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LONG-TERM FLOW OF THE  
CARSON RIVER IN CALIFORNIA AND NEVADA <sup>3</sup>

By

<sup>5</sup> *Frederick, 1913-*  
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LONG-TERM FLOW OF THE  
CARSON RIVER IN CALIFORNIA AND NEVADA

By

Howard F. Matthai

Introduction

The U.S. Attorney's Office, Department of Justice, requested the U.S. Geological Survey to determine the long-term average annual runoff of the Carson River upstream from Lahontan Reservoir.

The observed or estimated annual runoff of Carson River at the gaging station near Fort Churchill, NV, was adjusted for depletions and imports to approximate the long term average under natural conditions.

The long-term average annual runoff near Fort Churchill was computed for the 74-year period, 1900-1973, on the basis of streamflow records since 1900. This period is the same as that used for the Truckee River (Matthai, 1974) since it is representative of a longer period and allows a direct comparison between long-term averages in both basins.

## Data Available

The longest continuous record is that for the Carson River near Fort Churchill which started in 1911. Intermittent records were collected on the East and West Forks Carson River in the 1890's, and continuous records have been collected on the West Fork Carson River at Woodfords, CA, 1900-1915, 1916-20, and 1938-73, and on the Carson River near Empire, NV, 1900-1923. Records at Woodfords for 1907-15, 1916-20 are not equivalent at times to the other records due to diversions for irrigation.

Records for diversions to the Buckland ditch near Fort Churchill were collected only for the period 1963-71.

Depletions upstream from Fort Churchill were estimated from water use information (P. A. Glancy, written communication, 1975).

Annual imports of water from areas near Lake Tahoe were obtained from the South Lake Tahoe Utility District, the Incline General Improvement District, the Douglas County Sewer District No. 1, and the Marlette Lake Water System.

## Estimates of Missing Records

Annual runoff values near Fort Churchill were correlated with concurrent data collected near Empire and at Woodfords to estimate the 1901-11 annual discharges for the Carson River near Fort Churchill. Correlation coefficients were 0.98 and 0.93, respectively.

The correlation with the Empire record was used since it is the nearest site to Fort Churchill and should be a better index of actual flows near Fort Churchill.

The only nearby record available for the water year 1900 is for the Truckee River at Farad, CA. A correlation of the Farad and Fort Churchill records was made and used to estimate the flow in 1900 at Fort Churchill.

The 1912-73 record near Fort Churchill was extended to 74 years (table 1) by estimating the 1900-1911 period as explained in the previous paragraphs. The average annual runoff for the 62 years of record is 264,000 acre-feet, and for the 74-year period 1900-1973 it is computed to be 295,000 acre-feet.

Table 1. - Computation of adjusted flows, Carson River near Fort Churchill, NV.

Water Year	Flow nr. Fort Churchill	Adjustments Buckland ditch	Depletion	Imports	Adjusted Flow nr. Ft. Church.	Water Year	Flow nr. Fort Churchill	Adjustments Buckland ditch	Depletion	Imports	Adjusted Flow nr. Ft. Church.	Water Year	Flow nr. Fort Churchill	Adjustments Buckland ditch	Depletion	Imports	Adjusted Flow nr. Ft. Church.
		(a)		(b)		1926	114	16	35	1	170	1956	533	16	35	1	580
						27	341	16	35	1	390	57	224	16	35	1	280
Flows are in 1,000's of acre-feet						28	170	16	35	1	220	58	341	16	35	1	390
						29	92	16	35	1	140	59	108	16	35	1	160
1900	<sup>c</sup> 205	16	35	1	260	1930	149	16	35	1	200	1960	60	16	35	1	110
1	<sup>d</sup> 420	16	35	1	470	31	65	16	35	1	120	61	44	16	35	1	100
2	<sup>d</sup> 275	16	35	1	330	32	307	16	35	1	360	62	218	16	35	1	270
3	<sup>d</sup> 325	16	35	1	380	33	122	16	35	1	170	63	338	16	35	1	390
4	<sup>d</sup> 555	16	35	1	610	34	76	16	35	1	130	64	136	15	35	0	190
5	<sup>d</sup> 260	16	35	1	310	35	210	16	35	1	260	65	382	16	35	0	430
6	<sup>d</sup> 605	16	35	1	660	36	275	16	35	1	330	66	171	17	35	0	220
7	<sup>d</sup> 1030	16	35	1	1080	37	262	16	35	1	310	67	449	16	35	1	500
8	<sup>d</sup> 205	16	35	1	260	38	580	16	35	1	630	68	162	15	35	-1	210
9	<sup>d</sup> 485	16	35	1	540	39	140	16	35	1	190	69	561	20	35	-3	610
1910	<sup>d</sup> 385	16	35	1	440	1940	279	16	35	1	330	1970	322	14	35	-3	370
<sup>a</sup> 11	<sup>d</sup> 705	16	35	1	760	41	244	16	35	1	300	71	295	16	35	-3	340
12	174	16	35	1	230	42	403	16	35	1	460	72	188	16	35	-5	230
13	161	16	35	1	210	43	403	16	35	1	460	73	276	16	35	-6	320
14	1617	16	35	1	670	44	169	16	35	1	220						
15	297	16	35	1	350	45	310	16	35	1	360	1900-73					
16	550	16	35	1	600	46	262	16	35	1	310	Total	21,856				25,690
17	467	16	35	1	520	47	165	16	35	1	220	Average	295				347
18	223	16	35	1	280	48	152	16	35	1	200						
19	256	16	35	1	310	49	167	16	35	1	220						
1920	145	16	35	1	200	1950	260	16	35	1	310						
21	298	16	35	1	350	51	423	16	35	1	480						
22	460	16	35	1	510	52	587	16	35	1	640						
23	329	16	35	1	380	53	240	16	35	1	290						
24	91	16	35	1	140	54	177	16	35	1	230						
25	267	16	35	1	320	55	114	16	35	1	170						

a. Estimated 1900-1962, 1972-73.

b. Walker River basin - Lake Tahoe basin flows.

c. Estimated from Truckee River at Farad.

d. Estimated from Carson River near Empire.

### Adjusted Flow near Fort Churchill, NV

The annual runoff near Fort Churchill, estimated for 1900-1911 and observed for 1912-73, has been adjusted to approximate "natural flow" (table 1). Some of the adjustments are estimated, others are based on furnished data. Also, two possible adjustments were considered negligible.

One assumption relates to the possible effect of storage in the basin. There are 21 small reservoirs upstream from Fort Churchill. Maximum capacity in individual reservoirs ranges from 31 to 4,700 acre-feet, and the total capacity is only 18,900 acre-feet. There are no records of water-surface elevations or contents for any of the reservoirs, but carry-over storage from one year to the next is generally minor. Therefore, no adjustment for annual changes in storage is necessary.

The total surface area of these reservoirs is small, so evaporation is also considered negligible.

Another assumption relates to the water diverted by the Buckland ditch just upstream from the Fort Churchill gaging station. There is a water right for the Buckland ditch dating back to 1874, but there are only



9 years of record, 1963-71. Annual diversions during this period ranged from 14,000 to 20,000 acre-feet and averaged 16,000 acre-feet. Therefore, the average diversion of 16,000 acre-feet was assumed to be typical of diversions in all the other years.

Depletions upstream from Fort Churchill were estimated from water use information for Carson Valley, Dayton Valley, and Churchill Valley. The water uses include those for agricultural, domestic, municipal, and industrial purposes plus evapotranspiration losses from phreatophytes and playas. The latter losses were estimated and were subtracted from the total water use.

Though there have been changes in water use and in evapotranspiration losses since 1900, definitive information is not available. Therefore an average value of 35,000 acre-feet was used for the net depletion.

There is conflicting information regarding the amount of imported water from the Walker River basin through Adrian Gap. Huxel (1969, p. 22) estimates an annual amount of 1,000 acre-feet for the period 1949-65 though flow only occurs in extremely wet years. Recent information from a local resident indicates that there has been no transbasin flow



for at least the past 30 years. Any imported water would drain to the Carson River between the Fort Churchill gage and Lahontan Reservoir, and since the amount is relatively small, 1,000 acre-feet per year has been added to the Fort Churchill flows.

The average annual runoff, adjusted, for the 74-year period, 1900-1973, is computed as 347,000 acre-feet.

#### Variability of Annual Flows

The maximum and minimum annual flows near Fort Churchill (table 1) are 1,030,000 acre-feet in 1907 and 44,000 acre-feet in 1961 - a ratio of 23 to 1. The maximum year is 349 percent of the long-term average flow, and the minimum year is 15 percent of average.

Of the 10 driest years in the 74-year period, 6 occurred in the 11-year period, 1924-34, when the average annual flow was 163,000 acre-feet, 55 percent of the 74-year average.

Several studies of flows in the Truckee and Carson River basins have been made and different periods have been used for computing average flows. Piper (1969) used synthesized records prepared by the U.S.

Bureau of Reclamation and the State engineer of Nevada for the East and West Forks Carson River for the period 1901-65 to conclude that "the average for the 52 water years, 1909-60, affords the most credible value of mean yearly runoff over the long term."

The Pyramid Lake Task Force (1971) used the 53-year period, 1918-70, for their base period.

Matthai (1974) used the 74-year period, 1900-1973, because it included virtually all the available streamflow data on the Truckee River. Also, the average annual precipitation at Sacramento for 1900-1973 was 94 percent of the average annual precipitation for the 124 years of record.

The average annual runoff of the Carson River is tabulated below for the different periods using data in table 1.

Period	Years	Average annual runoff		Percentage of	
		Computed or Observed Acre-feet	Adjusted Acre-feet	74-year average Observed	Adjusted
1909-60	52	278,000	330,000	94	95
1918-70	53	252,000	304,000	85	88
1900-1973	74	295,000	347,000	100	100

## Summary

The long-term average flows were based upon the 74 years of record that were either observed or estimated. The actual average annual runoff at the Fort Churchill gaging station is estimated as 295,000 acre-feet. The adjusted average annual runoff for the 1900-1973 period is estimated as 347,000 acre-feet.

The flows for individual years vary widely from the long-term average flow. The maximum year is 349 percent of average, and the minimum year is 15 percent of average - a 23 to 1 ratio.

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