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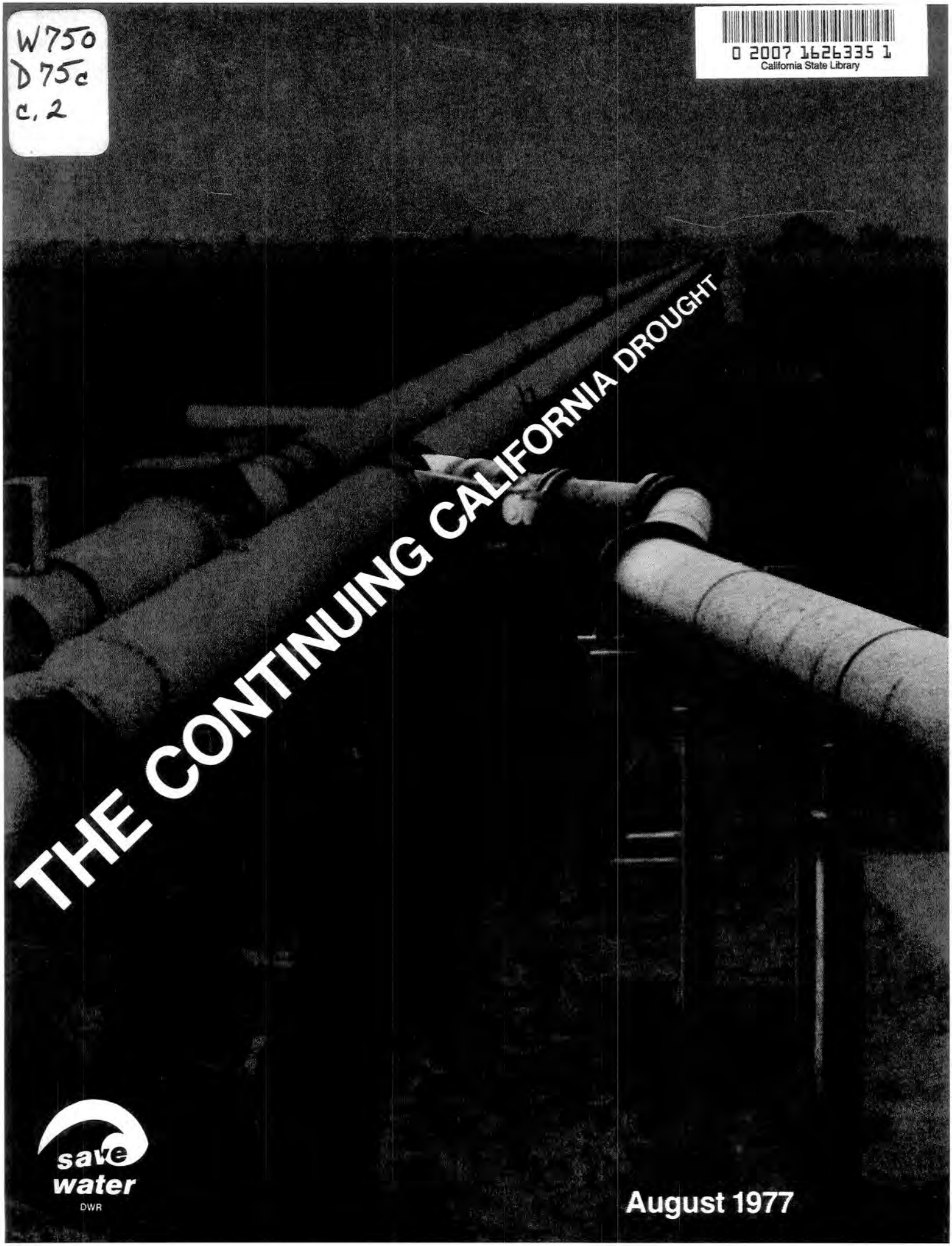

THE CONTINUING CALIFORNIA DROUGHT

save water
DWR

August 1977

ON THE COVER: As the drought continues into 1977, many emergency water supply connections have been constructed to exchange water or to obtain emergency supplies. Typical is the temporary connection at Middle River in the Sacramento-San Joaquin Delta, constructed through the cooperation of the Department of Water Resources (DWR) and the East Bay Municipal Utility District (EBMUD).

A temporary pipeline (right foreground) conveys water from a temporary pumping plant (not shown) in Middle River to one drought-emptied pipeline of EBMUND's Mokelumne Aqueduct, where it is transported a few miles for release into the Contra Costa County Water District's canal intake at Rock Slough. The system is now providing high-quality water to the Contra Costa system, previously threatened by increasing salinity at Rock Slough.

A second connection is currently under construction by EBMUD to provide emergency supplies to EBMUD and additional capacity for Marin County as part of the exchange agreement between Metropolitan Water District of Southern California and the DWR. Water for Marin will be furnished from the DWR's State Water Project and for EBMUD, from the Central Valley Project.

State of California
The Resources Agency

Department of
Water Resources

The Continuing California Drought

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August 1977

Snowcover differences between a near-normal runoff season (1975) and a drought year (1977) in the Sierra Nevada Mountains near Lake Tahoe as observed by satellite

25 February 1975
Average Snowline Elevation = 4,500 feet

14 February 1977
Average Snowline Elevation = 6,500 feet

FOREWORD

This is the third in a series of detailed reports on the continuing California drought, the worst in history.

We have learned a great deal about individual and institutional capabilities and resources during this drought. Response to the need for better water management and reduced use has been forthcoming. Water is being used more wisely in most areas, innovative alternative sources of supply are being tried and the people of our State are coping quite well. Economic impact is being minimized by federal and state programs of assistance. A spirit of cooperation and helpfulness has prevailed.

As to major water projects, even with their limited reserves they continue to serve us well. We have, however, learned that the many preceding years of plentiful water left us less well prepared for drought operations than we should be. Special efforts need to be taken now to devise new operating procedures to better meet future droughts.

One of the most important tasks before us is planning for next year. We have no assurance that 1977-78 will not also be dry. We must plan for the worst on an assumption that the dry conditions of 1976-77 will continue another year. If such is the case, impacts will be far more severe than these past two years. We cannot permit the attitude that "it can't happen here" to limit our efforts at assuring we are prepared for another very dry year.

Ronald B. Robie

Ronald B. Robie, Director
Department of Water Resources
The Resources Agency
State of California

State of California
The Resources Agency
Department of Water Resources

The Continuing California Drought
August 1977

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CONVERSION FACTORS

English to Metric System of Measurement

Quantity	English unit	Multiply by	To get metric equivalent
Length	inches (in)	25.4	millimetres (mm)
		.0254	metres (m)
	feet (ft)	.3048	metres (m)
	miles (mi)	1.6093	kilometres (km)
Area	square inches (in^2)	6.4516×10^{-4}	square metres (m^2)
	square feet (ft^2)	.092903	square metres (m^2)
	acres	4046.9	square metres (m^2)
		.40469	hectares (ha)
		.40469	square hectometres (hm^2)
		.0040469	square kilometres (km^2)
	square miles (mi^2)	2.590	square kilometres (km^2)
Volume	gallons (gal)	3.7854	litres (l)
		.0037854	cubic metres (m^3)
	million gallons (10^6 gal)	3785.4	cubic metres (m^3)
	cubic feet (ft^3)	.028317	cubic metres (m^3)
	cubic yards (yd^3)	.76455	cubic metres (m^3)
	acre-feet (ac-ft)	1233.5	cubic metres (m^3)
		.0012335	cubic hectometres (hm^3)
		1.233×10^{-6}	cubic kilometres (km^3)
Volume/Time (Flow)	cubic feet per second (ft^3/s)	28.317	litres per second (l/s)
		.028317	cubic metres per second (m^3/s)
	gallons per minute (gal/min)	.06309	litres per second (l/s)
		6.309×10^{-5}	cubic metres per second (m^3/s)
	million gallons per day (mgd)	.043813	cubic metres per second (m^3/s)
Mass	pounds (lb)	.45359	kilograms (kg)
	tons (short, 2,000 lb)	.90718	tonne (t)
		907.18	kilograms (kg)
Power	horsepower (hp)	0.7460	kilowatts (kW)
Pressure	pounds per square inch (psi)	6894.8	pascal (Pa)
Temperature	Degrees Fahrenheit (°F)	$\frac{tF - 32}{1.8} = tC$	Degrees Celsius (°C)

Figure 1

PRECIPITATION OCTOBER 1, 1976 TO AUGUST 9, 1977

A REVIEW OF WATER AVAILABILITY IN 1977

In most of Northern and Central California, precipitation in the 1976-77 water year[1/] has been less than one-third of normal. Over the State, precipitation has averaged only 35 percent of normal. This has been reflected in record low figures for stream runoff into reservoirs and for mountain snowpack. There is no real possibility of any significant relief before November. Figure 1 shows current water year precipitation figures for selected locations in the State (covering the period October 1, 1976 to August 9, 1977) compared to normal precipitation for the year.

Reservoir Storage, Snowpack, and Runoff

At the start of the water year, October 1, 1976, reservoir storage had already declined to record lows. Since October, reservoir storage has actually decreased -- this during a time when storage normally is building up. Table 1 compares reservoir storage by hydrologic areas on October 1, 1976, August 1, 1977, and the average August 1 conditions for the ten years 1967 to 1976. It shows that total storage in 143 reservoirs representing the bulk of California's surface water storage (excluding storage in the Colorado River) declined from 16 600 cubic hectometres (13,500,000 acre-feet) on October 1, 1976, to 11 800 cubic hectometres (9,560,000 acre-feet) on August 1, 1977. Total storage on August 1 represented only 39 percent of normal for that time of year. The Central Valley's reservoirs, with a total capacity of 33 000 cubic hectometres (27 million acre-feet) and average storage of 24 400 cubic hectometres (19,800,000 acre-feet) on August 1, contained only 9 000 cubic hectometres (7,290,000 acre-feet), or 37 percent of normal.

Snowpack water storage on April 1 was the lowest in 47 years in all basins except the Trinity and Feather Rivers. On that date the accumulated statewide snowpack water content was only 25 percent of normal. This is very significant since the maximum seasonal accumulation usually occurs by April 1.

The record lack of snowpack continued to be demonstrated by the conditions at Norden in the Sierra near Donner Summit. Figure 2 shows how this year's pack at Norden compared to the average conditions and to those of 1923-24, previous record holder for minimum snowpack. In both instances (1977 and 1924), snowpack was essentially gone by mid-April. However, above normal precipitation in May added some snow to the Sierra. This, together with thunderstorm activity in June, increased the runoff in many basins to above what was forecast on May 1.

Runoff from the Sierra snowpack is completing its journey to valley reservoirs and total water availability for 1977 can now be projected. This year's pack was so light runoff is very low, and the runoff, which often extends into July, was essentially complete by early June. April-July runoff, for Central Valley basins dependent on snowmelt, is shown on Table 2. For the period April-July, the table indicates that 11 out of 14 Central Valley basins will have the lowest snowmelt runoffs on record. All major basins in the Central Valley between the latitudes of Chico and Bakersfield produced less than 25 percent of normal snowmelt runoff, and the lower elevation Cosumnes and Tule basins produced only 8 percent. The Sacramento basin, with the best record, produced only 45 percent of normal.

It is clear that current record low reservoir storage, when augmented by the

---

1/ October 1, 1976 - September 30, 1977

TABLE 1

RESERVOIR STORAGE BY HYDROLOGIC AREA*
CUBIC HECTOMETRES
(thousands of acre-feet)

Area	Number of Reservoirs	Total Capacity	Storage October 1 1976	10-Year Ave Storage Aug 1	Storage Aug 1 1977	Percent of Average
INTRASTATE						
North Coastal	6	3 456 (2,803)	2 030 (1,646)	2 923 (2,370)	762 (618)	26
San Francisco Bay	17	846 (686)	366 (297)	556 (451)	371 (301)	67
Central Coastal	6	1 210 (981)	613 (497)	794 (644)	380 (308)	48
South Coastal	28	2 603 (2,111)	1 244 (1,009)	1 320 (1,070)	1 076 (872)	82
Sacramento Valley	47	20 796 (16,866)	8 612 (6,985)	16 472 (13,354)	6 179 (5,009)	38
San Joaquin Valley	31	12 100 (9,814)	3 498 (2,837)	7 955 (6,449)	2 814 (2,281)	35
Lahontan	8	525 (426)	256 (208)	403 (327)	217 (176)	54
Subtotal	143	41 536 (33,687)	16 619 (13,479)	30 423 (24,665)	11 799 (9,565)	39
INTERSTATE						
North Coastal	3	1 486 (1,205)	783 (635)	912 (739)	614 (498)	67
Lahontan	5	1 338 (1,085)	493 (400)	1 095 (888)	186 (151)	17
Colorado Desert (1)	4	66 006 (53,533)	51 791 (42,004)	41 842 (33,921)	48 512 (39,329)	116
Subtotal (1)	12	68 830 (55,823)	53 067 (43,039)	43 849 (35,548)	49 312 (39,978)	112
TOTAL (1)	155	110 366 (89,510)	69 686 (56,518)	74 272 (60,213)	61 111 (49,543)	82

(1) Includes data for Lake Mead and Lake Powell which regulate flow of the Lower Colorado River, the major source of water for the Colorado Desert and South Coastal Areas.

* The reservoirs used in this tabulation include most, but not all, of the storage capacity available in each area.

Figure 2

SNOW DEPTH AT DONNER SUMMIT
(NORDEN-ELEVATION 7,000 FEET)

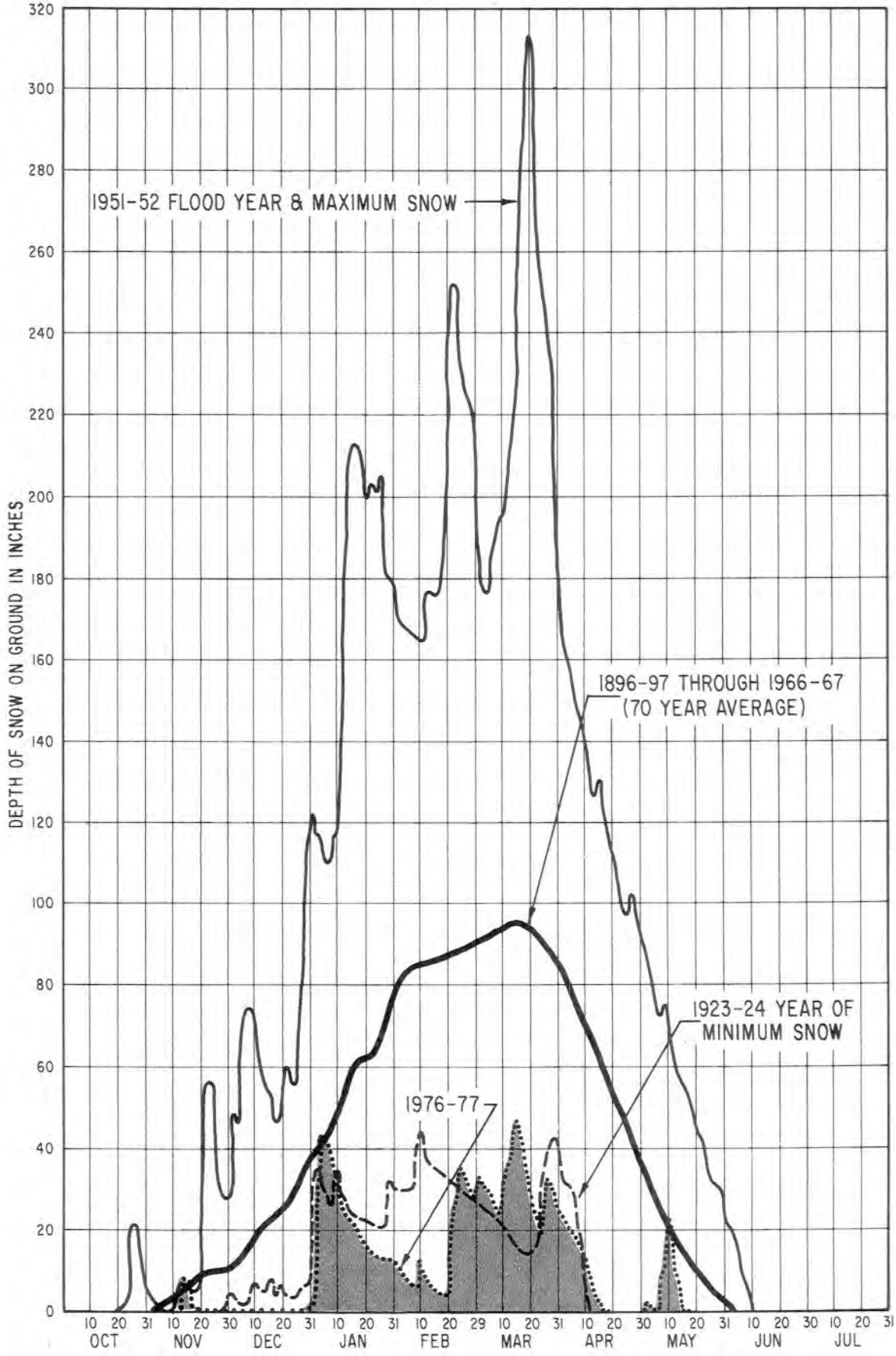


TABLE 2

1977 APRIL-JULY RUNOFF
COMPARED TO MINIMUM OF RECORD
CUBIC HECTOMETRES
(Thousands of acre-feet)

Basin	Record Minimum Runoff Amount	Year	Percent of Average	1977 Runoff Amount	Percent of Average
Sacramento, Shasta	895 (726)	1924	41	984 (798)	45
Feather, Oroville	488 (396)	1924	21	490 (397)	21*
Yuba, Smartville	295 (239)	1924	22	234 (190)	18*
American, Folsom	317 (257)	1924	19	288 (233)	17*
Cosumnes, Michigan Bar	15 (12)	1924	9	14 (11)	8*
Mokelumne, Pardee	157 (127)	1976	26	129 (105)	23*
Stanislaus, Melones	206 (167)	1924	23	148 (120)	16*
Tuolumne, Don Pedro	471 (382)	1976	28	339 (275)	20*
Merced, Lake McClure	216 (175)	1976	28	158 (128)	21*
San Joaquin, Millerton	382 (310)	1924	26	323 (262)	22*
Kings, Pine Flat	345 (280)	1924	24	338 (274)	23*
Kaweah, Terminus	85 (69)	1934	26	76 (62)	23*
Tule, Success	2 (2)	1934[1/]	3	6 (5)	8
Kern, Isabella	104 (84)	1961[1/]	20	113 (91)	22
Truckee, Tahoe to Farad	74 (60)	1924	23	72 (58)	22*
West Carson at Woodfords	27 (22)	1961[1/]	43	15 (12)	23*
East Carson near Gardnerville	58 (47)	1924	26	53 (43)	24*
West Walker near Coleville	52 (42)	1924	29	43 (35)	24*
East Walker near Bridgeport	10 (8)	1924	13	10 (8)	13*

[1/] Records not available for 1924.

* At or below minimum of record.

meager runoff remaining, will result in water availability of record low proportions for 1977. Table 3 compares the total runoff forecast in each basin for 1976-77 with the minimum runoff of record. Only 3 of 19 basins shown will not set a new record low for total yearly runoff. Reservoir storage is dwindling as a result of summer usage, and storage this fall will also reach record lows at most reservoirs.

Ground Water Levels

As California experienced its second consecutive year of drought, ground water levels continued to drop. Figure 3 shows the extent and magnitude of the changes.

In the northern Sacramento Valley, in Tehama, Glenn, Butte, and Colusa Counties, average ground water levels in the spring of 1977 were 1.1 metre (3.6 feet) lower than in the spring of 1976 based on measurements at 283 wells. This decline is in addition to the average lowering of 1.8 metres (6 feet) in the previous year of drought. Elsewhere in Northern California (except for the north coast), ground water levels were generally lower by 0.3 to 2.1 metres (1 to 7 feet), generally equalling or less than the lowering of the previous year. In the north coastal area, ground water levels were lower by 0.3 to 1.5 metres (1 to 5 feet), an amount often exceeding the previous year's drop. The current year is the first year of severe drought for the North Coast and the second for the Sacramento Valley.

In the lower Sacramento Valley, south of Butte and Colusa Counties, in those areas where wells are the major source for water, ground water levels have fallen even lower than the all-time lows reached last year. In some areas of Yolo County, the levels this spring have dropped more than 3.0 metres (10 feet) from the levels in the spring of 1976. In the Wheatland-Olivehurst area of Yuba County, the decline is from 1.5 to 2.4 metres (5 to 8 feet), and in southern Sacramento County an average lowering of 1.5 metres (5 feet) was measured. Elsewhere in this region, ground water levels declined slightly.

In the San Joaquin Valley, the effect of increased pumping during 1976 is shown by the lowering of ground water levels along the eastern flanks of the Valley. Comparison of (spring) 1977 levels to those recorded in the (spring) of 1976 indicate an average lowering of 2.3 metres (7.6 feet) for 19 districts covering most of the east side of the Valley. The average drop in levels was 1.5 metres (5 feet) for eastern San Joaquin County, 2.2 metres (7.1 feet) for 3 districts in the San Joaquin River basin, 2.0 metres (6.7 feet) for 3 in the Kings River service area, 2.1 metres (6.8 feet) for 10 in the Friant-Kern service area, 3.9 metres (12.9 feet) for 2 in the Kaweah River service area, and 2.7 metres (8.8 feet) for 1 district in the Tule River service area.

Ground water levels for the west side of the San Joaquin Valley, showing minimal reliance on ground water extraction, continued to rise or hold stable. These are areas served by state and federal water from the California Aqueduct and the Delta-Mendota Canal. Confined aquifer water levels in the Mendota-Huron area (Westlands Water District) showed pressure rises of from 0 to 9.1 metres (0 to 30.0 feet), based on measurements of 351 deep wells. (This does not represent an actual increase in storage, but reflects the increase in pressure from the deeper, confined aquifer.) The Delta-Mendota area showed a minimal decrease of 0.3 metres (1.1 feet), and the Wheeler Ridge-Maricopa area showed changes ranging from +5.8 to -4.6 metres (+19.0 to -15.0 feet), with an average overall change of +0.7 metres (+2.4 feet).

On the whole, during 1976, the San Joaquin Valley experienced a ground

TABLE 3

1977 FORECASTS OF WATER YEAR RUNOFF
COMPARED TO MINIMUM OF RECORD
CUBIC HECTOMETRES
(Thousands of Acre-feet)

Basin and Station	Record Minimum Runoff Amount	Year	Percent of Average	1977 Water Year Runoff Amount	Percent of Average
Sacramento, Shasta	3 057 (2,479)	1924	43	3 076 (2,495)	46
Feather, Oroville	1 597 (1,295)	1924	30	1 178 (955)	22*
Yuba, Smartville	743 (603)	1924	27	395 (320)	14*
American, Folsom	670 (543)	1924	21	444 (360)	14*
Cosumnes, Michigan Bar	49 (40)	1924	11	25 (20)	6*
Mokelumne, Pardee	234 (190)	1924	27	160 (130)	18*
Stanislaus, Melones	322 (261)	1924	24	197 (160)	15*
Tuolumne, Don Pedro	670 (543)	1924	30	413 (335)	19*
Merced, Lake McClure	311 (252)	1924	27	185 (150)	16*
San Joaquin, Millerton	547 (444)	1924	27	444 (360)	22*
Kings, Pine Flat	483 (392)	1924	25	480 (390)	25*
Kaweah, Terminus	126 (102)	1924	25	120 (95)	24*
Tule, Success	23 (19)	1961 2/	14	20 (16)	12*
Kern, Isabella	216 (175)	1961 2/	28	222 (180)	29
Truckee, Tahoe to Farad	120 (97)	1924	25	105 (85)	22*
West Carson at Woodfords	38 (31)	1961	44	22 (18)	26*
East Carson near Gardnerville	94 (76)	1924	31	74 (60)	24*
West Walker near Coleville	75 (61)	1924	34	62 (50)	28*
East Walker near Bridgeport	30 (24)	1924	23	31 (25)	24

1/ Forecast based on actual flows from October 1, 1976 to July 31, 1977, and projected flows for August and September, 1977.

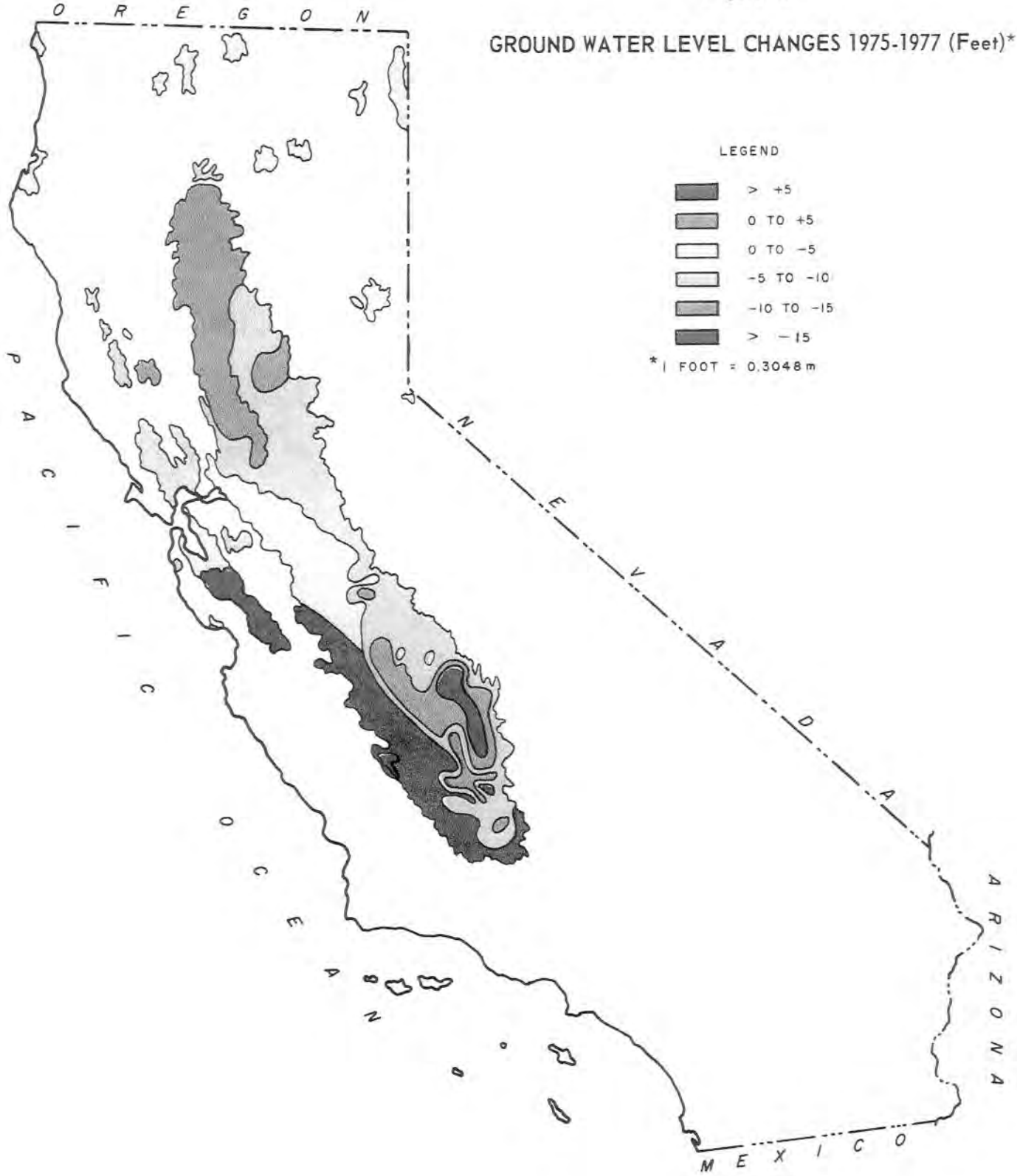
2/ Records not available for 1924.

* At or below minimum of record.

Note: Water year is from October 1 to September 30.

Figure 3

GROUND WATER LEVEL CHANGES 1975-1977 (Feet)*



water storage reduction of 3 700 to 4 300 cubic hectometres (3 to 3.5 million acre-feet). This compares to a normal value of 1 500 cubic hectometres (1.2 million acre-feet) annual extraction. The drops in water level noted above are from 2 to 3 times the normal values.

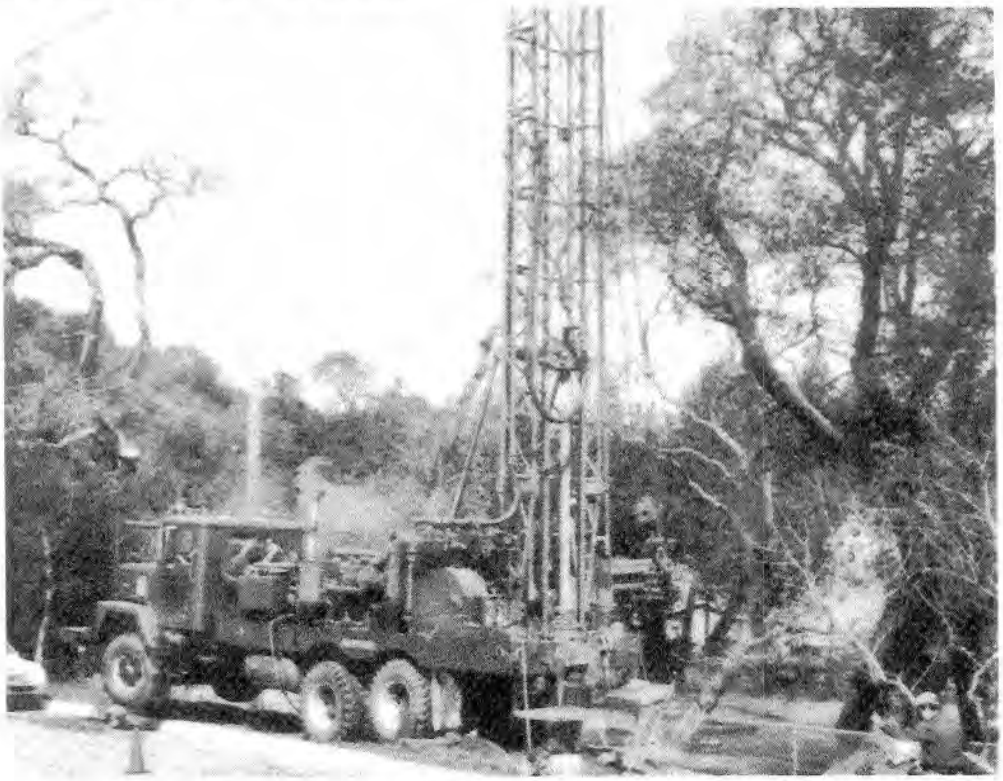
In 1977, because of reduced surface water supply in the San Joaquin Valley (the SWP is expected to supply 690 cubic hectometres [560,000 acre-feet] less in 1977 compared to 1976 and the CVP, 2 700 cubic hectometres [2,180,000 acre-feet] less), ground water levels can be expected to drop again. During 1977, ground water storage depletion in the San Joaquin Valley is expected to approximate 7 400 cubic hectometres (6 million acre-feet), a figure reflecting expected reductions in crop acreage and lessened recharge from natural sources and from applied water.

The Salinas Valley reported a ground water lowering of 1.7 metres (5.6 feet) from spring 1976 to spring 1977 and for the same period, the southern Santa Clara Valley showed a lowering of 7.9 metres (26 feet). The South Bay portion of the Santa Clara Valley reflected an average decline of 4.1 metres (13.4 feet), the Sonoma Valley 1.2 metres (3.8 feet), and the Napa Valley 1.2 metres (4.0 feet).

Major basins in the southern part of the State showed little effect in 1976 and conditions are expected to remain stable in 1977, except that those areas where ground water recharge programs have been curtailed as a result of the drought will experience some lowering.

Areas dependent on springs, and coastal and foothill areas dependent on wells will again be subjected to water supply failures due to stoppage or decreased flow.

The effect of the drought upon major ground water basins is shown on Table 4.



2. Tapping the underground. As surface supplies became scarce, more emphasis was placed on ground water. This well rig is drilling in a San Rafael park.

TABLE 4

GROUND WATER LEVEL CHANGES
FEET 1/

District or Area	Average Depth Spring 1977	Average Annual Change 1970-75	Annual Change 1975 1976	Annual Change 1976 1977	Net Change 1970-77
San Joaquin Valley					
San Joaquin County:					
Mokelumne River Area	73.5	- 1.1	- 4.7	- 4.9	-15.3
Calaveras River Area	93.1	- 1.5	- 3.8	- 5.1	-16.4
Farmington-Collegville Area	87.1	- 1.6	- 4.4	- 5.4	-17.8
South San Joaquin I.D.	30.5	- 0.9	- 1.6	- 4.4	-10.3
Delta Area	16.9	- 0.4	- 1.0	- 2.0	- 5.2
Stanislaus County:					
Oakdale I.D.	71.2	- 0.3	- 2.9	- 2.2	- 6.5
Modesto I.D.	20.2	-0-	- 1.7	- 2.3	- 4.8
Turlock I.D.*	9.8	+ 0.1	+ 0.2	- 1.6	+ 1.3
Area East of Turlock	94.1			- 6.5	***
City of Modesto	44.5			- 2.4	***
Merced County:					
Merced I.D. (Deep)	37.1	- 0.7	- 5.2**		- 7.9
(Shallow)	24.5	- 0.6	- 1.6**		
El Nido I.D.	87.8	- 2.7	- 0.9	- 7.0	-21.6
Delta Mendota Area	23.6	+ 0.6	- 0.9	- 1.1	+ 1.0
Merced Bottoms	32.8	- 1.1	- 1.8	- 2.3	- 9.6
Madera County:					
Chowchilla W.D.	99.5	- 2.9	- 3.6	- 9.3	-27.3
Madera I.D.	81.1	- 0.8	- 3.9	- 4.9	-12.7
West Chowchilla Area	62.7	- 3.1	- 4.0	- 2.4	-22.0
Fresno County:					
Fresno I.D.	62.0	- 0.8	- 1.4	- 6.6	-11.8
City of Fresno	87.4	- 0.9	- 0.9	- 1.3	- 6.5

* Shallow test wells, only.

** Fall 1976 measurements.

*** Insufficient data.

1/ 1 foot = 0.3048 metres.

TABLE 4 (Continued)

GROUND WATER LEVEL CHANGES
FEET 1/

District or Area	Average Depth Spring 1977	Average Annual Change 1970-75	Annual Change 1975 1976	Annual Change 1976 1977	Net Change 1970-77
San Joaquin Valley (Continued)					
Fresno County: (Continued)					
Fresno Slough Area	96.0	- 2.6	-10.8	+ 0.6	-23.2
Consolidated I.D.	50.8	- 0.9	- 3.6	- 5.3	-13.2
Mendota-Huron Area 2/	329.3	+13.2	+11.2	+10.2	+87.5
Poso Conservation District	9.3	- 0.2	- 1.3	0.0	- 2.5
San Luis Canal Company	14.8	- 0.1	- 0.1	- 9.1	- 9.6
Centerville Bottoms	17.3	+ 0.2	- 5.3	+ 2.3	- 9.6
Garfield Water District	94.0	+ 0.4	- 3.4	- 1.4	- 2.7
Pleasant Valley Area	286.3	- 4.4	-10.4	- 5.8	-38.2
James I.D.	110.9	+ 0.2	- 7.1	- 2.4	- 8.7
Tranquillity I.D.	47.6	+ 0.1	- 7.5	+ 2.2	- 4.9
Raisin City Area	121.6			- 1.6	***
Tulare County:					
Alta I.D.	40.0	- 1.4	- 7.9	- 8.3	-23.4
Orange Cove I.D.	29.3	- 0.4	- 3.9	- 4.4	-10.1
Stone Corral I.D.	24.0	- 1.2	- 4.1	- 3.8	-13.9
Ivanhoe I.D.	65.5	+ 0.3	- 4.1	- 9.0	-11.4
Kaweah Delta W.C.D.	69.6	- 1.3	- 4.5	-10.9	-21.9
Tulare I.D.	91.3	- 1.3	- 3.6	-14.9	-25.1
Exeter I.D.	52.8	+ 0.7	- 6.0	- 3.0	- 5.6
Lindsay-Strathmore I.D.	45.0	+ 0.1	- 3.3	- 6.0	- 8.7
Lindmore I.D.	54.6	+ 2.2	- 3.4	- 5.7	+ 2.0
Porterville I.D.	35.1	- 0.2	+ 1.4	-10.5	-10.2
Lower Tule River I.D.	84.2	- 1.3	- 0.4	- 8.8	-15.7
Vandalia I.D.	123.3	-0-	- 2.1	- 3.4	- 5.4
Saucelito I.D.	145.5	+ 0.3	- 0.3	- 6.4	- 5.1
Pixley I.D. (Shallow)	136.5	***	- 4.7	- 5.0	-21.8
(Deep)	157.7	+ 1.5	- 4.4	- 6.4	- 5.1
Alpaugh-Allensworth Area (Shallow)		- 2.5	+ 9.8	+ 5.7	+ 2.9
(Deep)	205.8	-10.6	- 5.8	- 2.5	***

*** Insufficient data.

1/ 1 foot = 0.3048 metres.

2/ Reflects increase in pressure (not basin storage) in confined aquifer.

TABLE 4 (Continued)

GROUND WATER LEVEL CHANGES
FEET 1/

District or Area	Average Depth Spring 1977	Average Annual Change 1970-75	Annual Change 1975 1976	Annual Change 1976 1977	Net Change 1970-77
San Joaquin Valley (Continued)					
Tulare County: (Continued)					
Delano-Earlimart I.D.	143.6	+ 0.7	+ 7.3	- 7.2	+ 1.6
Terra Bella I.D.	125.1	- 1.3	NM	NM	***
Kern County:					
Kern-Tulare W.D.	543.3	***	-21.0	-14.6	***
South San Joaquin M.U.D.					
(Shallow)	113.4	+ 0.4	- 1.1	- 7.6	- 6.9
(Deep)	224.6	- 5.1	- 2.1	-14.3	-41.7
North Kern W.S.D.					
(Shallow)		-10.4	- 6.8	- 1.8	***
(Deep)	254.9	- 4.1	-12.0	+ 0.3	-32.2
Shafter-Wasco I.D.	270.4	- 5.7	-16.5	-11.6	-56.4
City of Bakersfield	215.9	- 3.7	- 7.2	- 5.2	-30.8
Kern River Delta					
(Shallow)		- 1.9	- 7.3	- 2.0	-18.9
(Deep)	154.0		- 4.9	- 5.1	***
Wheeler-Ridge - Maricopa	337.4			+ 2.4	***
Edison-Maricopa	364.3	- 7.3	+ 0.6	- 6.0	-42.0
Buena Vista W.S.D., North Area	97.5	- 2.7	+ 2.3	- 6.8	-18.0
Semitropic W.S.D.					
(Shallow)		- 0.6	+ 1.9	- 0.2	- 1.5
(Deep)	245.0	- 6.5	- 4.2	- 8.2	-44.9
Arvin-Edison W.S.D.	391.8	- 1.1	- 9.6	- 7.6	-22.7
Kings County:					
Corcoran I.D. (Shallow)	45.1	+ 0.9	+ 7.8	- 7.7	+ 4.7
(Deep)	157.5	+ 3.0	-21.8	-36.2	-43.2
Lower Kings River					
(Shallow)		- 2.0	- 0.1	-12.7	-22.8
(Deep)	121.1	+ 4.0	- 9.2	-32.7	-21.7
Kings County W.D.					
(Shallow)	66.2	- 1.7	- 3.5	-13.3	-25.1
(Deep)		+ 1.1			***

*** Insufficient data.

1/ 1 foot = 0.3048 metres.

TABLE 4 (Continued)

GROUND WATER LEVEL CHANGES
FEET 1/

District or Area	Average Depth Spring 1977	Average Annual Change 1970-75	Annual Change 1975 1976	Annual Change 1976 1977	Net Change 1970-77
Northern Interior Region					
Alturas Basin	15	- 0.1	- 1.4	- 1.5	- 3.4
Big Valley (Lassen)	17	- 0.1	- 2.1	- 2.0	- 4.8
Fall River Valley (Shasta)	18	- 0.2	- 1.4	- 1.0	- 3.6
Redding Basin	67	- 0.2	- 4.5	- 1.8	- 7.5
Sierra Nevada Mountain Region					
Mohawk Valley (Plumas)	7.2	+ 0.2	- 0.8	- 0.2	0.0
Sierra Valley (Plumas)	4.7	- 0.2	- 1.8	- 0.8	- 3.8
South Tahoe Valley	27.5	- 0.1	- 2.5	- 2.0	- 5.2
Lake County Basins					
Coyote Valley	16.0	+ 0.4	- 4.2	- 0.7	- 2.9
Upper Lake Valley	20	- 0.3	- 5.6	- 6.2	-13.4
Collayomi Valley	14.7	+ 0.5	- 2.8	- 2.4	- 2.7
Scott Valley	35	+ 0.2	- 4.2	-23.0	-26.2
Kelseyville Valley	23	+ 0.1	- 8.1	- 5.2	-12.6
High Valley	34	- 0.3	- 7.0	- 7.6	-16.0
Lower Lake Area	20	+ 0.4	- 6.5	- 1.7	- 6.0
Sacramento Valley					
Sutter County	18.1	+ 0.1	- 5.1	- 3.3	- 7.8
Yuba County	49.4	- 0.2	- 5.7	- 5.9	-12.8
Placer County	53.3	+ 0.6	- 2.8	- 4.2	- 3.1
Sacramento County	71.6	- 1.0	- 3.6	- 3.5	-12.0
Yolo County	43.7	- 0.2	- 7.9	- 6.4	-15.3
Capay Valley (Yolo)	29.3	+ 0.2	- 5.8	- 3.8	- 8.5
Solano County	33.3	+ 0.2	- 4.8	- 4.1	- 7.7
Tehama County	40	+ 0.2	- 6.5	- 2.7	- 8.3
Glenn County	38	- 0.1	- 7.3	- 5.3	-13.3
Butte County	31	- 0.3	- 4.8	- 3.6	- 9.9
Colusa County	42	+ 0.2	- 7.3	- 3.0	- 9.5

1/ 1 foot = 0.3048 metres.

TABLE 4 (Continued)

GROUND WATER LEVEL CHANGES
FEET 1/

District or Area	Average Depth Spring 1977	Average Annual Change 1970-75	Annual Change 1975 1976	Annual Change 1976 1977	Net Change 1970-77
Lahontan Region					
Surprise Valley (Modoc)	51	- 0.8	+ 0.1	- 3.5	- 7.5
Honey Lake Valley (Lassen)	16	- 0.5	- 2.0	- 2.5	- 7.0
North Coastal Region					
Del Norte County:					
Smith River Plain	13	+ 0.5	- 0.2	- 3.3	- 1.0
Siskiyou County:					
Butte Valley	34	+ 0.2	- 1.6	- 2.2	- 2.6
Shasta Valley	30	+ 0.9	- 0.9	- 0.5	+ 3.2
Scott River Valley	9	+ 0.3	- 1.2	- 1.2	- 0.9
Humboldt County:					
Mad River Valley	10	+ 0.7	- 0.3	- 2.9	+ 0.3
Eel River Valley	15	+ 0.6	- 1.2	- 2.7	- 1.1
Mendocino County:					
Round Valley	13	+ 0.1	- 1.2	- 7.7	- 8.5
Laytonville Valley	11	+ 0.7	- 2.8	- 5.6	- 4.6
Little Lake Valley	17	+ 0.8	- 1.2	- 5.7	- 2.7
Potter Valley	9.2	+ 0.4	- 1.2	- 1.3	- 0.7
Ukiah Valley	12.1	+ 0.7	- 4.8	- 2.6	- 3.8
Sanel Valley	12.2	+ 0.8	- 5.3	- 2.8	- 4.2
Sonoma County:					
Alexander Valley	13.6	+ 0.7	- 7.2	- 1.6	- 5.5
Santa Rosa Area	21.7	- 0.5	- 4.1	- 3.9	-10.3
Healdsburg Area	18.8	- 0.4	- 2.3	- 0.6	- 5.0
Petaluma Valley	23.0	- 0.6	- 3.3	- 2.0	- 8.4
Sonoma Valley	27.6	- 0.1	- 5.1	- 3.8	- 9.5

1/ 1 foot = 0.3048 metres.

TABLE 4 (Continued)

GROUND WATER LEVEL CHANGES
FEET 1/

District or Area	Average Depth Spring 1977	Average Annual Change 1970-75	Annual Change 1975 1976	Annual Change 1976 1977	Net Change 1970-77
Central Coastal Valleys					
Napa Valley	23.6	- 0.1	- 5.6	- 4.0	-10.0
Suisun-Fairfield Valley	9.9	0.0	- 2.2	- 0.7	- 3.0
Pittsburg Plain	34.5	0.0	- 0.4	- 0.1	- 0.6
Clayton Valley	23.3		- 2.1	- 1.9	
Ygnacio Valley (Contra Costa)	20.5	- 0.1	- 1.2	- 1.1	- 2.8
North Santa Clara Valley- East Bay	34.3	+ 1.4	- 4.9	+ 4.8	+ 7.1
South Bay	84.6	+ 6.0	- 3.5	-13.4	+13.0
South Santa Clara Valley	66.0			-26.0	***
Livermore Valley	52.4	+ 2.4	- 1.6	- 4.5	+ 6.0
Half Moon Bay Terrace	26.9	- 0.8	- 3.8	- 3.8	-11.4
San Gregorio Valley	13.5	- 0.5	- 2.4	- 1.6	- 6.7
Pescadero Valley	11.8	- 0.5	- 3.5	- 0.8	- 7.0
Soquel Valley	66.2	- 0.6	- 0.9	- 2.4	- 6.2
West Santa Cruz Terrace	82.8		- 3.1	- 3.1	
Scotts Valley (Santa Cruz)	74.2		- 2.0	- 2.0	
San Benito County	90.0			-20.4*	***
Salinas Valley	10-175		- 3.7	- 5.6	***

* Range -1.0 to -54.2.

*** Insufficient data.

1/ 1 foot = 0.3048 metres.

State and Federal Water Projects and the Delta

The Department of Water Resources (DWR) and the U. S. Bureau of Reclamation (USBR), through a coordinated operating agreement, operate their upstream reservoirs of the State Water Project (SWP) and the federal Central Valley Project (CVP) to provide water in the Sacramento-San Joaquin Delta for Delta consumptive use, state and federal exports, and Delta outflow for water quality control. The SWP is being operated in 1977 to maintain the Delta water quality objectives established by the State Water Resources Control Board (SWRCB). These objectives have been modified twice this year, once on February 8, 1977, and again on June 2, 1977.

The February 8 modification, designated as the "Interim Water Quality Control Plan for 1977, Sacramento-San Joaquin Delta and Suisun Marsh", changed Delta water quality standards such that less water was required for Delta outflow. The June 2 modification, known as the "Emergency Regulation Order" and currently in effect, established drought emergency regulations for conserving limited water supplies upstream from the Delta for its protection. It changed the Delta water quality standards to further reduce the quantity of water required for Delta outflow. The water saved as a result of the two modifications is to remain in storage at upstream reservoirs of the SWP and CVP.

The DWR is obligated to meet the SWRCB standards, but the USBR does not consider such standards as a legal obligation and operates the CVP according to its own operating policy and water quality objectives. The USBR's primary Delta water quality objective has been 750 ppm TDS* at the Tracy Pumping Plant intake. This objective generally required less Delta outflow than the SWRCB standards in effect before June 7, 1977. Therefore, on numerous occasions during the period from January 1, 1977, to June 1, 1977, the USBR outflow index was less than that of the DWR. Whenever the USBR outflow index was less, the DWR made up the difference by releases from SWP reservoirs. The following table shows the quantities of additional water (in cubic hectometres and acre-feet) released from SWP facilities to make up the USBR deficit since January 1, 1977.

Month	Additional SWP Releases	
January	4	(2,795)
February	31	(25,294)
March	7	(5,863)
April	38	(30,861)
May	17	(13,799)
June	0	(0)
July	3	(2,497)
Total	100	(81,109)

Since June 1, 1977, the DWR and USBR have been in agreement on the Delta outflow index, except for 3 days in July. The SWP has not released additional water for Delta outflow since July 23, 1977.

Despite the interim water quality standards adopted February 8, 1977, which provided for a relaxation of existing standards, it was not possible to meet all quality objectives in the several months of operation under those standards. On the Sacramento River at Emmaton, near the middle of Sherman Island, the 10-day mean salinity maximum standard of 1000 mg/l of chlorides was exceeded from February 8 through 16, again on February 21 and 22, from April 8 to May 12, and from May 27 to June 7, when the standards were modified. Values on July 1 were 1146 mg/l. At Rock Slough, intake to the Contra Costa Canal, the maximum mean daily standard of 250 mg/l chlorides was exceeded from February 8 to early June, except for 4 days in late March. By late June, chloride levels remained less than 250 mg/l. Without intervention, the chloride concentration would have risen abruptly following the onset of the irrigation season.

* Parts per million Total Dissolved Solids.

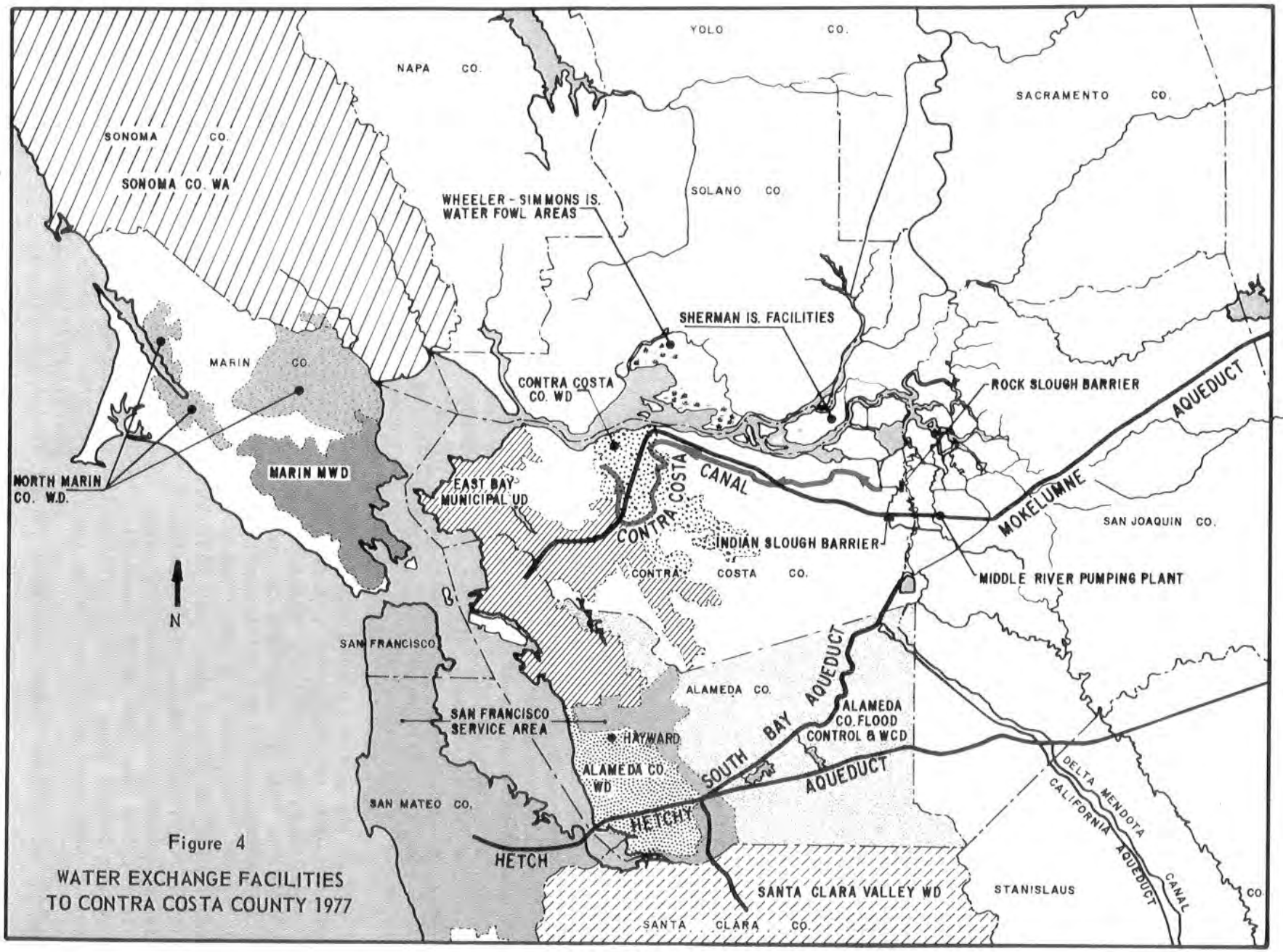


Figure 4

WATER EXCHANGE FACILITIES
TO CONTRA COSTA COUNTY 1977

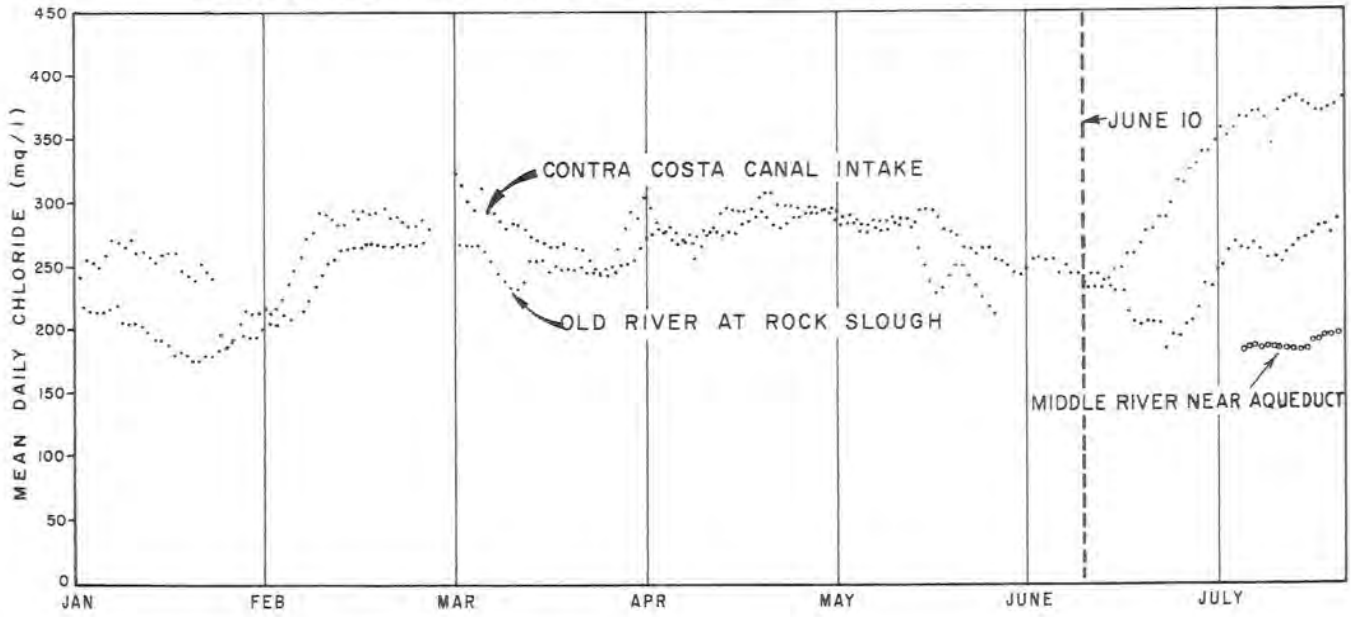
In early June, following construction costing about $3,000,000, the DWR sponsored Middle River exchange facilities became operational. This project consists of rock barriers constructed by the DWR across Indian and Rock Sloughs and a pumping plant at Middle River, constructed by the DWR and EBMUD. It provides for higher quality water from Middle River to be transported to the intake channel of the Contra Costa Canal, now isolated from the Delta by the rock barriers. These facilities are shown on Figure 4. Water from Middle River began flowing to the Contra Costa Canal intake on June 10, 1977. Water quality improvement at the intake was noticed immediately as the chloride content of the intake's water dropped below 250 mg/l, whereas water quality in the adjacent portion of Rock Slough (unprotected by the barriers) began to deteriorate rapidly. Figure 5 shows chloride measurements taken near Rock Slough and at the Canal Intake for the periods January 1, 1977 to July 15, 1977. Effect of the exchange facilities is demonstrated by the divergence in quality at the two stations beginning about June 10. Also shown for comparative purposes are chloride measurements taken at the Middle River source since July.

3. Dams in the Delta. Rock Slough barrier, one of several constructed by DWR to control Delta water quality. Together with the Indian Slough Barrier, this structure serves to maintain better quality water for residents of Contra Costa County.

To mitigate the effect of lowered water quality upon agriculture and wildlife in the western Delta, the DWR has undertaken to construct facilities which provide water from easterly sources to agricultural interests on Sherman Island and

Figure 5

EFFECT OF MIDDLE RIVER EXCHANGE ON CHLORIDES AT CONTRA COSTA CANAL INTAKE



to wildlife habitat in the Suisun Marsh. The program included construction of new, more easterly, points of diversion to tap Delta water of higher quality and new or modified transmission facilities, all of which cost about $110,000. These are shown on Figure 6.

As consideration for providing the overland facilities, the Sherman Island and North Delta interests agreed to modified chloride standards of 1 700 mg/l at Emmaton, and 570 mg/l at Rio Vista, after August 1, subject to certain adjustments. They also waived objections to certain temporary barriers.

To protect South Delta agriculture, the DWR constructed barriers on Old River and the San Joaquin River. The work, completed July 20, 1977, at a cost of nearly $130,000, is shown on Figure 7.

With the exception of the two standards not met as described above, all Delta water quality criteria were bettered at all stations throughout the period from February 8 to the present. This was accomplished by greater than normal releases from storage in SWP and CVP reservoirs. The Delta Outflow Index averaged 158 m^3/s (5,651 cfs) in February, 103 m^3/s (3,704 cfs) in March, 109 m^3/s (3,927 cfs) in April, 82 m^3/s (2,887 cfs) in May, 60 m^3/s (2,126 cfs) in June, and 65 m^3/s (2,295 cfs) in July. During especially critical periods outflow index ranged up to 196 m^3/s (7,000 cfs) (several days in mid-February).

The summer of 1977 sees the federal and state projects committed to significant releases from project reservoirs to maintain Delta water quality. In May it appeared that, unless additional steps were taken to conserve water, Oroville Reservoir would essentially dry up by April 30, 1978. At that point, Delta water quality would no longer be controlled and the Delta would be lost as a source of agricultural, municipal, and industrial water.

Figure 6

DROUGHT MITIGATIVE FACILITIES - SUISUN MARSH AND SHERMAN ISLAND 1977

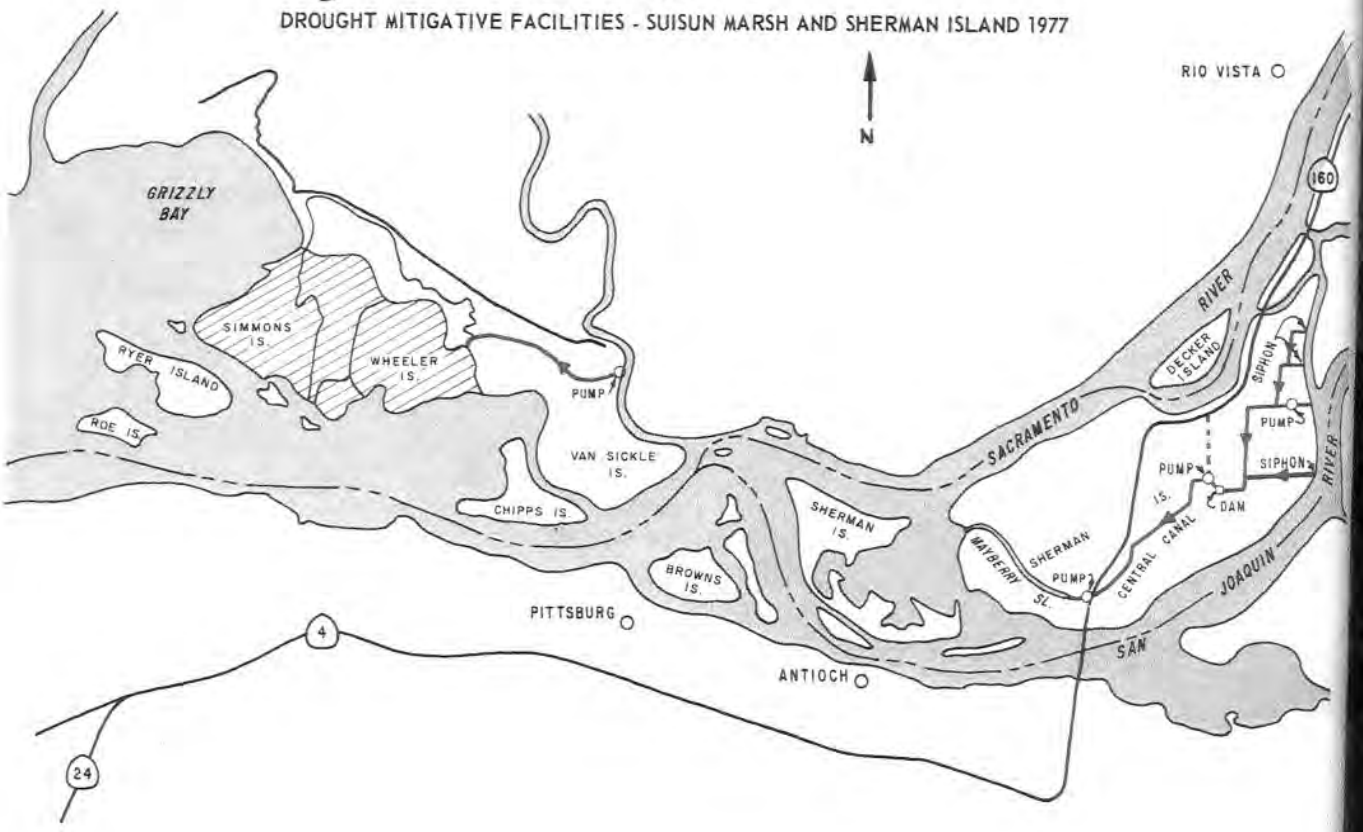
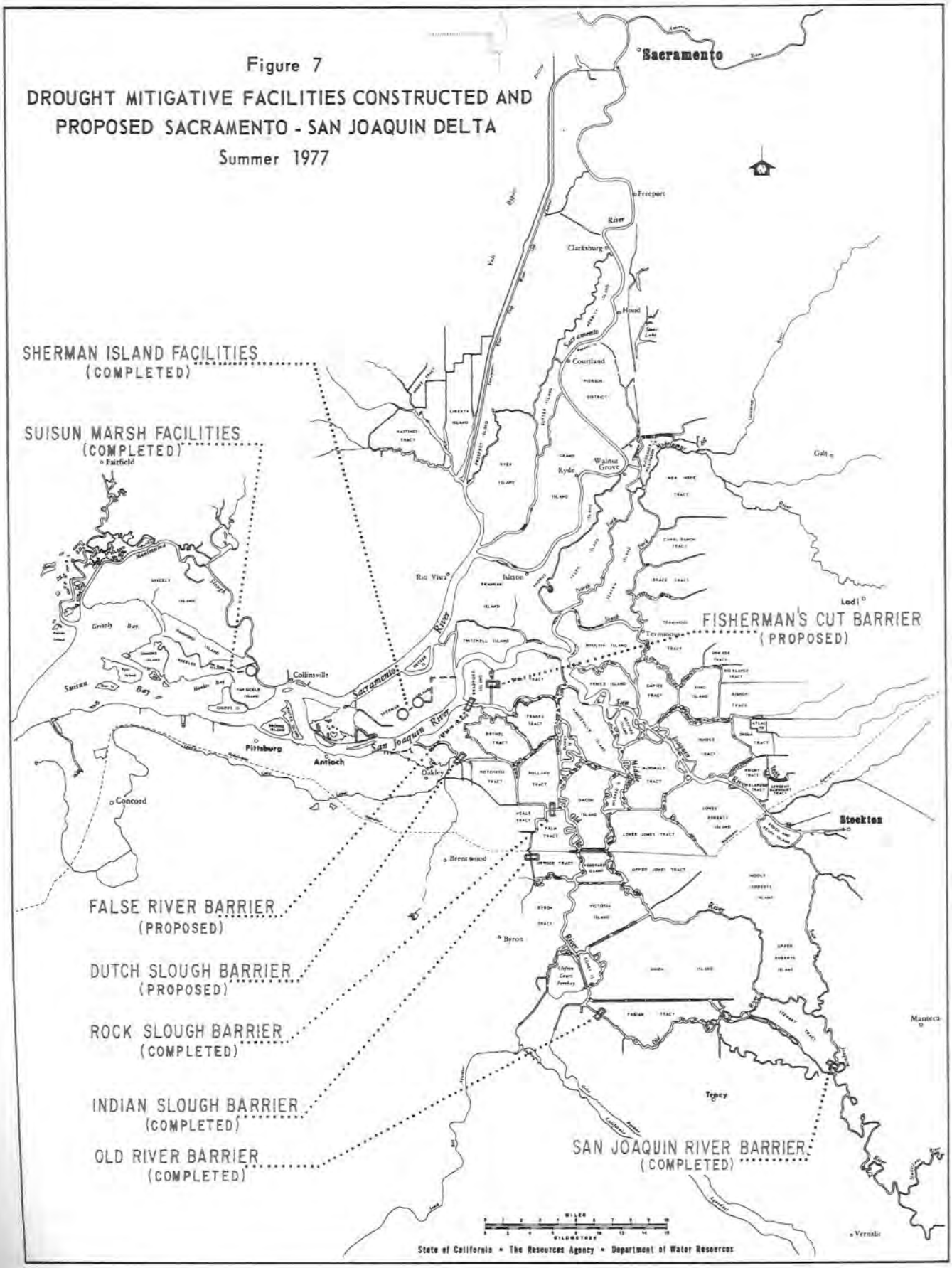


Figure 7

DROUGHT MITIGATIVE FACILITIES CONSTRUCTED AND PROPOSED SACRAMENTO - SAN JOAQUIN DELTA

Summer 1977



To forestall that event, the DWR in a May 24, 1977, hearing before the SWRCB proposed a combination of moves which would conceivably save up to 330 cubic hectometres (270,000 acre-feet) in 1977 and up to 860 cubic hectometres (700,000 acre-feet) total in upstream storage if continued into 1978. They included (1) release of 49 cubic hectometres (40,000 acre-feet) from Lake Davis in the Feather watershed, (2) provision of substitute (overland) water supply facilities to Sherman Island in the western Delta with tidal pumping at Delta Cross Channel controlled by operation of the gates there, (3) construction of temporary rock barriers in the Western Delta at False River, Dutch Slough, and Fisherman's Cut, and (4) modification of Delta water quality standards.

On June 2, 1977, the SWRCB replaced its interim water quality criteria (established February 8, 1977) with emergency criteria. The following table compares the two sets of criteria.

Point of Measurement	Chloride (mg/l) Interim	Chloride (mg/l) Emergency	EC (mmhos)[1] Interim	EC (mmhos)[1] Emergency
Emmaton				
Until August 1	1,000	1,400	--	4.8
August 1 - March 31	1,400	1,700	--	5.7
Blind Point				
Until August 1	1,000[3]	1,400	3.6	4.9
August 1 - March 31	1,000[3]	1,700	3.6	5.9
San Andreas Landing	--	350	--	1.9
Rio Vista				
Until August 1	--	350	--	1.3
August 1 - March 31	--	570	--	2.1
Chipps Island at O and A Ferry				
Until August 1	5,000[3]	5,500	15.6[2]	16.3
August 1 - March 31		6,000		17.7
Clifton Court				
Maximum	--	300	--	--
Minimum	--	200	--	--

[1] Electrical conductivity in milli mhos.

[2] Limit until June 1.

[3] Approximate values.

The DWR has constructed the substitute facilities for Sherman Island at a cost of $110,000; it has also received a legislative appropriation (AB 127, Fazio) to construct the West Delta Barrier Project consisting of rock barriers at False River, Dutch Slough, and Fisherman's Cut. (The proposed facilities are shown

on Figure 7.) The barriers are estimated to cost about $3,800,000, a portion of which will be reimbursed by the Federal Government under its Drought Emergency Program authorized by Public Law 95-18 and administered by the Department of Interior. Public Law 95-18 was enacted with specific provisions suggested by the DWR enabling state participation in the program.

It will be the Department's objective to meet the water quality requirements of the SWRCB Emergency Regulation as well as its agreement with the North Delta interests. Accomplishing this, and using the physical means to control or relieve water quality conditions, as described above, it is projected, at least to the end of 1977, that water quality at key locations within the Delta will be substantially as described above.

State Water Project

The worsening precipitation pattern, which revealed a continuation of dry conditions through February, March, and April resulting in record low runoffs to most river basins, had its effect on project reservoirs. The cool, showery weather in May improved the situation somewhat, primarily by decreasing Sacramento in-basin uses and Delta consumptive uses.

Another significant development is the Emergency Regulation Order adopted by the State Water Resources Control Board (SWRCB) on June 2, 1977 (discussed previously). This order relaxed water quality standards in the Delta, thus permitting a decrease in Delta outflow and, in turn, decreased releases from Lake Oroville as well as upstream CVP reservoirs.

It is now estimated that Lake Oroville inflow in 1977 will be only 1 178 cubic hectometres (955,000 acre-feet), down significantly from the 1 590 cubic hectometres (1,289,000 acre-feet) forecast on February 15. As a result of lowered runoff, Oroville storage on December 31, 1977 will be lower than previously forecast by 412 cubic hectometres (334,000 acre-feet).

4. Oroville Reservoir, keystone of the State Water Project, in April 1977. At the beginning of the season of intensive water use, the 4 320-cubic hectometre (3.5-million acre-foot) reservoir contained only 1 850 cubic hectometres (1.5 million acre-feet).

If the remaining five months of 1977 are as dry as the pattern established for the first seven months of 1977, Lake Oroville will be drawn down to about 1 073 cubic hectometres (870,000 acre-feet) by December 31, 1977. And if 1978 is as dry as projected 1977, Lake Oroville will be drawn down to about 307 cubic hectometres (250,000 acre-feet) by December 31, 1978. This project operation of Lake Oroville under extremely dry conditions assumes that the current SWRCB emergency regulations would be extended through 1978 if the drought conditions continue. Under the above plan the SWP, combined with the CVP, would meet Sacramento in-basin uses with current deficiencies, meet Delta consumptive use, supply a Delta outflow index sufficient to meet SWRCB emergency regulations, and allow for a minimum level of diversions from the Delta. For the SWP this minimum level of diversions would be South Bay Aqueduct demands plus excess water resulting from winter storms.

Under those conditions, SWP storage (in cubic hectometres and acre-feet) in SWP reservoirs is projected to be:

Reservoir	December 31, 1977		December 31, 1978	
Oroville	1 085	(880,000)	307	(250,000)
Del Valle	27	(22,000)	18	(15,000)
San Luis	340	(276,000)	73	(59,000)
Pyramid	181	(147,000)	168	(136,000)
Castaic	47	(38,000)	47	(38,000)
Silverwood	53	(43,000)	53	(43,000)
Perris	65	(53,000)	20	(16,000)
Total	1 798	(1,459,000)	686	(557,000)

Deliveries from the SWP in 1978 will be limited to meeting 50 percent of the municipal and industrial entitlements of its customers, with no agricultural deliveries.

The current July 1977 operational plan, in terms of total reservoir storage is shown on Figure 8.

The past history of many years of plentiful water left the SWP less well prepared for drought years. The lessons learned in these two years of drought are being used to devise new operating procedures to cope with the probable full range of water availability. The DWR has undertaken a study, to be completed in September 1977, to develop a decision tool, termed a "Rule Curve", for its use in determining deliveries to water contractors under a full range of possible water supply conditions. The "Rule Curve", to be operational in the 1978 season, will provide a basis for SWP planning and for the operational decisions dictated by changing conditions as the water year unfolds.

Another development since the February drought report has been the change in projected deliveries resulting from the decisions of several SWP customers to exchange portions or all of their 1977 allotments to make those amounts available to others in greater need. Four agencies have agreed to do this in 1977: MWD of Southern California, San Bernardino Valley MWD, Coachella Valley County Water Agency, and Desert Water Agency. Table 5 shows the amounts currently projected for delivery to SWP customers in 1977. It reflects the previously imposed 60 percent cuts to agricultural users and 10 percent cuts to municipal and industrial customers and the effects of the exchanges noted.

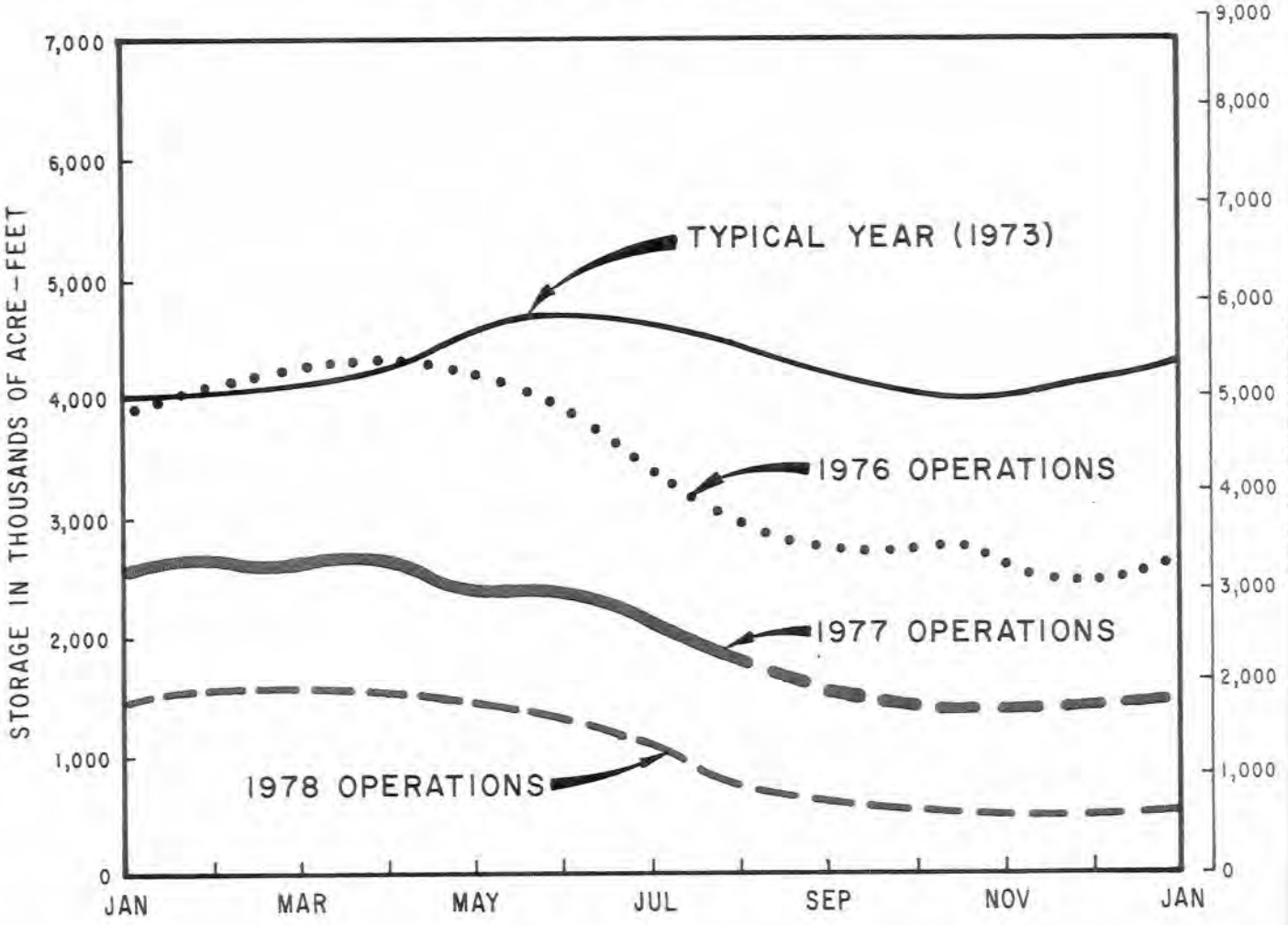
TABLE 5

State Water Project
Deliveries and Projected Deliveries
1976 and 1977
(acre-feet)[1/]

	1976 Deliveries[2/]	1977 Entitlement	1977 Allotment[3/]	Effect of Exchanges	Projected Delivery
1. City of Yuba City	-0-	-0-	-0-	-0-	-0-
2. County of Butte	527	1,800	1,800	-0-	1,800
3. Plumas Co. F.C.&W.C.D.	382	620	620	-0-	620
4. Napa Co. F.C.&W.C.D.	-0-	-0-	-0-	-0-	7,192[4/]
5. Solano Co. F.C.&W.C.D.	-0-	-0-	-0-	-0-	-0-
6. Alameda Co. F.C.&W.C.D., Zone 7	20,767	18,400	15,962	-0-	15,962
7. Alameda Co. W.D.	25,447	22,200	19,980	3,000	22,980
8. Santa Clara Valley W.D.	112,805	88,000	76,282	-0-	76,282
9. County of Kings	1,600	1,700	1,530	-0-	1,530
10. Devils Den W.D.	17,427	12,700	5,080	6,836	11,916
11. Dudley Ridge W.D.	61,844	30,400	12,160	16,365	28,525
12. Empire West Side I.D.	6,457	3,000	1,200	1,617	2,817
13. Hacienda W.D.	7,620	4,200	1,680	2,156	3,836
14. Kern Co. W.A.	881,400	483,600	218,990	232,841	451,831
15. Oak Flat W.D.	7,879	3,700	1,480	1,898	3,378
16. Tulare Lake Basin W.S.D.	112,717	54,800	21,920	28,121	50,041
17. San Luis Obispo Co.F.C.&W.C.D.	-0-	-0-	-0-	-0-	-0-
18. Santa Barbara Co.F.C.&W.C.D.	-0-	-0-	-0-	-0-	-0-
19. Antelope Valley-E. Kern W.A.	27,782	50,000	23,415	22,152	45,567
20. Castaic Valley W.A.	-0-	11,400	4,500	-0-	4,500
21. Coachella Valley Co.W.D.	7,600	8,421	7,579	-7,579	-0-
22. Crestline-Lake Arrowhead W.A.	1,002	2,030	1,363	-0-	1,363
23. Desert W.A.	12,000	13,000	11,700	-11,700	-0-
24. Littlerock Creek I.D.	589	730	292	362	654
25. Mojave W.A.	-0-	20,200	62	-0-	62
26. Palmdale W.D.	-0-	8,220	-0-	-0-	-0-
27. San Bernardino Valley M.W.D.	12,273	57,500	40,592	-16,000	24,592
28. San Gabriel Valley M.W.D.	6,071	14,800	9,000	-0-	9,000
29. San Gorgonio Pass W.A.	-0-	-0-	-0-	-0-	-0-
30. Metropolitan W.D. of So. Calif.	628,483	755,900	680,310	-400,000[6/]	280,310
31. Ventura Co. F.C.D.	-0-	-0-	-0-	-0-	-0-
Subtotals	1,952,672	1,667,321	1,157,497	-119,931	1,044,758
Unallocated Reserve	-0-	-0-	-0-	80,667	-0-
Marin Mun. Water District	-0-	-0-	-0-	10,800	10,800
Urban Reserve	-0-	-0-	-0-	20,099	20,099
Butte Co. Joint Water Districts	-0-	-0-	-0-	180	180
Non-State Water Serv. Contractors[5/]	-0-	-0-	-0-	8,185	8,185
GRAND TOTALS	1,952,672	1,667,321	1,157,497	-0-	1,084,022

1/ 1,000 acre-feet equal 1.233 cubic hectometres.
2/ Preliminary values.
3/ Based on 60 percent cuts in agricultural and 10 percent in municipal and industrial entitlements.
4/ Temporarily served from the Putah South Canal of the Solano Project.
5/ Water to be allocated by U. S. Bureau of Reclamation among some 15 water districts.
6/ Includes 80,000 acre-feet being kept in storage for possible later delivery to Metropolitan W.D. of So. Calif.

Figure 8
STATE WATER PROJECT STORAGE

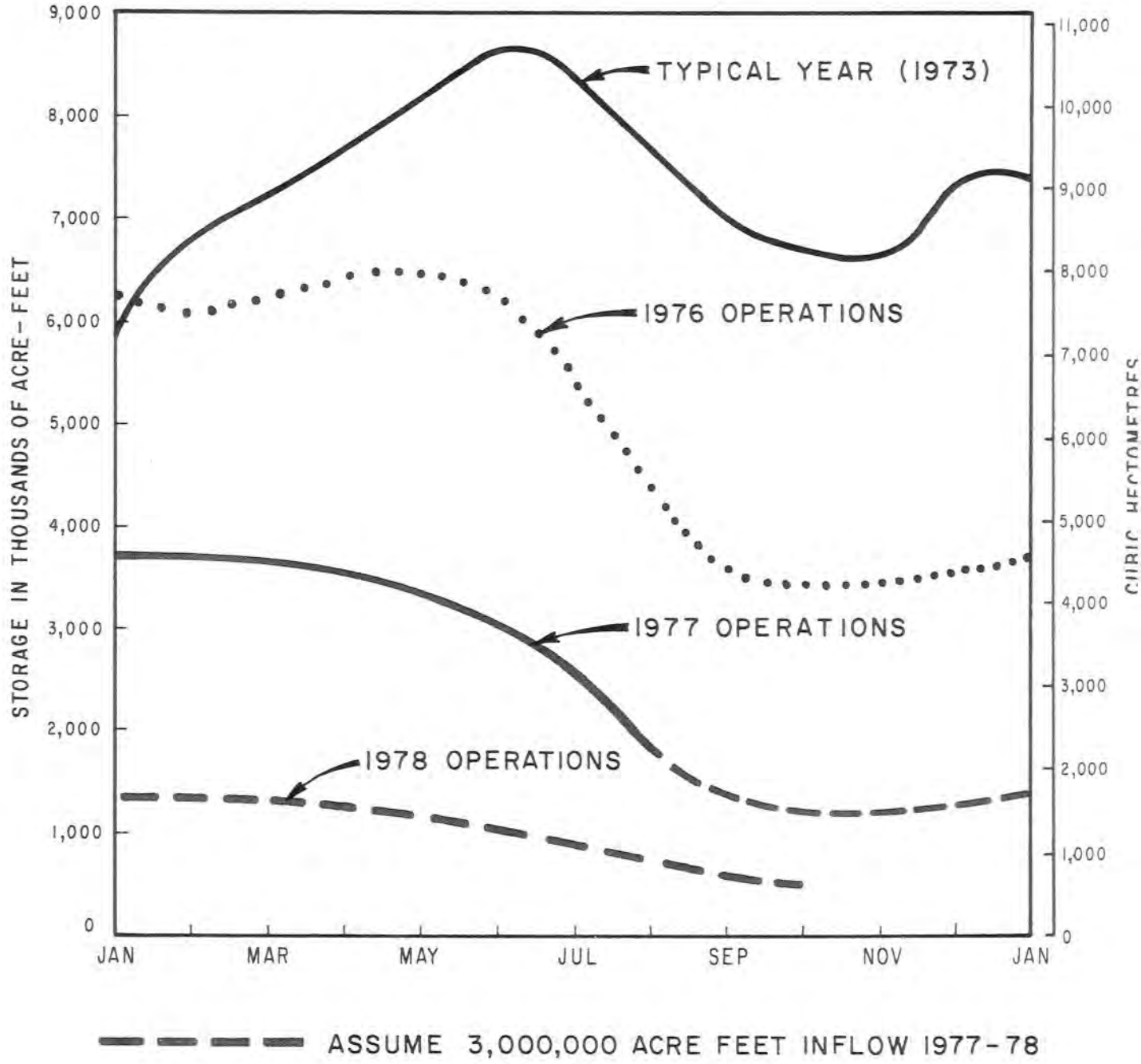


Central Valley Project

The USBR, operator of the CVP, is also faced with difficult choices. Inflow into its three major northern system reservoirs (Shasta, Trinity, and Folsom) is estimated to be 3 700 cubic hectometres (3,000,000 acre-feet) in 1977. This compares to an average inflow of 11 720 cubic hectometres (9,500,000 acre-feet) and last year's (1976) inflow of 6 290 cubic hectometres (5,100,000 acre-feet). Even with the reduced scale of operations in 1977, which has seen cuts of up to 75 percent in contract entitlement deliveries, the USBR estimates that carry-over storage in the three reservoirs plus Whiskeytown and San Luis Reservoirs will be only 1 578 cubic hectometres (1,280,000 acre-feet) on October 1, 1977. When compared to the average annual demand on this system of over 8 630 cubic hectometres (7,000,000 acre-feet), it is clear that without substantial runoff in 1977-78, most needs will not be met. Figure 9 shows the CVP plan of operation for 1977 in terms of total project storage. The USBR is studying various alternative plans for allocating water in 1978. With a repeat of 1976-77 water conditions in 1977-78, the USBR indicates that delivery of agricultural water would be limited to its customers having water rights at the

Figure 9

CENTRAL VALLEY PROJECT STORAGE



5. Shasta Dam and Lake, key feature of the Central Valley Project, with a storage capacity of 5 615 cubic hectometres (4,552,000 acre-feet). When this photo was taken on August 3, 1977, storage was 840 cubic hectometres (680,500 acre-feet). (photo by CH_2M Hill, Redding, California)

Delta and along the Sacramento River. Even these would have entitlement deliveries cut by 25 percent. Municipal and industrial users would have deliveries cut 75 percent. Under this plan, 3 157 cubic hectometres (2,560,000 acre-feet) would be delivered, 172 cubic hectometres (140,000 acre-feet) of which would go to municipal and industrial users with the remainder scheduled for agricultural users with water rights. Storage in CVP reservoirs would be down to 616 cubic hectometres (500,000 acre-feet) on October 1, 1978.

Prospects for Irrigated Agriculture

Conditions within the State's agricultural regions vary according to the availability of water. Most areas in Southern California and along the central coastal area (Monterey, San Luis Obispo, and Santa Barbara Counties) have adequate supplies for agricultural purposes from surface and ground water sources. Areas dependent on Colorado River storage are enjoying the effects of surface water storage 128 percent of normal.

Elsewhere in the State, conditions range from barely adequate to near zero surface water supplies. Excluding Colorado River reservoirs, storage in the State's reservoirs on May 1, 1977, (nominal beginning of the intensive irrigation season) amounted to only 50 percent of the average for that date. In the Central Valley, surface storage was only 47 percent of normal. In the Sacramento Valley, it was 45 percent, and in the San Joaquin it was 53 percent.

Areas dependent, in whole or in part, on ground water for irrigation use are finding, in many instances, water levels at all time lows. In most cases this will

not result in decreased crop acreage, but will mean increased costs for pumping energy. In the San Joaquin Valley alone, it is estimated that the drop in water levels will result in extra energy costs of nearly $5,000,000 to farm operators. This is in addition to the extra energy costs associated with the increased ground water extraction, this year estimated to be approximately 3 330 cubic hectometres (2,700,000 acre-feet) greater than normal, at an estimated cost to San Joaquin operators of $16,000,000. Statewide, the extra energy associated with extra lift and additional ground water extraction is estimated to be about 1 billion kilowatt-hours at a cost of over $25,000,000.

Ground water levels are expected to drop throughout the State as increased reliance is placed upon this resource. In some locations with limited ground water basins, such as the Clear Lake basins, or dependent upon deep wells, such as Yolo County, and districts in or adjoining the foothills of the Sierra, shortages or dry wells may become commonplace. Santa Clara Valley may again experience ground subsidence associated with ground water overdraft. In a few coastal areas, seawater intrusion will be a threat.

Following is a brief analysis of the water situation on a county-by-county basis. Refer to Figure 10 for county location.

Alameda County

Irrigated agriculture in the county depends almost exclusively on ground water, with the Fremont-Milpitas area and the Livermore Valley the two remaining areas of any agricultural significance. The former area's agriculture consists mainly of truck farming with some deciduous orchards. Ground water, primarily from the Niles Cone ground water basin, has supplied the needs of the area.

In the Livermore Valley the delivery of SWP water was curtailed, but irrigated agriculture, mostly vineyards, is being maintained by ground water.

Rangeland, however, was greatly impacted, with the livestock population down to 20 percent of average. Feeder steers brought in last fall left prematurely because of the early drying range condition.

On the plus side, the landscape-horticulture business has been helped by the 25 percent cutback in water use which has removed the root diseases in shrubs, lawns, etc. (Overwatering in the past had been causing root diseases that could have been cured by less water without the use of chemical compounds.)

Alpine County

Irrigated crops in the County consist primarily of pasture and hay grown in Diamond Valley. Water for irrigation comes from off-stream storage via the East and West Forks of the Carson River and reclaimed water from South Tahoe PUD's Indian Creek Project. Until recently, the entire 2 600 irrigable hectares (approximately 6,300 acres) were being irrigated and in full production. However, with depletion of off-stream storage, only about 50 percent of irrigable land is presently under irrigation. This will drop to zero percent by September 1 of this year.

Amador County

The limited irrigated agriculture in the County occurs primarily in Ione Valley and Jackson Valley. Nearly half of the irrigated crops is pasture while the remainder consists of a variety of row crops and some tree crops.

The western portion is served principally by the Jackson Valley Irrigation District from its Lake Amador. Other areas obtain water from wells and from temporary diversion dams on Dry Creek. Some wells were deepened and other new wells have been put down.

Figure 10
COUNTIES OF CALIFORNIA

Normal water usage for Jackson Valley Irrigation District is about 12.3 cubic hectometres (10,000 acre-feet). The available supply for this year is 8.3 cubic hectometres (6,700 acre-feet). Expected storage at the end of the irrigation season is zero, except for 0.7 cubic hectometres (600 acre-feet) reserved for fire fighting. Early in the season, farmers were informed that supply from Jackson Valley ID would be 55 percent of the normal, and individual allotments were established. This reduced supply, however, did not substantially change agricultural crop patterns. There was an increase in irrigated grain crops but this increase coincided with the normal reduction in sugar beet acreage due to the 2 year beet crop rotation pattern. Beans, requiring less water, replaced sugar beets this year. As deciduous crops look now, the yield should be close to normal. Most growers were able to obtain water supplements, in addition to their allotment, by exchanges in assignment among growers.

Overall, irrigated crops fared better than anticipated earlier. On the other hand, dry farming operations, including grain and hay crops and range, suffered serious losses.

Butte County

The Butte Joint Water District Board is an amalgamation of Biggs-West Gridley Water District and Richvale Irrigation District in Butte County, Butte Water District (60% in Butte County and 40% in Sutter County), and Sutter Extension Water District in Sutter County. The total water supply to the Joint Board is from the State Water Project.

Normal service in Butte County by the Joint Board is 487 cubic hectometres (395,000 acre-feet) to irrigate 21 000 hectares (52,000 acres). In 1977, water available is only 296 cubic hectometres (240,000 acre-feet) for an estimated 13 000 hectares (33,000 acres) to be irrigated. Some ground water is being pumped by individual farmers to supplement the supplies available from the Joint Board. Peach and other types of orchards are doing better than was expected earlier in the year. Some supplemental exchange water (tailwater) was obtained from the Richvale ID, and is credited with helping to improve the overall availability of irrigation water. Rice acreage was reduced 50 percent.

The Western Canal Company, a public utility owned by PG&E, also receives water from the State Water Project for rice and pasture irrigation. In 1977, the Company has taken a 50 percent deficiency from its normal supply of 185 cubic hectometres (150,000 acre-feet).

Paradise Irrigation District has had mandatory rationing since April 1, 1977. In this district agricultural water users are cut back to 50 percent of their 1975 usage. PID has purchased some supplemental water from PG&E, Butte County, Del Oro Water Company, California Water Company, and Thermalito ID, and hopes to have at least 1.2 cubic hectometres (1,000 acre-feet) carryover in storage

6. A Butte County farmer's desperate plea. The picture tells the entire story.

to 1978 (normal demand is 9.5 cubic hectometres [7,700 acre-feet]).

Ground water is extensively utilized in Butte County, primarily for orchard irrigation. Ground water levels have not dropped nearly as much as they have on the west side of the valley. Relatively few ground water problems are anticipated for the valley floor portion of Butte County.

Calaveras County

Irrigated acreage in the county consists of small amounts of deciduous orchard (apples and walnuts), vineyard, and irrigated pasture.

Water is supplied by Calaveras County WD, Calaveras PUD, PG&E, and Union PUD, all from surface water sources. In addition, some individuals have their own wells. There is no alternative supply for the County.

Because of extremely low reservoir levels, allotments of 50 percent are being imposed in most areas of the County. Many of the private wells are going dry. It is expected that there will be little or no crop this year on the deciduous trees and vineyard, but by pruning back, the trees and vines will be kept alive. Many trees are dropping leaves already.

Irrigated pasture will be about 1/3 of normal. This is the only change in crop pattern.

Nonirrigated pasture and forage below the 1 500 metre (5,000 foot) elevation is in bad shape, with only limited production on north slopes and at elevations above 900 metres (3,000 feet). Above 1 500 metres the rangeland is fairly good. Many cattlemen have been feeding cattle since November 1976 and many will have to sell off all or part of their herds.

7. Salt Springs Valley Reservoir, serving the Rock Creek Water District, is typical of the smaller foothill reservoirs. The effect of the drought on stock ponds is shown by the low levels of ponds in the lower foreground and in the background. This photo was taken in April 1977.

Colusa County

In the Arbuckle area the Colusa County WD received a 25 percent cut in its 1977 USBR allotment of drain water. This drain water comes from other areas irrigated by the Sacramento River and ground water. To help make up the deficiency, the water district has obtained supplemental water from USBR via Reclamation District No. 108 and from the Colusa County entitlement. Some individual farmers have reactivated abandoned wells in order to have as much irrigation water as they feel they need. This District is largely made up of orchards. District water deliveries were 600 millimeters per hectare (24 inches per acre) during 1976 but, due to the water shortage, only 450 millimeters per hectare (18 inches per acre) is available for use during 1977.

For the many individual farmers and some organized districts who depend on the Colusa Drain for all or part of their water supply, the effect of USBR cuts to upstream users, plus the water conservation being practiced by many of the irrigation districts, means much less water will be available. (The SWRCB notified Colusa Drain users on March 29, 1977, to expect the water supply to be approximately 50 percent of normal.) In 1976 and again in 1977 the USBR authorized Reclamation District No. 108 to pump Sacramento River water into the Colusa Drain with the express purpose of supplementing that portion of the Colusa County Water District's supply which is obtained from the drain.

Areas served by the Tehama-Colusa Canal, the federal and state game refuges, and other areas that receive their water from the Sacramento River or other surface sources have received less water than that required for full irrigation of lands normally planted. Federal wildlife refuge managers predict less than 50 percent of the normal food crop for migrating birds arriving in August. Because of this shortage, increased predation is expected on surrounding agricultural lands. Ground water from deep irrigation wells will be able, in most cases, to supply normal irrigation demands for other lands in the Tehama-Colusa service area.

For information on the Glenn-Colusa Irrigation District, Princeton-Codora-Glenn Irrigation District, and Provident Irrigation District, see remarks under Glenn County.

Contra Costa County

The shortage of water, resulting in increased salt content in the western Delta, has caused water quality problems with some damages. This is especially true west of Old River including the Hotchkiss, Bethel, Webb, Jersey, and Holland Tracts.

Before the Middle River facilities were constructed, poor water quality in the Contra Costa Canal with high chloride levels created a problem for those areas served by the canal. The project, constructed by the DWR, has alleviated problems caused by the higher salt contents.

Tomatoes in the Brentwood area, served by the East Contra Costa Irrigation District, have been injured by poor water quality. Salinity retards seed germination, forcing some replanting of tomatoes. Through extra effort, losses will be kept to around 5 percent of a normal year's crop.

The southeastern part of the County, served by the Byron-Bethany ID, has not been affected as seriously as other areas in the County because its water is derived from a location of higher quality in the Delta.

Some damage to tree crops, mainly almonds, has become evident. Initially there was a good set of almonds but the poor quality water has caused fringe and tip burn. Defoliation may cause a

quality and yield reduction of about 10 percent.

About 250 acres of the corn crop was shifted to barley. The double cropped lettuce which follows barley will be planted in August. The effect of the drought on this crop will not be known until the latter part of August.

The drought has been disastrous to the nonirrigated crops such as small grains. These crops were planted, but have not been worth harvesting for hay. While the grazing lands were better than they were last year, they were still only about 20 percent of normal.

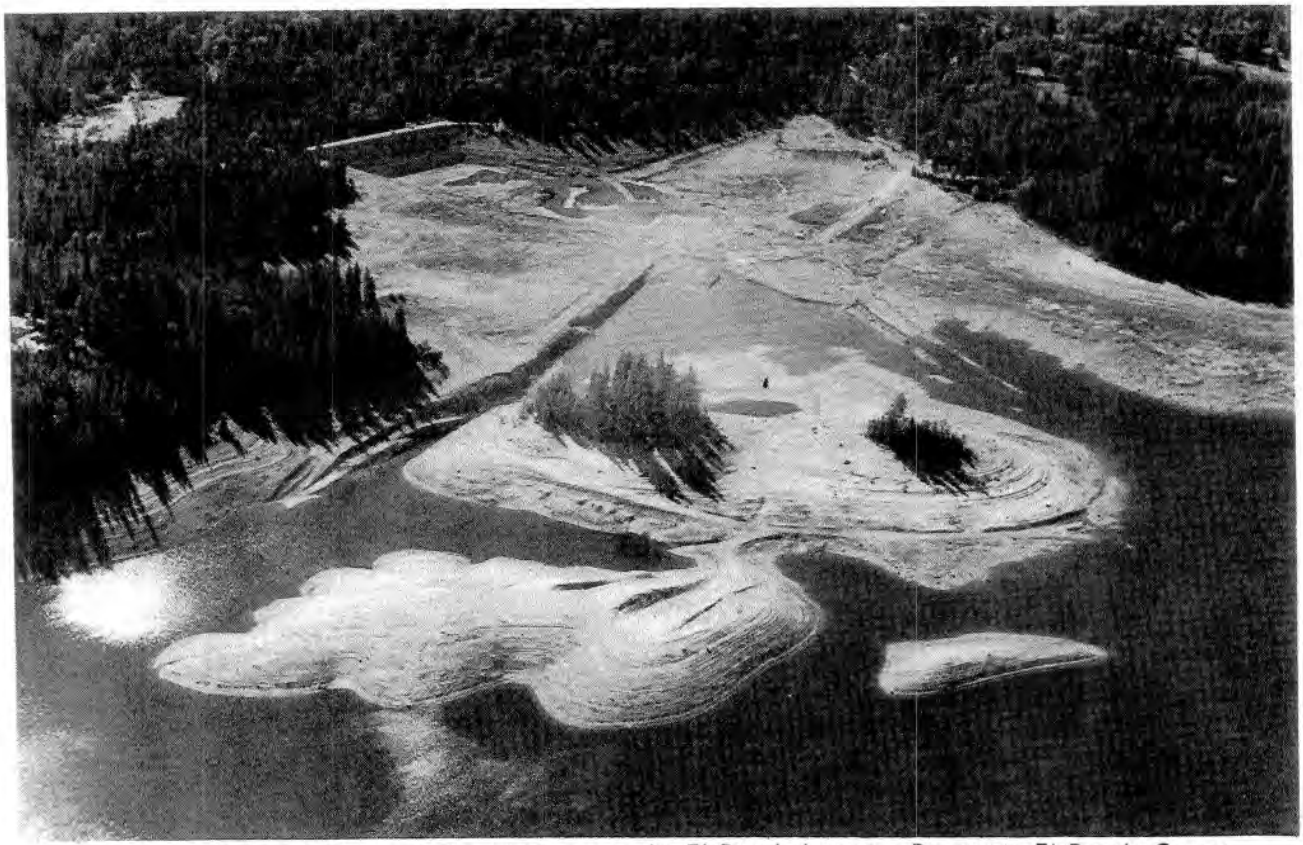
Del Norte County

The Smith River is low, but since most irrigation water is supplied from wells, no problem with supply for the Smith River plain is presently forecast.

El Dorado County

Irrigated agriculture in the County is limited to its western half, and consists primarily of deciduous fruits (pears and apples), irrigated pasture, and to a lesser extent, grapes and Christmas trees.

Water is supplied by the El Dorado ID, Georgetown Divide PUD, and from private wells, diversions and ponds. The largest supplier is the El Dorado ID which has two surface water sources: Sly Park Reservoir and a PG&E reservoir, both of which are extremely low. Water is being allocated by the District for agriculture by crop type: 7 010 cubic metres per hectare (2.3 acre-feet per acre) for deciduous fruit trees, 4 600 cubic metres per hectare (1.5 acre-feet per acre) for vineyard, and 6 200 cubic metres per hectare (2.03 acre-feet per acre) for pasture. Alternative water supplies



8. Sly Park Dam and Jekinson Lake, which serves the El Dorado Irrigation District in El Dorado County. Storage capacity of Jekinson Lake is 51 cubic hectometres (41,000 acre-feet). The reservoir was down to 14 cubic hectometres (11,000 acre-feet) when this photo was taken in October 1976. (photo by U.S. Bureau of Reclamation)

from the American River were developed in mid-1977 to help meet the deficit. Permanent pasture parcels of less than 1.2 hectare (3 acres) were allowed to dry to increase irrigation supply for orchard crops. This did not substantially affect the irrigated acreage, however. Pear crop yield is expected to be above normal because of better irrigation practices and the apple crop is expected to be normal. EID, in cooperation with the University of California Extension Service and the U. S. Bureau of Reclamation, has implemented water management practices which impose minimum application of water and yet attain full crop production.

Individuals with private ponds are in relatively good shape because there was enough runoff to fill them, but those who divert from surface streams are experiencing insufficient supplies. There is little irrigation from ground water pumping.

Nonirrigated pasture at the lower elevations seeded out and dried up sooner than normal, but at higher elevations, rangelands are in better condition. Cattle were either moved to the higher elevations or were sold off.

Fresno County

Fresno County is the richest agricultural producing county in the State of California with an irrigated area of 486 000 hectares (1,200,000 acres). There are 31 irrigation and water districts within, or partly within, the County. The largest are Westlands Water District and the Fresno and Consolidated Irrigation Districts.

The surface water supply for the County comes from the San Joaquin and Kings Rivers, the CVP's Delta-Mendota Canal, and SWP's California Aqueduct.

Districts served by the San Joaquin and Kings Rivers will receive greatly reduced supplies and, in some cases, no surface delivery. Those districts in the CVP

9. When will it fill? Consolidated Irrigation District's Fowler-Switch Canal near Fresno has been empty for two years. Runoff from the Kings River has been insufficient for CID to exercise its water rights.

Millerton Lake service area will receive 25 percent of their Class I allotments which will amount to about 13 percent of the normal annual project allocation. Those districts operating under exchange contracts, James, Tranquillity, and Central California Irrigation Districts, will receive about 75 percent of entitlement.

Fresno Irrigation District will receive surface deliveries from the Kings River over a two-and-one-half-month period compared to normal deliveries over a five-month period. Other Kings River districts will receive lesser amounts or no surface delivery, or have allocations too small to prime their distribution systems and make deliveries.

Westlands Water District will receive about 25 percent of entitlement from the San Luis Division of the CVP.

Eastside citrus growing areas dependent on Friant-Kern Canal water and those areas above the Canal are in more serious trouble since capability to pump ground water is limited. It is expected

that some eastside wells will go dry. On the westside, the Westlands Water District's reduced capacity to pump, due to abandonment of so many wells, may present problems. It is estimated that about 77 percent of the District has been planted.

Glenn County

The Glenn-Colusa Irrigation District is served by the Sacramento River and Black Butte Reservoir via Stony Creek. The USBR has imposed a 25 percent cut in CVP water pumped from the Sacramento River and only a small quantity of water is available from Black Butte Reservoir. Farmers have been asked by the Irrigation District to reduce their irrigated acreage to reflect a 25 percent reduction in allotted water.

The Princeton-Codora-Glenn Irrigation District is supplied by the Sacramento River and by drain water from outside the District. The USBR has imposed a 25 percent cut in the water supply from the Sacramento River and there has been less drain water available to the District because of shortages and conservation practices in areas draining into the district. The District has ordered mandatory water rationing and farmers have been told they will have a limited quantity of water delivered. This means that farmers have had to reduce irrigated acreage or change crop type in order to have an adequate water supply.

The Orland Unit Water Users Association is served from Black Butte Reservoir, East Park Reservoir, and Stony Gorge Reservoir, all located on Stony Creek. At the season's beginning, it was believed there was only enough water for one irrigation. But, due to the purchase of supplemental USBR Black Butte Reservoir water, about three irrigations are now probable. There are 1 600 hectares (4,000 acres) of orchard located within the association's boundaries in danger of dying or being severely damaged. The Orland Unit qualified to receive a loan of 2.5 million dollars from the Federal Government to establish deep water wells, but the well drilling plan ran into opposition from some members of the Association and was abandoned.

The Provident Irrigation District is served from the Sacramento River and by one deep irrigation well (610-millimetre [24-inch]). The USBR has imposed a cut of 25 percent in CVP water pumped from the river. The District has drilled two 610-millimetre (24-inch) wells to a depth of approximately 120 metres (400 feet) to supplement its present water supply. At this time, however, only one is in use.

The Stonyford area supplied by Stony Creek is affected by low flows and lack of storage on Stony Creek. Irrigated pasture comprises most of the 400 to 600 hectares (1,000 to 1,500 acres) under irrigation.

The Tehama-Colusa Canal service area is supplied from the Sacramento River. Tehama-Colusa users will receive only 25 percent of their normal allotment from the USBR, and there will be no deliveries to other irrigation districts from the canal. Farmers who cannot supplement surface water deliveries with ground water have had to cut back on irrigated acreage.

Other areas and other users who receive their water from the Sacramento River and other surface supplies have received, in general, less water than that required for full irrigation of lands normally planted. Ground water from deep irrigation wells has been able, in most cases, to supply normal irrigation demands, but shallow wells in some of the outlying areas, particularly on the west side, may go dry before the end of the irrigation season.

Humboldt County

The flood plains and deltas of the Eel and Van Duzen Rivers are served by shal-

low wells. Since the two rivers have record low flows there may be a problem with salt water intrusion into some of the irrigation wells this summer, although none has been reported.

The Mad River's flood plain and delta also receive irrigation water from shallow wells. Because the Mad also has record low flows and most of the flows will be utilized by the Humboldt Bay Municipal Water District for pulp mills and its other municipal users, salt water intrusion may be a problem.

Imperial County

The Imperial Valley, one of the largest irrigated agricultural areas in the State, is served by the Imperial Irrigation District (242 000 hectares [600,000 acres]) through its All-American Canal from the Colorado River. Colorado sources contain 128 percent of normal supplies and there is no water shortage problem anticipated.

Part of the Coachella Valley County Water District extends into the County. See Riverside County for comments.

Inyo County

There are no organized irrigation or water districts in the County. The largest agricultural area is the Owens Valley, where irrigation water is supplied from ground water basins and the eastern Sierra streams tributary to the Owens River.

The City of Los Angeles owns most of the agricultural land, together with water rights, and leases some 4 900 hectares (12,000 acres) for irrigated agriculture. It is estimated that approximately 42 cubic hectometres (34,000 acre-feet) will be allocated for irrigation purposes in 1977 as compared to a normal supply of about 58 cubic hectometres (47,000 acre-feet).

The City has been ordered by the court to provide 86 cubic hectometres (70,000 acre-feet) for all uses on city-owned lands in Inyo and Mono Counties in 1977 (about 63 cubic hectometres [51,000 acre-feet] for Inyo and 23 cubic hectometres [19,000] for Mono); this compares to a normal year supply of 113 cubic hectometres (92,000 acre-feet) for the two counties.

Kern County

The County's 30 or so irrigation and other water or conservation districts derive their surface water supplies from the Kern River, the CVP's Friant-Kern Canal, and the SWP's California Aqueduct. Ground water also provides a significant portion of the total water supply.

Surface runoff on the Kern River is forecast to be only 222 cubic hectometres (180,000 acre-feet), or about 540 cubic hectometres (440,000 acre-feet) below normal. The Friant-Kern and Cross Valley Canals can deliver only 83 cubic hectometres (66,700 acre-feet) compared to average deliveries of 478 cubic hectometres (388,000 acre-feet), or about 395 cubic hectometres (320,000 acre-feet) less than normal. The SWP can deliver about 544 cubic hectometres (441,000 acre-feet), or about 53 cubic hectometres (43,000 acre-feet) short of 1977 entitlement. Total deficiency of surface supply in Kern County is about 1 000 cubic hectometres (812,000 acre-feet), most of which has been made up by increased ground water pumping.

South San Joaquin Municipal Utility District has an overall deficit of about 11 percent, or about 20 cubic hectometres (22,000 acre-feet) below all available supply of surface and ground water. Other districts dependent on Kern River water may not be able to meet the demands by pumping ground water. The ground water basin will be further overdrafted, and some shallow wells may go dry. In 1976, 388 000 hectares (960,000 acres) were irrigated in the adjacent San Joaquin Valley. This year 7 percent (26 300 hectares [65,000 acres]) will be left idle in order to conserve water.

Kings County

The surface water supply for the 19 irrigation and water districts and several ditch companies in Kings County comes from the Kings, Kaweah, and Tule Rivers, supplemented by CVP water from the Friant-Kern Canal, when available, and SWP water from the California Aqueduct.

It is estimated that the county will be short about 620 cubic hectometres (500,000 acre-feet), 45 percent, of surface supply during the 1977 water year. Pumping facilities are inadequate to make up the entire deficit. Further overdraft of the ground water basin will occur and some wells have already gone dry. Two City of Hanford wells (out of 12) have started drawing air. In the Hanford-Lakeside area, the ground water levels have dropped 6 to 9 metres (20 to 30 feet) for the 12-month period July 1976 to July 1977. For all of Kings County the water level drop for the same period has been 3 to 3.7 metres (10 to 12 feet). There may be some crop losses. About 8 100 hectares (20,000 acres) will be left idle for lack of water. Within each district rationing is being applied, and farmers who do not have pumping capabilities will be given some priority for the limited surface supply available, especially for use on permanent crops.

Lake County

Big Valley, served entirely by ground water, has had some wells which failed along the margins of the valley in June and July, while others broke suction on occasion. A relatively cool month of July reduced crop irrigation demands. Those wells still producing are in continual operation in an attempt to provide normal quantities of irrigation water. One estimate is that 30 percent of the wells will be dry before the season ends.

Irrigated walnuts will be in trouble if wells go dry, with an estimated 25 percent economic loss because of a reduction in walnut meat quality. Wine grapes under irrigation in Big Valley should survive the drought without damage.

Scott Valley is in the same situation as Big Valley. Fifty percent of the wells may be in trouble before the season ends.

Upper Lake, served entirely by ground water, could be affected. On the average, wells supplying pear orchards are holding out until mid-August. It is estimated that less than 25 percent of the wells may be in trouble before the season ends. About one-half of the wells used to irrigate walnuts may experience problems before the walnut crop is developed.

The Middletown area, supplied by ground water, does not appear to be affected as much. It is felt that the irrigated grapes and walnuts in this area will not yield as well as during a normal year, but the economic loss should not be too great.

It is estimated that as many as 400 to 800 hectares (1,000 to 2,000 acres) of dryland walnut trees in Lake County could experience moderate branch damage.

Lassen County

The Lassen Irrigation District is supplied by the Susan River and its tributaries, McCoy Flat Reservoir, Hog Flat Reservoir, and Lake Leavitt. In mid-April, there were approximately 0.75 cubic hectometres (600 acre-feet) in storage in Lake Leavitt, and the other two were dry. No water was delivered since the quantity in storage was so small. Storage in the three reservoirs ordinarily would be over 37 cubic hectometres (30,000 acre-feet). The snow course in mid-April showed 610 millimetres (24 inches) of pack; last year there was 890 millimetres (35 inches) of snowpack, yielding approximately 4 cubic hectometres

(3,000 acre-feet). The Susan River normally flows 1.5 to 2 m^3/s (60-70 cfs) in mid-April; flow this year was 0.5 m^3/s (16 cfs), and July flows had dropped to 0.1 m^3/s (4 cfs). Because of low water availability, very little irrigation will take place on the upper Susan River this season. Stock water may be all that will be available later this season.

Along the lower Susan River and Willow Creek, where tail water from Willow Creek is a partial supply for those persons irrigating on the lower Susan River, springs feeding Willow Creek are still yielding what would be expected during a normal year. No shortage is expected.

In the Honey Lake drainage area, many smaller local creeks that receive runoff from the snowpack and provide water for ground storage have very low flows or are dry. Some irrigation wells have already gone dry and it is expected that others will soon.

Los Angeles County

Irrigation use comprises about 2 percent of total water demand in the county. Water sources are primarily ground water and imported Colorado River water which have been only slightly affected by the drought.

Madera County

Two major districts are in Madera County, Madera Irrigation District and Chowchilla Water District. These districts receive surface water from the San Joaquin River, via the CVP's Madera Canal, with additional amounts from the Chowchilla and Fresno Rivers, when available. Madera Irrigation District's normal surface supply is about 219 cubic hectometres (178,000 acre-feet); this year the District will receive about 26 cubic hectometres (21,200 acre-feet). Ground water will be used to make up the deficiency.

Chowchilla Water District's normal surface supply is about 166 cubic hectometres (135,000 acre-feet); in 1977 it was scheduled to receive about 17 cubic hectometres (13,700 acre-feet) of water. However, because of the comparatively small amount of water involved, CWD decided to sell the water to other districts and to depend upon ground water resources instead.

Due to increased pumping within the irrigation districts, and lack of surface supplies for recharge, areas outside districts which normally have to pump will find water levels declining more rapidly than usual; some wells will dry up and some crops may be lost.

Marin County

The 202 hectares (500 acres) of irrigated pasture (total irrigated land in the County) did not receive water this summer. The water is being saved for livestock.

Water hauling for livestock began in early spring with scheduled runs using two tankers running two shifts per day. In July, the County was hauling between 530,000-570,000 litres (140,000-150,000 gallons) of water per day. It is anticipated that the peak summer demand (in September) will require 30 drivers and 11 trucks working two 8-hour shifts per day for seven days a week. Water is purchased from North Marin WD for 23¢ per cubic meter (60¢/1000 gallons).

Mariposa County

There is limited surface irrigation in Mariposa County because there is no surface supply available. Some small parcels of pasture land are irrigated by ground water pumping. Declining water levels have restricted pumping for uses other than domestic.

Mendocino County

Round Valley (Covelo and vicinity) is served by irrigation wells and several creeks that enter the valley. Even dur-

10. Quenching a bovine thirst after stock ponds dried up near Marshall in Marin County, where trucks have been hauling water since the summer of 1976. A typical scene in the dairy communities of Marin County. (photo courtesy of *Point Reyes Light*)

ing a normal year, surface water supply is rarely adequate for a full season of irrigation and this year there will be even less than usual. Ground water has shown a substantial drop (see Table 4) since the 1976 season, and it is expected that some irrigation wells at the outlet end of the valley will be dry by the end of the season.

Redwood Valley ran out of surface water during a late cold period and approximately 121 hectares (300 acres) of grapes did not receive water for frost protection. Approximately 50 percent of the crop will be lost.

Potter Valley is receiving a supply of water from Lake Pillsbury that will just meet agricultural needs with no water passing through to Lake Mendocino.

In general, soil moisture in late May was adequate in the vineyards and deciduous fruit orchards and it appears irrigation water will be available through the middle of August, which is the end of the irrigation season for that area.

Deep wells (below 30 metres [100 feet]) in the Upper Russian River Service Area are not encouraged as a source of water because of excessive boron content.

Merced County

Within the County there exists the Merced Irrigation District, a portion of the Turlock Irrigation District (see Stanislaus County), a portion of the Central California Irrigation District, El Nido Irrigation District, and some 18 other water districts.

The Merced River supplies the Merced Irrigation District and diverters along the river, as well as downstream water districts. Normal surface water supply to Merced I. D. from Lake McClure is about 740 cubic hectometres (600,000 acre-feet). Some lands within the District near the river are irrigated by direct diversion from the river in the amount of 117 cubic hectometres (95,000 acre-feet). Pumping from district wells provides an additional 123 cubic hectometres (100,000 acre-feet), for a total normal supply of about 980 cubic hectometres (795,000 acre-feet).

This year the Merced River is forecast to provide only about 185 cubic hectometres (150,000 acre-feet); therefore, ground water has been called upon to meet the remaining requirement of some 795 cubic hectometres (645,000 acre-

feet). Individual farms without wells face a reduced irrigation season.

Districts served by CVP's Delta-Mendota Canal, such as the Central California ID, have also had to pump supplemental water. Districts dependent on ground water will feel the impact of increased pumping and lack of surface water for recharge.

Some shallow wells will be going dry (projected ground water level lowering about 3.1 metres [10 feet] average) with some loss of crops.

Modoc County

In the basin served by the North Fork Pit River and its tributaries, streamflows are about 20 percent of normal and snowpack was the lowest on record. May and June rains allowed ranchers to produce one of the best hay crops ever, but subsequent pasture growth has been curtailed due to an inadequate supply of irrigation water. Ranchers began selling off livestock early in the year in anticipation of the inadequate supply of irrigation and stock water.

Flows in the South Fork Pit River above West Valley Reservoir in early April averaged 1.1 m^3/s (40 cfs), with the majority of the water being diverted into West Valley Reservoir. Storage on May 15 was 15 cubic hectometres (12,500 acre-feet) compared to its capacity of 27 cubic hectometres (21,700 acre-feet). (The reservoir is usually full.) At Canby, normal flow is approximately 7 m^3/s (250 cfs) in mid-April; this year flow was less than 0.1 m^3/s (5 cfs). July flow increased to 0.5 cubic metres per second (18 cfs) due to reservoir releases for irrigation. The low flows indicate a shortage of water in the area, including the South Pit Irrigation District and parts of Lassen County, which could be as much as 50 percent of the normal supply.

The Hot Springs Valley Irrigation District, served from Rattlesnake Creek with storage in Big Sage Reservoir, has enough water in storage to meet 100 percent of normal irrigation requirements.

The Big Valley area, partly in Lassen County, is served from the Pit River, Ash, Rush, Butte, and Willow Creeks, among others; by Roberts Reservoir and other reservoirs; and by ground water pumping. Because of the lack of snowpack in the upper Pit River drainage area, the low storage in West Valley and Dorris Reservoirs, and water conservation by irrigators, little of the Pit River water will reach Big Valley. Other streams that enter Big Valley are estimated to have about 50 percent of normal supply. Reservoirs contained only enough water for about one irrigation. Thus, the major source of summer irrigation water for Big Valley is tail water from the Hot Springs Valley Irrigation District.

Big Valley is not receiving enough irrigation and stock water from the Pit River and some ranchers are in serious trouble this summer. There will be little or no water available for irrigation later in the summer, and it may be difficult to provide stock water.

Tule Lake Irrigation District, partly in Siskiyou County, is supplied by the USBR Klamath Project and should have enough water to meet normal requirements if water conservation methods are employed.

Mono County

The southern portion of the county is served by ground water and the eastern Sierra tributaries to the Owens River. The City of Los Angeles normally provides 31 cubic hectometres (25,000 acre-feet) to farm lease holders; in 1977 that amount has been cut to 23 cubic hectometres (19,000 acre-feet).

Farther north, in the Bridgeport and Antelope Valleys, the natural flow of the Walker River became unavailable to ranchers and farmers in late July as federal commissioners activated an 1859 decree giving all remaining natural

11. An exception to the devastating impact of the drought, Lake Berryessa in Napa County contained almost 1 233 cubic hectometres (1 million acre-feet) of water in April 1977. The lake, the source of irrigation water for 21 000 hectares (52,000 acres) in the Solano Irrigation District, contains sufficient water to meet the district needs for several years.

flow to an Indian reservation in Nevada. For the remainder of the summer, Bridgeport Reservoir, Topaz Lake, (both nearly empty) and ground water will be the only sources of supply.

Monterey County

Ground water provides all irrigation water in the Salinas Valley of Monterey County whose ground water basin is recharged by surface flows from Nacimiento Reservoir on the Nacimiento River and San Antonio Reservoir on the San Antonio River. The supply is expected to be adequate in the Valley this year, although there may be a problem due to salt water intrusion in the coastal portion of the basin.

No problems are expected in the Carmel Valley, which has adequate ground water supplies.

Napa County

Agricultural water use in Napa County is derived from the Napa River, ground water, and private reservoirs. Although this year the Napa River is virtually dry, the area has not experienced any real problems since it depends mainly on ground water. (The Napa River is used primarily in the spring for frost protection.)

The USBR has provided water to a group of farmers in the Suisun-Gordon Valley of Napa County, from Lake Berryessa via the Putah South Canal.

Nevada County

The Nevada Irrigation District serves the southwestern portion of Nevada County and the northern portion of Placer County. The main sources of water are the Yuba and Bear Rivers. Primary agricultural use is for irrigated pasture (approximately 3 200 hectares [8,000 acres]), with smaller uses for orchards (approximately 60 hectares [150 acres]). This year the Gold Hill area is the beneficiary of an exchange involving the PG&E Co. and the Placer County Water Agency (for details, see Placer County).

Farmers in the area were allotted 50 to 60 percent of their normal supply to be used as needed. Because May was cool and some precipitation fell, most agricultural users were able to delay using their share of irrigation water until later in the season. As a result, present supplies should last until September when the growing season is all but over. No substantial reduction in the harvest is expected.

Irrigated pasture was given an approximate 50 percent reduction, while deciduous orchards received a 25 percent cutback. The pastures are reported to be in very bad shape. Feed will be purchased by the livestock owners to make up for the reduced yield of irrigated pasture and rangeland.

Orange County

The primary water supply for irrigation is the Colorado River Aqueduct, with some small usage from local surface and ground waters. Ground water supplies in the southern portion of the County are limited. Because Colorado River storage is 128 percent of normal, no major water shortage has occurred yet, although capacity of the Aqueduct will be the controlling factor.

Placer County

The three county water agencies have incurred a wide range in cutbacks.

The South Sutter Water District has no water to deliver. Its rice fields (about 2 200 hectares [5,500 acres]) and pasture (about 1 010 hectares [2,500 acres]) are depending on ground water. New wells have been drilled and the old ones cleaned and pumps reset.

The Nevada Irrigation District serves approximately 400 hectares (1,000 acres) of deciduous orchard and has cut back one-third of normal delivery. The freeze

during the end of March had a disastrous effect on some of the fruit, killing in some locations 80 to 90 percent of the crop. This year's water supply is being concentrated on the parts of the orchards that did not freeze. The remaining trees are irrigated merely to maintain growth for next year's crop.

The Placer County Water Agency delivers water to approximately 400 hectares (1,000 acres) of deciduous orchard and some pasture land. The cutback on this year's water is 25 percent of the normal deliveries. The freeze affected this area a little less, reducing the crop an estimated 40 percent. Rice, pasture, and irrigated grain grown west of Roseville and Lincoln are using ground water for irrigation.

Customers who purchase water on an annual basis (one miner inch), will receive only 50 percent of what they received last year (greater than 1 miner inch). Customers who purchase water from April 15 through October 15 will receive only 75 percent of what they got last year.

On June 15, 1977, an exchange was worked out between the Placer County WA, Nevada ID, Pacific Gas and Electric Company, and the U. S. Bureau of Reclamation, to provide water that PG&E normally delivers to the Nevada ID service area (for use in the Gold Hill area) instead to the PCWA service area at an upstream location. In turn, water from the American River (releases from the PCWA's Hell Hole Reservoir) are being supplied to the Gold Hill area. The exchange will continue until the end of the irrigation season (October 15).

Plumas County

Irrigated agriculture is limited to Sierra Valley in the eastern portion of the County and to smaller valleys near Quincy and Crescent Mills. Crops consist of pasture, alfalfa, and hay.

In Sierra Valley, part of which is in Sierra County, most irrigation is from the Feather River and its tributaries, where runoff is less than 25 percent of normal. About 10 000 hectares (40,000 acres) have surface water rights while about 800 hectares (2,000 acres) of irrigated lands use wells. Drilling rigs were utilized in the Valley, but the number of acres which benefitted is small.

Frenchman Reservoir, with a capacity of 68 cubic hectometres (55,000 acre-feet) had 10 cubic hectometres (8,500 acre-feet) in storage on August 15. Last Chance Water District, serving 3 200 hectares (8,000 acres) in Sierra Valley, normally uses 15 cubic hectometres (12,000 acre-feet) from Frenchman Reservoir, but will be receiving only 6 cubic hectometres (5,000 acre-feet) this year. The District held off on delivery, taking advantage of the May and June rains.

Lake Davis, with a capacity of 103 cubic hectometres (84,000 acre-feet), had only 47 cubic hectometres (37,750 acre-feet) of water in storage on August 15. The Lake is being drawn down to 46.3 cubic hectometres (37,500 acre-feet) with about 24.7 cubic hectometres (20,000 acre-feet) of water going to Lake Oroville to help sustain power production until April of 1978. (This drawdown has resulted in a taste and odor problem being detected at the water treatment plant near Portola.) The two riparian users downstream of the dam will be receiving 100 percent of their entitlement. Antelope Reservoir, with a capacity of 28 cubic hectometres (22,500 acre-feet), was drawn down (and the water used for downstream uses) last year for removal of rough fish. It had 3 cubic hectometres (2,600 acre-feet) in storage on August 15. Streamflow releases of 28.1 litres per second (1 cfs) were being made though the inflow was only 6 litres per second (0.2 cfs).

Irrigated land is producing about 50 percent of the normal crop. Rangeland production is down 70 percent from normal

and cattle are being moved to higher range. May and June rains helped in the hay and grazing lands, but stock water is a problem on the rangelands because virtually all streams and springs are nearly dry. Cattle are being driven to wherever stock water can be found.

The dry grain crops were prevented from being a total loss by the spring rains.

Riverside County

The western portion of the County has as its primary source ground water and Colorado River water. Agriculture use represents 75 percent of applied water. In the inland portion, containing the Coachella Valley County Water District, the primary supply is from the Colorado River Aqueduct. Since Colorado River storage is 128 percent of normal, little impact is expected.

Sacramento County

Agriculture in Sacramento County within the Delta has been affected by water quality. The ill effects of the drought have been similar to those in other parts of the Delta. In the Delta, as in other parts of the valley, salt concentrations have built up in the soils due to the lack of precipitation during the last two years. Winter rains normally wash surface salts down into the soil, but in their absence, leaching must be done by applied water. It is possible that this may take several years.

Another problem has been the dropping ground water table which has caused many farmers to lower their pump bowls.

Irrigated portions of the County outside the Delta have not suffered as much, especially along the Sacramento River where water has been available. In the northwest portion of the County, there is very little agricultural land idled due to the drought. (During this dry year, more land has been irrigated than in many other years in the past.) Rice acreage in the Natomas area has been reduced somewhat as 10 600 cubic metres per hectare (3.5 acre-feet per acre) of water has been distributed to farm operators. Accordingly, rice has been replaced with safflower, milo, sugar beets, corn, and tomatoes. This district has elected to install five large pumps at the Natomas Cross Canal in the event that 1978 is also dry. They have applied for an interest-free USBR loan for $250,000 and have received local approval.

The biggest problem in the County is associated with dry land areas. The long-run effect may be greater due to the fact that seeds that germinated with the rains have died. This has been repeated more than once and the seeds which remain in the soil have become depleted, causing concern over a future need to reseed the range.

San Benito County

Ground water provides the main source of irrigation supplies in San Benito County. One reservoir, Hernandez on the San Benito River, with storage capacity of 23 cubic hectometres (18,700 acre-feet), has been down to 0.62 cubic hectometres (500 acre-feet) since June 1. (This is dead storage.) It normally provides recharge water for the ground water basin, as well as a supply for a few small surface diversions from the San Benito River.

Ground water levels are declining, and reports by the San Benito Water Conservation District indicate water levels to be the lowest in ten years. Average depth to ground water county-wide is 24 to 27 metres (80 to 90 feet) with some depths as great as 69 metres (225 feet). Water quality has not been affected by the lowering of ground water levels.

Well failures will probably occur in some shallow wells and some crop loss experienced.

San Bernardino County

Agriculture uses about 35 percent of the

water applied in the County. In the western portion of the County, the primary sources are local surface water and ground water. Stored ground water will continue to satisfy most needs.

In the inland portion, ground water supplies can support present uses.

San Diego County

Agriculture represents a major factor in the County's economy and accounts for 40 percent of water usage. The surface and ground water storage supplies contain very little water so that there is a heavy dependence on continued supply from the Colorado River Aqueduct which is being used at capacity.

The Valley Center Municipal Water District, serving agricultural water users in the upper San Luis Rey River Valley, has adopted ordinances for mandatory application rate restrictions. The restriction allows use of 56 litres/minute/hectare (6 gallons/minute/acre) for irrigation use, primarily for citrus and avocado orchards. This corresponds to a normal use rate of 75 litres/minute/hectare (8 gallons/minute/acre). No reduction in acreage is expected.

In the Vista Irrigation District, wells are losing production. Two new wells are under contract at this time (late July). Funding for the wells ($100,000) is expected to come from either the Economic Development Agency (EDA) or from the Davis-Grunsky Fund for drought related emergencies.

San Francisco County

There is practically no irrigated agriculture in this county.

San Joaquin County

The South San Joaquin Irrigation District has suffered the most within the County. Only three irrigations were possible with the available supply. By late July, the District was in the third and last irrigation and each water user was being allowed to irrigate at a rate of about 58 hectares (144 acres) per 24-hour period. However, some users have wells which compensate for the lack of available surface water. Crops in the Lodi area, where a considerable amount of ground water is pumped, appear to be in good condition.

The Tracy area has suffered water problems similar to that of the rest of the Delta. Apricots did not size well this spring.

The longer run effect of the drought will be the dropping water table in the northern and eastern parts of San Joaquin County. Most farmers applied water during the winter and, with a good spring, farmers in August were looking at the crops more optimistically than they were five months ago.

San Luis Obispo County

Water supply, primarily from ground water and three reservoirs, is anticipated to be generally adequate with spot shortages this fall in some areas (such as Nipomo, Morro Bay, Templeton, Atascadero, and Cambria). No serious shortage is expected in other areas of the County.

San Mateo County

Agriculture in the County depends in large part on runoff from local streams to fill many small and a few larger reservoirs with only a very small amount of ground water pumped to supplement the surface supply. Rainfall in May extended the growing period of late planted grain, but came a little late to make much of an impact on rangeland.

Rangeland is in very poor condition, and is supporting only 20 to 40 percent of the normal stocking capacity. Farmers are using all means possible to divert any trickle of water from going to the ocean, but flower and truck farmers could lose 50 percent of their crop with an early end to the season.

Santa Barbara County

The County's water supplies are primarily from ground water, the USBR's Cachuma Project, and two other reservoirs. Ground water levels are holding up fairly well, but the USBR has indicated that there will be only 2.5 cubic hectometres (2,000 acre-feet) surplus water available from Cachuma Reservoir this year, one-third of normal.

Irrigated agriculture is not expected to be significantly affected.

Santa Clara County

Little of the agriculture in the Santa Clara Valley receives surface water, using instead ground water as the major supply. Ground water levels are dropping, but deciduous orchards are being irrigated as normal.

Soil moisture was adequate for the dry-farmed apricots on the east side. It appears that the tomato acreage increased slightly to offset some of the anticipated reduction in the Central Valley.

In general, the County anticipates a normal agricultural year.

Santa Cruz County

Ground water is the main source of supply for agriculture and overdraft is occurring. The ground water level has dropped about 3 metres (10 feet) this year compared to a normal drop of 0.9-1.2 metres (3-4 feet) in normal years. There is insufficient data, however, to determine the quantity of overdraft. In the lower end of the Pajaro River fan, the overdraft is expected to increase salt water intrusion. Although voluntary conservation measures are being implemented, farmers are not expecting any shortage at the present time.

Shasta County

The Anderson-Cottonwood Irrigation District, supplied by the Sacramento River, can meet all irrigation requirements, even with a 25 percent cut in water entitlements, because their rights to water exceed current use.

Mountain areas east of the Sacramento Valley draining directly into the Sacramento River, supplied mainly by North Cow, South Cow, Clover, Oak Run, and Digger Creeks, among others, account for approximately 3 600 hectares (9,000 acres) of irrigated pasture. There is little surface storage and much of the area, irrigated from local streams presently registering about 25 percent of normal flows, have been without adequate irrigation water since early summer. Cattlemen in the area who use the irrigated pasture to supplement native range are affected.

The Fall River Valley, supplied by the Pit River, Big Springs-McArthur Diversion, Fall River, and ground water, is expected to fare reasonably well. It is assumed the supply from Fall River and Big Springs will be adequate to meet full irrigation requirements. However, those farmers diverting water from the Pit River above the Big Spring-McArthur Diversion will not receive an adequate irrigation supply.

There will be a problem with stock water in the late summer months on many of the isolated ranches surrounding the valley.

The Bella Vista Water District derives its supply from the Sacramento River. Even with a 75 percent cut in water, the district does not anticipate any problems. The district is purchasing surplus water from the City of Redding, whose contract entitlement exceeds current use.

Sierra County

Irrigated crops in Sierra County consist primarily of pasture, alfalfa, and hay, grown in the Sierra Valley in the eastern part of the County. For further information, see Plumas County.

Siskiyou County

Scott Valley receives its water supply from the Scott River and its tributaries, and from ground water. Flows in streams serving this area were nearing late summer flows in April. Irrigations of pasture and alfalfa started about the middle of March, and ground water must supplement surface supplies for normal irrigation demand.

Shasta Valley is supplied by the Shasta River and its tributaries (with storage in Dwinnell Reservoir and reservoirs off the Little Shasta River), and ground water in selected parts of the valley. All streams in the area are far below average. On August 1 Dwinnell Reservoir contained 3.4 cubic hectometres (2,750 acre-feet), which is much less than that required to meet normal irrigation requirements. The watermaster has set many of the ditches at only a percentage of their water right, with low priority users receiving no water.

Severe losses have been sustained by cattlemen who have had to either buy expensive feed or sell cattle at reduced prices. Many new wells are being drilled in Shasta Valley. These new wells could have an effect on springs that feed into the existing surface water supplies. All streams in the area are flowing far below normal or have ceased to flow altogether.

Butte Valley is supplied by ground water and local streams. All streams in the area are flowing far below normal. In areas supplied by surface water, largely irrigated pasture, there is not enough water to meet the irrigation requirements. Without adequate water, local cattlemen who depend on irrigated pasture for winter fed hay and late summer feed will have to buy feed from outside the area or sell the cattle at existing prices.

Solano County

Agricultural water supplies in Solano County are derived from Lake Berryessa, the Sacramento River, a group of small reservoirs, and ground water. The Solano ID is continuing to get its contractual commitment from Berryessa this year. This, together with a stable ground water basin, is getting the County through the 1977 irrigation season without water deficiencies.

The Solano ID is making special efforts to reclaim and use all return flows, virtually eliminating any outflows from the County.

Sonoma County

The drought has not changed the crop pattern in Sonoma County. The majority of the agriculture will remain as vineyards, deciduous orchards, and pasture. Very little field and truck crops are grown.

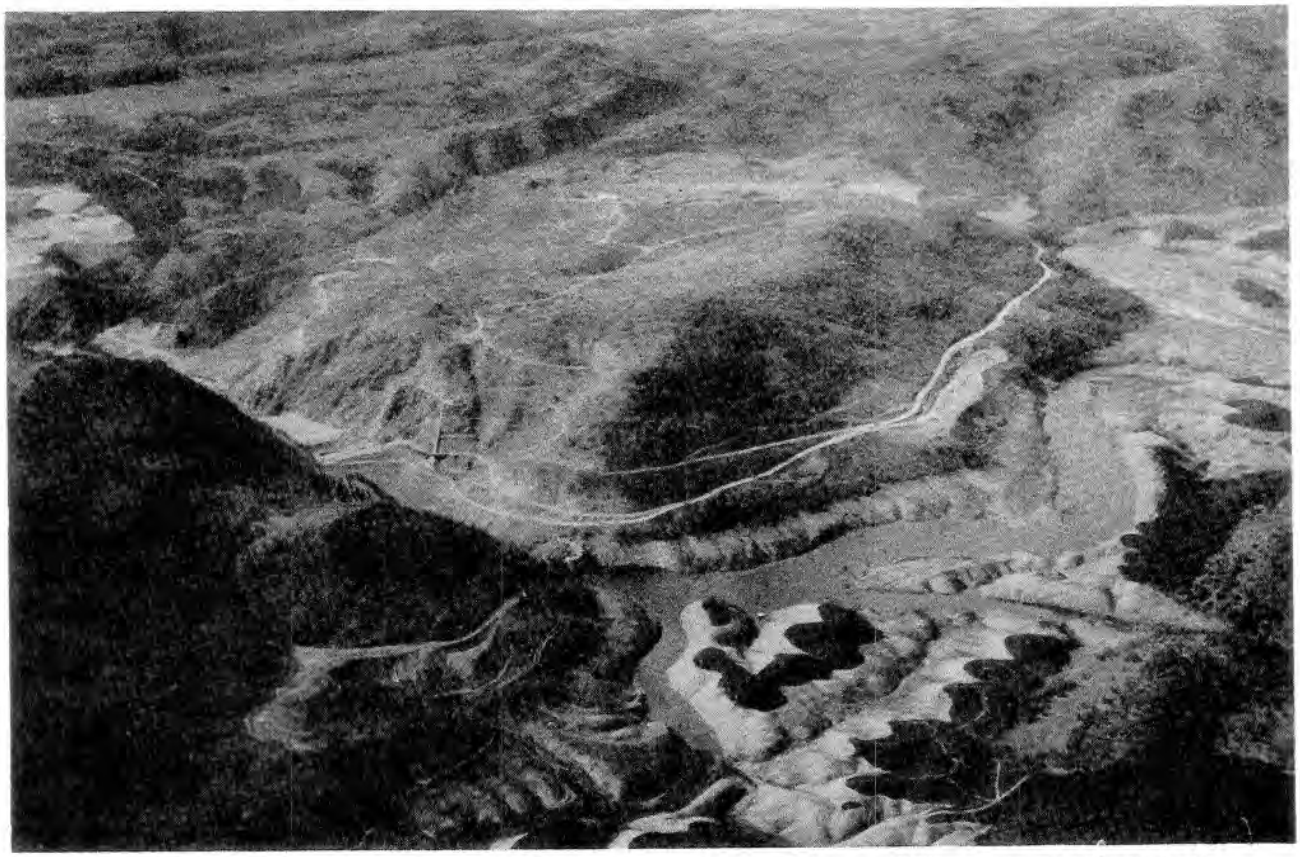
Because of May rains, soil moisture near the end of May this year was very similar to soil moisture that normally occurs in April.

At the present time, it appears the area will squeeze by using ground water.

Stanislaus County

Of the 19 irrigation and water districts in Stanislaus County, the larger ones are Modesto, Oakdale, Turlock, and Waterford Irrigation Districts which are served by the Stanislaus and Tuolumne Rivers. Patterson Water District and the West Stanislaus Irrigation District divert directly from the San Joaquin River and are dependent on upstream return flows. Westside districts, such as the Central California ID (see Merced County), receive water from the Delta-Mendota Canal. One district, Oak Flat ID, receives water from the California Aqueduct.

Normal surface supplies to Oakdale, Turlock, Modesto, and Waterford Irrigation Districts total some 1 600 cubic hectometres (1,300,000 acre-feet), with



12. Melones Reservoir on the Stanislaus River, photographed in February 1977, stores water for irrigation of 47 000 hectares (116,000 acres) in the Oakdale and South San Joaquin Irrigation Districts. In 1977, the two districts had less than half of their normal water supplies. New Melones Dam and Spillway sites appear on the left.

ground water supplying an additional 370 cubic hectometres (300,000 acre-feet). The 1977 water year is producing about 17 percent of normal runoff for the Stanislaus and Tuolumne Rivers, or about 610 cubic hectometres (495,000 acre-feet). One-half of the Stanislaus River flow or about 101 cubic hectometres (82,000 acre-feet) will be used in San Joaquin County.

Turlock I.D., with a normal demand of 1 160 cubic hectometres (940,000 acre-feet), will be especially hard hit because it used much of its reservoir supply in 1976. The result is a carry-over supply of only about 113 cubic hectometres (92,000 acre-feet). Allowing for the April-July runoff the projected surface water deficit approximates 800 cubic hectometres (650,000 acre-feet), depending on acreage put into production.

Ground water must supply some 1 670 cubic hectometres (1,360,000 acre-feet) if total requirements are to be met in the larger districts. Those districts dependent on spill and return flows, such as West Stanislaus and Patterson, have very little surface supply. Westside districts served by the CVP's Delta-Mendota Canal and California Aqueduct also have to pump ground water to meet requirements. Some wells will probably go dry during the late summer months, resulting in the loss of some crops. Some farmers who do not have pumps may be able to purchase water from neighbors.

Sutter County

About 23 000 hectares (55,000 acres) are included in the South Sutter Water District of which 10 000 hectares (25,000 acres), mostly rice, were irri-

gated in 1975. Normal water source for the District is Camp Far West Reservoir on the Bear River. The reservoir was essentially emptied in 1976, and the District is serving no water during 1977. For the duration of the drought, many of the farmers in the District have returned to use of wells installed prior to construction of Camp Far West Reservoir. Some new wells are being drilled. During 1977, an estimated 5 200 hectares (13,000 acres) are being irrigated.

The limited amount of water available in Camp Far West Reservoir this year goes to Camp Far West Irrigation District under terms of a water rights agreement between the two Districts.

The Sutter Extension Water District and the portion of Butte Water District in Sutter County obtain water from the Feather River as regulated by the State Water Project. They normally serve 284 cubic hectometres (230,000 acre-feet) of water to irrigate 12 000 hectares (30,000 acres) of land. In 1977, this will change to 166 cubic hectometres (135,000 acre-feet) for 7 900 hectares (19,500 acres).

The Oswald Water District, the Tudor Mutual Water Company, Inc., the Garden Highway Mutual Water Company, and the Feather Water District have also taken 50 percent deficiencies from the SWP in 1977.

13. Typical of the foothill reservoirs, Camp Far West Reservoir in Nevada and Placer Counties is the primary source of irrigation water for 11 000 hectares (27,000 acres) of farmland in the South Sutter Water District and Camp Far West Irrigation District—photographed in April 1977.

14. A big loser—dry-land farmers lost heavily as grain fields reflected the scarcity of water. This scene shows short-stemmed wheat being harvested in July in western Tehama County. The short stems affected harvest efficiency, resulting in some loss of yield.

Tehama County

The Sacramento Valley floor east of the Sacramento River from Red Bluff south to the county line is served by the Sacramento River, Antelope Creek, Deer Creek, and Mill Creek, among others. Most of the area is also served by wells or has ground water available. The area should have no problem meeting normal irrigation requirements with the exception of those farmers who depend totally on east side streams. The majority of land totally dependent on east side streams is irrigated pasture, where the availability of surface water is expected to be less than 50 percent of normal.

The Sacramento Valley floor west of the Sacramento River from Red Bluff south is served mainly by the USBR's Corning and Tehama-Colusa Canal, Thomes Creek, and ground water. The Corning and Tehama-Colusa Canal users will receive only 25 percent of their contract amounts. There are no temporary deliveries by the USBR to other irrigation districts. Thomes Creek and other west side streams are at or below 50 percent of normal flow. Farmers totally dependent on these creeks for water do not have an adequate supply for their irrigated pastures.

Farmers receiving water from the Corning or the Tehama-Colusa Canal who cannot supplement surface water deliveries with ground water are forced to cut back on irrigated acreage. Ground water from deep wells will be able, in most cases, to supply normal irrigation demands. However, those lands irrigated by shallow wells in some of the outlying areas may go dry.

The Corning Water District has had its deliveries from the USBR's Corning Canal cut by 75 percent. The District feels there is not enough water for the

production of two crops and that there is only enough water for orchardists to keep their trees alive. There are deep irrigation wells in the district and farmers are bringing abandoned wells back into production. Farmers who cannot supplement surface water deliveries with ground water have had to cut back on irrigated acreage.

Trinity County

Irrigated lands are primarily in Hayfork Valley and are served by surface streams, which are flowing less than 50 percent of normal. Farmers are planning to line diversion ditches to deliver as much of the reduced supply to the fields as possible, hoping to just get by in 1977. The May rains did little good below the 610-metre (2,000-foot) elevation, but increased forage above.

Tulare County

Surface water supply for the County's 24 irrigation and water districts comes from the Kings, Kaweah, and Tule Rivers, and from the San Joaquin River via the CVP's Friant-Kern Canal. Fourteen districts receive CVP water with average deliveries totaling some 850 cubic hectometres (689,100 acre-feet). The CVP supply available for 1977's uses is about 170 cubic hectometres (138,000 acre-feet), assuming 25 percent of Class I deliveries for 1977 plus carryover storage. This results in a total shortage of about 679 cubic hectometres (551,000 acre-feet) of CVP water.

The County's surface supplies from the Kings, Kaweah, and Tule Rivers will be less than normal by about 495 cubic hectometres (400,000 acre-feet), for a total surface supply deficiency of about 1 170 cubic hectometres (951,000 acre-feet).

Pumping facilities are inadequate to meet the entire deficit, resulting in some crop loss and land left idle.

Further overdrafting of the ground water basin will cause some wells to go dry.

Those districts which have the greatest deficit in overall water supply are: Stone Corral (56%), Teapot Dome (28%), Lindsay-Strathmore (33%), Terra Bella (20%), Orange Cove (26%), and Lindmore (20%).

Within each district rationing is being applied and farmers who do not have pumping capabilities are being given some priority to the limited surface supply available, especially for permanent crops. To ease problems of supply, farmers who have wells adjacent to the Friant-Kern Canal are allowed to pump into the canal and move water to other areas of need.

Tuolumne County

No major surface irrigation is practiced in Tuolumne County because it is located in the foothill and mountainous area on the westerly slope of the Central Sierra Nevada. Ground elevations range from 121 metres (400 feet) in the foothill area to 4 000 metres (13,000 feet) at the crest of the Sierra Nevada. Except for the foothill area, most of the County is within either Stanislaus National Forest, Yosemite National Park, or Emigrant Basin Primitive Area.

Ventura County

The County is supplied primarily from ground water and agriculture accounts for about 70 percent of applied water. Those ground water users located near the periphery of the ground water basins may gradually lose well production as water levels continue to fall, but the majority of irrigation users will be able to obtain water by overdraft of the ground water basins.

Yolo County

Irrigated agriculture is extensive in

Yolo County; the principal crops are canning tomatoes, grain, field crops, and fruits of deciduous orchards.

The County is served by a large water district, the Yolo County Flood Control and Water Conservation District, several smaller water districts, and reclamation districts. The Yolo County FC&WCD normally supplies water from Indian Valley Reservoir, Clear Lake, and from ground water. This year water is not available from Indian Valley or Clear Lake, so only ground water is being used. The other districts' supply is from ground water or the Sacramento River. Water for land which is not in districts must come from private wells.

Many shallow wells have gone dry or will go dry this summer, while deep wells should produce normally. Many new wells are being put in and others deepened.

Many areas ordinarily supplied by Indian Valley Reservoir are without alternative water sources and no crops can be planted. Some individuals with private wells are using the canal distribution system to help neighbors without wells, especially those with orchards.

Areas in the northeastern part of the County depending on water from the Colusa Drain have little or no water from that source this summer. Sacramento River water users have had a cut in allotments.

Crop changes have involved either not growing a second crop or growing a less water-dependent crop, such as wheat or safflower, in place of corn or sugar beets. Tomato acreage is expected to be normal.

In the western County, the dry land grain harvest was expected to be about 30 percent of normal. The rest was lost. Rangeland is in poor shape and livestock are being sold.

Yuba County

Agricultural water users diverting from the Yuba River, primarily the Cordua Irrigation District, Hallwood Irrigation Company, and Browns Valley ID, are taking 37 percent deficiencies in 1977, based on a normal runoff year in 1978. Browns Valley ID, however, is taking a slightly larger cut overall because storage in Merle Collins Reservoir is low. Land which is dependent upon the Merle Collins Reservoir for water (mostly pasture land) has been subjected to a 75 percent cut in irrigation. Other crops, such as rice, which are normally irrigated with Yuba River water, have had a 30 percent reduction in water. Individual deficiencies in Cordua and Hallwood may be somewhat less than 37 percent since these agencies have historically had low irrigation efficiencies with substantial drainage through sloughs. This year there have been reductions in acreage planted to rice and pasture within the Districts and increased use of drainage water.

Extensive areas in the Valley floor portion of the County are irrigated from ground water, primarily for fruit and nut crops. These areas are maintaining the trees with minimum pumping and full use of drainage water.

Economic Impacts

Despite the severity of the drought in 1977, its economic impact on the State has not been as great as was anticipated in the February update. The greatest negative impact has been to agriculture and closely related industries. The greatest positive effect has been shared by well drillers, who have had a literal plethora of work orders since the drought began.

An estimate of agriculturally related jobs that have or will be lost this year due to the drought is 5,900. The agricultural occupations most affected

by the drought are farm workers employed in soil preparation, cultivation, and harvesting of field crops and vegetables. There has also been a decrease in the need for farm equipment operators, irrigators, thinners and weeders, and packinghouse workers. Overall, farmers have been able to adapt to the conditions of the drought and absorb most surplus labor.

Steps are being taken by adversely affected farmers to mitigate the impacts of the drought. In general, farmers have increased their acreage of less water-intensive crops, such as cotton, and have reduced the amount of heavy water-using crops such as rice and sugar beets. Ground water supplies have been used more heavily for irrigation. In some cases more than 50 percent of the water used for cultivation was pumped from underground aquifers.

The hardest hit of the agricultural water users are the ranchers and dairymen. The Department of Food and Agriculture estimates that $500 million could be lost in the livestock industry this year. Ranchers and dairymen have been forced to sell large portions of their herds at reduced prices, including as much as 25 percent of their breeding stock. It is likely that 2-3 years will be needed for the California livestock industry to recover from the drought.

The following table represents estimated drought losses in California agriculture and related industries under optimistic, most likely, and pessimistic conditions (in billions of dollars):

Losses to Agriculture - Related Industry
(billions of dollars)

	Pessimistic	Most Likely	Optimistic
Crop	1.0	0.3	0.0
Livestock	0.5	0.5	0.5
Total Gross Farm Income Loss	1.5	0.8	0.5

Below are the estimated 1977 losses in gross state output, employment, and personal income in the same three drought scenarios.

Losses to Gross State Output, Employment, and Personal Loans

	Pessimistic	Most Likely	Optimistic
Gross State Output (millions of dollars)	2,900	1,800	1,000
Employment (persons)	111,000	51,000	8,500
Personal Income (millions of dollars)	830	490	210

15. These two photographs show the result of the 1928-1934 California drought. The orchard was planted in 1923, and by 1936, the area was barren because of the lack of water.

As this growing season progresses, economists believe that these loss estimates may be revised downward again.

The Urban Situation

What was only feared in February had become a reality by May. The hoped for March and April replenishment of reservoirs exhausted in 1976 did not materialize, and it became clear that, in most instances, existing carry-over storage was insufficient for normal 1977 municipal and industrial usage. As a consequence, numerous Northern and Central California urban areas are being forced by circumstances to reevaluate their true needs, identify nonessential uses and assign orders of priority to other uses, and to develop and carry out plans to make the most of available water supplies in 1977 and to ensure a reserve for 1978, should it be dry.

Among the most threatened areas is the highly urbanized complex surrounding the San Francisco Bay, comprising most of the counties of Alameda, Contra Costa, Marin, San Francisco, San Mateo, Santa Clara and Sonoma. (Napa and Solano Counties are feeling lesser impacts.) Urban water supplies to this area are provided, in large part, from 6 major aqueduct systems - East Bay MUD's Mokelumne Aqueduct and San Francisco WD's Hetch-Hetchy Aqueduct, both originating in the Sierra; the USBR's Contra Costa Canal, diverting from the Delta; Sonoma County WA's and North Marin County WD's aqueduct systems from the Russian River; the SWP's South Bay Aqueduct - and local surface reservoirs, such as those supplying the Marin MWD.

All of the region's sources of supply are threatened with depletion by the drought's continuation in 1978. On August 1, 1977, EBMUD had 200 cubic hectometres (161,000 acre-feet) in storage in its reservoirs (normal annual demand is 303 cubic hectometres [246,000 acre-feet]), San Francisco had 323 cubic hectometres (262,000 acre-feet)[1/] (normal demand, 370 cubic hectometres [300,000 acre-feet]), and Marin MWD had 12 cubic hectometres (10,000 acre-feet) (normal demand, 39 cubic hectometres [32,000 acre-feet]). The Russian River users (Sonoma and North Marin) are faced with

1/ Excluding storage in Lakes Lloyd and Eleanor, used primarily for hydroelectric generation and for satisfaction of downstream water rights.

16. Urban users feel the pinch—Nicasio Reservoir, principal storage reservoir for the Marin Municipal Water District's 180,000 customers, as it looked in October 1976. Storage on July 1, 1977 was only 0.3 cubic hectometres (250 acre-feet) of its storage capacity of 28 cubic hectometres (22,500 acre-feet).

a probable dry riverbed in early fall (river flow is almost entirely dependent upon releases from PG&E's Lake Pillsbury and Lake Mendocino, both of which were extremely low on August 1 with 20 cubic hectometres (16,000 acre-feet) and 33 cubic hectometres (27,000 acre-feet), respectively). Users dependent on the Delta (Contra Costa and the SWP customers in Alameda and Santa Clara Counties) face the possibility of its becoming a vast inland saltwater pool should upstream reservoirs, such as Shasta, Oroville, Trinity, and Folsom empty and become unable to control saline intrusion from San Francisco Bay. It was expected this could occur as early as April 1978, before the action taken by the SWRCB in June 1977, to relax Delta water quality standards and to require maintenance of minimum reserves of upstream reservoir storage. The effect of the SWRCB decision is to delay that possibility until late 1978. Reserves are still quite low, however. On August 1, 1977, Oroville had only 1 230 cubic hectometres (997,000 acre-feet) in storage and by late December this is expected to drop to 1 085 cubic hectometres (880,000 acre-feet). Shasta's storage, which on August 1 was 840 cubic hectometres (680,000 acre-feet), will drop to 715 cubic hectometres (580,000 acre-feet) by October; Folsom, with 247 cubic hectometres (200,000 acre-feet) on August 1, will drop 173 cubic hectometres (140,000 acre-feet); and Trinity, holding 660 cubic hectometres (535,000 acre-feet), will drop to 247 cubic hectometres (200,000 acre-feet).

It is clear that, without significant rainfall this winter, the entire Bay Area could be without water from traditional sources sometime in 1978 or early 1979. (This assumes no reduction from normal consumption and no mitigative actions taken.) It is important, therefore, that all agencies affected undertake and follow through on effective conservation measures. Since the Delta may become the "pool of last resort" for Bay area users, the SWP's Oroville Reservoir will be operated to repel saltwater intrusion and maintain

17. Pardee Reservoir—source of 95 percent of the East Bay Municipal Utility District's water supply, serving 1.1 million customers in 30 communities—as it looked in February 1977. By the end of February, Pardee contained only 27 percent of its capacity of 259 cubic hectometres (210,000 acre-feet)—just 70 cubic hectometres (56,500 acre-feet), an all-time low since the reservoir first filled in the 1930's. (photo by Ed Brady, Aero Photographers, Sausalito, California)

water quality in the Delta. This will necessarily limit its usefulness for other purposes.

Southern California is not left out of the current issues brought on by water scarcity. Its continued near-normal use of the liquid threatens to become a drain on all surface sources, including those of the SWP, in 1978. Increased reliance on Colorado River sources and more effective conservation may be necessary to ensure continued supply to all users.

The drought has spawned a number of imaginative, mitigative measures by urban water suppliers. For a discussion of water exchanges and conservation efforts, please see the next chapter. In another example, EBMUD has developed a plan to squeeze out of its Pardee Reservoir approximately 19 cubic hectometres (15,000 acre-feet) of otherwise unusable dead storage, water that is below the elevation of the tunnel intake to its Mokelumne Aqueduct. Its strategy calls for draining the water through the base of the dam (through an old tunnel constructed at the time the dam was built) and allowing it to flow downstream to a ravine traversed by the Aqueduct. At this point a small dam would be constructed to impound water, forcing it through holes cut into the Aqueduct, where it would be pumped to the East Bay.

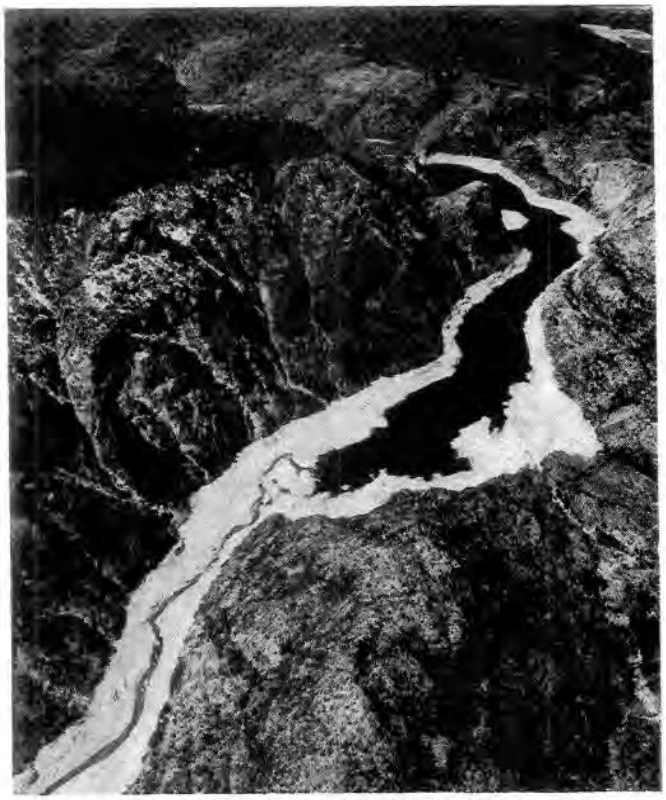
18. The 100-foot-tall outlet tower at Pardee Reservoir, main storage facility for the East Bay Municipal Utility District, already looked high and dry by March 20, 1977. A tunnel below the apparent ground level is still supplying the Mokelumne Aqueduct from Pardee. As of August 4, Pardee held only 86 cubic hectometres (67,000 acre-feet), compared with its capacity of 259 cubic hectometres (210,000 acre-feet). (photo by East Bay Municipal Utility District)

19. Hetch-Hetchy, source of water for 2.0 million residents in San Francisco, San Mateo, Alameda, and Santa Clara Counties, as it appeared in February 1977, when it contained 37 cubic hectometres (30,000 acre-feet) of its capacity of 444 cubic hectometres (360,000 acre-feet). (San Francisco Public Utilities Commission photo)

The drought has focused attention on some of the less conventional sources of water. Reclaimed water is an example and the Santa Clara Valley WD's experience may become typical. Even before its new reclamation plant in Palo Alto became operational in June, its output was oversubscribed for park, industrial, and agricultural uses. Interest has been high because the rising cost of unused water (in short supply because of the drought) has made reclaimed water cost-competitive. In addition, because the reclaimed water still contains nitrogen and phosphates, nutrients needed by plants, agricultural benefits will be realized.

The Water District has received a $1,000,000 interest-free loan from the USBR under provisions of the Emergency Drought Act of 1977, with the money to be used to provide new reclamation facilities including aeration and oxidation ponds and chlorination facilities at the District's Gilroy plant. Eight miles of pipeline will take the reclaimed water to customers along Uvas Creek - the city's golfcourse, a new high school (for landscaping), a tree farm, a seed farm, and two major wholesale nurseries.

The City of Santa Rosa, along with the adjacent Cities of Sebastopol, Rohnert Park, and Cotati, has put into operation its new sewage reclamation facility near Santa Rosa. Reclaimed water is being distributed to farmers and dairymen to irrigate pasture land, hay, and corn grown for livestock. Although the project was already under construction, drought provided the impetus to complete it a year ahead of schedule.



20. Another view of Hetch-Hetchy Reservoir as it appeared in April 1977. At that time, the reservoir, with a capacity of 444 cubic hectometres (360,000 acre-feet), contained only 36 cubic hectometres (29,000 acre-feet). In the background, similarly low, are Lake Lloyd and Lake Eleanor, sources of hydroelectric energy for the City.

Recreation

Winter sports, especially in Northern and Central California, again suffered from the scarcity of snow during the 1976-77 season. In Northern California, ski areas either did not open or had abbreviated seasons in 1976-77 and all were closed before Easter. Ski Shasta never opened, Cedar Pass was open only one-half day during the season, Horse Mountain was open 8 weekends, and Lassen ski area was open about half of the scheduled days. All of these ski areas expect to open next winter sometime after Thanksgiving, if snowfall is adequate.

Despite the drought, Californians will be able to find adequate recreational opportunities through the fall of 1977. Boating, camping, picnicking, fishing, hiking, and swimming enthusiasts, although perhaps finding their favorite spots at less than optimum conditions, will still have plenty of activities and spots to enjoy them during the entire recreational season.

Although many water supply reservoirs are drawn down below normal boat ramp elevations, a number of agencies and concessionaires have constructed ramp extensions or temporary facilities to accommodate boats. Table 6 provides current and projected information on the effect of 1977 water supply upon recreational lakes. It also indicates mitigative measures taken.

Normal or near-normal recreational activities are still available in association with large afterbays or forebays below major reservoirs; the Sacramento-San Joaquin Delta waterways; the large natural lakes and seas; the ocean with its bays, coves, and beaches; the Colorado River reservoirs; and a number of other reservoirs within the State.

Among the larger afterbays or forebays,

TABLE 6

ANTICIPATED LAKE RECREATION AT SELECTED LOCATIONS, SUMMER – 1977

RESERVOIR OR LAKE NAME	CONTACT	Boating Ramps Available	Fishing	Camping	Swimming	MAX. OPER. ELEV.	LAKE LEVELS (FT.) 1/ ACTUAL Jun 1	EXPECTED Aug 1	EXPECTED Oct 1	MIN. RAMP ELEV. (FT.)	REMARKS
Almanor (Canyon Dam) (Plumas)	U.S.F.S., Chester (916) 258-2141	•	•	•	•	4485	4475	4475	4470	4478	Ramps to be made available all summer. PG&E and Federal campgrounds open; first come, first serve. Private resorts around lake; call for reservations.
Amador (Amador)	Jackson Valley I.D. (209) 274-2625	•	•	•		468	394	325	320	417	No water skiing. Boat rental available. Day use picnic and recreation area.
Anderson (Santa Clara)	Santa Clara Co. Parks (408) 779-3634 Marina, (408) 779-4895	•	•			475	543	533	522	OK	Facilities in operation. No swimming allowed. Day use only.
Antelope (Plumas)	U.S.F.S., (916) 284-7126		•	•	•	5002	4970	4965	4964	4987	Lake 1/3 full. Launching of car-top and portable boats OK. No boat ramp. All campsites open. Fishing fair.
Baum Lake (Shasta)	PG&E, (916) 335-4536		•	•		2995	2995	2995	2995	No Ramp	Normal recreation at this fishing site. Campgrounds 1/2 mile south of the lake at Castle Campground. No motors.
Beardsley (Tuolumne)	(209) 965-3214		•			3397	3214	3211	3207	3340	No recreation potential this year. Walk-in fishing only.
Benbow Lake (Humboldt)	State Parks, (707) 247-3318		•	•	•	359	333	333	333	No Ramp	Dam being modified this summer; river use is available. Campgrounds available.
Berryessa (Napa)	U.S.B.R., (707) 966-2111 8-5 Daily	•	•	•	•	440	400	388	383	400	Boat ramp at Markley Canyon closed; others in operation. Recreation facilities all open and in operation. Private resorts around lake.
Big Bear Lake (San Bernardino)	Chamber of Commerce (714) 866-4601	•	•	•		72	58	58	56	54	Fishing excellent. Eight USFS campgrounds - most on Ticketron. No swimming
Big Lagoon (Humboldt)	Park Supervisor, (707) 445-7650	•	•	•	•	13	11	7	3	1	One concrete boat ramp available. Ten campsites available.
Big Sage (Modoc)	Hot Springs Valley I.D. (916) 233-2225	•	•	•	•	4898	4887	4886	4885	OK	Normal recreation and fishing. Boat ramp is natural granite slope.
Black Butte (Tehama)	U.S.C.E. Park Manager, (916) 865-4781, 8-6 Weekdays, 8-10 Weekends		•	•	•	474	427	411	408	410	Ramps closed. Fishing all season. Campgrounds and picnic areas open.
Blue Lakes (Lake)	Private Resort, (707) 275-9987	•	•	•	•	1341	1340	1339	1338	1338	Normal recreation. RV camping, motel and cabins available.
Boca (Nevada)	U.S.F.S., Truckee (916) 587-3558	•	•	•		5605	5587	5585	5521	5588	Boat ramps in operation. Skiing and fishing OK. Campground open with water. Campgrounds along Hwy. Rte. 89 to be open all summer. Call for any change.
Buchanan (Madera)	Park Manager, (209) 689-3255		•	•	•	588	444	442	441	462	Normal recreation. No motor boats on lake.
Bucks Lake (Plumas)	U.S.F.S., Oroville (916) 534-6500	•	•	•	•	5126	5123	5121	5107	OK	All facilities available. Road from Oroville side in poor condition. Call for current status.
Buena Vista (Kern)	Kern County Parks, (805) 763-1526	•	•	•	•	296	293	289	288	OK	Recreation normal. 112 campsites.
Cachuma (Santa Barbara)	Santa Barbara Co. Parks (805) 688-4658	•	•	•		750	722	718	715	Port-Ramp	No water contact activities allowed. Swimming pool open in recreation area. Portable ramps being lowered. Recreation normal.
Camanche (San Joaquin)	Camanche Regional Park (209) 772-1277	•	•	•	•	235	181	161	140	200	New boat ramps available. Recreation about 55% normal. Water skiing good. Lake low. Boat rental available.
Camp Far West (Placer)	Concessionaire, (916) 645-8069	•	•	•	•	300	213	195	175	175	Boat ramp good (no water skiing). No marina or gas on lake. North side campground closed. 46 units on south side recreation area open.
Casitas (Ventura)	Lake Casitas Recreation Area (805) 649-2233	•	•	•		567	541	539	536	OK	No adverse effect on recreation due to drought is anticipated.
Castaic (Los Angeles)	L.A. County Parks Department (805) 257-2845	•	•	•	•	1515	1371	1347	1330		Boat ramp at Dam Overlook available. Forest Service campground nearby. Boat rental available. Day use fee $1.50/day.
Clair Engle (Trinity)	(916) 246-5222 Recording - (916) 246-5338 Assoc. - (916) 243-2643	•	•	•		2370	2246	2171	2112	2295	Fawn, Bushy Tail, Alpine View and Stoney Creek campgrounds closed this year (no water). Portable ramps at Fairview, Cedar Stock and Estralada.
Clear Lake (Lake)	Chamber of Commerce, Lakeport (707) 263-6131 Sheriff, (707) 263-2331	•	•	•	•	1326	1317	1316	1315	1316	State park boat ramp closed. Launching to 24 ft. at resort areas. County parks, day use only. State park open. Resorts have swimming pools and boat rentals.
Collins Lake (Yuba)	Concessionaire, (916) 692-1600	•	•	•	•	1183	1122	1117	1110	1140	Launching any size boats. Water skiing restricted to southern end of lake. Boat rental and dock moorage available. Camping - RV park normal.
Copco (Siskiyou)	Pacific Power & Light, (503) 243-4395 Concessionaire, (916) 459-3654	•	•	•	•	2608	2604	2604	2604	OK	All facilities in operation. Camping area for self-contained vehicles only. Cabins available. Water skiing restricted to one area of lake. Lake near full.
Coyote (Santa Clara)	Santa Clara Valley WD (408) 842-7800			•		777	722	722	722		Camping and hiking. Lake completely dry.
Crowley (Mono)	L.A. Department of Parks and Recreation, (213) 485-4853	•	•			6782	6750	6748	6740	6745	New ramp and road constructed. Special water skiing season (July 1 to September 5). Day use only but private accommodations nearby.
Davis Lake (Plumas)	U.S.F.S. (916) 836-2575 (916) 832-5161		•	•		5775	5768	5768	5761		Lake low. Boat ramp closed at Lighting Tree. Small boats can be launched at Coot Bay and Big Flat at boaters' own risk. Two campgrounds open for overnight use.
Del Valle (Alameda)	Del Valle Park, (415) 443-4110	•	•	•	•	745	703	701	700	662	No water skiing this year. Speed limit 10 mph. Fishing OK. Overnight facilities available. No electricity. Picnic areas. Swimming beach area. Hiking area, equestrian trails.
Donnells (Tuolumne)	U.S.F.S., (209) 965-3214					4916	4736	4736	4736		No camping, swimming, boating or fishing. Lake too low.
Donner Lake (Nevada)	(702) 789-4646	•	•		•	5936	5934	5934	5930	5927	Normal recreation. No camping. Privately owned boat ramps available.
Don Pedro (Tuolumne)	Turlock I.D. Recreation Operations, (209) 852-2396	•	•	•	•	830	651		600	595	Boat ramps available to minimum pool (600 ft). Recreation normal. Swimming and marina at Fleming Meadows.
Dorris (Modoc)	Sport Fish & Wildlife (916) 233-3572		•			4399	4393		4383	No Ramp	Fishing OK. No ramps. Boats up to 14 feet only.
Eagle (Lassen)	U.S.F.S., Eagle Lake (916) 257-2595	•	•	•	•	5125	5106	5105	5104	5100	Natural lake. Lake near full. Forest campgrounds open. First come, first serve. Heavy use.
Eastman Lake (Troutlake) (Shasta)	PG&E, (916) 335-4536	•	•			3305	3305	3305	3305	OK	Normal recreation, will remain nearly full all summer.
East Park (Colusa)	U.S.B.R., (916) 934-7066					1200	1131	1131	1131	No Ramp	Closed to recreation; lake too low.
Edison Lake (Fresno)	U.S.F.S., (209) 841-3294; S.C.E.C. at Big Ck. (209) 893-3260	•	•	•		7642	7558	7573	7554	No Ramp	Lake low; launching of cartop boats only. Speed limit - 15 mph. Hikers ferry service is available.
Edson (El Dorado)	(916) 333-4312		•	•		4262	4228	4217	4210	4227	U.S.F.S. campgrounds open. Fishing available. No ramps - aluminum and hard top boats only.
El Capitan (San Diego)	City of San Diego, (714) 236-5645	•				750	669	669	651	Movable	Boating normal. Fishing poor. No camping facilities.
Elsinore (Riverside)	State Parks & Rec., (714) 674-3005	•	•	•	•	1233	1230	1229	1228	OK	Limited fishing.
Englebright (Nevada)	U.S.C.E. Park Manager (916) 639-2342	•	•	•	•	527	522	504	469	518	Launching OK. Boat-in camping at this lake.
Ewing (Trinity)	Trinity Co. Waterworks (916) 628-5449		•			2428	2428	2420	2414	No Ramp	Normal picnicking and fishing. No camping, swimming or boating allowed.
Exchequer (Lake McClure) (Mariposa)	McClure Point, (209) 378-2521 Barrett Cove, (209) 378-2711	•	•	•	•	867	677	630	615	745	Boat ramps to be extended at Barrett Cove and McClure Points as necessary. Two concessionaires on lake. Make reservations with Park Ranger, (209) 378-2521.
Fauchere (Nevada)	Nevada I.D., (916) 273-6185					6123	6093	6090	6090	OK	Boat launching available from road. No power boats. Use fee dropped.
Florence (Fresno)	U.S.F.S., (209) 841-3294 S.C.E.C., (209) 893-3260	•	•	•		7328	7237	7239	7225	OK	Lake low. Launching near resort. Cartop boats only. Speed limit - 15 mph. Hikers ferry service is available.
Folsom (Sacramento)	California State Parks, (916) (916) 988-0205, Marina 933-1300	•	•	•	•	465	386	357	345	390	Launching on "Haul Road" at Beals Point. Boats to 26-feet can launch at Brown's Ravine. Gas not available at lake.
French Meadows (Placer)	U.S.F.S., (916) 367-2224			•	•	5263	5194				Cartop boats only. Camping facilities open. Water low. Gas not available at lake.
Frenchman (Plumas)	U.S.F.S., (916) 253-2223 State Parks & Rec., (209) 948-7782			•	•	5588	5551	5545	5545	5569	No boat launching available. Must carry cartop boats a long way to water. Camping - 80 units. Picnicking and swimming OK.
Gerle Creek (El Dorado)	U.S.F.S., Fishpond (916) 644-2348			•	•	5231	5223	5226	5226		No facilities. Canoeing OK. Constant level, small lake. Fishing, swimming and camping available.
Lower Hell Hole (Placer)	U.S.F.S., (916) 622-5061 Recording, (916) 626-1551	•	•	•	•	4630	4526			4530	Cartop and portable boats only. All other recreation normal. U.S.F.S. campground.
Henshaw (San Diego)	Vista I.D., (714) 724-8811 Lake Report, (714) 782-3501	•	•	•		2670	2655	2652	2652	2641	Fishing, boat rentals available. No swimming. Trailer park camping. Boat ramp available for small boats.
Hidden (Madera)	Park Manager, (209) 673-5151		•		•	540	452	445	445	405	Recreation facilities under construction. Walk-in fishing and swimming OK.
Huntington (Fresno)	So. Calif. Edison, Big Creek (209) 893-3260 U.S.F.S., (209) 841-3311	•	•	•	•	6950	6948	6947	6942	No Ramp	Recreation normal. Lake near full. Expect facilities in operation through Labor Day.
Ice House (El Dorado)	U.S.F.S. at Fresh Pond (916) 644-2348, 8-6 Daily		•	•	•	5450	5389	5396	5382	5403	No boat ramp facilities. No reservations necessary. Call for current status.
Indian Creek (Alpine)	So. Tahoe Public Utility District (916) 544-6474	•	•	•	•	5600	5594	5584	5584	5583	Boat launching primarily for fishing type boats. Recreation expected to be about same as last year.
Indian Valley (Lake)	Yolo County FC&WCD (916) 662-0266			•		1475	1331	1330	1329		Camping OK. All other recreation nil.
Iron Canyon (Shasta)	PG&E, (916) 335-4536	•	•		•	2665	2660	2661	2662		Reservoir will vary widely depending on power needs. Boat ramp difficult to use at low levels.
Iron Gate (Siskiyou)	Pacific Power & Light Co. (503) 243-4795	•	•	•	•	2328	2325	2324	2324	OK	Normal recreation. Three boat ramps open - eight camp and picnic facilities available.
Isabella (Kern)	U.S. Corps of Engrs., (714) 379-2742 Answering dev. after hours	•	•	•	•	2605	2538	2526	2521	2522	Concrete ramp to minimum pool (elev. 2522') also old Hwy 178. Camping near water where little vegetation-no fire hazards. Fishing reported good. Park conditions good. Launching OK thru July.

1/ – 1 foot = 0.3048 metre

RESERVOIR OR LAKE NAME	CONTACT	Boating Ramps Available	Fishing	Camping	Swimming	MAX. OPER. ELEV.	LAKE LEVELS (FT.) 1/ ACTUAL Jun 1	EXPECTED Aug 1	EXPECTED Oct 1	MIN. RAMP ELEV.	REMARKS
Jackson Meadows (Nevada)	U.S.F.S., (916) 273-6185 (916) 265-4531		•	•	•	6036	5944	5933	5933	6010	Lake low. Car top boats only. No launching. Fishing poor. Pass Creek and Woodcamp campgrounds open with water. Call for any changes.
Keswick (Shasta)	U.S.B.R., (916) 484-4676 U.S.F.S., (916) 246-5222 Visitor Information,(916) 243-2643	•	•			588	586	586	586	OK	Normal recreation, fishing and picnicking. Day use only.
Lake Britton (Shasta)	Calif. State Parks, (916) 335-2777 PG&E, Burney, (916) 335-4536	•	•	•	•	2758	2754	2754	2754	OK	Boat ramps, camping, fishing, swimming all open and operating. Day use picnic area.
Lake McSwain (Mariposa)	Marina, (209) 378-2534 Reservations,(209) 378-2521	•	•	•	•	164	164	164	164	OK	No water skiing on this lake. Fishing, camping and overnight use available. Call and check for reservations.
Lake Red Bluff (Tehama)	U.S.B.R., (916) 527-7440	•	•	•	•	253	253	253	253	240	Normal recreation. Campgrounds, picnic area, 2 boat ramps.
Lake Siskiyou (Box Canyon) (Siskiyou)	Lake Siskiyou Campgrounds (916) 926-2618	•	•	•	•	3181	3181	3181	3179	3167	Normal operations. Lake full since April. No water skiing. Speed limit - 10 mph. Sail boats OK. Call for reservations.
Lewiston (Trinity)	U.S.F.S., (916) 246-5222 Assoc., (916) 243-2643	•	•	•		1902	1901	1901	1901	1892	Normal recreation. Boat launching, camping, picnicking available. Speed limit - 10 mph.
Little Grass Valley (Plumas)	Oroville-Wyandotte I.D. (916) 534-1221		•	•		5047	5015	5014		5020	Ramps closed. Carry-in boats OK. Fishing, camping and picnicking OK through September.
Loon Lake (El Dorado)	U.S.F.S., Fresh Pond (916) 644-2348, 8-6 Daily	•	•	•	•	6410	6371	6374	6351	6360	Boat ramp available. No reservations required. First come, first serve. Call for current status.
Lopez (San Luis Obispo)	San Luis Obispo Co. FC&WCD	•	•	•	•	520	504	504	503	450	No adverse effect on recreation, due to drought, is anticipated. No reservations accepted over telephone. Must be made in person at main gate no earlier than 3 days in advance.
Lower Bear (Amador)	PG&E, San Francisco,(415) 781-4211 (415) 781-4217	•	•	•	•	5816	5777	5605	5604	No Ramp	Fishing good. Lake 3/4 full.
Mammoth Pool (Fresno)	U.S.F.S., (209) 877-2218	•	•	•	•	3330	3302	3213	3197	OK	Unpaved boat ramp available. Car top and portable boats OK. Lake down 30 feet. All other recreation normal.
McCloud (Shasta)	PG&E, (916) 335-4536	•	•	•	•	2678	2675	2658	2040	OK	Normal recreation and fishing. Will remain at constant elevation about 40' low. Star City Creek campground available.
Melones (Calaveras)	U.S.F.S., (209) 965-3214 U.S.C.E., (209) 847-0225		•	•	•	735	620			618	Ongoing construction in area. No potable water. Call for any changes.
Mendocino (Mendocino)	U.S. Corps of Engineers Mendocino, (707) 462-7581		•	•	•	765	721	702	656	720	Boat ramps now out of water. Car top or portable boats OK. Camping and picnicking all year.
Millerton (Friant) (Fresno)	State Parks and Rec., Park Ranger, (209) 822-2332	•	•	•	•	578	499	498	470	470	Reservations for 90 days in advance. Boat ramps should be available all summer.
Nacimiento (San Luis Obispo)	(408) 424-0866, (805) 472-2311	•	•	•	•	800	706	702	693	693	Boat ramps, fishing, camping and swimming available. Recreation conditions normal.
New Bullards Bar (Yuba)	U.S.F.S., (916) 288-3242		•	•		1957	1768	1755	1736	1782	Boat ramp approx. 20 feet out of water. Hand carried boats only. Camp sites accessible by boat closed. Some debris on lake. Call for current status. Campgrounds open.
Newell Creek Project (Santa Cruz)	(408) 426-5000					577	535	520	510		All recreation facilities closed. No access allowed.
New Hogan (Calaveras)	U.S. Corps of Engineers Project Manager,(209) 772-1343	•	•	•	•	713	611	610	593	582	Launching OK through July. Boat rental and gas available at Marina.
Oroville (Butte)	Park Headquarters,(916) 534-2409	•	•	•		900	713	662	642	725	Launching available at several locations. Call for current status. No night launching - ramps not lighted.
Oroville Diversion Dam (Butte)	Spillway, (916) 534-2335		•				223				Walk-in fishing from bank only. No boats.
Pardee (Amador)	(209) 772-1472					568	472	478	473	540	Recreation facilities are closed. Lake very low.
Perris (Riverside)	State Parks & Rec.,(714) 657-7321	•	•	•	•	1590	1567	1566	1565		All facilities in operation. Boat rentals available. 250 new campsites open beginning July 1.
Pillsbury (Lake)	U.S.F.S., Soda Creek,(707) 743-1582 U.S.F.S.,Mendocino,.(707) 275-2361	•	•	•	•	1900	1870	1863	1855	1810	U.S.F.S. and private campgrounds. Permanent ramps closed. A road has been constructed down to lake - can be used as boat ramp.
Pine Flat (Fresno)	U.S. Corps of Engineers (209) 787-2589	•	•	•	•	954	820	694	674	740	U.S.F.S. Sycamore #1 and #2 campgrounds have no water. Water level falling but still a lot of lake surface. Ramps closed in late July.
Piru (Ventura)	United Water Conservation Dist., (805) 525-4431	•	•	•		1055	965	965	965	953	One boat ramp in service. Fishing normal. Camping normal. Some limitations on water skiing. Boat rentals not presently available.
Prosser (Nevada)	U.S.F.S., Truckee, (916) 587-3558			•		5741	5684	5622	5622		Lake virtually dry. Lakeside campgrounds open only on holiday weekends. Prosser campgrounds open all summer.
Pyramid (Los Angeles)	U.S.F.S., (805) 257-2790 State Parks & Rec.,(805) 967-3494	•	•		•	2579	2576	2574	2569	2557	Boat ramps OK. Some picnic facilities available. Day use only. First come, first serve. Use limited to parking facilities. No fee for use. Boat rental available.
Ralston (El Dorado)	Department of Fish & Game (916) 544-6420; (916) 644-2348		•	•	•	7788	not regulated				Day use only. Backpacking and hiking in this wilderness. No motor vehicles allowed in wilderness area.
Rancho Seco (Sacramento)	Sacramento county Parks & Rec. (916) 366-2061	•	•		•	180	180	180	180	OK	Relatively stable small lake. No power boats. Recreation normal.
Rollins (Nevada)	(916) 273-6185					2171	1988			2140	Recreation facilities closed.
Ruth (Trinity)	U.S.F.S., Mad River Ranger District., (707) 574-6233	•	•	•	•	2654	2629	2620	2608	2625	Newly installed boat ramp in operation. Campgrounds and all facilities open.
Salt Springs (Amador)	PG&E, (209) 295-4211 Weekends and holidays	•	•		•	3959	3781	3746	3734	3846	Three campgrounds available about 3 miles from shore. Carry-in boats best. Reservoir too low for large boats.
San Antonio (Monterey)	(408) 424-0866; (408) 372-4536	•	•	•	•	780	738	720	691	603	Boat ramps, fishing, camping and general park conditions normal. Expect normal recreation all year.
San Lorenzo Creek (Don Castro Res.) (Alameda)	Alameda Co. FC&WCD (415) 881-6258 E.B.R.P.D., (415) 531-9300		•		•	230	229	228	226		Hiking and riding trails. No boating - water low.
San Luis Reservoir & O'Neil Forebay (Merced)	State Parks & Rec.,(209) 826-1196	•	•	•	•	543	469	381	352		Overnight facilities available at O'Neil only. Swimming best at O'Neil Forebay beach area. Water skiing best at O'Neil.
Santa Margarita (San Luis Obispo)	San Luis Obispo Co. FC&WCD	•	•				1277	1274	1271		Recreation normal.
Scotts Flat (Nevada)	Nevada I.D., (916) 273-6185		•	•		3075	3018	2996	2967	3030	Campgrounds. Good fishing. Boat ramp available for car top boats.
Shasta (Shasta)	U.S.F.S., (916) 246-5222 Visitor Info., (916) 243-2643	•	•	•	•	1067	896	847	839	1004	Portable ramps at Jones Valley, Bridge Bay, Holiday Harbor, O'Brien and Centimudi. Lakeshore camping OK. Recording - (916) 246-5338.
Shastina (Siskiyou)	Property Manager, (916) 938-2711		•	•	•	2805	2777	2768	2769		At minimum pool by mid-summer. Campgrounds, motel, swimming pool, golf course and other facilities available.
Shaver Lake (Fresno)	So. Cal. Edison, Big Creek (209) 893-3260	•	•	•	•	5370	5308	5307	5305	5350	Boat launching possible at your risk. Lake is about 25% full. Gradual drawdown now underway. Plenty of camping space available.
Silverwood (San Bernardino)	State Parks & Rec.,(714) 389-2281	•	•	•	•	3355	3337	3330	3326	3308	Boating available. Picnicking, camping and swimming OK. Boat rental available. Reservations available through Ticketron.
Sly Creek (Butte)	Oroville-Wyandotte ID (916) 533-4578					3531	3415	3387	3334		Primitive recreation area. No facilities.
Sly Park (El Dorado)	El Dorado I.D., (916) 622-4513		•			3471	3402	3394	3389		Boat ramp not available. Fishing only from bank. No water-related activities allowed.
Spaulding (Nevada)	U.S.F.S., (916) 273-1371 PG&E, Grass Valley	•	•	•	•	5014	4973	4982	4938	4935	Car-top boats OK. Ramp open. 24 camp units available, seven day limit. First come, first serve. $2.00 per night.
Spring Lake Park	Sonoma Co. Water Agency (707) 527-2211	•	•	•	•	281	281	280	279	272	Heavy recreation use expected. Picnicking, swimming, sail boating. No power boats.
Stampede (Sierra)	U.S.F.S., Truckee (916) 587-3558		•	•		5949	5857	5849	5848	5909	Temporary boat ramp closed. Shoreline launching OK for car-top boats. Will be drawn down for fish kill. Camping facilities open.
Stony Gorge (Glenn)	U.S.B.R., (916) 934-7086		•			841	782	782	782	825	No boating or body contact sports at this site are allowed. Reservoir closed for recreation except for walk-in fishing.
Success (Tulare)	U.S. Corps of Engineers (209) 784-0215	•	•	•	•	653	600	586	570	583	Boating recreation will be limited as lake drops to about 50% of last year's volume. Boat launching may be halted by August 15. Call and check conditions.
Tahoe (Placer)	Call Marina or Resort areas in Yellow Pages	•	•	•	•	6229	6224	6223	6222	6223	Boat launching available at most resorts. Channel deepening now underway in most areas.
Terminous (Tulare)	U.S.C.E. Manager, (209) 597-2301	•	•	•	•	694	630	564	570	566	Boat ramps available to elevation of 565 feet. Recreation expected to be fair until August.
Thermalito Forebay (Butte)	Calif. State Parks, (916) 534-2335	•	•		•	225	223	223	223	220	No power boats. Sail boats only. Day use facilities only.
Thermalito Afterbay (Butte)	Calif. State Parks, (916) 534-2335	•	•			136	126	126	126	123	Power boats OK. Day use facilities only.
Tulloch (Tuolumne) (Stanislaus)	Beardsley Powerhouse (209) 965-3214 (209) 881-3335	•	•	•	•	510	489	488	488	480	Walk-in fishing and carry-in boats. Trailer park, boat rental, gas available. Call to check current status of facilities.
Turlock (Owens Reservoir) (Stanislaus)	Calif. State Parks, (209) 874-2008	•	•	•	•	240	225	222	222	221	Boat launching from sand bar when water low. Campsite reservations through Ticketron.
Union Valley (El Dorado)	U.S.F.S., Fresh Pond (916) 644-2348, 8-6 Daily			•	•	4870	4747	4749	4719	4790	Long way to water from roads and campgrounds. Expect to close latter part of summer. Walk-in fishing and car-top boats OK.
West Valley (Modoc)	(916) 233-3925		•	•	•	4767	4757	4738	4729	OK	Normal fishing available. Boat ramp is natural slope. Camping limited due to fresh water supp
Whiskeytown (Shasta)	N.P.S., (916) 241-6584 Visitor Info., (916) 243-2643		•	•	•	1210	1209	1209	1155	1190	Normal recreation this summer until after Labor Day when reservoir will begin to draw down. Camping, picnicking, beach and boat launching facilities available. Heavy use expected.
Wishon (Fresno)	U.S.F.S., Dinkey Ck, (209) 841-3404 PG&E, Fresno, (209) 264-3806		•	•	•	6550	6532	6517	6479		Lake near full but starting to drop slowly. Boat speed limit - 15 mph. Resort and campgrounds open. Unsurfaced boat ramp usable.

NOTE: THIS DATA IS PRELIMINARY AND SUBJECT TO CHANGE DEPENDING ON PRECIPITATION, RUNOFF, AND DOWNSTREAM REQUIREMENTS

1/ 1 foot 0.3048 metre

21. New uses for an "old" product—Caltrans truck hauling reclaimed water for landscape irrigation in Marin County. On the right is a view of the El Dorado Hills golf course, which discontinued the use of fresh water for its greenery and plans to use reclaimed water permanently.

good recreation is available at Whiskeytown Reservoir near Redding, Thermalito Forebay and Afterbay at Oroville, O'Neill Forebay near San Luis at Los Banos, Castaic Lagoon near Castaic, and Lake Natoma near Folsom.

Among the larger natural lakes, Eagle Lake, Clear Lake, and Lake Tahoe have retained nearly all of their normal recreational potential.

The extreme drought conditions this year caused most Northern California streams to drop below satisfactory levels for whitewater boating unusually early. (See Table 7.) By May 1, most north coast streams were near typical mid- or late June levels. The Klamath River basin was near mid-July levels. The Sacramento and Klamath Rivers are likely to retain minimum satisfactory flows this summer. Other major rivers such as the Eel, Russian, upper Trinity, and upper Smith were already too low for boating by May 1, as were the smaller Coastal and Central Valley streams. The latter streams include the Shasta, Scott, Mad, Mattole, Gualala, Garcia, and Noyo Rivers, and Redwood Creek in the North Coast, and the Cache, Cottonwood, Elder, and Grindstone Creeks in the Central Valley.

In May, releases from Keswick Dam on the Sacramento River averaged around 210 cubic metres per second (7,400 cubic feet per second) and ranged from 280 m^3/s (9,840 cfs) on May 1 to 180 m^3/s (6,500 cfs) by the end of the month. In June, the flow from Keswick averaged 260 m^3/s (9,300 cfs), while the range was from 180 m^3/s (6,500 cfs) to 300 m^3/s (11,000 cfs) on June 30. On July 1, the releases from Keswick were about 320 m^3/s (11,500 cfs). Releases remained above 250 m^3/s (9,000 cfs) through the first part of August and then began an expected gradual decrease to about 85 m^3/s (3,000 cfs) by October 1. These releases will provide satisfactory flows for canoeing and kayaking all summer. Power boating will become very difficult when flows drop below 198 m^3/s (7,000 cfs) sometime in August. Boaters should remember that there are major diversions from the river at Redding, Red Bluff, and near Hamilton City, so the flows in the river

TABLE 7

River Flow and Boating Conditions

Summer 1977

Recorded or estimated river flows and boating conditions for major California streams. Current reservoir inflows and releases, and current river flows are available on a telephone recording, (916) 322-3327, prepared daily (Monday - Friday) by DWR. For additional river information, call DWR (916) 445-3555.

For information on whitewater classes available in your area, call DNOD (916) 445-2427.

STREAM	COUNTY	REACH			RIVER MILES	WHITEWATER	FLATWATER	DESIRABLE FLOW (CFS) 2/ MIN.	DESIRABLE FLOW (CFS) 2/ MAX.	EST. MAY FLOWS (CFS)	EST. JUNE FLOWS (CFS)	EST. JULY FLOWS (CFS)	REMARKS ABOUT BOATING SEASON
American; No. Fork	Placer	Colfax	to	Ponderosa Weir	9	•		200		65			Already much too low for boating.
American; So. Fork	El Dorado	Chili Bar	to	Folsom Lake	19	•		500		690	100	20	Generally unsatisfactory, intermittent flows up to 1700 cfs available on short notice.
American; lower Main	Sacramento	Nimbus Dam	to	Sacramento River	23		•	850		500*	1100*	800*	Marginally satisfactory boating flows.
Cache Creek 1.	Yolo	Bear Creek	to	Rumsey	8	•		350		<10	<10	10<	Too low all season.
Cache Creek 2.	Yolo	Rumsey	to	Guinda	7		•	350		<10	<10	10<	Too low all season.
Carson R., E. Fork	Alpine	Markleeville	to	nr. Gardnerville	18	•		400	3000	200	250	50	Too low all season.
Eel River; Main 1.	Mendocino	Scott Dam	to	Van Arsdale Dam	7	•		300		39	30	50*	Too low all season.
Eel River; 2.	Mendocino, Trinity, Humboldt	Dos Rios	to	South Fork	78	•		1000		300	50	30	Too low all season.
Eel River; 3.	Humboldt	South Fork	to	Rio Dell	22		•	2200		480	100	80	Too low all season.
Eel River; MiddleFork	Mendocino	Eel River R.S.	to	Dos Rios	30	•		750		15	30	20	Too low all season.
Eel River; South Fork	Mendocino, Humboldt	Leggett	to	Main Eel	64	•	•	500		50	50	50	Too low all season.
Feather River; Main	Butte, Sutter, Yuba	Thermalito	to	Sacramento River	44		•	1000		950*	1000	1600*	Satisfactory for small craft.
Kern River; 1.	Kern	vicinity Kernville				•		275		95	160	180	Marginal all season.
Kern River; 2.	Kern	Miracle Hot Sp.	to	Democrat Springs	14	•		450		260*	400*	500*	
Kings River; 1.	Fresno	above Pine Flat Dam			10	•		500		1840*	1700*	400*	Good boating May and June, marginal July.
Kings River; 2.	Fresno	Alta Weir	to	Reedley	27		•	800		150*	2000*	1500	Satisfactory for small craft since June 1.
Klamath River; 1.	Siskiyou	Iron Gate Dam	to	Seiad Valley	56		•	1300		1000	738	710	Minimal satisfactory flows all season.
Klamath River; 2.	Siskiyou	Seiad Valley	to	Salmon River	66	•		1600		1970	1100	1100	Minimal flows all season for paddle craft.
Klamath River; 3.	Humboldt	Salmon River	to	Weitchpec	22	•		2100		2900	1400	1400	Minimal flows all season for paddle craft.
Klamath River; 4.	Humboldt	Weitchpec	to	Klamath Glen	37	•		3500		5600	2000	2000	Minimal flows all season for all boating.
Mad River	Trinity, Humboldt	Ruth Reservoir	to	Blue Lake	38	•		400		7*	10*	25*	Much too low all season.
Merced River	Mariposa	Briceburg	to	Lake McClure		•		500		900	200	130	Good boating in May; too low in June and July.
Mokelumne River; 1.	Amador, Calaveras	Electra	to	Rt. 49	3	•		(250)		290	70	50	Marginal for canoeing in May; too low since then.
Mokelumne River; 2.	San Joaquin	Camanche Dam	to	Lodi			•	150		190*	300*	300*	Satisfactory for canoeing all season.
Owens River	Inyo	Bishop	to	Aberdeen	75		•	200		157*	206*	230*	Satisfactory for canoeing.
Redwood Creek; 1.	Humboldt	Rt. 299	to	Lacks Creek	16	•		200		90	20	50	Much too low all season.
Redwood Creek; 2.	Humboldt	Lacks Creek	to	Brick	25	•		650		400	50	70	Marginal for canoes in May, too low rest of season.
Russian River; 1.	Mendocino, Sonoma	Ukiah	to	Asti	34	•		500		70	80*	80*	Too low all season.
Russian River; 2.	Sonoma	Asti	to	Mirabel Park	35		•	700		<100*	70*	70*	Too low all season.
Russian River; 3.	Sonoma	Mirabel Park	to	Austin Creek	15		•	1000		30*	50*	50*	Too low all season.
Sacramento River; 1.	Siskiyou, Shasta	Box Canyon Dam	to	Lake Shasta	36	•		300	600	150	100*	100*	Too low all season.
Sacramento River; 2.	Shasta, Tehama	Keswick Dam	to	Red Bluff	59		•	5000	15000	7400*	9400*	10000*	Suitable for all types of boating.
Sacramento River; 3.	Tehama, Glenn Butte, Colusa	Red Bluff	to	Colusa	107		•	5000	15000	7500*	8500*	7000*	Suitable for all types of boating.
Salmon River	Siskiyou	Forks of Salmon	to	Klamath River	194	•		600		850	300	150	Minimum boating flows in May.
Scott River	Siskiyou	Etna	to	Klamath River	40	•	•	700		121	100	90	Too low all season.
Shasta River	Siskiyou	4 mi. N. of Yreka	to	Klamath River	7	•		400		90*	10*	10*	Too low for all boating; all season.
Smith River; Main	Del Norte	South Fork	to	U. S. 101	12		•	900		1500	500	300	Minimal for first half of summer.
Smith River; Middle Fk.	Del Norte	Patrick Creek	to	Gasquet	8	•		350		300	100	50	Too low all season.
Smith River; North Fk.	Del Norte	"Major Moore's"	to	Gasquet	13	•		500		300	100	50	Too low all season.
Smith River; South Fk.	Del Norte	Goose Creek	to	Smith River	13	•		650		750	150	70	Too low for all boating, all season.
Stanislaus River 1.	Calaveras, Tuolumne	Camp 9	to	Rt. 49	18	•		450	4000	650*	450*	350*	Suitable for paddle craft in May.
Stanislaus River 2.	Stanislaus	Knights Ferry	to	Caswell S. P.			•	250		20*	20*	10*	Too low all season.
Trinity River; Main 1.	Trinity	Lewiston	to	Junction City	30	•		550		400	150	150	Marginal for paddle craft.
Trinity River; 2.	Trinity	Junction City	to	Cedar Flat	31	•		1000			200	180	Marginal for paddle craft.
Trinity River; 3.	Trinity	Hawkins Bar	to	South Fork	8	•		1350		500	300	250	Too low all season.
Trinity River; 4.	Humboldt	South Fork	to	Weitchpec	31	•		1600		1200	400	350	Marginal flows all season.
Trinity River; South Fk.	Trinity	Underwood Creek	to	Trinity River	20	•		550		350	200	150	Too low all season.
Truckee River	Placer, Nevada	Tahoe City	to	Boca	25	•	•	250		200*	200*	150*	Marginal for rafting.
Tuolumne River 1.	Tuolumne	Lunsden Branch	to	Wards Ferry	18	•		800	4000	175*	1300*	*	Too low all season.
Tuolumne River 2.	Stanislaus	LaGrange	to	Waterford	20		•	200	1000	3*	3*	3*	Too low all season.
Tuolumne River 3.	Stanislaus	Waterford	to	San Joaquin River	26		•	100		60*	<40*	*	Marginal for canoeing.
Van Duzen	Humboldt	Bridgeville	to	Carlotta	22	•		500		300	40	10	Too low all season.
Yuba River; North Fk.	Nevada	Goodyear Bar	to	Rt. 49	9	•		300		450	200	90	Too low all season.
Main	Yuba	Rt. 20	to	Marysville	16		•	200		360*	500*	400*	Marginally suitable for paddle craft.

* Subject to variation due to upstream reservoir operations.

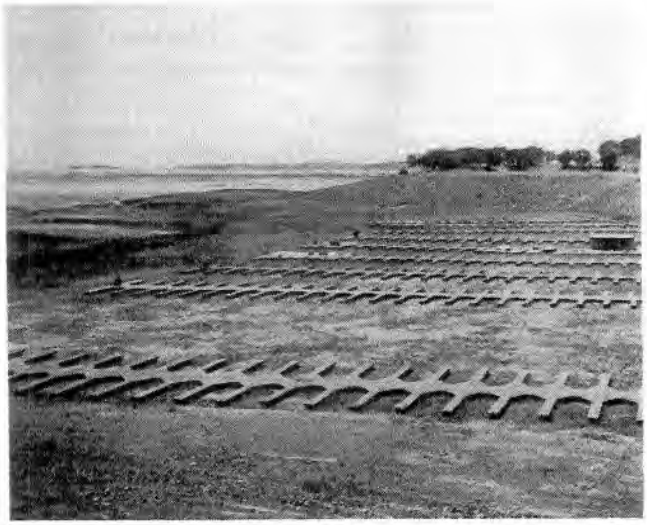
1/ Stations for which daily data are available. Other streams do not have daily data available for this report.

2/ The reported "desirable flow" for Whitewater streams are considered satisfactory for the average kayaker, canoes would require about 50-80% of these flows, rafts would require about 150-200% of these flows. On flatwater streams, all craft require similar flows.

3/ 1 cfs = .028317 cms.

The use of the following guide books has been most helpful: "West Coast River Touring" by Dick Schwind, 1974; "Sierra Whitewater" by Charlie Martin, 1974; and "Canoeing Waters of California" by Ann Dwyer

RIVER FLOWS AFFECT SAFETY



22. A common sight—Beached mooring facilities shown at Brown's Ravine in Folsom Lake. The temporarily relocated marina is at the left background. The photo was taken in July 1977.

below these points are substantially less than the Keswick release. Streamflow information for various locations is published in local newspapers and given in local TV and radio newscasts.

Releases from Iron Gate Dam on the upper Klamath River averaged about 28 m^3/s (1,000 cfs) through May with the day to day variance in flows. In June, the releases from Iron Gate averaged 21 m^3/s (740 cfs), except for a few days around mid-month when heavy rains resulted in releases near 25 m^3/s (900 cfs). The flow on August 1 was 20 m^3/s (710 cfs). Depending upon the elevation of Klamath Lake, which is upstream from the dam, flows are expected to remain at a 20 m^3/s (710 cfs) minimum until October. This should result in a flow of about 42 m^3/s (1,500 cfs) at Orleans, which should provide minimum satisfactory conditions for rafting, canoeing, and kayaking. Power boating will be very difficult or impossible in some reaches of the Klamath.

Flows in the Smith River below its south fork, the Trinity River below its south fork, and the Salmon River below the fork are too low for good rafting.

In the central part of the State, reduced river flows early in the season cut short the whitewater boating activities on many streams, and in most other streams dropped below minimum necessary flows by mid-May. No river running is expected on the Tuolumne this season. On the Stanislaus, running ended about mid-May as was the case with the Merced. On the Kings, rafting can be accommodated down to flows of about 20 m^3/s (700 cfs), and in late April flows of 50 m^3/s (1,000 cfs) were being registered at Pine Flat. Commercial rafting on the Kern, ordinarily requiring flows of 11 to 14 m^3/s (400-500 cfs) above Isabella Reservoir and 17 to 20 m^3/s (600-700 cfs) below Isabella, was discontinued early as flows in late April were less than 11 m^3/s (400 cfs) and 8 m^3/s (300 cfs) above and below Isabella, respectively. However, enough water for kayaking was still available.

Most National Forest recreation areas in Northern California are open for use this summer, but there could be some problems due to low water supplies and extreme fire hazard. The fire season started earlier than usual due to the extremely dry conditions.

23. Lake recreation suffered as lake levels dropped to record lows. Typical is the Loafer Creek camp ground and marina area at Lake Oroville. Many marinas incurred financial losses as patronage dropped and operational costs spiraled.

Some campground water supplies may go dry in late summer, while others will have water reductions of 25-50 percent. In some cases, portable toilets will replace flush toilets so campgrounds without water can be used.

The fire danger will depend on the rest of this summer's weather and the success of a summer cloud seeding program undertaken by the State. In early August, a series of lightning storms started several major fires, mostly in remote areas. Should conditions worsen, fire permits could be suspended and camping restricted to designated campgrounds, or portions of the forests could be closed to use. Fire closures are not likely at the higher elevations, but streams are very low and backpackers should carry water and purification tablets. Horsepackers are operating as usual and were able to get into the backcountry two to four weeks earlier than usual.

The outlook for specific forests:

Six Rivers National Forest - All facilities and areas are expected to remain open. Recreation use so far is higher than normal. A few campgrounds may have water supply problems later. There may be fire restrictions or forest closures later this summer, if the fire hazard is extreme. Many small intermittent streams are already dry.

Klamath National Forest - All facilities and areas are open. Fire hazard has been extreme with a major fire in the Forks of the Salmon area. Some closures may be necessary later.

Modoc National Forest - All areas and facilities are expected to remain open, but the fire hazard is exemplified by the occurrence of several major fires in early August. The backcountry is arid and vegetation is not dense, so closure should not be required. Backpackers should take plenty of water. Medicine Lake is in good shape.

Shasta-Trinity National Forest - Only about two-thirds of the campgrounds in the forest were opened this summer due to the expected low use, especially at Shasta and Trinity Lakes. Some campground water supplies may go dry later this summer and the fire danger is likely to be extreme. Expect some fire restrictions and closures later in the summer.

The Shasta-Trinity Forest again has a dial-a-number service to provide recreationists with boating and campground information this summer (916-246-5338).

Mendocino National Forest - Campgrounds and other areas will remain open this summer, but fire danger will be extreme. Some closures are likely. Backcountry lakes and streams are very low; backpackers should carry water.

Lassen National Forest - All campgrounds are expected to remain open. Water supplies are adequate so far. Lakes and streams in the backcountry are low. Some closures are possible if the fire danger gets extreme.

Lassen National Park - Campgrounds, day use areas, and backcountry areas were opened as usual. Water supply and fire danger conditions are not expected to cause the park to be closed to the public. Some areas were closed temporarly because of bubonic plague.

Sierra National Forest - There are no plans to close the forest and pack train activity is expected to continue throughout the summer and early fall. All of the country above the 1 800-metre (6,000-foot) elevation remains open.

Fish and Wildlife

The impact created by the drought on fish and wildlife ranges from none to severe. Problems south of the Tehachapis and in the desert are relatively minor. The situation in the rest of the

State is moderate to severe. This is of major concern to the Department of Fish and Game (DFG), which is now proceeding with efforts to aid fish and wildlife adversely affected by drought.

Anadromous fish species have been particularly victimized by the reduced flows and increased temperatures in rivers resulting from the drought. Coastal populations, especially steelhead and silver salmon, will be continually affected during 1977. Rainfall occurring in May and June of this year eased the situation somewhat for downstream migrants in the Northcoast Rivers. However, it is expected that early fall-run king salmon -- particularly in the Sacramento, Feather, Klamath, and Trinity Rivers -- will face adverse water temperatures. Spawning success will be poor for fish which spawn prior to November 1. Subsequent to November 1, spawning conditions are expected to be at least marginally adequate in all streams except the Feather, Stanislaus, and American Rivers.

During the 1976 fall-run, cool water from Trinity Dam was mixed with warmer water from Shasta Reservoir to control the temperature of the Sacramento River. This year, however, storage in the Trinity Reservoir will be too low to provide the amount of water necessary to cool the discharge from Shasta. Water temperatures suitable for egg incubation are around 13°-14° C (56°-58° F). Temperatures of the outflow at Shasta Reservoir could reach as high as 20°-21° C (68°-70° F). Under such conditions, salmon eggs could not survive.

Spring spawning conditions were adequate for striped bass, but spawning occurred earlier and further downstream than normal. Young-of-the-year survival through July 1977 may improve over that during the last several years because of reduced Sacramento-San Joaquin Delta exports.

Low April through June flows impaired

24. Casualties of the drought. These fish were victims of low streamflow, as their usual pools dried up by early summer. This photo of carcasses in Stony Creek near Orland was taken in July 1977.

shad spawning migrations and fisheries in the American, Yuba, and Lower Feather Rivers. Most shad spawning occurred in the Sacramento River below Red Bluff and should be adequate. However, evidence indicates that reduced spring and summer flows will result in a reduced survival rate of juvenile fish.

Trout and other game fish in the middle and low elevations have also been adversely affected by the drought. Intermittent flows have become common this summer in the smaller streams and some will dry up completely. Especially hard-hit are those fish in streams draining the foothills of both the east and the west slopes of the Coast Range.

Due to the lack of run-off reaching streams and reservoirs, only a limited amount of nutrients are finding their way into the game fish food chain. One result is that the DFG's Trophy Trout Program has been damaged, apparently because the nutrient deficient waters

have prevented or reduced threadfin shad production. In the absence of this necessary dietary item, plants of trout have not yielded the usual returns of trophy-sized fish. In warm water reservoirs the sparse nutrient content has reduced the production of zooplankton, utilized as food by young sunfish.

Fish populations in cold water reservoirs are being seriously affected this summer. Many reservoirs have, or will become, quite low, making angler and planting access difficult. A few reservoirs will lose all of their water and, therefore, the trout and angling which they supported.

Drought damage to fish populations in warm water reservoirs has been of considerable magnitude, but it is hoped that the damage is only temporary. Some reservoir fisheries will be lost in instances where loss of water is complete or where the high temperatures and low dissolved oxygen in residual pools cause fish die offs.

In most remaining warm water reservoirs, the natural reproduction and recruitment of warm water species will be limited or nonexistent. For example, in drought impacted reservoirs, the habitat suitable for largemouth and smallmouth bass spawning and egg incubation is greatly reduced. Therefore, not only will the occurrence of these activities be curtailed, but they will generally lack suitable cover and substrate type to be very successful.

Native non-game fish populations in the smaller lower and middle elevations are exposed to the same types of drought impacts as were described for the gamefish in those locations. Lake populations of non-game fish should be less susceptible to drought conditions with the exception of stream spawners like the Clear Lake hitch.

It is difficult to assess the drought's impact on amphibians and reptiles. Since the southwest desert area has received near normal amounts of precipitation, the large amphibian and reptile populations in that area have not yet been adversely affected. The situation in the north is more complex. Where the life cycles of reptile and amphibian species are dependent upon an abundant water supply, e.g. salamander, the drought will have a negative effect on populations. Other, not so water-dependent, varieties will be less affected. An overall negative impact on reptiles and amphibians can be expected, but the degree and duration are unknown.

The drought continues to have a deleterious effect on the nesting and migratory habitat of waterfowl. Due to the lack of precipitation, much fresh water marsh habitat has dried up, forcing more and more birds to concentrate on less available area. Under such crowded conditions, the outbreak of disease among the birds is a serious threat.

In the Sacramento Delta-Suisun Marsh Area, food supplies for wintering waterfowl are expected to be critically short this season. Waterfowl usually feeding in this area will be forced to turn to other sources. Farmers stand to lose crops to depredation by the birds. Some population loss due to poor feeding conditions is also expected. The DFG is preparing to institute out-of-the-sack feeding in order to keep birds on state and federal areas, should it be necessary.

Big game and other forest wildlife will also be subjected to negative impacts by the drought. Lack of moisture in the forests and rangelands has substantially lowered the quantity and quality of available forage. As the quality of forage goes down so does the nutritional plane of wildlife. This results in a decreased production and survival rate of the animals.

Smaller springs and waterholes have dried up, forcing the animals to concentrate near permanent water sources and to overuse the associated riparian vege-

tation. The concentration of wildlife is likely to increase the potential for the spread of disease. The entire situation is compounded where livestock also concentrates in areas used by game species. Since ranchers' livestock are faced with the same type of reduced food conditions as the wildlife, it is probable that livestock and wildlife will be competing for forage in some areas.

As natural forage dwindles, many species will resort to man-made feed conditions. Ranchers expect a fair amount of crop depredation by elk, deer, and antelope. Bear depredation in campgrounds and garbage dumps is also expected to increase.

Muskrats, racoons, and opposum suffered losses last year when many miles of irrigation ditches were drained or not filled. This year even more miles of habitat are being affected. Depredation, especially by beavers, will increase as water levels in ditches continue to drop.

Of special interest is the effect of the drought on rare and endangered species. The most severely impacted will be some fish, amphibians and reptiles. It is possible that their already precarious existence, a condition caused by man, will not be able to withstand the additional stress of the drought. One exception to this grim picture is the blunt nosed leopard lizard. If the drought reduces the rate at which the remaining wildlands of the San Joaquin go "under the plow", state and federal biologists will have additional time to protect a habitat essential to the survival of this species.

No major problems are foreseen for endangered mammals; however, some short-term changes may occur.

The drought impact on rare and endangered birds varies. The low water and dryness of northeast California lakes will reduce food supplies for the bald eagles and ospreys in that area. However, loss of wildlife and other mammals in the condor range could benefit the condor by increasing the food supply.

During the remainder of 1977, there will be increased demands for water appropriations from all users, together with requests for relaxation of minimum flow standards. If approved, the lower flows will result in additional negative impacts to fish and wildlife.

When flow conditions are below normal, the total dissolved solids (TDS) carried by the stream increases, with the potential for a water quality problem. The effects on fish and wildlife may vary, but when the TDS exceeds established tolerances set by the Basin Plans, the effects are certain to be deleterious. An example of such a problem is in Spring Creek, a tributary of the Sacramento River north of Redding. A portion of the drainage into Spring Creek is from an old copper mine. The copper content and, therefore, the acidity of this water is very high. In a normal year, water released from Shasta Dam has been sufficient to dilute the acidic water from Spring Creek to tolerable levels. This fall, however, water flow from Shasta Dam may not be great enough to dilute the Spring Creek drainage. Unless adequate dilution water is released, the fall-run salmon could be wiped out by the flows.

Dewatering of streams not only affects the local aquatic resources but also damages the riparian vegetation. Although the damage will not be permanent, the length of time required for full recovery will depend upon the duration of the water shortage. Some adverse impacts on vegetation will remain for several growing seasons after the drought subsides.

The situation in the Suisun Marsh is of great concern to the DFG. The lowered flow from the Sacramento River will be unable to prevent saltwater intrusion into the Sacramento Delta and Suisun Marsh. Higher salinity of the water will result in damage to the vegetation

in the area as well as the local wildlife. Specifically, the alkali bulrush production in the Marsh in 1977 is expected to be 50 percent or less than that of a normal year. Since the seeds of this plant are a major source of food for wintering waterfowl, problems in feeding the birds this winter are imminent. One year of normal rainfall will not be able to amend the situation; it will take several years to successfully flush the salt from the soil in the Suisun Marsh and Sacramento Delta. Until that time, waterfowl populations will continue to be adversely affected.

Another water quality problem which may arise as a result of the drought involves treated municipal waste water. A decrease in the flow through treatment plants could result in a higher toxicity of waste discharges. Public health concerns dictate heavy chlorination of waste water effluents. Unless effective dechlorination techniques are employed, aquatic organisms in the receiving waters may suffer.

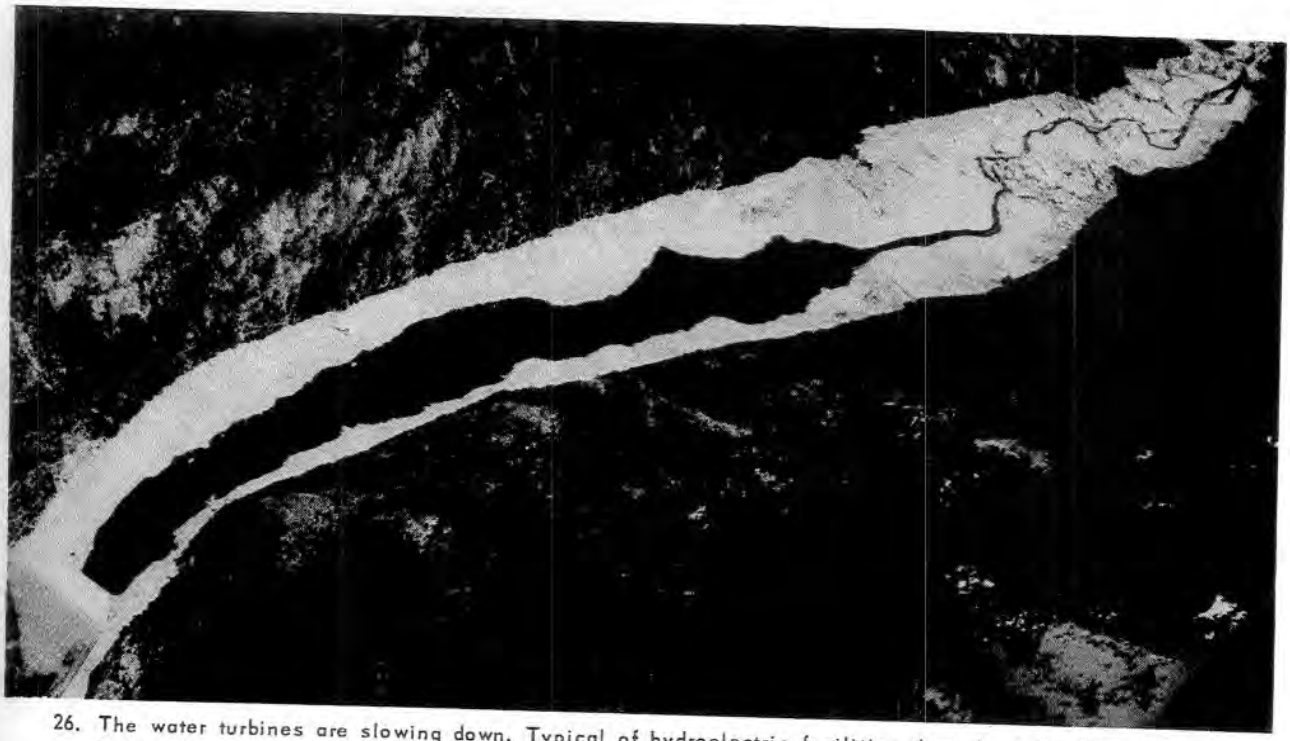
Energy

Californians were fortunate that surface reservoirs were reasonably full at the beginning of the drought last year. Power utilities elected to continue using their reservoirs to generate power in 1976, creating reservoir levels much lower than normal. With the added drawdown and the record low stream runoff as a result of the continuation of the drought this year, reservoirs are at an extremely low level.

Reservoir storage in California during 1976 was sufficient to generate about half the normal amount of hydroelectric energy. This will not be the case in 1977. As the water level in the reservoir drops, the energy generated per unit of water is reduced. For example, at the beginning of 1976, an acre-foot of water released from Lake Oroville generated about 550 kilowatt hours (Kwh) of electrical energy, while at end of 1976, an acre-foot of water generated about 460 Kwh of electrical energy.

In an average year, hydroelectric output is about 32.6 billion Kwh or about 20 percent of the State's total electrical generating capacity. Hydroelectric generation during 1977 is expected to be 63 percent below average, falling short by

25. Cherry Lake, a source of hydroelectric energy for San Francisco, as it appeared in February 1977. The low level shows the effect of two years of drought. (photo courtesy of San Francisco Public Utilities Commission)



26. The water turbines are slowing down. Typical of hydroelectric facilities throughout the Sierra, Salt Springs Reservoir on the Pacific Gas and Electric Company system contained only 6.7 cubic hectometres (5,400 acre-feet) of its 172 cubic-hectometre (139,400-acre-foot) capacity when this photo was taken on April 15, 1977.

about 20 billion Kwh. This means that about 7 percent of California's electrical energy in 1977 will come from hydro facilities, with the remaining 13 percent of the total generating output shifted to other sources. Replacement of the 20 billion Kwh of hydroelectric energy with fossil fuel powered steam generation would require 33 million barrels of oil at a cost of about $500 million.

In 1976, the effects of the drought on hydroelectric generation were reduced by purchasing over 12.5 billion Kwh of firm and surplus energy from the Pacific Northwest. Because precipitation in the Pacific Northwest has been below normal, surplus hydroelectric energy will not be available in California. Firm deliveries will also be reduced in 1977. Total hydroelectric energy imported from the Pacific Northwest is expected to be about 4 billion Kwh.

In addition to the shortage of hydroelectric energy, the decrease in surface water available for irrigation has precipitated an increase in the amount of agricultural pumping. This year an additional (in excess of normal) 4 200 hectometres (3,400,000 acre-feet) is expected to be withdrawn from ground water basins. This will use about 1 billion Kwh of energy at a power cost of over $25,000,000. Costs are expected to continue rising because of the additional power necessary for raising water from lower levels.

Because Northern California ordinarily relies on hydroelectric power for one-third of its energy requirements, the Pacific Gas and Electric service area is more affected by the drought than other areas. PG&E expects to purchase additional power from San Diego Gas and Electric, the Los Angeles Department of Water and Power's Scattergood Plant, Southern California Edison, Nevada Power Company, and Arizona's Salt River Project. Southern California utilities should not be affected by the drought as they rely chiefly on fossil fuel generation. Assuming no unforeseen events, such as unplanned outages of generation

or unusually hotter summer weather, PG&E expects to meet all the electricity requirements of its customers. The likelihood of planned outages this summer is doubtful, but utilities will be operating at a reduced margin above peak demand.

In order to avoid a delay in action, should an energy shortage occur because of the drought, Assembly Bill No. 446 (Fazio) was approved by Governor Brown on June 30, 1977. AB 446 gives the Governor explicit authority to declare a state of emergency due to a "sudden and severe energy shortage". Local authorities are also given the power to declare a "local emergency" due to an energy shortfall. The measure is designed to render the State capable of taking the quick and decisive actions which may be required to deal effectively with an energy shortfall.

In addition to water conservation education programs aimed at conserving energy, some utilities are initiating conservation programs in order to reduce peak demand loads. At the request of the California Public Utilities Commission, PG&E lowered the upper voltage limit by 3 percent to its commercial and residential customers. Previously, voltages ranged from a low of 114 volts to a high of 126 volts, and with the 3 percent reduction, the range is now 114-122 volts. The reduction in voltage has no effect on normal household use.

The Sacramento Municipal Utilities District (SMUD) is experimenting with a load management program aimed at reducing summer peak-time demand loads by turning off selected residential air-conditioning units in the Sacramento area.

SMUD has installed remote-controlled switches on the air-conditioner compressors in 300 volunteer homes. SMUD can then turn off some or all of these air-conditioners for a period of five to nine minutes. The purpose of the load management experiment is to study the effects of the program, consumer acceptance, and to note what changes in lifestyle are present.

If the initial program is successful, SMUD would like to equip about 140,000 homes. The net effect of the program would be that of a "negative generator" in which SMUD plans to conserve about

27. A borate bomber is caught in an oft-repeated scene as California's tinder-dry forests entered the 1977 fire season. After two years of drought, the fire potential is extremely high.

two years' peak generating capacity.

Forests and Wildlands

Lack of rain has caused a severe moisture stress in brush and timber areas in California. The two major impacts have been the increased wildland fire potential and an increased loss of trees to insects and disease.

Large fire fuels, such as logs, snags, large tree limbs and stumps, usually buried in snow and wet during the winter months, were exposed and dry this past winter. When large fuels do not receive adequate moisture to reduce their burning potential, they contribute to the overall devastating effects of fires by causing them to grow larger, to burn hotter and faster, and to be more difficult to control.

In addition to a more volatile fuel supply this summer, fire fighters will be hindered by the lack of water supply for combating the fires. Water from traditional sources such as lakes, ponds, rivers, and streams may be nonexistent or difficult to gain access to in many areas. As a result fire fighting techniques have had to be modified somewhat this year. Wildland fire fighters have intensified training and use of "dry" fire fighting methods (handlines -- bulldozers). They have also had to haul water into critical areas and provide portable pumps to isolated water sources which are not easily accessible.

The following table shows comparative figures for California wildland fires this year versus the predrought five-year average (as of August 8). Until the end of July, firefighters, anticipating a bad fire season, were able to keep the amount of acreage burned down to 15 percent or less of average. Starting August 1, 1977, however, a series of lightning storms throughout the State started over 800 fires. During the next seven days, roughly 104 000 hectares (256,000 acres) burned.

WILDLAND FIRES AND HECTARES (ACRES) BURNED
AS OF AUGUST 8, 1977

	1977	5-Year Average	% Gain or Loss
Number of Fires	7,058	9,609	-27%
Number of Hectares (Acres) Burned	114 000 (281,000)	63 000 (156,000)	+ 81%

Fuel conditions remain extremely critical in most of the State. There is still a grave potential for this year's fire season to be even more destructive.

Tree mortality is a serious problem in water-stressed areas. During this drought year, great concern about tree mortality has been warranted by two ominous indicators. First, tree mortality appeared early this year, at least four months ahead of usual in forested zones below 1 500 metres (5,000 feet) in elevation. It is occurring in both individual large trees and in numerous stands of young timber. Secondly, unusually warm weather increases the number of bark beetles, a natural enemy of trees. In the past two years, temperatures have been, for the most part, higher than usual.

The drought is expected to cause a large number of trees of all species and at all elevations to die. During the drought of the early sixties, an estimated 1 billion feet of timber was killed. At this time the CDF is anticipating the loss of 1.5 billion board feet of lumber. The dead trees will add to the already serious fuel accumulations in wildlands.

STEPS BEING TAKEN IN 1977

Although the 1977 water supply situation is dismal and requires prudent management to meet all essential needs, it is being accommodated by a variety of countermoves at all levels. Water reserves will be dangerously low, however, at the end of the water year in October 1977.

Disaster Relief (Federal)

Public Law 9518, effective April 11, 1977, provides for establishment of a federal "water bank" to be administered by the USBR. Those individuals or agencies having water for sale can receive payment from the "bank" in return for releasing water to the USBR. Those needing water can buy from the water bank. The law as written provides that only USBR customers and Indian projects are eligible to purchase water under water bank provisions. To date, little use has been made of the new law.

Public Law 9518 also appropriates $15,000,000 for emergency construction loans to assist nonfederally funded projects in all the states. Most of the California irrigation water supply agencies are expected to be eligible.

The Department of Food and Agriculture had suggested streamlined procedures to expedite federal agricultural disaster assistance for drought emergency. Pressure exerted by the states upon the federal administration has borne fruit in the form of unraveling the red tape associated with drought disaster emergency loans administered by the U. S. Department of Agriculture. On April 12, 1977, the Secretary of Agriculture began a liberalized drought credit program which will enable eligible farmers to get emergency loans immediately, in many cases, instead of having to wait until actual losses can be calculated at the end of the season. The loans, at 5 percent, are available from the Farmer's Home Administration.

On June 13, 1977, Secretary of Commerce, Juanita M. Kreps, approved an $11.8 million package for drought relief programs in California. The funds were the first to be approved under the $175 million Community Emergency Drought Relief Act that President Carter signed into law May 23.

Marin Municipal Water District will receive a $5,560,000 loan and a $1,387,000 grant to help cover the cost of the pipeline over the Richmond-San Rafael Bridge and to purchase 12.9 million cubic metres (3.4 billion gallons) of water from the U. S. Bureau of Reclamation.

The Placer County Water Agency will receive an $85,000 loan and an $85,000 grant for pumps to draw water from the American River where the water level is below existing intakes.

A $2,306,000 loan and a $2,406,000 grant have been approved for the El Dorado Irrigation District at Placerville to provide additional water for domestic and agricultural use and to aid in fire protection in the El Dorado National Forest. The program includes distribution and storage facilities at Jenkinson Lake and financing the purchase of water from PG&E.

On July 6, the Economic Development Administration approved a $6 million loan and a $1.5 million grant to the East Bay Municipal Utilities District (EBMUD) for meeting expenses resulting from the drought. EBMUD is faced with increasing its rates to pay for emergency supply facilities and to maintain the level of revenues necessary to operate its water system.

The federal aid will cover the costs of an emergency pumping plant at Middle River in the Sacramento-San Joaquin Delta, where lower quality Delta water will be blended with higher quality

water from Pardee Reservoir on the Mokelumne River. The emergency facilities also include extra purification equipment and a new chlorination facility.

A listing of federal drought-related assistance programs follows:

Program Name	Description
Administered by Farmer's Home Administration[1]:	
Emergency Loans	Guaranteed/insured loans at 5 percent interest to repair, restore, or replace damaged or destroyed farm property and to provide operating expenses, refinance debts, and finance farming adjustments.
Emergency Livestock Loans	Guaranteed/insured loans at negotiated interest rates for agricultural production purposes essential to livestock operations related to breeding, raising, fattening, or marketing.
Farm Operating Loans	Guaranteed/insured loans (now at 8 percent) to purchase animals, fish and bees, and equipment, provide operating expenses and for other miscellaneous uses.
Farm Ownership Loans	Guaranteed/insured loans at 5 percent interest to enlarge, improve, and buy family farms, refinance debts, provide water and water facilities, soil treatment and conservation, and other uses.
Soil and Water Loans	Guaranteed/insured loans at 5 percent interest to level land, carry out basic treatment practices; establish permanent pastures and farm forests; improve irrigation; develop water supplies for home use and livestock; purchase pumps, sprinkler systems and other irrigation equipment; acquire water rights; restore and repair ponds and tanks, ditches, and canals for irrigation; dig ditches and install tile to drain farmland; and other designated purposes.
Irrigation and Drainage Loans	Guaranteed/insured loans at 5 percent interest for irrigation, drainage, or other soil conservation measures.

[1] An agency of the U. S. Department of Agriculture.

Community Program Loans	Loans at 5 percent interest, grants at 50 percent of cost for community facilities including those providing or supporting overall community development such as water supply, fire and rescue services, transportation, traffic control, and community, social cultural, health, and recreational benefits. On May 23, $225 million was appropriated to this program for drought-related loans and grants to communities under 10,000 population.
Administered by Agricultural Stabilization and Conservation Service[1/]	
Emergency Conservation Measures Program	Project grants (up to 80 percent of cost) for emergency cost sharing limited to new conservation problems created by natural disasters which, if not treated will impair or endanger the land; materially affect the productive capacity of the land; represent damage which is unusual in character and, except for wind erosion, is not the kind which would recur frequently in the same area; and would be so costly to rehabilitate that Federal assistance is or will be required. A total of $1,090,000 was made available to participants in Imperial, Riverside, El Dorado, and Tehama Counties.
Livestock Transportation Assistance Program	Project grants, limited to two-thirds of the cost of transportation (up to $24 per head). In lieu of hay transportation assistance or emergency livestock feed assistance, this program provides federal reimbursement for the costs of transporting eligible livestock to and from distant pastures where forage is available.
Agricultural Conservation Program (ACP)	Project Grants (usually 50/50 cost sharing and not more than 75 percent by ACP) to stimulate and help farmers, ranchers, and woodland owners to carry out approved soil, water, woodland and wildlife conservation practices. As part of the White House "drought package", an additional $100 million

1/ An agency of the U. S. Department of Agriculture.

	($11,500,000 allocated to California) was appropriated to the 1977 program for drought-related soil conservation measures. Called the Drought and Flood Conservation Program, it has proved extremely popular with Californians, who have submitted applications totaling $29,000,000.
Disaster Payments Program	Disaster Payments/Direct Grants. The Disaster Payments Program (composed of the Upland Cotton Program, The Wheat and Feed Grain Programs, and the Rice Program) provides income protection for farmers with crop allotments by making disaster payments when eligible crops suffer a natural disaster (prevented plantings) and by making deficiency payments when market prices average less nationally than the target prices (abnormally low yields).
Emergency Feed Program	Project grants (reimbursement for up to 10 pounds of grain or equivalent per beef cow at 2 cents per pound not to exceed 50% of actual cost) to livestock owners with insufficient feed, suffering loss of feed, requiring larger than usual purchase of feed, and suffering undue financial hardship in obtaining feed through normal channels, all as a result of the emergency.
Administered by Federal Crop Insurance Corporation[1/]	
Federal Crop Insurance	Insurance (provides guarantees on productive costs up to 75 percent of average crop yield in an area) to improve economic stability of agriculture through a system of crop insurance by providing all-risk protection for individual farmers to assure return of basic operating dollars in the event drought, freezes, insects or other natural hazards destroy the insured crop.

1/ An agency of the U. S. Department of Agriculture.

Administered by the Forest Service[1/]

Cooperative Forest Fire Control	Formula Grants to provide permanent protection of nonfederal timberland, potential timberland, and certain non-forested watershed lands from fire danger.
Cooperative Forest Insect and Disease Management	Project Grants (federal cost sharing not to exceed expenditure by cooperators). Assistance in the prevention, detection, evaluation, and suppression of forest insect and disease outbreaks on state and private lands.
Rural Community Fire Protection Program	Project Grants (up to 50 percent of the amount spent) to protect lives and property by providing technical, financial and other assistance to state foresters who, in turn, provide assistance in training, organizing, and equipping rural fire fighting forces.

Administered by Soil Conservation Service[1/]

Resource Development and Conservation	Project Grants; Advisory Service and Counseling to provide assistance to local units of government for developing a planning process through which long and short range plans can be prepared for the conservation, utilization, and development of natural resources in the area. Based on the long-range plan, financial and/or technical assistance is available for planning and carrying out measures for purposes such as flood prevention, erosion, and sediment control, public water-based recreation and fish and wildlife developments, agricultural water management purposes, and others.
Conservation Technical Assistance	Advisory Services and Counseling to plan and carry out a national soil and water conservation program, and to provide leadership in conservation, development, and productive use of the nation's soil, water, and related resources.
Watershed Protection and Flood Prevention	Grants, Advisory Services and Counseling assistance in planning, designing, and installing watershed works of improvement; in sharing costs of flood prevention, irrigation, drainage, sedimentation control, and public water-based

[1/] An agency of the U. S. Department of Agriculture.

	fish and wildlife and recreation; and in extending long-term credit to help local interests with their share of the costs.
Administered by Department of Interior	
Emergency Fund	Emergency loans to meet unusual or emergency conditions such as "canal bank failures, damages to transmission lines; or other physical failures or damages, as acts of God, or of the public enemy, fires, flood, drought, epidemics, strikes, or freight embargos, or conditions interrupting water or power services". As part of the White House "drought package", an additional $30 million was appropriated to this fund bringing the FY 1977 total to $30 million.
Drought Emergency Program	Loans, Grants, and Deferments (1) to establish a water bank to assist water users to purchase water from willing sellers, including producers of lower value annual crops, and to redistribute such available water supplies for the maintenance of higher value perennial crops, crops to support foundation dairy and beef cattle herds and other breeding stock; and other uses as appropriate; (b) to augment water supplies in 1977 by permitting water user organizations to undertake construction; develop wells; build pipelines; pump water from dead pool storage, rivers, streams and drains; and other activities to alleviate the impact of the drought; (c) to conduct studies to identify opportunities to augment, utilize, or conserve water supplies and evaluate potential facilities to mitigate the effect of a recurrence of the current emergency and make recommendations to the President and the Congress; (d) to provide non-reimbursable funds of state water resources agencies for drought-related projects; and (e) to aid the Fish and Wildlife Service in its fish and wildlife mitigation measures.

Drought-Related Technical Assistance	Several ongoing water resource development and management programs which provide a basis for drought-related technical assistance. The area in which assistance can be provided include: (1) planning, design, and construction of facilities to supply water for irrigation and other purposes; (2) management and operation of irrigation water conveyance and distribution systems and on-farm water management to maximize the productivity of limited water supplies; and (3) atmospheric water resources management, i.e., cloud-seeding and other techniques to increase natural precipitation where conditions are favorable.
Grazing Privileges	Use of property and facilities to allow domestic livestock grazing on public lands through permits and leases.
Administered by Economic Development Administration[2/]	
Community Emergency Drought Relief	Loans (5 percent interest); grants (up to 50 percent of cost) for the improvement, expansion, or construction of water supply systems; the purchase and transportation of water to provide immediate relief of an existing drought condition, and the promotion of water conservation. Projects which reduce or eliminate threats to public health or safety will be emphasized.
Economic Adjustment Program	Project grants (25 percent matching share, cash or in kind) to provide funds to help State and local areas meet special needs arising from actual or threatened unemployment as a result of economic dislocation. Funds may be used for any of the following: public facilities, public services, business development, planning, rent supplements, mortgage payment assistance, unemployment compensation, and other appropriate purposes.
Public Works Impact Projects	Project grants (80-100 percent grant rate; local matchings share may be waived if governmental entity can demonstrate exhaustion of its taxing

2/ An agency of the Department of Commerce.

	and borrowing capacity). Construction of public facilities to provide immediate jobs to the unemployed or underemployed in designated project areas. The local Public Works Act of 1977, incorporating the "Packwood Amendment" to an earlier authority, allows the substitution of drought-related projects for projects already approved.
Administered by Small Business Administration	
Emergency Drought Disaster Loans	Guaranteed/insured loans; currently 6-5/8 percent interest, with 5 percent to remedy the effects of actual or prospective substantial economic injury resulting from the 1976-1977 drought and for short-term projects to improve water conservation projects or repair, replace or improve affected water supply facilities.
Physical Disaster Loans	Direct loans and Guaranteed/Insured Loans; interest formula based on cost of money to SBA, up to 30 years for repayment; to provide loans to restore the victims of physical-type disasters to pre-disaster condition; funds may be used to repair or replace damaged or destroyed realty, machinery, and equipment, household and other personal property; loans not available for agricultural purposes.
Economic Injury Disaster Loans	Direct Loans and Guaranteed/Insured Loans; interest formula based on cost of money to SBA, up to 30 years for repayment; to assist business concerns suffering economic injury in a designated disaster area; funds can be provided to pay current liabilities; working capital for a limited period can be provided to continue the business in operation until conditions return to normal; no funds available for realty, equipment repair, or acquisition.
Administered by Employment and Training Administration[3/]	
Unemployment Insurance - Grants to States	Project Grants to provide unemployment insurance coverage to eligible workers through a cooperative federal-state

3/ A subdivision of the Department of Labor.

	program in which state unemployment insurance tax collections are used to pay benefits and federal unemployment insurance tax collections are used to cover the administrative costs of the state programs as well as to reimburse the states for one-half the amount paid in benefits. Table II of the Emergency Jobs and Unemployment Assistance Act of 1974 established a temporary federal program of Special Unemployment Assistance (SUA) for workers who are unemployed during a period of aggravated unemployment and who are not otherwise eligible for unemployment compensation under any other Federal or State law.
Farm Workers	Project Grants. Farm worker families may be offered services such as relocation assistance, occupational training, education, health services, day care, nutritional service, legal, job development, placement, and other supportive services.
Comprehensive Employment and Training Programs	Formula Grants; Project Grants. Title VI of the Emergency Jobs and Unemployment Assistance Act is directed to providing temporary public service employment for unemployed and underemployed persons. Preferred consideration is given to workers who have exhausted all unemployment compensation or are not eligible for it and workers who have been without a job 15 weeks or longer.
Employment Services	Advisory Services and Counseling to place persons in employment by providing services to individuals in need of preparation and/or placement and to employers seeking qualified individuals to fill job openings. Services provided to veterans, the disadvantaged, youth, older workers, the handicapped, rural residents and workers. In regard to the latter, services include year round recruitment and placement of workers, assistance to farmers in meeting critical labor needs, and recruitment and transport of migratory farm workers.

Civil Defense - Emergency Water Supply Equipment

Use of Property, Facilities, and Equipment to restore temporarily water supplies in communities suffering shortages from enemy attack or natural disaster emergencies. Loan of equipment (including electric generators, pipes, pumps, purifiers, storage tanks, etc.) is usually on a 90-day basis but may be extended if conditions warrant. The government loans directly to the states.

Drought Emergency Loans (State)

In connection with the low-interest (2-1/2 percent) Davis-Grunsky drought emergency loan program made possible by AB 3793 (Keene, 1976), eleven small public agencies have been provided loans to undertake mitigative measures in 1977. They are Lime Saddle CSD, granted a $35,000 loan on February 10, 1977, to dig a new well; Stinson Beach Co. WD, loaned $45,000 on March 11, 1977, to furnish and install water meters; Mariposa PUD, loaned $40,300 on March 17, 1977, to drill a new well; El Dorado ID, $100,000 on March 29, 1977, for transfer facilities; Templeton CSD, $50,000 on April 5, 1977, for a new well; Fall River Mills, $55,000 on May 20, 1977, for a new well; Orick CSD, $44,250 on June 7, 1977, a new well; Bolinas CPUD, $100,000 on June 10, 1977, for a new well; City of Williams, $75,000 on June 22, 1977 for new wells; Vista ID, $100,000 on June 24, 1977, for a new well, and Denair CSD, $100,000 on August 9, 1977, for pumping facilities and a new well. Four other applications were being reviewed as of August 1, 1977.

The 1976 legislation (AB 3793, Keene) has been broadened and extended by AB 395 (Gualco, 1977) signed on June 1, 1977. The 1977 legislation doubled the loan amounts available (now up to $200,000 per community), made larger communities eligible (by changing maximum size criteria from 100,000 population to 200,000), extended the period of eligibility through 1978, and deleted

28. A vanishing pool. Stockton Creek Reservoir, once the source of water for the town of Mariposa, has become so low that it will soon be unusable. The town has drilled a number of wells, but their dependability is in question and water rationing is in effect. Merced *Sun-Star* photo.

the $2,000,000 appropriative limit set by 1976 law. AB 395 also provides that public agencies in California can enter into federal agreements for drought relief without necessity of local elections.

In late July, two bills, SB 720 and SB 469, were in the State Assembly. These bills would establish a state-operated fund for low-interest loans to agricultural water users. If passed, drought stricken agricultural users meeting certain criteria would be eligible for funds with which to finance development and operation of water storage and delivery systems.

The funds will be made available in the form of 10-year loans at 2-1/2-3% interest. This is the first action of its kind to be considered by the State.

"Safe Drinking Water" Bond Act Loans

This Bond Act, passed by the electorate in June 1977, provides for loans to upgrade existing water systems. The first loans were approved by the DWR in June 1977. Recipients are the Crestline-Lake Arrowhead WA, $1,225,000 on June 2, 1977, for a treatment plant and transmission facilities to consolidate several independent systems; Pine Mountain Mutual WC (Mendocino County), $25,000 on June 10, 1977, for upgrading a treatment plant and transmission facilities; La Habra Heights Mutual WC, $1,500,000 on June 21, 1977, for transmission facilities and a pumping station; Quincy WC, $500,000 on June 30, 1977, for water storage, treatment, transmission, and metering facilities; and Patterson City WC, $111,770 on June 30, 1977, to replace old and leaking water mains and relocating a trunk sewer threatening the water supply.

The Department of Health held a public hearing on August 9 in Berkeley to update the list and add new applications received since February.

To aid water storage districts experiencing cash flow problems due to the drought, SB 795 (effective June 30, 1977) temporarily modifies current limitations on the issuance of interest-bearing warrants. This allows the districts to spread the cost of current obligations over future years when revenues will be derived from the sale of normal water supplies.

Warrants issued prior to August 1, 1978, will be subject to the following limitations:

1. Maximum annual interest of 8%;
2. Maximum term of 10 years;
3. Maximum of $4 million to be sold in any fiscal year (i.e., a total of $8 million may be issued by any water storage district under the provisions of SB 795).

State Equipment Loans and Services

In a continuation of the program begun in 1976, the Office of Emergency Services (OES) is loaning to public water agencies, on a short-term emergency basis, materials and equipment needed to provide continuity of service during the drought emergency. Recipients

29. Emergency Lines—In a scene repeated in many locations, a temporary pipeline carries emergency supplies of water. This photo shows facilities installed by the El Dorado Irrigation District to serve the Monte Vista area. The rock wall is part of an early ditch system serving the city of Folsom.

and a description of services rendered follow:

Jurisdiction Area Date of Agreement	Purpose of Loan
Amador County	
Pine Acres CSD, June 30, 1976	Two 100 GPM[1/] pumps, one 100 GPM water purification unit, two 1,500 gallon water tanks to connect existing well to a fourth well for 800 people.
Pioneer CSD, July 15, 1976	One 1,500 GPM pump, 14,400 feet[2/] of 8-inch[3/] pipe, two 1,500 gallon water tanks to provide water for domestic and fire-fighting purposes for 1,600 people.
City of Plymouth, August 26, 1976	3,600 feet of 8-inch pipe, one 100 GPM pump, one 30 Kw generator to add an existing well to the water system for 650 people.
Calaveras County	
Calaveras County WD, June 8, 1977	Three 15 Kw generators to pump domestic water from White Pines Reservoir to pipelines leading down-County for 1,600 families.
El Dorado County	
El Dorado County ID (EID), July 27, 1976	3,000 feet of 8-inch pipe, one 1,500 GPM pump, one 100 GPM pump to pump and pipe water from existing reservoirs to depleting tank for 3,000 people in Pleasant Valley, Diamond Springs, El Dorado, Shingle Springs, and Cameron Park.
EID, August 20, 1976	One 30 Kw generator.
EID, March 11, 1977	Two 100 GPM water purification units to filter and purify water in mine shafts, ponds, creeks, and other sources, and then transfer it to main water distribution system.
EID, May 11, 1977	One 250 Kw generator to supply power for the Sly Park emergency intertie or the Bass Lake emergency intertie.

1/ GPM - gallons per minute, 1 gallon equals 3.7854 litres

2/ 1 foot = 0.3048 metres.

3/ 1 inch = 25.4 millimetres.

Glenn County	
Elk Creek CSD, August 26, 1976	One 100 GPM water purification unit to purify water from receding levels of Stony Gorge Dam for 2,000 persons.
Marin County	
North Marin County WD and Marin MWD, July 28, 1976	2,500 feet of 8-inch pipe, 14 couplings, two 3,000 gallon water tanks to transfer water from Lagunitas Creek and other plentiful areas to scarce areas of Bolinas, Inverness, Pt. Reyes Station, and Stinson Beach.
North Marin Co. WD	35,518 feet of 8-inch pipe, 1,794 couplings.
Marin MWD	One 1,500 GPM pump, 15,000 feet of 8-inch pipe, 936 couplings.
North Marin Co. WD, March 11, 1977	One 1,500 GPM pump, ten 8-inch couplings, two 8-inch gate valves to pump water from Lagunitas Creek to reservoir storage for controlled release to subscribers later this year.
Marin Co. Emergency Services, March 21, 1977	Three 1,500 gallon rubber collapsible water storage tanks to provide a readily available source of quality water for domestic consumers.
Mariposa County	
Mariposa Co. Emergency Services, March 28, 1977	3,000 feet of 8-inch pipe, four 8-inch gate valves, 180 8-inch couplings to tie together the Greenamyer wells and water storage system to municipal water systems to supply one-third of Mariposa County water needs.
Mono County	
Mammoth Co. WD, August 26, 1976	2,500 feet of 8-inch pipe, 125 8-inch couplings to carry water from Lake Mary to Mammoth Creek and Owens River for 3,500 people.
Napa County	
Cities of St. Helena and Calistoga, June 8, 1977	21,000 feet of pipe and accessories to develop an emergency water source capability using the existing wells available, and to further develop St. Helena's capability to immediately react to a loss of its primary water supply.

Shasta County

Mountain Gate CSD, May 13, 1976	One 1,500 GPM pump, 1,500 feet of 8-inch pipe, 96 couplings to connect water system to receding Shasta Lake for 1,800 persons.
Mountain Gate CSD, March 28, 1977	3,000 feet of 8-inch pipe, 165 8-inch couplings and accessories to draw water from Shasta Lake.

Siskiyou County

Siskiyou Co. Emergency Services, February 28, 1977	Two 1,500 gallon water tanks to comply with directive from Public Utilities Commission to provide quality water to housing tract adjacent to City of Yreka.

Tulare County

City of Porterville, June 18, 1976	One 3,000 gallon water tank, one chlorinator, 12,000 feet of 8-inch pipe, 864 couplings to transport water from existing well to an empty well for 500 people.
Tulare Co. Emergency Services, March 15, 1977	Three 3,000 gallon rubber collapsible water storage tanks, three gallon rubber collapsible water storage tanks to provide temporary and stationary limited quality water for small communities in County.

The Defense Civil Preparedness Agency (DCPA), Department of Defense, loans directly to the States in the event of a natural disaster emergency. Loan of equipment and facilities is usually on a 90-day basis, but the period may be extended if conditions warrant.

The California Conservation Corps announced that it has around 700 members available for drought-related labor. Their use is free to state agencies and is available to local governments on a 20 percent reimbursement ($6.80 per day) basis. They can also be used to assist private utilities. The seven CCC camps in Northern California are located at Bishop, Angels Camp, Auburn, Chico, Red Bluff, Weott, and Crescent City. Two other camps are at San Luis Obispo and Escondido.

The California National Guard is available at any time, subject to call up, if necessary to fight fires.

In other actions, the Drought Emergency Task Force has surveyed the State to determine availability of tank trucks for use in Sonoma and Marin Counties to help dairy farmers provide water for their herds. The district fairs associations indicated they have trucks available for use, as has the U. S. Corps of Engineers.

Caltrans supplied a well drilling rig to determine the feasibility of using

ground water as an alternate water supply to the Orland Water Users Association, a farming area among the hardest hit by lack of water in the State. Their Stony Gorge and East Park reservoirs were depleted well before summer. Drilling began at Orland on March 26, 1977. Additional wells have been authorized by Association vote and $2,000,000 in interest-free loans has been made available for this work by the USBR.

To facilitate statewide dissemination of drought information, the Drought Information Center, in March 1977, instituted the use of a toll-free telephone number. Now anyone in the State may pick up a phone, dial 800-952-5530 and receive up-to-date information on drought status and assistance programs.

Drought Emergency Task Force

On March 4, 1977, Governor Brown signed Executive Order No. B-27-77 providing for the creation of the Drought Emergency Task Force, under the direction of Major General Frank J. Schober, Commanding General of the State Military Forces. The duties of the Task Force include the direction and coordination of State efforts to combat the effects of the drought, and the provision of public information regarding the nature and extent of the drought, and efforts to combat it. Membership includes the Departments of Food and Agriculture, Water Resources, Forestry, and Military, the Office of Emergency Services, Public Utilities Commission, Energy Resources, Conservation and Development Commission, and the State Water Resources Control Board. Also participating is the U. S. Corps of Engineers.

In discharging its duties, the Task Force has held a number of public meetings throughout the State to gather information on local problems. It prepared a 31 page directory of assistance programs and has distributed copies to county boards of supervisors, agricultural commissioners, and field offices of the State Office of Emergency Services. The summary lists federal aid programs available and local officials are encouraged to pass the information along to applicants. The Task Force has also provided assistance in suggesting corrective legislation and help in determining local needs for loans and grants.

Water Exchanges

a) The Metropolitan Water District (MWD) of Southern California, in a February 10, 1977, agreement with the Department of Water Resources (DWR), East Bay Municipal Utility District (EBMUD), the U. S. Bureau of Reclamation (USBR), the State Water Resources Control Board (SWRCB), Contra Costa County Water District and Marin Municipal Water District agreed to reduce its demands upon the State Water Project (SWP) by up to 493 cubic hectometres (400,000 acre-feet) of water, and to call upon its alternate supply from the Colorado River to replace the SWP water. The water thus freed is being made available to agricultural users, mainly in the San Joaquin Valley, and to San Francisco Bay urban users. By reason of this exchange, and that in (g) following, San Joaquin Valley water contractors were allocated an additional 342 cubic hectometres (277,769 acre-feet). With this water, the agricultural contractors will receive a total which is equivalent to 91 percent of their 1977 entitlement, instead of the 40 percent they would have received without it.

b) The Marin MWD is the principal urban beneficiary of the MWD exchange noted above. In a separate agreement dated March 21, 1977, between DWR, San Francisco PUC, City of Hayward, EBMUD, and Marin MWD, the DWR agreed to furnish approximately 13 cubic hectometres (10,800 acre-feet) to

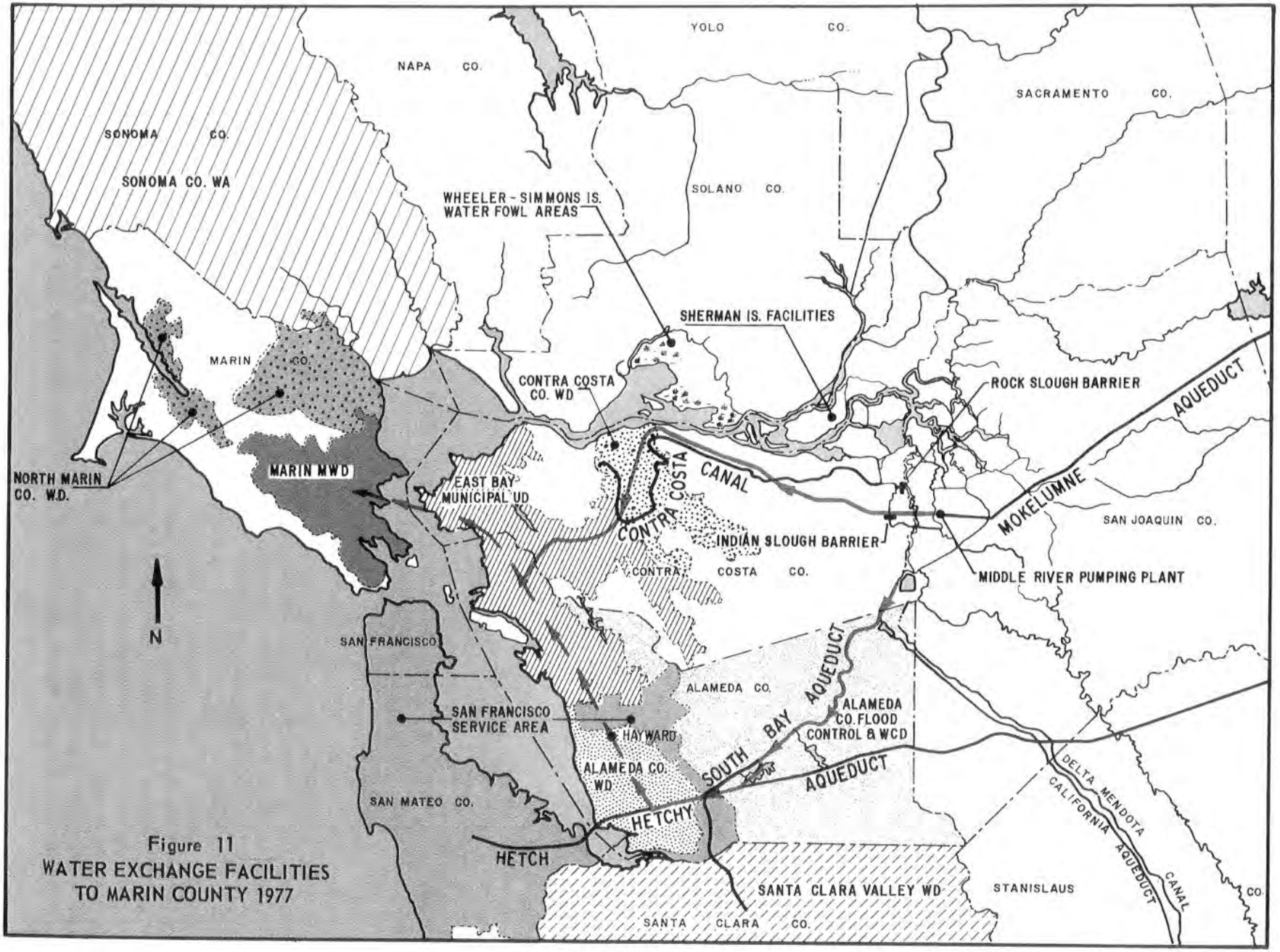


Figure 11
WATER EXCHANGE FACILITIES
TO MARIN COUNTY 1977

Marin MWD during 1977. The DWR agreed to provide water from its South Bay Aqueduct and deliver it into San Francisco's San Antonio Reservoir, near Sunol. San Francisco is storing and treating the water and delivering it to the city of Hayward for transmission through the latter's facilities to the EBMUD service area. The EBMUD has constructed a connecting facility and is delivering an equivalent amount of water to a pumping plant constructed by Marin MWD in Richmond near the easterly terminal of the Richmond-San Rafael Bridge. The Department of Transportation agreed to the use of a lane on the bridge for the placement of a pipeline, installed by Marin MWD, conveying water to Marin's existing facilities near San Rafael. The exchange facilities to Marin County are pictured in Figure 11.

The first SWP water began flowing into San Antonio Reservoir on April 4, 1977. First water arrived in San Rafael on June 7, 1977.

c) In an effort to minimize the effect upon water quality in the Contra Costa Canal service area from the low Delta water flows expected in 1977, the DWR agreed to provide certain temporary facilities to direct better quality water from within the Delta to the Contra Costa Canal intake at Rock Slough. Signatories to this June 3, 1977 agreement include DWR, EBMUD, USBR, and the Contra Costa County WD. As a part of this plan, rock barriers were installed at Rock Slough and at Indian Slough to tap the better quality water of the latter. This work was completed March 8, 1977. The second part of the plan envisioned pumping from Middle River, with still better quality water, into EBMUD's Mokelumne Aqueduct No. 1, where it will be transported and then released at the Rock Slough intake. Power will be supplied by the USBR. This will provide water quality required under the most recent SWRCB criteria.

Work on the pumping plant at Middle River began under DWR contract on April 4, 1977, and water began flowing through the EBMUD line on June 10, 1977.

d) On March 11, 1977, the DWR entered into an agreement with Reclamation District No. 341, serving part of Sherman Island in the Delta, and the North Delta Water Agency, to provide water of usable quality for agricultural purposes to the western end of the island, threatened with increased salinity intrusion as a result of decreased Delta flows in 1977. The Department has furnished and installed four pumps totalling 1.7 m^3/s (60 cfs) capacity and assisted in deepening a drainage canal to utilize higher quality water from waterways bordering the eastern edge of the Island. In return, the District and the Agency agreed to a relaxation of the water quality standards at Emmaton on the Sacramento River.

30. Lifeline to Marin—A temporary 610-millimetre (24-inch) pipeline conveys water across the Richmond-San Rafael bridge to drought-stricken Marin County. Water is pumped from the Sacramento-San Joaquin Delta and uses facilities of the East Bay Municipal Utilities District, the San Francisco Water Department, the city of Hayward, and the State Water Project to get to this point.

e) In another move to counter the expected saline intrusion in the western Delta, the DWR entered into a March 30, 1977, agreement with the Department of Fish and Game and certain owners and operators of duck clubs in the Wheeler-Simons Islands area of the Suisun Marsh. The agreement provides for bringing higher quality water from Montezuma Slough through the DFG-managed Grizzly Island Wildlife Management Area to the islands in question. This will permit bettering soil salinities which in turn will promote higher waterfowl food production in 1977. Costs of approximately $8,000 will be shared, 75 percent by the two state agencies and 25 percent by the owners.

f) In another agreement, executed June 3, 1977, the USBR will supply up to 92 cubic hectometres (75,000 acre-feet) of water during 1977 for use by EBMUD. Such water will be obtained from the Delta by pumping into EBMUD's Mokelumne Aqueduct No. 2 at Middle River. The EBMUD also agrees to wheel through its aqueduct that portion of the SWP water promised Marin MWD in the March 21, 1977, agreement that cannot be delivered through the San Francisco-Hayward connection. The facilities are shown on Figure 11.

g) An agreement dated April 28, 1977, provides that the DWR will construct, operate, and remove three rock barriers located on the Old, Middle, and San Joaquin Rivers. (The Middle River work was subsequently postponed.) The two temporary barriers, equipped with flap gates to counter tidal action, were completed July 20, 1977, and are serving to provide an adequate pumping level for agricultural users and to minimize quality degradation of channel water used for irrigation in the south Delta. Signatories to this agreement are the DWR and the South Delta Water Agency. Affected are 12 950 hectares (32,000 acres) irrigated from the San Joaquin River between Vernalis and Paradise Cuts from Tom Paine Slough and Old River near the north end of the slough, and from the southern portion of Middle River.

h) In examples of the cooperation being evidenced during the difficulty, three Southern California SWP water contractors have agreed to forego 44 cubic hectometres (35,279 acre-feet) of their 1977 entitlement so that additional water may be made available to drought-stricken Northern California. San Bernardino Valley MWD gave up 20 cubic hectometres (16,000 acre-feet) of its 50 cubic hectometre (40,592 acre-foot) entitlement and both Coachella Valley County WD and Desert WA gave up their entire 1977 entitlements, 9.3 cubic hectometres (7,579 acre-feet) and 14.4 cubic hectometres (11,700 acre-feet), respectively.

Of the amounts relinquished, 37 cubic hectometres (30,180 acre-feet) have been allotted to SWP agricultural users and 6.3 cubic hectometres (5,099 acre-feet) are held in reserve for urban use.

i) Public Law 95-18 provides for a federal "Water Bank" where water users and suppliers can buy and sell water. Several rice growers in the Pleasant Grove-Verona Mutual Water Company have agreed to forego planting about 1 000 hectares (2,500 acres) of rice, and instead sell the water, about 12 cubic hectometres (10,000 acre-feet), to farmers in the Friant-Kern service area.

j) The Devil's Den Water District is delivering 5 cubic hectometres (4,000 acre-feet) of its 1977 SWP

entitlement to Westlands Water District (served by the CVP) for use on lands owned by one company with ownerships in both districts. The transfer of water will make it possible to maintain viable farming operations in both areas.

k) A similar transfer is being processed to permit movement of up to 1.3 cubic hectometres (1,020 acre-feet) of SWP water from Tulare Lake Basin WSD to Westlands WD of the CVP. The affected landowner is rehabilitating wells on the Tulare farmland and the transfer will allow the continuation of his Westlands farming operation and the continued employment of 15 workers.

l) The City of Redding agreed to sell its unused CVP entitlement, 2.5 cubic hectometres (2,026 acre-feet), to 4 local water districts encountering water supply difficulties. The 4 are: (1) Mountain Gate CSD, 123 000 cubic metres (100 acre-feet), (2) Summit City PUD, 32 000 cubic metres (26 acre-feet), (3) Bella Vista WD, 1.7 cubic hectometres (1,400 acre-feet), and (4) Shasta Dam PUD, 0.6 cubic hectometres (500 acre-feet).

m) The Paradise ID, in Butte County, is the beneficiary of an exchange in which the California Water Co., PG&E, and Butte County agree to make available up to 0.7 cubic hectometres (540 acre-feet) of water in 1977. Butte County will provide the water from its 1977 allotment of SWP water, and PG&E will wheel it. Both PG&E and CWC will be compensated for extra costs associated with the exchange.

n) Modesto ID and Turlock ID, co-operators of New Don Pedro Reservoir on the Tuolumne, are planning to drawdown the reservoir below minimum pool so that Turlock ID may obtain an additional 123 cubic hectometres (100,000 acre-feet) for the 1977 irrigation season. MID's share of storage would be unaffected. An agreement signed May 26, 1977, provides that TID would be responsible for lost power generation as a result of the move.

o) The DWR has approved the request of two farm operators in the Westlands WD to store pumped ground water in the California Aqueduct. Pumping would take place during periods of low use by the farmers with subsequent retrieval of replacement water as it is needed.

Water Conservation

In a statement on May 16, 1977, the California Water Commission (CWC) and the Department of Water Resources (DWR) declared it to be the policy of both agencies to achieve maximum practical water conservation and the most efficient use of water in the State.

Implementation of the water conservation policy expressed by the CWC and

31. Cooperation requested—As the drought heightened, many communities resorted to unusual tactics. This sign at the entrance to Inverness (in Marin County) requests cooperation in its conservation efforts.

the DWR is being achieved by the following:

- Actions are being taken to ensure that water is used in a reasonable manner and to prevent unreasonable use or waste of water, while recognizing the unique nature of each water use.
- Extending State help to local agencies in implementing conservation through advisory services and technical advice.
- For areas where opportunities for water savings exist, local agencies are being requested to prepare water need forecasts and to develop and implement a program to achieve reasonable and practical water conservation.
- Current use of water supplies is being examined to determine the extent to which conservation measures can satisfy additional needs in an area before endorsing any plans for additional water development for that area.
- All means are being explored for implementing water conservation, including additional legislation to authorize or require local water agencies to mandate water conservation and to establish conservation-inducing water pricing measures.
- A public education program to increase awareness, encourage people to conserve water, and instill a conservation ethic in the population.
- Water conservation projects are being encouraged throughout the State to provide examples of water conservation methods.

On August 6, 1976, aware of the coming drought emergency in California, the Legislature passed Assembly Concurrent Resolution 165 calling on all state agencies to review their programs and activities for the purpose of implementing water conservation measures. The Department of Water Resources was asked to consult and advise other agencies and make recommendations for water conservation.

Sixty-one state agencies have prepared, or are now preparing, plans to conserve water.

General Services (GS) has control over bathrooms and drinking fountains in most state-owned buildings. It plans to save about 125 megalitres (33 million gallons) of water a year through bathroom and drinking fountain retrofitting. In addition, GS owns 1,300 residential units leased to private individuals. An additional 102 megalitres (27 million gallons) of water per year can be saved by retrofitting bathrooms and kitchens in these units.

The California Youth Authority, Department of Corrections, and the Military Department are also retrofitting their bathroom fixtures. The amount of water that will be saved is unknown so far.

The Department of Parks and Recreation expects to reduce water use at Cal-Expo by 30 percent. At its state parks it has instituted a program to reduce water consumption by restricting landscape watering and by installing low-flow showers, springloaded or self-closing faucets, low-flush toilets, and toilet dams. In some areas, it is closing restrooms and substituting chemical toilets.

Caltrans is installing toilet water dams and low-flow shower heads in its facilities. Since landscaping uses constitute the major fraction of its total water consumption (about 49 cubic hectometres [40,000 acre-feet] of the total 62 cubic hectometres [50,500 acre-feet]), considerable emphasis has been

placed on cutting landscape use. A four-phase plan has been adopted and the first two levels have been in effect since February 10, 1977. Levels 1 and 2 provide for: extending night watering, decreasing unit amounts of water according to plant type, monitoring automatic controllers, selective thinning of leafy plants, increased use of mulches, using reclaimed water, using wetting agents, discontinuing nitrogen fertilizers, considering use of anti-transpirants, elimination of replanting, and elimination of lawn and ground cover watering in flat areas. Level 3 would eliminate all watering to remaining ground cover and associated shrubs, with level 4 calling for discontinuing all watering.

The Governor's Office of Emergency Services (OES) has conducted a series of community water resource management workshops in various locations around the State. Financed under a federal grant, the program is aimed at community water managers and local officials and is concerned with the technical, managerial, and physical aspects of developing and operating local water conservation and community water management programs.

A total of 11 workshops have been conducted. The Department of Water Resources (DWR), Valley Regional Training Center, County Supervisors Association of California, League of California Cities, and the Association of California Water Agencies, in addition to OES, served as sponsoring agencies for the workshops.

A drought conference bringing together state and local officials, water and sanitary agencies, and representatives from industry and manufacturing was held in late July. Two conference sections, one in Northern California (Concord) and one in Southern California (Los Angeles), convened to discuss, on a statewide level, strategies for water conservation and responses to the drought situation. Technical information regarding water conservation was shared among those in attendance and some new and innovative water conservation methods were discussed. The sponsoring agencies were OES, DWR, and the California Manufacturers Association.

The urban areas of Northern and Central California are feeling the effects of the second year of drought. More than 100 communities now have some form of mandatory water conservation or rationing, and almost every community in the State has placed restrictions on the outdoor uses of water, such as car washing, hosing off sidewalks and driveways, and watering lawns and shrubs. Table 8 demonstrates the extent of the urban problem and the measures being taken by communities throughout the State. It shows, for example, that rationing programs allowing as little as 189 litres/person/day (50 gallons/person/day) have been necessary to provide for meeting domestic needs in 1977 and to provide a reserve for 1978. Table 9 is a measure of the effectiveness of those conservation programs in 35 of the State's communities. The Monterey Peninsula Communities, East Bay MUD, and Marin MWD, among the most stringently rationed areas in the State, as expected demonstrate some of the highest conservation rates, with 46 percent, 36 percent, and 53 percent, respectively, through June 30, 1977.

32. Hand-held hoses, a common scene in suddenly water-conscious communities. This method of watering has been mandated in a number of water-short areas because it reduces application rates and eliminates wasteful runoff.

TABLE 8

COMMUNITIES IMPACTED BY DROUGHT
PRACTICING CONSERVATION IN 1977
As of July 15, 1977

County and City	Source of Supply	Savings Goal Percent	Degree of Effort	Remarks
ALAMEDA				
Albany Berkeley Castro Valley Oakland San Leandro San Lorenzo	EBMUD	35	Mand.	Rationing: 225 gals/household/day Industry cut to 80%, commercial 70%, parks 40% of normal use.
Fremont Newark Union City	Alameda Co. WD, SWP, Hetch Hetchy, Wells.	25	Mand.	Rationing: 369 gals/household(3)/ day.
Hayward	Hetch Hetchy	25	Mand.	
ALPINE				
None reported				
AMADOR				
Amador City Drytown Ione Jackson Sutter Creek	PG&E's Amador Canal	25	Mand.	Restricted outside use. 25% cut to metered customers, 50% to others.
Pine Acres	Wells	30	Mand.	
Pine Grove	Well	50	Vol.	
Pioneer	Antelope Creek	65	Mand.	Rationing: 50 gals/person/day. Moratorium[1/]
Plymouth	Arroyo Ditch, Wells	50	Mand.	Rationing: 600 gals/household/ day. 75% cut to commercial uses.
BUTTE				
Cohasset	Indiv. Wells			Individuals hauling water.
Forest Ranch	Indiv. Wells			Individuals hauling water.

1/ Moratorium on new service connections.

TABLE 8 (Continued)

COMMUNITIES IMPACTED BY DROUGHT
PRACTICING CONSERVATION IN 1977
As of July 15, 1977

County and City	Source of Supply	Savings Goal Percent	Degree of Effort	Remarks
BUTTE (Continued)				
Lime Saddle CSD	Wells			Some wells failing. Deep well funded by drought emergency loan to be completed in late summer.
Magalia	1 well and tie to Paradise ID		Mand.	Well supply falling. Emergency supplies available from PG&E, PID, and Bader Mine. Mand. rationing: 213 gals/household/day. 50% for business and agric.; 33% for public facilities. Restricted outside use.
Paradise	Paradise Res. Magalia Res.		Mand.	Both reservoirs low. Rationing and restricted outside use since April 1. Exchange water from Cal. Water Service, Butte Co. Purchasing from Del Oro WC and PG&E.
CALAVERAS				
Angels Camp	PG&E	35	Mand.	Restricted outside use.
Copper Cove Copperopolis Ebbets Pass Rancho Calaveras Sheep Ranch West Point Wilseyville	Calaveras Co. WD via PG&E, Wells	25	Mand.	
Carson Hill Douglas Flat Murphys Vallecito	Union PUD via PG&E	25	Mand.	

TABLE 8 (Continued)

COMMUNITIES IMPACTED BY DROUGHT
PRACTICING CONSERVATION IN 1977
As of July 15, 1977

County and City	Source of Supply	Savings Goal Percent	Degree of Effort	Remarks
COLUSA				
Arbuckle	3 wells	40	Vol.	Water levels 70 feet down since January 1. One well to be lowered. Applied for FmHA grant.
Colusa	5 wells	40	Vol.	Water levels dropping. Best well to be lowered.
Williams	4 wells		Mand.	Two wells out of service - New well to be drilled with drought emergency loan funds. Restricted outside use.
CONTRA COSTA				
Antioch Clayton Concord	Contra Costa WD	30	Mand.	Restricted outside use.
El Cerrito	EBMUD	35	Mand.	Rationing: 225 gals/household/day. Industry cut to 80%, commercial 70%, parks 40%, apartments 65%, of normal use.
Martinez	Contra Costa W.D.	30	Mand.	Rationing: 363 gals/household/day. Industry and commercial cut 10%, apartments 30%, parks 50%.
Pacheco Pleasant Hill	Contra Costa W.D.	30	Mand.	Restricted outside use.
Pittsburg	Contra Costa W.D.		Mand.	Rationing: 360 gals/household/day. 30% cut to commercial uses.
Richmond	EBMUD	35	Mand.	Rationing: 225 gals/household/day. Industry cut to 80%, commercial 70%, parks 40%, apartments 65%, of normal use.
Walnut Creek	Contra Costa W.D.	30	Mand.	Restricted outside use.

TABLE 8 (Continued)

COMMUNITIES IMPACTED BY DROUGHT
PRACTICING CONSERVATION IN 1977
As of July 15, 1977

County and City	Source of Supply	Savings Goal Percent	Degree of Effort	Remarks
DEL NORTE				
Klamath CSD	Well			Well and pump shut down 2/18/77 for salt water intrusion. Emergency tie in to Simpson Timber Co.
EL DORADO				
Cameron Park Diamond Springs El Dorado El Dorado Hills Placerville	El Dorado ID	67	Mand.	Users placed on "lifeline" rates. Rationing: 150 gals/household/day.
FRESNO				
Fresno	Wells	20	Vol.	Mostly educational campaign.
Orange Cove	CVP and wells		Vol.	Wells insufficient for CVP deficit. Eliminating lawn watering by drastic rate increase above 350 gals/household/day.
GLENN				
Artois	Indiv. Wells			Wells drying. New WD requesting loan for deep well and distribution system.
Elk Creek	Stony Gorge Res.	25	Vol.	Supply remaining in Stony Gorge Reservoir is extremely muddy; Purification unit on loan from OES.
Stonyford	Indiv. Wells			Individuals hauling water.
HUMBOLDT				
Blue Lake	Humboldt Bay MWD		Vol.	Increased water rates. Paper mills may be curtailed in October.

TABLE 8 (Continued)

COMMUNITIES IMPACTED BY DROUGHT
PRACTICING CONSERVATION IN 1977
As of July 15, 1977

County and City	Source of Supply	Savings Goal Percent	Degree of Effort	Remarks
HUMBOLDT (Continued)				
Eureka	Humboldt Bay MWD	?	Mand.	Enough water till Nov. for two pulp mills. Restricted outside use.
Trinidad	Luffenholtz Creek		Vol.	Creek flow low. Rationing may be necessary in late summer.
IMPERIAL				
None reported.				
INYO				
None reported.				
KERN				
Delano			Mand.	Restricted outside use.
KINGS				
Armona	Wells		Mand.	Groundwater level dropping. Restricted outside use.
Corcoran	Wells		Mand.	Groundwater level dropping. Restricted outside use.
LAKE				
Kono Tayee	Wells		Vol.	Well drying, has trucked in water; drilling new well.
Lakeport	3 Wells		Mand.	Phase I (restricted outside use) began 5/15. Rationing 50 gals/day/person may begin later.
LASSEN				
None reported.				

TABLE 8 (Continued)

COMMUNITIES IMPACTED BY DROUGHT
PRACTICING CONSERVATION IN 1977
As of July 15, 1977

County and City	Source of Supply	Savings Goal Percent	Degree of Effort	Remarks
LOS ANGELES				
Avalon	Southern Cal. Edison	50	Mand.	Restricted outside use effective May 25. Landscape watering 1 hour on Tuesdays, only.
Leona Valley	Wells			Moratorium. Prohibited outside use. Will connect to SWP in September.
Los Angeles	MWD, Owens Valley Local Sources	10	Mand.	SWP deliveries cut. Owens Valley supply low. Restricted outside use effective May 16. 10% cuts effective July 1.
MADERA				
Chowchilla	Wells		Mand.	Water levels dropping. Alternate day watering. No open hoses for car washing.
Madera	Wells		Mand.	Restricted outside use. Lawn watering 2 days/week, only.
MARIN				
Belvedere Corte Madera Fairfax Kentfield Larkspur Mill Valley Ross San Anselmo San Rafael Sauselito Terra Linda Tiburon	Marin MWD	57	Mand.	Rationing: Approximately 45 gals/person/day.
Inverness Olema Point Reyes	No. Marin W.D.	30	Mand.	Restricted outside use. 10% cut to commercial and ag. uses, 20% to households, 50% to 4 large users. Moratorium in Inverness.

TABLE 8 (Continued)

COMMUNITIES IMPACTED BY DROUGHT
PRACTICING CONSERVATION IN 1977
As of July 15, 1977

County and City	Source of Supply	Savings Goal Percent	Degree of Effort	Remarks
MARIPOSA				
Mariposa	Stockton Creek Res., 6 wells	?	Mand.	Reservoir is dry; ground water limited. Three new wells. Moratorium. Rationing: 50 gals per capita per day.
MENDOCINO				
Albion	Well			Hauling in portion of water needed.
Fort Bragg	Noyo Riv., Springs		None	Spring & river flows low. Conservation plan being formulated.
Mendocino	Wells, individual			Wells drying, water being hauled.
Ukiah	Russian River, Wells		Vol.	
Willits	Morris Lake, well		Mand.	Restricted outside use.
MERCED				
Merced	Wells	10	Vol.	Primarily educational.
MODOC				
None reported.				
MONO				
Mammoth Lakes	Creek Diversion		Mand.	Restricted outside use. Water-saving devices required on all facilities.

TABLE 8 (Continued)

COMMUNITIES IMPACTED BY DROUGHT
PRACTICING CONSERVATION IN 1977
As of July 15, 1977

County and City	Source of Supply	Savings Goal Percent	Degree of Effort	Remarks
MONTEREY				
Carmel City of Sand Del Rey Oaks Monterey Pacific Grove Seaside	Carmel River, Reservoirs	?	Mand.	Rationing: 50 gals per capita per day. Industrial and golf use cut to 80% and 50%, respectively, of 1976 use.
NAPA				
Calistoga	Kimball Reservoir, Wells		Mand.	Rationing: 50 gals/person/day. Moratorium. Plan to use geothermal water plus new well.
St. Helena	Wells, Bell Reservoir, Napa		Vol.	2 wells added to system; supply now appears ample.
NEVADA				
Grass Valley Lake of the Pines	NID	50	Mand.	Lawn watering prohibited. Other outside uses restricted.
Nevada City	NID, Deer Creek	50	Mand.	Lawn watering prohibited. Other outside uses restricted.
ORANGE				
Irvine	Irvine Ranch	10	Mand.	Restricted outside use.
Fullerton		?	Mand.	Restricted outside use.
PLACER				
Auburn Lincoln Loomis Newcastle Penryn Rocklin	Placer Co. WA	50	Mand.	Prohibited outside use. Ag. users cut 50% to 75%. Parks, industry, and commercial uses cut 25% to 60%.

TABLE 8 (Continued)

COMMUNITIES IMPACTED BY DROUGHT
PRACTICING CONSERVATION IN 1977
As of July 15, 1977

County and City	Source of Supply	Savings Goal Percent	Degree of Effort	Remarks
PLACER (Continued)				
Colfax	PG&E	50	Mand.	Rationing: 375 gals/household/day. Industrial and commercial uses cut 40%. Ag. users cut 75%. Restricted outside use.
Foresthill	Wells	50	Mand.	Restricted outside use. No new hookups.
Roseville	Folsom Res.	30	Mand.	Restricted outside use.
PLUMAS				
Quincy	Springs, Wells		Mand.	Restricted outside use. May pump from Spanish Creek.
RIVERSIDE				
None reported.				
SACRAMENTO				
Arcade	Wells	30	Mand.	Restricted outside use.
Carmichael	American River, Wells	26	Vol.	
Orangevale	Folsom Res., Wells	30	Mand.	Restricted outside use.
San Juan WD	Folsom Res.	30	Vol.	
Sacramento	Sacramento River, American River, Wells	20	Vol.	
SAN BENITO				
Hollister	Wells		Mand.	Restricted outside use.
SAN BERNARDINO				
None reported.				

TABLE 8 (Continued)

COMMUNITIES IMPACTED BY DROUGHT
PRACTICING CONSERVATION IN 1977
As of July 15, 1977

County and City	Source of Supply	Savings Goal Percent	Degree of Effort	Remarks
SAN DIEGO				
None reported.				
SAN FRANCISCO				
San Francisco	Hetch Hetchy	25	Mand.	
SAN JOAQUIN				
Lodi		?	Mand.	Restricted outside use.
SAN LUIS OBISPO				
Atascadero	Wells	?	Vol.	Wells inadequate; drilling new ones.
Cambria	Wells	?	Mand.	Ground water level dropping. Rationing: 50 gals/person/day. Restricted outside use. Plan to drill new wells.
Los Berros	Indiv. Wells			Ground water level dropping.
Morro Bay	Wells	20	Mand.	Ground water level dropping. Restricted outside use.
Squire Canyon	Indiv. Wells			Ground water level dropping.
SAN MATEO				
Atherton Menlo Park Portola Valley San Carlos San Mateo South San Francisco Woodside	Cal. Water Service Co. via Hetch Hetchy	25	Mand.	
Brisbane		29	Mand.	Restricted outside use.

TABLE 8 (Continued)

COMMUNITIES IMPACTED BY DROUGHT
PRACTICING CONSERVATION IN 1977
As of July 15, 1977

County and City	Source of Supply	Savings Goal Percent	Degree of Effort	Remarks
SAN MATEO (Continued)				
Daly City	Hetch Hetchy	25	Mand.	Rationing: 225 gals/household/day. Apartments: 150 gals/unit/day - industrial cut to 90%, commercial to 75%.
El Granada Half Moon Bay Montara Redwood City San Bruno	Hetch Hetchy, Wells, Streams	25	Mand.	
SANTA BARBARA				
Goleta	Cachuma Res. Wells	10	Mand.	Restricted outside use.
Montecito	Cachuma Res. Wells		Mand.	Moratorium. Water allocations based on prior use.
SANTA CLARA				
Gilroy	Wells	25	Mand.	Water levels dropping 2 to 3 feet per week. Restricted outside use.
Milpitas	Hetch Hetchy	25	Mand.	Rationing: 125 gals/person/day, plus additional for small households. Restricted outside use.
Morgan Hill	Wells	25	Mand.	Restricted outside use.
Mountain View	Hetch Hetchy	25	Mand.	Restricted outside use. Commercial cut 25%; industry 10%. Irrigation cut 50%.
Palo Alto	Hetch Hetchy	25	Mand.	Rationing began July 1. Restricted outside use.
San Jose	San Jose Waterworks, SWP	25	Vol.	

TABLE 8 (Continued)

COMMUNITIES IMPACTED BY DROUGHT
PRACTICING CONSERVATION IN 1977
As of July 15, 1977

County and City	Source of Supply	Savings Goal Percent	Degree of Effort	Remarks
SANTA CLARA (Continued)				
Santa Clara	SWP	25	Vol.	
Sunnyvale	Hetch Hetchy (50%), SCVWD (25%), wells (25%)	25	Mand.	Goal is 60 gals/day/person. Restricted outside use.
SANTA CRUZ				
Big Basin	Springs, wells	35	Mand.	Outside watering limited to 4 hours/week.
Ben Lomond Boulder Creek Brookdale	San Lorenzo Valley CWD, Streams, wells		Mand.	Rationing: 60-100 gals/person/day - Commercial uses cut 24%. No new hookups.
Felton	Citizen's Utilities, Streams, wells	20	Vol.	Increasing use of wells. May ration later.
Scotts Valley	Wells		Vol.	Drilling wells.
Santa Cruz	Reservoir, Streams, wells	30	Mand.	Rationing: 85-90 gals/person/day. Restricted outside use. Other uses cut 30%.
SHASTA				
Centerville CSD	Clear Creek CSD		Vol.	Household use and waste to be lessened.
Clear Creek CSD	Whiskeytown Res. (USBR)		Vol.	USBR cut PUD supply 75%. Can get water from 3 other agencies.
Fall River Mills	Fall River		Vol.	Expect 60% supply this summer. May ration later. Drought emergency loan approved for new well.
McArthur	Fall River, well			May ration later.

TABLE 8 (Continued)

COMMUNITIES IMPACTED BY DROUGHT
PRACTICING CONSERVATION IN 1977
As of July 15, 1977

County and City	Source of Supply	Savings Goal Percent	Degree of Effort	Remarks
SHASTA (Continued)				
Moose Camp				Hauling water since December 1976.
Shasta Dam PUD	Shasta Res. (USBR)			USBR cut PUD supply 50%. Getting 500 acre-feet from Redding.
SIERRA				
None reported.				
SISKIYOU				
Dorris	1 well		Vol.	Well down; no lawn watering.
Montague	Dwinnel Res.		Vol.	Rationing expected later.
SOLANO				
None reported.				
SONOMA				
Cotati Forestville Petaluma Rohnert Park Santa Rosa Valley of the Moon	Sonoma Co. WA	30	Mand.	Drilling 2 wells. Restricted outside use began March 1 for all 7 cities. Rationing could begin August 1.
Sonoma	Sonoma Co. WA	35	Mand.	Rationing: 100 gals/person/day. Apartments: 200 gals/unit/day. Business and industry cut 30%.
STANISLAUS				
Knight's Ferry	Stanislaus R., tank			River flow low. Requesting FmHA grant for increasing storage capacity.
Modesto	46 wells			Restricted outside use.
Riverbank	Wells			Inadequate well depths.

TABLE 8 (Continued)

COMMUNITIES IMPACTED BY DROUGHT
PRACTICING CONSERVATION IN 1977
As of July 15, 1977

County and City	Source of Supply	Savings Goal Percent	Degree of Effort	Remarks
SUTTER				
None reported.				
TEHAMA				
Paskenta CSD	Thomes Creek		Vol.	Creek drying; may ration later.
Manton	Digger Creek			Water being hauled.
TRINITY				
Weaverville	East Weaver Creek		Vol.	Rationing began July 5: 125 gals/person/day.
TULARE				
Exeter			Mand.	Restricted outside use.
Springville	Tule River			River expected to dry. May haul water.
TUOLUMNE				
Columbia Jamestown Sonora Tuolumne City Twain Harte	PG&E's Tuolumne Ditch	35	Mand.	Rationing: to reduce 35% at meters and 50% for all others. Restricted outside use.
Groveland	Hetch Hetchy	25	Mand.	Construction use prohibited.
VENTURA				
None reported.				
YOLO				
None reported.				
YUBA				
Smartville	NID, China Ditch.		Mand.	Restricted ditch service.

TABLE 9

MUNICIPAL WATER USE
SELECTED CITIES
in Millions of Gallons[1/]

City	Jan. 1, 1976 - June 30, 1976	Jan. 1, 1977 - June 30, 1977	Difference	Difference in Percent
Eureka	694	546	-148	-21
Redding	938	816	-122	-13
Alturas	153	140	-13	-8
Chico	2,471	1,969	-502	-20
Subtotal	4,256	3,471	-785	-18
Sacramento	13,156	9,846	-3,310	-25
San Francisco	18,980	13,633	-5,347	-28
San Jose	20,808	15,495	-5,313	-26
East Bay MUD	39,553	25,161	-14,392	-36
Alameda Co. WD	4,912	3,458	-1,454	-30
Stockton	4,828	3,565	-1,263	-26
Contra Costa Co. WD	18,414	14,633	-3,781	-21
Santa Clara	3,789	2,921	-868	-23
San Mateo	2,302	1,492	-810	-35
Daly City	1,440	1,025	-415	-29
Hayward	2,737	1,756	-981	-36
Sunnyvale	3,963	2,859	-1,104	-28
Marin MWD	3,934	1,848	-2,086	-53
North Marin Co. WD	1,160	717	-443	-38
Santa Rosa	2,263	1,424	-839	-37
Subtotal	142,118	99,764	-42,354	-30
Fresno	10,297	7,658	-2,639	-26
Bakersfield	7,539	6,087	-1,452	-19
Modesto	5,016	3,777	-1,239	-25
Merced	2,043	1,518	-525	-26
Monterey Bay	2,652	1,423	-1,229	-46
Sonora-Jamestown	267	200	-67	-25
Subtotal	27,814	20,663	-7,151	-26
Los Angeles	95,670	83,421	-12,249	-13
Long Beach	10,873	9,148	-1,725	-16
San Diego	25,344	23,584	-1,760	-7
Anaheim	8,479	7,624	-855	-10
Riverside	6,755	5,919	-836	-12
Santa Barbara	2,376	1,926	-450	-19
Oxnard	2,802	2,649	-153	-5
Ventura	3,463	2,799	-664	-19
San Luis Obispo	1,041	924	-117	-11
Santa Maria	1,297	1,068	-229	-18
Subtotal	158,100	139,062	-19,038	-12
Total Reported	332,289	262,960	-69,328	-21

[1/] 1 million gallons = 3.785 megalitres.

Some communities have reportedly cut their consumption by as much as 60 percent. Several areas are finding rationing to be so successful that they are now modifying their initial water rationing programs.

With water consumption down 38 percent over last year, the North Marin County Water District (NMWD) on July 5, 1977, relaxed its restrictions on outdoor use in some areas because the District feels it has a sufficient water supply for the current drought year, including most of next year. The NMWD will continue to maintain the present rationing target of 30 percent.

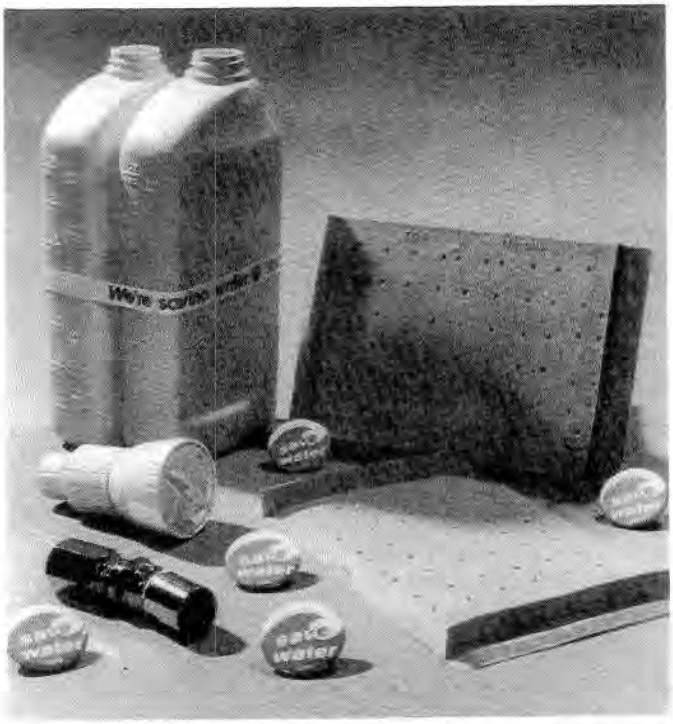
Milpitas had originally set a goal of cutting water use by 25 percent, but residents in May used only 43 percent of what they used during the same month last year, and in June, they used 58 percent of the amount used in June 1976. The City Council voted on July 5, 1977, to increase the current maximum allotment for households with one, two, or three persons an additional 164 litres (43 gallons) per day from April to October, and an additional 83 litres (22 gallons) per day from November to March.

Conservation has been so successful in the San Francisco Bay area that several agencies have had to raise their rates to replace revenues lost through active water conservation. Because of zealous consumer water conservation, water officials are faced with the reality of substantially declining revenues.

The Martinez City Council decided on July 6, 1977, it would be better to increase the daily water allocation than to increase rates again. A family of four will be allowed 1 589 litres (420 gallons) per day during July and August instead of 1 498 litres (396 gallons). For September, the allotment will be 1 498 litres (396 gallons) per day instead of 1 374 (363), and for October, a family of four will be allowed 1 374 litres (363 gallons) instead of 1 135 (300).

Faced with rapidly declining revenues, the officials of the Alameda County Water District, which serves the Cities of Fremont, Newark, and Union City, have temporarily rescinded their enforcement of the mandatory rationing program. Although this is not a voluntary program, the District feels that consumers will continue to reduce consumption by 25 percent without strict enforcement policies.

Senate Bill 51 (Nejedly), which has passed the Senate and is now being voted upon by the Assembly, would legislate mandatory water conservation regulations in some instances. In the bill's present form, it would authorize the board of a municipal utility district to meet water shortage emergencies by ordinance. Violations of these ordinances would constitute a misdemeanor.



33. Ye little old water savers. Shown are items included in household conservation kits being distributed under a DWR pilot program authorized by Assembly Bill 380. Areas receiving them are Santa Cruz County, El Dorado Irrigation District, San Diego, Sanger, Oak Park (near Ventura), and El Segundo.

Potential water savings as a result of metering have become more apparent with the current drought. Metering, accompanied with an appropriate pricing system, can be an effective means for achieving water conservation throughout the State. In a study conducted in 1974, the SWRCB found savings of 20 to 55 percent as a result of metering. Based on data collected at the time of the study it was found that water use could be reduced by as much as 409 cubic hectometres (332,000 acre-feet) a year. Metering provides the means for both effective urban water conservation programs and implementing equitable pricing systems.

Several bills were introduced in the legislature to mandate water metering. Assembly Bill 775 (Perino), which is still in the Assembly, would mandate installation of water meters to domestic customers. Under this bill, systems serving more than 200 users would be required to submit a water meter installation plan to the State Water Resources Control Board. Implementation of the plans would have to occur by December 31, 1983. Twenty-five percent of the capital cost of the metering project, approximately $40-$47 million, would be paid by money from the General Fund.

The measure is controversial primarily because of the money involved. The major opponents of the bill are the municipalities in the Central Valley area where flat rate service is predominant. The California Public Utilities Commission and the City of Los Angeles both support the bill.

Under authorization provided by 1977 legislation, AB 380 (Gualco), the Department of Water Resources is conducting a large scale test involving various methods of distribution and voluntary acceptance of interior residential water conservation kits (consisting of toilet dams, showerhead and faucet flow restrictors, and dye tablets). Should the program achieve a 30 percent use rate of the toilet dams and flow restrictors, the Department estimates the program applied statewide would result in an energy savings of $30,000,000 in equivalent barrels of oil, and about 136 cubic hectometres (110,000 acre-feet) of water. The savings to California households from shower water heating alone would be about $14 million per year.

The study is being conducted in a number of areas throughout the State. To develop a suitable distribution plan, the Department is distributing the kits using a variety of methods, involving areas with water rationing programs and areas without water rationing. Listed below are areas involved in the Department's distribution program:

- Santa Cruz County: DWR and the County of Santa Cruz are testing public acceptance of water-saving devices and locally controlled distribution in an area experiencing water shortages.

- El Dorado Irrigation District: This coordinated effort with DWR will test the willingness of the public to purchase water conservation devices at cost in an area with rationing.

- San Diego: This state-managed program would test public acceptance of devices and a variety of distribution techniques in an area that has no mandatory rationing.

- Sanger (near Fresno): This program would involve distribution by local youth groups to test public acceptance and community involvement in the distribution of water conservation devices in an area which is not rationed.

- Oak Park (near Ventura): This program involves the distribution and installation of the devices in about 700 homes. By monitoring water consumption and sewage flows, the test should provide information as to the effectiveness of water conservation devices.

- El Segundo: This program involves the sale of water conservation devices at cost. The program is designed to test the public's willingness to purchase water conservation devices in an area without mandatory rationing.

In connection with the study program outlined above, the DWR invited manufacturers and suppliers of water-saving devices to submit samples of their wares for testing. Approximately 50 firms responded by providing 131 different varieties of items for inspection and tests. Items submitted included 31 types of toilet devices, 63 flow restrictors or valves, 17 different low-flow showerheads, and 20 leak detecting dye samples. The DWR tested all samples in a testing program conducted at its Bryte laboratory. Results have been evaluated and form the basis for selecting state-furnished devices distributed to communities involved in the conservation study outlined above.

The Office of Appropriate Technology and DWR have planted a demonstration garden of drought-resistant plants. The garden provides information on water conservation techniques useful in landscaping, encourages the use of drought-resistant plants and native vegetation, demonstrates water-saving techniques, and provides information on plants' water demand. Open to the public, the garden can be seen at 17th and N Streets in downtown Sacramento.

The Interagency Agricultural Information Task Force has prepared a number of pamphlets with tips on meeting water needs during the drought. These pamphlets are free, and they are available at any drought information office.

With severe cutbacks in deliveries to agricultural users, a program of planned water conservation can meet current needs. Each of the following offers some potential for reduction in agricultural water use:

1. Irrigation method.
2. Irrigation scheduling.
3. Good drainage.
4. Soil management.
5. Weed and phreatophyte control.
6. Seepage control.
7. Crop factors.
8. Land use.

34. Drip irrigation of a young orchard. Water-conserving techniques are becoming more common.

Persons interested in better water conservation management programs should contact the following agencies for more information:

- Local Agricultural Stabilization and Conservation Service office for possible special practices or cost-sharing.
- Farmers Home Administration for special local programs or available disaster loans.
- Local Cooperative Extension Service Office.
- Local irrigation district or irrigation officials.
- Local Soil Conservation District Office and Conservation District officials.
- Agricultural Research Service.
- Department of Water Resources.
- State Water Resources Control Board.
- U. S. Bureau of Reclamation.
- U. S. Geological Survey.

Regulatory Actions

The Public Utilities Commission on February 10, 1977, ordered the distribution of water-saving kits to all agencies under its jurisdiction, the forecasting of water supply available in 1977, and drafts of water rationing plans and local ordinances for their enforcement, if forecast supplies are inadequate. The utility serving the Monterey Bay area is already under PUC ordered rationing.

The State Energy Commission is determining the availability of energy to meet needs in 1977. It is working with all the State's utilities to assure adequate supplies in all areas of the State.

The SWRCB's interim Delta water quality criteria for 1977 (discussed elsewhere in this report) allowed additional water to be conserved for beneficial use elsewhere. The Board's June 2, 1977, emergency criteria provides for conservation of additional supplies. The Board is also holding expedited hearings to provide special permits to appropriate water on a temporary basis and is providing special supervision to determine and enforce priorities of existing use. The Board exercised its regulatory powers in cutting off surface water supplies to a residential recreational lake in Mission Viejo. It considered filling the lake with scarce surface supplies, an unreasonable use of water in this drought year.

In other actions to ensure equitable use of existing water, the SWRCB has sent letters to diverters holding permits and licenses in the Sacramento and San Joaquin Valleys informing them that, due to record low runoffs, water would soon become unavailable for their use under existing priorities.

On March 29, 1977, about 520 permittees and license holders in the Sacramento Valley were advised that water available for their 1977 uses would probably end in May. Colusa Drain diverters were advised to expect less than half the water available in 1976.

On April 18, 1977, the SWRCB sent letters to 103 permittees and license holders on the San Joaquin River system informing them that under existing priorities, water would be unavailable to them at some point this summer. Cutoff dates for individuals ranged from April to August.

Riparians and permit and license holders in the Delta (2,385 in number) were sent letters on May 18, 1977. Riparians were requested to reduce consumptive use in accordance with expected stream runoffs, and permittees and license holders were informed that no water would be available to them after May 1.

35. A disappearing river—The Cosumnes River, shown here near Sloughhouse in mid July, was among the first to stop flowing.

Riparians and pre-1914 appropriators on the San Joaquin River system were informed on May 27, 1977, that water on the Calaveras and Cosumnes Rivers would be unavailable after June 1.

Riparians on other rivers in the San Joaquin Valley were requested to cut back their use to the percentage of available supply as calculated by the State. Pre-1914 appropriators were notified that no natural flows would be available to them commencing in June.

The Board, in cooperation with the DWR, has also initiated a diversion monitoring program in the Sacramento Valley to ensure that water reaches those entitled to receive it. The SWRCB reports that cooperation is excellent as everyone is trying to comply with the State's conservation efforts.

The SWRCB has adopted a Policy and Action Plan for Water Reclamation in California and the guidelines and criteria therein make it possible for many communities faced with drought-caused water shortages to solve some supply problems by using reclaimed water. The Regional Water Quality Control Boards are working with individual communities to help them in this effort. The SWRCB is also urging all state agencies to identify activities and uses where reclaimed water could be substituted for fresh water.

Watermaster service (by the DWR, Northern District) started two weeks early in Shasta Valley, Surprise Valley, South Fork, and North Fork Pit River areas, and a month early in the Susanville area, due to the drought.

In a move to conserve energy made scarce by the drought, the State PUC adopted regulations April 12, 1977, providing for a restructuring of natural gas rates so that prices will jump as usage increases above "lifeline" amounts.

Fish and Wildlife Contingency Plans

The Department of Fish and Game (DFG) has prepared a rather comprehensive contingency plan to mitigate the effects of the drought on fish and

36. Rescue Operations—A full dip net of steelhead trout is displayed by a member of the California Conservation Corps during a recent rescue of fish stranded in the San Lorenzo River. The fish were returned to the ocean in an operation conducted by the Department of Fish and Game with the aid of the CCC. (photo by Jack White, Department of Fish and Game, Yountville, California)

wildlife. Action dictated by the five part plan has already started as 1977 continues as the driest year in California history.

The first part of the plan involves rescue and transportation of drought-stricken wildlife. This includes such activities as transporting fish trapped by low flows, monitoring rare and endangered species and supplemental feeding of wildlife.

Two major fish rescues have already taken place this year. In May, 114 steelhead trout trapped in shallow pools in the San Lorenzo River were rescued and transported downstream to areas of the river where the flow was adequate to accommodate their seaward migration. In Butte and Tehama Counties, a two-month long rescue operation saved 2,000 king salmon. The fish were taken from below the Red Bluff Diversion Dam because the water flow at the mouth of spawning tributaries was inadequate to permit migration to higher elevation spawning areas. The DFG, in cooperation with the U. S. Fish and Wildlife Service (USFWS), trucked the king salmon to their spawning areas in Mill, Deer, Chico, and Butte Creeks.

Plans to aid fall-run salmon are also being prepared. These plans include helping fish endangered by low flows and high temperatures. The DFG and USFWS plan to discourage fish passage at Red Bluff Dam Fishways, thus forcing as many salmon as possible to spawn in downstream areas where the threat of copper pollution is lessened. Not all of the spawners can be stopped at Red Bluff; therefore, the placement of another barrier just above the mouth of Battle Creek is under consideration. Protecting the spawning run this year will assure a return of more adult salmon three years from now.

Supplemental feeding of wildlife may include both range animals and waterfowl, but alleviating the plight of the waterfowl is the main intent of the action. Since much of their normal food supply will be lost this year through various impacts of the drought (farmers changing to drought resistant crops; decrease in alkali bulrush production), their survival may indeed depend on DFG intervention.

As the second part of the DFG's drought contingency plan, a special information service has been made available to the public. The five regional offices are prepared to report on current fishing opportunities, boat launching conditions, and the status of access to waters in their respective areas.

The third contingency effort has been to step up the catchable trout stocking program to provide better fishing earlier in the season. This permits anglers to take fish while water conditions are most suitable and thins out the number of fish in hatcheries where water allotments may be curtailed later this summer. The general trout fishing situation for the five regions follows.

In the Northern Counties (Region I), a decrease in the Darrah Springs Hatchery water supply forced the DFG to plant a large percentage of its trout early in the season. Even before spring stocking started, plans to plant some of the lakes and streams in Modoc and Lassen Counties were cancelled because low flow and unsuitable temperatures existed. No problem is expected in the larger lakes and reservoirs. In general, the abundant water resources in that area can be expected to remain suitable for trout populations throughout the summer.

In the inland counties north of the Stanislaus River (Region II), planting started a month to a month and a half earlier than usual. Planting is expected to carry on as normally as possible through July, August, and September. Some problems may crop up due to water temperature increase during August.

The central coastal counties (Region III), have fared the worst of all the areas in the State. Low water levels and increasing temperatures have caused problems. The DFG has attempted to stock the normal amount of fish, however, by planting heavier in available waters and by planting earlier in the season when flow and temperature conditions were still suitable. Planting lessened during July and August in many areas. Fish die offs were experienced in Lake Pillsbury and Lake Hennessey in late June due to high temperatures and the associated oxygen depletion. Lake Pillsbury is expected to be essentially empty by the end of the summer.

The inland counties south of the Stanislaus River (Region IV) are having a better season than anticipated. This is due to some heavy rainfall over the southern Sierra Nevadas in late spring and early summer. In anticipation of another dry summer, more trout were planted earlier in the season than in a normal year. Three quarters of the fish had been planted by the July 4th weekend leaving the fishing prospects for the rest of the season a little less than average. Although some of the smaller streams will exhibit low flows and high temperatures by late summer, there are no particularly bad spots in this region.

Southern California (Region V) is experiencing a near-normal trout season. Heavy plants were made in the spring during optimum water conditions. All of the higher elevation lakes and streams are expected to remain in good condition. Lower elevation streams, especially in Inyo County, are expected to experience adverse flow and temperatures.

The fourth contingency measure to be implemented by the DFG is to negotiate for water allotments with other water users. The intent of the DFG is to assure, as much as possible, that sufficient quantities of water will be available to support the fish and wildlife dependent upon it for survival. Discussions are under way with the DWR and the Bureau of Reclamation with the aim of regulating streamflow and temperatures, when necessary, for the benefit of the anadromous fisheries. In the past, such arrangements have been made with water at Shasta, Trinity, and Oroville Dams.

The final action proposed by the DFG to aid drought impacted wildlife is the drilling of wells on state waterfowl management areas and federal refuges on which the DFG regulates hunting. As a result of drilling wells, the DFG hopes to provide more habitat, food, and space for the millions of ducks which winter in California. It also hopes to decrease crop depredation, and alleviate the threat of widespread waterfowl disease this winter (associated with large concentrations of birds). Federal funds have been requested by the DFG to dig wells at four state waterfowl management areas.

Several unique opportunities for wildlife management have been made available as a result of the drought. It is pertinent to mention them here, as they could not be implemented if the State water systems were not abnormally dry.

The first is the opportunity to observe the effects of unusual water conditions that will occur in the Delta. This data will be useful in verifying estimates of the effects of intensive water management there. The Bay-Delta fisheries program is monitoring the situation.

Low water levels in reservoirs will provide opportunities for controlling undesirable fish. Such fish may be eliminated by drying the reservoir, or by using chemical treatments too expensive to use on a large volume of water in a non-drought year.

While water levels are low and more shoreline is exposed, aerial seeding of selected plant species may be undertaken. Plants which would be promoted are those which will provide shelter for juvenile game fish when the water level returns to normal. Also, the decomposition of the plants will release nutrients valuable to the productivity of the water body.

Along with plants, shelters of a more substantial nature may be built. Both juvenile and adult game fish species will benefit from this construction.

Man-made waterfowl nesting islands can be constructed in the water depleted lakes and marshes. This will be done with the cooperation of the U. S. Forest Service and the Bureau of Land Management where their lands are involved.

As far as game animals are concerned, monitoring activities will be necessary to determine the effects of the drought on habitat changes, shifts in animal populations, behavior patterns and overall effects. The opportunities will be available to find out which springs are permanent and which are intermittent. This will be done by field personnel in conjunction with other field activities.

Under "The Emergency Drought Act of 1977", $10 million was appropriated to the Bureau of Reclamation to be used for projects relating to the acquisition of new sources of water for fish and wildlife. It is expected that the majority of the appropriation will be used to fund the drilling of wells on federal land. Although projects have been submitted for funding, no decision has been made yet as to how the funds will be allocated.

Other Mitigative Actions

The Department of Water Resources has initiated a $125,000 cloud-seeding program in Northern California and in the Kern River Basin where there are usually cumulus clouds which can be seeded to increase the amount of precipitation. In addition to providing a soil-moisture base for this winter's runoff, there will be major benefits in reduced fire hazards; water supply for livestock, wildlife, and fish; and improved range conditions. Seeding activities, employing 3 twin-engine aircraft, will continue throughout summer and early fall. Radar will be used to locate and help direct the seeding operations and to avoid any precipitation in areas which might be damaged by rainfall.

The Department of Navigation and Ocean Development has been engaged in extending boat ramps to mitigate impacts upon recreation. Ramps were extended at Packer's Bay on Shasta Lake and improvements are under construction for Lakeside Park, a Lake County facility on Clear Lake near Kelseyville. The improvements, consisting of deepening an entrance channel, should be completed by late August at an estimated cost of $15,000. Other Department Projects completed or under construction include channel dredging for the Lucerne Park at Clear Lake (completed July 22, 1977, at a cost of $9,000), a ramp extension at Ruth Lake in Trinity County (being constructed as the water level drops, at a cost of $15,000), constructing an access road to a portable USFS ramp at Trinity Center on Clair Engle Lake (under construction at a cost of $15,000), furnishing landing mats for temporary extensions of ramps being constructed by the Department of Parks and Recreation at Folsom and Oroville Lakes, and a ramp extension at Broderick in Yolo County (estimated completion in late August at a cost of $16,000).

Because of fast developing changes in conditions caused by the drought, the Department of Parks and Recreation has changed its system of reservations for state parks and recreational areas. No longer will reservations be accepted

as much as 90 days in advance of planned use. The limit for 1977 is 30 days.

The Wildlife Conservation Board is funding the extension of boat ramps at Lake County's Redbud Park at Clear Lake Highlands. This project, still under construction, was operational by July 4, 1977. The Board is also extending the state-owned ramps at Anderson on the Sacramento River, and at Lake Forest near Tahoe City. Both of these projects are expected to be completed in September.

The U. S. Forest Service, in moves to conserve water, has banned the use of water for dust abatement on the roads in its 9.7 million hectares (24 million acres) of forestland, is reducing landscape watering by 50 percent, practicing conservation intended to save 25 percent of its domestic water, using water-saving devices at its recreational sites, and has placed a moratorium on uses of water beyond established activities.

In planning for the fire season, the U. S. Forest Service began training two months early and expects to activate its Red Flag Alert statewide. Recreational sites in the forests are being examined for projected water availability for drinking and sanitation purposes. To learn the amount and location of drought-caused tree mortality, information needed for salvage operations, the USFS is planning aerial surveys. Salvage operations are planned for quick removal of dead and drying trees to prevent the spread of an infestation of insects and disease. The public will be granted the use of dead or downed woody material for noncommercial uses.

Recognizing the devastating potential of the 1977 wildlands fire season, the California Department of Forestry (CDF) had developed a plan of augmented fire protection measures. Eight million dollars has been appropriated for the implementation of the plan to check the increased fire danger this year. The key points of the mitigative effort include:

1. Increased manpower on engine crews.

2. Increased number of lookouts and aerial reconnaissance of forests for fire detection.

3. Intensified fire prevention effort.

4. Renting of water tankers and pumps to increase the availability of water.

5. Increased length of time that air tankers and helicopters are available.

Since 95 percent of wildland fires are man caused, the CDF has made thousands of contacts and inspections, urging citizen cooperation in preventing these disasters.

It is extremely important that every person who lives in, works in, or uses the State's rural or forested areas help to prevent fires from starting. The public should also take measures to protect its exposed homes and other property from the possibility of encroaching wildland fires. The U. S. Forest Service (USFS) suggests the following preventive measures for the public to decrease both fire and disease hazards on private land.

1. Reducing the number of trees, shrubs, and bushes.

2. A deep-watering program if local water rationing programs are not in effect.

3. Pruning out dead and dying tree parts; thinning tree crowns.

4. Promptly treating wounds in trees.

5. Removing dwarf mistletoe plants from tree crowns.

6. Postponing home-improvement projects that would injure tree roots (e.g., sidewalks, driveways, patios, curbs).

7. NOT stacking firewood against trees -- because beetles could be living in the firewood.

8. Refraining from parking and driving cars under trees -- their weight can break tree rootlets.

9. Guarding against careless skinning of bark from trees when lawn mowing and pruning -- certain insects and disease organisms are attracted to these wounds.

10. Keeping hatchets away from children.

The Department of Finance has prepared a report on the economic impact of the drought covering its effect on segments of the economy and upon the different geographical areas. It has been available since May 1977.

The State is pursuing a coordinated plan of water development and permanent Delta protection, involving the cooperation of the U. S. Bureau of Reclamation, and Federal legislation to authorize federal participation in protective measures.

In a stepped-up drought year program, the DWR will take additional measurements of ground water levels in the San Joaquin Valley. To monitor the effects of increased agricultural pumping expected this year, the DWR agreed to undertake measurements in June and August to supplement those normally taken each spring. The information thus gained should prove useful to water agencies, individuals, and farm interests.

Water Supply Forecasting

The difficulties experienced by operators of California's water supply projects and their customers during the drought forcibly illustrates the need for an accurate assessment of available water. Reliable runoff projections are needed to make early reservoir operating decisions to avoid disaster in a severe drought. They provide for more effective management decisions in normal and wet years as well.

The Department has long been involved in water supply forecasting through the California Cooperative Snow Survey Program.* Although the basic procedures used in making the forecasts in this program were developed years ago, they have been refined and improved through the years as more data became available.

These forecasting procedures are primarily statistical in nature, involving over the years the collection of snow water content and other data for various watersheds and correlating this data with runoff data. Data collected by the snow surveyors in the first half of each year is then measured against this "data base", enabling estimates of spring and summer streamflow. This approach has worked reasonably well.

However, there has been one serious problem. Because there is no proven system of long-range weather forecasting, assumptions of future weather conditions must be made. The assumption always made is that future precipitation in any given year would be normal -- regardless of what the first part of the year had been. This assumption has resulted in the largest single error in DWR forecasts during past years, including the current drought. Another problem is that the correlations used to predict runoff do not extend low

* This program, which originated in 1929, now involves more than 50 state, national, and private agencies, which pool their efforts in collecting snow data. More than 300 snow courses are sampled each winter.

enough on the graphs. In other words, we have had no previous experience with a year this dry.* A complicating factor is the condition of the soil during a drought. Abnormally dry soil absorbs much of the moisture that otherwise would appear as runoff.

The drought has underscored the need to further the "State-of-the-Art" in water supply forecasting, and a real opportunity exists in this area. The Department intends to act aggressively in this field, and some of the efforts in this regard are:

- Studying two long-range weather forecasting methods, one by the Dr. Irving Krick Organization (based on projections of future atmospheric pressure patterns), and one by Scripps Institute of Oceanography (correlating Pacific Ocean sea surface temperatures with weather in California).
- Investigating runoff forecasting techniques of other agencies, particularly computer modeling.**
- Budgeting for additional telemetering equipment (automatic snow sensors that can be read by remote control).
- Operationally testing, under a 4-year contract with the National Aeronautic and Space Administration, the use of satellite photos to improve snowmelt estimates.

In addition to these long-range efforts to improve water supply forecasting techniques, the DWR will begin issuing forecasts of future runoff conditions based on the assumption that existing weather trends will continue. (This would be in addition to the usual forecasts assuming normal future water conditions.)

Commission for Revising California Water Rights Law

Existing laws in California establishing water rights have undergone little change since the mid-1800s. The current legislation is not only an obstacle to optimal water management practices, but it also contributes to waste of the State's scarce water resources.

On May 11, 1977, Governor Brown announced his appointees to head the Governor's Commission to Review California Water Rights Law. The Commission is to review and recommend changes concerning present laws governing water rights in California. The members of the Commission include:

- Chairman Donald R. Wright, Chief Justice, Supreme Court of California, 1970 to 1977.
- Ira J. Chrisman, former member of the California Water Commission, 9 years as chairman.
- James A. Cobey, former California State Senator, co-organizer of the Western States Water Council,

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* Other agencies with forecasting activities have reported similar difficulties this year.

**One such model is that used by the National Weather Service River Forecast Center in Sacramento. It is a hydrologic computer model which makes extended runoff forecasts for many watersheds in California, taking into account numerous factors, including antecedent conditions, estimates of soil moisture, and temperature. (DWR's staff participated in the early development of this model several years ago for flood forecasting purposes.) Complex models such as this require large computer capacity and must continuously be fed large amounts of basic data or synthesized information, but they may have the potential of providing better extended projections, especially in unusual situations such as droughts or floods, and during snowmelt periods.

and since 1966, associate justice, California Court of Appeal, Second Appellate District, Division Three, Los Angeles.

- David Hansen, Associate Professor of Agricultural Economics at the University of California in Davis, and a member of the State Board of Food and Agriculture.

- Arthur L. Littleworth, an attorney practicing in the field of water rights.

- Mary Anne Mark, an engineer presently associated with the U. S. Army Corps of Engineers, and a member of the Water Committee of the Sierra Club.

- Charles Jarvis Meyers, Dean of Stanford University Law School, a distinguished law professor and author of a leading casebook on water law.

- Arliss L. Ungar, member of the League of Women Voters and the Delta Environmental Advisory Council.

- Thomas Zuckerman, an attorney specializing in water law.

Ronald B. Robie, Director of the Department of Water Resources, and John E. Bryson, Chairman of State Water Resources Control Board will serve as ex-officio members on the Commission.

1978 OUTLOOK

California has just experienced, back-to-back, two of the driest years of the century, with the current year setting all-time records for low precipitation and runoff. As a result, the State's surface reservoirs contain barely enough water, in many cases, to meet the minimal needs of 1977 -- even with current conservation practices. Ground water levels have been drastically lowered. Thus, we approach 1978 with little in the way of reserves and with no margin for error in planning the use of water in the remainder of the current year.

Even if 1978 were to bring with it a return to average rain and snow, the water supply deficit leading into 1978 would not be erased. Furthermore, we cannot assume that 1978 will be wet, and that 1977 is the last dry year of this series. In recent history, we have had as many as six consecutive years of below normal precipitation.

The critical impact of a third dry year, the probability that 1978 could be below normal, and the more remote but real possibility that 1978 could be as dry as 1977, demands that a drought strategy be developed to ensure meeting critical needs, alleviating general drought conditions as much as possible, and identifying actions to make the best use of very limited resources. This chapter discusses the outlook for 1978 and provides a basis upon which drought strategy plans can be prepared.

For the development of drought strategies, it is prudent to consider the "worst condition" that realistically could occur. A repeat of 1977 runoff during the 1978 water year is such a condition.

There are a number of other assumptions also necessary to determine where contingency plans may be required and to serve as a basis for problem assessment. The following have been adopted in this evaluation:

- Surface water supply availability will be based on full utilization of surface reservoir storage with most reservoirs emptied by the end of October 1978, if necessary to meet water demands.
- The current (June 2, 1977) emergency water quality standards for the Sacramento-San Joaquin Delta and other critical areas will apply during 1978.
- Ground water pumping will be at least as much in 1978 as it was in 1977. (A conservative assumption.)
- Energy will be available as needed for ground water pumping and for the pumping plants of water conveyance systems.

The Department of Water Resources and the Governor's Drought Emergency Task Force provided assistance to local areas in 1977 by acting as a catalyst in negotiations with local areas to reallocate water, providing technical assistance and information, focusing drought aid programs, undertaking construction of interties, and providing emergency supplies from the State Water Project. It is expected that similar assistance will continue in 1978. It is assumed that Southern California's SWP entitlement will be released for use elsewhere in the same amounts as in 1977, and that Colorado River supplies will be used to make up the difference.

For purposes of a statewide summary of the 1978 water supply and demand, and the assessment of critical areas, it is also assumed that local agencies, which are responsible for delivering two-thirds of the water used in California, will respond as ably in 1978 as they did in 1977. However, in some cases solutions to critical problems are beyond the technical, legal, or financial capabilities of local areas. To identify

those areas where the State may need to take an active role in preparing and implementing drought contingency plans, the following guidelines were developed.

1. If a local area can reasonably be expected to have a 1978 water supply capable of producing a minimum of 284 litres (75 gallons) per capita per day (about half of normal minimum usage) and 75 percent of 1976 use for governmental, commercial, and industrial purposes, a State action contingency plan will not be necessary. If these minimum amounts cannot be anticipated, alternative plans will be prepared.

2. If a local area has no reasonable expectation of being able to provide 132 litres (35 gallons)per capita per day for domestic water supply, or 75 percent of 1976 use for governmental, commercial, and industrial requirements, State emergency powers could be exercised to provide up to this amount.

3. Contingency plans will be formulated for maintenance water for perennial crops and for livestock but not for other agricultural purposes.

Based on the assumptions and policy guidelines described above, the following elements of the potential 1978 water shortage were analyzed:

° Potential supplies from major reservoirs.

° General operation of water importation projects.

° Water supply and demand by hydrologic areas of the State.

° Water deficiency assessment by hydrologic areas of the State.

° Critical water deficient areas.

This water demand-supply-deficiency analysis will be the basis for preparation of drought contingency plans by the Governor's Drought Emergency Task Force and covers a range of different impacts due to the drought. The contingency plans will assist local agencies in their efforts to cope with the drought if it continues into 1978 with the same intensity as in 1977.

Potential Supplies From Major Reservoirs

Table 10, entitled "Projected 1978 Water Supply Availability From Selected Reservoirs", lists 28 reservoirs within California that provide the basic surface water supplies and hydroelectric energy generation for much of the State. It illustrates the water shortage and carry-over storage situation resulting from the current drought situation and as projected into 1978.

The Colorado River storage system (i.e., Lakes Powell, Mead, Davis, and Parker), a major source of water and hydroelectric power for Southern California and the Pacific Southwest, has not been included since its large quantities of carry-over storage will continue throughout 1978 to effectively mitigate many of the drought impacts in the Lower Colorado River Basin states, including Southern California.

In formulating this table, the assumptions were made that streamflow conditions during the 1977 water year would be repeated in the 1978 water year and that most reservoirs would be drawn down to dead storage, if necessary, by October 1, 1978. The actual conditions that will occur in 1978 will vary from those presented as a result of precipitation and runoff differing from that assumed. In addition, different operational strategies may be adopted by the operating agencies. This is particularly important in those drainage basins that have been developed by more than a single agency.

TABLE 10

PROJECTED 1978 WATER SUPPLY AVAILABILITY FROM SELECTED RESERVOIRS

(Assuming: Repetition of 1977 Water Year Runoff in 1978; and All Reservoirs Drawn down to Minimum (Dead) Storage by September 30, 1978)
(Water Units are 1,000 acre-feet equal to 1.233 cubic hectometres)

		Reservoir Inflows			Storage Levels				Reservoir Release		
Reservoir	River	Normal[1] Year	1978[2]	Percent of Normal	Maximum	Average for 10/1 1966-75	10-1-77[3]	Minimum[4] Power	9-30-78[5]	Normal[6] Year	1978[7] Potential	Percent of Normal
Auth	Mad	202	23	11	52	31	4	NA	0	73	27	37
Blair Engle	Trinity	1,243	196	16	2,448	1,897	184	313	10	970	361	37
Hillsbury	Eel	396	30	8	94	43	15	*	0	185	44	24
Mendocino	Russian	77	36	47	123	59	3	NA	0	163	39	24
Shasta	Sacramento	5,710	2,170	38	4,552	3,350	582	502	116	2,810	2,622	93
Oroville	Feather	4,350	750	17	3,484	2,537	740	852	30	1,850	1,194	65
Almanor	Feather	632	310	49	1,308	817	500	*	298	512	512[8]	100
Englebright & New Bullards Bar	Yuba	2,274	290	13	1,040	630	200	260	10	1,100	474	43
Black Butte, East Park, & Stony Gorge	Stony	392	21	5	260	51	20	NA	20	171	17	10
Clear Lake & Indian Valley	Cache	270	0	0	700	79	0	NA	0	94	0	0
Merryessa	Putah	360	20	6	1,602	1,375	667	NA	492	195	195[8]	100
French Meadows & Hell Hole	American	391	27	7	342	227	6	*	6	98	27	28
Union Valley	American	164	37	23	271	175	7	*	7	242	37	15
Folsom	American	2,598	300	12	1,010	700	150	90	0	1,230	441	36
EBMUD System	Mokelumne	707	80	11	801	467	154	NA	14	243	215	89
Melones & Tri Dam System	Stanislaus	1,085	150	14	343	160	21	NA	10	600	157	26
Hetch Hetchy System	Tuolumne	1,168	251	21	866	404	313	*	254	310	310[8]	100
New Don Pedro	Tuolumne	1,367	173	13	2,030	395	200	309	30	1,021	338	33
McClure	Merced	920	115	13	1,026	564	115	115	0	970	223	23
Millerton	San Joaquin	1,659	280	17	521	176	135	NA	17	1,712	388	23
Pine Flat	Kings	1,568	305	19	1,002	422	70	NA	0	1,624	368	23
Isabella	Kern	629	155	25	570	186	30	30	0	640	177	28
Tahoe	Truckee	524	164	31	732	494	0	NA	0	217	164	76
Nacimiento & San Antonio	Salinas	257	5	2	698	319	67	NA	32	180	35	19
Cachuma	Santa Ynez	74	1	1	205	172	115	NA	88	28	28[8]	100
Casitas	Ventura	24	1	4	254	160	183	NA	164	20	20[8]	100
Crowley	Owens	146	68	47	184	139	36	NA	1	146	96	66
Whale Rock	Old Creek	6	0	0	40	31	26	NA	22	4	4[8]	100

[1] Long-term mean annual inflow.

[2] 1978 inflow equals that for 1977; and adjusted for evaporation by approximate methods.

[3] Forecasted carry-over storage into the 1978 water year.

[4] Minimum level at which power plant can operate. *Head on power plants are not affected by reservoir level.

[5] Dead storage, i.e., storage at the lowest level gravity outlet.

[6] Average scheduled reservoir releases.

[7] With no residual storage for carry-over into the 1979 water year.

[8] Normal reservoir release assumed. See text discussion for major reservoirs.

The long-term mean annual inflow to the 28 reservoirs listed totals approximately 36 000 cubic hectometres (29.2 million acre-feet), and the projected 1978 inflow is about 7 200 cubic hectometres (5.8 million acre-feet), or approximately 20 percent of normal. The variation in individual basins is from 49 percent to 0 percent. (It should be noted that inflow to Clear Lake and Indian Valley Reservoir is shown as zero, although some inflow will actually occur. This is because reservoir evaporation will consistently exceed that small inflow and no water will actually be available to the operating agency.) Also, inflow to the Hetch Hetchy system is shown as only that portion that is divertible by San Francisco. The total inflow is projected to be 240 cubic hectometres (195,000 acre-feet) with 83 cubic hectometres (67,000 acre-feet) being included as inflow to New Don Pedro Reservoir.

The total storage capacity of the listed reservoirs is 32 800 cubic hectometres (26.6 million acre-feet), and the average October 1 storage over the period 1966-75 has been about 19 900 cubic hectometres (16.1 million acre-feet), or 60 percent of capacity. Projected carry-over storage as of October 1, 1977, is only 5 400 cubic hectometres (4.4 million acre-feet), or 17 percent of capacity and only 28 percent of the average October 1 storage.

Available carry-over storage will vary from zero on Cache Creek and for Lake Tahoe to 910 cubic hectometres (740,000 acre-feet) for Oroville. The figures shown for minimum power represent the storage (in acre-feet) remaining when a reservoir falls to the minimum level at which the associated power plants can operate. Much of the water in storage at minimum power level is potentially available for release for other purposes. However, permission of the Federal Power Commission will generally be required to draw a reservoir below minimum power pool. Whether or not this is actually done will partially depend on the analysis of the tradeoffs involved in using this water to provide a base for continued power production rather than for water supply.

Projected total reservoir storage on October 1, 1978, will be 1 700 cubic hectometres (1,375,000 acre-feet), or only 9 percent of average. Of this total, 460 cubic hectometres (375,000 acre-feet) is dead storage (i.e., the storage below the lowest gravity outlet of the reservoir) and would require pumping to be available. The remaining 1 230 cubic hectometres (1 million acre-feet) of stored water would be in five reservoirs: Almanor, Berryessa, Cachuma, Casitas, and Whale Rock.

Scheduled reservoir releases in a normal year average 21 500 cubic hectometres (17.4 million acre-feet). Potential releases for the 1978 water year approximate 10 500 cubic hectometres (8.5 million acre-feet), or 49 percent of normal. Percentages range from zero for the Cache Creek system to 100 for Almanor, Berryessa, Cachuma, Casitas, and Whale Rock. The latter three reservoirs experience relatively small demands and are isolated from the main areas of water demand in the State. Therefore, the October 1, 1978, carry-over in Lakes Almanor and Berryessa is all that would be readily available for redistribution to water short areas. Their storage is estimated to total 970 cubic hectometres (790,000 acre-feet).

It should be reiterated that, with the five exceptions noted above, the underlying assumption for the 1978 reservoir operation scenario is that all surface storage would be drawn down to minimum level by October 1, 1978, the beginning of the 1979 water year, with no residual storage for carry-over into the 1979 year. In most situations, this is not judged to be a prudent mode of operation.

General Mode of Operation and Capabilities of Major Diversion Projects

The major project systems serving California via transbasin diversions of

water supplies are shown on Figure 12. They are: Hetch Hetchy Project from the Tuolumne River, serving the City of San Francisco; the Mokelumne River Aqueduct, which delivers to the East San Francisco Bay communities; the Colorado River Aqueduct operated by The Metropolitan Water District of Southern California; the Los Angeles Aqueduct and associated hydroelectric generation facilities, which make deliveries from the Owens River and Mono Basin to that City; the Central Valley Project operated by the U. S. Bureau of Reclamation principally to provide agricultural water service within the Sacramento and San Joaquin Valleys; and the State Water Project providing municipal, industrial, and agricultural water services to a total of 31 contractors in the Central Valley, south San Francisco Bay, and Southern California regions.

This discussion relates the normally available delivery capabilities of these project systems to their anticipated capabilities in 1978.

The Hetch Hetchy Project

Normal annual water need of the service area, based on use during 1975-76, was about 380 cubic hectometres (310,000 acre-feet).

This year, the City of San Francisco initiated a mandatory rationing program to reduce water use by 25 percent. Based on a 25 percent reduction, annual water use in the service area in 1977 will be about 280 cubic hectometres (231,000 acre-feet).

All of the water delivered by the Hetch Hetchy system comes from system storage in Hetch Hetchy Reservoir and Lakes Lloyd and Eleanor in the Tuolumne watershed and several local Bay Area reservoirs. Lakes Lloyd and Eleanor ordinarily serve as hydrolectric sources for the City and as storage for satisfaction of downstream water rights. This year the two reservoirs were connected, by means of reactivating an old canal, to the Hetch Hetchy Aqueduct intake. Thus, their storage can be made available for water supply deliveries. Total fixed reservoir capacity is 1 070 cubic hectometres (866,000 acre-feet). The average water supply to the Hetch Hetchy system consists of about 310 hectometres (253,000 acre-feet) from the Tuolumne watershed and 70 cubic hectometres (57,000 acre-feet) from local watersheds.

Initial studies had indicated that a substantial amount of water presently stored in the system's reservoirs would be required to meet water needs for 1977-78. However, precipitation in the upper Tuolumne River drainage basin during May 1977 was 300 percent of the long-term average and a thunderstorm in the first week of June produced additional unexpected inflow to the reservoirs. As a result, the July 1 storage in the system was about 490 cubic hectometres (400,000 acre-feet), about one-third of which was contained in Lakes Eleanor and Lloyd, considerably more than had been anticipated by the May 1 forecast.

If 1976-77 runoff should be repeated in 1977-78, and if a 25 percent mandatory conservation level is maintained, the January 1, 1979, storage would be 435 cubic hectometres (353,000 acre-feet). This appears to be an adequate carry-over storage reserve for the San Francisco service area.

Availability of the runoff for system use is complicated, however, by downstream water rights on the Tuolumne River. Hetch Hetchy water and power credits to serve these water rights, accumulated in New Don Pedro Reservoir, will be exhausted some time in 1978, should there be a repetition of this year's water supply in 1977-78. If 1978-79 should also be dry, much of the runoff originating above the Hetch Hetchy system reservoirs would have to be devoted to satisfaction of downstream water rights. This could severely restrict the amount of water that could

Figure 12

MAJOR AQUEDUCTS IN CALIFORNIA

be obtained from runoff into the system reservoirs and might necessitate full reliance upon the accumulated storage.

The Mokelumne River Aqueduct

The East Bay Municipal Utility District imports most of its water supply from Pardee Reservoir on the Mokelumne River via the Mokelumne Aqueduct. Normal aqueduct deliveries are 270 cubic hectometres (219,000 acre-feet) per year, and local reservoirs supply 30 cubic hectometres (24,000 acre-feet). The District uses no ground water; however, there are private wells in the service area. Normal annual water use is 300 cubic hectometres (243,000 acre-feet). Early in 1977, the District initiated a mandatory conservation program to reduce total water use by 25 percent, later increased to 35 percent. With these programs in effect since February 1977, 1976-77 water use is expected to total 210 cubic hectometres (168,000 acre-feet), 69 percent of normal. Water supply for a dry 1977-78 will consist of 212 cubic hectometres (172,000 acre-feet) of existing district stored water and 46 cubic hectometres (37,000 acre-feet) from the Folsom-South Canal Unit of the USBR's Central Valley Project. The District has assumed that all 1977-78 water year runoff from the Mokelumne River will be needed to satisfy prior water rights and losses, and none will be available to the District. The projected water supply is sufficient to deliver the same amount of water as delivered in 1976-77, meeting 65 percent of its normal deliveries, and still maintain a reserve (51 cubic hectometres or 41,000 acre-feet) in storage.

The Colorado River Aqueduct

Under the assumption that only minimal SWP water will be delivered to Southern California in 1978, or that if large deliveries were possible they would be exchanged with Central and Northern California, it will be necessary to operate the Colorado River Aqueduct to the full extent of the conveyance facility's capacity of 1 500 cubic hectometres (1,2 million acre-feet). For areas of the Metropolitan Water District with access to Colorado River water, priority demands can be met by applying essentially the same operational criteria developed for the remainder of this year. However, emergency storage in the Mathews and Skinner Reservoirs will fall below minimum acceptable levels unless additional conservation and increased ground water pumping are attained. At least 20 percent conservation would be required. Since these areas would be almost entirely dependent upon continued maximum operation of the Colorado River Aqueduct, emergency storage levels would need to be maintained to provide a 90-day supply.

The Los Angeles Aqueduct

The Los Angeles Aqueduct from the Owens River and Mono Basins ordinarily provides about 80 percent of the water supply, 580 cubic hectometres (470,000 acre-feet) per year, for the City of Los Angeles. In 1977, the effects of the drought will reduce surface supply to 134 cubic hectometres (108,500 acre-feet), and a court-imposed restriction on pumping water from the Owens Valley ground water basin will reduce pumped deliveries to 187 cubic hectometres (151,800 acre-feet), for a total of 320 cubic hectometres (260,000 acre-feet). The difference is being made up by increased purchase of MWD water, mainly from the Colorado River Aqueduct. An injunction had limited annual pumping to 134 cubic hectometres (108,500 acre-feet), down from the full pumping capability of 280 cubic hectometres (228,000 acre-feet), but it has been temporarily suspended from August 1, 1977, until March 1978. Only 300 cubic hectometres (245,800 acre-feet) will be available from the Owens and Mono basins if the injunction is reinstated in March 1978. On the other hand, if the court extends the suspension of the injunction for all of 1978, it

would permit the City to pump an additional 150 cubic hectometres (120,000 acre-feet), for a total supply from ground water and surface sources of 410 cubic hectometres (333,000 acre-feet). In any event, increased reliance on the MWD source will be necessary in 1978.

The State Water Project and The Central Valley Project

For a discussion of these two systems, refer to preceding portions of this report.

Potential 1978 Water Demands and Supplies by Major Hydrologic Regions

Table 11 shows 1977 and 1978 applied water demands and supplies by major geographic regions of the State, assuming a continuation of 1977 conditions. On this table, 1972 is shown as the pre-drought "baseline" period of water use.[1/]

The 1972 level was used as a base for comparison because it is the last period for which fully reliable data has been compiled on a statewide basis. Since 1972, however, population in California has increased from 20.5 million to about 21.8 million persons in 1977, and there were substantial increases in irrigated agricultural acreages up to 1975 (just prior to the current drought).

California's statewide applied water uses at the 1972 development level were estimated to be 45 900 cubic hectometres (37.2 million acre-feet) annually. Without the constraints imposed by drought-related water shortages, the increases in population and irrigated acreage (the latter principally in the Sacramento Valley, the San Joaquin Valley, and the Central Coastal region) would have resulted in applied water use of about 48 600 cubic hectometres (39.4 million acre-feet) in 1977.

Applied water requirements for irrigation are quite sensitive to precipitation conditions. The early growing season moisture available in extremely dry years, such as 1976 and 1977, is less than in normal years, and applied water needs are greater. Accordingly, the estimated water demands for the drought year 1977 and for 1978 have been adjusted to show increased water demand to correct this moisture deficiency. Table 11 reflects an increased demand in the order of 1 800 cubic hectometres (1.5 million acre-feet) resulting in an indicated overall municipal, industrial, and agricultural applied water demand in 1977 of 50 500 cubic hectometres (40.9 million acre-feet). It should be noted that this is a hypothetical demand for water, i.e., the use that would have occurred without the reductions in irrigated acreages or changes in crop patterns, etc., which have resulted this year due to the water supply deficiencies.

The table indicates that 1972 water supply from surface sources was some 27 200 cubic hectometres (22.1 million acre-feet). As a result of the sustained 1976-77 drought conditions, this supply has been reduced to 19 900 cubic hectometres (16.1 million acre-feet) for 1977. Conversely, ground water pumping has increased about 4 200 cubic hectometres (3.4 million acre-feet), statewide, to 22 800 cubic hectometres (18.5 million acre-feet).

The results indicate that there is presently an overall statewide water supply deficiency in fully meeting normally applied water demands during the current (1977) year of some 7 800 cubic hectometres (6.3 million acre-feet). Almost 90 percent of this deficiency is occurring within the extensive agricultural areas of the Central Valley, primarily the San Joaquin and Tulare Lake regions.

1/ DWR Bulletin No. 160-74, "The California Water Plan--Outlook in 1974".

TABLE 11

ESTIMATED WATER DEMANDS, SUPPLIES, AND DEFICIENCIES*
Cubic Hectometres
(1,000 acre-feet)

	1972 Level Water Use			1977 & 1978 Estimated Water Demand			1977 Estimated Water Supply			1978 Estimated Water Supply			1978 Deficiency (-) (Surplus) (+)
	Surface	Ground Water	Total	Urban	Agricultural	Total	Surface	Ground Water	Total	Surface 1/	Ground Water 2/	Total	
North Coastal	1 233 (1,000)	123 (100)	1 356 (1,100)	123 (100)	1 233 (1,000)	1 356 (1,100)	863 (700)	247 (200)	1 110 (900)	863 (700)	247 (200)	1 110 (900)	-247 (-200)
San Francisco Bay	986 (800)	493 (400)	1 480 (1,200)	1 233 (1,000)	370 (300)	1 603 (1,300)	740 (600)	617 (500)	1 356 (1,100)	617 (500)	617 (500)	1 233 (1,000)	-370 (-300)
Central Coastal	123 (100)	1 356 (1,100)	1 480 (1,200)	247 (200)	1 356 (1,100)	1 603 (1,300)	123 (100)	1 356 (1,100)	1 480 (1,200)	123 (100)	1 356 (1,100)	1 480 (1,200)	-123 (-100)
South Coastal	1 973 (1,600)	2 096 (1,700)	4 069 (3,300)	2 959 (2,400)	1 100 (900)	4 070 (3,300)	2 343 (1,900)	1 850 (1,500)	4 192 (3,400)	2 096 (1,700)	1 850 (1,500)	3 946 (3,200)	-123 (-100)
Sacramento Valley	6 535 (5,300)	2 219 (1,800)	8 754 (7,100)	1 233 (1,000)	9 864 (8,000)	11 097 (9,000)	5 672 (4,600)	3 083 (2,500)	8 754 (7,100)	4 809 (3,900)	3 083 (2,500)	7 891 (6,400)	-3 206 (-2,600)
San Joaquin Valley	11 837 (9,600)	11 713 (9,500)	23 550 (19,100)	863 (700)	24 660 (20,000)	25 523 (20,700)	5 918 (4,800)	15 043 (12,200)	20 961 (17,000)	3 946 (3,200)	15 043 (12,200)	18 988 (15,400)	-6 535 (-5,300)
North Lahontan	493 (400)	123 (100)	617 (500)	123 (100)	493 (400)	617 (500)	123 (100)	123 (100)	247 (200)	123 (100)	123 (100)	247 (200)	-370 (-300)
South Lahontan	123 (100)	370 (300)	493 (400)	123 (100)	370 (300)	493 (400)	123 (100)	370 (300)	493 (400)	123 (100)	370 (300)	493 (400)	0
Colorado Desert	3 946 (3,200)	123 (100)	4 069 (3,300)	123 (100)	3 946 (3,200)	4 070 (3,300)	3 946 (3,200)	123 (100)	4 070 (3,300)	3 946 (3,200)	123 (100)	4 070 (3,300)	0
Totals	27 249 (22,100)	18 616 (15,100)	45 868 (37,200)	7 027 (5,700)	43 392 (35,200)	50 432 (40,900)	19 851 (16,100)	22 812 (18,500)	42 663 (34,600)	16 646 (13,500)	22 812 (18,500)	39 458 (32,000)	-10 974 (-8,900)

1/ Based on 1977 estimated values adjusted for changes in major reservoir carry-over storage. Reservoirs were assumed drawn down to dead storage by October 1, 1978, if needed. SWP supplies were assumed to have been redistributed from South Coastal and Colorado Desert areas to northern areas as in 1977 water supply estimate. CVP supplies were assumed to meet 75 percent of Sacramento River and Mendota Pool water rights and 25 percent of M&I deliveries. Remaining water was assumed to provide agricultural water for trees and vines only and for reduced Delta outflow.

2/ Assumed to equal values shown for 1977.

* Hypothetical demands for 1977 and 1978 without major urban water conservation constraints imposed by drought related water shortages but with the additional drought related water requirements to grow normal crops. See text for a more detailed discussion.

Should the current drought extend through 1978 unabated, with normal cropping patterns and no further increase in ground water pumping, the magnitude of these deficiencies would be increased to nearly 11 000 cubic hectometres (8.9 million acre-feet). Again, the hardest hit region would be the Central Valley Basin, but critical deficiencies may also occur at localized areas within all other regions except, perhaps, the South Lahontan and Colorado Desert. These latter areas appear to have generally adequate water supplies to meet normal requirements in 1978.

The primary difference in the estimate for 1977 and that shown for 1978 is found in the decreased amount of carry-over storage available from the State's reservoirs to meet 1978 demands. (See Table 10.)

The supply estimate indicated for 1978, as well as the 1977 estimate, has assumed a redistribution of State Water Project entitlements amounting to a shift of 414 cubic hectometres (336,000 acre-feet) from the South Coastal Area and 24 cubic hectometres (19,300 acre-feet) from the Colorado Desert region contractors to various service areas north of the Tehachapi mountains. The allocation of Central Valley Project supplies among hydrologic regions was assumed in accordance with recently announced USBR dry-year project operational policies.

As previously indicated, the 1978 supply estimate is predicated upon the same natural runoff conditions and reservoir inflows as the present (1977) year. Accordingly, estimates were made of the storage available at the beginning of the 1978 water year (October 1, 1977), and it was assumed that, if necessary for water supply needs during 1978, reservoirs would be drawn down to dead storage levels without regard to adverse effects on those power plants dependent upon reservoir stage for operating head. In computing supply available to meet demand, an exception to the dead storage drawdown was made in the case of reservoirs with unusually large amounts in storage; it was assumed they would be used to meet only their service area demands, and the water remaining in storage among these reservoirs represents an additional block of about 1 230 cubic hectometres (1,000,000 acre-feet) available to meet shortages in other service areas, if conveyance can be arranged. The quantity of water indicated as available from reservoirs to meet their service area demands was compared with the estimated amount used from storage in 1977 (difference in beginning and ending storage for the 1977 water year) to find the change in supply available from storage for 1978. This amount was used to adjust the 1977 surface water supply to obtain the 1978 surface supply estimate. The estimate is somewhat conservative in that no allowance was made for anticipated smaller evaporation losses in 1978, compared with 1977, because of lower reservoir levels. From 123 to 247 cubic hectometres (100,000 to 200,000 acre-feet) may be involved.

From this generalized 1978 supply assessment by hydrologic regions (illustrated by Table 11), it was assumed that ground water supplies would be the same in 1978 as estimated for 1977. Therefore, the total water supply for 1978 reflects only the effects of the changes in carryover storage in 1978, compared with 1977. It is recognized that other distributions of SWP and CVP supplies, as well as increases in ground water pumping, may be advisable in the final allocation of available supplies to meet expected 1978 demands, should the drought continue.

Ground water supplies take on greater importance during drought periods. Under normal conditions of water supply, ground water sources have traditionally met a large portion of California's water demands. During drought periods, however, it is the State's most significant and important source of reserve supplies. When surface supplies become inadequate and where ground water underlies an area, increased pumping from existing wells takes place, new wells are constructed, and unused or abandoned wells are frequently placed back into service.

In recent years (prior to the current drought), the average annual pumping of ground water has been about 19 000 cubic hectometres (15 million acre-feet). This has accounted for 40 percent of the State's normal water supplies for municipal, industrial, and agricultural purposes. Of this amount, 17 000 cubic hectometres (13 million acre-feet) per year has been derived from natural accretion, artificial recharge, and percolation of applied water, and 2 600 cubic hectometres (2.1 million acre-feet) annually has been provided by withdrawals from ground water storage in excess of average annual recharge, commonly referred to as "overdrafting".

Under the drought conditions in 1976, resulting in less natural accretion and return flows, the net depletion of ground water in storage was about 6 000 cubic hectometres (4.9 million acre-feet), or about 4.2 percent of the readily usable ground water (generally the water within 200 feet of the ground surface).

Use of ground water accelerated significantly in 1977 with the 7 400 cubic hectometres (6.0 million feet) statewide reduction in the availability of surface water supplies. Increased ground water

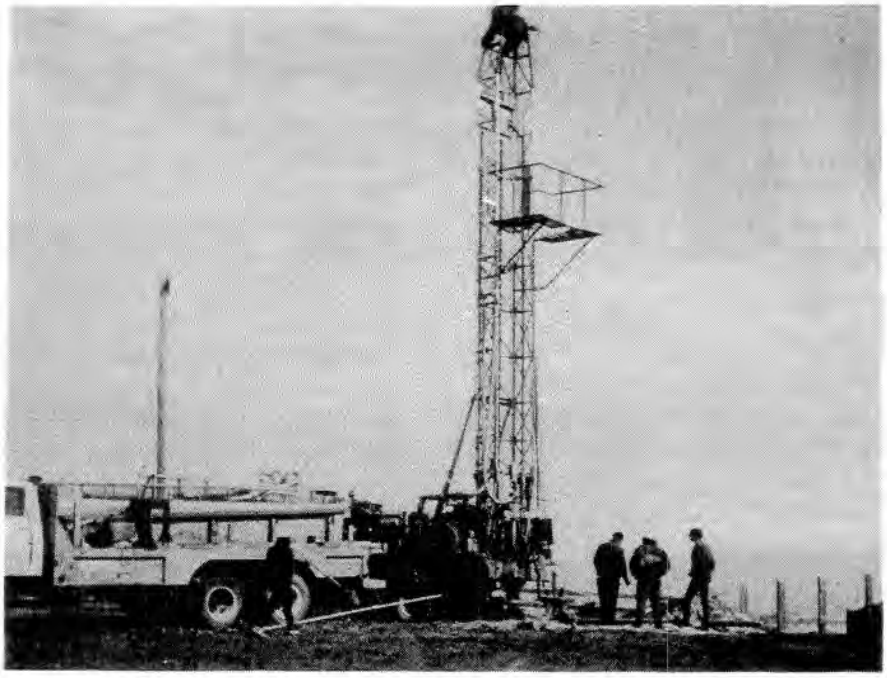
pumping has offset a large portion of this deficiency. It is cursorily estimated that pumping in 1977 will be at least 22 800 cubic hectometres (18.5 million acre-feet), resulting in a net decrease in ground water storage reserves of perhaps 12 300 cubic hectometres (10 million acre-feet). This is about 8.4 percent of the readily usable ground water in storage statewide.

It becomes evident, therefore, that ground water reserves have assisted significantly in preventing disastrous consequences to large segments of irrigated agriculture and to many domestic and industrial users.

This has been accomplished not without certain problems, however. Additional energy is required for ground water extraction from greater depths, and additional surface subsidence may well occur in some areas as a result of increased pumping. Less surface water availability means less salt leaching will take place, and additional applied water will be required in the future to leach out the accumulated salts from the soil. The salt build up may result in an increase in total salt percolation to the ground water basins (instead of normal flushing to the sea or natural salt sinks) causing degradation of ground water supplies. With less applied surface water, there will be reduced deep percolation to recharge the ground water.

For this assessment, the assumption has been made that ground water pumping will remain essentially at the same amount next year, in the event of a continuation of the drought, as is occurring in 1977. But it is recognized that further increases in ground water utilization will undoubtedly occur, and will indeed be necessary, should the 1978 water year remain substantially below normal.

The following tables list the general sources of ground water pumped (statewide) and the estimated net reductions in ground water storage in the Northern California hydrologic regions.



37. A new well is drilled near Watsonville in Santa Cruz County. The drought will necessitate drilling many new wells, and upgrading many old ones, in 1978.

GENERAL SOURCES OF GROUND WATER PUMPED
STATEWIDE
1000 cubic hectometres
(million acre-feet)

	Normal Year	1976	Assumed 1977	1978
Percolation from Applied Water and Artificial Recharge	9.2 (7.5)	7.4 (6.0)	6.8 (5.5)	6.8 (5.5)
Natural Recharge	6.8 (5.5)	4.9 (4.0)	3.7 (3.0)	3.7 (3.0)
Reduction in Storage	2.6 (2.1)	6.3 (5.1)	12.3 (10.0)	12.3 (10.0)
Total	18.6 (15.1)	18.6 (15.1)	22.8 (18.5)	22.8 (18.5)

ESTIMATED NET DECREASE IN GROUND WATER STORAGE
NORTHERN CALIFORNIA
Cubic Hectometres
(1,000 acre-feet)

Hydrologic Basin	1976	1977	1978
North Coastal	86 (70)	123 (100)	123 (100)
San Francisco Bay	469 (380)	615 (500)	615 (500)
Central Coastal	308 (250)	370 (300)	370 (300)
Sacramento	1 209 (980)	2 470 (2,000)	2 470 (2,000)
San Joaquin-Tulare	3 810 (3,090)	7 400 (6,000)	7 400 (6,000)
North Lahontan	111 (90)	123 (100)	123 (100)
Total	5 993 (4,860)	12 330 (10,000)	12 330 (10,000)

Water Deficiency Assessments by Hydrologic Regions

As indicated by Table 11 and based upon the assumptions previously discussed, the 1978 deficiency in statewide water supplies could be as high as 11 000 cubic hectometres (8.9 million acre-feet), or about 22 percent of the normally required applied water demand, should the current drought continue next year with the same severity as during the current (1977) year. Accordingly, there would be a resultant increase in statewide water deficiencies of 3 200 cubic hectometres (2.6 million acre-feet) over those occurring in the current year. The following paragraphs discuss the estimated magnitudes and generalized location of these additional water deficiencies according to the nine hydrologic regions shown on Figure 13.

North Coastal

The 1978 deficiency is projected to be about 247 cubic hectometres (200,000 acre-feet), or approximately the same as this year. Most of this deficiency will continue to be within the upper Klamath area as a result of decreased local stream supplies and the delivery capabilities of the Klamath Project. The remaining shortage will occur in coastal areas and certain isolated inland regions. Of particular importance is the supply availability from Ruth Reservoir on the Mad River, which is the primary source of water for domestic and industrial service to the Humboldt Bay cities. Further curtailments and rationing may be necessary.

San Francisco Bay

A resulting increase in deficiencies of up to 123 cubic hectometres (100,000 acre-feet), bringing the total 1978 deficiency to 370 cubic hectometres (300,000 acre-feet), may occur in the Bay Area should the drought continue. Depending upon operational modes of the major aqueduct importation systems, most of the added deficiencies will be in the South Bay subarea, served by the Hetch Hetchy and Mokelumne Aqueducts. Reductions in SWP and CVP imports, as well as in local supplies, could also be sizeable. In the North Bay subarea, service reduction will continue primarily from local surface water sources of Lake Mendocino and in the importations from the Eel River to the Russian River.

Central Coastal

Areawide, it is believed that the 1978 supply will be about the same as during the current year, but some particularly critical local problems may develop within the Monterey Bay vicinity. The indicated deficiency is about 123 cubic hectometres (100,000 acre-feet) in both 1977 and 1978.

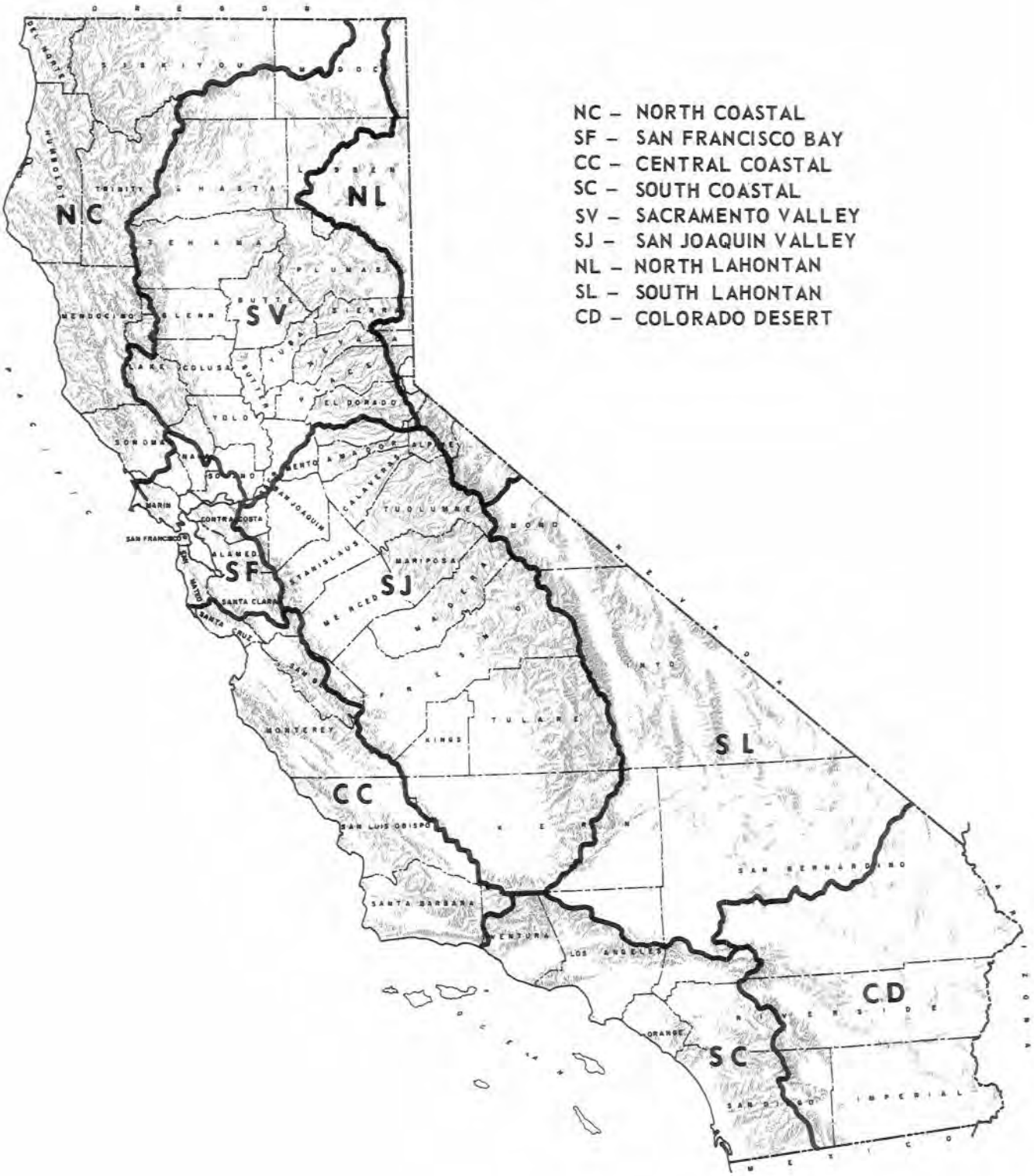
Although Naciemento Reservoir will have a deficiency in normal water supply, the water is normally all percolated to ground water. Since the net result will be a decrease in ground water storage and existing pumps can be used, no deficiency was indicated. However, there will be a lowering of the water table as a result of reduced recharge. Whale Rock and Cachuma Reservoirs together will have about 96 cubic hectometres (78,000 acre-feet) in storage in excess of their service area requirements. This could be used in other service areas, but service interconnections would be difficult, if not impossible.

South Coastal

In this area there will be a reduction in supply in 1978, as compared with 1977, when no deficiency was indicated. This will occur primarily in the SWP service areas. The small deficiency shown (123 cubic hectometres or 100,000 acre-feet) could be met, if necessary, by increasing SWP deliveries. Determination of a prudent level of emergency storage in terminal reservoirs of the Colorado River Aqueduct and SWP systems is still to be considered. Increased

Figure 13

MAJOR HYDROLOGIC REGIONS
OF CALIFORNIA



conservation (above the present 10 percent goal) should be considered.

Sacramento Valley

The Sacramento Valley is an area of large, continuing deficiencies, estimated to be 3 200 cubic hectometres (2,600,000 acre-feet) in 1978. The supply in 1978, as compared with 1977, represents an assumed further reduction of 620 cubic hectometres (500,000 acre-feet) in CVP agricultural deliveries resulting from reduced carry-over storage in the system's reservoirs. Reduced carry-over storage in other Sierra reservoirs accounts for an additional 247 cubic hectometres (200,000 acre-feet) reduction from 1977 values. For 1978, deliveries by the CVP were assumed to equal 75 percent for water rights users on the Sacramento River and 25 percent for municipal and agricultural users. Water would be supplied to other agricultural users for survival of trees and vines only. The foregoing analysis does not include nearly 370 cubic hectometres (300,000 acre-feet) available in PG&E-owned Lake Almanor and potentially available to meet deficiencies in areas which it could serve. Similarly, nearly 616 cubic hectometres (500,000 acre-feet) may be available in Lake Berryessa after meeting the USBR's Solano Project demands.

During 1977, the Department of Water Resources imposed a 50 percent reduction of normal appropriative diversion entitlements for agriculture in areas served from the Feather River. The 1977 entitlements totaled 548 cubic hectometres (444,000 acre-feet). Acreages of rice and other annual crops were reduced by about 50 percent and the number of orchard irrigations were reduced while increasing use of drainage water took place. There was only a light increase in ground water pumping. Similar actions and operations would be expected in 1978.

In the Yuba River service area, rice is the predominant crop and normal water use is 191 cubic hectometres (155,000 acre-feet) annually. Irrigated acreage was reduced 20 percent in 1977. New Bullards Bar Reservoir on the Yuba will have only minimum carry-over storage and there may be little water, if any, available for irrigation.

In the Bear River service area, Camp Far West Reservoir water supplies will probably not be available for irrigation in 1978. Increased ground water pumping took place in 1977 and ground water will be the major water supply for 1978 for irrigated land that remains in production, about one-half of the normal area.

Other areas of the Sacramento Valley will have similar water supply problems. Changes in crops, reduced acreage, and increased ground water pumping can be expected.

San Joaquin Valley

The reduction in supply for 1978 represents about 250 cubic hectometres (200,000 acre-feet) in SWP supply, about 1 100 cubic hectometres (900,000 acre-feet) in CVP supply, and about 620 cubic hectometres (500,000 acre-feet) in other Sierra reservoir supplies, all as a result of reduced carry-over storage. Deficiencies are indicated as 4 500 cubic hectometres (3,700,000 acre-feet) in 1977 and 6 500 cubic hectometres (5,300,000 acre-feet) in 1978.

The SWP supply is based on an assumed transfer of nearly 310 cubic hectometres (250,000 acre-feet) of Southern California water to the Tulare Basin area and about 25 cubic hectometres (20,000 acre-feet) to the San Joaquin area, as was assumed for the 1977 supply.

The estimated CVP supply represents 75 percent of normal deliveries to Mendota water rights users and 25 percent delivery to municipal and industrial users.

Other agricultural users in the Mendota and San Luis service areas will receive water to permit survival of trees and vines only. Delivery of amounts in addition to the above will be beyond the capability of the CVP system due to decreased reservoir carry-over storage in 1978.

Under continued drought conditions, it is expected that a number of water, irrigation, and water storage districts will be able to meet most of the crop requirements by ground water pumping from district and private wells. Reductions in crop acreage and changes in crops planted will depend upon availability of ground water, capability to pump the water, and an assessment of the economics of the farm operation.

All districts should be able to meet emergency permanent crop requirements except the following districts that do not have ground water capability:

Belridge Water Storage District,
16 200 hectares (40,000 acres) crops,
1 600 hectares (4,000 acres) perennial crops, Northwestern Kern County.

Berrenda Mesa Water Storage District,
14 500 hectares (36,000 acres) crops,
10 900 hectares (27,000 acres) tree crops, Northwestern Kern County.

Dudley Ridge Water District,
5 300 hectares (13,000 acres) crops,
2 800 hectares (7,000 acres) perennial crops, Western Kings County.

Lost Hills Water District,
15 800 hectares (39,000 acres) crops,
4 900 hectares (12,000 acres) perennial crops, Northwestern Kern County.

Terra Bella Irrigation District,
4 200 hectares (10,500 acres) crops,
4 000 hectares (10,000 acres) perennial crops, South Central Tulare County.

In addition to the districts listed above, the following districts which also use ground water are faced with the possibility of no surface water supplies from the CVP Friant-Kern Canal and may have problems in protecting their perennial crops:

Orange Cove Irrigation District,
9 600 hectares (23,800 acres) crops,
9 200 hectares (22,700 acres) perennial crops, Fresno and Tulare Counties.

Lindsay-Strathmore Irrigation District,
5 300 hectares (13,000 acres) crops,
5 300 hectares (13,000 acres) perennial crops, Central Tulare County.

Teapot Dome Water District,
1 100 hectares (2,800 acres) crops,
1 100 hectares (2,800 acres) perennial crops, Southern Tulare County.

Stone Corral Irrigation District,
2 300 hectares (5,800 acres) crops,
2 300 hectares (5,800 acres) perennial crops, Northern Tulare County.

International Water District,
280 hectares (700 acres) crops,
200 hectares (500 acres) perennial crops, North Central Fresno County.

Problems in maintaining perennial crops may also occur in Oak Flat Water District with 120 hectares (300 acres) of perennial crops and Wheeler Ridge-Maricopa Water Storage District with 8 500 hectares (20,900 acres) of perennial crops in the portion of the District that uses only surface water.

Those districts which will depend largely on ground water supplies will experience a greater lowering of the ground water table, greater pumping lifts, and increased power consumption. Of the 50 districts or areas monitored, depth to ground water in 27 is less than 30 metres (100 feet) and in 9 is less than

46 metres (150 feet). In the other 14 areas or districts, depth to water ranges from 46 to 120 metres (150 to 390 feet). The Edison-Maricopa area (southeast of Bakersfield), which includes Arvin-Edison and Wheeler Ridge-Maricopa Water Storage Districts, has the greatest depth to water of 120 metres (390 feet).

The Mendota-Huron area, which includes Westlands Water District, has depths to water of 101 metres (330 feet). North Kern and Semitropic Water Storage Districts, northwest of Bakersfield, have recorded depths to water of 76 metres (250 feet). Depth to water in Shafter--Wasco is 82 metres (270 feet). Areas having the lower water levels will require more costly well construction, greater pumping costs, and greater energy consumption.

North Lahontan

The North Lahontan region will be deficient in water supply by about 370 cubic hectometres (300,000 acre-feet) in 1977 and in 1978 but there are no changes anticipated in the area as a result of reservoir operation. Local surface and import water supplies will continue below normal in 1978 as in 1977.

South Lahontan

While there will be a minor reduction in water available from the SWP, the South Lahontan supply should be generally adequate to meet demands in 1978.

There is a shortage of water in the East and West Walker Rivers. Federal Decree C-125, set forth in 1859, allocates all natural flow to the Walker River Indian Reservation at Schurz, Nevada. The decree was enforced in 1977 by the federal watermaster and all upstream diversions, including those for stockwatering, were shut off on August 1. Storage in Bridgeport Reservoir and Topaz Lake is essentially gone. This situation will probably continue in 1978.

Colorado Desert

There appear to be adequate supplies from the Colorado River to meet the normal demands of the Colorado Desert area in 1978.

Critical Areas and Special Problem Assessment

Large areas of California have been affected by the 1976-77 drought, and the effects will be intensified if the drought continues into 1978 with runoff conditions similar to those in 1977. Many cities and communities have had to resort to emergency measures, such as temporary importation of water from other areas, drilling new wells, mandatory conservation measures and, in some cases, rationing to meet the basic essential water needs.

Most of the more severely affected areas have developed, or are in the process of developing, contingency plans for 1978. There are, however, several cities and communities where local resources are inadequate to develop drought contingency plans or physical solutions. This is especially critical for small communities in the foothills and other areas where ground water availability is limited. Table 12 indicates 39 communities (mostly small) in that category.

The guidelines discussed at the beginning of this chapter were used to determine those areas where special problems can be expected. It was assumed that a state contingency plan was not necessary if the community could expect its water supply to provide over 284 litres per capita per day (LPCPD) (75 gallons per capita per day [GPCPD]) and meet 75 percent of the 1976 level of industrial water use. A water use of 284 LPCPD (75 GPCPD) is about one-half the normal value and should not place undue constraints on living under severe drought conditions. A special problem was considered to exist if less than 284 LPCPD (75 GPCPD) could be expected and the

AREAS WITH POSSIBLE WATER SHORTAGES IN 1978[1]

County	City, District Agency or Community[2]	Water Source	Domestic Supply Availability GPCD More Than 75	Domestic Supply Availability GPCD More Than 35	Risk to Perennial Crops	Remarks
Amador	Pine Grove	Well	No	Yes		Well production inadequate.
	Pioneer	Antelope Creek and Spring	No	Yes		Supply about 1/3 of normal.
	Pine Acres	Wells	No	Yes		Well production is inadequate.
	Plymouth	Wells, Consumnes River via Arroyo Tiffell	Yes[3]	Yes		Normally 20% ground water and 80% surface water.
	Drytown	PG&E Amador Canal	No	Yes		Supply short due to unauthorized use of water from open ditch supply line.
Butte	Cohasset Ridge	Individual wells.	No	No		Most individual wells dry.
	Forest Ranch	Individual wells.	No	No		Most individual wells dry.
	Lime Saddle CSD	Wells.	No	Yes		New deep well in 1977.
	Magalia	Wells & tie in to Paradise	No	Yes		Emergency supplies available.
	Paradise ID	Paradise Reservoir and Magalia Reservoir	No	Yes		Emergency supplies from Cal. Water Service Co., Butte Co., Del Oro WC and PG&E.
Calaveras	Copperopolis	Surface water.	No	No		Area will install a well if they can obtain a grant.
Contra Costa	CCCWD (Including Antioch, Pittsburg, Walnut Creek, etc.)	CVP and wells.	No	Yes		Supply from CVP uncertain. Shortage may be severe.
Colusa	Stonyford	Individual wells.	No	No		Most individual wells dry.
	Sites	Individual wells.	No	No		Most individual wells dry.
	Lodoga	Individual wells.	No	No		Most individual wells dry.
Fresno	Dinuba	Wells.	No	Yes		Wells going dry.
	Kerman	Wells.	No	Yes		Wells going dry.
	Orange Cove	Friant-Kern Canal and wells	No	Yes		Wells going dry. Limited Friant-Kern Canal deliveries.
Glenn	Tehama-Colusa Canal Service Area	Sacramento River (CVP)			Yes	Over 11,000 acres of tree crops. No Tehama-Colusa delivery except for some tree survival. Limited ground water extraction capability.
	Orland Water Users Assn.	East Park Reservoir and Stony Gorge Reservoir			Yes	3,000 acres of tree crops. No surface supply. Limited ground water extraction capability.
	Grindstone Rancheria-Indian Reservation	Stony Creek	No	No		No supply available from Stony Creek.
Humboldt	Trinidad	Luffenholtz Creek.	No	Yes		Insufficient flow available.
	Humboldt Bay MUD	Mad River.	Yes	Yes		Insufficient supply for full operation of major pulp mills.
Kern	Berrenda Mesa WD	California Aqueduct (SWP)			Yes	46,600 total crop acres. 27,000 acres of tree crops. Limited SWP delivery. No ground water.
	West Kern WD	SWP and wells.			Yes	25,000 crops acreage. 12,000 acres permanent crops. No ground water.
	Belridge Water Storage Dist.	SWP and wells.			Yes	Crop acreage 40,000. 4,000 acres of permanent crops. No ground water.
Kings	Dudley Ridge WD	SWP and wells.			Yes	13,000 total crop acreage. 7,000 acres of permanent crops. No ground water.
Lake	Lakeport	City-owned wells.	Yes	Yes		Existing wells cannot be deepened. Are trying another ground water basin.
Los Angeles	Avalon	Surface water reservoir and wells.	No	No		Existing supplies depleted by Aug. 1978. Plan to rehabilitate and expand sea water system for sanitation and fire protection. Plan to barge water from mainland for domestic use.
Marin	Bolinas Community PUD	Local stream.	No	No		Other sources not available.
	Marin Municipal WD	Surface reservoirs and temporary importation and exchanges.	No	Yes		75% deficiency without emergency importation.
	Stinson Beach Co., WD	Local stream.	No	Yes		Other sources not available.
Mariposa	Mariposa	Wells	No	Yes		New wells added under Davis-Crunsky loan. Can supply only 50 GPCD.
Mendocino	Cupella	Ground water.	No	Yes		Low yielding ground water basin.
	Mendocino	Individual wells.	No	No		Wells in shallow terraces. Nearly dry. Cannot be deepened.
	Point Arena	Private water co. (wells and springs).	No	No		Wells in shallow terraces. Nearly dry. Cannot be deepened.
Merced	Merced ID	Lake McClure and wells.			Yes	Less than 25% surface supply. Lowered ground water levels.
Monterey	Monterey Bay Cities	Carmel River and wells.	No	Yes		Currently operating under PUC ordered rationing.
Napa	Calistoga	Wells.	No	Yes		Water quality problem with some wells.
San Joaquin	Banta Carbona ID	San Joaquin River and wells.			Yes	5,300 acres of trees. Minimal supply from San Joaquin River. Lowered ground water levels.
	South San Joaquin ID	Stanislaus River and wells.			Yes	Less than 35% surface supply. Some wells. 43,000 acres of orchard.
Santa Cruz	Santa Cruz	Surface water, Loch Lomond Reservoir, and wells.	Yes[3]	Yes		Local supplies limited and no imported water available.
Shasta	Sugarloaf	Spring.	No	No		Have tried to clean spring, but no help.
Siskiyou	Campbell Tract	Individual wells.	No	No		Low yield ground water basin. Having water trucked in.
Tehama	Corning Canal	Sacramento River (CVP)			Yes	1,900 acres of trees. No surface deliveries except some for tree survival. Some ground water capability.
	Flourney	Individual wells.	No	No		Low yielding water formation.
	Manton	Digger Creek via open ditch	No	No		Low yeidling water formation.
	Tehama-Colusa Canal	Sacramento River (CVP)			Yes	See Glenn County.
Trinity	Weaverville	East Weaver Creek.	No	Yes		New reservoir was leaking. Was necessary to empty it.
Tulare	Springville	Tule River.	No	No		Normal supply dry. Trucking water
	Terra Bella ID	Friant-Kern Canal (CVP) and wells.			Yes	10,000 crop acres--10,000 perennial crops. Limited ground water.

1/ Agencies and areas are not included in this table where water shortages are not drastic enough to warrant special consideration under the guidelines as discussed at the beginning of this chapter.

2/ ID = Irrigation District.
WD = Water District
MUD = Municipal Utility District
PUD = Public Utilities District
CSD = Community Services District

3/ Household allowance 300 GPD.

Figure 14

AREAS WITH POSSIBLE WATER SHORTAGE PROBLEMS IN 1978 MEETING CONTINGENCY PLANNING GUIDELINES

problem was considered to be critical if less than 130 LPCPD (35 GPCPD) would be available. The 130 LPCPD (35 GPCPD) was assumed to be the minimum average water use to maintain health and welfare. Irrigated agricultural areas were considered to have a special drought problem if permanent tree or vine crops were endangered.

If a local area has no reasonable expectation of providing 75 percent of 1976 use for industrial requirements, then this was also considered to be a special problem because economic well-being and jobs could be affected.

Based on contacts with the various communities and review of drought questionnaires, the special problem areas listed in Table 12 were identified. The location of the areas are shown on Figure 14. Most of the identified areas have had problems in 1977 and are discussed earlier in this report.

38. An exception to the rule—Burney Falls in Shasta County typifies many of the springs in the northeast corner of California. Due to inflow from the volcanic soils in that region, basic streamflows remain relatively constant year in and year out, regardless of the annual fluctuation in precipitation.