STATE OF NEVADA

DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES

DIVISION OF WATER RESOURCES

Carson City

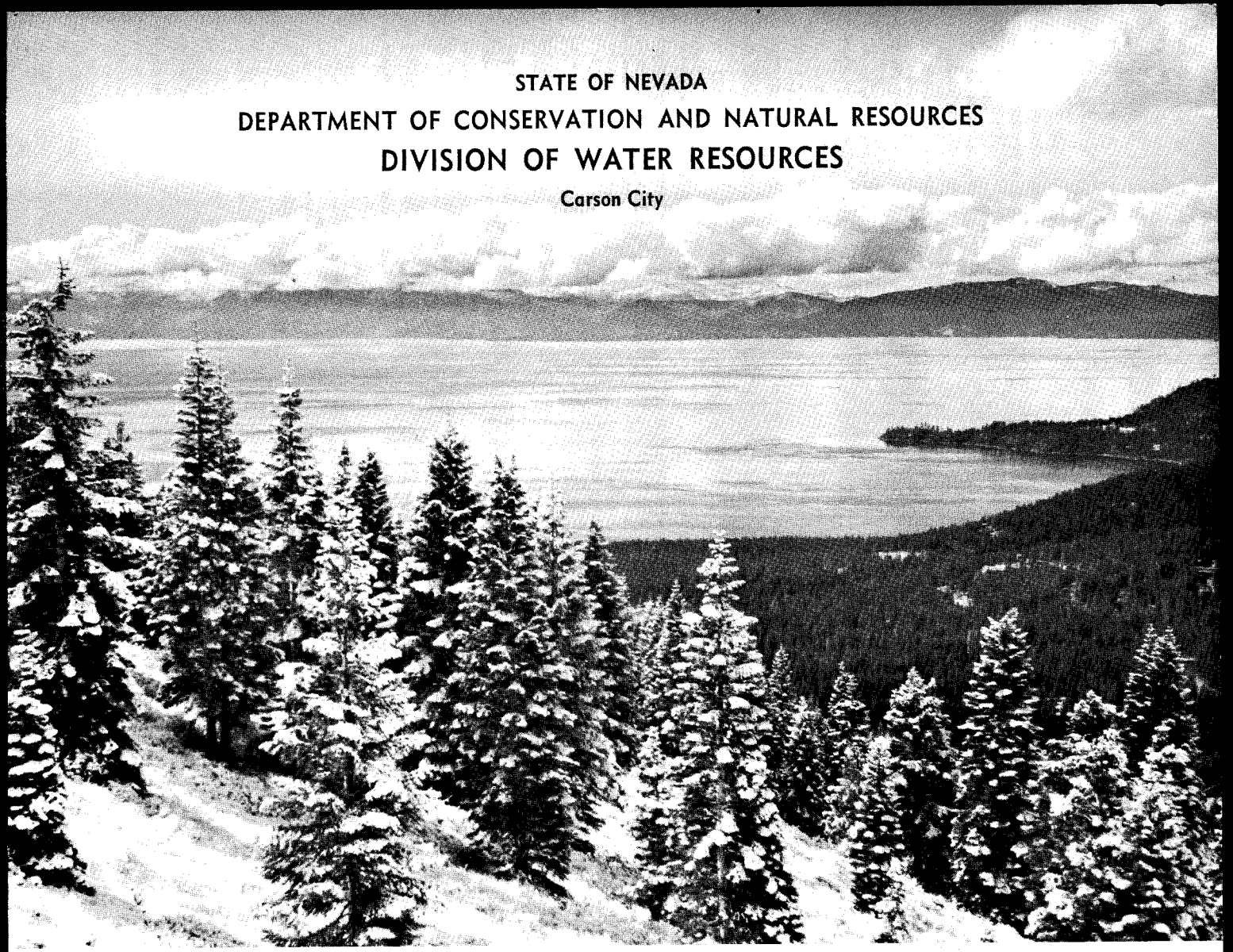


Photo by Patrick A. Glancy

View of Lake Tahoe.

WATER RESOURCES–INFORMATION SERIES

REPORT 17

BATHYMETRIC RECONNAISSANCE OF LAKE TAHOE, NEVADA AND CALIFORNIA

By

F. Eugene Rush

(Sounding control by
U.S. Coast and Geodetic Survey)

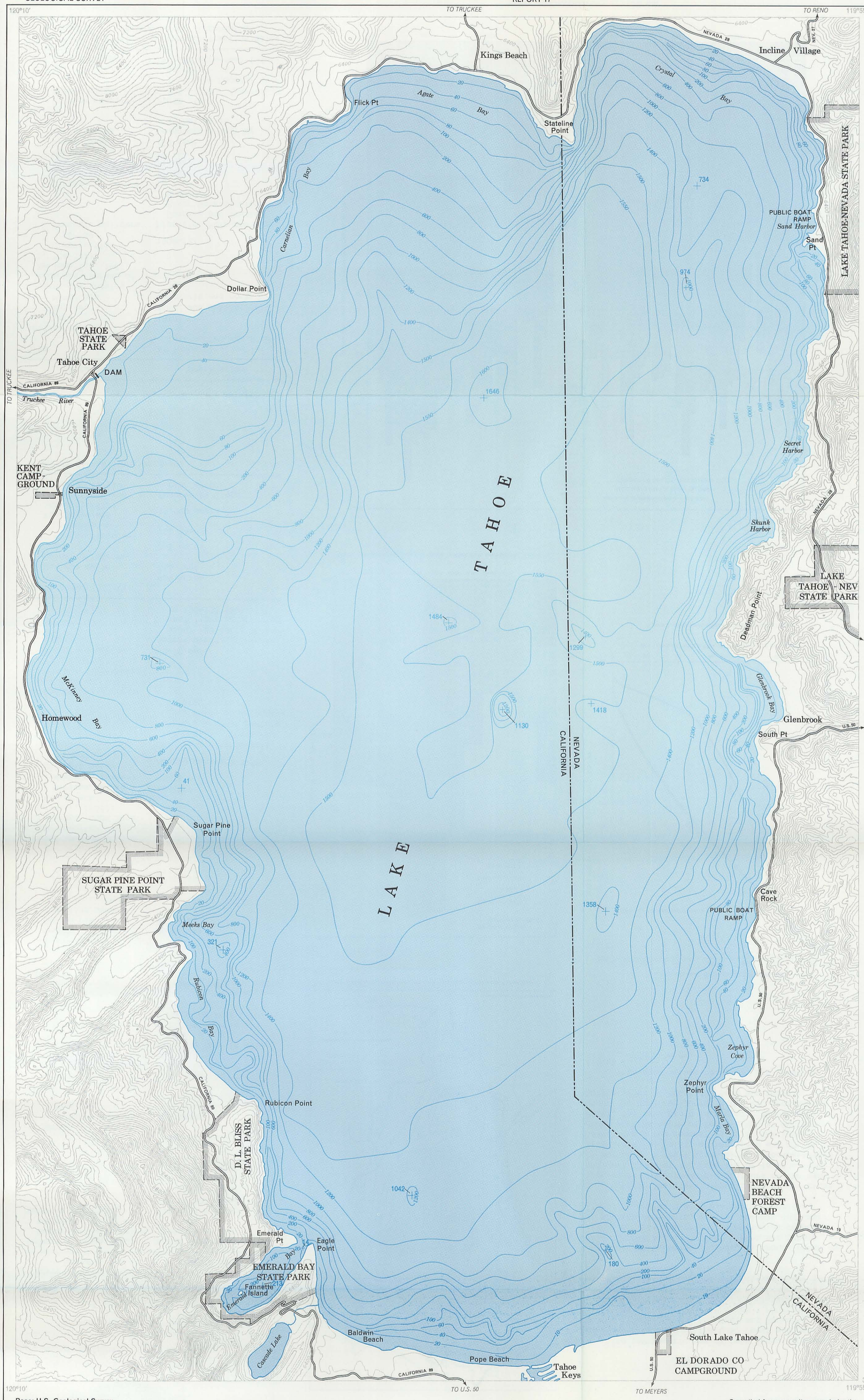
Prepared cooperatively by the Geological Survey,
U.S. Department of the Interior

1973

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER RESOURCES-INFORMATION SERIES
REPORT 17

STATE OF NEVADA
DEPARTMENT OF FISH AND GAME AND
DIVISION OF WATER RESOURCES



Base: U.S. Geological Survey
1:62,500 topographic series:
Carson City, Nev., 1956
Fallen Leaf Lake, Calif., 1955
Freel Peak, Nev.-Calif., 1956
Tahoe, Calif., 1955

Compiled from soundings made by the U.S. Coast and Geodetic Survey (1923)
Cartography by Charles A. Bosch

EXPLANATION

1550

Lines of equal water depth, in feet; contour interval variable. Datum is lake surface at a stage of 6229 feet above mean sea level (U.S. Bureau of Reclamation datum of 1929, supplementary adjustment of 1959)

321
Data point
Number is depth of water in feet

1 0 1 2 3 4 miles

Topographic contour interval, 80 feet
Datum is mean sea level

INTRODUCTION

Lake Tahoe is on the Nevada-California State line, 10 miles west of Carson City, Nevada, as shown in figure 1. The natural outflow from Lake Tahoe, high in the Sierra Nevada, is to the Truckee River, which flows through Reno to Pyramid Lake. Since the beginning of the 20th century, a part of the Truckee River flow has been diverted through a canal of the Newlands Project (U.S. Bureau of Reclamation) for use in the Carson River Basin near Fallon, Nevada (60 miles east of Carson City).

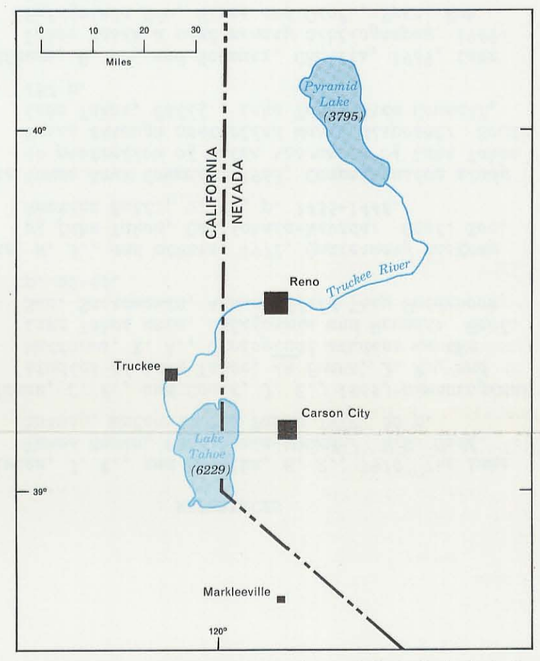


Figure 1.-Index map of northwestern Nevada and eastern California showing the location of Lake Tahoe (Numbers in parenthesis are water-surface altitudes)

Table 1 is an informational summary for the Lake Tahoe Basin. In addition, the U.S. Forest Service (1972) has published data on land-use capability. This report shows that approximately three-fourths of the land has either a high relative erosion potential or disturbance hazard. The 1970 U.S. Census indicates a total population in the basin of about 26,000. Table 2 summarizes facts about Lake Tahoe. The facts presented describe the lake at a stage of 6,229 feet above mean sea level, U.S. Bureau of Reclamation Lake Tahoe datum, which is the maximum stage regulated by use of a small dam (table 3). The Lake Tahoe datum is 1.14 feet higher than the sea level datum of 1929 used elsewhere in the area, as determined by the U.S. Geological Survey in November 1960. Reference stages of 6,223 feet and 6,225 feet have been used in other studies (Matthews and Schwarz, 1969), but for a series of bathymetric reconnaissances, of which this study is a part, the decision was made to evaluate each lake and reservoir when "full".

Table 1.--Summary for the Lake Tahoe Basin

Feature	Description	
Basin area (mostly from Crippen and Pavelka, 1970)	506 square miles (324,000 acres)	
Land area (approximate)	306 square miles (196,000 acres)	
Water area (approximate)	200 square miles (128,000 acres)	
Lakes in basin:		
Tahoe (stage 6,229 feet)	194 square miles (124,000 acres)	
Fallen Leaf	1,400 acres	
Marlette	381 acres	
Upper and Lower Echo	330 acres	
Cascade	210 acres	
Spooner	97 acres	
Numerous small lakes and ponds	600 acres	
Length (north-south)	40 miles	
Width	18 miles	
Highest altitude (Freel Peak)	10,881 feet	
Lowest altitude (deepest point of lake)	4,583 feet	
Generalized rock distribution in order of outcropping abundance (adapted from Crippen and Pavelka, 1970)		
Granitic rocks (Sierra Nevada batholith)	East, south, and southwest ranges.	
Glacial deposits	Mostly south and west of Lake Tahoe.	
Volcanic rocks	Scattered, but mostly in northwest range.	
Metamorphic rocks	Southwest range.	
Lake beds	Along west, south, and north shores up to an altitude of about 7,000 feet. Underlying the floor of Lake Tahoe with a thickness of at least 400 feet (Hyne and others, 1972, p. 1435). Bottom sediments are summarized in figure 2.	
Land ownership January 1972 (U.S. Forest Service, 1972)	Square miles	Percent
Federal Government:		
In Nevada	28	9
In California	153	50
State Government:		
Nevada	9.5	3
California	5.6	2
Private	110	36
Total (rounded)	306	100
Weather at Tahoe City (Crippen and Pavelka, 1970):		
Temperature (°F):		
Maximum	94	
Minimum	-15	
Mean annual	42	
Average frost-free period		86 days
Mean annual precipitation		31 inches
Mean annual snowfall		18 feet

BATHYMETRIC RECONNAISSANCE OF LAKE TAHOE, NEVADA AND CALIFORNIA

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1973

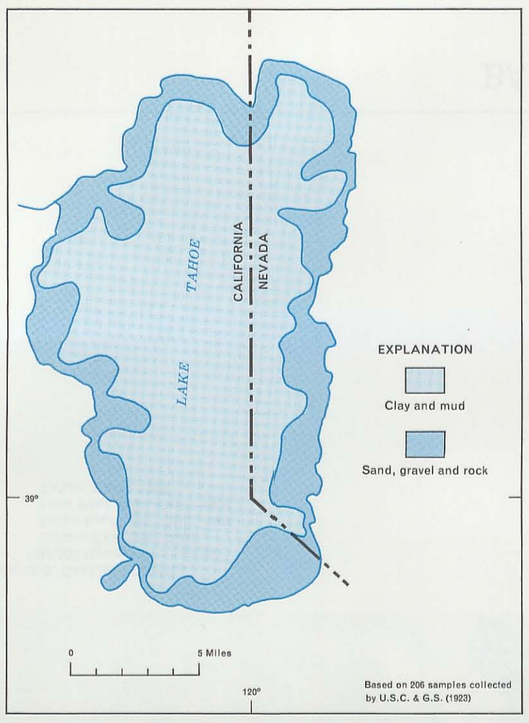

Figure 2.-General distribution of lake-bottom sediments

Table 2.--Summary for Lake Tahoe

Feature	Description
Reference stage (U.S. Bureau of Reclamation datum)	6,229 feet above mean sea level
Water-surface area	194 square miles (124,000 acres)
Nevada part	61 square miles
California part	133 square miles
Maximum depth	1,646 feet (Hyne and others, 1972, p. 1435, report 1,627 feet as deepest encountered)
Rank:	
In North America	3d deepest
In world	10th deepest
Volume	125 million acre-feet
Stage:	
Natural outlet	6,223 feet
Recorded variations (1901-71):	
Maximum	6,231.26 feet in July 1907
Minimum	6,211.74 feet in December 1934
Mean	6,226.5 feet
Maximum prehistoric (approximate)	7,000 feet (Hyne and others, 1972, p. 1435)
Length	22 miles
Width	12 miles
Shoreline (approximate)	75 miles
Nevada	30 miles
California	45 miles
Shoreline ownership (U.S. Forest Service, 1972):	
Private	55 miles
Federal	12 miles
States	8 miles
Water temperature (mostly from Crippen and Pavelka, 1970; and Lake Tahoe Area Council, 1963):	
At surface:	
Minimum (winter)	40-45°F
Maximum (summer)	65-75°F
At depth below 500 feet	Nearly constant 39°F
Freezing	Only to a minor extent in shallow, protected inlets, except Emerald Bay, which occasionally freezes over.
Water quality (Crippen and Pavelka, 1970; and Lake Tahoe Area Council, 1963):	
Dissolved solids	60-70 mg/l
Clarity	Secchi disc[1] visible to about 120 feet; 90 percent light penetration to 120-130 feet.
Emerald Bay:	
Area	460 acres
Maximum depth	213 feet
Fannette Island:	
Area	2.5 acres
Height (approximate)	100 feet
Age (Hyne and others, 1972)	10,000 years
Origin (Hyne and others, 1972)	Scoured by Tioga glaciation

[1] White, 8-inch diameter disc.

Table 3.--Summary for dam at lake outlet

Feature	Description
Site	At Tahoe City, outlet of lake to Truckee River
Initial dam:	
Date	1870[1]
Builder	A. W. Von Schmidt[1]
Materials	Wood crib and rock
Present dam (mostly from U.S. Bureau of Reclamation, 1961, p. 534-542):	
Construction period	1909-13[1]
Probable builders	Floriston Pulp and Paper Company and Truckee River General Electric Company[1]
Structural height	16 feet
Hydraulic height	11 feet
Top width	11 feet
Maximum base width	19 feet
Crest length	109 feet
Outlet works	Seventeen 5-foot by 4-foot gates
Design:	
Outflow capacity	2,630 cfs
Active stage	6,223-6,229.1 feet (legal limits by Federal Court decree)
Active capacity	744,600 acre-feet (USGS)

[1] Published information on dam-construction dates and builders is inconsistent. Information presented hopefully is correct.

The basin was formed about 2 million years ago by faulting and volcanism. The basin is a graben, or down-dropped block. The lake level has been lowered by erosion of a natural dam created by tilting and faulting (Hyne and others, 1972, p. 1435).

Precipitation, the source of water in Lake Tahoe, is summarized in figure 3. The greatest precipitation is on the western and southwestern mountains. Most of the precipitation falls in the winter and spring as snow. Snow-melting and subsequent runoff to the lake occur principally in the period April-July, as shown by a graph of the runoff distribution of the Upper Truckee River (fig. 4), a major tributary to the lake at Tahoe Keys. Outflow to Truckee River occurs each year, as summarized in figure 5. Precipitation, runoff, and evaporation from the lake surface are the principal factors controlling the interrelation between the outflow to the Truckee River and the fluctuations in lake stage (fig. 6).

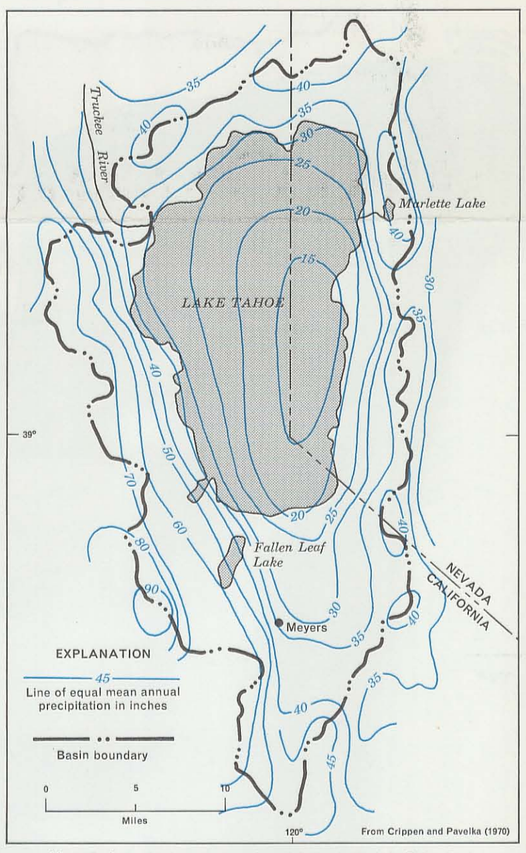

Figure 3.-Approximate mean annual precipitation in the Lake Tahoe Basin

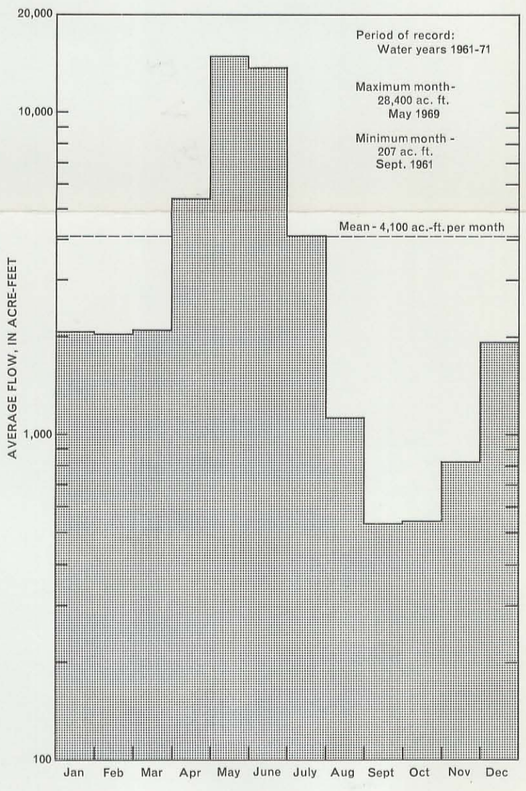

Figure 4.-Mean monthly flow of Upper Truckee River near Meyers, California

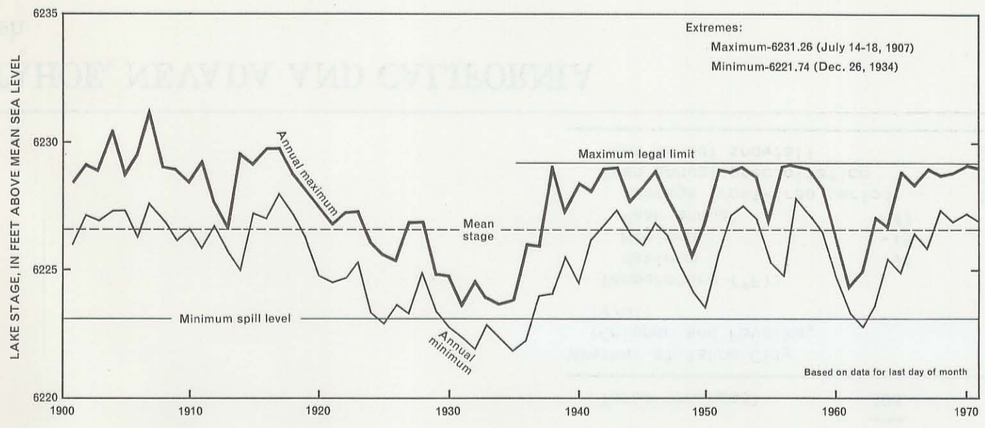

Figure 6.-Annual variations in stage of Lake Tahoe

BATHYMETRY

The bathymetric map of Lake Tahoe is based on a soundings map of the U.S. Coast and Geodetic Survey (1923). The U.S. Coast and Geodetic Survey map shows water depths for about 1,800 points. The deepest sounding in the lake, 1,646 feet and the only sounding greater than 1,600 feet, was about 6 miles due east of the Truckee River outlet and along the axis of the lake.

Several submerged mounds, as shown, range in height up to about 400 feet. Hyne and others (1972, p. 1441) describe the mounds as composed of slumped sediments, whereas Goldman and Court (1968) suggested a possible volcanic origin.

Most of the steep slopes shown by the close spacing of the bathymetric contours on the east and west sides of the lake are of fault origin. In addition, a fault scarp extends southwestward from Stateline Point, at the north end of the lake, toward the deepest point in the lake. About 2 miles north of Emerald Bay at Rubicon Point, the lake depth increases 1,300 feet in about the same horizontal distance, producing a bottom slope of about 45° from horizontal.

Stage-area-volume relations are shown in figure 7.

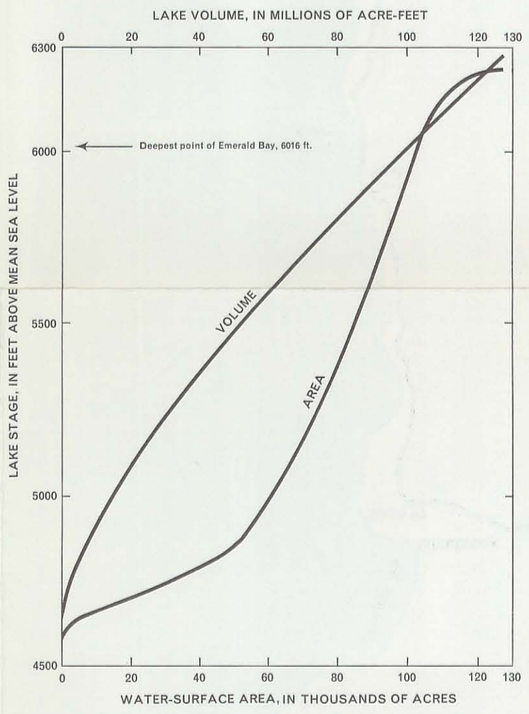

Figure 7.-Stage-area-volume relation for Lake Tahoe

WATER BUDGET

A water budget for a lake relates the various components of water inflow, outflow, and change in storage:

$$Inflow = Outflow \pm Change\ in\ storage. \qquad (1)$$

For Lake Tahoe, equation (1) is modified as follows:

$$I_{sw} + I_{gw} + P = O_{sw} + E + D \pm \Delta S, \qquad (2)$$

where the elements of inflow are: I_{sw}, inflow of all surface water; I_{gw}, inflow of ground water; and P, precipitation directly on the lake surface. The elements of outflow are: O_{sw}, surface-water outflow from the lake to the Truckee River; E, evaporation from the lake surface; and D, diversions from the lake. ΔS is change in lake storage associated with net stage change for the budget period. Ground-water seepage from the lake is believed to be negligible to nonexistent.

For the purposes of this reconnaissance, an approximate mean annual water budget for the lake can be computed by omitting ground-water inflow (I_{gw}), diversions from the lake (D), and storage change (ΔS), because these elements, though pertinent, are small in relation to the other budget elements and the total water in storage. Equation (2) therefore is modified as follows:

$$I_{sw} + P = O_{sw} + E. \qquad (3)$$

A 71-year period, 1901-71 was used as a base for computation. Based largely on estimates of Crippen and Pavelka (1970, p. 36), equation (3) becomes (rounded):

$$310{,}000 + 220{,}000 = 180{,}000 + 350{,}000,$$

or approximately 530,000 acre-feet of total mean annual inflow and outflow. However, because the 71-year period of record is believed to be somewhat wetter than normal, this total, when adjusted to the base periods 1919-69 and 1931-60 of average wetness, probably is more nearly 500,000 acre-feet per year.

The lakes and reservoirs of this series are listed as follows:

Lake or Reservoir	*Publication*
Pyramid Lake	USGS HA-379[1]
Walker Lake	USGS HA-415
Lahontan Reservoir	Nev. DWR Info. Ser. 9[2]
Big and Little Washoe Lakes	Nev. DWR Info. Ser. 10
Big and Little Soda Lakes	Nev. DWR Info. Ser. 11
Topaz Lake	Nev. DWR Info. Ser. 12
Rye Patch Reservoir and Upper and Lower Pitt-Taylor Reservoirs	Nev. DWR Info. Ser. 13
Marlette and Spooner Lakes	Nev. DWR Info. Ser. 14
Weber Reservoir	Nev. DWR Info. Ser. 15
Wild Horse Reservoir	Nev. DWR Info. Ser. 16
Lake Tahoe	Nev. DWR Info. Ser. 17

[1] U.S. Geological Survey Hydrologic Atlas.
[2] Nevada Division of Water Resources Information Series Report.

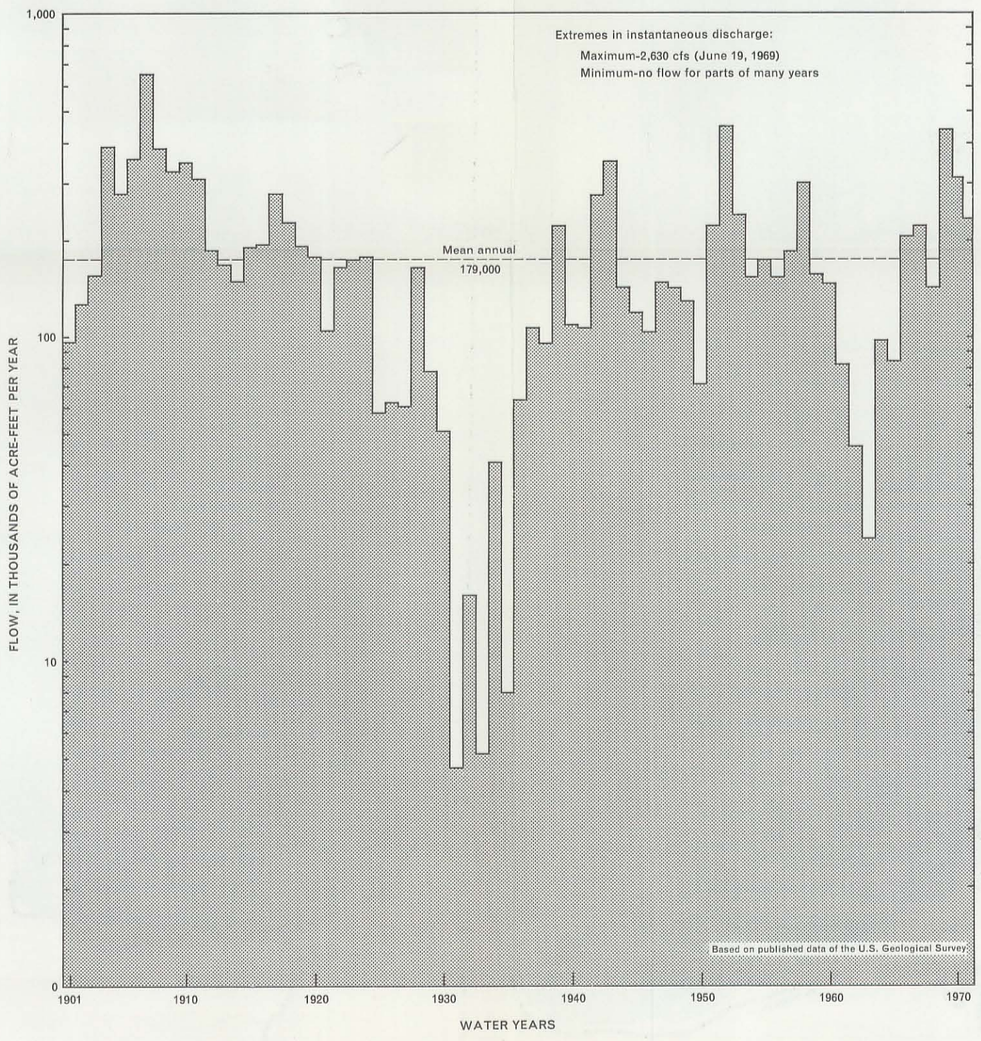

Figure 5.- Flow from Lake Tahoe to the Truckee River

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