Testimony of Russell T. Brown- Exhibit 3

SWRCB Public Hearing Regarding Emergency Drought Conditions

February 17, 2009

I sent a letter to Ms. Rice (SWRCB Executive Director) on February 9, 2009 providing additional information for her consideration of the DWR and Reclamation request for relaxation of the X2 objectives in February of 2009. My resume of work in the Delta is included as exhibit 1. A copy of my letter to M. Rive is provided as exhibit 2, and this written testimony (exhibit 3) summarizes and clarifies the suggestions in my letter. This testimony primarily addresses Key Issues 1 and 8.

My evaluation supports the DWR and Reclamation request for relaxation of the X2 objectives in February. I am also suggesting that the Delta outflow requirements be further relaxed in February, March and April of 2009 to a constant minimum outflow of 4,500 cfs. This is a lower Delta outflow than the 7,100 cfs (Collinsville X2) that DWR and Reclamation have requested for February. An outflow of 4,500 cfs is the January objective for low runoff years (it is 6,000 cfs if the December Eight River Index is greater than 800 taf). Table 1b in my letter indicated that December runoff was less than 800 taf in about the lowest 30% of the years from 1967-2008. I believe that this also represents a reasonable minimum outflow for February, March and April during drought conditions.

My testimony concerns the allocation of the Delta inflow for balanced beneficial uses for water supply and estuarine fish habitat protection during the spring of low runoff years. Table 1 of this testimony shows the allocation of Delta inflow for exports and outflow, when the inflow is less than 30,000 cfs. During the February-June period (X2 objectives), the minimum Delta outflow and the maximum Export/Inflow (E/I) ratio are the two major allocation rules. Some of the inflow is required for in-Delta diversions and losses. The estimated channel depletions range from about 1,000 cfs in February to almost 4,000 cfs in June.

Table 1 shows that for February (with a depletion of 1,000 cfs), the three minimum outflows of 4,500 (suggested minimum), 7,100 cfs (Collinsville X2) and 11,400 cfs (Chipps Island X2) will provide a range of allowable exports. If the February inflow remains similar to the January 2009 inflow of about 12,000 cfs, the allowable February exports would be about 6,500 cfs with the suggested outflow of 4,500 cfs, would be about 3,900 with the 7,100 cfs outflow, and would be zero for the 11,400 outflow (because inflow would not be enough to meet the depletions and the outflow requirement).

The second part of Table 1 shows the outflow and exports for the E/I ratio of 35% and 45%. The February 2009 E/I ratio is 45%, because the January Eight River Index was less than 1,000 taf. If the Delta inflow was less than 10,000 cfs, the minimum outflow of 4,500 cfs would limit exports to less than 45% of the inflow. Comparison of the allowable exports for the various outflow objectives and E/I objectives show that the minimum outflow is the controlling objective at low Delta inflows. Therefore, the minimum Delta outflow must be carefully selected to provide adequate fish habitat protection, while allowing sufficient water supply exports during drought conditions.

I am suggesting that 4,500 cfs is a better minimum Delta outflow during the X2 period than 7,100 cfs, as required in February, March , and April in D-1641 (D-1641 reduces the required outflow to 4,000 cfs in May and June of dry years). It is difficult to directly evaluate the fish habitat protection benefits achieved with X2 outflow objectives. Delta outflow is often low (3,000 cfs to 10,000 cfs) during the September-December period when the Fall Mid-water Trawl (FMWT) fish surveys are collected at about 100 stations throughout the upper estuary; but identifying the salinity effects on the fish distribution is difficult because other factors may affect the abundance and distribution of these estuarine fish.

Comparing the direct effects of Delta outflow on salinity within the upper estuary is more reliable. Table 2 shows the salinity (EC) values that are expected at several Delta monitoring stations for a range of Delta outflow from 3,000 cfs to 15,000 cfs. The estimated chloride (mg/l) and EC (uS/cm) values at the CCWD Rock Slough intake (PP#1) are given in the first two columns. The EC at Jersey Point and at Antioch are given in the next columns. Finally, the EC at Collinsville and Chipps Island (X2 stations) and at Martinez are given. These EC estimates are based on "negative-exponential" equations, which have been shown to match the historical EC data, once the Delta outflow is converted to the effective outflow (i.e., moving average) with the CCWD "G-model" equation.

At the minimum Delta outflow of 3,000 cfs, the Rock Slough chloride will be about the maximum objective of 250 mg/l, and the X2 would be at about Jersey Point (and Emmaton, km 92). This outflow has substantial effects on Delta salinity. At the suggested minimum outflow of 4,500 cfs, the Rock Slough chloride would be reduced to about 150 mg/l, (the secondary D-1641 objective that must be achieved for 155 days each year). The X2 location (EC of about 2,750 uS/cm) would be just upstream of Antioch on the San Joaquin River, and midway between Collinsville and Emmaton on the Sacramento River. The Jersey Island EC would be about 1,250 uS/cm. An outflow of 7,100 cfs will move X2 to Collinsville and will reduce the Jersey Island EC to about 450 uS/cm, which is the agricultural EC objective beginning April 1 of most years (not critical).

An outflow of 7,100 cfs is sufficient to reduce the Rock Slough chloride to less than 50 mg/l (which is the CCWD Los Vaqueros diversion target). The Chipps Island EC would be about 6,000 uS/cm, about twice the X2 objective. An outflow of 11,400 will move X2 to Chips Island, and reduce the Collinsville EC to about 1,000 uS/cm (the D-1641 drinking water objective). Table 3 gives the estimated X2 locations for these 4 outflows, using the daily X2 equation. This equation (steady-state form) indicates that a 10% increase in outflow will move X2 downstream about 1.1 kilometers.

In conclusion, a relaxed outflow objective of 4,500 cfs during February, March, and April during drought conditions will provide a substantial water supply benefit compared to the D-1641 minimum X2 objective of 7,100 cfs (about 5,000 af per day). This minimum outflow will cause X2 (and the estuarine salinity gradient) to shift about 5 km upstream of Collinsville, but will provide reasonable control on salinity intrusion at Jersey Point and Rock Slough. The CCWD chloride is expected to be about 150 mg/l.

I suggest that SWRCB staff work cooperatively with DWR, Reclamation and other Bay-Delta stakeholders to revise the D-1641 X2 objectives to allow relaxed outflow objectives to be more easily determined in future drought conditions.

Table 1. Relationship Between Inflow and Allowable Exports and Outflow with Alternative Objectives
Inflow = Channel Depletions + Exports + Outflow

Exports = Outflow
Exports > 10,000

1000 cfs Channel Depletion assumed

Total Inflow (cfs)	4,500 Outflow Exports (cfs)	7,100 Outflow Exports (cfs)	11,400 Outflow Exports (cfs)	35% E/I Exports (cfs)	35% E/I Outflow (cfs)	45% E/I Exports (cfs)	45% E/I Outflow (cfs)	65% E/I Exports (cfs)	65% E/I Outflow (cfs)
5,000	0	0	0	1,750	2,250	2,250	1,750	3,250	750
6,000	500	0	0	2,100	2,900	2,700	2,300	3,900	1,100
7,000	1,500	0	0	2,450	3,550	3,150	2,850	4,550	1,450
8,000	2,500	0	0	2,800	4,200	3,600	3,400	5,200	1,800
9,000	3,500	900	0	3,150	4,850	4,050	3,950	5,850	2,150
10,000	4,500	1,900	0	3,500	5,500	4,500	4,500	6,500	2,500
11,000	5,500	2,900	0	3,850	6,150	4,950	5,050	7,150	2,850
12,000	6,500	3,900	0	4,200	6,800	5,400	5,600	7,800	3,200
13,000	7,500	4,900	600	4,550	7,450	5,850	6,150	8,450	3,550
14,000	8,500	5,900	1,600	4,900	8,100	6,300	6,700	9,100	3,900
15,000	9,500	6,900	2,600	5,250	8,750	6,750	7,250	9,750	4,250
16,000	10,500	7,900	3,600	5,600	9,400	7,200	7,800	10,400	4,600
17,000	11,500	8,900	4,600	5,950	10,050	7,650	8,350	11,050	4,950
18,000	12,500	9,900	5,600	6,300	10,700	8,100	8,900	11,700	5,300
19,000	13,500	10,900	6,600	6,650	11,350	8,550	9,450	12,350	5,650
20,000	14,500	11,900	7,600	7,000	12,000	9,000	10,000	13,000	6,000
21,000	15,500	12,900	8,600	7,350	12,650	9,450	10,550	13,650	6,350
22,000	16,500	13,900	9,600	7,700	13,300	9,900	11,100	14,300	6,700
23,000	17,500	14,900	10,600	8,050	13,950	10,350	11,650	14,950	7,050
24,000	18,500	15,900	11,600	8,400	14,600	10,800	12,200	15,600	7,400
25,000	19,500	16,900	12,600	8,750	15,250	11,250	12,750	16,250	7,750
26,000	20,500	17,900	13,600	9,100	15,900	11,700	13,300	16,900	8,100
27,000	21,500	18,900	14,600	9,450	16,550	12,150	13,850	17,550	8,450
28,000	22,500	19,900	15,600	9,800	17,200	12,600	14,400	18,200	8,800
29,000	23,500	20,900	16,600	10,150	17,850	13,050	14,950	18,850	9,150
30,000	24,500	21,900	17,600	10,500	18,500	13,500	15,500	19,500	9,500

Table 2. Estimated Salinity (EC) at Various Outflows

G-model estimates of Effective Outflow
Negative Exponential Estimates from Historical 1976-1991 EC and Outflow Data
EC(uS/cm) = 5,000 x Exp (-.0006 x Effective Outflow) + 175

Effective Delta Outflow (cfs)	Rock Slough Cl	Rock Slough EC	Jersey EC	Antioch EC	Collinsville EC	Chipps Island EC	Martinez EC
	1500	5000	10000	15000	15000	25000	35000
	20	175	175	175	175	175	175
	-0.00060	-0.00060	-0.00050	-0.00035	-0.00025	-	-0.00006
						0.00020	
3,000	268	1,001	2,406	5,424	7,260	13,895	29,409
3,500	204	787	1,913	4,581	6,428	12,590	28,545
4,000	156	629	1,528	3,874	5,693	11,408	27,707
4,500	121	511	1,229	3,280	5,045	10,339	26,893
5,000	95	424	996	2,782	4,473	9,372	26,104
5,500	75	359	814	2,363	3,968	8,497	25,337
6,000	61	312	673	2,012	3,522	7,705	24,594
6,500	50	276	563	1,717	3,129	6,988	23,872
7,000	42	250	477	1,469	2,782	6,340	23,172
7,500	37	231	410	1,262	2,475	5,753	22,492
8,000	32	216	358	1,087	2,205	5,222	21,832
8,500	29	205	318	941	1,966	4,742	21,192
9,000	27	198	286	818	1,756	4,307	20,571
9,500	25	192	262	715	1,570	3,914	19,968
10,000	24	187	242	628	1,406	3,558	19,383
10,500	23	184	227	555	1,262	3,236	18,816
11,000	22	182	216	494	1,134	2,945	18,265
11,500	22	180	207	443	1,021	2,681	17,730
12,000	21	179	200	400	922	2,443	17,211
12,500	21	178	194	364	834	2,227	16,708
13,000	21	177	190	334	757	2,032	16,219
13,500	20	177	187	308	688	1,855	15,745
14,000	20	176	184	287	628	1,695	15,285
14,500	20	176	182	269	575	1,551	14,838
15,000	20	176	181	254	528	1,420	14,405

Table 3. Estimating Daily X2 (km) from daily outflow (cfs)

X2 (km) = 10.16 + 0.945 Previous X2 - 1.487 Log (Outflow [cfs])
Steady state X2 (km) = 184.7 - 27.036 Log (Outflow [cfs])

Each 10% increase in outflow moves X2 downstream about 1.1 km

Outflow	X2	Outflow	X2
3,000	90.7	3300	89.6
4,500	85.9	4950	84.8
7,100	80.6	7810	79.5
11,400	75.0	12540	73.9