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Chapter 3 Watershed and Delta Hydrology

This chapter presents a brief overview of the hydrologic conditions in the watersheds that affect water quality in rivers and channels of the Sacramento-San Joaquin Delta (the Delta). In the following chapters, water quality at various stations is discussed in the context of Delta hydrologic conditions.

Six weather stations were selected to represent the general precipitation patterns in areas that influence the Delta. Figure 3-1 shows the locations of these stations relative to the Delta and the San Joaquin River (SJR) and Sacramento River. The 3 northern stations—Redding Fire Station, Durham, and Sacramento Executive Airport—are within the Sacramento Valley; the other 3 stations— Brentwood, Stockton Fire Station, and Madera—are in the San Joaquin Valley. Data for Redding Fire Station, Stockton Fire Station, and Sacramento Executive Airport were obtained from the Western Regional Climate Center in Reno, Nevada. Data for the remainder of the stations were from the California Irrigation Management Information System (CIMIS) of the California Department of Water Resources (DWR).

Figure 3-1 Location of selected weather stations (map)

Also presented are water outflows at 3 Delta locations and a hydrologic classification index that categorizes water-year types based on river runoff.

Precipitation

The stations within the Sacramento Valley (the northern stations) generally recorded more rainy days and more intense rain than did the stations in the San Joaquin Valley (the southern stations) during the reporting period (Table 3-1). For example, during the study period, there were 239 rainy days at the Redding station and the highest daily precipitation was 3.17 inches; whereas there were 160 rainy days at the Stockton Fire Station, and the highest daily rainfall was 1.13 inches. The southern stations recorded only a few days with more than one inch of rain; whereas the northern stations recorded several more days of heavier rainfall.

Table 3-1 Summary of daily precipitation (in inches) at six weather stations

Figure 3-2 presents the cumulated monthly precipitation for the 6 stations. Table 3-2 summarizes these data, clearly showing the differences in cumulated monthly precipitation among the stations. Monthly and total accumulated precipitation at the selected stations were lower during the 2001 water year than during the 2000 water year; monthly and total accumulated precipitation were comparable for both the 1999 and 2001 water years (Table 3-2 and Figure 3-2). Although these stations indicate a general pattern of precipitation within the contributing watersheds, they cannot be used as a reliable measure of total precipitation and runoff in these watersheds. For example, although total cumulated precipitation was the highest in the 2000 water year, runoff in the watershed was not the greatest in that water year. This is discussed in the following section, "Runoff Index."

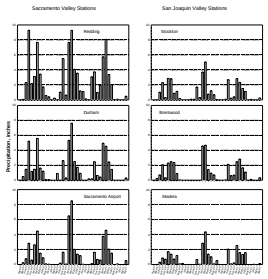


Figure 3-2 Cumulative monthly precipitation at six weather stations

Table 3-2 Summary of monthly precipitation (in inches) at six weather stations

Most rainfall occurred from September through April at all stations (Figure 3-2). The northern stations had considerably more rain than the southern stations during all rainy months. Rainfall during the months of

June, July, and August were negligible at all stations except for the Redding station. In some years, considerable precipitation occurred in May or June, but this was generally followed by a dry September of the same year.

Runoff Index

The Delta receives water from the SJR and Sacramento River systems, which depend on runoff water from their watersheds. To classify runoff years, the State Water Resources Control Board developed a hydrologic index based on the amount of unimpaired watershed runoff. The definition and method of calculating the index can be found in Water Right Decision 1641, revised March 15, 2000 (SWRCB 2000).

DWR maintains a database containing hydrologic indices for the SJR and Sacramento River systems. In calculating these indices, unimpaired runoff represents the natural water production of a river basin unaltered by upstream exports, storage, or diversion to or import of water from other basins. For the Sacramento River system, the index uses the total runoff (in million acre-feet) of Sacramento River at Bend Bridge, Feather River inflow to Lake Oroville, Yuba River at Smartville, and American River inflow to Folsom Lake. The runoff for the SJR system is the total of Stanislaus River inflow to New Melones Lake, Tuolumne River inflow to New Don Pedro Reservoir, Merced River inflow to Lake McClure, and SJR inflow to Millerton Lake.

Table 3-3 summarizes year type classification. Water year 2001 was a dry year for both valleys, indicating that runoff was lower than normal. This index is not necessarily related to total rainfall at the selected stations in the 2 watersheds. Runoff into the rivers is determined not only by the amount of precipitation in the 2 watersheds but also by the precipitation in the Sierra Nevada. Total precipitation at the 6 stations was lower in the 2001 water year than it was in the 2000 water year (Table 3-2). Consequently, less water entered the river system as shown in Figure 3-3, which presents daily flows at Sacramento River at Freeport and SJR at Vernalis. The SJR outflows as measured at Vernalis were significantly lower than outflows of the Sacramento River as measured at the Freeport station (Figure 3-3). This is so because the Sacramento Valley had considerably more rain than the San Joaquin Valley during all rainy months as discussed in the previous section, "Precipitation."

Table 3-3 Hydrologic index classification based on measured unimpaired runoff at selected rivers

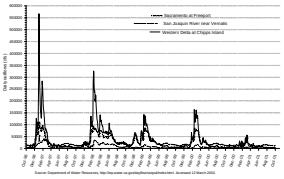


Figure 3-3 Daily outflows at three Delta locations

Due to the differences in runoff among the 3 water years, water quality varied by watershed. The effect of precipitation and runoff on water quality at various stations and at the diversion pumps is discussed in later chapters.

Delta Outflows

Delta inflows mostly come from the SJR and Sacramento River systems. Water inflows to these rivers come from their major tributaries, reservoirs, and drainage canals within their watersheds. A proportion of the water within the Delta is diverted through the State Water Project, Contra Costa Pumping Plant, Central Valley Project (CVP), the North Bay Aqueduct, the CVP's Tracy Pumping Plant, and Contra Costa Water District's intake at Rock Slough (Contra Costa Pumping Plant #1), Old River at Station 9, and Mallard Slough. The remaining water is allowed to continue as Delta

outflows into the San Francisco and Suisan bays at the western end of the Delta to help maintain marine ecosystems. The outflows also help control seawater influence in the western Delta by holding back the daily tides. Therefore, a steady Delta outflow is necessary to preserve the quality of source waters in the Delta.

The Interagency Ecological Program of DWR routinely calculates the daily outflows at Chipps Island at the western end of the Delta. This daily outflow is often referred to as net total outflow of the Delta. Figure 3-3 presents the calculated Delta outflows and inflows at SJR and Sacramento River from water years 1997 to 2001. Delta inflows and outflows varied widely among water years and within each water year. During the reporting period, Delta outflows were highest in the 1998 water year and lowest during the 2001 water year. Outflow patterns were similar in the 1999 and 2000 water years (Figure 3-3). Low Delta outflows in water year 2001 were attributable to significantly less runoff that year within major watersheds (Table 3-3). The reduced Delta outflows during the 2001 water year adversely affected water quality at various stations, particularly those in the western and central Delta. Water quality at these stations with respect to changes in Delta outflow are discussed in following chapters.

Table 3-1 Summary of daily precipitation (in inches) at six weather stations

Station	Reporting days	Days rained	Range	Mean	Median	Days of varying intensity >= 0.1	>= 0.5	>= 1	>= 2
Sacramento Valley									
Redding Fire Station	1,157	239	0.01–3.17	0.40	0.19	161	68	26	3
Durham	1,157	192	0.01–1.74	0.30	0.17	119	39	9	0
Sacramento Executive Airport	1,157	175	0.01–2.99	0.29	0.16	109	39	8	1
San Joaquin Valley									
Stockton Fire Station	1,157	160	0.01–1.13	0.23	0.12	92	25	3	0
Brentwood	1,157	205	0.01–1.78	0.17	0.08	97	18	2	0
Madera	1,157	157	0.01–1.39	0.17	0.08	75	16	1	0

Table 3-2 Summary of monthly precipitation (in inches) at six weather stations

Station	Cumulated monthly precipitation Range[b]	Mean[b]	Median[b]	Cumulated precipitation during each water year[a] 1999	2000	2001
Sacramento Valley						
Redding Fire Station	0.03–9.29	2.96	2.11	30.90	37.24	26.43
Durham	0.08–7.63	2.07	1.45	18.85	21.44	17.20
Sacramento Executive Airport	0.03–8.49	1.75	1.17	13.75	21.57	15.33
San Joaquin Valley						
Stockton Fire Station	0.03–5.07	1.31	0.95	11.55	13.64	11.41
Brentwood	0.01–4.69	1.33	0.89	11.19	12.44	11.94
Madera	0.02–4.36	1.05	0.79	7.05	10.89	9.44

a. Water year runs from October 1 to September 30; for example, the 1999 water year runs from 1 October 1998 to 30 September 1999.
b. Calculated with data from wet months only.

Table 3-3 Hydrologic index classification based on measured unimpaired runoff at selected rivers

Water year	Sacramento Valley	San Joaquin Valley
1997	Wet	Wet
1998	Wet	Wet
1999	Wet	Above normal
2000	Above normal	Above normal
2001	Dry	Dry

Figure 3-1 Location of selected weather stations

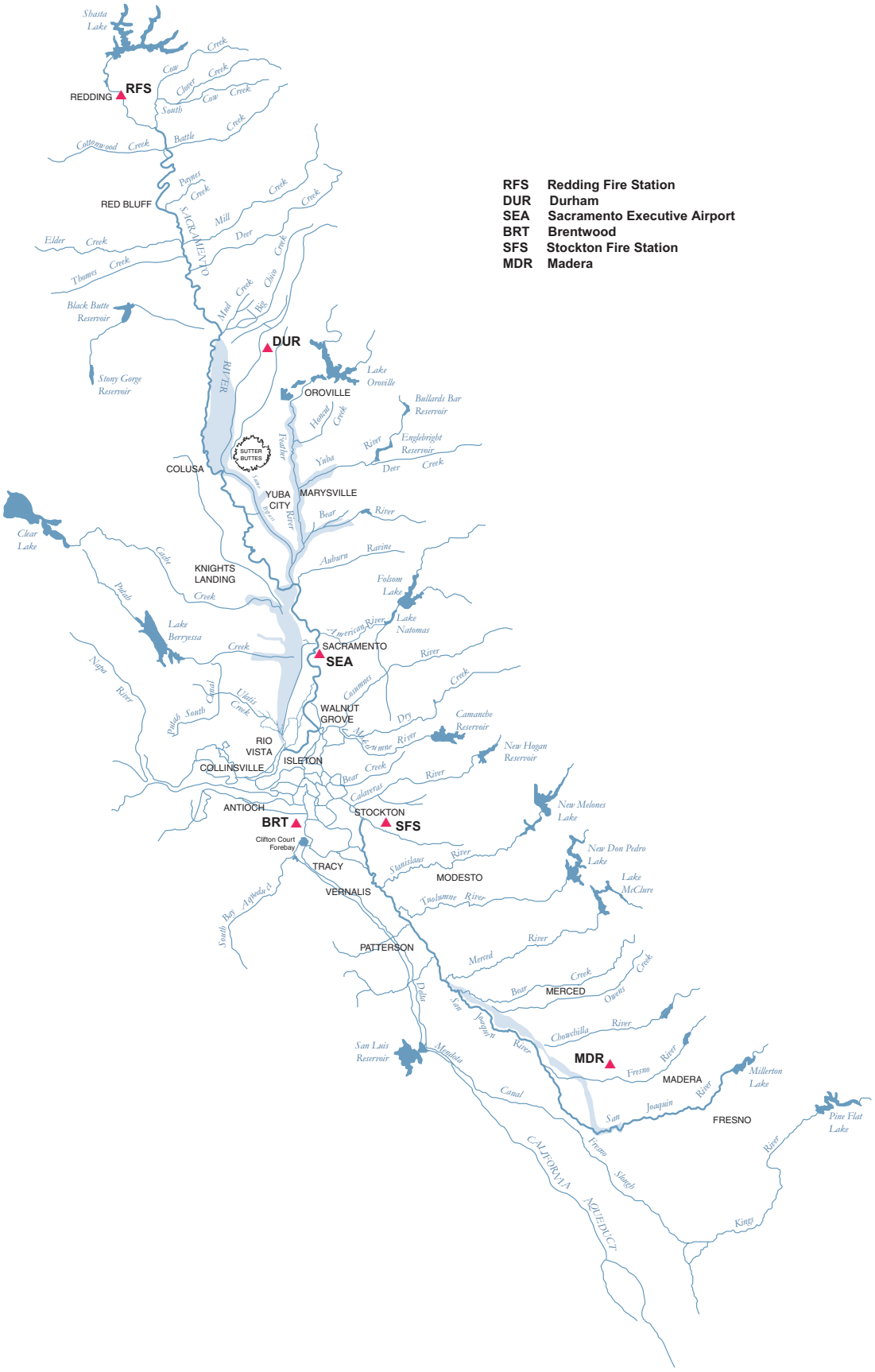


Figure 3-2 Cumulated monthly precipitation (in inches) at six weather stations

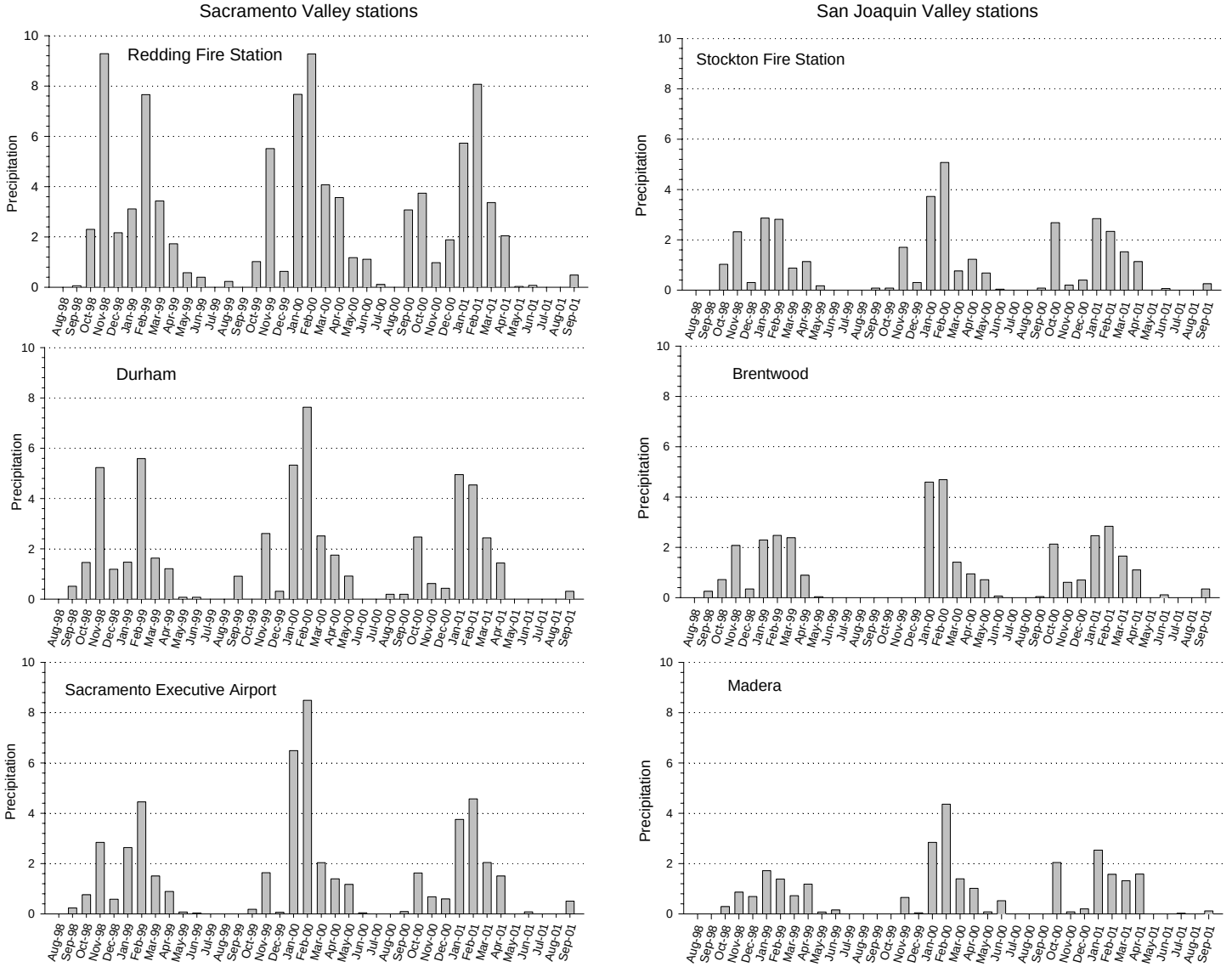
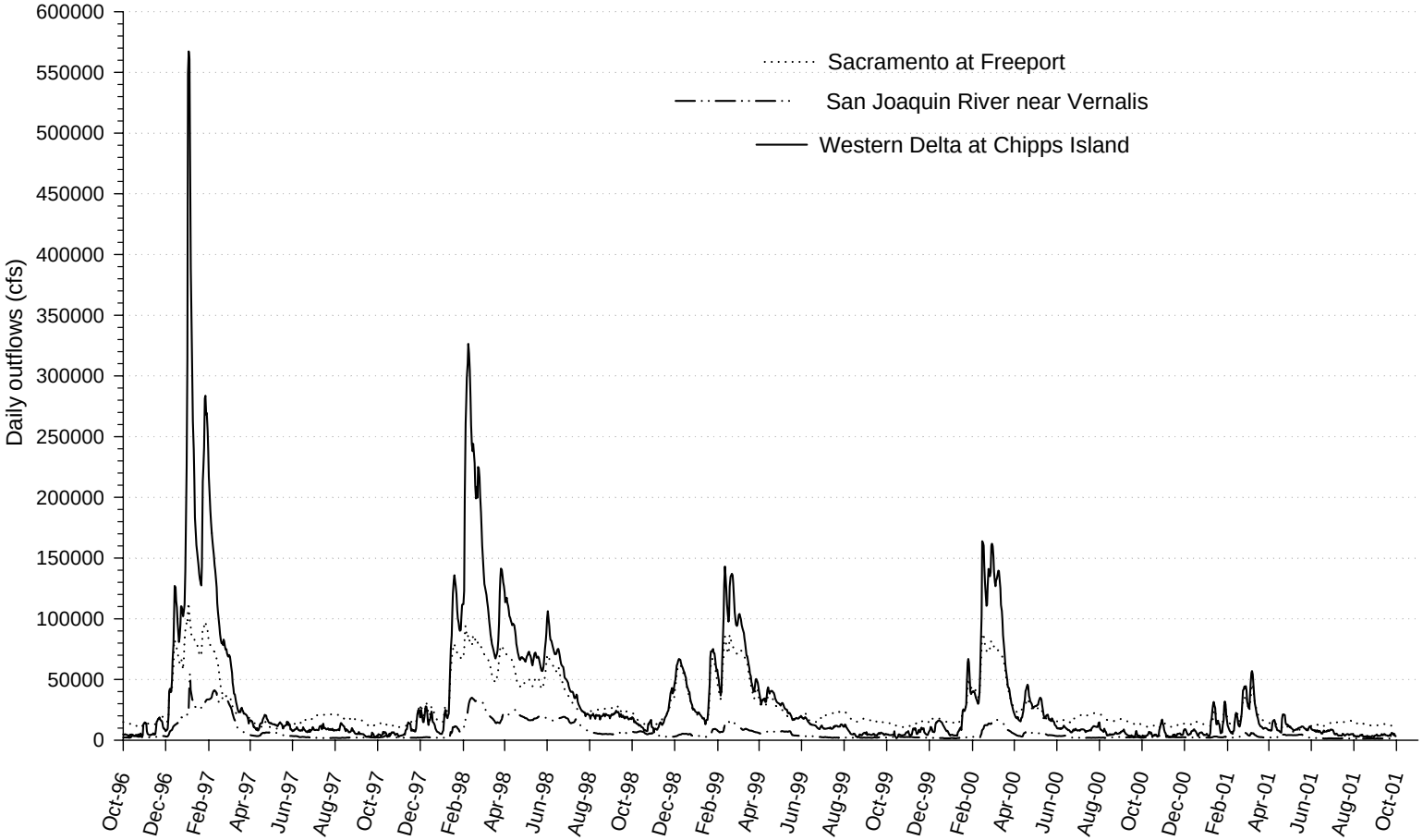


Figure 3-3 Daily outflows at three Delta locations



Source: Department of Water Resources, http://iep.water.ca.gov/dayflow/output/index.html. Accessed 12 March 2002.
cfs = cubic feet per second