STATE OF UTAH

DEPARTMENT OF NATURAL RESOURCES

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DIVISION OF
WATER RIGHTS

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Area Engineer

RECEIVED MAR 10 1969 STATE ENGINEER'S OFFICE

March 6, 1969

MEMORANDUM

TO: Inter-office Study

FROM: Dee C. Hansen, Northern Utah Area Engineer

SUBJECT: Little Bear River Flood Routing

The problem of properly routing a flood in the Little Bear River System is fairly difficult since the reservoirs on the system were not constructed for flood control purposes but rather for storage of irrigation waters. One problem is that if the levels of the reservoirs are lowered to an extent capable of handling an expected flood, there may not be enough water to refill the reservoirs to their maximum levels once the flood peak had passed. A compromise, however, has been reached, and under the willing leadership of Marion Olsen, and with the assistance of the U. S. Geological Survey and the Soil Conservation Service, some attempts at predicting the possible runoff and routing the runoff by using the remaining storage of approximately 5000 acre feet in the Hyrum Reservoir, the following figures have been computed.

During the period between March 1 and the beginning of the spring runoff, the Porcupine Reservoir will be drawn down to a pool level of approximately 3000 acre feet, at the suggestion of Marion Olsen. This will make room for some additions storage during the peak runoff, and will also help relieve some of the pressure from the Hyrum Reservoir since Porcupine Reservoir may be able to take the peak flow from the East Fork.

To obtain a typical hydrograph, the runoff peak for 1965 was chosen. The 24-hour peak was 714 c.f.s. and as can be seen from the attached sheet, by utilizing the 5000 acre feet additional storage remaining in the Hyrum Reservoir, it would be possible to successfully route the flood and maintain the downstream channel flow below Hyrum Reservoir at 370 c.f.s., maximum flow. Using the ratio of the 1965 runoff hydrograph to an assumed peak of 1200 c.f.s., with a maximum downstream flow of 400 c.f.s., routing was again attempted as shown on Page 2 of the computations. As can be noted, it was not possible to route this much water with the available storage. On Page 3, routing was again attempted with a maximum downstream flow of 600 cf.s. and, as can be noted, could be successfully contained.

Since there has been much discussion and comparison of this year's snow pack and water content with the 1952 figures, I felt that perhaps it would be wise to attempt routing the actual runoff for the inflow peak in 1952 as compared to what actually happened. As indicated on Page 4, 1952 was an exceptionally heavy runoff year with a high flow being sustained over a long period of time. Routing was attempted with a maximum outflow of 550 c.f.s. and as can be seen on Page 4, the maximum storage was immediately exceeded. Therefore, it was necessary to re-route with a maximum flow of 650 c.f.s. as shown on Page 5. As indicated, this also exceeded the maximum storage by approximately 1000 acre feet. It was therefore necessary to assume a maximum outflow below the Hyrum Reservoir of 700 c.f.s., and as can be seen by the figures, this was successfully routed. It may be of interest to compare this figure with the actual outflow figures during the 1952 runoff which reached a maximum below the Hyrum Reservoir of slightly more than 900 c.f.s.

It should be noted that both Wallace Jibson of the U. S. Geological Survey and Joe Fletcher of the Utah Water Research Laboratory, who are both engaging in this type of work, indicated that the above figures were perhaps conservative and that although the peak may be reached, they doubted whether the flow would remain high for as many days as are contained in the computations. I have also included inflow-outflow hydrographs of the assumed peaks and runoff periods on Pages 6, 7 and 8.

914 a.f.s. Peak & Peak Runoff Day 1965 | Little Bear Flood Routing | Compiled by Dee Hansen | 1

Days	Flow	Ac. ft	Acc. Σ Ac. ft	Spillway Out Flow ac. ft	Spillway Σ OF ac. ft	Acc. Res. Storage
				Max Outflow =		370 a.f.s.
Apr 26	276	548	548	548	548	0
27	320	635	1183	635	1183	0
28	439	870	2053	735	1918	135
29	498	990	3043	735	2653	390
30	334	1060	4103	735	3358	715
May 1	774	1417	5520	735	4123	1397
2	624	1238	7758	735	4858	2900
3	546	1082	8840	735	5593	3247
4	492	976	9816	735	6328	3488
5	510	1012	10,828	735	7063	3765
6	426	846	11,674	735	7798	3876 Peak Storage
7	355	705	12,379	735	8533	3846
8	310	615	12,994	735	9268	3726
9	290	576	13,570	735	10,003	3567
10	262	520	14,090	735	10,738	3352
11	253	503	14,593	735	11,473	3120
12	258	513	15,106	735	12,208	2898
13	262	520	15,626	735	12,943	2683
14	267	530	16,156	735	13,678	2478
15	300	596	16,752	735	14,413	2339
16	365	725	17,477	735	15,148	2329
	370	735	18,212	735	15,883	2329

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1200 c.f.s. Assumed
Peak Runoff Shifts
Using Ratio to 1200 Runoff Hydrograph

Dee Hansen

2

Day No.	Inflow Flow	Inflow Ac. Ft.	Accum Ac. Ft.	Spillway Outflow Ac. Ft.	Spillway Accum Ac. Ft.	Spillway Accum Res. Storage
				Assuming max. outflow = 400 c.f.s.		
1	352	700	700	700	700	0
2	410	814	1514	800	1500	14
3	448	890	2404	800	2300	104
4	456	905	3309	800	3100	209
5	464	921	4230	800	3900	330
6	537	1065	5295	800	4700	595
7	735	1460	6755	800	5500	1255
8	836	1660	8415	800	6300	2115
9	896	1780	10,195	800	7100	3095
10	1200	2380	12,575	800	7900	4675
11	1050	2080	14,655	800	8700	5955
12	917	1820	16,475	800	9500	6975
13	826	1640	18,115	800	10,300	7815
14	856	1700	19,815	800	11,100	8715
15	715	1420	21,235	800	11,900	9335
16	596	1182	22,417	800	12,700	9717
17	520	1032	23,449	800	13,500	9,949
18	487	966	24,415	800	14,300	10,115
19	440	874	25,289	800	15,100	10,189
20	425	844	26,133	800	5,900	10,233
21	434	861	26,994	800	16,700	10,294
22	440	873	27,867	800	17,500	10,367
23	450	893	28,760	800	18,300	10,460
24	505	1000	29,760	800	19,100	10,660

Exceeding Storage

Concentration

Outflow 1200 c.f.s Peak

	Inflow Ac. Ft.	Accum. Ac. Ft.	Accum. Res. Storage
	Assuming Max. Out = 600 c.f.s		
1	700	700	0
2	814	1514	0
3	890	2404	0
4	906	3309	0
5	921	4230	0
6	1065	5295	0
7	1200	6493	262
8	1200	7693	722
9	1200	8893	1302
10	1200	10,093	2482
11	1200	11,293	3362
12	1200	12,493	3982
13	1200	13,693	4422
14	1200	14,893	4922
15	1200	16,093	5142 Max Storage
16	1200	17,293	5124
17	1200	18,493	4956
18	1200	19,693	4722
19	1200	20,893	4396
20	1200	22,093	4040
21	1200	23,293	3701
22	1200	24,493	3374
23	1200	25,693	
24	1200	26,893	

↓ Decreasing

Marion Loop
Good Footing

Carried by
Dec 4 1951

Acres 445 Min.
Inches 550 c.f.s.

Date		Inch	Acre Ft	Accum Ac Ft	Carried Acre Ft	Accum. Acre Ft	Acres Irrigated
Apr	6	262	520	520	520	520	0
	7	458	908	1428	908	1428	0
	8	527	1045	2473	1045	2473	0
	9	334	662	3135	662	3135	0
	10	311	617	3752	617	3752	0
	11	340	674	4426	674	4426	0
	12	407	807	5233	807	5233	0
	13	447	887	6120	887	6120	0
	14	538	1067	7187	1067	7187	0
	15	447	887	8074	887	8074	0
	16	325	645	8719	645	8719	0
	17	381	756	9475	756	9475	0
	18	550	1091	10,566	1091	10,566	0
	19	476	941	11,507	1091	11,657	250
	20	634	1258	12,765	1091	12,748	417
	21	542	1075	14,240	1091	13,839	401
	22	604	1198	15,438	1091	14,930	508
	23	636	1261	16,699	1091	16,021	778
	24	710	1408	18,207	1091	17,112	1095
	25	662	1313	19,520	1091	18,203	1317
	26	807	1601	21,121	1091	19,294	1827
	27	1040	2063	23,184	1091	20,385	2799
	28	1000	1983	25,167	1091	21,476	3691
	29	898	1781	26,948	1091	22,567	4381
	30	730	1448	28,396	1091	23,658	4738
May	1	834	1654	30,050	1091	24,749	5301
	2	985	1954	32,004	1091	25,840	
	3	1060	2106	34,110	1091	26,931	
	4	1020	2023	36,133	1091	28,022	
	5	844	1674	37,807	1091	29,113	
	6	807	1601	39,408	1091	30,204	
	7	787	1561	40,969	1091	31,295	
	8	730	1448	42,417	1091	32,386	
	9	608	1206	43,623	1091	33,477	
	10	523	1037	44,660	1091	34,568	
	11	520	992	45,652	1091	35,659	9993
	12	538	1067	46,719	1091	36,750	
	13	582	1154	47,873	1091	37,841	
	14	562	1115	48,988	1091	38,932	
	15	515	1021	50,009	1091	40,023	
	16	493	978	50,987	1091	41,114	
	17	413	819	51,806	1091	42,205	
	18	374	742	52,548	1091	43,296	
	19	340	674	53,222	1091	44,387	
	20	435	863	54,085	1091	45,478	
	21	472	936	55,021	1091	46,569	
	22	445	883	55,904	1091	47,660	
	23	369	732	56,636	1091	48,751	

Mar. Storage
Exceeded
water shortage

		Flow	Ac. Ft.	Accum Ac. Ft.
May	24	344	682	57,318
	25	369	732	58,050
	26	400	793	58,843
	27	392	778	59,621
	28	352	698	60,319
	29	348	690	61,009
	30	341	682	61,691
	31	297	589	62,280
June	1	262	520	62,800

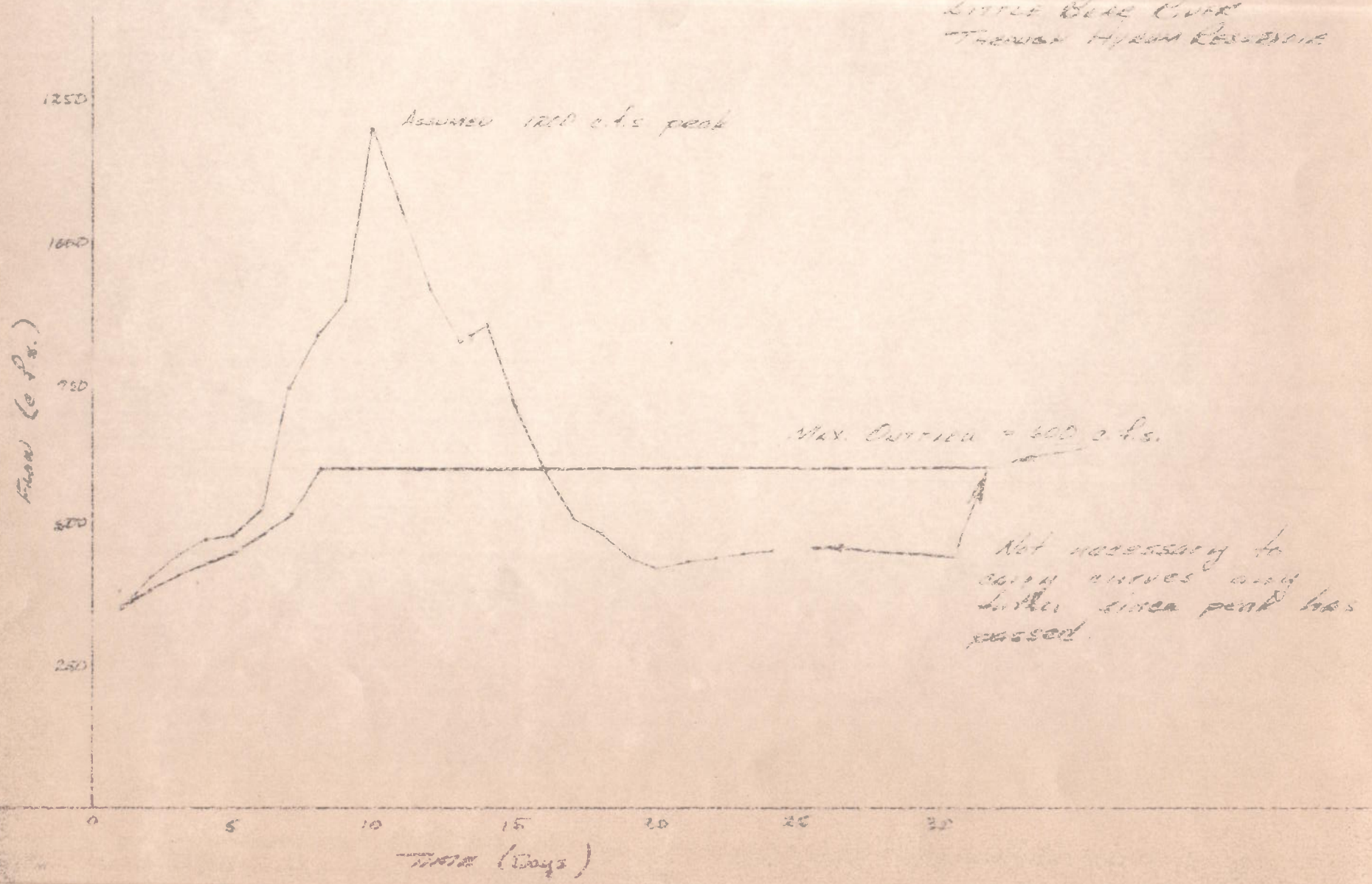
Continuation of 1952 Lahontan Basin Hydrograph — 4500 c.f.s.

Continuation of 1952 Lahontan Assume Max. Outflow = 700 c.f.s.

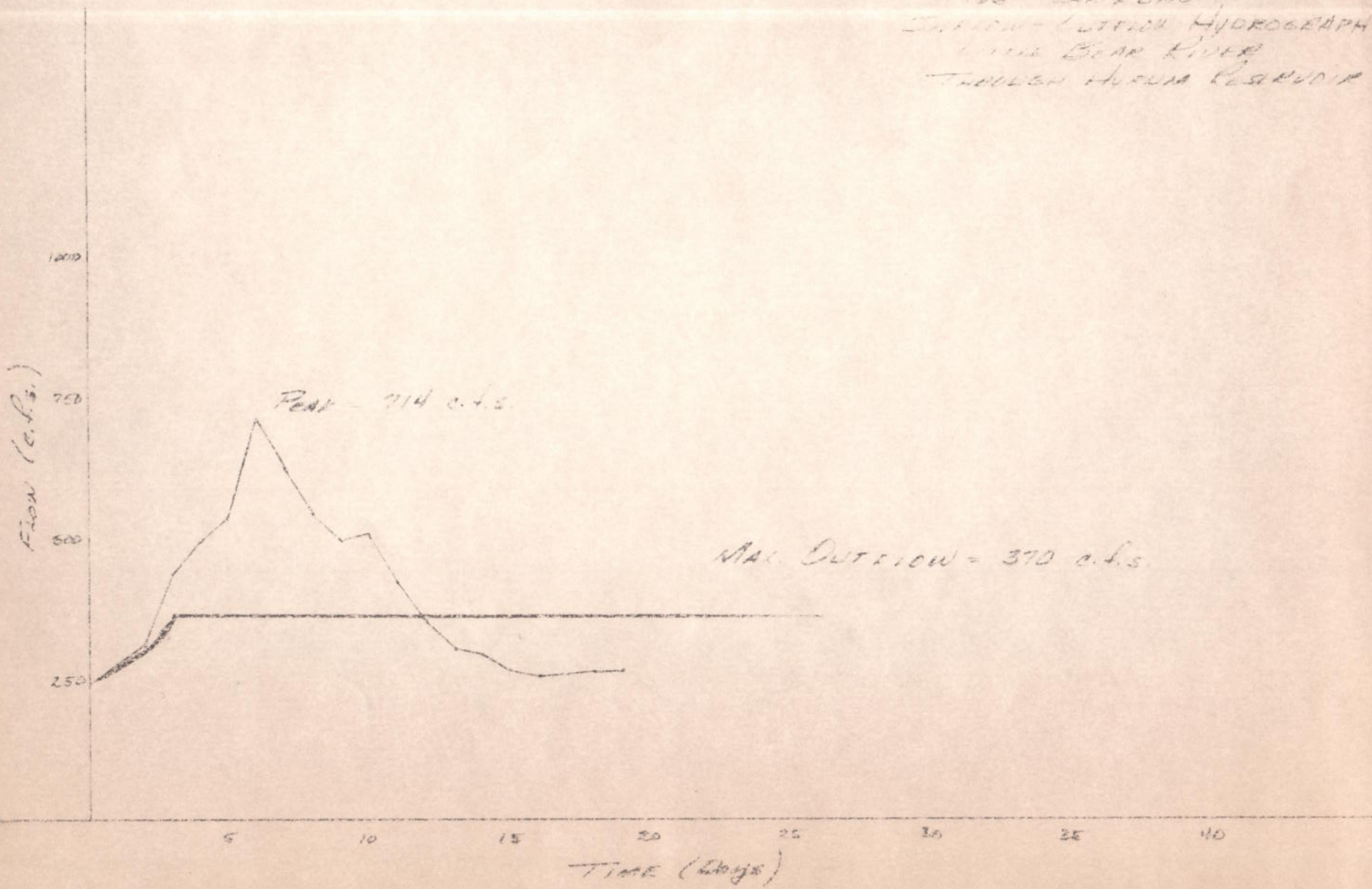
		Outflow c.f.s.	Basin c.f.s.	Basin Ft. Storage			
Apr	6	520	520	0	520	520	0
	7	969	489	0	908	1428	0
	8	1045	2473	0	1045	2473	0
	9	662	3135	0	662	3135	0
	10	617	3752	0	617	3752	0
	11	674	4426	0	674	4426	0
	12	807	5233	0	807	5233	0
	13	887	6120	0	887	6120	0
	14	1067	7187	0	1067	7187	0
	15	887	8074	0	887	8074	0
	16	645	8719	0	645	8719	0
	17	756	9475	0	756	9475	0
	18	1091	10,566	0	1091	10,566	0
	19	1290	11,856	51	1341	11,907	0
	20	1290	13,146	19	1268	13,165	0
	21	1290	14,436	0	1075	14,240	0
	22	1290	15,726	0	1198	15,438	0
	23	1290	17,016	0	1561	16,999	0
	24	1290	18,306	0	1390	18,189	18
	25	1290	19,596	0	1331	19,520	0
	26	1290	20,886	235	1390	20910	211
	27	1290	22,176	1008	1390	22300	784
	28	1290	23,466	1701	1390	23690	1484
	29	1290	24756	2192	1390	25080	1868
	30	1290	26046	2350	1390	26470	1926
May	1	1290	27336	2714	1390	27860	2190
	2	1290	28626	3375	1390	29250	2754
	3	1290	29916	4194	1390	30640	3470
	4	1290	31206	4927	1390	32030	4103
	5	1290	32496	5311	1390	33420	4487
	6	1290	33786	5622	1390	34810	4578
	7	1290	35076	5893	1390	36200	4769
	8	1290	36366	6051	1390	37590	4827
	9	1290	37656	5967	1390	38980	4665
	10	1290	38946	5714	1390	40370	4290
	11	1290	40236	5416	1390	41760	3892
	12	1290	41526	5193	1390	43150	3569
	13	1290	42816	5057	1390	44540	
	14	1290	44106	4882	1390	45930	
	15	1290	45396	4613	1390	47320	
	16	1290	46,686	4301	1390	48710	
	17	1290	47976		1390	50100	
	18				1390	51490	
	19				1390	52880	
	20				1390	54270	
	21						
	22						
	23						

Decreasing

Decreasing



— Assumed —
Inflow - Outflow Hydrograph
Little Bear River
Through Hyrum Reservoir
Assumed 1200 c.f.s. peak
Max. Outflow = 600 c.f.s.
Not necessary to carry curves any further since peak has passed.
Flow (c.f.s.)
1250
1000
750
500
250
0
5
10
15
20
25
30
Time (Days)


105 YEAR RUNOFF
INFLOW - OUTFLOW HYDROGRAPH
LITTLE BEAR RIVER
THROUGH HYRUM RESERVOIR
PEAK - 714 c.f.s.
MAX. OUTFLOW = 370 c.f.s.
FLOW (c.f.s.)
1000
750
500
250
5
10
15
20
25
30
35
40
TIME (days)