DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

Prepared in cooperation with the
U.S. ARMY CORPS OF ENGINEERS

WATER-RESOURCES INVESTIGATIONS REPORT 85-4184

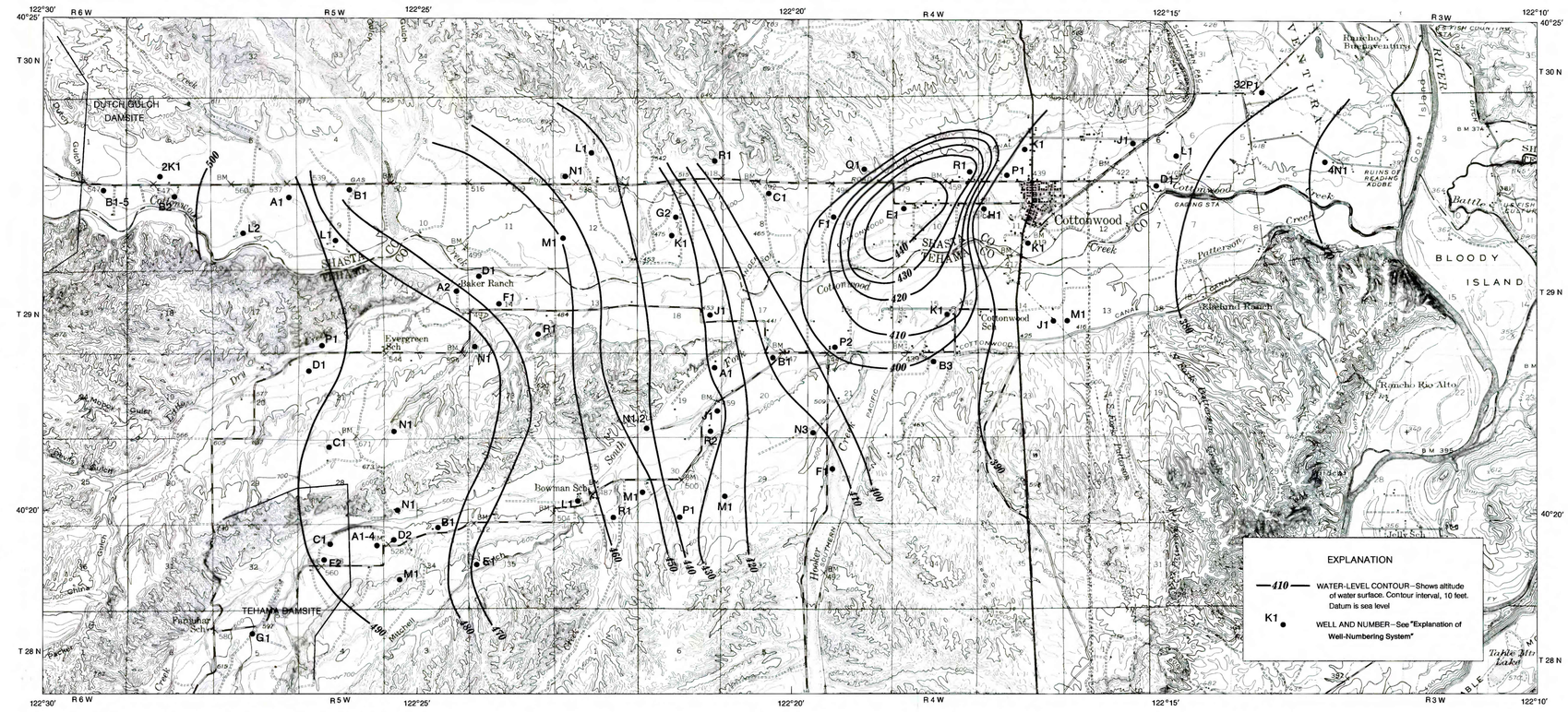


FIGURE 1.– GROUND-WATER LEVELS, AUGUST 1983

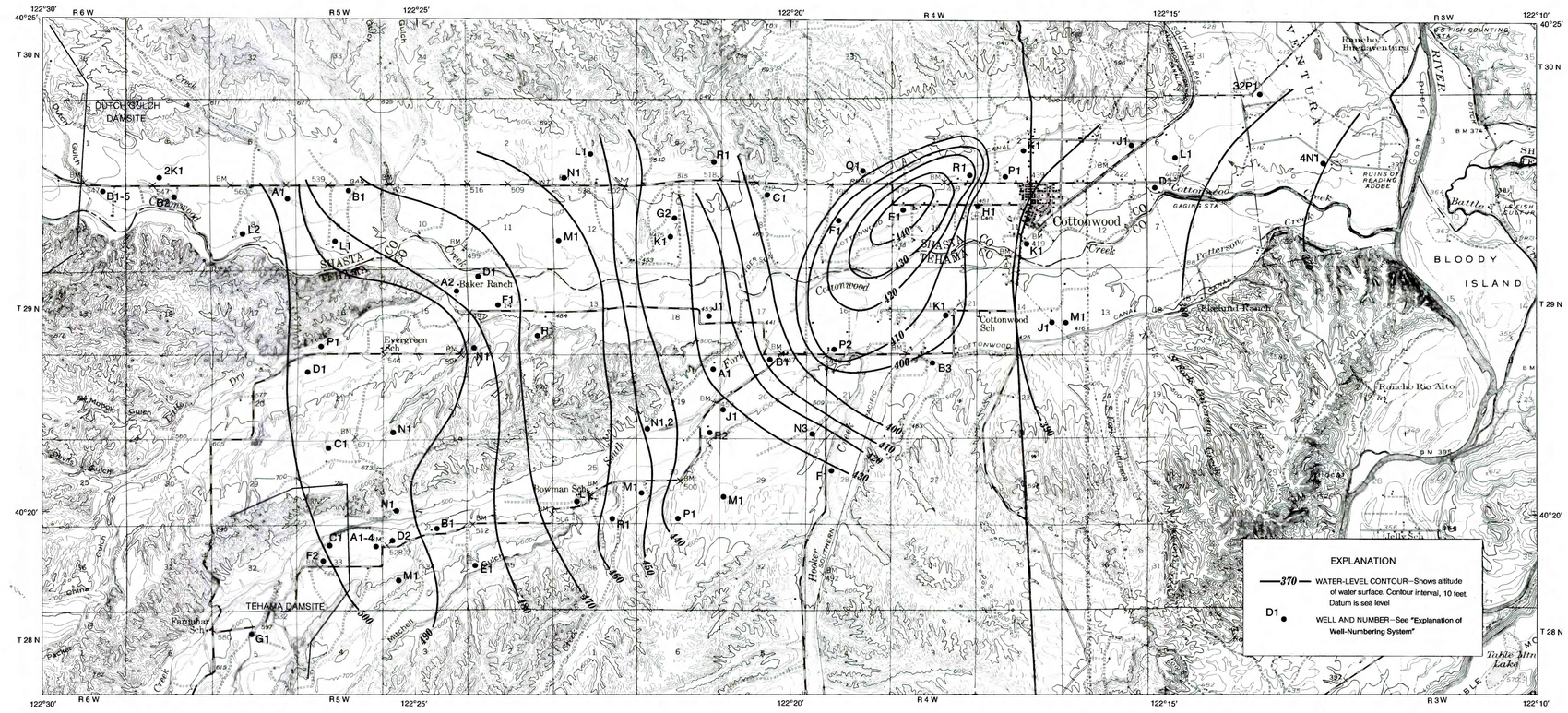


FIGURE 2.– GROUND-WATER LEVELS, MARCH 1984

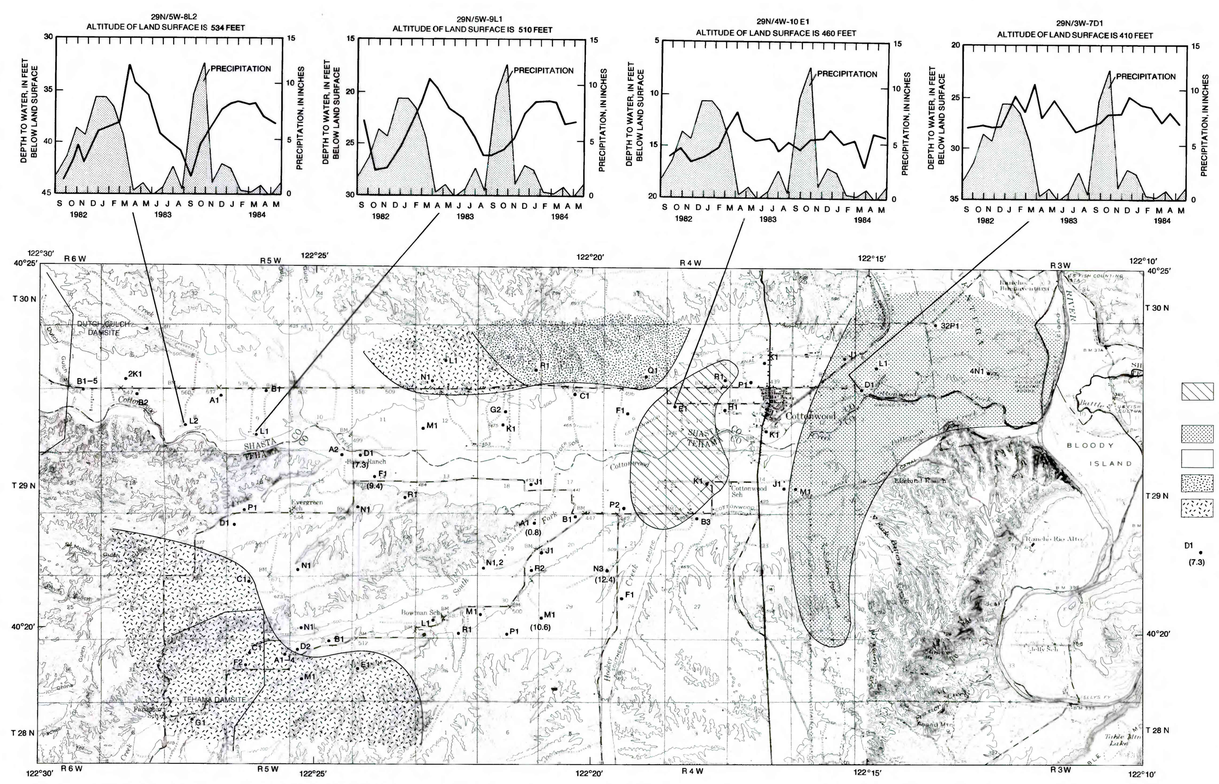


FIGURE 3.– NET CHANGE IN GROUND-WATER LEVELS FROM AUGUST 1983 TO MARCH 1984, AND HYDROGRAPHS SHOWING WATER-LEVEL CHANGES FROM SEPTEMBER 1982 TO MAY 1984

Base from U.S. Geological Survey,
French Gulch, 1945, Ono, 1952; 1:62,500,
Cottonwood, Gulch, Hooker, Mitchell,
Olinda, 1965; 1:24,000

INTRODUCTION

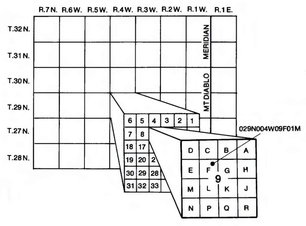
In September 1982, the U.S. Geological Survey, in cooperation with the U.S. Army Corps of Engineers, established two ground-water-monitoring networks in the Cottonwood Creek area. These networks were to monitor ground-water levels and ground-water quality in order to document baseline conditions prior to construction of two proposed dams: the Dutch Gulch Dam to be located on Cottonwood Creek and the Tehama Dam to be located on South Fork Cottonwood Creek. The ground-water-level network is part of an ongoing monitoring program, whereas the ground-water-quality network was discontinued in 1984. Data for the first year of records (September 1982 to August 1983) are in Fogelman and Evenson (1985). This report summarizes the second year of data (August 1983 to March 1984) for ground-water levels, and both years of data (October 1982 to May 1984) for ground-water quality.

The Cottonwood Creek area is in the Redding Basin between Redding and Red Bluff, California. Cottonwood Creek and South Fork Cottonwood Creek are currently (1985) unregulated streams that drain the eastern slopes of the Coast Ranges and flow eastward to the Sacramento River. The two proposed dams will be located approximately 15 miles upstream from the Sacramento River. The monitored area is generally downstream from the damsites and upstream from the Sacramento River. Few wells are located in the areas of future impoundment and on the borders of the Cottonwood Creek area.

EXPLANATION OF WELL-NUMBERING SYSTEM

Wells are identified according to their location in the rectangular system for the subdivision of public lands. The identification consists of the township number, north or south; the range number, east or west; and the section number. Each section is further divided into sixteen 40-acre tracts lettered consecutively (except I and O), beginning with A in the northeast corner of the section and progressing in a sinusoidal manner to R in the southeast corner. Within the 40-acre tract, wells are sequentially numbered in the order they are inventoried. The final letter refers to the base line and meridian. All wells in the study area are referenced to the Mount Diablo base line and meridian (M). The diagram below shows how the well number 029N004W09F01M is derived.

Well numbers shown in figures are tract sequence numbers. Township, range, and section numbers have been omitted for simplicity.



GROUND-WATER LEVELS

The ground-water-level network consists of 98 wells; 3 are equipped with continuous recorders, and 95 are measured monthly. For this study, monthly measurements were taken from 71 network wells in the valley area. These wells are mostly domestic, range in depth from 100 to 200 feet deep, and penetrate unconsolidated alluvial material consisting of sand, gravel, and clay.

Wells in the bordering hills of the Cottonwood Creek area are mostly domestic but have depths that vary greatly, ranging from 40 to 450 feet. Water levels in these wells deviate considerably from the contours drawn between wells in the valley area, indicating that local variations in the geology and hydrology may exist in this area. Therefore, data from wells in the bordering hills of the Cottonwood Creek area have been omitted from this report.

Throughout the study period, monthly ground-water level measurements showed that water levels are lowest in autumn and highest in spring. The levels reported in August 1983 (fig. 1) and March 1984 (fig. 2) represent the lowest and the highest water levels for the period covered in this report. In both months, the ground-water surface had the same downstream slope from the proposed damsites to the Sacramento River. A ground-water mound, located between the town of Cottonwood and the confluence of the South Fork Cottonwood Creek and Cottonwood Creek, was the only exception to the easterly slope of the water table. Leakage from the unlined Anderson-Cottonwood Irrigation District Canal, which runs through the center of this area, is probably the cause of the higher ground-water levels.

Precipitation is the main source of recharge water to the aquifers. Hydrographs of selected wells in the Cottonwood Creek area for 1982-84 (fig. 3) show water levels generally high in the winter and early spring because of precipitation, and low in the late summer and autumn due to withdrawal of water from wells and the lack of precipitation. Precipitation records from the Coleman Fish Hatchery near Redding show the same trend (fig. 3). Water levels vary little seasonally because most of the wells are used for domestic supply, which typically demand less water than irrigation or industrial uses. Comparison of water levels between the August and March maps (figs. 1 and 2) shows that within the aquifers there was little fluctuation (fig. 3). Water-level fluctuations were greater than 8 feet upstream of the proposed Tehama damsite; 2 to 5 feet between the proposed damsites and the confluence of South Fork Cottonwood Creek and Cottonwood Creek; and up to 2 feet downstream from the town of Cottonwood. The major exception to this trend was in the area of the ground-water mound: Instead of the typical rise in water levels from summer to winter, water levels in most of the wells dropped slightly, up to 11.5 feet. The decline probably was caused by the absence of water flowing through the Anderson-Cottonwood Irrigation District Canal during the winter months.

GROUND-WATER QUALITY

The ground-water-quality-monitoring network had 47 wells and samples were collected semiannually. Significant changes in water quality were not detected, and few wells exceeded U.S. Environmental Protection Agency recommended limits for maximum concentrations of any constituent in domestic (U.S. Environmental Protection Agency, 1977 and 1979) or irrigation water supplies (National Academy of Sciences and National Academy of Engineering, 1973). Constituents present in concentrations greater than the U.S. Environmental Protection Agency drinking-water recommended limits were nitrate-nitrogen, iron, and manganese (table 1). Concentrations of dissolved solids were low in comparison to concentrations in ground water throughout the northern Sacramento Valley, but were average for the Redding basin.

TABLE 1.--Recommended limits for selected chemical constituents in drinking water

[All concentrations are in milligrams per liter]

Constituent	U.S. Environmental Protection Agency drinking-water recommended limits: Primary (1977)	Secondary (1979)
Sulfate (SO_4)	--	250
Chloride (Cl)	--	250
Fluoride (F)	[1]1.6	--
Dissolved solids, residue at 180°C	--	500
Nitrate-nitrogen (NO_3-N)	10	--
Arsenic (As)	0.05	--
Iron (Fe)	--	0.3
Manganese (Mn)	--	0.05

[1] Concentration based on mean annual maximum daily air temperature in the study area.

Distinction is made between primary drinking-water regulations and secondary drinking-water recommended limits in table 1. Primary drinking-water regulations (U.S Environmental Protection Agency [EPA], 1977) pertain to constituents that may present a health hazard. Secondary drinking-water recommended limits (U.S. Environmental Protection Agency, 1979) pertain to constituents that may be objectionable to the esthetic qualities but do not necessarily present a health hazard.

The minimum, maximum, mean, and median concentrations for the two autumn and two spring samples are shown in table 2. Comparison of autumn and spring water-quality data shows little variation in dissolved concentrations throughout the study period. The concentration of dissolved solids is only slightly higher in autumn than in spring. Because little chemical variation was detected, the ground-water-quality-monitoring program was discontinued.

SELECTED REFERENCES

Fogelman, R. P., and Evenson, K. D., 1985, Water-resources monitoring in the Cottonwood Creek area, Shasta and Tehama Counties, California, 1982-83: U.S. Geological Survey Water-Resources Investigations Report 84-4187, 70 p.

Fogelman, R. P., 1982, Dissolved-solids concentrations of ground water in the Sacramento Valley, California: U.S. Geological Survey Hydrologic Investigations Atlas HA-645.

National Academy of Sciences and National Academy of Engineering, 1973 [1974], Water quality criteria, 1972: U.S. Environmental Protection Agency, EPA R3-73-033, 594 p.

National Oceanic and Atmospheric Administration, 1983, Climatological data annual summary, California, 1983: v. 87, no. 1-12.

National Oceanic and Atmospheric Administration, 1984, Climatological data annual summary, California, 1984: v. 88, no. 1-12.

Pierce, M. J., 1983, Ground water in the Redding Basin, Shasta and Tehama Counties, California: U.S. Geological Survey Water-Resources Investigations Report 83-4052, 40 p.

U.S. Environmental Protection Agency, 1977, National interim primary drinking water regulations: U.S. Environmental Protection Agency, Office of Water Supply, EPA 570/9-76-003, 159 p.

———1979, National secondary drinking water regulations: Federal Register, v. 44, no. 140, July 19, 1979, p. 42195-42202.

CONVERSION FACTORS

For readers who prefer to use the metric units rather than inch-pound units, the conversion factors for the terms used in this report are listed below.

Multiply	By	To obtain
ft (feet)	0.3048	meters
mi (miles)	1.609	kilometers
mi^2 (square miles)	2.590	square kilometers

INDEX MAP

TABLE 2.--Summary of ground-water-quality data in the Cottonwood Creek area

[Specific conductance is in microsiemens per centimeter at 25 degrees Celsius. pH is in units. Temperature is in degrees Celsius. All other values are in milligrams per liter. All constituents are dissolved unless otherwise noted. <, actual value is less than value shown. --, no data available]

Properties and constituents	October 1982	May 1983	October 1983	May 1984
Specific conductance				
Minimum-maximum	75-424	58-412	64-516	59-407
Mean	243	248	240	245
Median	234	226	226	253
pH				
Minimum-maximum	6.4-8.1	6.5-8	6.4-8.2	6.7-8.1
Mean	7.4	7.2	7.3	7.3
Median	7.3	7.1	7.3	7
Temperature				
Minimum-maximum	11-20	15.5-22.5	14-21.5	15.5-20.5
Mean	17.2	19	18	18.5
Median	17.5	18.5	18	18
Hardness as $CaCO_3$				
Minimum-maximum	18-189	16-180	16-200	13-190
Mean	97	99	97	97
Median	92	90	92.5	96
Hardness, noncarbonate				
Minimum-maximum	0-67	0-50	0-69	0-56
Mean	3	4	3.5	3
Median	0	0	0	0
Calcium (Ca)				
Minimum-maximum	3.3-42	3.1-39	3.2-38	2.5-39
Mean	19	19	19	19
Median	17	18	17	19
Magnesium (Mg)				
Minimum-maximum	2.3-27	2-25	1.9-28	1.6-26
Mean	12	13	12	12
Median	12	11	10	12
Sodium (Na)				
Minimum-maximum	6.3-25	6.4-20	6.5-40	6.3-24
Mean	14	13	14	13
Median	13	13	13	13
Potassium (K)				
Minimum-maximum	0.3-3	0.3-3	0.3-3	0.3-2.9
Mean	0.8	0.8	0.87	0.7
Median	0.7	0.7	0.7	0.6
Alkalinity, total as $CaCO_3$				
Minimum-maximum	28-185	25-170	25-180	19-160
Mean	109	108	107	108
Median	113	110	110	111
Sulfate (SO_4)				
Minimum-maximum	<5-24	0.2-20	0.5-26	0.2-22
Mean	--	6.1	6.6	6.3
Median	--	5	6.8	4.6
Chloride (Cl)				
Minimum-maximum	1.7-23	1.3-20	1.6-45	1.1-25
Mean	6.2	6.7	7.8	6.8
Median	3.7	3.9	4	4.1
Fluoride (F)				
Minimum-maximum	0.1-0.2	<0.1-0.2	<0.1-0.2	<0.1-0.3
Mean	--	--	--	--
Median	--	--	--	--
Silica (SiO_2)				
Minimum-maximum	17-74	20-74	9.5-70	19-73
Mean	42	43	41.4	42.7
Median	43	42	42	42
Dissolved solids, residue at 180°C				
Minimum-maximum	76-304	70-277	71-306	77-269
Mean	166	162	164.2	164
Median	156	155	151.5	162
Nitrogen, $NO_2 + NO_3$				
Minimum-maximum	0.1-12	0.2-9.2	0.17-14	0.1-4.9
Mean	1.5	1.8	1.5	1.3
Median	0.9	0.9	0.9	0.1
Phosphorus, ortho as P				
Minimum-maximum	<0.01-0.22	<0.02-0.25	<0.01-0.23	<0.01-0.31
Mean	--	--	--	--
Median	--	--	--	--
Aluminum (Al)				
Minimum-maximum	<0.01-0.02	<0.01-0.02	--	--
Mean	--	--	--	--
Median	--	--	--	--
Arsenic (As)				
Minimum-maximum	<0.001-<0.003	<0.001-<0.003	--	--
Mean	--	--	--	--
Median	--	--	--	--
Boron (B)				
Minimum-maximum	<0.01 -0.05	--	<0.01-0.09	<0.01-0.06
Mean	--	--	--	--
Median	--	--	--	--
Iron (Fe)				
Minimum-maximum	<0.003-0.17	<0.003-0.05	<0.003-0.26	<0.003-0.65
Mean	--	--	--	--
Median	--	--	--	--
Manganese (Mn)				
Minimum-maximum	<0.001-0.066	<0.001-0.02	<0.001-0.093	<0.001-0.19
Mean	--	--	--	--
Median	--	--	--	--

For additional information write to:
District Chief
U.S. Geological Survey
Federal Building, Room W-2234
2800 Cottage Way
Sacramento, CA 95825

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MAPS SHOWING GROUND-WATER CONDITIONS IN THE COTTONWOOD CREEK AREA, SHASTA AND TEHAMA COUNTIES, CALIFORNIA, 1983-84

By
Kristin D. Evenson and W. B. Kinsey

1985