Bulletin 69-95
October 2003

State of California
The Resources Agency
Department of Water Resources

California High Water

Gray Davis
Governor
State of California

Mary D. Nichols
Secretary for Resources
The Resources Agency

Michael J. Spear
Interim Director
Department of Water Resources

COVER PHOTO:
Western Placer County's
Dry Creek produced
record flooding in
portions of the City of
Roseville.

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Foreword

Bulletin 69-95 is the twentieth in a series documenting high water and flood events. The bulletin focuses on meteorological and hydrological accounts of the January and March 1995 floods and other flood-related events during the 1994/95 water year. It also includes a summary of the Department of Water Resources' coordinated flood emergency response as directed from the State-Federal Flood Operations Center and in the field.

Severe storms over Northern and Central California resulted in widespread flooding over many of Northern and Central California's hydrologic basins, while isolated incidents occurred in Southern California south of the Tehachapi Mountains.

Forecasters were able to predict the magnitude of many of the resulting flood flows during the January and March storms, providing lead time and accurate public warnings and information necessary to minimize loss of life, property damage, and environmental degradation.

These floods affected thousands of people. Damages totaled about $120 million for the January 1995 event and about $100 million for the March 1995 event. State and federal disaster areas were declared in 42 counties in January and 57 counties in March. The January flood claimed 11 lives, and the March flood claimed 17 lives.

The State's losses would have been significantly higher without the cooperation and contributions made by many public and private employees and private citizens during these significant weather and flood events. Employees of numerous State, federal, and local government agencies, including several hundred from the Department of Water Resources, were involved in the flood fight, evacuation, and rescue efforts. Workers from the Salvation Army, Red Cross, and other humanitarian aid organizations provided direct assistance to victims in both flood events.

Michael J. Spear, Interim Director
Department of Water Resources
The Resources Agency

If you need this publication in an alternate form, contact the Department's Division of Flood Management or the Office of Water Education at 1-800-272-8869.

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The California Water Commission serves as a policy advisory body to the Director of the Department of Water Resources on all California water resources issues. The citizen commission provides a water resources forum for the people of the State, acts as a liaison between the legislative and executive branches of State government, and coordinates federal, State, and local water resources efforts.

The Division of Flood Management would like to acknowledge the contributions of the 1995 California Water Commission during the floods of water year 1994/1995. The following people were members of the 1995 California Water Commission.

JANUARY 1995 WATER COMMISSION

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Introduction

Introduction

The State's precipitation varies significantly. California's mountain ranges influence the weather by lifting clouds and moisture. This increases precipitation on west-facing mountain slopes compared with the drier valley floor. Average annual precipitation on the North Coast mountains can be more than 100 inches while some areas in the southeastern part of the State receive less than 3 inches annually. Consequently, flooding in Northern California occurs more frequently.

The Sacramento Valley is especially vulnerable to flooding. In the mid-1800s, prior to the construction of the levees, the smallest floods would result in widespread inundation. The January 1847 flood is the earliest recorded flood in the San Joaquin Valley. Between 1850 and 1900, many floods occurred in the Sacramento and San Joaquin River basins. Among them are the December 1861 and January 1862 floods, which created a sea in the lower Sacramento River region and resulted in the City of Sacramento raising downtown and its levees. Other major flood events occurred in 1867, 1868, 1881, 1889, and 1890. Significant flood events in the 1900s occurred in 1904, 1907, 1909, 1911, 1928, 1939, 1950, 1955, 1964, 1969, 1970, 1983, 1986, and 1995. The events in the early 1900s gave rise to flood control measures in the Sacramento and San Joaquin River systems. Folsom, Oroville, and Shasta dams further reduced the threat of flooding in the Sacramento River Basin.

California spans 159,000 square miles with a population of 32 million people. The northern part of the State receives about 75 percent of the precipitation, but more than two-thirds of the population live in the southern half of the State.

The Sacramento River system generates 32 percent of the State's annual runoff and is the major contributor to California's water supply. Estimated average annual precipitation in California is about 193 million acre-feet of which 122 million acre-feet is lost to evaporation and transpiration, leaving the remaining 71 million acre-feet as average annual runoff. Runoff ranges from 35 million acre-feet in drought years (1987–1992) to more than 130 million acre-feet (1995 runoff).

Overflow at Colusa Weir on March 11, 1995. The Colusa Basin is the flooded area in the background.

Table 1. Summary of Hydrology in Water Years 1987-1994

Water Year	Statewide Precipitation (%)	April 1 Snowpack Water Content (%)	Water Year Runoff (%)	Sacramento River Unimpaired Runoff (maf)	September 30 Statewide Storage (maf)
1987	61	55	48	9.2	18.9
1988	80	30	48	9.2	14.8
1989	86	75	72	14.8	16.7
1990	69	40	45	9.2	13.6
1991	76	75	43	8.4	13.8
1992	85	60	43	8.9	12.7
1993	140	150	125	22.2	24.0
1994	65	50	40	7.8	15.9

maf = million acre-feet

After the 1986 floods California had six years of drought. The drought ended with heavy precipitation in the winter of 1993. The following is a summary of each water year between 1986 and 1995 (Table 1).

- ❶■ **Water Year 1987: October 1986 through September 1987**
  This was the first year of the six-year drought. The eastern slope of the Sierra was the driest portion of the State while the southeastern desert and far North Coast regions were the wettest on a percent-of-average basis. No region, however, received average amounts of precipitation. Year-end statewide totals were 61 percent of average precipitation, 48 percent of average runoff, and 80 percent of average reservoir storage.

- ❶■ **Water Year 1988: October 1987 through September 1988**
  This was the second year of below-average rainfall and snow water content. After a dry start December had significantly above-average precipitation in Northern California and would remain the wettest month of the water year. Although below average, January amounts were sufficient to relieve drought concerns, but February and March were dry with runoff less than 50 percent of average. The San Francisco Bay and Central Coast hydrologic regions were particularly dry with runoff at about 30 percent of average. Year-end statewide totals were slightly above 80 percent of average precipitation, 48 percent of average runoff, and about 67 percent of average reservoir storage.

- ■ **Water Year 1989: October 1988 through September 1989**
  Water year 1989 was wetter than the preceding two years but still considerably below average. Three northern hydrologic regions—North Coast, Sacramento River, and San Francisco Bay—received average rainfall, but the Central and South Coast regions received about 65 percent of average. By late summer more than 10 million Californians were practicing water conservation, and by August five counties had declared drought emergencies. Year-end statewide totals were 86 percent of average precipitation, 72 percent of average runoff, and 74 percent of average reservoir storage.

- ■ **Water Year 1990: October 1989 through September 1990**
  The fourth year of drought had numerous negative impacts to the State, and the federal Central Valley Project and the State Water Project reduced water deliveries for only the second time in their histories. Snow water

Looking south toward downtown Sacramento with Discovery Park and the American River in the foreground. The Sacramento River is on the top right.

content peaked on March 1, a month earlier than normal. All regions had below-average snowpack throughout the year and conditions similar to those of the drought year of 1976 until May, which was a wet month. In comparison, statewide snow water content on May 1, 1976, was 35 percent of average; but on May 1, 1990, it was just 10 percent of normal. Year-end statewide totals were 69 percent of average precipitation, about 45 percent of average runoff, and 60 percent of average reservoir storage.

- **Water Year 1991: October 1990 through September 1991**
  The fifth year of drought continued generally dry until the "miracle" month of March, when statewide precipitation was nearly three times the average. More than 18 inches of rain raised the seasonal total from about 35 to 75 percent of average. Totals were highest in the southern half of the State and somewhat less than the overall average in the Northern California watersheds that generate a majority of the State's runoff. The statewide snow water content increased from about 15 to 75 percent of average during March. Year-end statewide totals were 76 percent of average precipitation, 43 percent of average runoff, and 56 percent of average for reservoir storage. The Sacramento River Index for the year was 8.4 million acre-feet, a "critically dry" year when compared to the 18.1 million acre-feet average.

- **Water Year 1992: October 1991 through September 1992**
  In this sixth consecutive drought year, snow water content reached 70 percent of average on March 1 but declined to 60 percent of average by April 1. The South Coast was the only hydrologic region with above-average runoff, the result of heavy rains in February and March. Year-end statewide totals were about 85 percent of average precipitation, 43 percent of average runoff, and 56 percent of average reservoir storage. The Sacramento River Index was 8.9 million acre-feet for the year, the third critically dry year in succession.

- **Water Year 1993: October 1992 through September 1993**
  Water year 1993 broke the six-year drought—the third and most severe drought of the century in Northern California. (The century's longest drought occurred from 1928 to 1935.) By April 1 statewide snow water content averaged about 150 percent of normal, with the San Joaquin River Hydrologic Region the highest at 165 percent of average and the North Coast Hydrologic Region the lowest at 110 percent. Year-end statewide totals were about 140 percent of average precipitation, 125 percent of average runoff, and about 110 percent of average reservoir storage. Lake Tahoe, Lake Berryessa, and New Melones Reservoir were the only large lakes that did not fully recover. The Sacramento River Index rose to 22.2 million acre-feet, soundly breaking the three-year period of critically dry years.

- **Water Year 1994: October 1993 through September 1994**
  California's water situation took a turn for the worse, and there were fears that the drought might resume. March was one of the driest on record in Northern California, and as of April 1 statewide seasonal runoff stood at about 40 percent of average compared to 110 percent in 1993. Snow water content stood at 50 percent of average compared to 150 percent in 1993. Year-end statewide totals were 65 percent of average precipitation, 40 percent of average runoff, and 73 percent of average reservoir storage.

Widespread flooding over much of California's hydrologic basins occurred during the January and March storms of 1995. These floods affected thousands of people and resulted in significant property damage, environmental degradation, and loss of life. Damages for the January 1995 event totaled about $120 million and for the March 1995, about $101 million. Forty-two counties in January and fifty-seven counties in March were declared State and federal disaster areas (figures 1 and 2).

Figure 1. Counties Declared by Federal Government as Flood Disaster Areas, January 1995

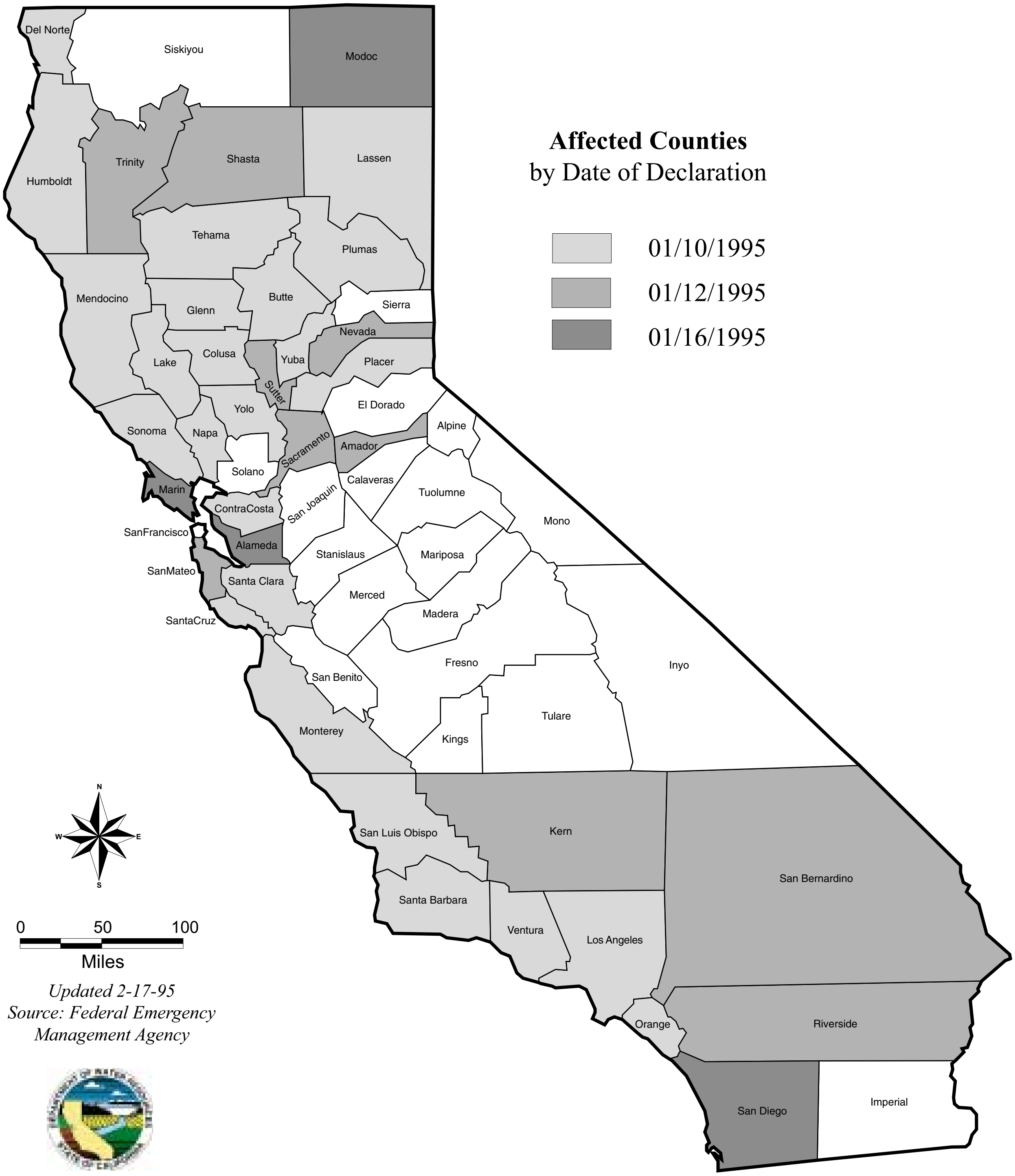
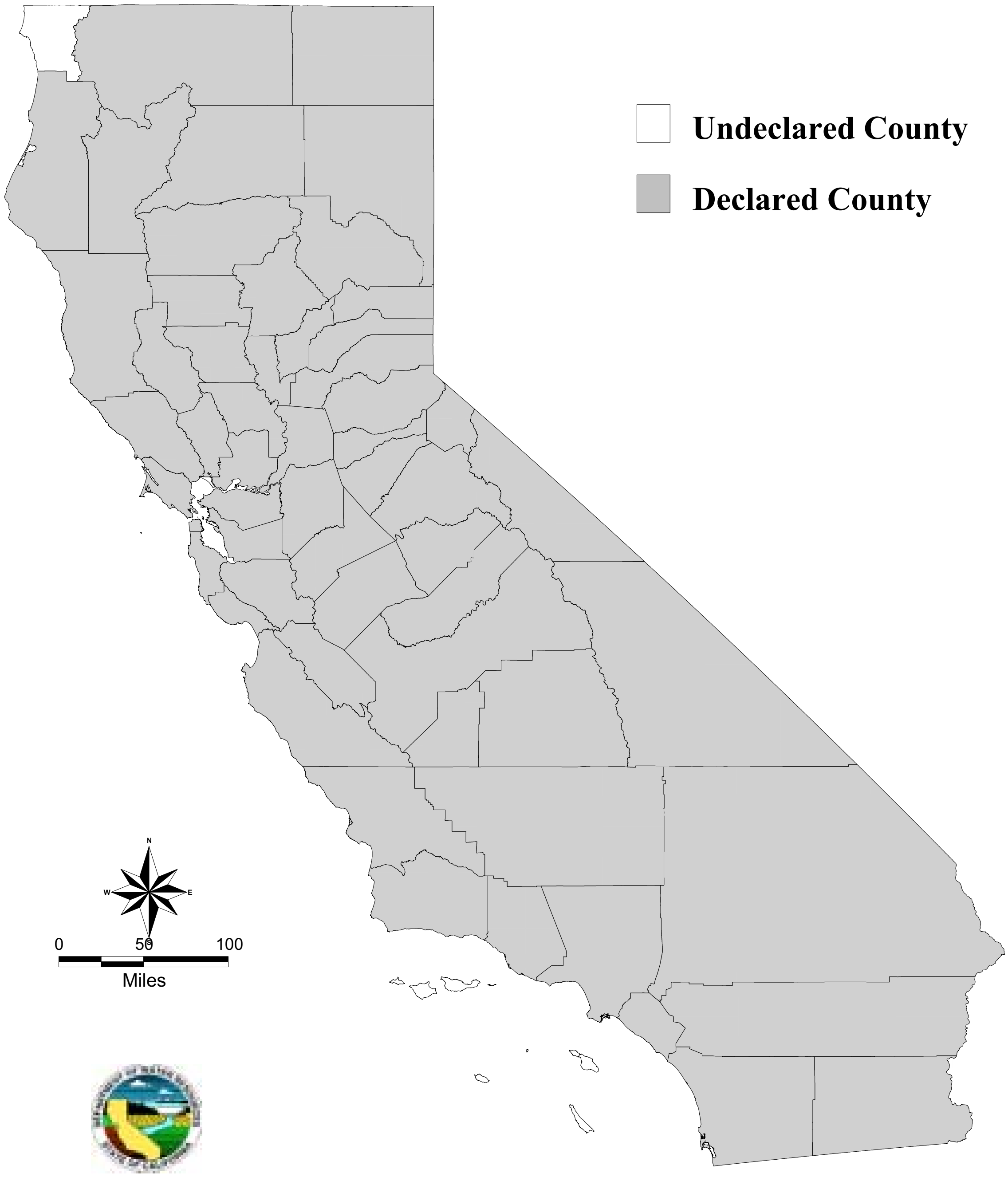


Figure 2. Counties Declared by Federal Government as Flood Disaster Areas, March 1995



Source: Federal Emergency Managment Agency

Overview of Meteorology: Weather Patterns of 1994/95

Overview of Meteorology: Weather Patterns of 1994/95

Warmer ocean temperatures off the eastern Pacific Ocean (El Niño) developed in the late summer and fall of 1994 followed by mature El Niño conditions in the tropical eastern Pacific during winter and spring. The El Niño pattern produced classic wet conditions along the West Coast consisting of an enhanced jet stream and storm track across the Pacific at lower than normal latitudes. The jet core and average storm track were displaced 15 to 20 degrees latitude south from their normal locations during January.

This pattern produced wetter than normal storms in Central and Southern California and under-producing storms in the Pacific Northwest. During January and March, but not February, this storm track was a major influence in steering frequent and potent Pacific storm systems across California with widespread flooding in their wake. Although not all El Niño years in California are wet, studies have shown that moderate to strong El Niño events, as in 1994/95, usually result in a stronger than normal subtropical jet stream with an active storm track along its path. Figure 3 depicts the January weather patterns taken from the National Oceanic and Atmospheric Administration Special Climate Summary, February 1995.

The Northern Sierra 8-Station Index measured 85.4 inches (171 percent of the annual average of 49.8 inches) for the 1995 water year, second only to the 88.5 inches in water year 1983 (Table 2). Cold temperatures and low snowlines resulted in the development of a significant snowpack throughout the winter.

The Sacramento River Hydrologic Region has headwaters in the northern Sierra and southern Cascade mountains and includes watersheds of the Sacramento, Feather, Yuba, and American rivers. The region is the source of a large percentage of California's water supply and includes some of California's largest flood control reservoirs. Historically computed for water years beginning with 1922, the Northern Sierra 8-Station Index provides

Figure 3. National Oceanic and Atmospheric Administration Special Climate Summary for January 1995

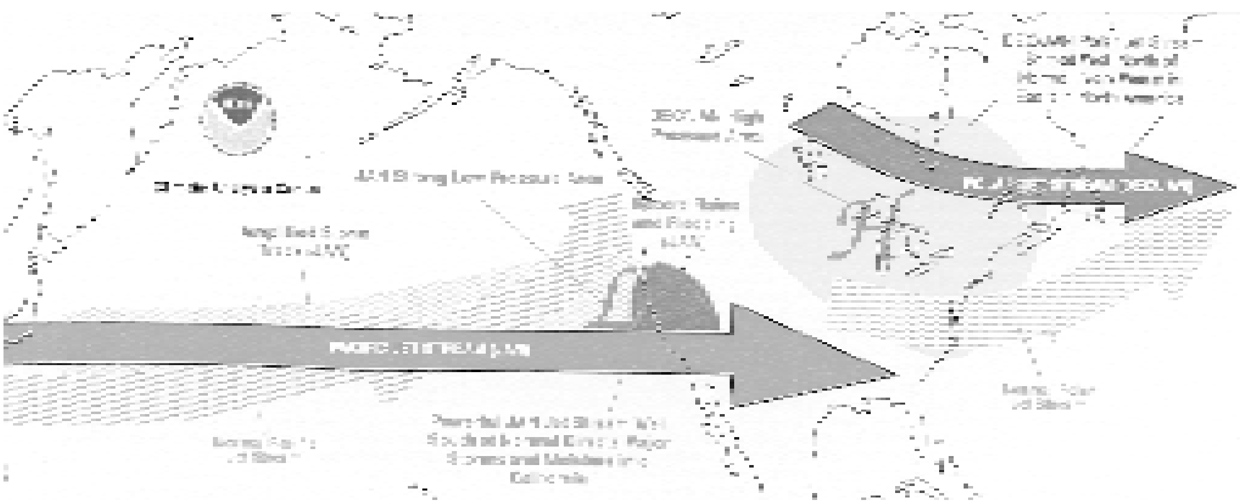


Table 2 Northern Sierra 8-Station Index for Water Year 1995

Month	1995 Monthly Total[1]	1922-1995 Monthly Average[1]	Percent of Average	Cumulative Total for Water Year[1]	1922-1995 Cumulative Average[1]
Oct	0.8	3.2	24	0.8	3.2
Nov	8.6	6.6	131	9.4	9.8
Dec	7.6	8.3	91	17.0	18.1
Jan	27.1	8.8	308	44.1	26.9
Feb	1.9	7.9	25	45.0	34.8
Mar	22.9	6.8	336	67.9	41.6
Apr	8.5	3.9	219	76.4	45.5
May	4.6	2.0	231	81.0	47.5
Jun	3.1	0.9	339	84.1	48.4
Jul	0.3	0.2	150	84.4	48.6
Aug	0.0	0.3	0	84.4	48.9
Sep	0.0	0.9	0	84.4	49.8

[1] Measurement in inches
WY Total: 85.4 (171% of the annual average of 49.8 inches)

an indicator of wetness throughout the Sacramento River Hydrologic Region. The eight stations (Figure 4)—Mount Shasta City, Shasta Dam, Mineral, Quincy Ranger Station, Brush Creek Ranger Station, Sierraville Ranger Station, Blue Canyon, and Pacific House—are averaged to compute the index. Figure 5 comparatively plots the 1995 8-Station Index against other water years including 1983 (wettest) and 1977 (drought).

April through July snowmelt runoff in the Sacramento River Hydrologic Region totaled 13.4 million acre-feet, or 201 percent of average. This volume had only been exceeded during water years 1907, 1952, and 1983. The Sacramento River unimpaired runoff was 34.1 million acre-feet, or 189 percent of average. This was the second wettest water year since the record began in 1906, exceeded only in 1983 with 37.7 million acre-feet of runoff. Other notable years were 1907 with 33.7 million acre-feet, and 1982 with 33.3 million acre-feet.

Snowmelt runoff in the San Joaquin River Hydrologic Region was about 8 million acre-feet, exceeded only in 1906, 1969, and 1983. Table 3 shows water year snowfall totals at selected locations in the Sierra, and Figure 6 compares the 1994/95 snow depth at the Central Sierra Snow Lab near Donner Summit against other historically significant years.

Table 3. Selected Sierra Nevada Snowfall Totals for Water Year 1995

Location	Amount (inches)
Manzanita Lake	308
Bowman Dam	346
Lake Spaulding	395
Donner Summit	598
Truckee Ranger Station	318
Tahoe City	334
Twin Lakes	586
Mammoth Lakes Ranger Station	322
Grant Grove	335
Lodgepole	371

October 1994

October was drier and a little warmer than normal in most of the State. The driest areas were the North Coast and northern Sierra where precipitation was about 25 percent of average. Near-normal amounts occurred in the central and southern Sierra and the San Joaquin Valley. Locally heavy rain fell on October 4–5 as showers and thunderstorms were triggered by an upper-level low pressure system over Northern and Central California. The origin of this upper low was unusual because it developed over Alberta and northern Montana on October 2 and then moved southwest over Northern California on October 4.

The heaviest 24-hour and monthly totals were recorded at Yosemite Park's south entrance with 4.40 inches and 4.92 inches, respectively. The heaviest rainfall on the San Joaquin Valley floor was 1.41 inches at Madera on October 4-5. A narrow band of thunderstorms deposited heavy rain in eastern Sacramento County on October 4 with as much as 1.02 inches in 15 minutes at Cresta Park.

November 1994

It was a cold November with average temperatures mostly 4 to 8 degrees below normal across the State. The largest departure from normal occurred at Thermal in the Colorado River Region, with an average temperature of 51.7 degrees, 10.4 degrees below normal. The average temperature of 59 degrees in Sacramento was the third coolest on record. Precipitation fell on November 4–6, 9–11, 15–17, and 24–26. November precipitation was 120 to 160 percent of average in Northern and Central California, and near 50 percent of normal in Southern California. There were 19 rain days at Eureka but just 5 in San Diego. The largest monthly total was 17.33 inches at Gasquet in the North Coast's Smith River Plain Basin.

With a stationary weather front and moist southwest flow aloft, a November 5 storm in the northern San Francisco Bay Area produced as much as 8 inches at Lake Lagunitas and Corte Madera in Marin County. Also in Marin, Kentfield had 7.96 inches in 24 hours and 10.11 inches in 48 hours. San Francisco set a single-day record of 5.54 inches on November 5 and 6.66 inches in 36 hours on November 5–6. Less than a half inch of rain fell in San Jose, just 50 miles to the south. November snowfall totals were as much as 98 inches at Twin Lakes near Bridgeport with 22 inches falling on November 25.

December 1994

Frequent Pacific weather systems crossed the State, mostly in the north. Precipitation ranged from 105 percent of average in the Sacramento Valley to 50 percent along the South Coast. The northern Sierra received 97 percent of the monthly precipitation average. The heaviest precipitation for December was 16.31 inches at Strawberry Valley in the Middle Fork Feather River Basin with 6.04 inches falling on December 4 for the largest single-day total. Eureka had 21 days with measurable rainfall, but Los Angeles International Airport had only 3. December temperatures ranged from near normal in the south to about 3 degrees below normal in the Sacramento Valley.

The most precipitation fell in Northern California on December 2–4 as a stationary front developed along the Interstate 80 corridor and waves moved up the front into orographically favored areas. Large 3-day totals included 9.91 inches at Strawberry Valley, 7.77 inches at Nevada City, and 7.50 inches at Lake Spaulding. Precipitation in Southern California remained light until the final 10 days of the month when several upper-level low pressure systems triggered moderate to heavy amounts from December 22–29. A number of locations received more than one inch on December 24 with the heaviest of 2.33 inches recorded at Lake Arrowhead. By the end of December the Northern Sierra 8-Station Index had recorded 17 inches for the season, or 94 percent of average. December's snowiest location was Lake Spaulding where 17 inches fell on December 12; 70 inches were measured for the month.

Table 4. Locations Recording the Wettest Month on Record, January 1995

Northern California		Central and Southern California	
Station	Precipitation (inch)	Station	Precipitation (inch)
Whiskeytown Reservoir	47.53	Gibraltar Reservoir	34.26
Bucks Creek Powerhouse	39.94	Cachuma Reservoir	25.13
Dunsmuir	39.14	Santa Barbara	24.20
Shasta Dam	38.21	San Dimas Dam	17.44
McCloud	33.11	Lompoc	15.37
Paradise	32.29	Long Beach Airport	13.65
Mt. Shasta City	27.48	Los Angeles Airport	13.36
Scotia	26.41	Santa Ana	13.20
Covelo	24.35	Santa Maria	11.78
Chester	23.41	King City	9.64
Redding Airport	22.93	Merced	8.72
Red Bluff	21.49	Panoche 2W	7.99
Weaverville	21.07	Haiwee	7.30
Stony Gorge Reservoir	20.21	Modesto	7.27
East Park	20.20	Coalinga	6.52
Orland	17.37	Cuyama	5.94
Winters	17.21	Death Valley	2.59
Chico	16.97		
Volta Powerhouse	15.87		
Folsom Dam	15.62		
Willows 6W	15.46		
Travis Air Force Base	12.52		
Nicolaus	10.04		

January 1995

January was extraordinarily wet with storms and heavy precipitation throughout the State. Rainfall fell almost daily along the northern and central coasts with 29 rain days at Richardson Grove State Park, 28 in Palo Alto and Scotia, and 27 in San Francisco and Eureka. In Southern California, Mount Wilson and Mount Palomar both recorded 17 rain days. At least 40 locations recorded their wettest month on record during January (Table 4).

The Northern Sierra 8-Station Index recorded 27.1 inches, or 308 percent of average, making the month the wettest January in the Index since 1922. The second wettest January was 25.1 inches in 1970. In addition, January 1995 was the second wettest (tied with February 1986) of any month, exceeded only by December 1955 at 30.8 inches. (Two years later December 1997 would exceed January with 28.9 inches.) Some locations in Northern and Central California recorded 400 percent of average, and a few Southern California locations recorded 600 percent of average. Figures 7 and 8 are isohyetal maps of percent-of-average and total precipitation for January.

Some of the largest January totals occurred above Lake Shasta with 56 inches at Stouts Meadow, 51.52 inches at Lakeshore, and 47.33 inches at Girard. The largest totals in the Feather River basin were 54.34 inches at Bucks Lake and 47.85 inches at La Porte. Some of the larger Southern California totals included 41.49 inches at Juncal Dam (Santa Barbara County), 34.74 inches at Lytle Creek Ranger Station, 34.52 inches at Gibraltar Dam, 29.62 inches at Lake Arrowhead, and 28.22 inches at Mount Wilson. Santa Barbara recorded its wettest month on record at 24.20 inches.

Heavy rains drenched Southern California on January 3–4 and much of the State on January 7–13. Heavy rain fell in Northern California on January 22–

23 and on January 30–31. In the northern Sierra about 40 percent of a normal year's precipitation fell during January 4–15. By January 24 additional storms had raised the seasonal total to 80 percent of average for the water year.

Rain fell throughout San Luis Obispo and Santa Barbara counties on January 3–4. A 24-hour record was set at Santa Barbara with 8 inches on January 4. Record-breaking rains fell in the Sacramento Valley on January 7–13, mostly along the west side. Fifty stations reported record six-day rainfall totals led by Cobb in the Clear Lake drainage, which received 35.18 inches. Heavy snows of 6 to 12 feet fell in the Sierra from January 7 to 13.

A strong intrusion of moist tropical air produced some of the heaviest rains on January 8–11. Southern California four-day totals included 14.47 inches at Gibraltar Dam, 18 inches at Lytle Creek Ranger Station, and 22.64 inches at Juncal Dam (11.36 inches on January 10). Other large four-day Northern and Central California totals included 17.36 inches at Humbug Summit (Feather River basin), 15.36 inches at Lakeshore (Shasta Lake), 14.84 inches at Three Peaks in Monterey County, 14.26 inches at Shasta Dam, 12.48 inches at Venado (Russian River), and 11.46 inches at Mount Umunhum in the Santa Cruz Mountains.

Recurring thunderstorms produced historic 24-hour rainfall in Sacramento and the northeast suburbs on January 9–10. Figure 9 is an isohyetal map of the event and includes rainfall totals and return periods for stations with long records. The maximum 24-hour rainfall of 7.57 inches was recorded at the Granite Bay Country Club. The 24-hour total for downtown Sacramento on January 9–10 was 4.47 inches and broke all January duration records from 5 minutes to 24 hours. The 30-minute total of 1.27 inches on January 9 was also a Sacramento record for any month, and the 24-hour total of 4.47 inches was the fourth heaviest on record. The all-time 24-hour record of 7.24 inches occurred during the storm of April 20–21, 1880.

Because of the frequent storms, abundance of clouds, and lack of nighttime cooling, temperatures were above normal throughout most of the State in January. The largest departures from normal, about 5 degrees above normal, occurred along the North Coast. The South Coast was closest to average at about 0.3 degrees above normal.

February 1995

February was a dry month between the two wet months of January and March throughout most of the State. Precipitation totals ranged from 20 to 30 percent of average in Northern and Central California but were near 70 percent in Southern California. The month was mild with average temperatures generally 3 to 6 degrees above normal across the State. Southern California again was the exception, experiencing several upper-level low pressure systems through the first half of the month with exceptionally heavy rains on February 14. Many Southern California locations totaled more than an inch with the heaviest single-day totals occurring at Lake Arrowhead with 7.20 inches, Lytle Creek Ranger Station with 6.55 inches, and Mount Wilson with 5.23 inches. Little precipitation fell during the second half of February. Heaviest precipitation for the month was 9.26 inches at Lake Arrowhead.

March 1995

After a quiet February an area of blocking high pressure over the Gulf of Alaska set the stage for a return of January-like storms in March. A parade of storms from subtropical latitudes produced nearly daily rainfall in Northern California from March 1 through March 24. The Northern Sierra 8-Station Index gained 22.8 inches (335 percent of the March average), breaking the previous March record of 20.1 inches set in 1983. March precipitation was as much as four times normal in Northern California, and five to six times normal in Central California. Many March records were set including 25.31 inches at Calaveras Big Trees, 22.75 inches at Pacific House, 18.29 inches at Morro Bay, 16.89 inches at Hetch Hetchy, 16.48 inches at San Luis Obispo, and 12.31 inches at Paso Robles. Other significant March totals included 36.29 inches at Bucks Creek Powerhouse in the Feather Basin, 35.44 inches at Cobb (Clear Lake drainage), 34.38 inches at Lake Spaulding (Yuba River Basin), 33.90 inches at Camp Six (Del Norte County), 20.06 inches at Juncal Dam (Santa Barbara County), 19.27 inches at Lake Arrowhead, and 19.27 inches at Palomar Mountain.

Table 5 shows March precipitation and historical rankings. National Weather Service analyses of March precipitation and percentages of normal are summarized in Figures 10 and 11.

Significant precipitation fell over Northern California on March 2–3, 8–15, and 18–24. North

Table 5. Precipitation, March 1995

Station	March 1995 Total (inch)	March 1995 Historical Rank
Eureka	10.8	5
Shasta Dam	29.0	2
De Sabla	26.7	4
Blue Canyon[1]	29.8	2
Sacramento	7.8	5
San Francisco Airport	9.0	2
Yosemite	18.6	3
Merced	5.6	5
Fresno	6.0	2
Glennville	7.7	4
Paso Robles	12.3	1
Bakersfield	3.4	3
Santa Barbara	9.3	3
Los Angeles Airport	5.7	2
Blythe	0.5	11
San Diego	3.8	14

[1] Wettest March since 1907 (35.11).

Coast river flooding was triggered by 5 to 10 inches of rain on March 8–9 as a strong low-level jet stream developed along a slow-moving cold front fed by a flow of subtropical moisture. This system shifted south into Central California with heavy rain, record-setting in some areas, on March 9–10.

Some 45 stations reported the highest single-day rainfall totals on March 10 (Figure 12). These locations were north of San Francisco Bay and in Central California where record flooding occurred in the Salinas River Basin and the Arroyo Pasajero drainage (San Joaquin Valley near Coalinga). The heaviest single-day total was measured at Guerneville on the Russian River with 9.07 inches—a 100-year return event (1 percent chance in any single year) as the storm produced severe flooding throughout the Russian and Napa River basins. On the upper Salinas River, the 7.40 inches in 24 hours at Paso Robles was a 1,100-year return event (0.09 percent chance in any year). The 24-hour record of 3.74 inches at Coalinga was an estimated 2,400-year return event (0.04 percent chance in any year) topping the previous record of 2.53 inches in 1914.

Large two-day totals over March 9–10 in the Central Coast included 19.9 inches at Three Peaks (Monterey County), 15.0 inches at Mining Ridge (Monterey County), 13.50 inches at Morro Bay, 10.12 inches at Santa Margarita Booster, 8.44 inches at Paso Robles, and 8 inches at San Luis Obispo.

March snowfall in the Sierra was also heavy with totals of 8 to 15 feet, including 100 inches at Lodgepole and Tahoe City, and 166 inches at Twin Lakes. Heavy snow again fell on March 20-24 with an additional 90 inches at Twin Lakes, 75 inches at Tahoe City, and 63 inches at Lodgepole.

April 1995

April precipitation was about twice normal in the Northern California mountains, above normal in most of Central California, and slightly below normal in Southern California. The Northern Sierra 8-Station Index received 8.5 inches, or 219 percent of the April average. Below-normal exceptions included locations in the San Francisco Bay Area and Central Coast.

The highest monthly precipitation total was 14.34 inches at Bucks Creek Powerhouse in the Feather River Basin, including 4.07 inches on April 29 alone. The highest monthly snowfall total was 45 inches at Twin Lakes near Bridgeport. Colder storms from the Gulf of Alaska brought lower snow levels during storms on April 12–14 and 16–20. Almost all precipitation in Southern California fell between April 16 and 20. The heaviest precipitation in Northern and Central California fell from April 28 to 30, with 3 to 5 inches over much of the Sierra Nevada. April temperatures were near normal statewide except for the Central Valley and Sierra where they were slightly below normal.

May 1995

The wet and cool spring continued with Northern Sierra 8-Station Index adding 4.6 inches, or 231 percent of the May average. Precipitation was two to four times average in most of Northern and Central California, and up to twice normal in Southern California. Average temperatures were 1 to 3 degrees below normal statewide, except for near-normal conditions along the North Coast. The largest monthly precipitation total was 8.45 inches at Calaveras Big Trees in the Stanislaus River Basin. The largest monthly snowfall total was 32 inches at Twin Lakes. A strong cold front brought heavy precipitation to Northern and Central California on May 1, with as much as 4.16 inches at Bucks Lake and 4 inches at Round Mountain. Amounts of 1 to 3 inches were typical in most mountainous areas. A cold, upper-level trough triggered showers and thunderstorms over much of the State May 4–6. The Van Maren Lane precipitation station in Citrus Heights (Sacramento County) received 1.14 inches in 30 minutes on May 5, a 100-year return event. An upper level low brought showers and thunderstorms to Southern California with 1-inch daily totals at a few locations. Strong onshore flow from the Gulf of Alaska produced daily showers over much of Northern and Central California May 9–15.

June 1995

June continued the cool, wet pattern and delayed snowmelt in the Sierra. Many high-elevation snow measuring stations still had 30 inches of snow water content in late June. June temperatures were below normal statewide, as much as 6 degrees below average at Trona in the Mojave Desert.

June precipitation was 2 to 5 times average in Northern California and 5 to 10 times average in Central and Southern California. The Northern Sierra 8-Station Index gained another 3.1 inches during June, or 339 percent of average. Most precipitation fell in the form of showers and thunderstorms June 14-19 as an upper-level low pressure area drifted across the State. The wettest monthly total was 6.76 inches at Buckhorn in the Pit River Basin, and the greatest single-day total of 2.91 inches fell at Whiskeytown Reservoir west of Redding. Fairfield also had a record single-day total of 1.63 inches on June 16. The largest monthly snowfall total was 8.5 inches at Grant Grove.

Table 6. Precipitation at Selected Locations in California, Water Year 1995

Station[1]	Avg. WY	Inches Since Oct. 1	Percent of Avg.
Eureka	38.2	52.6	138
Shasta Dam	58.2	97.2	167[2]
De Sabla	66.0	112.7	171[3]
Blue Canyon	62.0	118.3	191[4]
Sacramento	17.7	31.8	179
San Francisco Airport	19.4	29.5	152
Yosemite	37.2	61.1	164[5]
Merced	12.1	17.6	145
Fresno	11.0	18.8	171
Glennville	18.2	29.4	162
Paso Robles	13.6	29.9	220
Bakersfield	6.1	10.2	167
Santa Barbara	17.5	39.8	227[6]
Los Angeles Airport	12.3	22.9	186
Blythe	3.7	4.7	126
San Diego	9.9	17.1	173

[1] Stations listed from north to south.
[2] Third wettest year since record began in 1944.
[3] Wettest year since record began in 1904 (previous wettest was 1983 with 105.50").
[4] Second wettest year since record began in 1900.
[5] Third wettest year since record began in 1904.
[6] Third wettest year since record began in 1868.

July 1995

Normal summer heat arrived in July with temperatures above average along the coast and a little below average inland and in the mountains. Scattered showers fell along the North Coast July 9–12. The only significant rainfall elsewhere was triggered by an upper-level low, which moved north from Baja California on July 16 and into Northern California July 18–19. Thunderstorms dropped half-inch rainfall totals on Bridgeport, Vinton, and Susanville in the northern Sierra on July 19.

August 1995

Temperatures rose in August to near normal in Northern California and 2 to 4 degrees above normal in Central and Southern California. Monsoon flow from the southeast brought thunderstorms and heavy rain to some desert locations with 1.94 inches at Mojave on August 20 and 1.36 inches at Blythe on August 21.

September 1995

The hot weather continued in September with temperatures above normal statewide and as much as 5 degrees above normal in the southeastern desert. No significant rainfall fell during September as water year 1995 came to a close. Table 6 shows total precipitation during water year 1995 for selected locations in California.

Figure 4. Northern Sierra 8-Station Index Stations

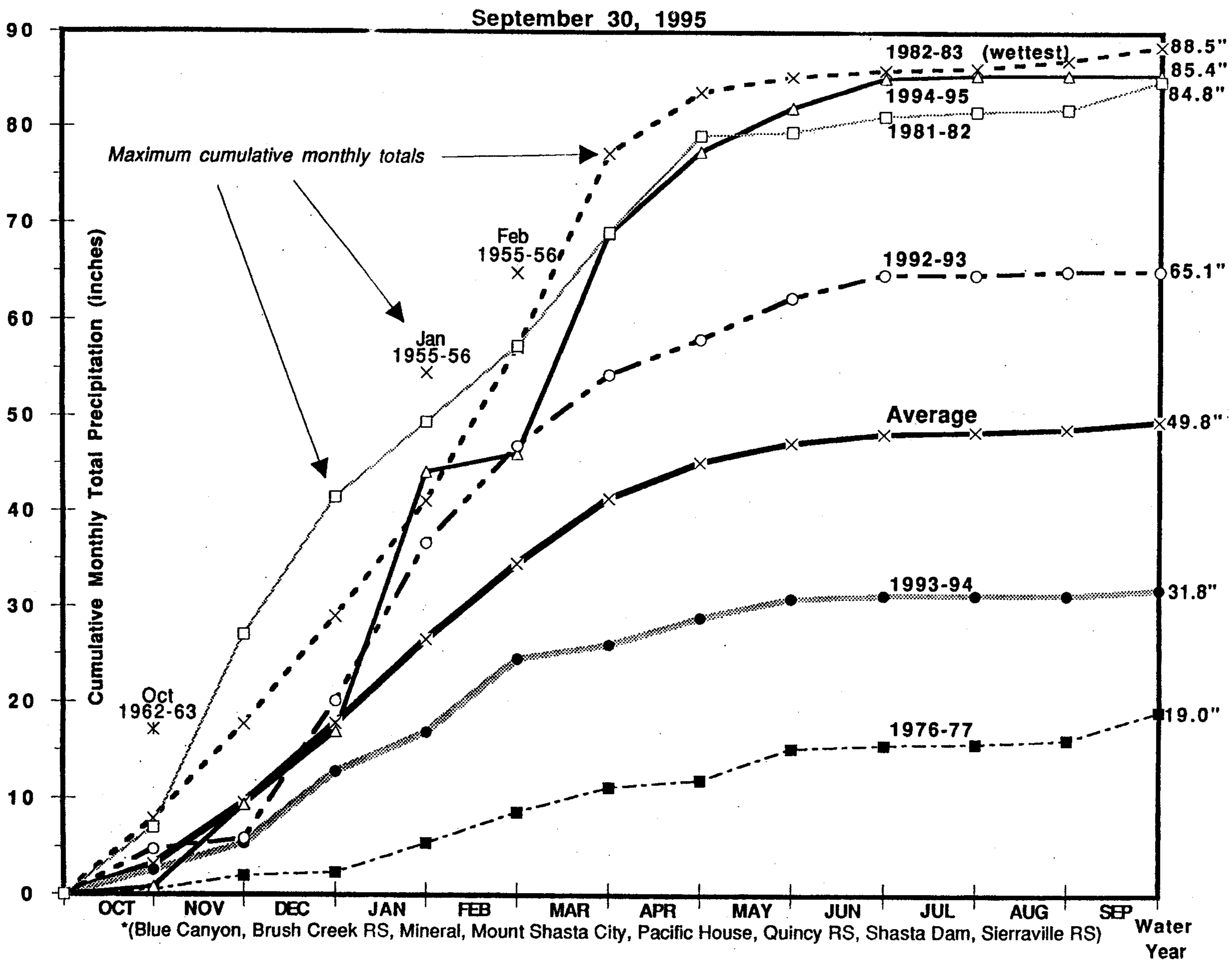


Figure 5. Northern Sierra 8-Station Plot

Figure 6. Snow Depth at the Central Sierra Snow Lab

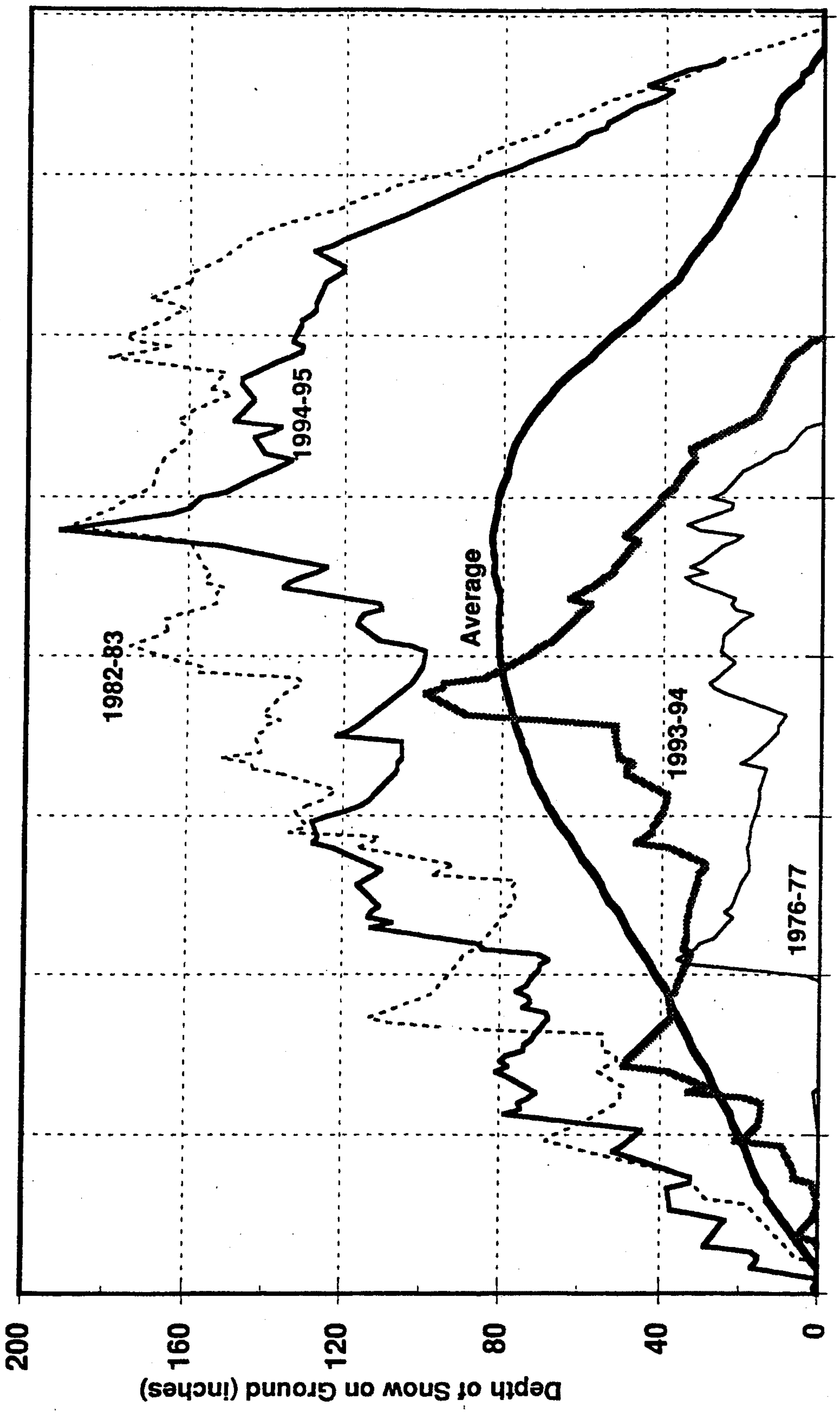


Figure 7. Total Precipitation (inches), January 1995

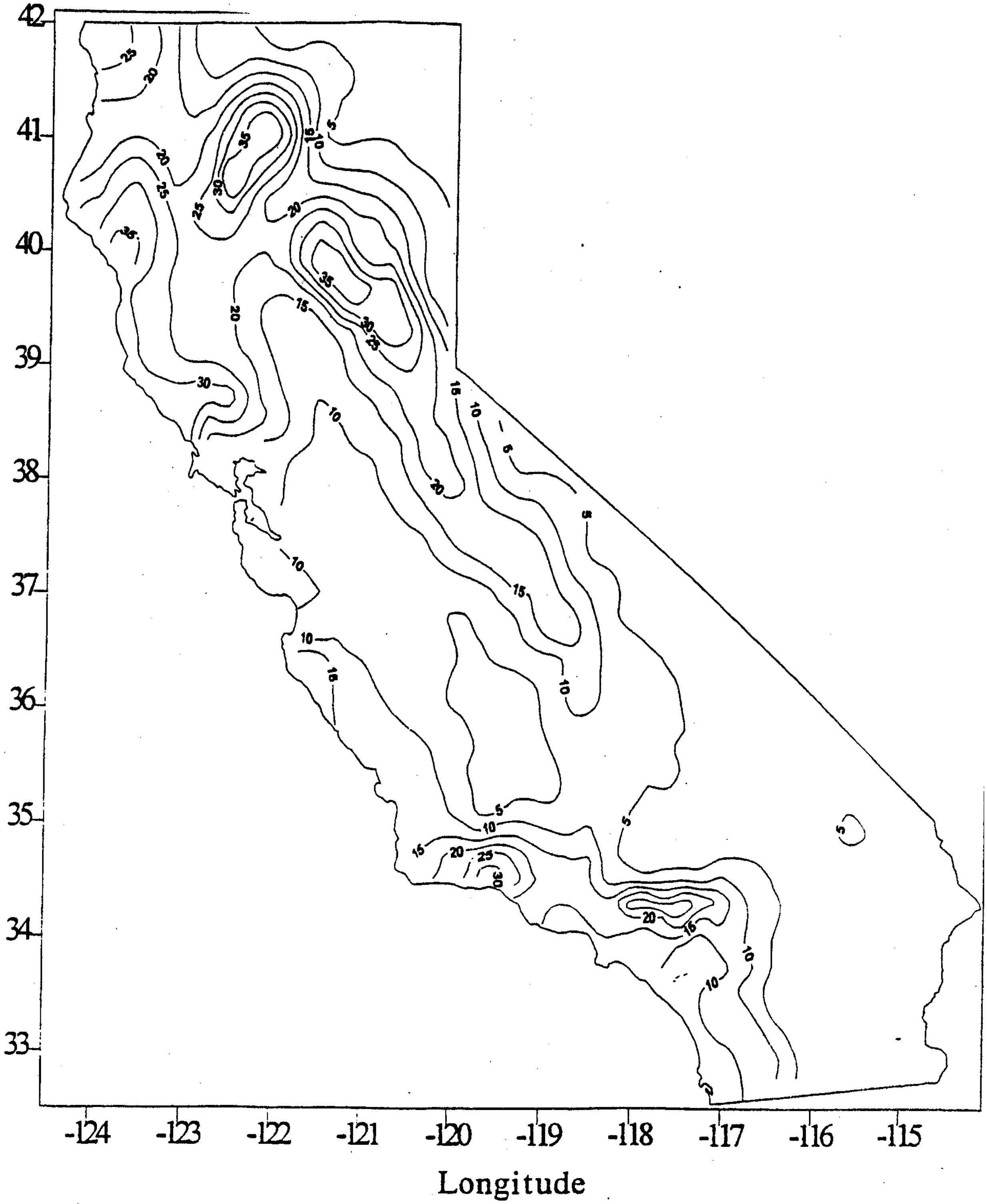


Figure 8. Percent of Normal Precipitation, January 1995

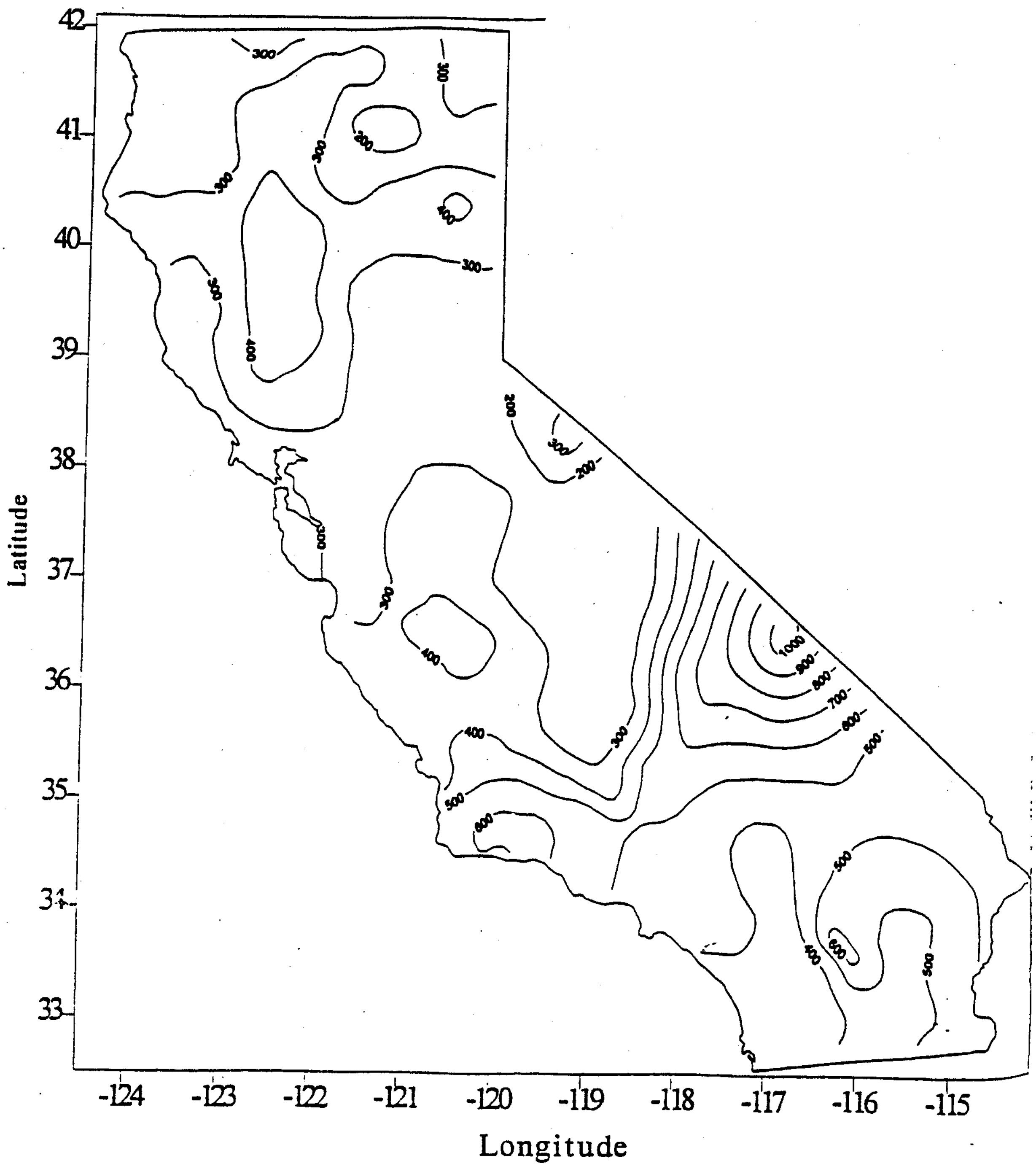


Figure 9. Storm of January 9-10, 1995

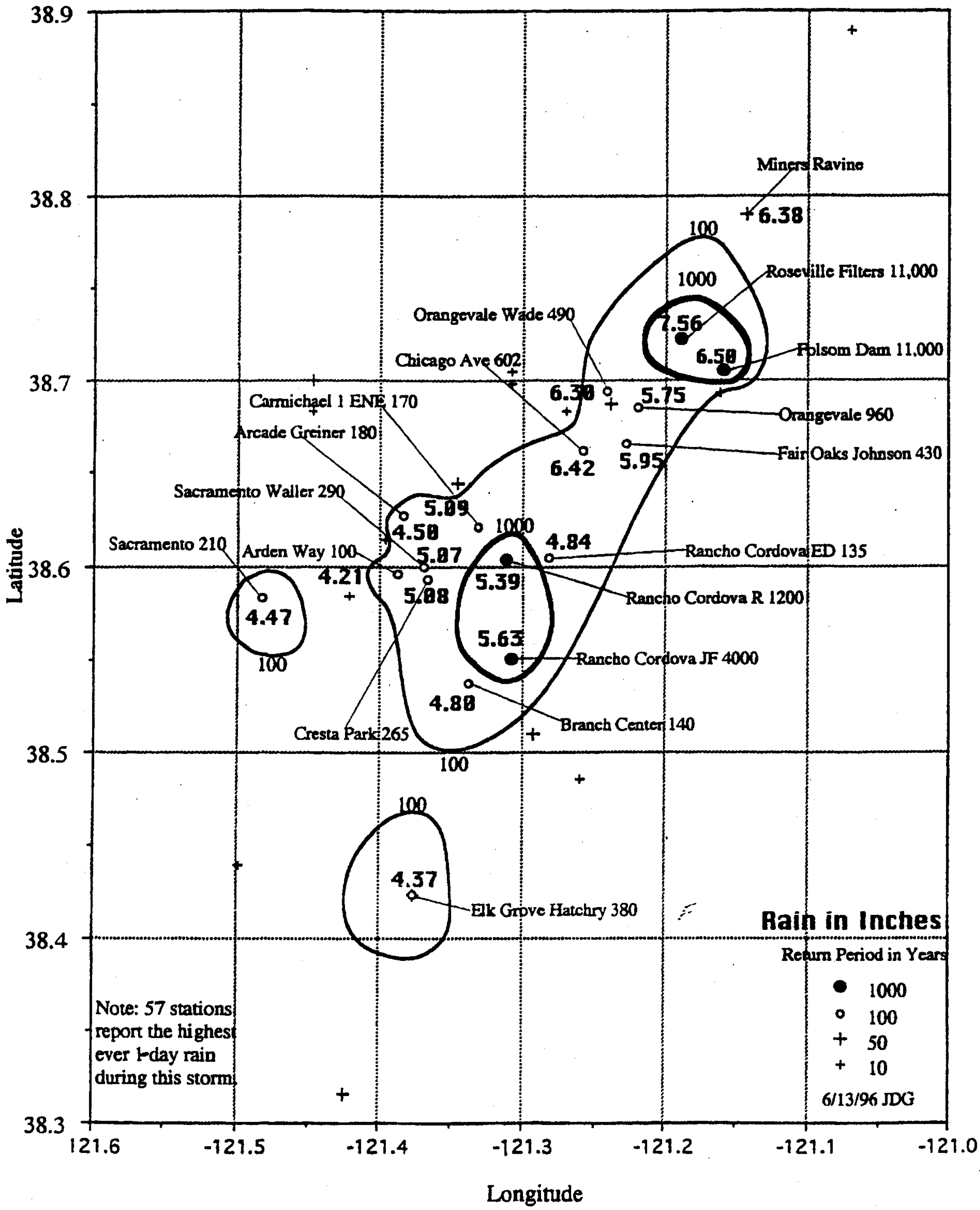
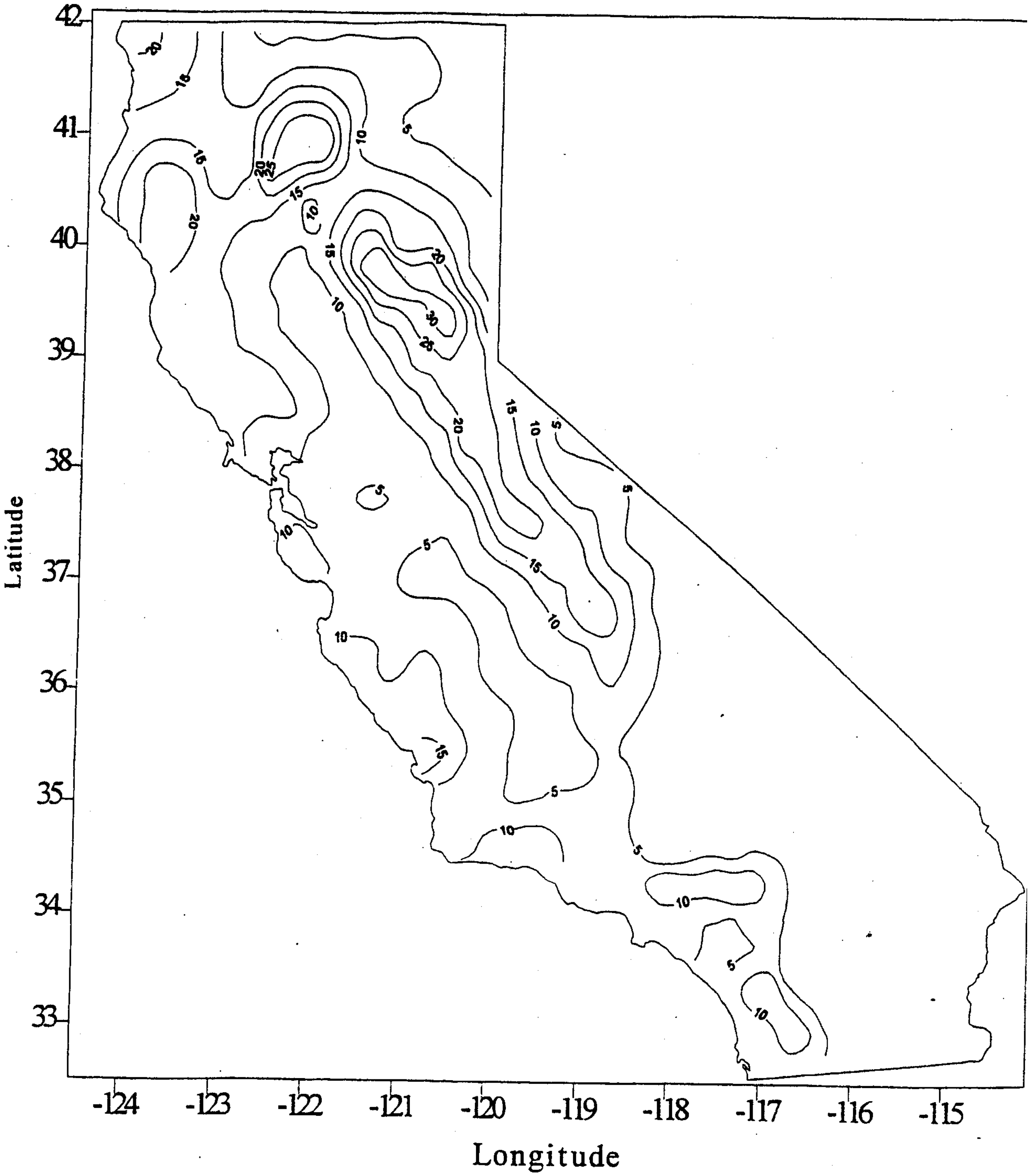


Figure 10. Total Precipitation (inches), March 1995



Credit: James Goodridge, Retired State Climatologist

Figure 11. Percent of Normal Precipitation, March 1995

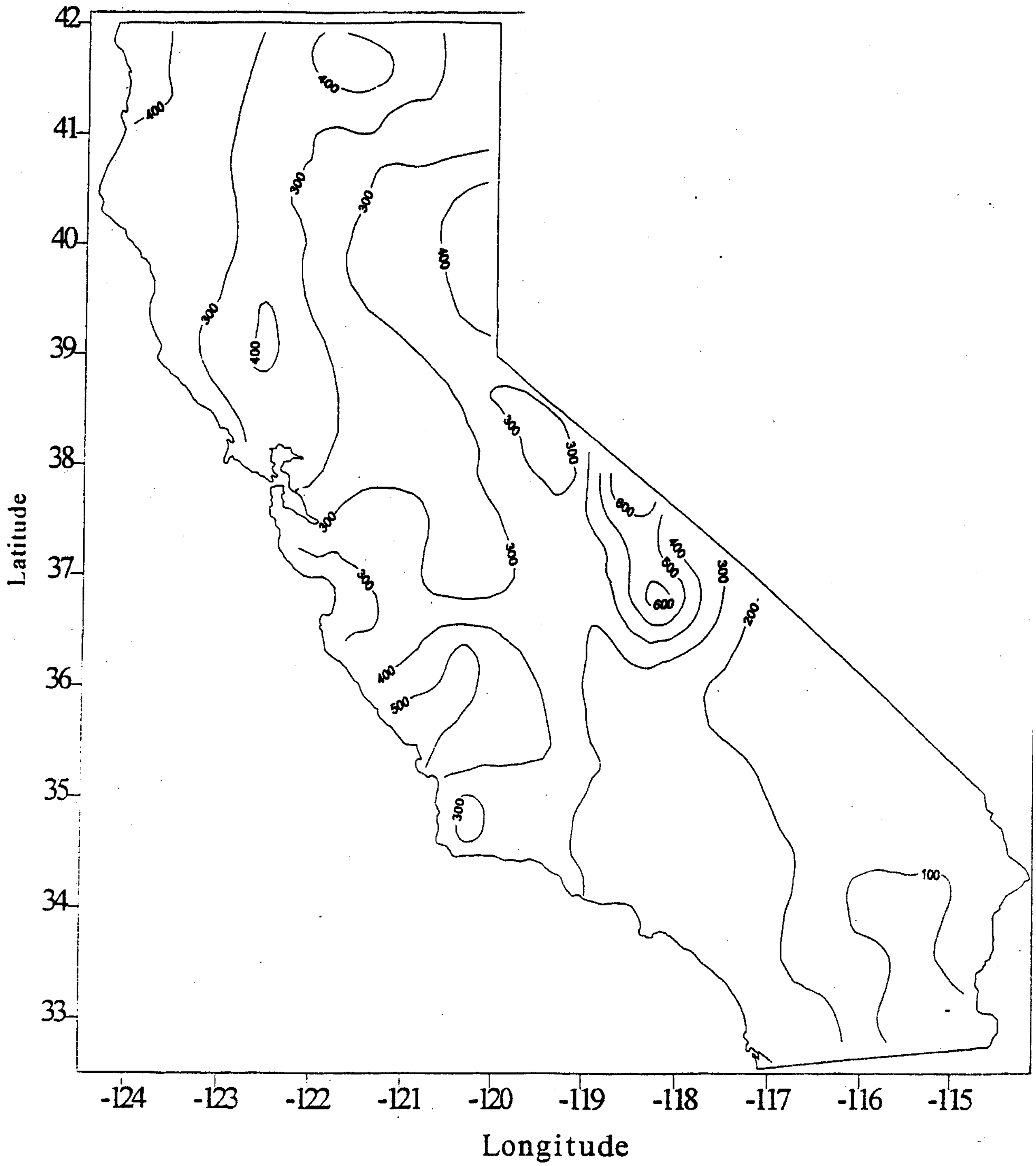
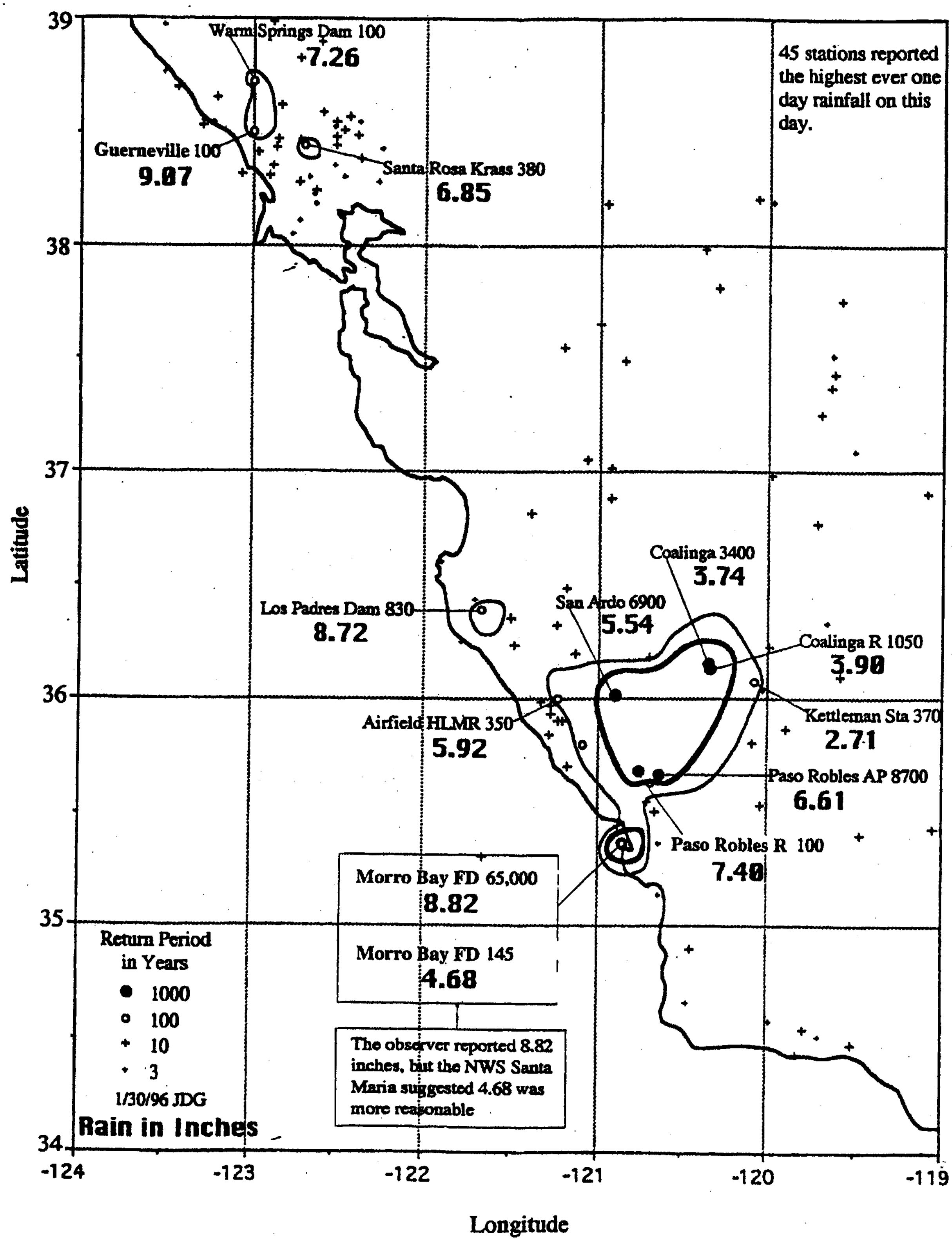
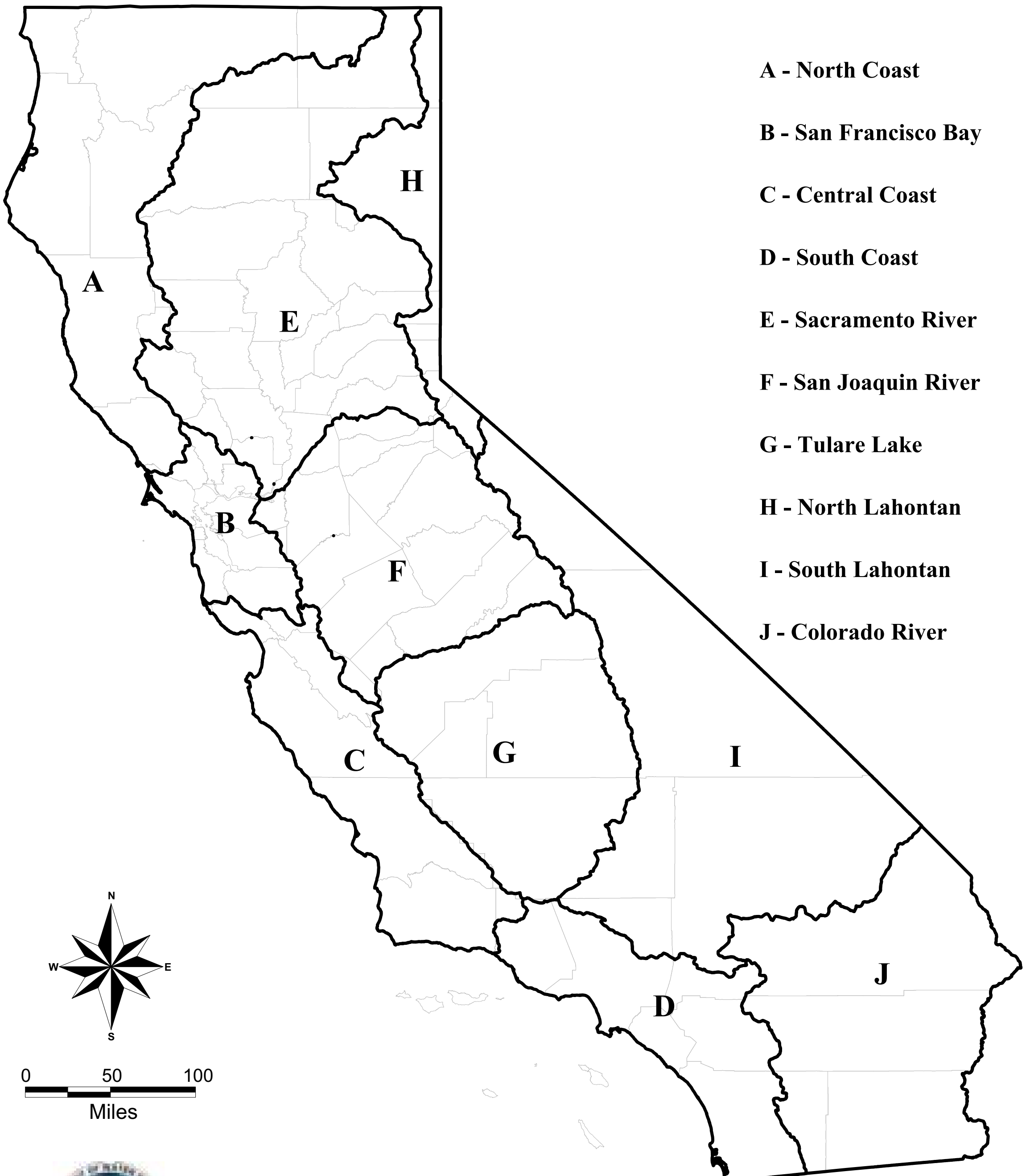


Figure 12. Storm of March 10, 1995



Overview of Hydrology

Figure 13. Hydrologic Regions of California



Overview of Hydrology

California endured six years of drought for the second time in the 20th century from 1987 through 1992. The first drought was from 1928 through 1934. The "drought watch" of 1994 ended in water year 1995 with one of the wettest years in the 20th century. The year 1995 was somewhat unusual in that California had two periods of substantial flooding (January and March) and the extent embraced most of the State at one time or another. The 1995 flood and snowmelt runoff refilled all but a few of California's major reservoirs. Heavy snowpack developed in Northern and Central California with an average statewide water content greater than 200 percent. Springtime runoff volumes were high, particularly in the San Joaquin River and Tulare Lake hydrologic regions. Figure 13 shows California's 10 hydrologic regions, which correspond to the State's major drainage areas.

The water year began quietly. November 1994 was cool and wet, but by the end of December northern Sierra precipitation was about 90 percent of average. Heavy rains began during the second week of January 1995 with the Coast Range north of San Francisco and the upper Sacramento Valley hardest hit. The Russian River jumped from low flow levels to near record levels (set in February 1986) in just three days. Levels on the Napa and Eel rivers, although not as high as in 1986, were well above flood stage. Highlights of water year events are summarized in the remainder of this section.

January Flood Event

When the January storms began, storage in Northern California's major flood control reservoirs was quite low after the extremely dry 1994 water year. As a result much of the reservoir inflow runoff volume during the January storms was stored with minimal downstream impacts to the streams and flood control systems on the Central Valley floor. Statewide storage increased nearly 8 million acre-feet during January from 75 percent to 104 percent of average.

Unregulated tributary inflows below Shasta Dam produced flood stages along the upper Sacramento River. At some gaging stations, levels were higher than February 1986 but lower than the larger March 1983 flood. Peak stages farther downstream were less than the record levels of 1986—about 3 feet lower at the Fremont and Sacramento weirs. Inflow to Shasta Lake exceeded 100,000 cubic feet per second twice during the week of storms but was almost completely stored. Runoff from major Sierra Nevada rivers was not that unusual and was also mostly stored at the reservoirs. Peak Feather River inflow was about 120,000 cubic feet per second to Lake Oroville with releases from the Oroville complex to the Feather River only 14,100 cubic feet per second by February 1, compared with 150,000 cubic feet per second in 1986. Peak American River inflow was about 68,000 cubic feet per second to Folsom Reservoir with releases to the American River from Nimbus Dam only 35,000 cubic feet per second by January 27 compared with 125,000 cubic feet per second in 1986. The storm featured periods of intense rainfall over small watersheds. Up to 7 inches of rain fell on the 80-square-mile Dry Creek watershed near Roseville in western Placer County (see cover photo), producing runoff up to 15,000 cubic feet per second.

March Flood Event

After a dry February a series of early March storms dropped significant precipitation, and many flood control reservoirs filled their flood storage reservations. Releases to the Sacramento River from Shasta Dam were increased to the design channel capacity of 79,000 cubic feet per second. Releases from Oroville and Folsom dams were boosted to about half the design capacity of their downstream channels. Oroville releases peaked at 87,000 cubic feet per second to the Feather River, and Folsom releases reached 50,000 cubic feet per second to the American River. Peak March flows in the upper Sacramento Valley were less than peak January flows because of lower runoff volumes on unregulated tributary streams.

Peak stage on the Sacramento River near Fremont Weir was a foot higher than in January because of larger reservoir releases, but the river remained within channel design capacities. To help control Sacramento River levels on March 11, the Department opened 22 of the 48 gates of the

Floodwaters from the Arroyo Pasajero washed out a 100-foot section of Interstate 5 near Coalinga on March 10, 1995. (AP/Wide World Photos)

Sacramento Weir. This was the first use of the weir since the February 1986 flood.

The March storms produced a new record stage on the Salinas River near Spreckles and exceeded the 1986 peak on the Napa River by 0.3 feet. High flows above monitor stage were also produced along the lower San Joaquin River. The Arroyo Pasajero, a tributary to the Tulare Lake Hydrologic Region on the eastern side of the Coast Range near Coalinga, experienced estimated 100-year plus magnitude flows that washed out an Interstate 5 bridge crossing. (Photo on page 32.)

Unusually heavy and widespread precipitation patterns made the January and March storms distinctive. Major flood control works in Sacramento River and San Joaquin River basins managed the flood runoff and reservoir releases well, although moderate levee damage was sustained on some Delta levees and at other locations. Other flood-related incidents occurred on smaller streams and on unregulated or partially regulated rivers, particularly in the northern San Francisco Bay and Central Coast regions.

Arroyo Pasajero

In southwest Fresno County, erosion from the Arroyo Pasajero has produced the largest alluvial fan in the western San Joaquin Valley. The alluvial fan and its juncture with the Kings River fan/delta complex on the east side of the San Joaquin Valley has formed the Tulare Lake Hydrologic Region and prevents the Tule, Kaweah, and Kern rivers from directly draining into the Sacramento-San Joaquin Delta. The California Aqueduct and Interstate 5 traverse the fan, and the Westlands Water District, the agricultural community of Huron, and 250,000 acres of productive farmland are located on the fan. The San Luis Canal reach of the California Aqueduct is at approximately mid-fan elevation. It provides nominal capacity to pass Arroyo Pasajero floodwater to the east, and during large floods it impounds these floodwaters upstream and west of the Aqueduct behind an 11-mile long flood control dike.

Arroyo Pasajero floodflows peaked at an estimated 28,000 cubic feet per second on March 10. This unprecedented flow washed out the northbound and southbound I-5 bridges spanning the Arroyo and claimed the lives of seven motorists. The 54-hour storm produced a volume of about 35,000 acre-feet, more than 10 percent of which was composed of entrained sediment that covered 3,000 acres of farmland and other properties with 1 to 4 feet of sand, silt, and clay. The Arroyo Pasajero's floodwater inundated more than 10,000 acres of farmland, causing a reported $13 million in crop losses and related damage.

Other impacts included the closure of State highways 198 and 269 because of flooding and sediment deposition. Highway 269 was closed for 65 days while 150,000 cubic yards of sediment were cleared north of Huron. Other local roads and bridges were damaged or closed due to flooding along the Arroyo and its tributaries of Los Gatos, Warthan, Jacalitos, and Zapato Chino creeks. Up to 10 feet of scour in the Arroyo's channel downstream of I-5 ruptured an 18-inch crude oil pipeline and resulted in the spillage of thousands of gallons over thousands of acres. A 66-inch Westlands Water District water pipeline—crossing Zapato Chino Creek upstream of its confluence with the Arroyo Pasajero—was unearthed and ruptured.

Floodwater breached the California Aqueduct's western flood control embankment and entered the Aqueduct carrying sediment and oil from the ruptured crude oil pipeline. The inflow of floodwater along the San Luis Canal north of the Arroyo Pasajero from Cantua, Salt, and other creeks led to dangerously high water levels in the Aqueduct. State Water Project operators diverted a portion of the floodwater through the Kern River Intertie into the Kern River and Tulare basins.

A five-year feasibility study to evaluate flood protection options on the Arroyo Pasajero was completed by the U.S. Army Corps of Engineers and the Department. The U.S. Bureau of Reclamation, as joint owner and operator of the San Luis Canal portion of the State Water Project, and the Department were the local cost-sharing sponsors. A March 1999 draft feasibility report concluded that a high likelihood existed for surface floodwater to breach the Aqueduct. The potential consequences of a serious breach included the threat to more than a million acres of productive agricultural land in the San Joaquin Valley and the disruption of water deliveries to parts of the valley and Southern California. Damage estimates ran as high as $800 million with a potential of more than 16 million people facing water shortages.

Late April Storms

Late April storms produced another strong rise on the Sacramento River and renewed weir overflow into the Sutter and Yolo bypasses in early May. Lake Oroville releases increased to 60,000 cubic feet per second, and the overflow depth at Fremont Weir reached 2.5 feet on May 4, more than a foot higher than the maximum depth recorded during the May 1983 flood.

San Joaquin Valley, April through July Snowmelt

Heavy snowpack in the southern Sierra Nevada produces a serious snowmelt flood in the San Joaquin Valley about once every 10 years. Water year 1995 produced well above-average snow water content in the snowpack, with the fourth greatest April-July volume exceeded only in the 1983, 1907, and 1906 water years (Figure 14). Unseasonably cool spring temperatures delayed the snowmelt. About three-quarters of the April-July runoff normally occurs by mid-June, but by that time in 1995, only 57 percent of the volume had melted. High rates of runoff occurred well into July in the San Joaquin River and Tulare Lake regions.

Reservoir operators, engineers, hydrologists, and managers must optimally manage a difficult balance. During wet years full capacities are operationally targeted just after the snowmelt peaks occur. When reservoirs fill too soon, the risk of uncontrolled spills from late-season runoff increases. If too much water is released prior to the snowmelt peak, the remaining runoff volume may be insufficient to fill the reservoir. This situation can result in unmet summer irrigation demands, loss of hydropower revenues, and reduced carryover storage into the following year.

Low runoff volumes were observed during mid-June, and operators were concerned that the forecasted snowmelt volumes were too high. Based on experience suggesting that a delayed melt might result in reduced runoff volumes and that delays have occurred as late as August, the Department and other forecasters began to reduce forecasted April-July runoff volumes by 5 to 10 percent in many high-elevation watersheds. Reservoir operators responded by reducing releases in mid-June, which produced lower stages along the San Joaquin River and its tributaries. As river levels dropped many farmers began to plant annual crops on the floodplains.

Temperatures in the southern Sierra did not begin to increase to typical summer levels until the end of June as shown by a temperature plot from Tuolumne Meadows in Yosemite National Park at elevation 8,600 feet (Figure 15). Sufficient high-elevation snowpack remained to generate peak or near-peak daily snowmelt runoff volumes in several southern Sierra watersheds.

By early July most of the San Joaquin River and Tulare Lake hydrologic basins' reservoirs along the southern Sierra were nearly full, and operators reacted to the higher runoff by increasing releases to the downstream river channels. Although well within safe flood-carrying levels, these higher flows caused seepage conditions to return, flooding many newly planted fields along the rivers and resulting in significant crop losses.

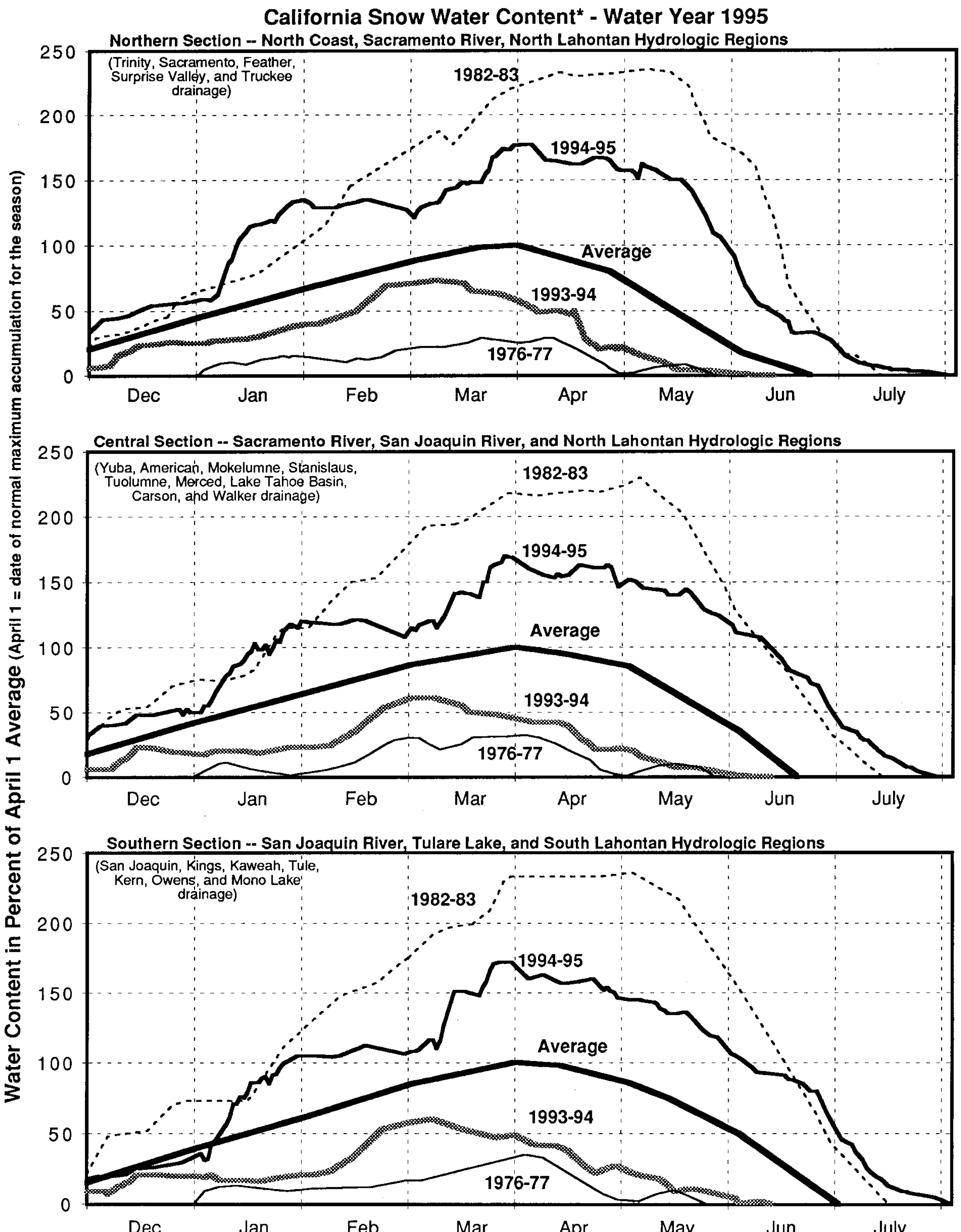
Continued warm weather produced a surge of snowmelt in early July as daily runoff peaks in the upper Tuolumne through Kings River watersheds approached or matched earlier peaks. After 24 hours of thunderstorm activity and warm southerly mountain winds, an unexpected secondary peak occurred on July 9 on many southern Sierra rivers. As several reservoirs approached capacity, operators were required to make substantial releases, swelling the lower San Joaquin River and many tributaries to near or above monitor stages during the second week of July. Warm high-elevation nighttime winds reduced the usual amount of radiation cooling, which contributed to this final snowmelt surge.

By the end of July river flows had decreased but remained well above normal for the time of year. Statewide runoff during July was 330 percent of average, and August 1 flows in the San Joaquin River near Vernalis, the southern inflow point into the Delta, were about 7,000 cubic feet per second compared with the August 1 average of approximately 1,500 cubic feet per second.

The San Joaquin River Flood Control System with its many multipurpose reservoirs, flood control bypasses, and floodways adequately managed the late-season snowmelt flood event. Although crop losses were frustrating and costly, loss of life and serious property damage were averted.

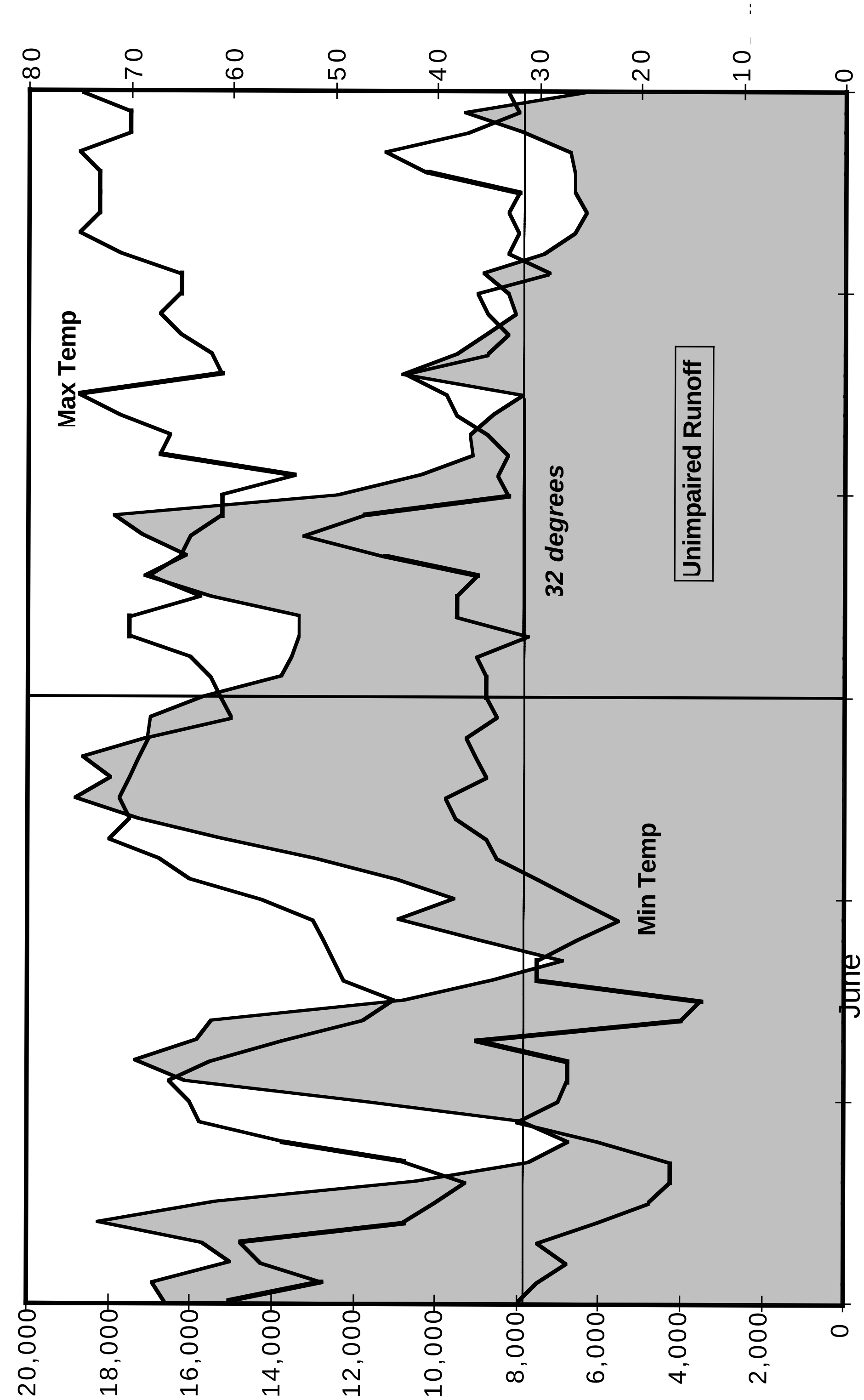
Flood and water supply forecasters, reservoir operators, and emergency managers gained a wealth of experience during the January and March floods and the late-season snowmelt. This experience will prove extremely valuable in future flood events.

Figure 14. California Snow Water Content, August 1, 1995



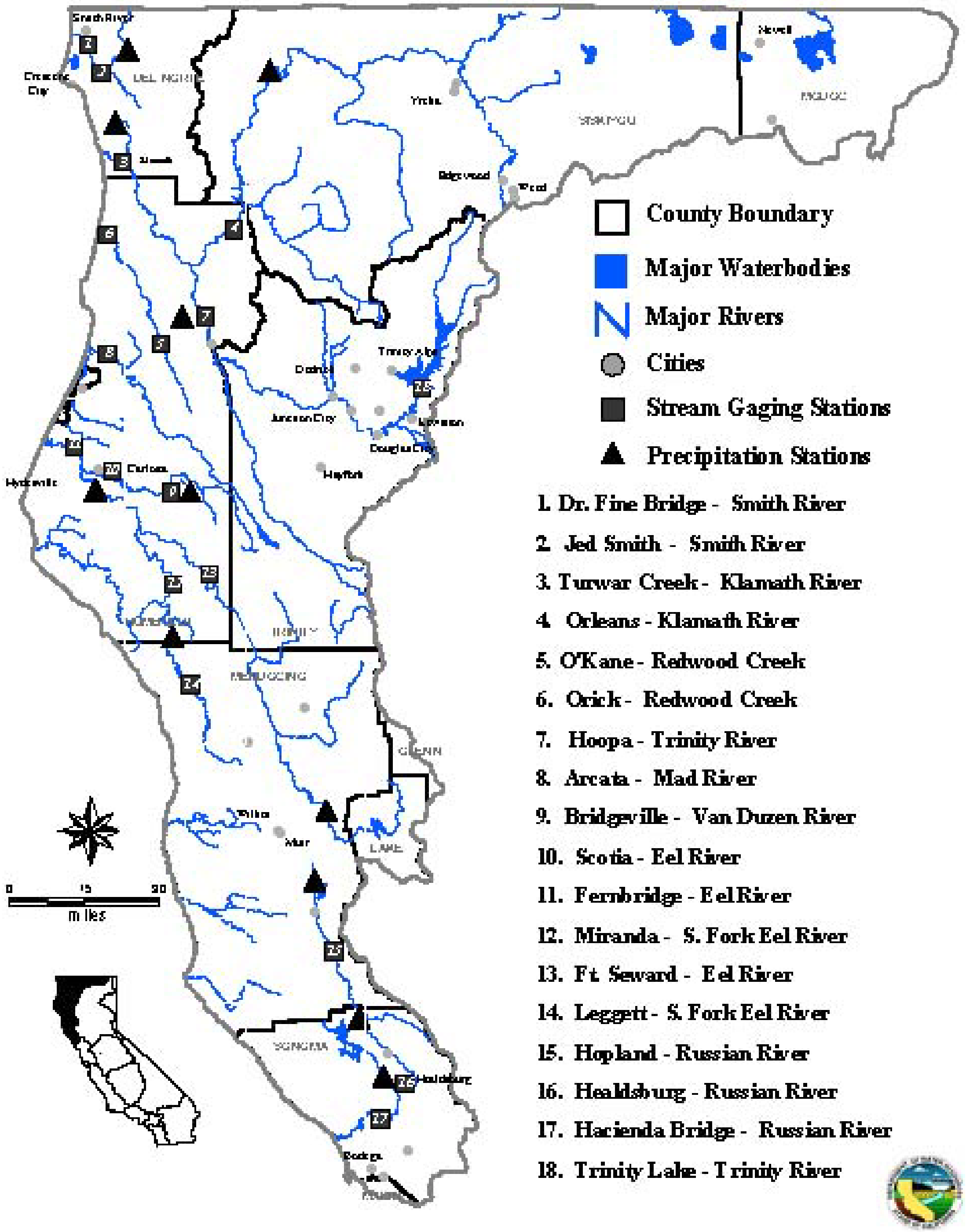
* Telemetered daily snow water equivalent data from automatic snow sensors operated by the Snow Surveys Program. Data from prior years is based on fewer sensors.

Figure 15. Tuolumne Meadows Daily Temperatures and Daily Unimpaired Snowmelt Runoff for the Tuolumne River in 1995



North Coast Hydrologic Region

Figure 16. Real Time Stream Gages and Selected Precipitation Stations, North Coast Hydrologic Region



North Coast Hydrologic Region

January Flood Event

January storms produced 245 percent of the monthly average precipitation and increased the seasonal total to 140 percent of average. Heavy precipitation produced runoff of about 7.1 million acre-feet, or 130 percent of average. Significant responses to storm runoff are summarized for key stream gaging stations (Figure 16) in the following paragraphs.

Smith River

- Jed Smith peaked at 25.6 feet on January 9, 3.4 feet below flood stage, with a maximum flow of 81,400 cubic feet per second.
- Dr. Fine Bridge peaked at 30.7 feet on January 9, 2.3 feet below flood stage, as the station's rain gage recorded almost 5.4 inches of rain (Figure 17).

Trinity River

- Hoopa peaked at 36.9 feet, well below monitor stage, with a maximum flow of 83,600 cubic feet per second. The basin received approximately 16 inches of precipitation in January (Figure 18).

Klamath River

- Orleans peaked at 25.9 feet on January 31, well below monitor stage, with a maximum flow of 112,000 cubic feet per second. The basin received an average of approximately 20 inches of rainfall in January (Figure 19).
- Turwar Creek (near Klamath Glen) peaked at 29.6 feet on February 1, 4.4 feet below flood stage, with maximum flows in excess of 248,000 cubic feet per second (Figure 20).

Humboldt County Sheriff Search and Rescue operations in the Mad River near Blue Lake. (The Times-Standard/Rick Bickel)

Residents used alternative means to navigate flooded city streets.

Redwood Creek

- Orick peaked at 21.5 feet on January 9, well below monitor stage, with a maximum flow of 18,600 cubic feet per second as almost 4 inches of rain fell on this day (Figure 21).

Mad River

- Arcata peaked at 20.3 feet on January 10, 3.7 feet below the 1995 flood stage of 24.0 feet, with a maximum flow of 38,100 cubic feet per second (Figure 22).

Van Duzen River

- Bridgeville (Grizzly Creek State Park) peaked at 19.7 feet on January 9, 2.7 feet above flood stage, with a maximum flow of 43,700 cubic feet per second. This was the highest stage recorded since March 1974 and has only been exceeded five times since 1952 (Figure 23).

Eel River

- Fort Seward peaked at 51.9 feet on January 9, 3.1 feet below monitor stage, with a maximum flow of 287,000 cubic feet per second (Figure 24).
- Scotia peaked at 51.3 feet on January 9, 0.3 feet above flood stage, with an estimated flow of 368,000 cubic feet per second.
- Fernbridge peaked at 25.2 feet on January 9, 5.2 feet above flood stage. This was the highest stage recorded since February 1986, and has only been exceeded five times since 1937. The

A Ferndale police officer stands watch on a flooded Main Street. Merchants used sandbags against the flood. (The Times-Standard/Cheryle Easter)

river remained above flood stage for 33 hours. A second rise to 1.8 feet above flood stage occurred on January 14 (Figure 25).

South Fork Eel River

- Leggett peaked at 18.8 feet on January 9, with a maximum flow of 33,100 cubic feet per second. The basin received 5.2 inches of rain on January 13.
- Miranda peaked at 28.4 feet on January 9, with a maximum flow of 81,000 cubic feet per second (Figure 26).

Russian River

- Hopland peaked at 22.4 feet on January 9, 1.4 feet above flood stage, with a maximum flow of 27,600 cubic feet per second (Figure 27).
- Healdsburg peaked at 26.2 feet on January 9, 7.2 feet above flood stage, with a maximum flow of 73,000 cubic feet per second. The basin received almost 32 inches of rain during January (Figure 28).
- Hacienda Bridge (upstream from Guerneville) peaked at 48.0 feet on January 9 just below the 1986 record of 48.6 feet, with an estimated flow of 93,900 cubic feet per second (Figure 29).

After experiencing the wettest November in 10 years, the North Coast was primed for storms tracking across the Pacific during the first week in January. By the evening of January 8, with the final in a series of five storms approaching, most North Coast rivers were headed for monitor or flood stage.

Along the Russian River approximately 1,500 properties were damaged in Guerneville, Monte Rio, Sebastopol, and Healdsburg. More than 300 people were evacuated in Guerneville, Sebastopol, and Santa Rosa. Portions of Sebastopol were under 9 feet of water when the Laguna de Santa Rosa overflowed.

Low-lying areas were evacuated near Myers Flat and Weott along the South Fork Eel River and in Carlotta on the Van Duzen River. National Weather Service warnings prompted evacuation of livestock from the Eel River Delta, but approximately 700 head of livestock were lost in the flooded pastures. Many smaller streams and rivers also flooded small valleys and secondary roads. Other flooded areas and roads included the following:

- The Eel River Delta, including portions of Fernbridge, Ferndale, and Loleta, Cannibal Island road west of Loleta, and State Highway 211, west of Fernbridge.

- State Highway 254 (Avenue of the Giants) between Myers Flat and Dyerville Loop Road near Weott, along the South Fork Eel River.
- Van Duzen County Park and State Highway 36, east of Carlotta along the Van Duzen River.
- Little Lake Valley east of Willits, from tributaries of the upper South Fork Eel River.

The Del Norte County Office of Emergency Services reported damage to homes and businesses, loss of telecommunication services, and road closures caused by winds of up to 75 miles per hour. Floodwater also led to high levels of silt in well water. About 30 homes lost tap water for a few days.

All counties in the North Coast Hydrologic Region except Siskiyou were declared federal disaster areas.

Stormy sea pounds cliffs below houses.

March Flood Event

After a dry February, a series of strong Pacific storms produced about 295 percent of average precipitation for March and raised the seasonal total to about 145 percent of average. Overall, North Coast rivers responded less dramatically than in January. The combined precipitation in January and March produced about 14.9 million acre-feet of runoff, and the seasonal average stood at 155 percent on April 1. Significant responses to storm runoff are summarized for key stream gaging stations in the following paragraphs.

Smith River

- Jed Smith peaked at 19.7 feet on March 20, 5.9 feet below the January peak, with a maximum flow of 38,400 cubic feet per second.
- Dr. Fine Bridge peaked at 21.0 feet on March 20, 9.7 feet below the January peak (see Figure 17).

Residents try to save belongings from Russian River floodwaters in Guerneville. (Sacramento Bee/Jose Luis Villegas)

Trinity River

- Hoopa peaked at 32.4 feet on March 12, 4.5 feet below the January peak, with flows in excess of 63,700 cubic feet per second. The basin received approximately 11 inches of precipitation in March (see Figure 18).

Klamath River

- Orleans peaked at 19.0 feet on March 20, 6.9 feet below the January peak, with a maximum flow of 54,600 cubic feet per second (see Figure 19).
- Turwar Creek peaked at 24.8 feet on March 12, 4.8 feet below the January peak, with a maximum flow near 110,000 cubic feet per second (see Figure 20).

Redwood Creek

- Orick peaked at 18.5 feet on March 18, 3.0 feet below the January peak, with a maximum flow near 10,000 cubic feet per second (see Figure 21).

Mad River

- Arcata peaked near 15.8 feet on March 9, 4.5 feet below the January peak, with flows in excess of 18,000 cubic feet per second (see Figure 22).

Van Duzen River

- Bridgeville peaked at 16.8 feet on March 14 just below flood stage, 2.9 feet below the January peak, with a maximum flow of 32,500 cubic feet per second (see Figure 23).

Eel River

- Fort Seward peaked at 38.7 feet on March 9, well below the January peak, with a maximum flow of 166,000 cubic feet per second (see Figure 24).
- Scotia peaked at 39.2 feet on March 9, also well below the January peak, with flows near 202,000 cubic feet per second.
- Fernbridge peaked at 19.9 feet, 5.3 feet below the January peak, on March 9 (see Figure 25).

South Fork Eel River

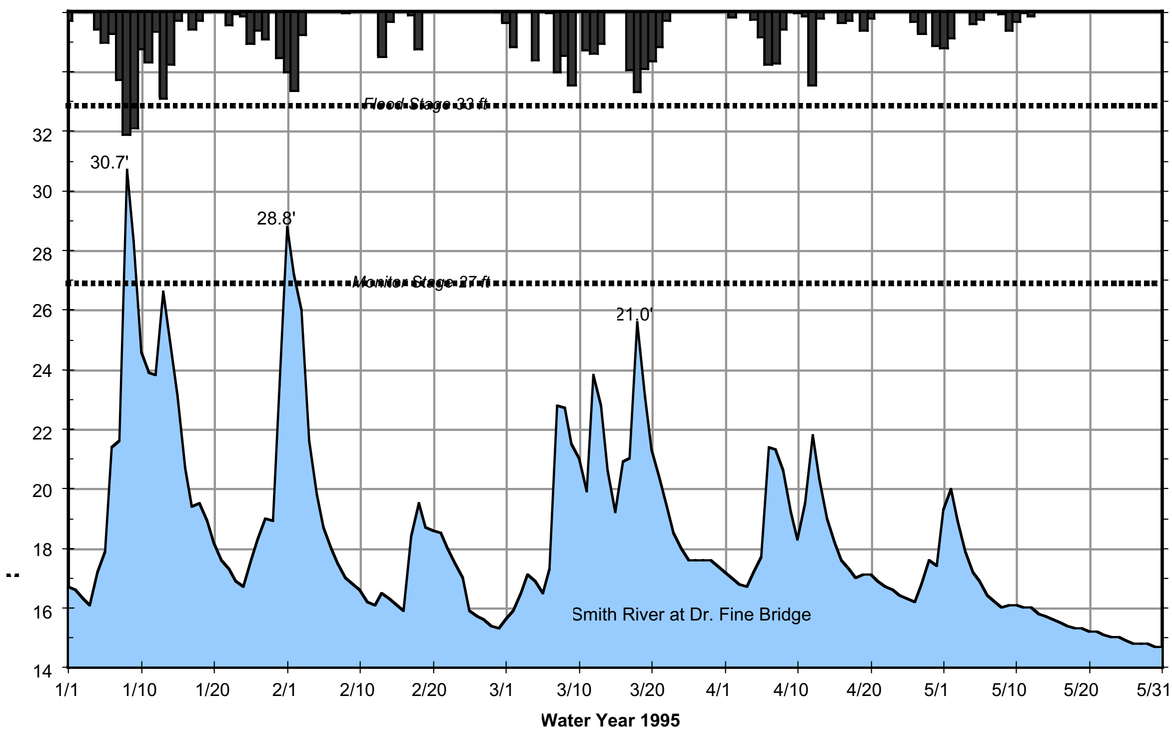
- Leggett peaked near 13.4 feet on March 14, 5.4 feet below the January peak, with flows near 17,600 cubic feet per second. The basin received about 20 inches of rainfall during March.
- Miranda peaked at 24.1 feet on March 14, 4.3 feet below the January peak, with flows near 46,000 cubic feet per second (see Figure 26).

Russian River

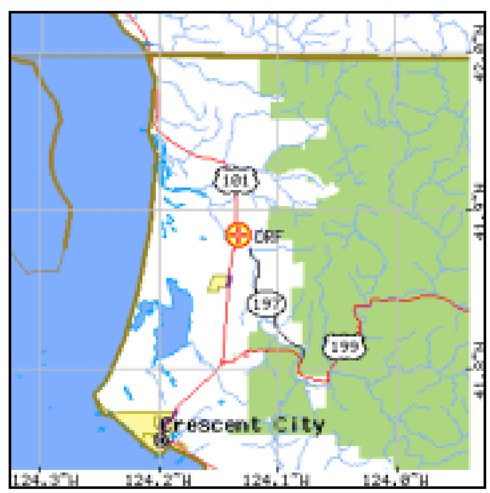
- Hopland peaked above 18.2 feet, 4.2 feet below the January peak, with flows in excess of 19,000 cubic feet per second (see Figure 27).
- Healdsburg peaked at 22.8 feet on March 9, 3.4 feet below the January peak, with flows near 58,000 cubic feet per second. The basin received almost 21 inches of rain during March (see Figure 28).
- Hacienda Bridge peaked at 42.0 feet on March 10, 6.0 feet below the January peak, with flows in excess of 63,000 cubic feet per second (see Figure 29).

All counties in the North Coast Hydrologic Region except Del Norte were declared federal disaster areas.

Figure 17. Hydrograph of the Smith River at Dr. Fine Bridge



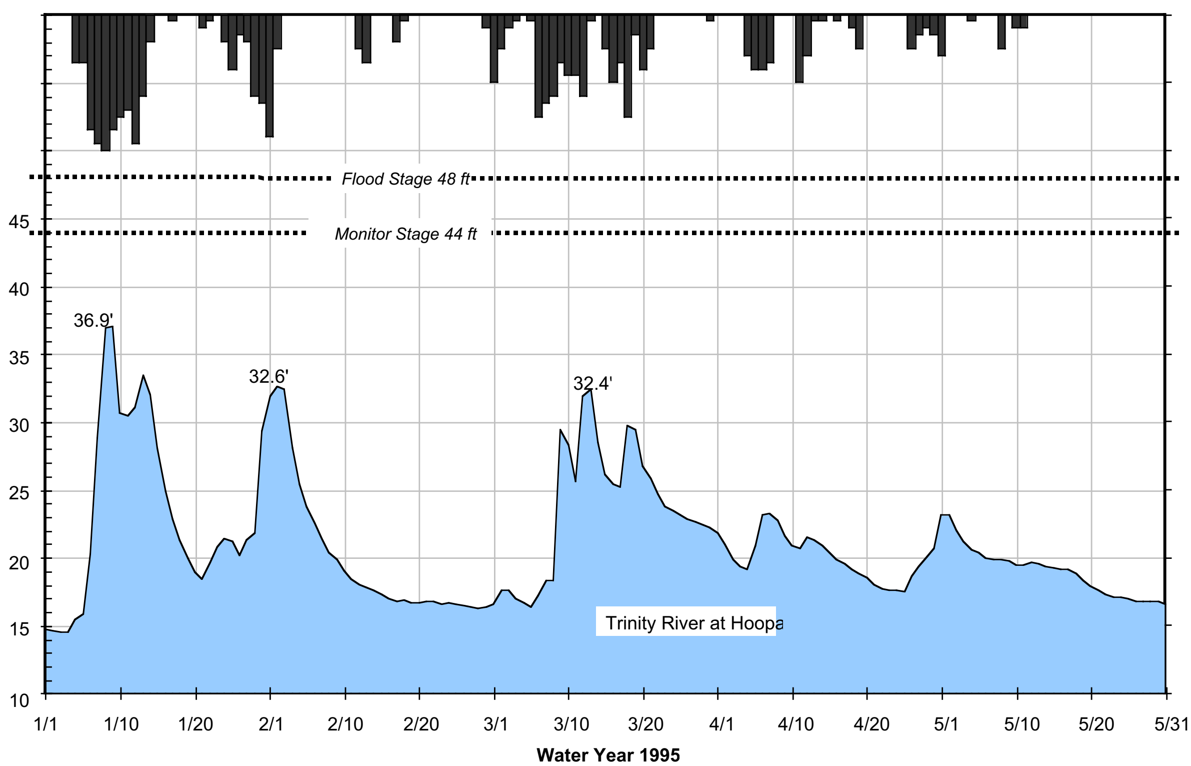
Gage Information
CDEC ID: DRF
Cooperating Agencies: USGS, DWR
Data Collection: Microwave, Satellite



Gage Location
Hydrologic Region: North Coast
River Basin: Smith River
County: Del Norte
Latitude: 41.8830°N
Longitude: 124.1330°W
Elevation: 63 feet

River Stage Information
Datum: 0=0.0 feet NGVD
Peak of Record: 39.5 feet on December 22, 1964

Figure 18. Hydrograph of the Trinity River at Hoopa



Gage Information
CDEC ID: HPA
Cooperating Agencies: USGS, DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: North Coast
River Basin: Trinity River (Lower Klamath River Tributary)
County: Humboldt
Latitude: 41.0260°N
Longitude: 123.6510°W
Elevation: 330 feet

River Stage Information
Datum: 0=274.83 feet NGVD
Peak of Record: 57.0 feet on December 22, 1964

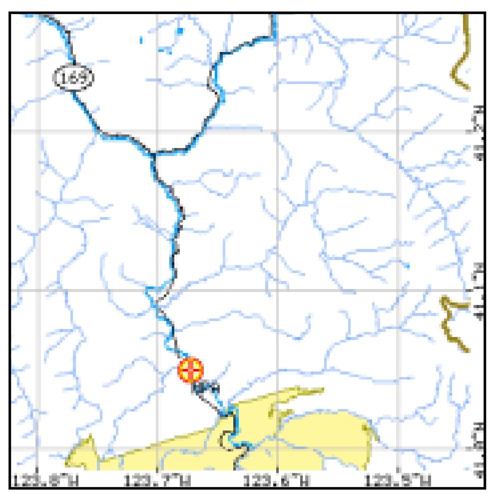
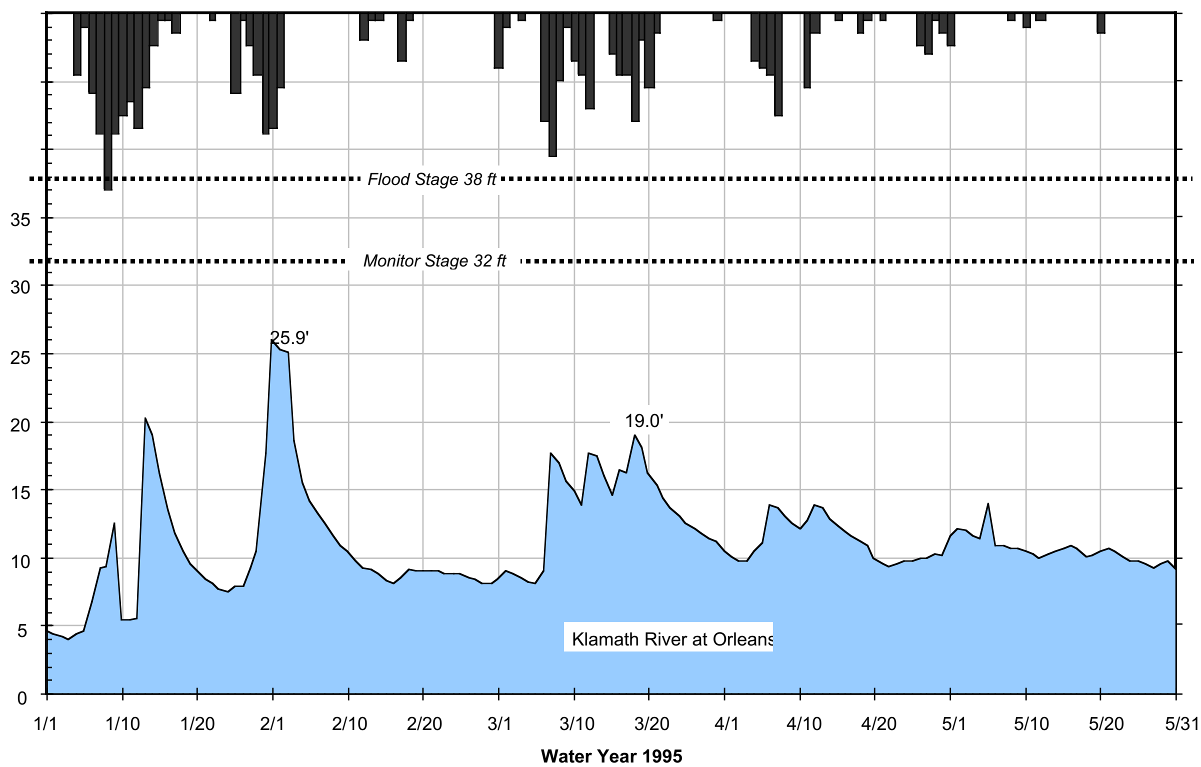


Figure 19. Hydrograph of the Klamath River at Orleans

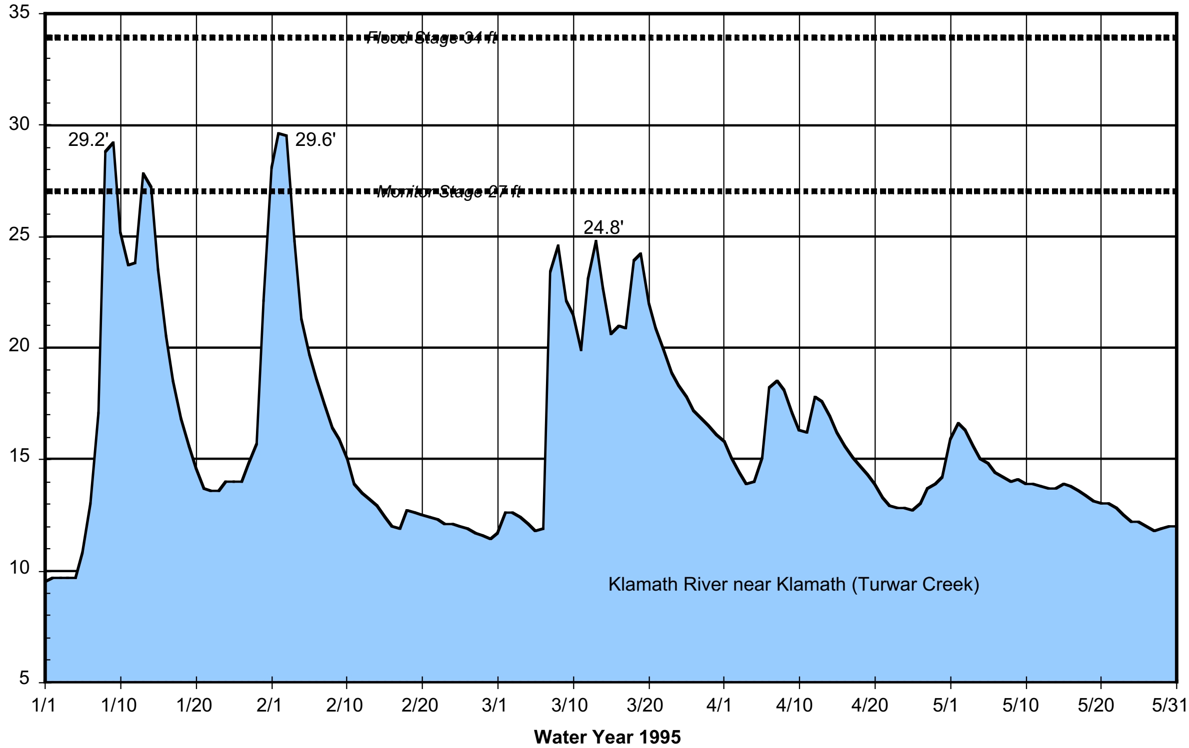


Gage Information
CDEC ID: OLS
Cooperating Agencies: USGS, NWS, DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: North Coast
River Basin: Lower Klamath River
County: Humboldt
Latitude: 41.3000°N
Longitude: 123.5330°W
Elevation: 430 feet

River Stage Information
Datum: 0=353.98 feet NGVD
Peak of Record: 48.3 feet on December 22, 1964

Figure 20. Hydrograph of the Klamath River near Klamath (Turwar Creek)



Gage Information
CDEC ID: TUR (Official USGS name is Klamath River near Klamath)
Cooperating Agencies: USGS, DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: North Coast
River Basin: Lower Klamath River
County: Del Norte
Latitude: 41.5120°N
Longitude: 123.9990°W
Elevation: 6 feet

River Stage Information
Datum: 0=0.0 feet NGVD
Peak of Record: 55.3 feet on December 23, 1964

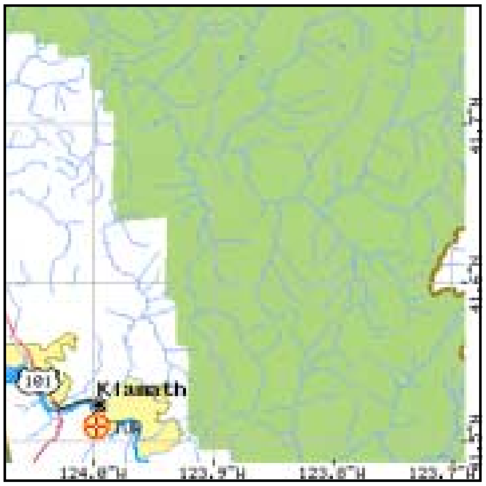
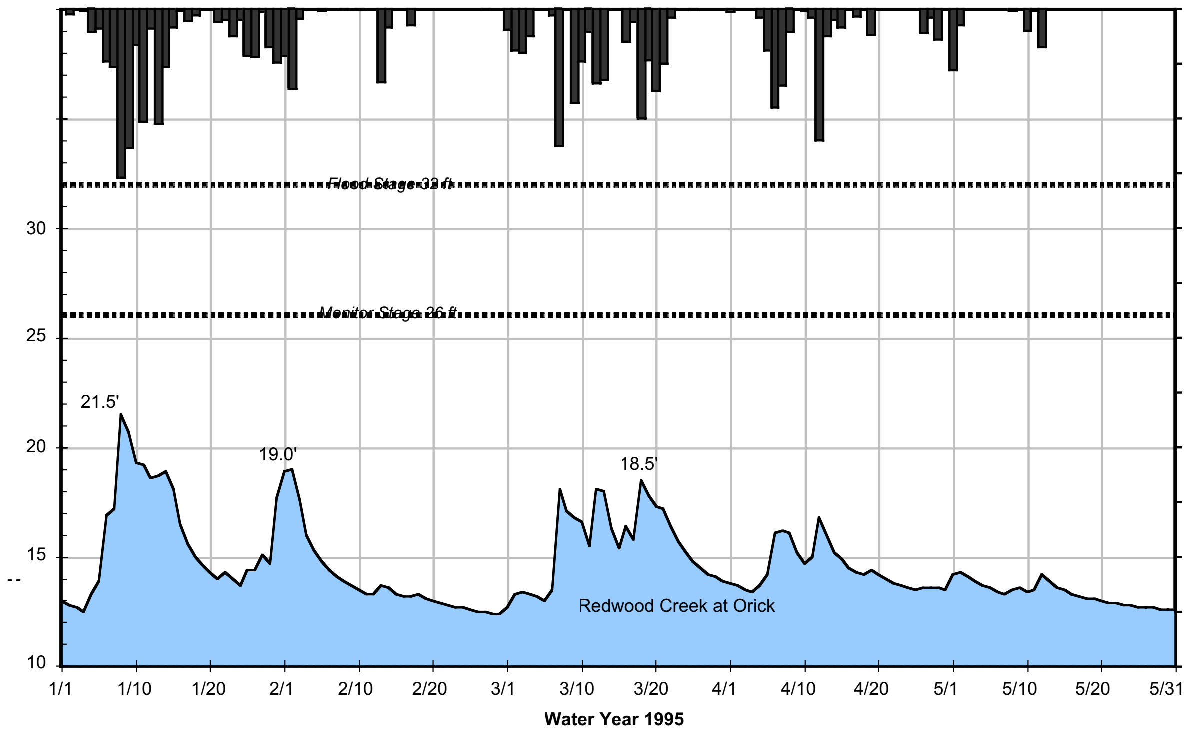


Figure 21. Hydrograph of Redwood Creek at Orick



Gage Information
CDEC ID: ORK
Cooperating Agencies: USGS, DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: North Coast
River Basin: Redwood Creek
County: Humboldt
Latitude: 41.2830°N
Longitude: 124.0500°W
Elevation: 36 feet

River Stage Information
Datum: 0=5.16 feet NGVD
Peak of Record: 28.22 feet on January 1, 1997

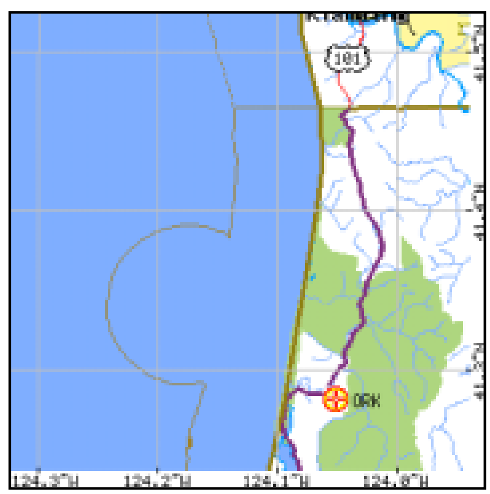
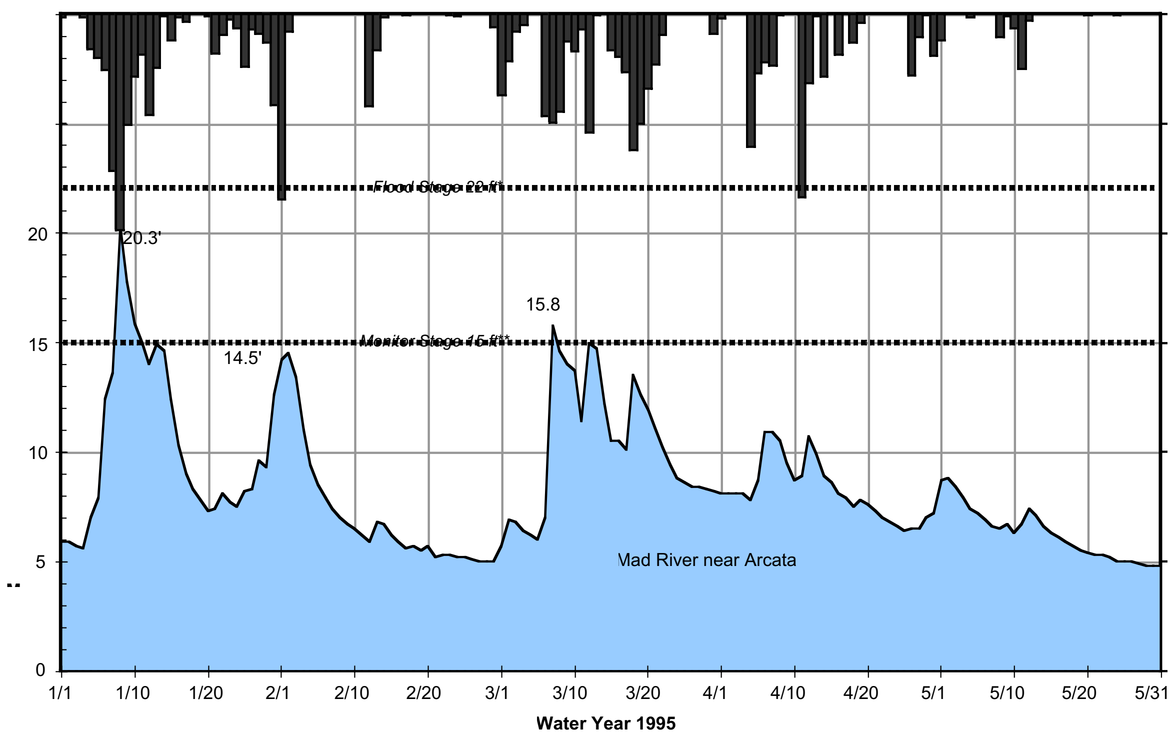


Figure 22. Hydrograph of the Mad River near Arcata



*Flood stage reduced from 24.0 to 22.0 feet in November 1999.

**Monitor stage reduced from 17.0 to 15.0 feet in June 1999.

Gage Information
CDEC ID: ARC
Cooperating Agencies: USGS, DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: North Coast
River Basin: Mad River
County: Humboldt
Latitude: 40.9100°N
Longitude: 124.0600°W
Elevation: 33 feet

River Stage Information
Datum: 0=10.79 feet NGVD
Peak of Record: 30.7 feet on December 22, 1964

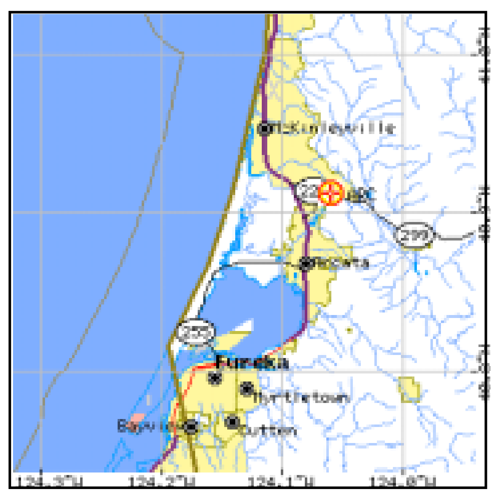
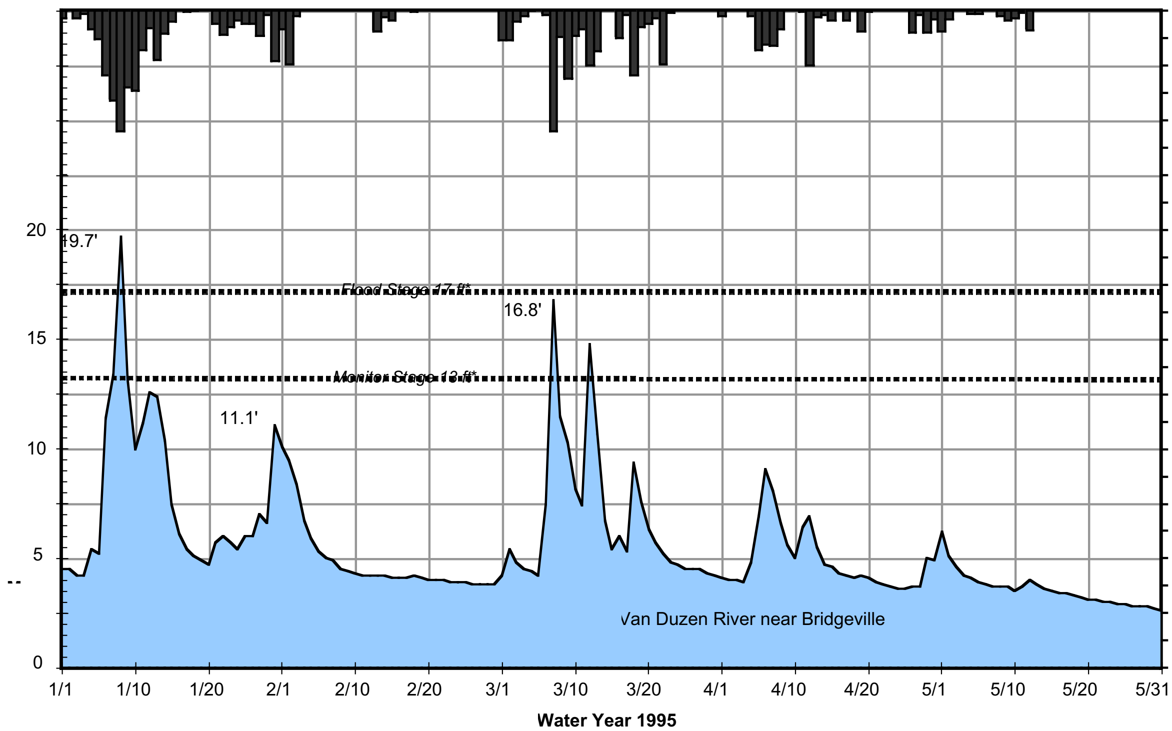
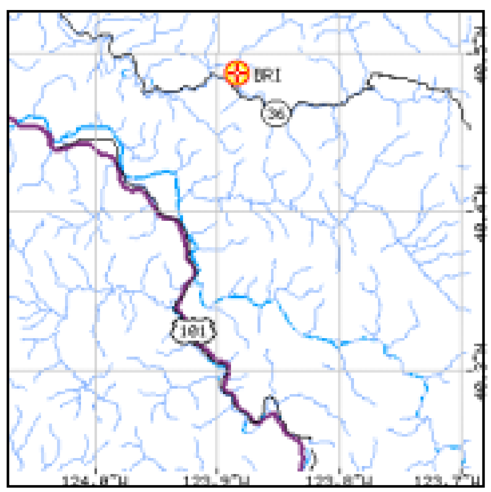


Figure 23. Hydrograph of the Van Duzen River near Bridgeville



* Monitor stage reduced from 15.0 to 13.0 feet prior to 1996-97 flood season.

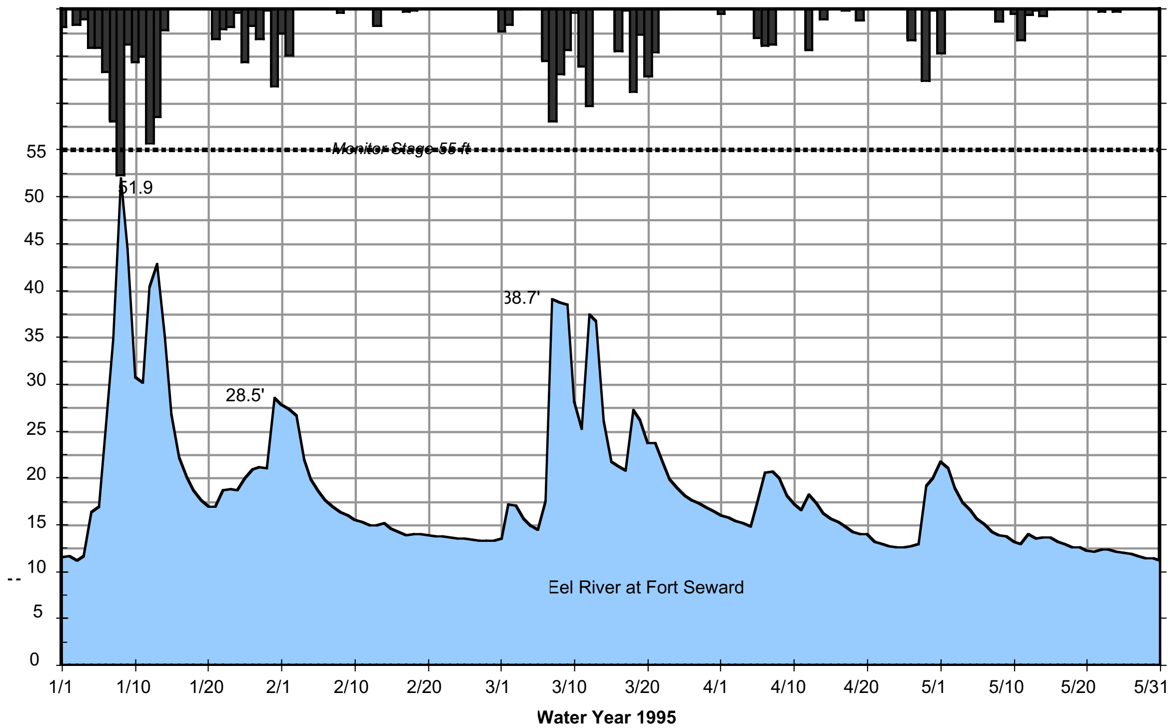


Gage Information
CDEC ID: BRI
Cooperating Agencies: USGS, DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: North Coast
River Basin: Van Duzen River (Eel River Tributary)
County: Humboldt
Latitude: 40.4830°N
Longitude: 123.8830°W
Elevation: 358 feet

River Stage Information
Datum: 0=358.18 feet NGVD
Peak of Record: 24.0 feet on December 22, 1964

Figure 24. Hydrograph of the Eel River at Fort Seward

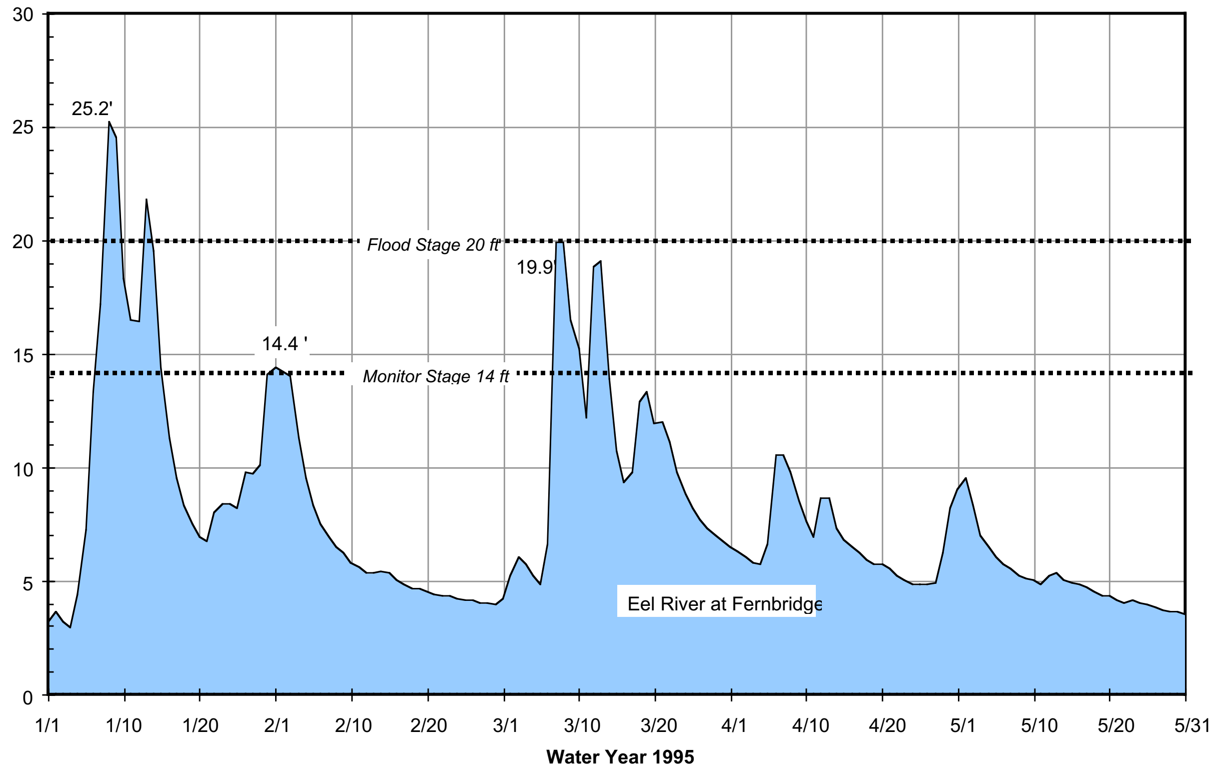


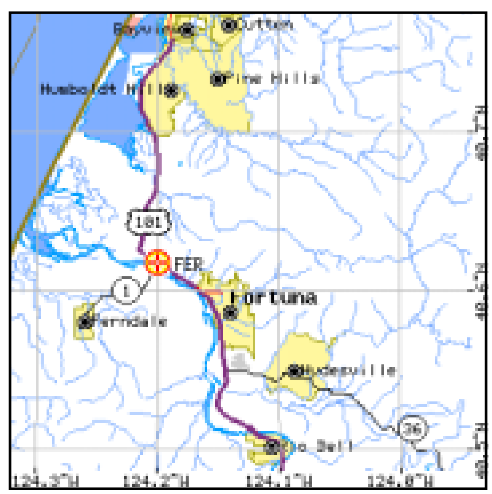
Gage Information
CDEC ID: FSW
Cooperating Agencies: USGS, NWS, DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: North Coast
River Basin: Eel River
County: Humboldt
Latitude: 40.2170°N
Longitude: 123.6330°W
Elevation: 320 feet

River Stage Information
Datum: 0=217.26 feet NGVD
Peak of Record: 82.6 feet on December 22, 1964

Figure 25. Hydrograph of the Eel River at Fernbridge



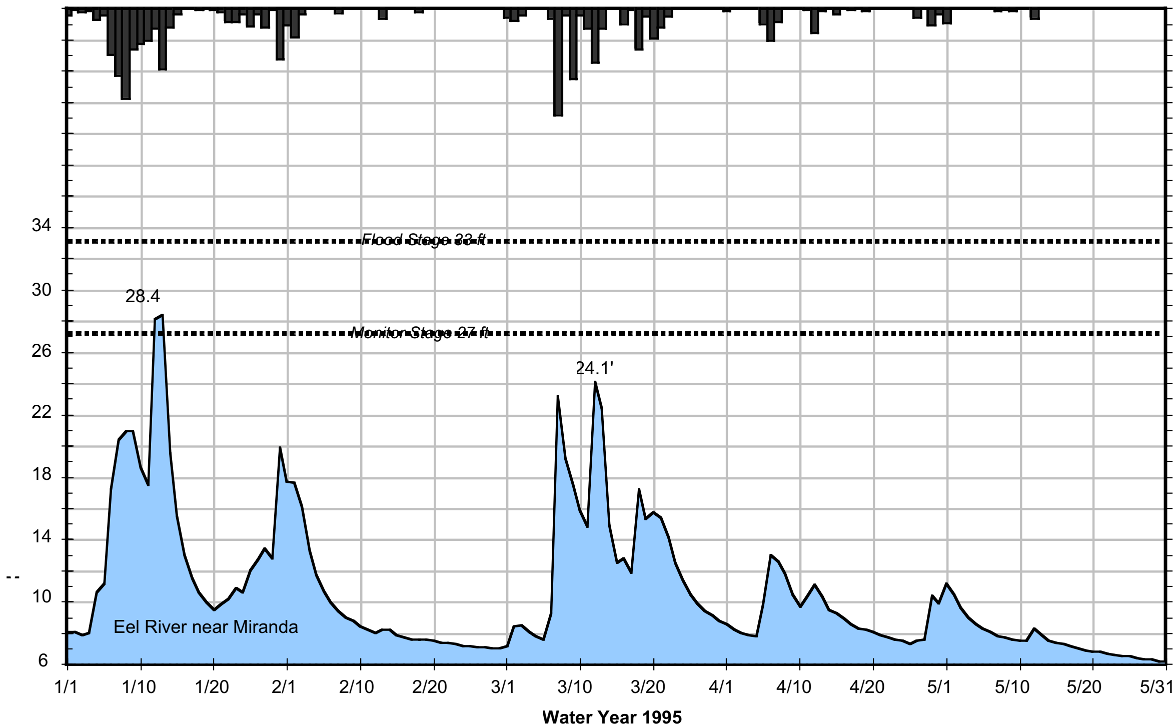


Gage Information
CDEC ID: FER
Cooperating Agencies: USGS, DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: North Coast
River Basin: Eel River
County: Humboldt
Latitude: 40.6170°N
Longitude: 124.2000°W
Elevation: 20 feet

River Stage Information
Datum: 0=3.64 feet NGVD
Peak of Record: 29.5 feet on December 23, 1964

Figure 26. Hydrograph of the South Fork Eel River near Miranda



Gage Information
CDEC ID: MRD
Cooperating Agencies: USGS, DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: North Coast
River Basin: Eel River
County: Humboldt
Latitude: 40.1830°N
Longitude: 123.7830°W
Elevation: 218 feet

River Stage Information
Datum: 0=217.57 feet NGVD
Peak of Record: 46.0 feet on December 22, 1964

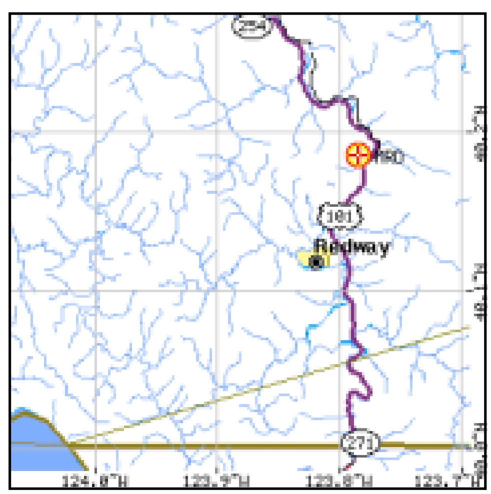
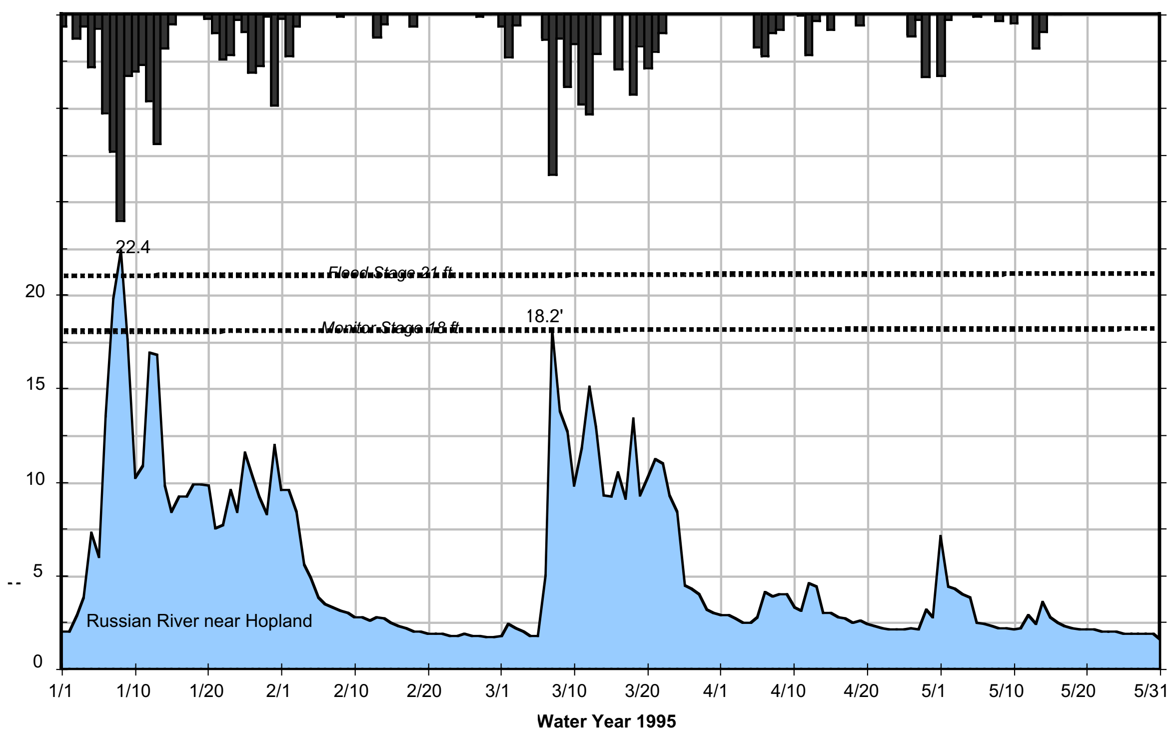
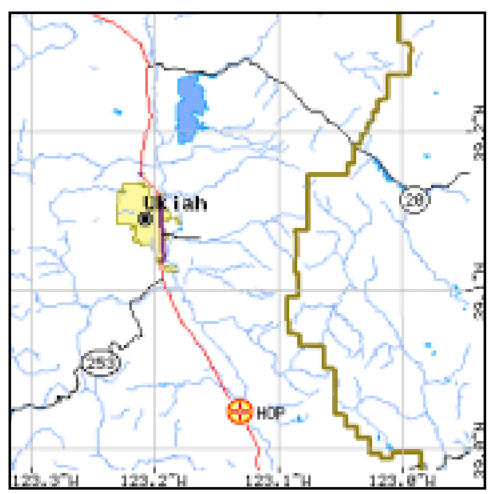


Figure 27. Hydrograph of the Russian River near Hopland



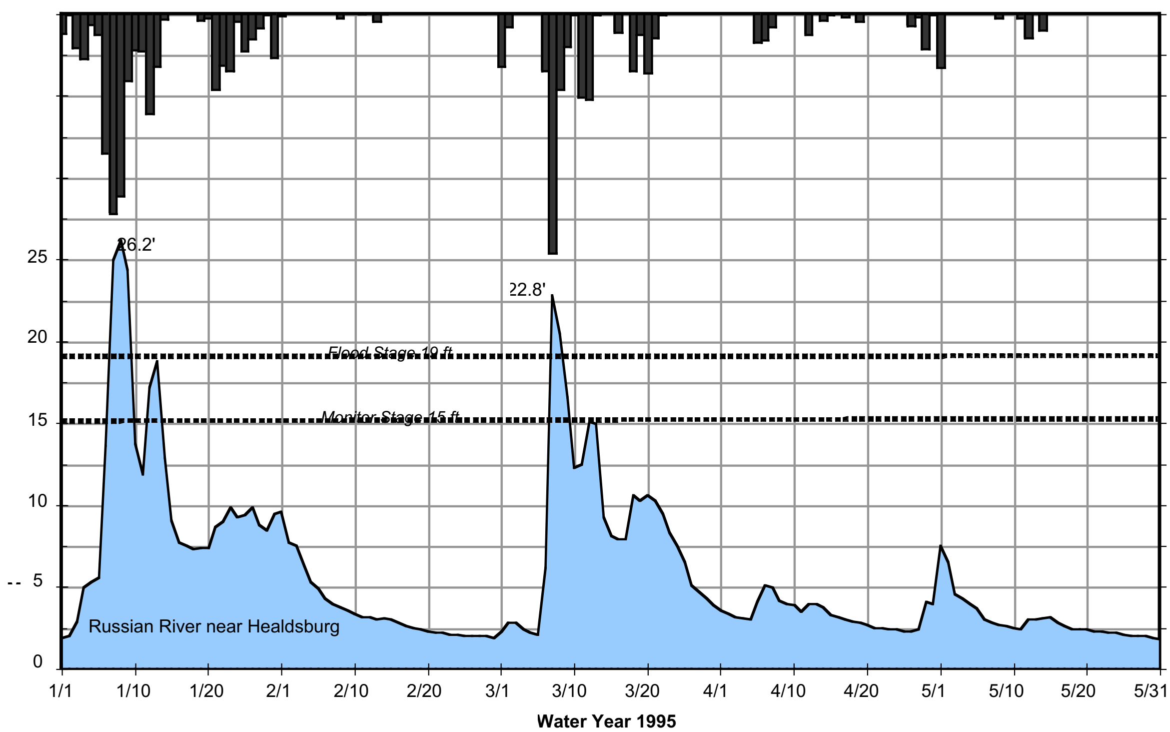
Gage Information
CDEC ID: HOP
Cooperating Agencies: USGS, Sonoma County, DWR
Data Collection: Microwave, Satellite



Gage Location
Hydrologic Region: North Coast
River Basin: Russian River
County: Mendocino
Latitude: 39.0260°N
Longitude: 123.1290°W
Elevation: 498 feet

River Stage Information
Datum: 0=497.61 feet NGVD
Peak of Record: 30.0 feet in December 1937 flood

Figure 28. Hydrograph of the Russian River near Healdsburg



Gage Information
CDEC ID: HEA
Cooperating Agencies: USGS, Sonoma County, DWR
Data Collection: Satellite

Gage Location
Hydrologic Region: North Coast
River Basin: Russian River
County: Sonoma
Latitude: 38.6170°N
Longitude: 122.8670°W
Elevation: 108 feet

River Stage Information
Datum: 0=77.01 feet NGVD
Peak of Record: 30.8 feet in December 1937 flood

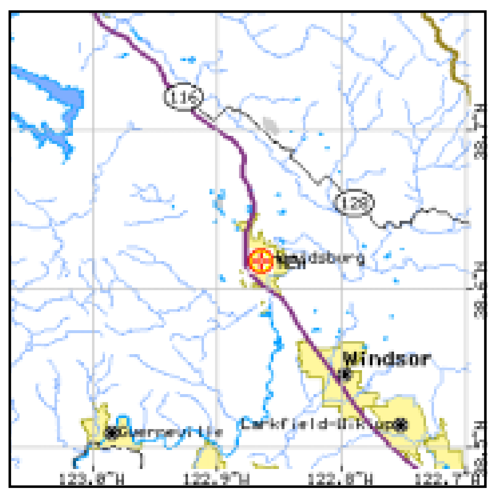
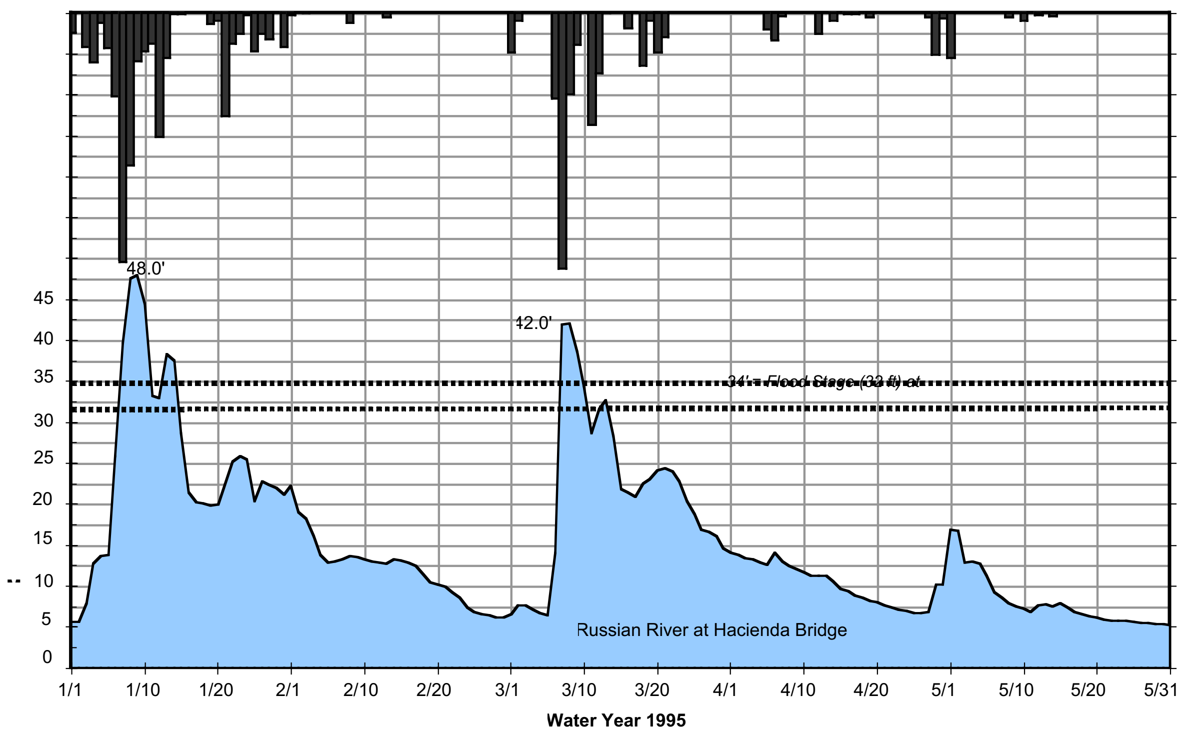


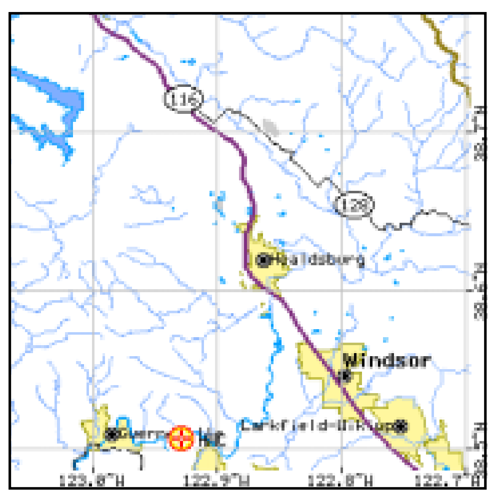
Figure 29. Hydrograph of the Russian River at Hacienda Bridge



Gage Information
CDEC ID: HAC
Cooperating Agencies: USGS, Sonoma County, DWR
Data Collection: Satellite

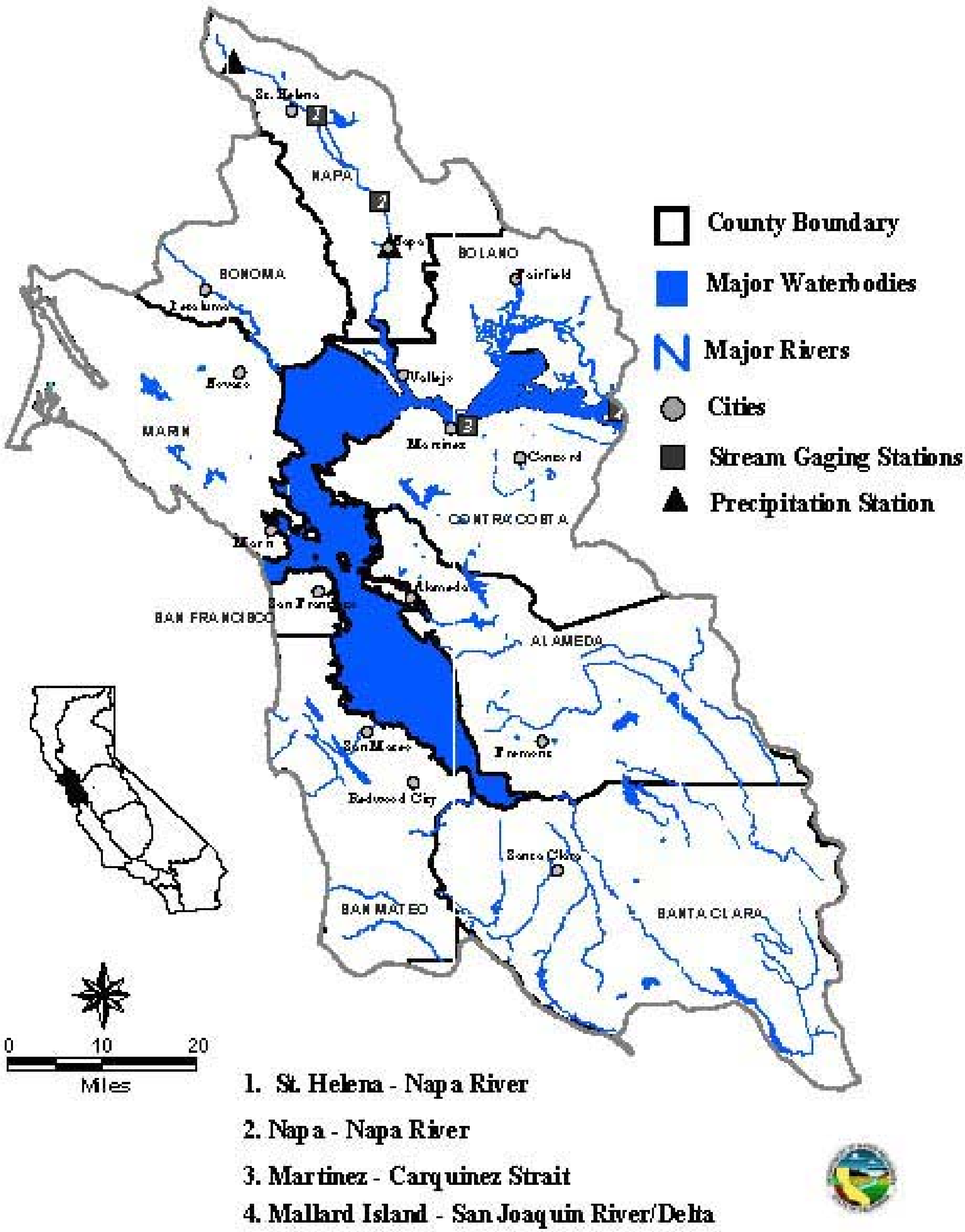
Gage Location
Hydrologic Region: North Coast
River Basin: Russian River
County: Sonoma
Latitude: 38.5090°N
Longitude: 122.9270°W
Elevation: 20 feet

River Stage Information
Datum: 0=20.1 feet NGVD
Peak of Record: 48.6 feet on February 18, 1986



San Francisco Bay Hydrologic Region

Figure 30. Location of Real Time Stream Gages and Selected Precipitation Stations, San Francisco Bay Hydrologic Region



San Francisco Bay Hydrologic Region

January Flood Event

January rainfall produced about 250 percent of average monthly precipitation and increased the seasonal total to about 170 percent of average, much higher than the 60 percent of average in 1994. Figure 30 shows the location of stream gages in the San Francisco Bay Hydrologic Region. Napa River runoff totaled about 190,000 acre-feet, nearly 195 percent of average. Significant responses to storm runoff are summarized for key stream gaging stations in the following paragraphs.

Napa River

- St. Helena peaked at 17.5 feet on January 9, 4.5 feet above flood stage, with flows in excess of 9,100 cubic feet per second (Figure 31).
- Downstream near Napa the river peaked at 26.4 feet on January 10, 1.4 feet above flood stage, with flows near 21,000 cubic feet per second (Figure 32).

The City and County of San Francisco reported storm damage to the coastline. The combined storm water and sewage system in San Francisco sustained damage from heavy street runoff.

March Flood Event

March rainfall produced about 345 percent of average monthly precipitation and increased the seasonal level to about 165 percent of average. Napa River runoff totaled about 149,000 acre-feet, nearly 240 percent of average. Significant responses to storm runoff are summarized for key stream gaging stations in the following paragraphs.

Napa River

- St. Helena peaked at 18.3 feet on March 9, 5.3 feet above flood stage, with flows near 11,000 cubic feet per second (see Figure 31). In St. Helena, 400 residents were evacuated from a riverside mobile home park and two apartment buildings.

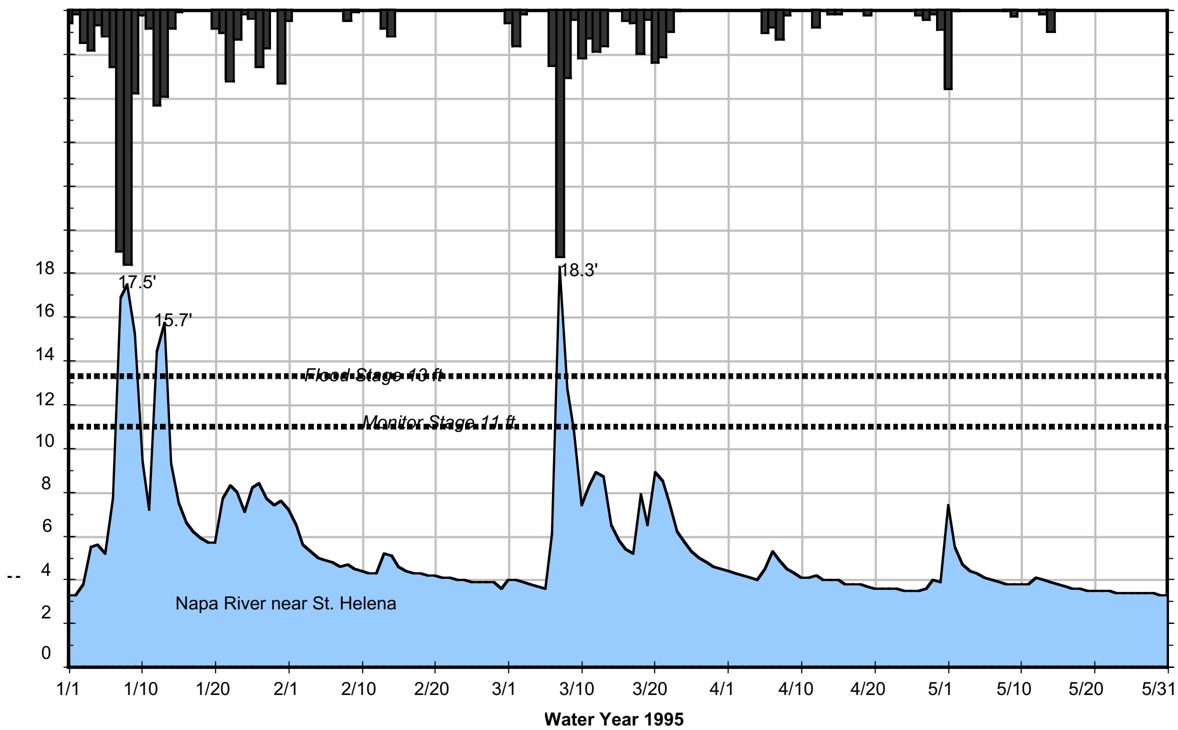
Rain continues to fall while floodwater surrounds a a building in St. Helena. (Photo by Napa County)

- Downstream near Napa the river peaked at 30.5 feet on March 9, 5.5 feet above flood stage, with a maximum flow of 32,600 cubic feet per second (see Figure 32). The water in downtown Napa was high, and officials reported cars floating down streets.

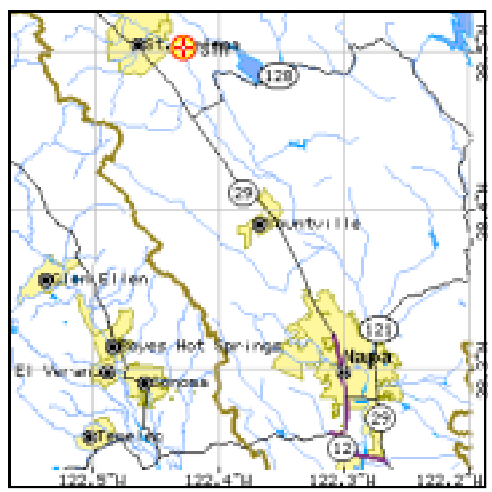
The City and County of San Francisco reported storm damage to the coastline. Again, the combined storm water and sewage system in San Francisco suffered damage. On March 8, torrential rains falling on saturated watersheds caused heavy runoff and a flash flood on Napa Creek. On March 10 the usually quiet Guadalupe River became a torrent, roaring over its banks and leaving downtown San Jose knee-deep in water. The river reached the tops of its bridges and flowed into nearby residential neighborhoods, sending residents fleeing to hastily prepared emergency shelters.

All counties in this region were declared federal disaster areas.

Figure 31. Hydrograph of the Napa River near St. Helena



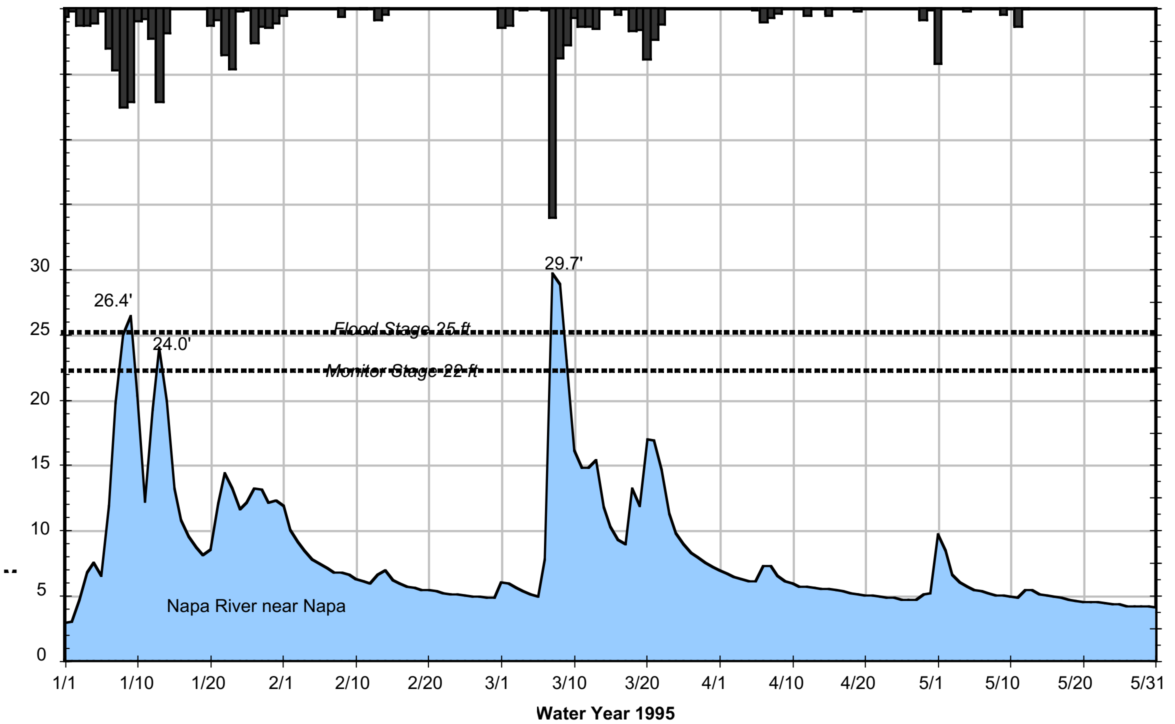
Gage Information
CDEC ID: STH
Cooperating Agencies: USGS, DWR
Data Collection: Microwave, Satellite

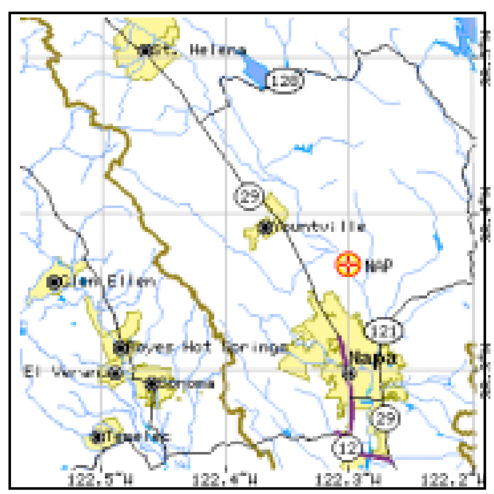


Gage Location
Hydrologic Region: San Francisco Bay
River Basin: Napa River
County: Napa
Latitude: 38.4980°N
Longitude: 122.4270°W
Elevation: 173 feet

River Stage Information
Datum: 0=170.12 feet NGVD
Peak of Record: 18.52 feet on February 17, 1986

Figure 32. Hydrograph of the Napa River near Napa





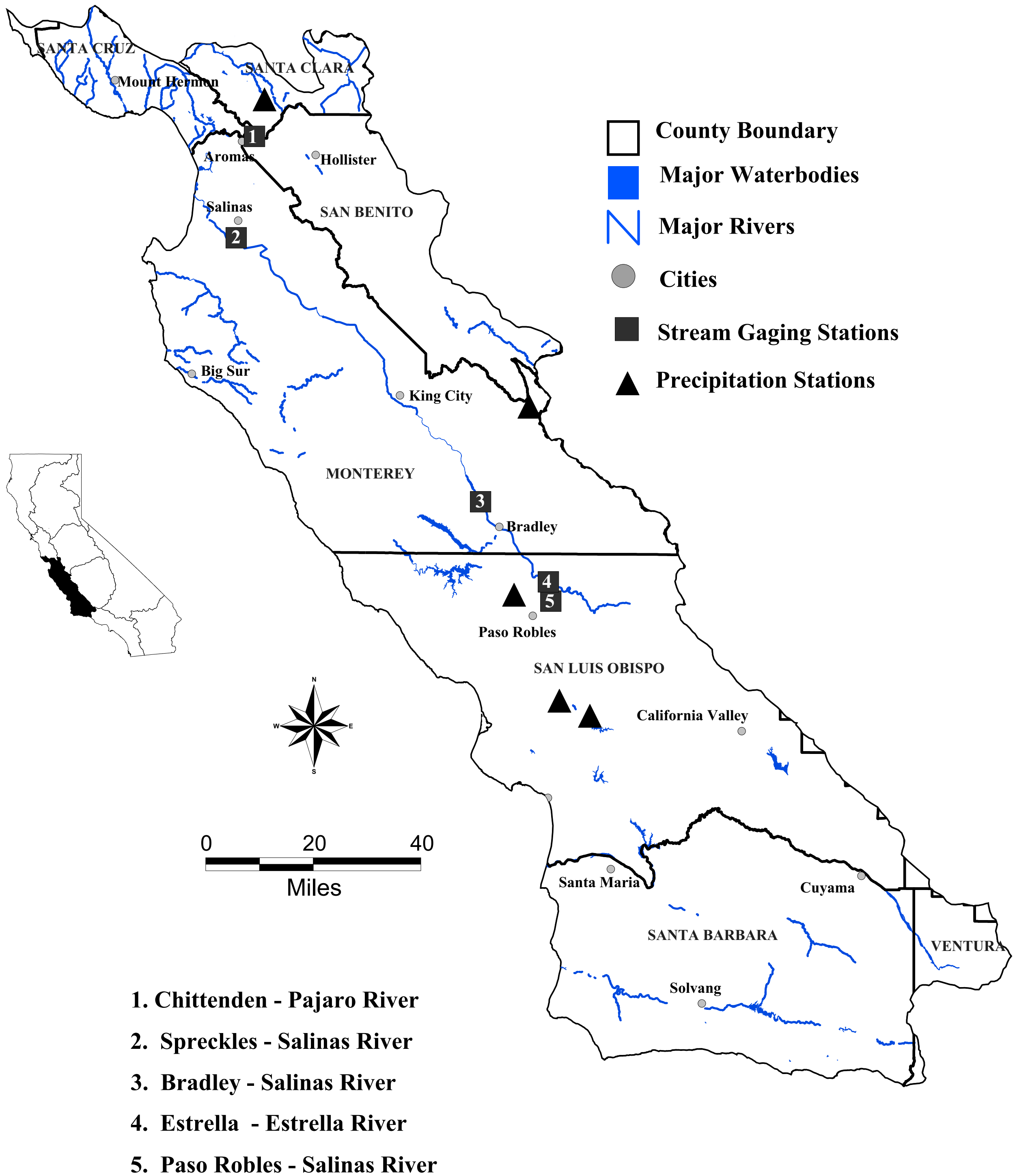
Gage Information
CDEC ID: NAP
Cooperating Agencies: USGS, DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: San Francisco Bay
River Basin: Napa River
County: Napa
Latitude: 38.3670°N
Longitude: 122.3000°W
Elevation: 25 feet

River Stage Information
Datum: 0=24.74 feet NGVD
Peak of Record: 30.5 feet on March 9, 1995

Central Coast Hydrologic Region

Figure 33. Location of Real Time Stream Gages and Selected Precipitation Stations, Central Coast Hydrologic Region



Central Coast Hydrologic Region

January Flood Event

January storms produced 395 percent of the monthly average precipitation and increased the seasonal total to 210 percent of average in stark contrast to the 1994 season total of 60 percent of average. Heavy precipitation produced runoff of about 239,000 acre-feet, or 185 percent of average.

Significant responses to storm runoff are summarized for key stream gaging stations (Figure 33) in the following paragraphs.

Pajaro River

- Chittenden peaked at 20.6 feet on January 25, 4.4 feet below monitor stage, with a flow near 4,500 cubic feet per second (Figure 34).

Salinas River

- Bradley peaked at 12.6 feet on January 11, 0.4 feet above the 1995 flood stage with flows near 14,000 cubic feet per second (Figure 35).
- Spreckles peaked at 20.3 feet on January 26, 2.7 feet below flood stage, with flows near 12,500 cubic feet per second (Figure 36).

Although threatened by swollen creeks, Santa Cruz County flooding was localized and limited to a few areas. The main flooding in Monterey County occurred west of Highway 1 and in the Carmel Valley due to excessive rains on a saturated watershed. The Carmel River overtopped its banks and breached private levees. Excessive rainfall submerged 90 miles of railroad track between San Luis Obispo and Los Angeles forcing cancellation of Amtrak service. The City of Santa Barbara was affected by storm runoff and flooding from the overflowing of Mission Creek.

All counties in this region except San Benito were declared federal disaster areas.

Carmel River Inn with encroaching January floodwaters as viewed from the Highway 1 Bridge. (Golden State Floodlight)

March Flood Event

Record March rainfall produced 345 percent of the monthly average precipitation and increased the seasonal total to 195 percent of average. Runoff totaled about 615,000 acre-feet, or 220 percent of average.

Significant responses to storm runoff are summarized for key stream gaging stations in the following paragraphs.

Pajaro River

- Chittenden peaked at 32.1 feet on March 10 just above flood stage with a maximum flow of 21,500 cubic feet per second (see Figure 34). Most of the town of Pajaro's 2,500 residents were ordered out of their homes after a levee failed, flooding homes and businesses to depths up to 7 feet. Unfortunately, two men drowned.

Salinas River

- Bradley peaked at 23.4 feet on March 11, 10.4 feet above the 1995 flood stage, and 3.1 feet above the previous record set in February 1969, with maximum flow of 120,000 cubic feet per second (see Figure 35).

- Spreckles peaked at 30.4 feet on March 12, 7.4 feet above flood stage, and 4.2 feet above the previous record set in January 1952, with flows near 95,000 cubic feet per second (see Figure 36). The river flooded Highways 1 and 68, cutting off the Monterey peninsula from the north and east. Thousands of people were evacuated, hundreds of homes were flooded, and more than 100,000 acres of choice farmland were inundated.

This storm triggered a number of mudslides and floods throughout the Central Coast Hydrologic Region. Thousands of acres of farmland were inundated in Monterey and Santa Cruz counties including the Pajaro and Salinas valleys. In Santa Cruz County the San Lorenzo River reached its highest level since flooding in the early 1980s. In Monterey County's rural Carmel Valley, stages on the Carmel River reached record levels forcing evacuation of 2,500 residents along 30 miles of river. The Carmel washed out a bridge on Highway 1 cutting off the Monterey peninsula from the south. Flooding on the Pajaro, Salinas, and Carmel rivers completely isolated the peninsula from the rest of the State. In San Luis Obispo County excessive rainfall resulted in significant flooding in the small coastal community of Cambria.

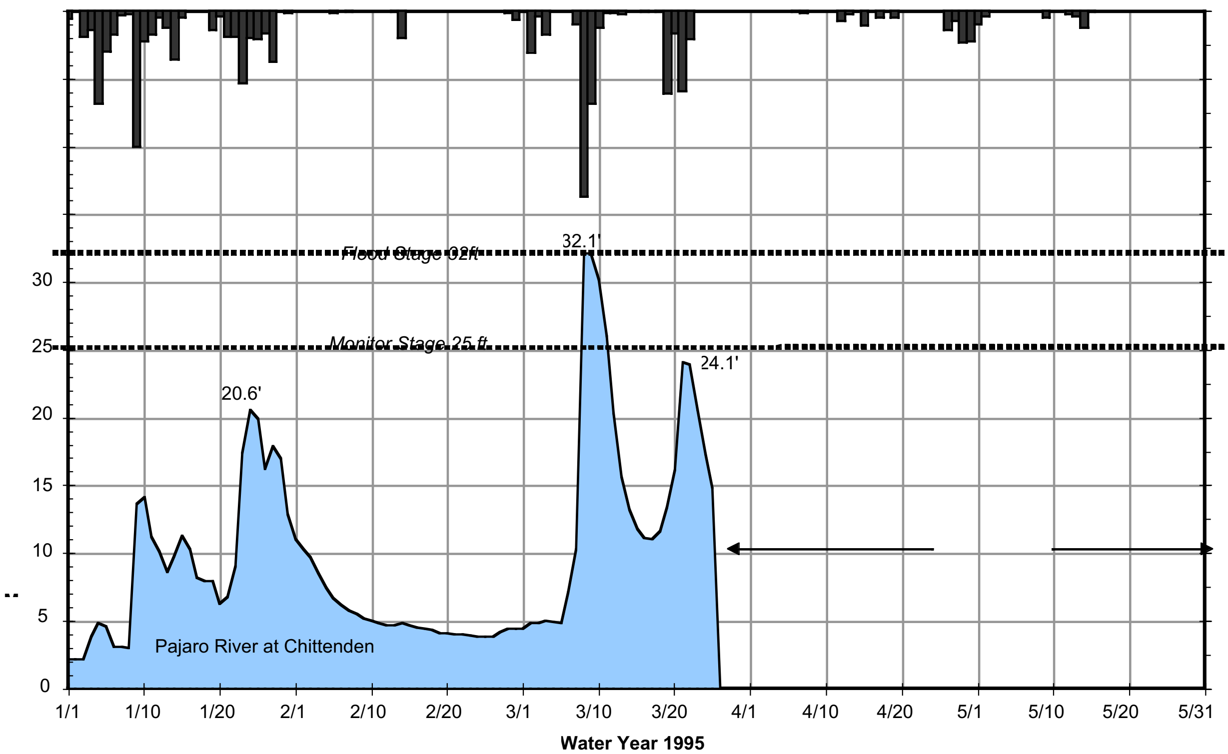
Farther south in Santa Barbara County storms produced record rainfall causing widespread flooding and slides with damage to many homes and downtown businesses. Flooding also occurred along San Antonio Creek. U.S. Highway 101 northbound was closed near Manchester Canyon in Santa Barbara County. Flooded runways closed the Santa Barbara Airport. In the city of Santa Barbara a wave of water from Sycamore Creek crashed through a home and washed away an occupant who was later found deceased.

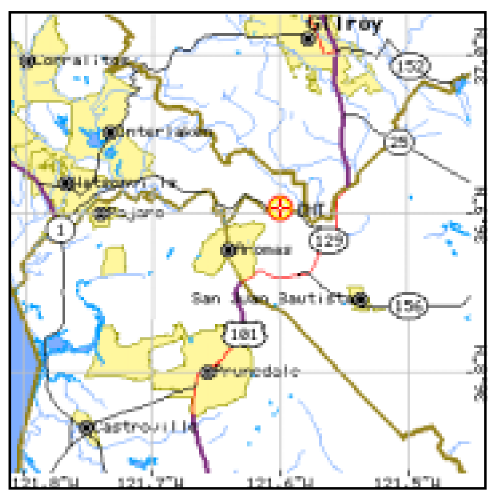
All counties in the region were declared federal disaster areas.

Near Santa Barbara, residential areas in Goleta were flooded by Maria Ygnacio Creek. This photo was taken on March 12, 1995.

Sycamore Creek ravaged portions of Santa Barbara, flooding and severely damaging many bridges, trailer parks, and residential areas. This photo was taken on March 12, 1995. (Photos on this page provided by Santa Barbara County Flood Control and Water Conservation District)

Figure 34. Hydrograph of the Pajaro River at Chittenden



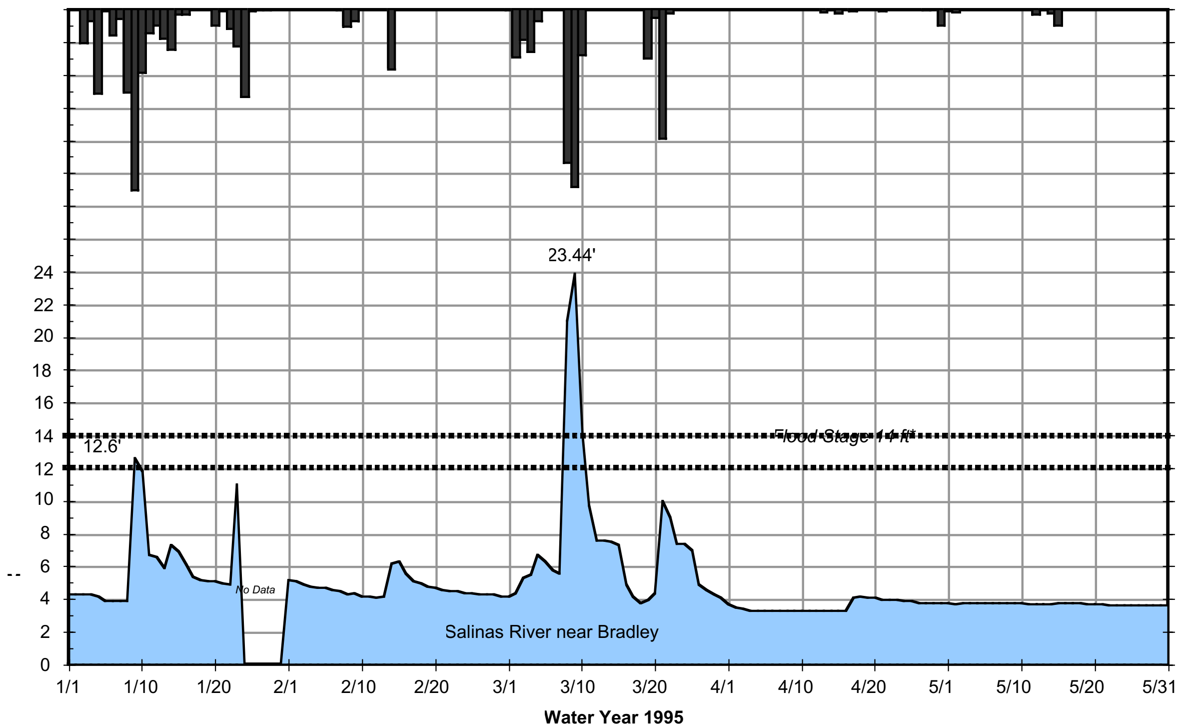


Gage Information
CDEC ID: CHT
Cooperating Agencies: USGS, DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: Central Coast
River Basin: Pajaro River
County: Monterey
Latitude: 36.9020°N
Longitude: 121.6050°W
Elevation: 82 feet

River Stage Information
Datum: 0=81.89 feet NGVD
Peak of Record: 33.74 feet on February 3, 1998

Figure 35. Hydrograph of the Salinas River near Bradley



* Flood stage raised from 13.0 to 14.0 feet July 1996.

Gage Information
CDEC ID: BRA
Cooperating Agencies: USGS, DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: Central Coast
River Basin: Salinas River
County: Monterey
Latitude: 35.9300°N
Longitude: 120.8680°W
Elevation: 443 feet

River Stage Information
Datum: 0=442.69 feet NGVD
Peak of Record: 23.44 feet on March 11, 1995

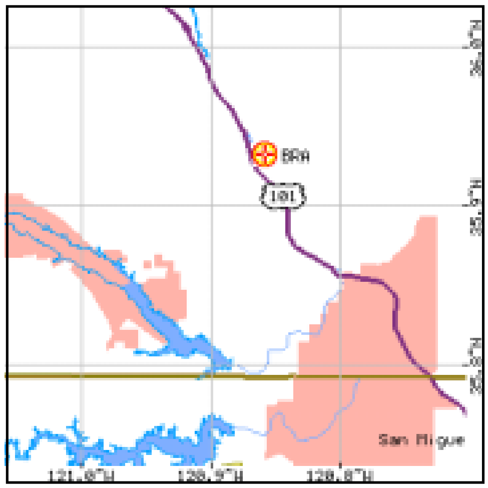
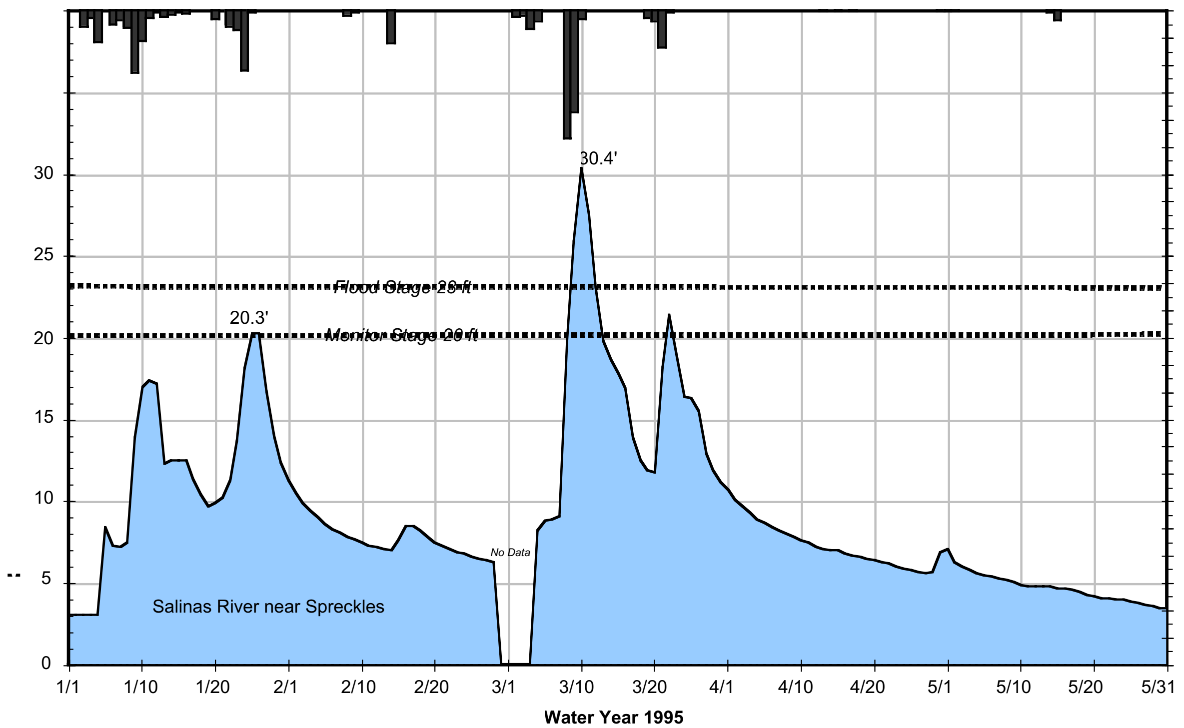


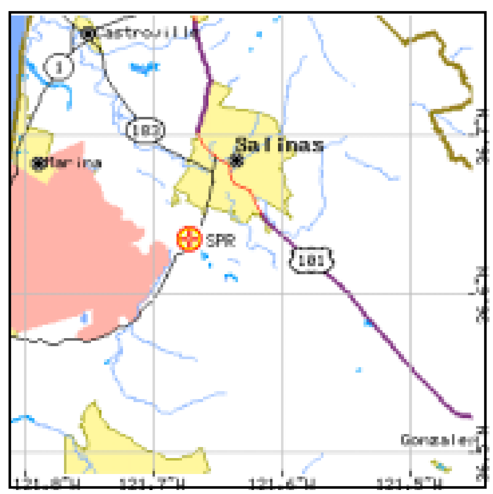
Figure 36. Hydrograph of the Salinas River near Spreckles



Gage Information
CDEC ID: SPR
Cooperating Agencies: USGS, DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: Central Coast
River Basin: Salinas River
County: Monterey
Latitude: 36.6330°N
Longitude: 121.6670°W
Elevation: 53 feet

River Stage Information
Datum: 0=20.56 feet NGVD
Peak of Record: 30.29 feet on March 12, 1995



Sacramento River Hydrologic Region

Figure 37. Location of Real Time Stream Gages and Selected Precipitation Stations, Upper Sacramento River

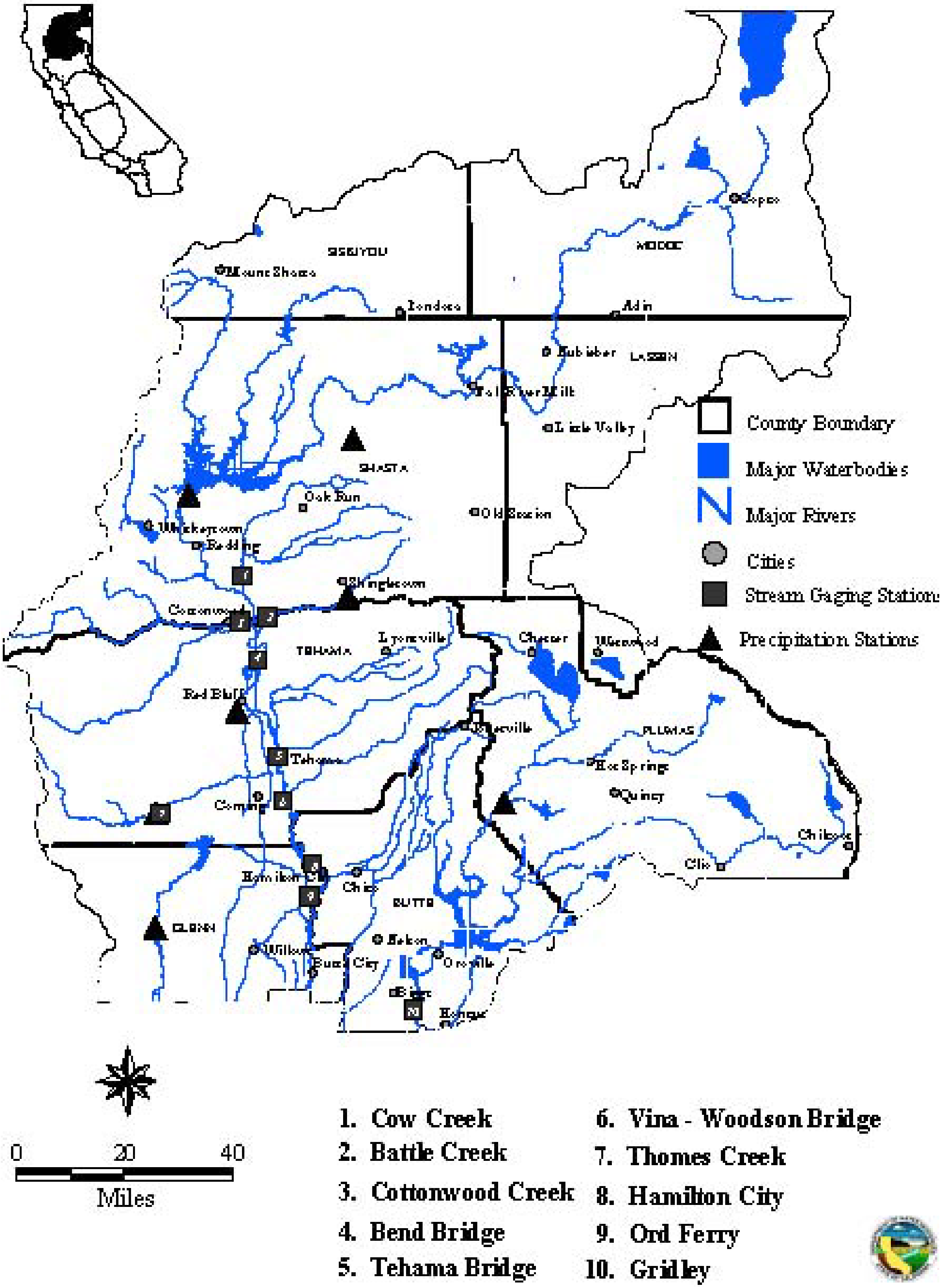
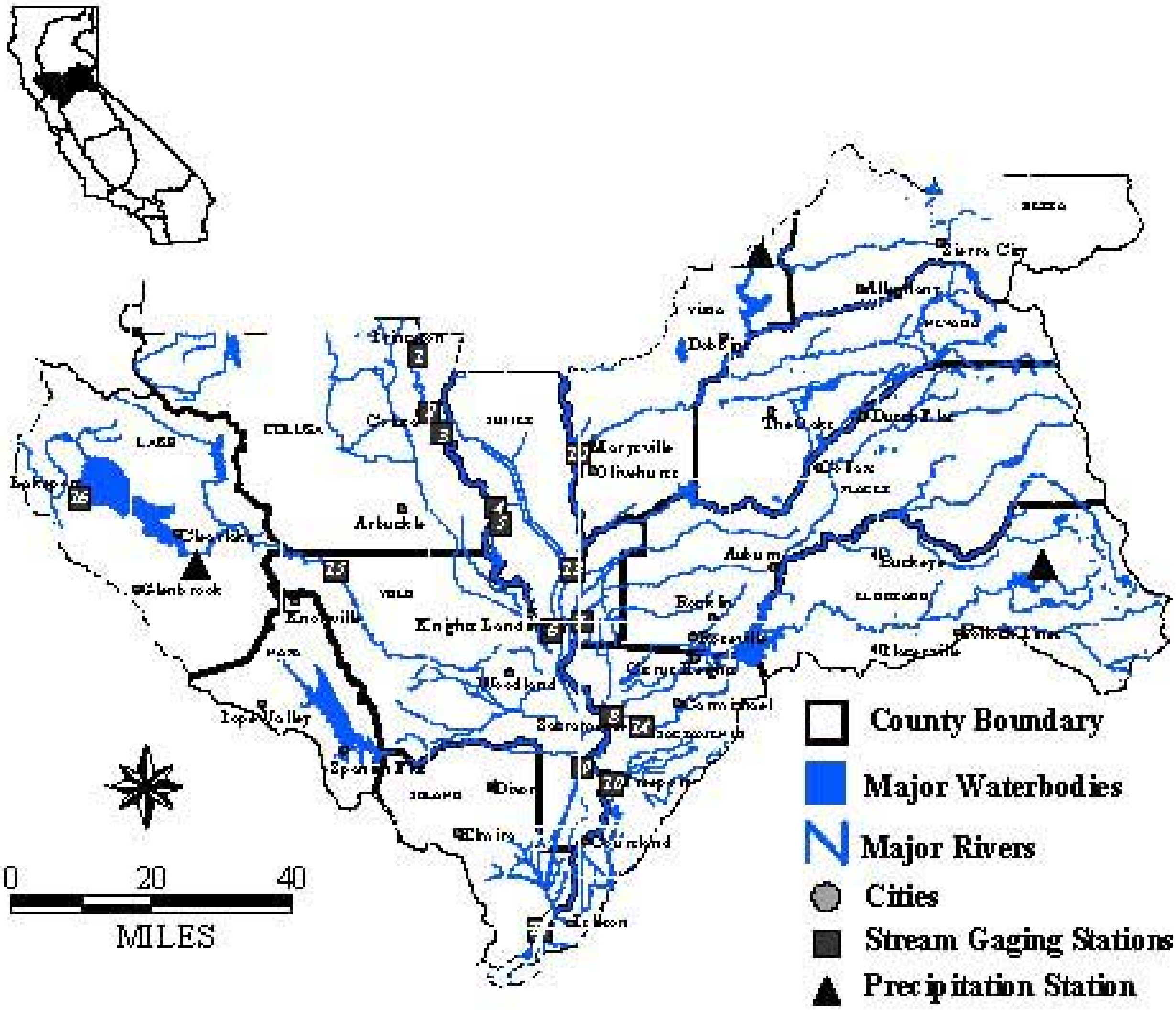


Figure 38. Location of Real Time Stream Gages and Selected Precipitation Stations, Lower Sacramento River



1. Moulton Weir - Sacramento River
2. Colusa Weir - Sacramento River
3. Colusa Bridge - Sacramento River
4. Tisdale Weir - Sacramento River
5. Wilkins Slough - Sacramento River
6. Fremont Weir - Sacramento River
7. Verona - Sacramento River
8. I Street - Sacramento River
9. Lisbon - Yolo Bypass
10. Freeport - Sacramento River
11. Rio Vista Bridge - Sacramento River
12. Yuba City - Feather River
13. Nicolaus - Feather River
14. H Street - American River
15. Rumsey - Cache Creek
16. Lakeport - Clear Lake

Sacramento River Hydrologic Region

January Flood Event

The Sacramento River Hydrologic Region received about 290 percent of average monthly precipitation during January. As a result the seasonal total increased to near 175 percent of average by the end of the month, which was significantly higher than the 60 percent of average seasonal total in 1994. The Northern Sierra 8-Station Index recorded the fourth wettest January since 1922. The resulting runoff pushed the seasonal total to about 8.7 million acre-feet, or 150 percent of average.

Lake Shasta began the month at 44 percent of capacity, but by month end it had filled to 77 percent capacity. The reservoir slightly encroached into the flood control space with a gain in storage of 1.5 million acre-feet. Storage in Lake Oroville increased by 1 million acre-feet, and Folsom Lake storage increased by 307,000 acre-feet.

The peak combined flow of the Yolo Bypass and Sacramento River at the latitude of the City of Sacramento was estimated to be approximately 250,000 cubic feet per second on January 12, or roughly 42 percent of the flood control project's design capacity. Although this represented a moderate flood volume, it was well within project limits, and no major incidents were reported within the project.

Outside the flood control project, widespread urban and small stream flooding was common. The City of Red Bluff recorded its wettest month in 114 years. Roadways, low-water crossings, and bridges were washed out in numerous areas. Heavy rains closed Highway 32 between Chico and Hamilton City and sections of Interstate 5 and Highway 99. Overflows and levee breaches caused flooding in numerous areas. Streams in and around the cities of Sacramento and Roseville caused extensive damage to structures, especially along Dry Creek. Figures 37 and 38 show locations of real time stream gages and selected precipitation stations.

Significant responses to storm runoff and reservoir flood control operations are summarized for key stream gaging stations in the following paragraphs.

Aerial view toward the northeast of flooded areas covering Highway 20 and the southwestern section of the town of Colusa (photo taken January 14, 1995/Rick Burnett, DWR Flood Flight Specialist).

Flooded orchards in the Butte Basin.

A resident of Sweetbrier, Shasta County, watches the swollen Sacramento River swirl around the lower deck pilings of his home. (Golden State Floodlight)

Sacramento River Tributary Creeks

- Cow Creek peaked at 17.4 feet on January 9, with a maximum flow of 22,900 cubic feet per second (Figure 39).
- Cottonwood Creek peaked at 18.5 feet on January 9, with a maximum flow of 48,600 cubic feet per second (Figure 40).
- Battle Creek peaked at 10.4 feet January 9, with a maximum flow of 11,300 cubic feet per second (Figure 41).
- Thomes Creek peaked at 8.8 feet on January 13, with flows in excess of 10,000 cubic feet per second (Figure 42).

Sacramento River

- Figure 43 depicts Lake Shasta operations.
- Bend Bridge peaked at 27.8 feet on January 9, 0.80 feet above flood stage, with a maximum flow of 105,000 cubic feet per second (Figure 44).
- Red Bluff peaked at 21.6 feet on January 14, 1.4 feet below flood stage. The local riverside park was closed during high water, but no damage was reported.
- Tehama Bridge peaked at 221.2 feet on January 9, 8.2 feet above flood stage. Limited evacuations in Tehama occurred on January 9 (Figure 45). At river stages above 218.6 feet, local roads begin to flood, including access to a trailer park on the east bank. At 221.0 feet, water flows into the trailer park, and homes west of the river begin to flood. Some mandatory evacuations begin at this level.

- Vina-Woodson Bridge peaked at 189.6 feet on January 10, 6.6 feet above flood stage, with a maximum flow of 162,000 cubic feet per second (Figure 46).
- Hamilton City peaked at 150.7 feet on January 10, 2.7 feet above flood stage, with a maximum flow of 155,000 cubic feet per second. As a precaution Hamilton City had been evacuated on January 9. High stages caused extensive damage to the left bank levee upstream from the Hamilton City Bridge, and seven farm levee breaks occurred along nearby Pine Creek causing flooding south of the town of Nord. When stages are above 146 feet, orchards upstream of Hamilton City flood. The left bank is designed to divert floodwaters into the Butte Basin at stages above 148 feet. Repairs to the Deseret Levee requiring 43,000 sandbags—the largest sandbag repair ever undertaken by the Department—began on January 27. Downstream of Hamilton City, flood control releases from Black Butte Reservoir on Stony Creek also contributed to high stages (Figure 47).
- Ord Ferry peaked at 118.7 feet on January 10, 4.7 feet above flood stage with a maximum flow of 147,600 cubic feet per second (Figure 48). Three flood-relief structures integral to the overall design of the Sacramento River Flood Control Project Flood diverted overflows to the east into the Butte Basin upstream of Ord Ferry. Overflow is designed to begin at flows that produce a stage of 110.0 feet at Ord Ferry. Butte Basin floodwaters flow south into the Sutter Bypass.
- Butte City peaked near 94.7 feet on January 10, 2.5 feet below flood stage.
- Moulton Weir is constructed to divert water from the river into the Butte Basin when stages exceed 76.8 feet. Overflow occurred from January 9–17, with a maximum depth of 5.5 feet on January 11 (Figure 49).
- Colusa Weir is constructed to divert water from the river into the Sutter Bypass when stages exceed 61.8 feet. Overflow occurred from January 8 to February 12, with a maximum depth of 6.2 feet on January 11 (Figure 50).
- Colusa peaked at 67.6 feet on January 11, 2.4 feet below flood stage, with a maximum flow of 48,900 cubic feet per second (Figure 51).
- Tisdale Weir is constructed to divert water from the river into the Sutter Bypass when stages exceed 45.5 feet. Overflow occurred from January 8 to February 17, with a maximum depth of 6.4 feet on January 12 (Figure 52).
- Wilkins Slough peaked at 51.6 feet on January 12, 1.1 feet below flood stage, with a maximum flow of 30,700 cubic feet per second (Figure 53).
- Fremont Weir is constructed to divert water from the Sacramento River into the Yolo Bypass when stages exceed 33.5 feet. Overflow occurred from January 10 through February 16. A peak of 37.6 feet occurred on January 12, 3.2 feet below flood stage, with 4.1 feet of overflow depth (figures 54 and 55).
- Verona peaked at 36.5 feet on January 12, 4.8 feet below flood stage, with flows in excess of 75,000 cubic feet per second (Figure 56).
- The Sacramento Weir, which is about three miles upstream of the mouth of the American River, is the only weir in the Sacramento River Flood Control Project requiring operation by the Department. All other weirs and the flood-relief structures overflow by gravity. Below Sacramento the river's design channel capacity is limited to 110,000 cubic feet per second. The weir provides the capability to divert up to about 116,000 cubic feet per second of Sacramento and/or American River floodwaters through the mile-long Sacramento Bypass into the Yolo Bypass. Operation of the weir was not required in January (Figure 57).
- I Street Bridge, a mile below the mouth of the American River, peaked at 26.7 feet on January 12, 4.3 feet below flood stage, with flows near 93,000 cubic feet per second (Figure 58).
- Freeport peaked at 20.9 feet on January 12, with flows near 98,000 cubic feet per second (Figure 59).
- At Rio Vista, stages are typically tidal, with a flood stage of 12.0 feet. Floodwaters from the Sacramento River system combined with an astronomical high tide produced several high stages, but none greater than 9.2 feet (Figure 60).

Coloma Street, Citrus Heights

Feather River

- Figure 61 depicts Lake Oroville operations.
- Gridley peaked above 81 feet in early February, well below flood stage with flows in excess of 13,000 cubic feet per second (Figure 62).
- Yuba City peaked at 55.0 feet on January 11, well below flood stage (Figure 63).
- Nicolaus peaked at 41.3 feet on January 11, 6.7 feet below flood stage (Figure 64).

Yuba River

- Figure 65 depicts New Bullards Bar Reservoir operations.

American River

- Figure 66 depicts Folsom Lake operations.
- H Street Bridge peaked at 32.7 feet on both January 12 and 28, well below the 40-foot monitor stage (Figure 67).

Cache Creek Basin and Yolo Bypass

- Clear Lake at Lakeport rose above the 7.6-foot monitor stage on January 14 and peaked near the 9-foot flood stage on January 31.
- At Rumsey Bridge Cache Creek peaked at 14.1 feet on January 8, just above flood stage, with flows near 13,000 cubic feet per second (Figure 68). This rapid rise stranded homeowners and led to the evacuation of the small town of Yolo.

High levels at Clear Lake flooded homes in Lakeport. (Sacramento Bee/Bryan Patrick)

- Lisbon (south of West Sacramento) peaked near 22 feet on January 13, 2 feet above flood stage (Figure 69). Stages above 14 feet threaten tracts in the lower bypass, and the area is under tidal influence during low flow conditions. Figure 70 shows historical overflow in the Yolo Bypass from water years 1935 through 1995.

All counties in this region except El Dorado, Sierra, and Solano were declared federal disaster areas.

March Flood Event

The Sacramento River Hydrologic Region received about 350 percent of average monthly precipitation during March, increasing the seasonal total to near 170 percent of average by month's end. The April 1 snowpack measurements at 83 snow courses showed snow water content equivalent of 49.1 inches, which is about 170 percent of seasonal average to date. Significant precipitation in January and March resulted in the seasonal runoff from

High winds toppled many trees in the Sacramento area, causing widespread damage. (Sacramento Bee/ Kim D. Johanson)

Table 7. Sacramento River at Ord Ferry, Annual Hours of High Water Stages

Water Year	Total Time Above 111.0 ft (Hrs.)[1]	Percentage of Flood Season (percent)[2]	Total Time Above 114.0 ft (Hrs.)[3]	Percentage of Flood Season (percent)[2]
1975-76	0	—	0	—
1976-77	0	—	0	—
1977-78	277	7.6	105	2.9
1978-79	0	—	0	—
1979-80	381	10.4	149	4.1
1980-81	18	0.5	0	—
1981-82	354	9.7	22	0.6
1982-83	1,417	38.8	317	8.7
1983-84	199	5.4	93	2.5
1984-85	0	—	0	—
1985-86	603	16.5	281	7.7
1986-87	0	—	0	—
1987-88	0	—	0	—
1988-89	0	—	0	—
1989-90	0	—	0	—
1990-91	0	—	0	—
1991-92	0	—	0	—
1992-93	103	2.8	20	0.5
1993-94	0	—	0	—
1994-95	786	21.5	437	12.0

[1] One foot above monitor stage.
[2] Flood season: November 15 through April 15.
[3] Flood stage.

streams draining into the basin of about 19.4 million acre-feet, or 180 percent of the April 1 average. The previous year's runoff for the same period was 40 percent of average. Storage in the region's 43 reservoirs was about 13.1 million acre-feet, or 105 percent of average for March.

Reservoirs in the Sacramento River Hydrologic Region were near their maximum flood control reservations at the beginning of March. The heavy precipitation produced large inflows with required increased flood control releases to the downstream river channels.

The maximum release to the Sacramento River from Keswick Dam below Lake Shasta was 79,000 cubic feet per second, more than the 1986 maximum of 76,900 cubic feet per second. By the end of March, Lake Shasta stood at approximately 86 percent of capacity; 500,000 acre-feet encroached into the flood control space. The maximum release to the Feather River from the Lake Oroville complex was 87,000 cubic feet per second, also the largest since 1986. By the end of March, Lake Oroville was out of encroachment and at 78 percent of capacity.

Table 7 lists the total hours of high river stages during water years 1976 through 1995 on the Sacramento River at Ord Ferry. Totals for water year 1995 were second only to water year 1983 during that span. Refer to "Weir Operations" for further descriptions on operations of the five Sacramento River overflow weirs.

Dry Creek floodwaters covered areas of Rio Linda. (Sacramento Bee/Mitch Toll)

The maximum combined flow of the Yolo Bypass and Sacramento River at the latitude of Sacramento was estimated to be approximately 370,000 cubic feet per second on March 13, or 62 percent of the total flood control system design capacity. Much of the increase from the January peak was due to increased reservoir flood control releases.

Widespread urban and small stream flooding was again common.

Significant responses to storm runoff and reservoir flood control operations are summarized for key stream gaging stations in the following paragraphs.

Dry Creek floods in Roseville. (Sacramento Bee/Owen Brewer)

Sacramento River Tributary Creeks

- Cow Creek peaked at 17.9 feet on March 14, with a maximum flow of 24,300 cubic feet per second (see Figure 39).
- Cottonwood Creek peaked at 16.1 feet on March 10, with a maximum flow of 38,000 cubic feet per second (see Figure 40).
- Battle Creek peaked at 10.0 feet on March 9, with a maximum flow of 10,600 cubic feet per second, but the highest stage for the year occurred on April 29 at 13.5 feet, with flows in excess of 20,000 cubic feet per second (see Figure 41).
- Thomes Creek peaked at 9.2 feet on March 9, with flows in excess of 12,500 cubic feet per second (see Figure 42).

Sacramento River

- See Figure 43 for a depiction of Lake Shasta operations.
- Bend Bridge peaked at 30.6 feet on March 15, 3.60 feet above flood stage, with maximum flow of 7,000 cubic feet per second (see Figure 44). No damage was reported.
- Red Bluff peaked at 23.1 feet on March 15, just above flood stage. In Red Bluff an elderly woman died after driving her car off a frontage road into the swollen river.

Redding citizens gathered at Caldwell park on March 17, 1995, to watch wave action in the Sacramento River.

- Tehama Bridge peaked at 220.1 feet on March 15, 7.1 feet above flood stage (see Figure 45). One house in the southeast corner of town was flooded, and minor road damages were reported.
- Vina-Woodson Bridge peaked at 188.1 feet on March 9, 5.1 feet above flood stage, with flows in excess of 142,000 cubic feet per second (see Figure 46). Recreation facilities at a trailer park on the east bank of the river were repeatedly flooded, and minor mud and water damages were reported.
- Hamilton City peaked at 149.2 feet, 1.2 feet above flood stage on March 10, with flows near 148,000 cubic feet per second. Temporary repairs to the Deseret Levee made in January on the left bank upstream of the Hamilton City Bridge performed well. Nearby Pine Creek again caused problems, including the closure of many local roads. Downstream of Hamilton City, flood control releases from Black Butte Reservoir on Stony Creek again contributed to the high stages (see Figure 47). No damage was reported.
- Ord Ferry peaked at 117.3 feet on March 10, 3.3 feet above flood stage, with flows in excess of 130,000 cubic feet per second. Several roads were flooded in the Butte Basin (see Figure 48).
- Butte City peaked near 93.1 feet on March 11, 4.1 feet below flood stage. No structures were reported damaged.
- Moulton Weir overflow occurred from March 10-27, with a maximum depth of 4.7 feet on March 11 (see Figure 49).
- Colusa Weir overflow occurred from March 9-April 1, with a maximum depth of 5.4 feet on March 16 (see Figure 50).

Flood control releases from Shasta Dam to the Sacramento River reached 79,000 cubic feet per second in March.

Above: Staff gage at Fremont Weir

Left: Sacramento Weir was operated in March 1995, the first time since 1986.

- Colusa peaked at 66.7 feet on March 16, 3.3 feet below flood stage, with flows near 47,000 cubic feet per second (see Figure 51). No damage was reported.
- Tisdale Weir overflow occurred from March 10 to April 10, with a maximum depth of 5.2 feet on March 17 (see Figure 52).
- Wilkins Slough peaked at 50.0 feet on March 17, 2.7 feet below flood stage, with flows near 30,000 cubic feet per second (see Figure 53).
- Fremont Weir overflow occurred from March 10 through April 30. A peak of 38.6 feet occurred on March 11, 2.1 feet below flood stage, with 5.1 feet of overflow depth (see figures 54 and 55).
- Verona peaked at 37.5 feet on March 13, 3.8 feet below flood stage, with flows in excess of 78,000 cubic feet per second (see Figure 56).
- Six of the 48 gates of the Sacramento Weir were opened on March 11, followed by another 16 the following day. This marked the first time the Department opened the weir since the February 1986 floods. All gates were closed by March 25 (see Figure 57).
- I Street Bridge peaked at 27.2 feet on March 11, 3.8 feet below flood stage, with a maximum flow of 94,900 cubic feet per second (see Figure 58). The combined effect of Sacramento Valley drainage and reservoir flood releases from Shasta, Black Butte, Oroville, New Bullards Bar, and Folsom influenced the stages. On March 9 a large sternwheel paddleboat broke from its moorings stranding a large group of school children. No one was injured, and no damages were reported.
- Freeport peaked at 21.8 feet on March 12, with flows near 102,000 cubic feet per second (see Figure 59).
- Rio Vista peaked at 9.8 feet on March 17, 0.6 feet higher than in January but still 2.4 feet below flood stage (see Figure 60).

Feather River

- See Figure 61 for a depiction of Lake Oroville operations.
- Gridley peaked at 94.7 feet on March 12, just below monitor stage, with a maximum flow of 89,400 cubic feet per second (see Figure 62).
- Yuba City peaked at 67.6 feet on March 14, still well below the 80.2-foot flood stage (see Figure 63). No damage was reported.
- Nicolaus peaked at 45.0 feet on March 12, 3.0 feet below flood stage (see Figure 64). No damage was reported.

Yuba River

- See Figure 65 for a depiction of New Bullards Bar Reservoir operations.

Flood control releases from Folsom Dam to the American River reached 50,000 cubic feet per second in March.

American River

- See Figure 66 for a depiction of Folsom Lake operations.
- H Street peaked near 35.2 feet on March 12, 4.8 feet below flood stage (see Figure 67).

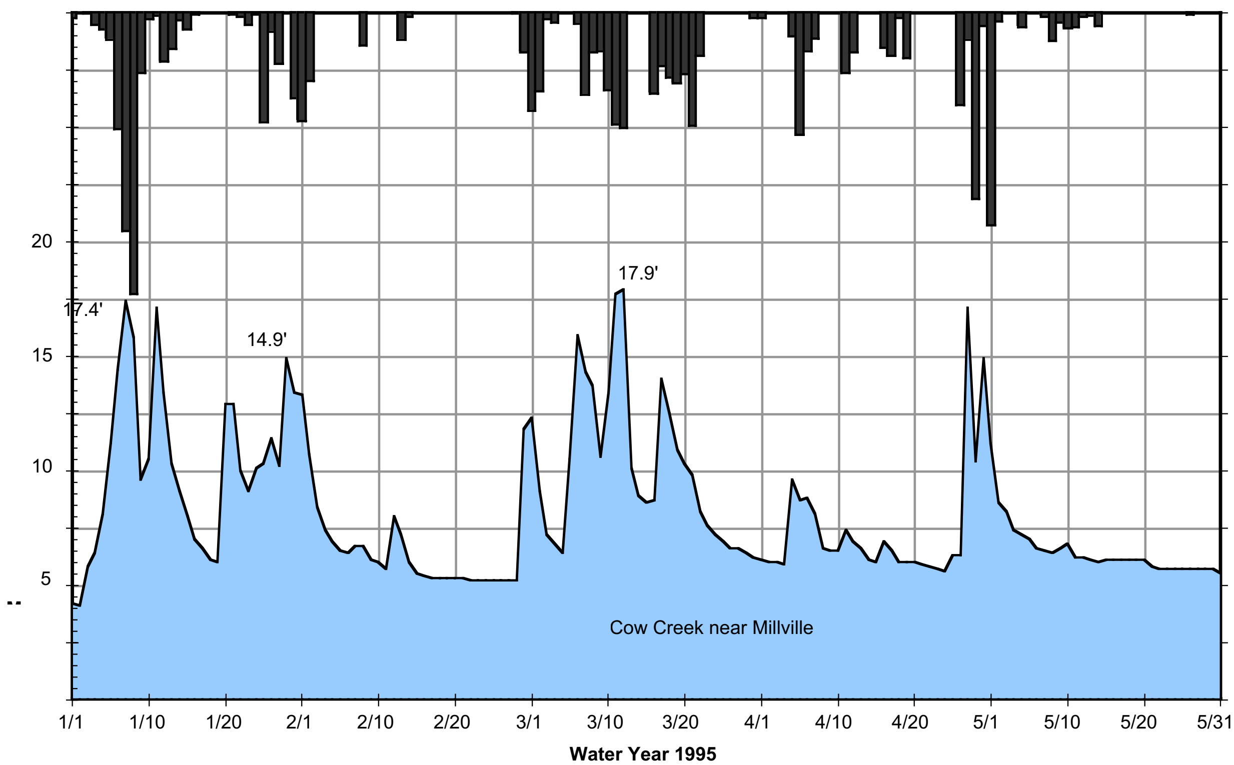
Cache Creek Basin and Yolo Bypass

- Clear Lake at Lakeport rose above the 7.6-foot monitor stage on March 9 and peaked at 10.7 feet on March 24, 1.7 feet above flood stage. The lake remained above flood stage into April, and many homes and businesses were flooded.
- At Rumsey Bridge Cache Creek peaked at 17.1 feet on March 9, 3.1 feet above flood stage (see Figure 68). This event caused 100 people to be evacuated from Yolo County, and another 25 people from Rumsey on March 9. Seven homes along the creek were isolated when the bridge was damaged.
- Lisbon (south of West Sacramento) peaked at 23.8 feet on March 13, 3.8 feet above flood stage (Figure 69). See Figure 70 for historical overflow in the Yolo Bypass from 1934–1995.

All counties in this region were declared federal disaster areas.

Cache Creek North Levee on March 29, 1995, approximately a quarter mile below the town of Yolo.

Figure 39. Hydrograph of Cow Creek near Millville



Gage Information
CDEC ID: COW
Cooperating Agencies: USGS, DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: Sacramento River
River Basin: Cow Creek (Sacramento River Tributary)
County: Shasta
Latitude: 40.5050°N
Longitude: 122.2320°W
Elevation: 385 feet

River Stage Information
Datum: 0=385.7 feet NGVD
Peak of Record: 24.2 feet on November 16, 1981

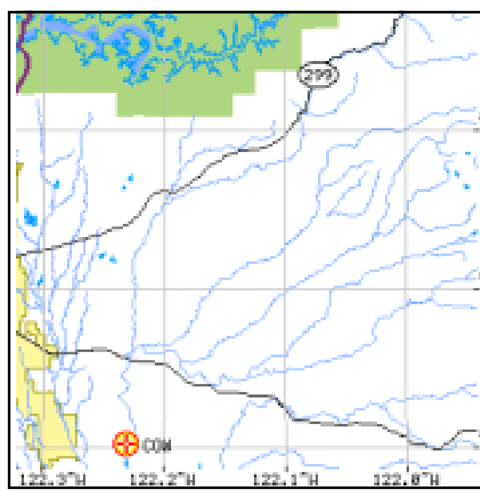
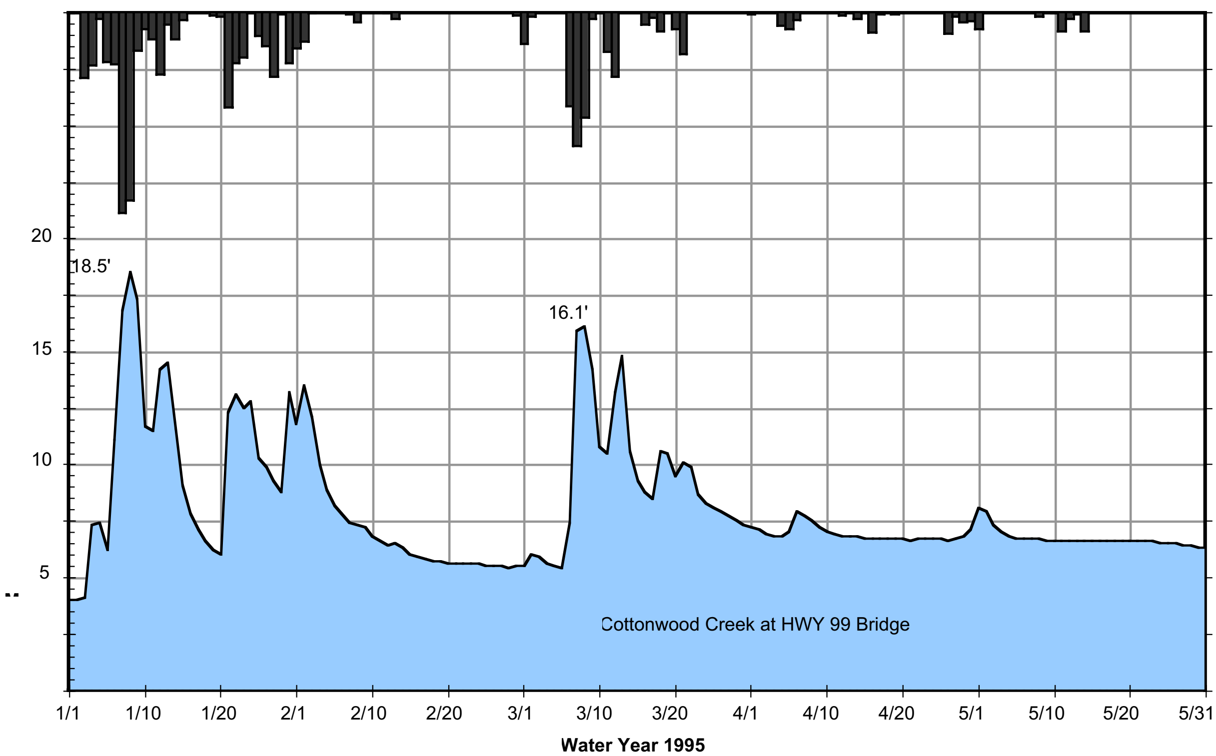
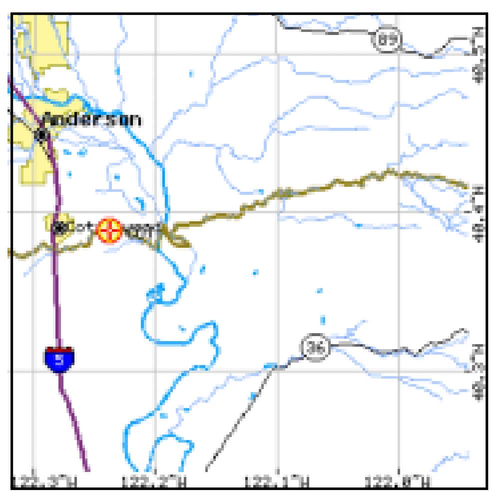


Figure 40. Hydrograph of Cottonwood Creek at HWY 99 Bridge

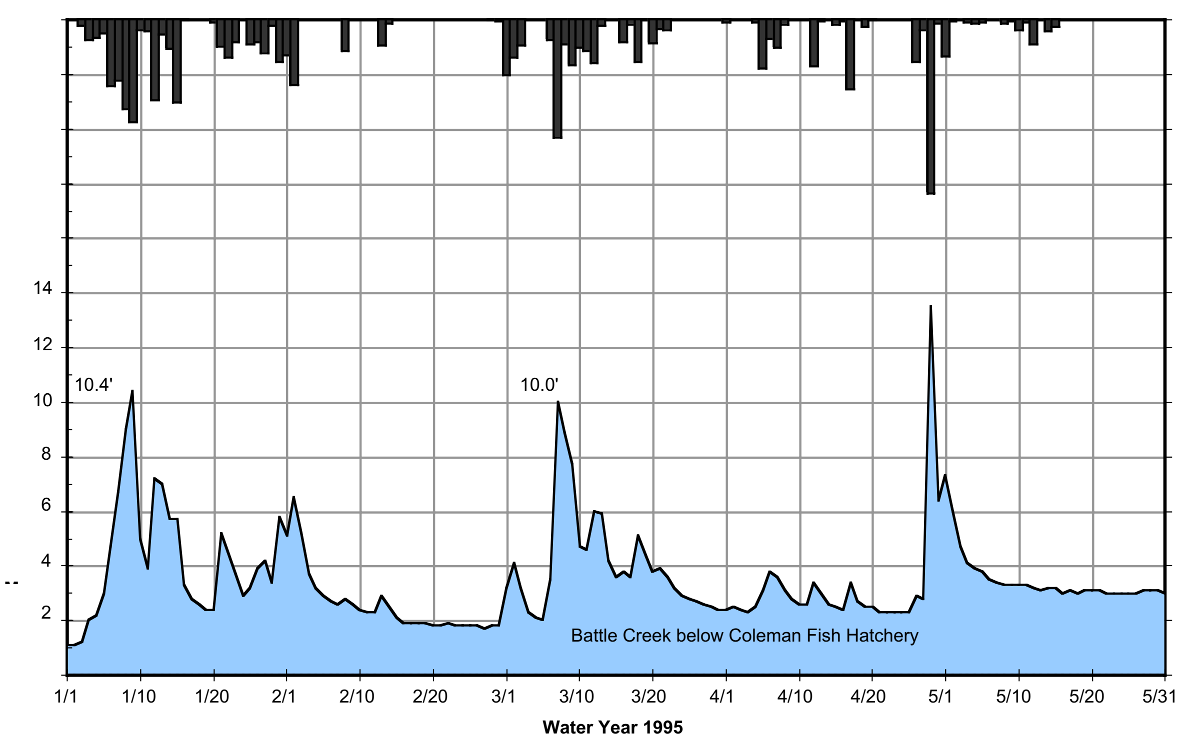




Gage Information
CDEC ID: COT
Cooperating Agencies: USGS, DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: Sacramento River
River Basin: Cottonwood Creek (Sacramento River Tributary)
County: Tehama
Latitude: 40.3870°N
Longitude: 122.2390°W
Elevation: 53 feet

Figure 41. Hydrograph of Battle Creek below Coleman Fish Hatchery



Gage Information

CDEC ID: BAT
Cooperating Agencies: USGS, DWR
Data Collection: Microwave, Satellite

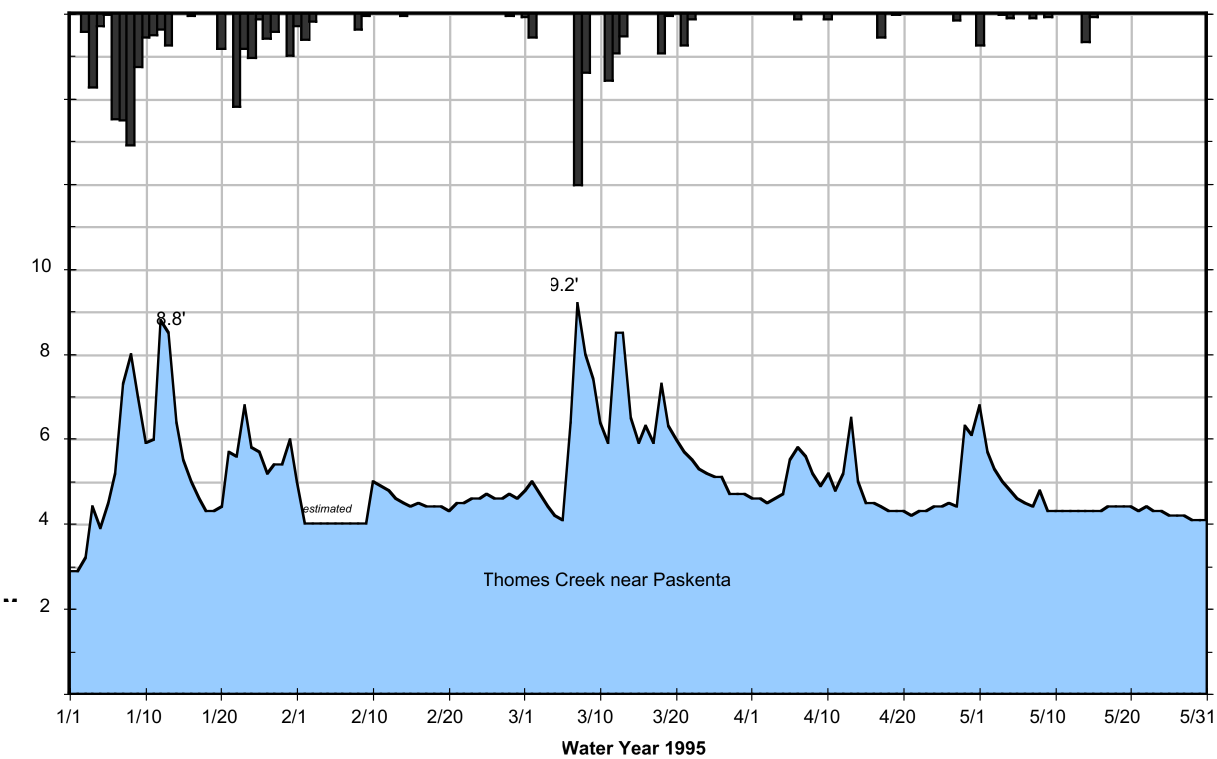
Gage Location

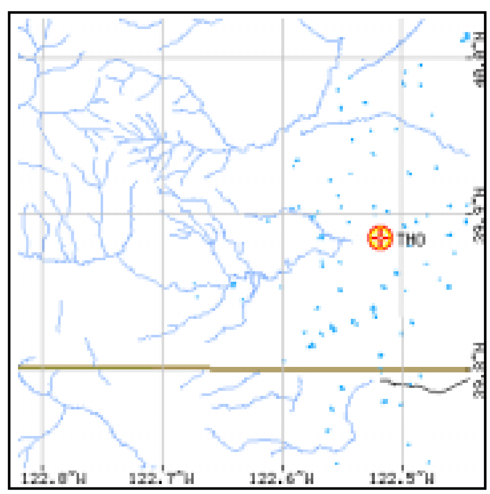
Hydrologic Region: Sacramento River
River Basin: Battle Creek (Sacramento River Tributary)
County: Tehama
Latitude: 40.3990°N
Longitude: 122.1450°W
Elevation: 200 feet

River Stage Information

Datum: 0=415.0 feet NGVD
Peak of Record: 14.8 feet on January 24, 1970

Figure 42. Hydrograph of Thomes Creek near Paskenta

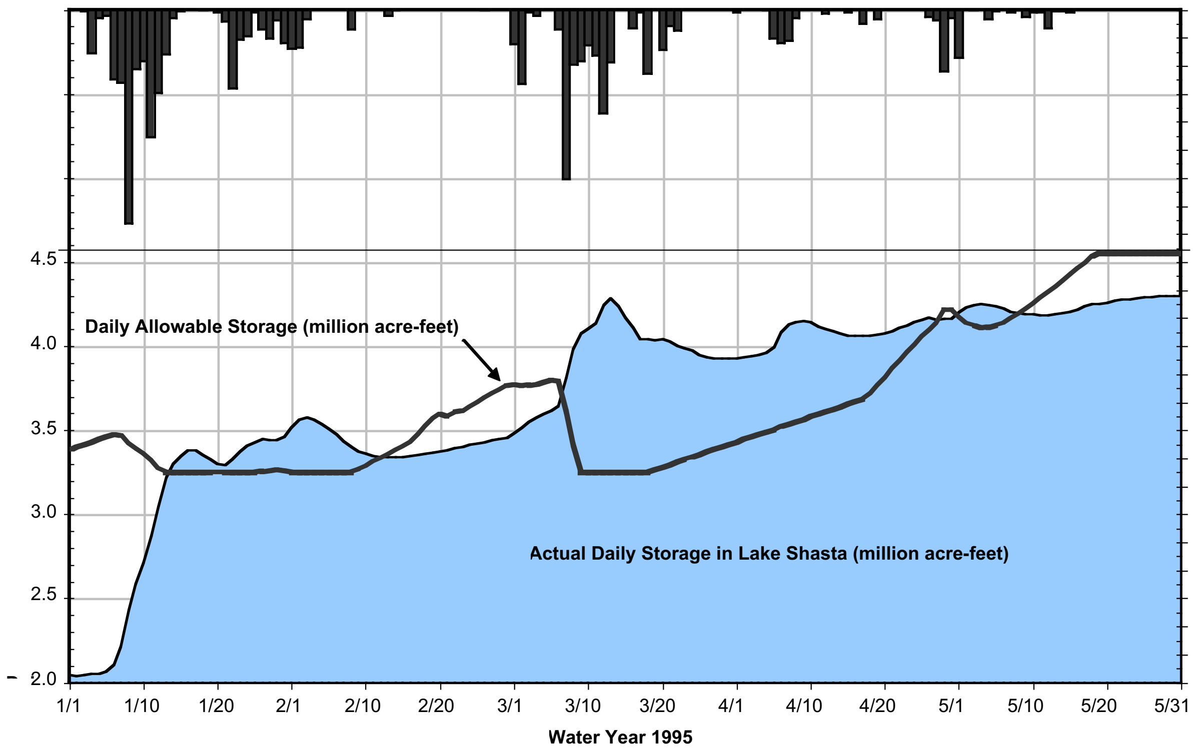




Gage Information
CDEC ID: THO
Operator(s): DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: Sacramento River
River Basin: Thomes Creek (Sacramento River Tributary)
County: Tehama
Latitude: 39.8830°N
Longitude: 122.5170°W
Elevation: 720 feet

Figure 43. Lake Shasta Operations, Sacramento River



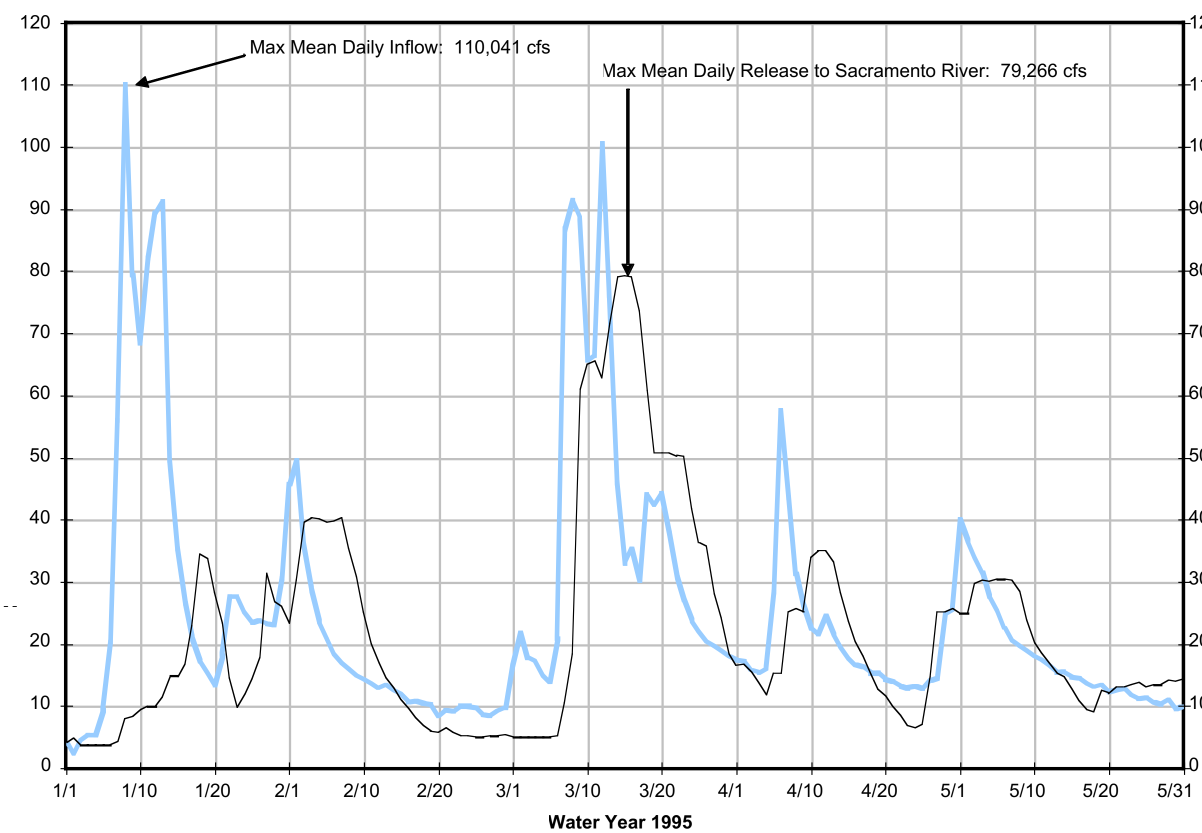
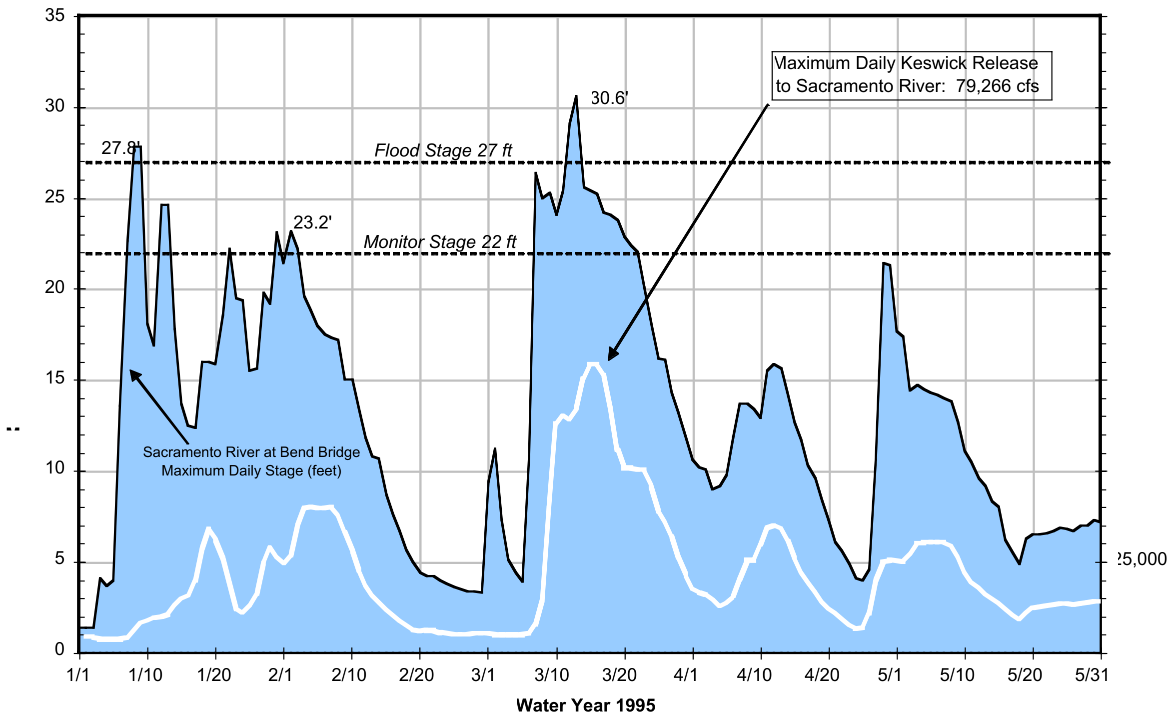


Figure 44. Hydrograph of the Sacramento River at Bend Bridge, including Keswick Dam Release

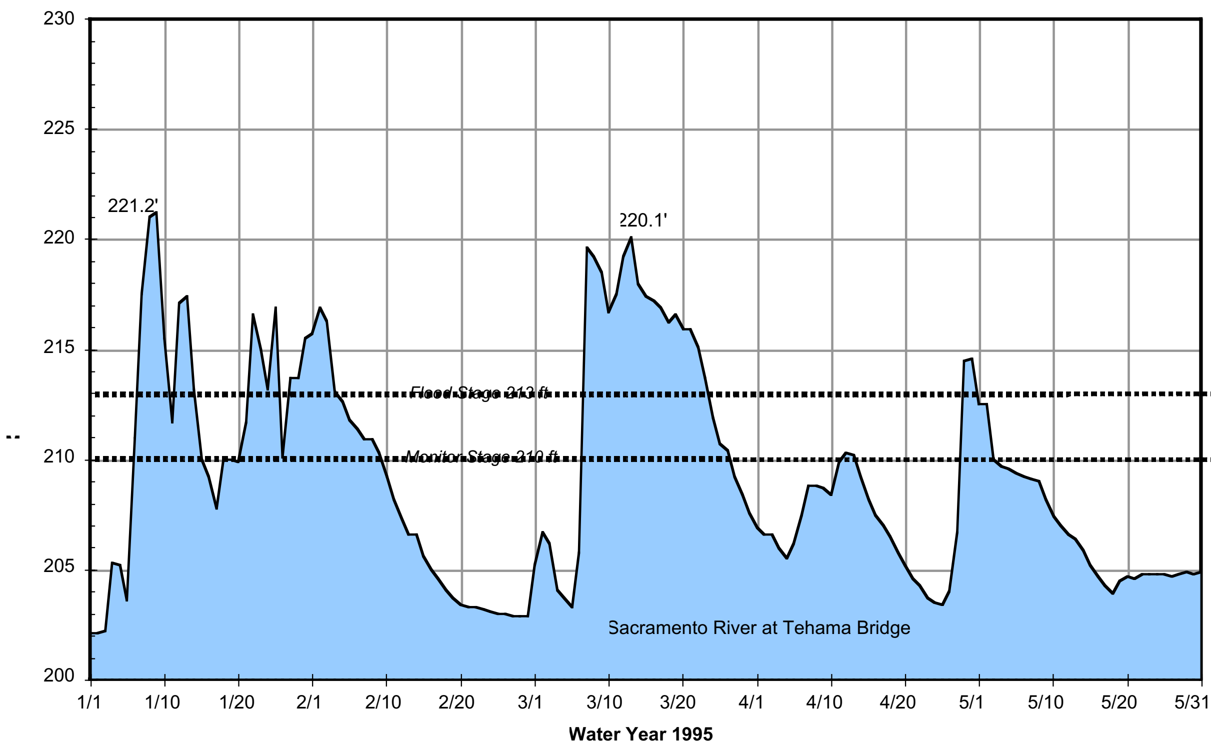


Gage Information
CDEC ID: BND
Cooperating Agencies: USGS, USBR, DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: Sacramento River
River Basin: Sacramento River
County: Tehama
Latitude: 40.2870°N
Longitude: 122.1850°W
Elevation: 286 feet

River Stage Information
Datum: 0=285.8 feet NGVD
Peak of Record: 38.9 feet on February 28, 1940, before Shasta Dam

Figure 45. Hydrograph of the Sacramento River at Tehama Bridge



Gage Information
CDEC ID: TEH
Operator(s): DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: Sacramento River
River Basin: Sacramento River
County: Tehama
Latitude: 40.0330°N
Longitude: 122.1170°W
Elevation: 213 feet

River Stage Information
Datum: 0=(-) 5.7 feet NGVD
Peak of Record: 222.7 feet on March 1, 1983

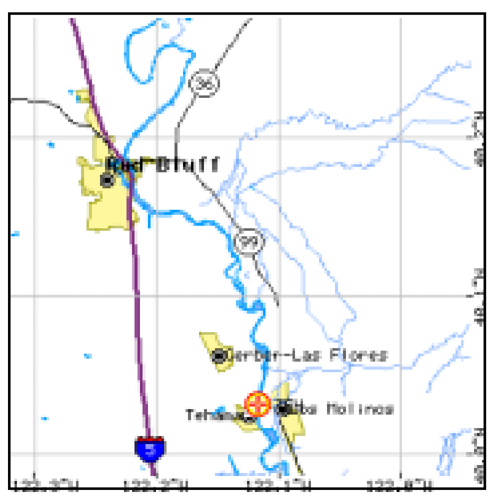
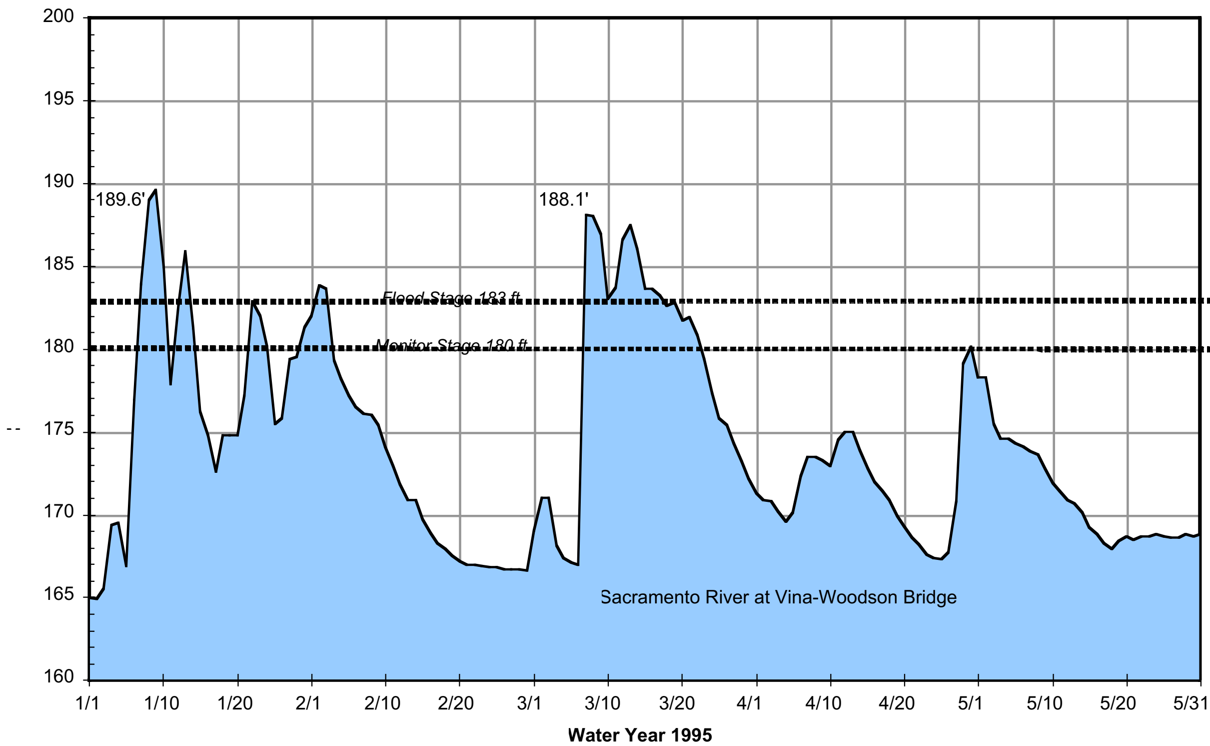


Figure 46. Hydrograph of the Sacramento River at Vina-Woodson Bridge

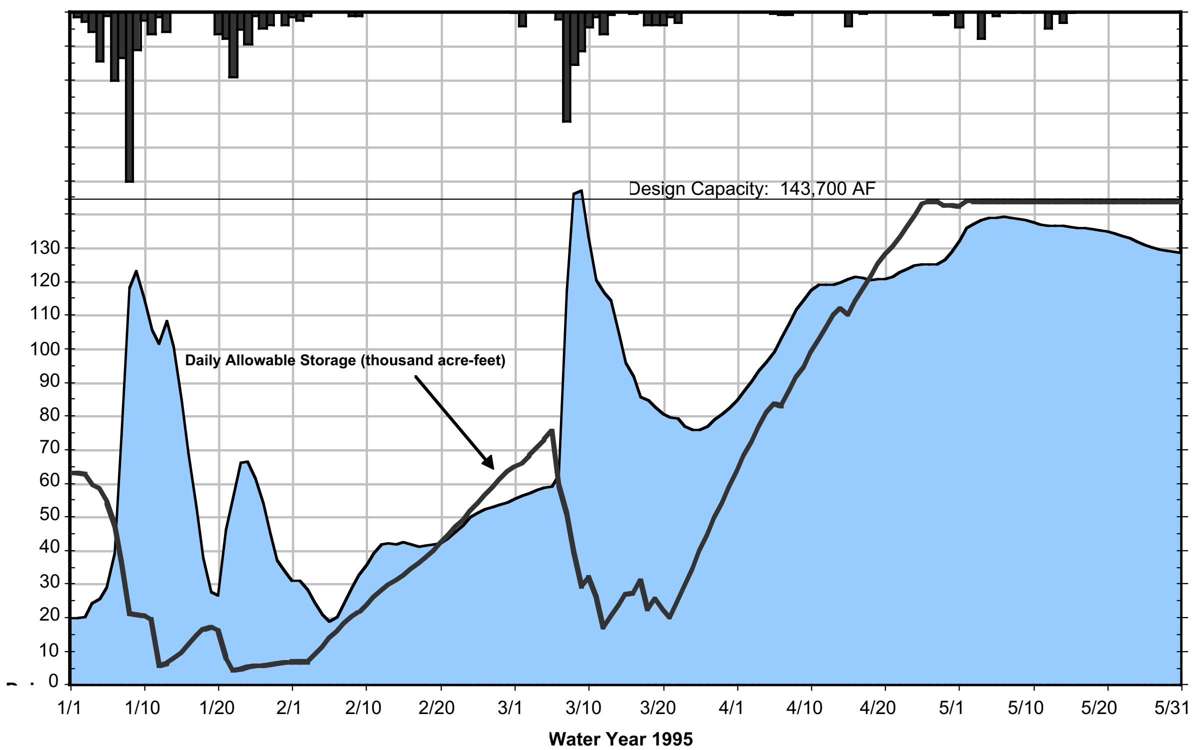


Gage Information
CDEC ID: VIN
Operator(s): DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: Sacramento River
River Basin: Sacramento River
County: Tehama
Latitude: 39.9170°N
Longitude: 122.1000°W
Elevation: 185 feet

River Stage Information
Datum: 0=0.0 feet USED
Peak of Record: 191.5 feet on January 24, 1970

Figure 47. Black Butte Reservoir Operations, Stony Creek



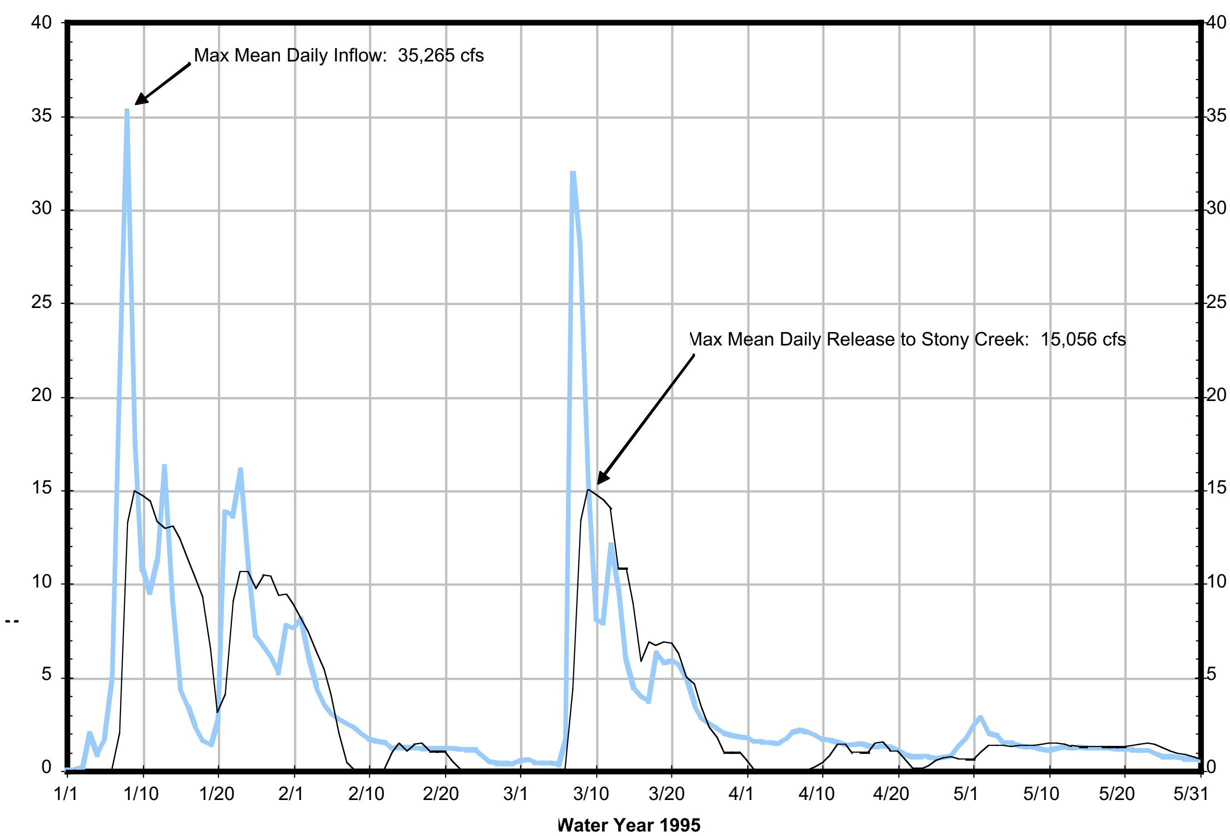
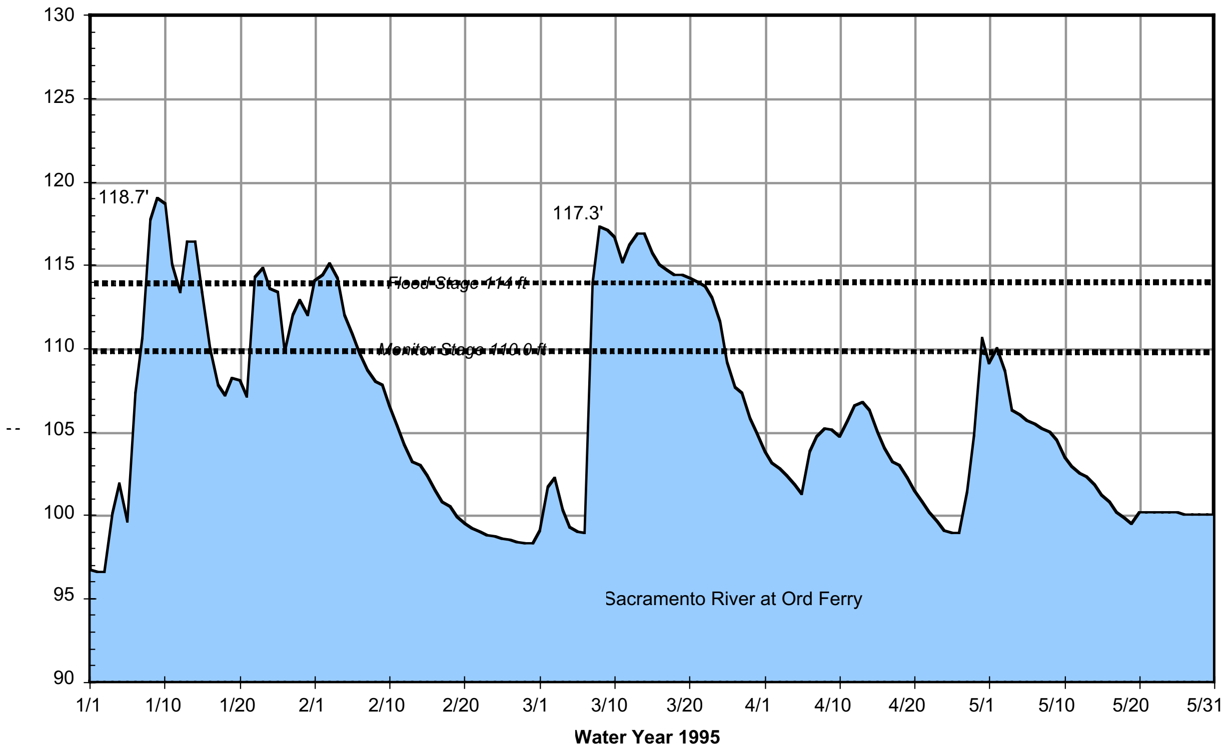


Figure 48. Hydrograph of the Sacramento River at Ord Ferry



Gage Information
CDEC ID: ORD
Operator(s): DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: Sacramento River
River Basin: Sacramento River
County: Glenn
Latitude: 39.6670°N
Longitude: 122.0000°W
Elevation: 115 feet

River Stage Information
Datum: 0=0.0 feet USED
Peak of Record (after Shasta Dam constructed): 120.1 feet on Feburary 25, 1958
Peak of Record (before Shasta Dam): 121.7 feet on February 28, 1940

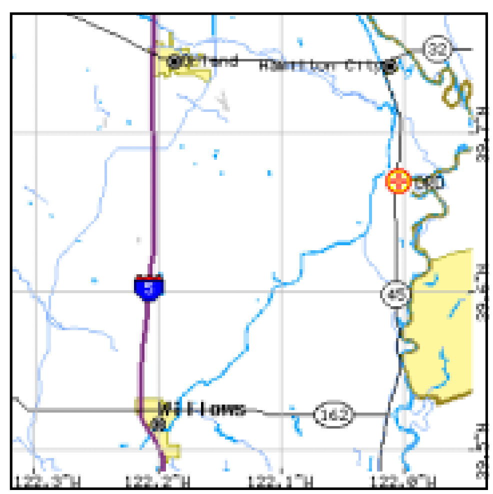


Figure 49. Period of Record of Moulton Weir overflow

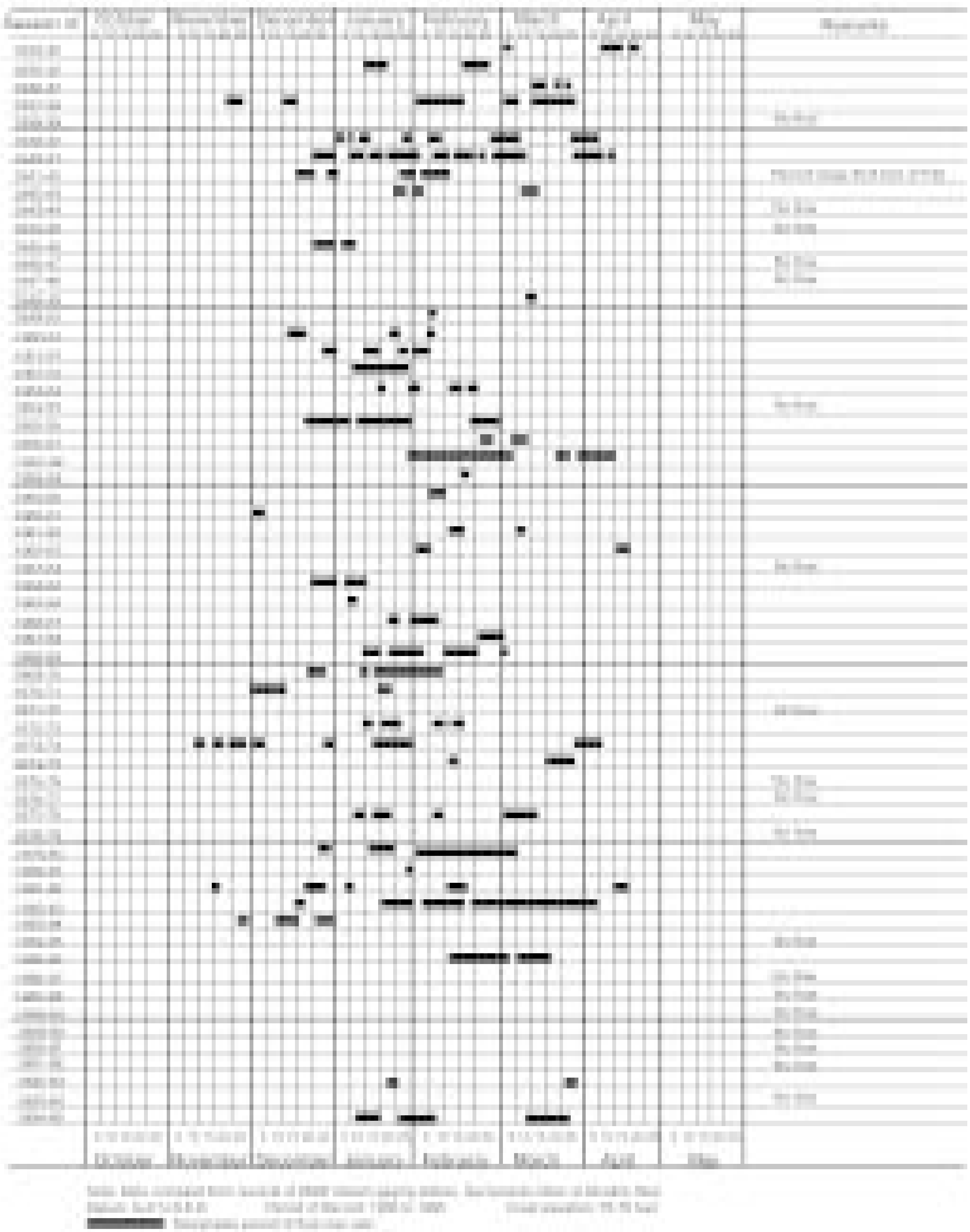
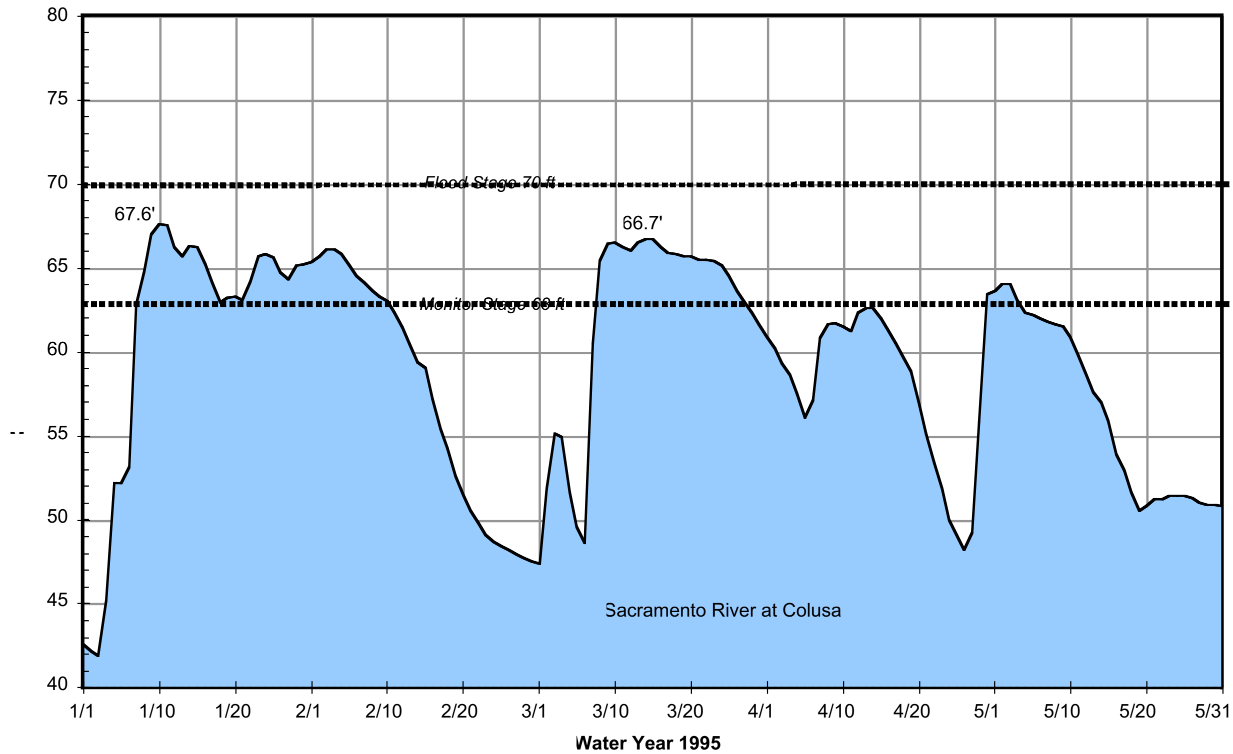


Figure 50. Period of Record of Colusa Weir overflow

Figure 51. Hydrograph of the Sacramento River at Colusa



Gage Information
CDEC ID: COL
Cooperating Agencies: USGS, DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: Sacramento River
River Basin: Sacramento River
County: Colusa
Latitude: 39.2140°N
Longitude: 121.9990°W
Elevation: 70 feet

River Stage Information
Datum: 0=0.0 feet USED
Peak of Record (after Shasta Dam constructed): 68.7 feet on January 3, 1997
Peak of Record (before Shasta Dam): 69.2 feet on February 8, 1942

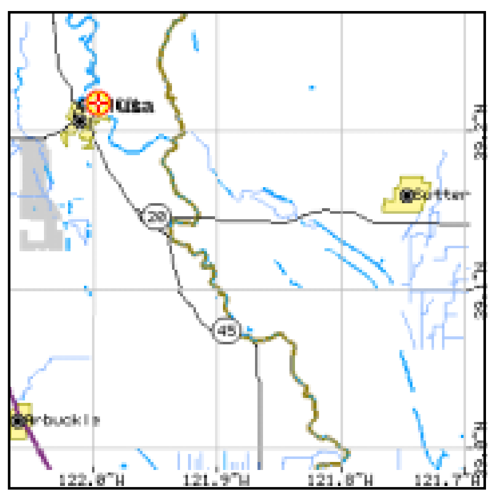
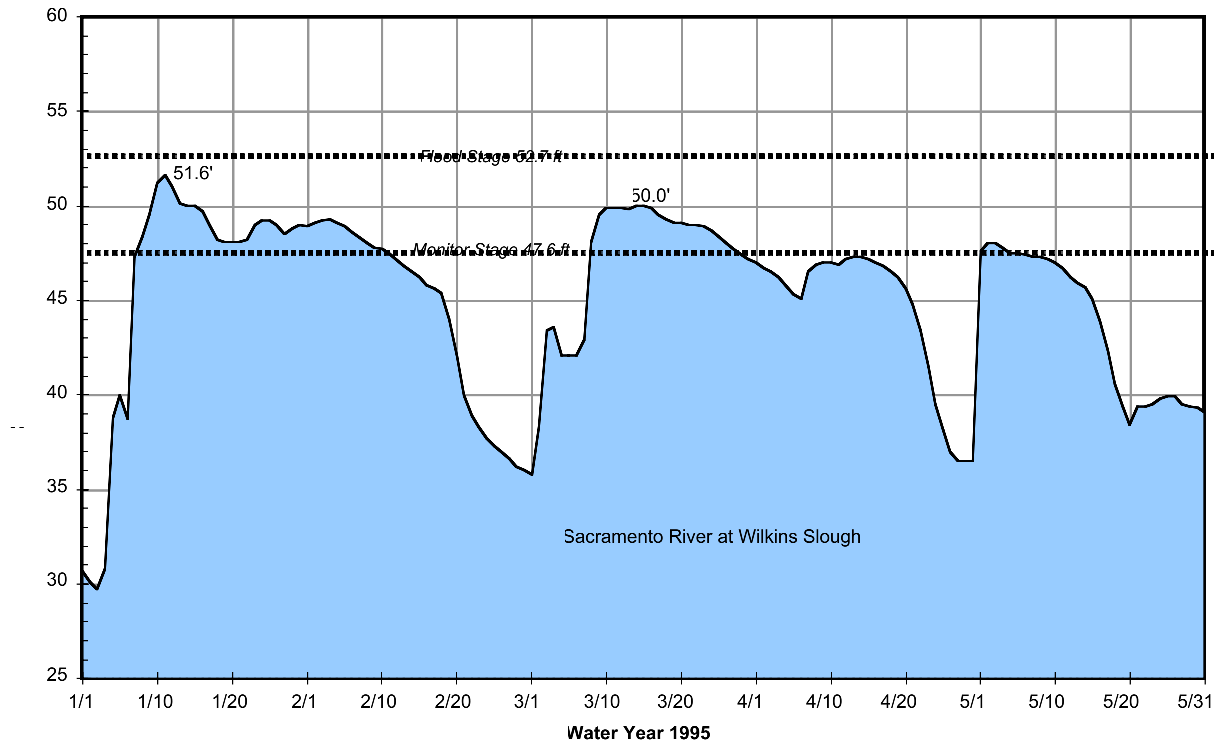


Figure 52. Period of Record of Tisdale Weir overflow

Figure 53. Hydrograph of the Sacramento River at Wilkins Slough



Gage Information
CDEC ID: WLK
Cooperating Agencies: USGS, USBR, DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: Sacramento River
River Basin: Sacramento River
County: Sutter
Latitude: 39.0100°N
Longitude: 121.8240°W
Elevation: 30 feet

River Stage Information
Datum: 0=0.0 feet USED
Peak of Record (after Shasta Dam was constructed): 52.7 feet on January 4, 1997
Peak of Record (before Shasta Dam): 52.8 feet on March 1, 1940

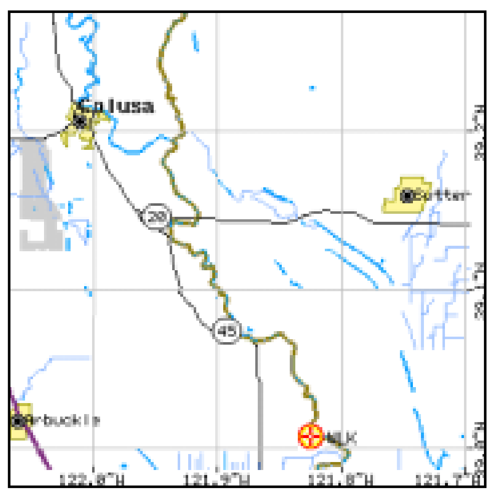
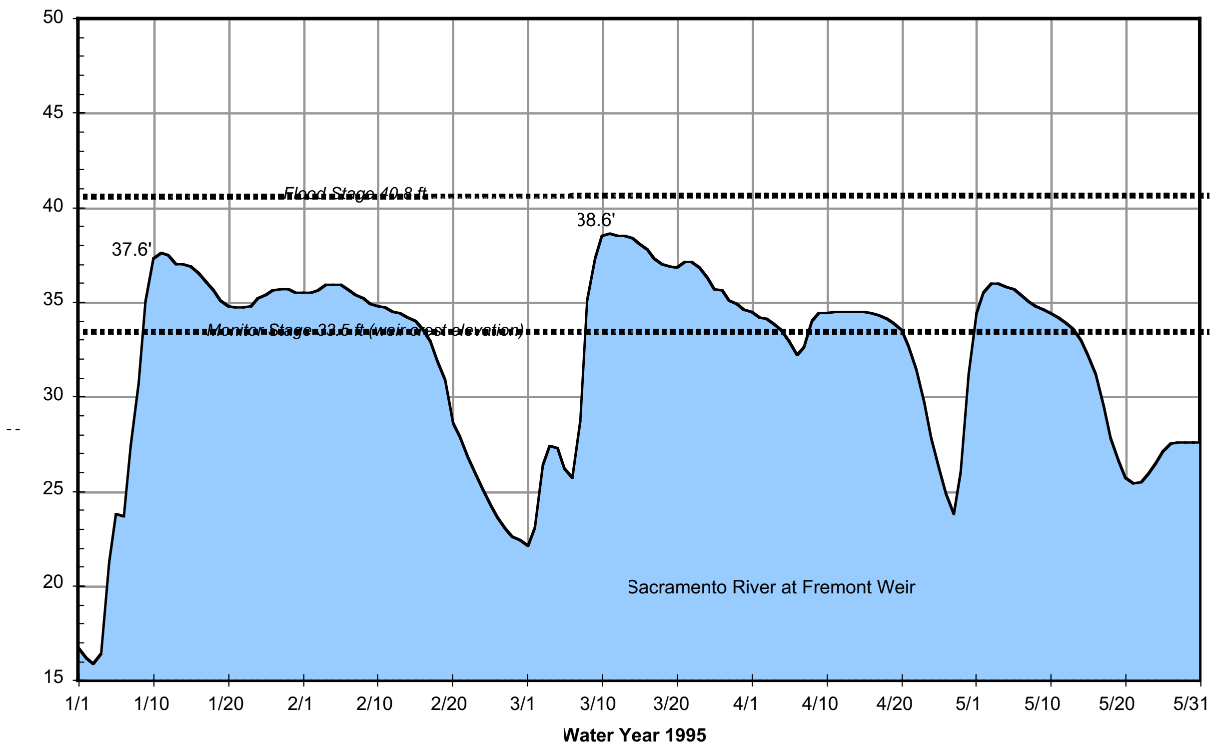


Figure 54. Hydrograph of the Sacramento River at Fremont Weir



Gage Information
CDEC ID: FRE
Cooperating Agencies: USBR, DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: Sacramento River
River Basin: Sacramento River
County: Yolo
Latitude: 8.7670°
Longitude: 121.6670°W
Elevation: 40 feet

River Stage Information
Datum: 0=0.0 feet USED
Peak of Record: 42.47 feet on January 2, 1997

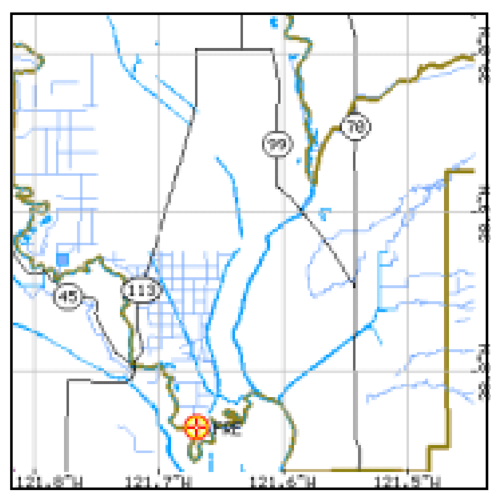


Figure 55. Period of Record of Fremont Weir overflow

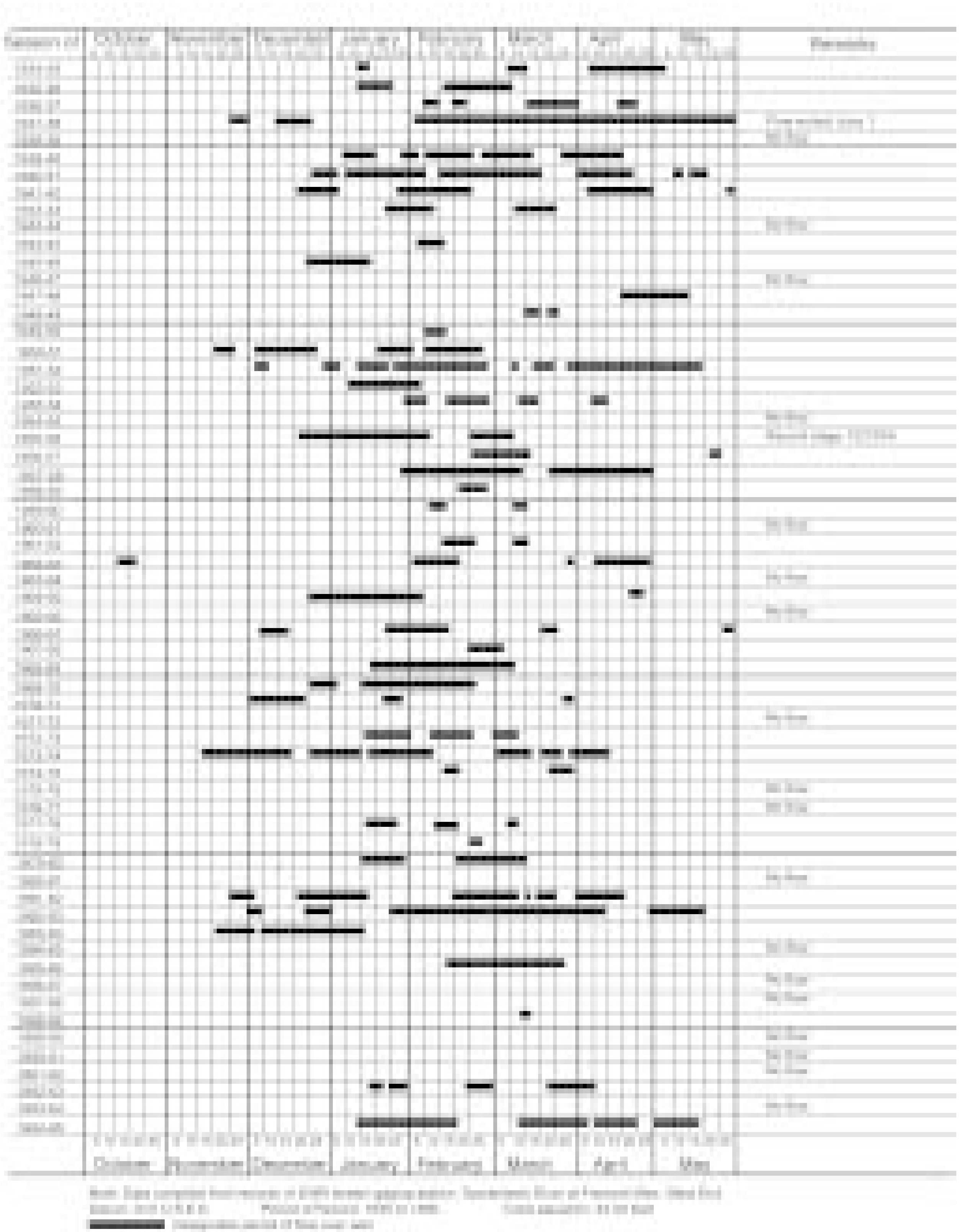
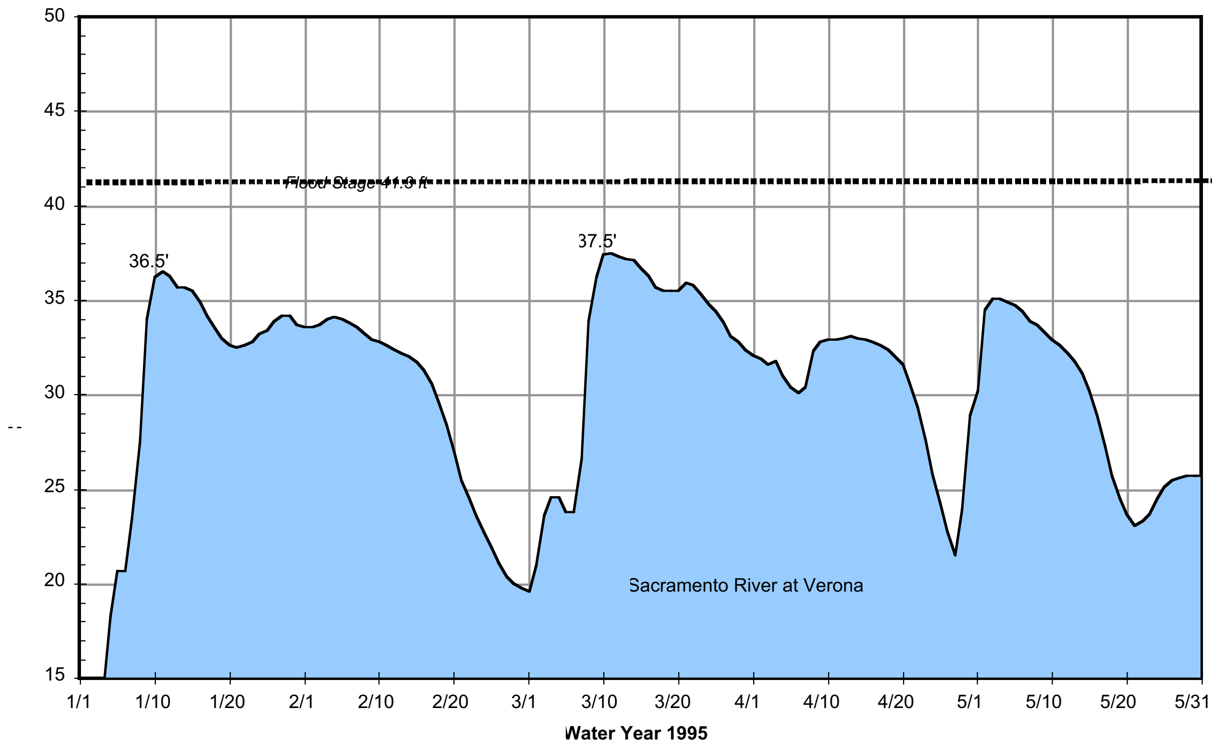


Figure 56. Hydrograph of the Sacramento River at Verona



Gage Information
CDEC ID: VON
Cooperating Agencies: USGS, DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: Sacramento River
River Basin: Sacramento River
County: Sutter
Latitude: 38.7830°N
Longitude: 121.5830°W
Elevation: 43 feet

River Stage Information
Datum: 0=0.0 feet USED
Peak of Record: 42.11 feet on February 20, 1986

Figure 57. Period of Record of Sacramento Weir overflow

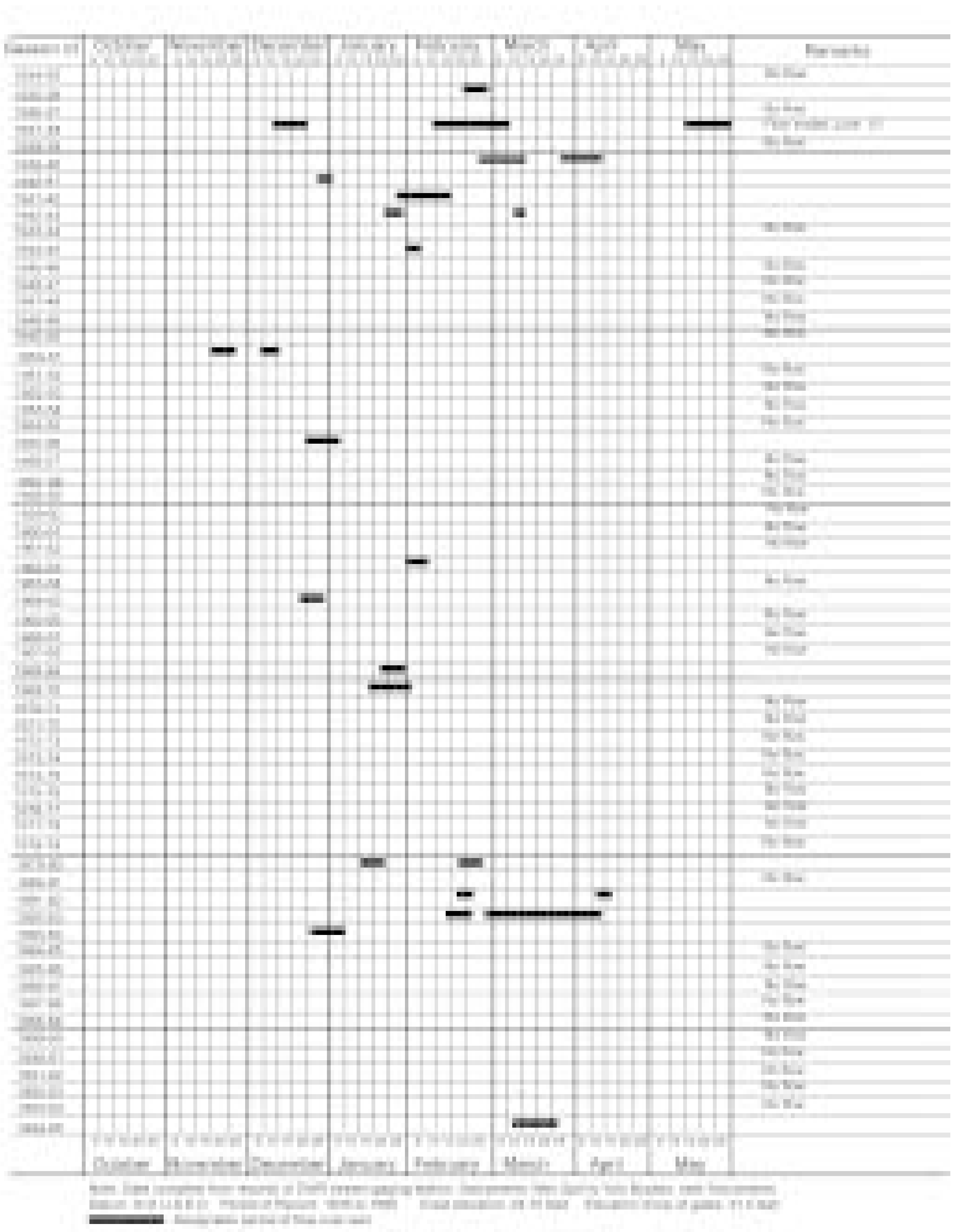
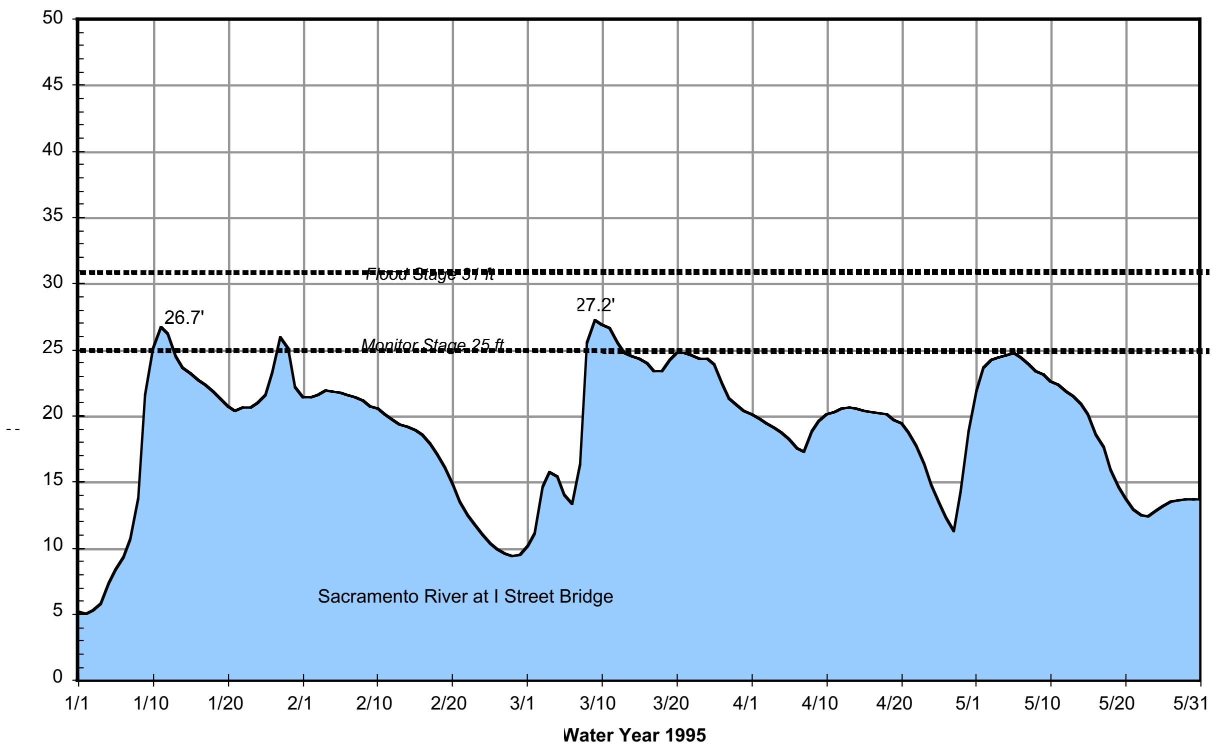


Figure 58. Hydrograph of the Sacramento River at I Street Bridge



Gage Information
CDEC ID: IST
Cooperating Agencies: DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: Sacramento River
River Basin: Sacramento River
County: Sacramento
Latitude: 38.5890°N
Longitude: 121.5040°W
Elevation: 27 feet

River Stage Information
Datum: 0=0.0 feet NGVD
Peak of Record: 30.68 feet on February 19, 1986

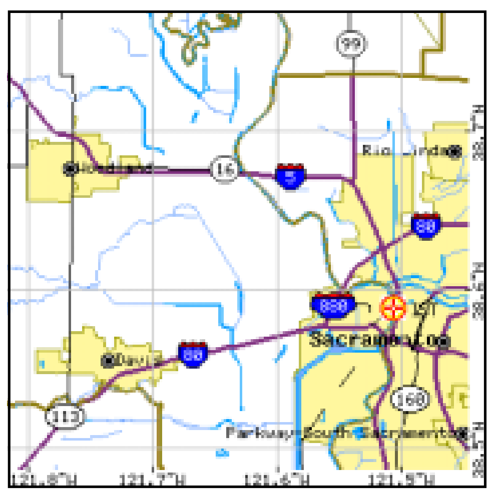
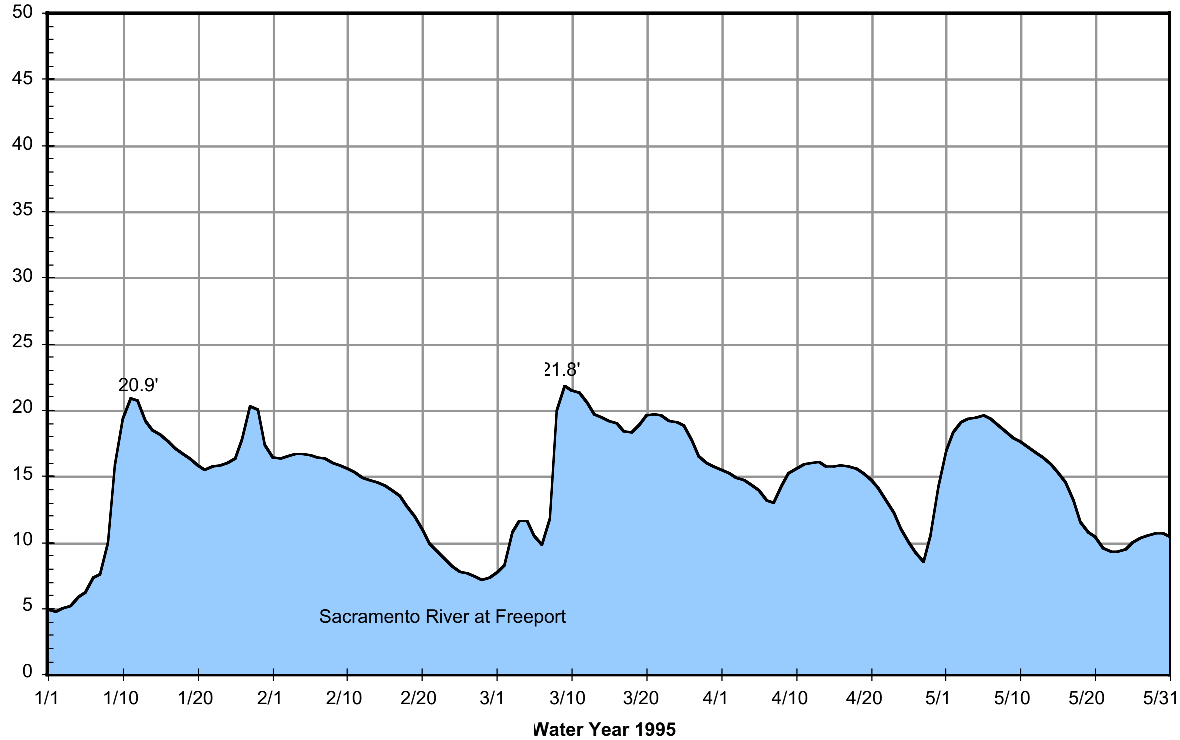


Figure 59. Hydrograph of the Sacramento River at Freeport



Gage Information
CDEC ID: FPT
Cooperating Agencies: USGS
Data Collection: Data Exchange

Gage Location
Hydrologic Region: Sacramento River
River Basin: Sacramento River
County: Sacramento
Latitude: 38.4500°N
Longitude: 121.5000°W
Elevation: 0 feet

River Stage Information
Datum: 0=-100.0 feet NGVD
Peak of Record: 25.0 feet on February 19, 1986

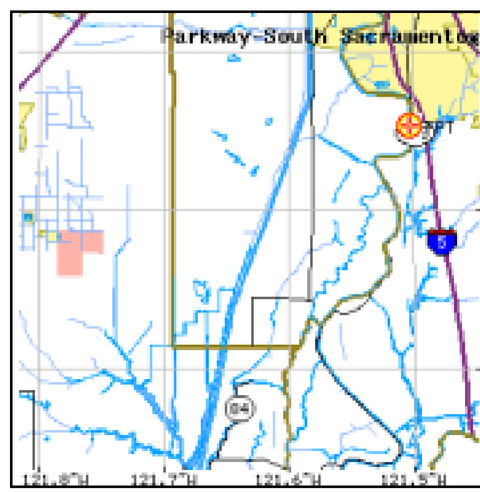
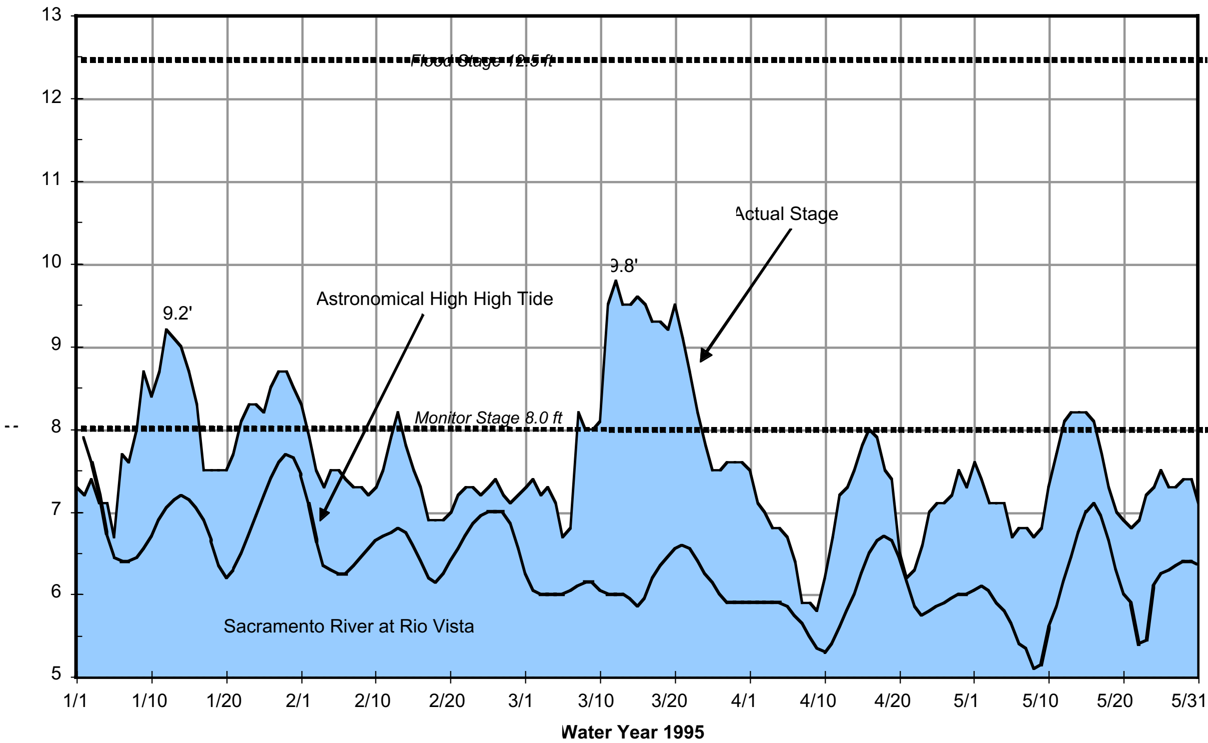


Figure 60. Hydrograph of the Sacramento River at Rio Vista



Gage Information
CDEC ID: RVB
Cooperating Agencies: DWR
Data Collection: Microwave

Gage Location
Hydrologic Region: Sacramento River
River Basin: Sacramento River
County: Solano
Latitude: 38.1500°N
Longitude: 121.7000°W
Elevation: 0 feet

River Stage Information
Datum: 0=0.0 feet USED
Peak of Record: 11.5 feet on February 20, 1986

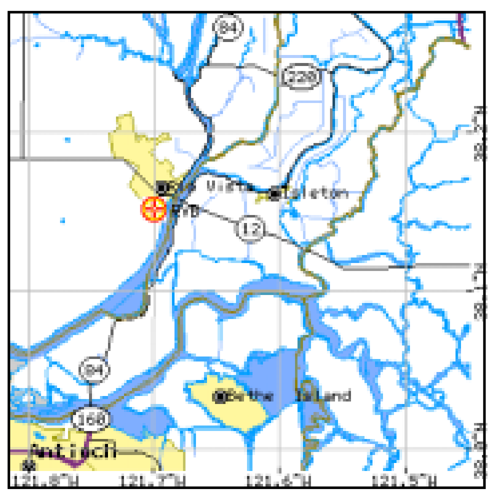
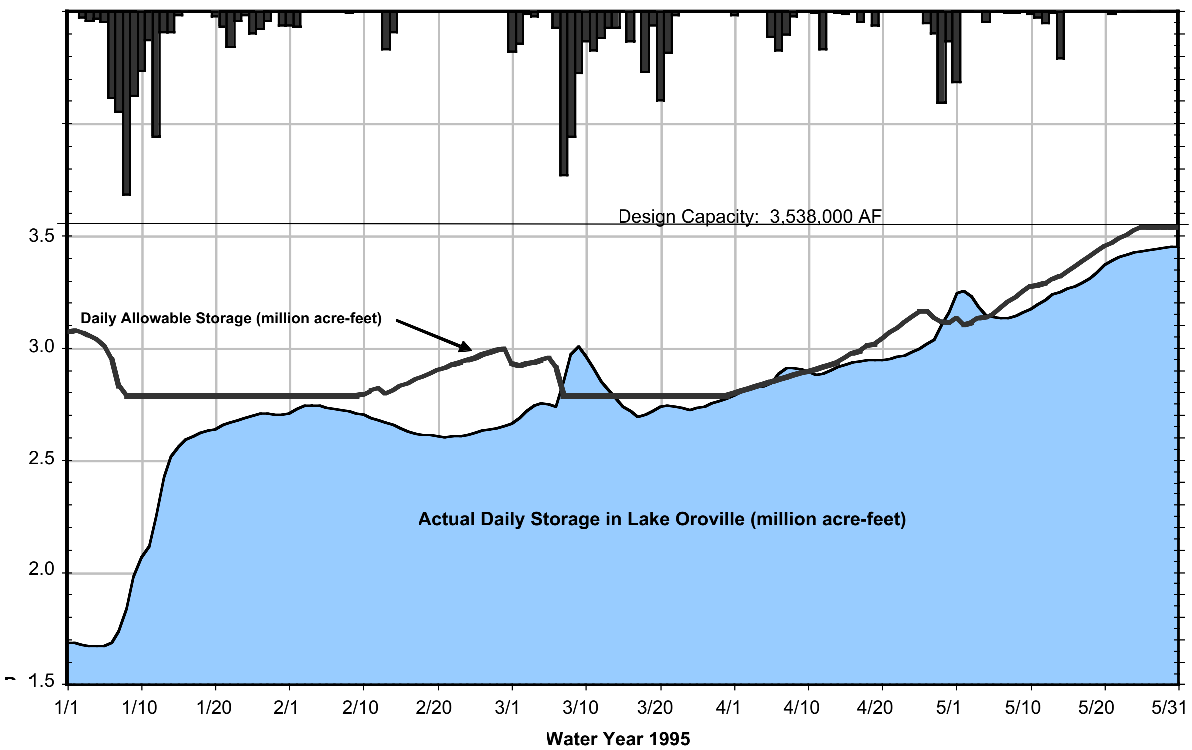


Figure 61. Lake Oroville Operations, Feather River



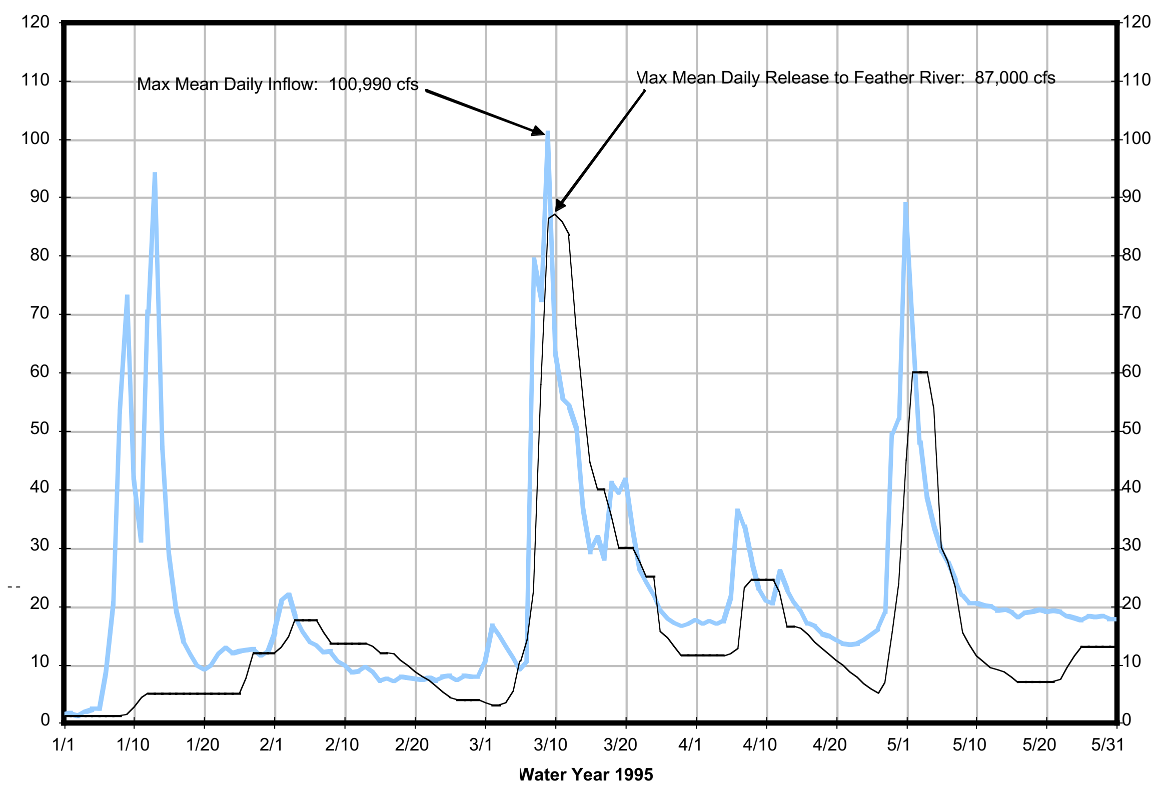
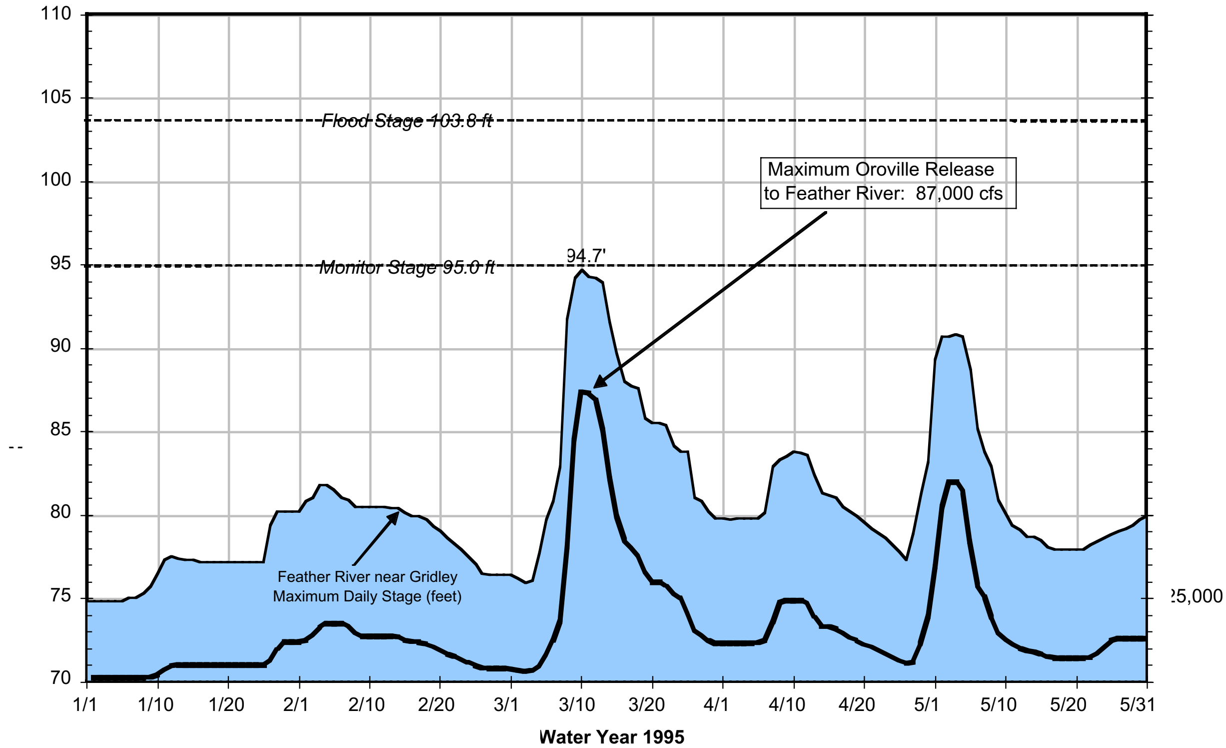


Figure 62. Hydrograph of the Feather River near Gridley including Oroville Dam Release

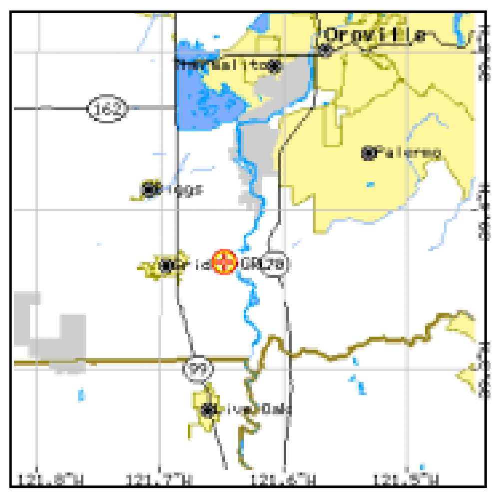


Gage Information

CDEC ID: GRL
Cooperating Agencies: DWR
Data Collection: Microwave, Satellite

Gage Location

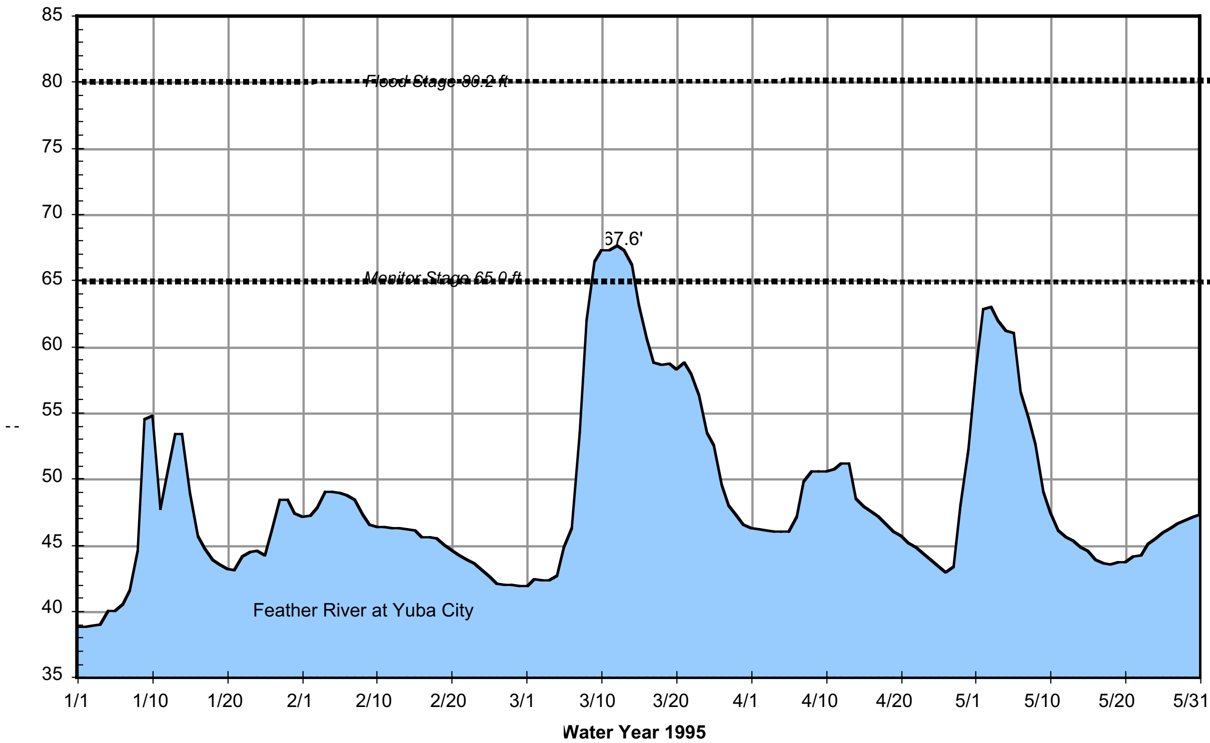
Hydrologic Region: Sacramento River
River Basin: Feather River (Sacramento River Tributary)
County: Butte
Latitude: 39.3670°N
Longitude: 121.6460°W
Elevation: 92 feet



River Stage Information

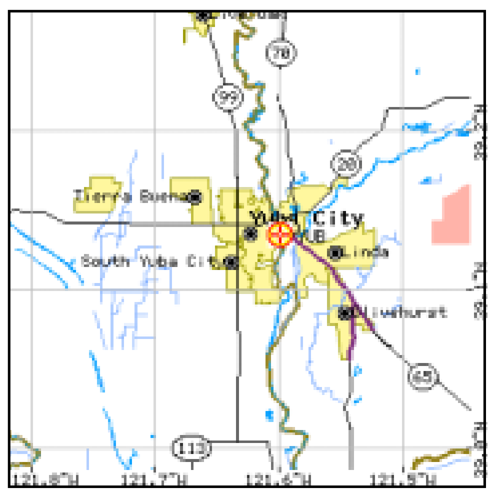
Datum: 0=0.0 feet USED
Peak of Record (after Oroville Dam constructed): 100.1 feet on February 19, 1986
Peak of Record (before Oroville Dam): 102.25 feet on December 23, 1955

Figure 63. Hydrograph of the Feather River at Yuba City



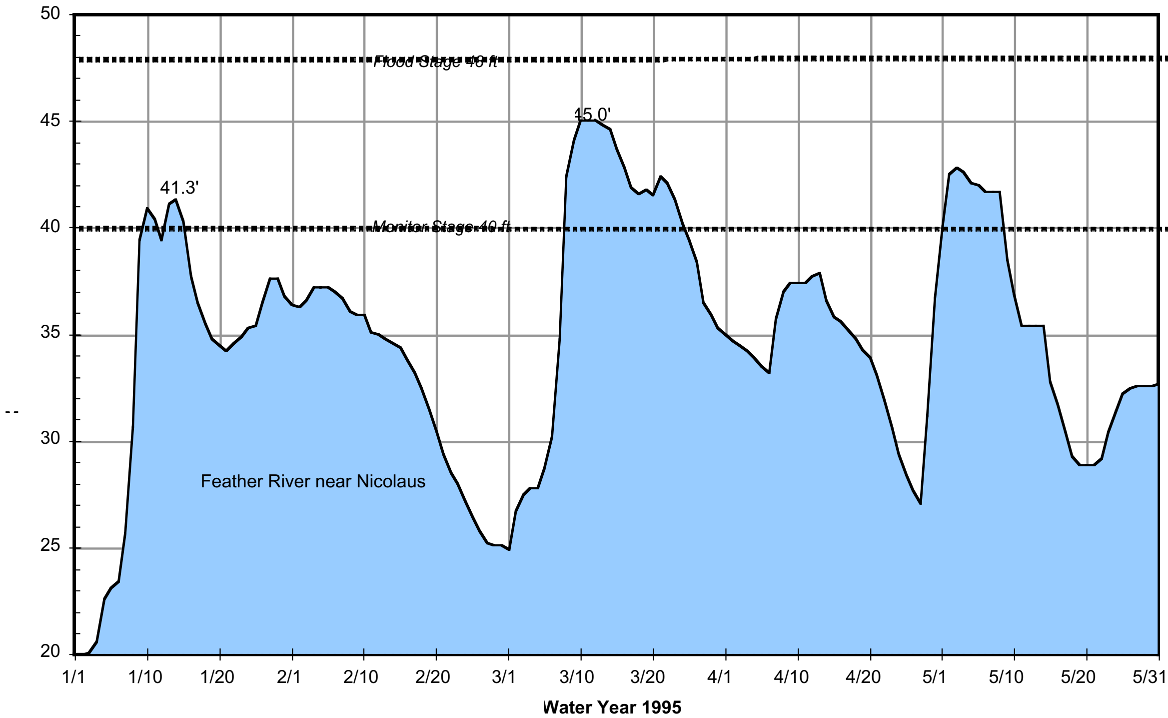
Gage Information
CDEC ID: YUB
Operator(s): DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: Sacramento River
River Basin: Feather River (Sacramento River Tributary)
County: Sutter
Latitude: 39.1330°N
Longitude: 121.6000°W
Elevation: 80 feet



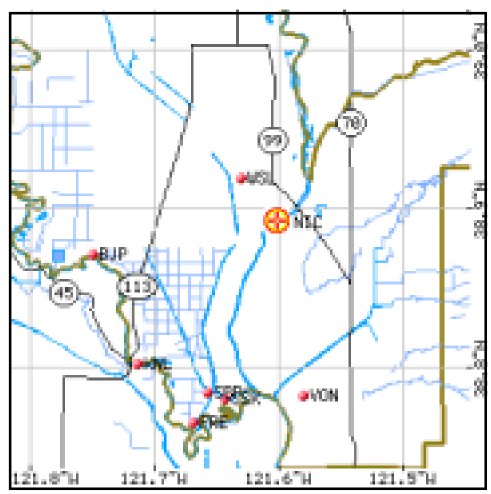
River Stage Information
Datum: 0 =0.0 feet USED
Peak of Record (after Oroville Dam constructed): 78.2 feet on January 2, 1997
Peak of Record (before Oroville Dam): 82.4 feet on December 24, 1955

Figure 64. Hydrograph of the Feather River near Nicolaus



Gage Information

CDEC ID: NIC
Cooperating Agencies: DWR
Data Collection: Microwave, Satellite



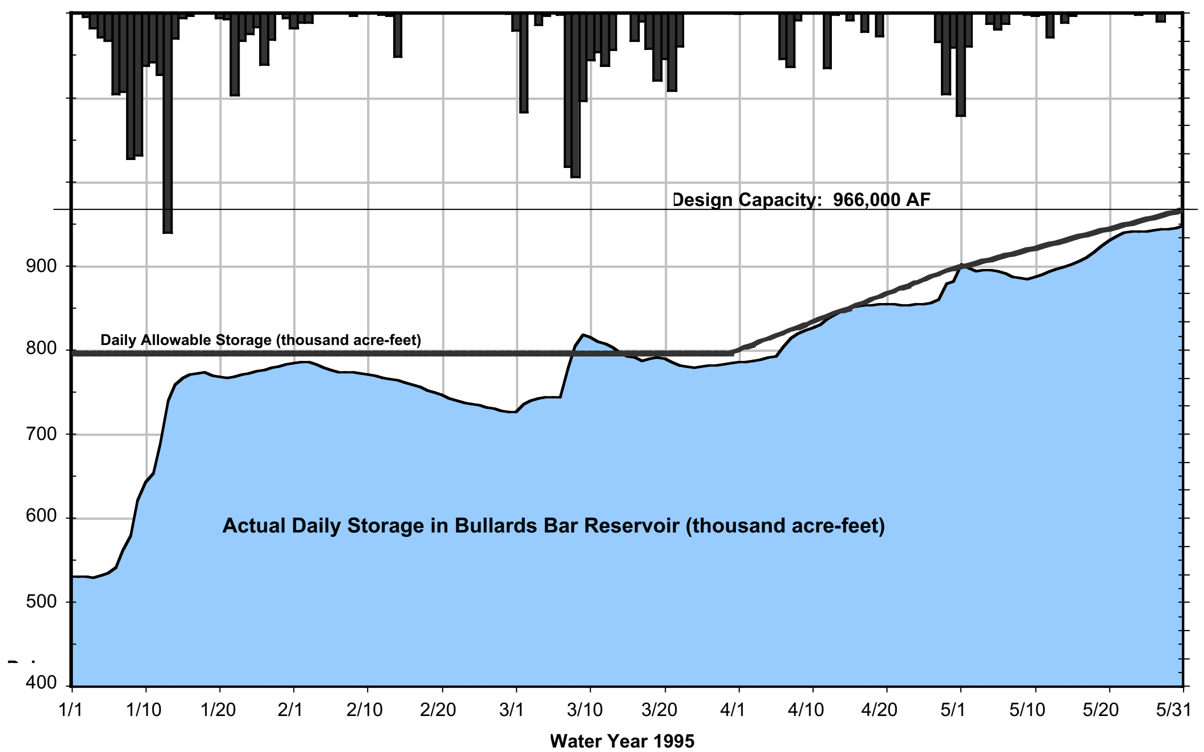
Gage Location

Hydrologic Region: Sacramento River
River Basin: Feather River (Sacramento River Tributary)
County: Sutter
Latitude: 38.9170°N
Longitude: 121.5500°W
Elevation: 43 feet

River Stage Information

Datum: 0=0.0 feet USED
Peak of Record (after Oroville Dam constructed): 50.4 feet on January 2, 1997
Peak of Record (before Oroville Dam): 51.6 feet on December 23, 1955

Figure 65. New Bullards Bar Reservoir Operations, Yuba River



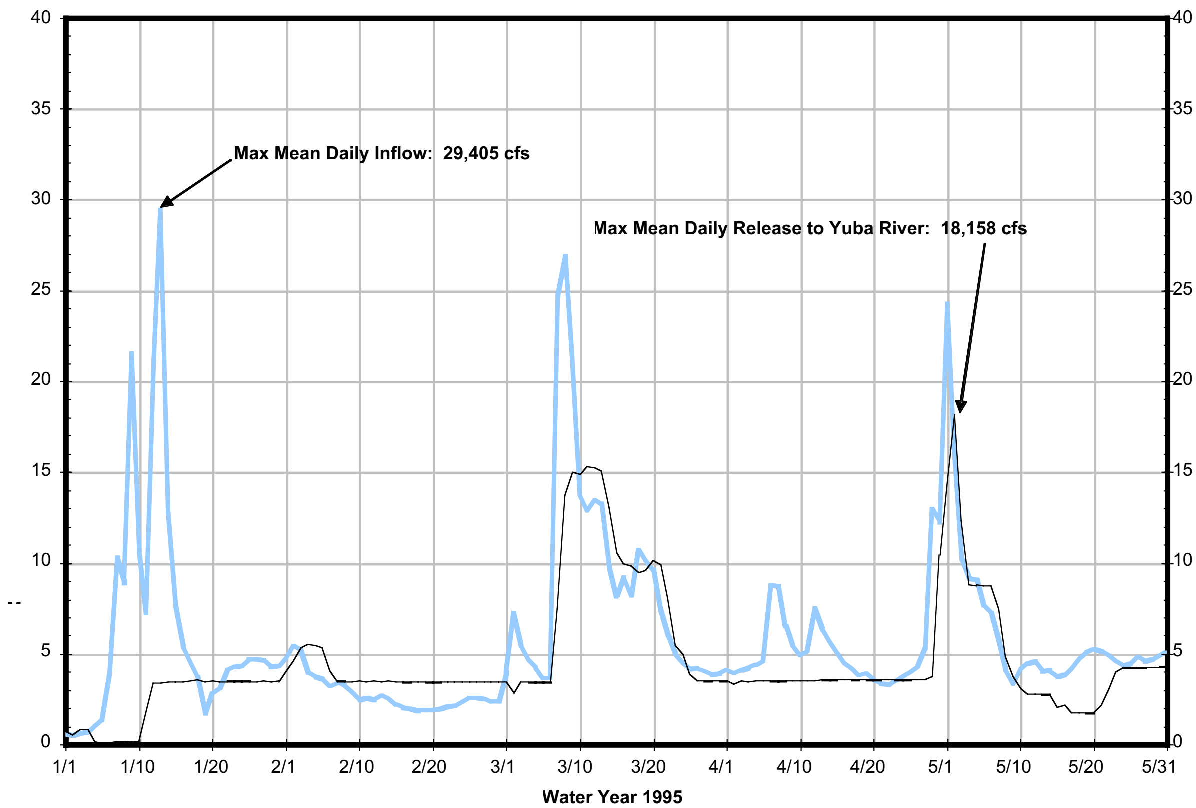


Figure 66. Folsom Lake Operations, American River

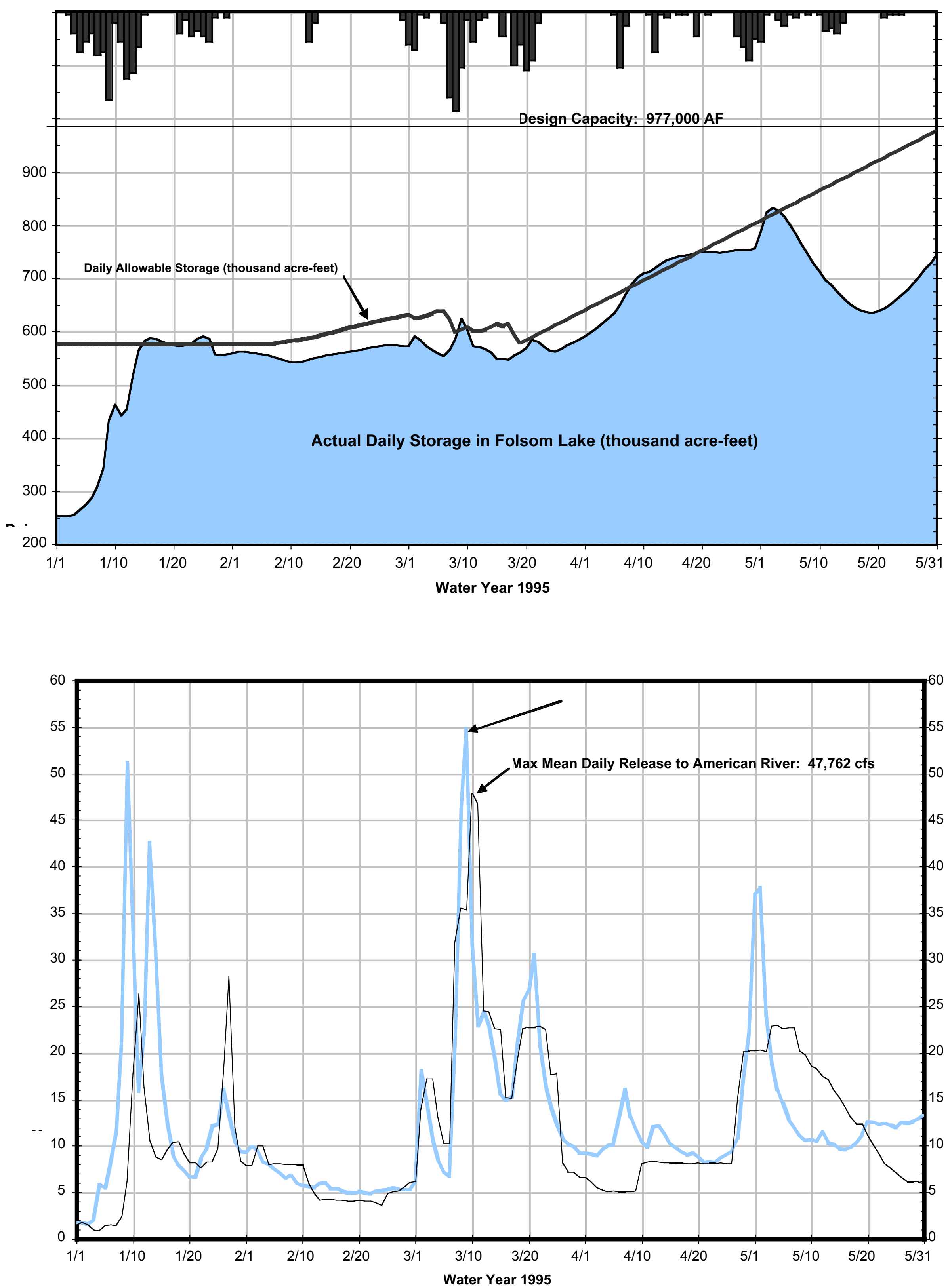
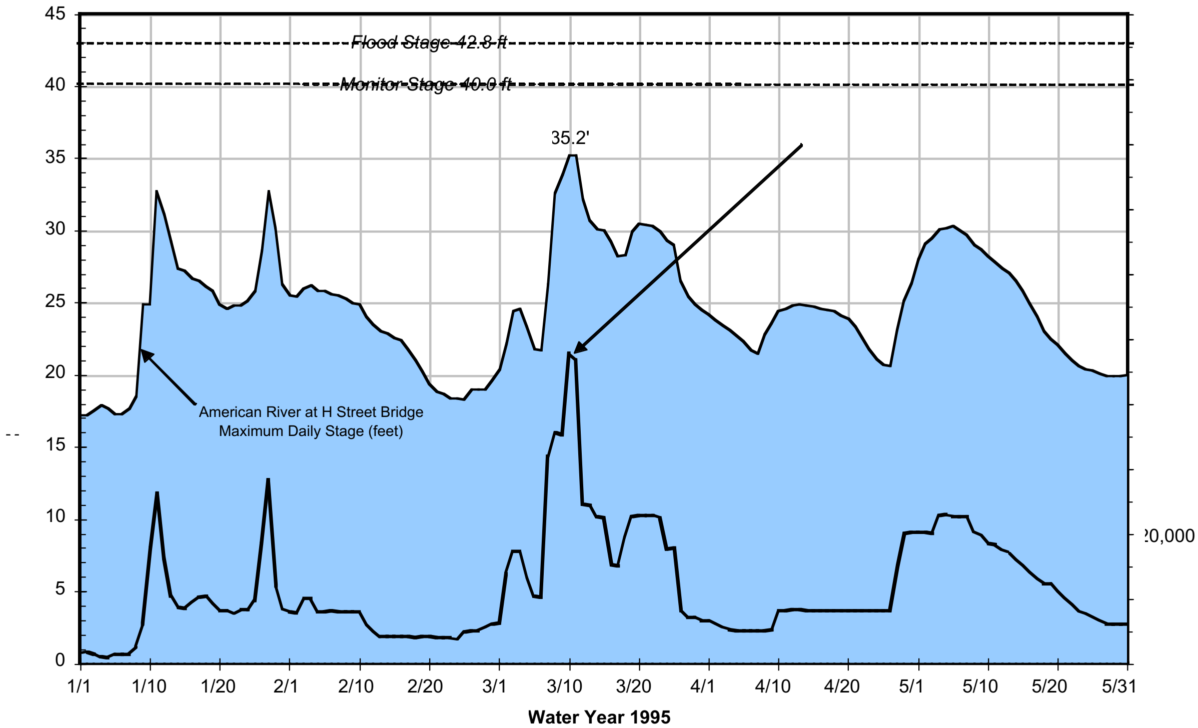
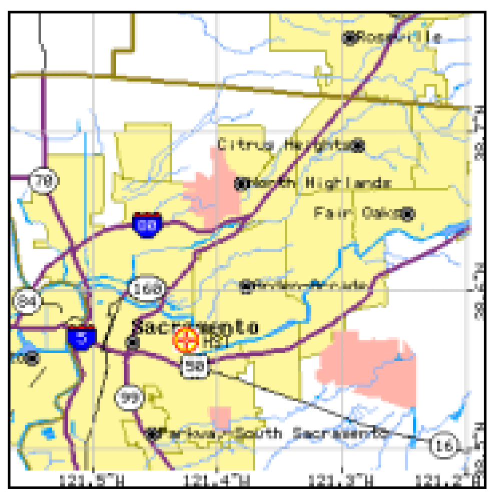


Figure 67. Hydrograph of the American River at H Street Bridge including Nimbus Dam Release



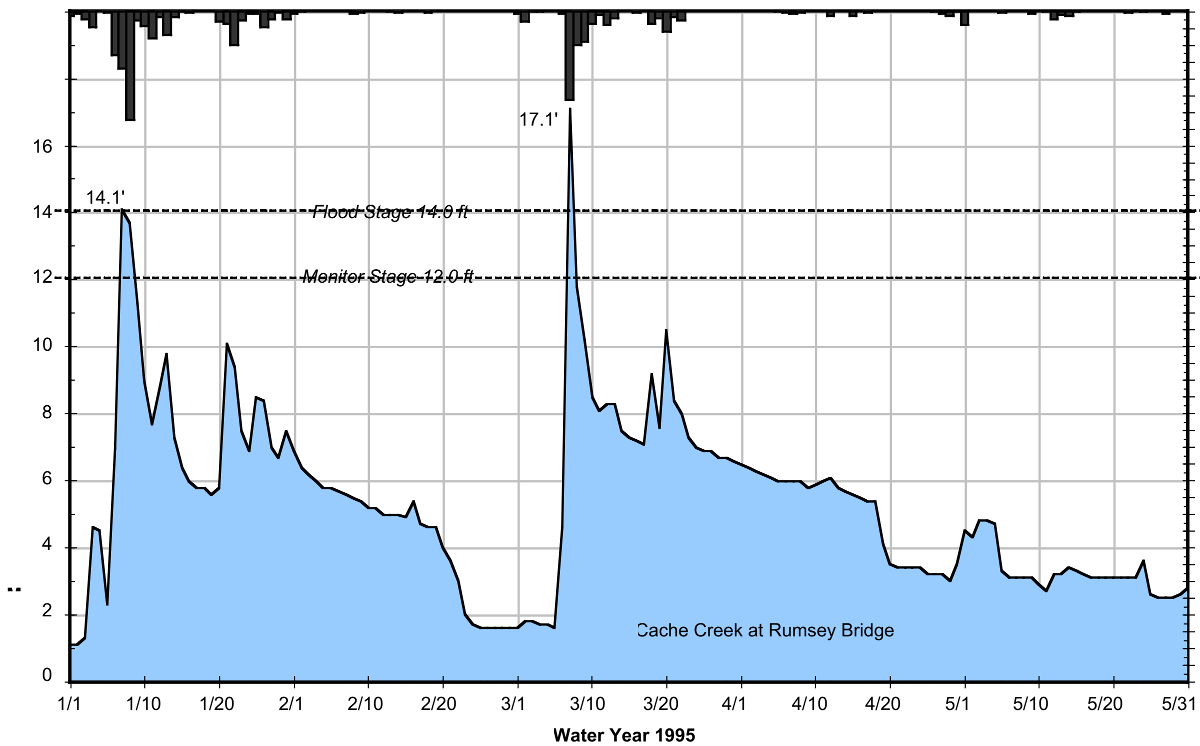
Gage Information
CDEC ID: HST
Cooperating Agencies: USBR, DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: Sacramento River
River Basin: American River (Sacramento River Tributary)
County: Sacramento
Latitude: 38.5690°N
Longitude: 121.4230°W
Elevation: 45 feet



River Stage Information
Datum: 0=0.0 feet USED
Peak of Record (after Folsom Dam constructed): 43.4 feet on February 19, 1986
Peak of Record (before Folsom Dam): 45.7 feet on November 21, 1950

Figure 68. Hydrograph of Cache Creek at Rumsey Bridge

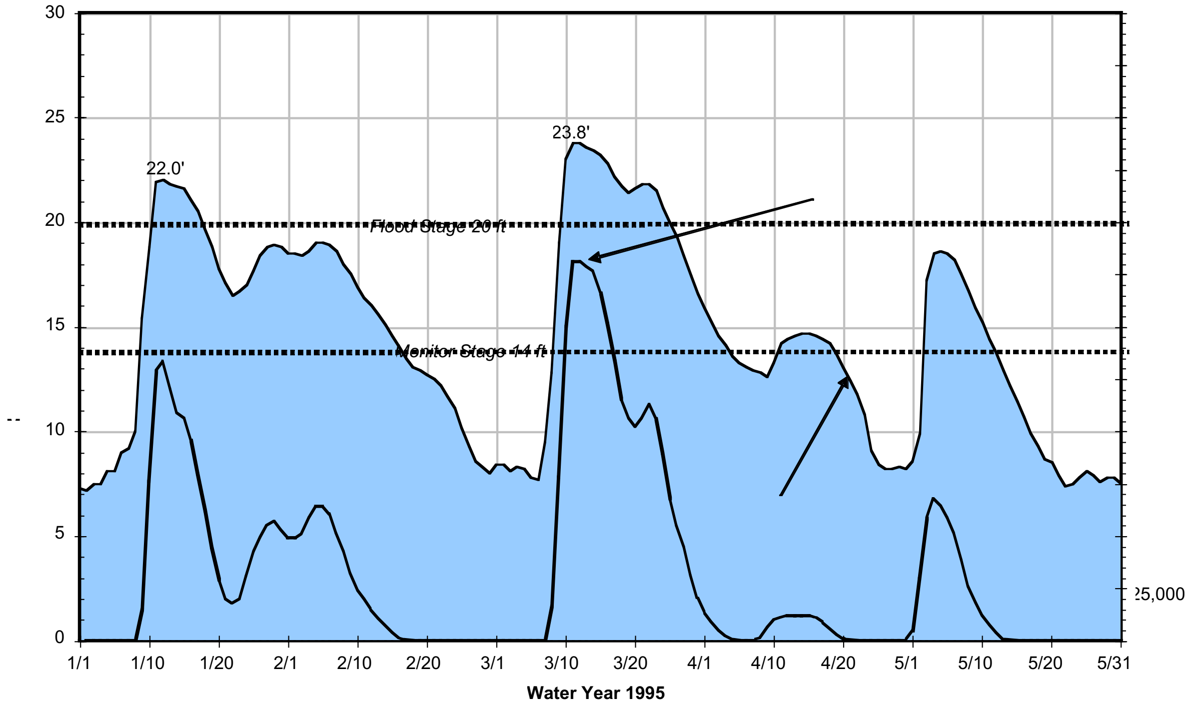


Gage Information
CDEC ID: RUM
Cooperating Agencies: USBR, DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: Sacramento River
River Basin: Cache Creek (Tributary to the Sacramento River via the Yolo Bypass)
County: Yolo
Latitude: 38.8900°N
Longitude: 122.2380°W
Elevation: 53 feet

River Stage Information
Datum: 0=403.7 feet NGVD
Peak of Record: 17.88 feet on January 26, 1983

Figure 69. Hydrograph of the Yolo Bypass at Lisbon including Flow over Fremont Weir



* Monitor stage reduced from 19 to 14 feet, and flood stage reduced from 26.2 to 20 feet November 15, 2002

Gage Information
CDEC ID: LIS
Cooperating Agencies: DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: Sacramento River
River Basin: Sacramento River
County: Yolo
Latitude: 38.4830°N
Longitude: 121.5830°W
Elevation: 0 feet

River Stage Information
Datum: 0=0.0 feet USED
Peak of Record: 27.5 feet on January 20, 1986

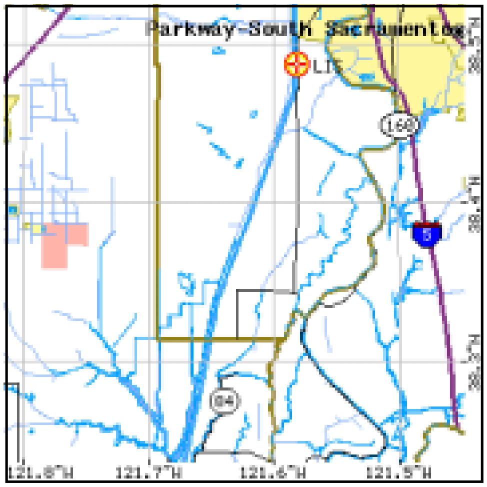
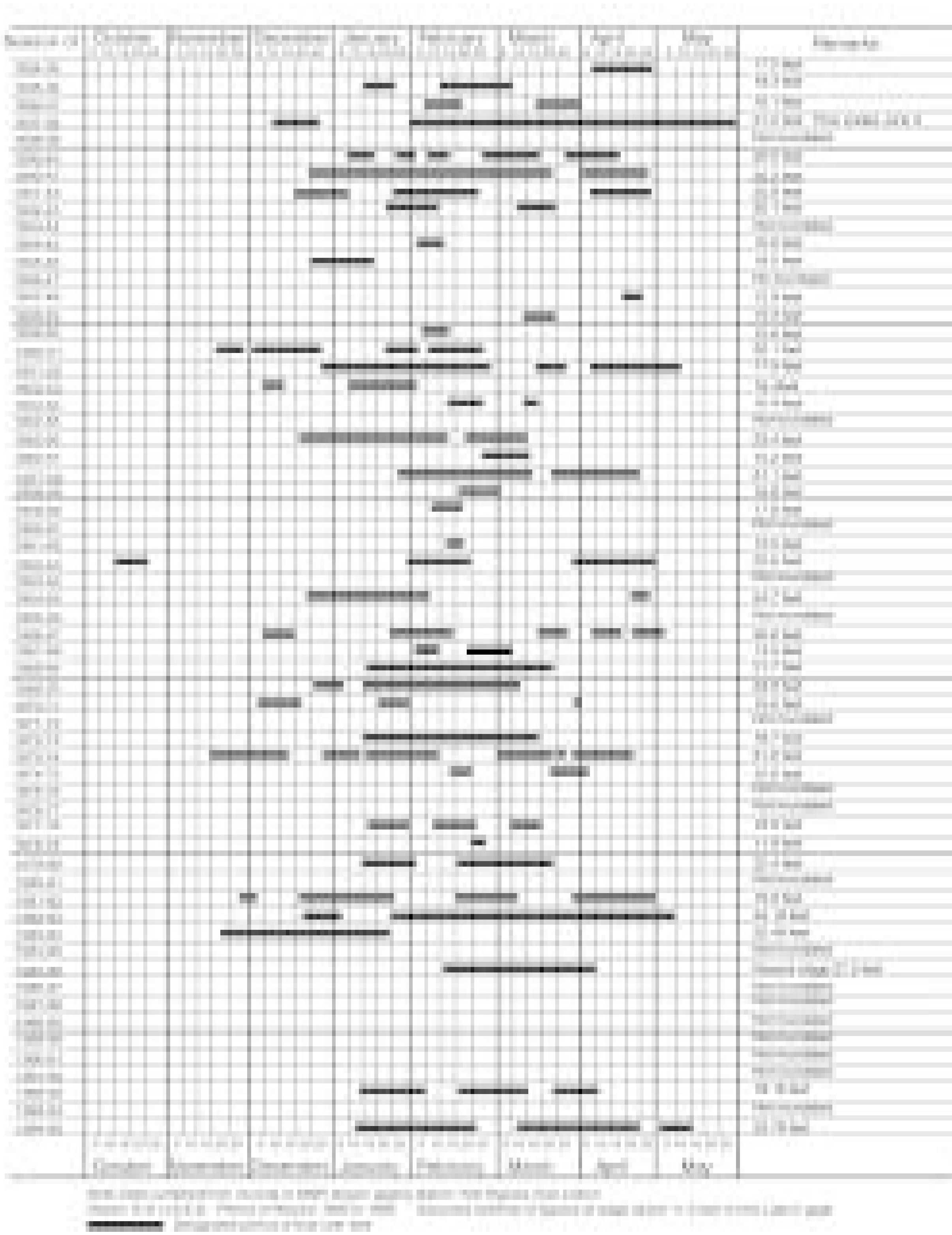
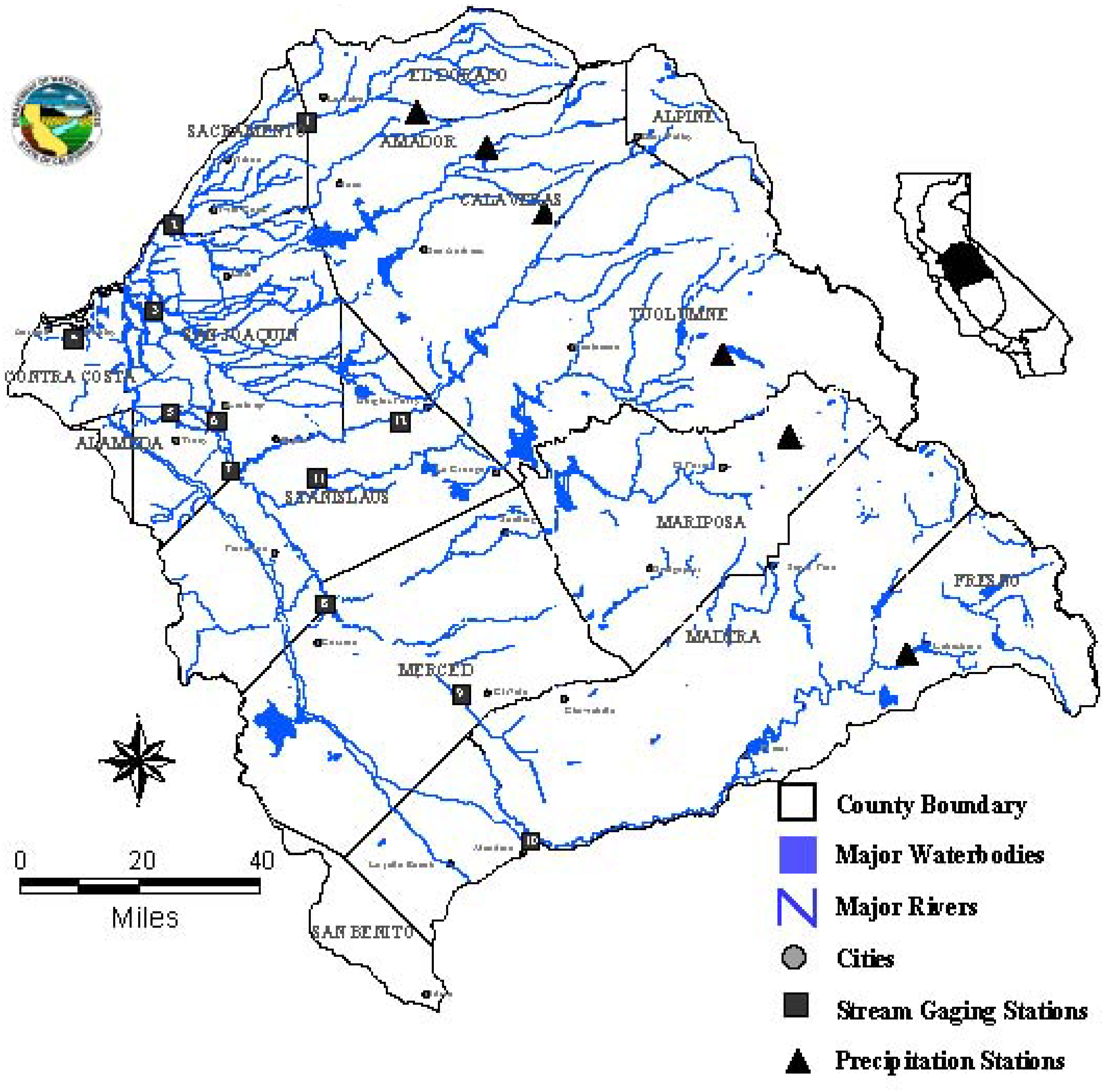


Figure 70. Period of Record of Yolo Bypass overflow



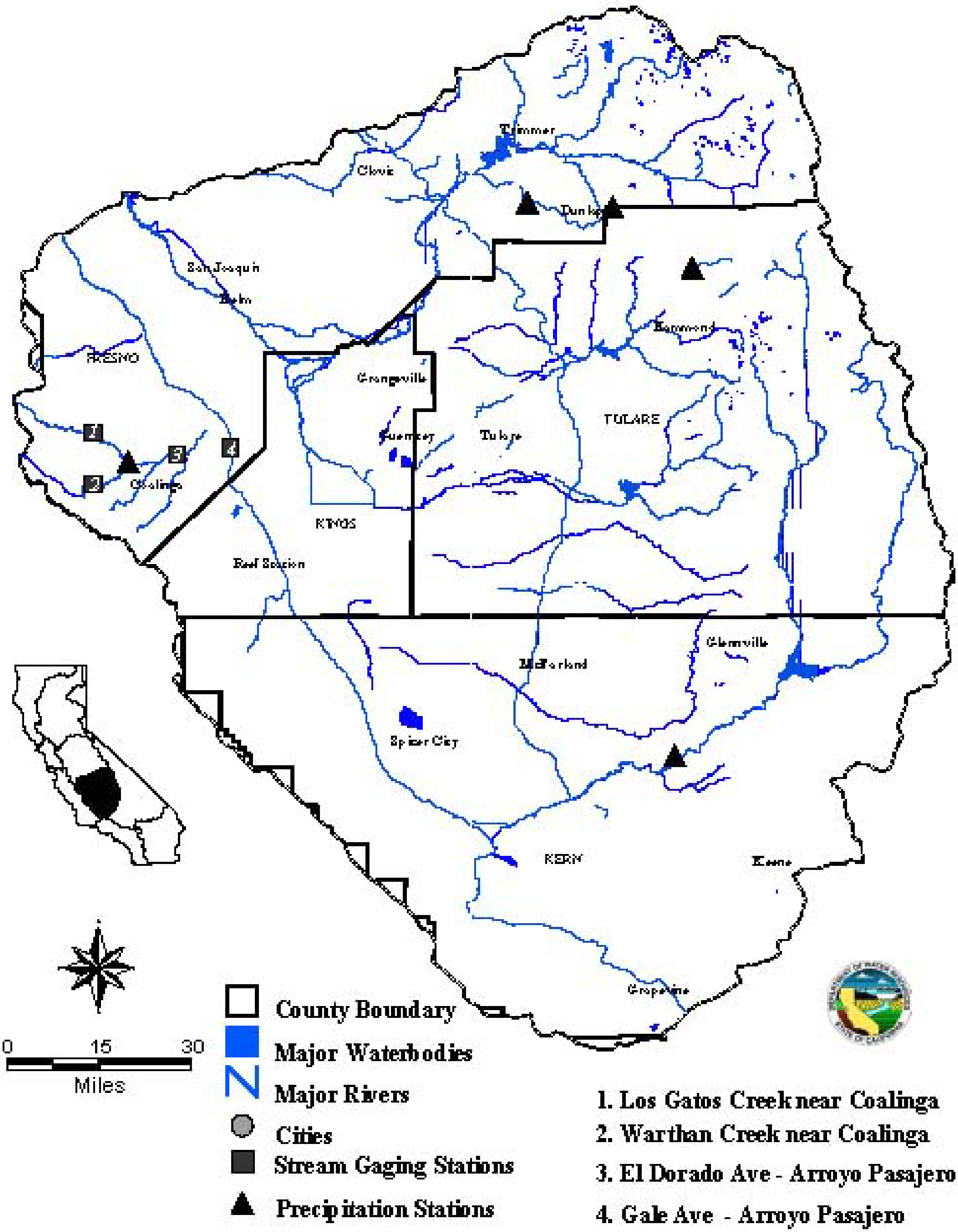
San Joaquin River and Tulare Lake Hydrologic Regions

Figure 71. Location of Real Time Stream Gages and Selected Precipitation Stations, San Joaquin Hydrologic Region



1. Michigan Bar - Cosumnes River
2. Benson's Ferry (Thornton) - Mokelumne River
3. Venice Island - San Joaquin River/Delta
4. Antioch - San Joaquin River/Delta
5. Old River near Tracy/Delta
6. Mossdale - San Joaquin River
7. Vernalis - San Joaquin River
8. Newman - San Joaquin River
9. El Nido - Eastside Bypass
10. Mendota - San Joaquin River
11. Modesto - Tuolumne River
12. Orange Blossom Bridge - Stanislaus River

**Figure 72. Real Time Stream Gages and Selected Precipitation Stations
Tulare Lake Hydrologic Region**



San Joaquin River and Tulare Lake Hydrologic Regions

January Flood Event

A series of storms produced 285 and 265 percent of average monthly precipitation in the San Joaquin River and Tulare Lake hydrologic regions during January. Runoff in the San Joaquin River Hydrologic Region totaled 1.8 million acre-feet, with a seasonal total of 160 percent of average. Runoff in the Tulare Lake Hydrologic Region totaled about 460,000 acre-feet, with a seasonal total of 115 percent of average.

Heavy precipitation over the southern San Joaquin Valley caused widespread urban and small-creek flooding, especially around January 24–25. Flooding could have been worse had it not been for low reservoir storage totals—about 70 percent of average at the end of December.

Significant responses to storm runoff and reservoir flood control operations are summarized for key stream gaging stations in the following paragraphs. See figures 71 and 72 for location of real time stream gages and selected precipitation stations in these two hydrologic regions.

San Joaquin River

- Mendota did not respond significantly to the January storms, peaking at 10.0 feet on February 1. Flows downstream of Mendota Dam were low with minimal river inflows and no Pine Flat Reservoir flood control diversions.
- Newman peaked at 57.8 feet on January 29, well below the 63-foot monitor stage, with a maximum flow of 5,150 cubic feet per second.
- Vernalis peaked at 19.6 feet on January 29, well below the 24.5-foot monitor stage, with a maximum flow of 11,900 cubic feet per second.

Eastside Bypass

- El Nido showed little response to the January storms as the stage remained below the 12.0-foot monitor stage.

Merced River

- The Merced was not a primary player in January with storage at New Exchequer Reservoir (Lake McClure) quite low after many dry years.

Tuolumne River

- Modesto peaked at 50.6 feet on January 28, just above monitor stage, with a maximum flow of 6,100 cubic feet per second.

Stanislaus River

- The Stanislaus was also quiet in January with storage at New Melones Reservoir quite low after many dry years.

Typical stream gage.

Calaveras River

- The majority of runoff in the Calaveras River was stored in New Hogan Reservoir (Figure 73).

Mokelumne River

- Benson's Ferry (near Thornton) peaked at 14.7 feet on January 12 with the resulting floodwater causing widespread agricultural damage (figures 74 and 75).

Cosumnes River

- The Cosumnes River is unregulated by dams and responds quickly to rainfall over the basin. Michigan Bar peaked at 10.3 feet on January 10, 1.7 feet below flood stage, with a maximum flow of 17,700 cubic feet per second (Figure 76).

Tulare Lake Hydrologic Region – Arroyo Pasajero

- Los Gatos Creek, the main tributary for the Arroyo, had minor stage fluctuations with a peak stage of 8 feet recorded on January 23. The creek flows southeasterly down the west side of the San Joaquin Valley into the Arroyo Pasajero near Coalinga (Figure 77).
- Warthan Creek, a tributary to Los Gatos Creek, rose to about 4.0 feet on January 23 (Figure 78).
- El Dorado Avenue peaked just over 8.0 feet on January 9 (Figure 79).
- The impound basin at Gale Avenue peaked near 9.0 feet on January 26 (Figure 80).

Tulare Lake Hydrologic Region – Flood Control Reservoirs

- The four major flood control reservoirs in the region—Pine Flat Reservoir on the Kings River, Lake Kaweah (Terminus Reservoir) on the Kaweah River, Lake Success on the Tule River, and Lake Isabella on the Kern River—were not factors during the January storms.

Amador and Kern counties were declared federal disaster areas.

March Flood Event

After a relatively quiet February another series of storms produced 320 and 305 percent of average monthly precipitation in the San Joaquin River and Tulare Lake hydrologic regions during March, and corresponding seasonal precipitation totals stood at 170 and 165 percent of average. San Joaquin region runoff totaled 4.7 million acre-feet, with a seasonal total of 200 percent of average, and Tulare Lake region runoff totaled 1.4 million acre-feet, with a seasonal total of 160 percent of average.

New Melones Reservoir storage recovered from 16 percent of capacity in late 1994 to nearly 73 percent in 1995, storing all Stanislaus River runoff in the reservoir. Excess flows along the lower San Joaquin River were released from reservoirs on the San Joaquin, Merced, Tuolumne, Calaveras, and Mokelumne rivers, or were imported from the Kings River.

A significant flood occurred on the Arroyo Pasajero in the San Joaquin Valley near Coalinga, and is described in greater detail in the Overview of Hydrology section.

Significant responses to storm runoff and reservoir flood control operations are summarized for key stream gaging stations in the following paragraphs.

San Joaquin River

- See Figure 81 for Millerton Lake operations.
- Mendota peaked at 14.7 feet on March 14, 0.7 feet above flood stage, with a maximum flow of 4,050 cubic feet per second. No damage was reported. The water year peak of 15.2 feet occurred later in May because of snowmelt runoff and increased reservoir releases (Figure 82).
- Newman peaked at 64.8 feet on March 16, still 4.6 feet below flood stage, with a maximum flow of 21,300 cubic feet per second (Figure 83). No damage was reported.
- Vernalis peaked at 26.8 feet on March 19, 2.2 feet below flood stage, with a maximum flow of 26,100 cubic feet per second. The river rose above the 24.5-foot monitor stage for most of May and early June because of snowmelt runoff and increased reservoir releases. Beginning at stages near 22.0 feet, seepage into nearby fields can damage crops (Figure 84).

Looking southeast at the Arroyo Pasajero ponding basin, floodwaters emerge and pond against the California Aqueduct. (Golden State Floodlight)

Farther downstream, the Mossdale Trailer Park was evacuated, and several trailers were temporarily removed to higher ground.

Eastside Bypass

- El Nido peaked at 18.1 feet on March 17, 0.9 feet below flood stage, with a maximum flow of 15,800 cubic feet per second. No damage was reported. The bypass remained above monitor stage into late July except for a brief period in late June because of snowmelt runoff and increased reservoir releases (Figure 85).

Merced River

- New Exchequer Reservoir (Lake McClure) began small flood control releases in early March that continued through July (Figure 86).

Tuolumne River

- Don Pedro Reservoir made moderate flood control releases beginning in early March that would continue to fluctuate through July in response to the melting snowpack. Modesto peaked at 56.6 feet on March 12, 1.6 feet above flood stage, with a maximum flow of 11,100 cubic feet per second (figures 87 and 88). No damage was reported.

Stanislaus River

- The Stanislaus River was not a factor through March as New Melones Reservoir slowly recovered to storage levels above 70 percent by July (Figure 89).

Calaveras River

- New Hogan Reservoir made small flood control releases to the Calaveras River in late March and through most of April (see Figure 73).

Mokelumne River

- Benson's Ferry (near Thornton) peaked at 17.5 feet on March 12, 0.5 feet below flood stage, resulting in another round of flooding including the closure of Interstate 5 (see figures 74 and 75). Some agricultural lands were flooded as water backed up in low-lying locations.

Cosumnes River

- Michigan Bar had several peaks during March with a maximum stage of 11.5 recorded on March 9, 0.5 feet below flood stage, and a maximum flow of 24,400 cubic feet per second (see Figure 76).

Tulare Lake Hydrologic Region – Arroyo Pasajero

- Los Gatos Creek, the main tributary for the Arroyo, peaked at 12.6 feet on March 9 with a record flow of 5,700 cubic feet per second (see Figure 77).
- Warthan Creek peaked at 8.7 feet on March 9 (see Figure 78).
- El Dorado Avenue, responding to unusually high precipitation and runoff, peaked at 10.6 feet on March 9. The heavy runoff washed out Interstate 5 near Coalinga (see Figure 79 and the Overview of Hydrology section).
- The impound basin at Gale Avenue was filled with the unusually high Arroyo Pasajero runoff and peaked at 13.3 feet on March 9 (see Figure 80).

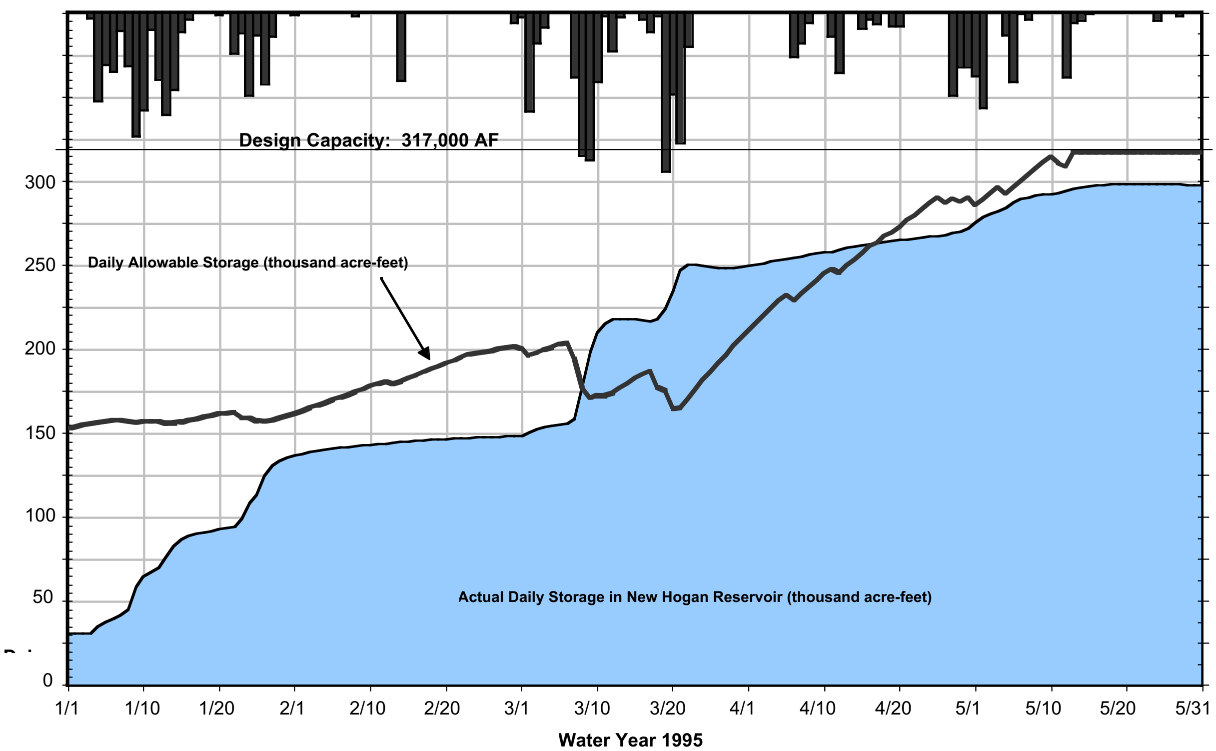
Tulare Lake Hydrologic Region – Flood Control Reservoirs

- The four major flood control reservoirs in the region—Pine Flat Reservoir on the Kings River, Lake Kaweah (Terminus) Reservoir on the Kaweah River, Lake Success on the Tule River, and Lake Isabella on the Kern River—began making flood control releases during March (figures 90–93).
- Below Pine Flat flood control, diversions were made out of the Kings River North at Crescent Weir to the James Bypass and Fresno Slough. These floodwaters flowed north to the Mendota Pool on the San Joaquin River adding to the total flood volume in the San Joaquin River Flood Control System.

On March 25 the National Weather Service in Hanford reported flooding on several roadways including Interstate 5 and many secondary highways. Caliente Creek, which flows west out of the Piute Mountains, flooded the Lamont area in Kern County. Kern County Office of Emergency Services helped place 110,000 sandbags to channel creek floodwaters down the streets. No homes were damaged. The National Weather Service in Bakersfield reported water on roadways in western San Joaquin Valley.

All counties in the San Joaquin River and Tulare Lake hydrologic regions were declared federal disaster areas.

Figure 73. New Hogan Reservoir Operations, Calaveras River



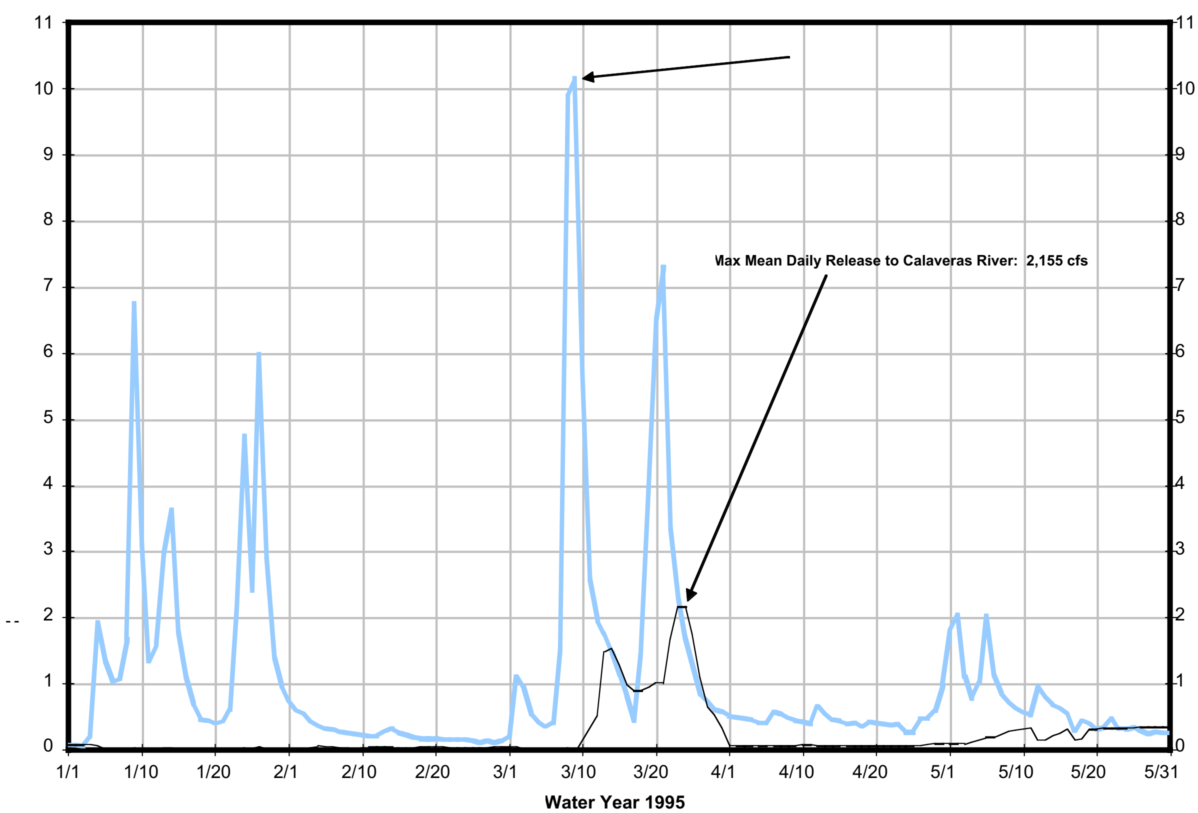
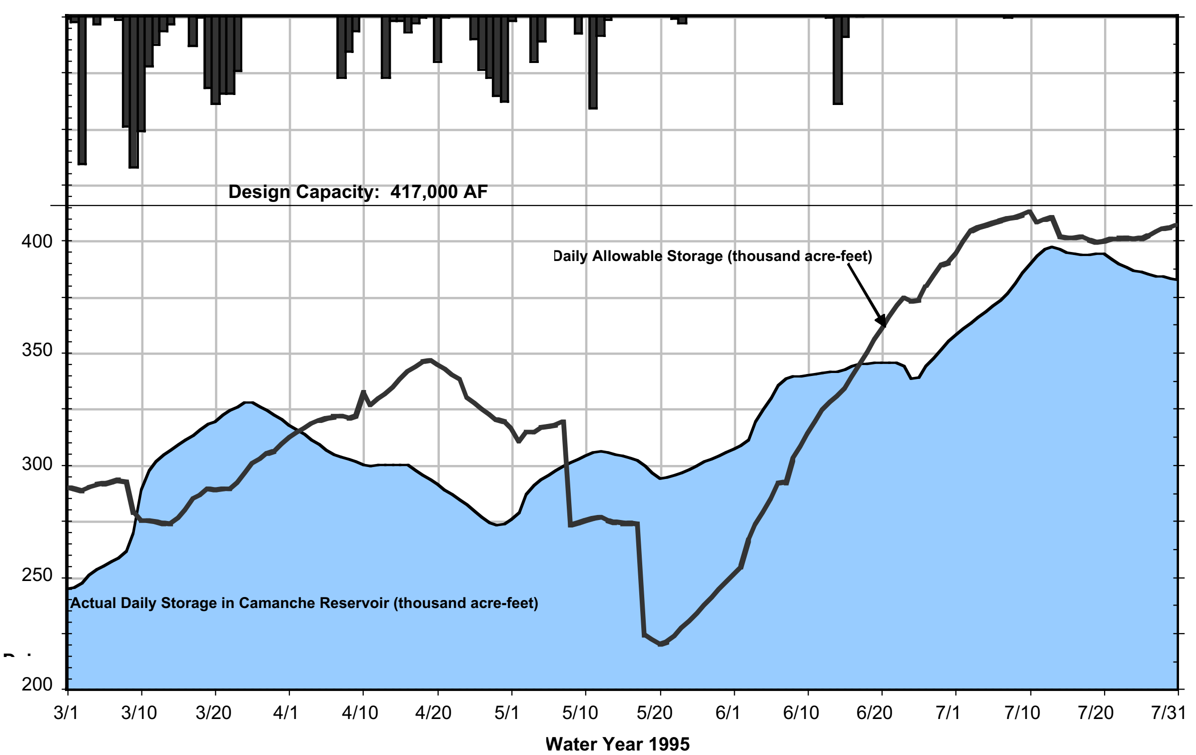


Figure 74. Camanche Reservoir Operations, Mokelumne River



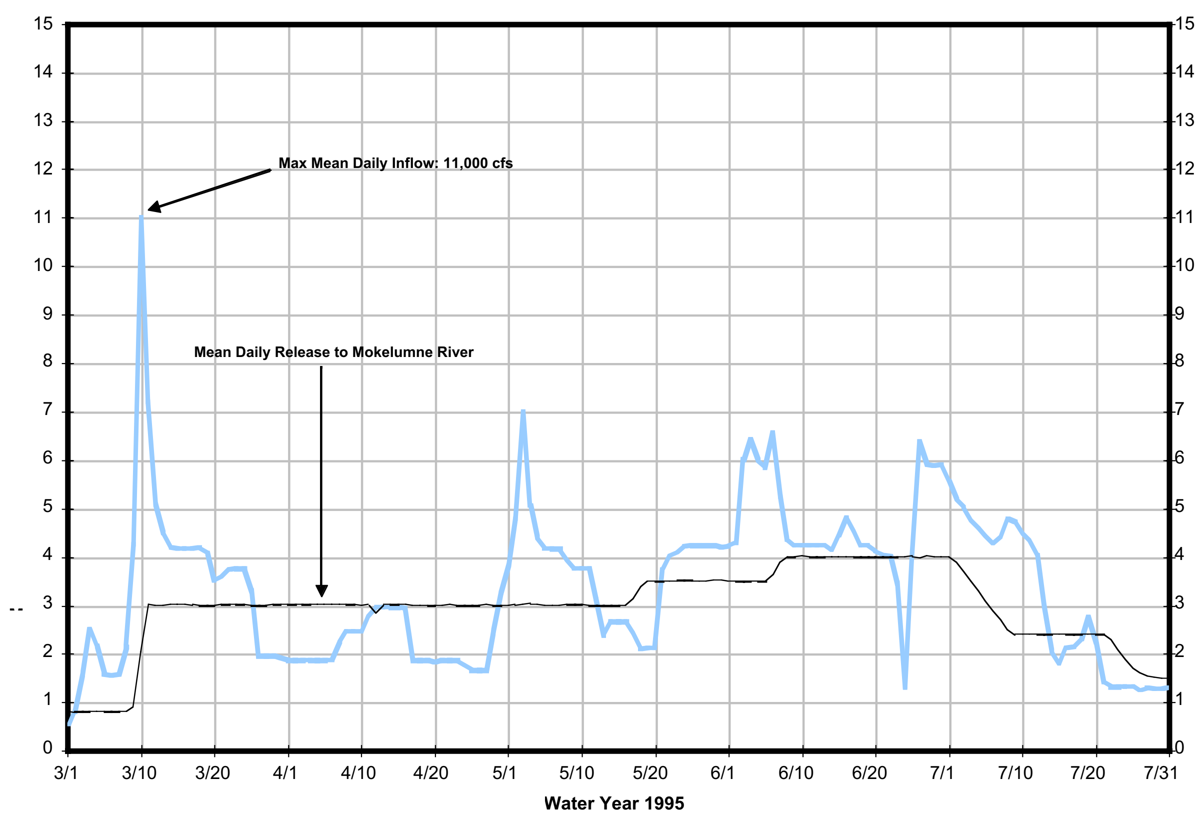
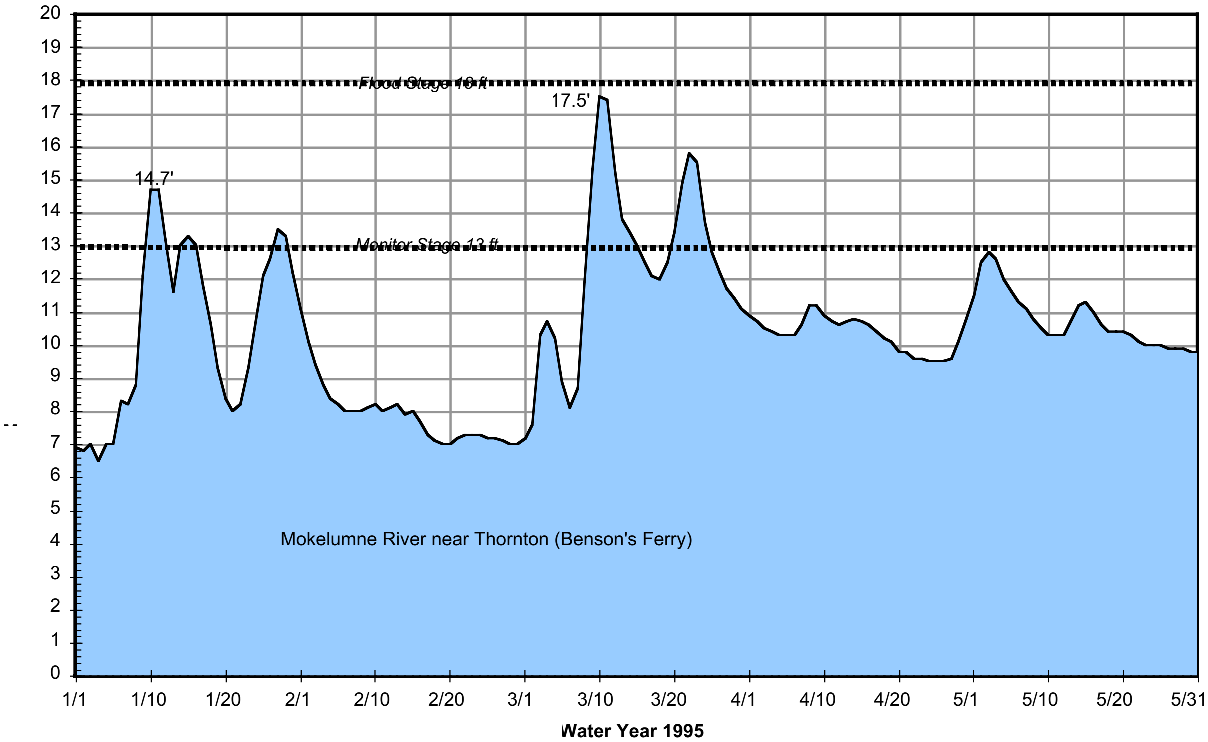
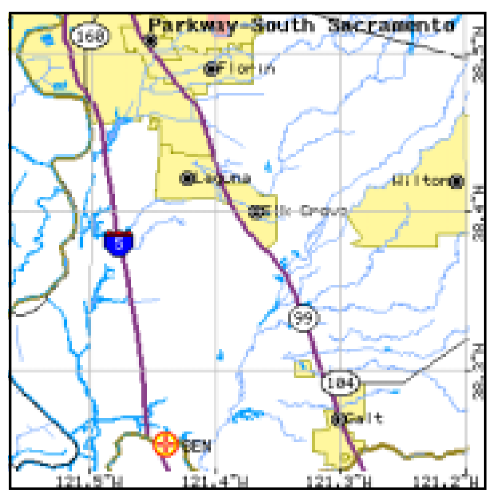


Figure 75. Hydrograph of the Mokelumne River near Thornton (Benson's Ferry)



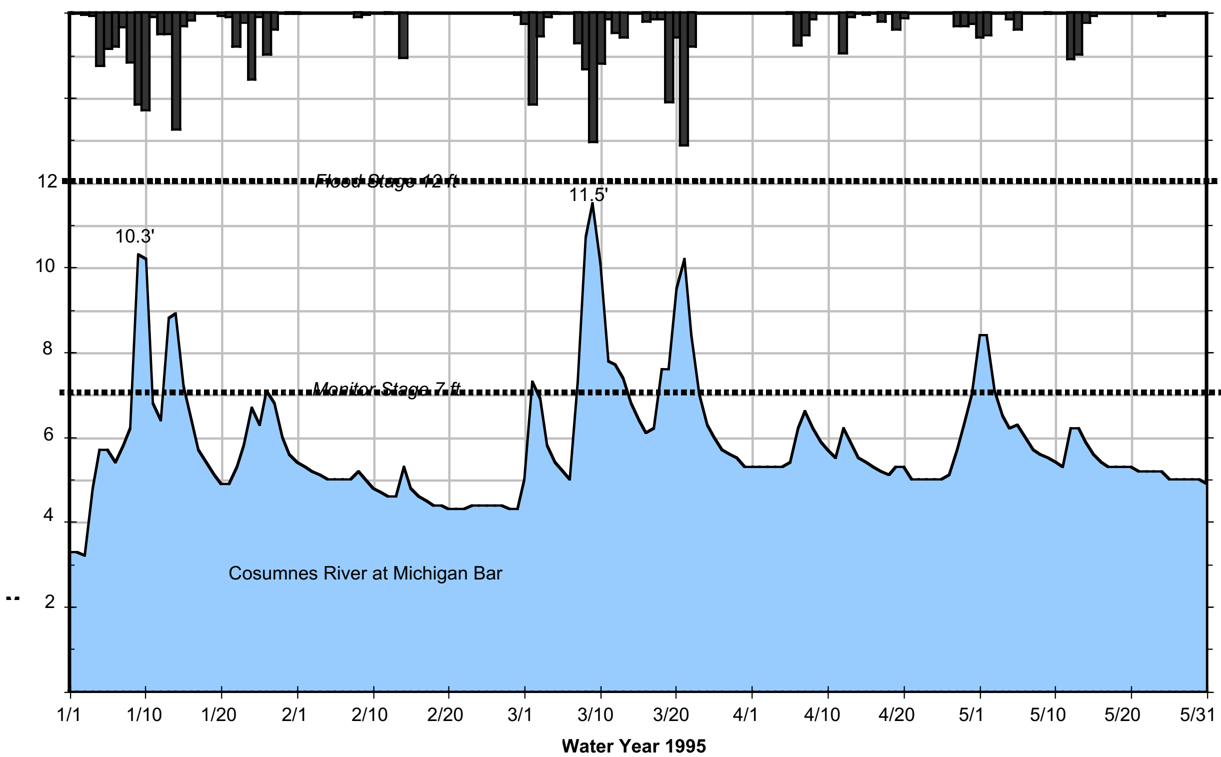
Gage Information
CDEC ID: BEN
Operator(s): DWR
Data Collection: Microwave, Satellite



Gage Location
Hydrologic Region: San Joaquin River
River Basin: Mokelumne River
County: San Joaquin
Latitude: 38.2560°N
Longitude: 121.4390°W
Elevation: 0 feet

River Stage Information
Datum: 0=(-) 3.0 feet NGVD
Peak of Record: 21.69 feet on January 3, 1977

Figure 76. Hydrograph of the Cosumnes River at Michigan Bar



Gage Information
CDEC ID: MHB
Cooperating Agencies: USGS, DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: San Joaquin River
River Basin: Cosumnes River
County: Sacramento
Latitude: 38.5000°N
Longitude: 121.0330°W
Elevation: 168 feet

River Stage Information
Datum: 0=168.1 feet NGVD
Peak of Record: 18.54 feet on January 2, 1997

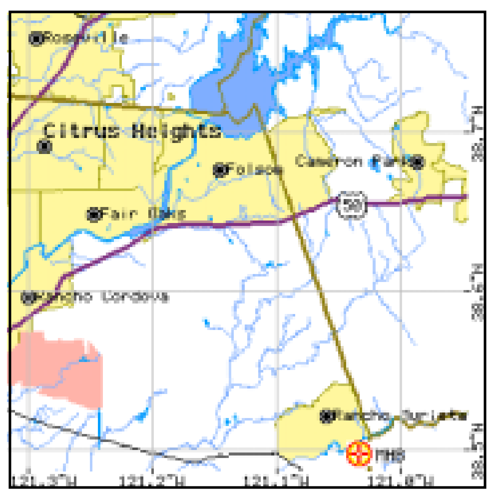
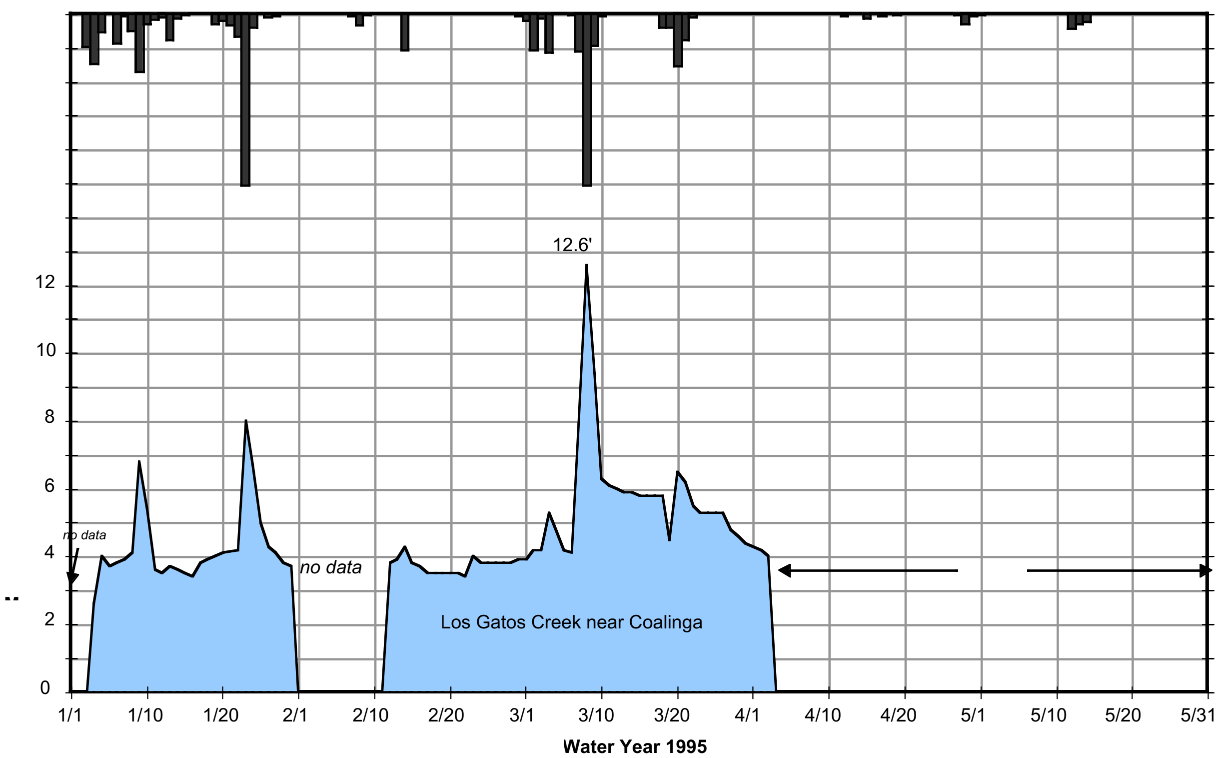


Figure 77. Hydrograph of Los Gatos Creek near Coalinga



Gage Information
CDEC ID: LGC
Cooperating Agencies: USGS, DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: Tulare Lake
River Basin: Arroyo Pasajero
County: Fresno
Latitude: 36.2170°N
Longitude: 120.4500°W
Elevation: 1,080 feet

River Stage Information
Datum: 1,065.2 feet NGVD (estimated)
Peak of Record: 6,500 cfs on March 10, 1995
(estimated by indirect method)

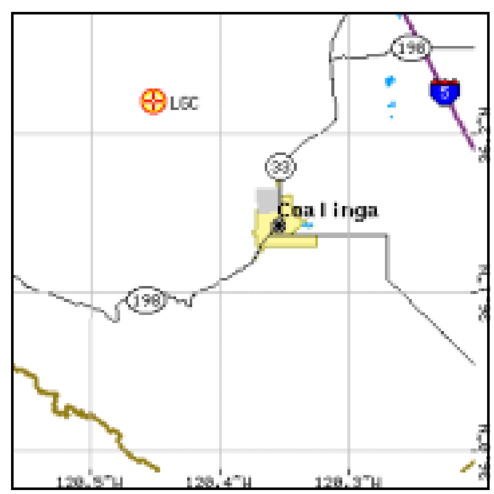
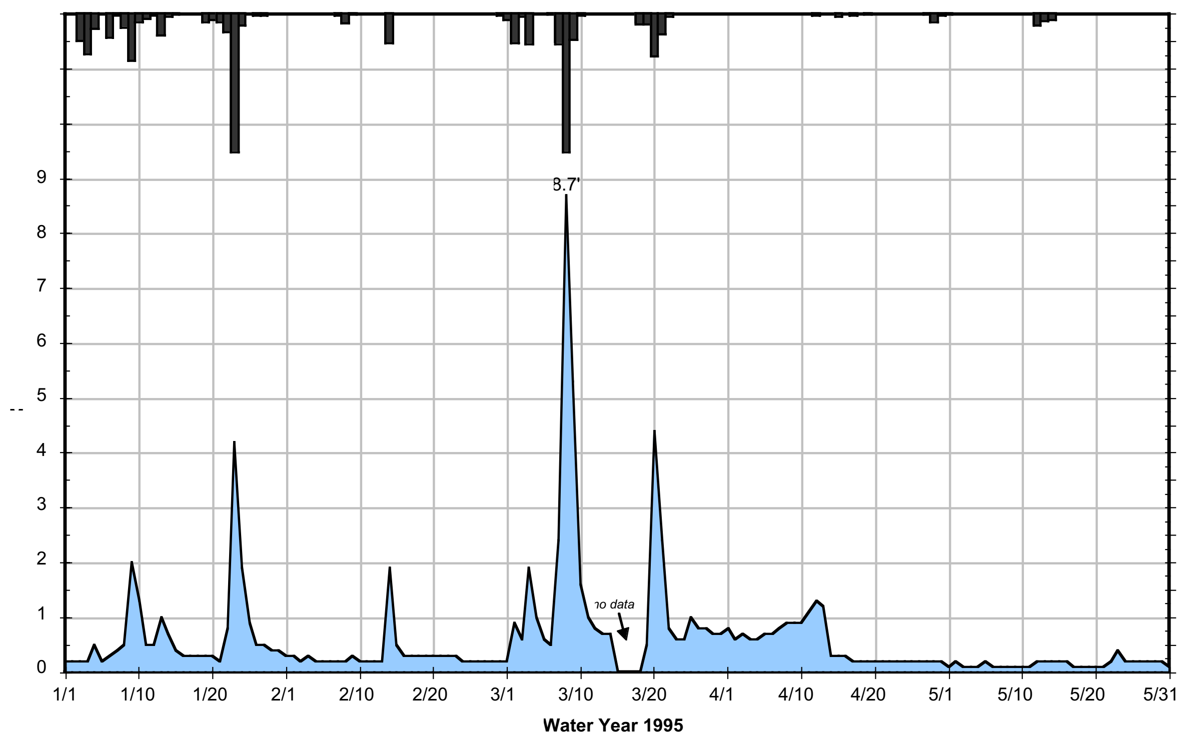


Figure 78. Hydrograph of Warthan Creek



Gage Information
CDEC ID: WRT
Cooperating Agencies: DWR
Data Collection: Satellite

Gage Location
Hydrologic Region: Tulare Lake
River Basin: Arroyo Pasajero
County: Fresno
Latitude: 36.0980°N
Longitude: 120.4430°W
Elevation: 989 feet

River Stage Information
Datum: 0=989 feet NGVD
Peak of Record: 8,200 cfs on March 10, 1995
(estimated by indirect methods)

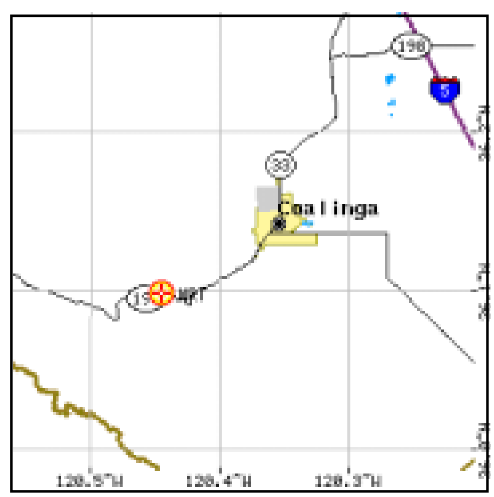
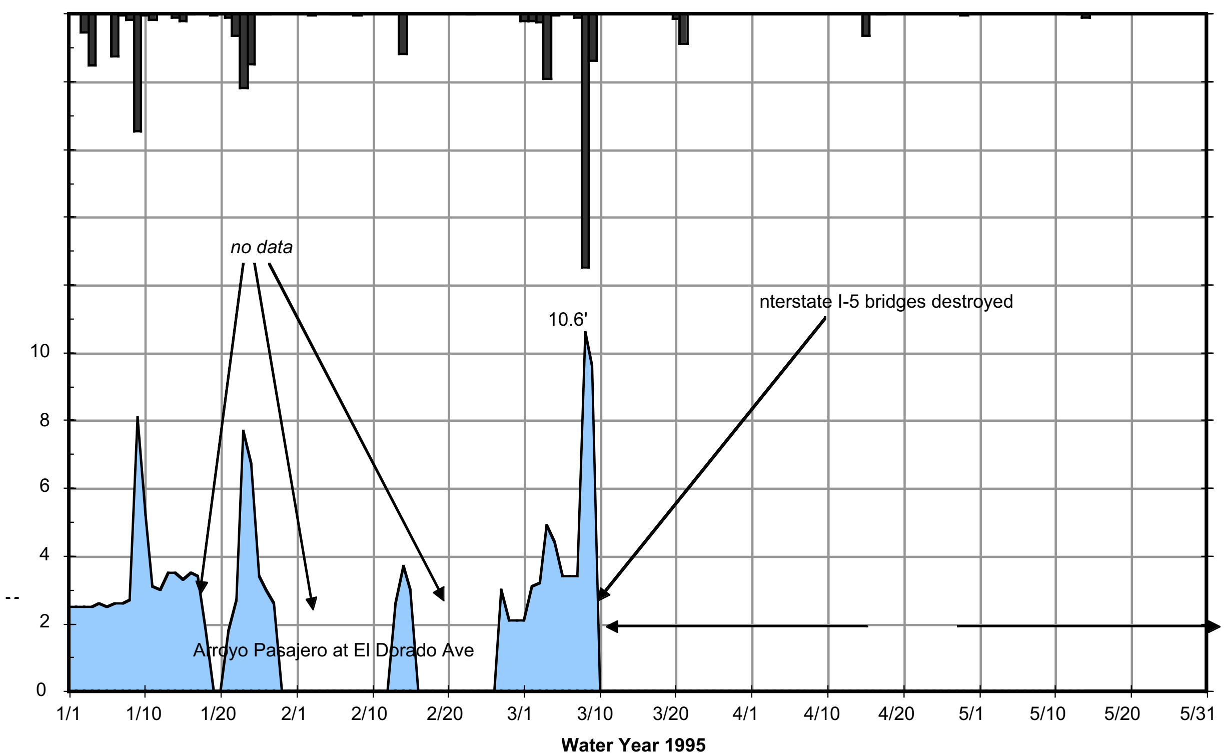


Figure 79. Hydrograph of Arroyo Pasajero at El Dorado Avenue



Gage Information
CDEC ID: EDA
Cooperating Agencies: DWR
Data Collection: Microwave

Gage Location
Hydrologic Region: Tulare Lake
River Basin: Arroyo Pasajero
County: Fresno
Latitude: 36.1670°N
Longitude: 120.2090°W
Elevation: 490 feet

River Stage Information
Datum: 0=461.7 feet NGVD
Peak of Record: 28,100 cfs on March 10, 1995
(estimated by indirect methods)

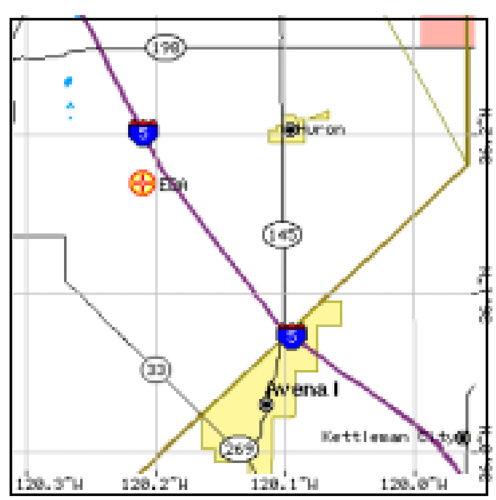
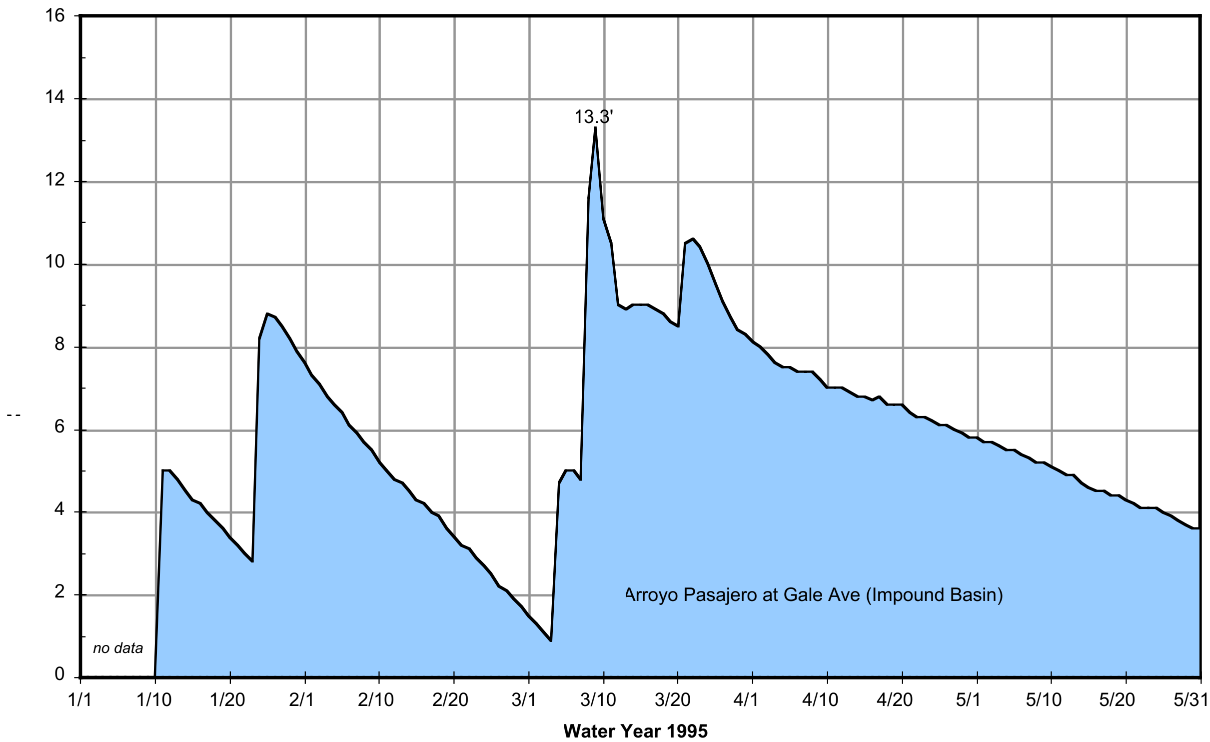


Figure 80. Hydrograph of Arroyo Pasajero at Gale Avenue (Impound Basin)

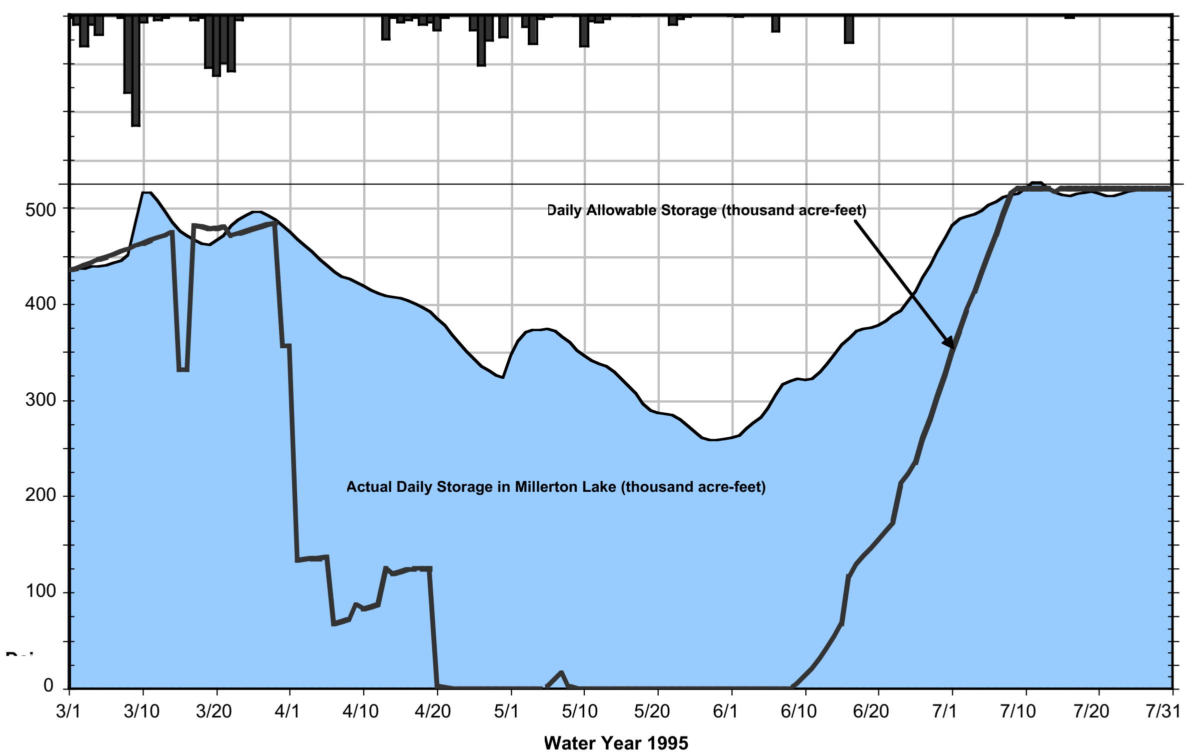


Gage Information
CDEC ID: GAL
Cooperating Agencies: DWR
Data Collection: Microwave

Gage Location
Hydrologic Region: Tulare Lake
River Basin: Arroyo Pasajero
County: Fresno
Latitude: 36.1830°N
Longitude: 120.0580°W
Elevation: 240 feet

River Stage Information
Datum: not available
Peak of Record: DWR estimates that the Gale Avenue impounding basin stored 30 to 35 thousand acre-feet of floodwaters during the March 9-10 storm. It is not known if this volume represents a record storage. Another significant event occurred in 1969, but long-period storage data is incomplete.

Figure 81. Millerton Lake Operations, San Joaquin River



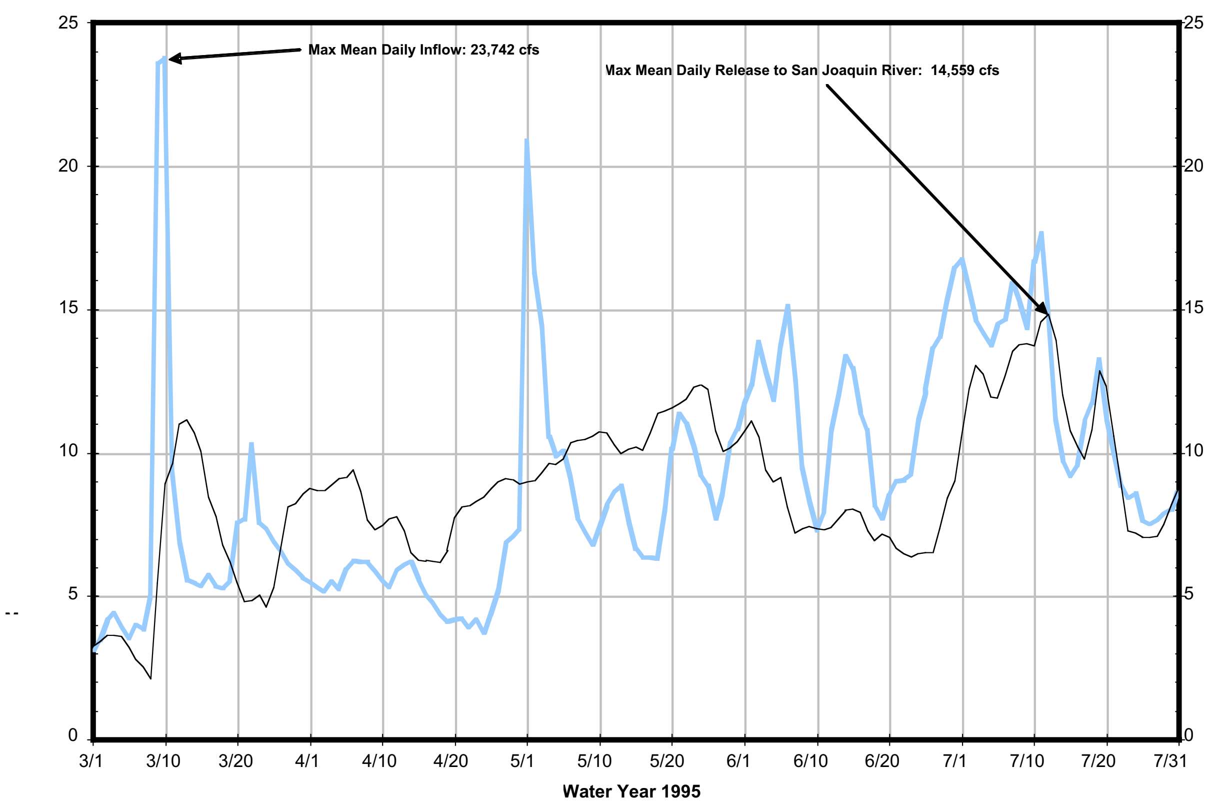
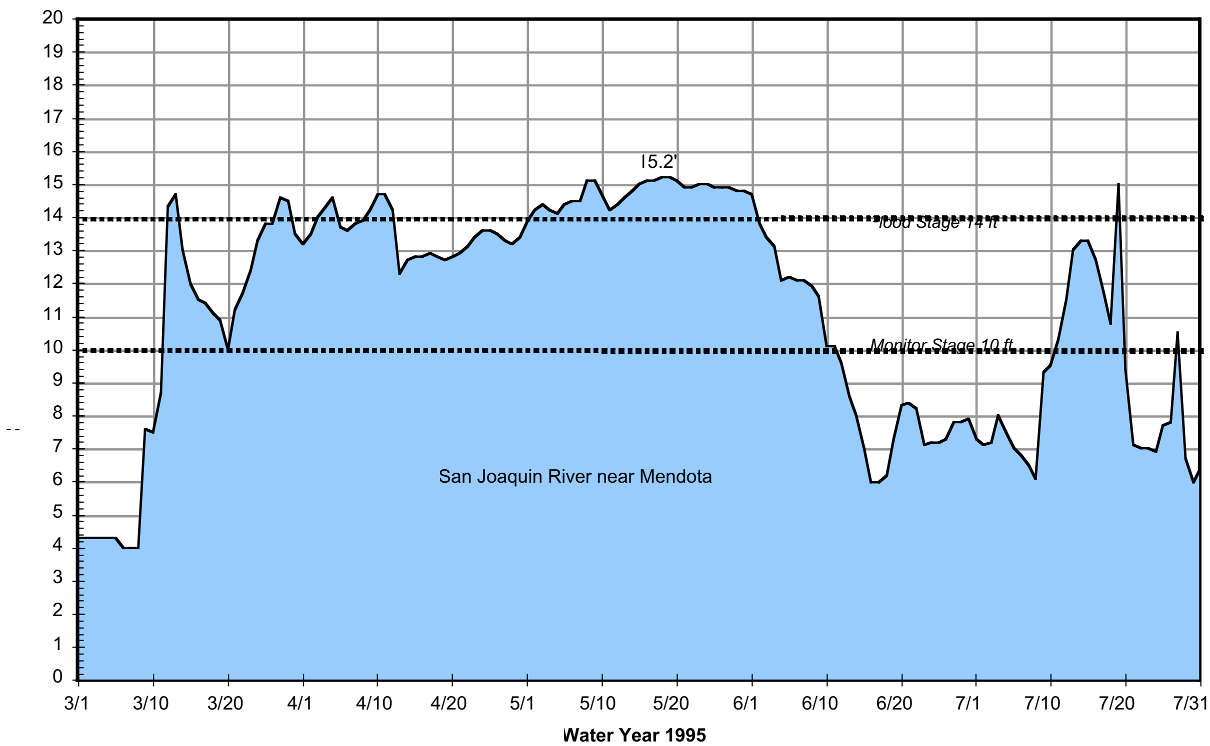
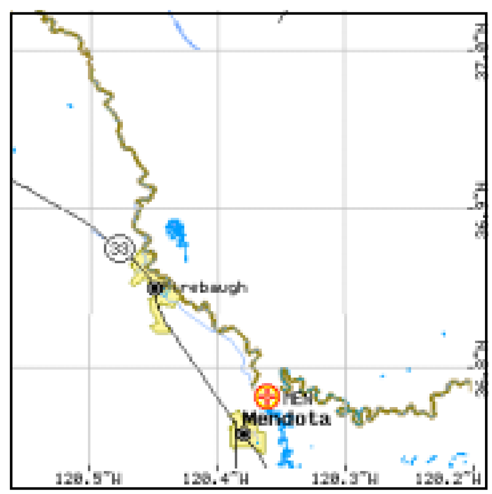


Figure 82. Hydrograph of the San Joaquin River near Mendota



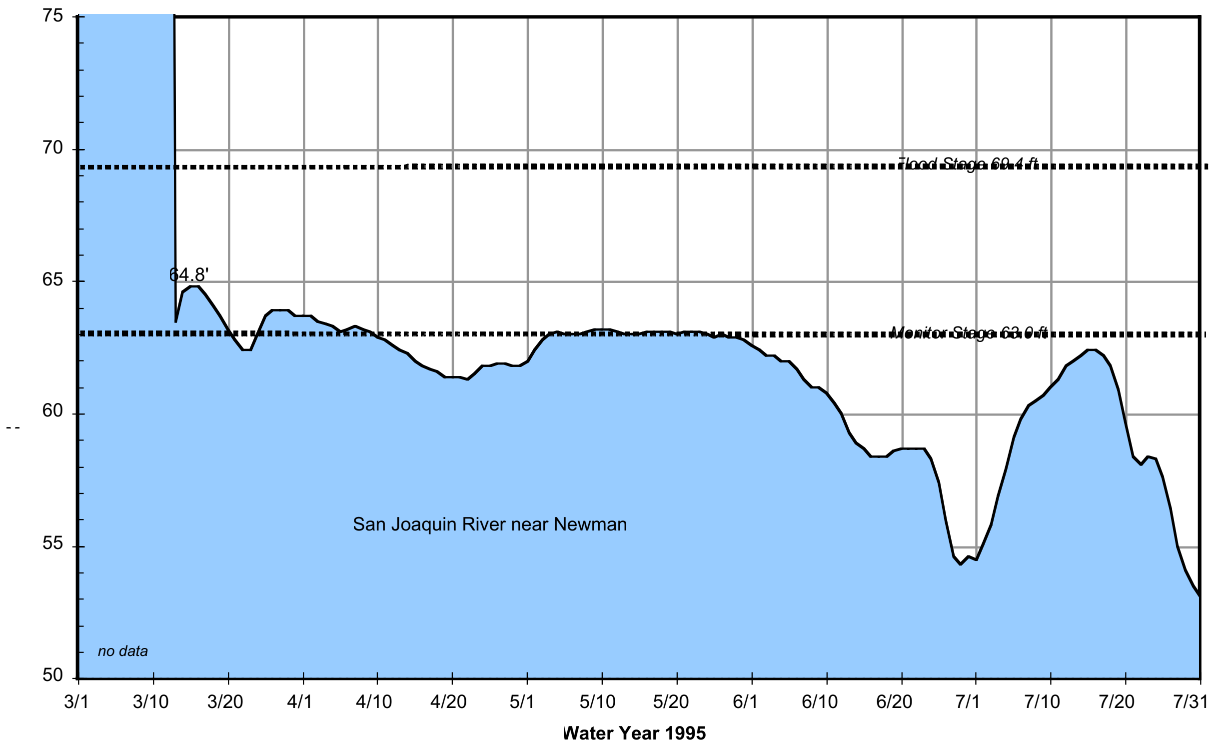
Gage Information
CDEC ID: MEN
Cooperating Agencies: DWR
Data Collection: Microwave, Satellite



Gage Location
Hydrologic Region: San Joaquin River
River Basin: San Joaquin River
County: Fresno
Latitude: 36.7830°N
Longitude: 120.3670°W
Elevation: 170 feet

River Stage Information
Datum: 0=0.0 feet NGVD
Peak of Record: 17.2 feet on February 3, 1997

Figure 83. Hydrograph of the San Joaquin River near Newman



Gage Information
CDEC ID: NEW
Cooperating Agencies: USGS, DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: San Joaquin River
River Basin: San Joaquin River
County: Merced
Latitude: 37.3500°N
Longitude: 120.9770°W
Elevation: 90 feet

River Stage Information
Datum: 0=0.0 feet NGVD
Peak of Record: 69.0 feet on January 2, 1868, from floodmarks, 66.14 feet on January 28, 1997

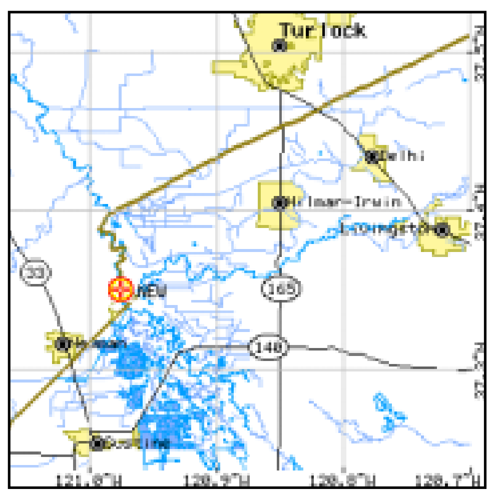
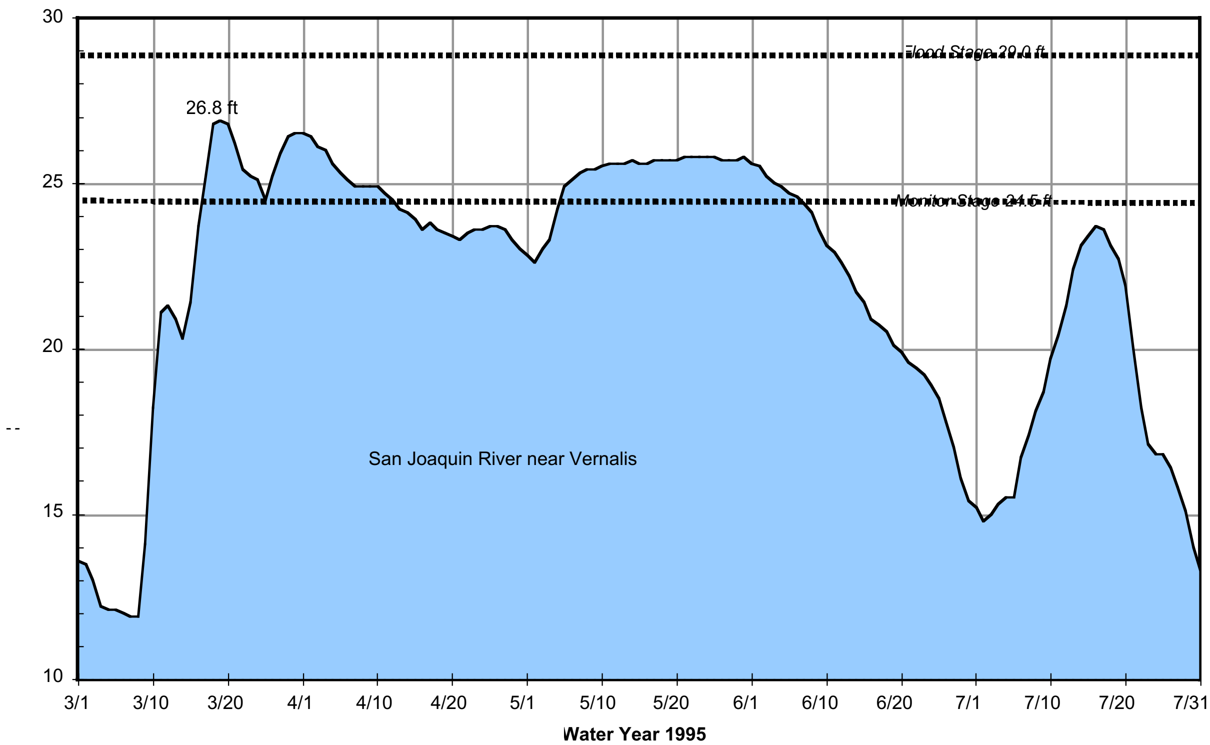


Figure 84. Hydrograph of the San Joaquin River near Vernalis



Gage Information
CDEC ID: VNS
Cooperating Agencies: USGS, DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: San Joaquin River
River Basin: San Joaquin River
County: San Joaquin
Latitude: 37.6670°N
Longitude: 121.2670°W
Elevation: 35 feet

River Stage Information
Datum: 0=0.0 feet NGVD
Peak of Record: 34.88 feet on January 5, 1997

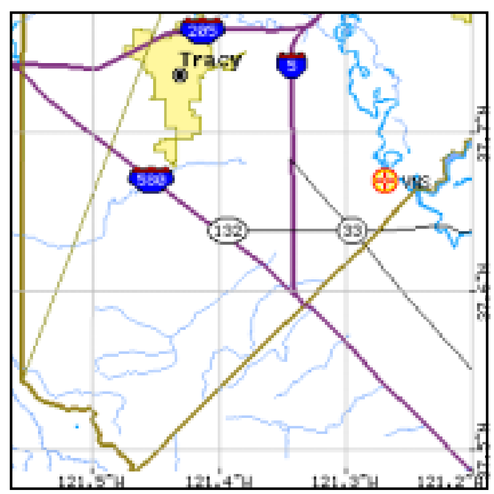
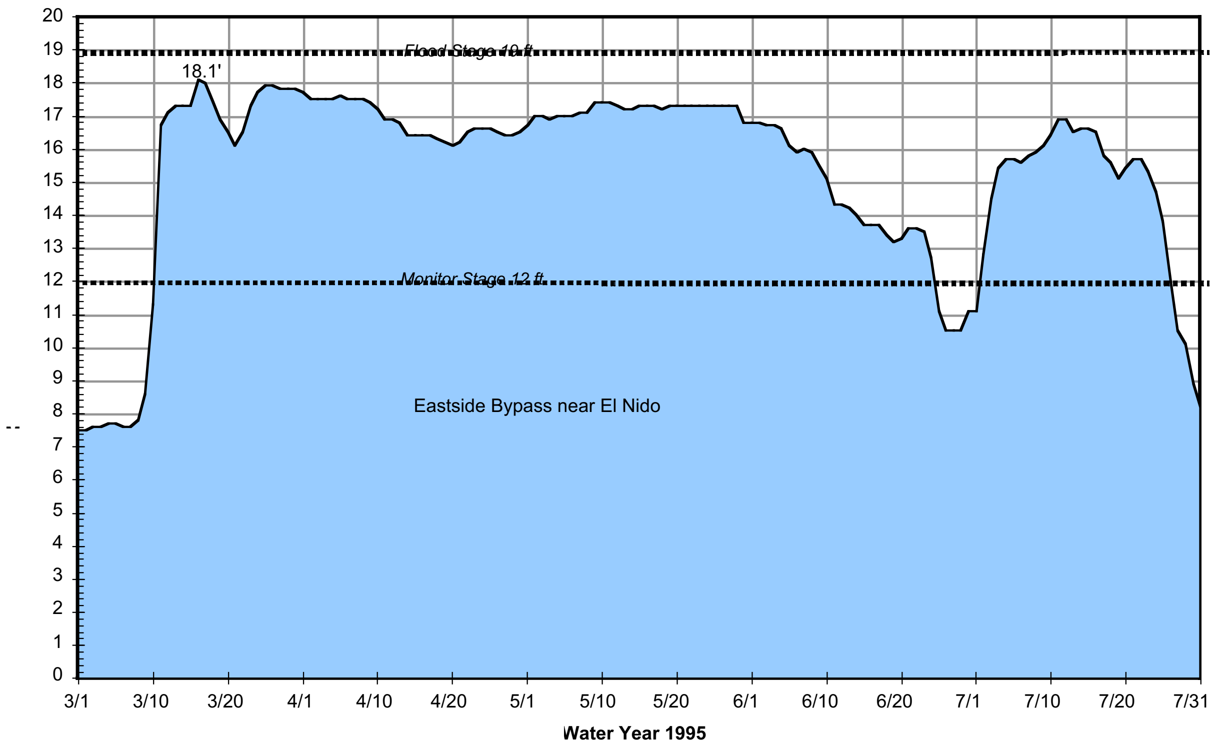


Figure 85. Hydrograph of the Eastside Bypass near El Nido



Gage Information
CDEC ID: ELN
Operator(s): DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: San Joaquin River
River Basin: San Joaquin River
County: Merced
Latitude: 37.7830°N
Longitude: 120.3670°W
Elevation: 100 feet

River Stage Information
Datum: 0=90.0 feet NGVD
Peak of Record: 20.8 feet on January 27, 1997

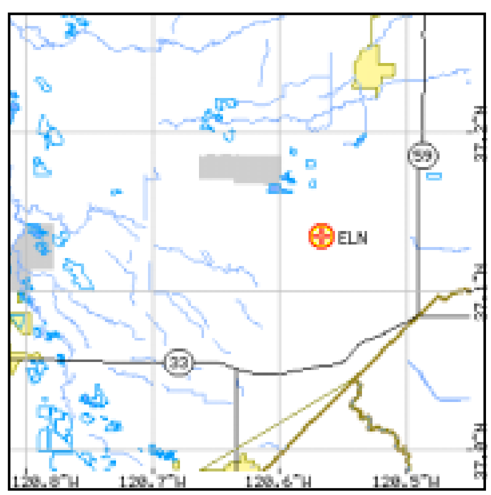
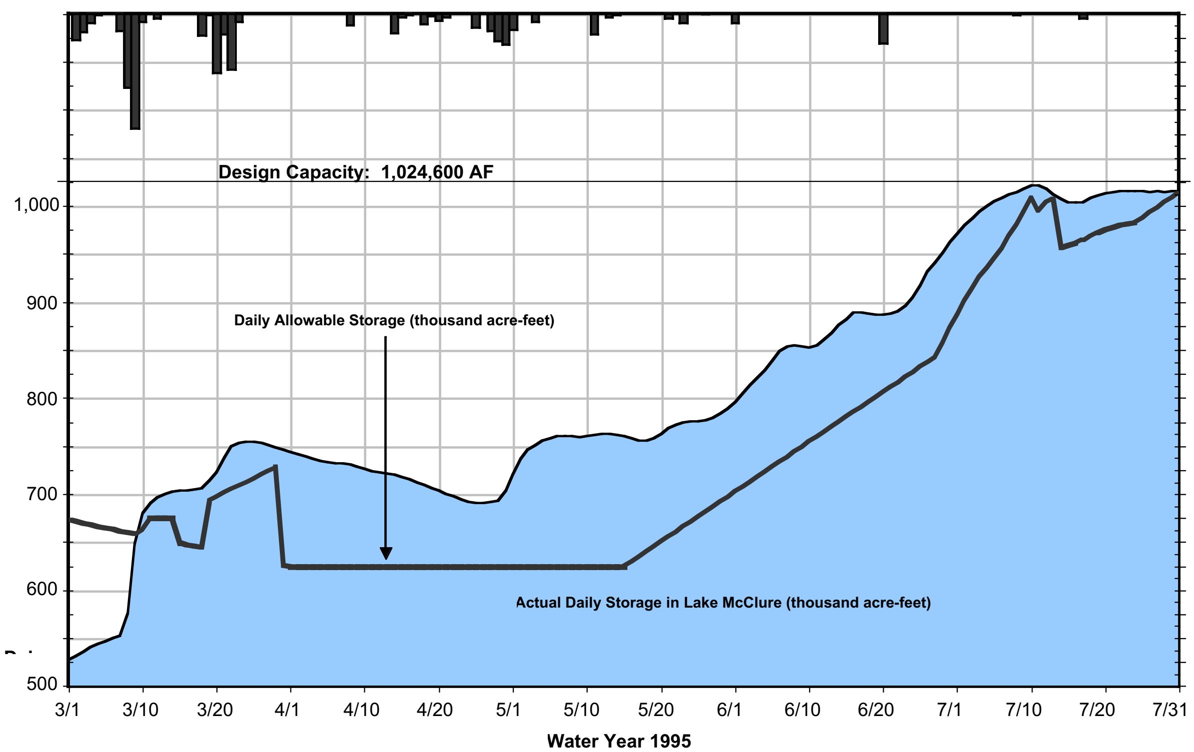


Figure 86. Lake McClure (New Exchequer Dam) Operations, Merced River



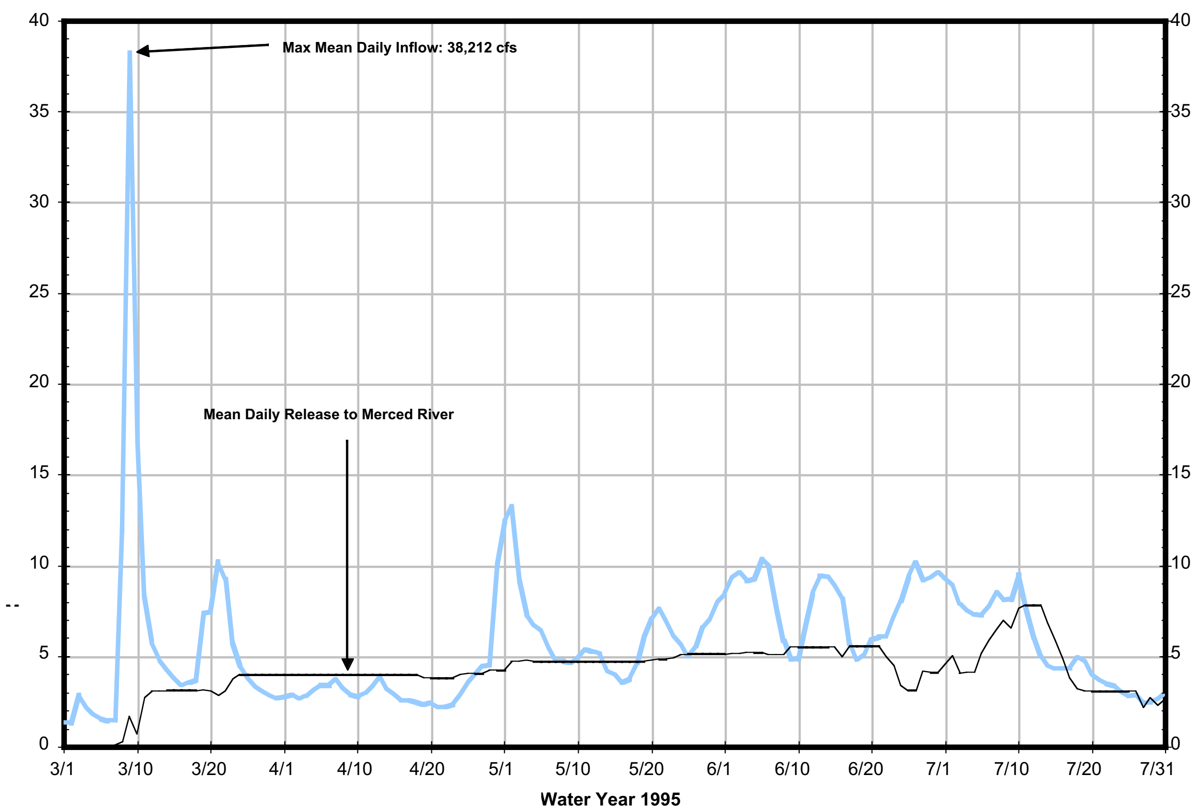
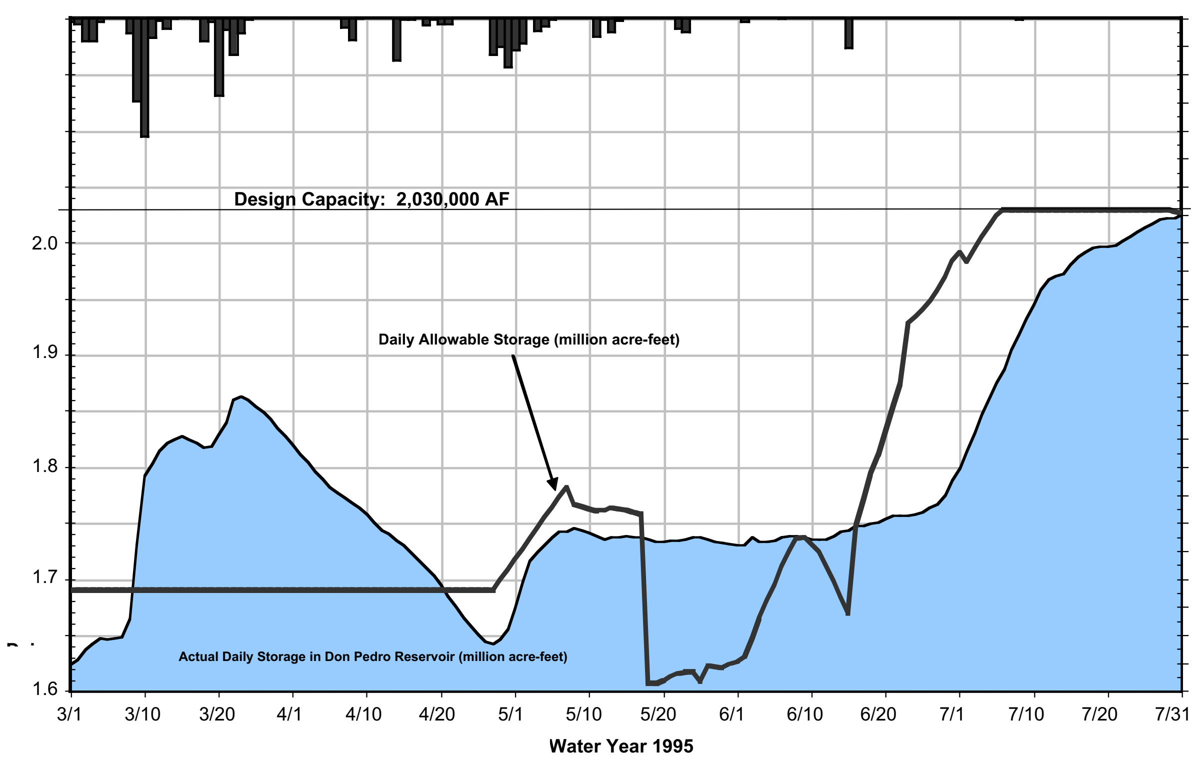


Figure 87. Don Pedro Reservoir Operations, Tuolumne River



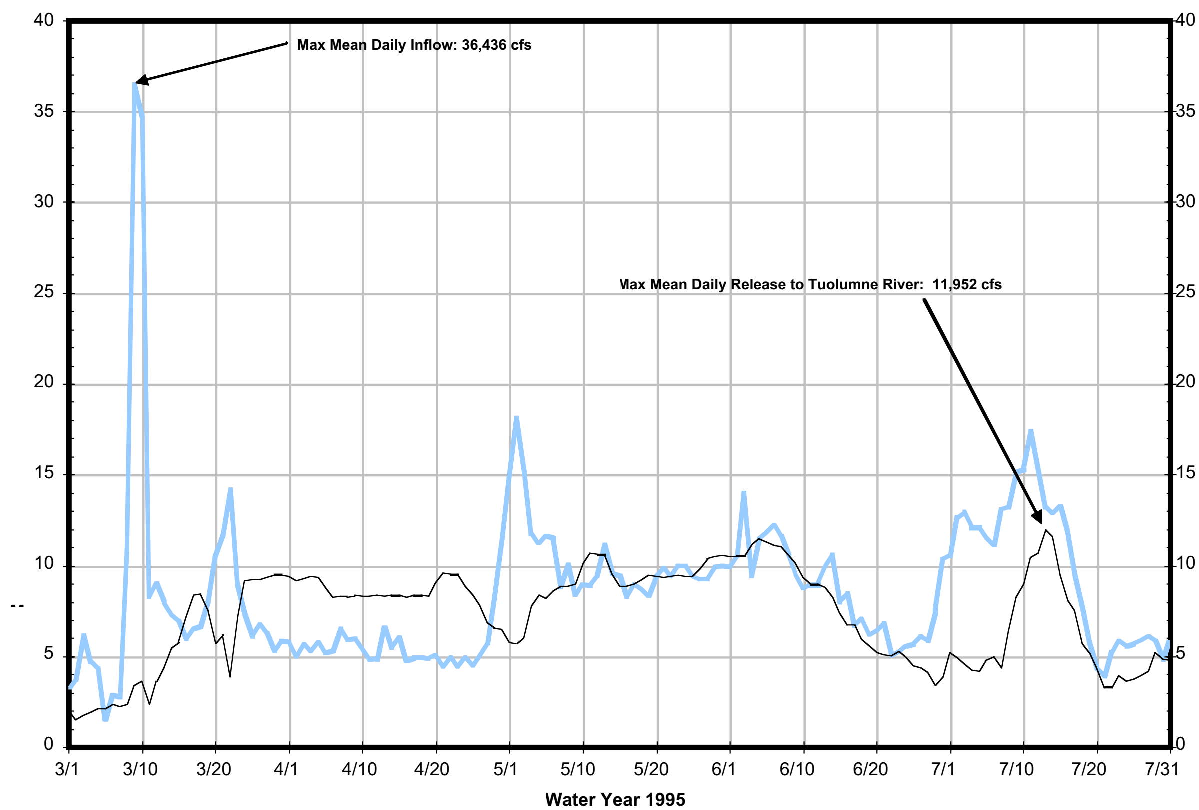
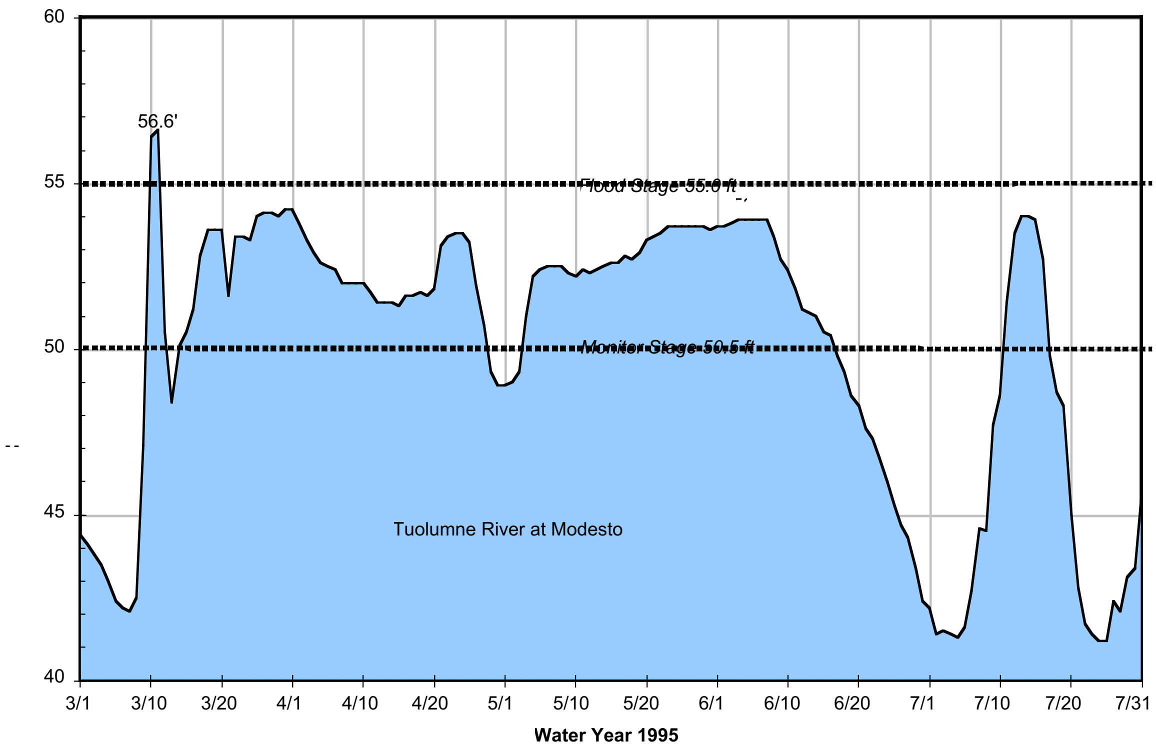
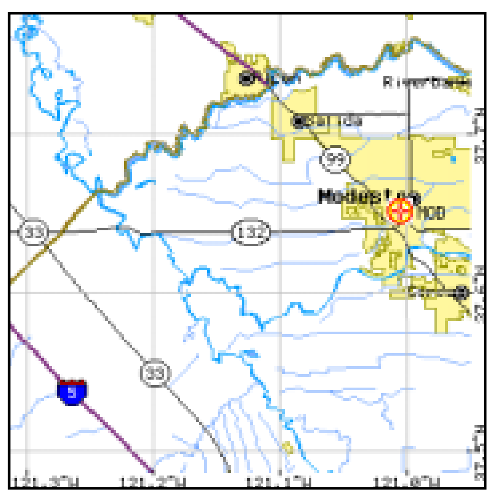


Figure 88. Hydrograph of the Tuolumne River at Modesto



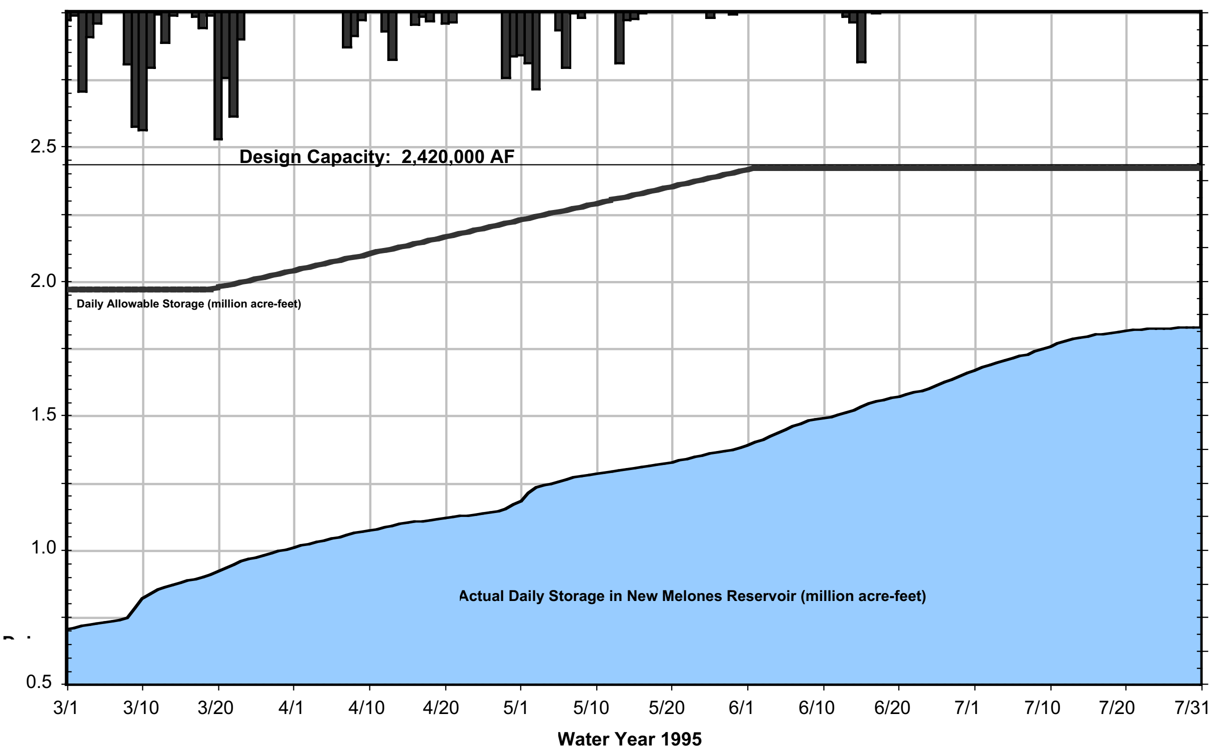


Gage Information
CDEC ID: MOD
Cooperating Agencies: USGS, DWR
Data Collection: Microwave, Satellite

Gage Location
Hydrologic Region: San Joaquin River
River Basin: Tuolumne River
County: Stanislaus
Latitude: 37.6500°N
Longitude: 121.0010°W
Elevation: 90 feet

River Stage Information
Datum: 0=0.0 feet NGVD
Peak of Record: 71.21 feet on January 4, 1997

Figure 89. New Melones Reservoir Operations, Stanislaus River



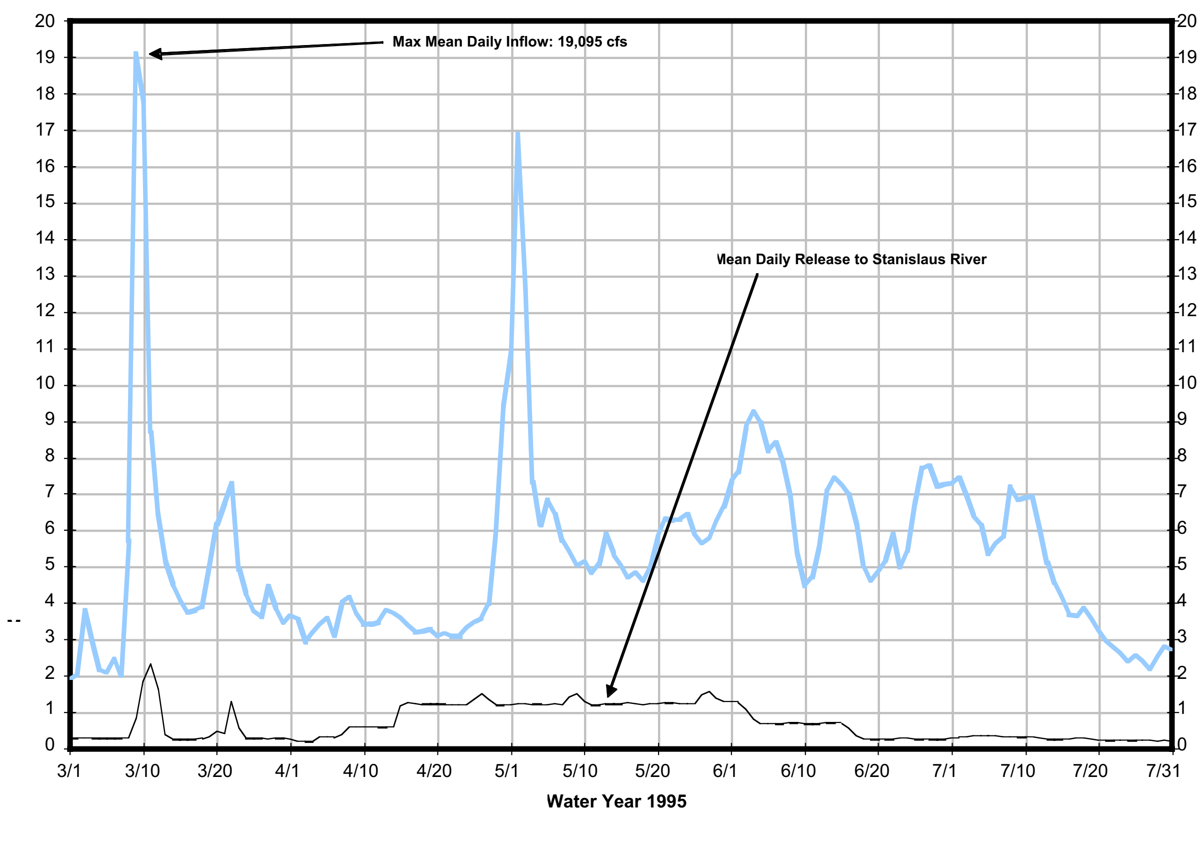
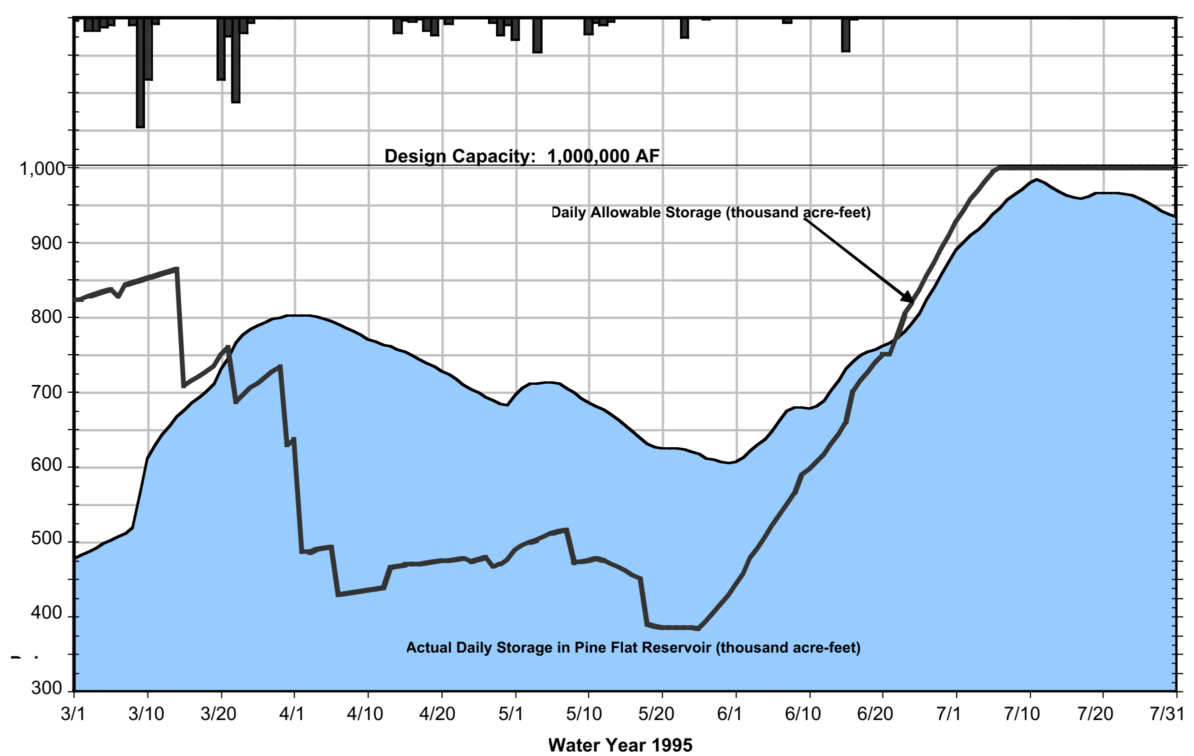


Figure 90. Pine Flat Reservoir Operations, Kings River



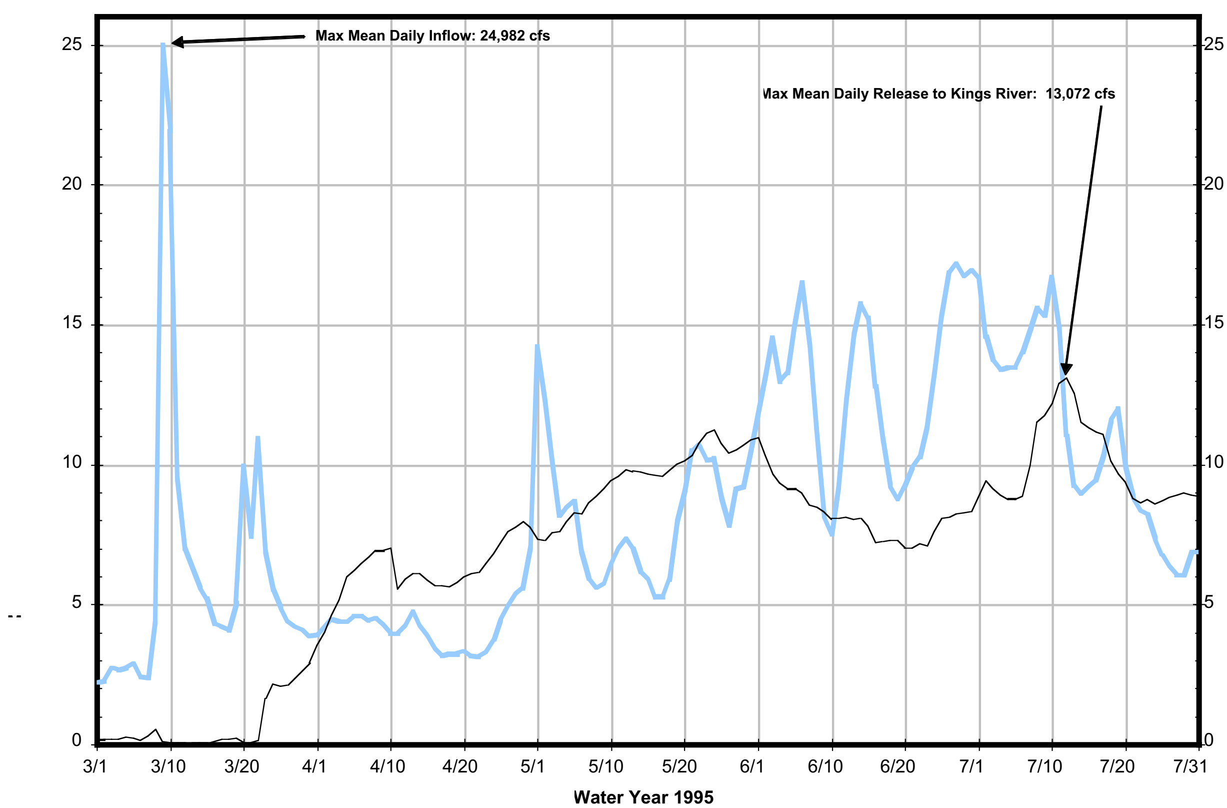
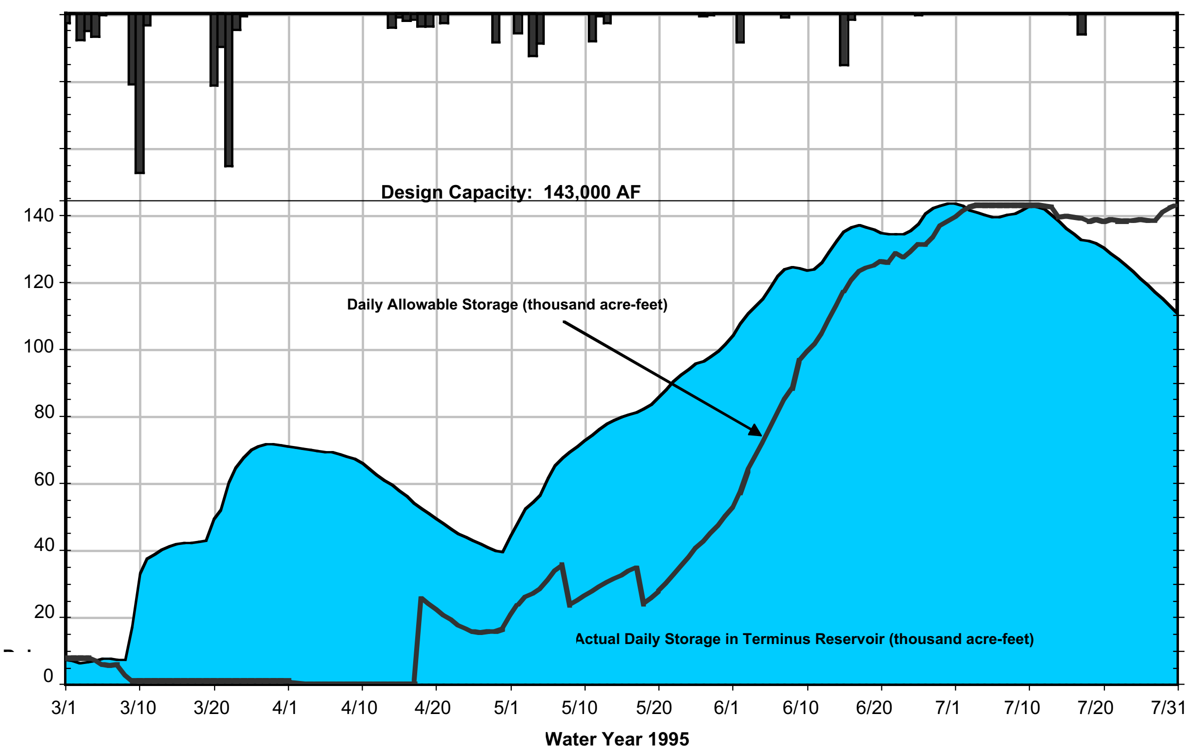


Figure 91. Lake Kaweah (Terminus Dam) Operations, Kaweah River



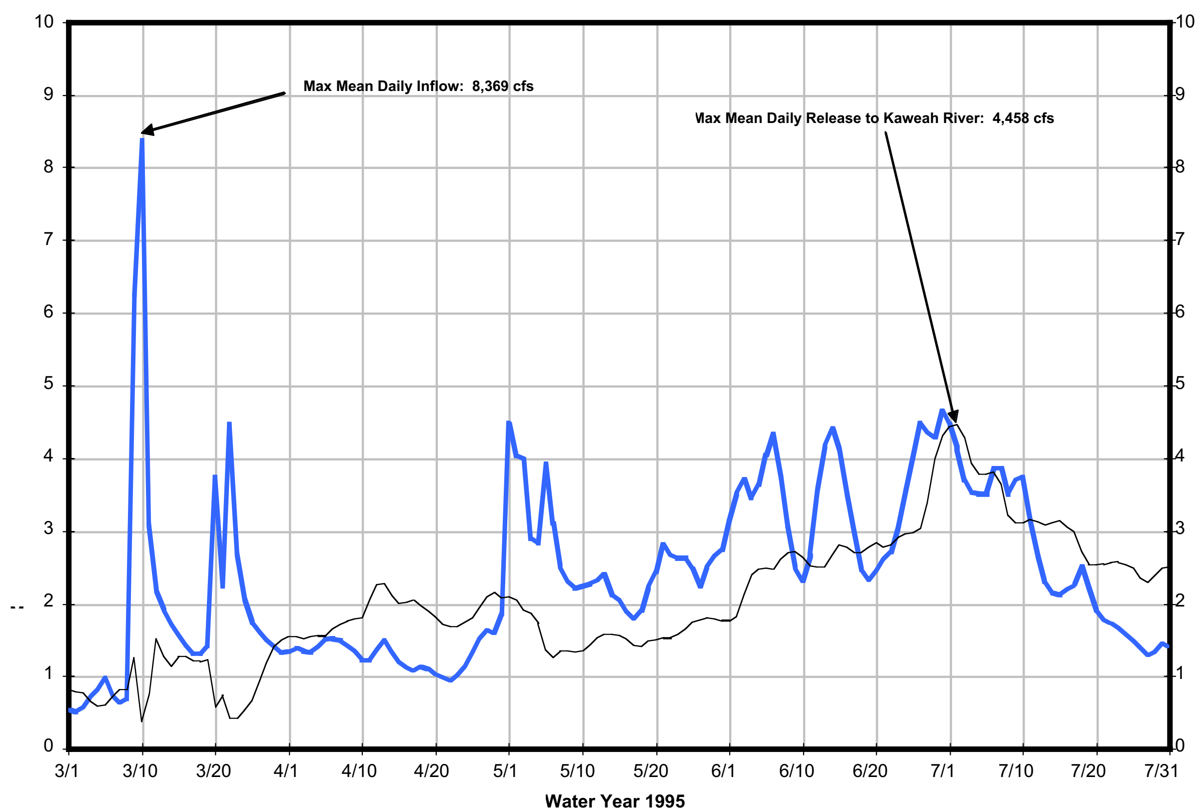
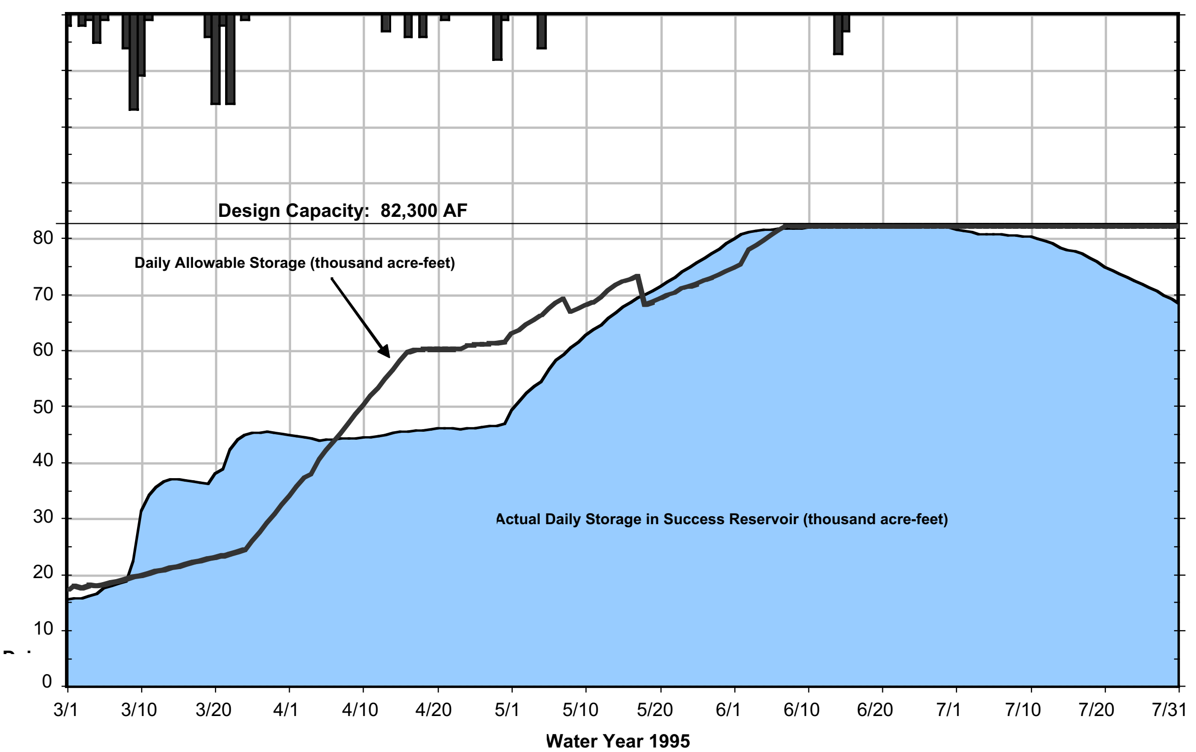


Figure 92. Lake Success Operations, Tule River



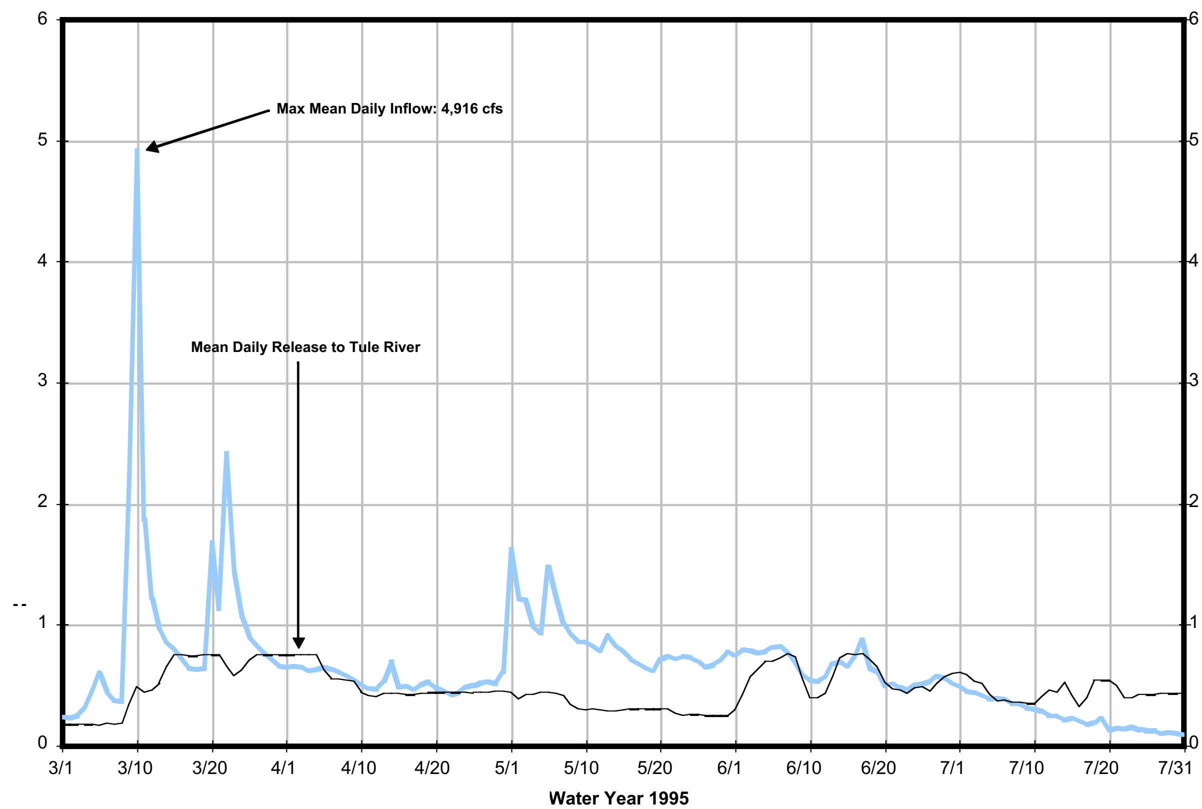
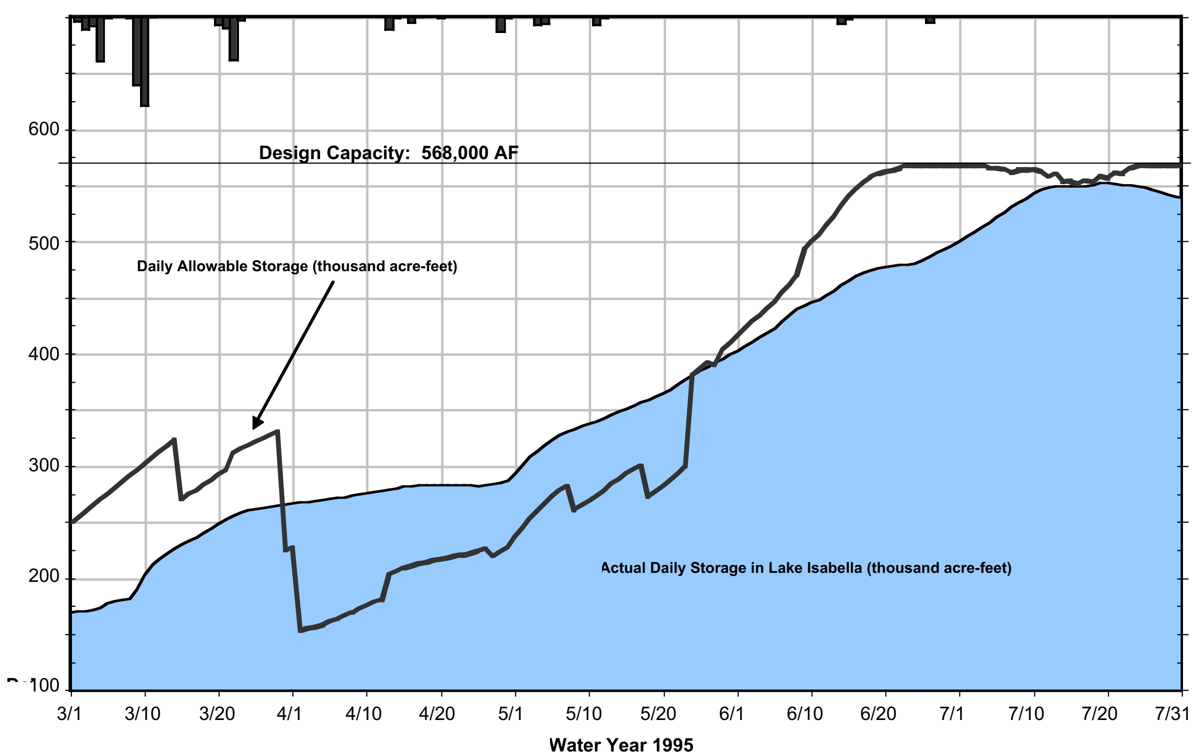
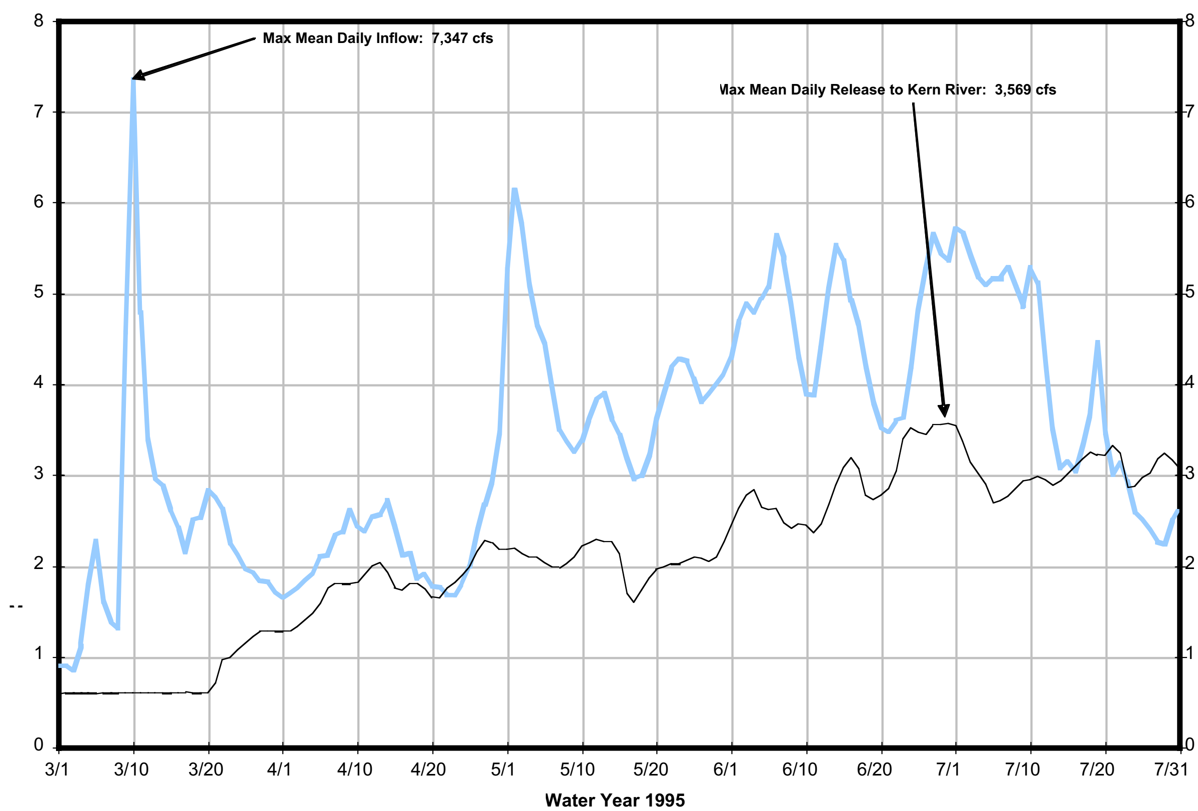


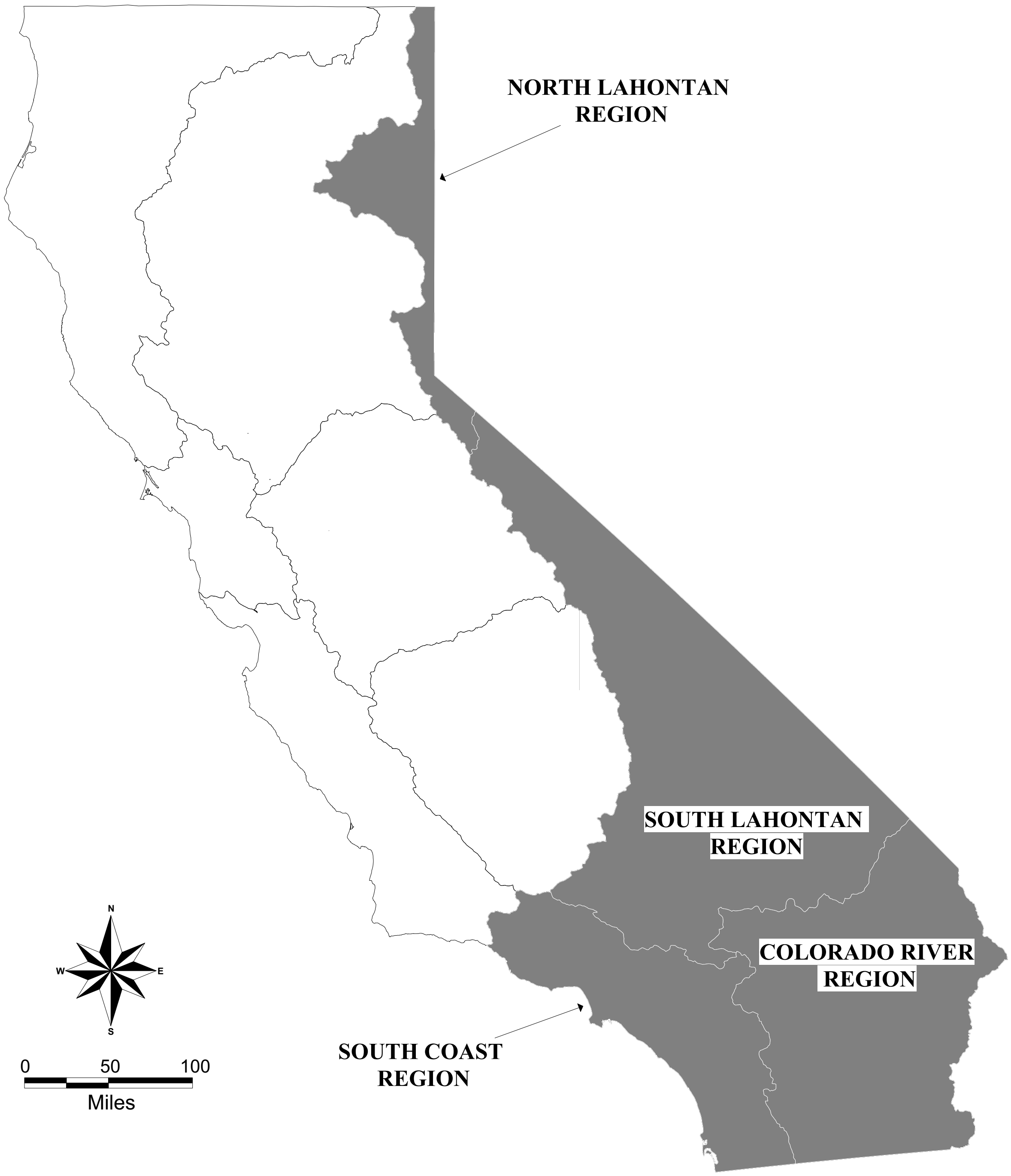
Figure 93. Lake Isabella Operations, Kern River





Other Hydrologic Regions

Figure 94. North Lahontan, South Lahontan, Colorado River, and South Coast Hydrologic Regions



Other Hydrologic Regions

North Lahontan Hydrologic Region

The North Lahontan Region borders the state of Nevada in northeastern California. The northern portion of the region includes eastern Modoc and Lassen counties with annual precipitation ranging from 4 to over 50 inches. Runoff is typically scant, and streamflow decreases rapidly after the snowpack melts. The southern portion of the region includes the Truckee, Carson, and Walker River drainages and parts of Sierra, Nevada, Placer, El Dorado, Alpine, and Mono counties. These rivers originate at high elevations on the eastern slope of the Sierra Nevada and flow to terminal lakes or desert sinks in Nevada.

One-hundred mile-per-hour winds were reported at mountaintop locations around Lake Tahoe on January 8. Interstate 80 was closed for 2 hours on January 9 because of downed power lines. Two thousand homes lost power after a fallen tree downed more power lines. Urban flooding occurred over the entire area, particularly in the cities of Reno and Sparks and around Lake Tahoe. The Lake Tahoe Basin and Truckee areas received heavy snowfall with Incline Village receiving 14 inches and Kirkwood Ski Area accumulating more than 20 inches in 24 hours. Urban and small-stream flooding occurred near the communities of Walker and Coleville in northern Mono County and in Nevada north of Reno and near Carson City. U.S. Highway 395 near Walker was closed as floodwater covered the roadway.

In March the south fork of the American River flooded homes and businesses along U.S. Highway 50, and a major mudslide destroyed or damaged several homes and temporarily dammed the river near the community of Kyburz.

Lake Tahoe benefited from the March storms, rising above its natural rim for only the second time since 1990. Abundant rainfall in the Sierra Nevada began a slow return to a healthy forest ecosystem after years of drought had caused widespread tree disease and losses.

Runoff on the Carson River caused flooding in the state of Nevada near the Carson City area. Access to residential subdivisions was cut when the river washed out roads, and several homes were damaged. In nearby Dayton one home and five businesses were damaged.

All counties in the North Lahontan Hydrologic Region except El Dorado and Alpine were declared federal disaster areas in January, and all counties were declared in March.

Table 8 summarizes data for the region. Figure 94 shows the hydrologic regions in this chapter.

South Lahontan Hydrologic Region

The South Lahontan Hydrologic Region extends farther east from the eastern slope of the southern Sierra Nevada and receives less precipitation than the North Lahontan Hydrologic Region. The region includes Antelope Valley, Death Valley, and the Mojave Desert.

North of the Los Angeles Basin, the Tehachapi Mountains and the Lancaster and Antelope valleys received heavy snowfall.

All counties except Mono and Inyo were declared federal disaster areas in January, and all counties were declared federal disaster areas in March.

Table 8 summarizes data for the region.

Table 8. Hydrologic Data in the North Lahontan and South Lahontan Hydrologic Regions

Region	Snowpack (% Of Avg.)		Precipitation (% Of Avg.)		Reservoir Storage[1] (% Of Avg.)		Runoff[2] (% Of Avg.)	
	Feb 1	April 1	Feb 1	April 1	Feb 1	April 1	Feb 1	April 1
N. Lahontan	125	145	155	180	20	40	80	145
S. Lahontan	115	195	230	190	95	95	70	80

[1] There are 5 reservoirs in the North Lahontan Hydrologic Region, and 8 in the South Lahontan Hydrologic Region.
[2] Runoff in the South Lahontan Hydrologic Region is for the Owens River below Long Valley only.

Heavy equipment operators clear tons of debris from the Pacific Coast Highway in Malibu. (AP/Wide World Photos)

Levee fortification and sandbags placed along Lake Elsinore for the protection of threatened homes.

South Coast Hydrologic Region

In Southern California the heaviest rainfall from the January storms generally fell over the coastal and mountainous areas. Snow and rainstorms on January 3 shut down the Grapevine section of Interstate 5 in the Tehachapi Mountains near the Los Angeles/Kern county line for two days. Flash flood conditions and saturated soils set the stage for rapid runoff and significant flooding when local storm drains and channels overflowed on January 4. Up to 4 feet of flooding occurred in many locations damaging more than 200 structures, forcing the evacuation of hundreds of residents, and stranding vehicles. High flows and overtopping washed out about 300 feet of levee and bank protection along the Dominguez Channel in the Los Angeles suburb of Wilmington. Coast Highway 1 was closed in several locations due to flooding and mudslides. Mudslides and landslides or debris flows caused significant damage in areas affected by the previous year's firestorms, including Malibu and Laguna Beach.

On January 7 Tejon Pass was closed when heavy snow fell on the Interstate 5 Grapevine section in the Tehachapi Mountains near the Los Angeles/ Kern county line. Heavy rains forced temporary closure of the Angeles Forest Highway from Pearblossom Highway to Angeles Crest. Flooding shut down sections of the Harbor, Long Beach, Artesia, Century, San Diego, and Golden State freeways. Metrolink trains ran behind schedule under reduced speeds, and tracks became temporarily impassible on January 10 due to mud and flooding in the Saugus Tunnel.

Ventura County, which reported the worst flooding in 25 years, evacuated more than 230 people to emergency shelters on January 11. The Ventura River raged over U.S. 101, forcing its closure for 33 hours, and inundated an encampment of approximately 200 homeless people. One body was pulled from the river. Additional flooding along Highway 101 just west of the city of Ventura engulfed a recreational vehicle resort, requiring emergency rescue efforts by air. The Ventura County Sheriff's office reported 33 individuals rescued from areas flooded by the Santa Clara and Ventura rivers.

In Los Angeles County flooding from the January storms resulted in the evacuation of approximately 90 homes in Carson and damaged Carson City Hall. The city of Long Beach experienced heavy flooding around the Colorado Lagoon, El Dorado Park, and the California State University Long Beach campus. More than 150 individuals were rescued from vehicles, and emergency responders worked numerous structure and roof collapses and multiple structure fires in the city. At least 137 homes sustained flood damage, and the death of one man in a stalled vehicle was attributed to the storm. Up the coast mudslides and flooding were common throughout Malibu and forced the closure of roads including the Pacific Coast Highway. In Orange County heavy rains inundated 250 homes in the city of Cypress. Flooding of homes and other structures also

Table 9. Hydrologic Data for the South Coast and Colorado River Hydrologic Regions

Region	Snowpack (% Of Avg.)		Precipitation (% Of Avg.)		Storage [1] (% Of Avg.)		Runoff (% Of Avg.)	
	Feb 1	April 1	Feb 1	April 1	Feb 1	April 1	Feb 1	April 1
South Coast	-	-	190	180	125	140	165	270
Colorado	95	110	-	-	-	-	-	-

[1] There are 29 reservoirs in the South Coast Hydrologic Region.

occurred in Huntington Beach, Laguna Beach, Los Alamitos, and Seal Beach. A 12-year-old boy drowned when he tried to cross rain-swollen Trabuco Creek.

Mountains near Los Angeles received 2 to 5 inches of snow in 24 hours when a broad storm system swept through Southern California on February 14. Heavy rains snarled commuter traffic throughout Los Angeles County and resulted in the posting of flash flood watches and warnings. The heavy rain was blamed for more than 290 accidents on Southern California roadways during the morning commute. According to the California Highway Patrol, this represented triple the normal accident totals for this time period. Landslides threatened the seaside village of La Conchita in Ventura County as another 2.5 inches of rain fell overnight. Heavy rains also contributed to rising floodwater in San Diego where a woman drowned in her basement. The Santee area near San Diego was flooded on February 14 when the San Diego River overflowed.

March storms again caused numerous landslides along coastal portions of Ventura, Los Angeles, and Orange counties. In La Conchita a landslide crushed nine homes and forced authorities to evacuate an additional 140 homes. Along the Pacific Coast Highway an estimated 100 homes were walled in by mud and other debris. The Ventura River again overflowed its banks inundating agricultural lands along the river and washing out bridges. Flooding also occurred in Ventura County along the Santa Clara River, and Highway 101 and State Route 33 were temporarily shut down.

At Lake Elsinore in Riverside County March storms caused inflow to the lake to exceed the outflow into the sole outlet channel (Temescal Wash). The lake's watershed covers about 750 square miles and is mostly drained by the San Jacinto River, which flows into the lake. On March 23 a few homes were flooded and Department staff assisted City of Lake Elsinore personnel to provide protective levees and berms and to place sandbags around threatened areas.

Table 9 summarizes hydrologic data for the region.

Colorado River Hydrologic Region

The Colorado River Hydrologic Region includes the Colorado River Valley, the Coachella Valley, the Imperial Valley, the Borrego Valley, and the Palo Verde Valley. The Sierra Nevada blocks much of the moisture from reaching this area, and as a result the average annual precipitation is about 7 inches per year. This region is not generally threatened by river flooding; however, flash-flooding is a frequent threat.

On the Colorado River the combined storage in Lakes Powell, Mead, Mojave, and Havasu stood at 39 million acre-feet on February 1, a seasonal average of 100 percent. By April 1 storage had increased to 39.3 million acre-feet, or 107 percent of average.

Historical records maintained by the Imperial Irrigation District indicate that the Salton Sea water surface elevation had been rising since 1993 because of higher than usual rainfall and lower evaporation rates. Because of the lack of an outlet for the inland sea, its water levels significantly increased due to the January storms. The rising waters flooded parts of a trailer park at Desert Shores on State Route 86 along the southwest shore. During January the water table increased to the ground surface on lots nearest the shore. Water seepage into the underground electrical system caused outages, and saltwater intrusion resulted in sewage system upsets. Sandbagging and rip-rapping activities were undertaken by Imperial County around the sea during the March storms. Dikes at Bombay Beach and Salton Sea Beach were raised, and 16 miles of dikes along the southern shore were raised from 2 to 4 feet.

Table 9 summarizes hydrologic data for the region.

Folsom Dam Gate Failure

Folsom Dam spillway gate number 3 releasing about 40,000 cubic feet per second on July 17, 1995. The gate is open at 45 degree angle.

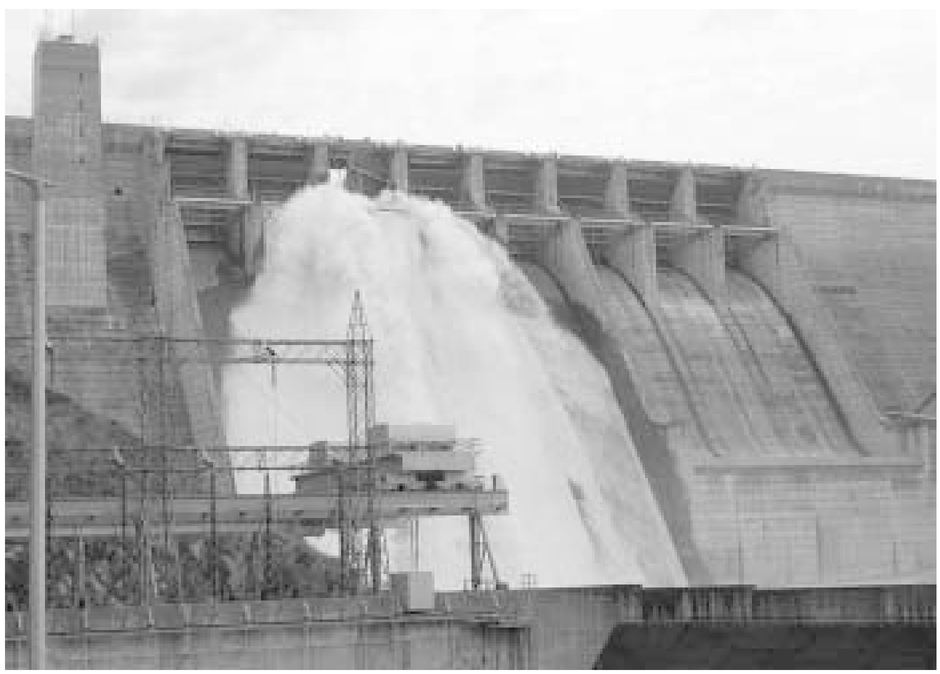
Folsom Dam Gate Failure

On July 17 at 8 a.m. a gate failed at Folsom Dam with Folsom Lake reservoir storage at 97 percent of capacity. The uncontrolled release of water resulted in unseasonably high stages and fast flows along the lower American River through Sacramento. Flows quickly increased from a typical summer rate of 6,000 cubic feet per second to more than 42,000 cubic feet per second shortly after the gate failed. Although this release was significant in magnitude, it was still well below the lower American River's design capacity of 115,000 cubic feet per second and was easily contained within the levee system. River stages at the H Street Bridge increased from 19.7 feet at 8 a.m. to 29.8 feet near 7 p.m., 10.2 feet below the 40-foot monitor stage.

Because the lower American River supports a large number of summer recreational users, the increased stages and flows posed a significant short-term safety hazard. Authorities cleared dozens of people from the riverbanks and closed nearby access roads and parks. The State-Federal Flood Operations Center relayed information to Sacramento area emergency managers, news media, and the public.

As a result of the failure, Folsom Lake levels dropped approximately 45 feet due to the release of approximately 410,000 acre-feet of water over a seven-day period. For precautionary reasons the lake and Folsom Dam Road were closed during this period.

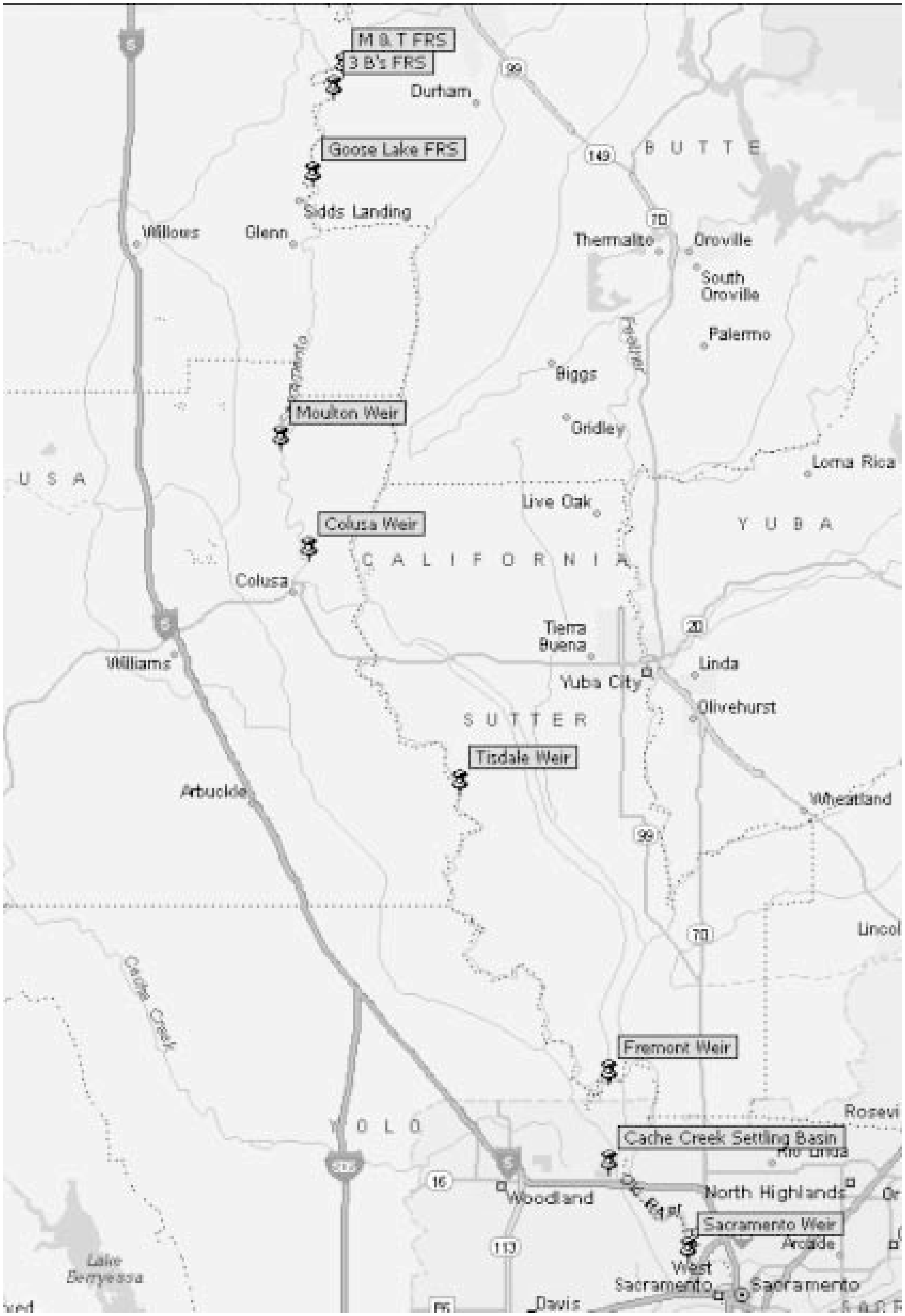
On July 20 a Department of Parks and Recreation boat was patrolling Folsom Lake near the dam and the open, broken gate. When the craft stalled and could not be restarted, it drifted over the dam's buoy line toward the open gate. The two lifeguards onboard abandoned the boat and swam to safety, but the boat was carried through the opening, over the spillway, and down to the river channel below the dam. Folsom Lake was immediately closed to boating activities and reopened after a more substantial log barrier was installed.



Uncontrolled releases from Folsom Dam continued for a few days after the gate failure on July 17.

Weir Operations

Figure 95. Overview Map of Weirs and Flood Relief Structures in the Sacramento River Flood Control Project



Weir Operations

There are 10 overflow structures in the Sacramento River Flood Control Project—6 weirs, 3 flood relief structures, and an emergency overflow roadway—that serve a similar function as pressure relief valves in a water supply system (Figure 95). Weirs are lowered sections of levees that allow floodflows in excess of the downstream channel capacity to escape into a bypass channel or basin. All six weirs of the project—Moulton, Colusa, Tisdale, Fremont, Sacramento, and Cache Creek—have (1) a fixed-level, concrete overflow section; followed by (2) a concrete, energy-dissipating stilling basin; with (3) a rock and/or concrete erosion blanket across the channel beyond the stilling basin; and (4) a pair of training levees that define the weir-flow escape channel. All overflow structures, except the Sacramento Weir, and other relief structures pass floodwater by gravity once the river reaches the overflow water surface elevation. The Sacramento Weir has gates on top of the overflow section that hold back floodwater until they are manually opened by the Department's Division of Flood Management.

The Sacramento Weir

The Sacramento Weir was constructed in 1916. Its purpose is to protect the City of Sacramento from excessive flood stages in the Sacramento River channel downstream of the American River. The weir is along the west levee of the Sacramento River approximately 4 miles upstream of Tower Bridge and about 2 miles upstream from the mouth of the American River. It is 1,920 feet long and consists of 48 gates that divert Sacramento and American River floodwaters to the west down the mile-long Sacramento Bypass to the Yolo Bypass. Each gate has 38 vertical wooden plank "needles" (4 inches thick by 1 foot wide by 6 feet long), hinged at the bottom, and retained at the top by a hollow metal beam. The beam is released using a latch. Flood forecasters provide the necessary predictive information to weir operators who manage the number of opened gates in order to control the river's water surface elevation.

The weir limits flood stages (water surface elevations) in the Sacramento River to project design

Sacramento Weir (All photos this section by: Flood Operations Center Archive)

Moulton Weir flows in 1995.

levels through the Sacramento/West Sacramento area. The Department operates the weir according to regulations established by the U.S. Army Corps of Engineers. Opening and closing criteria have been optimized to balance two goals: (1) minimize sediment deposition due to decreased flow velocities in the river channel downstream from the weir to the mouth of American River; and (2) limit flooding of agricultural lands in the Yolo Bypass until after they have been inundated by floodwater over the Fremont Weir.

The weir gates are not opened until the river reaches 27.5 feet at the I Street gage with a forecast to continue rising. This gage is about 1,000 feet upstream from the I Street Bridge and about 3,500 feet downstream from the mouth of the American River. The number of gates to be opened (until all are opened) is determined by the National Weather Service/California Department of Water Resources river forecasting team. The decision is determined by either of two criteria: (1) to prevent the stage at the I Street gage from exceeding 29 feet, or (2) to hold the stage at the downstream end of the weir to 27.5 feet. Once all 48 gates are open, Sacramento River stages from Verona to Freeport may continue to rise during a major flood event. Project design stages are 41.3 feet at Verona, 31.5 feet at the south end of the Sacramento Weir, and 31 feet at the I Street gage.

Colusa Weir

During a major flood, opening the weir gates at river stages below 27.5 feet would not reduce ultimate peak flood stages in the Sacramento River from Verona to Freeport. Diversion of the majority of Sacramento River, Sutter Bypass, and Feather River floodwaters to the Yolo Bypass from Fremont Weir controls Sacramento River flood stages at Verona. The design flood capacity of the American River (115,000 cubic feet per second) is 5,000 cubic feet per second higher than that of the Sacramento River channel past downtown Sacramento. The Sacramento Weir is a critical component of the project to keep flood control project runoff at safe water levels. Because floodflows from the American River channel during a major flood event often

Tisdale Weir (Photo by: Flood Operations Center Archive)

exceed the flood-carrying capacity of the Sacramento River channel past downtown Sacramento, floodwaters flow upstream from the mouth of the American River to the Sacramento Weir.

The weir gates are closed as rapidly as practicable once the stage at the weir drops below 25 feet. This provides "flushing" flows to resuspend sediment deposited in the Sacramento River between the Sacramento Weir and the American River during the low velocity flow periods in that reach when the weir is open during the peak of the flood event.

Other Weirs

Moulton Weir is 100 miles north of Sacramento; Colusa Weir is 12 miles downstream from Moulton Weir. Both discharge into the Butte Basin, a natural trough east of the river. Below Colusa Weir the Butte Basin empties through Butte Slough into the leveed Sutter Bypass, which intercepts overflow from the Sacramento River at Tisdale Weir, 56 miles north of Sacramento. The Sutter Bypass extends 55 miles to its terminus at

Fremont Weir (Photo by: Flood Operations Center Archive)

Cache Creek Settling Basin overflows in 1995.

Fremont Weir just upstream from the mouth of the Feather River.

The Sacramento River, Sutter Bypass, Feather River, and Natomas Cross Canal (all converging within a few miles from Fremont Weir) convey roughly 80 percent (at design capacities) of the southerly flowing floodwaters in the Sacramento River region. Fremont Weir is the first overflow structure on the river's west side, and its 2-mile length marks the end of the Sutter Bypass and the beginning of the Yolo Bypass. At this latitude the Yolo Bypass and Sacramento River channel carry floodwaters farther south. The bypass parallels the river to the west for more than 50 miles through Yolo and Solano counties until it dumps back into the river a few miles upstream from Rio Vista.

Cache and Putah creeks also drain into the Yolo Bypass from the west. Before sediment-laden floodwater from Cache Creek is allowed to discharge into the Yolo Bypass, it is spread and slowed through the Cache Creek Settling Basin just east of Woodland. A new roller-compacted concrete weir was constructed in 1991 along the east levee of the basin to control the discharge of floodwaters from the basin to the bypass.

Figures 49, 50, 52, 55, 57 and 70 in the Sacramento River Hydrologic Region section provide historical weir operation data for water years 1935 through 1995 for the five Sacramento River weirs and the Yolo Bypass.

Flood Relief Structures

Four other relief structures are concentrated along 18 river miles between Big Chico Creek (River Mile 194) and the upstream end of the left (east) bank levee of the Sacramento River Flood Control Project (near River Mile 176). These structures function in a similar manner as the weirs, but they are not called weirs because they do not have all four structural characteristics described in the first paragraph of the Weir Operations section. The area to the east of this 18-mile reach of river is known as the Butte Basin Overflow Area. Three of the structures are designated as flood relief structures (M&T, 3B's, and Goose Lake). If these three fail to function as planned, a raised 6,000-foot roadway near the south end of Parrott Ranch allows excess floodwater to escape the Sacramento River to the Butte Basin before being confined by the downstream project levees.

State-Federal Flood Operations Center and Cooperating Agencies

State-Federal Flood Operations Center and Cooperating Agencies

The Department's emergency response to the January and March floods was directed from the State-Federal Flood Operations Center. Emergency operations at the Center were coordinated with cooperating agencies, but the Standardized Emergency Management System, which became law in 1996, was not yet in use. The Department's Incident Command System was used to conduct field operations.

The joint California Department of Water Resources/National Weather Service river forecasting program forecasted stages on the Sacramento and San Joaquin rivers and their major tributaries, as well as major rivers in the North Coast, San Francisco Bay, and Central Coast hydrologic regions. Center staff, working in coordination with the NWS and other agencies, disseminated forecasts and warnings, made the required high-water notification calls, and tracked 76 flood incidents from January through July. The Center's phone lines brought in hundreds of calls; worried homeowners, government officials, and members of the international press asked questions about weather and river forecasts, reservoir releases, flooded areas, threatened levees, and numerous other flood-related topics.

As in all flood emergencies, local levee maintaining agencies and other special districts conducted initial flood fight responses. Reclamation, levee, and flood control districts, public works agencies, and others kept the Center informed and up to date on flood incidents and their associated impacts. When requested and necessary the Division of Flood Management dispatched Flood Fight Specialists to assess flood conditions, provide technical assistance, and to serve as temporary Initial Attack Incident Commanders to direct flood fight crews.

At the Center personnel coordinated with the U.S. Army Corps of Engineers under Public Law 84-99 on local agency requests for emergency assistance. Flood fight crews and supplemental material resources were provided by the California Department of Forestry and Fire Protection and California Conservation Corps in coordination with the Governor's Office of Emergency Services and county-level emergency response agencies.

Significant Flood Incidents in January

The Center operated under a Flood Alert from January 7-17, and from January 27 through February 8 with up to 24-hour operations as needed. The Department assisted in more than 30 flood incidents during January. Significant response activities coordinated from the Center included:

- Wave wash protection in the Colusa Basin at Reclamation District 108 beginning January 13.
- Wave wash protection on Bradford Island (RD 2059) in the Delta beginning January 14.
- Repairs to maintain the stability of flood relief structures along the Sacramento River in the Butte Basin including repairs to the Glenn County Road 29 "levee" beginning January 27.
- Repairs to the Deseret Levee near Hamilton City (unique in that the repairs required 43,000 sandbags, the largest sandbag repair ever undertaken by the Department) beginning January 27.

Significant Flood Incidents in March

A Flood Alert was again declared from March 8-27. The Department assisted in more than 40 flood incidents during March. Significant response activities coordinated from the Center included:

- Sacramento River nonproject levees at Pacific Farms upstream of Tehama beginning March 9.
- Cache Creek levee overtopping flood fight beginning March 9
- Twitchell Island (RD 1601) flood fight beginning March 10.
- Glenn County Road 29 levee break (same site as in January) beginning March 10.
- Opening the Sacramento Weir on March 11 for the first time since 1986.
- Pajaro River levee break beginning March 11.
- Clear Lake flooding and levee overtopping along feeder streams near Lakeport beginning March 13.
- Sacramento River above Hamilton City "J" levee beginning March 16.

- Lake Elsinore flooding in Southern California beginning March 20.
- Webb Tract (RD 2026) wind wave-wash erosion beginning March 22.

Other Activities

For the first time since 1983 summer snowmelt in June and July threatened portions of the San Joaquin River and Tulare Lake hydrologic regions. Center personnel worked with the Corps, reservoir operators, Department water supply forecasters, and the National Weather Service River Forecast Center to plan for and manage increased reservoir inflows and corresponding releases. In a unique out-of-state action in response to snowmelt flooding at Topaz Lake on the West Walker River the Center coordinated technical assistance with the Nevada Office of Emergency Management.

On July 17 a mechanical failure of one of the spillway gates at Folsom Dam resulted in a sudden and large release of water that caused quickly rising downstream river stages along the lower American River through Sacramento. The Center worked with the Department's Office of Water Education and the National Weather Service to provide river forecasts and updates to local emergency management agencies, news media, and the public during this period of heavy summer recreational use. A more detailed review of this incident is provided in the Folsom Dam Gate Failure section.

Other Responding Department Units and Cooperating Agencies

Office of Water Education staff were assigned to the Center and provided public information and media support throughout the January and March floods, the summer snowmelt, and the Folsom gate failure. Division of Local Assistance districts in Red Bluff, Sacramento, Fresno, and Glendale provided technical assistance and flood fight support to local agencies within their jurisdictions. The Division of Operations and Maintenance responded to State Water Project flooding including the March 9-10 flood on the Arroyo Pasajero that washed out Interstate 5 near Coalinga and disrupted project operations. Other Department volunteers working in the Center helped disseminate river forecasts, reservoir release schedules, and other flood-related information to cooperating agencies, the public, and media using the California Data Exchange Center.

River forecast bulletins, watches, warnings, statements, and advisories were produced by the National Weather Service's Sacramento Weather Forecast Office and California-Nevada River Forecast Center (the Department's prime federal cooperating agency and, at the time, co-located with the Center in the downtown Resources Building) as well as the weather forecast offices in Eureka, Monterey, Los Angeles, San Diego, Medford (Oregon), and Reno and Las Vegas (Nevada).

The Corps responded to Department requests for emergency assistance under Public Law 84-99 through its districts in Sacramento, San Francisco, and Los Angeles. Types of assistance included emergency repairs to levees and flood relief structures, technical assistance, debris removal from flood control works, and protection of structures. Representatives from the Sacramento District Reservoir Control group assisted in coordinating reservoir operations. A more detailed review of the Corps' response is provided in the section, U.S. Army Corps of Engineers Assistance under Public Law 84-99.

Representatives from the Governor's Office of Emergency Services helped coordinate assistance requests from levee maintaining agencies, counties, and other local agencies. The California Department of Forestry and Fire Protection and the California Conservation Corps assisted in analyzing and processing requests for flood fight teams and supplemental resources.

The City of Sacramento assigned representatives to the Center to coordinate flood fight activities and relay flood-related information between agencies in the Sacramento area.

Staff from throughout the Department of Water Resources work at Flood Operations Center phones in shifts up to 24 hours long during the January and March floods.

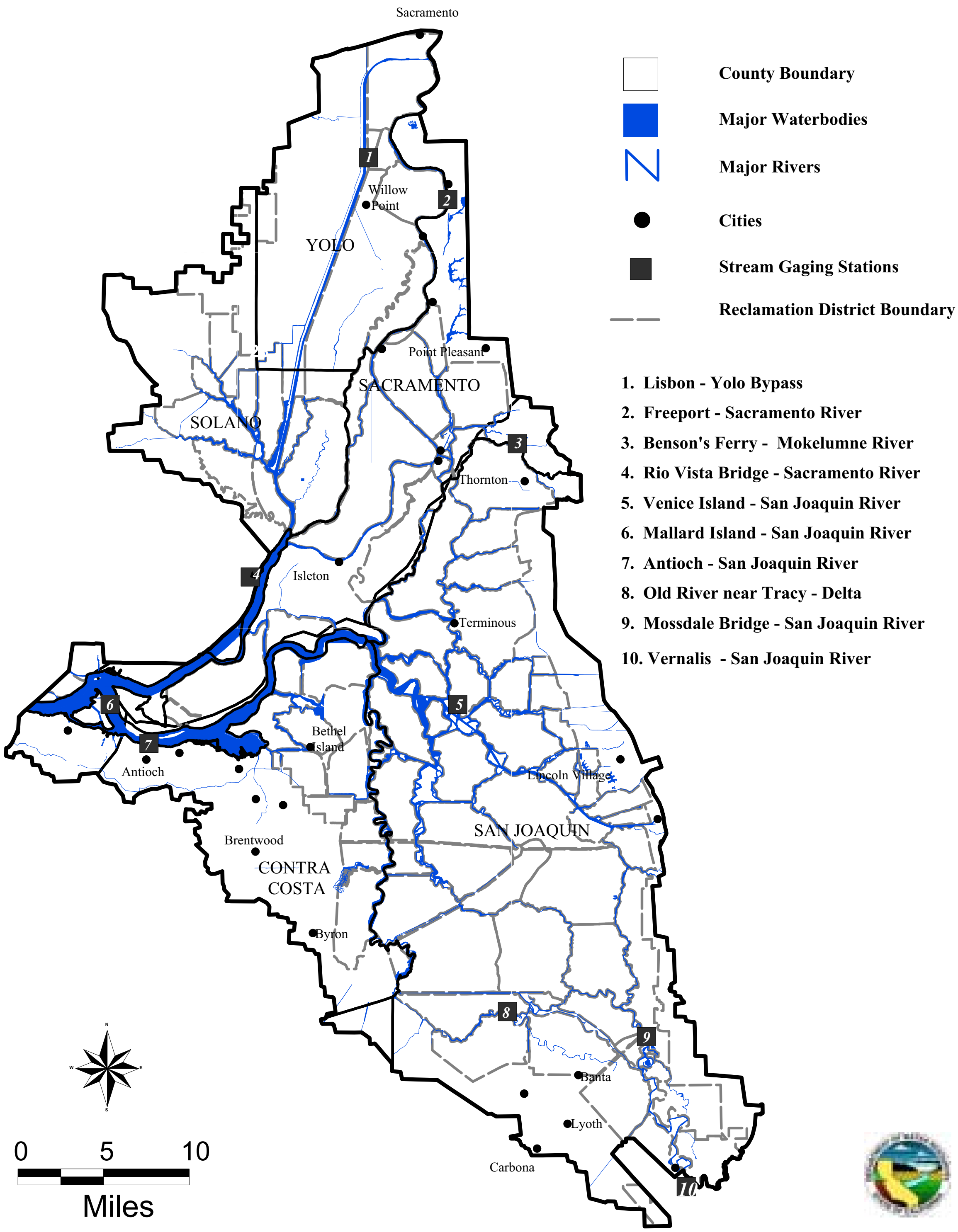
Move to the Joint Operations Center

In late summer 1995 Department staff from the Hydrology and Flood Operations Branches of the Division of Flood Management, including the Flood Operations Center and California Data Exchange Center, moved to a newly refurbished and larger water operations facility in northeastern Sacramento. This facility would later be named the Joint Operations Center and would additionally house the National Weather Services' Sacramento Weather Forecast Office and California-Nevada River Forecast Center, the State Water Project's Operations Control Office and Project Operations Center, and the U.S. Bureau of Reclamation's Central Valley Operations Office and Project Operations Center.

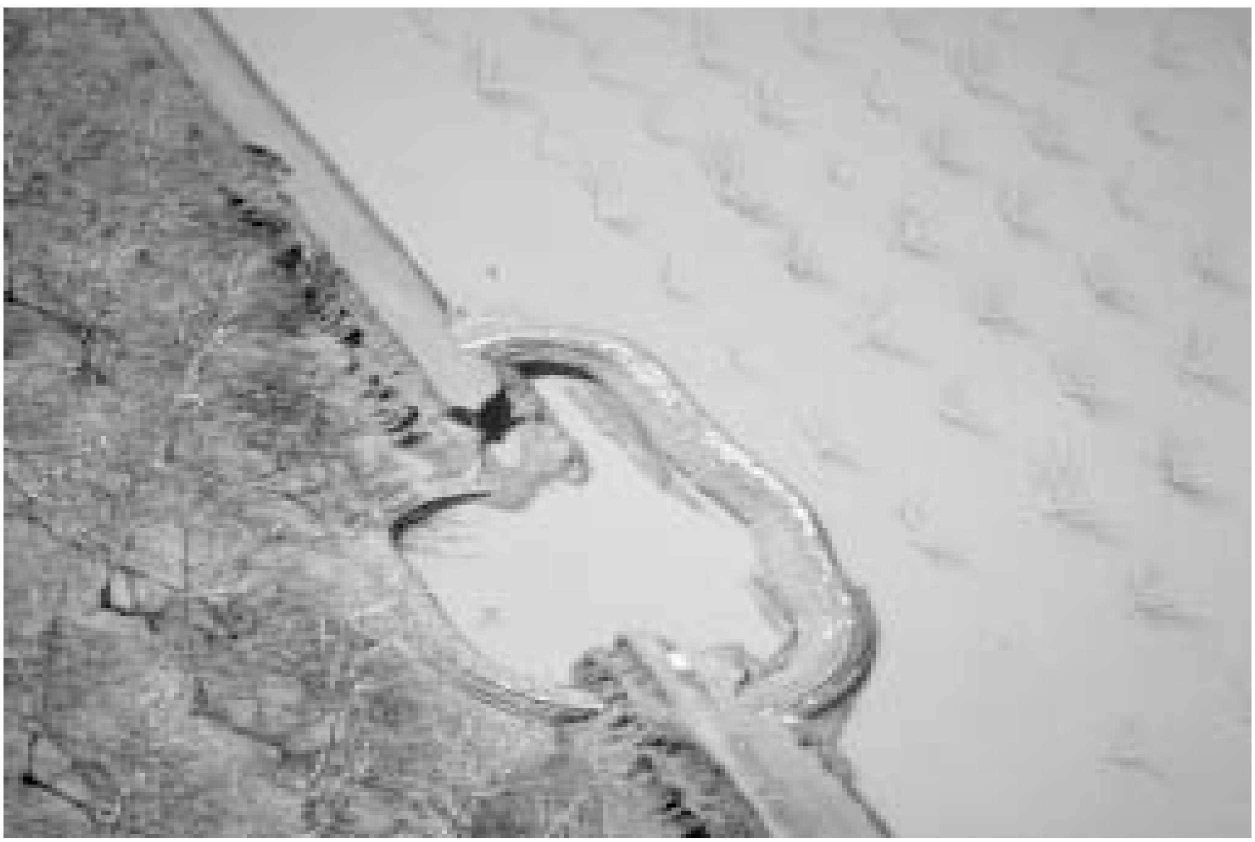
Lessons learned during the 1995 floods would be applied by staff of these co-located agencies to improve procedures for coordinated flood warning and emergency response. Not known at the time was that the opportunity to apply these new procedures would occur in less than two years during the New Year's Flood of January 1997.

DWR Flood Fight Assistance

Figure 96. Real Time Stream Gages, Legal Delta



These photos show the 43,000 sandbag structure constructed to close breach in the Deseret Levee in Butte County. Below is an aerial view of the completed structure.



DWR Flood Fight Assistance

Most Department flood fight assistance activities took place in Northern and Central California. Figure 96 shows the location of real time stream gages in the Sacramento-San Joaquin Delta. Although also battered by the heavy storms, Southern California flood fight activities with the exception of Lake Elsinore were handled by local agencies and did not require assistance from the Department.

Levee maintaining agencies within the federally constructed flood control projects and the Sacramento-San Joaquin Delta have the primary responsibility for flood emergency preparedness and response. When local agencies were no longer able to sufficiently respond, they requested assistance from within their county or from the Department.

However, since the Standardized Emergency Management System (SEMS) became law in 1996, this process now requires that local requests for assistance be completed at the county operational area level then forwarded to one of three regional offices of the Governor's Office of Emergency Services (OES). If State agency resources are required—including Department-sponsored Public Law 84-99 requests to the U.S. Army Corps of Engineers or California Conservation Corps/ California Department of Forestry and Fire Protection flood fight resources—OES will task State resources officially through SEMS. The Department continues to provide year-round technical assistance directly to local agencies without going through SEMS but no longer directly tasks other State agencies for crews and other flood fight resources.

During the 1995 floods the Department assisted several agencies by providing technical assistance—including geotechnical evaluations of flood-threatened levees—and flood fight crew

Crews work to protect a business in Colusa. (All photos in this section by: Flood Operations Center Archives)

The photographs above and below show wave wash protection repairs in Reclamation District 108 along the Colusa Basin Drain.

leadership. Incident Command Posts were established in the Colusa Basin and at the Deseret Levee in Butte County to coordinate and oversee California Conservation Corps and California Department of Forestry and Fire Protection crews. Command Post operations were coordinated with the Flood Operations Center using the Department's Incident Command System and other established protocols. Table 10 summarizes major Department flood fighting efforts in 1995. The following section titled "U.S. Army Corps of Engineers Assistance under Public Law 84-99" details those incidents where the Department acquired flood fighting assistance from the Corps.

Table 10. Major DWR Flood Fight Efforts in 1995

Location (flood event)	Type of Field Activity
Sacramento River Hydrologic Region	
Pacific Farms, Tehama County (January)	Technical assistance to lay approximately 300 feet of plastic levee slope protection, partially under water
Deseret Levee, Butte County (January)	Technical assistance to construct a 43,000 sandbag structure to close a levee breach on the east bank of the Sacramento River
Town of Colusa (January)	Technical assistance to lay approximately 4 miles of plastic wave wash protection and to sandbag homes
Colusa Basin Drain, RD 108 (January)	Technical assistance to lay approximately 3 miles of plastic wave wash protection
Clear Lake, Lake County (March)	Technical assistance to lay plastic sheeting and construct other structural reinforcement along feeder stream levees near Lakeport
Cache Creek, Yolo County (March)	Technical and direct assistance to lay plastic sheeting and sandbags to minimize overtopping damage
San Joaquin River Hydrologic Region	
Bradford, Merritt, and Twitchell Islands, and Webb and Orwood Tracts (January and March)	Technical assistance to flood fight crews placing wave wash protection and sandbags on levees
South Coast Hydrologic Region	
Lake Elsinore, Riverside County	Technical and direct flood fighting assistance to protect lakeside homes

Above: Sack ring constructed to reduce the flow and prevent further discharge of earthen material from a boil that developed near Elk Slough on Merritt Island (RD 150). Below: Levee repairs on Webb Tract (Reclamation District 2026) funded by the SB 34 Special Flood Control Projects Program.

U.S. Army Corps of Engineers Assistance Under Public Law 84-99

U.S. Army Corps of Engineers Assistance under Public Law 84-99

Under its disaster assistance mission, the Corps is authorized to provide emergency assistance for the protection of life and property when natural disasters or other emergencies occur. Emergency preparedness and response are primarily state and local responsibilities. However, in instances when the nature of the disaster exceeds the capabilities of state and local governments, the Corps may provide assistance to save human life, prevent immediate human suffering, or mitigate property damage. The authority for the Corps to provide such assistance is Public Law (PL) 84-99. Under this law assistance is authorized under the following six programs:

- Disaster Preparedness
- Emergency Operations
- Rehabilitation and Inspection of Flood Control Works
- Advance Measures
- Emergency Water Assistance
- Hazard Mitigation

During the 1995 floods the Corps provided assistance to California under the Disaster Preparedness, Emergency Operations, and Rehabilitation and Inspection programs.

Disaster Preparedness Program

State and local governments are responsible for natural disaster emergency preparedness including training and stockpiling of flood fight supplies. The role of the Corps is to supplement maximum efforts of the state and local authorities during a natural disaster emergency by providing the following assistance:

- Provide personnel to assist communities with public information programs for awareness and knowledge of natural disaster hazards.
- Participate in natural disaster emergency seminars or exercises when requested by state and local officials. The Corps participates in the Department's series of preseason meetings with levee-maintaining agencies and county emergency-response officials by presenting PL 84-99 program updates. In preparation for the 1995 flood season these meetings were held in Sacramento, Stockton, and Yuba City in September 1994.
- Provide technical assistance for development of emergency plans at the state and local level. Department and Corps engineers conduct joint geotechnical levee evaluations to assist in developing flood fight strategies.
- Inspect flood control works constructed or required by the Corps and advise local sponsors of needed maintenance.

Emergency Operations Program

The Corps may provide flood and post-flood emergency assistance to save lives and protect improved property. This assistance will supplement state and local entities, which must commit all available resources prior to Corps involvement. Corps assistance during flood fight operations is of a temporary nature to meet the immediate threat and is not intended to provide permanent solutions to flood problems. The Emergency Operations Program includes:

- Technical assistance to provide review and recommendations in support of state and local efforts including: reviewing flood fighting techniques and emergency construction methods; inspecting flood control projects and structurally threatened dams and recommending corrective actions; and providing hydraulic, hydrologic, or geotechnical evaluations, mapping, and historical data.

Table 11. 1995 Corps Emergency Operations PL 84-99 Program Assistance

Hydrologic Region (flood event)	Type of Assistance
Sacramento River Hydrologic Region	
City of Tehama (January)	Technical
Deseret Levee, Butte County (January)	Technical and sandbags
Town of Colusa (January)	Technical
Cache Creek, Yolo County (January)	Emergency debris removal from Capay Bridge
Sacramento River, Pedersen Levee (January)	Emergency rock revetment
Hamilton City, "J" Levee, Glenn County (March)	Technical
Middle Creek, Lake County (March)	Technical and flood fight materials
Central Coast Hydrologic Region	
Pajaro River, Santa Cruz and Monterey Counties (March)	Emergency rock revetment
Debris Clearing, Santa Barbara County (January)	Emergency debris removal from basins and channels

- Direct assistance including issuing supplies or loaning equipment; assisting in search and rescue operations; directing flood fight operations; and emergency contracting to construct temporary levees, make emergency levee repairs, strengthening, or temporary raising; and removal of stream obstructions.

On behalf of local governments and the State, the Department obtained Corps assistance at nine locations under the Emergency Operations Program in 1995 as shown in Table 11.

Rehabilitation and Inspection Program

The Corps' assistance under the Rehabilitation and Inspection Program is limited to rehabilitation of levees and other features of the federally constructed Sacramento River Flood Control Project and San Joaquin River Flood Control System. Bank protection is excluded from PL 84-99 rehabilitation. Damage to federal flood control works by nonflood disasters is also excluded from rehabilitation, but the Corps may make exceptions. If financial assistance for rehabilitation is provided by another federal agency, the Corps may assist only under an exception granted by Corps headquarters. The Corps pays for 100 percent rehabilitation of federal flood control projects under the regular Rehabilitation and Inspection Program.

In addition to emergency operations, the Corps provided assistance at 13 locations under the Rehabilitation and Inspection Program. From north to south these locations were the following:

- North Fork Pit River
- Murphy Slough (M&T Flood Relief Structure, Sacramento River)
- Cherokee Canal (Butte County)
- Reclamation District 108 (Colusa and Yolo Counties)
- Scott Creek (Lake County)
- Reclamation Districts 1600, 785, and 827 (Yolo Bypass)
- Willow Slough Bypass (Yolo County)
- Reclamation District 900 (Sacramento River and Yolo Bypass)
- Reclamation District 150 (Yolo County)
- Reclamation District 2060 and 2098 (Solano County)
- Reclamation District 404 (San Joaquin County)
- Kings River (North Fork)

Damage to 3 B's and M&T Flood Relief Structures

The M&T, Goose Lake, and 3 B's Flood Relief Structures are along the east bank of the Sacramento River in Butte County downstream of Big Chico Creek (River Mile 194) and upstream of Ord Ferry. During high flows. floodwaters are diverted out of the river at these locations into the Butte Basin Overflow Area. These structures are critical to the operation of the Sacramento River Flood Control Project in that they divert excess floodwaters from the river before they are confined by the downstream project levees, which begin near Ord Ferry.

The 3 B's structure sustained approximately 2,300 linear feet of severe levee erosion from the roadway at Murphy Slough Plug to the west property line of the State-owned property in January and February. Major damage included a 90-foot washout and deep scouring of the roadway downstream of Murphy Slough Plug. The M&T structure also sustained approximately 50 linear feet of bank erosion. Levee and relief structure repairs were completed under the Corps' Rehabilitation and Inspection Program following the 1995 flood season.

Damage to Glenn Country Road 29 Levee

At River Mile 188 on the Sacramento River above Ord Ferry, the end of Glenn County Road 29 acts as a levee and prevents flows from overtopping across the neck of Kimmelshue Bend just downstream. Prolonged high stages in January contributed to three breaks that flooded adjacent farmland. The Corps repaired these breaks under authority of the Sacramento River Bank Protection Project with the Corps and State Reclamation Board acting as the federal and nonfederal project sponsors. After another breach occurred on March 10 at the farthest upstream repair site, the Corps again made repairs under the Bank Protection Project authority.

Appendix A: Maximum Rainfall

Appendix A: Maximum Rainfall

Table A-1 Precipitation Stations Used in River and Reservoir Hydrographs

Precipitation Station	Hydrologic Region, Drainage	Station Elev	Jan 1995 Precip	Jan Avg	Jan 1995 % Avg	Mar 1995 Precip	Mar Avg	Mar 1995 % Avg
		feet	*inches*			*inches*		
Bridgeville 4 NNW	North Coast, Van Duzen R	2,100	30.35	10.83	280%	22.90	9.33	245%
Buckhorn	Sacramento, Cow CK	3,800	21.92	10.23	214%	21.02	8.67	242%
Bucks Creek PH	Sacramento, Feather R	1,760	**39.94**	12.07	331%	36.29	9.89	367%
Calaveras Big Trees	San Joaquin, Calaveras/Stanislaus R	4,695	25.07	9.79	256%	25.31*	8.52	297%
Calistoga	San Francisco Bay, Napa R	370	30.23	7.70	393%	17.85	5.24	341%
Clearlake 4 SE	Sacramento, Cache CK	1,349	25.96	5.45	476%	15.71	3.60	436%
Cloverdale	North Coast, Russian R	333	31.25	8.98	348%	20.14	6.06	332%
Coalinga	Tulare Lake, Arroyo Pasajero	670	6.07	1.51	402%	6.33	1.05	603%
Covelo	North Coast, Eel R	1,430	**24.35**	8.35	292%	15.62	5.91	264%
Eureka WSO	North Coast, Mad R	43	12.74	6.00	212%	11.18	5.32	210%
Fiddletown	San Joaquin, Cosumnes R	2,160	17.54	6.20	283%	17.75	5.66	314%
Gasquet RS	North Coast, Smith R	384	29.27	14.84	197%	22.63	12.93	175%
Gilroy	Central Coast, Pajaro R	194	11.17	4.03	277%	8.96	3.23	277%
Grant Grove	San Joaquin, Kings R	6,600	21.39	8.05	266%	22.23	6.69	332%
Happy Camp RS	North Coast, Klamath R	1,120	21.40	9.43	227%	14.90	6.81	219%
Healdsburg	North Coast, Russian R	102	29.90	9.10	329%	20.21	5.74	352%
Hetch Hetchy	San Joaquin, Tuolumne R	3,870	14.84	5.66	262%	16.89*	5.22	324%
Hoopa Trinity River	North Coast, Trinity R	333	21.70	10.37	209%	15.3	7.06	217%
Huntington Lake	San Joaquin, San Joaquin R	7,020	22.80	6.50	351%	21.00	5.95	353%
Kern River PH 3	Tulare Lake, Kern R	2,703	8.84	2.80	316%	5.28	2.18	242%
Lodgepole	Tulare Lake, Kaweah R	6,735	17.92	8.72	206%	17.74	6.71	264%
Orick Prairie Creek SP	North Coast, Redwood CK	160	20.84	10.14	206%	17.20	9.28	185%
Paskenta RS	Sacramento, Thomes CK	755	21.32	4.52	472%	10.92	3.49	313%
Paso Robles	Central Coast, Salinas R	700	11.51	3.01	382%	12.31	2.08	592%
Priest Valley	Tulare Lake, Los Gatos/Warthan CK	2,300	14.70	3.86	381%	12.92	3.35	386%
Red Bluff FSS	Sacramento, Cottonwood CK	349	**21.47**	4.13	520%	10.23	3.07	333%
Richardson Grove SP	North Coast, Eel R	500	38.65	12.56	308%	28.73	9.48	303%
Robbs Peak PH	Sacramento, American R	5,175	23.50	9.43e	249%	23.00	8.04e	286%
Salinas Dam	Central Coast, Salinas R	1,245	17.50	4.27	410%	14.16	3.80	373%
Santa Margarita Booster	Central Coast, Salinas R	1,100	23.76	6.39	372%	21.39	5.02	426%
Shasta Dam	Sacramento, Sacramento R	1,075	**38.21**	11.17	342%	28.87	9.06	319%
Springville RS	Tulare Lake, Tule R	1,750	7.70	3.23e	238%	8.50	3.34e	254%
St. Helena	San Francisco Bay, Napa R	225	23.30	7.95	293%	16.83	4.71	357%
Stony Gorge	Sacramento, Stony Creek	800	**20.21**	4.14	488%	9.66	2.68	360%
Strawberry Valley	Sacramento, Yuba R	3,808	42.49	14.96	284%	35.98	11.64	309%
Tiger Creek PH	San Joaquin, Mokelumne R	2,355	21.36	8.13	263%	18.64	7.01	266%
Volta PH	Sacramento, Battle CK	2,220	**15.87**	5.46	291%	10.14	4.58	221%
Willits 1NE	North Coast, Russian R	1,350	28.36	9.70	292%	18.93	7.05	269%
Yosemite Park HQ	San Joaquin, Merced R	3,966	16.31	6.16	265%	18.29	5.23	350%

Note: January 1995 precipitation is not shown on some San Joaquin and Tulare Lake region hydrographs where spring and summer snowmelt was more significant.

e = estimated **Jan-95 Bold = wettest month on record** * = wettest March on record

Appendix B: Changes in California Data Exchange Center

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Before the 1995 floods, limited data were collected and distributed on the more modern Unix computer systems. The older system was used to distribute data until fall 1995 when operations moved to the Joint Operations Center from the Resources Building. Before the move, information from the California Data Exchange Center (CDEC) was converted from 1985 mini-computers, using a flat-file database architecture, to Unix servers.

CDEC continues to exchange information on hydrologic conditions with such agencies as the National Weather Service, U.S. Army Corps of Engineers, and the U.S. Bureau of Reclamation. This database provides central resources of hydrologic data for managing the State's water resources.

Telemetry Operations

Before the 1995 floods, the Department's Flood Management telemetry system was based on three types of radio transmitters. Those systems were Thiokol and Multisonic in the 1970s and Department-built transmitters in the late 1980s. Real-time data from remote precipitation and stream gages were transmitted over the State's public safety microwave system and radio repeaters operating in the hydrologic frequency spectrum.

The 1995 floods tested the flood-warning network. Heavy rainfall produced a major rise on the Russian and Napa rivers on Sunday morning, January 8. River forecasts predicted the Russian River at Guerneville to be 16 feet over flood stage by Monday afternoon. Monday night's forecast called for Guerneville to be 15 feet above flood stage for 12 hours, and Tuesday mornings forecast indicated that the Russian River would recede in 12 hours.

As emergency responders and flood management agencies monitored the flooding, a wind-caused power outage cut all transmissions from the microwave radio repeater atop Mount St. Helena at 6 a.m. on Wednesday, January 11. The outage lasted about 30 hours, creating a blind spot in the forecasting network. Local agencies in Sonoma and Napa counties telephoned manual readings into the River Forecast Center to allow continued forecast operations.

To provide redundant communications, existing telemetry equipment was replaced with a dual-path system: the existing interrogated microwave radio path and a new path through the Geo-Stationary Operational Environmental Satellite Data Collection System (GOES). Emergency funding was appropriated to upgrade about 65 stations throughout California. New equipment installations began on February 2, 1995, and by the March flood event, 42 replacement stations were operating. The satellite communication path mitigated significant future microwave radio outages. The dual-path communications replacement program was complete in April 1995.

This replacement project required the participation and coordination of many agencies. The U.S. Geological Survey worked with the State to replace stream gaging telemetry and sensor equipment. The U.S. Bureau of Reclamation and National Weather Service provided about 30 satellite communication frequencies