REPORT NO. 18

AVAILABLE WATER SUPPLIES

at

POTENTIAL STORAGE RESERVOIR SITES

above

BEAR LAKE

Prepared By

W. V. Iorns, Project Engineer
U. S. Geological Survey

July 6, 1951

FOREWORD

Additional storage upstream from Bear Lake is one of the major issues facing the negotiators of a compact dividing the waters of Bear River between the States of Idaho, Utah, and Wyoming. Water users above the lake have insisted they are entitled to an equitable share of the storable waters of the river system. On the other hand, water users below Bear Lake maintain there are no storable waters available for new storage above the lake in excess of present rights and uses.

The question involved has broad aspects of both legal and engineering character. Those charged with the solution of the question, in order to reach an equitable answer, must need have a thorough knowledge of all facts pertaining thereto.

The purpose of this report is to present data on the adequacy of available storable supplies at various storage sites above Bear Lake. The presentation of this data has involved a study of upstream storage operations under prescribed conditions which are fully set forth in the report.

POTENTIAL STORAGE RESERVOIR SITES ABOVE BEAR LAKE

The Bureau of Reclamation has made preliminary surveys and cost estimates for a number of potential storage sites in the Bear River Basin above Bear Lake. Table 1, page 2, is a tabulation furnished by the Bureau, listing the most promising of these sites with estimated costs for various storage capacities. Included also in the tabulation, are other data on details of the dams and flooded acreage. On Page 3 is a map prepared by the Bureau of Reclamation showing location of reservoir sites.

The purpose of this report is to present data on the adequacy of available storable supplies if storage operations were limited to certain prescribed non-irrigation periods and periods during the irrigation season when upstream storage operations would not interfere with downstream direct flow irrigation rights. At some storage sites a brief tabulation of streamflow records will suffice to show that the supply is more than adequate for the maximum capacities shown in Table 1, while at others, available supplies may limit maximum reservoir capacity. In some cases, upstream storage using part of the storable supplies may need be taken into account in connection with downstream storage reservoir capacity limitations.

In a previous report titled "Limiting Flows for Bear River at Border Gaging Station for Allowance of Upstream Storage," it was illustrated that upstream storable supplies during the irrigation season were not very dependable unless a low limiting quantity was used as the required flow at Border. Downstream water users would probably object to a low limiting figure at Border and it may be advisable to set this figure sufficiently high to adequately protect their direct flow irrigation rights. The study indicated

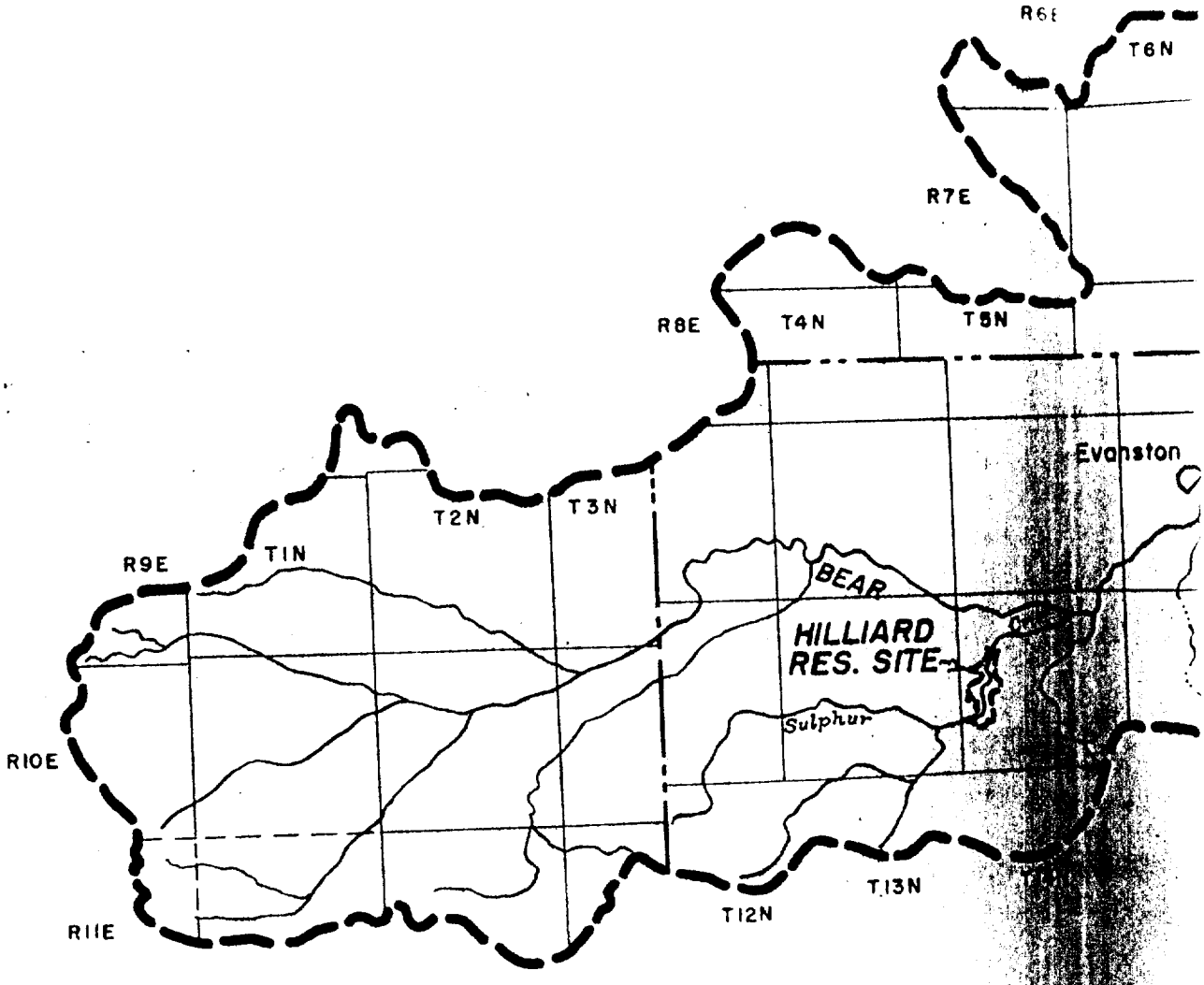
TABLE 1

PRELIMINARY COST ESTIMATES OF POTENTIAL
DAM SITES IN THE BEAR RIVER DRAINAGE AREA ABOVE BEAR LAKE
Prepared by Logan Project Office, Bureau of Reclamation

Dam Site	Stream	Total Capacity A. F.	Height Above Stream Bed-Ft.	Crest Length Feet	Maximum W. S. Area Ac.	Estimated Cost 1951 Price	Estimated Cost Per A.F. Live Storage Capacity *
Ashby	Smiths Fork	5,000	72	570	190	$ 670,000	141
		15,000	110	1,000	320	1,660,000	116
		21,000	120	1,070	430	1,980,000	100
Ferney	Hobble Creek	3,000	63	200	130	360,000	126
		7,000	91	500	200	630,000	95
		10,000	105	600	240	860,000	90
Giraffe	Thomas Fork	5,000	65	380	260	1,160,000	244
		10,000	85	460	360	1,560,000	164
Hilliard	Sulphur Creek	5,000	78	1,750	500	1,390,000	293
		10,000	90	1,900	630	1,880,000	198
Pleasant Valley	Pleasant Valley Creek	10,000	70	610	650	** 1,750,000	185
		25,000	94	820	1,300	** 2,385,000	100
		50,000	117	1,000	1,500	** 3,235,000	68
Poker Hollow	Smith Fork	6,000	98	690	200	1,250,000	219
Woodruff Narrows	Bear River	10,000	38	440	1,300	600,000	63
		40,000	61	560	2,400	935,000	25
		70,000	73	605	3,000	1,140,000	17
Lower Woodruff	Woodruff Creek	9,000	138		210	1,640,000	183
Upper Woodruff	Woodruff Creek	9,000	138		210	2,200,000	244

* Assume 5% of total capacity as dead storage.
** Prices include the cost of a feeder canal.

Woodruff Narrow 35000 Total Cap. @ $1,710,000
50000 each foot


R6E
T6N
R7E
R8E
T4N
T5N
Evanston
T2N
T3N
R9E
T1N
BEAR
HILLIARD
RES. SITE
Sulphur
R10E
R11E
T12N
T13N

T8N
T9N
T10N
T11N
T12N
T13N
T14N
R4E
R5E
T7N
Upper Dam Site
Lower Dam Site
WOODRUFF CR. RES. SITE
Woodruff Cr.
BEAR LA
Randolph
RIVER
PLEASANT VALLEY RES. SITE
WOODRUFF NARROWS RESERVOIR SITE
R120W
T19N
R119W
T17N
T18N
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R118W
T23N
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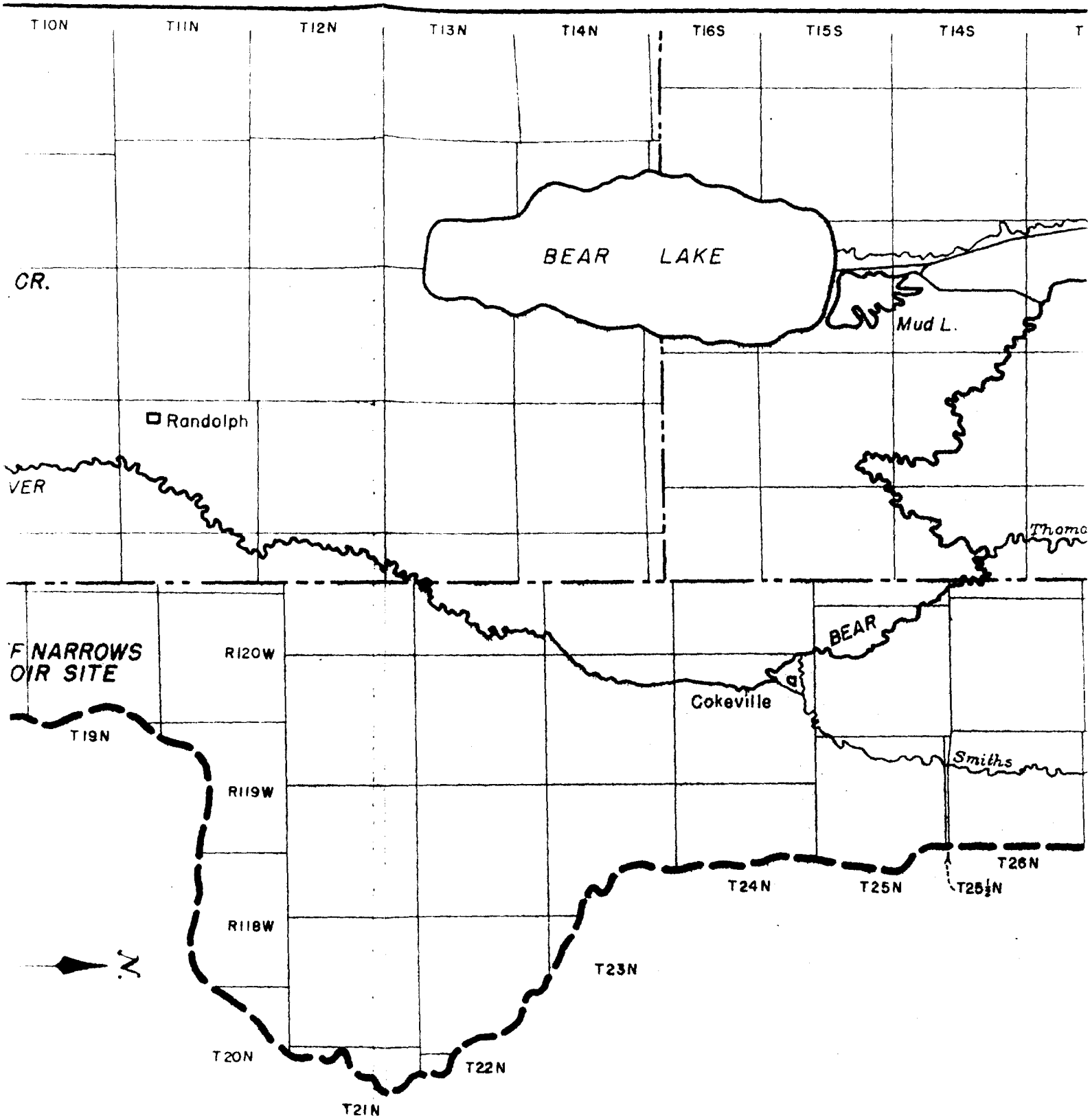
T10N
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BEAR LAKE
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F NARROWS
OIR SITE
R120W
BEAR
Cokeville
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Smiths
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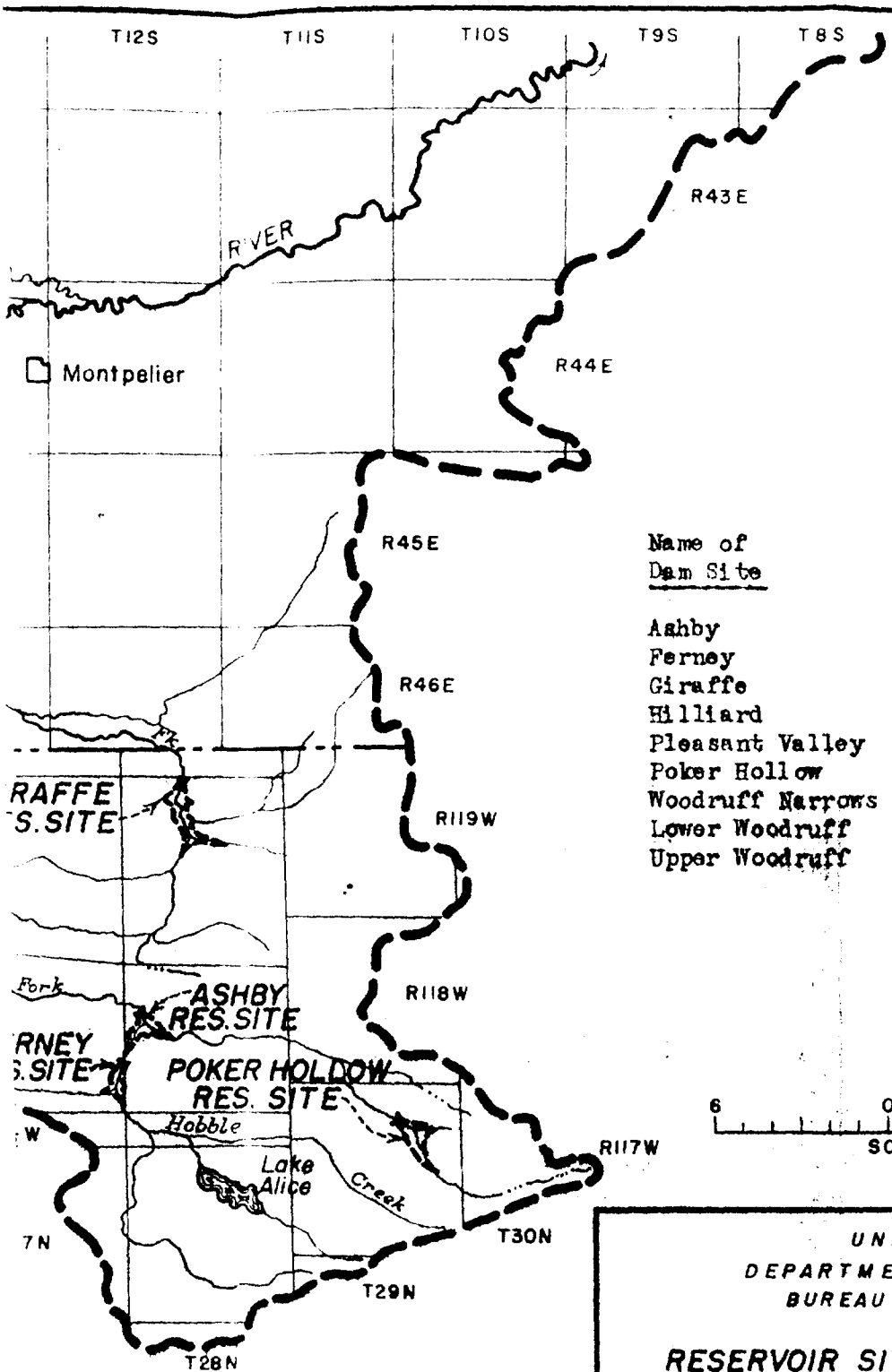

Name of Dam Site	Location of Dam Site
Ashby	S33, T28N, R118W, Wyo.
Ferney	S34, T28N, R118W, Wyo.
Giraffe	S19, T28N, R119W, Wyo.
Hilliard	S29, T14N, R119W, Wyo.
Pleasant Valley	S 9, T15N, R120W, Wyo.
Poker Hollow	S16, T29N, R117W, Wyo.
Woodruff Narrows	S32, T16N, R120W, Wyo.
Lower Woodruff	S31, T 9N, R 6E, Utah
Upper Woodruff	S 6, T 8N, R 6E, Utah

6 0 6 12
SCALE OF MILES

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

RESERVOIR SITES IN THE BEAR RIVER DRAINAGE AREA ABOVE BEAR LAKE

DRAWN: I.J.A. SUBMITTED:
TRACED: I.J.A. RECOMMENDED:
CHECKED: APPROVED:

LOGAN, UTAH. JUNE 1, 1951 | 55-415-80

that if a limiting flow of 750 second-feet was used for Border ~~[illegible]~~ downstream rights would rarely be violated. Applying this limitation, or its Harer equivalent of 900 second-feet, to the hydrographs of Border and Harer in the above named report, it is noted that little or no water could be stored during the irrigation seasons in 1926, 1930, 1931, 1933, 1934, 1935, 1939, 1940, 1941, 1942 and 1945. In all other years considerable water could be stored above Border during the high water part of the irrigation season without decreasing the flow at Border below 750 second-feet.

Since there could be no upstream storage, during the high water portion of the irrigation season, in eleven of the twenty-five years 1924 to 1948, it appears advisable to study upstream storage by placing special emphasis on storable supplies available during the non-irrigation season. It may be possible to firm up the non-irrigation season storable supplies by additional storage during the high water portion of the irrigation season without encroachment on downstream natural flow irrigation rights.

In this report the irrigation season is considered as the period in each year between May 1 and September 30 and the non-irrigation season as the period between October 1 of one year and April 30 of the following year. However, since there are some arguments that April 15 should be the dividing date, many of the tabulations have been prepared showing irrigation and non-irrigation seasons of two different lengths.

STORAGE AT AND ABOVE WOODRUFF NARROWS

Three reservoir sites at and above Woodruff Narrows are listed in Table 1. These include the Hilliard, Pleasant Valley, and Woodruff Narrows sites. The Pleasant Valley site was investigated as an alternative to the Woodruff

TABLE 2

Monthly and Period Discharge, in Acre-Feet
of
Bear River near Utah-Wyoming State Line

Water Year ending Sept. 30	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April 1 - 15	April 16 - 30	Total Oct.1 to Apr. 15	Total Oct.1 to Apr. 30
1943	2,700	2,900	2,090	1,840	2,010	2,840	3,440	14,240	17,820	32,060
1944	3,200	2,720	2,400	2,280	2,070	1,910	980	1,240	15,560	16,800
1945	3,150	2,160	1,730	1,850	1,670	1,880	890	2,300	13,330	15,630
1946	3,360	3,650	2,950	2,690	2,330	2,810	1,990	16,820	19,780	36,600
1947	3,350	3,230	2,920	2,460	2,330	2,790	1,570	5,500	18,650	24,150
1948	3,250	3,190	2,780	2,250	2,070	2,660	1,440	3,190	17,640	20,830

TABLE 3

Monthly and Period Discharge, in Acre-Feet
of
Mill Creek near Evanston, Wyoming

Water Year ending Sept.30	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April 1 - 15	April 16 - 30	Total Oct.1 to Apr.15	Total Oct.1 to Apr.30
1943	522	482	553	615	611	1,150	1,710	3,300	5,643	8,943
1944	497	452	443	418	357	369	412	473	2,948	3,421
1945	702	559	444	464	500	553	357	1,013	3,579	4,592
1946	633	153	799	774	666	1,190	1,660	4,630	5,875	10,505
1947	650	833	738	615	627	994	610	1,540	5,067	6,607
1948	1,110	1,030	922	774	573	837	635	1,785	5,881	7,666

TABLE 4

Monthly and Period Discharge, in Acre-Feet
of
Sulphur Creek near Evanston, Wyoming

Water Year ending Sept. 30	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April 1 - 15	April 16 - 30	Total Oct.1 to Apr.15	Total Oct.1 to Apr.30
1943	30	84	138	160	144	1,440	3,190	1;660	5,186	6,846
1944	125	178	126	123	115	123	2,170	3,510	2,960	6,470
1945	41	81	61	92	167	1;560	908	3,070	2;910	5,980
1946	244	877	530	580	401	2,560	3,590	3,350	8,782	12;132
1947	323	252	221	123	242	4,750	859	971	6,770	7;741
1948	183	252	220	225	170	675	1,270	6,670	2,995	9,665
1949	19	55	61	61	71	300	5,280	2500	5847	8,347
1950	183	268	177	184	327	797	3,664	6,056	5600	11,656
1951	101	424	440	218	421	730	4230	1,510	6564	8,074
1952	646	419	450	472	509	606	938	13,462	4040	17,502
								Average	5,170	9,440

Narrows site and since it is below most of the Wyoming lands and costs considerably more than the Woodruff Narrows site per acre-foot of storage, a study of its water supply will not be made in this report. Investigations so far have not resulted in the location of any favorable sites situated above all irrigated lands. The Hilliard site on Sulphur Creek is situated above only about half of the irrigated lands in the Upper Wyoming area and may be the only possibility for providing storage for Upper Wyoming.

In the study of storable water supply at and above Woodruff Narrows, the supply for the upstream reservoirs should first be considered. Then the total supply at Woodruff Narrows should be studied, keeping in mind that any water stored on any of the tributaries upstream from the Narrows will decrease the storable supplies at the Narrows by an amount practically equal to the extent of the upstream storage. The application of storage water to lands will augment, to some degree, the total supplies available during the irrigation season, for lands below Woodruff Narrows.

Stream flow records in the Upper Bear River Basin prior to about 1943 are very meager, being limited entirely to the records obtained at the Bear River near Evanston gaging station, which was established in 1913. However, with the records which have been obtained since 1943, and the long time records at the Evanston station, reasonably reliable determinations can be made of storable supplies.

Hilliard Reservoir

The source of water supply for Hilliard Reservoir would be runoff of Sulphur Creek and diversions during ice free periods from Mill Creek and Bear River. In Tables 3 and 4, on pages 5 and 6, are shown monthly and period

runoffs at the Bear River near Utah-Wyoming State Line, Mill Creek near Evanston, and Sulphur Creek near Evanston gaging stations.

In most years the diversions from Mill Creek and Bear River would be limited to October, November and April, because a diversion canal could not be operated during periods of extreme freezing. Table 5, shows the amounts available from Sulphur and Mill Creeks and the additional diversion required from Bear River. Although stream flow records are available only since 1942, it is believed that a reservoir at the Hilliard site of 10,000 acre-feet capacity could be filled in every year, from the combined sources of supply.

TABLE 5

Hilliard Reservoir Storable Supplies
Acre-Feet

Water Year ending Sept.30	Sulphur Creek		Mill Creek		Total Sulphur and Mill Creeks		Req'd.from Bear River to make 10,000 ac.-ft.	
	Oct.1 to Apr. 15	Oct.1 to Apr. 30	Oct. Nov. Apr. 1-15	Oct. Nov. Apr. 1-30	Oct.1 to Apr. 15	Oct.1 to Apr. 30	Oct.1 to Apr.15	Oct.1 to Apr.30
1943	5,200	7,100	2,700	6,000	7,900	13,100	2,100	0
1944	3,000	6,500	1,400	1,800	4,400	8,300	5,600	1,700
1945	2,900	6,000	1,600	2,600	4,500	8,600	5,500	1,400
1946	8,800	12,100	2,400	7,100	11,200	19,200	0	0
1947	6,800	7,700	2,100	3,600	8,900	11,300	1,100	0
1948	3,000	9,700	2,800	4,600	5,800	14,300	4,200	0

This reservoir would principally benefit lands served by canals diverting from Bear River between Myers Narrows and Woodruff Narrows, however, if water rights were regulated on a priority of right basis, a large portion could be applied to lands above Myers Narrows by exchange for natural flow. About 15,000 acres are irrigated from Bear River between Myers Narrows and Woodruff Narrows and about 17,200 acres are irrigated above Myers Narrows.

Woodruff Narrows Reservoir

As previously mentioned, in studying supplies available for storage at Woodruff Narrows, consideration must be given to the effect of upstream storage. In addition to new upstream storage which may be constructed such as the Hilliard Reservoir, this would include the requirements of the Crompton and Neponset reservoirs which have been in operation for many years. The Crompton and a number of other very small reservoirs, which are not mentioned, are too small to have any material effect on supplies available and need not be taken into account.

The Neponset Reservoir is supplied by the Chapman Canal, which diverts from Bear River a short distance below the Bear River near Evanston gaging station. Water is diverted for storage through this canal in the late fall and early spring months of each year. That the gain between the Evanston gaging station and Woodruff Narrows is practically equal to the amounts diverted to the Neponset Reservoir during the period October 1 to the following April 30 of each year, is evidenced in Table 6.

TABLE 6

October 1 to April 30 Runoff in Acre-Feet

Water Year ending Sept. 30	Chapman Canal at State Line (Diverted to Neponset Reservoir)	Bear River near Evanston Gaging Station	Bear River near Woodruff Gaging Station	Gain Evanston to Woodruff
1944	6,000	44,610	44,050	5,440
1945	5,498	41,280	38,300	2,518
1946	5,003	70,860	71,440	5,583
1947	4,301	55,340	57,450	6,411
1948	4,800	68,470	63,390	- 280
1949	1,455	46,623	50,330	5,162
1950	3,149	66,620	68,500	5,029
1951	5065	70,210	68,340	3,195

Since the gain, between the Bear River near Evanston gaging station and

the Bear River near Woodruff gaging station, which is located in Woodruff Narrows, is practically equivalent to the requirements of the Neponset Reservoir, the recorded flows at the Evanston gaging station may be used directly in extending records at the Woodruff station in storage supply determinations during the non-irrigation season. Shown in Table 7, page 12, are the recorded flows at the Evanston gaging station for 1924 to 1948 during the period October 1 to April 30. Table 8, page 13, shows the recorded flows at the Woodruff gaging station for 1943 to 1950. In each tabulation the month of April has been divided into two half month parts, and period totals given to show runoffs for storage periods of two different lengths; October 1 to April 15, and October 1 to April 30.

From the gaging station records in Tables 7 and 8, pages 12 and 13, the total water available in each of the years 1924 to 1948, for new storage at and above Woodruff Narrows for the two storage periods, can be determined. These are summarized in Table 9, page 14, and graphically represented on pages 15 and 16. The Woodruff gaging station records are used for the 1943 to 1948 water years and the Evanston gaging station records are used for the 1924 to 1942 water years.

In order to study the limitation of reservoir capacity as related to water supply, Tables 10 to 18, on pages 17 to 25, have been prepared. These tables show, for reservoirs of various capacity, the surpluses and deficiencies in supply for the two storage periods and the extent to which the deficiencies could be made up with additional storage during the irrigation season when the flow at Border exceeds 750 second-feet. It was noted on Page 4, that no storage could be accumulated during the irrigation season in 1926, 1930, 1931, 1933, 1934, 1935, 1939, 1940, 1941, 1942 and 1945 to make up winter storage deficiencies.

It is to be kept in mind that the storage and capacities shown would include all new storage developments at and above Woodruff Narrows. If 10,000 acre-feet were to be stored in Hilliard Reservoir, then 10,000 acre-feet would be deducted from the capacities and supplies available for a reservoir at Woodruff Narrows.

Tables 10 to 13 show for storage capacities at and above Woodruff Narrows, aggregating 20,000; 25,000; 30,000; and 35,000 acre-feet, the deficiencies which would occur if all storable flows between October 1 of one year and April 15 of the following year, were put into storage. There are also shown the deficiency in supply if additional storage were allowed after Apr. 15, providing storage were permitted while the flow at Border was greater than 750 second-feet.

Tables 14 to 18 show for storage capacities aggregating 30,000; 35,000; 40,000; 45,000 and 50,000 acre-feet similar information for a storage period extending from October 1 of one year to April 30 of the following year and with high water storage after May 1, while the flow at Border was above 750 second-feet.

The accumulative total of several consecutive years of deficiency would be an indication of additional holdover capacity required to make available, for delivery in every year, the amounts noted. In addition to this, an additional allowance for evaporation loss on holdover storage would need be taken into account.

TABLE 7

Monthly and Period Discharge, in Acre-Feet
of
Bear River near Evanston, Wyoming

Water Year ending Sept. 30	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April 1 - 15	April 16 - 30	Total Oct.1 to Apr. 15	Total Oct.1 to Apr. 30
1924	10,100	6,500*	4,000*	4,000*	3,500*	4,700*	31,700	13,700	64,500	78,200
1925	1,050	3,000*	2,500*	2,500*	2,450*	4,000*	7,000*	14,500*	22,500	37,000
1926	6,580	4,360	4,200*	3,500*	3,860*	16,200	8,280	16,320	46,980	63,300
1927	1,270	1,600*	2,000*	2,000*	2,000*	5,500*	11,050	12,950	25,420	38,370
1928	6,950	6,800*	4,500*	4,000*	4,000*	17,000*	7,410	11,590	50,660	62,250
1929	922	2,000*	1,700*	1,800*	1,700*	15,800*	5,620	17,580	29,540	47,120
1930	5,240	4,610	3,500*	3,000*	3,000*	9,000*	13,000	13,500	41,350	54,850
1931	3,970	2,580	2,770	3,070	4,170	19,100	4,960	4,620	40,620	45,240
1932	590	1,860	2,150	2,150	2,300	9,720	9,580	13,020	28,350	41,370
1933	1,730	2,790	1,710	1,540	1,940	7,810	4,800	8,200	22,320	30,520
1934	298	627	2,150	1,540	3,610	5,620	3,460	7,270	17,300	24,580
1935	188	383	984	2,150	3,330	5,030	4,160	6,690	16,220	22,920
1936	205	547	1,380	1,730	2,070	3,230	3,560	30,670	12,720	43,390
1937	2,420	4,220	2,810	1,970	1,470	5,120	12,920	24,690	30,930	55,620
1938	1,630	1,720	1,850	2,180	2,770	8,890	8,450	22,850	27,490	50,340
1939	3,000	3,410	3,160	3,370	2,950	17,120	8,120	11,720	41,130	52,850
1940	1,220	1,010	1,180	1,180	2,540	5,970	4,150	6,190	17,250	23,440
1941	3,050	2,860	2,000	1,750	2,150	7,590	4,720	4,130	24,120	28,250
1942	4,810	4,740	4,320	3,470	3,610	7,310	22,440	12,960	50,700	63,660
1943	569	1,200	2,180	2,470	3,170	7,820	14,630	20,570	32,040	52,610
1944	2,150	3,160	2,330	2,460	2,480	4,540	15,560	11,830	32,680	44,510
1945	1,090	2,080	1,630	2,540	2,730	9,080	7,420	14,710	26,570	41,280
1946	3,170	4,700	4,670	4,330	3,390	10,160	12,850	27,590	43,270	70,860
1947	2,390	5,260	4,840	3,750	3,820	20,830	5,960	8,490	46,850	55,340
1948	2,940	4,980	5,250	4,500	4,170	7,060	7,610	31,960	36,510	68,470

* Estimated.

TABLE 8

Monthly and Period Discharge in Acre-Feet
of
Bear River near Woodruff, Utah

Water Year ending Sept. 30	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April 1 - 15	April 16 - 30	Total Oct.1 to Apr.15	Total Oct.1 to Apr.30
1943	49	892	1,860	2,090	3,450	10,790	12,510	17,860	31,640	49,500
1944	801	1,840	2,350	2,550	2,690	2,690	17,700	13,430	30,620	44,050
1945	340	1,120	1,620	2,720	2,890	7,910	7,410	14,290	24,110	38,400
1946	3,490	5,790	5,320	4,920	3,690	10,770	11,820	25,640	45,800	71,440
1947	1,030	4,340	5,360	4,060	3,940	24,260	6,400	8,060	49,390	57,450
1948	2,680	4,460	5,040	5,160	4,600	6,350	6,770	28,330	35,060	63,390
1949	116	1,510	3,750	3,840	3,330	6,020	11,190	20,570	29,760	50,330
1950	1,800	2,860	3,460	3,300	3,920	8,140	15,490	29,530	38,970	68,500

TABLE 9

Storable Flow at and Above Woodruff Narrows
Acre-Feet

Water Year ending Sept. 30	October 1 to April 15	October 1 to April 30
1924	64,500	78,200
1925	22,500	37,000
1926	47,000	63,300
1927	25,400	38,400
1928	50,700	62,200
1929	29,500	47,100
1930	41,400	54,800
1931	40,600	45,200
1932	28,400	41,400
1933	22,300	30,500
1934	17,300	24,600
1935	16,200	22,900
1936	12,700	43,400
1937	30,900	55,600
1938	27,500	50,300
1939	41,100	52,800
1940	17,200	23,400
1941	24,100	28,200
1942	50,700	63,700
1943	31,600	49,500
1944	30,600	44,000
1945	24,100	38,400
1946	45,800	71,400
1947	49,400	57,400
1948	35,100	63,400

Note.- Water years 1943 to 1948 are actual runoffs of Bear River near Woodruff and 1924 to 1942 are actual runoffs of Bear River near Evanston.

9—213-A
(November 1939)

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES BRANCH

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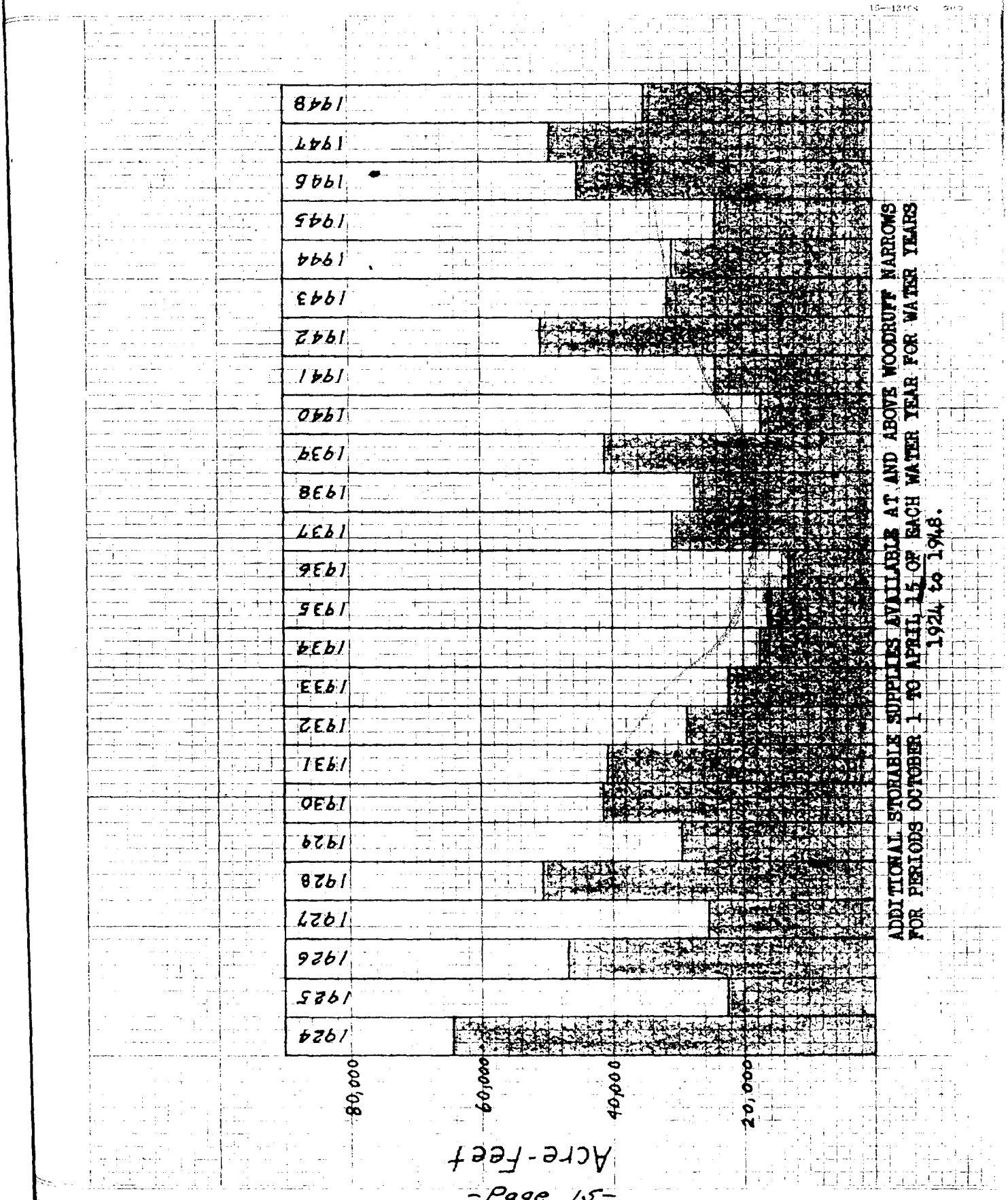

-Page 15-

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WATER RESOURCES BRANCH

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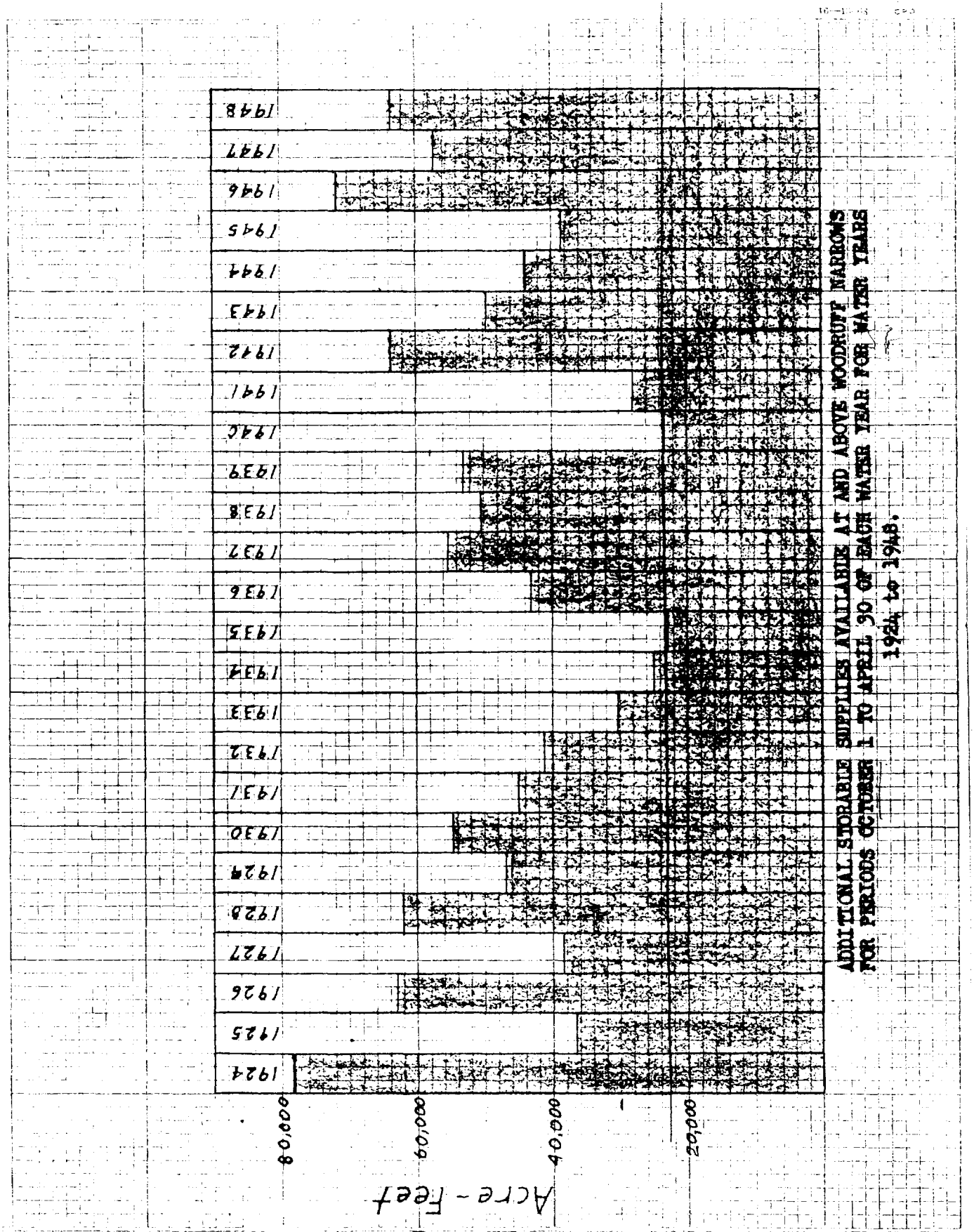

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TABLE 10

Storage Aggregating 20,000 Acre-Feet at and above Woodruff Narrows
Acre-Feet

Water Year ending Sept. 30	Storable Supply Oct. 1 to Apr. 15	Spill Oct. 1 to Apr. 15	Storage Period Oct. 1 to Apr. 15 only		Storage Period Oct. 1 to Apr. 15 and after Apr. 15 while Border above 750 c.f.s.	
			Reservoir Contents Apr. 16	Deficiency	Total Storage Accum.	Deficiency
1924	64,500	44,500	20,000	0	20,000	0
1925	22,500	2,500	20,000	0	20,000	0
1926	47,000	27,000	20,000	0	20,000	0
1927	25,400	5,400	20,000	0	20,000	0
1928	50,700	30,700	20,000	0	20,000	0
1929	29,500	9,500	20,000	0	20,000	0
1930	41,400	21,400	20,000	0	20,000	0
1931	40,600	20,600	20,000	0	20,000	0
1932	28,400	8,400	20,000	0	20,000	0
1933	22,300	2,300	20,000	0	20,000	0
1934	17,300	0	17,300	2,700	17,300	2,700
1935	16,200	0	16,200	3,800	16,200	3,800
1936	12,700	0	12,700	7,300	20,000	0
1937	30,900	10,900	20,000	0	20,000	0
1938	27,500	7,500	20,000	0	20,000	0
1939	41,100	21,100	20,000	0	20,000	0
1940	17,200	0	17,200	2,800	17,200	2,800
1941	24,100	4,100	20,000	0	20,000	0
1942	50,700	30,700	20,000	0	20,000	0
1943	31,600	11,600	20,000	0	20,000	0
1944	30,600	10,600	20,000	0	20,000	0
1945	24,100	4,100	20,000	0	20,000	0
1946	45,800	25,800	20,000	0	20,000	0
1947	49,400	29,400	20,000	0	20,000	0
1948	35,100	15,100	20,000	0	20,000	0

TABLE 11

Storage Aggregating 25,000 Acre-Feet at and above Woodruff Narrows
Acre-Feet

Water Year ending Sept. 30	Storable Supply Oct. 1 to Apr. 15	Spill Oct. 1 to Apr. 15	Storage Period Oct. 1 to Apr. 15 only		Storage Period Oct. 1 to Apr. 15 and after Apr. 15 while Border above 750 c.f.s.	
			Reservoir Contents Apr. 16	Deficiency	Total Storage Accum.	Deficiency
1924	64,500	39,500	25,000	0	25,000	0
1925	22,500	0	22,500	2,500	25,000	0
1926	47,000	22,000	25,000	0	25,000	0
1927	25,400	400	25,000	0	25,000	0
1928	50,700	25,700	25,000	0	25,000	0
1929	29,500	4,500	25,000	0	25,000	0
1930	41,400	16,400	25,000	0	25,000	0
1931	40,600	15,600	25,000	0	25,000	0
1932	28,400	3,400	25,000	0	25,000	0
1933	22,300	0	22,300	2,700	22,300	2,700
1934	17,300	0	17,300	7,700	17,300	7,700
1935	16,200	0	16,200	8,800	16,200	8,800
1936	12,700	0	12,700	12,300	25,000	0
1937	30,900	5,900	25,000	0	25,000	0
1938	27,500	2,500	25,000	0	25,000	0
1939	41,100	16,100	25,000	0	25,000	0
1940	17,200	0	17,200	7,800	17,200	7,800
1941	24,100	0	24,100	900	24,100	900
1942	50,700	25,700	25,000	0	25,000	0
1943	31,600	6,600	25,000	0	25,000	0
1944	30,600	5,600	25,000	0	25,000	0
1945	24,100	0	24,100	900	24,100	900
1946	45,800	20,800	25,000	0	25,000	0
1947	49,400	24,400	25,000	0	25,000	0
1948	35,100	10,100	25,000	0	25,000	0

TABLE 12

Storage Aggregating 30,000 Acre-Feet at and above Woodruff Narrows
Acre-Feet

Water Year ending Sept. 30	Storable Supply Oct. 1 to Apr. 15	Spill Oct. 1 to Apr. 15	Storage Period Oct. 1 to Apr. 15 only		Storage Period Oct. 1 to Apr. 15 and after Apr. 15 while Border above 750 c.f.s.	
			Reservoir Contents Apr. 16	Deficiency	Total Storage Accum.	Deficiency
1924	64,500	34,500	30,000	0	30,000	0
1925	22,500	0	22,500	7,500	30,000	0
1926	47,000	17,000	30,000	0	30,000	0
1927	25,400	0	25,400	4,600	30,000	0
1928	50,700	20,700	30,000	0	30,000	0
1929	29,500	0	29,500	500	30,000	0
1930	41,400	11,400	30,000	0	30,000	0
1931	40,600	10,600	30,000	0	30,000	0
1932	28,400	0	28,400	1,600	30,000	0
1933	22,300	0	22,300	7,700	22,300	7,700
1934	17,300	0	17,300	12,700	17,300	12,700
1935	16,200	0	16,200	13,800	16,200	13,800
1936	12,700	0	12,700	17,300	30,000	0
1937	30,900	900	30,000	0	30,000	0
1938	27,500	0	27,500	2,500	27,500	0
1939	41,100	11,100	30,000	0	30,000	0
1940	17,200	0	17,200	12,800	17,200	12,800
1941	24,100	0	24,100	5,900	24,100	5,900
1942	50,700	20,700	30,000	0	30,000	0
1943	31,600	1,600	30,000	0	30,000	0
1944	30,600	600	30,000	0	30,000	0
1945	24,100	0	24,100	5,900	24,100	5,900
1946	45,800	15,800	30,000	0	30,000	0
1947	49,400	19,400	30,000	0	30,000	0
1948	35,100	5,100	30,000	0	30,000	0

TABLE 13

Storage Aggregating 35,000 Acre-Feet at and above Woodruff Narrows
Acre-Feet

Water Year ending Sept. 30	Storable Supply Oct. 1 to Apr. 15	Spill Oct. 1 to Apr. 15	Storage Period Oct. 1 to Apr. 15 only		Storage Period Oct. 1 to Apr. 15 and after Apr. 15 while Border above 750 c.f.s.	
			Reservoir Contents Apr. 16	Deficiency	Total Storage Accum.	Deficiency
1924	64,500	29,500	35,000	0	35,000	0
1925	22,500	0	22,500	12,500	35,000	0
1926	47,000	12,000	35,000	0	35,000	0
1927	25,400	0	25,400	9,600	35,000	0
1928	50,700	15,700	35,000	0	35,000	0
1929	29,500	0	29,500	5,500	35,000	0
1930	41,400	6,400	35,000	0	35,000	0
1931	40,600	5,600	35,000	0	35,000	0
1932	28,400	0	28,400	6,600	35,000	0
1933	22,300	0	22,300	12,700	22,300	12,700
1934	17,300	0	17,300	17,700	17,300	17,700
1935	16,200	0	16,200	18,800	16,200	18,800
1936	12,700	0	12,700	22,300	35,000	0
1937	30,900	0	30,900	4,100	35,000	0
1938	27,500	0	27,500	7,500	35,000	0
1939	41,100	6,100	35,000	0	35,000	0
1940	17,200	0	17,200	17,800	17,200	17,800
1941	24,100	0	24,100	10,900	24,100	10,900
1942	50,700	15,700	35,000	0	35,000	0
1943	31,600	0	31,600	3,400	35,000	0
1944	30,600	0	30,600	4,400	35,000	0
1945	24,100	0	24,100	10,900	24,100	10,900
1946	45,800	10,800	35,000	0	35,000	0
1947	49,400	14,400	35,000	0	35,000	0
1948	35,100	100	35,000	0	35,000	0

TABLE 14

Storage Aggregating 30,000 Acre-Feet at and above Woodruff Narrows
Acre-Feet

Water Year ending Sept. 30	Storable Supply Oct. 1 to Apr. 30	Spill Oct. 1 to Apr. 30	Storage Period Oct. 1 to Apr. 30 only		Storage Period Oct. 1 to Apr. 30 and after Apr. 30 while Border above 750 c.f.s.	
			Reservoir Contents May 1	Deficiency	Total Storage Accum.	Deficiency
1924	78,200	48,200	30,000	0	30,000	0
1925	37,000	7,000	30,000	0	30,000	0
1926	63,300	33,300	30,000	0	30,000	0
1927	38,400	8,400	30,000	0	30,000	0
1928	62,200	32,200	30,000	0	30,000	0
1929	47,100	17,100	30,000	0	30,000	0
1930	54,800	24,800	30,000	0	30,000	0
1931	45,200	15,200	30,000	0	30,000	0
1932	41,400	11,400	30,000	0	30,000	0
1933	30,500	500	30,000	0	30,000	0
1934	24,600	0	24,600	~~5,400~~ 400	24,600	~~5,400~~ 400
1935	22,900	0	22,900	7,100 2,100	22,900	7,100 2,100
1936	43,400	13,400	30,000	0	30,000	0
1937	55,600	25,600	30,000	0	30,000	0
1938	50,300	20,300	30,000	0	30,000	0
1939	52,800	22,800	30,000	0	30,000	0
1940	23,400	0	23,400	~~6,600~~ 1600	23,400	~~6,600~~ 1600
1941	28,200	0	28,200	~~1,800~~ 0	28,200	~~1,800~~
1942	63,700	33,700	30,000	0	30,000	0
1943	49,500	19,500	30,000	0	30,000	0
1944	44,000	14,000	30,000	0	30,000	0
1945	38,400	8,400	30,000	0	30,000	0
1946	71,400	41,400	30,000	0	30,000	0
1947	57,400	27,400	30,000	0	30,000	0
1948	63,400	33,400	30,000	0	30,000	0

TABLE 15

Storage Aggregating 35,000 Acre-Feet at and above Woodruff Narrows
Acre-Feet

Water Year ending Sept. 30	Storable Supply Oct. 1 to Apr. 30	Spill Oct. 1 to Apr. 30	Storage Period Oct. 1 to Apr. 30 only		Storage Period Oct. 1 to Apr. 30 and after Apr. 30 while Border above 750 c.f.s.	
			Reservoir Contents May 1	Deficiency	Total Storage Accum.	Deficiency
1924	78,200	43,200	35,000	0	35,000	0
1925	37,000	2,000	35,000	0	35,000	0
1926	63,300	28,300	35,000	0	35,000	0
1927	38,400	3,400	35,000	0	35,000	0
1928	62,200	27,200	35,000	0	35,000	0
1929	47,100	12,100	35,000	0	35,000	0
1930	54,800	19,800	35,000	0	35,000	0
1931	45,200	10,200	35,000	0	35,000	0
1932	41,400	6,400	35,000	0	35,000	0
1933	30,500	0	30,500	4,500	30,500	4,500
1934	24,600	0	24,600	10,400	24,600	10,400
1935	22,900	0	22,900	12,100	22,900	12,100
1936	43,400	8,400	35,000	0	35,000	0
1937	55,600	20,600	35,000	0	35,000	0
1938	50,300	15,300	35,000	0	35,000	0
1939	52,800	17,800	35,000	0	35,000	0
1940	23,400	0	23,400	11,600	23,400	11,600
1941	28,200	0	28,200	6,800	28,200	6,800
1942	63,700	28,700	35,000	0	35,000	0
1943	49,500	14,500	35,000	0	35,000	0
1944	44,000	9,000	35,000	0	35,000	0
1945	38,400	3,400	35,000	0	35,000	0
1946	71,400	36,400	35,000	0	35,000	0
1947	57,400	22,400	35,000	0	35,000	0
1948	63,400	28,400	35,000	0	35,000	0

TABLE 16

Storage Aggregating 40,000 Acre-Feet at and above Woodruff Narrows
Acre-Feet

Water Year ending Sept. 30	Storable Supply Oct. 1 to Apr. 30	Spill Oct. 1 to Apr. 30	Storage Period Oct. 1 to Apr. 30 only		Storage Period Oct. 1 to Apr. 30 and after Apr. 30 while Border above 750 c.f.s.	
			Reservoir Contents May 1	Deficiency	Total Storage Accum.	Deficiency
1924	78,200	38,200	40,000	0	40,000	0
1925	37,000	0	37,000	3,000	40,000	0
1926	63,300	23,300	40,000	0	40,000	0
1927	38,400	0	38,400	1,600	40,000	0
1928	62,200	22,200	40,000	0	40,000	0
1929	47,100	7,100	40,000	0	40,000	0
1930	54,800	14,800	40,000	0	40,000	0
1931	45,200	5,200	40,000	0	40,000	0
1932	41,400	1,400	40,000	0	40,000	0
1933	30,500	0	30,500	9,500	30,500	9,500
1934	24,600	0	24,600	15,400	24,600	15,400
1935	22,900	0	22,900	17,100	22,900	17,100
1936	43,400	3,400	40,000	0	40,000	0
1937	55,600	15,600	40,000	0	40,000	0
1938	50,300	10,300	40,000	0	40,000	0
1939	52,800	12,800	40,000	0	40,000	0
1940	23,400	0	23,400	16,600	23,400	16,600
1941	28,200	0	28,200	11,800	28,200	11,800
1942	63,700	23,700	40,000	0	40,000	0
1943	49,500	9,500	40,000	0	40,000	0
1944	44,000	4,000	40,000	0	40,000	0
1945	38,400	0	38,400	1,600	38,400	1,600
1946	71,400	31,400	40,000	0	40,000	0
1947	57,400	17,400	40,000	0	40,000	0
1948	63,400	23,400	40,000	0	40,000	0

TABLE 17

Storage Aggregating 45,000 Acre-Feet at and above Woodruff Narrows
Acre-Feet

Water Year ending Sept. 30	Storable Supply Oct. 1 to Apr. 30	Spill Oct. 1 to Apr. 30	Storage Period Oct. 1 to Apr. 30 only		Storage Period Oct. 1 to Apr. 30 and after Apr. 30 while Border above 750 c.f.s.	
			Reservoir Contents May 1	Deficiency	Total Storage Accum.	Deficiency
1924	78,200	33,200	45,000	0	45,000	0
1925	37,000	0	37,000	8,000	45,000	0
1926	63,300	18,300	45,000	0	45,000	0
1927	38,400	0	38,400	6,600	45,000	0
1928	62,200	17,200	45,000	0	45,000	0
1929	47,100	2,100	45,000	0	45,000	0
1930	54,800	9,800	45,000	0	45,000	0
1931	45,200	200	45,000	0	45,000	0
1932	41,400	0	41,400	3,600	45,000	0
1933	30,500	0	30,500	14,500	30,500	14,500
1934	24,600	0	24,600	20,400	24,600	20,400
1935	22,900	0	22,900	22,100	22,900	22,100
1936	43,400	0	43,400	1,600	45,000	0
1937	55,600	10,600	45,000	0	45,000	0
1938	50,300	5,300	45,000	0	45,000	0
1939	52,800	7,800	45,000	0	45,000	0
1940	23,400	0	23,400	21,600	23,400	21,600
1941	28,200	0	28,200	16,800	28,200	16,800
1942	63,700	18,700	45,000	0	45,000	0
1943	49,500	4,500	45,000	0	45,000	0
1944	44,000	0	44,000	1,000	45,000	0
1945	38,400	0	38,400	6,600	38,400	6,600
1946	71,400	26,400	45,000	0	45,000	0
1947	57,400	12,400	45,000	0	45,000	0
1948	63,400	18,400	45,000	0	45,000	0

TABLE 18

Storage Aggregating 50,000 Acre-Feet at and above Woodruff Narrows
Acre-Feet

Water Year ending Sept. 30	Storable Supply Oct. 1 to Apr. 30	Spill Oct. 1 to Apr. 30	Storage Period Oct. 1 to Apr. 30 only		Storage Period Oct. 1 to Apr. 30 and after Apr. 30 while Border above 750 c.f.s.	
			Reservoir Contents May 1	Deficiency	Total Storage Accum.	Deficiency
1924	78,200	28,200	50,000	0	50,000	0
1925	37,000	0	37,000	13,000	50,000	0
1926	63,300	13,300	50,000	0	50,000	0
1927	38,400	0	38,400	11,600	50,000	0
1928	62,200	12,200	50,000	0	50,000	0
1929	47,100	0	47,100	2,900	50,000	0
1930	54,800	4,800	50,000	0	50,000	0
1931	45,200	0	45,200	4,800	45,200	4,800
1932	41,400	0	41,400	8,600	50,000	0
1933	30,500	0	30,500	19,500	30,500	19,500
1934	24,600	0	24,600	25,400	24,600	25,400
1935	22,900	0	22,900	27,100	22,900	27,100
1936	43,400	0	43,400	6,600	50,000	0
1937	55,600	5,600	50,000	0	50,000	0
1938	50,300	300	50,000	0	50,000	0
1939	52,800	2,800	50,000	0	50,000	0
1940	23,400	0	23,400	26,600	23,400	26,600
1941	28,200	0	28,200	21,800	28,200	21,800
1942	63,700	13,700	50,000	0	50,000	0
1943	49,500	0	49,500	500	50,000	0
1944	44,000	0	44,000	6,000	50,000	0
1945	38,400	0	38,400	11,600	38,400	11,600
1946	71,400	21,400	50,000	0	50,000	0
1947	57,400	7,400	50,000	0	50,000	0
1948	63,400	13,400	50,000	0	50,000	0

WEST SIDE CREEKS
in
WOODRUFF-RANDOLPH SECTION

Woodruff, Big, Randolph, and Otter Creeks flow into the Woodruff-Randolph Valley from the mountainous area on the west. Water is diverted for irrigation from these streams along their narrow valleys and on their alluvial fans on the west side of the main river valley. Practically all of the lands served by these streams are situated above lands irrigated by canals diverting from the main stem of the river. It has been the practice of water users on these streams to divert practically the entire water supply at all times of the year and little or no water from these streams reach the main stem of Bear River as surface flow.

A reservoir of approximately 600 acre-feet capacity has been in operation on Randolph Creek for a number of years. There is also one small reservoir of unknown capacity on Birch Creek, a tributary of Woodruff Creek. A reservoir of larger capacity, on this same tributary, is currently under construction. The Bureau of Reclamation has made preliminary storage investigations of two sites on Woodruff Creek which are included in Table 1. Limited investigations were also made of possible sites on Big and Otter Creeks.

A number of stream flow gaging stations were installed at various locations on the streams as early as 1938 to determine storable supplies. Although the extent of stream flow records are rather limited and the stations have not been operated continuously, they are sufficient in most cases to indicate storable supplies, which could be accumulated during winter periods and high-water runoff periods.

Woodruff Creek

Gaging stations have been operated at three different sites on Woodruff Creek above the mouth of Birch Creek. Records collected at these sites are equivalent, and monthly runoffs for October to April are shown in Table 19. On the basis of correlation with records of Little Bear River near Paradise, a tabulation for 13 years has been prepared which is given in Table 20. For the years of low storable flows, the following approximate additional storage could have been accumulated in May:

Water Year ending Sept. 30	Approximate Additional Storable in May
1939	0 Acre-feet
1940	0 "
1941	0 "
1942	1,000 "
1943	3,500 "
1944	2,000 "
1945	1,200 "

It is indicated that a reservoir of about 4,500 to 5,000 acre-feet capacity would fill in eleven of the 13 years and would only about half fill in each of the years, 1940 and 1941. About 5,700 acres of irrigated lands are dependent on Woodruff Creek as a source of supply.

TABLE 19

Woodruff Creek above mouth of Birch Creek
Acre-Feet

Water Year ending Sept. 30	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	Total Oct. to Apr.
1938	554	598	594	572	525	746	3,925	7,510
1940	334	285	284	287	287	462	1,030	2,970
1941	239	254	252	233	246	396	767	2,390
1942	311	289	252	246	222	278	2,321	3,920
1943	296	294	307	277	222	576	6,220	8,190
1950	825	696	686	686	651	1,150	4,350	9,040

TABLE 20

Woodruff Creek above mouth of Birch Creek
Acre-Feet

Water Year ending Sept. 30	Runoff Oct. 1 to Apr. 30	Water Year ending Sept. 30	Runoff Oct. 1 to Apr. 30
1938	7,510	1944	2,700*
1939	5,300*	1945	3,400*
1940	2,970	1946	11,900*
1941	2,390	1947	6,000*
1942	3,920	1948	6,600*
1943	8,190	1949	8,000*
		1950	9,040
		1951	9,860

* Determined from correlation curve with Little Bear River near Paradise, Utah.

average 6300

Birch Creek

A stream flow gaging station was installed on Birch Creek below the mouth of Allen Creek in September 1949 and records for only one year are so far available. The present small reservoir and the new reservoir now being constructed are located on Birch Creek above the mouth of Allen Creek. Discharge measurements made on Allen Creek and at the Birch Creek gaging station during 1950 indicate the supply available for storage at the new dam site is approximately 66 percent of the flow recorded at the Birch Creek gaging station. Sixty-six percent of the recorded October 1 to April 30 runoff of the Birch Creek gaging station for 1950 is 1,360 acre-feet. This runoff, 1,360 acre-feet, is 15 percent of the runoff recorded at the Woodruff gaging station for the same period of time. The relation of drainage areas and annual runoffs are approximately the same. This furnishes a basis for estimating period and annual runoffs of water supply at the new Birch Creek dam site. In Table 21 are shown estimated storable supplies October 1 to April 30, of Birch Creek at the new dam site for years 1938 to 1950.

TABLE 21

Birch Creek at New Dam Site
Acre-Feet

Water Year ending Sept. 30	Runoff Oct. 1 to Apr. 30	Water Year ending Sept. 30	Runoff Oct. 1 to Apr. 30
1938	1,130*	1945	510*
1939	800*	1946	1,790*
1940	450*	1947	900*
1941	360*	1948	990*
1942	590*	1949	1,200*
1943	1,230*	1950	1,360
1944	400*		

* Fifteen percent of Woodruff Creek runoff.

From this tabulation it would appear that a reservoir at this site would not store much water if the storage time was restricted to the period October 1 to April 30 of each year. A reservoir of about 2,000 acre-foot capacity would need to store water at all times of the year, except when necessary to release storage water for irrigation, in order to insure annual delivery for use of its approximate capacity.

Big Creek

A gaging station was established on Big Creek in March 1939, discontinued in September 1944, and reestablished in October 1949. Winter records were not obtained in the water years 1942 and 1943. On the basis of a correlation curve with Blacksmith Fork, for runoff October 1 to April 30 of the four years of winter record available, the winter runoff for missing years 1938 to 1950 have been computed, which are shown in Table 22. Approximately 2,500 acres are irrigated from Big Creek.

Shown in Table 23 are estimated and recorded runoffs of Hobble Creek and Smiths Fork near Border for the period October 1 to April 30, of each year from 1943 to 1950. The figures represent storable supplies available at the Ferney and Ashby dam sites and indicate that the supplies are more than sufficient for the reservoir capacities listed in Table 1.

TABLE 23

Hobble Creek and Smiths Fork
Acre-Feet

Water Year ending Sept. 30	Hobble Creek Oct. 1 to Apr. 30	Smiths Fork Oct. 1 to Apr. 30
1943	26,000*	42,160
1944	22,670	33,630
1945	19,420	27,450
1946	29,360	50,130
1947	23,700*	36,960
1948	23,000*	35,290
1949	23,500*	36,560
1950	23,000*	35,390

* Estimated on basis of correlation curve with Smiths Fork near Border.

THOMAS FORK

A gaging station was installed on Thomas Fork near the Wyoming-Idaho State line in September 1949. This gaging station is at the Giraffe dam site on Thomas Fork. Gaging stations have been in operation since 1940 on Thomas Fork above the mouth of Salt Creek and on Salt Creek above its mouth. The 1950 runoff of the station near the State line was 160 percent of the total flow of Salt Creek and of Thomas Fork above mouth of Salt Creek, for the period October 1 to April 30, 1950. On the basis of this relation, the records of the station near the State line have been extended back to 1940 as shown in Table 24. As indicated by this Table, a reservoir of 5,000 acre-feet

capacity would fill in practically every year.

TABLE 24

Thomas Fork near Wyoming-Idaho State line
Acre-Feet

Water Year ending Sept. 30	Thomas Fork Oct. 1 to Apr. 30 Runoff	This Fk Geneva 1/3
1940	5,400*	1800
1941	6,300*	2100
1942	10,000*	3300
1943	23,100*	7700
1944	7,500*	2500
1945	4,900*	1630
1946	28,600*	9,500
1947	14,800*	5000
1948	11,600*	3,900
1949	11,400*	3,800
1950	16,832	5,600
1951	18,840 ~~5,843~~ ave — ~~12,000~~ 13,300	~~4000~~ 4400

* Estimated on basis of upstream gaging stations.