276900, Tuolumne River Below Early Intake Near Mather, CA



Lake Eleanor

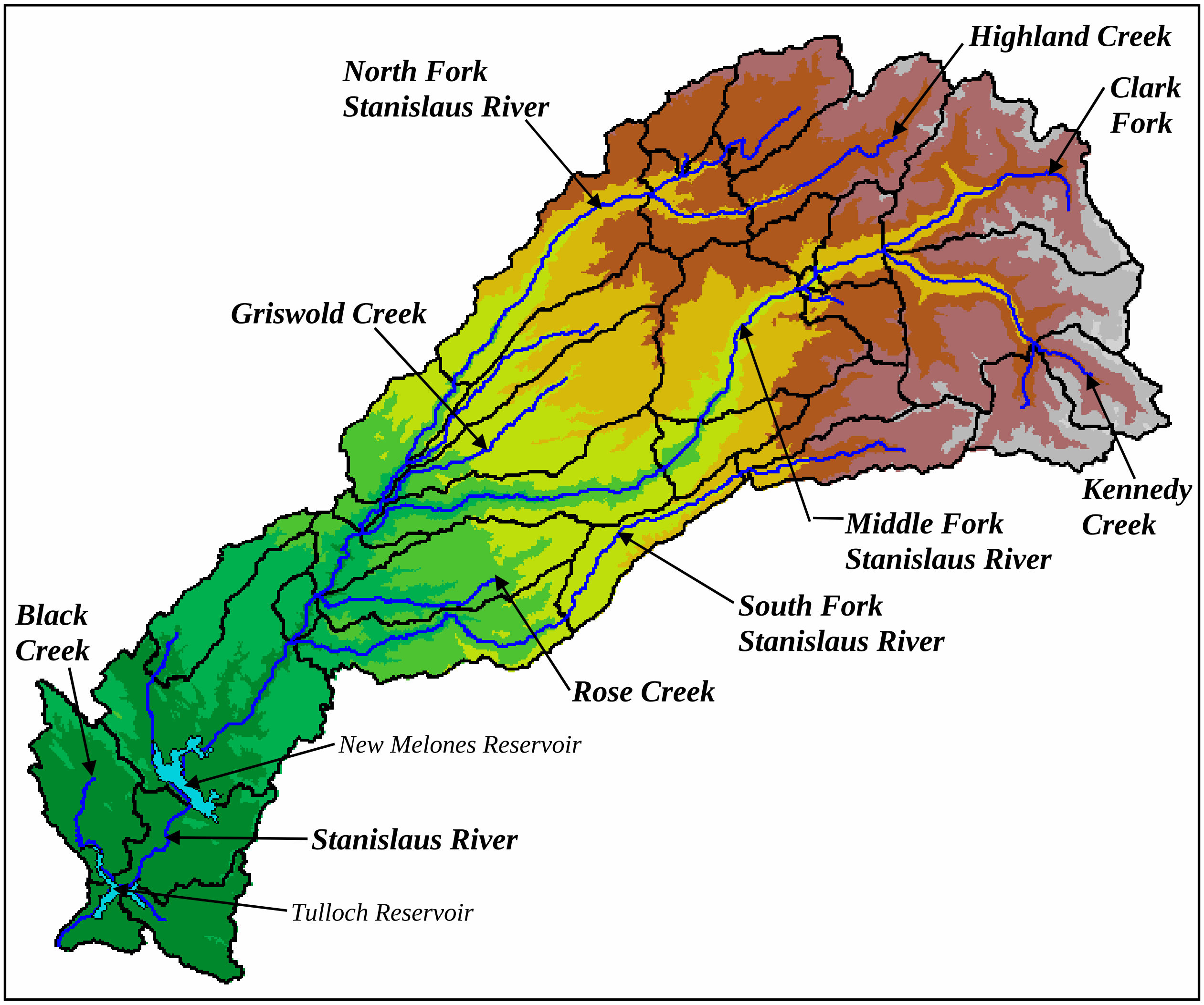


Cherry Lake

HEC-HMS Subbasin Parameters
Tuolumne River Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
TO76 Woods Cr	15	0.6	0.27	2.0	.04	0
TO28 WFk CherryCr	5	0.6	0.27	0.5	.001	0
TO26 EFk Cherry Cr	5	0.6	0.27	0.5	.001	0
TO24 @ Mather	15	0.6	0.27	2.5	.20	0
TO12 Piute Cr	2	0.6	0.27	2.5	.04	0
TO52 UpperClavey Cr	15	0.6	0.27	1.0	.04	0
TO22 HetchHetchy Bsn	2	0.6	0.27	2.5	.04	35
TO54 Reed Cr	15	0.6	0.27	1.0	.04	0
TO08 Return Cr	2	0.6	0.27	2.5	.04	0
TO34 CherryCr Bl Lk	15	0.6	0.27	0.5	.001	0
TO38 Eleanor Cr	15	0.6	0.27	0.5	.001	0
TO68 TO @Deer Cr	15	0.6	0.27	2.0	.04	0
TO66 Turnback Cr	15	0.6	0.27	1.0	.04	0
TO64 TO @NFk Hunter	15	0.6	0.27	0.5	.04	0
TO40 CherryCr @ TO	15	0.6	0.27	1.0	.001	0
TO74 Sullivan Cr	15	0.6	0.27	2.0	.04	0
TO10 Upper TO Cyn	2	0.6	0.27	2.5	.04	0
TO56 Lower ClaveyCr	15	0.6	0.27	2.0	.04	0
TO58 TO @BigHumbug	15	0.6	0.27	2.0	.04	0
TO78 Bl Cf Wds/Sul	15	0.6	0.27	2.0	.04	0
TO42 Coral Cr	15	0.6	0.27	0.5	.04	0
TO06 Tuolumne Falls	2	0.6	0.27	2.5	.04	0
TO50 @ JawboneRdg	15	0.6	0.27	2.0	.04	0
TO72 TO Ab DonPedro	15	0.6	0.27	2.0	.04	0
TO04 Dana Fk	2	0.6	0.27	2.5	.04	0
TO44 Middle Fk TO	15	0.6	0.27	1.0	.04	0
TO48 N/M/S Fk TO	15	0.6	0.27	2.0	.04	0
TO62 Lower Big Cr	15	0.6	0.27	2.0	.04	0
TO46 South Fk TO	15	0.6	0.27	1.5	.04	0
TO02 Lyell Fk	2	0.6	0.27	2.5	.04	0
TO70 Moccasin Cr	15	0.6	0.27	2.0	.04	0
TO60 Upper Big Cr	15	0.6	0.27	2.0	.04	0
TO20 Falls Cr	2	0.6	0.27	2.5	.04	0
TO16 Rancheria Cr	2	0.6	0.27	2.5	.04	0
TO18 Tiltill Cr	2	0.6	0.27	2.5	.04	0
TO14 Tuolumne Cyn	2	0.6	0.27	2.5	.04	10
TO32 Cherry Lk Bsn	5	0.6	0.27	0.5	.001	30
TO36 Eleanor Lk Bsn	5	0.6	0.27	0.5	.02	0
TO30 Cherry Cr Ab Lk	5	0.6	0.27	0.5	.001	0
TO80 Don Pedro Bsn	15	0.6	0.27	0.5	.04	25

Stanislaus River Basin



HEC-GeoHMS Subbasin Delineation

Stanislaus River

The Stanislaus River HMS model consists of a 986 square mile basin above Tulloch Reservoir located in the mid-east portion of the San Joaquin Watershed on the east side of the Sacramento-San Joaquin River Delta. The basin model is divided into 34 subbasins and connected with 17 routing reaches. The Stanislaus River basin has five headwater reservoirs and four reservoirs in the middle and lower portion of the basin. The observed hydrographs are: computed Inflows into Relief Reservoir, Donnell Reservoir, Beardsley Reservoir, New Melones Lake, Strawberry Reservoir, Union Reservoir, New Spicer Meadows Reservoir, and Tulloch Reservoir; and, at a gage on the South Fork near Long Barn. The computed peak inflow into New Melones Lake for the 1997 event was larger than the 1995 event (78,400 cfs vs. 31,700 cfs).

Using the adopted TC and R (Group 1) and Muskingum parameters, the computed hydrographs matched the observed hydrographs reasonably well. For reaches with a travel time of less than one hour, the lag method was used for routing. Muskingum was used for 9 routing reaches and lag was used for 8 routing reaches. For this modeling effort, rather than attempt to predict how the Donnell, Beardsley, New Melones, Tulloch, and Relief reservoirs were operated, the source and sink tools available in HMS were used. This technique allowed the observed outflow hydrographs from the three reservoirs to be passed downstream. As pointed out in “Section 6.6.5, Reservoir Modeling” of the main report, HMS is fairly limited in how it models releases from reservoirs. Calibration efforts at the nine reservoir locations required different loss and baseflow parameters for different subbasins. Ten percent impervious area was assumed for the subbasins that included lakes.

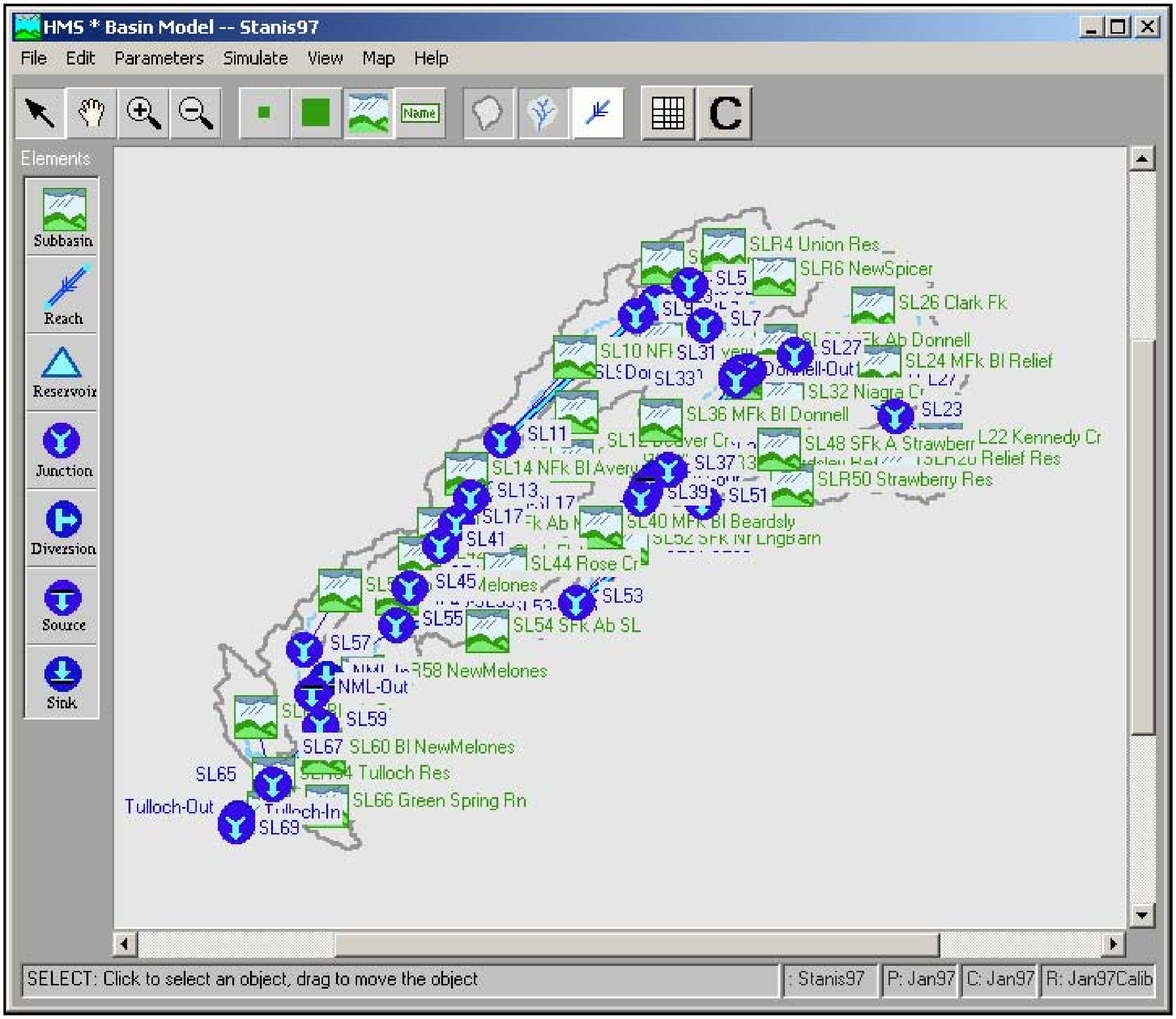
<u>Calibration of the 1995 Event:</u>

Calibration was not performed due to insufficient data for the Relief Reservoir inflow, but was performed for the other locations listed above. By using constant loss rates between 0.001 and 0.17 inches/hour and initial losses between 0.25 and 2.5 inches (most subbasins about 2 inches), the model calibrated well to observed hydrographs at Donnell Reservoir and Beardsley Reservoir. Only daily data were available for the observed inflow into the New Spicer Meadows Reservoir, Strawberry Reservoir and New Melones Reservoir and at the South Fork Near Long Barn gage, so the model was calibrated to fit the daily data reasonably well. An observed instantaneous peak was obtained to calibrate the model. The computed inflow into the Union Reservoir did not fit the observed data very well. The computed inflow showed two peaks around March 15, but the observed data showed no peak at all. At the inflow gage to the Tulloch Reservoir, the computed peak was close in magnitude to the observed peak, but off in time by about six hours. A recession ratio of 0.8 and a peak ratio of 0.2 defined the recession limb of the hydrograph. An initial baseflow of 1 - 3 cfs per square mile was assumed (most initial flows at 3 cfs per square mile).

Calibration of the 1997 Event:

By using constant loss rates between 0.01 and 0.17 inches/hour and initial losses between 1.5 and 2.5 inches (most subbasins about 1.5 inches), the model calibrated well to observed hydrographs at the Donnell Reservoir and Beardsley Reservoir. Only daily data were available for the observed inflow into the Relief Reservoir, New Spicer Meadows Reservoir, Strawberry Reservoir and New Melones Reservoir and at the South Fork Near Long Barn gage, so the model was calibrated to fit the daily data reasonably well. An observed instantaneous peak was obtained to calibrate the model. The computed inflow into the Union Reservoir fit the first observed peak well in magnitude, but was off in timing by about four hours. The generalized parameters for TC and R (Group 1) fit the observed hydrograph. The baseflow recession parameters of 0.8 for the constant and 0.2 for the peak ratio worked best. An initial baseflow of 1 to 3 cfs per square mile was assumed (most initial flows at 3 cfs per square mile).

Stanislaus River Basin HEC-HMS Model Schematic



Stanislaus River Basin Parameters

Subbasin Name	Area	Total Flow	Slope	Basin	Inital TC	Initial R	Regression TC	Regression R
		Flow Length	LFP	Factor	$1.4(LL_{CA}/S^{1/2})^{0.33}$	1.5 TC	$0.68(LL_{CA}/S^{1/2})^{0.46}$	1.5TC
	DA (Sq Mi)	L (Mi)	S (ft/mi)	$LL_{CA}/S^{1/2}$	(Hr)	(cfs/Hr)	(Hr)	(cfs/Hr)
SLR2 Lk Alpine	13.07	7.33	343.20	1.24	1.5	2.3	0.8	1.1
SL8 NFk Cfl Highland	22.63	6.94	322.08	1.13	1.5	2.2	0.7	1.1
SL26 Clark Fk	67.95	18.92	290.40	8.85	2.9	4.3	1.9	2.8
SL30 Darnelles Cr	10.09	5.90	570.24	0.53	1.1	1.7	0.5	0.8
SL28 MFk Ab Donnell	15.19	8.42	517.44	1.67	1.7	2.5	0.9	1.3
SLR34 Donnell Res	1.13	1.96	960.96	0.05	0.5	0.8	0.2	0.3
SL24 MFk Bl Relief	70.88	18.11	322.08	8.17	2.8	4.2	1.8	2.7
SLR38 Beardsley Res	19.12	9.75	475.20	1.77	1.7	2.5	0.9	1.3
SL32 Niagra Cr	13.38	8.35	491.04	1.73	1.7	2.5	0.9	1.3
SL16 Griswold Cr	51.70	20.17	274.56	14.33	3.4	5.1	2.3	3.5
SL22 Kennedy Cr	20.78	9.02	443.52	1.92	1.7	2.6	0.9	1.4
SL14 NFk Bl Avery	23.61	10.56	322.08	3.86	2.2	3.3	1.3	1.9
SL12 Beaver Cr	31.62	20.63	264.00	15.42	3.5	5.2	2.4	3.6
SL52 SFk Nr LngBarn	22.15	14.44	142.56	6.89	2.6	4.0	1.7	2.5
SLR20 Relief Res	24.92	11.10	364.32	2.94	2.0	3.0	1.1	1.7
SLR50 Strawberry Res	27.07	15.06	285.12	7.08	2.7	4.0	1.7	2.5
SL18 NFk Ab MFk	3.10	2.99	327.36	0.14	0.7	1.1	0.3	0.4
SL40 MFk Bl Beardsly	44.45	21.87	227.04	16.34	3.5	5.3	2.5	3.7
SL42 Nr Clark Flat	11.48	7.91	369.60	1.25	1.5	2.3	0.8	1.1
SL44 Rose Cr	42.64	17.88	242.88	12.12	3.2	4.8	2.1	3.2
SL46 Ab SFk	5.51	4.74	343.20	0.59	1.2	1.8	0.5	0.8
SL54 SFk Ab SL	39.72	19.33	205.92	12.84	3.3	4.9	2.2	3.3
SLR58 NewMelones	83.01	18.69	121.44	11.71	3.2	4.7	2.1	3.2
SL62 Black Cr	33.75	15.24	110.88	11.27	3.1	4.7	2.1	3.1
SLR64 Tulloch Res	0.03	0.62	95.04	0.02	0.4	0.6	0.1	0.2
SL60 Bl NewMelones	27.51	12.41	105.60	5.24	2.4	3.6	1.5	2.2
SL68 Bl Tulloch Res	9.09	6.56	132.00	1.55	1.6	2.4	0.8	1.2
SL66 Green Spring Rn	20.40	10.32	116.16	5.04	2.4	3.6	1.4	2.1
SLR6 NewSpicer	45.82	15.26	205.92	6.96	2.7	4.0	1.7	2.5
SLR4 Union Res	28.95	11.90	142.56	5.88	2.5	3.8	1.5	2.3
SL10 NFk Ab Avery	52.02	20.31	205.92	12.99	3.3	4.9	2.2	3.3
SL36 MFk Bl Donnell	64.02	13.54	369.60	3.83	2.2	3.3	1.3	1.9
SL56 Ab NewMelones	21.75	14.19	168.96	6.62	2.6	3.9	1.6	2.4
SL48 SFk A Strawberry	17.78	12.02	343.20	4.71	2.3	3.5	1.4	2.1

Stanislaus River Reach Parameters

Reach Name	Reach Length	Reach Slope	Ave Reach Vel	Initial K	Musk X	N steps
			$80 S_R^{1/2}$	$1.47 L_R / 1.5V_R$	or LAG (Min)	Time Step=
	L_R (Mi)	S_R (ft/ft)	V_R (fps)	K (Hr)		60
SL45-SL55, NEW MELONES	2.91	0.0001	0.80	3.6	0.4	3
SL11-SL13	5.46	0.0488	17.6	0.3	18	--
SL13-SL17	2.92	0.0415	16.3	0.2	12	--
SL17-SL41	2.79	0.0252	12.7	0.2	12	--
SL23-SL27	10.8	0.0207	11.51	1.0	0.4	1
SL27-SL31	4.30	0.0229	12.11	0.3	18	--
SL33-SL37	9.75	0.0293	13.69	1.0	0.4	1
SL39-SL41	18.13	0.0202	11.37	1.6	0.4	2
SL3-SL9	2.01	0.0461	17.18	0.1	6	--
SL41-SL45	5.03	0.0060	6.20	1.0	0.4	1
SL51-SL53	13.97	0.0169	10.40	1.3	0.4	2
SL53-SL55	18.83	0.0306	13.99	1.3	0.4	2
SL5-SL3	3.12	0.0351	14.9	0.2	12	--
SL59-SL67	6.88	0.0160	10.12	1.0	0.4	1
SL7-SL9	6.16	0.0264	13.00	0.5	30	--
SL9-SL11	16.20	0.0225	12.00	1.3	0.4	2
SL67-SL65, TULLOCH RES	0.05	0.0001	0.80	0.1	6	--

HEC-HMS Summary of Results
Stanislaus River Basin: March 1995 Event

Project	: Stanislaus		Run Name	: Mar95Calib	
Start of Run	: 08Mar95	0100	Basin Model	:	Stanis95
End of Run	: 15Mar95	2400	Met. Model	:	Mar95
Execution Time	: 16Feb01	0827	Control Specs.	:	Mar95

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
Tulloch-Out	2750.0	12 Mar 95 1300	15389	986.300
SL69	2750.0	12 Mar 95 1300	15389	986.300
SL56 Ab NewMelones	1600.9	10 Mar 95 1300	4876.0	21.747
SL57	1600.9	10 Mar 95 1300	4876.0	21.747
SLR4 Union Res	253.88	15 Mar 95 1600	445.86	28.950
SL5	253.88	15 Mar 95 1600	445.86	28.950
SL5-SL3	247.91	15 Mar 95 1700	445.50	28.950
SLR2 Lk Alpine	1163.0	15 Mar 95 1600	2046.3	13.073
SL3	1400.4	15 Mar 95 1600	2491.8	42.023
SL3-SL9	1378.5	15 Mar 95 1600	2490.1	42.023
SLR6 NewSpicer	1691.3	15 Mar 95 1600	2736.9	45.816
SL7	1691.3	15 Mar 95 1600	2736.9	45.816
SL7-SL9	1666.8	15 Mar 95 1700	2728.7	45.816
SL8 NFk Cfl Highland	2272.4	15 Mar 95 1600	6430.4	22.632
SL9	5227.2	15 Mar 95 1600	11649	110.471
SL9-SL11	5125.5	15 Mar 95 1800	11563	110.471
SL10 NFk Ab Avery	3726.6	10 Mar 95 1300	15124	52.016
SL11	7292.6	15 Mar 95 1800	26687	162.487
SL11-SL13	7178.2	15 Mar 95 1800	26645	162.487
SL12 Beaver Cr	2612.6	10 Mar 95 1400	10016	31.620
SL13	8438.6	15 Mar 95 1800	36661	194.107
SL13-SL17	8301.3	15 Mar 95 1800	36623	194.107
SL14 NFk Bl Avery	3371.3	10 Mar 95 1300	11196	23.610
SL16 Griswold Cr	4892.1	10 Mar 95 1400	17828	51.696
SL17	14920	10 Mar 95 1400	65647	269.413
SL17-SL41	14914	10 Mar 95 1400	65586	269.413
BRD-out	620.00	15 Mar 95 1900	8481.2	307.444
SL39	620.00	15 Mar 95 1900	8481.2	307.444
SL39-SL41	619.97	15 Mar 95 2100	8471.9	307.444
SL18 NFk Ab MFk	547.00	10 Mar 95 1800	1465.4	3.103
SL40 MFk Bl Beardsly	3839.2	10 Mar 95 1400	13160	44.454
SL41	19031	10 Mar 95 1400	88683	624.414
SL41-SL45	18871	10 Mar 95 1500	88305	624.414

... Continued ...

HEC-HMS Summary of Results
Stanislaus River Basin: March 1995 Event
(Continued)

Project : Stanislaus Run Name : Mar95Calib

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
SL42 Nr Clark Flat	1296.1	10 Mar 95 1200	3739.5	11.479
SL44 Rose Cr	3617.2	10 Mar 95 1300	11503	42.639
SL45	23009	10 Mar 95 1500	103547	678.532
SL45-SL55	22384	10 Mar 95 1800	101346	678.532
SL48 SFk A Strawberr	493.26	15 Mar 95 1700	1797.0	17.770
SLR50 Strawberry Res	345.04	15 Mar 95 1700	1265.3	27.073
SL51	838.31	15 Mar 95 1700	3062.3	44.843
SL51-SL53	794.58	15 Mar 95 1800	3058.5	44.843
SL52 SFk Nr LngBarn	1971.1	10 Mar 95 1300	6408.7	22.147
SL53	2449.0	10 Mar 95 1300	9467.2	66.990
SL53-SL55	2415.7	10 Mar 95 1500	9424.9	66.990
SL46 Ab SFk	582.27	10 Mar 95 1900	1641.5	5.512
SL54 SFk Ab SL	3072.1	10 Mar 95 1400	9703.5	39.720
SL55	26213	10 Mar 95 1800	122116	790.754
SLR58 NewMelones	6757.6	11 Mar 95 0200	21298	83.014
NML-In	31696	10 Mar 95 1900	148290	895.515
Relief-OUT	161.00	10 Mar 95 0100	1561.0	24.923
SL22 Kennedy Cr	62.325	08 Mar 95 0100	460.18	20.775
SL23	200.89	10 Mar 95 0100	2021.2	45.698
SL23-SL27	200.53	10 Mar 95 0200	2022.2	45.698
SL26 Clark Fk	1603.9	15 Mar 95 1700	5237.2	67.951
SL24 MFk Bl Relief	1240.8	15 Mar 95 1700	4245.9	70.884
SL27	2942.7	15 Mar 95 1700	11505	184.533
SL27-SL31	2867.2	15 Mar 95 1800	11494	184.533
SL30 Darnelles Cr	1342.5	15 Mar 95 1600	3061.8	10.085
SL28 MFk Ab Donnell	1437.4	15 Mar 95 1700	5897.5	15.190
SL31	5487.8	15 Mar 95 1700	20453	209.808
SLR34 Donnell Res	300.31	11 Mar 95 1300	988.08	1.131
Donnell-In	5612.0	15 Mar 95 1700	21441	210.939
Donnell-Out	745.00	08 Mar 95 0100	10657	210.939
SL32 Niagra Cr	726.79	15 Mar 95 1700	1763.8	13.377
SL33	1446.8	15 Mar 95 1700	12421	224.316
SL33-SL37	1425.4	15 Mar 95 1800	12415	224.316
SL36 MFk Bl Donnell	3663.6	15 Mar 95 1700	15285	64.018
SL37	5051.4	15 Mar 95 1700	27700	288.334
SLR38 Beardsley Res	1826.5	10 Mar 95 1200	6408.6	19.123
BRD-In	5896.0	15 Mar 95 1700	34108	307.457
SLR20 Relief Res	74.769	08 Mar 95 0100	568.92	24.923
Relief-IN	74.769	08 Mar 95 0100	568.92	24.923
NML-Out	211.00	09 Mar 95 1800	1522.4	895.515

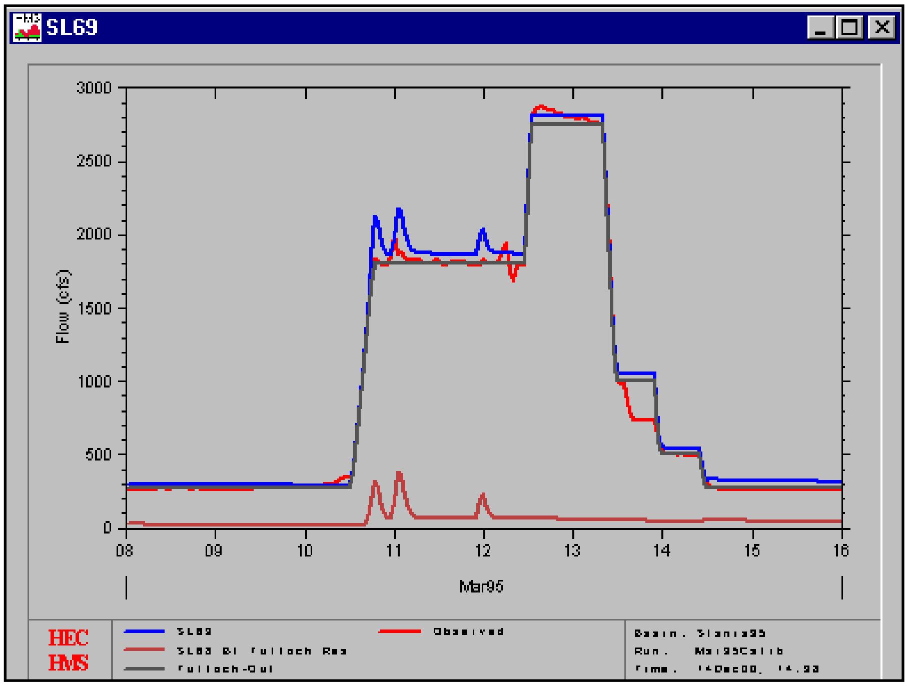
... Continued ...

HEC-HMS Summary of Results
Stanislaus River Basin: March 1995 Event
(Continued)

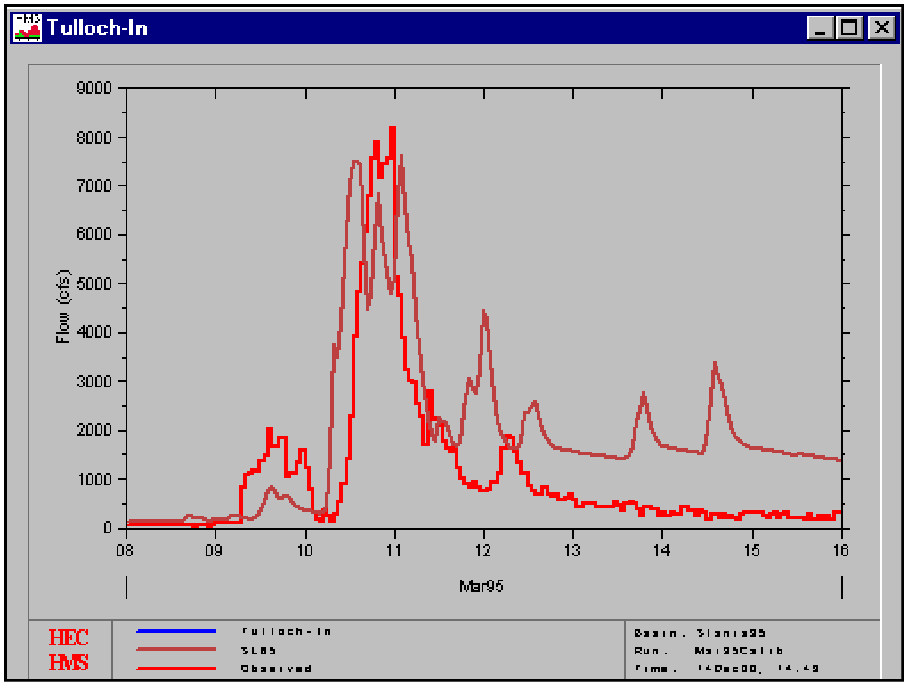
Project : Stanislaus Run Name : Mar95Calib

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
SL59	211.00	09 Mar 95 1800	1522.4	895.515
SL59-SL67	210.79	09 Mar 95 2000	1518.6	895.515
SL60 Bl NewMelones	3418.1	11 Mar 95 0200	11786	27.507
SL66 Green Spring Rn	2158.3	10 Mar 95 1300	7873.9	20.396
SL67	5599.4	11 Mar 95 0200	21179	943.418
SL67-SL65	5571.8	11 Mar 95 0200	21171	943.418
SL62 Black Cr	2337.7	10 Mar 95 1500	9090.4	33.754
SLR64 Tulloch Res	4.8968	10 Mar 95 1000	12.321	0.032
SL65	7600.8	11 Mar 95 0200	30274	977.204
SL68 Bl Tulloch Res	367.67	11 Mar 95 0100	870.06	9.094
Tulloch-In	7956.4	11 Mar 95 0200	31144	986.298

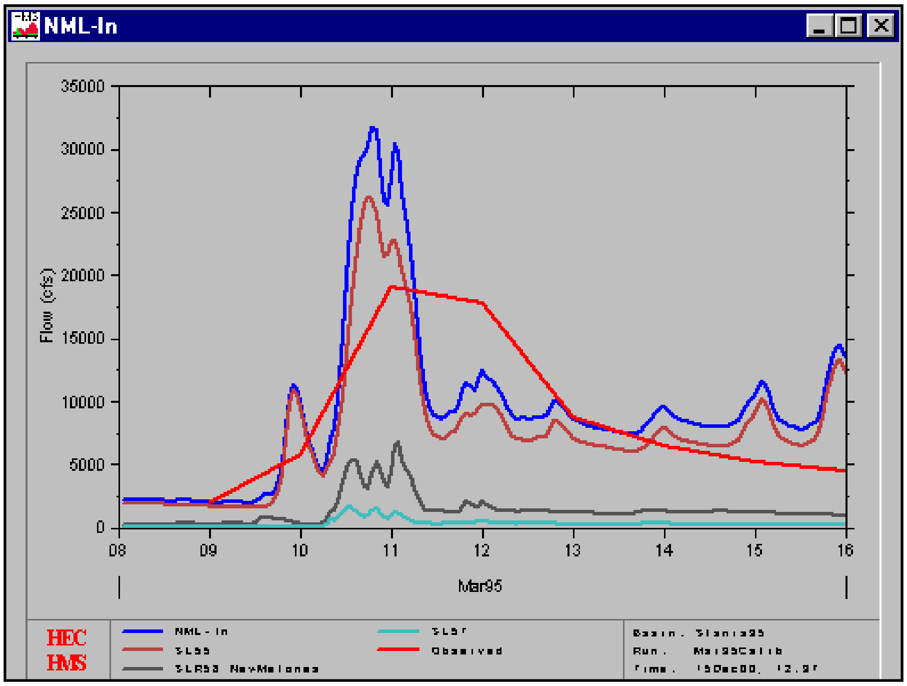
HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Stanislaus River Basin
March 1995 Event



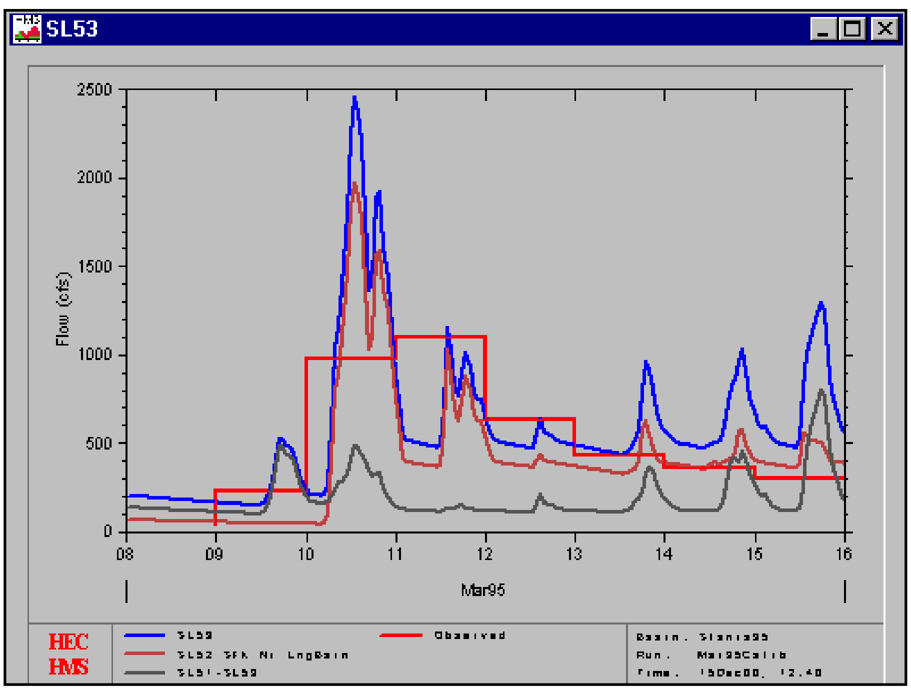
SL69 – Below Tulloch Reservoir



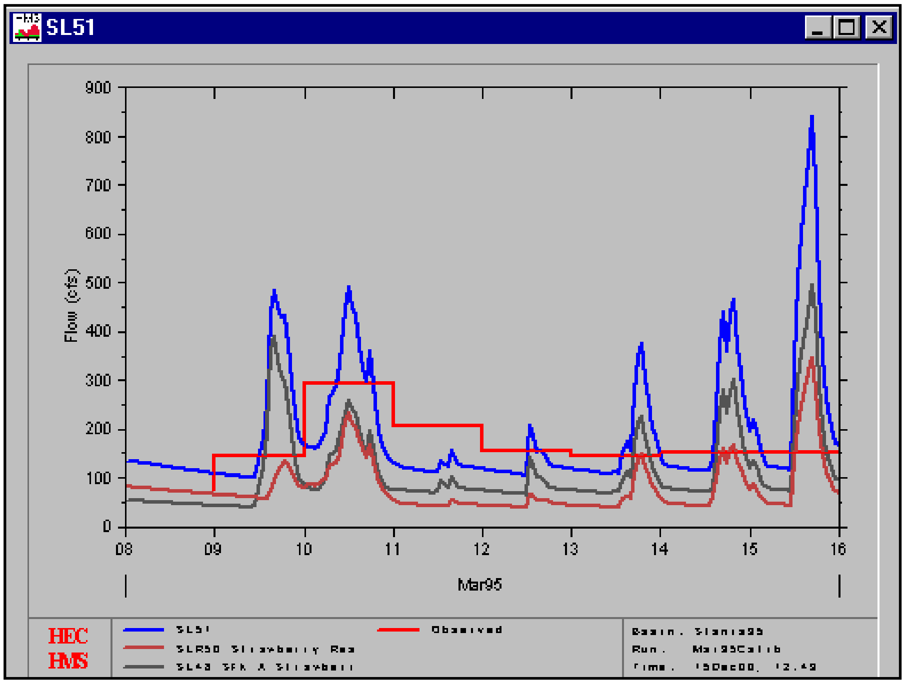
Tulloch-In – Tulloch Reservoir Inflow



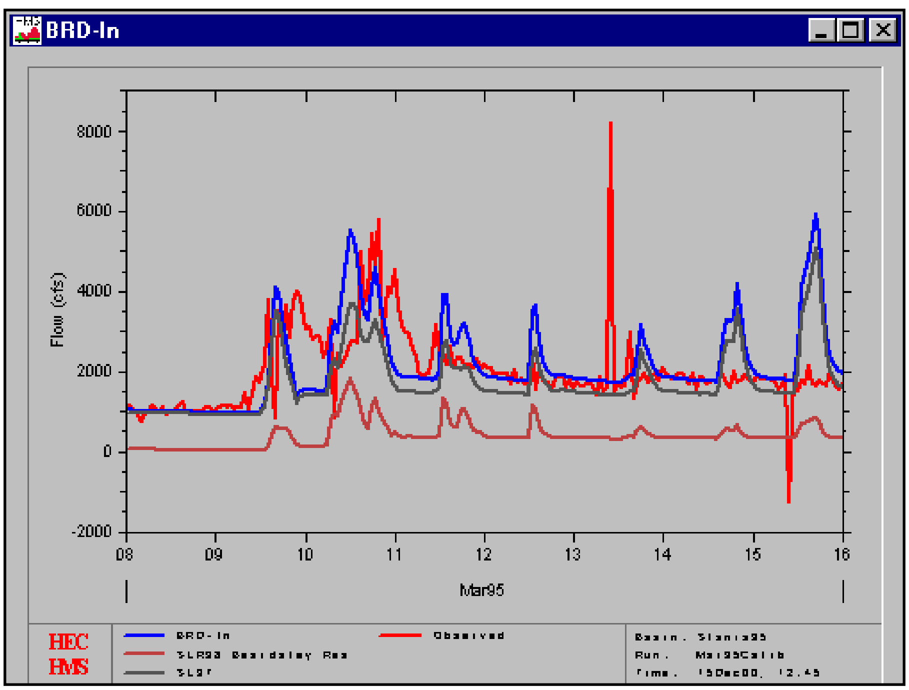
NML-In – New Melones Reservoir Inflow



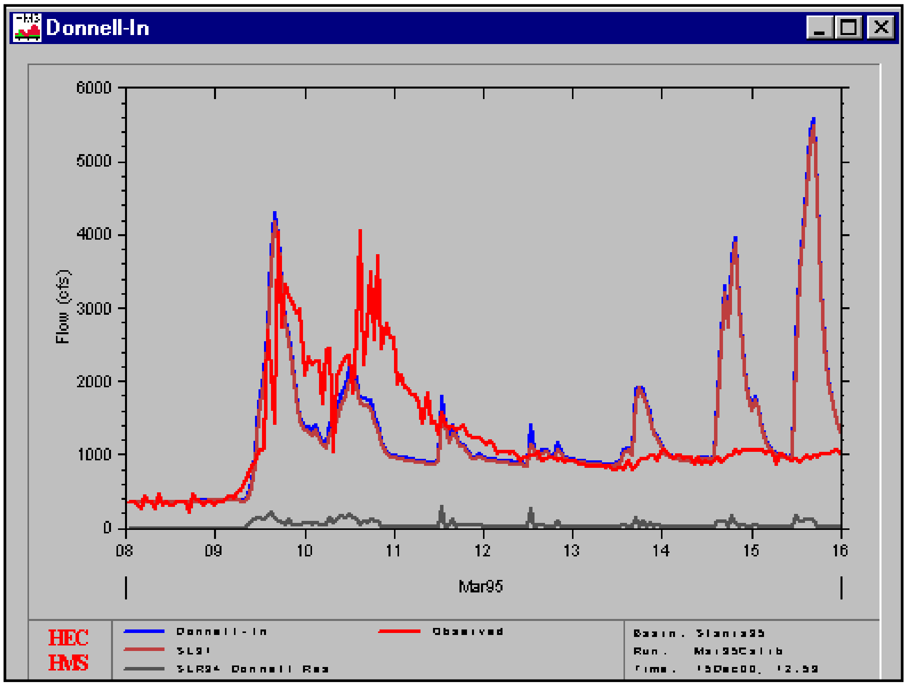
SL53 – South Fork Near Long Barn



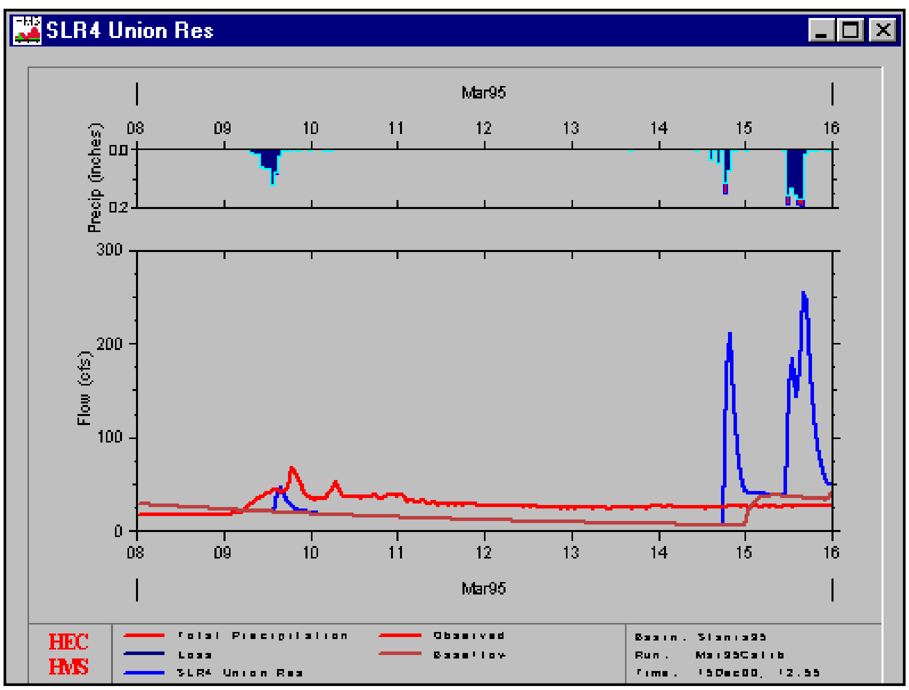
SL51 – Strawberry Reservoir



BRD-In – Beardsley Reservoir Inflow



Donnell-In – Donnell Reservoir Inflow



SL5 – Union Reservoir Inflow

HEC-HMS Subbasin Parameters
Stanislaus River Basin: March 1995 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
SLR2 Lk Alpine	3	0.8	0.2	1.5	.02	10
SL8 NFk Cfl Highland	3	0.8	0.2	1.5	.05	0
SL26 Clark Fk	1.5	0.8	0.2	1.5	.001	0
SL30 Darnelles Cr	1.5	0.8	0.2	1.5	.001	0
SL28 MFk Ab Donnell	1.5	0.8	0.2	1.5	.001	0
SLR34 Donnell Res	3	0.8	0.2	1.5	.05	0
SL24 MFk Bl Relief	1.5	0.8	0.2	1.5	.001	0
SLR38 Beardsley Res	3	0.8	0.2	2.1	.07	0
SL32 Niagra Cr	3	0.8	0.2	1.5	.05	0
SL16 Griswold Cr	3	0.8	0.2	2.0	.08	0
SL22 Kennedy Cr	3	0.8	0.2	1.5	.001	0
SL14 NFk Bl Avery	3	0.8	0.2	2.0	.08	0
SL12 Beaver Cr	3	0.8	0.2	2.0	.08	0
SL52 SFk Nr LngBarn	3	0.8	0.2	2.5	.08	0
SLR20 Relief Res	3	0.8	0.2	.25	.001	0
SLR50 Strawberry Res	3	0.8	0.2	2.5	.01	0
SL18 NFk Ab MFk	3	0.8	0.2	2.0	.08	0
SL40 MFk Bl Beardsly	3	0.8	0.2	2.0	.08	0
SL42 Nr Clark Flat	3	0.8	0.2	2.0	.08	0
SL44 Rose Cr	3	0.8	0.2	2.0	.08	0
SL46 Ab SFk	3	0.8	0.2	2.0	.08	0
SL54 SFk Ab SL	3	0.8	0.2	2.0	.08	0
SLR58 NewMelones	3	0.8	0.2	2.0	.08	10
SL62 Black Cr	1	0.8	0.2	1.5	.001	10
SLR64 Tulloch Res	1	0.8	0.2	1.5	.001	10
SL60 Bl NewMelones	1	0.8	0.2	1.5	.001	10
SL68 Bl Tulloch Res	3	0.8	0.2	2.5	.07	0
SL66 Green Spring Rn	1	0.8	0.2	1.5	.001	10
SLR6 NewSpicer	3	0.8	0.2	1.5	.05	0
SLR4 Union Res	1	0.8	0.2	1.5	.17	0
SL10 NFk Ab Avery	3	0.8	0.2	2.0	.08	0
SL36 MFk Bl Donnell	3	0.8	0.2	2.1	.07	0
SL56 Ab NewMelones	3	0.8	0.2	2.0	.08	0
SL48 SFk A Strawberr	3	0.8	0.2	1.5	.01	0

HEC-HMS Summary of Results
Stanislaus River Basin: December 1996 - January 1997 Event

Project	: Stanislaus		Run Name	: Jan97Calib	
Start of Run	: 25Dec96	0100	Basin Model	:	Stanis97
End of Run	: 08Jan97	2400	Met. Model	:	Jan97
Execution Time	: 16Feb01	0827	Control Specs.	:	Jan97

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
Tulloch-Out	7516.0	03 Jan 97 1300	139068	986.300
SL69	7516.0	03 Jan 97 1300	139068	986.300
SL56 Ab NewMelones	2006.9	02 Jan 97 1000	8141.5	21.747
SL57	2006.9	02 Jan 97 1000	8141.5	21.747
SLR4 Union Res	1935.4	02 Jan 97 1300	5473.5	28.950
SL5	1935.4	02 Jan 97 1300	5473.5	28.950
SL5-SL3	1862.3	02 Jan 97 1300	5472.4	28.950
SLR2 Lk Alpine	2455.0	02 Jan 97 1200	10309	13.073
SL3	4315.6	02 Jan 97 1300	15781	42.023
SL3-SL9	4279.0	02 Jan 97 1300	15780	42.023
SLR6 NewSpicer	6021.3	02 Jan 97 1400	24666	45.816
SL7	6021.3	02 Jan 97 1400	24666	45.816
SL7-SL9	6013.7	02 Jan 97 1400	24652	45.816
SL8 NFk Cfl Highland	3793.1	01 Jan 97 1400	17156	22.632
SL9	13614	02 Jan 97 1300	57587	110.471
SL9-SL11	13530	02 Jan 97 1500	57517	110.471
SL10 NFk Ab Avery	7211.6	01 Jan 97 1500	41780	52.016
SL11	20029	01 Jan 97 1600	99296	162.487
SL11-SL13	19947	01 Jan 97 1600	99273	162.487
SL12 Beaver Cr	3877.0	01 Jan 97 1500	23095	31.620
SL13	23796	01 Jan 97 1600	122368	194.107
SL13-SL17	23666	01 Jan 97 1600	122350	194.107
SL14 NFk Bl Avery	3280.9	02 Jan 97 1000	14426	23.610
SL16 Griswold Cr	5826.0	01 Jan 97 1500	35040	51.696
SL17	31333	01 Jan 97 1600	171815	269.413
SL17-SL41	31228	01 Jan 97 1600	171792	269.413
BRD-out	28979	02 Jan 97 1300	105494	307.444
SL39	28979	02 Jan 97 1300	105494	307.444
SL39-SL41	28997	02 Jan 97 1500	105368	307.444
SL18 NFk Ab MFk	840.74	02 Jan 97 0900	2520.8	3.103
SL40 MFk Bl Beardsly	3881.2	02 Jan 97 1200	23085	44.454
SL41	62260	02 Jan 97 1500	302766	624.414
SL41-SL45	62042	02 Jan 97 1600	302557	624.414

... Continued ...

HEC-HMS Summary of Results
Stanislaus River Basin: December 1996 - January 1997 Event
(Continued)

Project : Stanislaus Run Name : Jan97Calib

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
SL42 Nr Clark Flat	1644.3	02 Jan 97 1000	5925.7	11.479
SL44 Rose Cr	4015.2	02 Jan 97 1100	19105	42.639
SL45	65532	02 Jan 97 1500	327588	678.532
SL45-SL55	64894	02 Jan 97 1900	326762	678.532
SL48 SFk A Strawberr	2924.5	01 Jan 97 1400	11714	17.770
SLR50 Strawberry Res	3807.0	02 Jan 97 1400	14333	27.073
SL51	6464.9	01 Jan 97 1800	26047	44.843
SL51-SL53	6444.0	02 Jan 97 1500	26003	44.843
SL52 SFk Nr LngBarn	2646.8	01 Jan 97 1400	15294	22.147
SL53	8337.8	02 Jan 97 1500	41297	66.990
SL53-SL55	8165.3	02 Jan 97 1700	41241	66.990
SL46 Ab SFk	657.04	02 Jan 97 0900	1985.2	5.512
SL54 SFk Ab SL	3296.6	02 Jan 97 1100	16649	39.720
SL55	74113	02 Jan 97 1800	386638	790.754
SLR58 NewMelones	5310.0	02 Jan 97 1500	27040	83.014
NML-In	78361	02 Jan 97 1800	421819	895.515
SLR20 Relief Res	2790.2	02 Jan 97 1300	8222.5	24.923
SL22 Kennedy Cr	2608.6	01 Jan 97 1700	7627.2	20.775
SL23	5052.4	02 Jan 97 1300	15850	45.698
SL23-SL27	4898.4	02 Jan 97 1400	15834	45.698
SL26 Clark Fk	7128.0	01 Jan 97 1800	25068	67.951
SL24 MFk Bl Relief	8176.2	01 Jan 97 1800	27288	70.884
SL27	19978	01 Jan 97 1800	68190	184.533
SL27-SL31	19439	01 Jan 97 1800	68169	184.533
SL30 Darnelles Cr	1481.8	01 Jan 97 1300	5784.8	10.085
SL28 MFk Ab Donnell	2019.2	01 Jan 97 1300	7844.0	15.190
SL31	21764	01 Jan 97 1800	81798	209.808
SLR34 Donnell Res	218.06	01 Jan 97 0800	973.28	1.131
Donnell-In	21815	01 Jan 97 1800	82771	210.939
Donnell-Out	19310	02 Jan 97 1300	61115	210.939
SL32 Niagra Cr	2262.0	01 Jan 97 1300	8949.2	13.377
SL33	21343	02 Jan 97 1300	70064	224.316
SL33-SL37	21263	02 Jan 97 1400	69982	224.316
SL36 MFk Bl Donnell	9670.5	01 Jan 97 1400	44481	64.018
SL37	28754	02 Jan 97 1400	114463	288.334
SLR38 Beardsley Res	2324.1	01 Jan 97 1400	11530	19.123
BRD-In	30615	02 Jan 97 1400	125993	307.457
NML-Out	2890.0	02 Jan 97 1400	12459	895.515

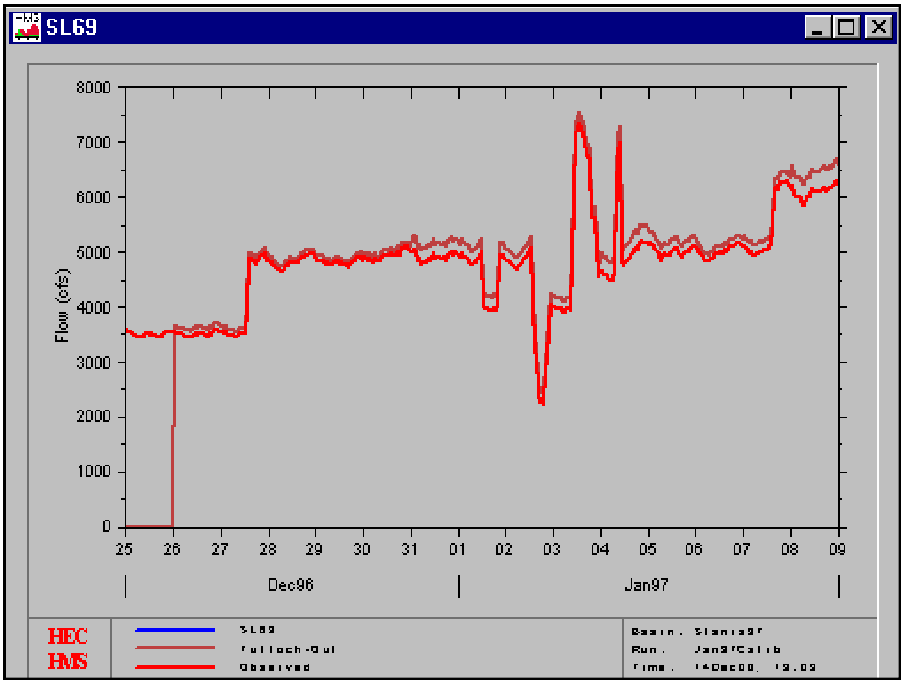
... Continued ...

HEC-HMS Summary of Results
Stanislaus River Basin: December 1996 - January 1997 Event
(Continued)

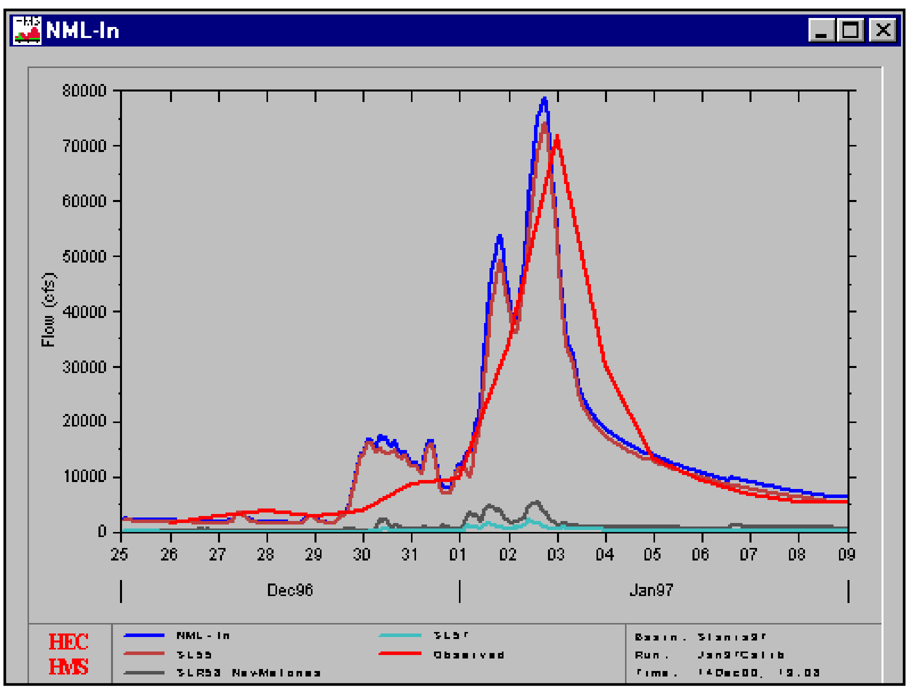
Project : Stanislaus Run Name : Jan97Calib

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
SL59	2890.0	02 Jan 97 1400	12459	895.515
SL59-SL67	2866.7	02 Jan 97 1500	12448	895.515
SL60 Bl NewMelones	1283.2	02 Jan 97 0900	5006.3	27.507
SL66 Green Spring Rn	1054.9	02 Jan 97 1000	3655.9	20.396
SL67	4658.1	02 Jan 97 1200	21111	943.418
SL67-SL65	4638.0	02 Jan 97 1200	21109	943.418
SL62 Black Cr	1998.0	02 Jan 97 1200	6596.9	33.754
SLR64 Tulloch Res	5.6968	02 Jan 97 0800	5.0253	0.032
SL65	6636.3	02 Jan 97 1200	27711	977.204
SL68 Bl Tulloch Res	841.06	02 Jan 97 0900	2339.0	9.094
Tulloch-In	7168.5	02 Jan 97 1200	30050	986.298

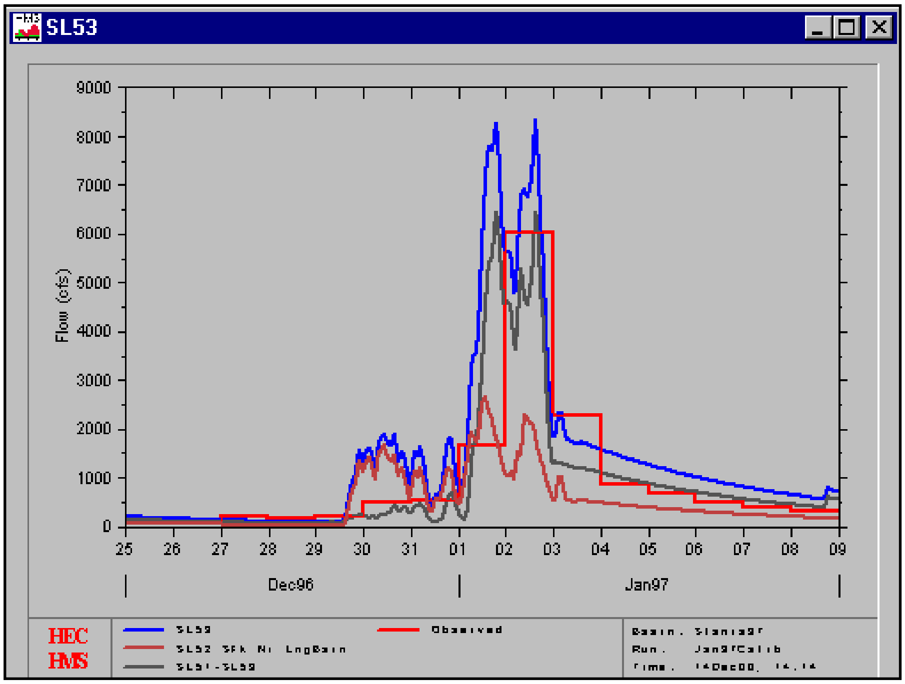
HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Stanislaus River Basin
December 1996 - January 1997 Event



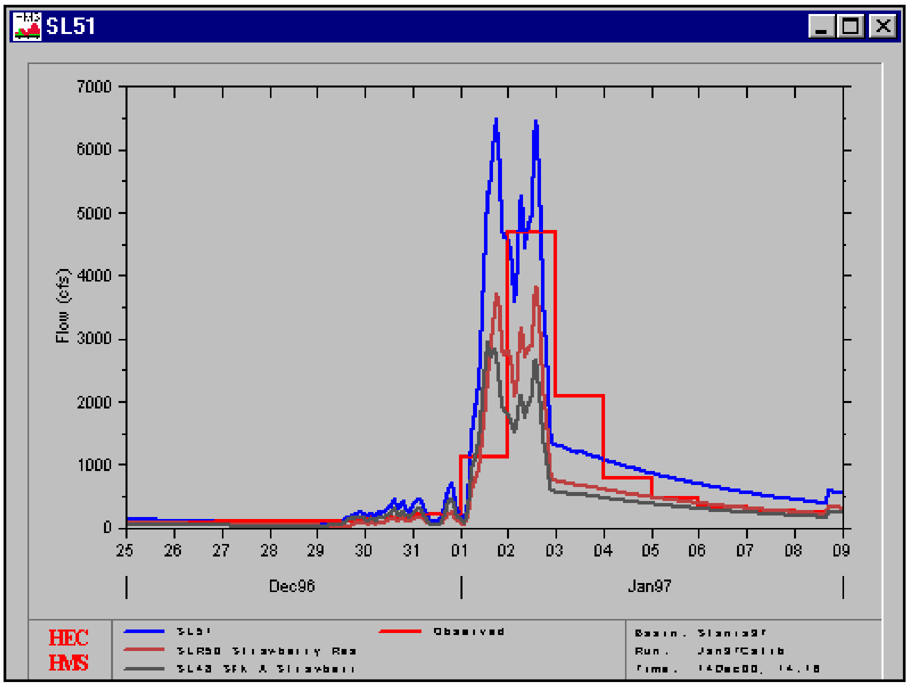
SL69 – Below Tulloch Reservoir



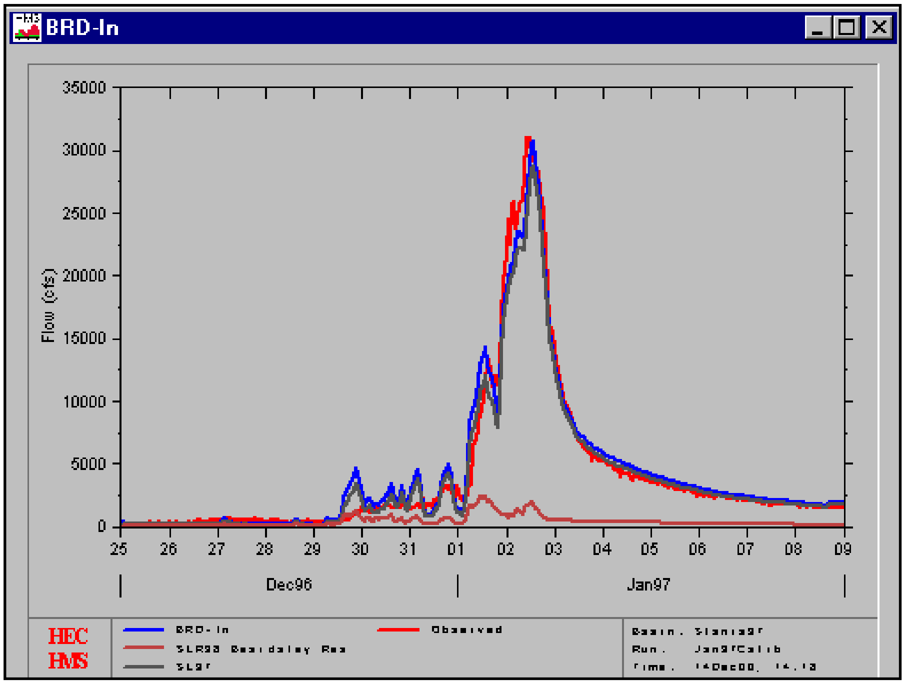
NML-In – New Melones Reservoir Inflow



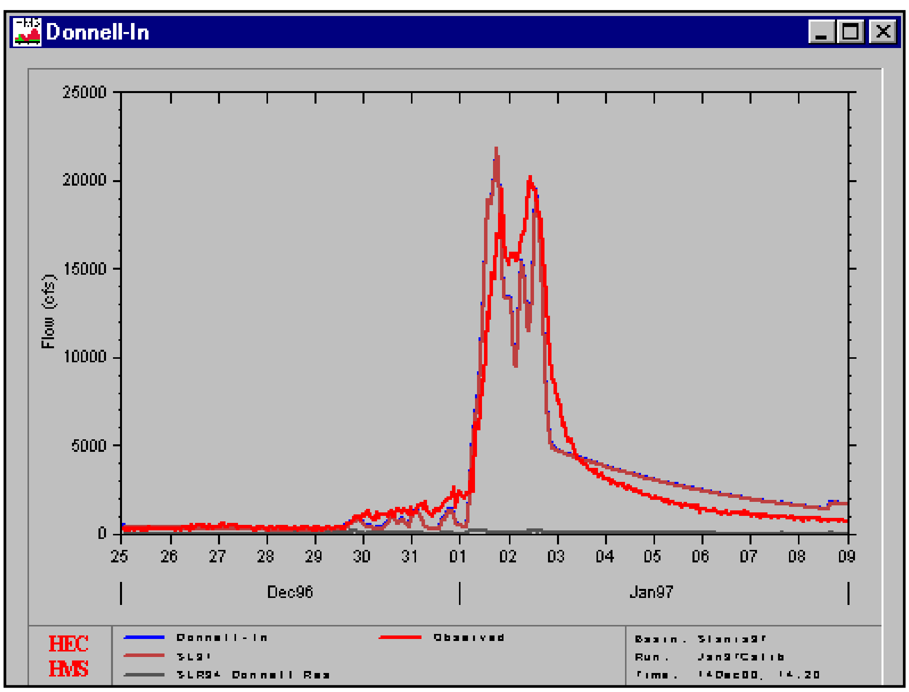
SL53 – South Fork Near Long Barn



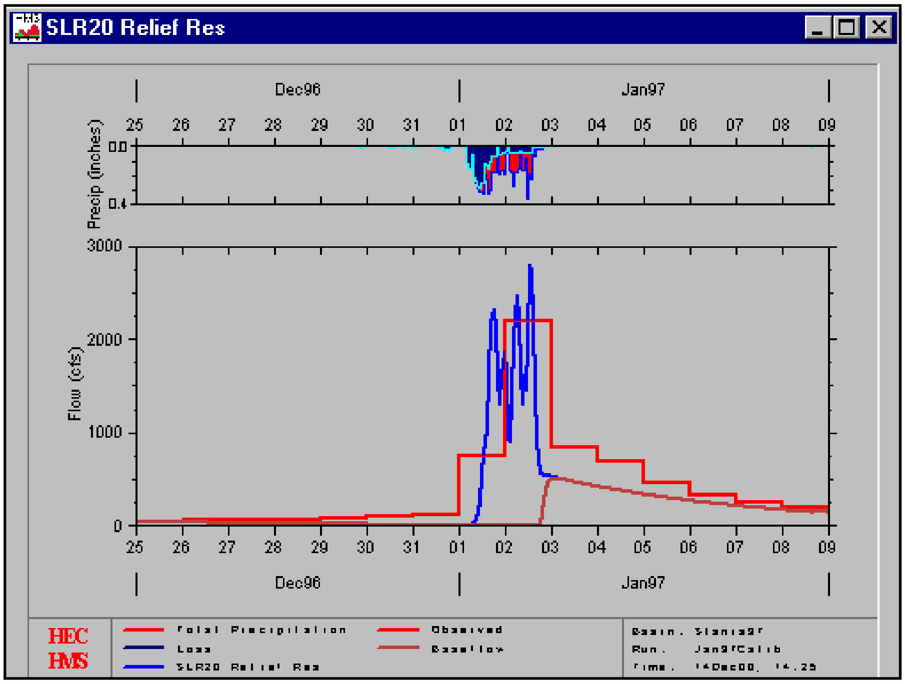
SL51 – Strawberry Reservoir



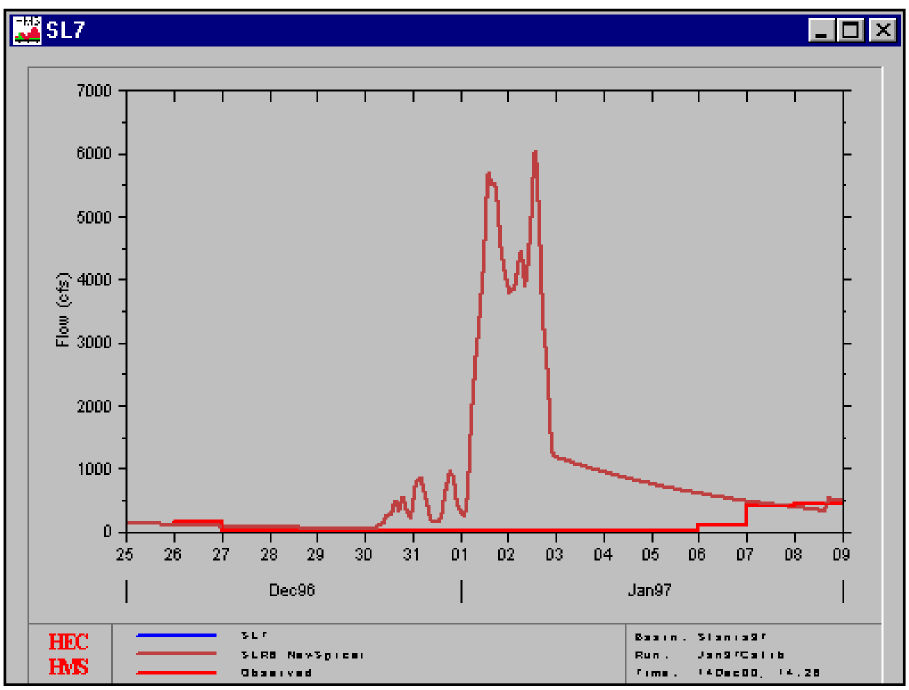
BRD-In – Beardsley Reservoir Inflow



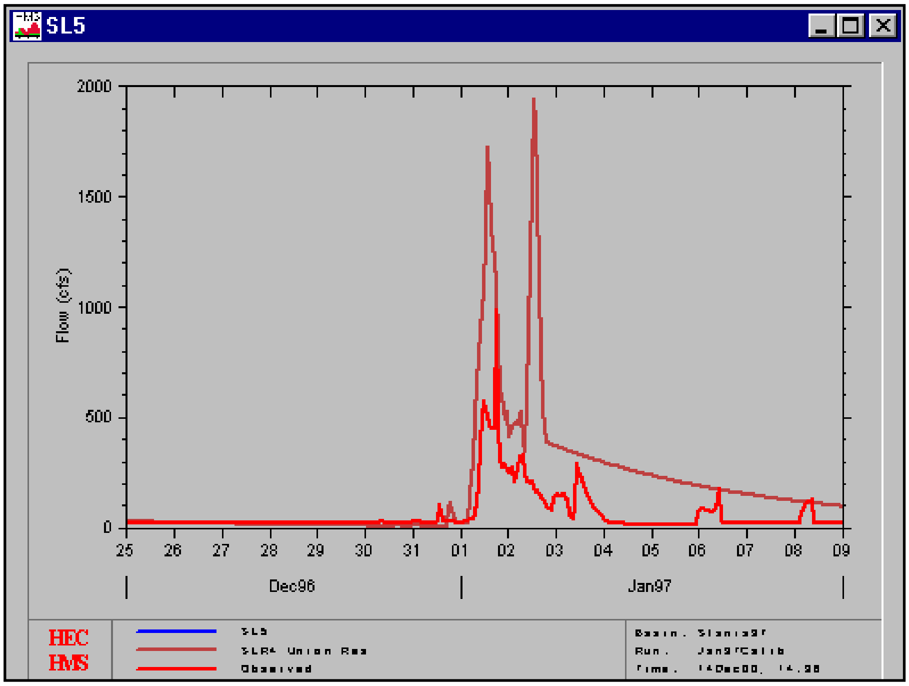
Donnell – In – Donnell Reservoir Inflow



SLR20 – Relief Reservoir Inflow



SL7 – New Spicer Reservoir

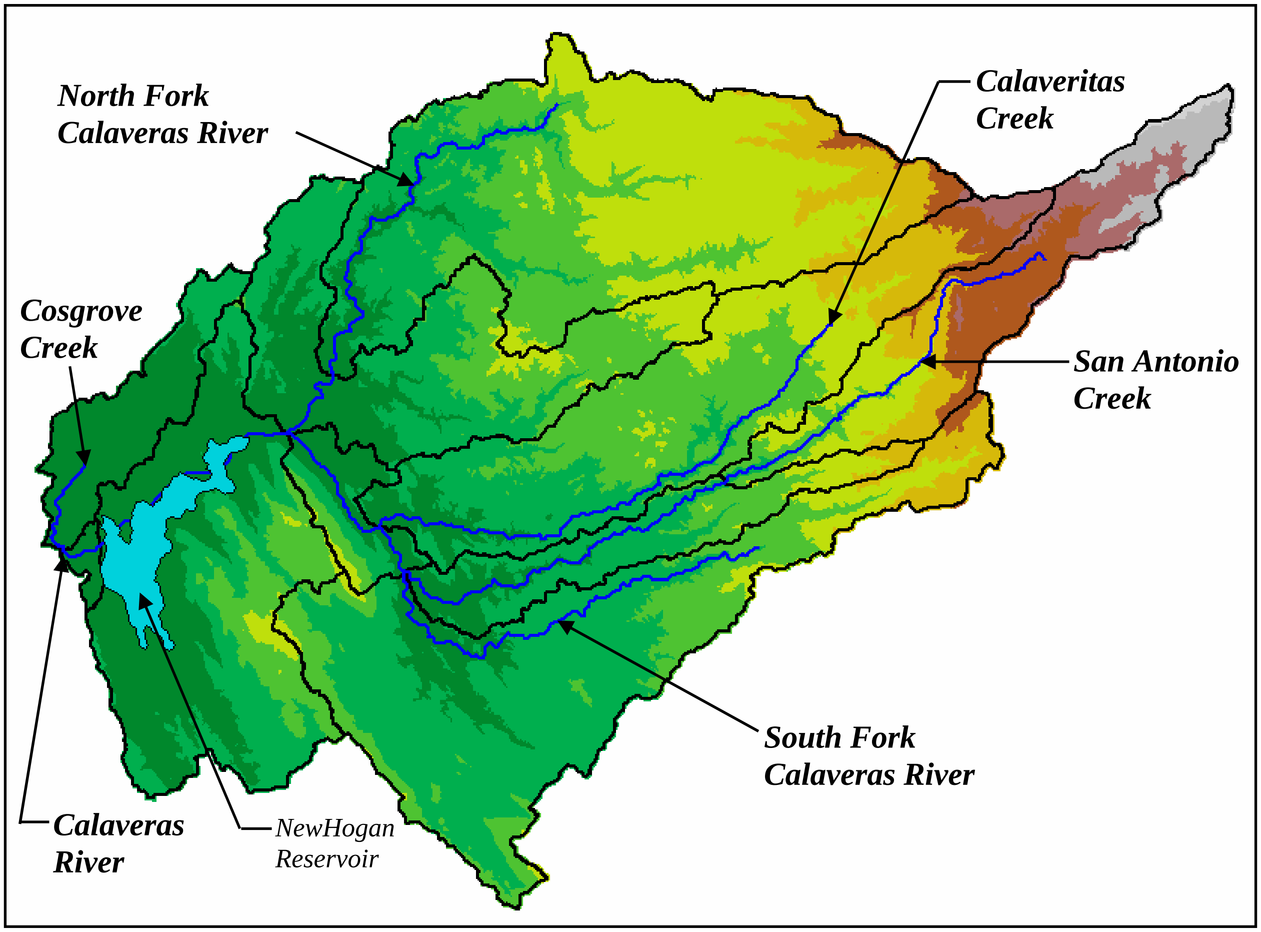


SL5 – Union Reservoir Inflow

HEC-HMS Subbasin Parameters
Stanislaus River Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
SLR2 Lk Alpine	3	0.8	0.2	1.5	.02	10
SL8 NFk Cfl Highland	3	0.8	0.2	1.5	.05	0
SL26 Clark Fk	2	0.8	0.2	1.5	.085	0
SL30 Darnelles Cr	2	0.8	0.2	1.5	.085	0
SL28 MFk Ab Donnell	2	0.8	0.2	1.5	.085	0
SLR34 Donnell Res	3	0.8	0.2	1.5	.05	0
SL24 MFk Bl Relief	2	0.8	0.2	1.5	.085	0
SLR38 Beardsley Res	3	0.8	0.2	1.5	.05	0
SL32 Niagra Cr	3	0.8	0.2	1.5	.05	0
SL16 Griswold Cr	3	0.8	0.2	1.5	.02	0
SL22 Kennedy Cr	2	0.8	0.2	1.5	.05	0
SL14 NFk Bl Avery	3	0.8	0.2	1.5	.02	0
SL12 Beaver Cr	3	0.8	0.2	1.5	.02	0
SL52 SFk Nr LngBarn	3	0.8	0.2	2.5	.01	0
SLR20 Relief Res	2	0.8	0.2	2.5	.05	0
SLR50 Strawberry Res	3	0.8	0.2	2.5	.01	0
SL18 NFk Ab MFk	3	0.8	0.2	1.5	.02	0
SL40 MFk Bl Beardsly	3	0.8	0.2	1.5	.02	0
SL42 Nr Clark Flat	3	0.8	0.2	1.5	.02	0
SL44 Rose Cr	3	0.8	0.2	1.5	.02	0
SL46 Ab SFk	3	0.8	0.2	1.5	.05	0
SL54 SFk Ab SL	3	0.8	0.2	1.5	.02	0
SLR58 NewMelones	3	0.8	0.2	1.5	.02	10
SL62 Black Cr	3	0.8	0.2	1.5	.07	10
SLR64 Tulloch Res	3	0.8	0.2	1.5	.07	10
SL60 Bl NewMelones	3	0.8	0.2	1.5	.07	10
SL68 Bl Tulloch Res	3	0.8	0.2	1.5	.05	10
SL66 Green Spring Rn	3	0.8	0.2	1.5	.07	10
SLR6 NewSpicer	3	0.8	0.2	1.5	.05	0
SLR4 Union Res	1	0.8	0.2	1.5	.17	0
SL10 NFk Ab Avery	3	0.8	0.2	1.5	.02	0
SL36 MFk Bl Donnell	3	0.8	0.2	1.5	.05	0
SL56 Ab NewMelones	3	0.8	0.2	1.5	.02	0
SL48 SFk A Strawberr	3	0.8	0.2	1.5	.01	0

Calaveras River Basin



HEC-GeoHMS Subbasin Delineation

Calaveras River

The Calaveras River HMS model consists of a 378 square mile basin above Cosgrove Creek, just below the New Hogan Reservoir located in the northeast portion of the San Joaquin Watershed on the east side of the Sacramento-San Joaquin River Delta. The basin model is divided into 10 subbasins and connected with 6 routing reaches. There is one observed hydrograph at a gage at the confluence of Cosgrove Creek. The computed peak flow at the Cosgrove Creek gage for the 1997 event was larger than the 1995 event (25,000 cfs vs. 20,000 cfs).

Using the adopted TC and R (Group 1) and Muskingum parameters, the computed hydrograph matched the observed hydrograph well. For reaches with a travel time of less than one hour, the lag method was used for routing. Muskingum was used for three routing reaches and lag was used for three routing reaches. Calibration efforts required different loss and baseflow parameters for different subbasins. Ten percent impervious area was assumed for the New Hogan Reservoir subbasin.

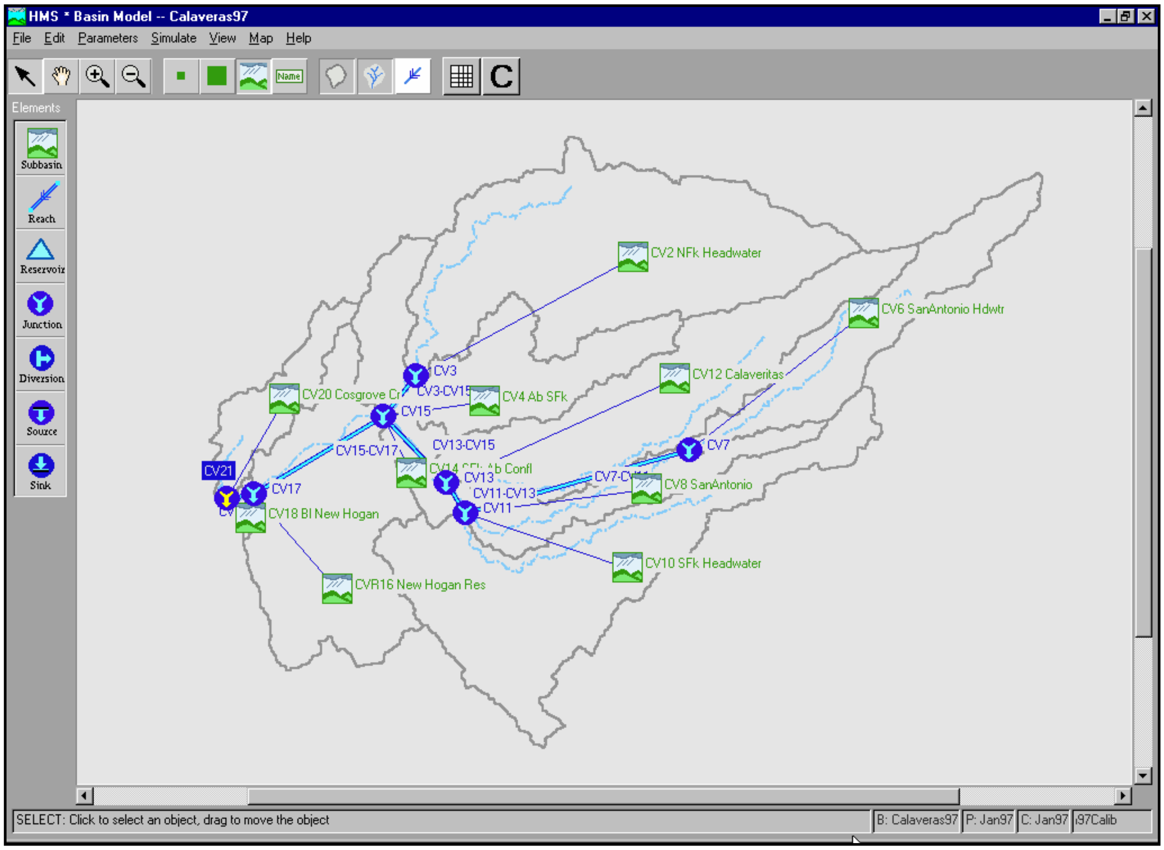
Calibration of the 1995 Event:

By using a constant loss rate of 0.06 inches/hour and an initial loss of 1.7 inches, the model calibrated well to the observed hydrograph. A recession ratio of 0.75 and a peak ratio of 0.18 defined the recession limb of the hydrograph. An initial baseflow of 1.5 cfs per square mile was used.

Calibration of the 1997 Event:

By using a constant loss rate of 0.04 inches/hour and an initial loss of 1.0 inch, the model calibrated well to the observed hydrograph. A recession ratio of 0.75 and a peak ratio of 0.18 defined the recession limb of the hydrograph. An initial baseflow of 4 cfs per square mile was used.

Calaveras River Basin HEC-HMS Model Schematic



Calaveras River Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Inital TC $1.4(LL_{CA}/S^{1/2})^{0.33}$ (Hr)	Initial R 1.5 TC (cfs/Hr)	Regression TC $0.68(LL_{CA}/S^{1/2})^{0.46}$ (Hr)	Regression R 1.5TC (cfs/Hr)
CV2 NFk Headwater	85.32	26.12	16.55	153.12	34.93	4.5	6.8	3.5	5.2
CV4 Ab SFk	40.94	16.90	6.65	116.16	10.43	3.0	4.6	2.0	3.0
CV20 Cosgrove Cr	13.97	11.36	5.81	100.32	6.59	2.6	3.9	1.6	2.4
CV14 SFk Ab Confl	8.40	7.26	3.09	290.40	1.32	1.5	2.3	0.8	1.2
CV12 Calaveritas	54.67	25.28	13.23	158.40	26.57	4.1	6.2	3.1	4.6
CV18 Bl New Hogan	1.49	2.74	1.07	190.08	0.21	0.8	1.3	0.3	0.5
CVR16 New Hogan Res	54.91	15.53	6.41	132.00	8.67	2.9	4.3	1.8	2.8
CV8 SanAntonio	18.36	17.89	9.19	147.84	13.52	3.3	5.0	2.3	3.4
CV10 SFk Headwater	67.96	23.92	9.29	126.72	19.74	3.7	5.6	2.7	4.0
CV6 SanAntonio Hdwtr	31.54	21.12	10.65	221.76	15.11	3.4	5.1	2.4	3.6

Calaveras River Reach Parameters

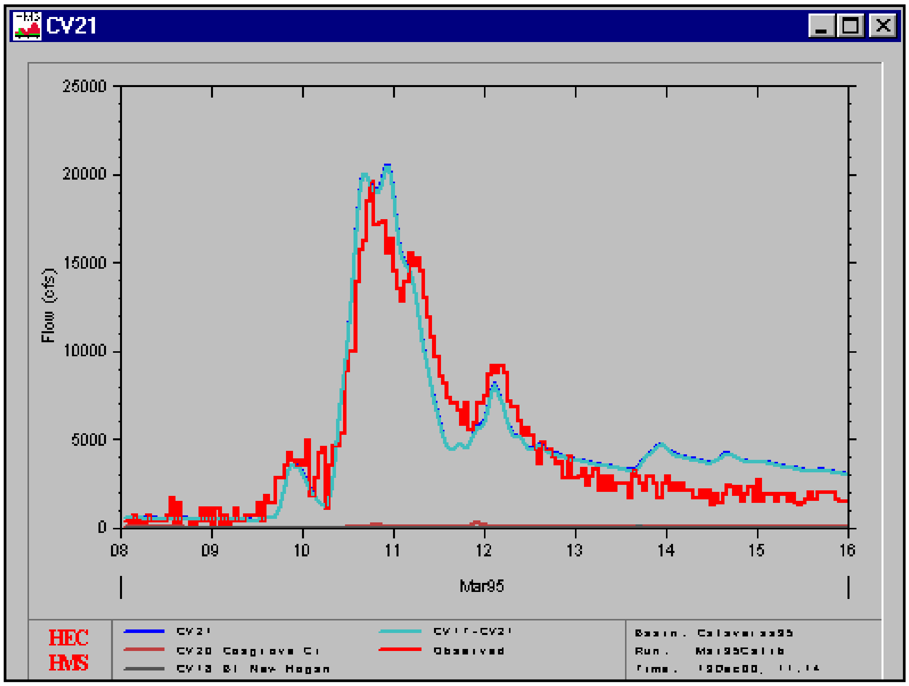
Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Ave Reach Vel $80\ S_R^{1/2}$ V_R (fps)	Initial K $1.47\ L_R / 1.5V_R$ K (Hr)	Musk X or LAG (Min)	N steps Time Step= 60
CV15-CV17	6.42	0.0071	6.76	1.0	0.4	1
CV17-CV21	1.27	0.0257	12.82	0.1	6	--
CV3-CV15	2.65	0.0048	5.54	0.5	30	--
CV13-CV15	4.18	0.0061	6.25	1.0	0.4	1
CV11-CV13	1.68	0.0054	5.88	0.3	18	--
CV7-CV11	11.93	0.0089	7.55	1.5	0.4	2

HEC-HMS Summary of Results
Calaveras River Basin: March 1995 Event

Project	: Calaveras	Run Name	: Mar95Calib
Start of Run	: 08Mar95 0100	Basin Model	: Calaveras95
End of Run	: 15Mar95 2400	Met. Model	: Mar95
Execution Time	: 04May00 1138	Control Specs.	: Mar95

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
CV2 NFk Headwater	6708.9	10 Mar 95 2100	21925	85.322
CV3	6708.9	10 Mar 95 2100	21925	85.322
CV3-CV15	6622.8	10 Mar 95 2200	21894	85.322
CV6 SanAntonio Hdwtr	3577.4	10 Mar 95 1400	12823	31.540
CV7	3577.4	10 Mar 95 1400	12823	31.540
CV7-CV11	3558.9	10 Mar 95 1600	12755	31.540
CV10 SFk Headwater	3575.2	10 Mar 95 2000	10907	67.965
CV8 SanAntonio	1380.4	10 Mar 95 2000	4191.8	18.361
CV11	8038.0	10 Mar 95 1500	27853	117.866
CV11-CV13	8031.0	10 Mar 95 1500	27829	117.866
CV12 Calaveritas	4231.2	10 Mar 95 2100	13589	54.673
CV13	11981	10 Mar 95 1500	41417	172.539
CV13-CV15	11933	10 Mar 95 1600	41301	172.539
CV14 SFk Ab Confl	380.89	10 Mar 95 1900	836.39	8.400
CV4 Ab SFk	2588.7	10 Mar 95 2000	6975.3	40.939
CV15	20201	10 Mar 95 2100	71007	307.200
CV15-CV17	20106	10 Mar 95 2300	70810	307.200
CVR16 New Hogan Res	924.59	11 Mar 95 2200	3021.3	54.911
CV17	20496	10 Mar 95 2200	73832	362.111
CV17-CV21	20442	10 Mar 95 2300	73811	362.111
CV18 Bl New Hogan	35.702	13 Mar 95 1700	37.123	1.486
CV20 Cosgrove Cr	272.40	11 Mar 95 2200	589.61	13.975
CV21	20496	10 Mar 95 2300	74438	377.572

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Calaveras River Basin
March 1995 Event



CV21 – Calaveras River Below New Hogan Dam

HEC-HMS Subbasin Parameters
Calaveras River Basin: March 1995 Event

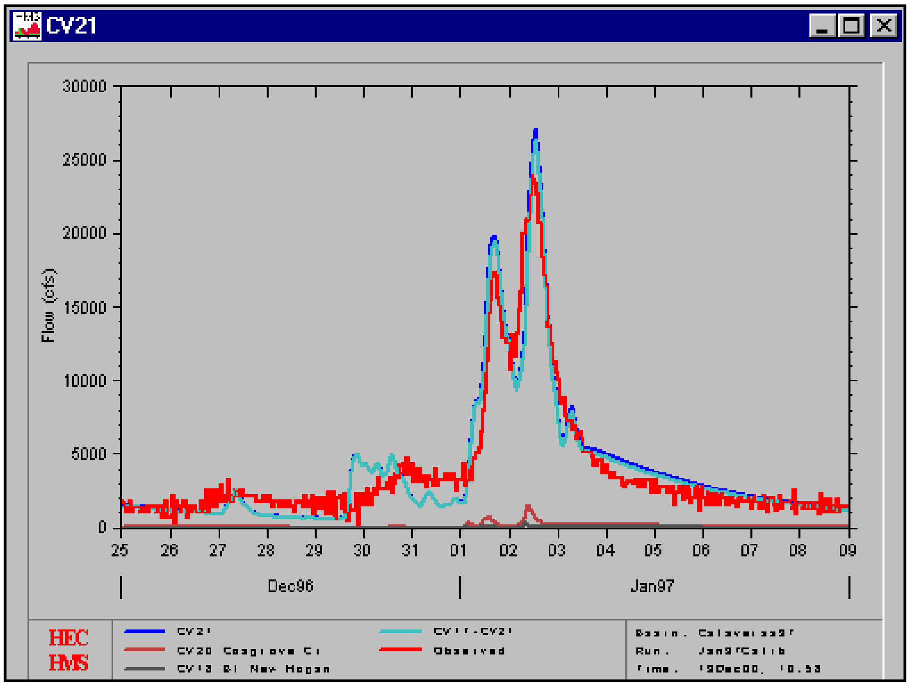
Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
CV2 NFK Headwater	1.5	0.75	0.18	1.7	0.06	0
CV4 Ab SFk	1.5	0.75	0.18	1.7	0.06	0
CV20 Cosgrove Cr	1.5	0.75	0.18	1.7	0.06	0
CV14 SFk Ab Confl	1.5	0.75	0.18	1.7	0.06	0
CV12 Calaveritas	1.5	0.75	0.18	1.7	0.06	0
CV18 Bl New Hogan	1.5	0.75	0.18	1.7	0.06	0
CVR16 New Hogan Res	1.5	0.75	0.18	1.7	0.06	10
CV8 SanAntonio	1.5	0.75	0.18	1.7	0.06	0
CV10 SFk Headwater	1.5	0.75	0.18	1.7	0.06	0
CV6 SanAntonio Hdwtr	1.5	0.75	0.18	1.7	0.06	0

HEC-HMS Summary of Results
Calaveras River Basin: December 1996 - January 1997 Event

Project	: Calaveras	Run Name	: Jan97Calib
Start of Run	: 25Dec96 0100	Basin Model	: Calaveras97
End of Run	: 08Jan97 2400	Met. Model	: Jan97
Execution Time	: 31May00 1342	Control Specs.	: Jan97

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
CV2 NFk Headwater	7825.5	02 Jan 97 1200	33880	85.322
CV3	7825.5	02 Jan 97 1200	33880	85.322
CV3-CV15	7722.4	02 Jan 97 1300	33883	85.322
CV6 SanAntonio Hdwtr	2976.0	02 Jan 97 1100	14466	31.540
CV7	2976.0	02 Jan 97 1100	14466	31.540
CV7-CV11	2902.3	02 Jan 97 1300	14467	31.540
CV10 SFk Headwater	4690.2	02 Jan 97 1200	15780	67.965
CV8 SanAntonio	1617.1	02 Jan 97 1100	5562.6	18.361
CV11	9016.4	02 Jan 97 1200	35809	117.866
CV11-CV13	8901.0	02 Jan 97 1200	35812	117.866
CV12 Calaveritas	4517.1	02 Jan 97 1200	17564	54.673
CV13	13418	02 Jan 97 1200	53376	172.539
CV13-CV15	13283	02 Jan 97 1300	53388	172.539
CV14 SFk Ab Confl	1070.7	02 Jan 97 0900	2402.6	8.400
CV4 Ab SFk	3482.3	02 Jan 97 1000	11083	40.939
CV15	23914	02 Jan 97 1300	100757	307.200
CV15-CV17	23982	02 Jan 97 1400	100776	307.200
CVR16 New Hogan Res	4510.9	02 Jan 97 1000	11448	54.911
CV17	26335	02 Jan 97 1400	112224	362.111
CV17-CV21	26325	02 Jan 97 1400	112227	362.111
CV18 Bl New Hogan	317.17	02 Jan 97 0800	517.16	1.486
CV20 Cosgrove Cr	1431.4	02 Jan 97 0900	3211.3	13.975
CV21	26971	02 Jan 97 1400	115955	377.572

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Calaveras River Basin
December 1996 - January 1997 Event

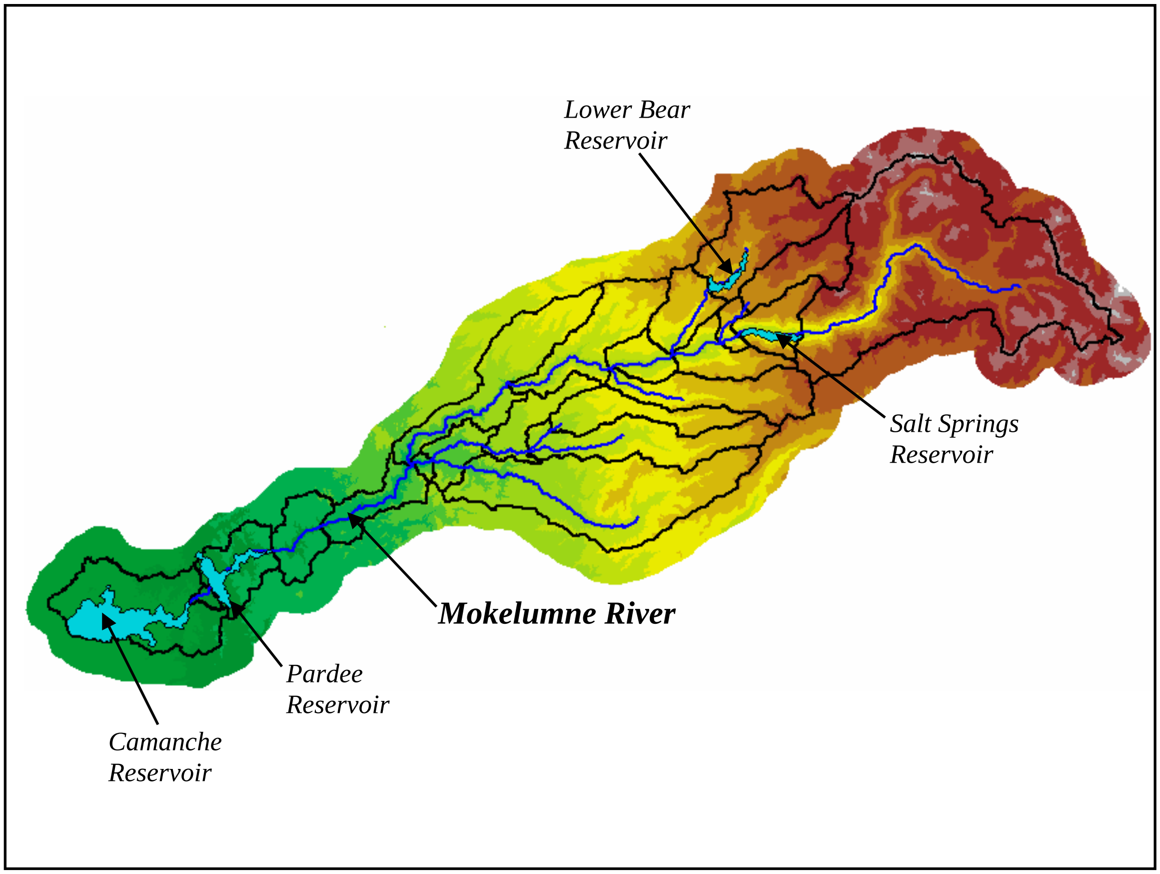


CV21 – Calaveras River Below New Hogan Dam

HEC-HMS Subbasin Parameters
Calaveras River Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
CV2 NFK Headwater	4	0.75	0.18	1	0.04	0
CV4 Ab SFk	4	0.75	0.18	1	0.04	0
CV20 Cosgrove Cr	4	0.75	0.18	1	0.04	0
CV14 SFk Ab Confl	4	0.75	0.18	1	0.04	0
CV12 Calaveritas	4	0.75	0.18	1	0.04	0
CV18 Bl New Hogan	4	0.75	0.18	1	0.04	0
CVR16 New Hogan Res	4	0.75	0.18	1	0.04	10
CV8 SanAntonio	4	0.75	0.18	1	0.04	0
CV10 SFk Headwater	4	0.75	0.18	1	0.04	0
CV6 SanAntonio Hdwtr	4	0.75	0.18	1	0.04	0

Mokelumne River Basin



HEC-GeoHMS Subbasin Delineation

Mokelumne River

The Mokelumne River HMS model consists of a 625 square mile basin above the Camanche Reservoir located in the northeast portion of the San Joaquin Watershed. The basin model is divided into 22 subbasins and connected with 18 routing reaches. Ten observed hydrographs were used to calibrate the model including: the inflow into Camanche, the inflow and outflow from the Pardee Reservoir, and the outflow from the Salt Springs Reservoir. The computed peak inflow into Camanche Reservoir for the 1997 event was larger than the 1995 event (36,459 cfs vs. 23,136 cfs).

The adopted TC and R (Group 1) values were used. The generic equation to compute the reach travel time (Muskingum K) was not used because the reach travel times were too short; thus, causing the computed peaks to occur too early. Instead, the reach travel time (K) was computed knowing the reach length and average velocity. The average velocity was computed using Manning's equation. The Manning's "n" value was estimated with Jarrett's equation, and the hydraulic radius was estimated from the Feather River equation, which was developed from a regression of field data (the Feather River equation was used because it was felt that it would represent the Mokelumne system the best). Of the 18 routing reaches, only 3 reaches used the Muskingum routing technique. The other 15 reaches used the lag method since the travel time within each of those reaches was less than the one-hour time step used by the Muskingum method. Three gages were used as part of the optimization process: Middle Fork Mokelumne at West Point (11317000); South Fork Mokelumne near West Point (11318500); and, Forest Creek (11316800). For the most part, the 1995 and 1997 computed hydrographs reasonably matched the observed hydrographs. Forty and fifty percent imperviousness were used for the subbasins that included the Camanche and Pardee reservoirs, respectively.

The Pardee outflow and the Camanche inflow hydrographs were nearly the same, since the Camanche is directly downstream of the Pardee reservoir. For this modeling effort, rather than attempt to predict how the Salt Springs and Pardee reservoirs were operated, the source and sink tools available in HMS were used. This technique allowed the observed outflow hydrographs from the Salt Springs and Pardee reservoirs to be passed downstream. As pointed out in "Section 6.6.5, Reservoir Modeling" of the main report, HMS is fairly limited in how it models releases from reservoirs. Another reason the observed reservoir outflows were used as sources was to replace the inadequate computed runoff from the upstream basins. Even with the losses reduced to minimal values, the computed volumes and peaks for the 1997 event could not match the observed inflow hydrograph. The thought was that the LWASS was not large enough to generate the observed volumes. This has been a problem in other basins as well.

Calibration of the 1995 Event:

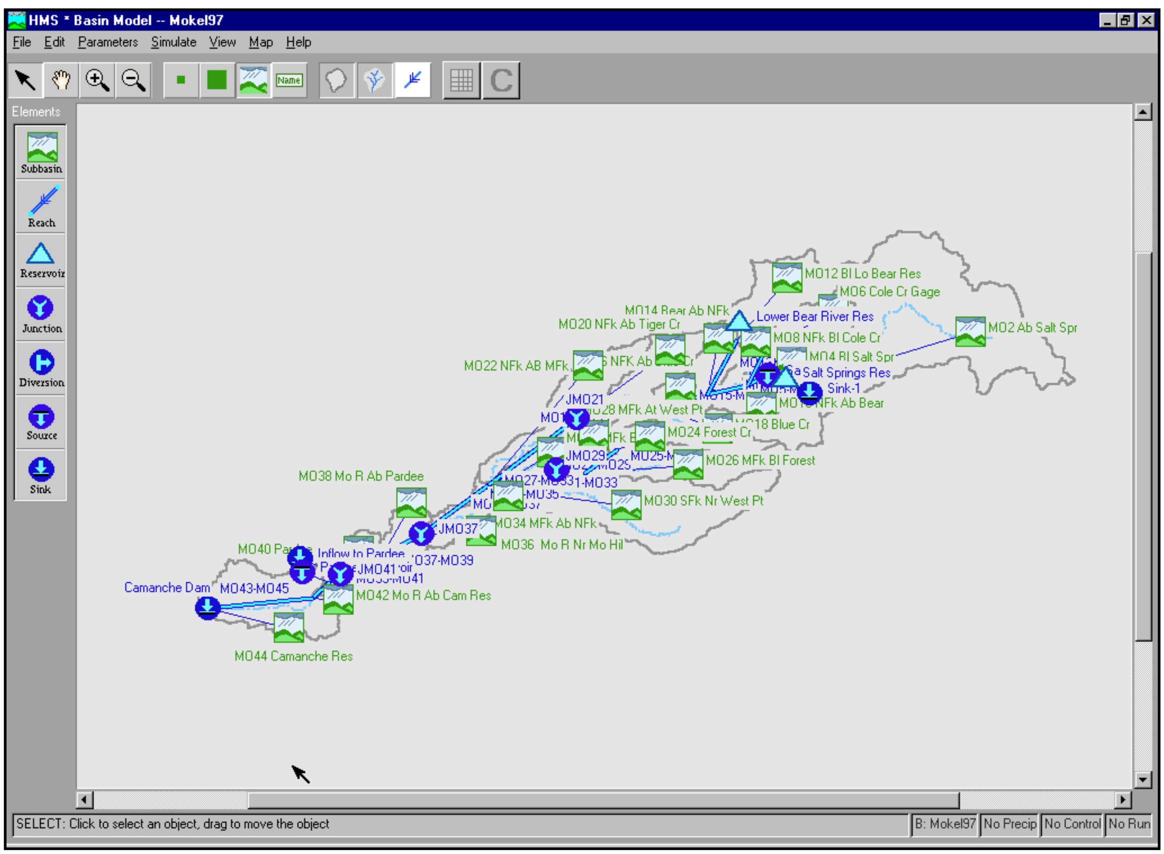
For the most part, the observed and computed hydrographs matched reasonably well. The only real exception was at the Pardee Reservoir inflow where neither the observed volume nor the observed peak could be matched. Interestingly, the computed and observed volumes and the peaks for the headwater basins matched relatively well. For the 1995 event, the initial losses were set to either 1.7 or 2.0 inches, except for the Cole Creek and Forest Creek subbasins, where they were set to 0.3 and 1.5 inches, respectively. The constant losses varied from basin to basin;

however, they were all in the normal range for constant losses. The initial baseflow values varied from 2 to 5 cfs per square mile, depending on the subbasin. The recession ratio and the threshold flow were 0.75 and 0.25, respectively.

Calibration of the 1997 Event:

For most cases, the observed and the computed hydrographs matched very well. Where there were problems were in the headwater basins where there wasn't enough runoff/snowmelt to produce the peaks or the volumes to match the observed hydrograph. In some cases where the observed hydrograph was based on daily records or some of the data were missing, the instantaneous peaks were obtained from the USGS to calibrate the model. In order to arrive at the 1997 observed flows, the majority of the initial losses were set to 2.5 inches. For subbasins that had an observed hydrograph, the initial losses were adjusted to match the locally observed hydrograph. For most subbasins, the constant losses were reduced to the minimal value of 0.001 inches/hour. The initial baseflow value was 5.0 cfs per square mile, the recession ratio of 0.8 and the threshold flow of 0.2 were used to calibrate the model.

Mokelumne River Basin HEC-HMS Model Schematic



Mokelumne River Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Initial TC $1.4(LL_{CA}/S^{1/2})^{.33}$ (Hr)	Initial R 1.5 TC (cfs/Hr)	Regression TC $0.68(LL_{CA}/S^{1/2})^{.46}$ (Hr)	Regression R 4.0 TC (cfs/Hr)
MO4 Bl Salt Spr	15.20	9.52	4.78	517.44	2.00	1.8	2.6	0.9	3.7
MO14 Bear Ab NFk	15.68	7.60	3.53	475.20	1.23	1.5	2.2	0.7	3.0
MO16 NFK Ab Blue Cr	9.97	5.78	2.25	390.72	0.66	1.2	1.8	0.6	2.2
MO10 NFk Ab Bear	15.67	9.68	4.13	464.64	1.86	1.7	2.6	0.9	3.6
MO8 NFk Bl Cole Cr	4.48	4.23	1.50	813.12	0.22	0.9	1.3	0.3	1.4
MO32 MFk Bl SFk	10.98	6.47	2.13	285.12	0.82	1.3	2.0	0.6	2.5
MO26 MFk Bl Forest	32.90	19.46	9.30	242.88	11.61	3.1	4.7	2.1	8.4
MO18 Blue Cr	28.96	16.74	9.36	290.40	9.20	2.9	4.4	1.9	7.5
MO22 NFk AB MFk	39.85	21.87	12.10	216.48	17.98	3.6	5.4	2.6	10.3
MO34 MFk Ab NFk	1.72	2.59	0.80	797.28	0.07	0.6	0.9	0.2	0.8
MO44 Camanche Res	46.08	13.00	5.27	52.80	9.43	2.9	4.4	1.9	7.6
MO40 Pardee Res	18.80	7.06	2.39	184.80	1.24	1.5	2.3	0.8	3.0
MO36 Mo R Nr Mo Hil	15.54	9.75	4.59	211.20	3.08	2.0	3.0	1.1	4.6
MO30 SFk Nr West Pt	74.99	26.01	11.50	190.08	21.69	3.9	5.8	2.8	11.2
MO28 MFk At West Pt	14.24	12.45	6.46	195.36	5.76	2.5	3.7	1.5	6.1
MO24 Forest Cr	20.78	16.28	7.12	242.88	7.43	2.7	4.1	1.7	6.8
MO6 Cole Cr Gage	20.87	11.94	5.75	242.88	4.40	2.3	3.4	1.3	5.4
MO12 Bl Lo Bear Res	37.13	13.67	6.00	248.16	5.20	2.4	3.6	1.5	5.8
MO20 NFk Ab Tiger Cr	30.23	15.15	8.16	279.84	7.39	2.7	4.1	1.7	6.8
MO42 Mo R Ab Cam Res	1.77	3.27	1.48	179.52	0.36	1.0	1.5	0.4	1.7
MO38 Mo R Ab Pardee	15.55	7.46	2.60	227.04	1.29	1.5	2.3	0.8	3.1
MO2 Ab Salt Spr	154.64	30.62	14.84	168.96	34.96	4.5	6.8	3.5	14.0

Mokelumne River Reach Parameters

Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Cum Drainage Area (from GeoHms) A (Sq. Mi.)	Feather River Field Reg. Eqa R =0.0043A + 6.051	Jarrett's Equation $n = .39S^{.38}R^{-.16}$	Manning's Velocity v (ft/s)	Travel Time K Hrs	Lag (Min)
MO7-MO9	3.27	0.149724	22	6.15	0.142	13.65	0.35	21
MO5-MO9	1.35	0.042222	170	6.79	0.086	12.73	0.16	9
MO13-MO15	5.74	0.083145	44	6.25	0.113	12.89	0.65	39
MO9-MO15	3.96	0.012876	208	6.95	0.055	11.25	0.52	31
MO15-MO19	4.68	0.007908	268	7.21	0.045	10.94	0.63	38
MO25-MO27	1.98	0.028861	21	6.15	0.076	11.20	0.26	16
MO27-MO33	4.78	0.049163	70	6.36	0.092	12.28	0.57	34
MO19-MO35	11.72	0.023127	365	7.63	0.067	13.03	1.32	MUSK
MO33-MO35	1.52	0.040870	155	6.72	0.085	12.58	0.18	11
MO31-MO33	2.46	0.058465	77	6.39	0.099	12.58	0.29	17
MO43-MO45	9.67	0.002481	580	436.05	0.035	121.89	0.12	7
MO39-MO41	5.32	0.011656	560	436.05	0.035	264.19	0.03	2
MO35-MO37	9.07	0.005954	538	8.37	0.040	11.96	1.11	MUSK
MO27-MO29	4.01	0.009236	66	6.34	0.049	10.02	0.59	35
MO3-MO5	4.51	0.013525	155	49.05	0.041	56.93	0.12	7
MO19-MO21	8.53	0.012071	326	7.46	0.053	11.84	1.06	MUSK
MO41-MO43	1.93	0.002585	580	8.55	0.035	9.05	0.31	19
MO37-MO39	4.12	0.002185	550	8.42	0.035	8.24	0.73	44

HEC-HMS Summary of Results
Mokelumne River Basin: March 1995 Event

Project : Mokelumne Run Name : Mar95Calib

Start of Run	: 08Mar95 0100	Basin Model	: Mokel95
End of Run	: 15Mar95 2400	Met. Model	: March 1995
Execution Time	: 31May00 1350	Control Specs.	: Mar 95 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
MO2 Ab Salt Spr	1168.5	15 Mar 95 1800	8084.2	154.644
MO3-MO5	1157.2	15 Mar 95 1800	8080.5	154.644
MO4 Bl Salt Spr	839.76	09 Mar 95 1600	4158.4	15.203
JMO05	1899.9	09 Mar 95 1700	12239	169.847
Sink-1	1899.9	09 Mar 95 1700	12239	169.847
MO30 SFk Nr West Pt	4964.9	10 Mar 95 2200	21278	74.993
MO31-MO33	4958.4	10 Mar 95 2200	21259	74.993
MO24 Forest Cr	1259.0	10 Mar 95 2000	5216.5	20.781
MO25-MO27	1253.5	10 Mar 95 2000	5211.1	20.781
MO26 MFk Bl Forest	1314.3	10 Mar 95 2000	5207.7	32.902
MO27-MO29	2540.7	10 Mar 95 2100	10399	53.683
MO28 MFk At West Pt	649.85	10 Mar 95 1900	2062.5	14.242
JMO29	3117.9	10 Mar 95 2000	12462	67.925
MO27-MO33	3109.9	10 Mar 95 2100	12442	67.925
MO32 MFk Bl SFk	1239.1	10 Mar 95 1900	4680.9	10.980
MO33-MO35	8810.0	10 Mar 95 2100	38360	153.898
MO12 Bl Lo Bear Res	655.40	15 Mar 95 1800	2718.7	37.125
MO13-MO15	639.49	15 Mar 95 1800	2707.9	37.125
SaltSprRes	402.00	10 Mar 95 2400	4916.4	170.000
MO5-MO9	401.10	10 Mar 95 2400	4913.8	170.000
MO6 Cole Cr Gage	1036.6	09 Mar 95 1600	3892.1	20.867
MO7-MO9	1029.6	09 Mar 95 1700	3879.8	20.867
MO8 NFk Bl Cole Cr	394.15	12 Mar 95 1300	1426.7	4.479
MO9-MO15	1435.5	15 Mar 95 1800	10188	195.346
MO14 Bear Ab NFk	842.04	10 Mar 95 1300	3403.7	15.681
MO10 NFk Ab Bear	776.55	10 Mar 95 1300	3368.2	15.666
MO15-MO19	2937.4	10 Mar 95 1300	19597	263.818
MO16 NFK Ab Blue Cr	848.11	12 Mar 95 1400	2524.5	9.971
MO18 Blue Cr	897.75	10 Mar 95 2000	4065.5	28.956
MO19-MO21	4366.5	10 Mar 95 1400	26024	302.745
MO20 NFk Ab Tiger Cr	1424.9	10 Mar 95 2000	5134.7	30.232
JMO21	5533.2	10 Mar 95 1400	31159	332.977
MO19-MO35	5401.2	10 Mar 95 1500	30908	332.977
MO34 MFk Ab NFk	254.59	10 Mar 95 1900	914.94	1.724
MO22 NFk AB MFk	2984.3	10 Mar 95 2000	12190	39.850
MO35-MO37	16923	10 Mar 95 2300	81974	528.449

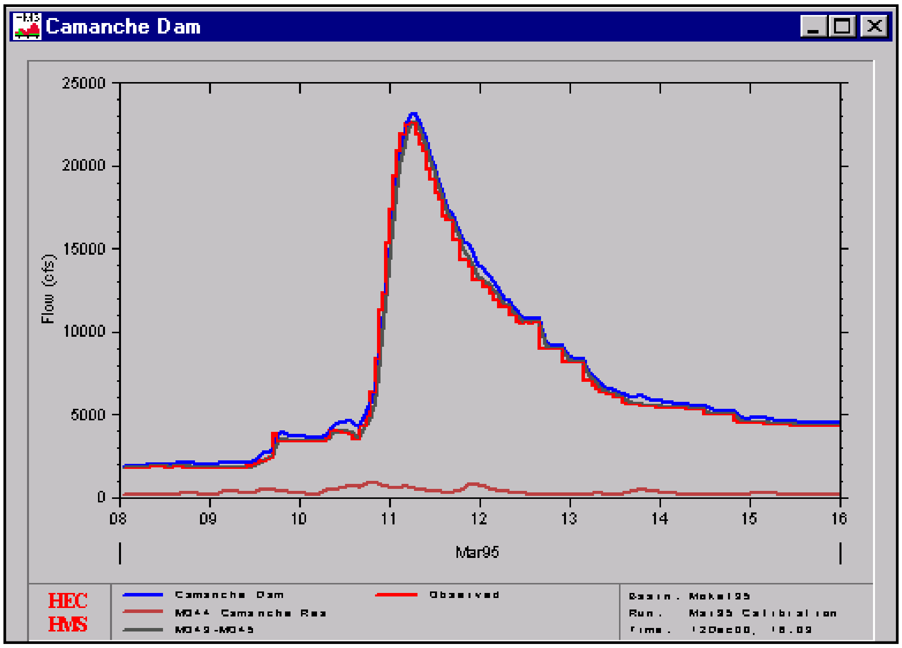
… Continued …

HEC-HMS Summary of Results
Mokelumne River Basin: March 1995 Event
(Continued)

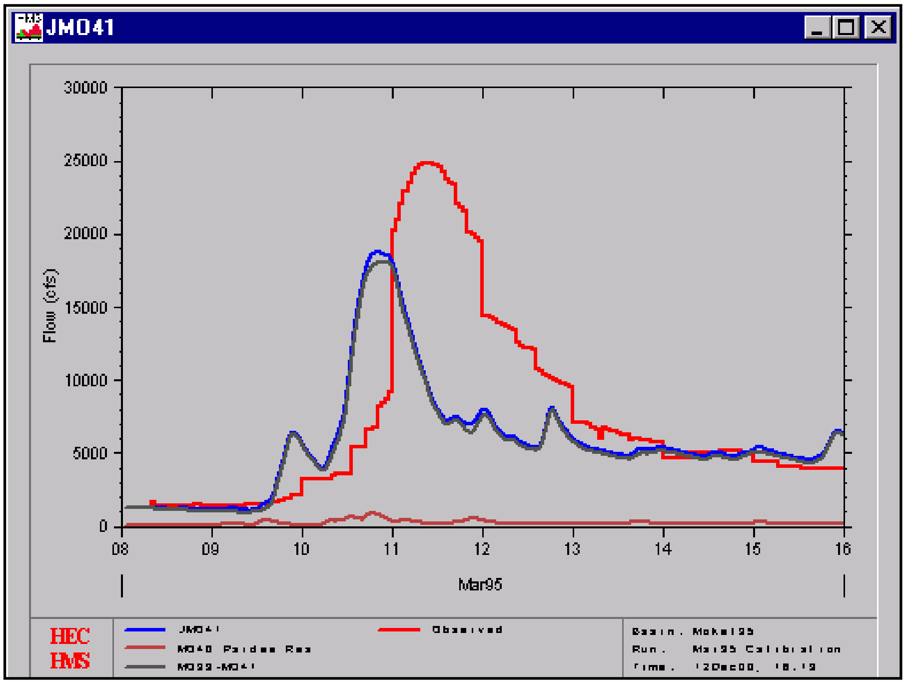
Project : Mokelumne Run Name : Mar95Calib

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
MO36 Mo R Nr Mo Hil	1314.5	10 Mar 95 2000	4957.3	15.537
JMO37	17826	10 Mar 95 2200	86931	543.986
MO37-MO39	17809	10 Mar 95 2300	86639	543.986
MO38 Mo R Ab Pardee	807.13	10 Mar 95 1900	2149.4	15.551
MO39-MO41	18082	10 Mar 95 2300	88685	559.537
MO40 Pardee Res	885.58	10 Mar 95 1900	3764.4	18.800
JMO41	18816	10 Mar 95 2000	92449	578.337
PardeeInflow	18816	10 Mar 95 2000	92449	578.337
Pardeeout	22622	11 Mar 95 0700	107000	578.000
MO41-MO43	22622	11 Mar 95 0700	106933	578.000
MO42 Mo R Ab Cam Res	39.645	11 Mar 95 2100	98.212	1.765
MO43-MO45	22622	11 Mar 95 0700	106979	579.765
MO44 Camanche Res	865.20	10 Mar 95 1900	4904.0	46.084
Camanche Dam	23136	11 Mar 95 0700	111883	625.849

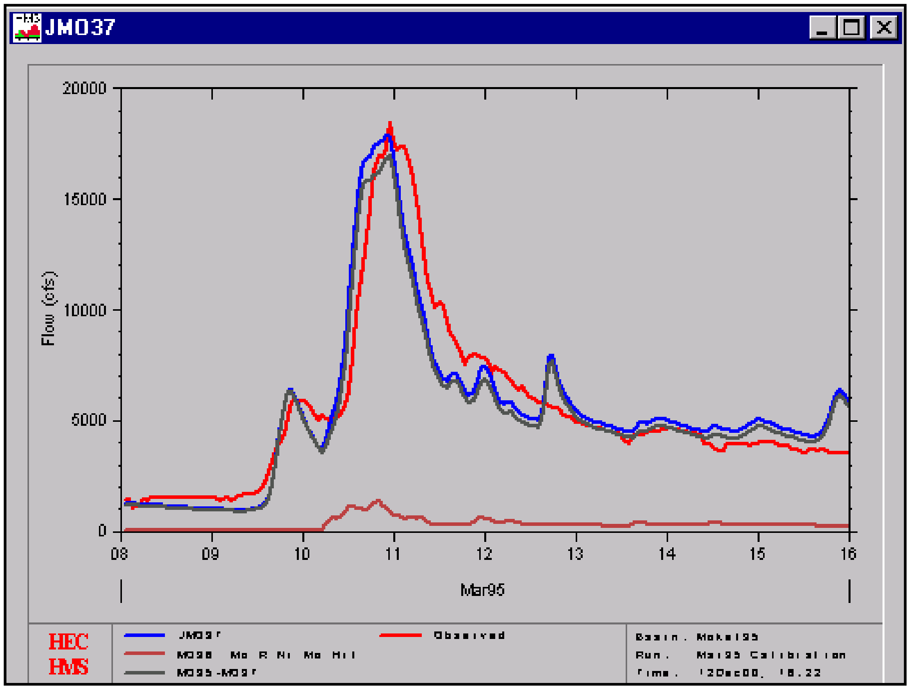
HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Mokelumne River Basin
March 1995 Event



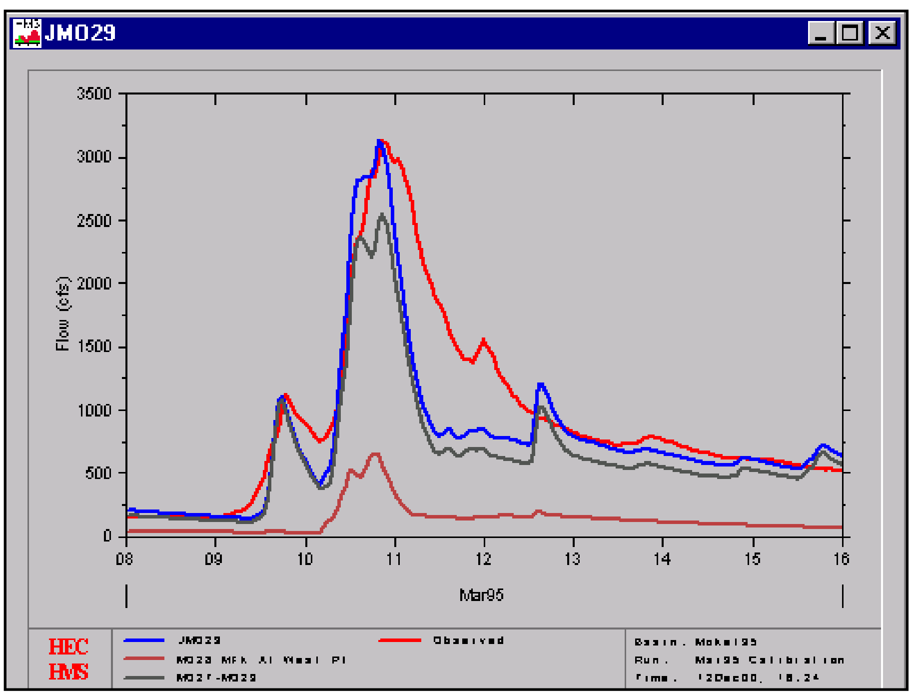
Inflow into Camanche Reservoir



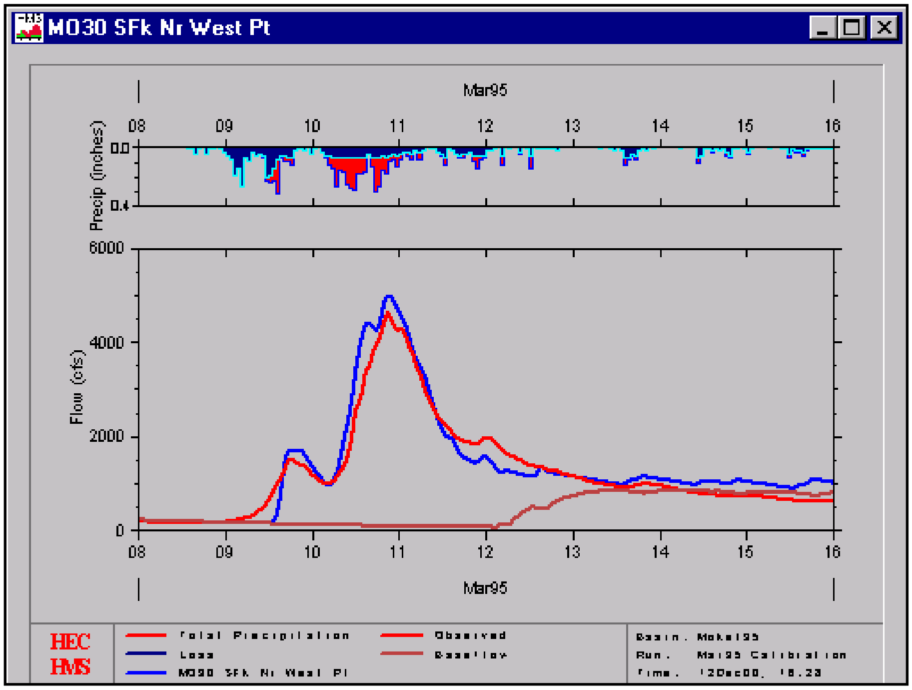
JMO41 Inflow into Pardee Reservoir



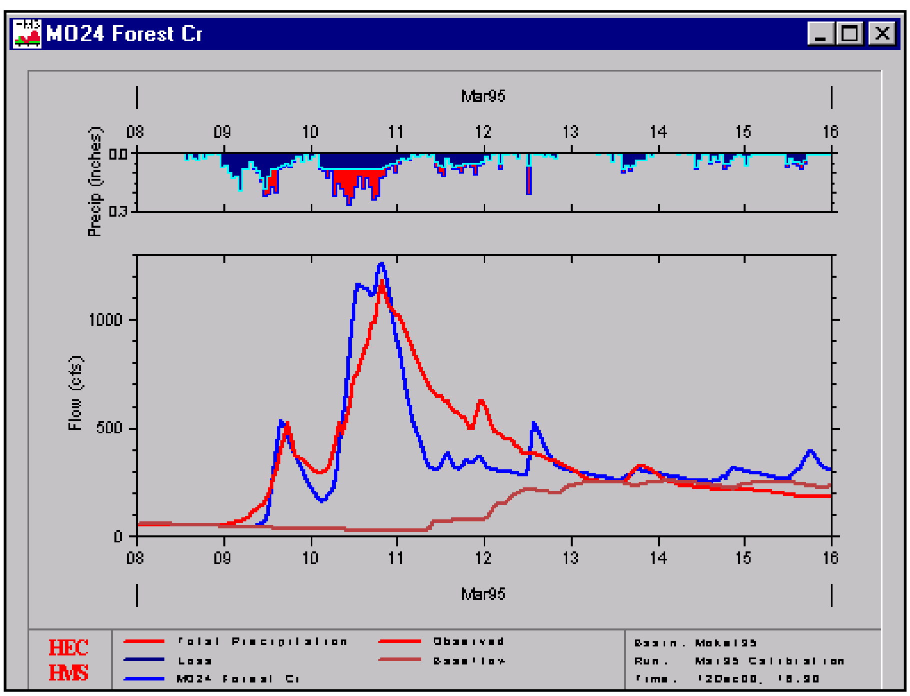
JMO37 Mokelumne River near Mokelumne Hill



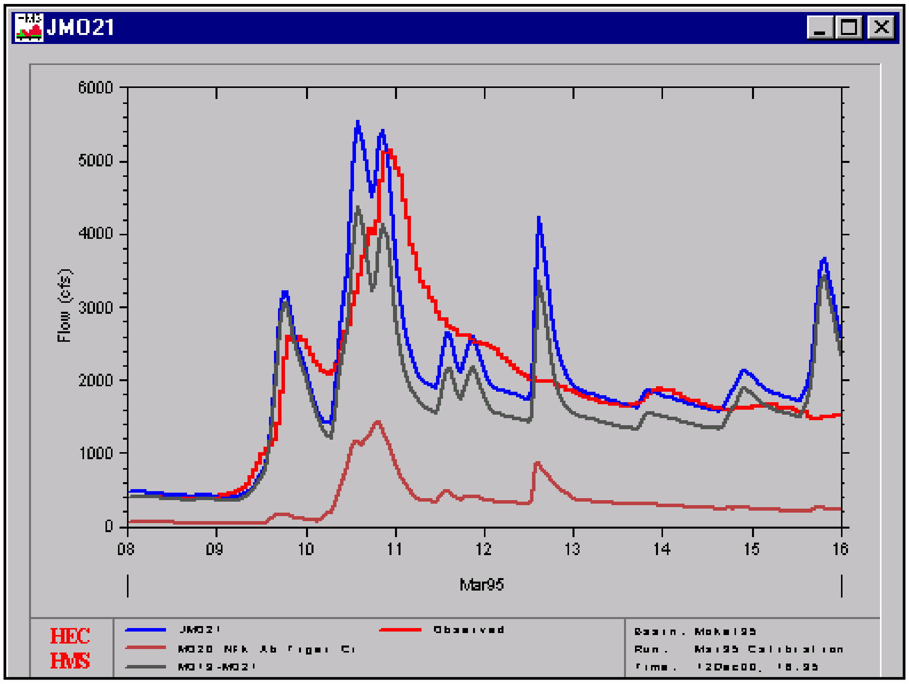
JMO29 Middle Fork Mokelumne River at West Point



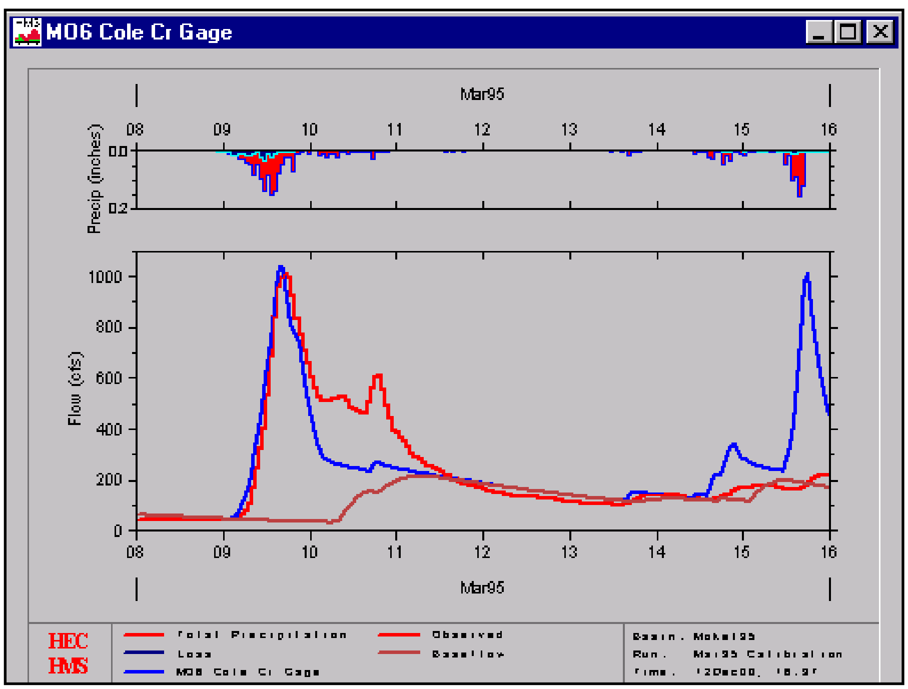
MO30 South Fork Mokelumne River near West Point



MO24 Forest Creek



JMO21 Middle Fork Mokelumne River above Tiger Creek



MO6 Cole Creek

HEC-HMS Subbasin Parameters
Mokelumne River Basin: March 1995 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
MO4 Bl Salt Spr	3	0.75	0.25	1.7	.07	0
MO14 Bear Ab NFk	2	0.75	0.25	2.0	.10	0
MO16 NFk Ab Blue Cr	2	0.75	0.25	2.0	.10	0
MO10 NFk Ab Bear	2	0.75	0.25	2.0	.10	0
MO8 NFk Bl Cole Cr	2	0.75	0.25	2.0	.10	0
MO32 MFk Bl SFk	5	0.75	0.25	1.7	.04	0
MO26 MFk Bl Forest	3	0.75	0.25	1.7	.12	0
MO18 Blue Cr	2	0.75	0.25	2.0	.10	0
MO22 NFk AB MFk	5	0.75	0.25	1.7	.04	0
MO34 MFk Ab NFk	5	0.75	0.25	1.7	.04	0
MO44 Camanche Res	3	0.75	0.25	1.7	.07	40
MO40 Pardee Res	3	0.75	0.25	1.7	.07	40
MO36 Mo R Nr Mo Hil	5	0.75	0.25	1.7	.04	0
MO30 SFk Nr West Pt	3	0.75	0.25	1.7	.07	0
MO28 MFk At West Pt	3	0.75	0.25	1.7	.12	0
MO24 Forest Cr	3	0.75	0.25	1.5	.08	0
MO6 Cole Cr Gage	3	0.75	0.25	0.3	.001	0
MO12 Bl Lo Bear Res	3	0.75	0.25	1.7	.07	0
MO20 NFk Ab Tiger Cr	2	0.75	0.25	2.0	.10	0
MO42 Mo R Ab Cam Res	3	0.75	0.25	1.7	.07	0
MO38 Mo R Ab Pardee	3	0.75	0.25	1.7	.07	0
MO2 Ab Salt Spr	3	0.75	0.25	1.7	.07	0

HEC-HMS Summary of Results
Mokelumne River Basin: December 1996 - January 1997 Event

Project	: Mokelumne	Run Name	: Jan97Calib
Start of Run	: 29Dec96 2400	Basin Model	: Mokel97
End of Run	: 08Jan97 2400	Met. Model	: January 1997
Execution Time	: 31May00 1350	Control Specs.	: Jan 97 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
MO2 Ab Salt Spr	18567	02 Jan 97 1600	79608	154.644
MO3-MO5	18559	02 Jan 97 1600	79604	154.644
MO4 Bl Salt Spr	2319.1	02 Jan 97 1400	10940	15.203
Salt Springs Res	20329	02 Jan 97 1600	90489	169.847
Sink-1	20329	02 Jan 97 1600	90489	169.847
MO30 SFk Nr West Pt	7022.8	02 Jan 97 1300	35344	74.993
MO31-MO33	7020.0	02 Jan 97 1300	35341	74.993
MO24 Forest Cr	1807.7	01 Jan 97 1600	8879.6	20.781
MO25-MO27	1792.7	01 Jan 97 1600	8879.1	20.781
MO26 MFk Bl Forest	2377.8	02 Jan 97 1300	11115	32.902
MO27-MO29	4099.6	02 Jan 97 1300	19994	53.683
MO28 MFk At West Pt	1028.1	02 Jan 97 1100	3582.6	14.242
JMO29	5056.9	02 Jan 97 1300	23577	67.925
MO27-MO33	5037.2	02 Jan 97 1300	23577	67.925
MO32 MFk Bl SFk	1464.4	02 Jan 97 1000	4837.9	10.980
MO33-MO35	13086	02 Jan 97 1300	63754	153.898
MO12 Bl Lo Bear Res	5701.3	02 Jan 97 1500	23205	37.125
MO13-MO15	5636.3	02 Jan 97 1500	23198	37.125
SaltSprRes	7880.0	03 Jan 97 0600	30223	170.000
MO5-MO9	7846.0	03 Jan 97 0700	30223	170.000
MO6 Cole Cr Gage	3363.2	02 Jan 97 1500	14004	20.867
MO7-MO9	3354.3	02 Jan 97 1500	14005	20.867
MO8 NFk Bl Cole Cr	752.73	01 Jan 97 1300	3361.8	4.479
MO9-MO15	8666.2	03 Jan 97 0700	47590	195.346
MO14 Bear Ab NFk	2235.6	01 Jan 97 1400	10700	15.681
MO10 NFk Ab Bear	2195.5	01 Jan 97 1400	10502	15.666
MO15-MO19	14084	02 Jan 97 1500	91972	263.818
MO16 NFK Ab Blue Cr	1122.1	01 Jan 97 1400	5267.7	9.971
MO18 Blue Cr	3618.3	02 Jan 97 1400	18444	28.956
MO19-MO21	18462	02 Jan 97 1600	115637	302.745
MO20 NFk Ab Tiger Cr	2891.6	02 Jan 97 1400	14080	30.232
JMO21	21103	02 Jan 97 1600	129717	332.977
MO19-MO35	21049	02 Jan 97 1700	129644	332.977
MO34 MFk Ab NFk	327.87	02 Jan 97 0900	940.53	1.724
MO22 NFk AB MFk	3257.8	02 Jan 97 1300	14012	39.850
MO35-MO37	35885	02 Jan 97 1700	208263	528.449

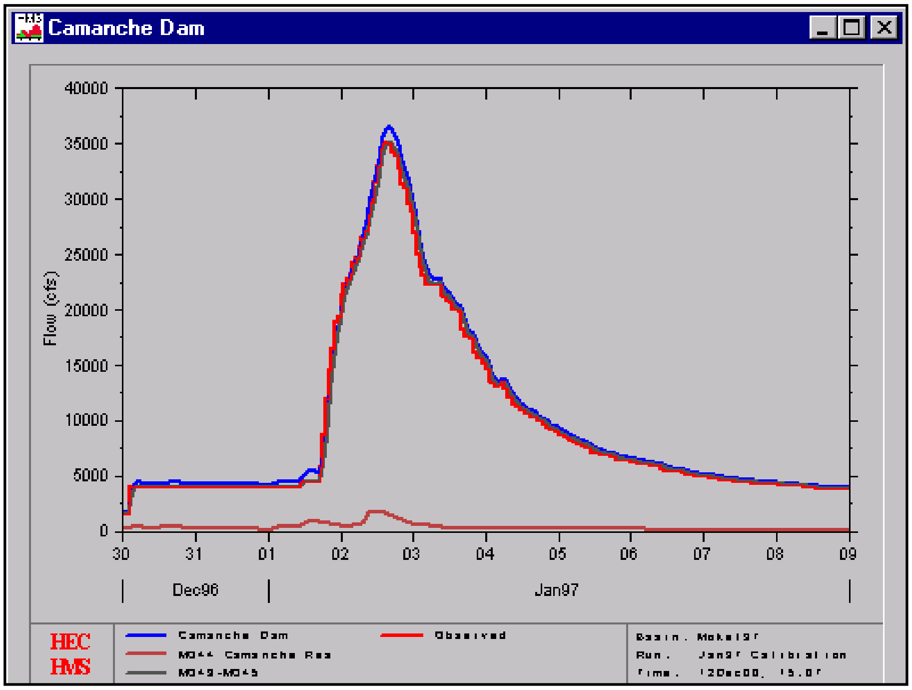
… Continued …

HEC-HMS Summary of Results
Mokelumne River Basin: December 1996 - January 1997 Event
(Continued)

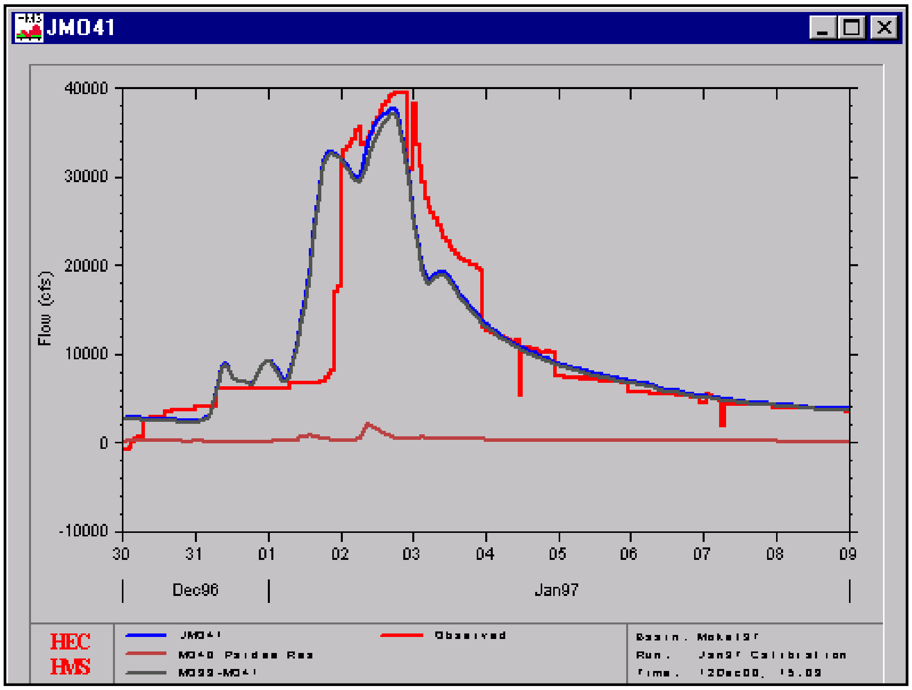
Project : Mokelumne Run Name : Jan97Calib

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
MO36 Mo R Nr Mo Hil	1654.5	02 Jan 97 1000	5060.2	15.537
JMO37	36793	02 Jan 97 1700	213323	543.986
MO37-MO39	36656	02 Jan 97 1800	213262	543.986
MO38 Mo R Ab Pardee	1569.8	02 Jan 97 0900	3951.3	15.551
MO39-MO41	37144	02 Jan 97 1800	217191	559.537
MO40 Pardee Res	2035.1	02 Jan 97 0900	5719.2	18.800
JMO41	37643	02 Jan 97 1700	222910	578.337
Inflow to Pardee	37643	02 Jan 97 1700	222910	578.337
Pardee Reservoir	34983	02 Jan 97 1700	192490	578.000
MO41-MO43	34982	02 Jan 97 1700	192430	578.000
MO42 Mo R Ab Cam Res	224.49	02 Jan 97 0900	479.27	1.765
MO43-MO45	35028	02 Jan 97 1700	192861	579.765
MO44 Camanche Res	1771.3	02 Jan 97 1200	6938.7	46.084
Camanche Dam	36459	02 Jan 97 1600	199800	625.849
Lower Bear River Res	0.0	29 Dec 96 2400	0.0	0.000

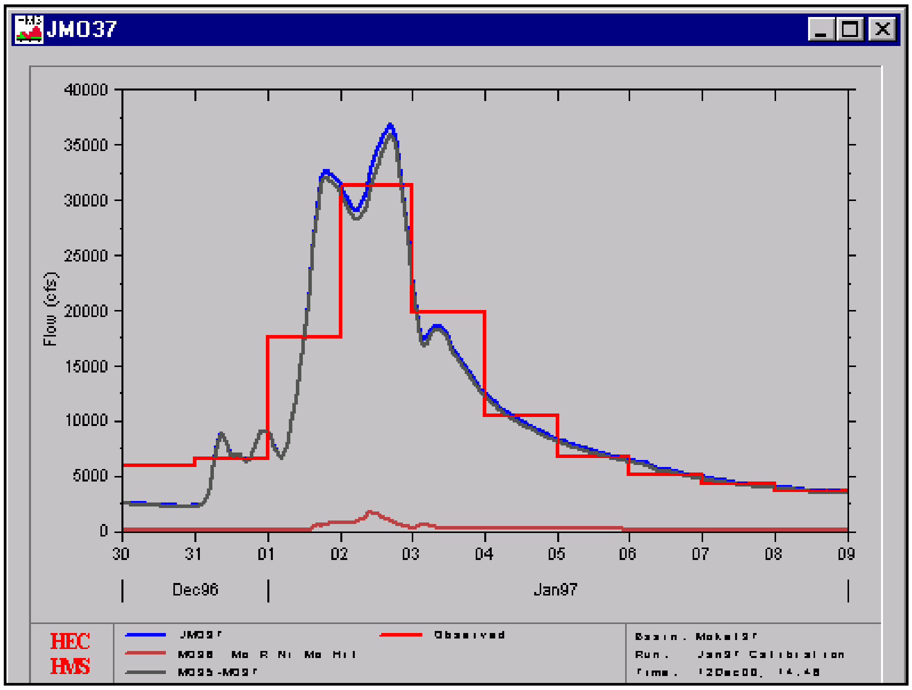
HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Mokelumne River Basin
December 1996 - January 1997 Event



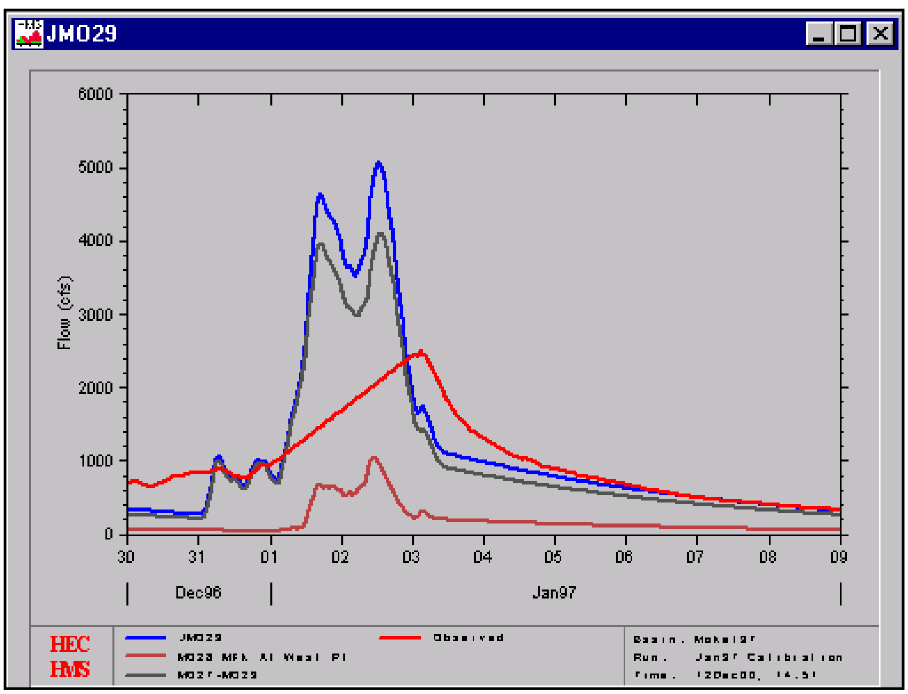
Inflow into Camanche Reservoir



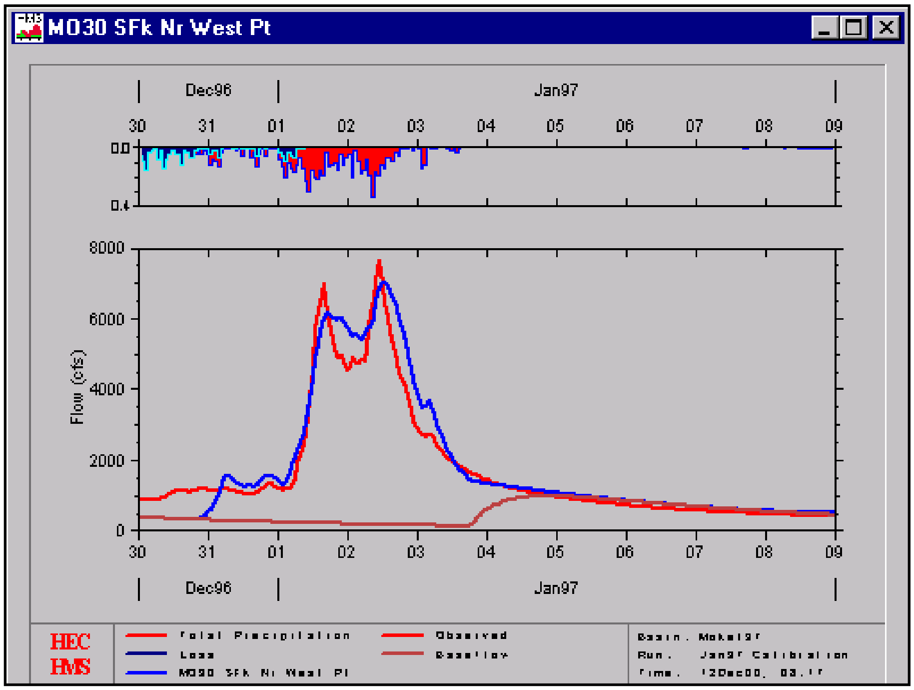
JMO41 Inflow into Pardee Reservoir



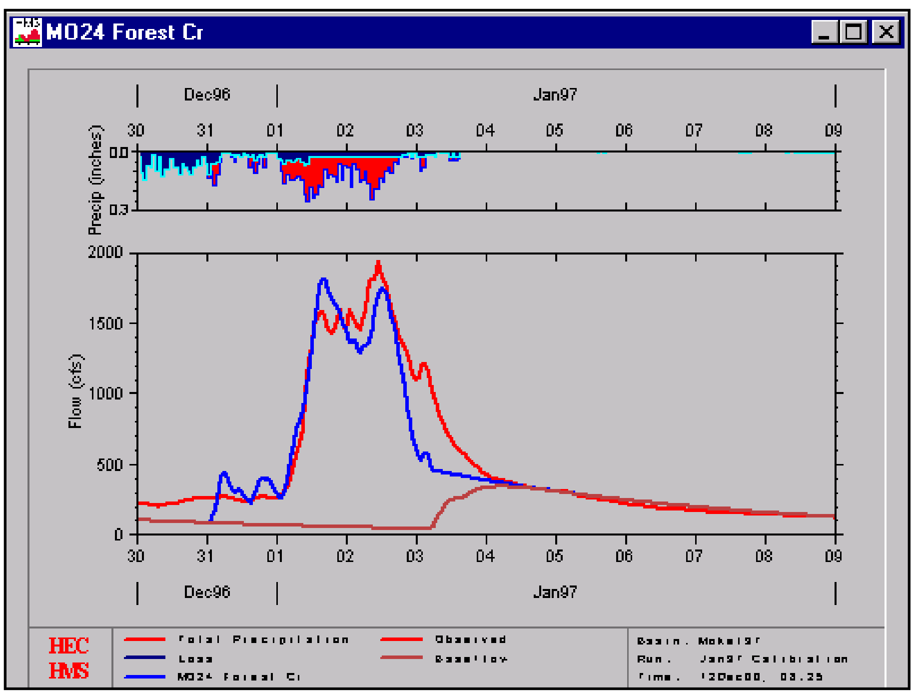
JMO37 Mokelumne River near Mokelumne Hill



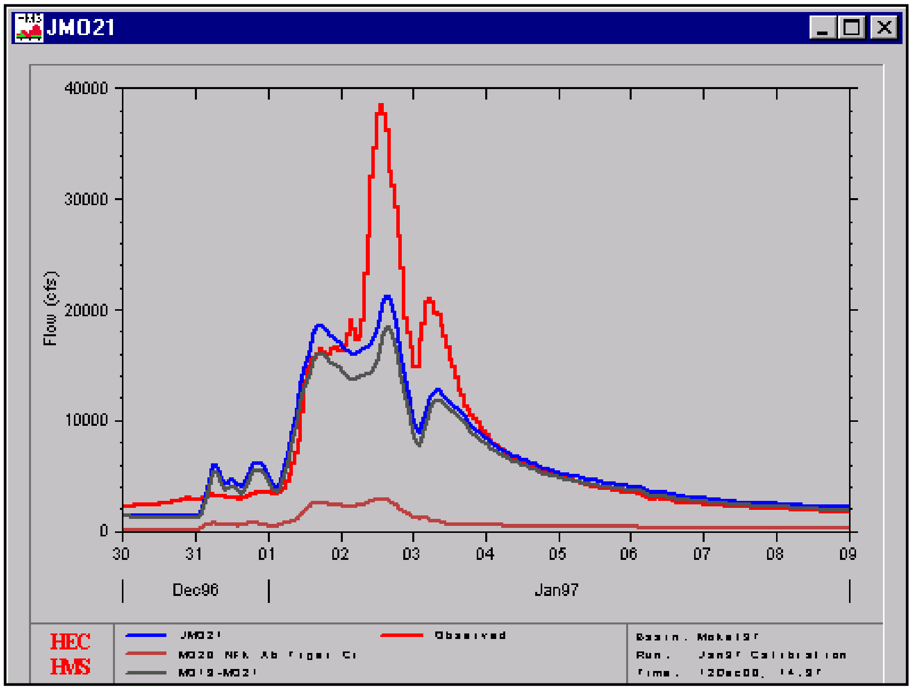
JMO29 Middle Fork Mokelumne River at West Point



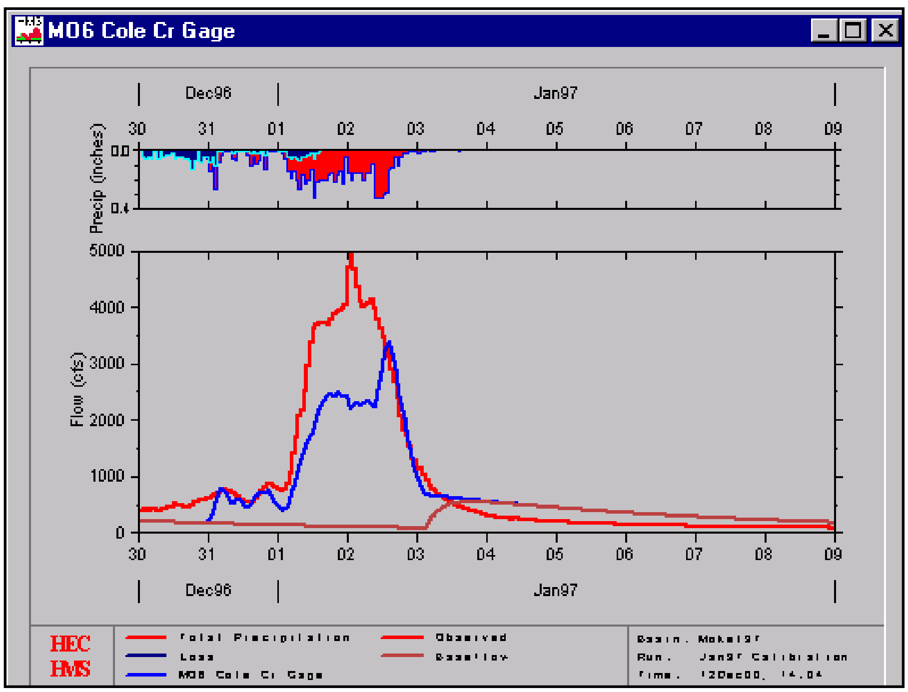
MO30 South Fork Mokelumne River near West Point



MO24 Forest Creek



JMO21 Middle Fork Mokelumne River above Tiger Creek

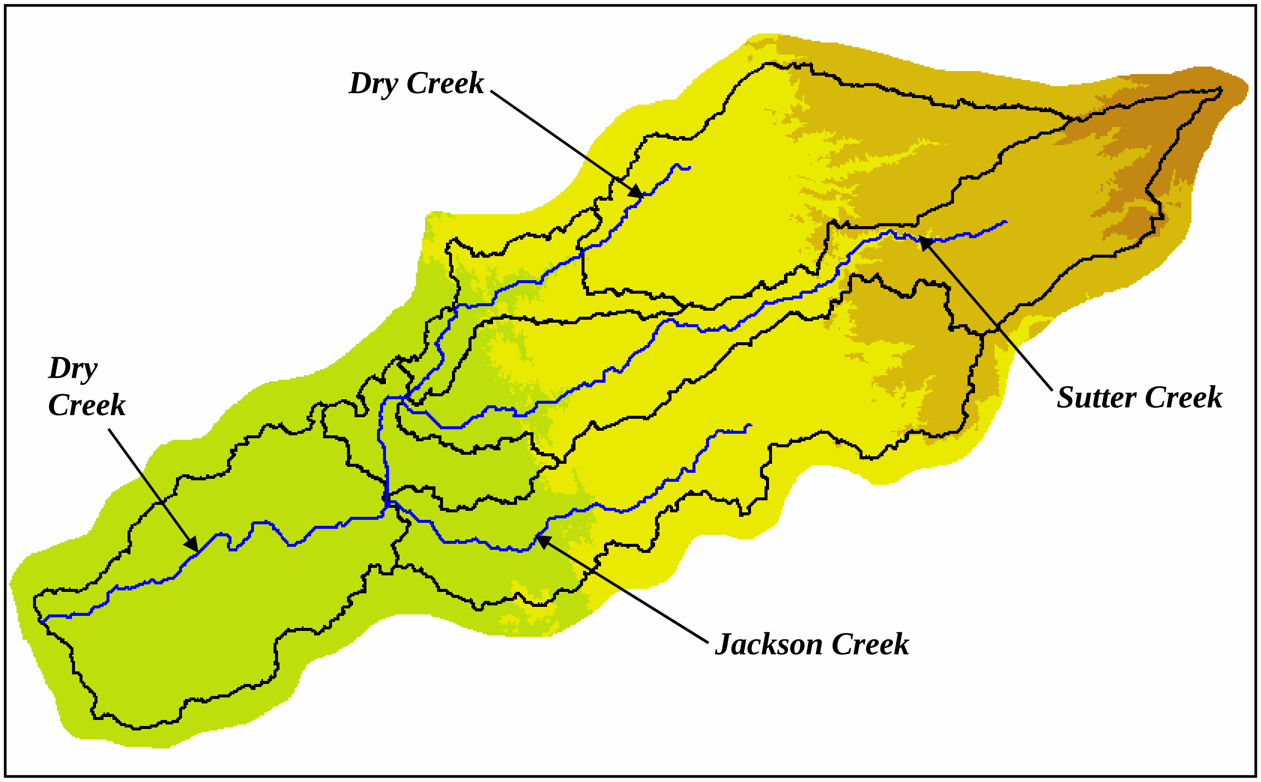


MO6 Cole Creek

HEC-HMS Subbasin Parameters
Mokelumne River Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
MO4 Bl Salt Spr	5	0.8	0.2	2.5	.001	0
MO14 Bear Ab NFk	5	0.8	0.2	2.5	.001	0
MO16 NFk Ab Blue Cr	5	0.8	0.2	2.5	.001	0
MO10 NFk Ab Bear	5	0.8	0.2	2.5	.001	0
MO8 NFk Bl Cole Cr	5	0.8	0.2	2.5	.001	0
MO32 MFk Bl SFk	5	0.8	0.2	2.5	.001	0
MO26 MFk Bl Forest	5	0.8	0.2	2.5	.045	0
MO18 Blue Cr	5	0.8	0.2	2.5	.001	0
MO22 NFk AB MFk	5	0.8	0.2	2.5	.001	0
MO34 MFk Ab NFk	5	0.8	0.2	2.5	.001	0
MO44 Camanche Res	5	0.8	0.2	2.5	.001	40
MO40 Pardee Res	5	0.8	0.2	2.5	.001	50
MO36 Mo R Nr Mo Hil	5	0.8	0.2	2.5	.001	0
MO30 SFk Nr West Pt	5	0.8	0.2	1.8	.001	0
MO28 MFk At West Pt	5	0.8	0.2	2.5	.045	0
MO24 Forest Cr	5	0.8	0.25	2.5	.025	0
MO6 Cole Cr Gage	10	0.8	0.2	2.0	.001	0
MO12 Bl Lo Bear Res	5	0.8	0.2	2.5	.001	0
MO20 NFk Ab Tiger Cr	5	0.8	0.2	2.5	.001	0
MO42 Mo R Ab Cam Res	5	0.8	0.2	2.5	.001	0
MO38 Mo R Ab Pardee	5	0.8	0.2	2.5	.001	0
MO2 Ab Salt Spr	5	0.8	0.2	2.5	.001	0

Dry Creek Basin



HEC-GeoHMS Subbasin Delineation

Dry Creek at Galt

The Dry Creek HMS model consists of a 325 square mile basin located in the northeast portion of the San Joaquin Watershed above Galt, CA and is situated between the Cosumnes and Mokelumne Rivers. The basin model is divided into 6 subbasins and connected with 3 routing reaches. With no observed flows in the basin, calibration could not be performed. Interestingly, the computed peak flow at the HMS basin model outlet for the 1995 event was greater than the 1997 event (8,578 cfs vs. 7,737 cfs); whereas, for the Cosumnes and Mokelumne basins, just the opposite was true. The headwater basins for Dry Creek do not extend as high in elevation as either of the two larger river basins, so perhaps Dry Creek is not receiving as much snowmelt as the other two river basins.

Using the adopted TC and R (Group 1) and initial Muskingum parameters, the HMS model was constructed. The initial and constant losses were kept at 1.5 inches and 0.05 inches/hour for both the 1995 and 1997 events. The baseflow values were also within the modeling guidelines.

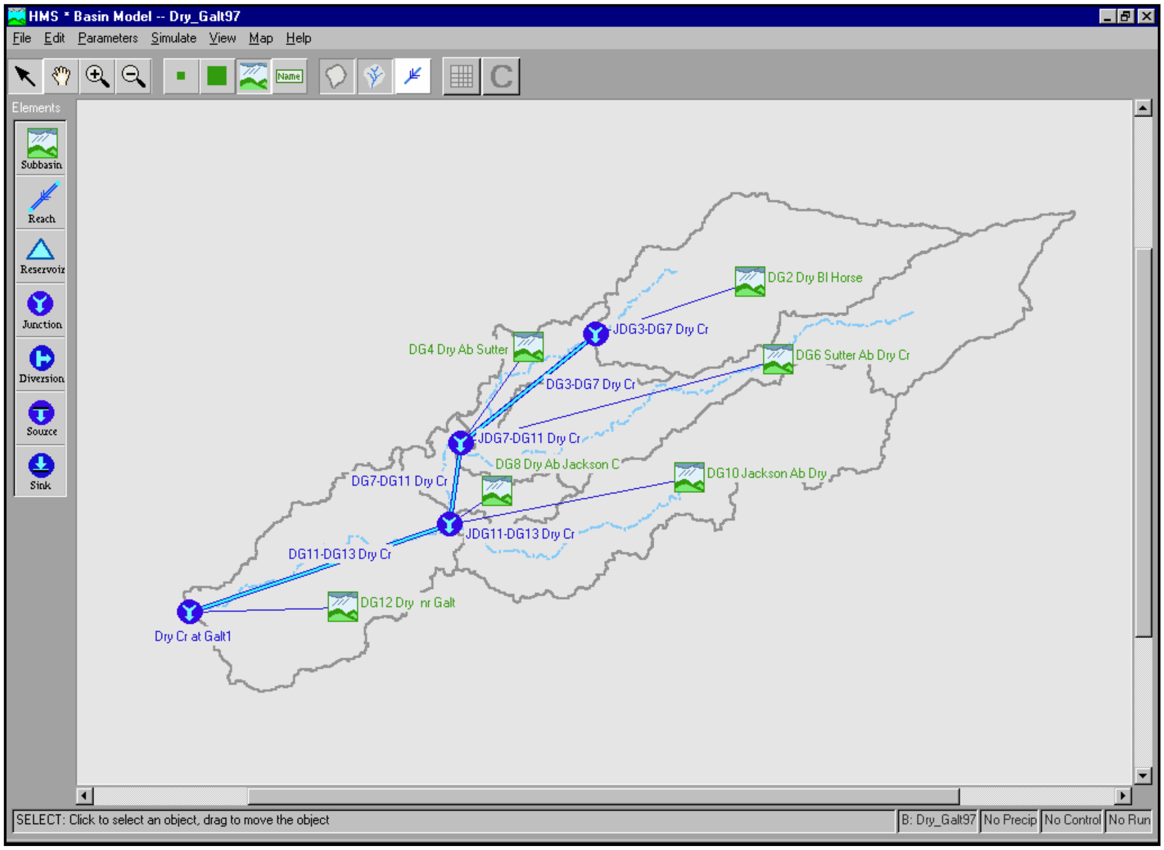
<u>Calibration of the 1995 Event:</u>

With no observed gage to calibrate to, the initial and constant loss rates of 1.5 inches and 0.05 inches/hour, respectively, were used. The baseflow values of 3.0 cfs per square mile, 0.8 and 0.2 for the initial flow, recession ratio, and the threshold flow, respectively, were also used to develop a flow at Galt, CA.

<u>Calibration of the 1997 Event:</u>

With no observed gage to calibrate to, the initial and constant loss rates of 1.5 inches and 0.05 inches/hour, respectively, were used. The baseflow values of 3.0 cfs per square mile, 0.8 and 0.2 for the initial flow, recession ratio, and the threshold flow, respectively, were also used to develop a flow at Galt, CA.

Dry Creek at Galt Basin HEC-HMS Model Schematic



Dry Creek at Galt Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Initial TC $1.4(LL_{CA}/S^{1/2})^{.33}$ (Hr)	Initial R 1.5 TC (cfs/Hr)	Regression TC $0.68(LL_{CA}/S^{1/2})^{.46}$ (Hr)	Regression R 4.0 TC (cfs/Hr)
DG2 Dry Bl Horse	67.19	20.10	9.32	142.56	15.69	3.5	5.2	2.4	9.7
DG4 Dry Ab Sutter	17.68	13.57	7.33	89.76	10.50	3.0	4.6	2.0	8.0
DG6 Sutter Ab Dry Cr	82.04	36.59	18.99	110.88	66.00	5.6	8.4	4.7	18.7
DG8 Dry Ab Jackson C	14.92	8.23	2.42	79.20	2.24	1.8	2.7	1.0	3.9
DG10 Jackson Ab Dry	77.00	27.91	14.58	95.04	41.72	4.8	7.2	3.8	15.1
DG12 Dry nr Galt	66.02	17.48	8.57	15.84	37.64	4.6	7.0	3.6	14.4

Dry Creek at Galt Reach Parameters

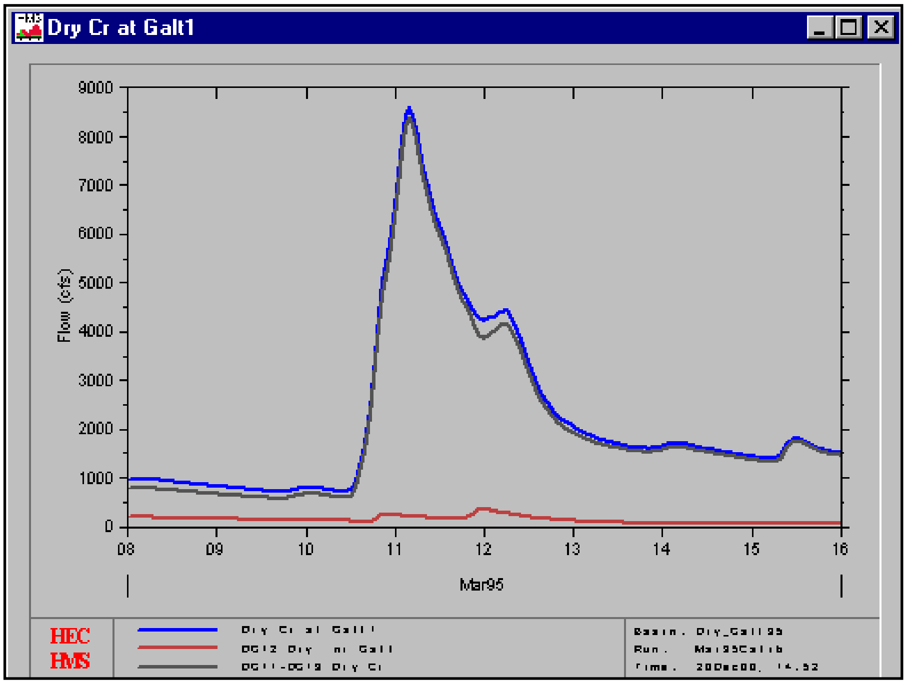
Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Ave Reach Vel $80\ S_R^{1/2}$ V_R (fps)	Initial K $1.47\ L_R / 1.5 V_R$ K (Hr)	Musk X or LAG (Min)	N steps Time Step= 60
DG3-DG7 Dry Cr	9.79	0.005	5.81	1.7	0.4	2
DG7-DG11 Dry Cr	4.56	0.002	3.65	1.2	0.4	1
DG11-DG13 Dry Cr	15.45	0.001	3.07	4.9	0.4	4

HEC-HMS Summary of Results
Dry Creek (at Galt) Basin: March 1995 Event

Project	: Dry_Galt	Run Name	: Mar95Calib
Start of Run	: 08Mar95 0100	Basin Model	: Dry_Galt95
End of Run	: 15Mar95 2400	Met. Model	: March 1995
Execution Time	: 31May00 1345	Control Specs.	: March 1995

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
DG2 Dry Bl Horse	3170.1	10 Mar 95 2000	11075	67.191
JDG3-DG7 Dry Cr	3170.1	10 Mar 95 2000	11075	67.191
DG3-DG7 Dry Cr	3143.6	10 Mar 95 2200	11024	67.191
DG4 Dry Ab Sutter	569.25	10 Mar 95 2000	1715.3	17.681
DG6 Sutter Ab Dry Cr	2709.9	10 Mar 95 2300	11194	82.037
JDG7-DG11 Dry Cr	6286.3	10 Mar 95 2200	23933	166.909
DG7-DG11 Dry Cr	6205.4	10 Mar 95 2300	23881	166.909
DG8 Dry Ab Jackson C	514.01	10 Mar 95 1900	1357.3	14.920
DG10 Jackson Ab Dry	2246.7	10 Mar 95 2200	8668.9	76.995
JDG11-DG13 Dry Cr	8596.7	10 Mar 95 2300	33907	258.824
DG11-DG13 Dry Cr	8369.6	11 Mar 95 0400	33647	258.824
DG12 Dry nr Galt	367.37	11 Mar 95 2300	2137.8	66.018
Dry Cr at Galt1	8578.1	11 Mar 95 0400	35785	324.842

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Dry Creek (at Galt) Basin
March 1995 Event



Dry Creek at Galt

HEC-HMS Subbasin Parameters
Dry Creek Basin: March 1995 Event

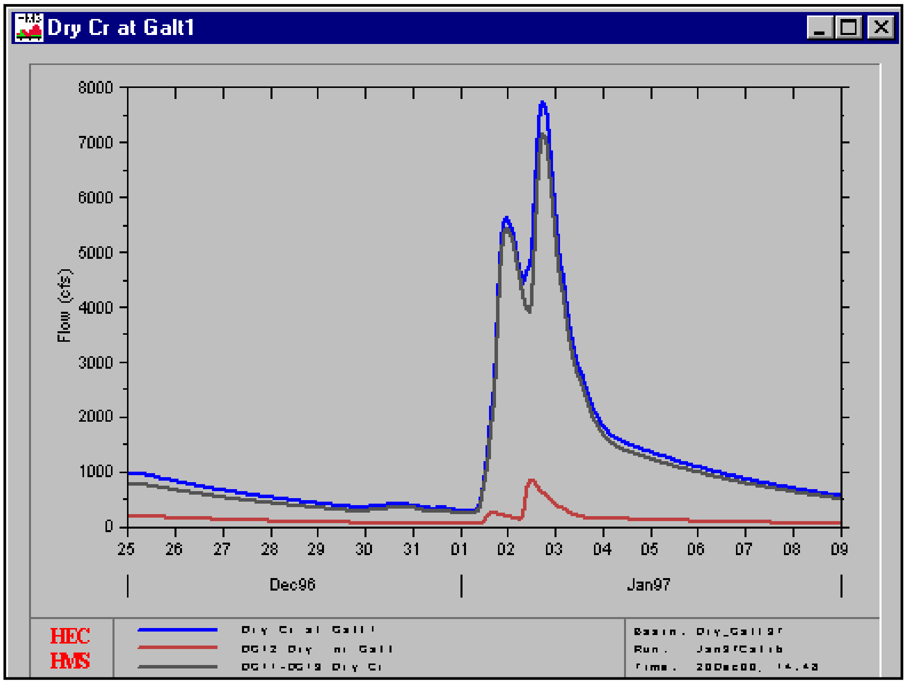
Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
DG2 Dry Bl Horse	3	0.8	0.2	1.5	.05	0
DG4 Dry Ab Sutter	3	0.8	0.2	1.5	.05	0
DG6 Sutter Ab Dry Cr	3	0.8	0.2	1.5	.05	0
DG8 Dry Ab Jackson C	3	0.8	0.2	1.5	.05	0
DG10 Jackson Ab Dry	3	0.8	0.2	1.5	.05	0
DG12 Dry nr Galt	3	0.8	0.2	1.5	.05	0

HEC-HMS Summary of Results
Dry Creek (at Galt) Basin: December 1996 - January 1997 Event

Project	: Dry_Galt		Run Name	: Jan97Calib	
Start of Run	: 25Dec96	0100	Basin Model	:	Dry_Galt97
End of Run	: 08Jan97	2400	Met. Model	:	Jan 1997
Execution Time	: 31May00	1345	Control Specs.	:	Jan 1997

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
DG2 Dry Bl Horse	1786.6	01 Jan 97 1600	7855.9	67.191
JDG3-DG7 Dry Cr	1786.6	01 Jan 97 1600	7855.9	67.191
DG3-DG7 Dry Cr	1782.0	01 Jan 97 1800	7870.5	67.191
DG4 Dry Ab Sutter	445.21	02 Jan 97 1000	1838.7	17.681
DG6 Sutter Ab Dry Cr	2365.1	02 Jan 97 1400	12119	82.037
JDG7-DG11 Dry Cr	4364.7	02 Jan 97 1300	21828	166.909
DG7-DG11 Dry Cr	4338.8	02 Jan 97 1400	21850	166.909
DG8 Dry Ab Jackson C	925.11	02 Jan 97 0900	2404.5	14.920
DG10 Jackson Ab Dry	2532.1	02 Jan 97 1300	11017	76.995
JDG11-DG13 Dry Cr	7258.4	02 Jan 97 1300	35272	258.824
DG11-DG13 Dry Cr	7126.5	02 Jan 97 1800	35386	258.824
DG12 Dry nr Galt	841.68	02 Jan 97 1200	3918.5	66.018
Dry Cr at Galt1	7736.6	02 Jan 97 1800	39304	324.842

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Dry Creek (at Galt) Basin
December 1996 - January 1997 Event

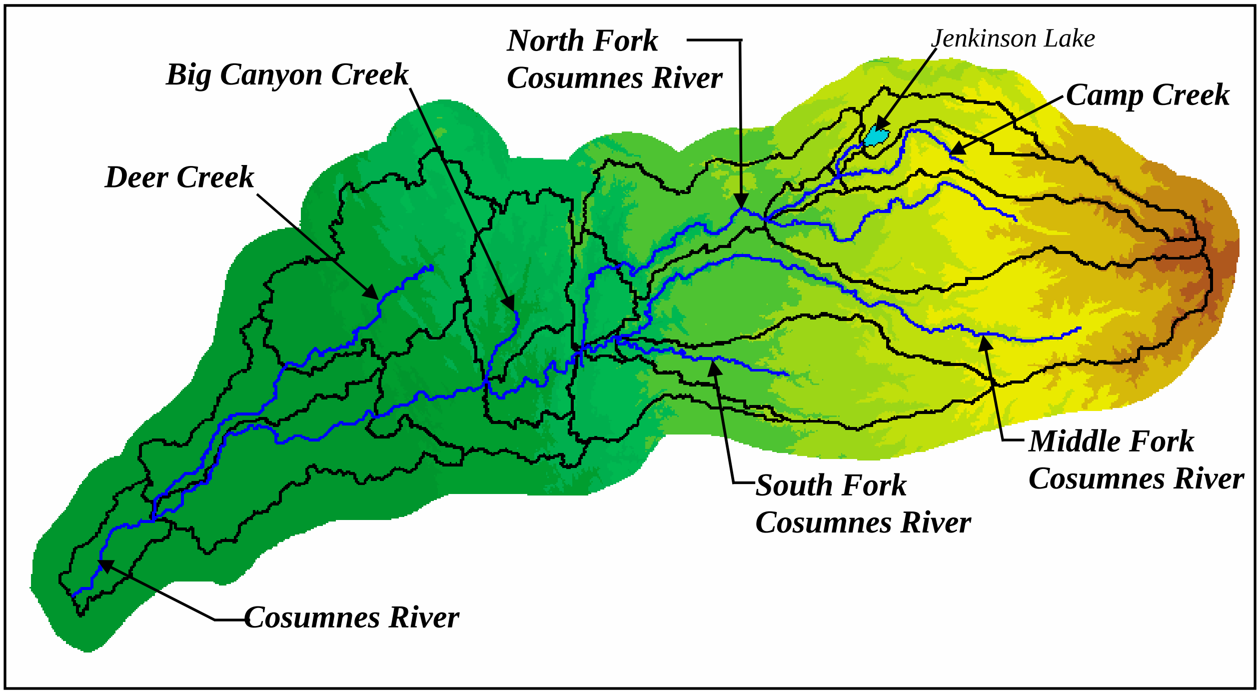


Dry Creek at Galt

HEC-HMS Subbasin Parameters
Dry Creek Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
DG2 Dry Bl Horse	3	0.8	0.2	1.5	.05	0
DG4 Dry Ab Sutter	3	0.8	0.2	1.5	.05	0
DG6 Sutter Ab Dry Cr	3	0.8	0.2	1.5	.05	0
DG8 Dry Ab Jackson C	3	0.8	0.2	1.5	.05	0
DG10 Jackson Ab Dry	3	0.8	0.2	1.5	.05	0
DG12 Dry nr Galt	3	0.8	0.2	1.5	.05	0

Cosumnes River Basin



HEC-GeoHMS Subbasin Delineation

Cosumnes River

The Cosumnes River HMS model consists of a 726 square mile basin located in the northeastern-most portion of the San Joaquin Watershed above the Highway 99 Bridge. The basin is divided into 18 subbasins and connected with 11 routing reaches. Two observed hydrographs were used to assist with the calibration: Camp Creek near Somerset (11333000), which includes the releases from the Sly Park Reservoir, and Cosumnes River above Michigan Bar (11335000). The computed peak flow at the HMS basin model outlet for the 1997 event was larger than the 1995 event (45,291 cfs vs. 27,719 cfs).

While the adopted value for TC was computed using the Group 2 equations, the value of R was set to 3.0TC. This revision was made so the shape of the computed hydrograph would better resemble the observed hydrograph. The generic equation to compute the reach travel time (Muskingum K) was not used because the reach travel times were too short; thus, causing the computed peaks to occur too early. Instead, the reach travel time (K) was computed knowing the reach length and average velocity. The average velocity was computed using Manning's equation. The Manning's "n" value was estimated with Jarrett's equation, and the hydraulic radius was estimated from the Feather River equation, which was developed from a regression of field data (the Feather River equation was used because it was felt that it would represent the Cosumnes system the best). Of the 11 routing reaches, 6 reaches used the Muskingum routing technique. The other 5 reaches used the lag method since the travel time within each of those reaches was less than the one-hour time step used by the Muskingum method.

For this modeling effort, rather than attempt to predict how the Sly Park Reservoir was operated, the source and sink tools available in HMS were implemented. This technique allowed the observed hydrograph at Camp Creek, which included outflow from the Sly Park Reservoir, to be passed downstream. As pointed out in "Section 6.6.5, Reservoir Modeling" of the main report, HMS is fairly limited in how it models releases from reservoirs. Another reason the observed reservoir outflows were used as sources was to replace the inadequate computed runoff from the upstream basins. Even with the losses reduced to minimal values, the computed volumes and peaks for the 1997 event could not match the observed hydrographs. The thought was that the LWASS was not large enough to generate the observed volumes. The timing appears consistent with the observed hydrograph, but the volume and peak are not. This has been a problem in other basins as well. For the 1995 event, the observed and computed hydrographs matched very well.

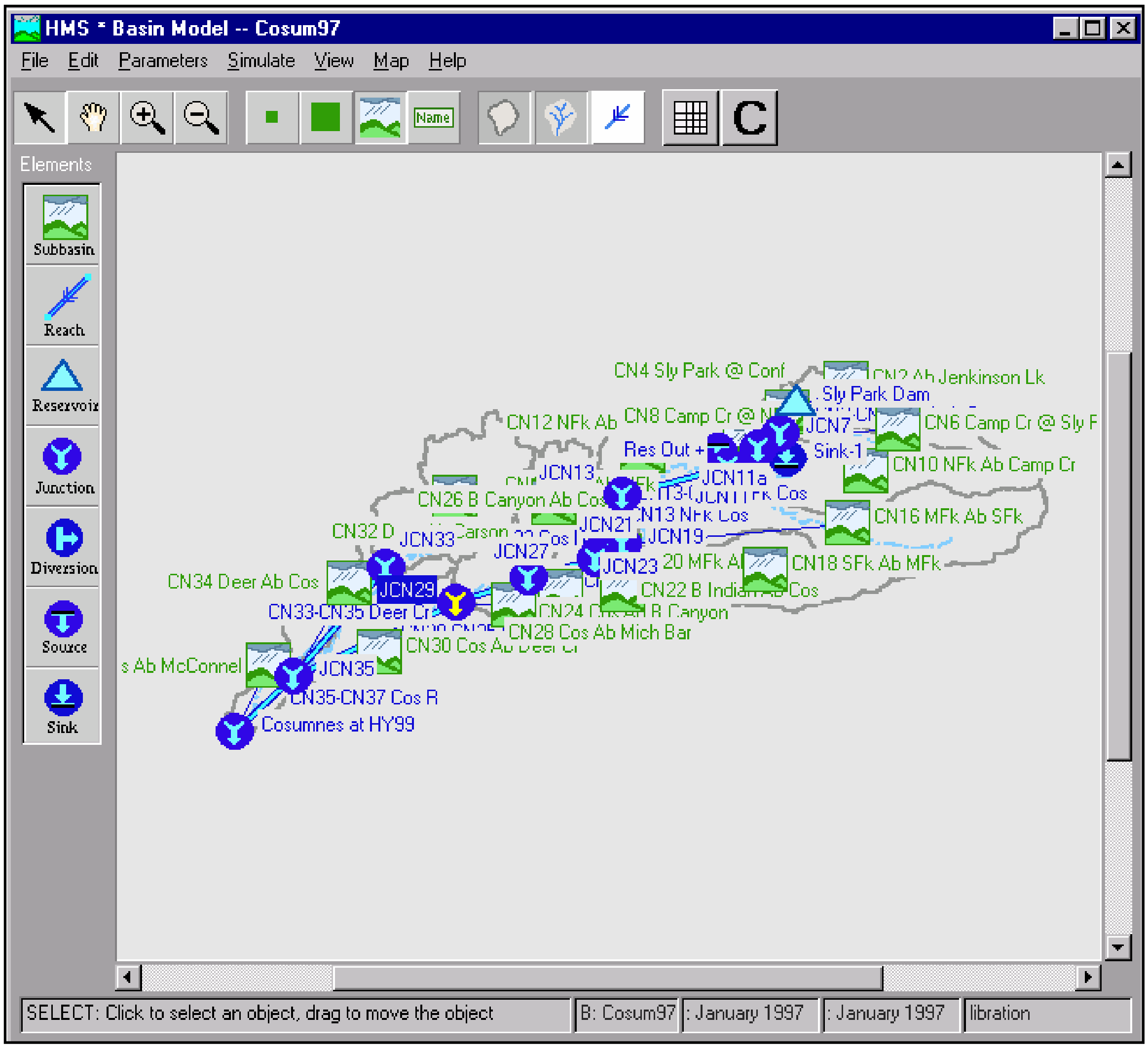
Calibration of the 1995 Event:

With the losses set to typical values (1.5 inches for initial losses and 0.01 inches/hour for constant losses), the observed and computed hydrographs matched very well at both gages. The timing, volume, and peaks all matched. The baseflow values of 3.0 cfs per square mile, 0.8 and 0.22 for the initial flow, recession ratio, and the threshold flow, respectively, were also used to calibrate the model.

Calibration of the 1997 Event:

As mentioned above, the observed and computed hydrograph peaks and volumes did not match for either gage. Even with the initial loss rates set to 0.1 or 0.5 inches and a constant loss rate of 0.001 inches/hour, the model could not produce enough volume. Better calibration of the snowmelt model would have to be performed for this basin. The baseflow values of 5.0 cfs per square mile, 0.8 and 0.22 for the initial flow, recession ratio, and the threshold flow, respectively, were also used to calibrate the model.

Cosumnes River Basin HEC-HMS Schematic



Cosumnes River Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Initial TC $1.4(LL_{CA}/S^{1/2})^{.33}$ (Hr)	Initial R 1.5 TC (cfs/Hr)	Regresssion TC $1.67(LL_{CA}/S^{1/2})^{.29}$ (Hr)	Regression R 3.0 TC (cfs/Hr)
CN16 MFk Ab SFk	134.02	43.26	24.23	158.40	83.26	6.0	9.0	6.0	18.1
CN10 NFk Ab Camp Cr	82.70	31.07	16.84	184.80	38.49	4.7	7.0	4.8	14.4
CN12 NFk Ab Martinez	52.24	20.37	6.88	153.12	11.32	3.1	4.7	3.4	10.1
CN34 Deer Ab Cos	33.81	19.88	9.66	21.12	41.78	4.8	7.2	4.9	14.8
CN24 Cos Ab B Canyon	18.01	9.83	4.24	126.72	3.71	2.2	3.2	2.4	7.3
CN14 NFk Ab MFk	14.53	8.26	3.90	147.84	2.65	1.9	2.9	2.2	6.6
CN22 B Indian Ab Cos	22.38	18.10	9.31	116.16	15.64	3.5	5.2	3.7	11.1
CN20 MFk Ab NFk	1.84	3.67	1.61	285.12	0.35	1.0	1.5	1.2	3.7
CN32 Deer Ab Carson	83.89	22.38	10.50	68.64	28.37	4.2	6.3	4.4	13.2
CN26 B Canyon Ab Cos	41.86	14.35	7.62	89.76	11.54	3.1	4.7	3.4	10.2
CN18 SFk Ab MFk	65.49	25.83	15.18	153.12	31.69	4.4	6.6	4.5	13.6
CN30 Cos Ab Deer Cr	54.98	23.87	11.42	26.40	53.07	5.2	7.8	5.3	15.9
CN36 Cos Ab McConnel	17.62	9.34	3.93	5.28	15.97	3.5	5.2	3.7	11.2
CN28 Cos Ab Mich Bar	40.17	16.68	5.95	58.08	13.02	3.3	4.9	3.5	10.5
CN4 Sly Park @ Conf	2.05	3.96	1.83	343.20	0.39	1.0	1.5	1.3	3.8
CN2 Ab Jenkinson Lk	18.67	11.79	5.11	216.48	4.10	2.2	3.3	2.5	7.5
CN8 Camp Cr @ NFk	4.62	5.68	2.85	359.04	0.86	1.3	2.0	1.6	4.8
CN6 Camp Cr @ Sly P	37.53	26.83	13.92	190.08	27.09	4.2	6.2	4.3	13.0

Cosumnes River Reach Parameters

Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Cum Drainage Area (from GeoHms) A (Sq. Mi.)	Feather River Field Reg. Eqa R =0.0043A + 6.051	Jarrett's Equation $n = .39S^{.38}R^{-.16}$	Manning's Velocity v (ft/s)	Travel Time K Hrs	Lag (Min)
CN3-CN7 Sly Park Cr	2.85	0.054	20	6.14	0.096	12.06	0.35	21
CN7-CN11 Camp Cr	5.23	0.027	60	6.31	0.073	11.34	0.68	41
CN11-CN13 NFk Cos	12.25	0.013	169	6.78	0.055	11.05	1.63	MUSK
CN13-CN21 NFk Cos	7.01	0.004	204	6.93	0.035	9.73	1.06	MUSK
CN19-CN21 MFk Cos	2.64	0.008	200	6.92	0.046	10.60	0.37	22
CN21-CN23 Cos R	0.32	0.003	414	7.84	0.035	9.89	0.05	3
CN23-CN27 Cos R	9.57	0.008	443	7.96	0.045	11.92	1.18	MUSK
CN33-CN35 Deer Cr	13.22	0.001	107	6.52	0.035	4.61	4.21	MUSK
CN29-CN35 Cos R	17.47	0.001	569	8.50	0.035	5.81	4.41	MUSK
CN35-CN37 Cos R	7.67	0.001	714	9.13	0.035	5.21	2.16	MUSK
CN27-CN29 Cos R	7.73	0.005	510	8.25	0.037	11.61	0.98	59

HEC-HMS Summary of Results
Cosumnes River Basin: March 1995 Event

Project	: Cosumnes		Run Name	: Mar95Calib
Start of Run	: 08Mar95	0100	Basin Model	: Cosum95
End of Run	: 15Mar95	2400	Met. Model	: March 1995
Execution Time	: 31May00	1344	Control Specs.	: March 1995

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
CN32 Deer Ab Carson	3430.4	11 Mar 95 1400	15161	83.893
JCN33	3430.4	11 Mar 95 1400	15161	83.893
CN33-CN35 Deer Cr	3397.4	11 Mar 95 1900	15019	83.893
CN18 SFk Ab MFk	4504.6	10 Mar 95 2200	20144	65.491
CN16 MFk Ab SFk	7035.6	10 Mar 95 2400	37259	134.019
JCN19	11469	10 Mar 95 2300	57403	199.510
CN19-CN21 MFk Cos	11425	10 Mar 95 2400	57336	199.510
Res Out +	3810.0	10 Mar 95 2200	17740	62.200
CN10 NFk Ab Camp Cr	4805.2	10 Mar 95 2300	23950	82.698
JCN11	8609.8	10 Mar 95 2200	41689	144.898
CN11-CN13 NFk Cos	8578.1	10 Mar 95 2400	41481	144.898
CN12 NFk Ab Martinez	1875.2	10 Mar 95 2100	8531.0	52.238
JCN13	10161	10 Mar 95 2300	50012	197.136
CN13-CN21 NFk Cos	10172	10 Mar 95 2400	49851	197.136
CN14 NFk Ab MFk	728.64	10 Mar 95 2000	2914.7	14.528
CN20 MFk Ab NFk	105.46	11 Mar 95 1200	374.22	1.842
JCN21	22106	10 Mar 95 2400	110476	413.016
CN21-CN23 Cos R	22089	10 Mar 95 2400	110458	413.016
CN22 B Indian Ab Cos	806.70	11 Mar 95 1800	3824.2	22.383
JCN23	22609	10 Mar 95 2400	114282	435.399
CN23-CN27 Cos R	22541	11 Mar 95 0100	113859	435.399
CN26 B Canyon Ab Cos	1769.8	10 Mar 95 2100	7996.5	41.856
CN24 Cos Ab B Canyon	709.37	11 Mar 95 1800	3102.3	18.006
JCN27	24279	11 Mar 95 0100	124957	495.261
CN27-CN29 Cos R	24275	11 Mar 95 0200	124583	495.261
CN28 Cos Ab Mich Bar	1379.8	11 Mar 95 1900	6678.3	40.170
JCN29	25237	11 Mar 95 0200	131261	535.431
CN29-CN35 Cos R	24971	11 Mar 95 0600	129685	535.431
CN34 Deer Ab Cos	1217.7	11 Mar 95 1700	4916.9	33.806
CN30 Cos Ab Deer Cr	1538.1	11 Mar 95 2100	7103.0	54.981

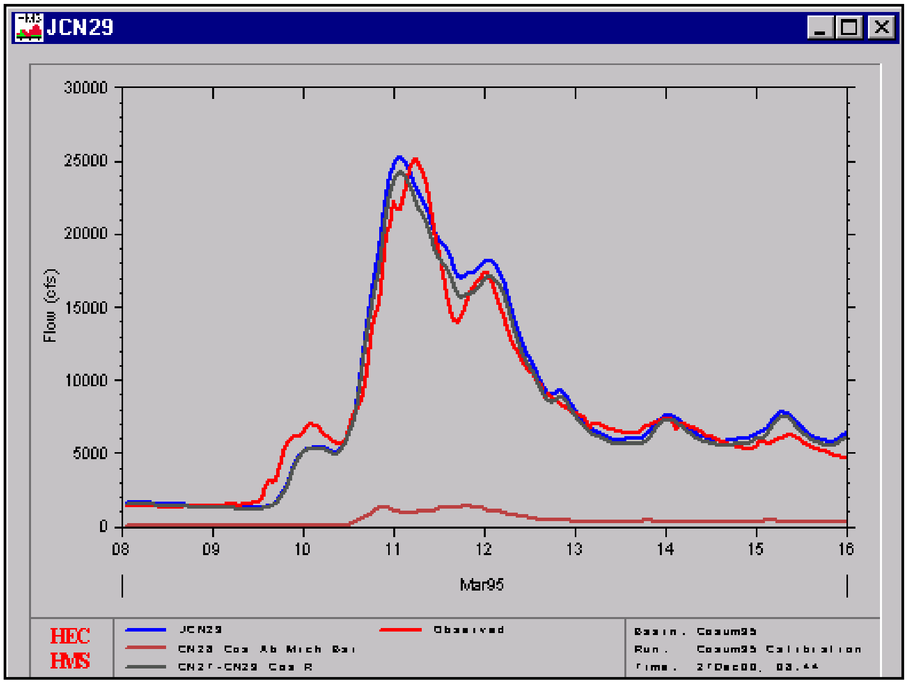
… Continued …

HEC-HMS Summary of Results
Cosumnes River Basin: March 1995 Event
(Continued)

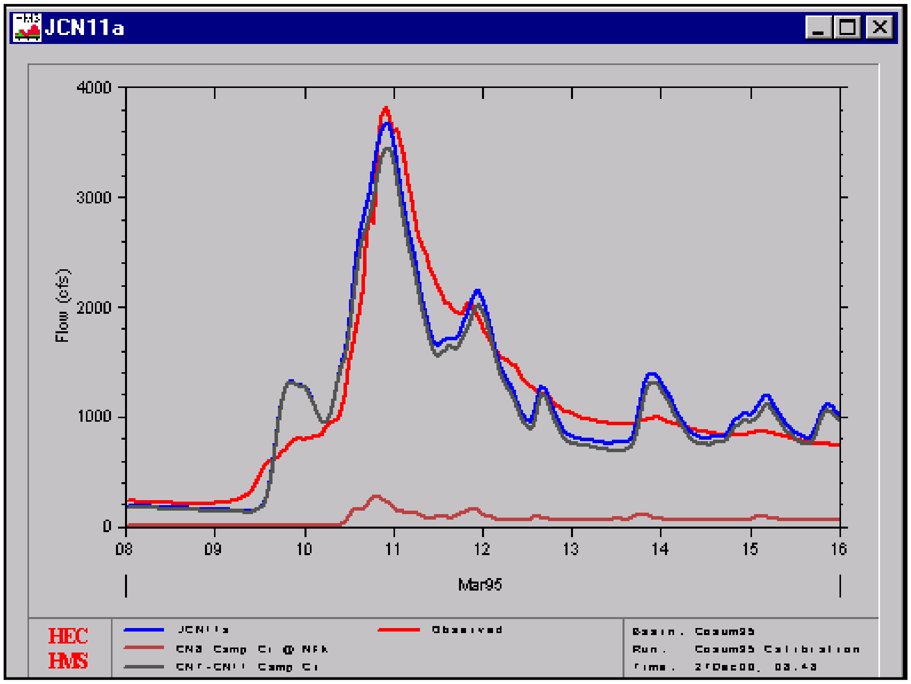
Project	: Cosumnes	Run Name	: Mar95Calib
Start of Run	: 08Mar95 0100	Basin Model	: Cosum95
End of Run	: 15Mar95 2400	Met. Model	: March 1995
Execution Time	: 31May00 1344	Control Specs.	: March 1995

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
JCN35	27719	11 Mar 95 0600	156724	708.111
CN35-CN37 Cos R	27660	11 Mar 95 0900	155854	708.111
CN36 Cos Ab McConnel	337.54	11 Mar 95 1800	1305.3	17.616
Cosumnes at HY99	27700	11 Mar 95 0900	157159	725.727
CN2 Ab Jenkinson Lk	1269.0	10 Mar 95 2100	5801.7	18.669
CN3-CN7 Sly Park Cr	1262.8	10 Mar 95 2200	5795.5	18.669
CN4 Sly Park @ Conf	136.85	10 Mar 95 1900	496.11	2.045
CN6 Camp Cr @ Sly P	2096.6	10 Mar 95 2200	10697	37.534
JCN7	3465.7	10 Mar 95 2200	16988	58.248
CN7-CN11 Camp Cr	3445.4	10 Mar 95 2300	16945	58.248
CN8 Camp Cr @ NFk	277.51	10 Mar 95 1900	998.59	4.617
JCN11a	3665.6	10 Mar 95 2200	17943	62.865
Sink-1	3665.6	10 Mar 95 2200	17943	62.865
Sly Park Dam	0.0	08 Mar 95 0100	0.0	0.000

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Cosumnes River Basin
March 1995 Event



JNC29 Cosumnes River above Michigan Bar



JNC11a Camp Creek at North Fork Cosumnes River

HEC-HMS Subbasin Parameters
Cosumnes River Basin: March 1995 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
CN16 MFk Ab SFk	3	0.8	0.22	1.5	.01	0
CN10 NFk Ab Camp Cr	3	0.8	0.22	1.5	.01	0
CN12 NFk Ab Martinez	3	0.8	0.22	1.5	.01	0
CN34 Deer Ab Cos	3	0.8	0.22	1.5	.01	0
CN24 Cos Ab B Canyon	3	0.8	0.22	1.5	.01	0
CN14 NFk Ab MFk	3	0.8	0.22	1.5	.01	0
CN22 B Indian Ab Cos	3	0.8	0.22	1.5	.01	0
CN20 MFk Ab NFk	3	0.8	0.22	1.5	.01	0
CN32 Deer Ab Carson	3	0.8	0.22	1.5	.01	0
CN26 B Canyon Ab Cos	3	0.8	0.22	1.5	.01	0
CN18 SFk Ab MFk	3	0.8	0.22	1.5	.01	0
CN30 Cos Ab Deer Cr	3	0.8	0.22	1.5	.01	0
CN36 Cos Ab McConnel	3	0.8	0.22	1.5	.01	0
CN28 Cos Ab Mich Bar	3	0.8	0.22	1.5	.01	0
CN4 Sly Park @ Conf	3	0.8	0.22	1.5	.01	0
CN2 Ab Jenkinson Lk	3	0.8	0.22	1.5	.01	0
CN8 Camp Cr @ NFk	3	0.8	0.22	1.5	.01	0
CN6 Camp Cr @ Sly P	3	0.8	0.22	1.5	.01	0

HEC-HMS Summary of Results
Cosumnes River Basin: December 1996 - January 1997 Event

Project	: Cosumnes	Run Name	: Jan97Calib
Start of Run	: 30Dec96 0100	Basin Model	: Cosum97
End of Run	: 06Jan97 2400	Met. Model	: January 1997
Execution Time	: 31May00 1344	Control Specs.	: January 1997

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
CN32 Deer Ab Carson	4141.9	01 Jan 97 2200	19502	83.893
JCN33	4141.9	01 Jan 97 2200	19502	83.893
CN33-CN35 Deer Cr	4110.2	02 Jan 97 0200	19480	83.893
CN18 SFk Ab MFk	4482.5	02 Jan 97 1300	22540	65.491
CN16 MFk Ab SFk	10429	02 Jan 97 1700	64653	134.019
JCN19	14763	02 Jan 97 1500	87194	199.510
CN19-CN21 MFk Cos	14760	02 Jan 97 1500	87171	199.510
Res Out +	8900.0	01 Jan 97 2400	43582	62.200
CN10 NFk Ab Camp Cr	7364.5	02 Jan 97 1100	45437	82.698
JCN11	15846	01 Jan 97 2400	89019	144.898
CN11-CN13 NFk Cos	15826	02 Jan 97 0200	89036	144.898
CN12 NFk Ab Martinez	2899.2	01 Jan 97 1400	13787	52.238
JCN13	18411	02 Jan 97 0200	102823	197.136
CN13-CN21 NFk Cos	18356	02 Jan 97 0300	102823	197.136
CN14 NFk Ab MFk	983.50	01 Jan 97 1300	3742.6	14.528
CN20 MFk Ab NFk	143.60	01 Jan 97 1200	484.07	1.842
JCN21	32878	02 Jan 97 0200	194220	413.016
CN21-CN23 Cos R	32870	02 Jan 97 1200	194217	413.016
CN22 B Indian Ab Cos	1068.2	01 Jan 97 2000	4824.6	22.383
JCN23	33866	02 Jan 97 0200	199041	435.399
CN23-CN27 Cos R	33849	02 Jan 97 1300	198958	435.399
CN26 B Canyon Ab Cos	2358.5	01 Jan 97 1400	10243	41.856
CN24 Cos Ab B Canyon	1082.8	01 Jan 97 1400	4282.9	18.006
JCN27	36561	02 Jan 97 0300	213484	495.261
CN27-CN29 Cos R	36559	02 Jan 97 0400	213405	495.261
CN28 Cos Ab Mich Bar	1999.4	01 Jan 97 1400	8945.2	40.170
JCN29	38231	02 Jan 97 1300	222350	535.431
CN29-CN35 Cos R	38143	02 Jan 97 1700	221947	535.431
CN34 Deer Ab Cos	1438.7	01 Jan 97 2300	7100.3	33.806
CN30 Cos Ab Deer Cr	2140.2	01 Jan 97 2300	11047	54.981

… Continued …

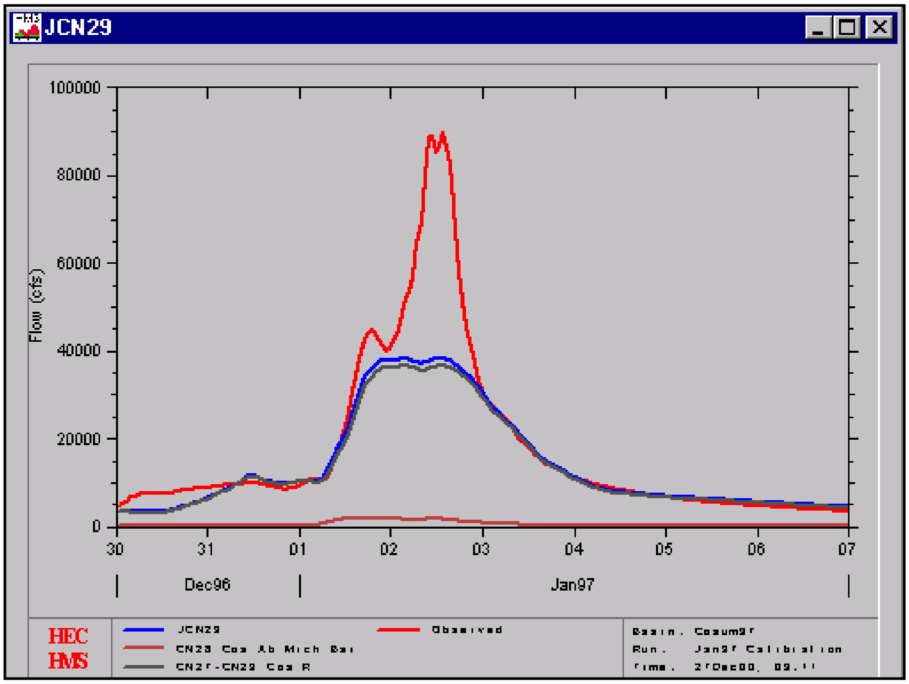
HEC-HMS Summary of Results
Cosumnes River Basin: December 1996 - January 1997 Event
(Continued)

Project : Cosumnes   Run Name : Jan97Calib

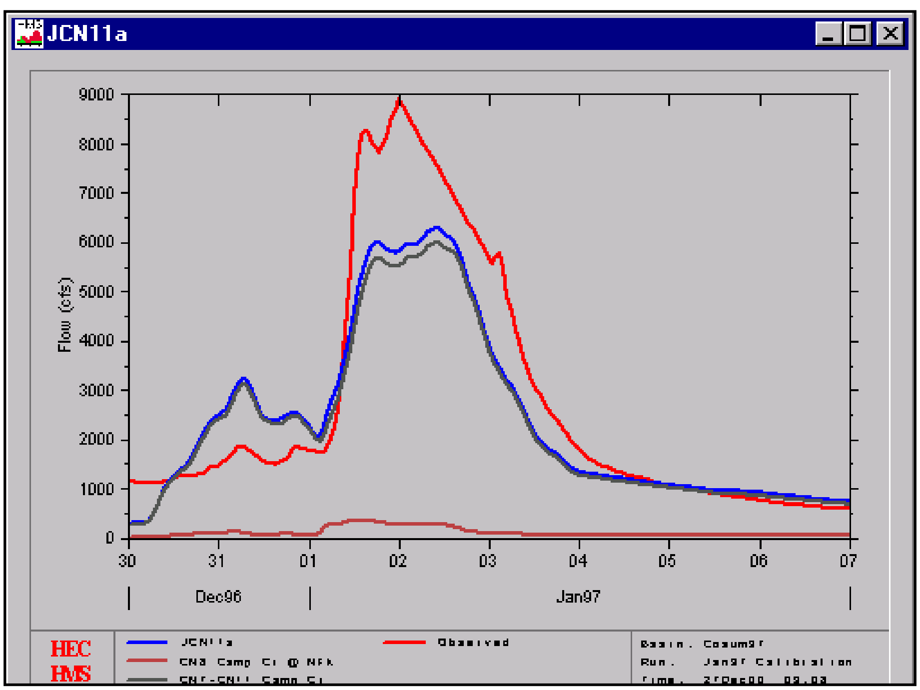
Start of Run : 30Dec96 0100   Basin Model : Cosum97
End of Run : 06Jan97 2400   Met. Model : January 1997
Execution Time : 31May00 1344   Control Specs. : January 1997

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
JCN35	45291	02 Jan 97 0300	259575	708.111
CN35-CN37 Cos R	45270	02 Jan 97 0500	259342	708.111
CN36 Cos Ab McConnel	776.87	01 Jan 97 1400	3442.8	17.616
Cosumnes at HY99	45806	02 Jan 97 0500	262785	725.727
CN2 Ab Jenkinson Lk	1994.3	02 Jan 97 0900	10997	18.669
CN3-CN7 Sly Park Cr	1992.9	02 Jan 97 0900	10993	18.669
CN4 Sly Park @ Conf	194.09	01 Jan 97 1300	935.87	2.045
CN6 Camp Cr @ Sly P	3845.8	02 Jan 97 1000	24388	37.534
JCN7	5989.5	02 Jan 97 0900	36317	58.248
CN7-CN11 Camp Cr	5987.5	02 Jan 97 1000	36295	58.248
CN8 Camp Cr @ NFk	368.44	01 Jan 97 1300	1740.9	4.617
JCN11a	6276.2	02 Jan 97 1000	38036	62.865
Sink-1	6276.2	02 Jan 97 1000	38036	62.865
Sly Park Dam	0.0	30 Dec 96 0100	0.0	0.000

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Cosumnes River Basin
December 1996 - January 1997 Event



JNC29 Cosumnes River above Michigan Bar

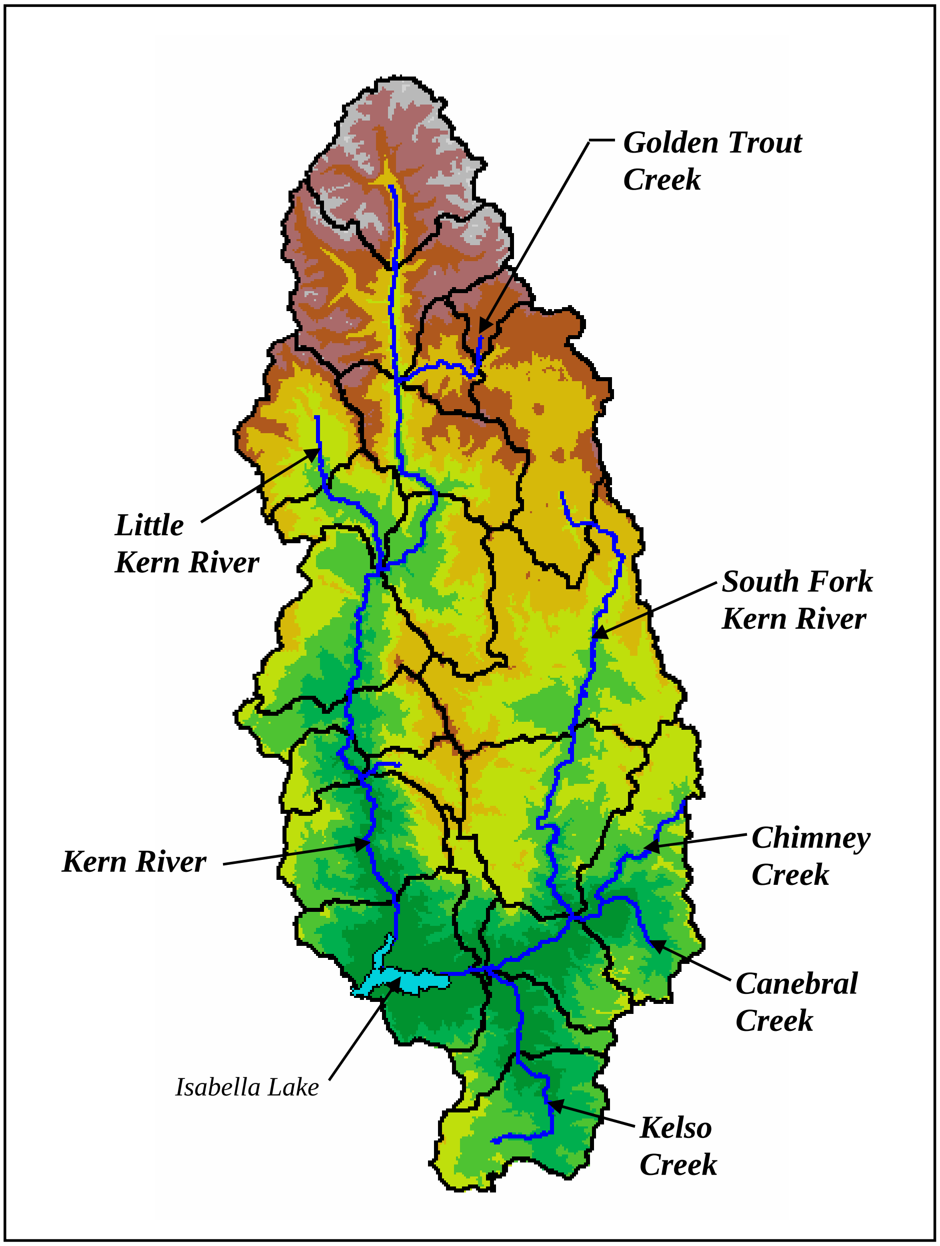


JNC11a Camp Creek at North Fork Cosumnes River

HEC-HMS Subbasin Parameters
Cosumnes River Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
CN16 MFk Ab SFk	5	0.8	0.22	0.5	.001	0
CN10 NFk Ab Camp Cr	5	0.8	0.22	0.5	.001	0
CN12 NFk Ab Martinez	5	0.8	0.22	0.5	.001	0
CN34 Deer Ab Cos	5	0.8	0.22	0.5	.001	0
CN24 Cos Ab B Canyon	5	0.8	0.22	0.5	.001	0
CN14 NFk Ab MFk	5	0.8	0.22	0.5	.001	0
CN22 B Indian Ab Cos	5	0.8	0.22	0.5	.001	0
CN20 MFk Ab NFk	5	0.8	0.22	0.5	.001	0
CN32 Deer Ab Carson	5	0.8	0.22	0.5	.001	0
CN26 B Canyon Ab Cos	5	0.8	0.22	0.5	.001	0
CN18 SFk Ab MFk	5	0.8	0.22	0.5	.001	0
CN30 Cos Ab Deer Cr	5	0.8	0.22	0.5	.001	0
CN36 Cos Ab McConnel	5	0.8	0.22	0.5	.001	0
CN28 Cos Ab Mich Bar	5	0.8	0.22	0.5	.001	0
CN4 Sly Park @ Conf	5	0.8	0.22	0.1	.001	0
CN2 Ab Jenkinson Lk	5	0.8	0.22	0.1	.001	0
CN8 Camp Cr @ NFk	5	0.8	0.22	0.1	.001	0
CN6 Camp Cr @ Sly P	5	0.8	0.22	0.1	.001	0

Kern River Basin



HEC-GeoHMS Subbasin Delineation

Kern River

The Kern River HMS model consists of a 2,055 square mile basin above Isabella Lake located in the southeastern-most portion of the Tulare Lake Bed Watershed. The basin model is divided into 22 subbasins and connected with 17 routing reaches. The observed hydrographs are the computed inflow into Isabella Lake and at gages near Onyx, Fairview and Kernville. The computed peak inflow into Isabella Lake for the 1997 event was larger than the 1995 event (7,900 cfs vs. 5,500 cfs).

The adopted TC and R (Group 2) values and Muskingum parameters were used, and the model calibrated reasonably well to observed hydrographs. For reaches with a travel time of less than one hour, the lag method was used for routing. Muskingum was used for 16 routing reaches and lag was used for 1 routing reach.

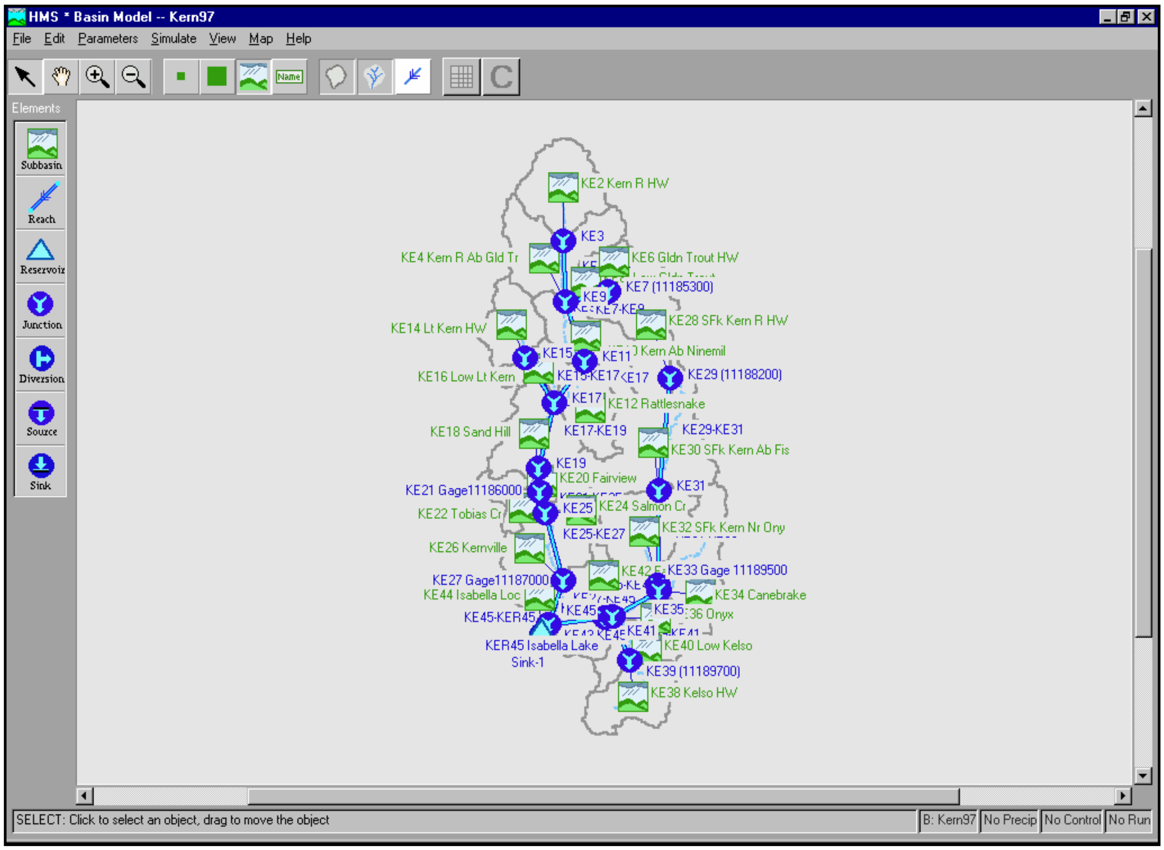
Calibration of the 1995 Event:

The 1995 model was calibrated to all hydrographs listed above except the gage near Onyx. By using constant loss rates between 0.05 and 0.2 inches/hour and initial losses of between 0.05 and 0.20 inches, the model calibrated reasonably well to observed hydrographs. A recession ratio of 0.8 and a peak ratio of 0.2 defined the recession limb of the hydrographs. An initial baseflow of 1 cfs per square mile was assumed for most subbasins. An initial baseflow of 0.2 cfs per square mile was assumed for the headwater subbasins.

Calibration of the 1997 Event:

By using constant loss rates between 0.12 and 0.90 inches/hour and high initial losses of 4-6 inches, the model calibrated reasonably well to all observed hydrographs. However, the computed peak was higher than the observed peak for the inflow into Isabella Lake and for the gage near Kernville (despite the high initial losses). The baseflow recession parameters of 0.8 for the constant and 0.1 to 0.3 for the peak ratio worked best. Initial baseflows of 0.1 to 1 cfs per square mile were used, with smaller initial baseflows at the headwaters.

Kern River Basin HEC-HMS Model Schematic



Kern River Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Initial TC $1.4(LL_{CA}/S^{1/2})^{.33}$ (Hr)	Initial R 1.5 TC (cfs/Hr)	Regression TC $1.67(LL_{CA}/S^{1/2})^{0.29}$ (Hr)	Regression R 4.0 TC (cfs/Hr)
KE10 Kern Ab Ninemil	101.19	18.27	2.45	364.32	2.34	1.9	2.8	2.1	8.5
KE12 Rattlesnake	92.82	17.74	6.50	253.44	7.24	2.7	4.0	3.0	11.9
KE14 Lt Kern HW	84.78	15.11	5.44	422.40	4.00	2.2	3.3	2.5	10.0
KE16 Low Lt Kern	47.86	17.10	7.58	258.72	8.06	2.8	4.2	3.1	12.2
KE18 Sand Hill	119.20	18.36	6.55	195.36	8.60	2.8	4.3	3.1	12.5
KE2 Kern R HW	129.93	19.13	8.76	359.04	8.84	2.9	4.3	3.1	12.6
KE20 Fairview	63.35	14.79	1.69	258.72	1.56	1.6	2.4	1.9	7.6
KE22 Tobias Cr	29.80	10.46	5.30	427.68	2.68	1.9	2.9	2.2	8.9
KE24 Salmon Cr	25.46	12.69	6.53	401.28	4.13	2.2	3.4	2.5	10.1
KE26 Kernville	107.20	16.63	6.14	300.96	5.89	2.5	3.8	2.8	11.2
KE28 SFk Kern R HW	146.23	30.76	11.39	116.16	32.49	4.4	6.6	4.6	18.3
KE30 SFk Kern Ab Fis	232.42	28.29	9.35	174.24	20.04	3.8	5.6	4.0	15.9
KE32 SFk Kern Nr Ony	151.88	30.11	13.58	200.64	28.88	4.2	6.4	4.4	17.7
KE34 Canebrake	136.86	26.59	11.82	195.36	22.48	3.9	5.9	4.1	16.5
KE36 Onyx	67.45	16.24	7.21	258.72	7.28	2.7	4.0	3.0	11.9
KE38 Kelso HW	101.53	24.98	11.17	184.80	20.51	3.8	5.7	4.0	16.0
KE4 Kern R Ab Gld Tr	147.34	23.78	8.25	300.96	11.31	3.1	4.7	3.4	13.5
KE40 Low Kelso	58.06	17.67	7.66	285.12	8.02	2.8	4.2	3.1	12.2
KE42 Fay Cr	25.34	16.79	7.74	385.44	6.62	2.6	3.9	2.9	11.6
KE44 Isabella Loc	126.44	16.68	4.89	337.92	4.44	2.3	3.4	2.6	10.3
KE6 Gldn Trout HW	23.88	9.94	4.84	348.48	2.58	1.9	2.9	2.2	8.8
KE8 Low Gldn Trout	35.69	11.85	5.07	422.40	2.92	2.0	3.0	2.3	9.1

Kern River Reach Parameters

Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Ave Reach Vel $80\ S_R^{1/2}$ V_R (fps)	Initial K $1.47\ L_R / 1.5V_R$ K (Hr)	Musk X or LAG (Hr)	N steps Time Step= 60
KE11-KE17	9.72	0.0099	7.96	1.2	0.4	1
KE15-KE17	10.46	0.0252	12.70	1.0	0.4	1
KE17-KE19	13.04	0.0114	8.54	2.0	0.4	2
KE19-KE21	4.79	0.0117	8.65	1.0	0.4	1
KE21-KE25	5.30	0.0096	7.84	1.0	0.4	1
KE25-KE27	12.86	0.0105	8.20	2.0	0.4	2
KE27-KE45	8.18	0.0008	2.26	3.5	0.4	3
KE29-KE31	23.71	0.0174	10.55	2.2	0.4	2
KE31-KE33	21.92	0.0246	12.55	1.7	0.4	2
KE35-KE41	9.52	0.0036	4.80	1.9	0.4	2
KE39-KE41	9.44	0.0094	7.76	1.2	0.4	1
KE3-KE9	10.02	0.0094	7.76	2.0	0.4	2
KE41-KE43	1.60	0.0031	4.45	0.4	24	17
KE43-KE45	9.17	0.0006	1.96	4.6	0.4	4
KE45-KER45	0.69	0.0001	0.80	1.0	0.4	1
KE7-KE9	9.35	0.0513	18.12	1.0	0.4	1
KE9-KE11	12.06	0.0188	10.97	1.1	0.4	1

HEC-HMS Summary of Results
Kern River Basin: March 1995 Event

Project : Kern   Run Name : Kern95

Start of Run : 08Mar95 0100   Basin Model : Kern95

End of Run : 15Mar95 2400   Met. Model : Mar95 Event

Execution Time : 31May00 1347   Control Specs. : Mar95 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
KE14 Lt Kern HW	745.99	13 Mar 95 2100	2702.9	84.776
KE15	745.99	13 Mar 95 2100	2702.9	84.776
KE15-KE17	735.56	13 Mar 95 2200	2694.3	84.776
KE2 Kern R HW	129.93	08 Mar 95 0100	995.78	129.931
KE3	129.93	08 Mar 95 0100	995.78	129.931
KE3-KE9	129.93	08 Mar 95 0100	1013.6	129.931
KE6 Gldn Trout HW	23.880	08 Mar 95 0100	178.14	23.880
KE7 (11185300)	23.880	08 Mar 95 0100	178.14	23.880
KE7-KE9	23.880	08 Mar 95 0100	179.78	23.880
KE4 Kern R Ab Gld Tr	185.08	10 Mar 95 2000	1401.3	147.336
KE8 Low Gldn Trout	166.79	13 Mar 95 2100	466.80	35.688
KE9	336.83	08 Mar 95 0100	3061.5	336.835
KE9-KE11	336.83	08 Mar 95 0100	3081.1	336.835
KE10 Kern Ab Ninemil	860.44	13 Mar 95 2000	2898.9	101.192
KE11	1056.1	13 Mar 95 2100	5980.1	438.027
KE11-KE17	1038.2	13 Mar 95 2200	5960.9	438.027
KE16 Low Lt Kern	766.46	13 Mar 95 2200	3172.7	47.857
KE12 Rattlesnake	995.00	15 Mar 95 2200	4544.2	92.818
KE17	3470.9	13 Mar 95 2200	16372	663.478
KE17-KE19	3391.0	13 Mar 95 2400	16151	663.478
KE18 Sand Hill	2107.4	10 Mar 95 0700	10038	119.198
KE19	4538.0	13 Mar 95 2400	26188	782.676
KE19-KE21	4500.3	14 Mar 95 0100	26064	782.676
KE20 Fairview	723.44	10 Mar 95 2200	3260.3	63.347
KE21 Gage11186000	4922.4	14 Mar 95 0100	29324	846.023
KE21-KE25	4886.7	14 Mar 95 0200	29211	846.023
KE22 Tobias Cr	803.07	11 Mar 95 0800	3702.8	29.800
KE24 Salmon Cr	323.29	13 Mar 95 2100	1065.3	25.464
KE25	5513.4	11 Mar 95 0200	33980	901.287
KE25-KE27	5472.3	11 Mar 95 0400	33788	901.287
KE26 Kernville	1560.7	10 Mar 95 0800	7634.4	107.196

… Continued …

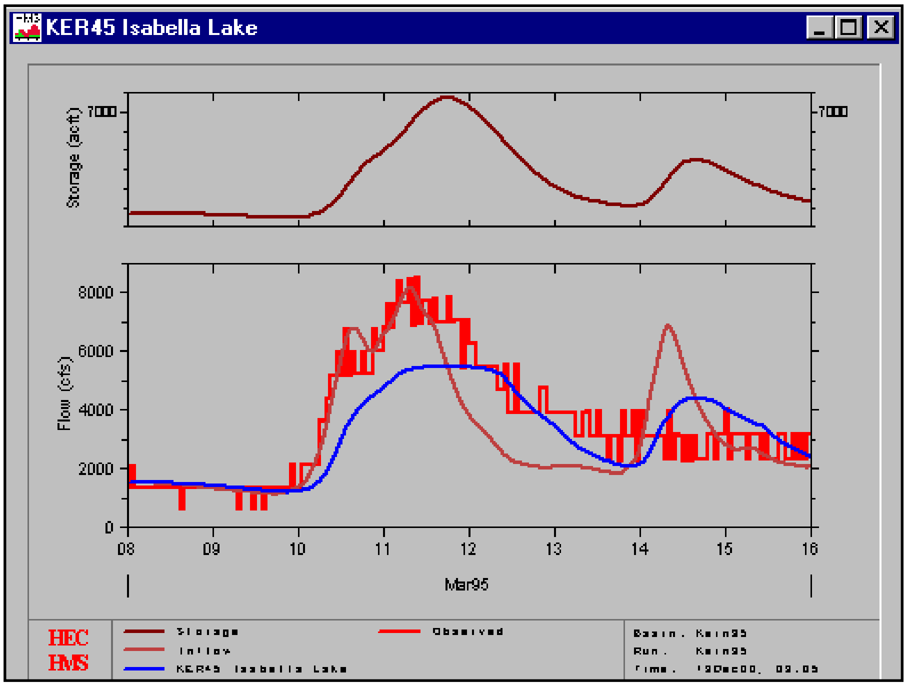
HEC-HMS Summary of Results
Kern River Basin: March 1995 Event
(Continued)

Project : Kern   Run Name : Mar95 Event

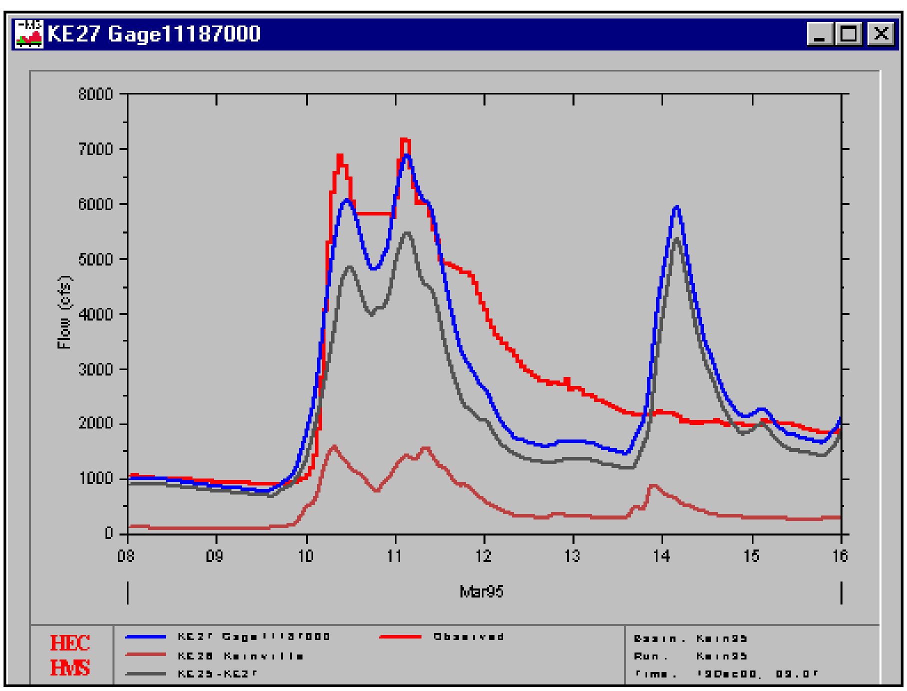
Start of Run	: 08Mar95 0100	Basin Model	: Kern95
End of Run	: 15Mar95 2400	Met. Model	: Mar95 Event
Execution Time	: 31May00 1347	Control Specs.	: Mar95 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
KE27 Gage11187000	6881.0	11 Mar 95 0300	41423	1008.483
KE27-KE45	6808.8	11 Mar 95 0700	41171	1008.483
KE38 Kelso HW	101.53	08 Mar 95 0100	763.38	101.529
KE39 (11189700)	101.53	08 Mar 95 0100	763.38	101.529
KE39-KE41	101.53	08 Mar 95 0100	771.53	101.529
KE28 SFk Kern R HW	169.33	15 Mar 95 2100	401.85	146.230
KE29 (11188200)	169.33	15 Mar 95 2100	401.85	146.230
KE29-KE31	161.21	15 Mar 95 2400	379.00	146.230
KE30 SFk Kern Ab Fis	1043.5	15 Mar 95 2300	3813.0	232.418
KE31	1202.1	15 Mar 95 2300	4191.9	378.648
KE31-KE33	1169.1	15 Mar 95 2400	4037.2	378.648
KE32 SFk Kern Nr Ony	333.46	10 Mar 95 1600	1377.1	151.879
KE33 (11189500)	1447.3	15 Mar 95 2400	5414.3	530.527
KE34 Canebrake	352.29	15 Mar 95 2400	1322.7	136.855
KE35	1799.5	15 Mar 95 2400	6737.0	667.382
KE35-KE41	1628.4	10 Mar 95 1800	6505.1	667.382
KE40 Low Kelso	58.060	08 Mar 95 0100	428.69	58.060
KE36 Onyx	67.455	08 Mar 95 0100	498.06	67.455
KE41	1753.1	10 Mar 95 1800	8203.4	894.426
KE41-KE43	1744.4	10 Mar 95 1900	8174.1	894.426
KE42 Fay Cr	79.956	11 Mar 95 0300	407.63	25.338
KE43	1780.0	10 Mar 95 1900	8581.7	919.764
KE43-KE45	1703.3	10 Mar 95 2400	8482.7	919.764
KE45	8086.2	11 Mar 95 0700	49654	1928.247
KE45-KER45	8086.2	11 Mar 95 0800	49598	1928.247
KE44 Isabella Loc	126.44	08 Mar 95 0100	933.57	126.438
KER45 Isabella Lake	5495.3	11 Mar 95 1800	49924	2054.685
Sink-1	5495.3	11 Mar 95 1800	49924	2054.685

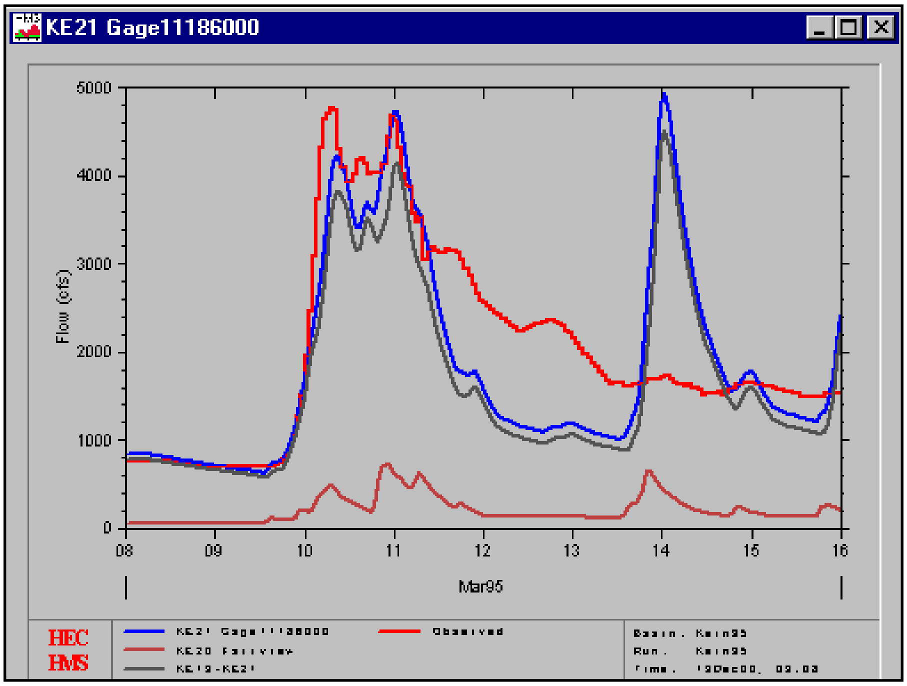
HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Kern River Basin
March 1995 Event



KER45 – Isabella Lake



KE27 – Gage 11187000, At Kernville



KE21 – Gage 11186000, Near Kernville

HEC-HMS Subbasin Parameters
Kern River Basin: March 1995 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
KE10 Kern Ab Ninemil	1	0.8	0.2	0.05	0.10	0
KE12 Rattlesnake	1	0.8	0.2	0.05	0.10	0
KE14 Lt Kern HW	1	0.8	0.2	0.05	0.10	0
KE16 Low Lt Kern	1	0.8	0.2	0.05	0.10	0
KE18 Sand Hill	1	0.8	0.2	0.05	0.10	0
KE2 Kern R HW	1	0.8	0.2	0.05	0.10	0
KE20 Fairview	1	0.8	0.2	0.05	0.10	0
KE22 Tobias Cr	1	0.8	0.2	0.05	0.05	0
KE24 Salmon Cr	1	0.8	0.2	0.05	0.05	0
KE26 Kernville	1	0.8	0.2	0.05	0.05	0
KE28 SFk Kern R HW	0.2	0.8	0.2	0.20	0.15	0
KE30 SFk Kern Ab Fis	0.2	0.8	0.2	0.20	0.15	0
KE32 SFk Kern Nr Ony	0.2	0.8	0.2	0.20	0.15	0
KE34 Canebrake	0.2	0.8	0.2	0.20	0.15	0
KE36 Onyx	1	0.8	0.2	0.50	0.20	0
KE38 Kelso HW	1	0.8	0.2	0.50	0.20	0
KE4 Kern R Ab Gld Tr	1	0.8	0.2	0.05	0.10	0
KE40 Low Kelso	1	0.8	0.2	0.50	0.20	0
KE42 Fay Cr	1	0.8	0.2	0.10	0.10	0
KE44 Isabella Loc	1	0.8	0.2	0.50	0.20	0
KE6 Gldn Trout HW	1	0.8	0.2	0.05	0.10	0
KE8 Low Gldn Trout	1	0.8	0.2	0.05	0.10	0

HEC-HMS Summary of Results
Kern River Basin: December 1996 - January 1997 Event

Project	: Kern	Run Name	: Kern97
Start of Run	: 25Dec96 0100	Basin Model	: Kern97
End of Run	: 08Jan97 2400	Met. Model	: Dec96Jan97 Event
Execution Time	: 31May00 1347	Control Specs.	: Dec96Jan97 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
KE14 Lt Kern HW	10754	02 Jan 97 2300	19335	84.776
KE15	10754	02 Jan 97 2300	19335	84.776
KE15-KE17	10604	02 Jan 97 2400	19313	84.776
KE2 Kern R HW	149.45	02 Jan 97 2400	1314.6	129.931
KE3	149.45	02 Jan 97 2400	1314.6	129.931
KE3-KE9	148.23	03 Jan 97 0200	1335.1	129.931
KE6 Gldn Trout HW	80.698	02 Jan 97 2300	299.80	23.880
KE7 (11185300)	80.698	02 Jan 97 2300	299.80	23.880
KE7-KE9	78.146	02 Jan 97 2400	301.55	23.880
KE4 Kern R Ab Gld Tr	2634.6	02 Jan 97 2300	6333.8	147.336
KE8 Low Gldn Trout	1586.3	02 Jan 97 2400	2757.0	35.688
KE9	4406.9	02 Jan 97 2400	10727	336.835
KE9-KE11	4365.4	03 Jan 97 0100	10744	336.835
KE10 Kern Ab Ninemil	7841.5	02 Jan 97 2300	13583	101.192
KE11	11807	02 Jan 97 2400	24327	438.027
KE11-KE17	11633	03 Jan 97 0100	24331	438.027
KE16 Low Lt Kern	5531.0	02 Jan 97 2400	11878	47.857
KE12 Rattlesnake	4964.8	03 Jan 97 0100	11732	92.818
KE17	32429	03 Jan 97 0100	67254	663.478
KE17-KE19	31949	03 Jan 97 0300	67176	663.478
KE18 Sand Hill	11325	02 Jan 97 2400	26062	119.198
KE19	41734	03 Jan 97 0200	93238	782.676
KE19-KE21	41458	03 Jan 97 0300	93174	782.676
KE20 Fairview	6616.9	02 Jan 97 2400	15610	63.347
KE21 Gage11186000	46206	03 Jan 97 0300	108785	846.023
KE21-KE25	45955	03 Jan 97 0400	108704	846.023
KE22 Tobias Cr	37.975	01 Jan 97 2400	133.72	29.800
KE24 Salmon Cr	580.16	01 Jan 97 2400	1607.8	25.464
KE25	46117	03 Jan 97 0400	110446	901.287
KE25-KE27	45654	03 Jan 97 0600	110275	901.287
KE26 Kernville	101.94	02 Jan 97 0100	362.84	107.196

… Continued …

HEC-HMS Summary of Results
Kern River Basin: December 1996 - January 1997 Event
(Continued)

Project : Kern Run Name : Kern97

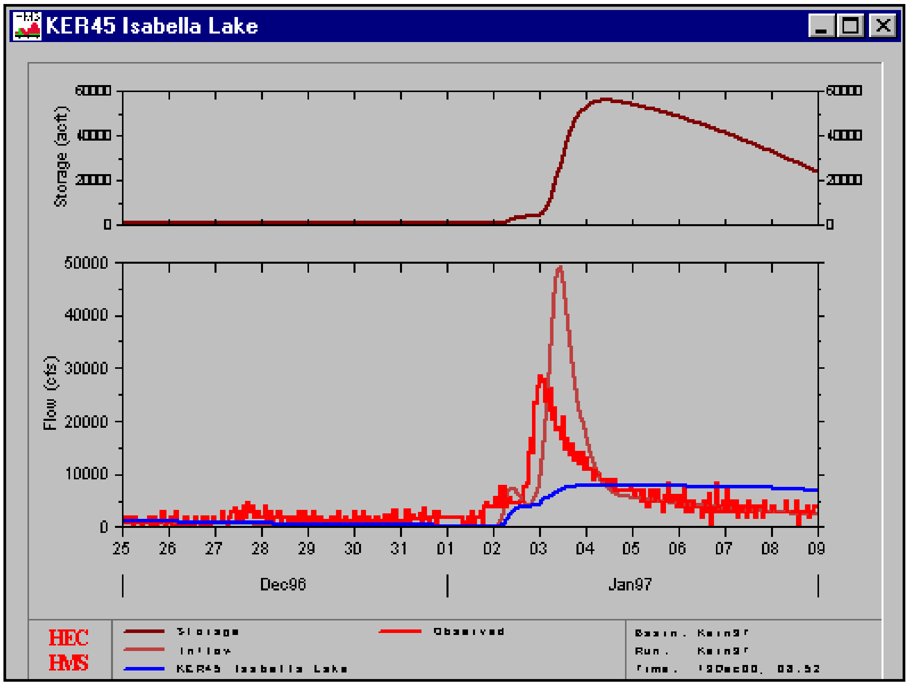
Start of Run : 25Dec96 0100 Basin Model : Kern97

End of Run : 08Jan97 2400 Met. Model : Dec96Jan97 Event

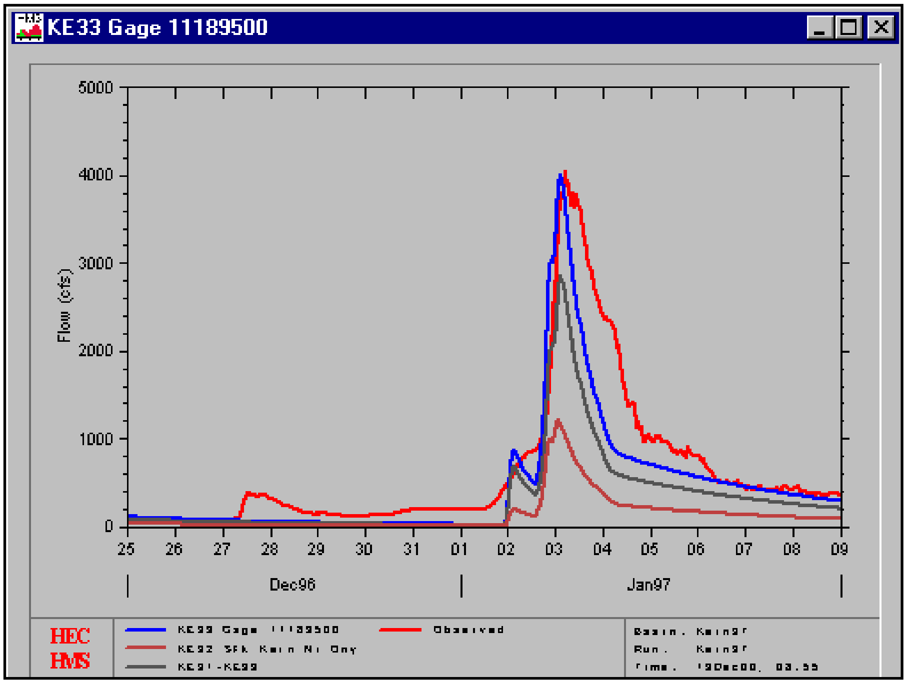
Execution Time : 31May00 1347 Control Specs. : Dec96Jan97 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
KE27 Gage11187000	45681	03 Jan 97 0600	110637	1008.483
KE27-KE45	44861	03 Jan 97 1000	110324	1008.483
KE38 Kelso HW	20.306	25 Dec 96 0100	174.08	101.529
KE39 (11189700)	20.306	25 Dec 96 0100	174.08	101.529
KE39-KE41	20.306	25 Dec 96 0100	176.03	101.529
KE28 SFk Kern R HW	303.14	03 Jan 97 0100	1022.1	146.230
KE29 (11188200)	303.14	03 Jan 97 0100	1022.1	146.230
KE29-KE31	297.74	03 Jan 97 0300	1023.5	146.230
KE30 SFk Kern Ab Fis	2641.0	03 Jan 97 0100	8454.4	232.418
KE31	2858.4	03 Jan 97 0100	9478.0	378.648
KE31-KE33	2837.1	03 Jan 97 0300	9460.2	378.648
KE32 SFk Kern Nr Ony	1204.9	03 Jan 97 0200	3950.8	151.879
KE33 Gage 11189500	3994.3	03 Jan 97 0300	13411	530.527
KE34 Canebrake	267.67	02 Jan 97 2100	991.52	136.855
KE35	4225.0	03 Jan 97 0300	14403	667.382
KE35-KE41	4178.5	03 Jan 97 0500	14375	667.382
KE40 Low Kelso	11.612	25 Dec 96 0100	99.552	58.060
KE36 Onyx	13.491	25 Dec 96 0100	117.99	67.455
KE41	4184.6	03 Jan 97 0500	14768	894.426
KE41-KE43	4152.2	03 Jan 97 0500	14764	894.426
KE42 Fay Cr	220.94	02 Jan 97 0100	525.85	25.338
KE43	4192.8	03 Jan 97 0500	15290	919.764
KE43-KE45	4104.2	03 Jan 97 1000	15232	919.764
KE45	48965	03 Jan 97 1000	125557	1928.247
KE45-KER45	48965	03 Jan 97 1100	125451	1928.247
KE44 Isabella Loc	20.611	02 Jan 97 0100	139.57	126.438
KER45 Isabella Lake	7897.2	04 Jan 97 1100	102855	2054.685
Sink-1	7897.2	04 Jan 97 1100	102855	2054.685

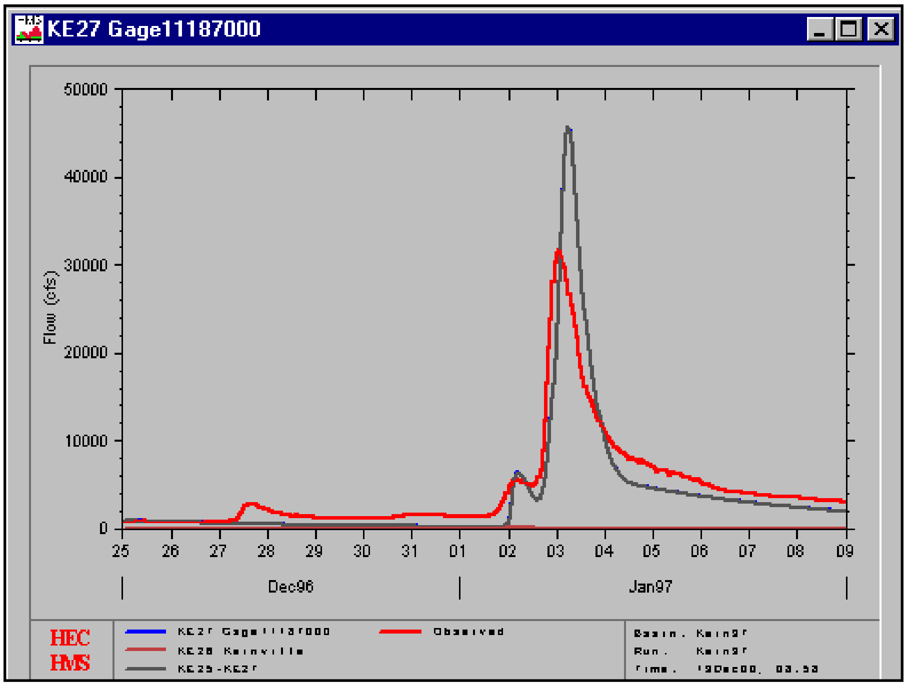
HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Kern River Basin
December 1996 - January 1997 Event



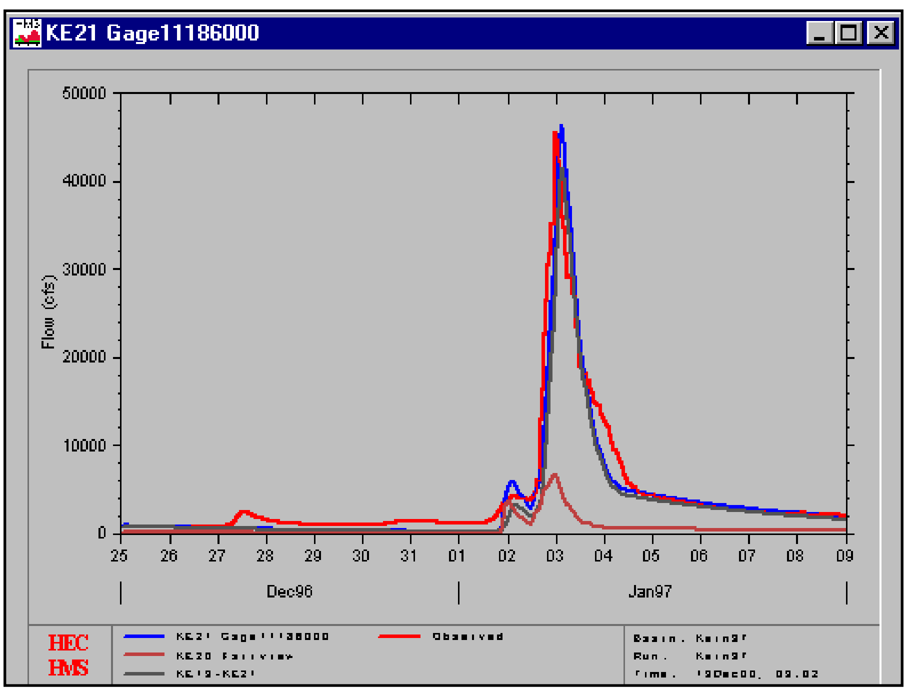
KER45 – Isabella Lake



KE33 – Gage 11189500, South Fork Near Onyx



KE27 – Gage 11187000, At Kernville

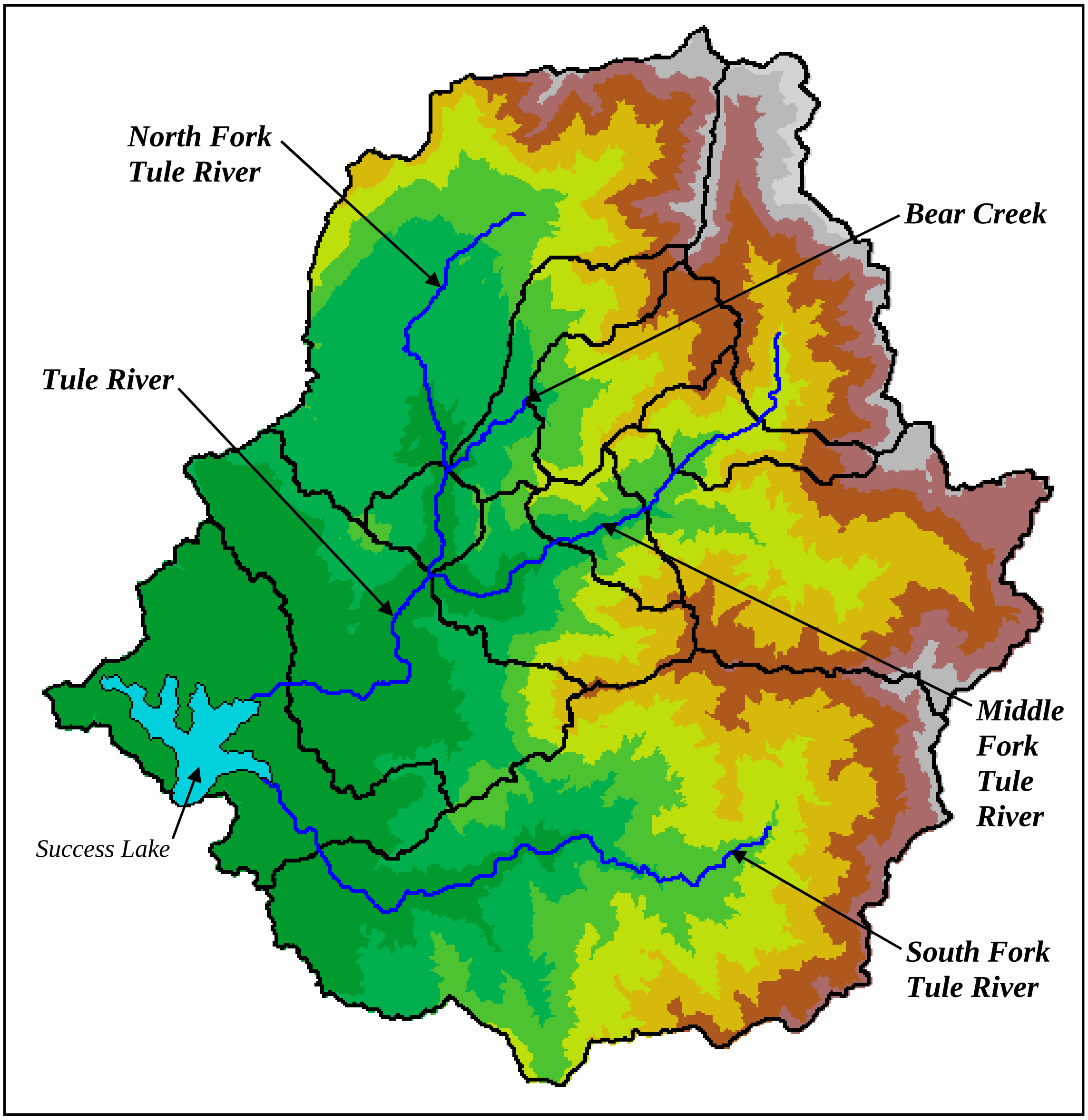


KE21 – Gage 11186000, Near Kernville

HEC-HMS Subbasin Parameters
Kern River Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
KE10 Kern Ab Ninemil	1	0.8	0.1	5	0.12	0
KE12 Rattlesnake	1	0.8	0.1	5	0.12	0
KE14 Lt Kern HW	1	0.8	0.1	5	0.12	0
KE16 Low Lt Kern	1	0.8	0.1	5	0.12	0
KE18 Sand Hill	1	0.8	0.1	5	0.12	0
KE2 Kern R HW	1	0.8	0.1	5	0.12	0
KE20 Fairview	1	0.8	0.1	5	0.12	0
KE22 Tobias Cr	0.1	0.8	0.3	5	0.50	0
KE24 Salmon Cr	0.1	0.8	0.3	5	0.90	0
KE26 Kernville	0.1	0.8	0.3	5	0.50	0
KE28 SFk Kern R HW	0.2	0.8	0.2	6	0.25	0
KE30 SFk Kern Ab Fis	0.2	0.8	0.2	6	0.25	0
KE32 SFk Kern Nr Ony	0.2	0.8	0.2	6	0.25	0
KE34 Canebrake	0.2	0.8	0.2	6	0.25	0
KE36 Onyx	0.2	0.8	0.2	4	0.50	0
KE38 Kelso HW	0.2	0.8	0.2	4	0.50	0
KE4 Kern R Ab Gld Tr	1	0.8	0.1	5	0.12	0
KE40 Low Kelso	0.2	0.8	0.2	4	0.50	0
KE42 Fay Cr	0.2	0.8	0.2	4	0.50	0
KE44 Isabella Loc	0.1	0.8	0.2	4	0.50	0
KE6 Gldn Trout HW	1	0.8	0.1	5	0.12	0
KE8 Low Gldn Trout	1	0.8	0.1	5	0.12	0

Tule River Basin



HEC-GeoHMS Subbasin Delineation

Tule River

The Tule River HMS model consists of a 392 square mile basin above Success Lake located in the mid-east portion of the Tulare Lake Bed Watershed. The basin model is divided into 12 subbasins and connected with 10 routing reaches. The observed hydrographs are the computed inflow into Success Lake and at gages near Camp Wishon, Camp Nelson and Springville and on the South Fork of the Tule River near Success Lake. The computed peak inflow into Success Lake for the 1997 event was larger than the 1995 event (41,100 cfs vs. 9,640 cfs).

The adopted TC and R (Group 2) values and Muskingum parameters were used, and the model calibrated reasonably well to observed hydrographs. For reaches with a travel time of less than one hour, the lag method was used for routing. Muskingum was used for 4 routing reaches and lag was used for 6 routing reaches.

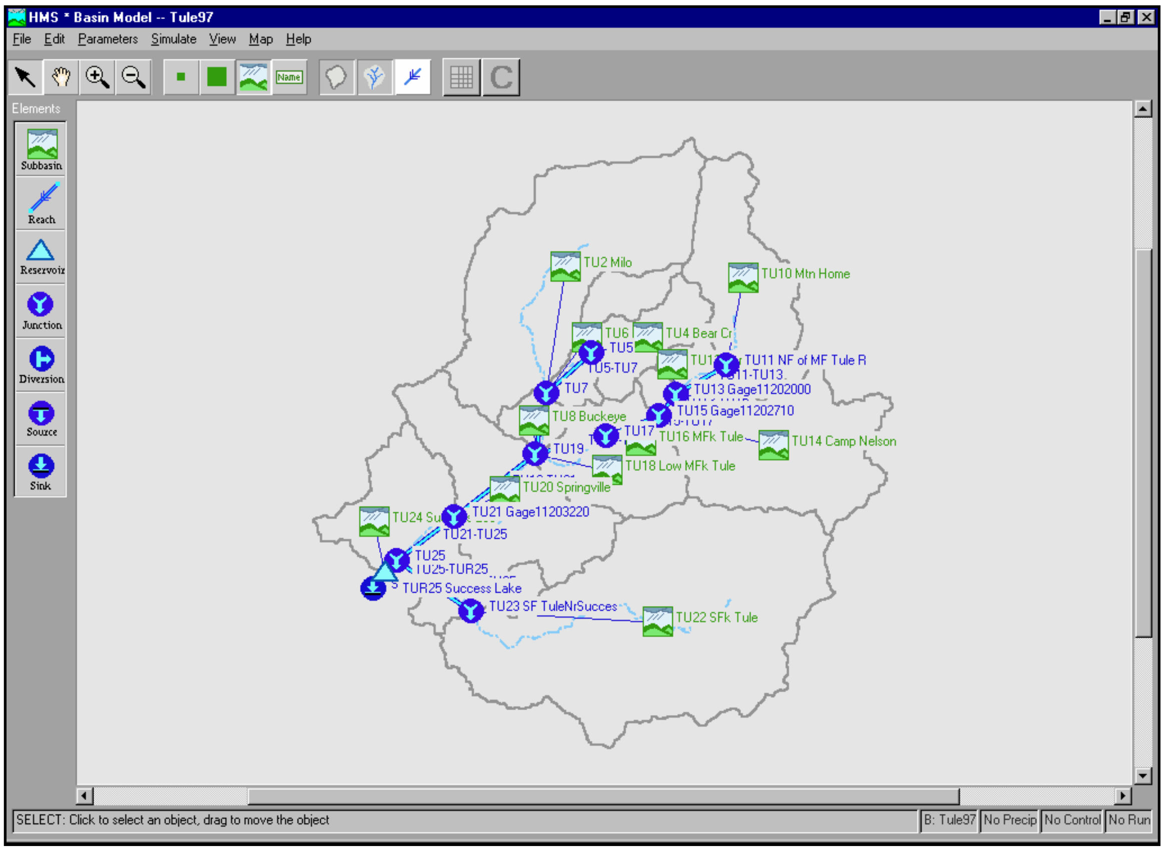
<u>Calibration of the 1995 Event:</u>

By using constant loss rates between 0.08 and 0.20 inches/hour and initial losses of 0.001 to 0.03 inches, the model calibrated reasonably well to observed hydrographs. Since the gage near Camp Wishon was a daily gage, the model was calibrated to the average daily flows with a known instantaneous peak. A recession ratio of 0.8 and a peak ratio of 0.2 defined the recession limb of the hydrographs. An initial baseflow of 1 cfs per square mile was assumed.

<u>Calibration of the 1997 Event:</u>

By using constant loss rates between 0.01 and 0.20 inches/hour and initial losses of 0.01 to 2.2 inches, the model calibrated reasonably well to all observed hydrographs. Since the gage near Camp Wishon was a daily gage, the model was calibrated to the average daily flows with a known instantaneous peak. Baseflow recession parameters of 0.7 to 0.8 for the constant and 0.1 to 0.2 for the peak ratio worked best. An initial baseflow of 1 cfs per square mile was used.

Tule River Basin HEC-HMS Model Schematic



Tule River Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Slope LFP S (ft/mi)	Basin Factor $LL_{CA}/S^{1/2}$	Initial TC $1.4(LL_{CA}/S^{1/2})^{.33}$ (Hr)	Initial R 1.5 TC (cfs/Hr)	Regression TC $1.67(LL_{CA}/S^{1/2})^{0.29}$ (Hr)	Regression R 4.0 TC (cfs/Hr)
TU10 Mtn Home	30.80	11.55	4.51	480.480	2.38	1.9	2.8	2.1	8.6
TU12 Camp Wishon	8.23	6.40	2.05	881.760	0.44	1.1	1.6	1.3	5.3
TU14 Camp Nelson	46.78	14.49	6.13	469.920	4.10	2.2	3.3	2.5	10.1
TU16 MFk Tule	7.07	4.52	1.24	1040.160	0.17	0.8	1.2	1.0	4.0
TU18 Low MFk Tule	17.02	8.86	4.73	649.440	1.64	1.6	2.5	1.9	7.7
TU2 Milo	67.34	16.90	7.32	475.200	5.68	2.5	3.7	2.8	11.1
TU20 Springville	39.21	8.90	2.55	501.600	1.01	1.4	2.1	1.7	6.7
TU22 SFk Tule	109.53	22.97	11.17	348.480	13.75	3.3	5.0	3.6	14.3
TU24 Success-Loc	35.26	9.72	2.14	253.440	1.30	1.5	2.3	1.8	7.2
TU4 Bear Cr	13.45	7.02	2.92	675.840	0.79	1.3	1.9	1.6	6.2
TU6 Rancheria Cr	11.95	10.21	3.99	696.960	1.54	1.6	2.4	1.9	7.6
TU8 Buckeye	5.11	4.20	2.03	469.920	0.39	1.0	1.5	1.3	5.1

Tule River Reach Parameters

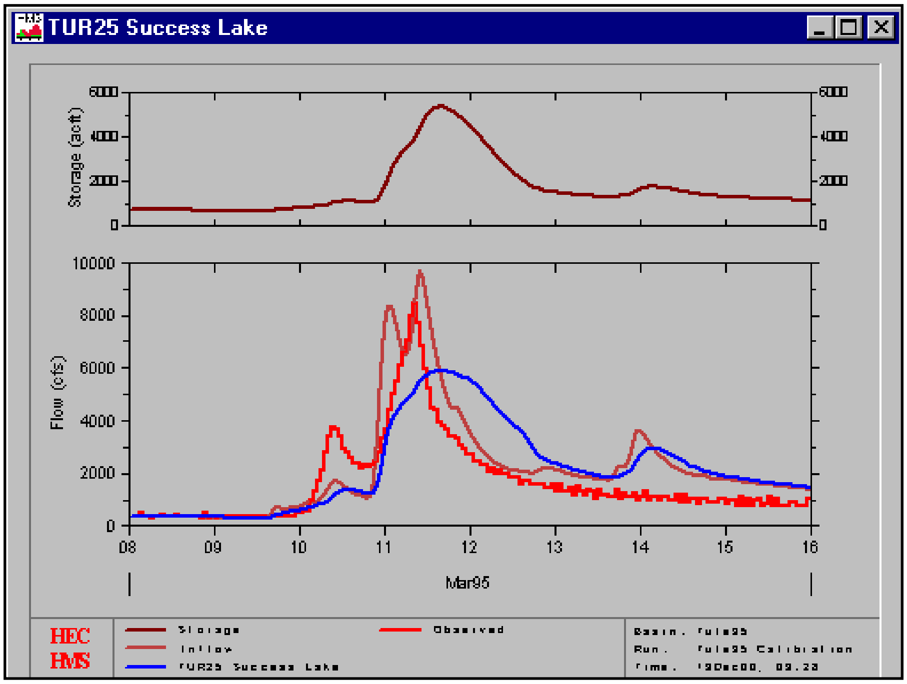
Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Ave Reach Vel $80\ S_R^{1/2}$ V_R (fps)	Initial K $1.47\ L_R / 1.5V_R$ K (Hr)	Musk X or LAG (Min)	N steps Time Step= 60
TU11-TU13	2.73	0.0774	22.26	0.1	6	--
TU13-TU15	1.37	0.0718	21.44	0.1	6	--
TU15-TU17	2.69	0.0504	17.96	0.1	6	--
TU17-TU19	4.20	0.0282	13.43	0.3	18	--
TU19-TU21	7.02	0.0096	7.84	1.0	0.4	1
TU21-TU25	3.32	0.0019	3.49	1.0	0.4	1
TU23-TU25	4.88	0.0034	4.66	1.0	0.4	1
TU25-TUR25	0.92	0.0001	0.80	1.1	0.4	1
TU5-TU7	3.39	0.0427	16.53	0.2	12	--
TU7-TU19	3.11	0.0157	10.02	0.3	18	--

HEC-HMS Summary of Results
Tule River Basin: March 1995 Event

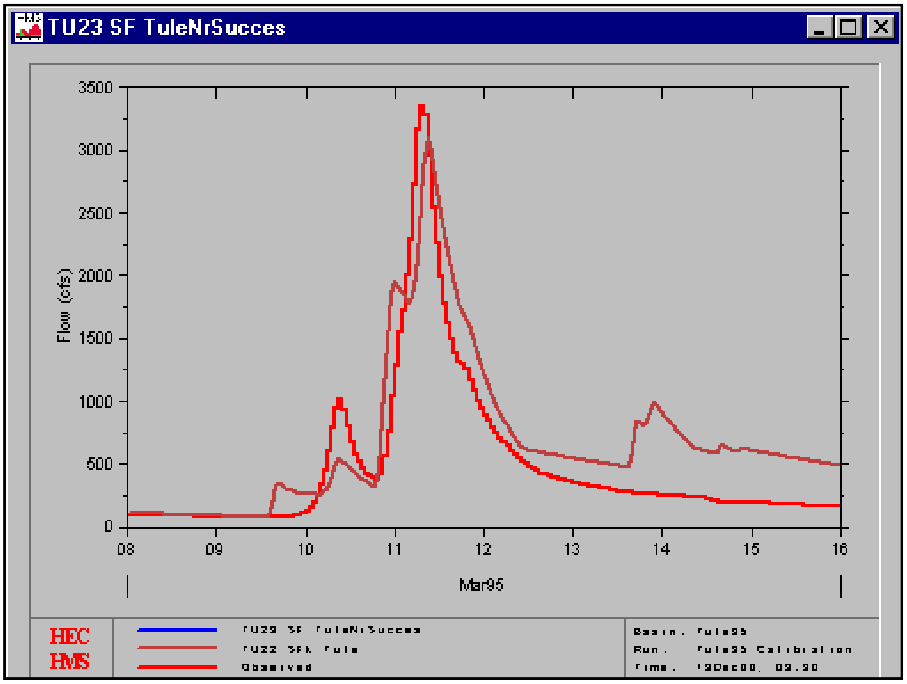
Project	: Tule	Run Name	: Tule95 Calibration
Start of Run	: 08Mar95 0100	Basin Model	: Tule95
End of Run	: 15Mar95 2400	Met. Model	: Mar95 Event
Execution Time	: 31May00 1353	Control Specs.	: Mar95 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
TU25-TUR25	0.0	08 Mar 95 0100	0.0	0.000
TU4 Bear Cr	1375.2	10 Mar 95 2300	3003.7	13.454
TU5	1375.2	10 Mar 95 2300	3003.7	13.454
TU5-TU7	1344.7	10 Mar 95 2300	3001.9	13.454
TU2 Milo	1960.4	11 Mar 95 0800	5635.6	67.337
TU6 Rancheria Cr	929.70	10 Mar 95 2400	2220.2	11.947
TU7	3800.0	10 Mar 95 2300	10858	92.738
TU7-TU19	3783.7	10 Mar 95 2400	10851	92.738
TU10 Mtn Home	983.59	10 Mar 95 2300	2968.3	30.801
TU11 NF of MF Tule R	983.59	10 Mar 95 2300	2968.3	30.801
TU11-TU13	977.93	10 Mar 95 2300	2967.3	30.801
TU12 Camp Wishon	423.95	11 Mar 95 0800	1299.2	8.234
TU13 Gage11202000	1362.5	10 Mar 95 2300	4266.5	39.035
TU13-TU15	1356.5	10 Mar 95 2300	4265.2	39.035
TU14 Camp Nelson	1087.7	13 Mar 95 2100	5279.9	46.783
TU15 Gage11202710	2409.7	10 Mar 95 2300	9545.1	85.818
TU15-TU17	2405.5	10 Mar 95 2300	9542.6	85.818
TU16 MFk Tule	367.65	11 Mar 95 0800	824.26	7.070
TU17	2624.4	10 Mar 95 2300	10367	92.888
TU17-TU19	2610.1	10 Mar 95 2300	10359	92.888
TU8 Buckeye	170.78	11 Mar 95 0700	357.70	5.108
TU18 Low MFk Tule	432.70	11 Mar 95 0800	1116.5	17.018
TU19	6501.4	10 Mar 95 2300	22684	207.752
TU19-TU21	6426.9	10 Mar 95 2400	22630	207.752
TU20 Springville	348.91	11 Mar 95 0800	808.30	39.207
TU21 Gage11203220	6669.5	11 Mar 95 0900	23438	246.959
TU21-TU25	6587.9	11 Mar 95 1000	23385	246.959
TU22 SFk Tule	3089.5	11 Mar 95 0900	10689	109.531
TU23 SF TuleNrSucces	3089.5	11 Mar 95 0900	10689	109.531
TU23-TU25	3053.1	11 Mar 95 1000	10658	109.531
TU25	9641.0	11 Mar 95 1000	34043	356.490
TU24 Success-Loc	52.837	11 Mar 95 0800	288.30	35.258
TUR25 Success Lake	5880.3	11 Mar 95 1600	33899	391.748
Sink-1	5880.3	11 Mar 95 1600	33899	391.748

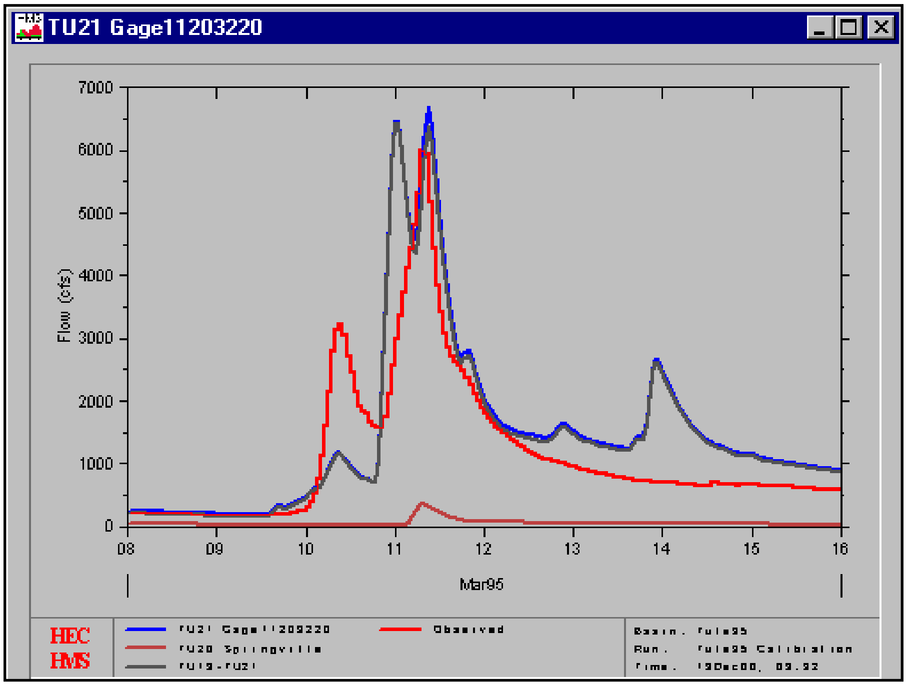
HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Tule River Basin
March 1995 Event



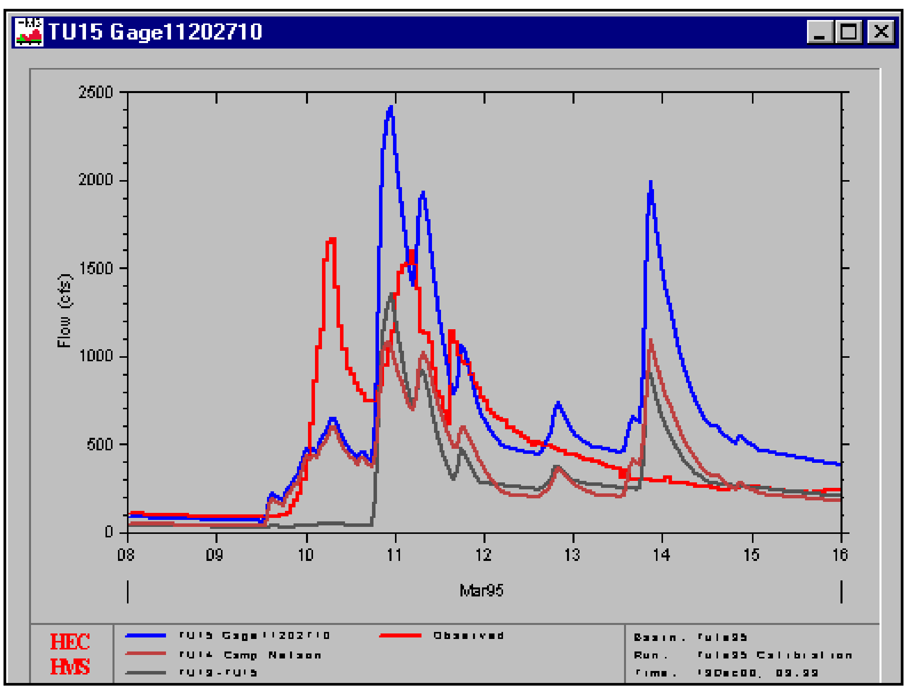
TUR25 – Success Lake



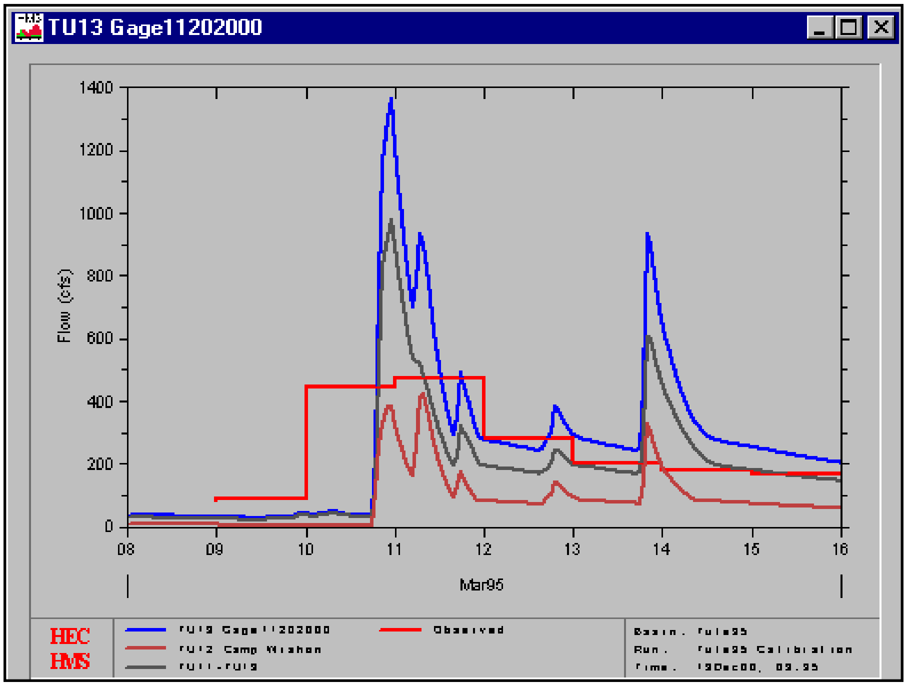
TU23 – South Fork Near Success



TU21 – Gage 11203220, Near Springville



TU15 – Gage 11202710, Middle Fork Below Intake Above Springville



TU13 – Gage 11202001, North Fork of Middle Fork Near Springville

HEC-HMS Subbasin Parameters
Tule River Basin: March 1995 Event

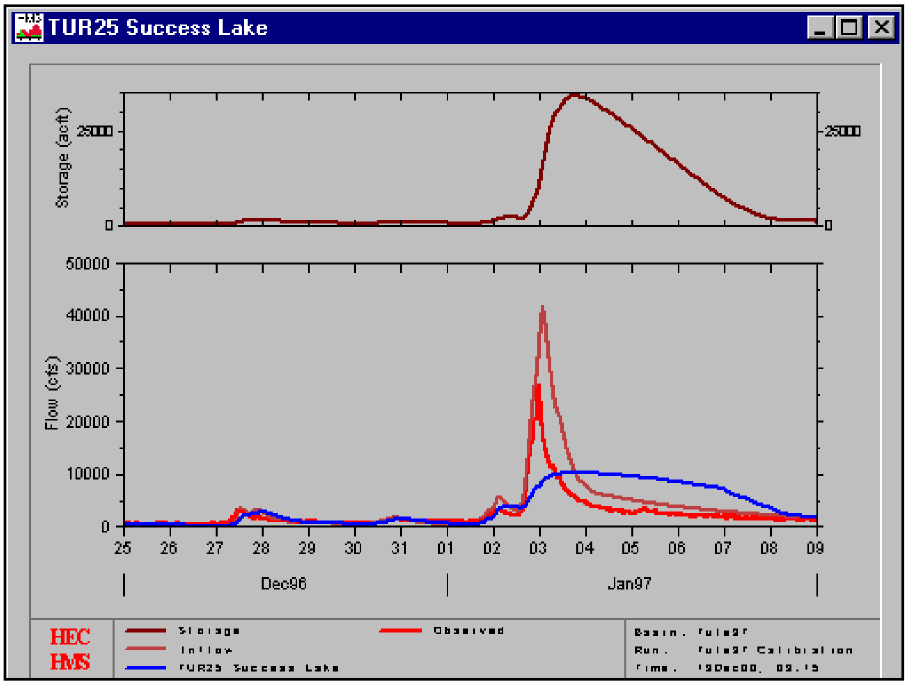
Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
TU10 Mtn Home	1	0.8	0.2	.001	0.10	0
TU12 Camp Wishon	1	0.8	0.2	.001	0.10	0
TU14 Camp Nelson	1	0.8	0.2	.001	0.10	0
TU16 MFk Tule	1	0.8	0.2	.01	0.15	0
TU18 Low MFk Tule	1	0.8	0.2	.01	0.15	0
TU2 Milo	1	0.8	0.2	.01	0.15	0
TU20 Springville	1	0.8	0.2	.001	0.20	0
TU22 SFk Tule	1	0.8	0.2	.03	0.08	0
TU24 Success-Loc	1	0.8	0.2	.001	0.20	0
TU4 Bear Cr	1	0.8	0.2	.01	0.15	0
TU6 Rancheria Cr	1	0.8	0.2	.01	0.15	0
TU8 Buckeye	1	0.8	0.2	.01	0.15	0

HEC-HMS Summary of Results
Tule River Basin: December 1996 - January 1997 Event

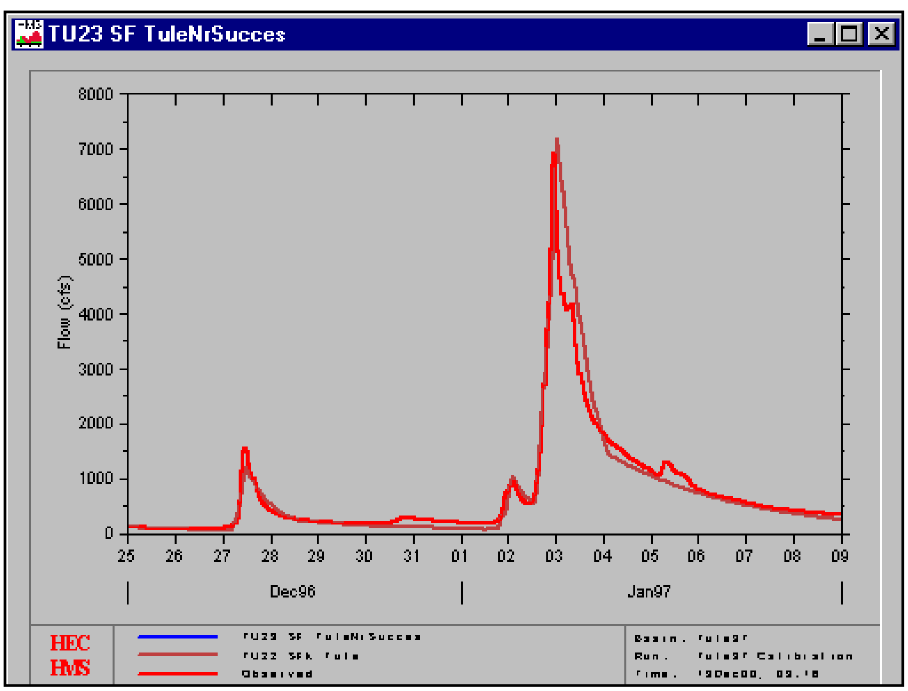
Project	: Tule	Run Name	: Tule97 Calibration
Start of Run	: 25Dec96 0100	Basin Model	: Tule97
End of Run	: 08Jan97 2400	Met. Model	: Dec96Jan97 Event
Execution Time	: 31May00 1353	Control Specs.	: Dec96Jan97 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
TU25-TUR25	0.0	25 Dec 96 0100	0.0	0.000
TU4 Bear Cr	2818.2	02 Jan 97 2300	7201.2	13.454
TU5	2818.2	02 Jan 97 2300	7201.2	13.454
TU5-TU7	2687.5	02 Jan 97 2300	7198.7	13.454
TU2 Milo	7775.8	02 Jan 97 2400	21233	67.337
TU6 Rancheria Cr	2018.3	02 Jan 97 2400	5828.1	11.947
TU7	12410	02 Jan 97 2400	34260	92.738
TU7-TU19	12177	02 Jan 97 2400	34243	92.738
TU10 Mtn Home	7888.9	02 Jan 97 2300	15179	30.801
TU11 NF of MF Tule R	7888.9	02 Jan 97 2300	15179	30.801
TU11-TU13	7793.0	02 Jan 97 2300	15178	30.801
TU12 Camp Wishon	2224.1	02 Jan 97 2300	3982.2	8.234
TU13 Gage11202000	10017	02 Jan 97 2300	19160	39.035
TU13-TU15	9911.4	02 Jan 97 2300	19159	39.035
TU14 Camp Nelson	9682.6	02 Jan 97 2400	24872	46.783
TU15 Gage11202710	19333	02 Jan 97 2400	44031	85.818
TU15-TU17	19320	02 Jan 97 2400	44028	85.818
TU16 MFk Tule	1080.4	02 Jan 97 2300	2320.4	7.070
TU17	20163	02 Jan 97 2400	46349	92.888
TU17-TU19	20131	02 Jan 97 2400	46340	92.888
TU8 Buckeye	307.18	02 Jan 97 2200	685.24	5.108
TU18 Low MFk Tule	1145.9	02 Jan 97 2400	2977.0	17.018
TU19	33691	02 Jan 97 2400	84246	207.752
TU19-TU21	33336	03 Jan 97 0100	84155	207.752
TU20 Springville	1263.6	02 Jan 97 2300	2698.5	39.207
TU21 Gage11203220	34341	03 Jan 97 0100	86854	246.959
TU21-TU25	34019	03 Jan 97 0200	86760	246.959
TU22 SFk Tule	7162.5	03 Jan 97 0100	21681	109.531
TU23 SF TuleNrSucces	7162.5	03 Jan 97 0100	21681	109.531
TU23-TU25	7078.6	03 Jan 97 0200	21669	109.531
TU25	41098	03 Jan 97 0200	108429	356.490
TU24 Success-Loc	556.59	02 Jan 97 2300	1326.7	35.258
TUR25 Success Lake	10240	03 Jan 97 1900	109191	391.748
Sink-1	10240	03 Jan 97 1900	109191	391.748

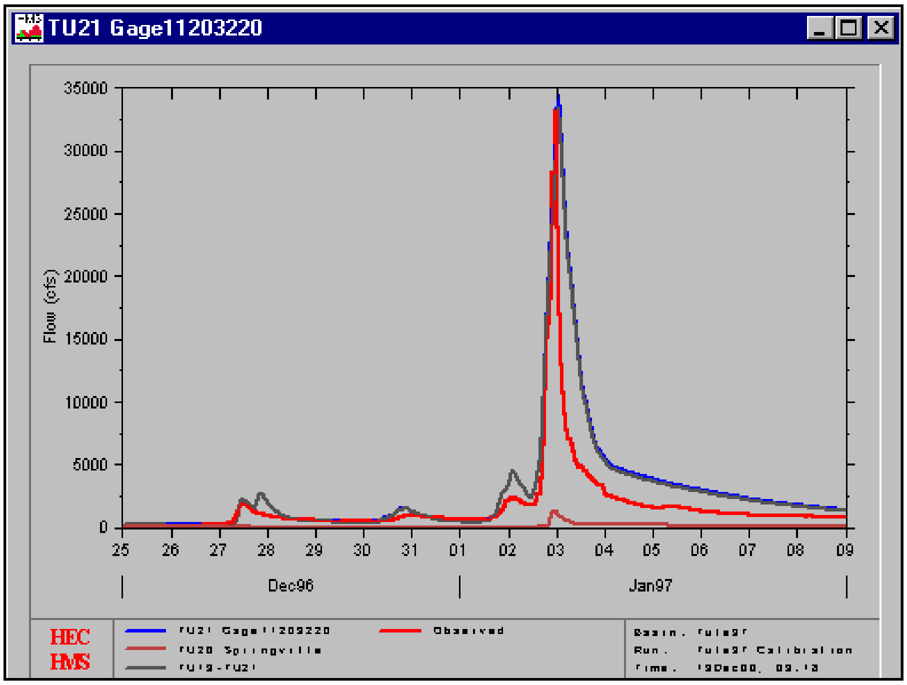
HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Tule River Basin
December 1996 - January 1997 Event



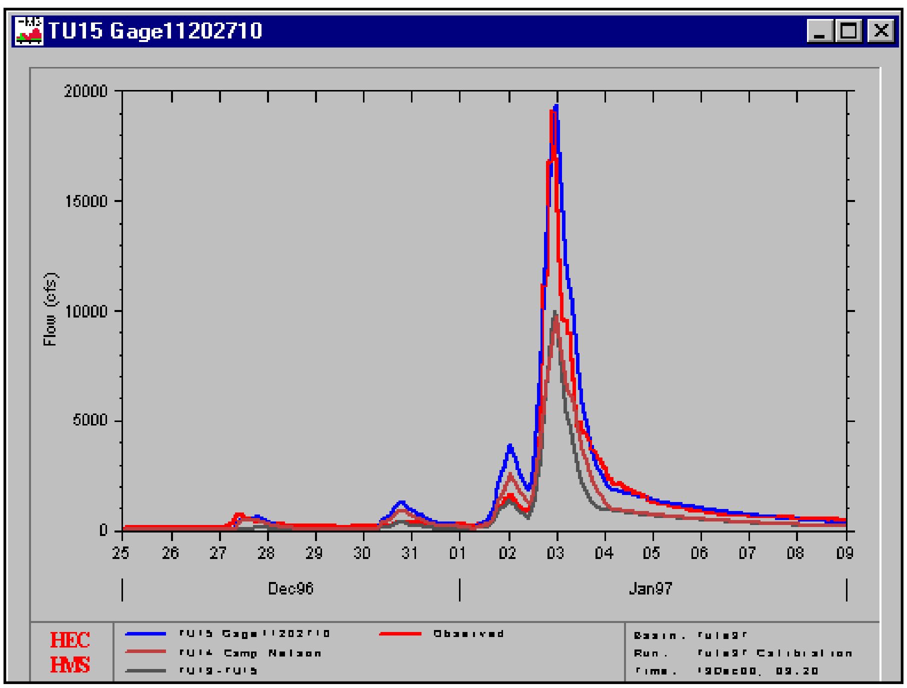
TUR25 – Success Lake



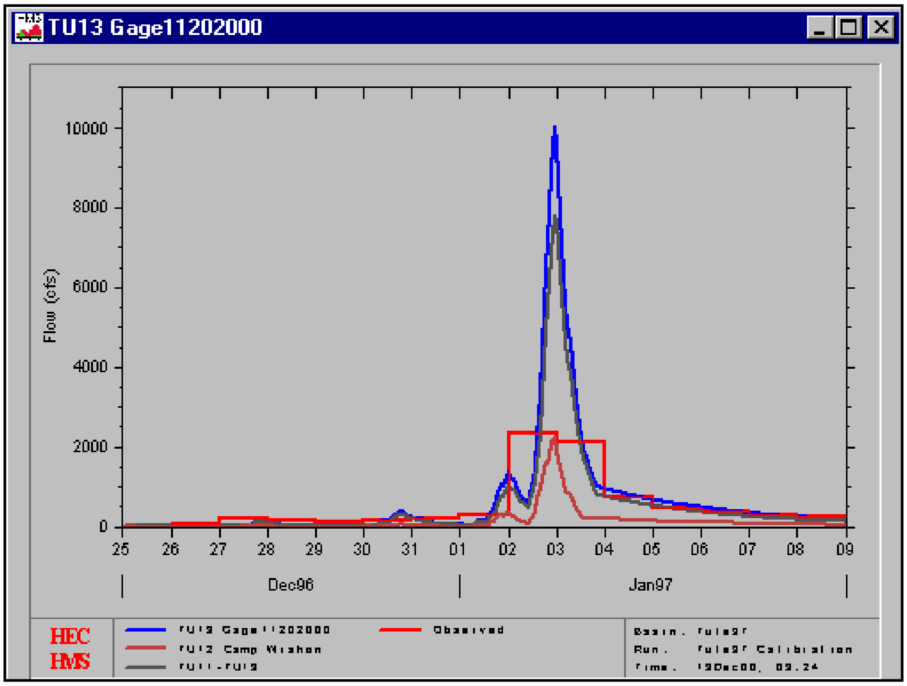
TU23 – South Fork Near Success



TU21 – Gage 11203220, Near Springville



TU15 – Gage 11202710, Middle Fork Below Intake Above Springville

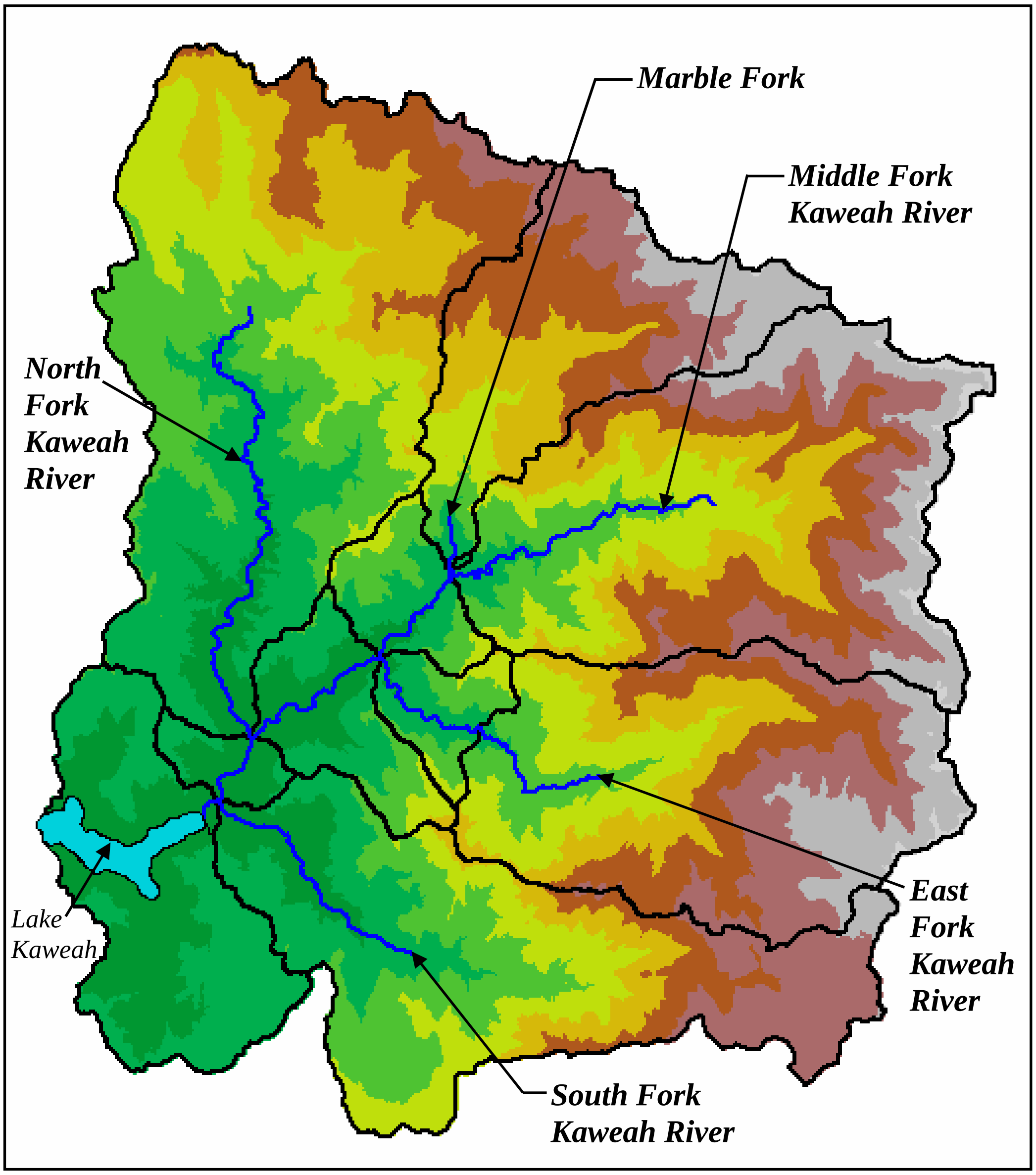


TU13 – Gage 11202001, North Fork of Middle Fork Near Springville

HEC-HMS Subbasin Parameters
Tule River Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
TU10 Mtn Home	1	0.7	0.1	2.2	0.01	0
TU12 Camp Wishon	1	0.7	0.1	2.2	0.01	0
TU14 Camp Nelson	1	0.7	0.1	2.2	0.01	0
TU16 MFk Tule	1	0.8	0.2	.01	0.15	0
TU18 Low MFk Tule	1	0.8	0.2	.01	0.15	0
TU2 Milo	1	0.8	0.2	.01	0.15	0
TU20 Springville	1	0.8	0.2	.01	0.20	0
TU22 SFk Tule	1	0.7	0.2	.15	0.15	0
TU24 Success-Loc	1	0.8	0.2	.15	0.20	0
TU4 Bear Cr	1	0.8	0.2	.01	0.15	0
TU6 Rancheria Cr	1	0.8	0.2	.01	0.15	0
TU8 Buckeye	1	0.8	0.2	.01	0.15	0

Kaweah River Basin



HEC-GeoHMS Subbasin Delineation

Kaweah River

The Kaweah River HMS model consists of a 560 square mile basin above Lake Kaweah (Terminus Dam) located in the mid-east portion of the Tulare Lake Bed Watershed. The basin model is divided into 10 subbasins and connected with 5 routing reaches. The observed hydrographs are the computed inflow into Lake Kaweah and at gages at Three Rivers and on the Marble Fork at Potwish. The computed peak inflow into Lake Kaweah for the 1997 event was much larger than the 1995 event (57,257 cfs vs. 13,333 cfs).

The adopted TC and R (Group 1) values were used. The generic equation to compute the reach travel time (Muskingum K) was not used because the reach travel times were too short; thus, causing the computed peaks to occur too early. Instead, the travel time (K) for the reach was computed knowing the reach length and average velocity. The average velocity was computed using Manning's equation. The Manning's "n" value was estimated with Jarrett's equation, and the hydraulic radius was estimated from the Yuba River equation, which was developed from a regression of field data (the Yuba River equation was used because it was felt that it would represent the Kaweah system the best). Because each of the reaches had a travel time of less than one hour, the lag method was used to route the flows through all 5 reaches. Ten percent impervious area was assumed for the reservoir subbasin.

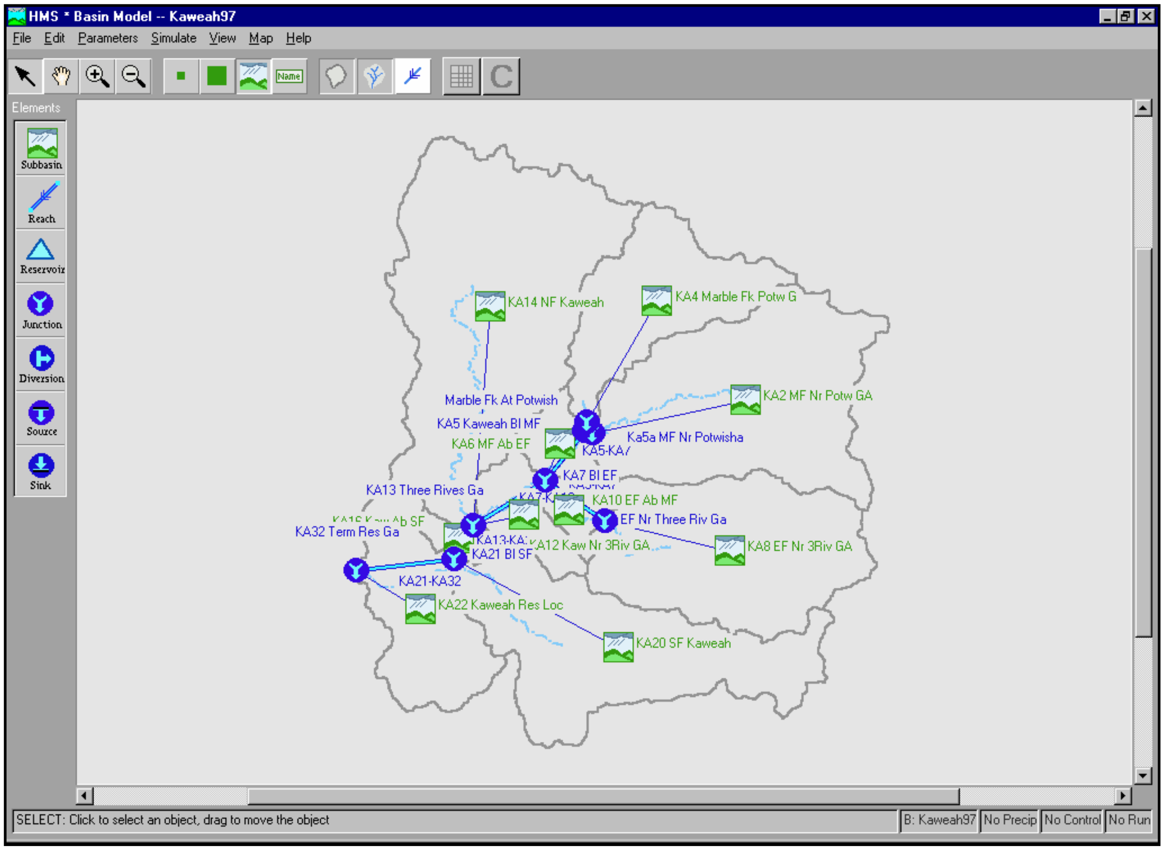
Calibration of the 1995 Event:

By using constant loss rates of 0.02 to 0.1 inches/hour and initial losses of 0.8 to 2.0 inches, the model calibrated well to observed hydrographs. Since no data were available for the 1995 event at the Marble Fork at Potwish gage, no calibration was performed at this location. A recession ratio of 0.7 and a peak ratio of 0.2 defined the recession limb of the hydrographs. An initial baseflow of 2 cfs per square mile was assumed.

Calibration of the 1997 Event:

By using constant loss rates of 0.2 to 0.35 inches/hour and an initial loss of 1.0 inch, the model calibrated reasonably well to all observed hydrographs. Since no data were available at the Three Rivers gage, no calibration was performed at this location. Baseflow recession parameters of 0.7 for the constant and 0.15 for the peak ratio worked best. An initial baseflow of 2 cfs per square mile was used.

Kaweah River Basin HEC-HMS Model Schematic



Kaweah River Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Slope LFP S (ft/mi)	Basin Shape Factor $LL_{CA}/S^{1/2}$	Initial TC $1.4(LL_{CA}/S^{1/2})^{.33}$ (Hr)	Initial R 2.33 TC (cfs/Hr)	Final TC $1.67(LL_{CA}/S^{1/2})^{.29}$ (Hr)	Final R 1.5 TC (Hr)
KA14 NF Kaweah	138.43	29.41	17.39	660.0	19.91	3.8	8.8	4.0	6.0
KA4 Marble Fk Potw G	51.62	17.83	9.47	675.8	6.49	2.6	6.0	2.9	4.3
KA2 MF Nr Potw GA	103.49	21.20	11.05	290.4	13.75	3.3	7.7	3.6	5.4
KA6 MF Ab EF	12.54	7.21	2.09	681.1	0.58	1.2	2.7	1.4	2.1
KA16 Kaw Ab SF	5.86	3.60	0.98	485.8	0.16	0.8	1.8	1.0	1.5
KA12 Kaw Nr 3Riv GA	17.68	8.65	3.59	396.0	1.56	1.6	3.8	1.9	2.9
KA10 EF Ab MF	9.37	7.50	3.06	195.4	1.64	1.6	3.8	1.9	2.9
KA22 Kaweah Res Loc	46.04	13.66	4.01	517.4	2.41	1.9	4.4	2.2	3.2
KA20 SF Kaweah	89.31	26.81	11.69	586.1	12.94	3.3	7.6	3.5	5.3
KA8 EF Nr 3Riv GA	85.77	19.22	8.21	464.6	7.32	2.7	6.3	3.0	4.5

Kaweah River Reach Parameters

Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Cum Drainage Area (from GeoHms) A (Sq. Mi.)	Yuba Field Reg. Eqa R=4.13Ln(A) - 6.393	Jarrett's Equation $n = .39S^{.38}R^{-.16}$	Manning's Velocity v (ft/s)	Travel Time K Hrs	Travel Time Lag (Min)
KA5-KA7	4.096	0.0348	160	14.57	0.071	23.38	0.26	15
KA7-KA13	5.598	0.0156	267	16.68	0.051	23.75	0.35	21
KA9-KA7	4.828	0.0529	91.1	12.24	0.085	21.29	0.33	20
KA13-KA21	2.445	0.0050	420	18.55	0.033	22.62	0.16	10
KA21-KA32	6.111	0.0079	520	19.44	0.039	24.83	0.36	22

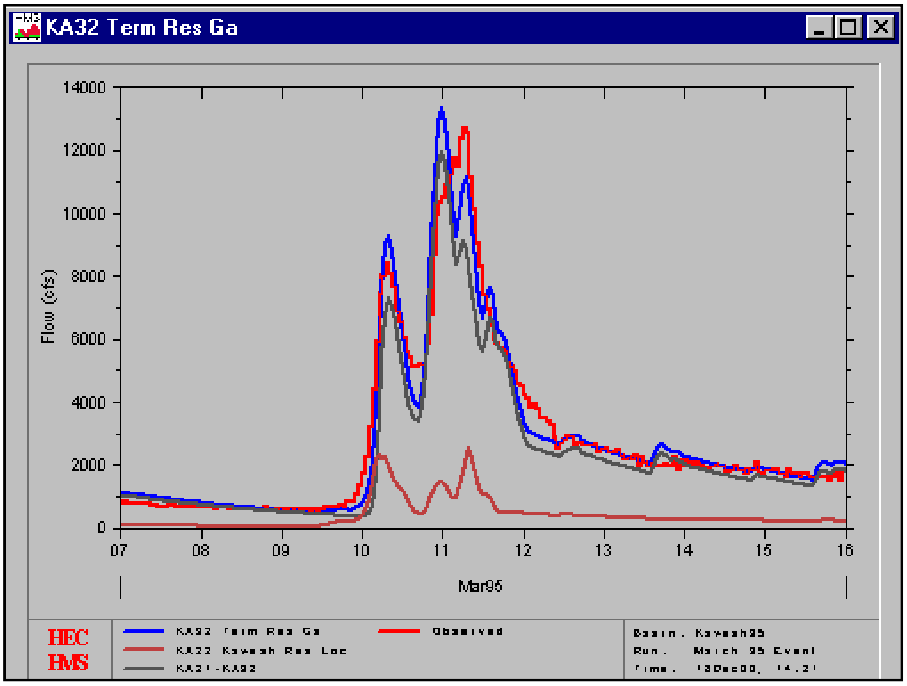
Routing parameters based on field observations and regression analysis.

HEC-HMS Summary of Results
Kaweah River Basin: March 1995 Event

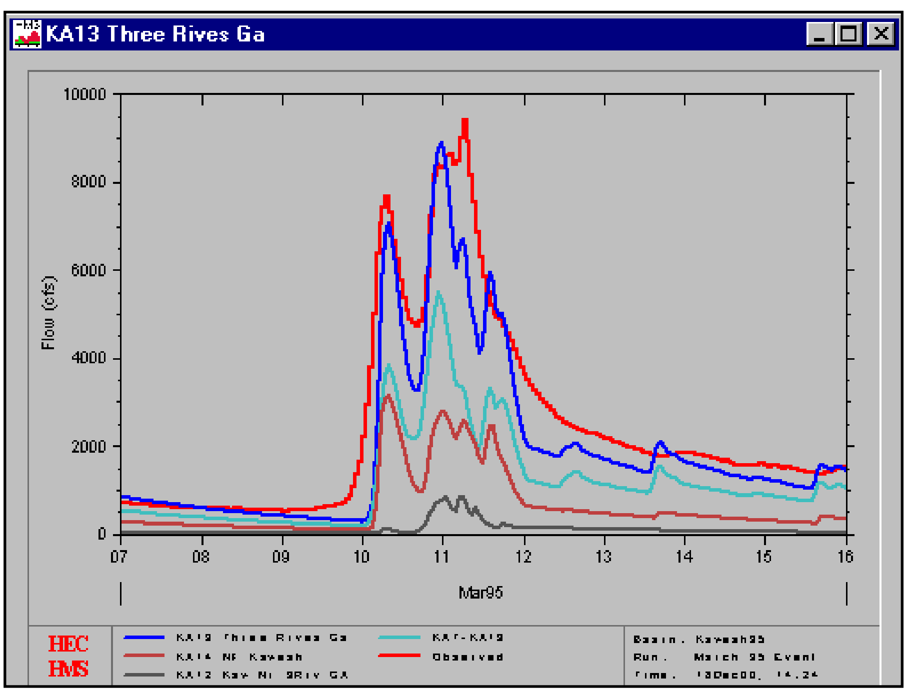
Project	: Kaweah	Run Name	: March 95 Event
Start of Run	: 06Mar95 2400	Basin Model	: Kaweah95
End of Run	: 15Mar95 2400	Met. Model	: Mar 95 Event
Execution Time	: 31May00 1346	Control Specs.	: Mar 95 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
KA4 Marble Fk Potw G	1050.2	10 Mar 95 0700	4051.2	51.622
Marble Fk At Potwish	1050.2	10 Mar 95 0700	4051.2	51.622
KA2 MF Nr Potw GA	2189.5	10 Mar 95 2300	8408.6	103.495
Ka5a MF Nr Potwisha	2189.5	10 Mar 95 2300	8408.6	103.495
KA5 Kaweah Bl MF	2859.6	10 Mar 95 2300	12460	155.117
KA5-KA7	2836.3	10 Mar 95 2300	12454	155.117
KA8 EF Nr 3Riv GA	1863.4	10 Mar 95 2200	6703.1	85.773
EF Nr Three Riv Ga	1863.4	10 Mar 95 2200	6703.1	85.773
KA9-KA7	1846.4	10 Mar 95 2300	6697.3	85.773
KA6 MF Ab EF	704.02	11 Mar 95 1300	1617.2	12.544
KA10 EF Ab MF	443.15	10 Mar 95 2400	927.22	9.368
KA7 Bl EF	5508.0	10 Mar 95 2300	21696	262.802
KA7-KA13	5467.0	10 Mar 95 2300	21681	262.802
KA14 NF Kaweah	3148.1	10 Mar 95 0800	11564	138.427
KA12 Kaw Nr 3Riv GA	845.44	11 Mar 95 0500	1931.9	17.677
KA13 Three Rives Ga	8876.8	10 Mar 95 2400	35177	418.906
KA13-KA21	8859.2	10 Mar 95 2400	35168	418.906
KA16 Kaw Ab SF	340.35	11 Mar 95 0500	722.41	5.863
KA20 SF Kaweah	2878.7	10 Mar 95 2400	7067.7	89.312
KA21 Bl SF	11973	10 Mar 95 2400	42958	514.081
KA21-KA32	11907	10 Mar 95 2400	42948	514.081
KA22 Kaweah Res Loc	2532.8	11 Mar 95 0800	7443.0	46.044
KA32 Term Res Ga	13333	10 Mar 95 2400	50391	560.125

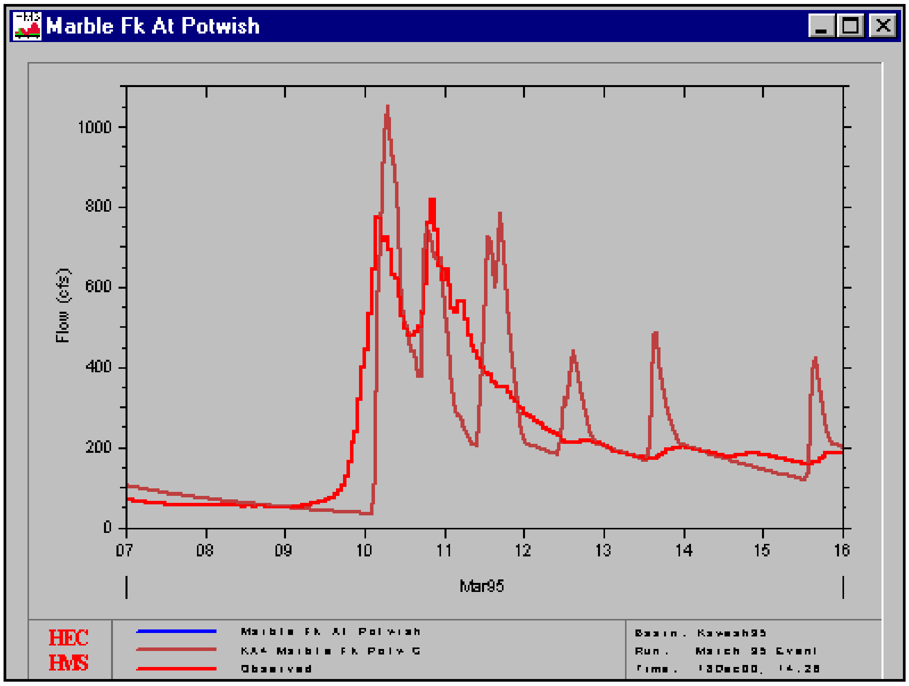
HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Kaweah River Basin
March 1995 Event



KA32 – Terminus Reservoir Gage



KA13 – Three Rivers Gage



Marble Fork At Potwish

HEC-HMS Subbasin Parameters
Kaweah River Basin: March 1995 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
KA14 NF Kaweah	2	0.7	0.2	1.75	0.10	0
KA4 Marble Fk Potw G	2	0.7	0.2	2.00	0.05	0
KA2 MF Nr Potw GA	2	0.7	0.2	1.75	0.05	0
KA6 MF Ab EF	2	0.7	0.2	1.75	0.10	0
KA16 Kaw Ab SF	2	0.7	0.2	1.75	0.10	0
KA12 Kaw Nr 3Riv GA	2	0.7	0.2	1.75	0.10	0
KA10 EF Ab MF	2	0.7	0.2	1.75	0.10	0
KA22 Kaweah Res Loc	2	0.7	0.2	1.75	0.10	10
KA20 SF Kaweah	2	0.7	0.2	1.75	0.10	0
KA8 EF Nr 3Riv GA	2	0.7	0.2	0.80	0.02	0

HEC-HMS Summary of Results
Kaweah River Basin: December 1996 - January 1997 Event

Project : Kaweah   Run Name : Jan 97 Event

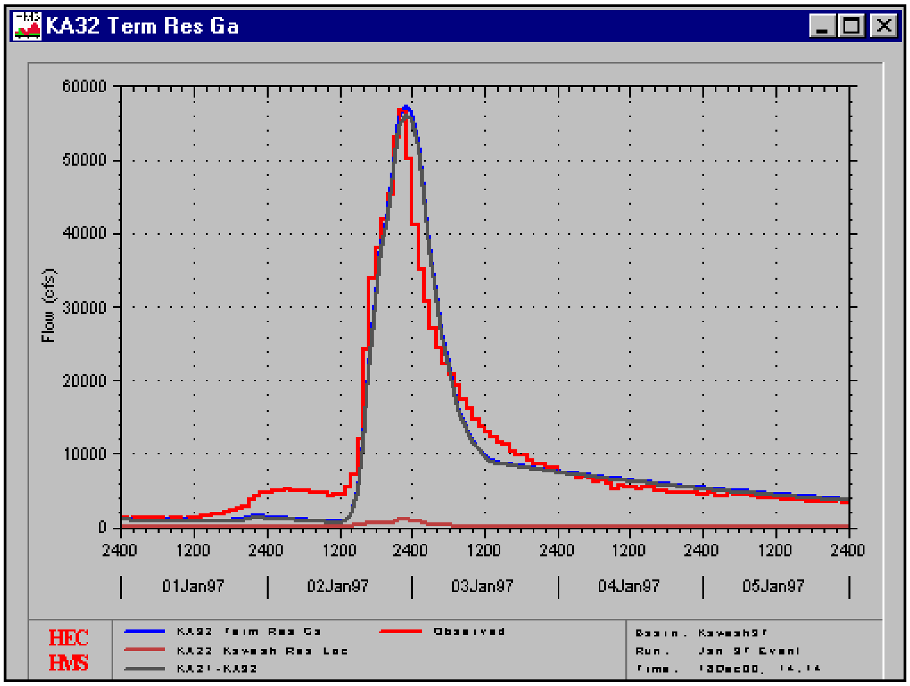
Start of Run : 31Dec96 2400   Basin Model : Kaweah97

End of Run : 05Jan97 2400   Met. Model : Jan 97 Event

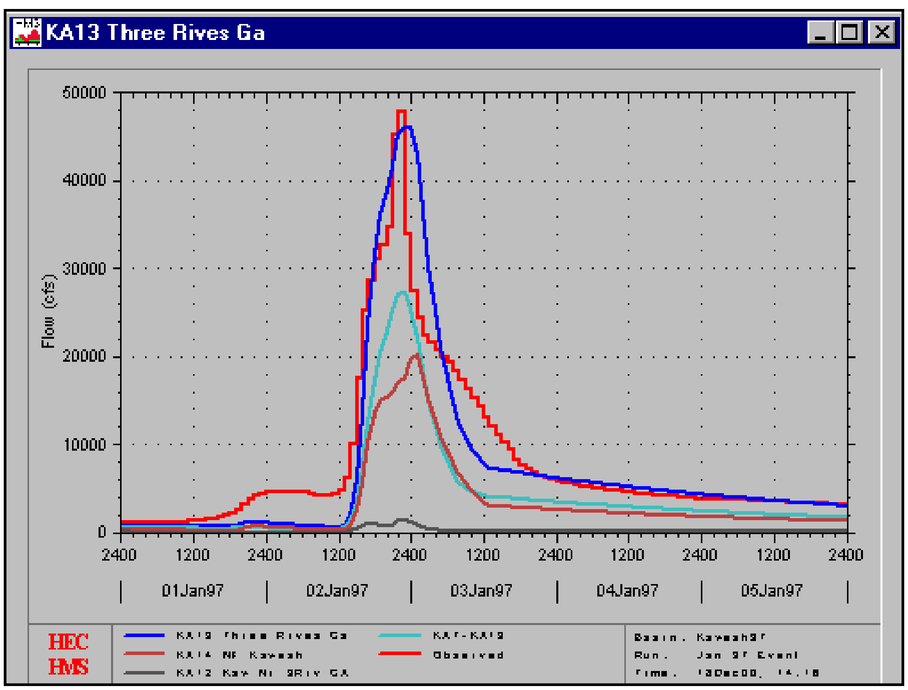
Execution Time : 31May00 1346   Control Specs. : Jan 97 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
KA4 Marble Fk Potw G	6301.1	02 Jan 97 1800	9105.7	51.622
Marble Fk At Potwish	6301.1	02 Jan 97 1800	9105.7	51.622
KA2 MF Nr Potw GA	9763.3	02 Jan 97 2300	14916	103.495
Ka5a MF Nr Potwisha	9763.3	02 Jan 97 2300	14916	103.495
KA5 Kaweah Bl MF	15682	02 Jan 97 2300	24022	155.117
KA5-KA7	15522	02 Jan 97 2300	24008	155.117
KA8 EF Nr 3Riv GA	10797	02 Jan 97 2100	13495	85.773
EF Nr Three Riv Ga	10797	02 Jan 97 2100	13495	85.773
KA9-KA7	10505	02 Jan 97 2200	13483	85.773
KA6 MF Ab EF	1415.0	02 Jan 97 2200	1785.5	12.544
KA10 EF Ab MF	570.83	02 Jan 97 2200	706.91	9.368
KA7 Bl EF	27453	02 Jan 97 2200	39984	262.802
KA7-KA13	27191	02 Jan 97 2300	39950	262.802
KA14 NF Kaweah	20098	03 Jan 97 0100	31593	138.427
KA12 Kaw Nr 3Riv GA	1363.6	02 Jan 97 2300	1683.1	17.677
KA13 Three Rives Ga	46122	02 Jan 97 2300	73226	418.906
KA13-KA21	46091	02 Jan 97 2400	73196	418.906
KA16 Kaw Ab SF	319.72	02 Jan 97 2200	294.79	5.863
KA20 SF Kaweah	10664	02 Jan 97 2200	12932	89.312
KA21 Bl SF	56168	02 Jan 97 2300	86423	514.081
KA21-KA32	56074	02 Jan 97 2300	86386	514.081
KA22 Kaweah Res Loc	1182.5	02 Jan 97 2300	2119.7	46.044
KA32 Term Res Ga	57257	02 Jan 97 2300	88505	560.125

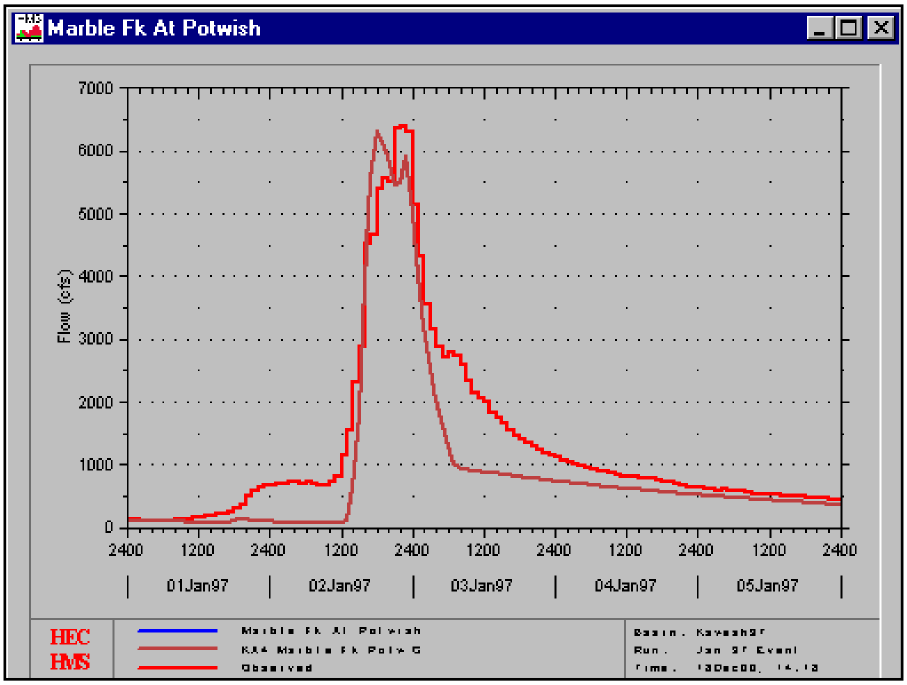
HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Kaweah River Basin
December 1996 - January 1997 Event



KA32 – Terminus Reservoir Gage



KA13 – Three Rivers Gage

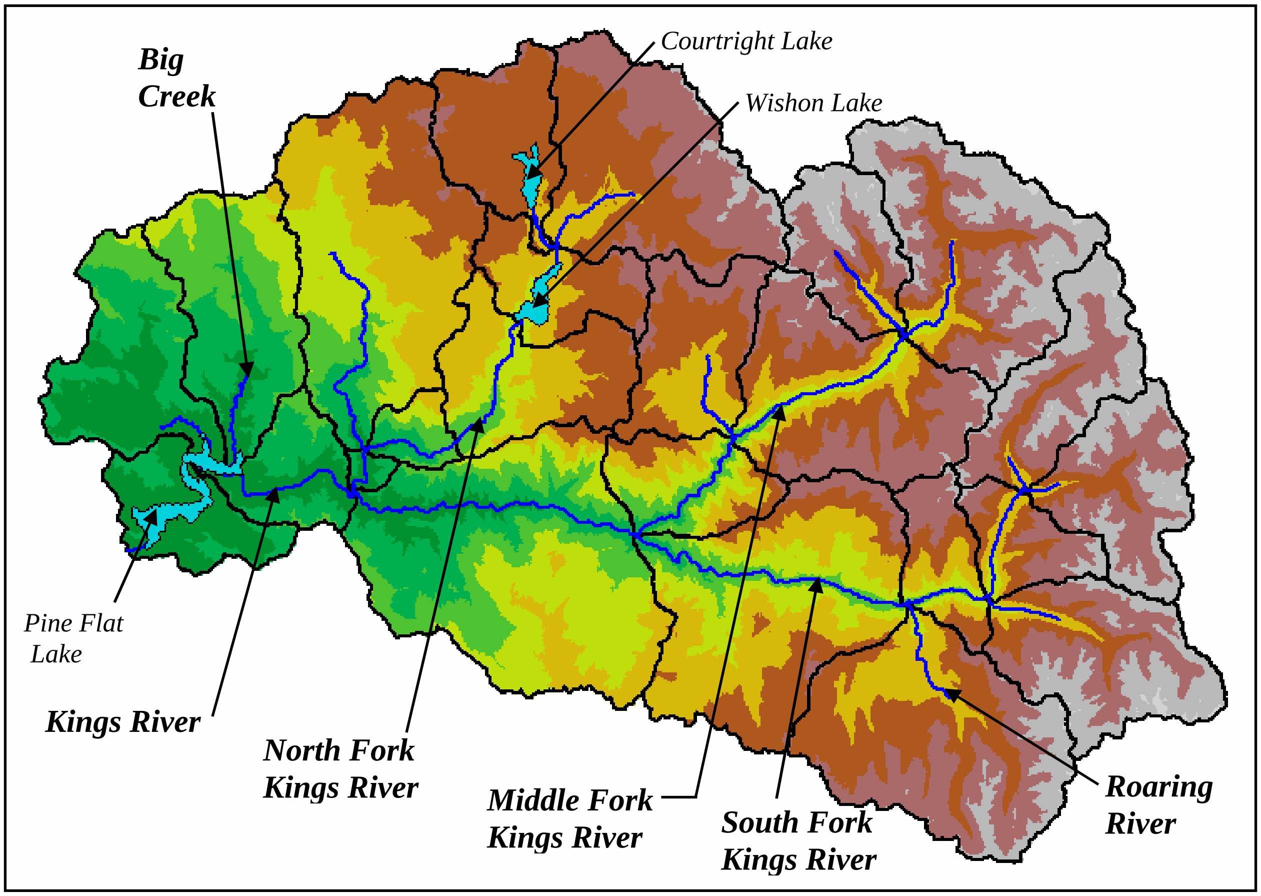


Marble Fork At Potwish

HEC-HMS Subbasin Parameters
Kaweah River Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
KA14 NF Kaweah	2	0.7	0.15	1	0.20	0
KA4 Marble Fk Potw G	2	0.7	0.15	1	0.35	0
KA2 MF Nr Potw GA	2	0.7	0.15	1	0.25	0
KA6 MF Ab EF	2	0.7	0.15	1	0.25	0
KA16 Kaw Ab SF	2	0.7	0.15	1	0.30	0
KA12 Kaw Nr 3Riv GA	2	0.7	0.15	1	0.20	0
KA10 EF Ab MF	2	0.7	0.15	1	0.25	0
KA22 Kaweah Res Loc	2	0.7	0.15	1	0.35	10
KA20 SF Kaweah	2	0.7	0.15	1	0.35	0
KA8 EF Nr 3Riv GA	2	0.7	0.15	1	0.25	0

Kings River Basin



HEC-GeoHMS Subbasin Delineation

Kings River

The Kings River HMS model consists of a 1,541 square mile basin above Pine Flat Lake located in the northeastern-most portion of the Tulare Lake Bed Watershed. The basin model is divided into 24 subbasins and connected with 13 routing reaches. The observed hydrographs are the computed inflow into Pine Flat Lake and at gages below Balch Diversion Dam and below the North Fork of the Kings River. The computed peak inflow into Pine Flat Lake for the 1997 event was larger than the 1995 event (90,259 cfs vs. 37,194 cfs).

The adopted TC and R values (Group 2) were used. Since the reaches had a travel time of less than one hour, the lag method was used to route the flow through all reaches. For this modeling effort, rather than attempt to predict how the Courtright and Wishon reservoirs were operated, the source and sink tools available in HMS were used. This technique allowed the observed outflow hydrographs from the reservoirs to be passed downstream. As pointed out in "Section 6.6.5, Reservoir Modeling" of the main report, HMS is fairly limited in how it models releases from reservoirs. Twenty percent impervious area was assumed for the Pine Flat subbasin, five percent was assumed for the subbasin at the upstream end of Pine Flat Lake and five percent was assumed for the subbasin above Big Creek.

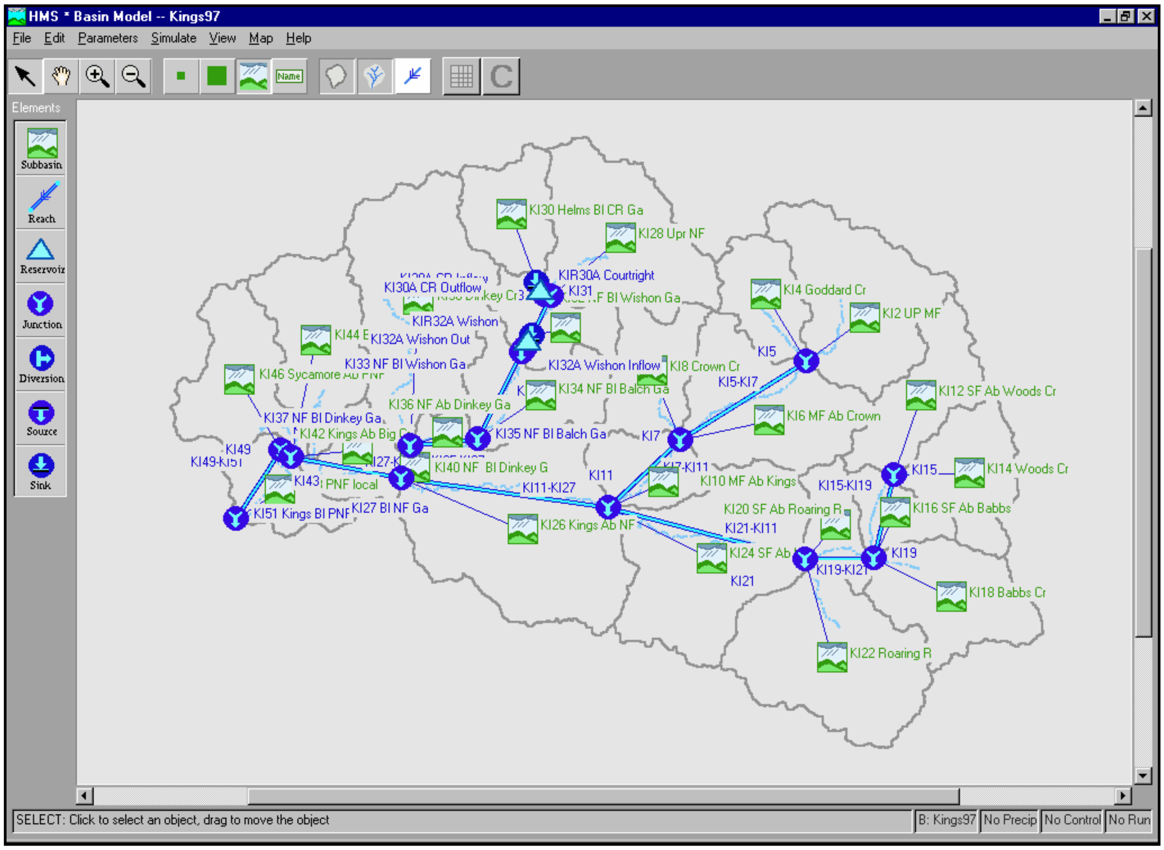
Calibration of the 1995 Event:

By using a constant loss rate of 0.01 inches/hour and an initial loss of 1.5 inches, the model calibrated well to observed hydrographs. Since the gage below the North Fork was a daily gage, the model was calibrated to the average daily flows with a known instantaneous peak. A recession ratio of 0.7 and a peak ratio of 0.2 defined the recession limb of the hydrographs. An initial baseflow of 3 cfs per square mile was assumed.

Calibration of the 1997 Event:

By using constant loss rates between 0.02 and 0.25 inches/hour and initial losses of 1 to 2.2 inches, the model calibrated reasonably well to all observed hydrographs. Baseflow recession parameters of 0.7 for the constant and 0.18 for the peak ratio worked best. An initial baseflow of 1 cfs per square mile was used.

Kings River Basin HEC-HMS Model Schematic



Kings River Basin Parameters

Subbasin Name	Area DA (Sq Mi)	Total Flow Length L (Mi)	Length to Centroid L_{CA} (Mi)	Slope LFP S (ft/mi)	Basin Shape Factor $LL_{CA}/S^{1/2}$	Initial TC $1.4(LL_{CA}/S^{1/2})^{.33}$ (Hr)	Initial R 2.33TC (cfs/Hr)	Final TC $1.67(LL_{CA}/S^{1/2})^{.29}$ (Hr)	Final R 2.33 TC (Hr)
KI2 UP MF	100.10	17.81	6.92	411.8	6.07	2.5	5.9	2.8	6.6
KI28 Upr NF	100.07	17.96	5.95	306.2	6.11	2.5	5.9	2.8	6.6
KI30 Helms Bl CR Ga	45.10	13.56	7.30	253.4	6.22	2.6	6.0	2.8	6.6
KI32 NF Bl Wishon Ga	36.20	10.93	3.79	396.0	2.08	1.8	4.2	2.1	4.8
KI34 NF Bl Balch Ga	56.66	13.88	6.20	433.0	4.14	2.2	5.2	2.5	5.9
KI4 Goddard Cr	40.03	12.45	5.89	596.6	3.00	2.0	4.7	2.3	5.4
KI6 MF Ab Crown	92.12	19.15	7.57	438.2	6.93	2.7	6.2	2.9	6.8
KI8 Crown Cr	49.39	13.29	5.70	570.2	3.17	2.0	4.8	2.3	5.4
KI38 Dinkey Cr	131.96	29.84	11.82	311.5	19.98	3.8	8.8	4.0	9.3
KI46 Sycamore Ab PNF	64.97	19.46	9.29	248.2	11.48	3.1	7.3	3.4	7.9
KI36 NF Ab Dinkey Ga	12.90	8.64	2.51	728.6	0.80	1.3	3.0	1.6	3.7
KI44 Big Cr Ab PNF	72.76	22.91	12.57	285.1	17.06	3.6	8.3	3.8	8.9
KI12 SF Ab Woods Cr	54.22	17.32	7.69	406.6	6.61	2.6	6.1	2.9	6.7
KI40 NF Bl Dinkey G	4.09	4.31	2.58	733.9	0.41	1.0	2.4	1.3	3.0
KI42 Kings Ab Big Cr	31.51	12.62	7.43	311.5	5.31	2.4	5.7	2.7	6.3
KI10 MF Ab Kings	37.05	11.01	4.12	781.4	1.62	1.6	3.8	1.9	4.5
KI48 PNF local	37.03	11.91	4.26	311.5	2.87	2.0	4.6	2.3	5.3
KI16 SF Ab Babbs	27.09	9.87	4.02	770.9	1.43	1.6	3.7	1.9	4.3
KI14 Woods Cr	54.35	13.96	6.15	406.6	4.25	2.3	5.3	2.5	5.9
KI20 SF Ab Roaring R	28.25	10.69	3.96	654.7	1.66	1.7	3.9	1.9	4.5
KI26 Kings Ab NF	158.05	29.05	9.46	258.7	17.08	3.6	8.3	3.8	8.9
KI24 SF Ab MF	126.43	20.38	9.92	443.5	9.60	3.0	6.9	3.2	7.5
KI18 Babbs Cr	69.42	16.91	7.36	506.9	5.53	2.5	5.7	2.7	6.4
KI22 Roaring R	115.20	17.63	7.61	427.7	6.49	2.6	6.0	2.9	6.7

Kings River Reach Parameters

Reach Name	Reach Length L_R (Mi)	Reach Slope S_R (ft/ft)	Cum Drainage Area (from GeoHms) A (Sq. Mi.)	Yuba Field Reg. Eqa R=4.13Ln(A) - 6.393	Jarret's Equation $n = .39S^{.38}R^{-.16}$	Manning's Velocity v (ft/s)	Travel Time K Hrs	Travel Time Lag (Min)
KI35-KI37	5.94	0.0787	244	16.31	0.095	28.30	0.31	18
KI37-KI27	3.28	0.0156	385	18.19	0.050	25.51	0.19	11
KI27-KI43	10.21	0.0003	1360	23.41	0.011	19.56	0.77	46
KI11-KI27	17.80	0.0138	866	21.54	0.047	28.91	0.90	54
KI7-KI11	8.53	0.0411	298	17.14	0.074	27.27	0.46	28
KI43-KI49	8.23	0.0091	1526	23.88	0.039	29.94	0.40	0
KI19-KI21	5.08	0.0118	219	15.86	0.046	22.03	0.34	20
KI21-KI11	17.31	0.0277	397	18.32	0.063	27.49	0.92	55
KI31-KI33	5.34	0.0156	149	14.27	0.052	20.87	0.38	23
KI33-KI35	8.54	0.0551	195	15.38	0.084	25.84	0.48	29
KI5-KI7	11.80	0.0295	195	15.38	0.066	23.97	0.72	43
KI15-KI19	6.52	0.0511	119	13.34	0.083	22.77	0.42	25
KI43-KI49	0.95	0.0001	1444	23.65	0.007	17.29	0.08	0

Routing parameters based on field obsevations and regression analysis.

HEC-HMS Summary of Results
Kings River Basin: March 1995 Event

Project	: Kings	Run Name	: Mar 1995 Event
Start of Run	: 08Mar95 0100	Basin Model	: Kings95
End of Run	: 15Mar95 2400	Met. Model	: Mar 1995 Event
Execution Time	: 31May00 1348	Control Specs.	: Mar 1995 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
KI32A Wishon Out	67.000	09 Mar 95 2100	340.41	178.000
KI33 NF Bl Wishon Ga	67.000	09 Mar 95 2100	340.41	178.000
KI33-KI35	64.933	09 Mar 95 2200	340.23	178.000
KI34 NF Bl Balch Ga	2094.6	10 Mar 95 0300	7122.0	56.658
KI35 NF Bl Balch Ga	2135.4	10 Mar 95 0300	7462.2	234.658
KI35-KI37	2093.4	10 Mar 95 0400	7459.8	234.658
KI38 Dinkey Cr	4119.0	10 Mar 95 0500	17314	131.964
KI36 NF Ab Dinkey Ga	1246.3	10 Mar 95 0400	4078.1	12.899
KI37 NF Bl Dinkey Ga	7398.5	10 Mar 95 0400	28852	379.521
KI37-KI27	7301.8	10 Mar 95 0400	28847	379.521
KI4 Goddard Cr	120.07	08 Mar 95 0100	675.82	40.025
KI2 UP MF	300.29	08 Mar 95 0100	1605.5	100.097
KI5	420.37	08 Mar 95 0100	2281.4	140.122
KI5-KI7	420.37	08 Mar 95 0100	2304.2	140.122
KI6 MF Ab Crown	639.86	10 Mar 95 0600	3204.7	92.117
KI7	850.87	10 Mar 95 0600	5508.9	232.239
KI8 Crown Cr	230.54	10 Mar 95 0200	1173.7	49.391
KI7-KI11	1015.8	10 Mar 95 0700	6707.9	281.630
KI12 SF Ab Woods Cr	162.67	08 Mar 95 0100	851.69	54.223
KI14 Woods Cr	163.06	08 Mar 95 0100	853.73	54.353
KI15	325.73	08 Mar 95 0100	1705.4	108.576
KI15-KI19	325.73	08 Mar 95 0100	1716.0	108.576
KI16 SF Ab Babbs	81.267	08 Mar 95 0100	460.03	27.089
KI18 Babbs Cr	208.25	08 Mar 95 0100	1093.3	69.416
KI19	615.24	08 Mar 95 0100	3269.3	205.081
KI19-KI21	615.24	08 Mar 95 0100	3285.2	205.081
KI22 Roaring R	345.61	08 Mar 95 0100	2357.7	115.204
KI20 SF Ab Roaring R	230.44	10 Mar 95 1900	983.25	28.250
KI21	1045.6	08 Mar 95 0100	6626.1	348.535
KI21-KI11	1045.6	08 Mar 95 0100	6692.3	348.535
KI10 MF Ab Kings	1172.2	10 Mar 95 2200	4802.7	37.055

… Continued …

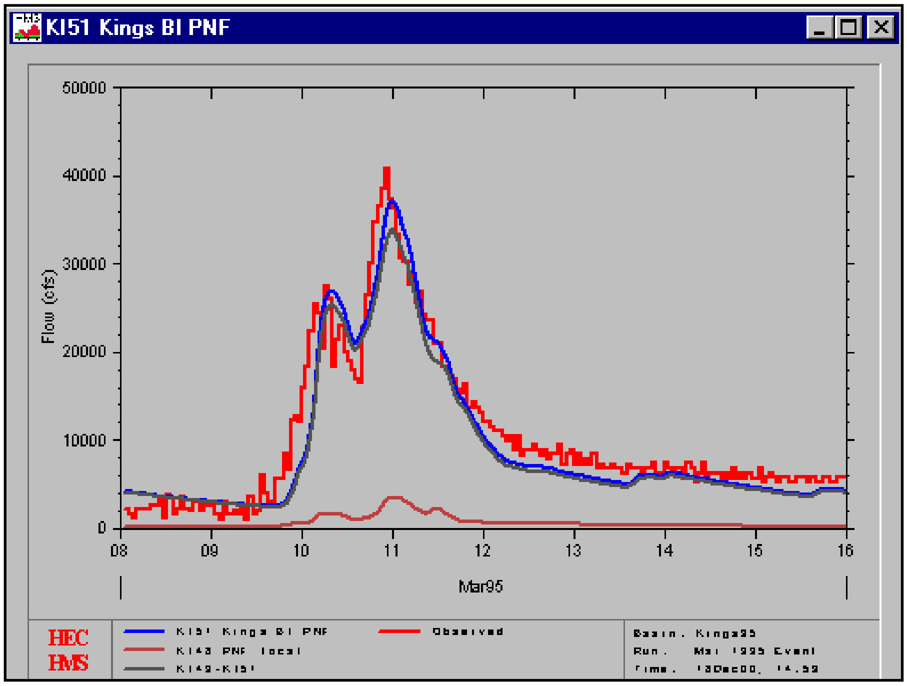
HEC-HMS Summary of Results
Kings River Basin: March 1995 Event
(Continued)

Project : Kings   Run Name : Mar 1995 Event

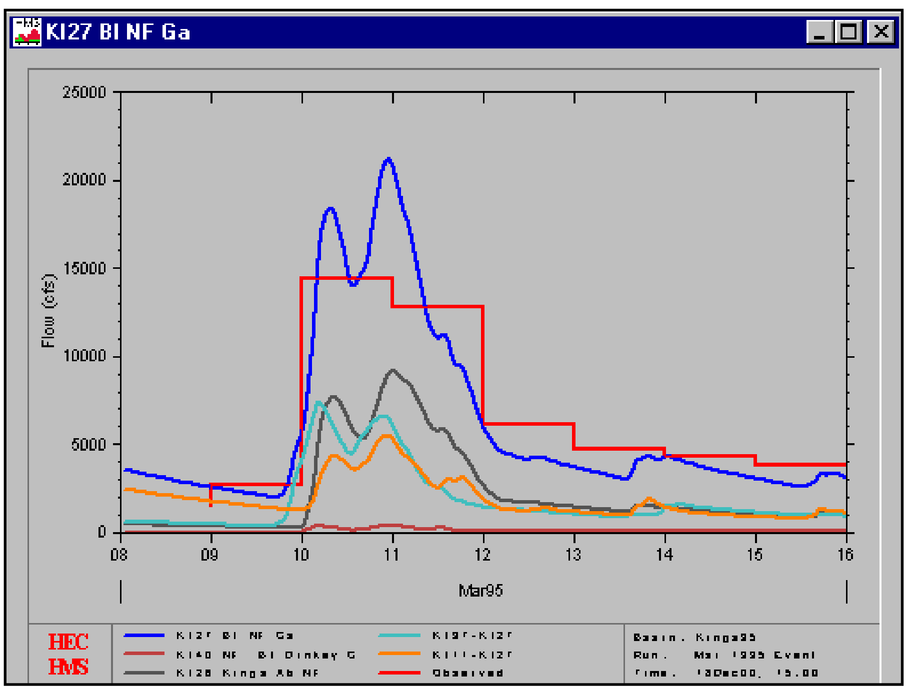
Start of Run	: 08Mar95 0100	Basin Model	: Kings95
End of Run	: 15Mar95 2400	Met. Model	: Mar 1995 Event
Execution Time	: 31May00 1348	Control Specs.	: Mar 1995 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
KI24 SF Ab MF	2692.0	10 Mar 95 2200	11456	126.429
KI11	5427.6	10 Mar 95 2200	29659	793.649
KI11-KI27	5420.2	10 Mar 95 2200	29756	793.649
KI40 NF Bl Dinkey G	393.01	10 Mar 95 2300	1285.1	4.094
KI26 Kings Ab NF	9132.9	10 Mar 95 2400	35524	158.046
KI27 Bl NF Ga	21186	10 Mar 95 2300	95412	1335.310
KI27-KI43	21074	10 Mar 95 2300	95427	1335.310
KI44 Big Cr Ab PNF	5462.0	10 Mar 95 2400	19914	72.762
KI42 Kings Ab Big Cr	2547.4	11 Mar 95 0100	7943.1	31.512
KI43	29014	10 Mar 95 2400	123284	1439.584
KI43-KI49	29014	10 Mar 95 2400	123284	1439.584
KI46 Sycamore Ab PNF	4842.0	11 Mar 95 0100	15641	64.965
KI49	33809	10 Mar 95 2400	138925	1504.549
KI49-KI51	33809	10 Mar 95 2400	138925	1504.549
KI48 PNF local	3400.3	11 Mar 95 0100	9573.1	37.030
KI51 Kings Bl PNF	37194	10 Mar 95 2400	148498	1541.579
KI30 Helms Bl CR Ga	135.30	08 Mar 95 0100	708.40	45.100
KI30A CR Inflow	135.30	08 Mar 95 0100	708.40	45.100
KI30A CR Outflow	7.7390	12 Mar 95 2400	118.30	40.000
KI31	7.7390	12 Mar 95 2400	118.30	40.000
KI28 Upr NF	300.21	08 Mar 95 0100	1574.6	100.071
KI31-KI33	307.85	08 Mar 95 0100	1701.9	140.071
KI32 NF Bl Wishon Ga	669.82	10 Mar 95 0200	2065.3	36.197
KI32A Wishon Inflow	823.22	10 Mar 95 0200	3767.3	176.268
KIR30A Courtright	0.0	08 Mar 95 0100	0.0	0.000
KIR32A Wishon	0.0	08 Mar 95 0100	0.0	0.000

HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Kings River Basin
March 1995 Event



KI51 – Kings River Below Pine Flat Reservoir



KI27 – Below North Fork Gage

HEC-HMS Subbasin Parameters
Kings River Basin: March 1995 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
KI38 Dinkey Cr	3	0.7	0.2	1.5	0.01	0
KI46 Sycamore Ab PNF	3	0.7	0.2	1.5	0.01	5
KI36 NF Ab Dinkey Ga	3	0.7	0.2	1.5	0.01	0
KI44 Big Cr Ab PNF	3	0.7	0.2	1.5	0.01	0
KI12 SF Ab Woods Cr	3	0.7	0.2	1.5	0.01	0
KI40 NF Bl Dinkey G	3	0.7	0.2	1.5	0.01	0
KI42 Kings Ab Big Cr	3	0.7	0.2	1.5	0.01	5
KI10 MF Ab Kings	3	0.7	0.2	1.5	0.01	0
KI48 PNF local	3	0.7	0.2	1.5	0.01	20
KI16 SF Ab Babbs	3	0.7	0.2	1.5	0.01	0
KI14 Woods Cr	3	0.7	0.2	1.5	0.01	0
KI20 SF Ab Roaring R	3	0.7	0.2	1.5	0.01	0
KI26 Kings Ab NF	3	0.7	0.2	1.5	0.01	0
KI24 SF Ab MF	3	0.7	0.2	1.5	0.01	0
KI18 Babbs Cr	3	0.7	0.2	1.5	0.01	0
KI22 Roaring R	3	0.7	0.2	1.5	0.01	0
KI30 Helms Bl CR Ga	3	0.7	0.2	1.5	0.01	0
KI28 Upr NF	3	0.7	0.2	1.5	0.01	0
KI32 NF Bl Wishon Ga	3	0.7	0.2	1.5	0.01	0
KI34 NF Bl Balch Ga	3	0.7	0.2	1.5	0.01	0
KI4 Goddard Cr	3	0.7	0.2	1.5	0.01	0
KI2 UP MF	3	0.7	0.2	1.5	0.01	0
KI8 Crown Cr	3	0.7	0.2	1.5	0.01	0
KI6 MF Ab Crown	3	0.7	0.2	1.5	0.01	0

HEC-HMS Summary of Results
Kings River Basin: December 1996 - January 1997 Event

Project : Kings   Run Name : Jan 1997 Event

Start of Run	: 25Dec96 0100	Basin Model	: Kings97
End of Run	: 08Jan97 2400	Met. Model	: Jan 1997 Event
Execution Time	: 31May00 1348	Control Specs.	: Jan 1997 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
KI32A Wishon Out	37.000	30 Dec 96 0100	854.67	178.000
KI33 NF Bl Wishon Ga	37.000	30 Dec 96 0100	854.67	178.000
KI33-KI35	37.000	30 Dec 96 0200	854.39	178.000
KI34 NF Bl Balch Ga	8243.7	02 Jan 97 2300	18435	56.658
KI35 NF Bl Balch Ga	8273.7	02 Jan 97 2300	19289	234.658
KI35-KI37	8145.0	02 Jan 97 2300	19285	234.658
KI38 Dinkey Cr	15133	02 Jan 97 2300	52046	131.964
KI36 NF Ab Dinkey Ga	1627.7	02 Jan 97 2200	3179.7	12.899
KI37 NF Bl Dinkey Ga	24687	02 Jan 97 2300	74511	379.521
KI37-KI27	24502	02 Jan 97 2300	74501	379.521
KI4 Goddard Cr	1556.4	02 Jan 97 1900	3481.9	40.025
KI2 UP MF	1227.1	02 Jan 97 1900	3272.3	100.097
KI5	2783.5	02 Jan 97 1900	6754.2	140.122
KI5-KI7	2727.5	02 Jan 97 2000	6758.5	140.122
KI6 MF Ab Crown	9111.7	02 Jan 97 2300	19872	92.117
KI7	11674	02 Jan 97 2300	26630	232.239
KI8 Crown Cr	7360.8	02 Jan 97 2200	15643	49.391
KI7-KI11	18841	02 Jan 97 2300	42265	281.630
KI12 SF Ab Woods Cr	332.84	02 Jan 97 1900	994.01	54.223
KI14 Woods Cr	165.76	02 Jan 97 1800	613.41	54.353
KI15	488.86	02 Jan 97 1900	1607.4	108.576
KI15-KI19	474.02	02 Jan 97 1900	1610.7	108.576
KI16 SF Ab Babbs	827.82	02 Jan 97 1900	1793.6	27.089
KI18 Babbs Cr	596.08	02 Jan 97 1900	1575.5	69.416
KI19	1897.9	02 Jan 97 1900	4979.9	205.081
KI19-KI21	1808.8	02 Jan 97 1900	4984.3	205.081
KI22 Roaring R	8328.7	02 Jan 97 2300	16086	115.204
KI20 SF Ab Roaring R	1609.2	02 Jan 97 2200	3184.8	28.250
KI21	11143	02 Jan 97 2300	24255	348.535
KI21-KI11	11037	02 Jan 97 2400	24259	348.535
KI10 MF Ab Kings	3885.3	02 Jan 97 2200	7184.2	37.055

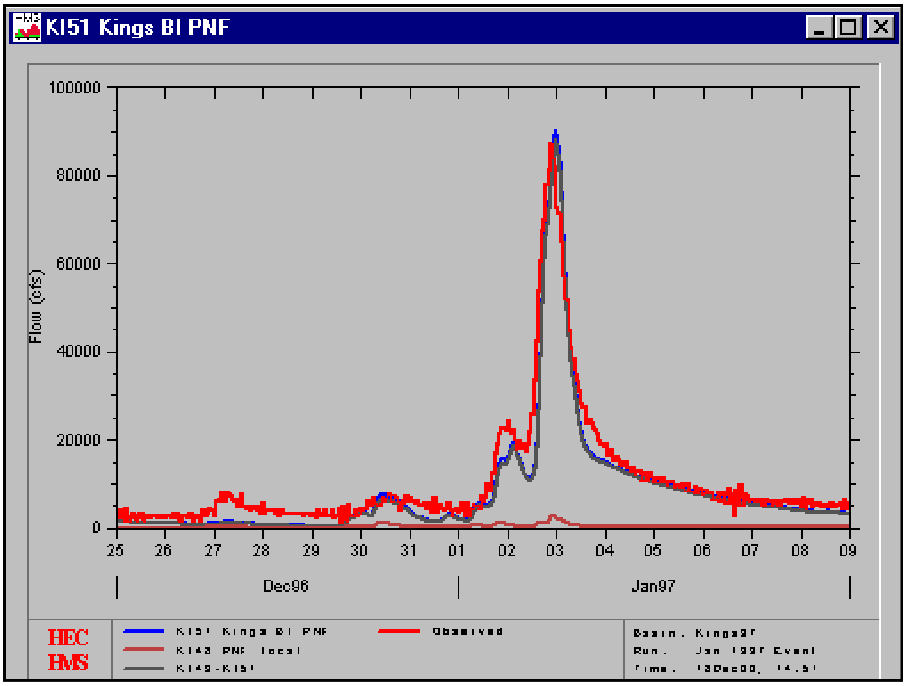
… Continued …

HEC-HMS Summary of Results
Kings River Basin: December 1996 - January 1997 Event
(Continued)

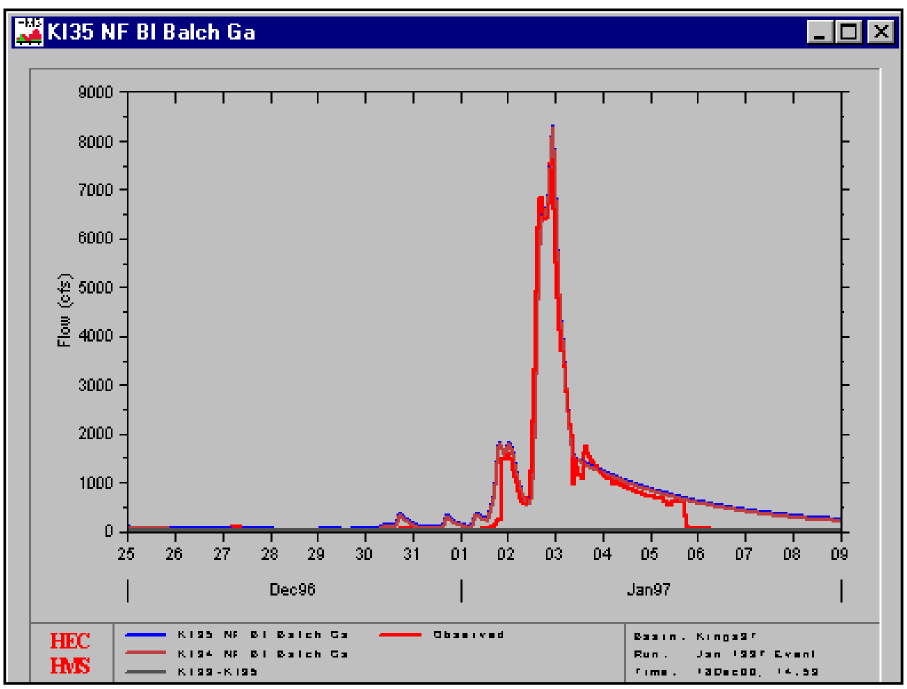
Project : Kings Run Name : Jan 1997 Event

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac-ft)	Drainage Area (sq mi)
KI24 SF Ab MF	13784	02 Jan 97 2400	27450	126.429
KI11	46323	02 Jan 97 2300	101159	793.649
KI11-KI27	46233	02 Jan 97 2400	101126	793.649
KI40 NF Bl Dinkey G	631.76	02 Jan 97 2200	2111.1	4.094
KI26 Kings Ab NF	9784.5	02 Jan 97 2400	20977	158.046
KI27 Bl NF Ga	80224	02 Jan 97 2400	198715	1335.310
KI27-KI43	79131	02 Jan 97 2400	198662	1335.310
KI44 Big Cr Ab PNF	3965.2	02 Jan 97 2300	17190	72.762
KI42 Kings Ab Big Cr	2561.3	02 Jan 97 2300	8658.5	31.512
KI43	85452	02 Jan 97 2400	224510	1439.584
KI43-KI49	85452	02 Jan 97 2400	224510	1439.584
KI46 Sycamore Ab PNF	2735.0	02 Jan 97 2300	10562	64.965
KI49	88034	02 Jan 97 2400	235071	1504.549
KI49-KI51	88034	02 Jan 97 2400	235071	1504.549
KI48 PNF local	2660.0	02 Jan 97 2200	9131.7	37.030
KI51 Kings Bl PNF	90259	02 Jan 97 2400	244203	1541.579
KI30 Helms Bl CR Ga	4720.5	02 Jan 97 1900	10028	45.100
KI30A CR Inflow	4720.5	02 Jan 97 1900	10028	45.100
KI30A CR Outflow	15.563	02 Jan 97 1400	205.61	40.000
KI31	15.563	02 Jan 97 1400	205.61	40.000
KI28 Upr NF	8941.0	02 Jan 97 1800	19846	100.071
KI31-KI33	8929.0	02 Jan 97 1800	20048	140.071
KI32 NF Bl Wishon Ga	5012.6	02 Jan 97 2200	10967	36.197
KI32A Wishon Inflow	13472	02 Jan 97 1800	31015	176.268
KIR30A Courtright	0.0	25 Dec 96 0100	0.0	0.000
KIR32A Wishon	0.0	25 Dec 96 0100	0.0	0.000

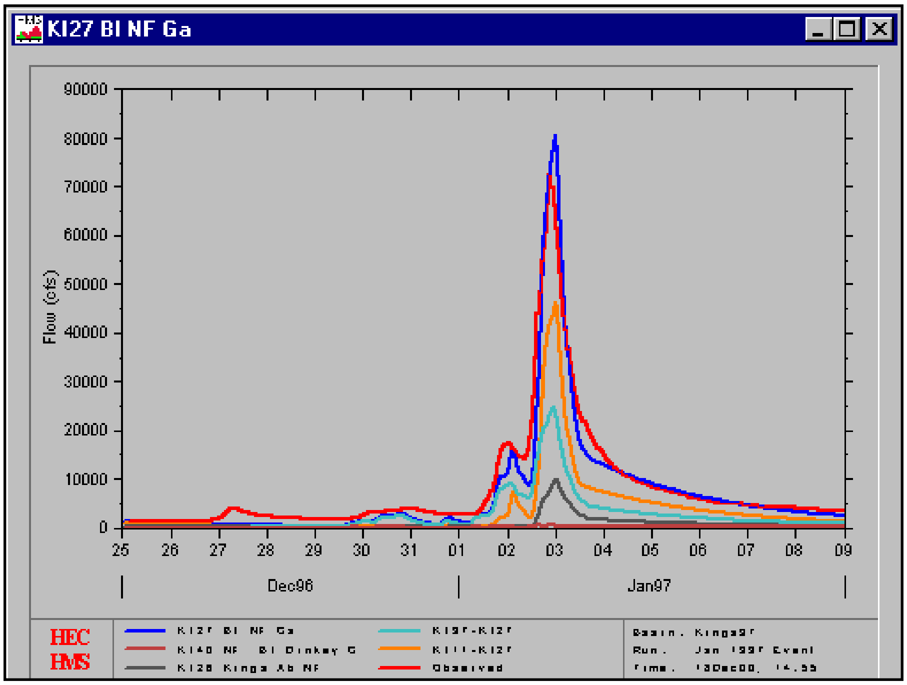
HEC-HMS: Comparison of Observed vs. Computed Hydrographs
Kings River Basin
December 1996 - January 1997 Event



KI51 – Kings River Below Pine Flat Reservoir



KI35 – Below Balch Gage



KI27 – Below North Fork Gage

HEC-HMS Subbasin Parameters
Kings River Basin: December 1996 - January 1997 Event

Subbasin Name	Baseflow Parameters			Losses		
	Initial Flow (cfs/sq mi)	Recession Ratio	Threshold Flow (peak ratio)	Initial Loss (in)	Constant Loss Rate (in/hr)	Imperviousness (%)
KI38 Dinkey Cr	1	0.7	0.18	1.0	0.02	0
KI46 Sycamore Ab PNF	1	0.7	0.18	1.0	0.02	5
KI36 NF Ab Dinkey Ga	1	0.7	0.18	1.5	0.10	0
KI44 Big Cr Ab PNF	1	0.7	0.18	1.0	0.02	0
KI12 SF Ab Woods Cr	1	0.7	0.18	1.0	0.25	0
KI40 NF Bl Dinkey G	1	0.7	0.18	1.0	0.02	0
KI42 Kings Ab Big Cr	1	0.7	0.18	1.0	0.02	5
KI10 MF Ab Kings	1	0.7	0.18	1.0	0.25	0
KI48 PNF local	1	0.7	0.18	1.0	0.02	20
KI16 SF Ab Babbs	1	0.7	0.18	1.0	0.25	0
KI14 Woods Cr	1	0.7	0.18	1.0	0.25	0
KI20 SF Ab Roaring R	1	0.7	0.18	1.0	0.25	0
KI26 Kings Ab NF	1	0.7	0.18	1.0	0.25	0
KI24 SF Ab MF	1	0.7	0.18	1.0	0.25	0
KI18 Babbs Cr	1	0.7	0.18	1.0	0.25	0
KI22 Roaring R	1	0.7	0.18	1.0	0.25	0
KI30 Helms Bl CR Ga	1	0.7	0.18	2.0	0.10	0
KI28 Upr NF	1	0.7	0.18	1.0	0.10	0
KI32 NF Bl Wishon Ga	1	0.7	0.18	2.0	0.10	0
KI34 NF Bl Balch Ga	1	0.7	0.18	2.2	0.10	0
KI4 Goddard Cr	1	0.7	0.18	2.0	0.10	0
KI2 UP MF	1	0.7	0.18	1.0	0.25	0
KI8 Crown Cr	1	0.7	0.18	2.0	0.10	0
KI6 MF Ab Crown	1	0.7	0.18	2.0	0.10	0