Appendix A
Water Project Facilities and Operations

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A.1 WATER PROJECT FACILITIES AND OPERATIONS

The State Water Project (SWP) and Central Valley Project (CVP) include upstream reservoirs (Shasta and Keswick dams on the Sacramento River, Oroville Dam on the Feather River, Folsom and Nimbus dams on the American River, New Melones Dam on the Stanislaus River), several water conveyance canals, water export and fish salvage facilities located in the South Delta, and various operable and temporary barriers located in the Delta. Depending on seasonal hydrometeorology, the operation of upstream dams frequently influence river flow and inflow from the Sacramento and San Joaquin rivers into the Delta. As drier conditions prevail, these operations play an increasingly significant role in controlling river flows and Delta inflow. For purposes of this assessment, operation of the upstream dams and reservoirs is not included in the gap analysis; however, freshwater inflow from the San Joaquin River into the Delta is included as part of water project operations. Elements of SWP and CVP operations considered in the gap analysis are briefly discussed below.

A.1.1 TEMPORARY, OPERABLE, AND NON-PHYSICAL BARRIERS

As part of SWP and CVP operations, both temporary rock barriers (e.g., agricultural barriers in the south Delta, the Head of Old River Barrier [HORB]) and operable barriers (Delta Cross Channel [DCC] radial gates) are used to regulate and manage water flows through Delta channels, reduce the effects of South Delta export operations on water elevation in Delta channels that impact agricultural irrigation diversions and improve water quality, and reduce the risk of juvenile salmon entrainment in the export facilities. In addition, in recent years, non-physical barriers for guiding downstream migrating Chinook salmon and steelhead have been tested in the Sacramento River at Georgiana Slough and San Joaquin River at the head of Old River.

The Temporary Barrier Project has been in place since 1991 and has included the seasonal installation and subsequent removal of rock barriers at several locations in the South Delta (DWR 2011a, 2011b). These barriers are used to increase water levels in South Delta channels and reduce the effects of exports on water levels, improve water circulation and water quality, improve flows and increase dissolved oxygen concentrations for adult fall-run Chinook migration, and reduce the migration of juvenile salmon and steelhead into Old River in the spring. Temporary barriers have been installed at various locations including Middle River, the HORB during both the spring and fall, Grant Line Canal, and Old River at Tracy barrier. Monitoring and analysis of barrier effects conducted by the California Department of Water Resources (DWR) and others have included salmon smolt survival studies, barrier effects on fish entrainment at the SWP and CVP, Swainson's Hawk surveys, water elevations, South Delta water quality, and hydrodynamic modeling of barrier effects (DWR 2011a, 2011b).

There are two primary operable barriers (radial gates) used as part of SWP and CVP operations in the Delta including the radial gates at the SWP Clifton Court Forebay (CCF) discussed below, and the CVP DCC. The DCC, located on the Sacramento River near Walnut Grove, was constructed in 195. The DCC is a constructed conveyance channel that includes two radial gates (each 60 by 30 feet) that can be opened and closed to manage Sacramento River water flowing into the interior Delta. Sacramento River water enters the Delta via Snodgrass Slough and a branch of the lower Mokelumne River, where it subsequently enters the San Joaquin River and the Old and Middle rivers (OMR) channels, and potentially the South Delta export facilities. The fresh Sacramento River water is used to improve South Delta water quality and convey Sacramento River water that is available for export to the SWP and CVP.

Seasonal radial gate operation of the DCC is controlled by the State Water Resources Control Board Decision 1641 (D-1641) and the National Marine Fisheries Service (NMFS) Biological Opinion (NMFS 2009). Based on NMFS (2009), closure of the gates is managed based on fish presence and water quality between October 1 and November 30. Between December 1 and January 31, the gates are closed for up to 45 days per D-1641, but per NMFS (2009), the gates are required to be closed except if D-1641 water quality standards are exceeded. In accordance with D-1641, the gates are closed for juvenile salmonid protection from February 1 through May 20. From May 21 through June 15, the gates are closed for 14 days for fishery protection at the request of NMFS and the California Department of Fish and Wildlife (CDFW). The gates are typically open between June 16 and October 31. Also, the gates are typically closed for flood protection when Sacramento River flows reach 20,000 to 25,000 cubic feet per second (cfs). The gates have also been closed on an intermittent basis to conduct hydrodynamic or fishery experiments. The number of days during October to December 2000 through 2011 when the DCC gates have been closed is summarized in Table A.1-1.

Table A.1-1. Number of Days During the Fall When the DCC Has Been Closed

				Experimental Purpose for Closure		
Year	**October**	**November**	**December**	**October**	**November**	**December**
2000	31	8	4	Yes	Yes	No
2001	21	8	27	Yes	No	No
2002	3	1	22	Yes	No	No
2003	0	0	31	No	No	No
2004	0	0	25	No	No	Yes
2005	0	4	28	No	No	No
2006	1	0	16	No	No	No
2007	0	0	17	No	No	No
2008	0	17	18	No	Yes	Yes
2009	4	11	18	Yes	No	No
2010	3	4	31	Yes	No	No
2011	10	0	31	Yes	No	No
Average	6	4	22			

A.1.2 CLIFTON COURT FOREBAY GATES

CCF is operated as a regulating reservoir within the tidal region of the south Delta to improve SWP water export operations (Clark et al. 2009). CCF was constructed in 1969 with a surface area of 2,200 acres. Water is diverted from Old River through five radial gates (each 20 by 20 feet) as the flooding tide reaches CCF and through the early part of the ebb tidal cycle. The frequency that the radial gates are opened to flood CCF depends on the SWP export rate, the volume of water storage in CCF, and tidal conditions. When the difference in water surface elevation between Old River and CCF is greatest, water velocities entering CCF typically exceed 15 feet per second at flow rates that typically range between 10,000 and 15,000 cfs (Clark et al. 2009). After CCF has been filled, the radial gates are closed and water exports are made from storage within CCF. Fish are entrained into CCF when the radial gates are open and are subject to very high pre-screen losses. The losses can occur from predation within CCF, salvage at the SWP Skinner Fish Facility, or entrainment through the louver guidance system into the water distribution canal the pumped water discharges to (Clark et al. 2009; Kano 1990; Gingras and McGee 1997; Gingras 1997). NMFS (2004) included a requirement to assess pre-screen losses within CCF on juvenile steelhead (Clark et al. 2009), and NMFS (2009) included a requirement to identify and implement actions that would reduce pre-screen losses resulting from radial gate and CCF operations.

A.1.3 SWP AND CVP EXPORTS

The SWP and CVP export water from the South Delta using pumps and conveyance canals at the Harvey O. Banks Pumping Plant (SWP) and the C.W. "Bill" Jones Pumping Plant (CVP). Both export facilities are equipped with louver fish guidance systems and include fish salvage facilities designed to collect, transport, and release fish that enter the facilities back into the Delta. The CVP export facility draws water directly from Old River while the SWP diverts water from Old River into CCF (see description above). The rate that water can be exported from the Delta varies in response to several factors that include seasonal restrictions imposed by D-1641, which limits exports during the late winter and spring to no more than 35% of total Delta inflow and during the summer and fall to no more than 65% of total Delta inflow. Constraints on the maximum rate of exports also exist to avoid channel erosion that is independent of Delta inflow. USFWS (2008) and NMFS (2009), in addition to the CDFW incidental take permit, include additional seasonal limits on exports through regulation of the OMR reverse flows to reduce the risk of entrainment losses of protected fish in the Delta. Export rates are also adjusted based on consideration of water quality conditions (e.g., electrical conductivity, and more recently turbidity to reduce the risk of delta smelt entrainment), water storage and demand, conveyance in distribution canals, and other factors.

A.1.4 OMR Flow

Old River and Middle River are the two primary channels in the central and southern regions of the Delta that convey water to the SWP and CVP export facilities. Hydrodynamic conditions in the OMR channels are influenced by tidal conditions, DCC operations, SWP and CVP export rates, CCF radial gate operations, installation of the HORB, and Delta inflows from the San Joaquin River. Depending on these conditions, the daily flow of water in the channels typically is positive (flowing downstream to the west into the Delta) and then becomes reversed (negative; flowing upstream toward the SWP and CVP export facilities), and the proportion of time flow is positive or negative, which varies depending on the hydrodynamic conditions listed above. Results of a series of analyses have identified relationships between the magnitude of reverse flow in OMR and the risk of juvenile Chinook salmon and delta smelt to entrainment and salvage at the SWP and CVP export facilities (USFWS 2008; NMFS 2009). Results of these analyses showed a general pattern of a substantial increase in salmon and smelt salvage when reverse flows are more negative than -5,000 cfs. Both USFWS (2008) and NMFS (2009) use seasonal restrictions on OMR reverse flows as a method to reduce the risk of smelt and salmon entrainment losses.

A.1.5 Vernalis Inflow:Export Ratio

NMFS (2009) included a restriction on SWP and CVP export rates during April and May to a proportion of the S inflow to the Delta from the San Joaquin River at Vernalis. The most restrictive operations limit combined SWP and CVP exports to 25% of the flow in the San Joaquin River when wet conditions prevail. The April-to-May export restriction was intended to improve downstream flow from the San Joaquin River and through the Delta during the spring outmigration period for juvenile steelhead produced in the San Joaquin River watershed, as well as reduce the risk of entrainment mortality of steelhead at the SWP and CVP export facilities. The April-to-May export operations restrictions were challenged in Federal District court by the public water agencies and DWR and were the subject of the NMFS Biological Opinion (NMFS 2009) remand by Judge Wanger. The remand of the NMFS Biological Opinion was subsequently overturned on appeal.

A.1.6 San Joaquin River Inflow

San Joaquin River flow at Vernalis originates from several upstream tributaries including the Merced, Tuolumne, and Stanislaus rivers, as well as the upper San Joaquin River and local runoff. Among these upstream tributaries, the Stanislaus River and operation of New Melones Reservoir is the only water-project-related operation identified in NMFS (2009). For purposes of the analysis conducted by the SST, the combined San Joaquin River flow measured at Vernalis was assessed, not the contribution of flow from individual tributaries.

A.2 REFERENCES

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