

Section V: Water Accounting and Water Supply Reliability

A. Quantifying the Water Supplier's Water Supplies

1. Agricultural Water Supplier Water Quantities

Table 41 shows typical water diversions from the CA Aqueduct during the representative water year (2012).

Table 41. BWSO Surface Water Diversions for 2012	
Month	Amount of Diversions (AF)
January	5,214
February	1,366
March	4,175
April	9,232
May	17,636
June	21,006
July	23,280
August	19,470
September	10,022
October	10,035
November	4,115
December	6,428
Total	131,979

Table 42. Surface and Other Water Supplies for 2012 (AF)														
Source	2012 Supply	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
CVP Class 1 Contracts	0													
Pre-1914 Rights	0													
SWP water contract	78,980													
Other Surface water	25,781*													
Banked Water Recovery	45,243													
Landowner Transfers	4,580													
Transfers & Exchanges In	26,226													
Total Supply	180,810													
Deliveries		5,214	1,366	4,175	9,232	17,636	21,006	23,280	19,470	10,022	10,035	4,115	6,428	131,979
Carryover balance														48,831
Note: * Includes 10,729 AF of water stranded in Lake Oroville and carried over to 2013.														

Table 42-13. Surface and Other Water Supplies for 2013 (AF)														
Source	2012 Supply	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
CVP Class 1 Contracts	0													
Pre-1914 Rights	0													
SWP water contract	42,528													
Other Surface water	36,390													
Banked Water Recovery	55,236													
Landowner Transfers	2,500													
Transfers & Exchanges In	26,422													
Total Supply	163,076													
Deliveries		1,478	3,479	5,683	12,969	20,113	23,019	25,882	18,542	14,163	10,945	2,870	2,438	141,581
Carryover Balance														21,495

Table 42-14. Surface and Other Water Supplies for 2014 (AF)														
Source	2012 Supply	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
CVP Class 1 Contracts	0													
Pre-1914 Rights	0													
SWP water contract	6,075													
Other Surface water	49,668													
Banked Water Recovery	65,363													
Landowner Transfers	990													
Transfers & Exchanges In	21,539													
Total Supply	143,635													
Deliveries		778	4,714	2,244	8,694	16,194	20,595	23,530	18,331	11,595	4,277	1,810	1,629	114,391
Carryover Balance														29,244

Table 42-15. Surface and Other Water Supplies for 2015 (AF)														
Source	2015 Supply	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
CVP Class 1 Contracts														
Pre-1914 Rights														
SWP water contract	24,302													
Other Surface water	30,486													
Banked Water Recovery	50,000													
Landowner Transfers	2,800													
Transfers & Exchanges In	16,951													
Total Supply														
Deliveries		446	3,849	5,942	10,127	17,145	19,863	23,238	17,583					
Carryover Balance														

Table 43 summarizes groundwater pumped by BWSO from groundwater banking projects located outside the District's boundaries during the representative year when SWP allocations were normal.

Table 43. Groundwater Supplies Summary for 2012 (AF)							
Month	Pumped by the Water Supplier			Pumped within Service Area by Customers			TOTAL
	Pioneer/BM Projects*	Basin 2	Basin 3	Basin 1	Basin 2	Basin 3	
January	0			0	0	0	
February	0			0	0	0	
March	1,500			0	0	0	1,500
April	0			0	0	0	
May	0			0	0	0	
June	2,200			0	0	0	2,200
July	0			0	0	0	
August	0			0	0	0	
September	0			0	0	0	
October	0			0	0	0	
November	0			0	0	0	
December	0			0	0	0	
TOTAL	3,700						3,700

Notes:
*Combined from Pioneer and Berrenda Mesa Projects out of the BWSO boundary and therefore are not included in Table 49. District does not keep record of the amount of groundwater pumped from private wells.

2. Other Water Sources Quantities

Table 44. Effective Precipitation Summary (AF)									
Month	Representative Year 2012		2013		2014		2015		Average
	Gross (in)	Effective (AF)*	Gross (in)	Effective (AF)*	Gross (in)	Effective (AF)*	Gross (in)	Effective (AF)*	
January	0.07	115	0.58	939	0.00	0	0.11		
February	0.19	622	0.16	518	0.09	279	0.11		
March	0.03	98	0.10	324	0.20	620	0.01		
April	2.12	6,944	0.00	0	0.02	62	0.16		
May	0.00	0	0.00	0	0.00	0	0.06		
June	0.00	0	0.00	0	0.02	62	0.03		
July	0.00	0	0.00	0	0.00	0	1.39		
August	0.00	0	0.00	0	0.00	0	0.00		
September	0.00	0	0.00	0	0.00	0			
October	0.00	0	0.00	0	0.00	0			
November	0.14	459	0.58	1,877	0.00	0			
December	0.88	1,441	0.19	307	1.60	2,479			
Total	3.43	9,679	1.61	3,964	1.93	3,502			
Note: *Assumes an effectiveness coefficient of 50% for the months of December and January and 100% for the remaining months. Volumes in AF result from multiplying the effective precipitation depth in a given year and the irrigated acreage (Table 26).									

B. Quantification of Water Uses

Table 45 shows the volume of water delivered to BWSD's irrigation water customers in 2012-2015 for delivery into the Service Area. The water delivered is based on the field personnel water measurements to the customers. During 2012, the volume of water delivered to the customers is within an estimated plus or minus 2% of the actual deliveries. The difference between the applied water versus the allocated water is the amount of water that was recharged or carried over to the next year (see Table 46).

Table 45. Applied Water (AF)						
	Rep. Year 2012					
		2013	2014	2015		
Applied Water* (from Table 23)	130,381	139,723	112,824			

Table 46 summarizes the crop water use within the BWSD service area in 2012-2015.

Table 46. Quantify Water Use (AF)						
Water Use	Rep. Year 2012					
		2013	2014	2015		
Crop Water Use (from Table 25)						
1. Crop Evapotranspiration	127,374	129,855	130,350			
2. Leaching	8,382	8,491	8,406			
3. Cultural practices	0	0	0			
Conveyance & Storage System						
4. Conveyance seepage*	758	812	656			
5. Conveyance evaporation*						
6. Conveyance operational spills	0	0	0			
7. Reservoir evaporation	0	0	0			
8. Reservoir seepage	0	0	0			
Environmental Use (consumptive)						
9. Environmental use – wetlands	0	0	0			
10. Environmental use – Other	0	0	0			
11. Riparian vegetation	0	0	0			
12. Recreational use	0	0	0			
Municipal and Industrial						
13. Municipal (from Table 28)	0	0	0			
14. Industrial (from Table 28)	1,600	1,858	1,567			
Outside the District						
15. Transfers or Exchanges out of the service area	0	0	0			
Conjunctive Use						
16. Groundwater recharge (from Table 29)**	0	0	0			
Other (from Table 30)	0	0	0			
Subtotal	138,114	141,016	140,979			
Note: *Seepage and evaporation losses combined. ** Recharge outside District boundary is not accounted here.						

Table 47. Quantify Water Leaving the District (AF)						
Water Supplies	Rep. Year 2012					
		2013	2014	2015		
1. Surface Water (summary total from Table 42)	131,979	141,581	114,391			
2. Groundwater (summary total from Table 43)	0	0	0			
3. Annual Effective Precipitation (summary total from Table 44)	9,679	3,964	3,502			
4. Water purchases	0	0	0			
Subtotal	141,658	145,545	117,893			
Note: Typographic error in 2012 AWMP subtotal corrected.						

Table 48. Irrecoverable Water Losses (Optional)* (AF)						
	Rep. Year 2012					
		2013	2014	2015		
Flows to saline sink	0	0	0	0		
Flows to perched water table	0	0	0	0		
Subtotal	0	0	0	0		

C. Overall Water Budget

Table 49 and Table 50, respectively indicate the 2012-2015 water supplies and water budget for the District.

Table 49. Quantify Water Supplies (AF)						
Water Supplies	Rep. Year 2012					
		2013	2014	2015		
1. Surface Water (summary total from Table 42)	131,979	141,581	114,391			
2. Groundwater (summary total from Table 43)	0	0	0			
3. Annual Effective Precipitation (summary total from Table 44)	9,679	3,964	3,502			
4. Water purchases	0	0	0			
Subtotal	141,658	145,545	117,893			
Note: Typographic error in 2012 AWMP subtotal corrected.						

Table 50. Budget Summary (AF)						
Water Accounting	Rep. Year 2012					
		2013	2014	2015		
1. Subtotal of Water Supplies (Table 49)	141,658	145,545	117,893			
2. Subtotal of Water Uses (Table 46)	138,114	141,016	140,979			
3. Drain Water Leaving Service Area	0	0	0			
Excess Deep Percolation*	3,544	4,529	(23,086)			
Note: *Calculated from lines 2 and 3 subtracted from line 1						

The District as a whole appears to be very efficient with its water supply. Data from Table 50 for year 2012 suggests a Total Water Use Efficiency (TWUE) for the District of approximately 97% under the assumptions used in the calculations (see Table 24 for details). Excess deep percolation and TWUE values vary accordingly with the year type. Crop water use estimates may be high. These results are due to uncertainties in the crop coefficients (might be high) values to estimate crop evapotranspiration and the salt tolerance threshold values to estimate the leaching requirement. These results suggest that growers are performing deficit irrigation in response to a limited, unreliable, and expensive water supply. These results also collaborate mobile lab results which indicate distribution uniformities (DU) for District Water Users ranged between 91% and 97% from 2006 to 2012.

In addition, it is probable that the growers are deficit irrigating in response to multiple years of insufficient water supplies. In 2010, the Table A allotment of 50% yielded a corresponding 97% TWUE. At Table A allotments of 35% in 2013 and 5% in 2014, growers would have been forced to abandon (some 2,000 acres have been taken out of production since 2010) or to under-irrigate their remaining crop. Table 46 (Adjusted) and Table 50 (Adjusted) illustrate the possible effects of minor (2013) and more severe (2014) deficit irrigation factors to the overall TWUE.

Table 46 (Adjusted). Quantify Water Use (AF)						
Water Use	Rep. Year 2012					
		2013	2014	2015		
Crop Water Use (from Table 25)						
Deficit Irrigation Adjustment		95% of ETc	80% of ETc			
1. Crop Evapotranspiration	127,374	123,363	104,280			
2. Leaching	8,382	8,066	6,725			
3. Cultural practices	0	0	0			
Conveyance & Storage System						
4. Conveyance seepage*	758	812	656			
5. Conveyance evaporation*						
6. Conveyance operational spills	0	0	0			
7. Reservoir evaporation	0	0	0			
8. Reservoir seepage	0	0	0			
Environmental Use (consumptive)						
9. Environmental use – wetlands	0	0	0			
10. Environmental use – Other	0	0	0			
11. Riparian vegetation	0	0	0			
12. Recreational use	0	0	0			
Municipal and Industrial						
13. Municipal (from Table 28)	0	0	0			
14. Industrial (from Table 28)	1,600	1,858	1,567			
Outside the District						
15. Transfers or Exchanges out of the service area	0	0	0			
Conjunctive Use						
16. Groundwater recharge (from Table 29)**	0	0	0			
Other (from Table 30)	0	0	0			
Subtotal	138,114	134,099	113,228			
Note: *Seepage and evaporation losses combined. ** Recharge outside District boundary is not accounted here.						

Table 50 (Adjusted). Budget Summary (AF)						
Water Accounting	Rep. Year 2012					
		2013	2014	2015		
1. Subtotal of Water Supplies (Table 49)	141,658	145,545	117,893			
2. Subtotal of Water Uses (Table 46)	138,114	134,099	113,228			
3. Drain Water Leaving Service Area	0	0	0			
Excess Deep Percolation*	3,544	11,446	4,665			
Note: *Calculated from lines 2 and 3 subtracted from line 1						

D. Water Supply Reliability

The SWP and groundwater banking projects are BWSD’s primary source of reliable water. As a participant in the Pioneer and Berrenda Mesa groundwater banking projects, BWSD has been actively banking SWP water when available. Water stored in the water banks is available to supplement SWP supplies, primarily in years of SWP delivery deficiencies. Annually, the maximum amount BWSD can extract from both banking projects is 15,000 AF. The District has banked a total of approximately 41,700 AF in these projects. Additional surface storage, well recovery capacity and groundwater recharge capacity are means to improve water reliability.

Another source of reliable water for certain landowners is through access to other groundwater banking projects located outside the District's boundaries.

The water supply reliability for the District is parallel to that of the SWP and is best described by DWR in the following excerpts from “The State Water Project Final Delivery Reliability Report 2011”, dated June 2012.

“The 2011 Report shows that the SWP continues to be subject to reductions in deliveries similar to those contained in the State Water Project Delivery Reliability Report 2009 (2009 Report), caused by the operational restrictions of biological opinions (BOs) issued in December 2008 and June 2009 by the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) to govern SWP and Central Valley Project operations. Federal court decisions have remanded the BOs to USFWS and NMFS for further review and analysis. We expect that the current BOs will be replaced sometime in the future. The operational rules defined in the 2008 and 2009 BOs, however, continue to be legally required and are the rules used for the analyses supporting the 2011 Report.”

Regulatory Restrictions on SWP Delta Exports

“Multiple needs converge in the Delta: the need to protect a fragile ecosystem, to support Delta recreation and farming, and to provide water for agricultural and urban needs throughout much of California. Various regulatory requirements are placed on the

SWP's Delta operations to protect special-status species such as delta smelt and spring- and winter-run Chinook salmon. As a result, as described below, restrictions on SWP operations imposed by State and federal agencies contribute substantially to the challenge of accurately determining the SWP's water delivery reliability in any given year."

Biological Opinions on Effects of Coordinated SWP and CVP Operations

"Several fish species listed under the federal Endangered Species Act (ESA) as endangered or threatened are found in the Delta. The continued viability of populations of these species in the Delta depends in part on Delta flow levels. For this reason, the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) have issued several BOs since the 1990s on the effects of coordinated SWP/CVP operations on several species.

These BOs affect the SWP's water delivery reliability for two reasons. Most obviously, they include terms that specifically restrict SWP pumping levels in the Delta at certain times under certain conditions. In addition, the BOs' requirements are based on physical and biological phenomena that occur daily while DWR's water supply models are based on monthly data.

The first BOs on the effects of SWP (and CVP) operations were issued in February 1993 (NMFS BO on effects of project operations on winter-run Chinook salmon) and March 1995 (USFWS BO on project effects on delta smelt and splittail). Among other things, the BOs contained requirements for Delta inflow, Delta outflow, and reduced export pumping to meet specified incidental take limits. These fish protection requirements imposed substantial constraints on Delta water supply operations. Many were incorporated into the 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta (1995 WQCP), as described in the "Water Quality Objectives" section later in this chapter.

The terms of the USFWS and NMFS BOs have become increasingly restrictive in recent years. In December 2008, USFWS issued a new BO covering effects of the SWP and CVP on delta smelt, and in June 2009, NMFS issued a BO covering effects on winter-run and spring-run Chinook salmon, steelhead, green sturgeon, and killer whales. These BOs replaced BOs issued earlier by the federal agencies.

The USFWS BO includes additional requirements in all but 2 months of the year. The BO calls for "adaptively managed" (adjusted as necessary based on the results of monitoring) flow restrictions in the Delta intended to protect delta smelt at various life stages. USFWS determines the required target flow, with the reductions accomplished primarily by reducing SWP and CVP exports. Because this flow restriction is determined based on fish location and decisions by USFWS staff, predicting the flow restriction and corresponding effects on export pumping with any great certainty poses a challenge. The USFWS BO also includes an additional salinity requirement in the Delta for September and October in wet and above-normal water years, calling for increased releases from SWP and CVP reservoirs to reduce salinity. Among other provisions

included in the NMFS BO, limits on total Delta exports have been established for the months of April and May. These limits are mandated for all but extremely wet years.

The 2008 and 2009 BOs were issued shortly before and shortly after the Governor proclaimed a statewide water shortage state of emergency in February 2009, amid the threat of a third consecutive dry year. NMFS calculated that implementing its BO would reduce SWP and CVP Delta exports by a combined 5% to 7%, but DWR's initial estimates showed an impact on exports closer to 10% in average years, combined with the effects of pumping restrictions imposed by BOs to protect delta smelt and other species. The 2008 USFWS and 2009 NMFS BOs have been subject to considerable litigation. Recent decisions by U.S. District Judge Oliver Wanger changed specific operational rules for the fall/ winter of 2011–2012, and both the USFWS BO and NMFS BO have been remanded to the agencies for further review and analysis. However, the operational rules specified in the 2008 and 2009 BOs continue to be legally required and are the rules used in the analyses presented in Chapters 5, 6, and 7 of this report. Chapter 5 presents a comparison of monthly Delta exports as estimated for this 2011 Report with those estimated for the 2005 Report, illustrating how the 2008 and 2009 BOs have affected export levels from the Delta.

The California Department of Fish and Game (DFG) issued consistency determinations for both BOs under Section 2080.1 of the California Fish and Game Code. The consistency determinations stated that the USFWS BO and the NMFS BO would be consistent with the California Endangered Species Act (CESA). Thus, DFG allowed incidental take of species listed under both the federal ESA and CESA to occur during SWP and CVP operations without requiring DWR or the U.S. Bureau of Reclamation to obtain a separate State-issued permit.

Specific restrictions on Delta exports associated with the USFWS and NMFS BOs and their effects on SWP pumping levels are described further in Chapter 5, "SWP Delta Exports," of this report."

Water Quality Objectives

"Because the Delta is an estuary, salinity is a particular concern. In the 1995 WQCP, the State Water Board set water quality objectives to protect beneficial uses of water in the Delta and Suisun Bay. The objectives must be met by the SWP (and federal CVP), as specified in the water right permits issued to DWR and the U.S. Bureau of Reclamation. Those objectives—minimum Delta outflows, limits on SWP and CVP Delta exports, and maximum allowable salinity levels— are enforced through the provisions of the State Water Board's Water Right Decision 1641 (D-1641), issued in December 1999 and updated in March 2000.

DWR and Reclamation must monitor the effects of diversions and SWP and CVP operations to ensure compliance with existing water quality standards. Monitoring stations are shown in Figure 4-1.

Among the objectives established in the 1995 WQCP and D-1641 are the “X2” objectives. D-1641 mandates the X2 objectives so that the State Water Board can regulate the locations of the Delta estuary’s salinity gradient during the months of February–June. X2 is the position in the Delta where the electrical conductivity (EC) level, or salinity, of Delta water is 2 parts per thousand. The location of X2 is used as a surrogate measure of Delta ecosystem health. For the X2 objective to be achieved, the X2 position must remain downstream of Collinsville in the Delta (shown in Figure 4-1) for the entire 5- month period, and downstream of other specific locations in the Delta on a certain number of days each month from February through June. This means that Delta outflow must be at certain specified levels at certain times—which can limit the amount of water the SWP may pump at those times at its Harvey O. Banks Pumping Plant in the Delta. Because of the relationship between seawater intrusion and interior-Delta water quality, meeting the X2 objective also improves water quality at Delta drinking-water intakes; however, meeting the X2 objectives can require a relatively large volume of water for outflow during dry months that follow months with large storms.

The 1995 WQCP and D-1641 also established an export/inflow (E/I) ratio. The E/I ratio, presented in Table 3 of the 1995 WQCP (SWRCB 1995:18– 22), is designed to provide protection for the fish and wildlife beneficial uses in the Bay-Delta estuary (SWRCB 1995:15). The E/I ratio limits the fraction of Delta inflows that are exported. When other restrictions are not controlling, Delta exports are limited to 35% of total Delta inflow from February through June and 65% of inflow from July through January.”

In addition to these potential reductions, the District's ability to deliver a reliable water supply to its landowners is further impacted by capacity issues on the Coastal Branch of the Aqueduct. Not only is DWR responsible for maintaining facilities, it is also responsible for controlling aquatic weed growth. Often during peak irrigation demand (May-September) the dense growth of aquatic weeds impacts DWR's ability to convey an adequate supply through the Coastal Branch. This forces the District to allocate capacity and reduce the amount of water available to landowners during the most critical growing period.