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QUALITY OF WATER OF COLORADO RIVER IN 1925–1926

BY

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AND

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ILLUSTRATIONS

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By W. D. Collins and C. S. Howard

SAMPLES

Most of the analyses given in this report represent composites of daily samples collected by the observers at United States Geological Survey gaging stations on Colorado River at Grand Canyon and Topock, Ariz. These stations are operated under the direction of W. E. Dickinson, district engineer of the Geological Survey at Tucson, Ariz., who personally collected some of the samples at other points and arranged for the collection of others.

At Grand Canyon samples from August 18, 1925, to September 30, 1926, were taken by B. S. Barnes; from October 25, 1925, to September 3, 1926, by D. H. Barber; and from September 4 to September 30, 1926, by Kenneth C. McCarter. At Topock samples from August 14, 1925, to July 13, 1926, were taken by James E. Klohr; from July 14 to July 27, 1926, by Kenneth C. McCarter; and from July 28 to September 30, 1926, by James E. Klohr. The samples for the single composite from Yuma were taken by P. J. Preston, superintendent of the irrigation project of the United States Bureau of Reclamation at Yuma. Other samples were taken by D. A. Dudley in connection with measurements of discharge at points in the river system. The points at which samples were taken are shown in Figure 6.

All the samples were collected in 4-ounce bottles, which were sent to the laboratory in Washington for analysis. For the composites a single bottle was filled each day, and the date and point of collection were marked on the bottle. Every effort was made to take samples that would truly represent the river water as to its content of dissolved mineral matter. Single samples for analysis consisted of four or eight bottles collected at one time. The continuity of collection of samples and the completeness of the analyses make the information in this report more comprehensive than that given in previous reports.[1]

[1] Forbes, R. H., The river irrigating waters of Arizona, their character and effects: Arizona Agr. Exper. Sta. Bull. 44, 1902. Stabler, Herman, Some stream waters of the western United States, with chapters on sediment carried by the Rio Grande and the industrial application of water analyses: U. S. Geol. Survey Water-Supply Paper 274, 1911. Scofield, C. S., Salt content of Colorado River: Eng. News Record, vol. 97, pp. 131–132, 1926.

METHODS OF ANALYSIS

C. S. Howard made all the analyses by the methods regularly used in the United States Geological Survey, which agree essentially with those recommended in "Standard methods of water analysis" published by the American Public Health Association.

The 4-ounce samples were allowed to stand in the laboratory till the suspended matter settled, leaving the liquid above apparently free from even traces of silt. Composite samples for 7-day periods

FIGURE 6.—Map of Colorado River drainage basin showing sampling points

were collected in flasks by drawing the clear liquid from the individual bottles through a siphon, without disturbing the sediment.

A sample of 5 cubic centimeters was taken from each small bottle for a chloride determination, but the results are not given in the table. They served as a check on the result obtained in the examination of the composite.

In the early part of the work the silt was washed from all the bottles of a set into an evaporating dish, which was placed on the steam bath. After the residue was dry it was heated in the oven at 180° C. for one or two hours. This heating made no significant change in the weight of the residue, and later the heating in the oven was discontinued. For most of the samples the weight of the suspended material in each bottle was found after drying on the steam bath. Correction was made for the weight of the soluble salts in the original water (usually 5 to 8 cubic centimeters) transferred from the bottle to the evaporating dish with the silt. The silt was washed from the bottle into the dish with distilled water. The quantities of silt reported in the table for composite samples are nearly all averages of the determinations for the daily samples.

A sample of 500 cubic centimeters of the clear composite was evaporated to dryness in platinum, and the residue was weighed after heating 12 or 18 hours at 180° C. Silica was determined, and the filtrate was divided into two parts. Iron was precipitated from one part and determined colorimetrically as thiocyanate, calcium was determined by titration of the oxalate with permanganate, and magnesium was weighed as pyrophosphate. From the other part sulphate was precipitated and weighed as barium sulphate, the mixed chlorides were weighed, and for most of the samples potassium was determined by weighing the platinum resulting from reduction of the potassium platinic chloride. If potassium was not determined, the total weight of mixed chlorides was calculated to sodium. Bicarbonate, chloride, and nitrate were determined by standard methods. No carbonate was found in any sample.

The percentage error of each analysis was calculated by dividing the difference between the sums of the equivalents of the bases and acids by the total sum. The calculations showed all the analyses to be well within the limits that are found for careful analytical work.

The weight reported as "residue on evaporation" is consistently higher than the sum of the determined constituents. This difference is commonly found in the analysis of waters that carry comparatively large quantities of calcium and sulphate.

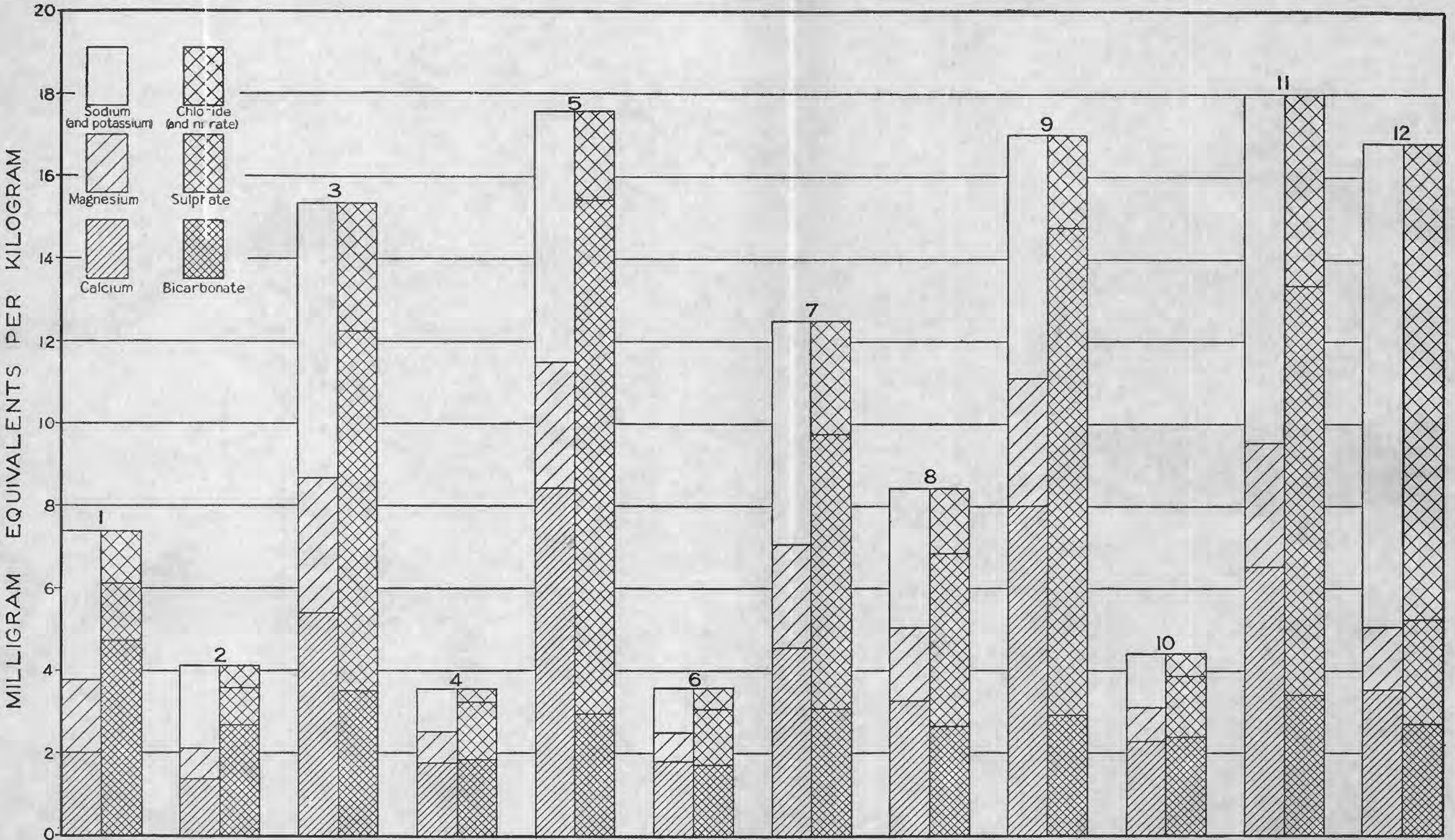
COMPOSITION OF WATER OF COLORADO RIVER AND TRIBUTARIES

The accompanying table gives all the individual analyses made for this report and two averages for Colorado River at Grand Canyon, which are shown with some of the analyses in Plate 6. The dates show the number of daily samples in each composite. Samples were collected each day at Grand Canyon and at Topock, but some samples were lost in transit. A few that contained hydrogen sulphide when received were rejected, because the hydrogen sulphide suggested decomposition of sulphate and possible change in the bicarbonate. The results for dissolved solids are sums of the constituents determined, with the bicarbonate divided by 2.03 to obtain the equivalent carbonate. The total hardness is the calcium carbonate equivalent to the calcium and magnesium together. The noncarbonate hardness is the total hardness minus the quantity of calcium carbonate equivalent to the bicarbonate. The mean discharge is that for the 7-day period represented by each analysis for Grand Canyon and Topock. The quantity of dissolved solids in tons per day is obtained by multiplying the dissolved solids in parts per million by the discharge in second-feet and the factor 0.002697. In other publications the quantity of dissolved material in the river has been calculated from the results of determinations of the residue on evaporation, which is always greater than the anhydrous dissolved mineral matter.

Analysis 65 in the table, which is shown as diagram 7 of Plate 6, is the average of the 51 analyses for Colorado River at Grand Canyon from October 9, 1925, to September 30, 1926. Analysis 65 and diagram 7 represent accurately the composition of water that would be contained in a vessel or reservoir that had received equal quantities of water from the river each day of the period covered by the analyses.

Analysis 66 is a weighted average of analyses 14 to 64. The quantities of the different constituents in each analysis were multiplied by the mean discharge for the period represented by the analysis. The sum of the 51 products for each constituent was divided by the sum of the discharges to obtain the weighted average given as analysis 66. This analysis and diagram 8 represent approximately the composition of water that would be found in a reservoir containing all the water that had reached Grand Canyon during the period considered, after thorough mixing in the reservoir. This shows obviously better water than that represented by analysis 65 and diagram 7, because at times of high discharge the river carries the least amount of dissolved solids. In analysis 65 and diagram 7 the waters represented by diagrams 5 and 6 have equal weight; in analysis 66 and diagram 8 the water represented by diagram 6 has over three times the weight of that represented by diagram 5. Because the composite samples for analysis were made from equal daily samples, the analyses themselves do not represent accurately the water that would be found in a reservoir containing the whole flow of the river for the period covered by an individual analysis. The error due to this effect is not great, but its tendency is to make analysis 66 and diagram 8 show more dissolved mineral matter than would be found in the water of a reservoir storing the whole flow of the river for a year.

The analyses for Topock show the water to have about the same content of dissolved mineral matter there as at Grand Canyon. This is brought out in Figure 7, which shows the dissolved mineral matter at Grand Canyon and Topock, with the discharge at Grand Canyon. The discharge at Topock is so near that at Grand Canyon that it is omitted to avoid confusion. The dissolved mineral matter shown in Figure 7 is not the residue on evaporation, but the sum of



COMPOSITION OF RIVER WATERS IN ARIZONA AND CALIFORNIA

1. Owens River at Charlies Butte, near Tinemaha, Calif. Composite sample August 7–16, 1908, U. S. Geol. Survey Water-Supply Paper 237, p. 121.
2. Owens River at Charlies Butte, near Tinemaha, Calif. Composite sample April 29 to May 8, 1908. U. S. Geol. Survey Water-Supply Paper 237, p. 121.
3. Colorado River at Lees Ferry, Ariz. January 11, 1926. Analysis 1 in table.
4. Colorado River at Lees Ferry, Ariz. Composite sample June 13–19, 1926. Analysis 7 in table.
5. Colorado River at Grand Canyon, Ariz. Composite sample October 9–15, 1925. Analysis 14 in table.
6. Colorado River at Grand Canyon, Ariz. Composite sample June 11–17, 1926. Analysis 49 in table.
7. Colorado River at Grand Canyon, Ariz. Average of 51 analyses of composite samples October 9, 1925, to September 30, 1926. Analysis 65 in table.
8. Colorado River at Grand Canyon, Ariz. Weighted average of analyses of composite samples October 9, 1925, to September 30, 1926. Analysis 66 in table.
9. Colorado River at Topock, Ariz. Composite sample October 16–22, 1925. Analysis 76 in table.
10. Colorado River at Topock, Ariz. Composite sample June 18–24, 1926. Analysis 112 in table.
11. Colorado River at Yuma, Ariz. Composite sample September 22–30, 1926. Analysis 127 in table.
12. Little Colorado River at Grand Falls, Ariz. Composite sample December 7–9, 1925. Analysis 128 in table.

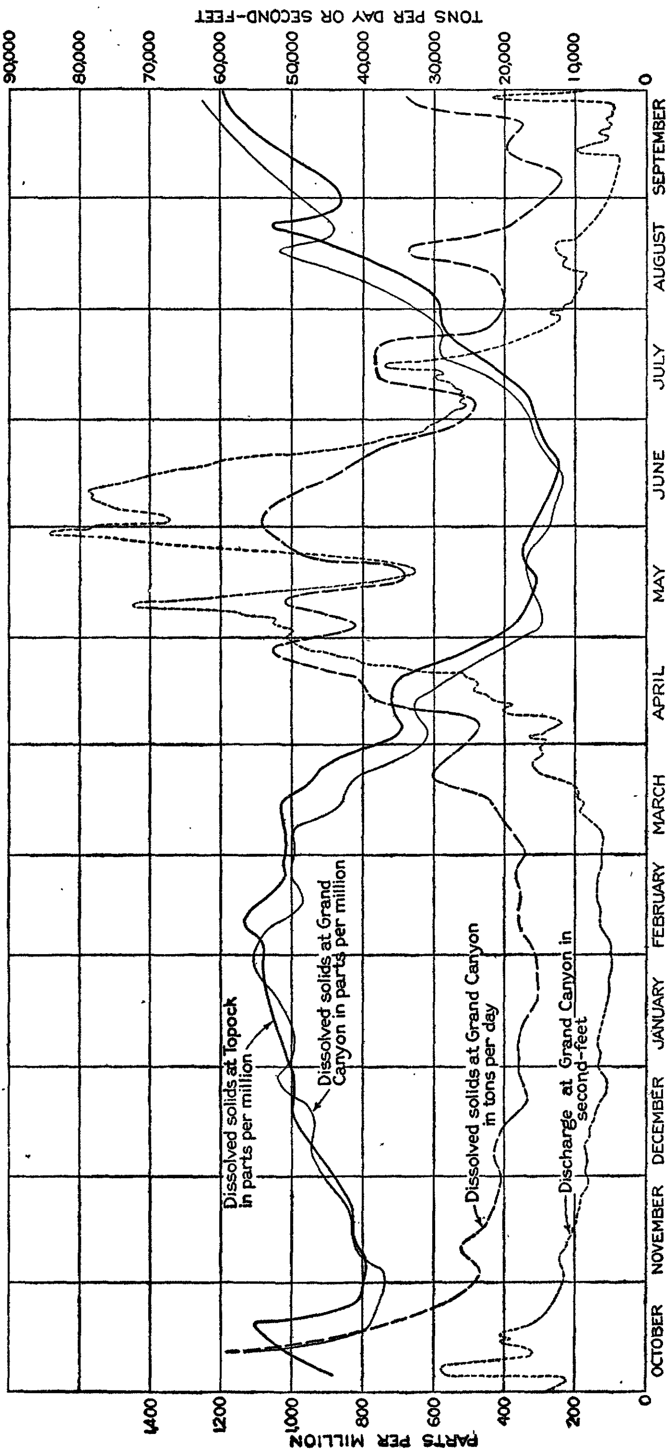


FIGURE 7.—Dissolved solids in Colorado River at Grand Canyon and Topock, Ariz., and discharge at Grand Canyon

the determined constituents with the bicarbonate calculated to carbonate.

Of the 137 analyses in the table, 113 represent samples from Grand Canyon and Topock. The samples from other points have only the value of occasional samples and can not serve for calculation of the quantities of material carried by the river. Consideration of the discharge at the time of collection in comparison with the discharge throughout the year will give some basis for an opinion as to whether a given analysis may represent average or extreme concentration of dissolved mineral matter.

SUSPENDED MATTER

The figures given for suspended matter are accurate for the samples as received. The samples were, however, taken without any special precautions to make them represent accurately the silt being carried by the river. It is possible, therefore, that the use of these results n computations may lead to incorrect conclusions. Work on the silt problem, which is still under way, may make it possible to use the results published in this paper, either with or without corrections, as a reliable basis for calculations.

ANALYSES

Analyses of water from Colorado River and certain tributaries

[C. S. Howard, analyst. Analytical results in parts per million]

Colorado River at Lees Ferry, Ariz.

No.	Date of collection	Suspended matter	Residue on evaporation	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate radicle (HCO_3)	Sulphate radicle (SO_4)	Chloride radicle (Cl)	Nitrate radicle (NO_3)	Dissolved solids	Hardness as $CaCO_3$ (calculated) Total	Hardness as $CaCO_3$ (calculated) Noncarbonate	Mean discharge (second-feet)	Dissolved solids (tons per day)
1	Jan. 11, 1926	638	1,012	20	0.19	108	41	148	8.3	214	414	108	15	968	438	263	6,170	16,100
2	Feb. 25	1,040	997	14	.12	100	43	150		199	428	96	8.2	937	426	263	6,320	16,000
3	Mar. 26	6,300	658	12	.21	66	27	109	7.4	188	273	57	.83	645	276	122	15,100	26,300
4	May 24, 26–28, 30	7,670	325	17	.34	49	13	32	3.7	129	121	15	Trace.	315	176	70	73,400	62,400
5	May 31 to June 6	3,470	252	17	.48	38	13	23	5.0	122	76	13	Trace.	246	148	48	71,300	47,300
6	June 7	2,490				46	10	[a] 25		139	76	12	.47	[b] 257	156	42	77,500	53,800
7	June 13–19	2,380	258	20	.19	36	8.9	26	.6	113	75	12	.26	235	126	34	63,500	40,200
8	June 20–27	2,110	282	23	.27	39	10	31	1.6	112	86	13	.33	259	138	47	38,600	27,000
9	July 10	3,730	434	34	1.0	58	15	50	2.1	126	165	30	.52	418	206	103	27,600	31,100
10	July 11	3,230	449	14	.51	61	16	51	2.1	126	185	28	.58	420	218	115	29,100	32,900

Colorado River at Grand Canyon, Ariz.

No.	Date of collection	Suspended matter	Residue on evaporation	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate radicle (HCO_3)	Sulphate radicle (SO_4)	Chloride radicle (Cl)	Nitrate radicle (NO_3)	Dissolved solids	Hardness as $CaCO_3$ (calculated) Total	Hardness as $CaCO_3$ (calculated) Noncarbonate	Mean discharge (second-feet)	Dissolved solids (tons per day)
11	Aug. 23–29, 1925	25,400	1,157	21	0.46	149	38	160		227	538	98	5.0	1,121	528	342	17,100	51,700
12	Sept. 5–8	30,500	1,069	25	.48	150	33	130		206	511	65	1.0	1,017	510	341	28,800	79,000
13	Sept. 23, 24, 26–30	18,000	965	17	.26	127	32	147		211	453	87	Trace.	967	449	276	19,100	49,800
14	Oct. 9–15	21,400	1,218	13	.27	170	38	138		181	607	80	Trace.	1,135	581	432	19,400	59,400
15	Oct. 16–22	8,350	823	23	.34	105	30	97	4.8	176	362	67	4.0	780	386	241	17,800	37,400
16	Oct. 23–29	3,140	787	20	.38	94	30	105	4.2	171	331	80	5.0	754	358	218	13,400	27,300
17	Oct. 30 to Nov. 5	1,510	776	18	.34	90	32	104	5.6	174	315	86	3.1	740	356	214	11,900	23,800
18	Nov. 6–12	2,050	828	27	.16	99	30	126		195	342	91	4.2	815	370	211	11,900	26,200
19	Nov. 13–19	1,410	862	12	.14	105	33	128		212	347	94	4.1	828	398	224	10,300	23,000
20	Nov. 20–26	1,040	889	14	.15	100	36	136		203	355	108	4.2	853	398	231	9,320	21,400
21	Dec. 1–3		923	18	.40	104	40	132	9.9	212	357	125	11	901	424	250	8,510	20,700
22	Dec. 4–10	[a] 821	981	24	.14	100	41	146	8.0	211	385	128	4.7	941	418	245	8,590	21,800
23	Dec. 11–17	791	982	23	.14	100	42	146	8.8	211	377	130	6.3	937	422	249	7,950	20,100
24	Dec. 18–24	546	1,010	19	.11	103	43	152	9.3	210	383	139	8.0	960	434	262	6,570	17,000
25	Dec. 25–31	517	1,086	21	.12	112	47	163	9.9	220	415	158	8.9	1,043	473	292	6,340	17,800

[a] Calculated.

[b] Includes 19 parts of silica, the average for analyses 1–5 and 7–10.

Analyses of water from Colorado River and certain tributaries—Continued

Colorado River at Grand Canyon, Ariz.—Continued

No	Date of collection	Suspended matter	Residue on evaporation	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate radicle (HCO_3)	Sulphate radicle (SO_4)	Chloride radicle (Cl)	Nitrate radicle (NO_3)	Dissolved solids	Hardness as $CaCO_3$ (calculated)		Mean discharge (second-feet)	Dissolved solids (tons per day)
															Total	Noncarbonate		
26	Jan. 1-7, 1926	591	1,038	18	0.17	109	39	152	18	221	381	149	13	988	432	251	6,870	18,300
27	Jan. 8-10, 12, 14	536	1,051	21	.20	107	41	159	19	222	391	143	14	1,005	436	254	6,540	17,700
28	Jan. 17-21	356	1,083	15	.16	108	45	175	7.2	232	390	165	10	1,030	454	264	5,750	16,000
29	Jan. 22-28	329	1,138	19	.22	106	45	193	6.9	237	415	173	11	1,086	450	255	5,350	15,700
30	Jan. 29-31, Feb. 2, 4	311	1,172	17	.20	109	46	197	8.7	246	409	190	7.1	1,105	461	260	5,290	15,800
31	Feb. 5-11	559	1,118	18	.23	111	45	183	7.2	233	409	167	8.0	1,063	462	271	6,420	18,400
32	Feb. 12-18	878	1,042	20	.10	105	42	158 (Na + K)		218	380	149	6.0	968	435	256	6,850	17,900
33	Feb. 19-25	1,030	1,050	22	.11	107	42	169 (Na + K)		216	404	147	6.0	1,004	440	263	6,970	18,900
34	Feb. 26 to Mar. 4	768	1,061	13	.11	102	43	173 (Na + K)		204	405	149	8.2	993	431	264	6,460	17,300
35	Mar. 5-11	1,030	1,049	17	.14	102	44	170	7.4	220	395	149	1.5	994	435	255	7,440	19,900
36	Mar. 12-18	2,710	911	14	.14	90	36	142	7.5	209	335	128	1.6	857	373	201	9,510	22,000
37	Mar. 19-25	5,850	865	15	.19	92	36	131	6.4	205	334	107	1.4	824	378	210	13,600	30,200
38	Mar. 26 to Apr. 1	7,230	701	13	.22	75	28	107	7.4	190	257	80	1.8	663	302	147	15,000	26,800
39	Apr. 2-8	6,280	667	14	.22	67	23	106	5.9	190	233	79	1.8	624	262	106	14,100	23,700
40	Apr. 9-13, 15	11,600	693	12	.29	75	24	109	7.4	192	264	70	1.7	658	286	129	21,500	38,200
41	Apr. 16-21	9,300	561	17	.28	67	24	77	5.6	187	207	51	Trace.	541	266	113	28,400	41,400
42	Apr. 23-29	13,800	449	24	.20	62	17	51	4.2	170	153	33	Trace.	428	225	85	45,600	52,600
43	Apr. 30 to May 6	9,410	302	13	.19	35	13	43	4.5	146	91	22	Trace.	294	141	21	52,000	41,200
44	May 7-13	6,790	318	9.6	.18	47	14	37	5.0	143	100	23	Trace.	306	175	58	61,800	51,000
45	May 14, 15, 17-20	3,760	343	23	.21	49	13	40	5.1	154	101	28	.51	336	176	50	37,100	33,600
46	May 21-27	4,260	340	20	.32	48	12	40	4.5	143	109	25	.34	330	169	52	55,000	48,900
47	May 28 to June 3	6,240	270	18	.41	41	12	29	5.3	124	86	18	1.1	272	152	50	73,900	54,200
48	June 4-10	3,250	254	18	.40	37	11	26	4.8	118	75	21	.38	252	138	41	76,300	51,900
49	June 11-17	2,320	248	28	.22	37	8.4	27	2.4	109	64	16	.31	237	127	38	69,800	44,600
50	June 22-24	1,820	297	14	1.2	41	10	42	7.7	127	92	28	.28	299	144	39	48,200	38,900
51	June 25 to July 1	1,540	342	26	.14	45	13	41	5.8	128	104	32	.48	331	166	61	31,100	27,800
52	July 3-8	906	364	19	.17	46	15	49	6.6	133	109	41	.55	352	176	67	26,200	24,900
53	July 10-15	4,870	476	20	.26	61	17	62	6.1	142	179	42	.55	458	222	106	30,500	37,700
54	July 16-22	9,520	612	27	.71	75	21	82	3.8	170	243	49	.60	586	274	134	24,300	38,400
55	July 23-29	3,220	603	23	.17	66	20	94	7.2	159	218	73	.69	580	247	117	14,200	22,200
56	July 30 to Aug. 5	4,510	705	15	.34	82	24	108	8.8	171	265	90	1.3	679	303	163	11,000	20,100
57	Aug. 6-12	5,490	880	20	.17	98	30	135	8.7	181	341	110	1.1	833	368	220	9,630	21,600
58	Aug. 13-19	8,280	1,102	25	.27	134	35	151	8.3	185	478	112	1.9	1,037	478	327	12,100	33,900
59	Aug. 20-22, 24-26	6,830	897	23	.20	88	32	153	4.5	204	373	102	.72	877	351	184	8,380	19,800
60	Aug. 27 to Sept. 2	2,980	986	25	.30	100	32	176	6.4	199	403	134	1.8	976	381	218	5,750	15,100
61	Sept. 3-9	718	1,104	18	.23	116	38	181	4.8	206	421	160	3.4	1,044	446	277	4,360	12,300
62	Sept. 10-16	17,900	1,191	16	.26	128	41	189	3.7	220	478	154	2.9	1,121	488	308	6,610	20,000

63	Sept. 17–23	8,660	1,262	16	.29	136	40	198	4.5	214	523	157	4.6	1,185	504	328	5,520	17,600
64	Sept. 24–30	32,800	1,414	19	.33	144	43	213	8.7	227	551	160	1.6	1,252	536	350	9,940	33,500
65	Average of analyses 14 to 64	-------	806	19	.25	89	31	120	7.0	188	309	98	3.5	768	350	196	-------	-------
66	Weighted average of analyses 14–64 (see p. 36)	-------	546	19	.31	66	21	[c] 75	[d] 5.7	159	201	56	.16	523	251	121	19,900	28,100
	Colorado River at Topock, Ariz.																	
67	Aug. 14–20, 1925	7,880	856	25	0.17	103	30	113		161	343	94	3.6	791	380	248	9,970	21,300
68	Aug. 22–27	10,200	1,029	18	.24	106	35	148		166	417	103	4.7	914	408	272	10,500	25,900
69	Aug. 28 to Sept. 3	25,500	1,172	12	.22	143	39	159		199	530	108	1.7	1,091	517	354	18,900	55,600
70	Sept. 4–10	43,700	1,186	21	.31	151	34	169		188	587	79	1.2	1,135	517	363	24,300	74,400
71	Sept. 11–17	27,200	1,016	21	.20	138	31	130		172	484	79	2.8	971	472	331	14,900	39,000
72	Sept. 18–24	21,600	1,073	19	.24	140	34	130		171	486	85	.71	979	489	349	18,600	49,100
73	Sept. 25 to Oct. 1	32,400	1,109	21	.25	146	33	132		166	530	69	1.0	1,014	500	364	19,700	53,800
74	Oct. 2–8	12,900	936	17	.13	119	32	126		170	425	84	2.6	889	429	289	15,700	37,700
75	Oct. 9–15	22,500	1,060	13	.13	150	35	129		176	528	72	1.2	1,015	518	374	22,300	61,000
76	Oct. 16–22	19,800	1,186	26	.42	161	38	132	5.9	178	572	80	2.4	1,105	558	412	18,300	54,500
77	Oct. 23–29	9,780	872	24	.41	114	30	102	7.4	171	371	78	2.1	813	408	268	14,100	30,900
78	Oct. 30 to Nov. 5	4,390	835	22	.38	103	31	108	5.6	178	342	86	4.9	791	385	239	11,800	25,200
79	Nov. 6–12	3,600	847	17	.24	101	32	119		178	350	94	5.6	807	384	238	11,900	25,900
80	Nov. 13–19	3,510	868	16	.20	102	31	133		187	357	96	2.9	830	382	229	10,800	24,200
81	Nov. 20–26	2,930	891	13	.16	104	37	121		192	361	105	4.1	840	412	254	9,400	21,300
82	Nov. 27 to Dec. 3	3,520	924	14	.14	102	38	132	8.7	203	365	116	4.7	881	411	244	8,480	20,200
83	Dec. 4–10	2,100	971	17	.10	107	41	139	11	211	379	127	8.9	934	436	263	8,410	21,200
84	Dec. 11–17	1,800	1,009	24	.11	110	42	149	12	210	399	132	11	983	447	275	8,160	21,600
85	Dec. 18–24	1,910	1,001	20	.11	108	43	158	8.2	210	416	134	4.7	995	446	274	7,240	19,400
86	Dec. 25–29, 31	1,620	1,032	18	.20	111	37	165	11	221	387	142	11	991	429	249	5,980	16,000
87	Jan. 1–7, 1926	1,680	1,086	18	.20	112	46	157	11	229	399	156	14	1,026	469	281	6,750	18,700
88	Jan. 8–14	1,600	1,101	16	.22	115	44	161	14	231	414	156	13	1,047	468	278	6,810	19,200
89	Jan. 15	1,370	-------	-------	-------	-------	-------	-------	-------	227	413	145	-------	-------	-------	-------	6,360	-------
90	Jan. 16	1,480	-------	-------	-------	-------	-------	-------	-------	217	395	160	-------	-------	-------	-------	6,230	-------
91	Jan. 22, 24–28	1,270	1,129	20	.21	116	46	175	8.3	232	410	175	8.2	1,073	479	289	5,560	16,100
92	Jan. 29 to Feb. 4	613	1,141	21	.23	115	46	182	9.1	235	408	174	6.9	1,078	476	284	5,300	15,400
93	Feb. 5–10	1,390	1,196	17	.21	118	47	197	8.7	242	428	189	8.6	1,133	488	289	5,740	17,500
94	Feb. 12–18	2,020	1,135	21	.25	113	45	184	8.5	240	399	176	16	1,081	467	270	6,510	19,000
95	Feb. 19–25	1,260	1,079	15	.22	111	43	175		224	390	164	10	1,019	454	270	6,910	19,000
96	Feb. 26 to Mar. 4	1,760	1,066	12	.18	110	42	179		223	402	158	9.0	1,022	447	264	6,610	18,200
97	Mar. 5–11	1,430	1,091	14	.16	111	44	176		221	412	152	7.4	1,025	458	277	6,420	17,700
98	Mar. 12, 14–16, 18	1,500	1,069	21	.16	107	41	176	8.2	223	409	159	1.6	1,033	436	253	8,290	23,100
99	Mar. 20–25	1,890	973	19	.20	98	38	154	8.5	212	374	138	1.5	936	401	227	10,900	27,500
100	Mar. 26 to Apr. 1	4,330	861	18	.12	95	34	129	8.0	203	338	109	1.6	833	377	211	14,700	33,000
101	Apr. 2–8	5,260	750	13	.24	82	30	105	6.2	193	269	86	.83	687	328	170	15,100	28,000
102	Apr. 9–15	8,900	782	14	.23	74	29	121	6.7	181	302	86	1.4	724	304	156	19,300	37,700
103	Apr. 16–22	8,840	727	15	.27	84	27	103	7.5	183	286	76	1.9	691	321	171	25,200	47,000
104	Apr. 23–29	9,400	556	8.2	.17	[c] 70	21	73	6.6	177	206	48	Trace.	520	261	100	40,400	54,200
105	Apr. 30 to May 6	7,300	397	8.0	.27	60	18	42	4.2	162	134	32	Trace.	378	224	91	50,900	51,900
106	May 7–13	5,920	342	9.4	.19	50	13	40	5.8	152	111	27	Trace.	331	178	54	60,100	53,600
107	May 14–19	4,970	324	19	.19	42	16	38	5.0	146	99	24	Trace.	315	171	51	43,900	37,300
108	May 21–27	3,450	363	15	.26	50	14	46	4.5	156	117	32	.40	356	182	54	41,700	40,000

[c] Average of 51. Sodium for 7 calculated from mixed chlorides on the assumption that the potassium was 5.7, the average of 44.

[d] Average of 44.

Analyses of water from Colorado River and certain tributaries—Continued

Colorado River at Topock, Ariz.—Continued

No.	Date of collection	Suspended matter	Residue on evaporation	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate radicle (HCO_3)	Sulphate radicle (SO_4)	Chloride radicle (Cl)	Nitrate radicle (NO_3)	Dissolved solids	Hardness as $CaCO_3$ (calculated) Total	Hardness as $CaCO_3$ (calculated) Noncarbonate	Mean discharge (second-feet)	Dissolved solids (tons per day)
109	May 28 to June 3	3,820	352	21	0.26	50	15	35	4.3	140	114	23	0.53	332	186	72	74,500	66,700
110	June 4–10	3,460	299	20	.41	42	13	31	2.7	139	88	20	.69	286	158	44	71,800	55,400
111	June 12, 14–17	2,320	256	15	.27	43	9.5	25	3.0	134	72	19	.62	253	146	37	75,100	51,200
112	June 18–24	3,360	279	14	.34	46	10	29	2.6	146	80	18	.56	272	156	36	55,400	40,600
113	June 25 to July 1	1,860	318	14	.25	48	12	39	1.9	143	91	30	.53	307	169	52	34,600	28,600
114	July 2–8	1,420	350	24	.24	48	13	42	3.5	134	109	36	.78	343	173	63	26,700	24,700
115	July 9–15	2,380	428	10	.16	61	17	47	6.7	144	146	40	.55	399	222	104	26,800	28,800
116	July 16–22	5,900	493	17	.21	67	18	70	5.9	149	196	52	.62	500	241	119	29,300	39,500
117	July 23–29	8,090	624	14	.28	78	22	77	7.1	160	248	54	.60	580	285	154	16,600	26,000
118	July 30 to Aug. 5	3,360	640	8.4	.17	78	23	87	6.4	165	231	74	.94	590	289	154	11,800	18,800
119	Aug. 6–12	4,210	744	6.0	.14	89	26	102	8.2	167	285	90	.85	689	329	192	9,300	17,300
120	Aug. 13–19	5,820	914	7.4	.20	107	31	127	7.9	184	347	114	1.0	833	395	244	10,400	23,400
121	Aug. 20–26	8,070	1,127	17	.31	137	36	157	8.3	207	486	113	1.9	1,059	490	320	9,440	27,000
122	Aug. 27 to Sept. 2	5,570	961	22	.21	98	32	145	4.8	209	354	102	2.9	864	376	205	6,120	14,300
123	Sept. 3–9	4,750	938	26	.23	98	34	157	4.3	212	364	121	3.0	912	384	211	5,520	13,600
124	Sept. 10–16	2,750	1,080	28	.25	107	40	184	4.8	201	408	150	3.2	1,024	432	267	4,520	12,500
125	Sept. 17–23	9,070	1,207	19	.38	124	42	195	4.8	199	488	166	4.1	1,141	482	319	6,160	19,000
126	Sept. 24–30	15,700	1,243	19	.25	129	46	200	6.4	217	538	144	.85	1,190	511	333	5,670	18,200

Colorado River at Yuma, Ariz.

No.	Date of collection	Suspended matter	Residue on evaporation	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate radicle (HCO_3)	Sulphate radicle (SO_4)	Chloride radicle (Cl)	Nitrate radicle (NO_3)	Dissolved solids	Hardness as $CaCO_3$ (calculated) Total	Hardness as $CaCO_3$ (calculated) Noncarbonate	Mean discharge (second-feet)	Dissolved solids (tons per day)
127	Sept. 22–30, 1926	7,380	1,206	19	0.26	130	38	189	9.1	209	475	172	6.5	1,142	481	309	3,660	11,300

Little Colorado River at Grand Falls, Ariz.

No.	Date of collection	Suspended matter	Residue on evaporation	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate radicle (HCO_3)	Sulphate radicle (SO_4)	Chloride radicle (Cl)	Nitrate radicle (NO_3)	Dissolved solids	Hardness as $CaCO_3$ (calculated) Total	Hardness as $CaCO_3$ (calculated) Noncarbonate	Mean discharge (second-feet)	Dissolved solids (tons per day)
128	Dec. 7–9, 1925	1,040	936	19	0.40	71	19	263	9.6	168	122	408	2.3	997	255	118	20	54
129	Dec. 11–15	1,340	556	16	.26	41	13	137	6.7	127	65	202	1.8	545	156	52	92	135
130	Dec. 16–20	474	605	27	.36	47	13	148	7.2	137	67	224	1.4	602	171	58	24	39
131	Dec. 21–25	470	758	19	.30	55	16	186	7.8	129	85	295	1.6	730	203	97	15	30
132	Dec. 26–29	704	894	14	.29	58	26	226	9.6	142	100	368	1.9	874	252	135	20	47
133	Jan. 12, 1926	223	1,346	21	.21	92	26	[a] 352	13	226	205	510	1.8	1,332	337	151	18	65
134	Feb. 18	66	1,683	17	.29	101	31	446	10	206	277	651	Trace.	1,635	380	211	0	0
135	Mar. 13	3,710	1,171	12	.17	72	19	339	6.4	184	133	505	.98	1,178	258	107	220	699
136	May 18	1,440	344	15	.15	26	7.2	82	5.3	95	49	109	Trace.	340	95	17	46	42

Gila River at Gillespie Dam, Ariz.

137	Feb. 27, 1926	90	2,827	28	0.09	162	71	753		312	408	1,167	5.2	2,748	696	441	37	274
138	Apr. 16	3,410	713	22	.24	136	8.5	136	8.5	194	101	220	1.3	674	259	100	3,460	6,290

San Juan River at Goodridge, Utah

139	Mar. 22, 1926	3,270	454	14	0.14	67	20	45	5.9	145	206	14	0.56	444	250	131	----	----

[a] Calculated.