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Finalized Weber Reservoir Operation Plan

February 2003

1. Background and References

This is the operations plan for Weber Dam to provide water supply service for in-stream flow in Weber Creek and water supply for consumptive use at Folsom. This plan provides the resolution of technical challenges in meeting environmental and water supply needs.

Previous work related to the development of this plan is discussed in the following documents:

Weber Creek at Weber Dam
Synthetic Unimpaired Stream Flow Record Review
December 11, 2002

Weber Reservoir Operation Plan
January 7, 2003

Weber reservoir Operation Plan Alternative 2
February 3, 2003

An annual fill and empty process is to be applied in meeting the water supply and in-stream purposes. The hydrologic characteristics of Weber Creek coupled with the limited storage capacity of Weber Reservoir are overriding factors for operating in an annual fill and empty process. Runoff from the basin occurs from rainfall during winter and is reduced to near zero during the summer period. The purposes of the reservoir is to support in-stream flows in downstream Weber Creek and to supply water for consumptive use at Folsom. It is desirable to have the reservoir full in June before the high summer water demands. The summer consumptive use would empty the reservoir leaving very poor in-stream flow conditions for late summer and fall.

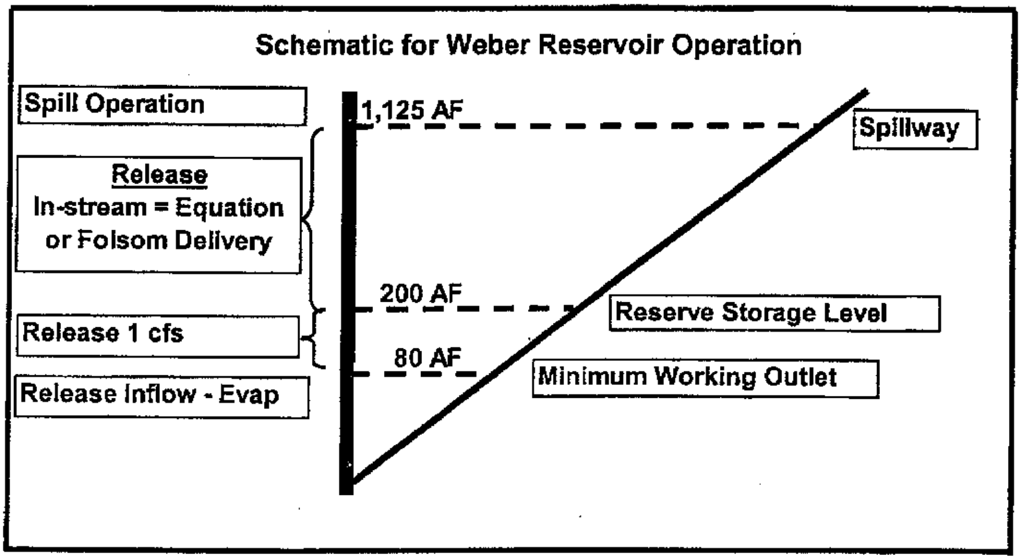
2. Operational Parameters

This report address real-time operational parameters agreed upon to operate Weber Dam for in-stream flow support and consumptive use deliveries at Folsom Lake. These parameters include:

- **a.** Reserve storage for in-stream flow support.
- **b.** In-stream flow equation.
- **c.** Stream and gage monitoring needs.
- **d.** Reporting Requirements.
- **e.** Change in release ramping constraints.
- **f.** Pulse flows.
- **g.** Interim operations until meeting pulse flow requirements.

The operation is based seasonal elements; storage occurs during the winter when there is normally plentiful runoff and the stored water is then released to meet downstream in-stream flow support and consumptive use needs at Folsom Lake. The release objective during July through September is to supply water at Folsom for consumptive use. A conveyance loss of 18% from Weber Dam to Folsom Lake is assumed. Figure 1 provides a schematic for the general allocation of storage and operational functions that occur to reference these parameters. The maximum and minimum storages are physical limitations, but the reserve storage is an agreed upon value.

Figure 1



Reserve storage for in-stream flow support

A block of storage is provided to support in-stream flows until the winter rainfall occurs. Based on modeling studies and discussions with the California Department of Fish and Game, a volume of 120 acre-feet of storage (200 acre-feet reservoir storage) would be held in reserve to support in-stream flow of 1 cfs for about 2 months during little or no inflow. This period usually occurs during September through December and the in-stream flow would be re-captured for consumptive use at Folsom. However, the bulk of consumptive use deliveries at Folsom will occur during July to September. During the month of June, only spill up to the scheduled delivery amount at Folsom would be claimed for consumptive use.

Deliveries at Folsom for consumptive use will be as high as 5.5 cfs and may occur from June through December, but Folsom delivery requirements determine releases only during the July – September period. Delivery at Folsom is curtailed when the reservoir is within the reserve storage range in which case the In-stream requirement prevails.
At any time the reservoir drops into the 200 acre-foot reserve storage, the release is to be 1 cfs, thereby preserving storage to maintain a minimum flow rate. However, the reserve storage may be depleted during severe drought conditions, reaching the 80 acre-foot dead storage pool. The outlet valve would then be opened to pass inflow minus evaporation until inflow again exceeds 1 cfs.

In-stream flow equation

When higher unimpaired inflow occurs and the reservoir is above 200 acre-feet, the in-stream flow will be computed according to the following relationship:

$$\mathbf{Q_{iss} = 0.67Q_{in}^{0.5}} \qquad \mathbf{(1)}$$

Where: $\mathbf{Q_{iss}}$ = Required in-stream flow in cfs greater then or equal to 1cfs.
$\mathbf{Q_{in}}$ = The monthly average inflow in cfs for the previous calendar month.

$\mathbf{Q_{in}}$ is computed from the average inflow of the previous month. Operations will have 7 days to perform this analysis before implementing the results. The operator will receive release instructions from an engineer.

For convenience, Table 1 shows computed values for equation (1) for average inflows ($\mathbf{Q_{in}}$) up to 100 cfs. Values greater than 100 cfs will be computed using equation (1). Notice that Table 1 shows the minimum release is 1 cfs for inflows below 2.2 cfs. Here the rule requires at least 1 cfs until the reserve storage is depleted. These determinations require the monitoring of inflow, outflow, and storage.

Table 1

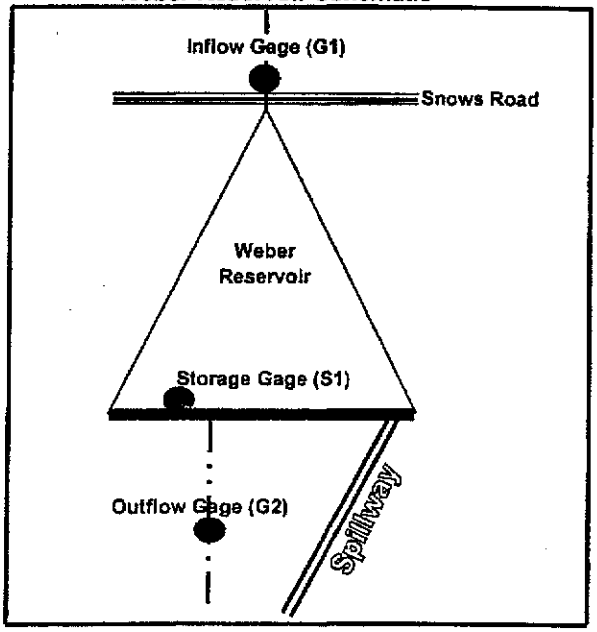
Weber Dam Minimum Release Criteria - Values in cfs

(Q_{in}) Running 30-day Average Inflow	Minimum Release	(Q_{in}) Running 30-day Average Inflow	Minimum Release
0	1.0	50	4.7
2.2	1.0	55	5.0
5	1.5	60	5.2
10	2.1	65	5.4
15	2.6	70	5.6
20	3.0	75	5.8
25	3.4	80	6.0
30	3.7	85	6.2
35	4.0	90	6.4
40	4.2	95	6.5
45	4.5	100	6.7

Stream and gage monitoring needs

Flow and storage monitoring equipment will be continuous recorders. A schematic for the key elements are shown in Figure 2. The inflow will be monitored by a recording gage at or near Snows Road where it crosses the North Fork Weber Creek just above Weber Reservoir. The average inflow for the previous calendar month will be applied to equation (1). The releases from the outlet plus any seepage will be monitored just downstream from the dam at the outflow gage (G2). The reservoir stage will be monitored along the dam at storage gage (S1). The stages will be converted to cfs and storage for applications and reporting.

Figure 2
Weber Reservoir Schematic



The storage gage (S1) will provide the stage information needed to compute spill through the uncontrolled spillway. The total outflow from the reservoir can then be determined by adding spill to the flow at G2.

Reporting Requirements

Posting the information on the Web may facilitate operations reporting. This could be provided through a link to the District's current web page. The plan calls for reporting mean daily flow at G1 and G2 and end-of-month storage. Reports will include spill, if any, and the algorithm parameters used to compute release.

Change in Release Ramping Constraints

Since the spillway does not have a control structure, the District does not have control of ramping the change in flow when the spillway is functioning. When the outlet operation is controlling, reductions in flow adjustments will be performed so that stream stages drop at rates less than 0.5 feet per hour. This is to provide aquatic life the chance to adjust and minimize their stranding along the stream banks.

Pulse flows

Generally, pulse flows will occur from storms while the reservoir is full and spilling because the outlet capacity is not sufficient to generate the intended bed load transport. Pulse flows require a rate of magnitude to move the streambed material suffieciently to restore the channel to fully support its appropriate habitat.

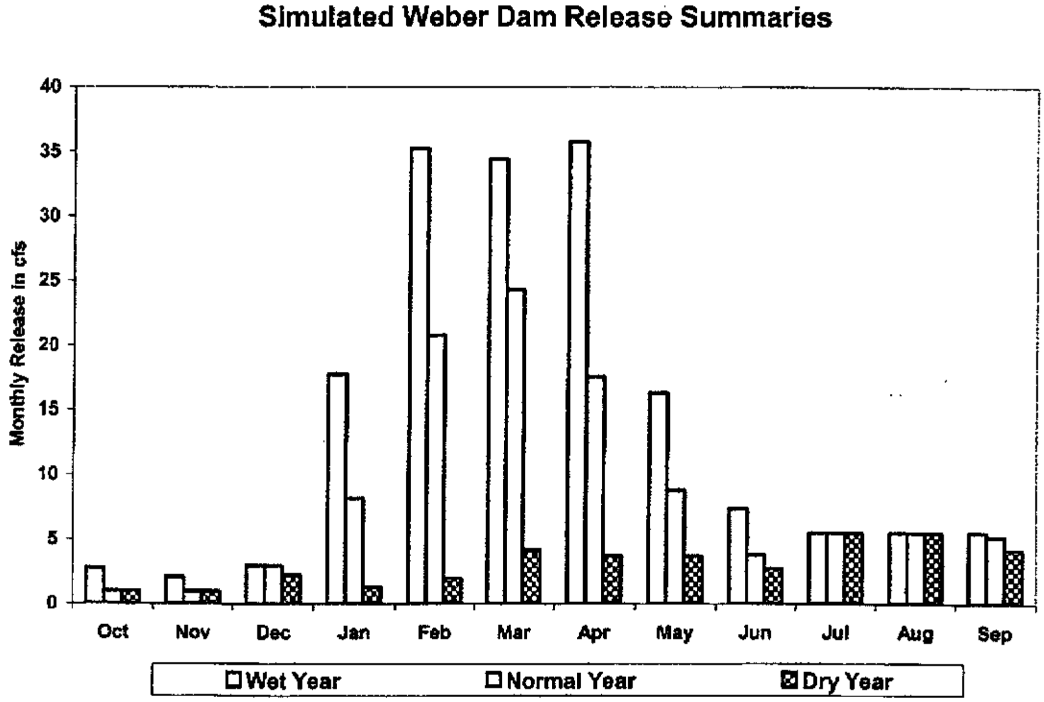
The needed pulse flow rate and duration has only been estimated by desktop analyses, indicating a flow of about 400 cfs for duration of 22 hours. An analytic process taking into account the physical stream and bed material will be required.

2. Example Results from Simulated Operations

The operating plan herein described was applied to a mathematical model to simulate monthly Weber Reservoir operations. A total of 74 years were simulated using the unimpaired inflow database. A summary of the results is shown in Figure 2 showing summaries for Dry, Normal, and Wet year categories. These categories, from the Department of Water Resources (DWR) Year Types, are not used to drive the operations but only to group them into categories.

Details showing total monthly releases and related statistics for Dry, Normal and Wet Years are provided in Tables 2, 3, and 4, respectively. Table 2, the dry year group, shows that in-stream flows dropped below 1 cfs in 8 years and in 1977 the releases in July and September were zero. The most severe dry years in the simulation were 1924, 1931, and 1977. Simulations in the Normal and Wet Year Groups indicate an improved flow regime.

Figure 2



3. Discussion

The storage rule procedure provides a usable tool in real-time operations. It will require a stream and reservoir-monitoring program, which will be compatible with such needs for reports in making deliveries to Folsom where the water will be pumped to the El Dorado Hills service area.

The procedures herein described do not focus on the matter of pulse flows needed to move streambed sediments. Weber Dam does not have the ability to release such flows until spill occurs. Then spillway operations are the result of filling and passing high inflows during random storm events. Spillway operations are expected to occur in most years as shown in Appendix I when the reservoir fills. Since the spillway is uncontrolled, such conditions cause random "pulse" flows, which may be more or less than desired. Reducing in-stream flows during refill would increase the chance of spill, but such actions would compromise in-stream flow habitat. This becomes a matter of priorities and the proposed operating plan provides a good compromise.

The results herein described were obtained by use of a mathematical model using the Microsoft Access program. The model is contained in an Access file called Weber Operations, which may be obtained upon request. The operating logic is in Visual Basic so that a user can change requirements to test different scenarios. Execution of the model builds 5 spreadsheet files so detailed monthly results can be examined and manipulated as desired. Therefore, a user may verify the results herein described and/or modify model-simulating criteria to test other procedure.

EL DORADO IRRIGATION DISTRICT
W-3 Weber outlet

DAILY DISCHARGE IN CUBIC FEET PER SECOND WATER YEAR OCT 2005 TO SEP 2006

Day	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	1.6	1.5	1.9	22	22	23	23	23	2.9	1.5	1.7	1.8
2	1.6		1.9	22	22	23	23	23	2.8	1.5	1.7	1.8
3	1.7	1.5	1.9	22	22	23	23	22	2.7	1.5	1.7	1.8
4	1.6	1.5	1.9	22	22	23	23	22	2.6	1.5	1.7	1.9
5	1.7	1.5	1.9	22	22	23	23	22	2.4	1.5	1.7	1.8
6	1.6	1.5	1.9	22	22	23	23	22	2.4	1.5	1.7	1.9
7	1.6	1.5	1.9	22	22	23	23	21	2.5	1.5	1.7	1.9
8	1.6	1.5	1.9	22	22	23	23	21	2.5	1.5	1.7	1.9
9	1.6	1.5	1.9	22	22	23	23	21	2.5	1.5	1.7	1.9
10	1.6	1.5	1.9	22	22	23	23	16	2.5	1.5	1.7	1.9
11	1.6	1.5	1.9	22	22	23	23	5.9	2.6	1.5	1.7	1.9
12	1.6	1.5	1.9	22	22	23	23	5.5	2.5	1.5	1.7	1.9
13	1.6	1.5	1.9	22	22	23	23	5.6	2.5	1.5	1.7	1.9
14	1.6	1.5	1.9	22	22	23	23	5.4	2.0	1.5	1.7	1.8
15	1.6	1.5	1.9	22	22	23	23	5.2	1.4	1.5	1.7	1.8
16	1.6	1.5	1.9	22	22	23	23	5.3	1.6	1.5	1.7	1.9
17	1.6	3.3	1.9	22	22	23	23	4.9	1.5	1.5	1.7	1.9
18	1.6	3.3	1.9	22	22	23	23	4.6	1.5	1.5	1.7	1.9
19	1.6	3.3	1.9	22	22	23	23	4.7	1.5	1.5	1.7	1.8
20	1.6	3.3	1.9	22	22	23	23	4.4	1.5	1.5	1.7	1.8
21	1.6	3.3	1.9	22	22	23	23	4.4	1.5	1.5	1.8	1.8
22	1.6	3.3	1.9	22	22	23	23	4.3	1.5	1.5	1.8	1.8
23	1.6	3.3	1.9	22	22	23	23	3.9	1.5	1.5	1.8	1.8
24	1.6	3.3	1.9	22	22	23	23	3.9	1.5	1.5	1.8	1.8
25	1.6	3.3	1.9	22	22	23	23	3.7	1.5	1.5	1.8	1.8
26	1.6	3.3	1.9	22	22	23	23	3.6	1.5	1.5	1.9	1.8
27	1.6	3.3	1.9	22	22	23	23	3.7	1.5	1.7	1.9	1.7
28	1.5	3.3	1.9	22	22	23	23	3.3	1.5	1.7	1.9	1.7
29	1.5	3.3	1.9	22	------	23	23	3.2	1.5	1.7	1.9	1.8
30	1.5	3.3	1.9	22	------	23	23	3.2	1.5	1.7	1.9	1.8
31	1.5	------	5.3	22	------	23	------	2.9	------	1.7	1.8	------
TOTAL	49.4	68.7	62.3	682	616	713	690	304.6	59.4	47.5	54.3	55.0
MEAN	1.59	2.37	2.01	22.0	22.0	23.0	23.0	9.83	1.98	1.53	1.75	1.83
MAX	1.7	3.3	5.3	22	22	23	23	23	2.9	1.7	1.9	1.9
MIN	1.5	1.5	1.9	22	22	23	23	2.9	1.4	1.5	1.7	1.7
AC-FT	98	136 *	124	1,350	1,220	1,410	1,370	604	118	94	108	109

CAL YEAR 2005	TOTAL*	566.97	MEAN	1.56	MAX	5.3	MIN	.60	AC-FT	1,120
WTR YEAR 2006	TOTAL*	3,402.20	MEAN	9.35	MAX	23	MIN	1.4	AC-FT	6,750

* Incomplete Record

EL DORADO IRRIGATION DISTRICT
W-1 Weber Inflow

DAILY DISCHARGE IN CUBIC FEET PER SECOND WATER YEAR OCT 2005 TO SEP 2006

Day	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	4.1	5.6	29	177	43	46	90	19	5.3	1.4	.44	.23
2	4.2	5.5	52	173	70	50	80	18	5.1	1.4	.45	.24
3	4.5	5.8	20	169	60	67	118	16	4.9	1.4	.45	.20
4	4.6	6.5	14	164	58	61	185	15	4.7	1.4	.43	.18
5	4.6	6.6	12	160	55	56	194	14	4.5	1.3	.43	.17
6	4.4	6.3	11	155	49	83	136	14	4.1	1.3	.48	.15
7	4.2	6.3	10	150	43	75	104	13	3.6	1.3	.48	.14
8	4.1	6.5	10	146	38	58	94	12	3.5	1.2	.51	.13
9	4.2	6.3	9.6	141	34	52	80	12	3.4	1.1	.46	.15
10	4.2	6.1	9.1	137	31	46	95	11	3.3	1.0	.40	.16
11	3.9	6.1	8.8	133	28	53	100	11	3.3	1.0	.37	.16
12	3.9	6.3	8.4	128	26	49	89	10	3.3	1.0	.36	.19
13	3.9	6.2	8.2	124	25	45	76	9.7	3.4	1.0	.36	.17
14	3.7	6.0	8.1	120	23	57	67	9.5	3.3	.94	.35	.17
15	4.6	6.0	8.0	116	22	57	61	9.1	3.1	.84	.35	.20
16	5.1	5.9	7.9	112	21	54	114	8.6	2.9	.78	.34	.27
17	4.9	5.8	7.9	108	20	79	119	8.2	2.8	.74	.34	.32
18	4.7	5.8	41	104	20	71	98	8.1	2.6	.66	.32	.28
19	4.7	5.8	40	101	20	63	83	7.9	2.5	.65	.31	.25
20	4.8	5.8	25	97	19	58	70	8.3	2.4	.59	.30	.23
21	4.8	5.8	26	93	18	56	63	9.4	2.3	.62	.28	.23
22	4.8	5.7	71	90	17	52	57	11	2.1	.63	.28	.23
23	4.6	5.8	41	86	17	47	53	9.9	2.1	.52	.26	.22
24	4.6	5.7	22	82	16	46	48	8.3	1.8	.50	.25	.19
25	4.6	7.0	26	79	16	87	40	7.3	1.8	.42	.24	.18
26	4.9	9.4	70	75	15	76	34	7.1	1.7	.39	.25	.74
27	6.1	7.6	41	72	27	64	30	7.1	1.6	.56	.25	.30
28	6.3	7.5	100	69	61	67	26	6.7	1.7	.40	.25	.21
29	6.0	17	78	67	------	69	23	6.2	1.6	.42	.23	.19
30	5.9	16	75	64	------	62	21	5.9	1.5	.43	.22	.19
31	5.7	------	178	52	------	75	------	5.6	------	.44	.21	------
TOTAL	145.6	208.7	1,068.0	3,544	892	1,881	2,448	318.9	90.2	26.33	10.65	6.67
MEAN	4.70	6.96	34.5	114	31.9	60.7	81.6	10.3	3.01	.85	.34	.22
MAX	6.3	17	178	177	70	87	194	19	5.3	1.4	.51	.74
MIN	3.7	5.5	7.9	52	15	45	21	5.6	1.5	.39	.21	.13
AC-FT	289	414	2,120	7,030	1,770	3,730	4,860	633	179	52	21	13

CAL YEAR 2005	TOTAL	3,573.27	MEAN	9.79	MAX	178	MIN	.50	AC-FT	7,090
WTR YEAR 2006	TOTAL	10,640.05	MEAN	29.2	MAX	194	MIN	.13	AC-FT	21,100