EXHIBIT SVWU-1

TESTIMONY OF WALTER BOUREZ, P.E.

1. I am a registered civil engineer in the State of California and am employed by MBK Engineers ("MBK"). I have over 20 years of experience in water resources engineering, and I have worked on numerous projects involving the modeling of surface water systems, including many projects involving operation of the CalSim II model of the state and federal water systems in the Central Valley. A copy of my resume, which accurately describes my education and work experience, is Exhibit SVWU-2.

2. Daniel Easton is a registered civil engineer in the State of California and is employed by MBK. Mr. Easton has nine years of experience in water resources engineering. Before joining MBK in 2007, Mr. Easton worked for the California Department of Water Resources ("DWR"), where his work focused on development and operation of the CalSim II model. A copy of Mr. Easton's resume, which accurately describes his education and work experience, is Exhibit SVWU-3. Mr. Easton assisted me in the hydrological modeling that is described in this testimony.

3. We were tasked with analyzing the effects of various scenarios, as further described below, on the operations of the Central Valley Project (CVP) and State Water Project (SWP) and flows in the Sacramento, Feather and American Rivers and the Delta. This testimony provides a summary of our findings. In addition, we were tasked with reviewing the January 12, 2010 draft paper entitled "On Developing Prescriptions for Freshwater Flows to Sustain Desirable Fishes in the Sacramento-San Joaquin Delta" by William E. Fleenor, William A. Bennett, Peter B. Moyle, and Jay R. Lund of the Delta Solutions Program, Center for Watershed Sciences, University of California – Davis. A copy of this draft paper is Exhibit SVWU-60. This review was specific to Figures 4, 5, and 7 in this draft paper, which compare long-term unimpaired flows with three specified shorter periods of historical flows.

Model Used

4. To conduct this analysis, we used the version of the CalSim II model that was used by DWR to develop its 2009 State Water Project ("SWP") reliability study, which DWR released to the public on January 29, 2010. This model is available for download from DWR's Web site at: http://baydeltaoffice.water.ca.gov/modeling/hydrology/CalSim/Downloads/CalSimDownloads/CalSim-IIStudies/SWPReliability2009/index.cfm

5. DWR, the Bureau of Reclamation and hydrological engineering firms like MBK use the CalSim II model to analyze how changes in various parameters, like changes in Delta outflow criteria, will affect the operations of the Central Valley

Project and the State Water Project, flows in the major rivers that are tributary to the Delta, and flows in the Delta. The CalSim II model that we used to prepare the analyses that is described in this testimony is the model that DWR used to prepare its 2009 draft State Water Project reliability report (draft dated January 26, 2010). This is the most recent, publicly available report that is based on CalSim II modeling.

Modeled Scenarios

6. We used the CalSim II model to model the amounts of Delta outflows, and the levels of storage in and releases of water from Shasta, Oroville and Folsom Reservoirs, that would occur under each of the following scenarios.

   a. Scenario A: The SWRCB's water rights Revised Decision 1641 ("D-1641"). This scenario is referred to in this testimony and our exhibits as the "D-1641" scenario.

   b. Scenario B: Scenario A plus reasonable and prudent alternatives ("RPAs") in the 2008 Fish and Wildlife Service Biological Opinion for the Coordinated Operations and the 2009 National Marine Fisheries Services Biological Opinion for OCAP. [Formal Endangered Species Act Consultation on the Proposed Coordinated Operations of the Central Valley Project and State Water Project (Reference # 81420-2008-F-1481-5) (FWS, December 2008) and the Biological Opinion and Conference Opinion on the Long-Term Operations of the Central Valley Project and State Water Project (NMFS, June 2009)] This scenario is referred to in this testimony and our exhibits as the "Biological Opinions" scenario.

   c. Scenario C: Scenario B plus the Delta outflow standards proposed by the Bay Institute in its document *Targets for Protection of the Delta Ecosystem as an Integral Part of a Health Estuary* (available on-line at http://www.bay.org/publications/delta-vision (last visited February 8, 2010)). Exhibit SVWU-59 is a copy of this Bay Institute document. Under Scenario C, we modeled the following two proposed "targets" in the Bay Institute proposal (Exhibit SVWU-59, pp. 13-17):

Target 5. Restore spring Delta outflow to provide low salinity habitat in Suisun Bay, with average February-June X2 values ranging from less than or equal to 70 km from the Golden Gate in critically dry years to less than 58 km in wet years.

Spring Delta outflow target for different water year types
Average February – June X2 location (km)

Water year type	Wet	Above normal	Below normal	Dry	Critical
Target	≤58	≤61	≤64	≤67	≤70

Target 6. Restore fall Delta outflow to provide low salinity habitat downstream of the Sacramento-San Joaquin River confluence, with September-November average X2 values to less than 80 km in all years except critically dry years.

Fall Delta outflow target for different water year types
Average September – November X2 location (km)

Water year type	Wet	Above normal	Below normal	Dry	Critical
Target	≤80	≤80	≤80	≤80	≤83

For both the spring and fall Delta outflow targets, it is assumed that water year type is defined by the 40-30-30 Sacramento Valley Index as described in the 1995 Water Quality Control Plan (WQCP). Scenario C is referred to in this testimony and our exhibits as the "Bay Institute" scenario.

d. <u>Scenario D</u>: Scenario B plus an example Delta outflow standard provided in the January 12, 2010 draft of the paper entitled "On Developing Prescriptions for Freshwater Flows to Sustain Desirable Fishes in the Sacramento-San Joaquin Delta," by William E. Fleenor, William A. Bennett, Peter B. Moyle, and Jay R. Lund, of the University of California, Davis, of the UC Davis Center for Watershed Sciences. Exhibit SVWU-60 is a copy of this draft paper (UCD draft paper). Pages 17-21 of the UC Davis draft paper describe various "Individual Functional Flow Objectives." The flow objectives are summarized in Table 3 on page 18 of the draft paper.

Item 5a of the draft paper suggests a Delta outflow requirement for the benefit of Delta smelt as follows: "A 48,000 cfs flow for 3 months (Mar-May) for 5 of 10 years would maintain freshwater to low salinity habitat in the northeastern Delta to the Napa River, facilitating a broad spatial and temporal range in spawning and rearing habitat (Bennett 2005, Hobbs et al. 2005)" (Exhibit SVWU-60, p. 20). A footnote to Table 3 implies the flow standard should be applied in the wettest 50th percentile years, and not strictly in every 5 of 10 years (Exhibit SVWU-60, p. 18).

Therefore, in Scenario D, a 48,000 cfs Delta outflow requirement was applied March through May in the wettest 41 years of the 82 year simulation (wettest 50th percentile of simulated years). I based wetness on the WQCP 40-30-30 Sacramento Valley Index. This scenario is referred to in this testimony and our exhibits as the "UCD1" scenario.

e. Scenario E: Scenario B plus Yolo Bypass and Sacramento River flow requirements provided in the January 12, 2010 UCD draft paper (Exhibit SVWU-60).

Items 1a and 1b of the UCD draft paper suggest Yolo Bypass flows of 2,000 cfs from February to April in the wettest 8 of 10 years, and 4,000 cfs from March to April in the wettest 6 of 10 years. The flows are assumed to come from the Sacramento River through a notch in the Fremont Weir, as proposed in preliminary BDCP studies. (*See* Exhibit SVWU-60, p. 17)

For Scenario E, the 2,000 cfs (Feb-Apr) and 4,000 cfs (Mar-Apr) Yolo Bypass flow requirements were applied in the wettest 80th percentile and 60th percentile of simulated years, respectively. Wetness is based on the 40-30-30 Sacramento Valley Index. Based on previous Bay Delta Conservation Plan implementations of the proposed notched Fremont Weir in CalSim II, flow of 35,674 cfs at Verona is necessary to spill 2,000 cfs into the Yolo Bypass through the proposed notched weir. (Verona is on the Sacramento River just downstream of the Feather River confluence.) Likewise, flow of 38,791 cfs at Verona is necessary to achieve a 4,000 cfs spill into the Yolo Bypass. Spills over the notched Fremont Weir can be influenced by flow in the Sacramento River, Sutter Bypass, and Feather River.

Items 2a, 2b, and 2c of the UCD draft paper are intended to help spring run adult salmon, spring run juvenile salmon, and sturgeon respectively. Item 2a proposes a Sacramento River Delta inflow of 10,000 cfs from October to June in the wettest 6 of 10 years. Item 2b proposes a Sacramento River Delta inflow of 25,000 cfs from March to June in the wettest 6 of 10 years. Item 2c proposes a Sacramento River Delta inflow of 70,000 cfs from January to May in the wettest year of 10 (Exhibit SVWU-60, p. 19). These Sacramento River Delta inflow standards are applied in Scenario E based on the wettest percentile years throughout the simulation. Item 2a and 2b are applied in the wettest 60th percentile of simulated years; item 2c is applied in the wettest 10th percentile of simulated years. Wetness is based on the 40-30-30 Sacramento Valley Index. This scenario is referred to in this testimony and our exhibits as the "UCD2" scenario.

Modeling Methods

7. We have reviewed the version of the CalSim II model described above, and for the analyses described in this testimony, we made the following minor adjustments to this model to shorten model run time and prevent oscillations between model cycles:

a. Condensed model from a two-step TXFR study to a single-step CONV study;

b. Operated Contra Costa Water District Delta diversions to DSM2 pre-processed intake salinity instead of ANN calculated intake salinity; and

c. Minor adjustment to the implementation of the Delta Cross Channel RPA in the Smelt BO.

8. All of the scenarios were modeled over the 82-year period of hydrological record from 1922 through 2003. Existing level of development in the Sacramento Valley, San Joaquin Valley, and export service areas was assumed. For a list of detailed assumptions, refer to Appendix A in the State Water Project Delivery Reliability Report (December 2009)

9. For this testimony, we organized the model's outputs by month and water-year type, so that those results show incremental hydrological impacts for each month of the year in each of the five different water year-types. In characterizing water-year types, we used the five-type standard of the WQCP 40-30-30 Sacramento Valley Index and therefore divided water years into wet, above normal, below normal, dry and critical years.

Scenario Comparisons

10. After modeling the five scenarios described above, we made the following comparisons of the scenarios' outputs:

a. Scenario B (Biological Opinions) vs. Scenario A (D-1641): This comparison shows the hydrological effects of implementation of the RPA's in the 2008 and 2009 Biological Opinions, in comparison to operations under D-1641.

b. Scenario C (Bay Institute) vs. Scenario B (Biological Opinions): This comparison shows the additional hydrological effects that would occur if the Bay Institute's above-referenced spring and fall Delta outflow requirements were implemented as additional regulatory requirements (in addition to the regulatory requirements in Scenario B).

c. Scenario D (UCD1) vs. Scenario B (Biological Opinions): This comparison shows the hydrologic impacts if one of the Delta outflow standards (Item 5a in Table 3) proposed in the UCD draft paper (Exhibit SVWU-60) was implemented as an additional regulatory requirement (in addition to the regulatory requirements in Scenario B).

d. Scenario E (UCD2) vs. Scenario B (Biological Opinions): This comparison shows the hydrologic impacts if the Yolo Bypass and Sacramento River flow standards as proposed in the UCD draft paper (Exhibit SVWU-60) were implemented as additional regulatory requirements (in addition to the regulatory requirements in Scenario B).

Modeling Results

Scenario B (Biological Opinions) vs. Scenario A (D-1641)

11. Exhibit SVWU-4 shows, by water-year type, the average monthly Delta outflows that would occur under Scenario A (D-1641) over the 82-year period of hydrological record. Exhibit SVWU-5 shows the average monthly Delta outflows that would occur under Scenario B (Biological Opinions). Exhibit SVWU-6 shows the differences in these average monthly flows. In Exhibit SVWU-6, positive bars indicate more Delta outflow would occur under Scenario B and negative bars indicate less Delta outflow would occur under Scenario B. Exhibit SVWU-7 shows, by water year type, the total average annual additional Delta outflows that would occur under Scenario B than under Scenario A.

12. Exhibits SVWU-8, SVWU-10 and SVWU-12 show the end-of-September storage volumes in Shasta, Oroville and Folsom Reservoirs under Scenario A (the D-1641 scenario, shown in blue) and Scenario B (the Biological Opinions scenario, shown in red). "RPA Storage Level" in Exhibit SVWU-8 and subsequent exhibits is a minimum Shasta Carryover Storage level that is specified in the 2009 Salmon Biological Opinion for maintenance of a cold water pool in Shasta to maintain temperature compliance for salmon in the Sacramento River below Keswick. Exhibits SVWU-9, SVWU-11, and SVWU-13 show the probabilities of different end-of-September storage levels in Shasta, Oroville, and Folsom Reservoirs under Scenarios A and B. The end-of-September storage is also referred to as "carryover storage."

13. Exhibits SVWU-14, SVWU-15 and SVWU-16 show the changes in flows below Keswick Dam on the Sacramento River, the Thermalito Afterbay on the Feather River, and Nimbus Dam on the American River that would occur under Scenario B, in comparison to Scenario A. In these exhibits, positive bars indicate that the river flows would be higher under Scenario B than under Scenario A and negative bars indicate flow would be lower under Scenario B than under Scenario A.

Scenario C (Bay Institute) vs. Scenario B (Biological Opinions)

14. Exhibit SVWU-17 shows February through June (spring) average X2 target for Scenario C, average X2 position under Scenario B (referred to in Exhibits SVWU-17 and SVWU-18 as "current criteria"), and average X2 position under Scenario C. The bars in Exhibits SVWU-17 and SVWU-18 with U's above them are for modeled years when the Bay Institute X2 targets cannot be met because

storage levels in Shasta and Folsom Reservoirs already are at these reservoirs' dead pool levels, and storage in Oroville Reservoir already is at its level where releases are not feasible, and these X2 targets still have not been met.

15. Exhibit SVWU-18 shows September through November (fall) average X2 target for Scenario C, average X2 position under Scenario B, and average X2 position under Scenario C.

16. Exhibit SVWU-19 shows, by water-year type, the average monthly Delta outflows that would occur under Scenario C (Bay Institute) over the 82-year period of hydrological record. Exhibit SVWU-20 shows the difference between these average monthly Delta outflows and the average monthly Delta outflows that would occur under Scenario B. In this exhibit, positive bars indicate more Delta outflow would occur under Scenario C and negative bars indicate less Delta outflow would occur under Scenario C. Exhibit SVWU-21 shows, by water year type, the total average annual difference in Delta outflows that would occur under Scenario C than under Scenario B.

17. Exhibits SVWU-22, SVWU-24 and SVWU-26 show the end-of-September storage volumes in Shasta, Oroville and, Folsom Reservoirs under Scenario C (the Bay Institute scenario, shown in red) and Scenario B (the Biological Opinions scenario, shown in blue). Exhibits SVWU-23, SVWU-25 and SVWU-27 show the probabilities of different end-of-September storage levels in Shasta, Oroville, and Folsom Reservoirs under Scenarios B and C.

18. Exhibits SVWU-28, SVWU-29 and SVWU-30 show the changes in flows below Keswick Dam on the Sacramento River, the Thermalito Afterbay on the Feather River, and Nimbus Dam on the American River that would occur under Scenario C, in comparison to Scenario B. In these exhibits, positive bars indicate that the river flows would be higher under Scenario C than under Scenario B and negative bars indicate flow would be lower under Scenario C than under Scenario B.

Scenario D (UCD1) vs. Scenario B (Biological Opinions)

19. Exhibit SVWU-31 shows, by water-year type, the average monthly Delta outflows that would occur under Scenario D (UCD1) over the 82-year period of hydrological record. Exhibit SVWU-32 shows the difference between these average monthly Delta outflows and the average monthly Delta outflows that would occur under Scenario B. In Exhibit SVWU-32, positive bars indicate more Delta outflow would occur under Scenario D and negative bars indicate less Delta outflow would occur under Scenario D. Exhibit SVWU-33 shows, by water year type, total average annual difference in Delta outflows that would occur under Scenario D as compared to Scenario B.

20. Exhibits SVWU-34, SVWU-36, and SVWU-38 show the end-of-September storage volumes in Shasta, Oroville, and Folsom Reservoirs under Scenario D (the UCD1 scenario, shown in red) and Scenario B (the Biological Opinions scenario, shown in blue). Exhibits SVWU-35, SVWU-37, and SVWU-39 show the probabilities of different end-of-September storage levels in Shasta, Oroville, and Folsom Reservoirs under Scenarios B and D.

21. Exhibits SVWU-40, SVWU-41, and SVWU-42 show the changes in flows below Keswick Dam on the Sacramento River, the Thermalito Afterbay on the Feather River, and Nimbus Dam on the American River that would occur under Scenario D, in comparison to Scenario B. In these exhibits, positive bars indicate river flows would be higher under Scenario D than under Scenario B and negative bars indicate flow would be lower under Scenario D than under Scenario B.

Scenario E (UCD2) vs. Scenario B (Biological Opinions)

22. Exhibit SVWU-43 shows, by water-year type, the average monthly Sacramento River inflow to the Delta that would occur under Scenario E (UCD2) over the 82-year period of hydrological record. Exhibit SVWU-44 shows, by water-year type, the average monthly Sacramento River flow over the Fremont Weir into the Yolo Bypass.

23. Exhibit SVWU-45 shows the difference between Scenario E (UCD2) average monthly Delta outflows and the average monthly Delta outflows that would occur under Scenario B. In this exhibit, positive bars indicate more Delta outflow would occur under Scenario E and negative bars indicate less Delta outflow would occur under Scenario E. Exhibit SVWU-46 shows, by water year type, the total average annual difference in Delta outflows that would occur under Scenario E as compared to Scenario B.

24. Exhibits SVWU-47, SVWU-49 and SVWU-51 show the end-of-September storage volumes in Shasta, Oroville, and Folsom Reservoirs under Scenario E (the UCD2 scenario, shown in red) and Scenario B (the Biological Opinions scenario, shown in blue). Exhibits SVWU-48, SVWU-50 and SVWU-52 show the probabilities of different end-of-September storage levels in Shasta, Oroville, and Folsom Reservoirs under these two scenarios.

25. Exhibits SVWU-53, SVWU-54 and SVWU-55 show the changes in flows below Keswick Dam on the Sacramento River, the Thermalito Afterbay on the Feather River, and Nimbus Dam on the American River that would occur under Scenario D, in comparison to Scenario B. In these exhibits, positive bars indicate river flows would be higher under Scenario D than under Scenario B and negative bars indicate flow would be lower under Scenario D than under Scenario B.

Discussion and Findings

26. **Compare Scenario B (Biological Opinions) to Scenario A (D-1641)**

Comparing key system parameters from the modeled scenarios shows the results of how operations of the water system vary under various outflow requirements. We initially compared Scenario B (Biological Opinions) to Scenario A (D-1641) to show the hydrological effects of implementation of the RPA's in the 2008 and 2009 OCAP Biological Opinions relative to D-1641 conditions. This comparison was made to demonstrate how conditions in the system have changed since the last time the SWRCB set Delta water quality objectives. The following provides my findings relative to key system parameters.

a. Delta outflow

Exhibit SVWU-6 shows that Delta outflow would increase on average in all months except in June and in winter months of wet years.

b. Annual Delta outflow

Exhibit SVWU-7 shows that average annual Delta outflow would increase by approximately 1.1 MAF over the period of record. Outflow increases in wet years by 1.4 MAF, above normal years by 1.5 MAF, below normal years by 0.9 MAF, dry years by 0.9 MAF, and critical years by 0.5 MAF.

c. Changes in upstream reservoir carryover storage

Shasta storage

Exhibits SVWU-8 and 9 contain Shasta carryover storage and show that under Scenario B storage is approximately 100,000 AF lower on average than under Scenario A.

Oroville storage

Exhibits SVWU-10 and 11 contain Oroville carryover storage and show that under Scenario B storage is approximately 260,000 AF lower on average than under Scenario A.

Folsom storage

Exhibits SVWU-12 and 13 contain Folsom carryover storage and show that under Scenario B storage is approximately 11,000 AF lower on average than under Scenario A, and falls to dead pool in 3 years. During times when storage is at dead pool no storage releases can be made to the American River and water supply deliveries from Folsom are reduced.

d. Changes in river flows

Sacramento River

Exhibit SVWU-14 shows that Sacramento River flows below Keswick are increased in September and November to satisfy additional Delta outflow requirements. Decreases in Sacramento River flows below Keswick during the spring and summer months are approximately 70,000 AF lower in Scenario B due to increases in Clear Creek flow requirements in the Biological Opinions.

Decrease in upper Sacramento River flows during summer months can result in increases in river temperatures. Meeting temperature compliance in the Sacramento River with lower flows may require additional releases from the Shasta cold water pool than under Scenario A, resulting in further depletion of Shasta cold water pool.

Feather River

Exhibit SVWU-15 shows that Feather River flows are essentially higher in the months of July through September and lower from October through June.

American River

As shown in Exhibit SVWU-16 differences in American River flows below Nimbus vary from month to month and by year type with a general trend of less flow during early summer months and greater flow in later summer and fall months.

27. **Compare Scenario C (Bay Institute) to Scenario B (Biological Opinions)**

We have compared Scenario C (Bay Institute) to Scenario B (Biological Opinions) to show the hydrological effects of implementation of the Bay Institute targets relative current operating conditions under D-1641 and the Biological Opinions.

a. X2 position

Exhibit SVWU-17 shows Scenario B and Scenario C February through June average X2 position and the Bay Institute spring X2 target. There are 5 years in Scenario C when this target is not met, this is due to unavailable supply because upstream project reservoirs already have released all available water to meet X2 targets and have dropped to their dead pool levels.

Exhibit SVWU-18 shows Scenario B and Scenario C September through November average X2 position and the Bay Institute fall X2 target. There are 11 years in Scenario C when this target is not met, this is due to unavailable supply because upstream project reservoirs already have released all available water to meet X2 targets and have dropped to their dead pool levels.

b. Delta outflow

Exhibit SVWU-20 shows that outflow during months when the X2 target is imposed on the system is higher under Scenario C than under Scenario B, unless the X2 target is already met under Scenario B. Outflow is reduced in months when there is no increased X2 target or it was already met under Scenario B. As shown on Exhibit SVWU-21, average annual Delta outflow is about 900,000 AF higher in Scenario C than under Scenario B. While outflow in dry and critical years increases over 2.1 MAF and 1.5 MAF in below normal years, outflow in wet years is decreased about 300 TAF and about 450 TAF in above normal years.

The increase in outflow required to satisfy the Bay Institute X2 targets results in violations of D-1641 outflow requirements. When this occurs, storage in Shasta and Folsom Reservoirs are at dead pool, Oroville Reservoir is at levels where releases are not feasible, exports are below health and safety minimums, and surface water diversions upstream of the Delta are reduced as much as 6,000 cfs.

c. Changes in upstream reservoir carryover storage

Shasta storage

Exhibits SVWU-22 and 23 contain Shasta carryover storage and show that under Scenario C carryover storage is approximately 630,000 AF lower on average. Under Scenario C, storage falls below levels specified in the 2009 salmon Biological Opinion 30% more often than in Scenario B. There are 14 years when Shasta hits dead pool under Scenario C, and that there are periods when Shasta is at dead pool for several consecutive years.

When Shasta storage falls below levels specified in the Salmon Biological opinion there is not enough cold water available to maintain temperature compliance for endangered salmon species in the Sacramento River below Keswick. In cases where Shasta is very low in consecutive years, temperature compliance may be of concern for extended periods.

When storage falls to dead pool, water deliveries are substantially reduced. Urban water supplies in the upper Sacramento River may receive deliveries that are below health and safety levels. Water deliveries to downstream agricultural users are also substantially reduced under these conditions.

Oroville storage

Exhibits SVWU-24 and 25 contain Oroville carryover storage and show that under Scenario C storage is 370,000 AF lower on average than under Scenario B.

Folsom storage

Exhibits SVWU-26 and 27 contain Folsom carryover storage and show that under Scenario C storage is about 130,000 AF lower on average than under Scenario B, and falls to dead pool in 13 years, and that there are periods when Folsom is at dead pool for several consecutive years.

When storage falls to dead pool water deliveries are substantially reduced. Urban water supplies met from Folsom Reservoir, Nimbus Dam, and the lower American River may receive deliveries that are below health and safety levels.

d. Changes in river flows

Sacramento River

Exhibit SVWU-28 shows that Sacramento River flows below Keswick are generally increased in February through June to satisfy the spring X2 target and in September and some Novembers to meet the fall X2 target. There are decreases in July and August, September in critical years, October, November in wetter years, December, January, and February in wetter years. Many of the decreases are a result of Shasta using most or all storage to satisfy X2 targets and having limited or no supply remaining to meet Sacramento River flow requirements specified by the SWRCB and the 2009 salmon biological opinion. Flow decreases in July and August would likely result in the inability to satisfy temperature requirements for the protection of Salmon.

Feather River

Exhibit SVWU-29 shows that Feather River flows are often higher in the February through June period to satisfy the spring X2 target and higher in September of below normal years to satisfy the fall X2 target. Flows in July and August are lower as well as December through March in wetter years.

American River

Exhibit SVWU-30 shows that flow below Nimbus is increased to meet both the spring and fall X2 targets. Although there are increased flows in September in below normal and dry years, flows are generally lower from July through January.

28. **Compare Scenario D (UCD1) to Scenario B (Biological Opinions)**

We have compared Scenario D (UCD1) to Scenario B (Biological Opinions) to show the hydrological effects of implementation of the UCD Delta outflow targets relative to current operating conditions under D-1641 and the Biological Opinions.

a. Delta outflow

Exhibit SVWU-32 shows that outflow during March through May is increased in below normal, above normal, and wet years to meet the 48,000 cfs target. Outflow is reduced in most months outside the March through May period. Exhibit 33 shows average annual Delta outflow is about 590,000 AF higher in Scenario D relative to Scenario B. Outflow decreases in critical years by approximately 50 TAF, and in dry years by about 230 TAF, while outflow increases by about 640 TAF in wet years, 2.1 MAF in above normal years, and 830 TAF in below normal years.

b. Changes in upstream carryover reservoir storage

Shasta storage

Exhibits SVWU-34 and 35 contain Shasta carryover storage and show under Scenario D storage is approximately 660,000 AF lower on average. Under Scenario D storage falls below levels specified in the 2009 salmon Biological Opinion 34% more often than in Scenario B. There are 8 years when Shasta hits dead pool under Scenario D and there are occurrences when Shasta is at dead pool or critically low storage for several consecutive years.

When Shasta storage falls below the RPA storage levels specified in the 2009 OCAP salmon Biological Opinion, there is not enough cold water available to maintain temperature compliance for endangered salmon species in the Sacramento River below Keswick. In cases where Shasta is very low in consecutive years, temperature compliance may be of concern for extended periods.

When storage falls to dead pool water deliveries are substantially reduced. Urban water supplies in the upper Sacramento River may receive deliveries that are below health and safety levels. Water deliveries to downstream agricultural users are also substantially reduced under these conditions.

Oroville storage

Exhibits SVWU-36 and 37 contain Oroville carryover storage and show that under Scenario D storage is 380,000AF lower on average than under Scenario B.

Folsom storage

Exhibits SVWU-38 and 39 contain Folsom carryover storage and show that under Scenario D storage is about 100,000 AF lower on average than under Scenario B, and falls to dead pool in 8 years, and that there are periods when Folsom is at dead pool or critically low storage for several consecutive years.

When storage falls to dead pool water deliveries are substantially reduced. Urban water supplies met from Folsom Reservoir, Nimbus Dam, and the lower American River may receive deliveries that are below health and safety levels.

c. Changes in river flows

Sacramento River

Exhibit SVWU-40 shows that Sacramento River flows below Keswick are generally increased in March through May to satisfy the outflow target. There are decreases in Keswick release from June to February. Many of the decreases are a result of Shasta using most or all storage to satisfy increased Delta outflow targets and having limited or no supply remaining to meet Sacramento River flow requirements specified by the SWRCB and the 2009 salmon biological opinion. Flow decreases in June through September will likely result in the inability to satisfy temperature requirements for the protection of Salmon.

Feather River

Exhibit SVWU-41 shows that Feather River flows are often higher from March through May to satisfy outflow targets. Flows in June through February are lower.

American River

Exhibit SVWU-42 shows that flow below Nimbus is increased to meet the March through May outflow target. In general flows outside this period are lower, the exception being June and August of dry and critical years.

29. **Compare Scenario E (UCD2) to Scenario B (Biological Opinions)**

We have compared Scenario E (UCD2) to Scenario B (Biological Opinions) to show the hydrological effects of implementation of the UCD Sacramento River and Yolo Bypass flow targets relative current operating conditions under D-1641 and the Biological Opinions.

a. Sacramento River inflow to the Delta

Exhibit SVWU-43 shows Sacramento River inflow to the Delta generally increases from the February through June period and decreases from the July through January period when comparing Scenario E to Scenario B.

b. Sacramento River flow to the Yolo bypass at Fremont Weir

Exhibit SVWU-44 shows decreases in Yolo Bypass flows in December through March of wetter years. Increases in Yolo Bypass flows from February through April occur in all below normal and dry years. Increases also occur in March and April of above normal years and April of wet years.

c. Delta outflow

Exhibit SVWU-45 shows increases in outflow during March through June most of the time and increases in February of below normal and dry years. Outflow tends to be lower in July, November through January, and February in wet and above normal years.

Exhibit SVWU-46 shows average annual Delta outflow is about 1.4 MAF higher in Scenario E relative to Scenario B. Outflow in wet years increases by 180 TAF, above normal years increase by 1.5 MAF, below normal years increase by by 4.2 MAF, dry year outflow increase by 2.3 MAF and outflow in critical years decreases by approximately 120 TAF,

d. Changes in upstream reservoir carryover storage

Shasta storage

Exhibits SVWU-47 and 48 contain Shasta carryover storage and show that, under Scenario E, storage is approximately 1,280,000 AF lower on average than under Scenario B. Under Scenario E, storage falls below the RPA Storage Level specified in the 2009 OCAP salmon Biological Opinion 54% more often than under Scenario B. There are 29 years when Shasta is at dead pool under Scenario E, and that there are periods when Shasta is at dead pool or critically low storage for several consecutive years.

When Shasta storage falls below the RPA Storage Level specified in the Salmon Biological opinion there is not enough cold water available to maintain temperature compliance for endangered salmon species in the Sacramento River below Keswick. In cases where Shasta is very low in consecutive years, temperature compliance may be of concern for extended periods.

When storage falls to dead pool, water deliveries are substantially reduced. Urban water supplies in the upper Sacramento River may receive deliveries that are below health and safety levels. Water deliveries to downstream agricultural users are also substantially reduced under these conditions.

Oroville storage

Exhibits SVWU-49 and 50 contain Oroville carryover storage and show that, under Scenario E, storage is 825,000AF lower on average than under Scenario B.

Folsom storage

Exhibits SVWU-51 and 52 contain Folsom carryover storage and show that, under Scenario E, storage is about 140,000 AF lower on average than under Scenario B, and is at dead pool in 20 years, and that there are periods when Folsom is at dead pool or critically low storage for several consecutive years.

When storage falls to dead pool water deliveries are substantially reduced. Urban water supplies in the met from Folsom Reservoir, Nimbus Dam, and the lower American River may receive deliveries that are below health and safety levels.

e. Changes in river flows

Sacramento River

Exhibit SVWU-53 shows that Sacramento River flows below Keswick generally increases from the March through May period and in February of below normal and dry years. Flows decrease from the July through January period and in February during wet and above normal years when comparing Scenario E to Scenario B. Because flows required to meet lower Sacramento River and Yolo Bypass targets cause high Shasta releases, there are many times when there is inadequate supply in Shasta to satisfy the upper Sacramento River flow requirements specified by SWRCB WR 90-5, the 1993 winter-run salmon Biological Opinion for temperature control, and the 2009 OCAP salmon Biological Opinion Action I.2.2. Flow decreases in June through September will likely result in the inability to satisfy temperature requirements for the protection of salmon.

Feather River

Exhibit SVWU-54 shows that Feather River flows are often higher from February through June to satisfy flow targets. Flows in July through January are lower.

American River

Exhibit SVWU-55 shows that flow below Nimbus is increased during May, June, and October to meet Sacramento River flow targets. Flow below Nimbus is often lower outside the period of these flow targets.

Comparisons of Historical Flows to Unimpaired Flows

30. The authors of the UC Davis draft paper have compared the unimpaired flows for a long period of record (1921-2003) to actual historical flows during three selected shorter periods. These are shown in Figure 4 for the Sacramento Valley outflow, Figure 5 for the San Joaquin Valley outflow, and Figure 7 for the Net Delta Outflows in the UC Davis Report (see Exhibit SVWU-60, pp. 10-12).

31. The authors attribute these changes solely to "… effects of large upstream diversions on the Sacramento and San Joaquin Rivers…" [page 10], and "The combined effects of water exports and upstream diversions…" [page 11].

32. Exhibits SVWU-56, SVWU-57 and SVWU-58 show the Sacramento Valley, San Joaquin Valley and Delta unimpaired outflows for the entire 1922-2003 period of record and for the three shorter periods for which Figures 4, 5, and 7 of the UC Davis Report show historical flows. (Our exhibits show unimpaired flows for 1986-2003 while the UC Davis draft paper shows historical flows for 1986-2005. We could not include unimpaired flows for 2004 and 2005 when we prepared our figures, because DWR's estimates of unimpaired flows are available only for years through 2003.)

33. Exhibits SVWU-56, 57, and 58 show that, contrary to statements in the UC Davis draft paper, the large differences between the monthly unimpaired flows for the 1921-2003 for January through May and the historical monthly flows for the 1949-1968, 1969-1985 and 1986-2005 period are largely because of differences in the unimpaired hydrology for these periods. These exhibits also show that, contrary to statements in the UC Davis draft paper, some of the differences in historical monthly flows for many months between the 1949-1968 and 1969-1985 periods and the 1986-2003 period are because of differences in the unimpaired hydrology for these periods. The UC Davis draft paper therefore is incorrect when it states that the lower historical monthly flows during the 1985-2005 period are solely because of water diversions and exports.