HYDROLOGIC REPORT
EVANS CREEK BLOCK "N"
HYDROLOGIC INVESTIGATION

Volume I - Report

Washoe County, NV
For
Washoe County Water Resources Department

Nimbus Job No. 9912
July, 1999

Nimbus Engineers

3785 Baker Ln., Suite 201 • Reno, NV 89509
Mail: P.O. Box 10220 • Reno, NV 89510
(775) 689-8630 • Fax (775) 689-8614
Email: nimbus@intercomm.com

HYDROLOGIC REPORT
EVANS CREEK BLOCK "N"
HYDROLOGIC INVESTIGATION

Volume I - Report

Washoe County, NV

For
Washoe County Water Resources Department

REGISTERED PROFESSIONAL ENGINEER STATE OF NEVADA
MARGARET P BOWKER
CIVIL
No. 5252
7/9/99

Nimbus Job No. 9912
July, 1999

Nimbus Engineers

3785 Baker Ln., Suite 201 • Reno, NV 89509
Mail: P.O. Box 10220 • Reno, NV 89510
(775) 689-8630 • Fax (775) 689-8614
Email: nimbus@intercomm.com

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

This report is Volume I of II and summarizes the hydrologic analysis of the upper Evans Creek watershed performed by Nimbus Engineers for the Washoe County Water Resources Department. Volume II - Technical Appendix contains the complete HEC-1 model runs and the parameter development worksheets.

The Evans Creek watershed is located northerly of the City of Reno with portions of the watershed located within the City of Reno corporate boundary (Figure 1, Vicinity Map). Upper portions of the watershed consist of portions of the foothills of Peavine Mountain, Panther Valley, and a portion old North Virginia Street.

The majority of the watershed upstream of Sierra Street contains land that is undeveloped. Development within this portion of the watershed consists of a mix of residential, commercial, industrial, recreational, and agriculture. Figure 2 shows the existing land use development within the study area.

Historical flooding of Evans Creek has resulted in proposed flood control measures. The most recent proposal as outlined in the Evans Creek Watershed Plan and Environmental Assessment (Natural Resource Conservation Service, August 1994) includes channel modifications and an 83-foot high earthen detention dam. This study examines the flood hydrology for existing conditions and with the proposed dam as outlined in the August 1994 environmental assessment. The following is a brief summary of the scope of work for this report.

Data Gathering

- conduct field investigation of watershed
- gather any relevant previous studies of the watershed and adjacent areas
- obtain information pertaining to historical flooding and rainfall

Develop Computer Model

- develop a computer model of upper watershed with parameters based on field investigations and other appropriate data gathered
- run model for existing conditions and with the proposed detention dam for the 5, 10, 25, 50, 100, and 500-year storm events.
- produce flood hydrographs at the proposed damsite and the storm drain inlet structure located at Sierra Street for both the existing and proposed conditions

The hydrologic analysis of the watershed was performed using the Corps of Engineers HEC-1 Flood Hydrographic Package v. 4.0 1E. Information used in the modeling included the Soil Conservation Service Curve Numbers (CN's), precipitation data based on historic values and the NOAA Southwest Semi-Arid Precipitation Frequency Study Group (SSPFS, 1997), soils and vegetation information, and land use.

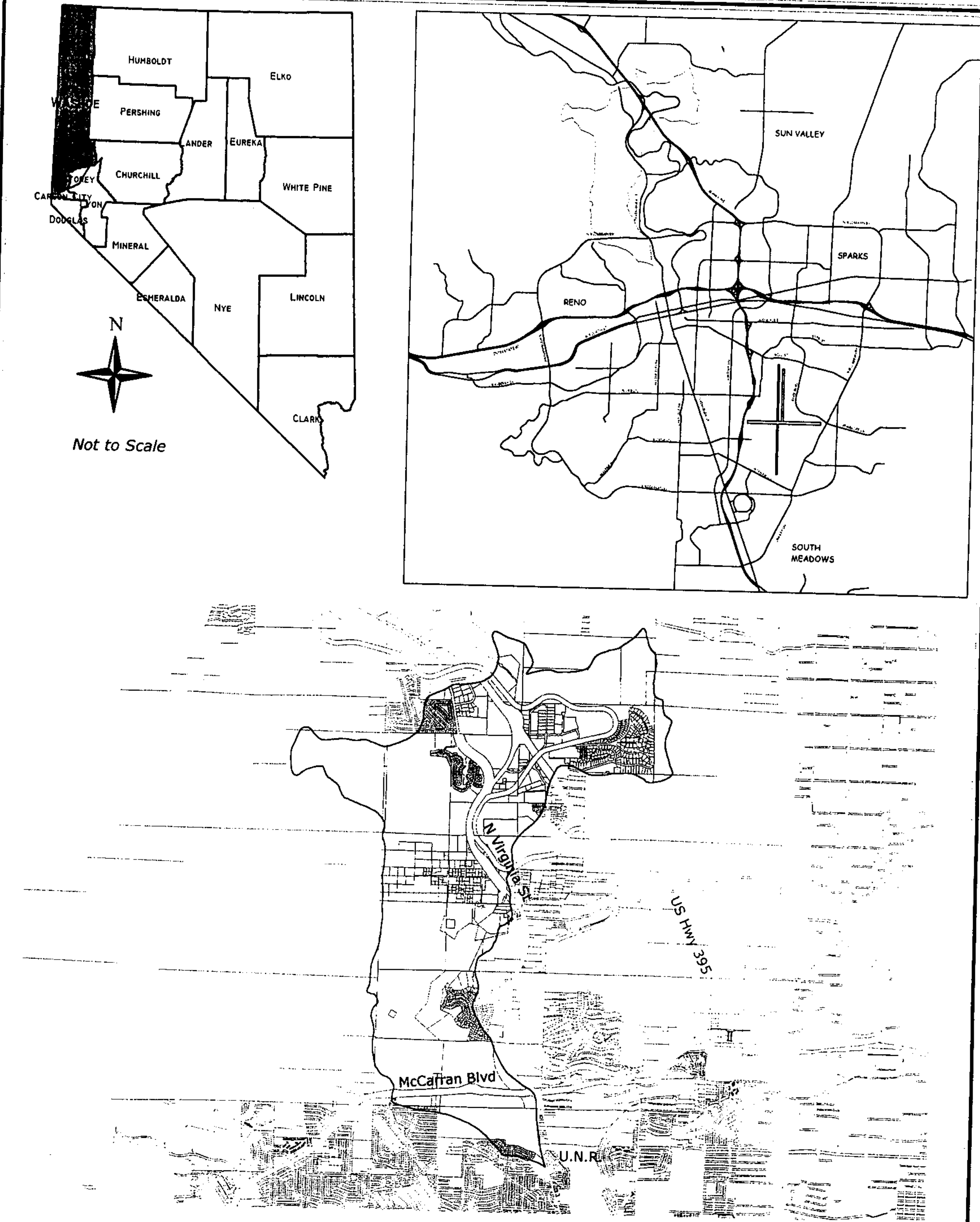


Figure 1
Vicinity Map

Nimbus Job #9912

Date: July 1999

Nimbus Engineers
3765 Baker Ln., Suite 201 • Reno, NV 89509
Mail: P.O. Box 10220 • Reno, NV 89510
(775) 689-8630 • Fax (775) 689-8614
Email: nimbus@intercomm.com

2.0 DATA GATHERING

Nimbus Engineers performed field investigations on May 5 and 26, 1999. Observations were made of soil type, vegetation type and cover, channel conditions, and the size and condition of culverts. Appendix A contains selected photographs from the field investigations. Further detailed discussion of site investigations are presented later in this report as they relate to model development.

The following is a summary of the source and type of information gathered during the project.

<u>NRCS</u>

- proposed damsite topography and other topographic and aerial photography
- Evans Creek Watershed Plan and Environmental Assessment, Washoe County, NV, August 1994 (NRCS)
- discharge curve data for the proposed damsite and outlet/spillways

<u>Washoe County Water Resources Department</u>

- topographic and aerial photography
- historic rainfall information

<u>University of Nevada/Reno Facilities Management</u>

- University of Nevada, Reno Utility Map

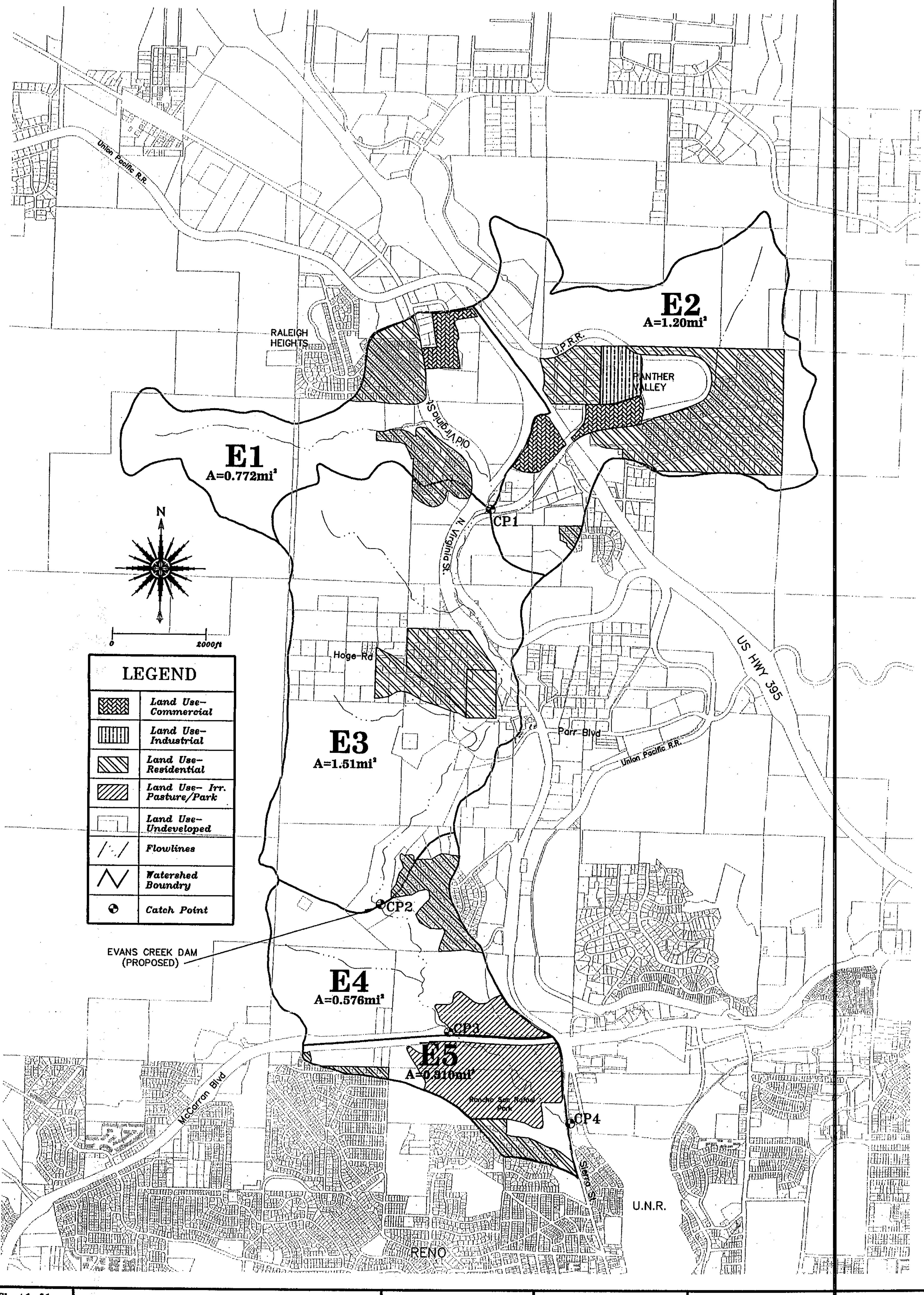
<u>Regional Transportation Commission (RTC)</u>

- Design Sheet SD-1; North Sierra Street with West 9th Street to North Virginia; SEA, Inc. 1991

<u>Other Sources</u>

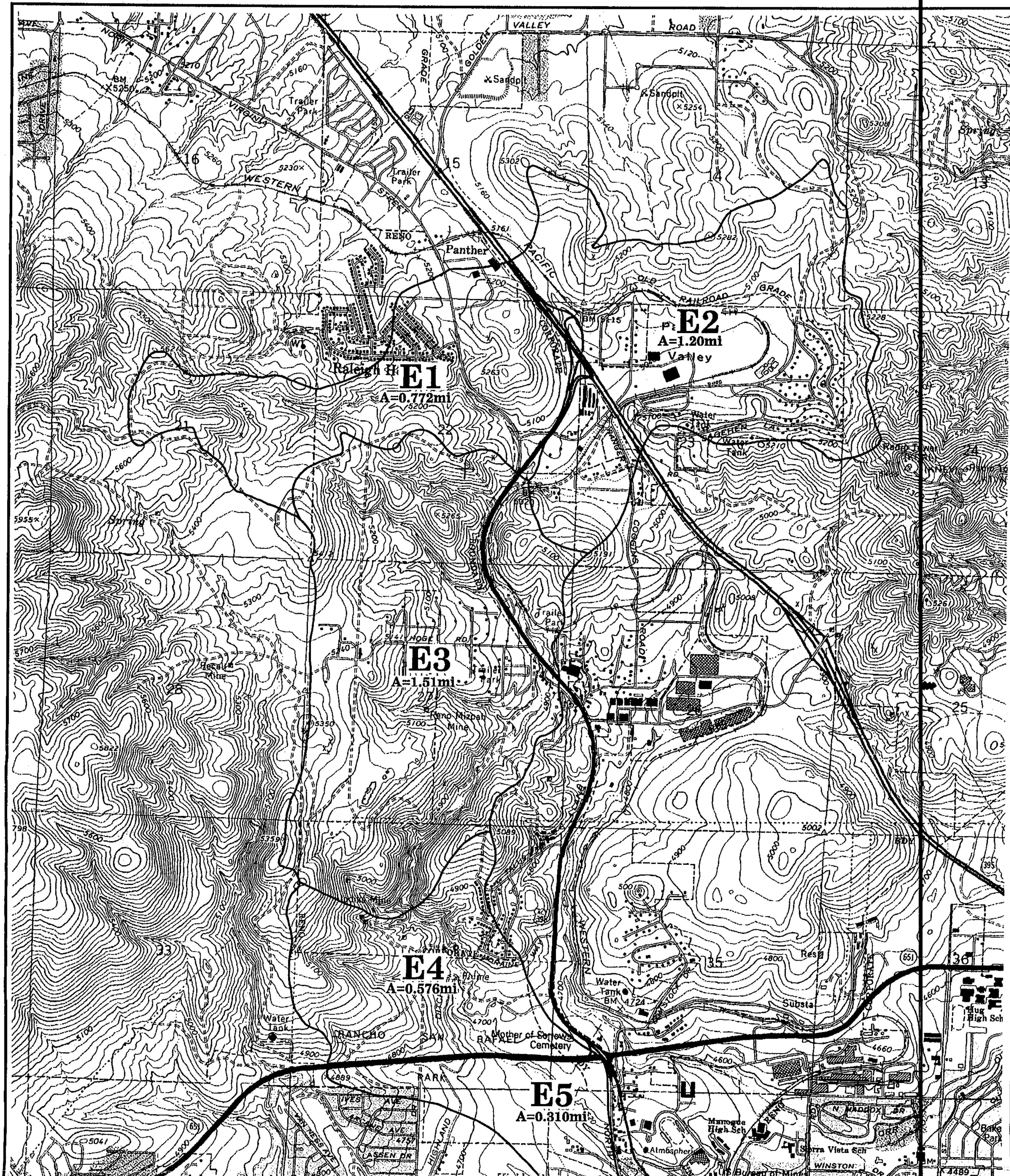
- Hal Klioforthe: precipitation data from unofficial raingage located on Royal Street
- Jim Ashby: precipitation data from unofficial raingage located on University Ridge
- Floyd Saltern: 1986 flood video; grading plans for North Virginian Apartments

Other information included personal communications with the above individuals and personnel of the above agencies. Not all information obtained was relevant to the purpose of this study. Pertinent information was evaluated and used based upon the applicability of the data to the study goals.



Sheet 1 of 1	FIGURE 2	Scale:	1 : 2000	Revisions:
Nimbus Job # 9912	UPPER EVANS CREEK WATERSHED EXISTING LAND USE	Contour Interval:	N/A	
	Evans Creek Block "N" Hydrology	File Name:	9912wsd.dwg	
		Drawn By:	KK	
Date: July 1999	*Sparks* *Washoe County* *Nevada*	Designed By:	CA	

Nimbus Engineers
3785 Baker Ln., Suite 201 • Reno, NV 89509
Mail: P.O. Box 10220 • Reno, NV 89510
(775) 689-8630 • Fax (775) 689-8614
Email: nimbus@intercomm.com



Sheet 1 of 1	FIGURE 3	Scale:	1 : 2000	Revisions:
Nimbus Job # 9912	WATERSHED MAP	Contour Interval:	20FT	
	Evans Creek Block "N" Hydrology	File Name:	912wsd_quad	
		Drawn By:	KK	
Date: July 1999	Reno — Washoe County — Nevada	Designed By:	CA	

Nimbus Engineers
3785 Baker Ln., Suite 201 • Reno, NV 89509
Mail: P.O. Box 10220 • Reno, NV 89510
(775) 689-8630 • Fax (775) 689-8614
Email: nimbus@int comm.com

3.0 HYDROLOGY

3.1 General Description

The upper Evans Creek watershed delineation was determined from a USGS quadrangle map and is shown in the watershed map in Figure 3. The hydrographic basin area for this study is 4.37 square miles. Elevations in the watershed range from approximately 5620' M.S.L. in the upper reaches westerly of Raleigh Heights to approximately 4590' M.S.L. at the culvert inlet at Sierra Street. Slopes within the watershed vary from greater than 20% in the foothills to approximately 2% in other areas. The lower sloping areas include portions of Panther Valley, mainstream drainage ways, and Rancho San Rafael Park.

Vegetation types were determined from field investigations and the Soil Survey of Washoe County, NV, South Part (Soil Survey). The predominant vegetation within the undeveloped portion of the hydrographic basin is a sagebrush/grass community; primarily consisting of sagebrush, cheatgrass, and bitterbrush with sparse Ponderosa Pine trees. Vegetation found in the riparian zones consist of sedges, Great Basin Wild Rye, willow, cattail, wild rose, Russian Olive, and cottonwood. Vegetation densities varied within the watershed from approximately 15 to 50% vegetative cover density. Vegetative density variations are discussed in further detail Section 3.4 of this report.

3.2 Hydrographic and Sub-Basin Areas

The watershed boundary derived from the USGS quadrangle map was digitized and is shown on Figure 2. There are five (5) sub-basins that were modeled. Sub-basin delineations were developed from a USGS quadrangle plotted on a 1" = 1000' scale. Sub-basin delineations were generated in order to provide homogeneity between the model parameters within a particular sub-basin; i.e. vegetation type/density, slopes, soil types, land-use, etc. Since the proposed damsite was also modeled, a concentration point or sub-basin delineation was created at that location. Sub-basin characteristics are discussed in further detail in Sections 3.4 through 3.6. The watershed map contained in Figure 3 shows sub-basin labels, boundaries, and areas on a topographic relief.

3.3 Precipitation

Precipitation depths for the 5, 10, 25, 50, 100, and 500-year recurrence intervals were calculated using the methodology contained in the Draft Washoe County Hydrologic Criteria and Drainage Design Manual (drainage manual) for input into HEC-1. The 2-year 1, 6, and 24 hour rainfall depths were obtained from the Precipitation Frequency Study of the United States, NOAA Atlas 14, Volume 1 - Semi-Arid Southwest United States (SSPFS, 1997) and the depth curves projected over the watershed and sub-basins. In order to account for variations in depths over the hydrographic basin and sub-areas, the isohyetal method was applied to each sub-basin to yield weighted values for the 2-year 1, 6, and 24 hour precipitation depths. These values were then used to calculate the rainfall input for each basin within the model per the draft Washoe drainage manual. In order to calculate the 500-year depth distribution, a linear regression was applied to the regional growth factors (RGFs) for the 2 through 100-year RGFs and the results used to estimate the 500-year RGFs. The isohyetal methodology resulted in an areal weighted, sub-basin average depth duration curve that was applied to each sub-basin. Appendix A in Volume II - Technical Appendix contains the calculated rainfall depth-duration values for each sub-basin and recurrence interval.

3.4 SCS CURVE NUMBERS

Soils within the study area were determined from the Soil Survey of Washoe County, Nevada, South Part (SCS). Soil types were differentiated according to their hydrologic soil group as classified by the SCS method; i.e. hydrologic soil groups A, B, C, and D. Soils within the watershed are predominantly hydrologic soil group D with smaller portions of soil groups C and B. Type D soils are characteristic of soils with slow infiltration rates and consequently higher runoff potential. Groups C, B, and A are characteristic of moderate to fast infiltration rates, respectively. Appendix A contains various photographs of vegetation conditions within the study area. The attachment in Appendix A shows the station locations where the photographs were taken.

Curve Number's (CN's) were based on a antecedent moisture condition II (AMC-II) which is the accepted soil moisture condition for western states. The AMC-II soil condition represents an average soil moisture condition. AMC-I and AMC-III would represent dry and water saturated soil moisture, respectively. Dry soils have a greater precipitation abstraction and therefore a lower runoff potential. The converse is true for saturated soils.

For each sub-basin, the percent by area of each soil type was calculated and a particular CN assigned to each soil type. For the undeveloped condition, CN values were obtained from the draft Sparks drainage manual, Figure 702 - Curve Number for Sage/Grass. This figure is attached as Appendix B. Vegetation cover densities were produced based upon field investigations, aerial photography, site photographs, and by comparing CN values with other references for semi-arid sagebrush/grass communities. Greater vegetation densities yield lower runoff values. Where vegetative densities varied widely within a sub-basin, a weighted average was used.

Table 1. Sub-basin CN's, percent vegetative cover, and existing land uses.

Sub-Basin Curve Numbers				
Sub-basin E1	Sub-basin E2	Sub-basin E3	Sub-basin E4	Sub-basin E5
76	77	81	78	80
Vegetative Cover Density in Undeveloped Areas				
40% cover	40% cover	25% cover	40% cover	40% cover
Types of Existing Development				
residential and commercial	residential, industrial, and commercial	residential	residential and irrigated pasture	residential and irrigated pasture/park

The weighted CN for the undeveloped condition was then weighted with the existing developed land use values. Existing land uses were determined from the site investigations. Table 1 shows the CN values used for each sub-basin. Runoff CN calculation sheets are contained in Appendix B of Volume II - Technical Appendix.

3.5 LAG TIME/TIME OF CONCENTRATION

Lag time and/or the time of concentration is the time for the most hydraulically distant water in a basin to reach a concentration point. The lag times and time of concentration calculated in this study use the methodology contained in the draft Washoe County drainage manual. Lag time calculations for the sub-basins are contained in Appendix C of Volume II - Technical Appendix. Table 2 summarizes the calculated lag times for sub-basins E1 through E5.

Table 2. Lag Times for Drainage Sub-Basins

	Sub-Basins				
	E1	E2	E3	E4	E5
Lag Time, hours	0.79	0.99	1.24	0.51	0.53

Lag times are calculated based upon the channel lengths, slopes and roughness as well as the shape of the sub-basin.

3.6 ROUTING

Streamflow Routing

Overland flow routing was calculated using the SCS Unit Hydrograph technique with the precipitation excess to produce hydrographs for the sub-basins. The resulting hydrographs were routed through subsequent basins using the Muskingum Cunge channel routing function which is the preferred and more stable routing technique for long, non-urbanized reaches. Table 3 summarizes the reach parameters used for all recurrence intervals with the exception of the 5-year recurrence interval. Given the well defined low flow channel that exists in the field and to avoid attenuation of the routed 5-year hydrographs, a channel bottom width of 6 feet was used for all reaches in the 5-year storm event model. All other routing parameters remain the same as outlined in Table 3.

Table 3. Muskingum Cunge Routing Parameters

Reach	Shape	Length, ft	Slope, ft/ft	Width, ft	Side Slope	Manning's "n"
Rch1	Trap	10,800	0.026	15	2	0.070
Rch2	Trap	4,200	0.023	20	2	0.090
Rch3	Trap	3,400	0.019	20	2	0.045

Field investigations showed that for high flow conditions (greater than 5-year flows), a trapezoidal channel of width and side slope as shown in Table 3 is a good approximation of the average channel conditions within the watershed. Appendix A contains photographs of various channel conditions.

Manning's "n" roughness coefficients were developed based upon site investigations and Table 802 of the draft Washoe drainage manual. Field observations and photographs were compared with the type of channel/vegetation description and a value chosen for each stretch. Due to the length of the reaches, it was necessary to choose a roughness value that was indicative of the whole reach, or average condition, routed through a particular sub-basin. Channel slopes and lengths were determined from the USGS quadrangle maps.

Reach 1 (Rch1) extends from concentration point 1 (CP1) to concentration point 2 (CP2) at the proposed dam site (see Figure 2). This reach is predominantly a "natural stream". There is one short stretch of paved channel in this reach, but due to the short length, the roughness was based upon the natural channel characteristics of vegetation type/density and channel bottom characteristics. Reach 2 (Rch2) extends from the proposed damsite (CP2) to McCarran Boulevard (CP3). This stretch contains moderate to heavy riparian and wetland vegetation. Reach 3 (Rch3) extends from McCarran (CP3) through Rancho San Rafael Park to the culvert entrance at North Sierra Street. This reach winds through mostly irrigated pasture with some weeds and stones, with the lower portion containing more dense riparian and some wetland vegetation.

Reservoir Routing

Modeling of the proposed reservoir utilized the level-pool reservoir routing component of HEC-1. Storage, elevation, and discharge curves were obtained from the NRCS and verified prior to input into the model. The discharge component of the NRCS data accounted for outflow from the principal and emergency spillways. The discharge curve was modified to account for outflow from the slotted 30" CMP riser as it is shown in Appendix B of the <u>1994 Evans Creek Watershed Plan and Environmental Assessment</u>. This resulted in outflow from the reservoir above elevation 4775', prior to outflow through the principal spillway. One run of the 100-year, 24 hour event with the original NRCS discharge curves was run and is summarized later in this report.

A reservoir routing component was input to the model for the 43"x68" RCP under Sierra Street. Storage surface areas were obtained from the City of Reno 2' contour map. A rating curve was developed for the storm drain using the methodology per Section 900 in the draft Washoe drainage manual. Flow over Sierra Street was modeled by obtaining a cross-sectional area from the grading plans for the North Virginian Apartments (SEA, Inc., 1979) for input into ISAP ver. 1.01 (Irregular Section Analysis Program) and the results incorporated into the discharge curve for input into HEC-1.

3.7 1986 Storm Event Simulation

Information gathered for the 1986 storm event was input into the model for the purpose of model calibration. While a true model calibration cannot be performed based upon the limited information available, the results of the simulation appear to confirm the validity of the model developed. Results of the 1986 storm event simulation are presented in Section 4.2.

The closest hourly precipitation data for the 1986 storm event is the Reno Airport gage. There are two unofficial rainfall gages located near to Rancho San Rafael Park that measure precipitation on a daily basis. One gage is located on Royal Street southwesterly of the park at an elevation of 4690' M.S.L. The other is located on University Ridge Drive at an elevation of 4902'.

A regression analysis between the airport and each of the respective unofficial sites for total monthly precipitation yielded a R^2 values of 0.90 and a t-statistic indicating a correlation within a 95% confidence interval. The resulting regression equation was used to predict precipitation values within the study area for input into HEC-1 based upon the most intense 24-hour period of rainfall recorded at the airport during the 1986 event. This period occurred from February 18 at 04:00 to February 19 at 03:00. This period corresponds to the peak flow event that occurred when precipitation fell on the saturated watershed when soil infiltration losses were small due to high soil moisture conditions. The results of this run are presented in section 4.0 as 1986 Regression. At the time of writing this report, daily precipitation information from a raingage located at Rancho San Rafael was still forthcoming. Table 4 shows the predicted cumulative rainfall depth distribution for this 1986-Regression simulation.

Table 4. PH Card - Predicted 24 hour Cumulative Rainfall Depth Distribution

	Time							
	5 min	15 min	1 hour	2 hour	3 hour	6 hour	12 hour	24 hour
Depth, in	0.01	0.04	0.15	0.25	0.39	0.92	2.33	3.67

Airport hourly precipitation between the dates of February 14 to February 20 were also input into a HEC-1 model for the purpose of checking the model output against historical estimates of the 1986 storm event.

In order to simulate the 1986 events with precipitation falling on a "saturated" watershed, the 1986 Regression and the 4 day 1986 model adjusted the AMC-II CN's to the corresponding AMC-III CN's (McCuen, R.H.; 1982). This increased runoff due to precipitation falling on a watershed with soils already saturated with moisture. It has been reported that this was the condition of the watershed during the peak of the 1986 storm event.

4.0 MODELING RESULTS

4.1 5-YEAR THROUGH 500-YEAR MODELING RESULTS

All model runs for each recurrence interval and 1986 simulation were run with no errors or warnings. HEC-1 input data, master summaries, and hydrographs at the proposed damsite and Sierra Street for all recurrence intervals and simulations are contained in Appendix D of Volume II - Technical Appendix. Master summaries and hydrographs are contained in this report as Appendix C. Table 5 summarizes peak flows for the 5 through 500-year, 24 hour model runs. Peak flows at Sierra Street without discharge into the storm drain are presented to show peak flows if the storm drain were not operational.

Table 5. Summary of 24-hour Peak Flows

	RECURRENCE INTERVAL PEAK FLOWS, cfs					
	5-yr	10-yr	25-yr	50-yr	100-yr	500-yr
Peak Flows Downstream of Proposed Damsite						
Proposed Dam	79	89	98	132	139	151
Existing Conditions	143	254	439	622	847	1278
Peak Flows at Sierra Street with Flow Through the Storm Drain Under Sierra Street						
With Proposed Dam	91	109	147	200	231	418
Existing Conditions	163	231	448	652	880	1409
Peak Flows at Sierra Street with Storm Drain Under Sierra Plugged						
With Proposed Dam	91	109	150	222	310	500
Existing Conditions	166	296	496	693	941	1415

Peak flows for the 500-year event with and without storm drain discharge are similar in value due to the large flow over Sierra Street. At the elevation which flow will go over Sierra Street, the storm drain will be carrying ~245 cfs. For Table 5, any flow over 245 cfs will essentially be the instantaneous peak flow over Sierra Street.

The 100-year, 24 hour model run using the NRCS discharge curve for the proposed dam shows a peak stage at the dam of 4812.24' with a peak flow below the damsite of 124 cfs. Peak flow at Sierra Street for this run is 229 cfs. With the storm drain plugged, the peak flow is 307 cfs. Existing condition flows are the same as shown in Table 5 for the 100-year event.

4.2 1986 Storm Event Simulation Results

The February 14 to February 20, 1986 and the peak 24 hour simulation results are presented in Table 6. As discussed in Section 3.4, these model runs used the equivalent SCS CN's for a AMC-III condition to simulate precipitation on a watershed with saturated soils.

The resulting February 14 to February 20 hydrograph at Sierra Street indicates that the proposed dam would have reduced the peak flow by 53% and the peak stage to ~4596', well below the elevation for overflow of Sierra Street.

Table 6. 1986 Storm Event Simulations; Peak Flows

	1986 SIMULATION PEAK FLOWS, cfs	
Peak Flows Downstream of Proposed Damsite		
	February 14th to 20th	1986 Regression
Proposed Dam	143	438
Existing Conditions	359	502
Peak Flows at Sierra Street with Flow Through the Storm Drain Under Sierra Street		
Proposed Dam	206	504
Existing Conditions	431	619
Peak Flows at Sierra Street with Storm Drain Under Sierra Plugged		
Proposed Dam	206	509
Existing Conditions	435	621

In a storm of similar intensity and duration to the 1986-Regression, modeling results indicate that the proposed dam would fill and briefly overtop through the emergency spillway creating a short duration peak in the hydrograph at Sierra Street resulting in overtopping of Sierra Street (see 2regPH.DAT, hydrographs, and stage graphs at end of Appendix D of Volume II - Technical Appendix).

From information gathered and by developing a cross-section of Sierra Street at the Virginian Apartments, the ISAP calculation indicates a peak flow of 377 cfs over Sierra Street at the peak of the 1986 storm event. It was also reported that manhole covers located behind the North Virginian Apartments were blown out, indicating pressure flow through the SD system during the 1986 storm event. The 1991 SEA, Inc. Evans Creek Storm Drain plans show a 36" RCP that would have been existing in 1986. Assuming a probable outflow of ~100 cfs, then the model run would indicate a peak flow 330 cfs over Sierra Street. This is within 47 cfs of what was calculated overflowing Sierra Street at the peak, indicating that the model is probably correct in simulating the watershed.

The 1986-Regression model results differ from the 4-day 1986 model run. This is due to the potential difference between precipitation depths between the study area and the airport raingage data. At the time of writing this report, daily precipitation information from a rain gage located at Rancho San Rafael was still forthcoming. Further rainfall information would provide additional information on the relationship between the study area precipitation and the airport hourly rainfall measurements.

5.0 POSSIBLE ALTERNATIVES TO PRESENT PROPOSED DESIGN

As part of this study, possible alternatives to the present proposed dam were briefly explored and are summarized as follows. Benefits related to costs were not analyzed.

Storm Detention Behind McCarran Boulevard
The area directly upstream of McCarran Boulevard could be utilized as a storm water detention basin. To implement this alternative, the following physical improvements would likely need to be constructed:

- improve and build outflow works below McCarran Boulevard
- construct an impermeable layer over the current embankment to prevent saturation of soils and possible damage to McCarran Boulevard

Concerns with this alternative would include, but are not limited to:

- damage to recreation and wetland areas within the portion of Rancho San Rafael Park to the north of McCarran Boulevard

Vegetation Improvement Within The Watershed
Runoff conditions could be improved through vegetation augmentation within portions of the watershed. Sub-basin E3 in particular could potentially benefit from a re-vegetation program due to existing low vegetative cover densities. The benefit of such a program would be to reduce runoff from un-improved portions of the watershed. Runoff from sub-basin E3 could potentially be reduced by up to 30%. This finding is based upon revising the curve numbers within the model to reflect a higher density of vegetation cover. In the case of the 100-year model run, a 30% reduction in runoff from sub-basin E3 would reduce total peak flow at Sierra Street by ~11%. Other sub-basins within the study area typically have relatively high (~40%) vegetative density and the benefit of vegetation augmentation would likely not decrease runoff to the same extent as within sub-basin E3.

The success of a re-vegetation program would also depend upon the type of soils to be re-vegetated. According to the Soil Survey, vegetation in areas with soil type D typically have low annual vegetation yields compared to other soil types. The most effective mode of re-seeding is to use drilling equipment. Drilling is limited to areas were sites can be accessed by the drilling equipment. The following is a brief summary of drilling and aerial seeding.

<u>Drilling</u>

- ~$650/acre for the drilling equipment
- ~$21.50/acre for a native seed mixture; ~$4.50/7 lbs/acre for a mixture of crested wheatgrass
- the BLM has drilled successfully using sagebrush
- there is a portion along US395 by the Portola exit where grasses were drilled; there is a high vegetative cover density

<u>Aerial Seeding</u>

- aerial seeding; $20 to $30/acre
- aerial seeding is not as effective as drilling and is dependent on the time of year and the necessary moisture for seed germination.

A vegetation augmentation program would likely reduce peak flows within the watershed but would probably not prevent the occurrence of flood events as shown with the 100-year event example mentioned previously.

Raise Sierra Street

Overflow of Sierra Street for some storm events could be prevented by raising the elevation of Sierra Street where overflow occurs. According to the City of Reno topographic map, overflow at the low point on Sierra Street occurs at approximately 4600'. The benefit of this option would depend upon the level that Sierra Street could be raised. For example, the peak stage of the 100-year model run without the proposed dam is 4603.34' with the storm drain system operating, requiring the road to be raised ~4'. Implementation of this option would likely depend upon regulatory and design requirements for street construction.

Lower The Level of the Current Proposed Dam

The new hydrologic modeling produced by Nimbus Engineers for the 24 hour events indicate that the level of the current proposed dam could be lowered from the present design height of 4831'. The peak stage of the 500-year 24 hour event is 4813'. This is 7' below the invert of the emergency spillway. Potential benefits would be to lessen visual/recreational impacts as well as costs.

Combination of the Above Alternatives

All the alternatives presented above could likely be implemented conjunctively or in combinations. Further research would need to be performed in order to analyze the benefit of any one or combination of the alternatives.

7.0 CONCLUSIONS

Given the model results, field investigations, and the data gathered, it is concluded that the HEC-1 model adequately simulates conditions within the study area. Model results show that the proposed dam will prevent overtopping of Sierra Street under the conditions modeled for the 5 through 500-year storm events. Other conclusions include:

- With the exception of the 1986-Regression run, all model runs showed peak stages well below the emergency spillway at the proposed damsite. Therefore, it is concluded that the proposed dam elevation could be lowered without compromising downstream flood protection under the modeled conditions.

- The 1986-Regression run assumes predicted hourly precipitation values for the study area. Without further hourly or daily precipitation data within the watershed for the 1986 event, any conclusion from this run that the proposed dam would not prevent flooding over Sierra Street would be unfounded. Given the strong correlation of monthly totals between the unofficial rain gages and the airport gage, the 1986-Regression run indicates that precipitation within the study area may be greater than would be observed at the airport.

- The location of the proposed dam is a preferred and feasible location for a flood control facility. Field investigations and modeling show that upstream sites would lack the necessary storage as well as being more exposed visually. The McCarran alternative site discussed in Section 5.0 would suffice as a detention facility but recreation, structural, and regulatory requirements may make this option difficult to implement. Combinations of the other alternatives presented may be more feasible and could be used in conjunction with a modification of the proposed facility.

- Vegetation augmentation within the study area may be hampered by the predominance of soil type D within the watershed as indicated in the Soil Survey. This option would reduce flood flows but not to the extent of preventing over-topping of Sierra Street by itself.

The alternatives presented would need further study to determine their ultimate feasibility.

6.0 REFERENCES

American Concrete Pipe Association, Concrete Pipe Design Manual, November, 1992

City of Sparks, Draft Hydrologic Criteria and Drainage Design Manual, June 30, 1998

City of Reno, Digital Maps, IDS ver. 3.2 #2, September 1998

McCuen, R.H; A Guide to Hydrologic Analysis Using SCS Methods, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1982

McCuen, R.H., Hromadka, T.V., and Yen, C.C.; Computational Hydrology in Flood Control Design and Planning, Lighthouse Publications, Mission Viejo, California, 1987

Ponce, V.M., Engineering Hydrology - Principles and Practices, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1989

U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-1 Flood Hydrograph Package User's Manual, Version 4.0 1E, September 1990

U.S. Bureau of Land Management; Personal Communication with Brad Hines

U.S. Bureau of Reclamation, Design of Small Dams, 1977

U.S. Geological Survey, Quadrangle Maps

U.S. Natural Resources Conservation Service, Hydraulics of Two-Way Covered Risers, Technical Release No. 29, June 1, 1965

U.S. Natural Resources Conservation Service, Engineering Field Manual - Chapter 6. Structures,

U.S. Natural Resources Conservation Service, Evans Creek Watershed Plan and Environmental Assessment, Washoe County, NV, August 1994

U.S. Soil Conservation Service, National Engineering Handbook - #4

Washoe County, Draft Hydrologic Criteria and Drainage Design Manual, December 2, 1996

Washoe County, Parcel Base and Land Use Maps, Washoe County Water Resources, January 1, 1999

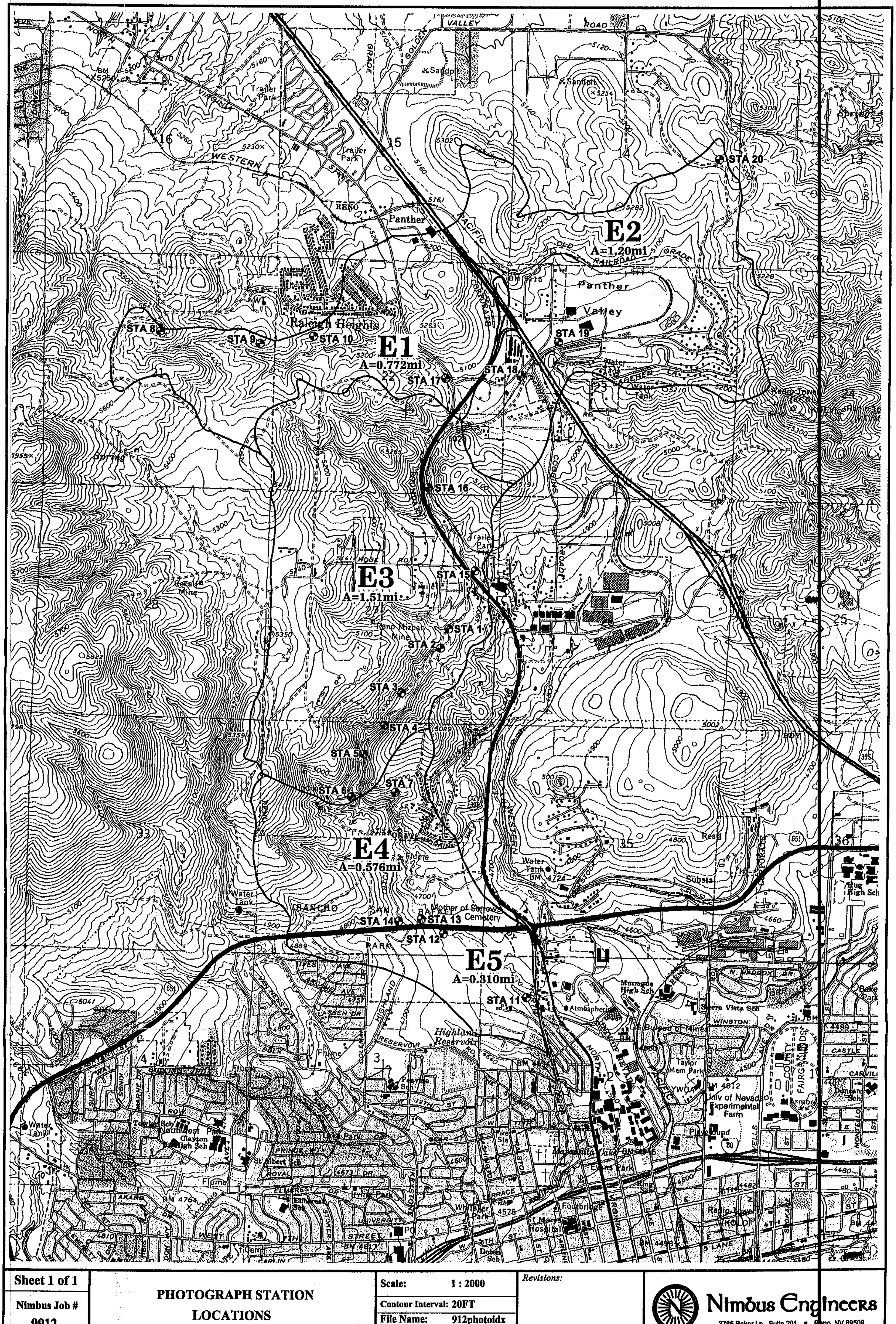
APPENDICES

Appendix A. Site Investigation Photosheets

Appendix B. Figure 702 - Curve Numbers for Sage/Grass (from draft City of Sparks Hydrologic Criteria and Drainage Design Manual)

Appendix C. HEC-1 Model Results and Hydrographs

Appendix A



Sheet 1 of 1	**PHOTOGRAPH STATION LOCATIONS**	**Scale:** 1 : 2000	Revisions:
Nimbus Job #	*Evans Creek Block "N" Hydrology*	**Contour Interval:** 20FT	
9912	Reno — Washoe County — Nevada	**File Name:** 912photoldx	
Date: July 1999		**Drawn By:** KK	
		Designed By: CA	

Nimbus Engineers
3785 Baker Ln., Suite 201 • Reno, NV 89509
Mail: P.O. Box 10220 • Reno, NV 89510
(775) 689-8630 • Fax (775) 689-8614
Email: nimbus@intercomm.com

Nimbus Engineers
3785 Baker Ln., Suite 201 • Reno, NV 89509
Mail: P.O. Box 10220 • Reno, NV 89510
(775) 689-8630 • Fax (775) 689-8614
Email: nimbus@intercomm.com

DATE 5/10/99
TIME ~13:00
PHOTO No. 1
LOCATION Station 1
VIEW Southwesterly
TAKEN BY CA

DESCRIPTION Sparse Ponderosa Pine; sparse cheatgrass; facing towards beginning of draw below Reno Mizpah Mine

DATE 5/10/99
TIME ~13:00
PHOTO No. 2
LOCATION Station 1
VIEW Southerly
TAKEN BY CA

DESCRIPTION Streambed vegetation - willow, Russian Olive.

Nimbus Engineers
3785 Baker Ln., Suite 201 • Reno, NV 89509
Mail: P.O. Box 10220 • Reno, NV 89510
(775) 689-8630 • Fax (775) 689-8614
Email: nimbus@intercomm.com

DATE 5/10/99
TIME ~13:30
PHOTO No. 3
LOCATION Station 2

VIEW Southerly
TAKEN BY CA

DESCRIPTION Upstream (North of) of Station 2. 60" RCP under dirt road. The 24" RCP to left of 60" does not daylight on the downstream side.

DATE 5/10/99
TIME ~13:30
PHOTO No. 4
LOCATION Station 2

VIEW Southerly
TAKEN BY CA

DESCRIPTION Taken from dirt road. Same hillside as pictured in Photo 1. 60" RCP daylights at bottom left corner. Stream channel daylights from 12" RCP easterly of this location.

Nimbus Engineers
3785 Baker Ln., Suite 201 • Reno, NV 89509
Mail: P.O. Box 10220 • Reno, NV 89510
(775) 689-8630 • Fax (775) 689-8614
Email: nimbus@intercomm.com

PHOTO 5/10/99
TIME ~13:30
PHOTO No. 5
LOCATION Station 2

VIEW Southerly
TAKEN BY CA

DESCRIPTION Facing downstram of Station 2. Main channel runs through foreground ~15' south of 60" RCP outlet pool. Main channel then continues through cattail and russian olive pictured on the right.

PHOTO 5/10/99
TIME ~13:30
PHOTO No. 6
LOCATION Station 2

VIEW Northerly
TAKEN BY CA

DESCRIPTION Taken ~100 yards south of Station 2. 60" RCP outlet below dirt road to Reno-Mizpah Mine.

Nimbus Engineers
3785 Baker Ln., Suite 201 • Reno, NV 89509
Mail: P.O. Box 10220 • Reno, NV 89510
(775) 689-8630 • Fax (775) 689-8614
Email: nimbus@intercomm.com

PHOTO 5/10/99
TIME ~13:30
PHOTO No. 7
LOCATION Station 2
VIEW Northerly
TAKEN BY CA

DESCRIPTION Same location as Photo No. 6 but facing south downstream.

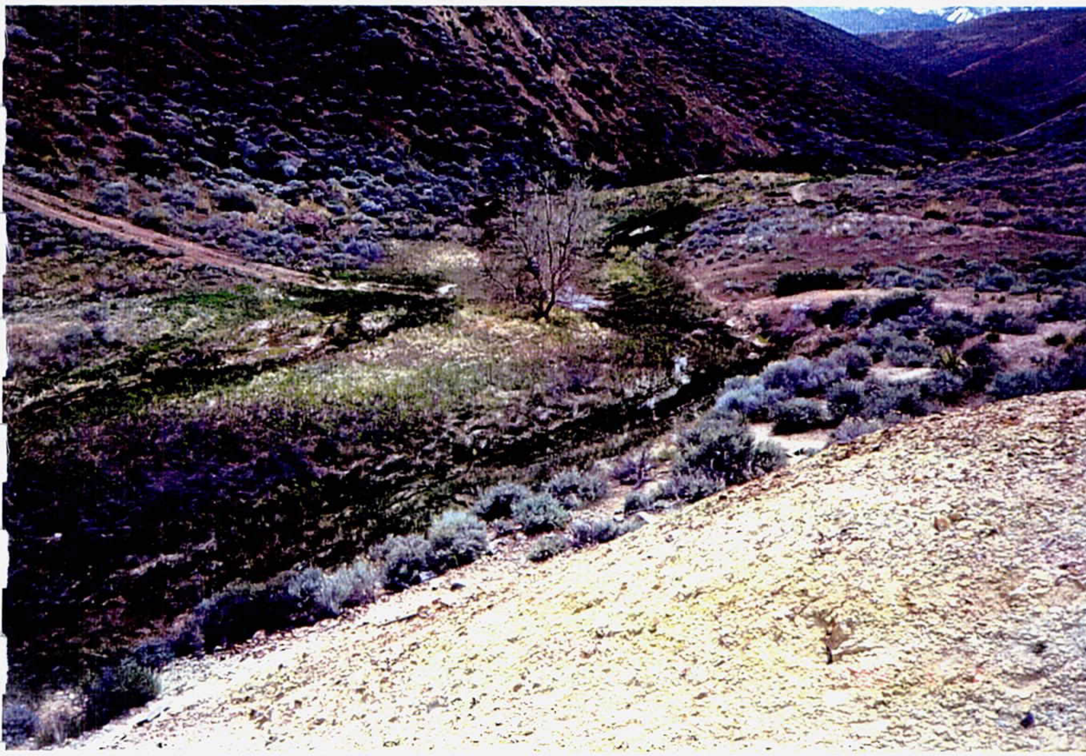


PHOTO 5/10/99
TIME ~14:00
PHOTO No. 8
LOCATION Station 3
VIEW Southwesterly
TAKEN BY CA

DESCRIPTION Looking down at streambed.

Nimbus Engineers
3785 Baker Ln., Suite 201 • Reno, NV 89509
Mail: P.O. Box 10220 • Reno, NV 89510
(775) 689-8630 • Fax (775) 689-8614
Email: nimbus@intercomm.com

PHOTO 5/10/99
TIME ~14:00
PHOTO No. 9
LOCATION Station 3
VIEW Northerly
TAKEN BY CA

DESCRIPTION Facing upstream from Station 3 back towards Station 2 .

PHOTO 5/10/99
TIME ~14:15
PHOTO No. 10
LOCATION Station 4
VIEW Northerly
TAKEN BY CA

DESCRIPTION Facing upstram. Riparian vegetation: sedges, Great Basin Wild Rye, and sagebrush. Channel bottom cobbly with small cobble to small boulder. Well defined channel.

Nimbus Engineers
3785 Baker Ln., Suite 201 • Reno, NV 89509
Mail: P.O. Box 10220 • Reno, NV 89510
(775) 689-8630 • Fax (775) 689-8614
Email: nimbus@intercomm.com

DATE 5/10/99

TIME ~14:15

PHOTO No. 11

LOCATION Station 4

VIEW Southerly

TAKEN BY CA

DESCRIPTION Facing downstream. Riparian vegetation: sedges, Great Basin Wild Rye, willow, wild rose, and sagebrush.

DATE 5/10/99

TIME ~14:30

PHOTO No. 12

LOCATION Station 5

VIEW Northerly

TAKEN BY CA

DESCRIPTION Facing upstream. Cottonwood pictured in foreground. Hillside above Station 4 pictured in background.

Nimbus Engineers
3785 Baker Ln., Suite 201 • Reno, NV 89509
Mail: P.O. Box 10220 • Reno, NV 89510
(775) 689-8630 • Fax (775) 689-8614
Email: nimbus@intercomm.com

DATE 5/10/99
TIME ~15:00
PHOTO No. 13
LOCATION Station 6
PROPOSED DAMSITE.

VIEW Northerly
TAKEN BY CA

DESCRIPTION Facing upstream. Photo taken at approximate location of proposed emergency spillway.

DATE 5/10/99
TIME ~13:30
PHOTO No. 14
LOCATION Station 6
PROPOSED DAMSITE.

DIR. OF Easterly
TAKEN BY CA

DESCRIPTION Location of proposed dam. Pictured at mid-photograph is unmarked survey lathe that approximately corresponds o the top of the proposed dam.

Nimbus Engineers
3785 Baker Ln., Suite 201 • Reno, NV 89509
Mail: P.O. Box 10220 • Reno, NV 89510
(775) 689-8630 • Fax (775) 689-8614
Email: nimbus@intercomm.com

Job No. 07775-9912

DATE 5/10/99

TIME ~15:00

PHOTO No. 15

LOCATION Station 7

VIEW Southeasterly

TAKEN BY CA

DESCRIPTION Stream channel pictured in foreground. Upper portion of sub-basin E4 in background.

DATE 5/10/99

TIME ~15:00

PHOTO No. 16

LOCATION Station 7

DIR. OF Southerly

TAKEN BY CA

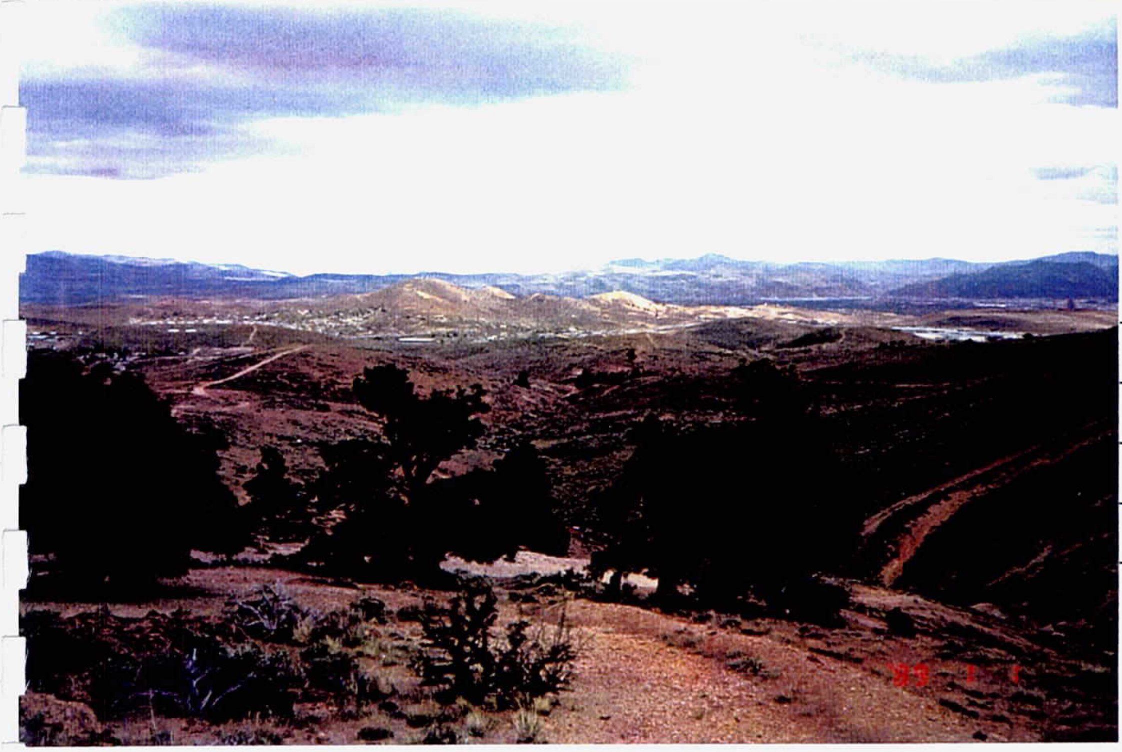
DESCRIPTION Facing southerly towards McCarran (left background).

Nimbus Engineers
3785 Baker Ln., Suite 201 • Reno, NV 89509
Mail: P.O. Box 10220 • Reno, NV 89510
(775) 689-8630 • Fax (775) 689-8614
Email: nimbus@intercomm.com

DATE 5/10/99
TIME ~15:30
PHOTO No. 17
LOCATION Station 8

VIEW Southwesterly
TAKEN BY CA

DESCRIPTION Upper portion of sub-basin E1



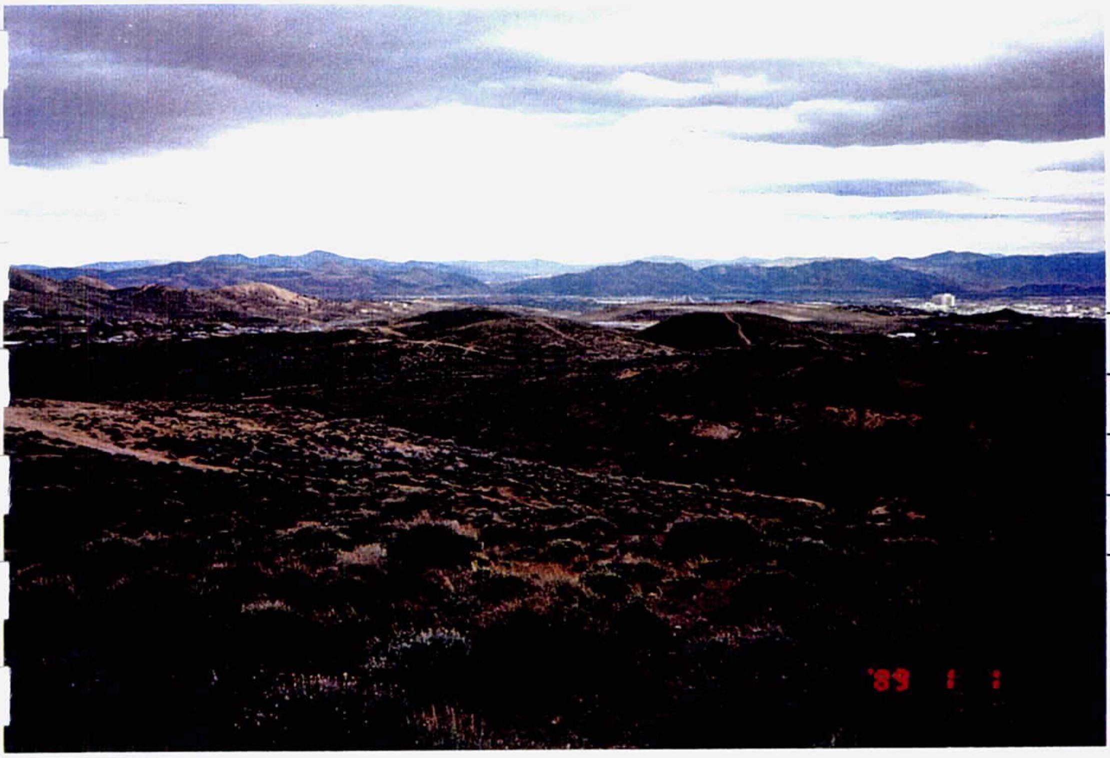
DATE 5/10/99
TIME ~15:45
PHOTO No. 18
LOCATION Station 9

VIEW Easterly
TAKEN BY CA

DESCRIPTION Facing directly downstream. Photo was taken ~100 feet above stream channel (lower left). Pictured in back ground is Panther Valley (upper left).

Nimbus Engineers
3785 Baker Ln., Suite 201 • Reno, NV 89509
Mail: P.O. Box 10220 • Reno, NV 89510
(775) 689-8630 • Fax (775) 689-8614
Email: nimbus@intercomm.com

Job No. 07775-9912



DATE 5/10/99

TIME ~16:00

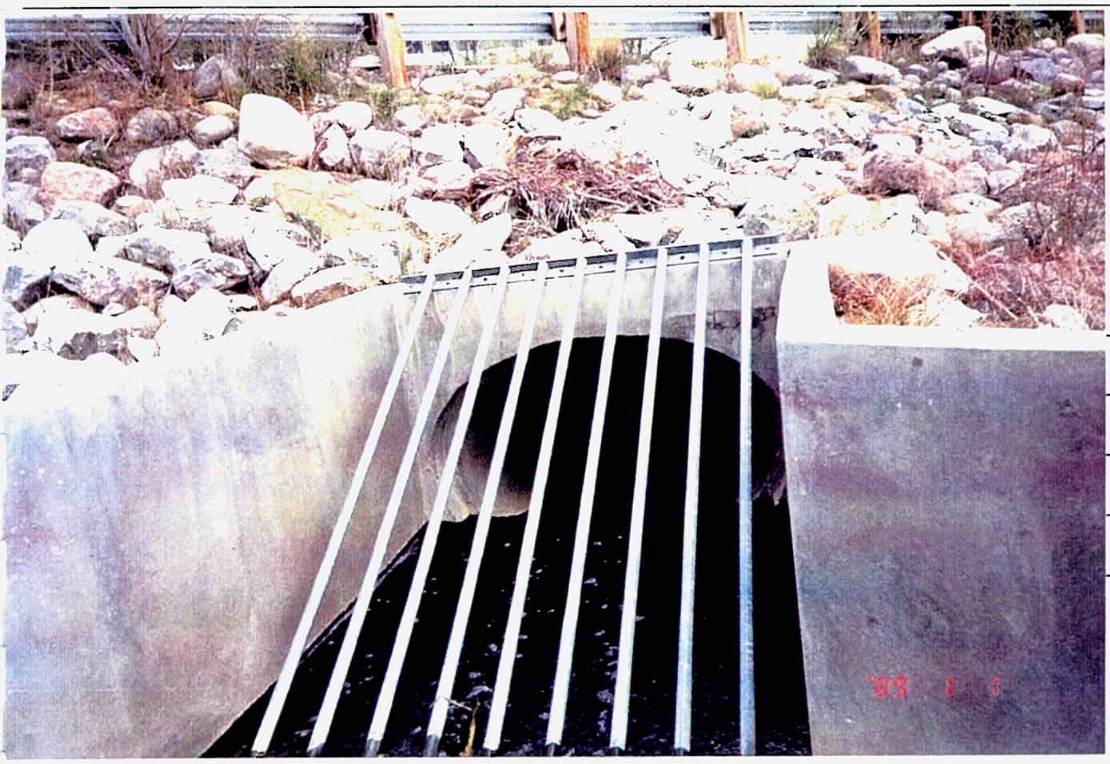
PHOTO No. 19

LOCATION Station 10

VIEW Southwesterly

TAKEN BY CA

DESCRIPTION Vegetation cover of sub-basin E1. Streambed is in ravine pictured in foreground.



DATE 5/10/99

TIME ~16:15

PHOTO No. 20

LOCATION Station 11

SIERRA STREET STORM DRAIN INLET

DIR. OF Easterly

TAKEN BY CA

DESCRIPTION 43"x68" horizontal elliptical RCP inlet to storm drain below North Sierra Street.

Nimbus Engineers
3785 Baker Ln., Suite 201 • Reno, NV 89509
Mail: P.O. Box 10220 • Reno, NV 89510
(775) 689-8630 • Fax (775) 689-8614
Email: nimbus@intercomm.com

Job No. 07775-9912

SHEET No. 11 Of 17

PHOTO DATE 5/26/99

TIME 09:30

PHOTO No. 21

LOCATION Station 12

VIEW Southerly

TAKEN BY CA

DESCRIPTION Old detention basin directly downstream of McCarran Boulevard.

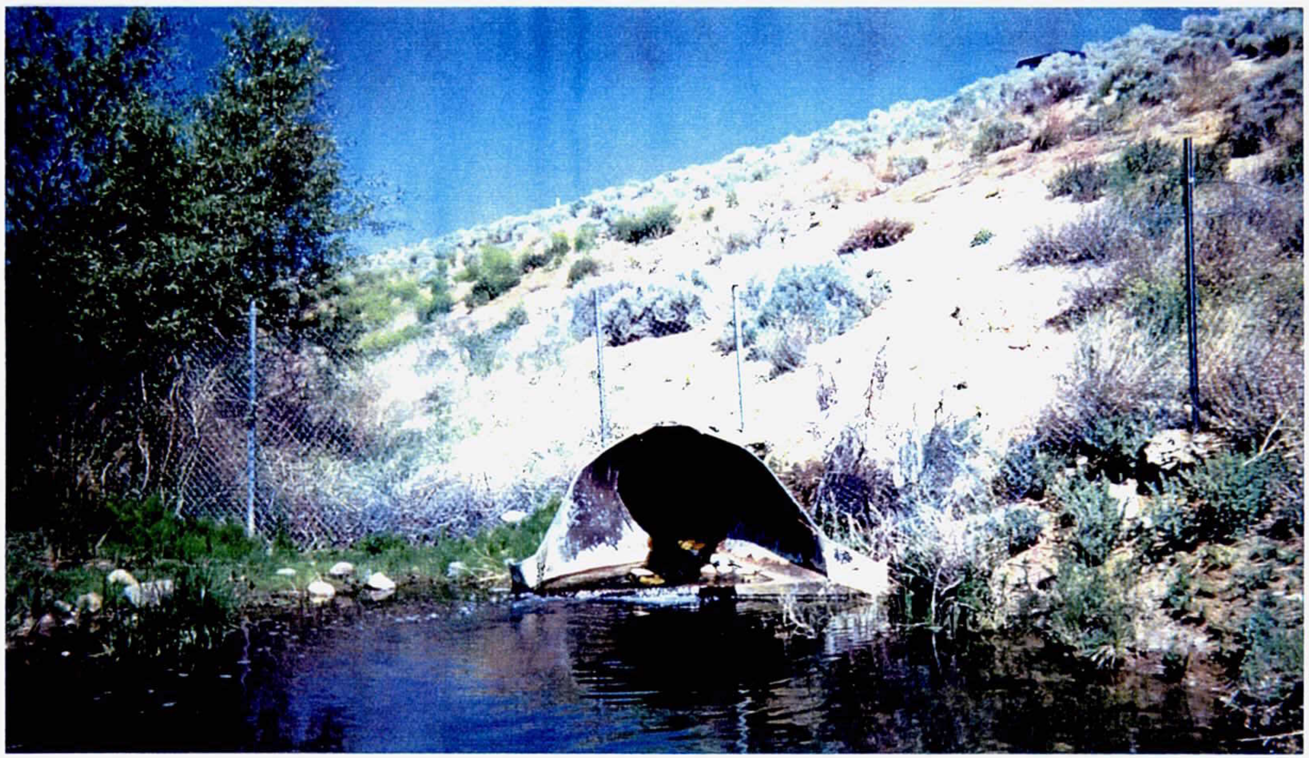


PHOTO DATE 5/26/99

TIME 09:30

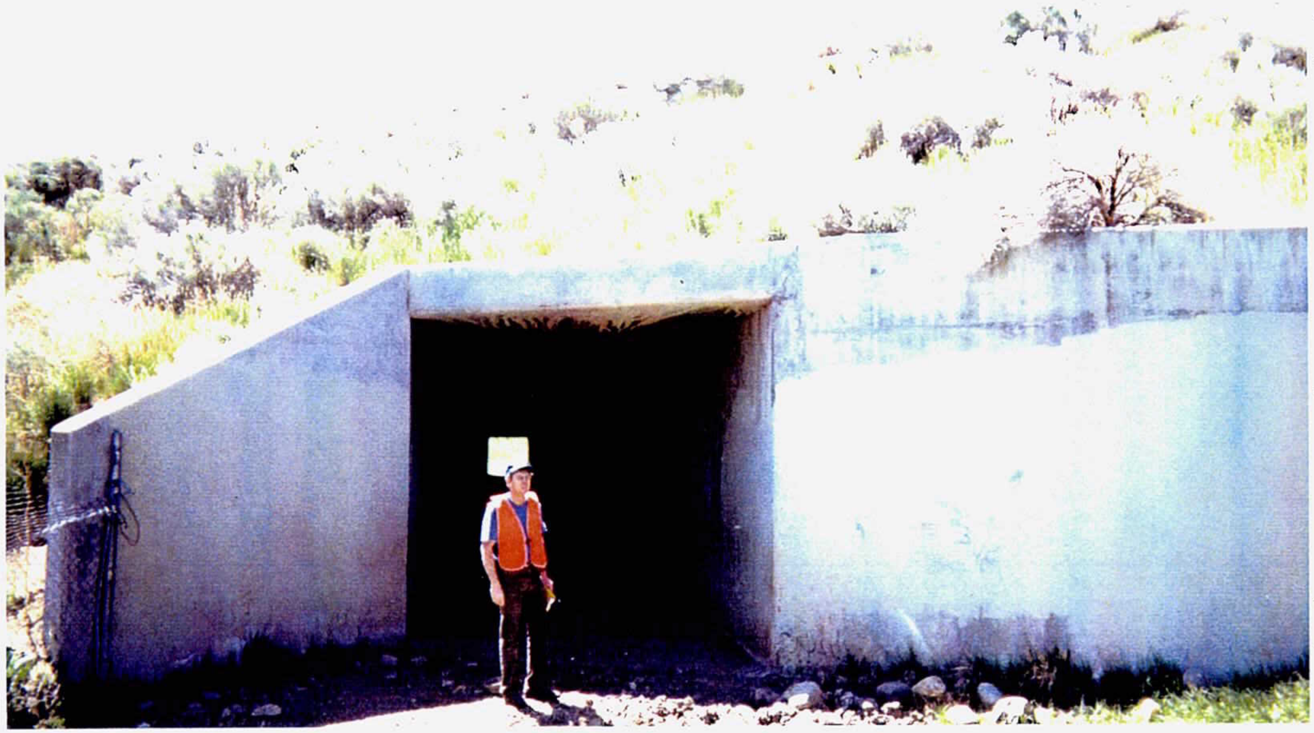
PHOTO No. 22

LOCATION Station 12

VIEW Northerly

TAKEN BY CA

DESCRIPTION Outlet to 48" RMP under McCarran Blvd.



Nimbus Engineers
3785 Baker Ln., Suite 201 • Reno, NV 89509
Mail: P.O. Box 10220 • Reno, NV 89510
(775) 689-8630 • Fax (775) 689-8614
Email: nimbus@intercomm.com

Job No. 07775-9912

SHEET No. 12 Of 17

PHOTO DATE 5/26/99

TIME 10:50

PHOTO No. 23

LOCATION Station 13 McCarran Boulevard

VIEW Easterly

TAKEN BY CA

DESCRIPTION Inlet to 48" CMP under McCarran. 10'x10' box culvert in background.

PHOTO DATE 5/26/99

TIME 11:00

PHOTO No. 24

LOCATION Station 13

VIEW Southerly

TAKEN BY CA

DESCRIPTION 10'x10' culvert under McCarran Blvd.

Nimbus Engineers
3785 Baker Ln., Suite 201 • Reno, NV 89509
Mail: P.O. Box 10220 • Reno, NV 89510
(775) 689-8630 • Fax (775) 689-8614
Email: nimbus@intercomm.com

Job No. 07775-9912

SHEET No. 13 Of 17

PHOTO DATE 5/26/99

TIME 11:00

PHOTO No. 25

LOCATION Station 14 McCarran Boulevard

VIEW Northerly

TAKEN BY CA

DESCRIPTION Facing northerly towards proposed damsite (middle background).

PHOTO DATE 5/26/99

TIME 11:00

PHOTO No. 26

LOCATION Station 14 McCarran Blvd.

VIEW NEasterly

TAKEN BY CA

DESCRIPTION Picture of wetlands/channel vegetation and pasture - north Rancho San Rafael Park.

Nimbus Engineers
3785 Baker Ln., Suite 201 • Reno, NV 89509
Mail: P.O. Box 10220 • Reno, NV 89510
(775) 689-8630 • Fax (775) 689-8614
Email: nimbus@intercomm.com

Job No. 07775-9912

SHEET No. 14 Of 17

PHOTO DATE 5/26/99

TIME 11:10

PHOTO No. 27

LOCATION Station 15

North of Bonanza Casino on North Virginia St.

VIEW Westerly

TAKEN BY CA

DESCRIPTION RCB box culvert inlet. Two at 4'x10' - RCB #B227. Box pictured on right is overgrown with vegetation and 2/3 filled with sediment.

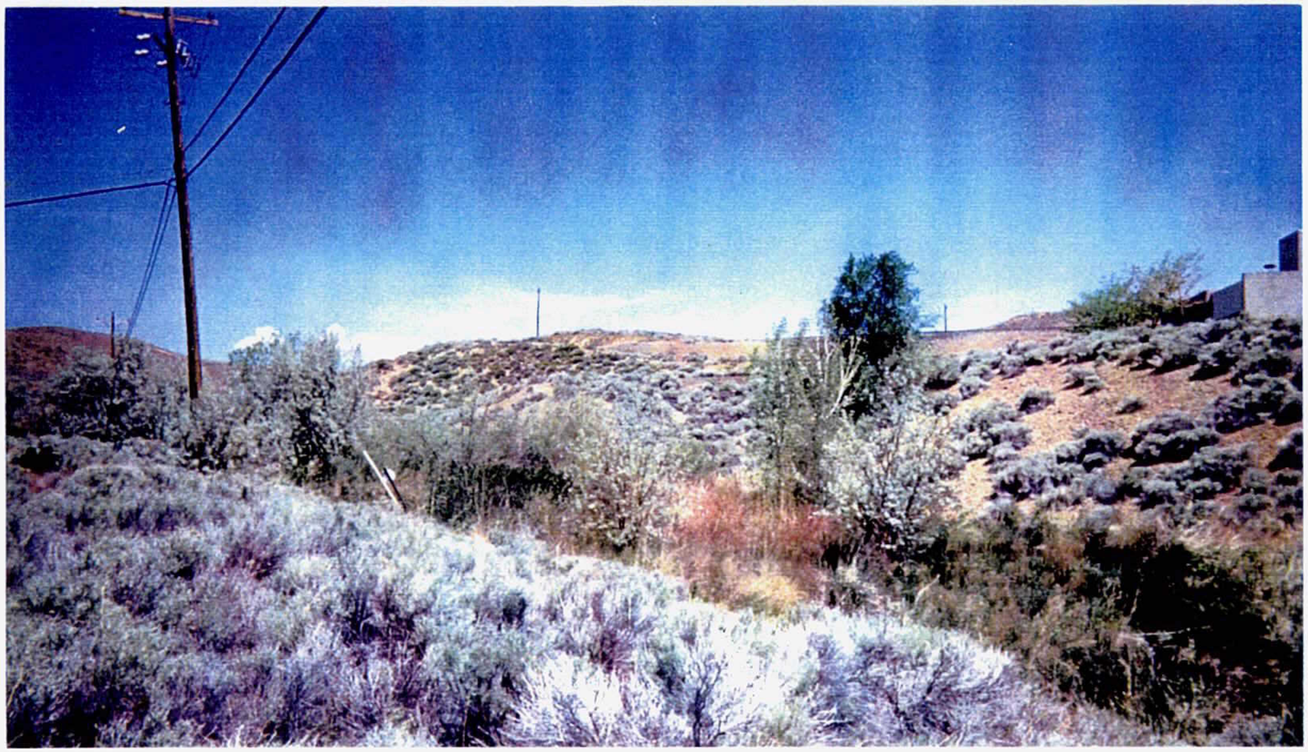


PHOTO DATE 5/26/99

TIME 11:20

PHOTO No. 28

LOCATION Station 15

North of Bonanza Casino on North Virginia St.

VIEW NEasterly

TAKEN BY CA

DESCRIPTION Channel directly above RCB #B227.

Nimbus Engineers

3785 Baker Ln., Suite 201 • Reno, NV 89509
Mail: P.O. Box 10220 • Reno, NV 89510
(775) 689-8630 • Fax (775) 689-8614
Email: nimbus@intercomm.com

Job No. 07775-9912

SHEET No. 15 Of 17

PHOTO DATE 5/26/99

TIME 11:35

PHOTO No. 29

LOCATION Station 16

North of Bonanza Casino on North Virginia St.

VIEW NEasterly

TAKEN BY CA

DESCRIPTION Channel geometry and vegetation next to railroad tracks. This portion of stream carry's flow from sub-basins E1 and E2

PHOTO DATE 5/26/99

TIME 11:45

PHOTO No. 30

LOCATION Station 17

Intersection of Old North Virginia and North Virginia St.

VIEW SEasterly

TAKEN BY CA

DESCRIPTION 48" CMP; receives flow from sub-basin E1.

Nimbus Engineers

3785 Baker Ln., Suite 201 • Reno, NV 89509
Mail: P.O. Box 10220 • Reno, NV 89510
(775) 689-8630 • Fax (775) 689-8614
Email: nimbus@intercomm.com

Job No. 07775-9912

SHEET No. 16 Of 17

PHOTO DATE 5/26/99

TIME 12:15

PHOTO No. 31

LOCATION Station 18

VIEW Easterly

TAKEN BY CA

DESCRIPTION Downstream end of 42" RCP

PHOTO DATE 5/26/99

TIME 12:25

PHOTO No. 32

LOCATION Station 18

VIEW Westerly

TAKEN BY CA

DESCRIPTION Upstream end of 42" RCP
US395 pictured in background.

Nimbus Engineers
3785 Baker Ln., Suite 201 • Reno, NV 89509
Mail: P.O. Box 10220 • Reno, NV 89510
(775) 689-8630 • Fax (775) 689-8614
Email: nimbus@intercomm.com

Job No. 07775-9912

SHEET No. 17 Of 17

PHOTO DATE 5/26/99

TIME 12:50

PHOTO No. 33

LOCATION Station 20

VIEW SWesterly

TAKEN BY CA

DESCRIPTION Upper portion of sub-basin E2 (Panther Valley in background).

PHOTO DATE

TIME

PHOTO No.

LOCATION

VIEW

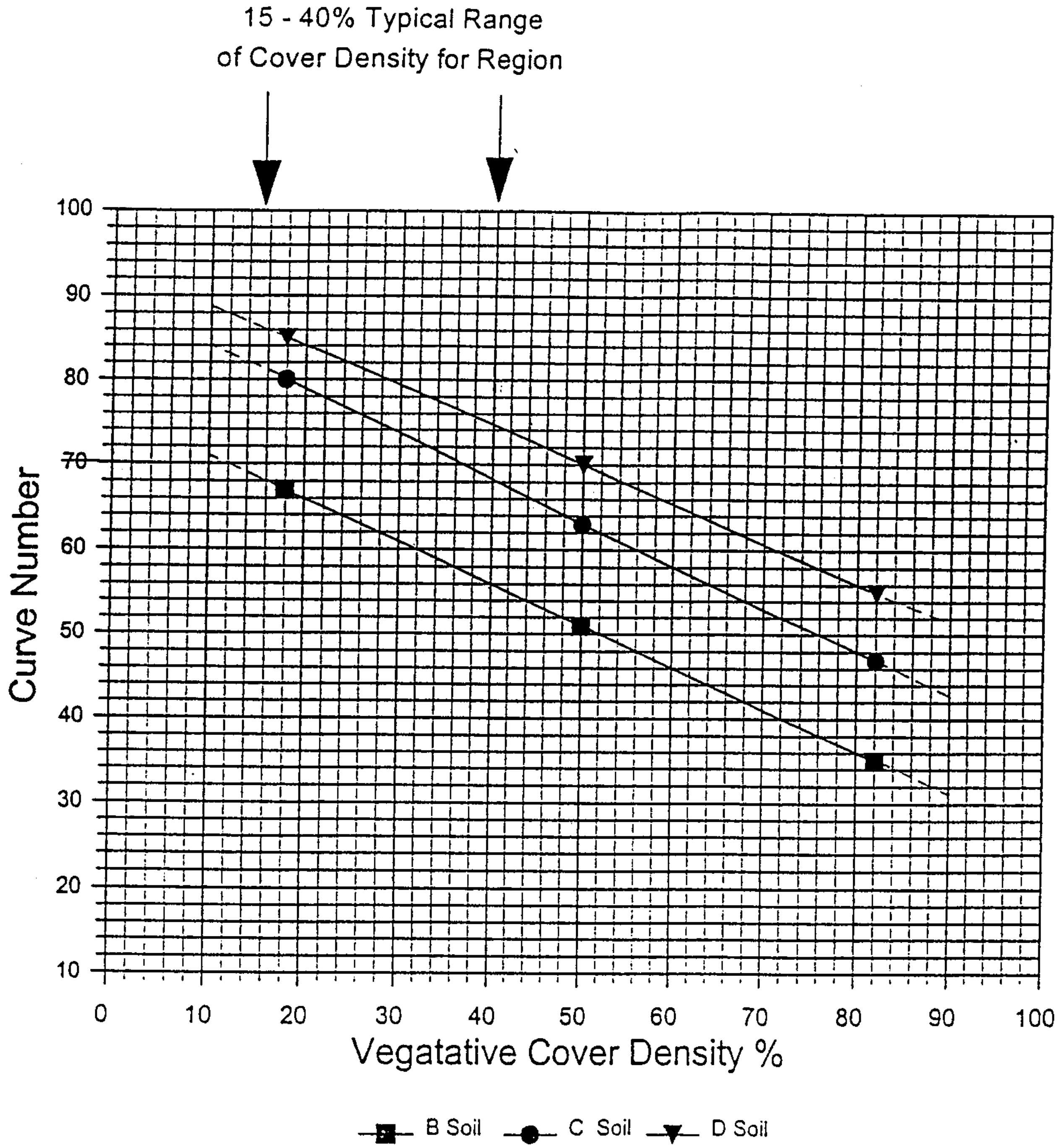
TAKEN BY

DESCRIPTION

Appendix B

DRAFT

CURVE NUMBER FOR SAGE/GRASS



VERSION: June 30, 1998	REFERENCE: SCS TR-55, NEH-4	FIGURE 702
WRC NEVADA, INC		

Appendix C

5-YEAR, 24 HOUR

5-year, 24 hour
2evns5.out

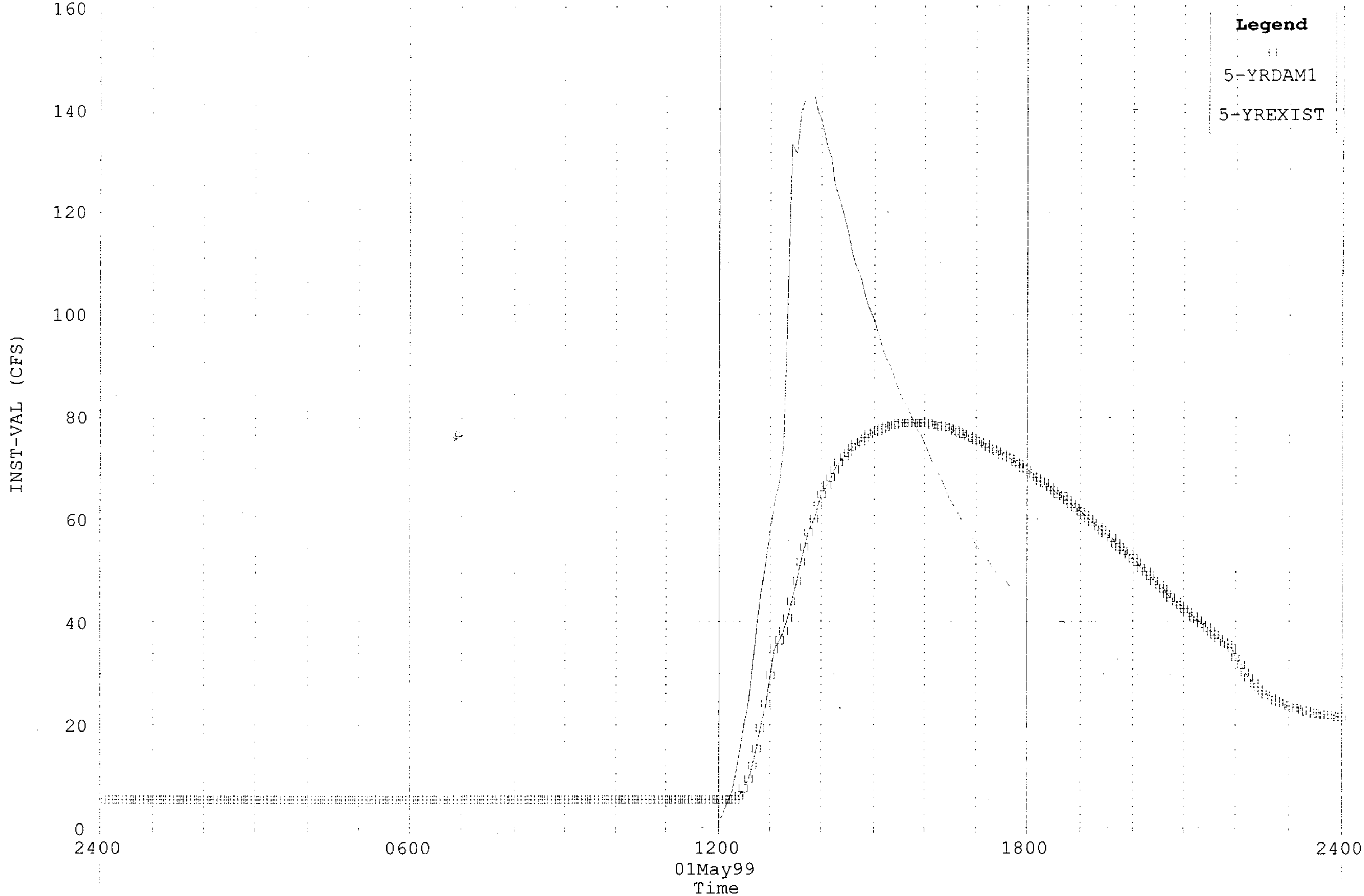
PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

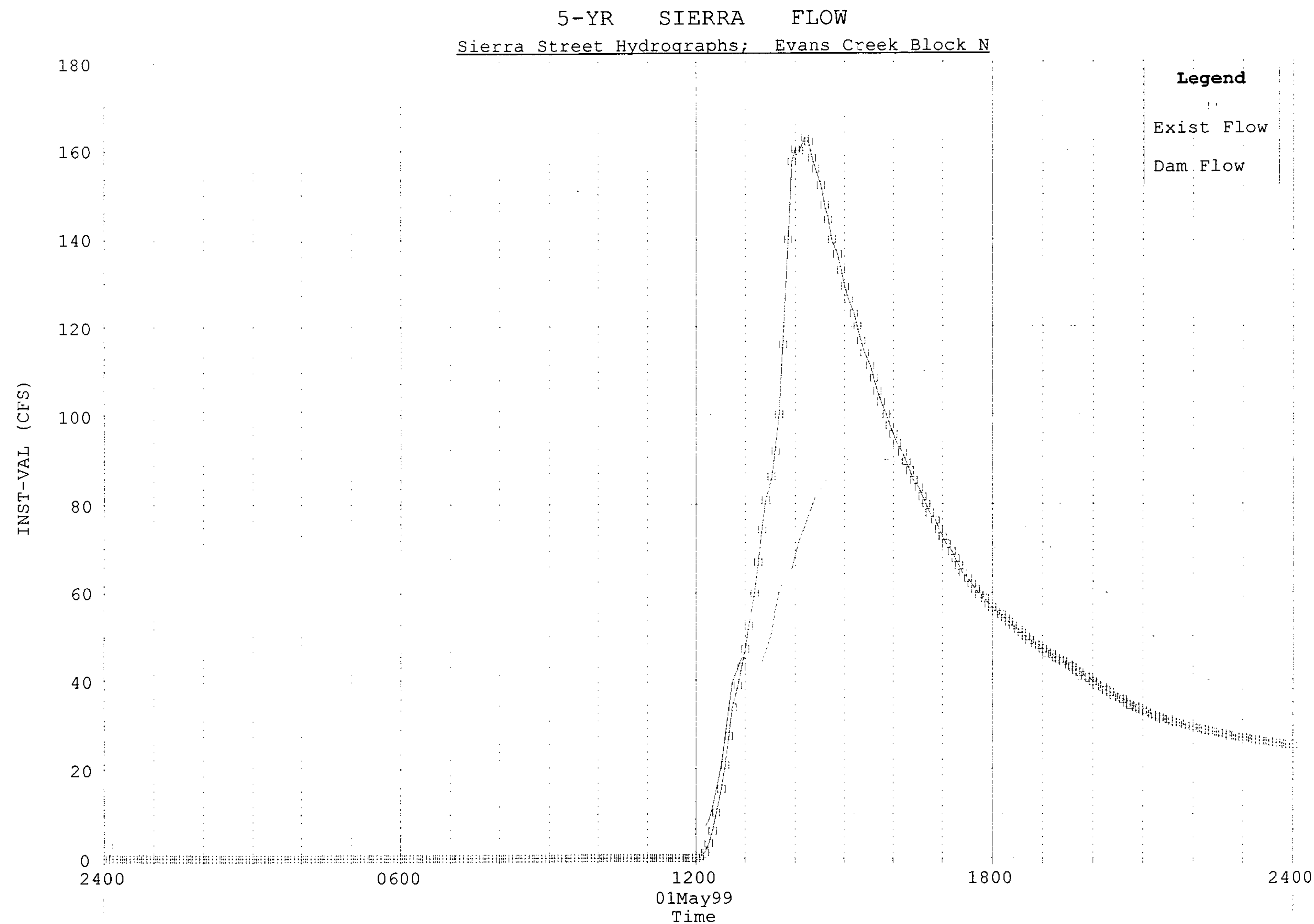
OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION RATIO 1 .99
HYDROGRAPH AT					
+	E1	.77	1	FLOW	31.
				TIME	13.08
			2	FLOW	31.
				TIME	13.08
HYDROGRAPH AT					
	E2	1.20	1	FLOW	38.
				TIME	13.33
			2	FLOW	38.
				TIME	13.33
2 COMBINED AT					
	CP1	1.97	1	FLOW	67.
				TIME	13.17
			2	FLOW	67.
				TIME	13.17
ROUTED TO					
+	RCH1	1.97	1	FLOW	68.
				TIME	13.75
			2	FLOW	68.
				TIME	13.75
HYDROGRAPH AT					
	E3	1.51	1	FLOW	77.
				TIME	13.50
			2	FLOW	77.
				TIME	13.50
2 COMBINED AT					
+	CP2	3.48	1	FLOW	143.
				TIME	13.75
			2	FLOW	143.
				TIME	13.75
ROUTED TO					
+	DAM1	3.48	1	FLOW	79.
				TIME	15.75
			2	FLOW	143.
				TIME	13.75
			** PEAK STAGES IN FEET **		
			1	STAGE	782.56
				TIME	15.75
			2	STAGE	.00
				TIME	.00
ROUTED TO					
+	RCH3	3.48	1	FLOW	79.
				TIME	16.00
			2	FLOW	146.
				TIME	13.92
HYDROGRAPH AT					

```
+                E4       .58    1   FLOW        25.
                                     TIME     12.75
                                 2   FLOW        25.
                                     TIME     12.75

  2 COMBINED AT
                CP3      4.06    1   FLOW        86.
                                     TIME     15.50
                                 2   FLOW       159.
                                     TIME     13.92

 ROUTED TO
+              RCH3      4.06    1   FLOW        86.
                                     TIME     15.58
                                 2   FLOW       158.
                                     TIME     14.08

 IYDROGRAPH AT
                 E5       .31    1   FLOW        17.
                                     TIME     12.58
                                 2   FLOW        17.
                                     TIME     12.58

  2 COMBINED AT
                CP4      4.37    1   FLOW        91.
                                     TIME     15.25
                                 2   FLOW       166.
                                     TIME     13.83

 :OUTED TO
+            SIERRA      4.37    1   FLOW        91.
                                     TIME     15.33
                                 2   FLOW       163.
                                     TIME     14.08

                                 ** PEAK STAGES IN FEET **
                                 1   STAGE   590.30
                                     TIME     15.33
                                 2   STAGE   592.90
                                     TIME     14.08
```

5-YR DAM1,EXIST FLOW

Proposed Damsite Hydrographs; Evans Creek Block N




5-YR SIERRA FLOW
Sierra Street Hydrographs; Evans Creek Block N
Legend
Exist Flow
Dam Flow
INST-VAL (CFS)
180
160
140
120
100
80
60
40
20
0
2400
0600
1200
01May99
Time
1800
2400

10-YEAR, 24 HOUR

10-YEAR, 24 HOUR

2EVN10.OUT

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS

FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES

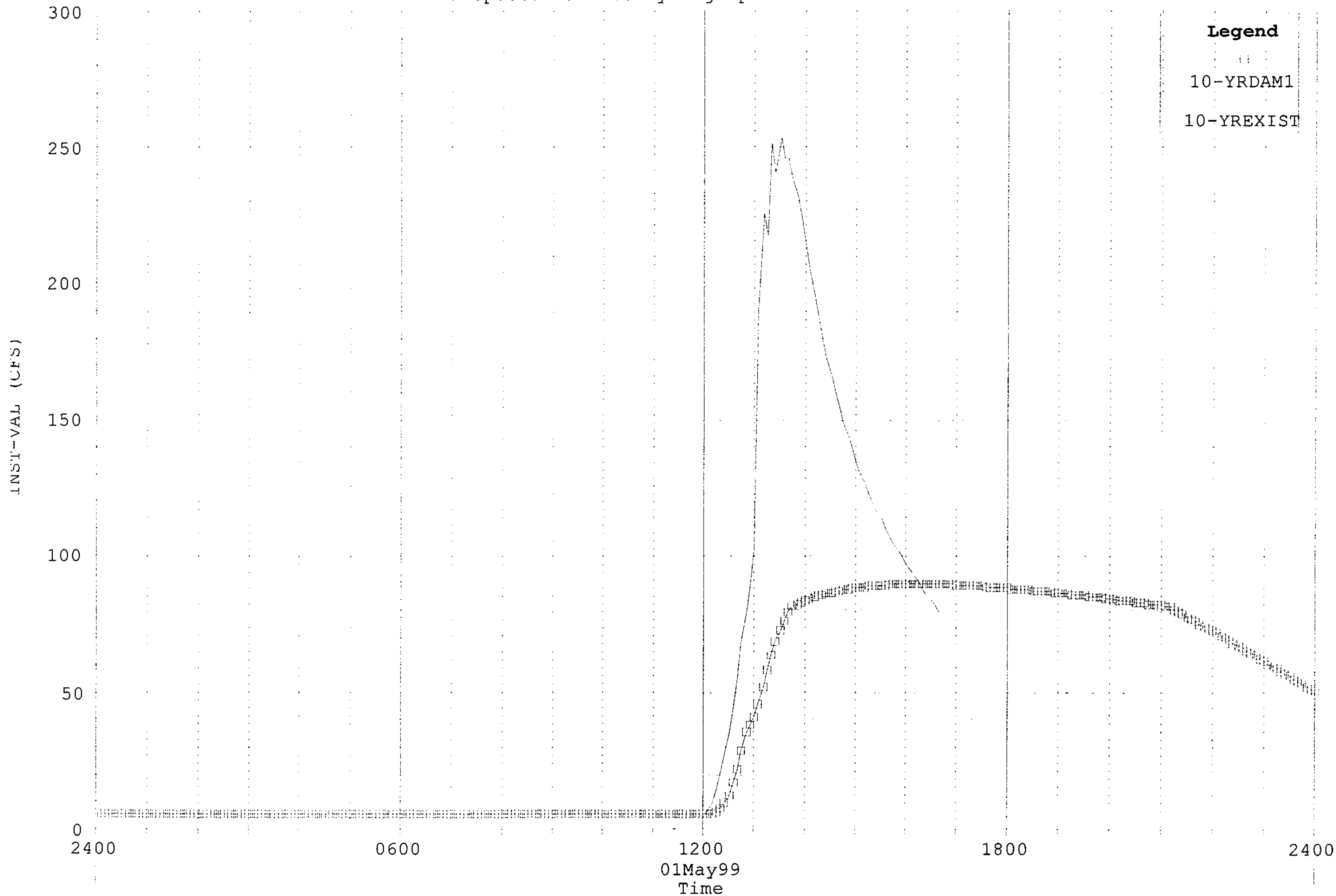
TIME TO PEAK IN HOURS

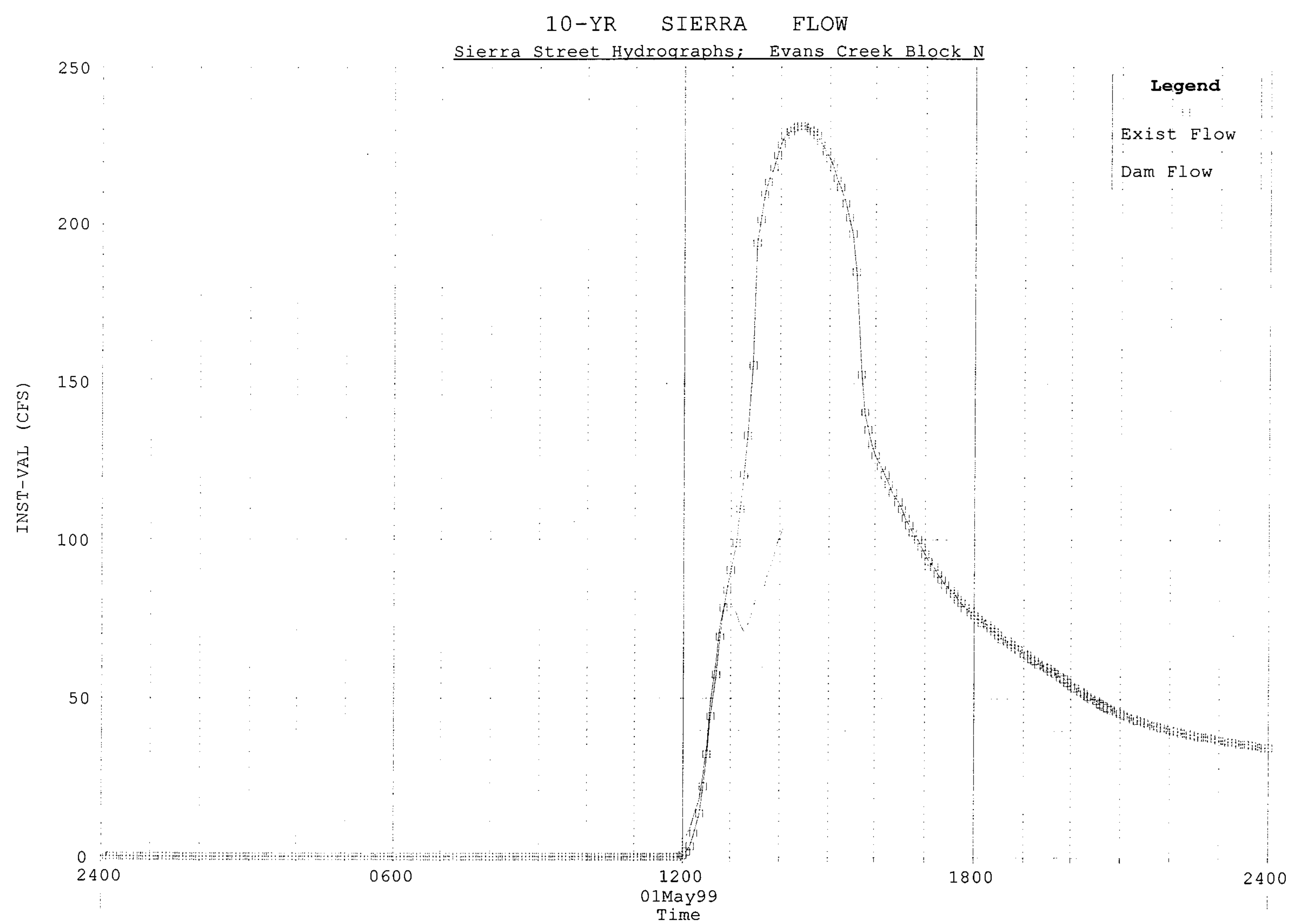
OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION RATIO 1 .99
HYDROGRAPH AT					
+	E1	.77	1	FLOW	57.
				TIME	12.92
			2	FLOW	57.
				TIME	12.92
YDROGRAPH AT					
	E2	1.20	1	FLOW	71.
				TIME	13.17
			2	FLOW	71.
				TIME	13.17
2 COMBINED AT					
	CP1	1.97	1	FLOW	125.
				TIME	13.08
			2	FLOW	125.
				TIME	13.08
OUTED TO					
	RCH1	1.97	1	FLOW	129.
				TIME	13.42
			2	FLOW	129.
				TIME	13.42
YDROGRAPH AT					
	E3	1.51	1	FLOW	124.
				TIME	13.42
			2	FLOW	124.
				TIME	13.42
2 COMBINED AT					
	CP2	3.48	1	FLOW	254.
				TIME	13.42
			2	FLOW	254.
				TIME	13.42
OUTED TO					
	DAM1	3.48	1	FLOW	89.
				TIME	16.17
			2	FLOW	254.
				TIME	13.42
			** PEAK STAGES IN FEET **		
			1	STAGE	788.30
				TIME	16.17
			2	STAGE	.00
				TIME	.00
ROUTED TO					
+	RCH3	3.48	1	FLOW	89.
				TIME	16.50
			2	FLOW	259.
				TIME	13.58
YDROGRAPH AT					

+	E4	.58	1	FLOW	50.
				TIME	12.67
			2	FLOW	50.
				TIME	12.67
2 COMBINED AT					
	CP3	4.06	1	FLOW	100.
				TIME	14.08
			2	FLOW	281.
				TIME	13.58
ROUTED TO					
+	RCH3	4.06	1	FLOW	100.
				TIME	14.17
			2	FLOW	283.
				TIME	13.50
YDROGRAPH AT					
+	E5	.31	1	FLOW	32.
				TIME	12.58
			2	FLOW	32.
				TIME	12.58
2 COMBINED AT					
	CP4	4.37	1	FLOW	109.
				TIME	14.17
			2	FLOW	296.
				TIME	13.50
..OUTED TO					
+	SIERRA	4.37	1	FLOW	109.
				TIME	14.25
			2	FLOW	231.
				TIME	14.33
			** PEAK STAGES IN FEET **		
			1	STAGE	590.95
				TIME	14.25
			2	STAGE	598.27
				TIME	14.33

10-YR DAM1,EXIST FLOW

Proposed Damsite Hydrographs Evans Creek Block N





10-YR SIERRA FLOW
Sierra Street Hydrographs; Evans Creek Block N
Legend
Exist Flow
Dam Flow
250
200
150
100
50
0
INST-VAL (CFS)
2400
0600
1200
01May99
1800
2400
Time

25-YEAR, 24 HOUR

25-YEAR, 24 HOUR

2EVN25.OUT

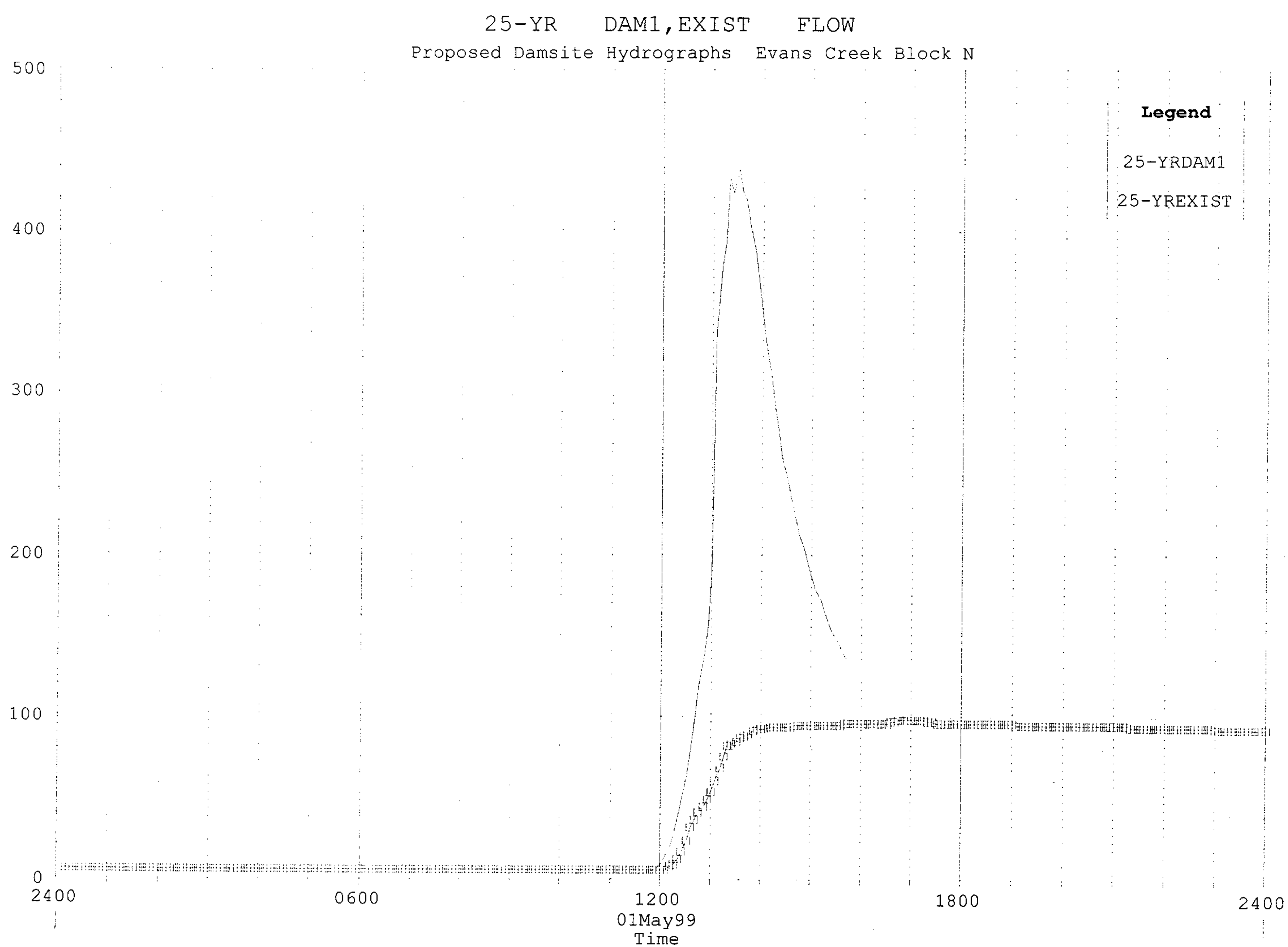
PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS

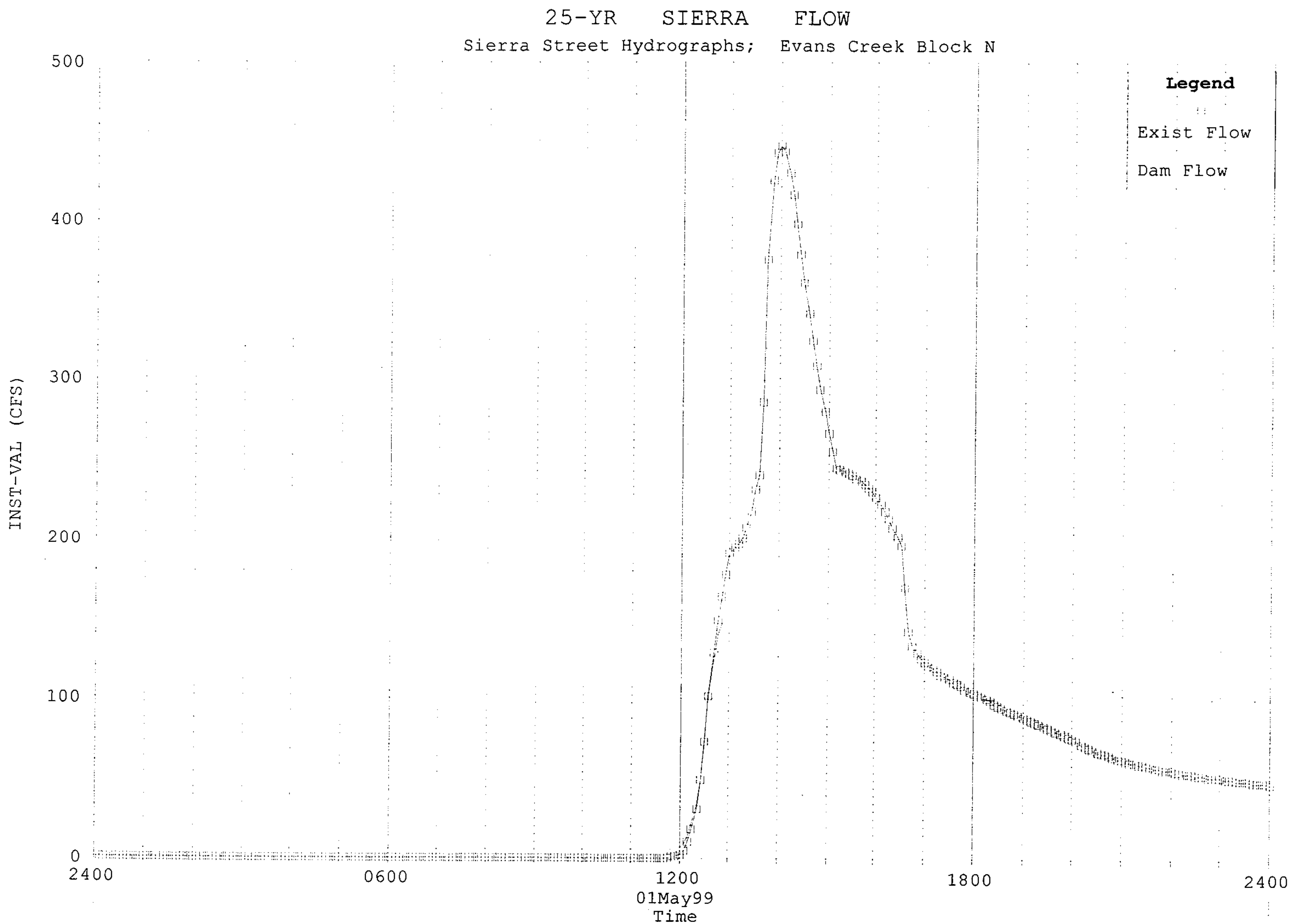
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES

TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION RATIO 1 .99
HYDROGRAPH AT					
+	E1	.77	1	FLOW	105.
				TIME	12.83
			2	FLOW	105.
				TIME	12.83
YDROGRAPH AT					
	E2	1.20	1	FLOW	129.
				TIME	13.08
			2	FLOW	129.
				TIME	13.08
2 COMBINED AT					
	CP1	1.97	1	FLOW	231.
				TIME	13.00
			2	FLOW	231.
				TIME	13.00
OUTED TO					
+	RCH1	1.97	1	FLOW	236.
				TIME	13.42
			2	FLOW	236.
				TIME	13.42
YDROGRAPH AT					
	E3	1.51	1	FLOW	204.
				TIME	13.33
			2	FLOW	204.
				TIME	13.33
2 COMBINED AT					
+	CP2	3.48	1	FLOW	439.
				TIME	13.42
			2	FLOW	439.
				TIME	13.42
)UTED TO					
	DAM1	3.48	1	FLOW	98.
				TIME	16.83
			2	FLOW	439.
				TIME	13.42
			** PEAK STAGES IN FEET **		
			1	STAGE	796.05
				TIME	16.83
			2	STAGE	.00
				TIME	.00
UTED TO					
+	RCH3	3.48	1	FLOW	98.
				TIME	17.17
			2	FLOW	440.
				TIME	13.58
DROGRAPH AT					

+	E4	.58	1	FLOW	93.
				TIME	12.58
			2	FLOW	93.
				TIME	12.58
2 COMBINED AT					
	CP3	4.06	1	FLOW	113.
				TIME	13.58
			2	FLOW	471.
				TIME	13.50
ROUTED TO					
+	RCH3	4.06	1	FLOW	114.
				TIME	13.75
			2	FLOW	480.
				TIME	13.67
HYDROGRAPH AT					
	E5	.31	1	FLOW	58.
				TIME	12.58
			2	FLOW	58.
				TIME	12.58
2 COMBINED AT					
	CP4	4.37	1	FLOW	150.
				TIME	12.67
			2	FLOW	496.
				TIME	13.67
ROUTED TO					
+	SIERRA	4.37	1	FLOW	147.
				TIME	12.75
			2	FLOW	448.
				TIME	13.92
			** PEAK STAGES IN FEET **		
			1	STAGE	592.32
				TIME	12.75
			2	STAGE	601.04
				TIME	13.92


25-YR DAM1,EXIST FLOW
Proposed Damsite Hydrographs Evans Creek Block N
500
400
300
200
100
0
2400
0600
1200
01May99
Time
1800
2400
Legend
25-YRDAM1
25-YREXIST



25-YR SIERRA FLOW
Sierra Street Hydrographs; Evans Creek Block N
Legend
Exist Flow
Dam Flow
INST-VAL (CFS)
500
400
300
200
100
0
2400
0600
1200
01May99
Time
1800
2400

50-YEAR, 24 HOUR

50-YEAR, 24 HOUR
2EVN50.OUT

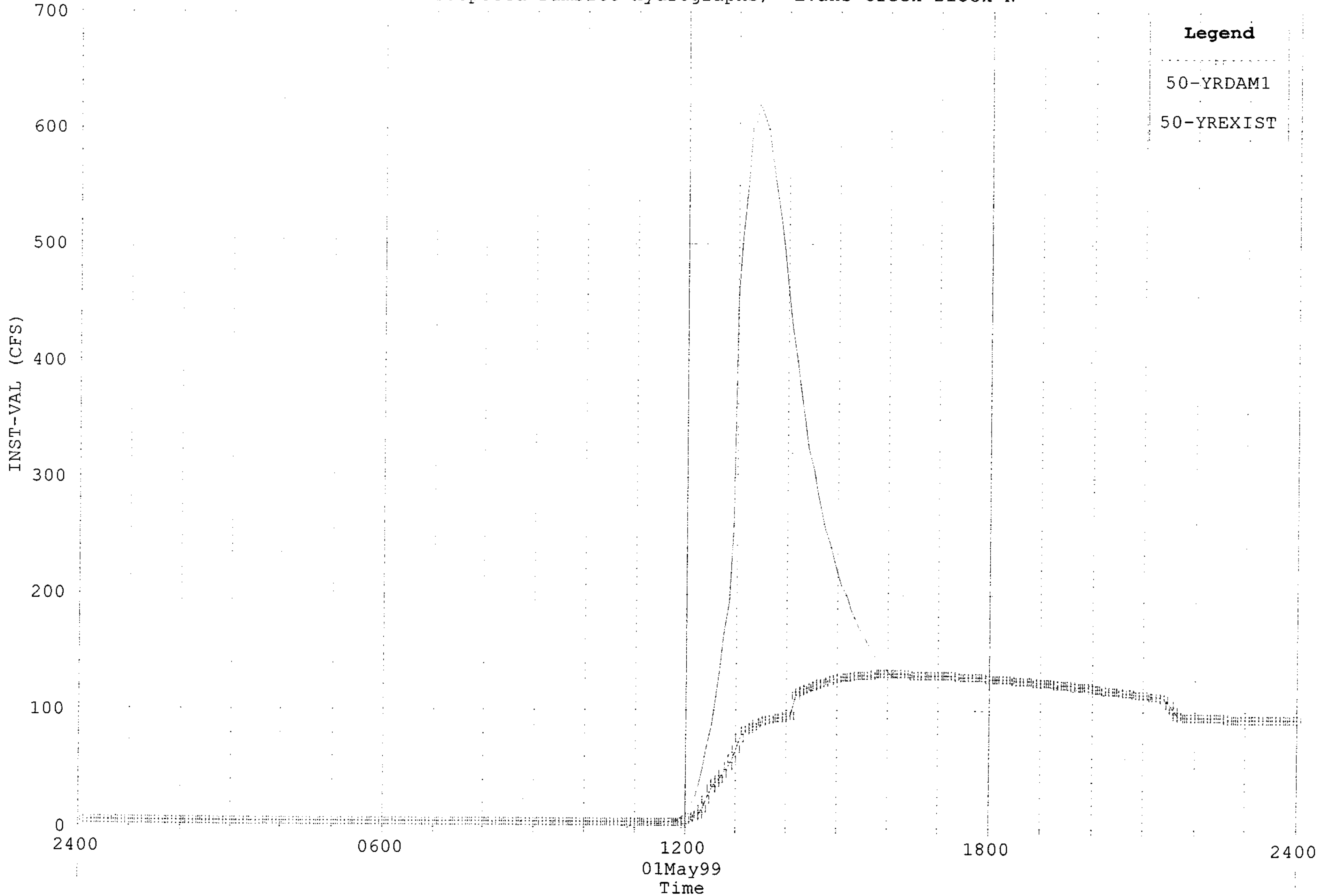
PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION RATIO 1 .99
HYDROGRAPH AT					
+	E1	.77	1	FLOW	154.
				TIME	12.83
			2	FLOW	154.
				TIME	12.83
IYDROGRAPH AT					
	E2	1.20	1	FLOW	190.
				TIME	13.08
			2	FLOW	190.
				TIME	13.08
2 COMBINED AT					
	CP1	1.97	1	FLOW	337.
				TIME	13.00
			2	FLOW	337.
				TIME	13.00
.OUTED TO					
+	RCH1	1.97	1	FLOW	342.
				TIME	13.33
			2	FLOW	342.
				TIME	13.33
'YDROGRAPH AT					
	E3	1.51	1	FLOW	280.
				TIME	13.33
			2	FLOW	280.
				TIME	13.33
2 COMBINED AT					
+	CP2	3.48	1	FLOW	622.
				TIME	13.33
			2	FLOW	622.
				TIME	13.33
OUTED TO					
	DAM1	3.48	1	FLOW	132.
				TIME	16.00
			2	FLOW	622.
				TIME	13.33
			** PEAK STAGES IN FEET **		
			1	STAGE	799.99
				TIME	16.00
			2	STAGE	.00
				TIME	.00
..OUTED TO					
+	RCH3	3.48	1	FLOW	132.
				TIME	16.25
			2	FLOW	633.
				TIME	13.42
YDROGRAPH AT					

+	E4	.58	1	FLOW	139.
				TIME	12.58
			2	FLOW	139.
				TIME	12.58
2 COMBINED AT					
	CP3	4.06	1	FLOW	152.
				TIME	12.83
			2	FLOW	679.
				TIME	13.42
kOUTED TO					
+	RCH3	4.06	1	FLOW	149.
				TIME	13.00
			2	FLOW	671.
				TIME	13.50
YDROGRAPH AT					
	E5	.31	1	FLOW	85.
				TIME	12.50
			2	FLOW	85.
				TIME	12.50
2 COMBINED AT					
	CP4	4.37	1	FLOW	222.
				TIME	12.67
			2	FLOW	693.
				TIME	13.50
OUTED TO					
+	SIERRA	4.37	1	FLOW	200.
				TIME	12.92
			2	FLOW	652.
				TIME	13.75
			** PEAK STAGES IN FEET **		
			1	STAGE	594.76
				TIME	12.92
			2	STAGE	602.08
				TIME	13.75

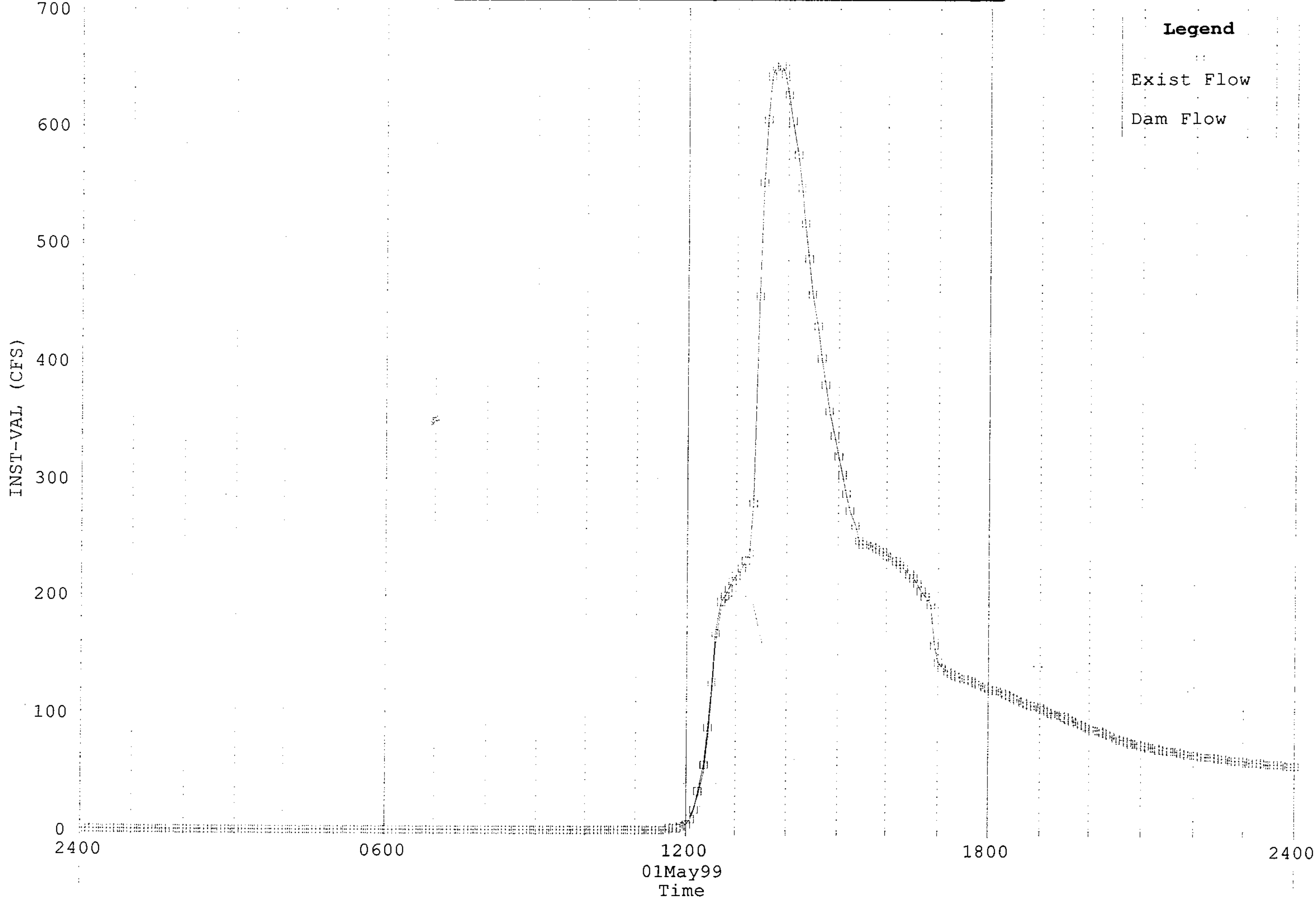
50-YR DAM1,EXIST FLOW

Proposed Damsite Hydrographs; Evans Creek Block N



50-YR SIERRA FLOW

Sierra Street Hydrographs; Evans Creek Block N



100-YEAR, 24 HOUR

100-YEAR, 24 HOUR

2EV100.OUT

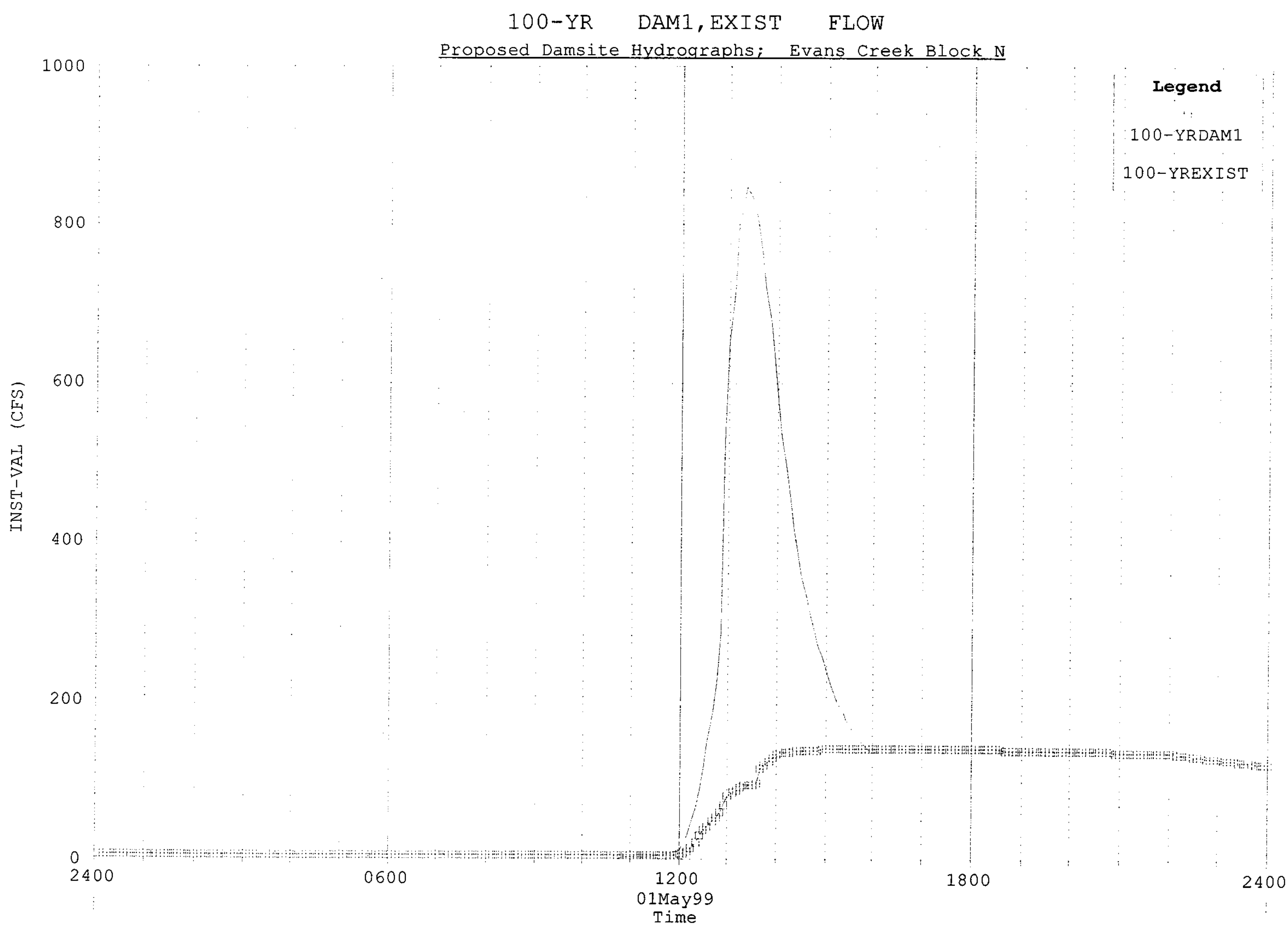
PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS

FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES

TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION RATIO 1 .99
HYDROGRAPH AT					
+	E1	.77	1	FLOW	215.
				TIME	12.83
			2	FLOW	215.
				TIME	12.83
HYDROGRAPH AT					
	E2	1.20	1	FLOW	264.
				TIME	13.08
			2	FLOW	264.
				TIME	13.08
2 COMBINED AT					
	CP1	1.97	1	FLOW	469.
				TIME	12.92
			2	FLOW	469.
				TIME	12.92
ROUTED TO					
+	RCH1	1.97	1	FLOW	475.
				TIME	13.25
			2	FLOW	475.
				TIME	13.25
HYDROGRAPH AT					
	E3	1.51	1	FLOW	372.
				TIME	13.33
			2	FLOW	372.
				TIME	13.33
2 COMBINED AT					
+	CP2	3.48	1	FLOW	847.
				TIME	13.25
			2	FLOW	847.
				TIME	13.25
ROUTED TO					
+	DAM1	3.48	1	FLOW	139.
				TIME	15.75
			2	FLOW	847.
				TIME	13.25
			** PEAK STAGES IN FEET **		
			1	STAGE	804.01
				TIME	15.83
			2	STAGE	.00
				TIME	.00
ROUTED TO					
+	RCH2	3.48	1	FLOW	139.
				TIME	16.00
			2	FLOW	857.
				TIME	13.33
HYDROGRAPH AT					

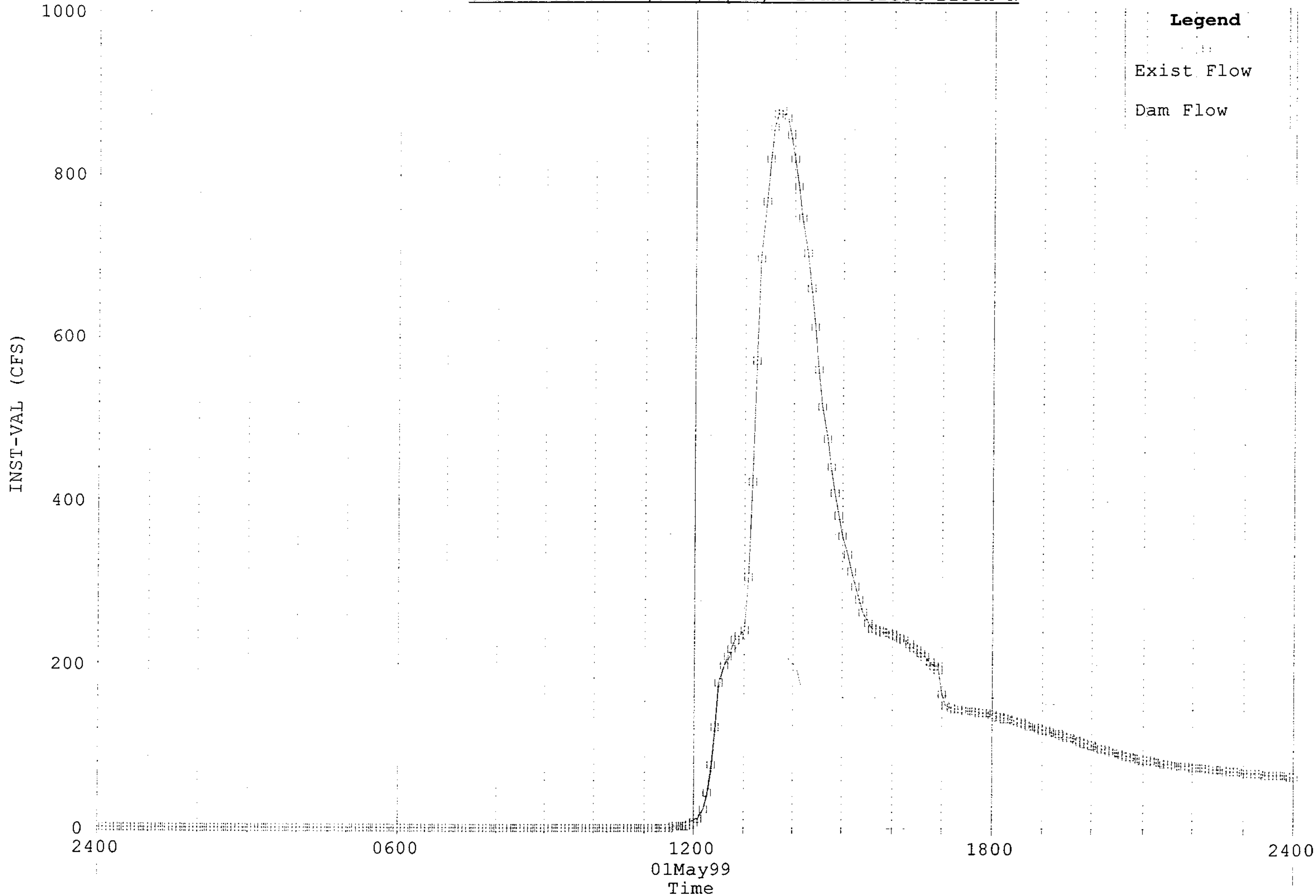
+	E4	.58	1	FLOW	196.
				TIME	12.58
			2	FLOW	196.
				TIME	12.58
2 COMBINED AT					
	CP3	4.06	1	FLOW	210.
				TIME	12.75
			2	FLOW	921.
				TIME	13.33
ROUTED TO					
+	RCH3	4.06	1	FLOW	207.
				TIME	12.92
			2	FLOW	915.
				TIME	13.42
HYDROGRAPH AT					
	E5	.31	1	FLOW	119.
				TIME	12.50
			2	FLOW	119.
				TIME	12.50
2 COMBINED AT					
	CP4	4.37	1	FLOW	310.
				TIME	12.67
			2	FLOW	941.
				TIME	13.42
ROUTED TO					
+	SIERRA	4.37	1	FLOW	231.
				TIME	13.08
			2	FLOW	880.
				TIME	13.67
			** PEAK STAGES IN FEET **		
			1	STAGE	598.20
				TIME	13.08
			2	STAGE	603.34
				TIME	13.67



100-YR DAM1,EXIST FLOW
Proposed Damsite Hydrographs; Evans Creek Block N
Legend
100-YRDAM1
100-YREXIST
INST-VAL (CFS)
1000
800
600
400
200
0
2400
0600
1200
01May99
Time
1800
2400

100-YR SIERRA FLOW

Sierra Street Hydrographs; Evans Creek Block N



500-YEAR, 24 HOUR

500-YEAR, 24 HOUR

2EV500.OUT

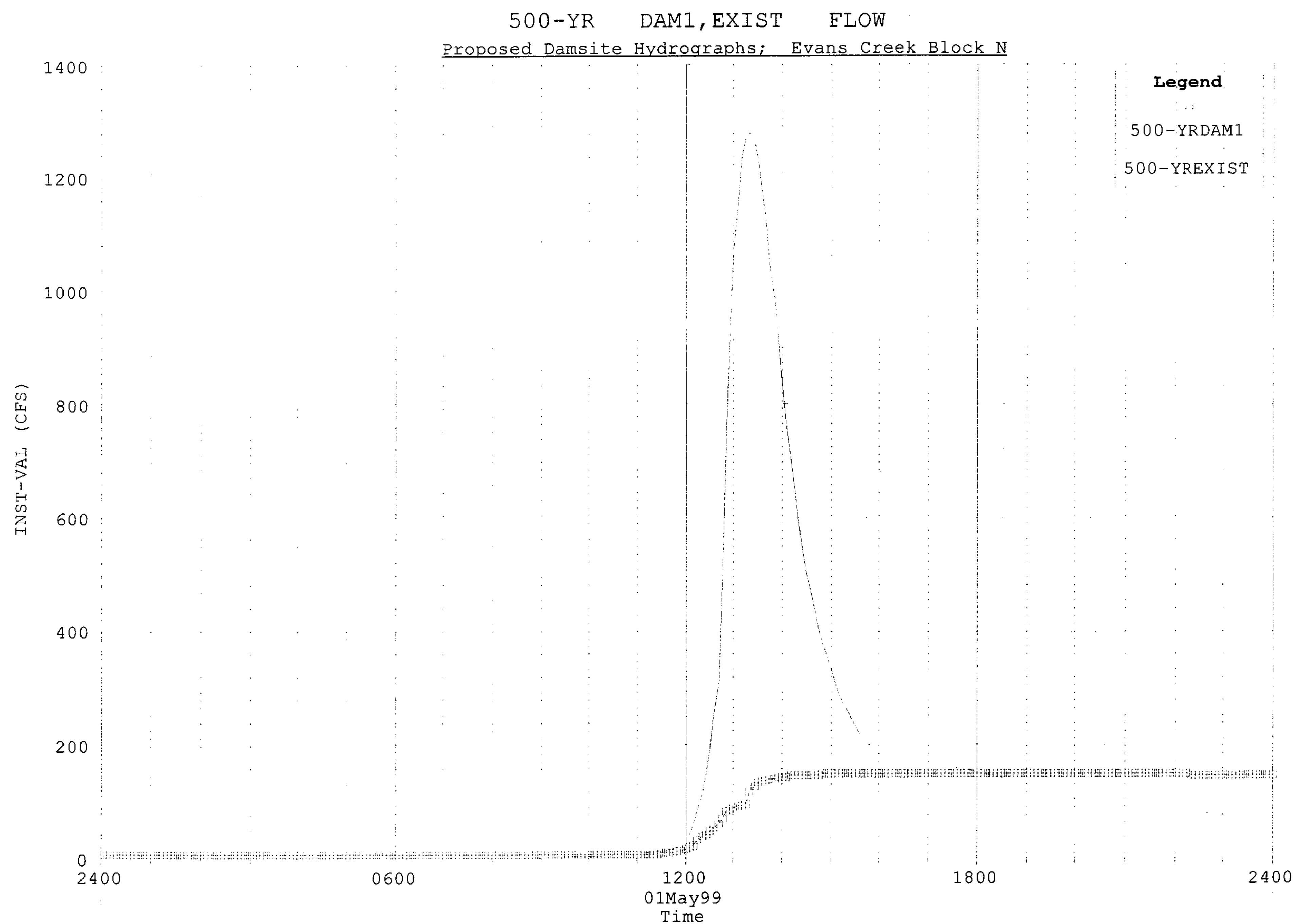
PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS

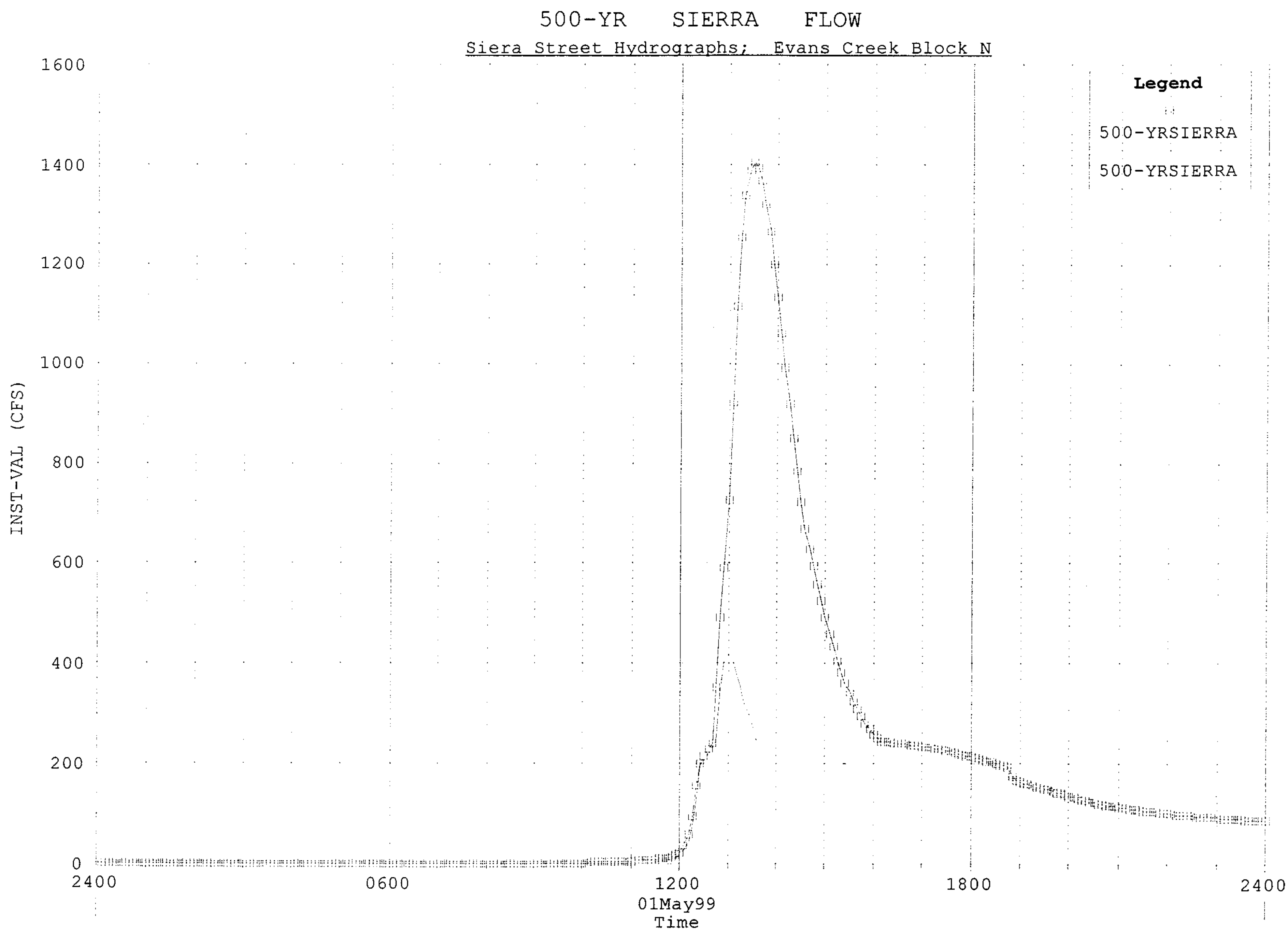
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES

TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION RATIO 1 .99
HYDROGRAPH AT					
	E1	.77	1	FLOW	334.
				TIME	12.83
			2	FLOW	334.
				TIME	12.83
YDROGRAPH AT					
	E2	1.20	1	FLOW	413.
				TIME	13.00
			2	FLOW	413.
				TIME	13.00
2 COMBINED AT					
	CP1	1.97	1	FLOW	732.
				TIME	12.92
			2	FLOW	732.
				TIME	12.92
OUTED TO					
	RCH1	1.97	1	FLOW	731.
				TIME	13.25
			2	FLOW	731.
				TIME	13.25
YDROGRAPH AT					
	E3	1.51	1	FLOW	546.
				TIME	13.25
			2	FLOW	546.
				TIME	13.25
2 COMBINED AT					
	CP2	3.48	1	FLOW	1278.
				TIME	13.25
			2	FLOW	1278.
				TIME	13.25
OUTED TO					
	DAM1	3.48	1	FLOW	151.
				TIME	17.92
			2	FLOW	1278.
				TIME	13.25
			** PEAK STAGES IN FEET **		
			1	STAGE	813.13
				TIME	18.00
			2	STAGE	.00
				TIME	.00
OUTED TO					
	RCH3	3.48	1	FLOW	151.
				TIME	18.17
			2	FLOW	1281.
				TIME	13.33
DROGRAPH AT					

```
 +                   E4       .58     1   FLOW        304.
                                          TIME        12.58
                                      2   FLOW        304.
                                          TIME        12.58

  2 COMBINED AT
                    CP3      4.06     1   FLOW        340.
                                          TIME        12.67
                                      2   FLOW       1375.
                                          TIME        13.33

 ROUTED TO
 +                 RCH3      4.06     1   FLOW        340.
                                          TIME        12.75
                                      2   FLOW       1371.
                                          TIME        13.33

  IYDROGRAPH AT
                     E5       .31     1   FLOW        183.
                                          TIME        12.50
                                      2   FLOW        183.
                                          TIME        12.50

  2 COMBINED AT
                    CP4      4.37     1   FLOW        500.
                                          TIME        12.67
                                      2   FLOW       1415.
                                          TIME        13.33

  ROUTED TO
 +               SIERRA      4.37     1   FLOW        418.
                                          TIME        12.92
                                      2   FLOW       1409.
                                          TIME        13.42

                                      ** PEAK STAGES IN FEET **
                                      1   STAGE      600.88
                                          TIME        12.92
                                      2   STAGE      603.09
                                          TIME        13.42
```


500-YR DAM1,EXIST FLOW
Proposed Damsite Hydrographs; Evans Creek Block N
Legend
500-YRDAM1
500-YREXIST
INST-VAL (CFS)
1400
1200
1000
800
600
400
200
0
2400
0600
1200
01May99
1800
2400
Time


500-YR SIERRA FLOW
Siera Street Hydrographs; Evans Creek Block N
Legend
500-YRSIERRA
500-YRSIERRA
INST-VAL (CFS)
1600
1400
1200
1000
800
600
400
200
0
2400
0600
1200
01May99
1800
2400
Time

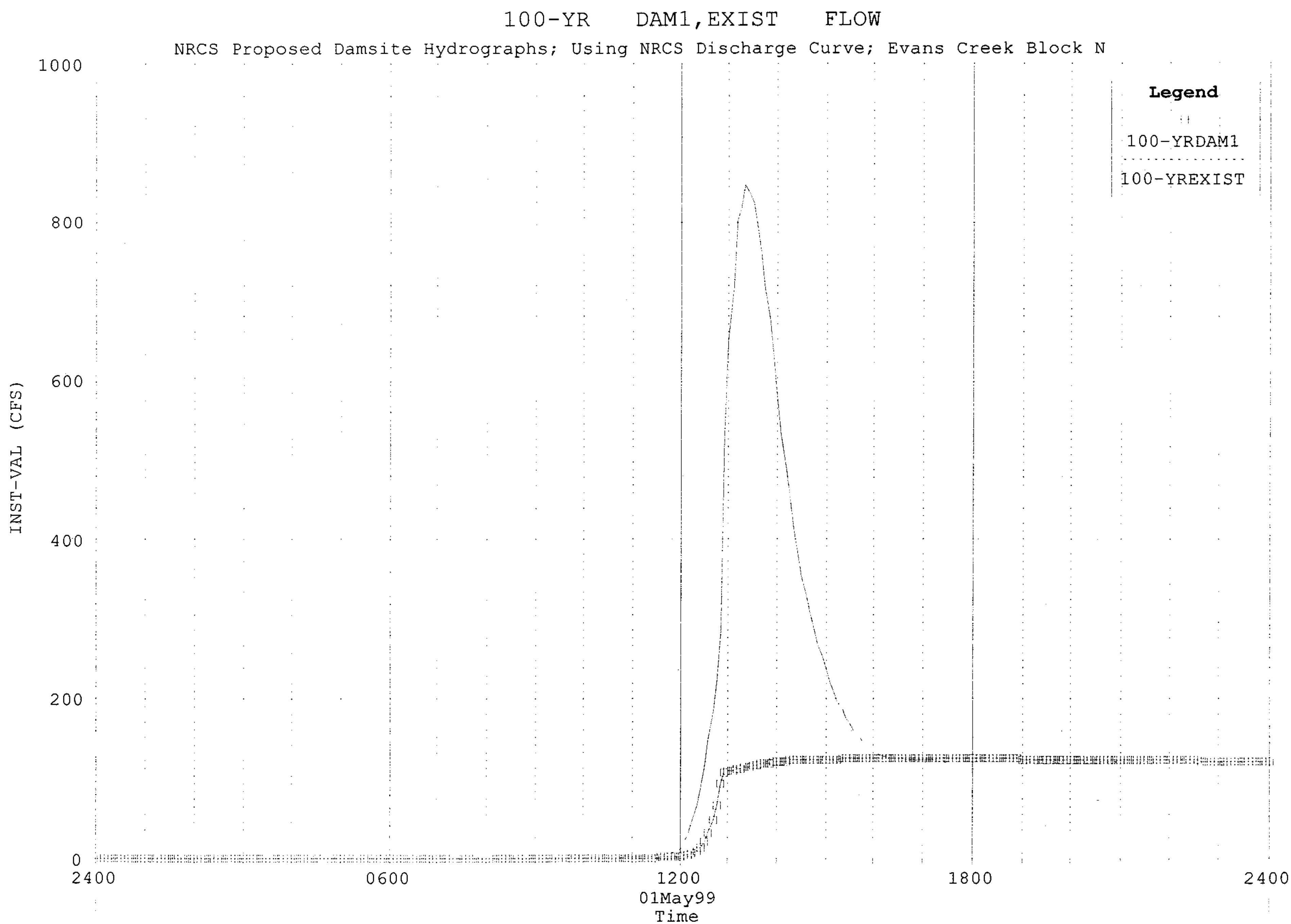
100-YEAR, 24 HOUR WITH NRCS DISCHARGE CURVE AT PROPOSED DAM

100-YEAR, 24 HOUR
NRCS DISCHARGE CURVE RUN
2SC100.OUT

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

PERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION RATIO 1 .99
YDROGRAPH AT					
	E1	.77	1	FLOW	215.
				TIME	12.83
			2	FLOW	215.
				TIME	12.83
HYDROGRAPH AT					
	E2	1.20	1	FLOW	264.
				TIME	13.08
			2	FLOW	264.
				TIME	13.08
2 COMBINED AT					
+	CP1	1.97	1	FLOW	469.
				TIME	12.92
			2	FLOW	469.
				TIME	12.92
OUTED TO					
	RCH1	1.97	1	FLOW	475.
				TIME	13.25
			2	FLOW	475.
				TIME	13.25
HYDROGRAPH AT					
+	E3	1.51	1	FLOW	372.
				TIME	13.33
			2	FLOW	372.
				TIME	13.33
2 COMBINED AT					
	CP2	3.48	1	FLOW	847.
				TIME	13.25
			2	FLOW	847.
				TIME	13.25
ROUTED TO					
	DAM1	3.48	1	FLOW	124.
				TIME	16.42
			2	FLOW	847.
				TIME	13.25
			** PEAK STAGES IN FEET **		
			1	STAGE	812.24
				TIME	16.42
			2	STAGE	.00
				TIME	.00
OUTED TO					
	RCH2	3.48	1	FLOW	124.
				TIME	16.67
			2	FLOW	857.
				TIME	13.33

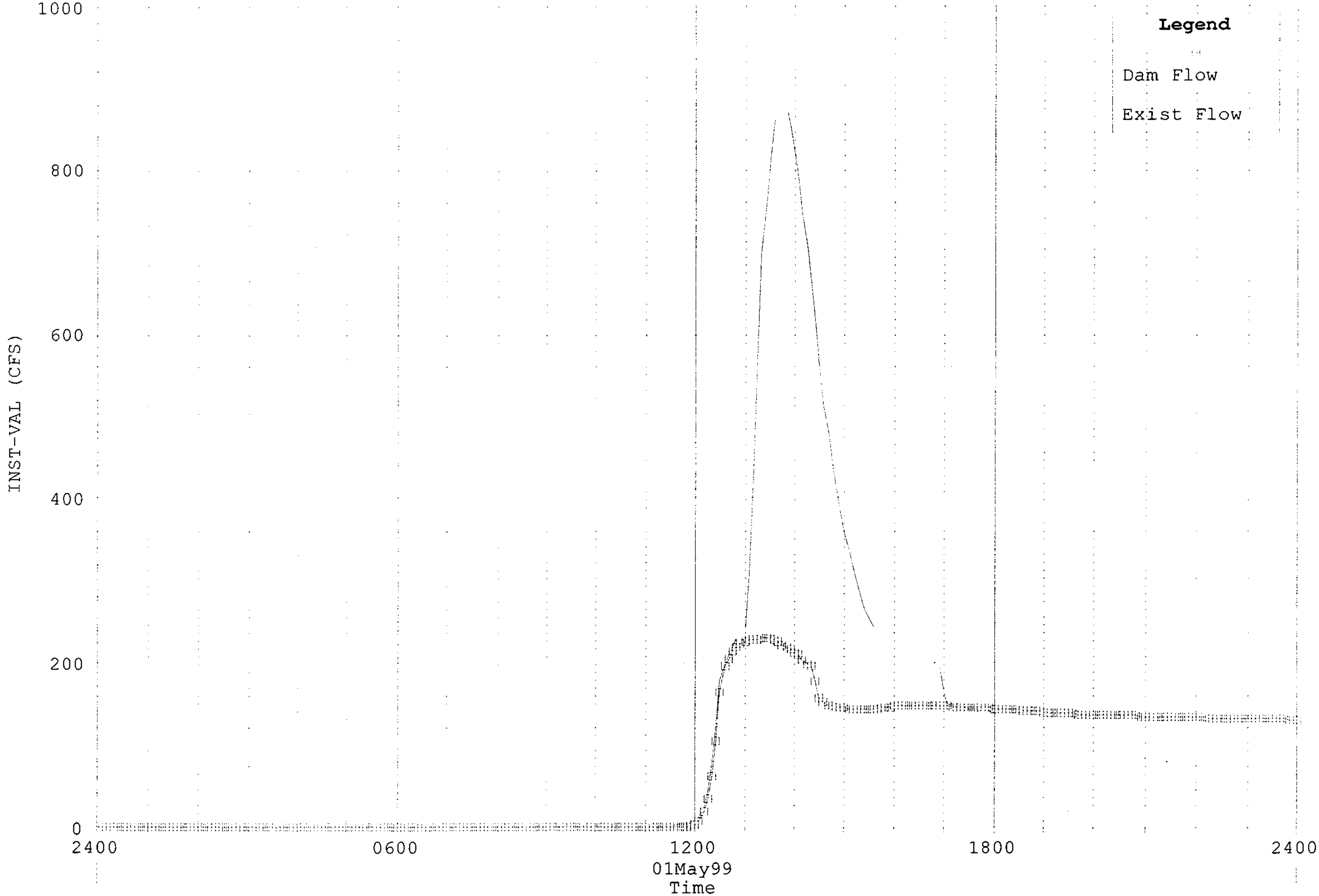
HYDROGRAPH AT					
	E4	.58	1	FLOW	196.
				TIME	12.58
			2	FLOW	196.
				TIME	12.58
2 COMBINED AT					
+	CP3	4.06	1	FLOW	206.
				TIME	13.08
			2	FLOW	921.
				TIME	13.33
ROUTED TO					
	RCH3	4.06	1	FLOW	205.
				TIME	13.25
			2	FLOW	915.
				TIME	13.42
HYDROGRAPH AT					
	E5	.31	1	FLOW	119.
				TIME	12.50
			2	FLOW	119.
				TIME	12.50
2 COMBINED AT					
+	CP4	4.37	1	FLOW	307.
				TIME	12.67
			2	FLOW	941.
				TIME	13.42
ROUTED TO					
	SIERRA	4.37	1	FLOW	229.
				TIME	13.33
			2	FLOW	880.
				TIME	13.67
			** PEAK STAGES IN FEET **		
			1	STAGE	598.06
				TIME	13.33
			2	STAGE	603.34
				TIME	13.67



100-YR DAM1,EXIST FLOW
NRCS Proposed Damsite Hydrographs; Using NRCS Discharge Curve; Evans Creek Block N
Legend
100-YRDAM1
100-YREXIST
INST-VAL (CFS)
1000
800
600
400
200
0
2400
0600
1200
1800
2400
01May99
Time

100-YR SIERRA FLOW

Sierra Street Hydrographs; With NRCS Discharge Curve; Evans Creek Block N



1986-REGRESSION, 24 HOUR

1986 SIMULATION

24-HOUR REGRESSION RUN

2REGPH.OUT

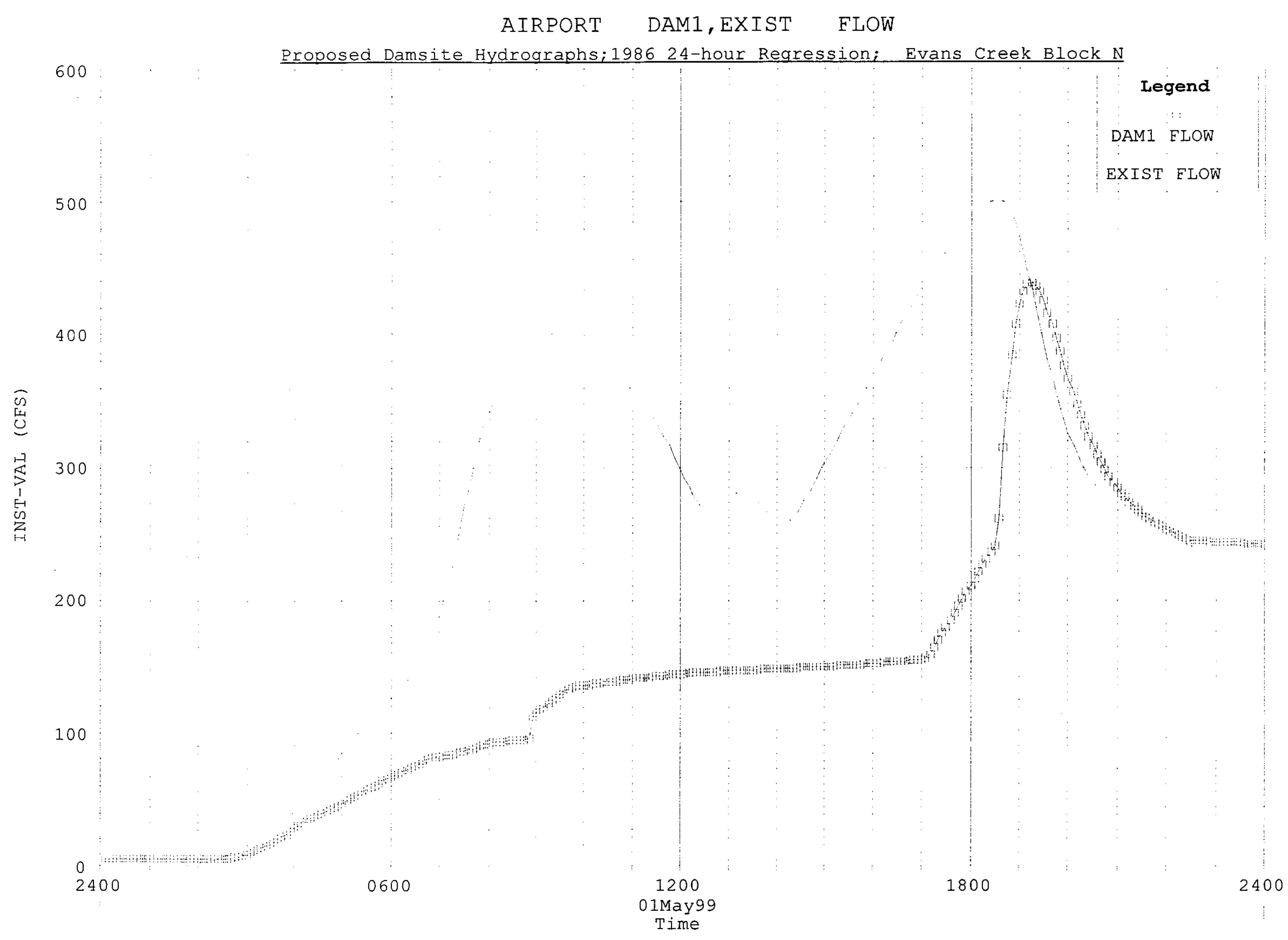
PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS

FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES

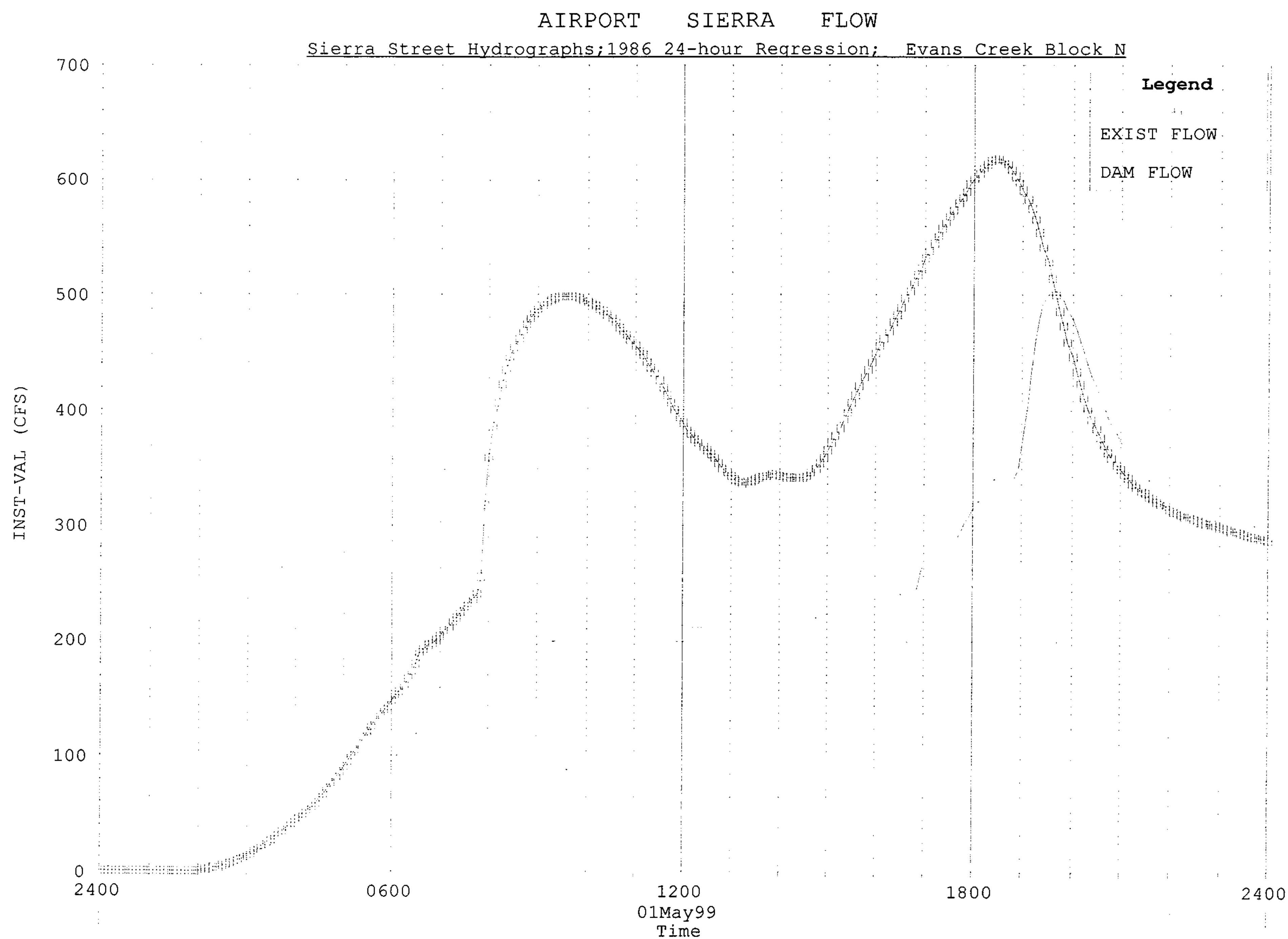
TIME TO PEAK IN HOURS

PERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION RATIO 1 .99
HYDROGRAPH AT					
	E1	.77	1	FLOW	111.
				TIME	18.08
			2	FLOW	111.
				TIME	18.08
YDROGRAPH AT					
	E2	1.20	1	FLOW	172.
				TIME	18.17
			2	FLOW	172.
				TIME	18.17
2 COMBINED AT					
	CP1	1.97	1	FLOW	283.
				TIME	18.17
			2	FLOW	283.
				TIME	18.17
ROUTED TO					
	RCH1	1.97	1	FLOW	283.
				TIME	18.58
			2	FLOW	283.
				TIME	18.58
YDROGRAPH AT					
	E3	1.51	1	FLOW	220.
				TIME	18.33
			2	FLOW	220.
				TIME	18.33
2 COMBINED AT					
	CP2	3.48	1	FLOW	502.
				TIME	18.42
			2	FLOW	502.
				TIME	18.42
..OUTED TO					
	DAM1	3.48	1	FLOW	438.
				TIME	19.17
			2	FLOW	502.
				TIME	18.42
			** PEAK STAGES IN FEET **		
			1	STAGE	820.87
				TIME	19.17
			2	STAGE	.00
				TIME	.00
ROUTED TO					
	RCH3	3.48	1	FLOW	439.
				TIME	19.33
			2	FLOW	502.
				TIME	18.58

HYDROGRAPH AT					
+	E4	.58	1	FLOW	88.
				TIME	18.00
			2	FLOW	88.
				TIME	18.00
2 COMBINED AT					
	CP3	4.06	1	FLOW	486.
				TIME	19.33
			2	FLOW	577.
				TIME	18.25
ROUTED TO					
	RCH3	4.06	1	FLOW	485.
				TIME	19.33
			2	FLOW	577.
				TIME	18.33
HYDROGRAPH AT					
+	E5	.31	1	FLOW	48.
				TIME	18.00
			2	FLOW	48.
				TIME	18.00
2 COMBINED AT					
	CP4	4.37	1	FLOW	509.
				TIME	19.33
			2	FLOW	621.
				TIME	18.25
ROUTED TO					
	SIERRA	4.37	1	FLOW	504.
				TIME	19.58
			2	FLOW	619.
				TIME	18.33
			** PEAK STAGES IN FEET **		
			1	STAGE	601.32
				TIME	19.58
			2	STAGE	601.91
				TIME	18.33



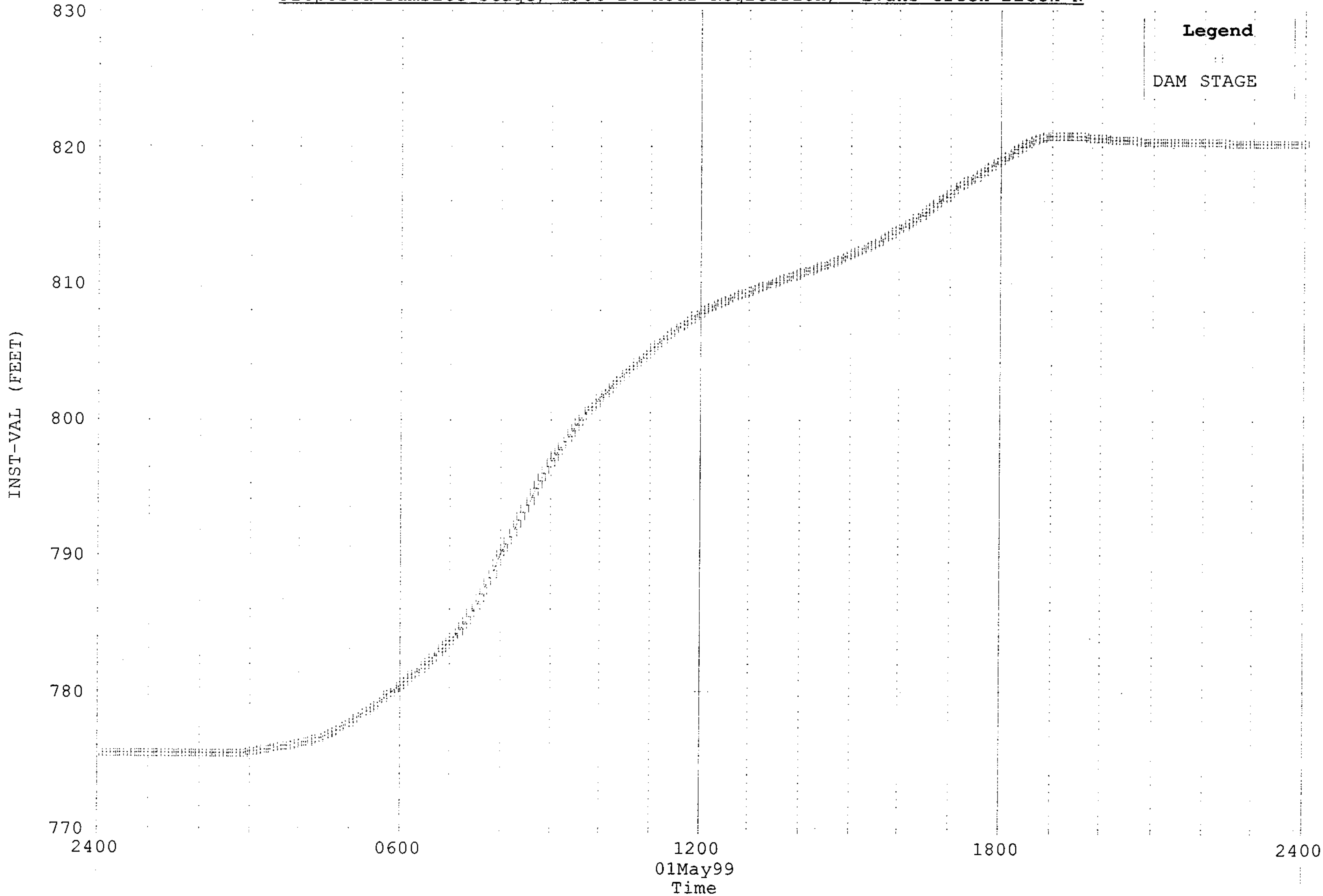
AIRPORT DAM1,EXIST FLOW
Proposed Damsite Hydrographs;1986 24-hour Regression; Evans Creek Block N
Legend
DAM1 FLOW
EXIST FLOW
INST-VAL (CFS)
600
500
400
300
200
100
0
2400
0600
1200
1800
2400
01May99
Time



AIRPORT SIERRA FLOW
Sierra Street Hydrographs;1986 24-hour Regression; Evans Creek Block N
Legend
EXIST FLOW
DAM FLOW
INST-VAL (CFS)
700
600
500
400
300
200
100
0
2400
0600
1200
01May99
Time
1800
2400

AIRPORT DAM1 STAGE

Proposed Damsite Stage; 1986 24-hour Regression; Evans Creek Block N



1986-AIRPORT DATA, 4-DAY

1

1986 SIMULATION - 4 DAY RUN

2PIAIR.OUT

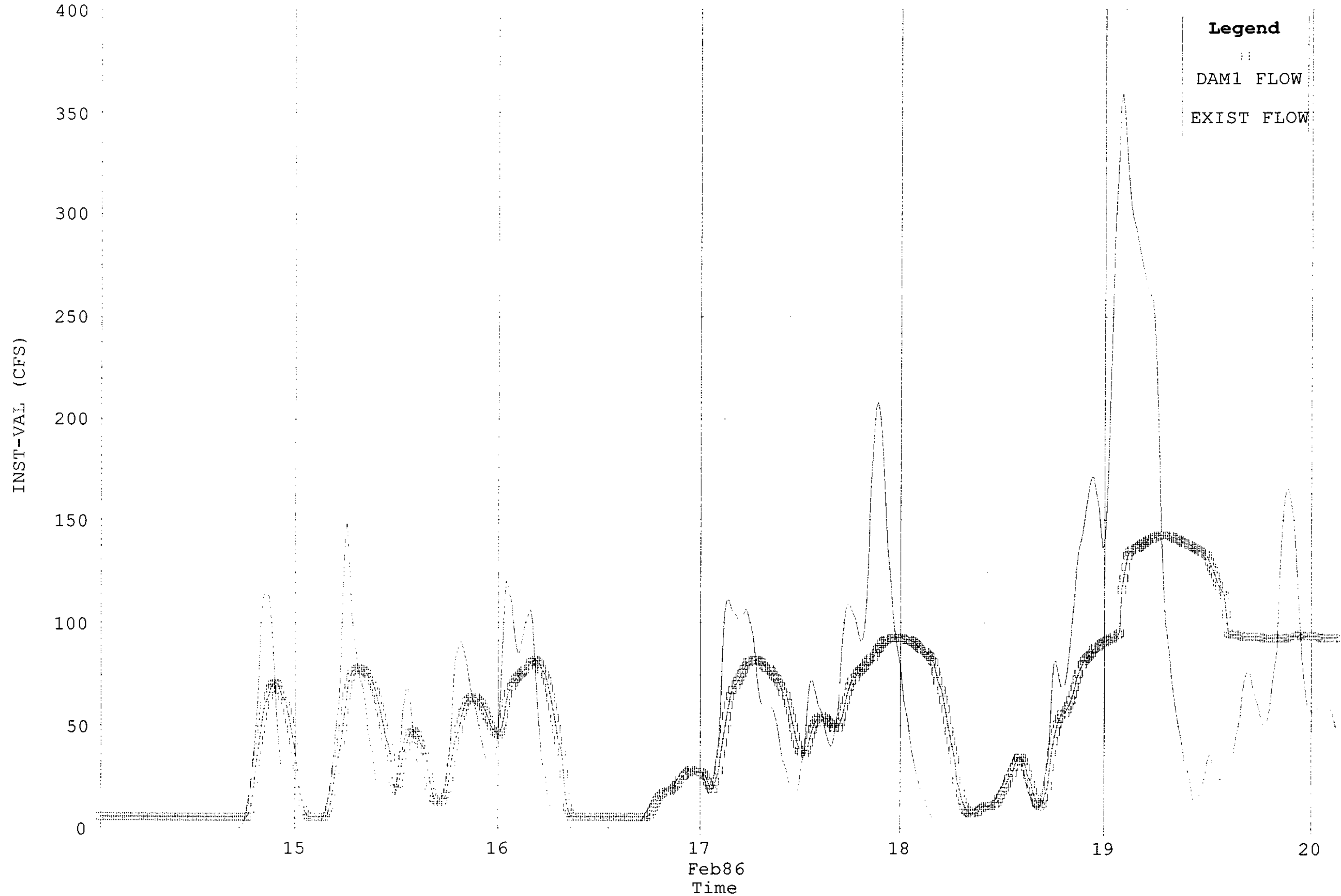
PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

OPERATION	STATION	AREA	PLAN		RATIOS APPLIED TO PRECIPITATION RATIO 1 0.99
HYDROGRAPH AT					
+	E1	0.77	1	FLOW	83.
				TIME	120.50
			2	FLOW	83.
				TIME	120.50
IYDROGRAPH AT					
	E2	1.20	1	FLOW	124.
				TIME	120.75
			2	FLOW	124.
				TIME	120.75
2 COMBINED AT					
	CP1	1.97	1	FLOW	206.
				TIME	120.50
			2	FLOW	206.
				TIME	120.50
:OUTED TO					
+	RCH1	1.97	1	FLOW	207.
				TIME	121.00
			2	FLOW	207.
				TIME	121.00
'IYDROGRAPH AT					
	E3	1.51	1	FLOW	152.
				TIME	121.00
			2	FLOW	152.
				TIME	121.00
2 COMBINED AT					
+	CP2	3.48	1	FLOW	359.
				TIME	121.00
			2	FLOW	359.
				TIME	121.00
.OUTED TO					
	DAM1	3.48	1	FLOW	143.
				TIME	125.75
			2	FLOW	359.
				TIME	121.00
			** PEAK STAGES IN FEET **		
			1	STAGE	807.25
				TIME	125.75
			2	STAGE	0.00
				TIME	0.00
.OUTED TO					
+	RCH3	3.48	1	FLOW	143.
				TIME	126.00
			2	FLOW	357.
				TIME	121.25
YDROGRAPH AT					

+	E4	0.58	1	FLOW	68.
				TIME	120.25
			2	FLOW	68.
				TIME	120.25
2 COMBINED AT					
	CP3	4.06	1	FLOW	183.
				TIME	124.00
			2	FLOW	408.
				TIME	121.00
ROUTED TO					
+	RCH3	4.06	1	FLOW	183.
				TIME	124.00
			2	FLOW	408.
				TIME	121.25
HYDROGRAPH AT					
	E5	0.31	1	FLOW	37.
				TIME	120.25
			2	FLOW	37.
				TIME	120.25
2 COMBINED AT					
	CP4	4.37	1	FLOW	206.
				TIME	122.25
			2	FLOW	435.
				TIME	121.25
ROUTED TO					
+	SIERRA	4.37	1	FLOW	206.
				TIME	122.50
			2	FLOW	431.
				TIME	121.25
			** PEAK STAGES IN FEET **		
			1	STAGE	595.78
				TIME	122.50
			2	STAGE	600.95
				TIME	121.25

1986 DAM1,EXIST FLOW

Proposed Damsite Hydrographs; Evans Creek Block N; Airport Gage Data with AMC-III CN's



1986 SIERRA FLOW

Sierra Street Hydrographs; Evans Creek Block N; Airport Gage Data with AMC-III CN's