BASE-FLOW INVESTIGATION ON THE SACRAMENTO RIVER, SEPTEMBER 25, 1985, NEAR SUNSPOT, OTERO COUNTY, NEW MEXICO

by
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U.S. GEOLOGICAL SURVEY
OPEN-FILE REPORT 89-239

Prepared in cooperation with the
City of Alamogordo

Albuquerque, New Mexico
1990

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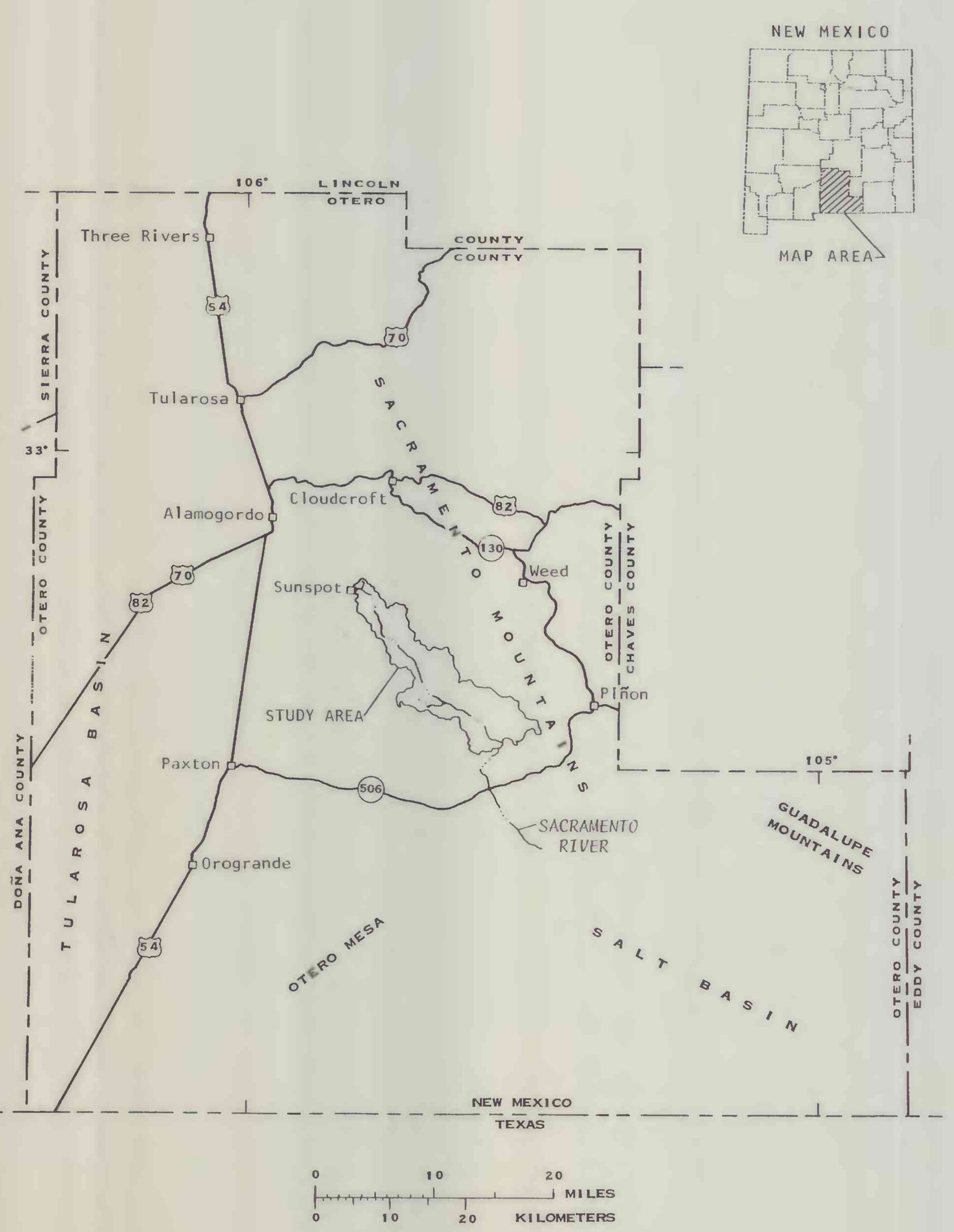

Figure 1.--Location of the study area.

INTRODUCTION

On September 25, 1985, the U.S. Geological Survey, in cooperation with the City of Alamogordo, conducted a base-flow investigation on the Sacramento River in Otero County, south-central New Mexico (fig. 1). The Sacramento River, whose headwaters are about 15 miles southeast of Alamogordo, flows southeast into the Salt Basin. This report is a compilation of the data collected during the base-flow investigation.

Purpose

Because population growth in the Alamogordo area is expected to increase, usage of water resources also will increase, creating a need to characterize, monitor, and understand the hydrologic systems of the Sacramento Mountains and surrounding area. This investigation, by determining the base-flow characteristics of the Sacramento River, provides information on gains and losses of discharge along the upper reach of the Sacramento River and its tributaries.

Approach

For identification of data-collection sites, river miles upstream on the Sacramento River from the mouth of Surveyors Canyon, which was designated as river mile 0.0 (site 17, fig. 2), were used as references. Although the Sacramento River channel continues for several miles southeast of Surveyors Canyon, the mouth of the Sacramento River is indeterminate because the river channel becomes dry as it enters into the Salt Basin. For the base-flow investigation, discharges were measured at selected points on the upper reach of the Sacramento River and its tributaries along that reach. Discharge measurements were made upstream and downstream from diversions. The diversions consist of a concrete box with a metal gate and screen for regulation that leads into a pipe. The diversions could not be measured directly. The base-flow investigation included measurements of discharge in the Sacramento River from the initial point of discharge (river mile 23.4, site 1, fig. 2), 5.2 river miles upstream from the stream-gaging station Sacramento River near Sunspot (river mile 18.2, site 8, fig. 2), to the point of zero flow (river mile 3.3, site 16, fig. 2). Twelve discharge measurements, three observations of zero flow, and two observations of initial discharge were made in this investigation.

Specific conductance, air temperature, and water temperature were measured concurrently with the discharge measurements (table 1). Specific conductance, reported in units of microsiemens per centimeter at 25 degrees Celsius, measures the capability of water to conduct an electrical current and is also an indicator of dissolved-solids concentration.

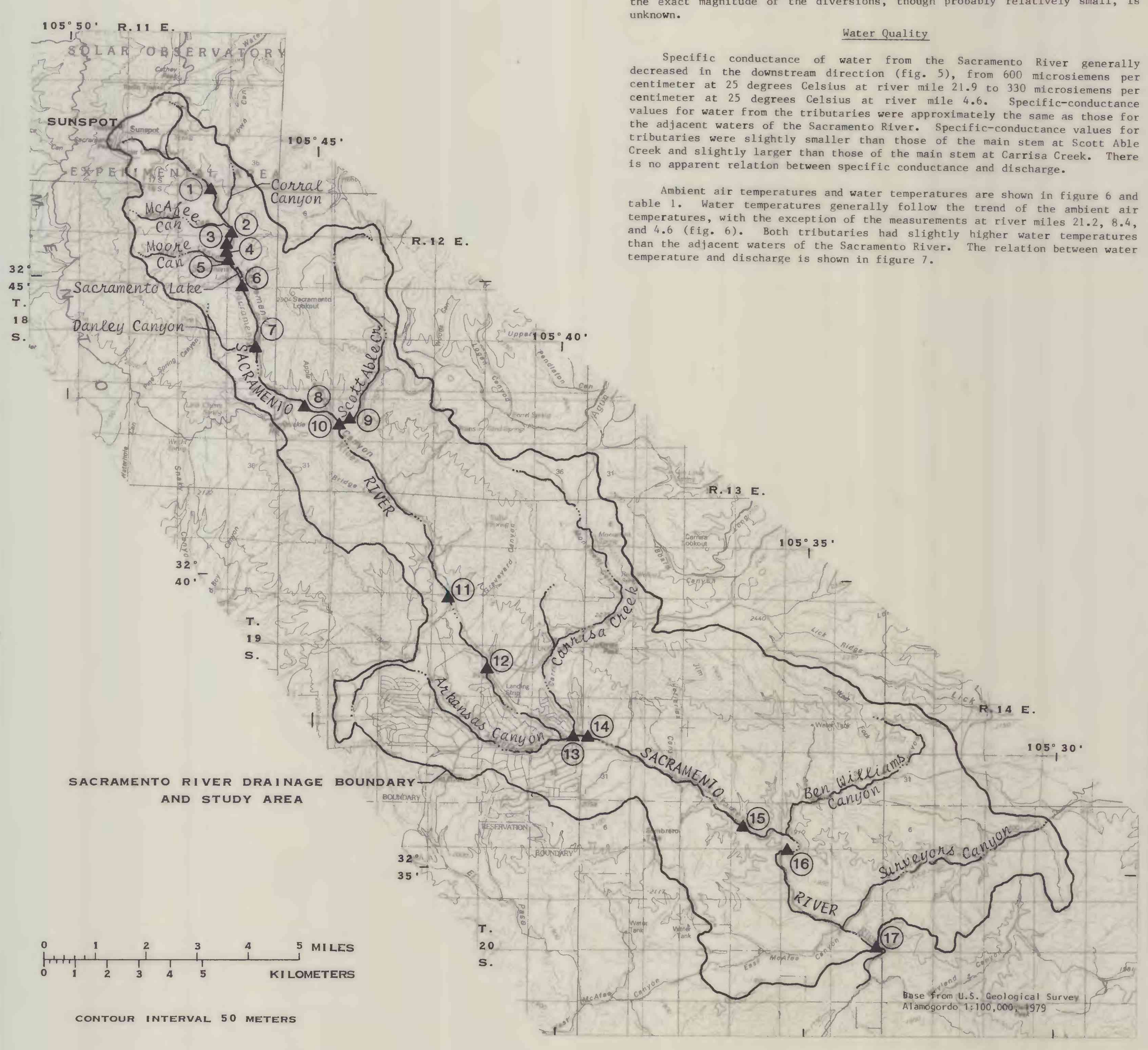

Figure 2.--Sacramento River drainage boundary and location of observation and discharge-measurement sites.

Physiographic Features

The Sacramento Mountains consist of a large block-faulted cuesta that dips gently to the east (Mourant, 1957, p. 8). The Permian San Andres Limestone caps the Sacramento Mountains in most places and the Hondo Sandstone Member occurs near the base of the San Andres Limestone. Underlying the San Andres Limestone is the Permian Yeso Formation, which predominantly consists of siltstone, shale, silty sandstone, and thin beds of limestone (Pray, 1954, p. 93, 101). The Yeso Formation is exposed in drainages that cut through the overlying limestone and along the valley floor (Mourant, 1957, p. 9).

Altitudes within the study reach of the Sacramento River drainage area range from 5,920 to 9,700 feet above sea level. Vegetation at higher altitudes consists primarily of dense forests of pine and Douglas fir and at lower altitudes consists of a mix of juniper, piñon, and grasses. Average annual precipitation generally ranges from 30 inches in the higher altitudes to about 16 inches in the lower altitudes (U.S. Department of Agriculture, Soil Conservation Service, 1972).

The Sacramento River has eroded steep canyons that are fairly narrow in the upper reaches and several hundreds of feet deep. The valley floor extends to a few hundred feet in width in places and consists of cienagas (Mourant, 1957, p. 5). These marshy areas were partly formed by a buildup of tufa (carbonate-cemented, organic material). The ground water of the area is enriched in calcium bicarbonate that precipitates on channel and streambank material as calcium carbonate. This results from ground-water-chemistry changes at the surface, such as changes in pH, temperature, or partial gas pressure. These tufa deposits may be 30 feet thick in some areas (Mourant, 1957, p. 10). Thin deposits of alluvium also occur along bottoms of stream drainages.

BASE-FLOW INVESTIGATION

The base-flow investigation was conducted during favorable conditions because there had been no precipitation for several days prior to the run. Data from the Sacramento River near the Sunspot gaging station indicate that the investigation was made during a period of stable base flow or a period when streamflow was not affected by runoff from recent precipitation.

Gains and Losses

Discharge began at river mile 23.4 and continued for 0.8 mile to about river mile 22.6 when flow again ceased for a short distance. Discharge reappeared at river mile 22.4 and continued downstream 19.1 river miles to river mile 3.3 (fig. 2 and table 1). Discharge measurements and observations showed a general increase in discharge from river mile 22.4 to a discharge of 6.69 cubic feet per second at river mile 8.4. Discharge decreased from river mile 8.4 to zero flow at river mile 3.3 (fig. 3; table 1).

Two tributaries included in this base-flow investigation were Scott Able Creek and Carrisa Creek (table 1). Two small, known diversions also were considered and are located near river mile 21.2 and at river mile 17.6. These diversions supply water to the village of Orogrande; one diversion is at Sacramento Lake and the other is immediately downstream from the mouth of Scott Able Creek.

The measurements made from river mile 21.9 to river mile 13.0 indicate both gains and losses in discharge, ranging from a loss of 0.39 cubic foot per second to a gain of 2.19 cubic feet per second between measurement sites (fig. 4, table 1). Measurements made from river mile 11.3 to the point of zero flow at river mile 3.3 indicate a consistent loss of discharge between measurement sites except where Carrisa Creek adds discharge to the river (fig. 3). These losses in discharge ranged from 0.29 to 3.80 cubic feet per second. Tributary discharge was considered to be a contribution but not a gain. Gains or losses of discharge were not calculated for reaches with diversions or for the tributary inflow at Scott Able Creek.

The results of the base-flow investigation are rated good from river mile 17.6 downstream because there were no complications to detract from describing base flow. Upstream from river mile 17.6, the results are rated fair because the exact magnitude of the diversions, though probably relatively small, is unknown.

Water Quality

Specific conductance of water from the Sacramento River generally decreased in the downstream direction (fig. 5), from 600 microsiemens per centimeter at 25 degrees Celsius at river mile 21.9 to 330 microsiemens per centimeter at 25 degrees Celsius at river mile 4.6. Specific-conductance values for water from the tributaries were approximately the same as those for the adjacent waters of the Sacramento River. Specific-conductance values for tributaries were slightly smaller than those of the main stem at Scott Able Creek and slightly larger than those of the main stem at Carrisa Creek. There is no apparent relation between specific conductance and discharge.

Ambient air temperatures and water temperatures are shown in figure 6 and table 1. Water temperatures generally follow the trend of the ambient air temperatures, with the exception of the measurements at river miles 21.2, 8.4, and 4.6 (fig. 6). Both tributaries had slightly higher water temperatures than the adjacent waters of the Sacramento River. The relation between water temperature and discharge is shown in figure 7.

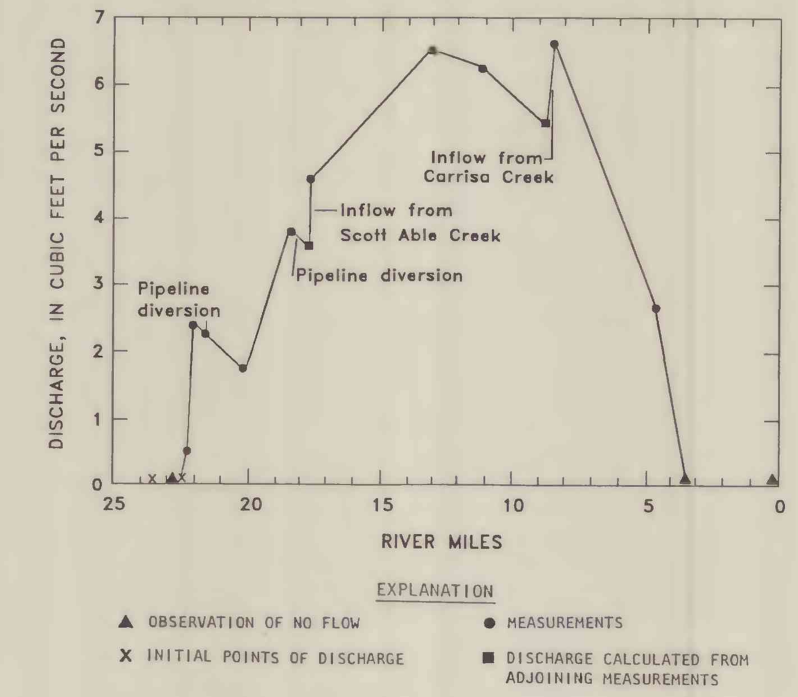

Figure 3.--Discharge of the Sacramento River.

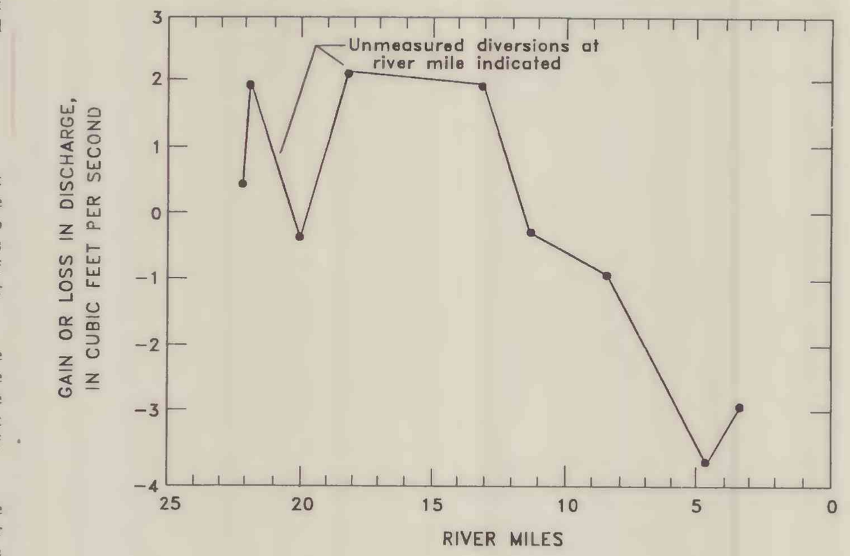

Figure 4.--Indicated gain or loss of discharge in the Sacramento River.

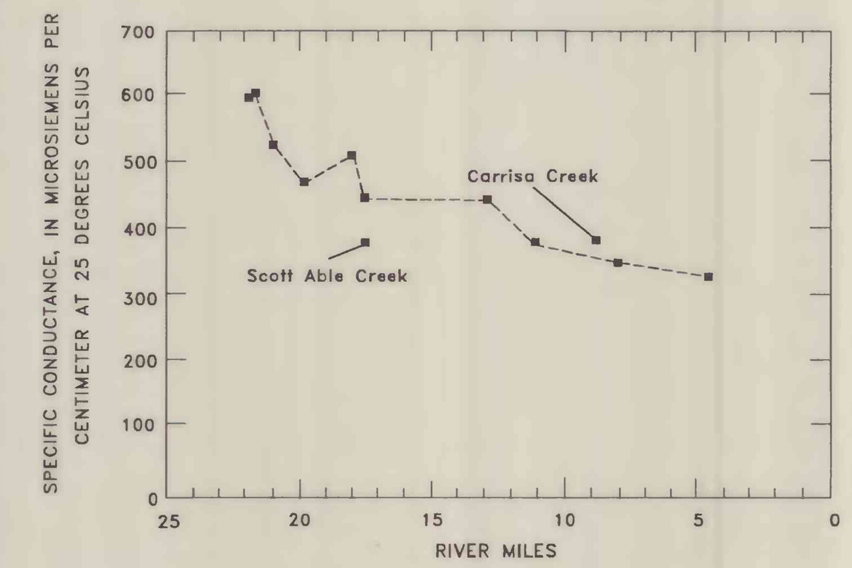

Figure 5.--Specific conductance of water from the Sacramento River.

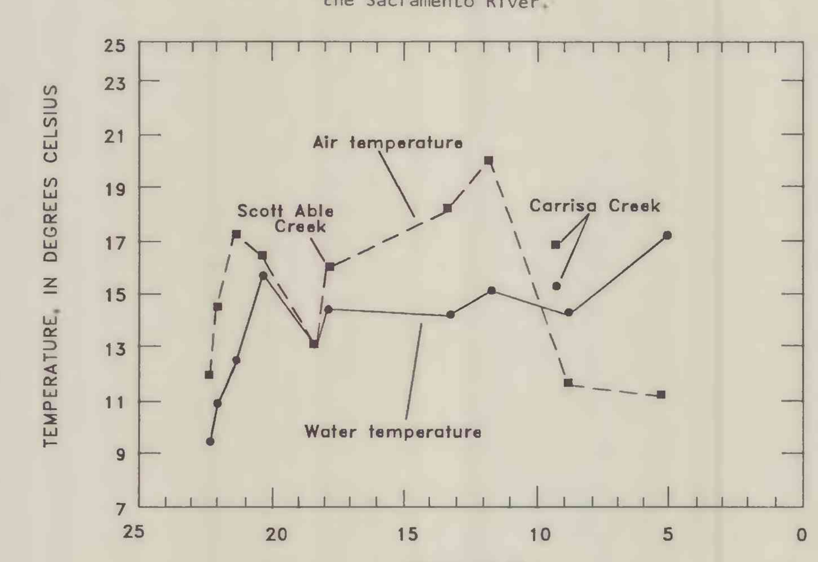

Figure 6.--Air and water temperatures of the Sacramento River.

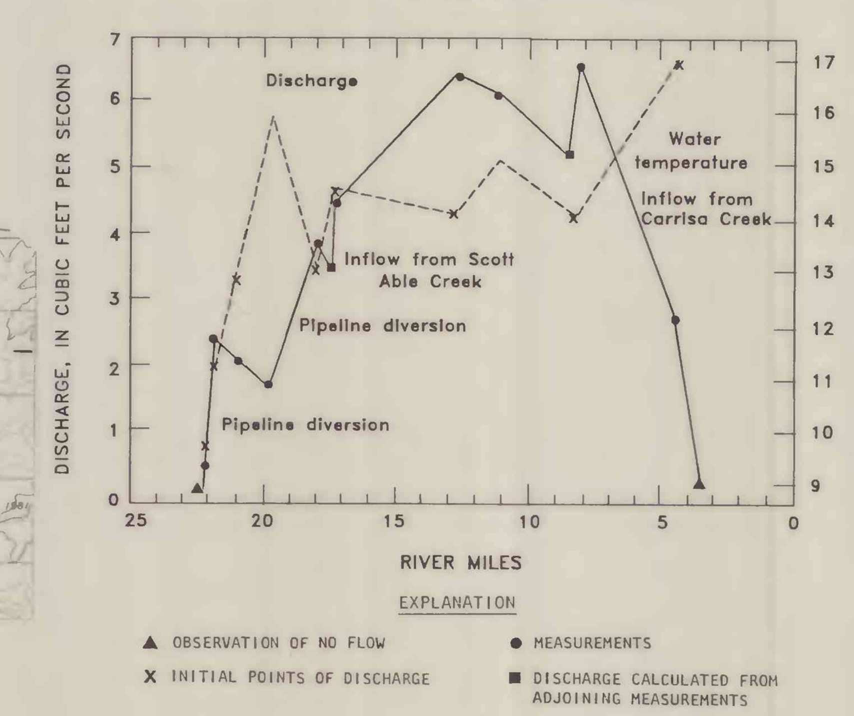

Figure 7.--Water temperature and discharge of the Sacramento River.

Table 1.--Data collected from base-flow investigation on the Sacramento River, September 25, 1985

[ft³/s = cubic feet per second; °C = degrees Celsius; μS/cm = microsiemens per centimeter at 25 °Celsius; mi = mile; ft = feet]

Site number (fig. 2)	River mile	Stream	Location	Time	Air temperature (°C)	Water temperature (°C)	Specific conductance (μS/cm)	Discharge, in ft³/s: Main stream	Tributary	Gain or loss
1	23.4	Sacramento River	Lat 32°46'21", long 105°47'10", T. 18 S., R. 11 E. (no sections on map), approximately 0.3 mi upstream from Corral Canyon.	—	—	—	—	—	—	—
2	22.6	do.	Lat 32°45'46", long 105°46'49", T. 18 S., R. 11 E. (no sections on map), approximately 0.3 mi downstream from McAfee Canyon.	0955	—	—	—	0.00	—	—
3	22.4	do.	Lat 32°45'38", long 105°46'50", T. 18 S., R. 11 E. (no sections on map), approximately 0.3 mi upstream from Moore Canyon.	—	—	—	—	—	—	—
4	22.2	do.	Lat 32°45'31", long 105°46'54", T. 18 S., R. 11 E. (no sections on map), 0.2 mi upstream from Moore Canyon.	1005	12.0	9.5	595	0.49	—	+0.49
5	21.9	do.	Lat 32°45'18", long 105°46'52", T. 18 S., R. 11 E. (no sections on map), 0.25 mi downstream from Moore Canyon.	1100	14.5	11.0	600	2.53	—	+2.04
6	21.2	do.	Lat 32°44'48", long 105°46'32", T. 18 S., R. 11 E. (no sections on map), approximately 0.4 mi downstream from Sacramento Lake.	1140	17.5	12.5	520	2.15	—	—(1)
7	20.0	do.	Lat 32°43'46", long 105°46'16", T. 18 S., R. 11 E. (no sections on map), 0.05 mi downstream from Danley Canyon.	1220	16.5	16.0	460	1.76	—	-0.39
8	18.2	do.	Gaging station near Sunspot (08492900), lat 32°42'50", long 105°45'15", in SW¼SE¼NE¼, sec. 30, T. 18 S., R. 12 E., 3.2 mi downstream from Sacramento Lake.	1315	13.0	13.0	510	3.95	—	+2.19
9	17.6	Scott Able Creek	Lat 32°42'35", long 105°44'34", in SE¼NW¼SW¼, sec. 29, T. 18 S., R. 12 E., approximately 80 ft upstream from mouth.	1400	16.0	16.0	375	—	+1.03	—
10	17.6	Sacramento River	Lat 32°42'32", long 105°44'37", in SE¼NW¼SW¼, sec. 29, T. 18 S., R. 12 E., approximately 80 ft downstream from mouth of Scott Able Creek.	1430	16.0	14.5	440	4.54	—	—(1)
11	13.0	do.	Lat 32°39'29", long 105°42'15", in NE¼SE¼NW¼, sec. 15, T. 19 S., R. 12 E., entrance crossing to Circle Cross Headquarters.	1525	18.0	14.0	440	6.49	—	+1.95
12	11.3	do.	Lat 32°38'22", long 105°41'31", in NE¼NW¼SW¼, sec. 23, T. 19 S., R. 12 E., at Timberon Airport.	1625	20.0	15.0	370	6.20	—	-0.29
13	8.8	Carrisa Creek	Lat 32°37'23", long 105°39'42", in SE¼NE¼SE¼, sec. 25, T. 19 S., R. 12 E., approximately 200 ft upstream from mouth.	1715	16.5	15.0	385	—	+1.40	—
14	8.4	Sacramento River	Lat 32°37'18", long 105°39'23", in NE¼SW¼SW¼, sec. 30, T. 19 S., R. 13 E., 0.25 mi downstream from Carrisa Creek.	1750	11.5	14.0	355	6.69	—	-0.91
15	4.6	do.	Lat 32°35'41", long 105°36'08", in SE¼NE¼SW¼, sec. 3, T. 20 S., R. 13 E., approximately 0.9 mi upstream from Ben Williams Canyon.	1840	11.0	17.0	330	2.89	—	-3.80
16	3.3	do.	Lat 32°35'23", long 105°35'22", in NE¼NW¼NW¼, sec. 11, T. 20 S., R. 13 E., 0.6 mi downstream from Ben Williams Canyon.	1910	—	—	—	0.00	—	—
17	0.0	do.	Lat 32°33'50", long 105°33'39", in NW¼SE¼SE¼, sec. 13, T. 20 S., R. 13 E., at mouth of Surveyors Canyon.	—	—	—	—	.00	—	—

(1) Losses were not calculated because diversions could not be measured.

CONVERSION TABLE

For readers who prefer to use metric (International System) units, conversion factors for units used in this report are listed below.

Multiply inch-pound unit	By	To obtain metric unit
inch	25.40	millimeter
foot	0.3048	meter
mile	1.609	kilometer
cubic foot per second	0.02832	cubic meter per second

Temperature in degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) by the equation:

$$°F = 9/5\ (°C) + 32$$

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "Sea Level Datum of 1929."

REFERENCES

Mourant, W.A., 1957, Reconnaissance of water resources on the upper part of the Sacramento River Canyon, Otero County, New Mexico: U.S. Geological Survey open-file report, 22 p.

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