EXHIBIT ARWA-100

TESTIMONY OF JEFFREY WEAVER, P.E.

1. I am a registered civil engineer in the State of California and am employed by the firm of HDR Engineering, Inc. (HDR). I hold a Bachelor of Science degree in Civil Engineering from the University of California, Davis.

2. I have over 17 years of experience in water resources engineering and have worked on numerous projects involving the modeling of surface water systems, including several projects involving the operation of CalSim II models of State and Federal water systems in the Central Valley. A copy of my resume, which accurately describes my education and experience, is **Exhibit ARWA-101.**

3. I have extensive experience in modeling the projected effects of water management measures related to the American River. As discussed in **Exhibit ARWA-101**, I have been the CalSim II modeling lead for the U.S. Army Corps of Engineers' update to the Folsom Reservoir Water Control Manual update that is associated with the construction and eventual operation of the Folsom Reservoir Auxiliary Spillway that is currently under construction. In addition, I have worked with the Sacramento Water Forum for many years in conducting CalSim II modeling of different potential management scenarios involving Folsom and Nimbus Dams and the lower American River. The Water Forum technically is part of the Sacramento City-County Office of Metropolitan Water Planning. When I and others involved in the water community in the Sacramento region talk about the Water Forum, however, what we mean is the effort of over 35 cities, counties, water suppliers, environmental groups, business organizations and public stakeholders who signed the Water Forum Agreement in 2000 to manage the region's water resources to meet co-equal water-supply and environmental objectives.

4. My testimony concerns my review and analysis of results from the hydrological modeling that the California Department of Water Resources (DWR) and the federal Bureau of Reclamation (Reclamation) have made available for review for this hearing. The summary of my testimony is provided in the PowerPoint presentation that is **Exhibit ARWA-102.** I did not conduct or prepare any independent modeling for purposes of this testimony, but rather only reviewed the modeling made available by DWR and Reclamation for this hearing.

5. As discussed in greater detail below, my review of the California WaterFix modeling results for the water years 1932 and 1933 – a below normal year followed by a critically dry year – that DWR and Reclamation have made available indicates the following:

   (a) The California WaterFix project – as represented in the Boundary 1, Alternative 4A H3, Alternative 4A H4 and Boundary 2 scenarios – would enable Reclamation to draw down Folsom Reservoir storage substantially

8618\CWF\Change Petition\Weaver\D083116A J Weaver Testimony.docx going into a critically dry year like 1933, relative to the No Action Alternative;

(b) The California WaterFix modeling does not appropriately indicate how Reclamation would operate Folsom Reservoir with the California WaterFix in the spring of a critically dry water year like 1933 because the modeling contains an unrealistic step function that triggers inappropriate reductions in lower American River streamflows as a result of projected future low Folsom Reservoir storage; and

(c) The California WaterFix modeling does not appropriately indicate how Reclamation would operate Folsom Reservoir during the summer of a critically dry year like 1933 with the California WaterFix because the modeled releases from the reservoir for 1933 swing dramatically from very low to very high releases in a manner that, in my experience, does not reflect a realistic operation of the reservoir.

Background Of CalSim II

6. CalSim II, a water resources planning model, is commonly used by hydrologic engineers in California to evaluate the hydrologic effects of different operations of the Central Valley Project (CVP) and the State Water Project (SWP).

7. CalSim II is a particular application of the Water Resources Integrated Modeling System (WRIMS). WRIMS is generalized water resources software developed by DWR's Bay-Delta Office. WRIMS is entirely data driven and can be applied to most reservoir river basin systems. WRIMS represents the physical system (reservoirs, streams, canals, pumping stations, etc.) by a network of nodes and arcs. The model user describes system connectivity and various operational constraints using a modeling language known as Water Resources Simulation Language (WRESL). WRIMS subsequently simulates system operation using optimization techniques to route water through the network based on mass balance accounting. A mixed integer programming solver determines an optimal set of decisions in each monthly time step for a set of user-defined priorities (weights) and system constraints. WRIMS uses an optimization engine, the XA solver, developed and distributed by Sunset Software Technology, and the Water Forum used XA16 for all simulations.

8. CalSim II was jointly developed by Reclamation and DWR for performing planning studies related to CVP and SWP operations. The primary purpose of CalSim II is to evaluate the water supply reliability of the CVP and SWP at current and future levels of development (e.g., 2015, 2035), with and without various assumed future facilities, and with different modes of facility operations. Geographically, the model covers the drainage basin of the Delta, all CVP deliveries and SWP deliveries to the Tulare basin, the San Francisco Bay Area (Bay Area), Central Coast, and Southern California. CalSim II typically simulates system operations for a 82-year period using a monthly time step. The model assumes that facilities, land use, water supply contracts, and regulatory requirements are constant over this period, representing a fixed level of development. The historical flow record of October 1921 to September 2003, adjusted for the influence of land use changes, upstream flow regulations, and

potentially climate change, is used to represent the possible range of water supply conditions.

9. I have been personally involved in writing portions of the software code that is part of commonly used versions of CalSim II. For my work associated with the Folsom Reservoir Water Control Manual Update, I wrote the software code that reflects the implementation, at Folsom and Nimbus Dams, of the 2006 lower American River flow management standard, which is known as the "2006 FMS." **Exhibit ARWA-103** is a copy of the July 31, 2006 technical memorandum entitled "Lower American River Flow Management Standard" that describes the 2006 FMS and was the basis for my work in modeling operations under the 2006 FMS. My understanding is that Reclamation began operating Folsom and Nimbus Dams consistent with the 2006 FMS in about 2007. In 2009, the National Marine Fisheries Service (NMFS) largely incorporated the 2006 FMS into its biological opinion (BiOp) for the operation of the CVP and the SWP as part of that opinion's reasonable and prudent alternatives. **Exhibit ARWA-104** is a copy of the 2009 NMFS's BiOp's Appendix 2-D, which reflects the 2006 FMS. As part of my technical work for the Folsom Reservoir Water Control Manual Update, I prepared the software code to implement in CalSim II the 2009 NMFS BiOp's terms that reflect the 2006 FMS. As part of my subsequent work with the Water Forum, I have revised versions of CalSim II to better reflect how the terms of the 2006 FMS and of the 2009 NMFS BiOp's Appendix 2-D would operate under real conditions.

10. Results from a single CalSim II simulation may not necessarily correspond to actual system operations for a specific month or year, but are representative of general water supply conditions over the modeled period of record. CalSim II can be used in either a comparative or an absolute mode. The comparative mode consists of comparing two model runs: one containing modifications representing an alternative and one that does not. Differences in certain factors, such as deliveries or reservoir storage levels, are analyzed to determine the impacts of each alternative. In the absolute mode, results of a single model run, such as the amounts of deliveries or reservoir levels, are considered directly.

11. Model results are generally believed to be more reliable in a comparative mode than in an absolute mode. In the comparative mode, all of the assumptions are the same for baseline and alternative model runs, except for assumptions regarding the action, and the focus of the analysis is on the differences in the results. My testimony concerns the use of CalSim II in the comparative mode presented in the California WaterFix modeling made available by DWR and Reclamation for this hearing.

Review And Production Of Modeling Results From CalSim II Modeling For California WaterFix

12. On or about June 13, 2016, I accessed the CalSim II modeling files for California WaterFix made available by DWR and located on the World Wide Web at http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/california_waterfix/water_right_petition.shtml. I accessed the available files for the

CalSim II model runs associated with the five California WaterFix alternatives that I understand DWR and Reclamation are presenting in this hearing. After having reviewed those files, I assembled the results for Folsom Reservoir storage and American River flows at Nimbus Dam and collected them in two types of graphics.

13. The first type of graphic that I prepared presents probability of exceedance curves for end-of-month Folsom Reservoir storage for the entire period of hydrologic record contained the CalSim II files made available by DWR at the above-referenced World Wide Web site. **Exhibit BKS-12**, a copy of which is submitted with my testimony for ease of reference, collects the end-of-month exceedance curves that I prepared for the months of July through December over the entire 82-year period of record.

14. The second type of graphic that I prepared presents end-of-month Folsom Reservoir storage, and average monthly American River flows at Nimbus Dam, for several calendar years within the period of hydrologic record contained the CalSim II files made available by DWR at the above-referenced World Wide Web site. **Exhibit BKS-13**, a copy of which is submitted with my testimony for ease of reference, collects the annual Folsom Reservoir storage plots and plots of American River flows at Nimbus Dam that I prepared for the months of July through December. With the exception of the calendar year of 1932, each of the calendar years depicted in Exhibit BKS-12 contains a January-September period that is part of a critically dry water year. The calendar year 1932 contains a January-September period that is part of a below normal year, with the water year 1933 that begins on October 1, 1932 being a critically dry water year. These water years are classified according to the Sacramento Valley Index, which was adjusted for climate change and defined as an input to DWR's CalSim II model.

The California WaterFix Modeling Results For 1932 And 1933 Demonstrate That The California WaterFix Project Would Enable Greater Drawdowns Of Folsom Reservoir Leading Into Dry Years, With Significant Impacts On The Reservoir's Storage Levels

15. As discussed above, I analyzed the CalSim II modeling results that DWR and Reclamation have made publicly available for California WaterFix. In particular, I reviewed the modeling results for Folsom Reservoir storage and Nimbus Dam flows in all of the critically dry water years within the 1922-2003 period of record and as defined by the Sacramento Valley Index. I also reviewed all of the modeling results for Folsom Reservoir storage and Nimbus Dam flows in all of the calendar years in the period of record that contain a January-September period that is part of a critically dry water year.

16. As **Exhibit BKS-13** indicates, those modeling results demonstrate that, as modeled, the calendar year 1933 – with the critically dry 1933 water year having started on October 1, 1932 – would begin with the amount of water stored in Folsom Reservoir being significantly lower in the California WaterFix with-project scenarios than in the No Action Alternative. (I refer to the following California WaterFix modeling scenarios collectively as the "With-Project" scenarios: Boundary 1; Alternative 4A H3; Alternative 4A H4; and Boundary 2.) The California WaterFix modeling results made available by DWR state that the end-of-December storage in Folsom Reservoir for the calendar year 1932 would be as follows in the following modeling scenarios

(a) No Action Alternative (NAA) – 477,477 acre-feet (AF);

(b) Boundary 1 – 353,452 AF (124,025 AF (26%) lower than the NAA);

(c) Alternative 4A H3 – 329,519 AF (147,957 AF (31%), lower than the NAA);

(d) Alternative 4A H4 – 321,014 AF (156,463 AF lower (33%) than the NAA); and

(e) Boundary 2 – 278,100 AF (199,377 AF (42%) lower than the NAA).

Exhibit ARWA-105 contains the numerical results from the California WaterFix modeling from the NAA and the With-Project scenarios for end-of-month Folsom Reservoir storage and Nimbus Flows for all months within the calendar years 1932 and 1933.

17. Based on this finding, I investigated further the California WaterFix modeling results for 1932 and 1933 made available by DWR.

18. **Exhibit ARWA-106** consists of figures that I prepared based on my review and assembly of information from the California WaterFix modeling made available by DWR for the calendar years 1932 and 1933 for the following parameters:

(a) End-of-month storage in Folsom Reservoir; and

(b) Average monthly streamflow releases from Nimbus Dam into the lower American River (I refer to this parameter as "Nimbus Flow").

19. The numerical modeling results in **Exhibit ARWA-105** and the figures in **Exhibit ARWA-106** indicate the following points:

(a) While water year 1932 – which began on October 1, 1931 – was a below normal year under the Sacramento Valley Index, Folsom Reservoir filled within 100 acre-feet, of its maximum simulated capacity of 967,000 AF in the NAA and all of the With-Project scenarios by the end of May 1932 and remained near that maximum storage capacity through June 1932;

(b) Beginning in July 1932, the With-Project scenarios cause drawdowns of Folsom Reservoir storage relative to the NAA. In all of the With-Project scenarios, the July 1932 Nimbus Flow is 5,000 cubic feet per second (cfs), while the July 1932 Nimbus Flow is only 2,010 cfs in the NAA.

(c) In July 1932 alone, the increased Nimbus Flows under the With-Project scenarios relative to the NAA result of 184,000 AF more water being released from Folsom Reservoir in the With-Project scenarios than in the NAA;

(d) While the minimum release requirement (MRR) for Nimbus Flow under the 2006 FMS and the 2009 NMFS BiOp, as reflected in the California WaterFix modeling, varies by month during the June 1932 through February 1933, total modeled Folsom Reservoir releases are substantially higher during that period in the With-Project scenarios than in the NAA. Specifically, the total amount of Nimbus Flow above the minimum release requirement during the June 1932 through February 1933 period for the NAA and each of the With-Project scenarios is as follows:

(i) NAA – 269,000 AF

(ii) Boundary 1 – 393,000 AF (124,000 AF more than the NAA);

(iii) Alternative 4A H3 – 393,000 AF (124,000 AF more than the NAA);

(iv) Alternative 4A H4 – 400,000 AF (131,000 AF more than the NAA); and

(v) Boundary 2 – 449,000 AF (180,000 AF more than the NAA).

(f) In other words, beginning in June of a below normal water year and continuing until February of a succeeding critically dry year, the California WaterFix modeling results indicate that the With-Action scenarios result in the release of between 124,000 AF and 180,000 AF additional water from Folsom Reservoir than the NAA. As described above, these modeled operations under the With-Project scenarios result in end-of-December 1932 Folsom Reservoir storage being substantially lower during a critically dry water year than the modeled operations under the NAA.

(g) This reduced Folsom Reservoir storage persists until February 1933 in the California WaterFix modeling results. In those results, Folsom Reservoir storage is as follows at the end of February 1933:

(i) NAA – 382,451 AF

(ii) Boundary 1 – 260,983 AF (121,468 AF (32%) lower than the NAA);

(iii) Alternative 4A H3 – 237,111 AF (145,340 AF (38%) lower than the NAA);

(iv) Alternative 4A H4 – 228,627 AF (158,823 AF (40%) lower than the NAA);

(v) Boundary 2 – 285,833 AF (196,618 AF (51%) lower than the NAA).

The Folsom Reservoir Operations Storage Depicted In The California WaterFix Modeling In The Spring And Summer Of 1933 Do Not Provide A Reasonable Depiction Of Folsom Operations In A Critical Dry Year

20. In the California WaterFix modeling results depicted in **Exhibit ARWA-106**, after February 1933, Folsom Reservoir storage recovers in the With-Project scenarios relative to the NAA until the results for all of the scenarios reach roughly the same storage level of roughly 400,000 AF at the end of May 1933. Based on my work on modeling of American River operations for the Folsom Reservoir Water Control Manual Update and the Water Forum and my work in preparing and refining

CalSim II to reflect the 2006 FMS and the related terms of the 2009 NMFS BiOp, however, it is my opinion that the recovery of Folsom Reservoir storage in the With-Project scenarios relative to the NAA between February 1933 and May 1933 reflects improper modeling of the terms of the 2006 FMS and the 2009 NMFS BiOp. My opinion is that proper modeling of the terms of the 2006 FMS and the 2009 NMFS BiOp would not show nearly the same amount of recovery of Folsom Reservoir storage between February 1933 and May 1933 in the With-Project scenarios relative to the NAA.

21. As discussed on pages one through four of Appendix 2-D to the 2009 NMFS BiOp (**Exhibit ARWA-104**), the minimum release requirement for Nimbus Flow generally is set according to certain defined hydrologic index values and other considerations. As discussed on page one of Appendix 2-D, this MRR is subject to certain adjustments in defined very dry conditions. As Appendix 2-D's page one states:

> The MRR and Adjusted MRR may be suspended in the event of extremely dry conditions, represented by "conference years" or "off-ramp criteria." Conference years are defined when the projected March through November unimpaired inflow into Folsom Reservoir is less than 400,000 acre-feet. Off-ramp criteria are triggered if forecasted Folsom Reservoir storage at any time during the next twelve months is less than 200,000 acre-feet.

22. Under the 2006 FMS and the 2009 NMFS BiOp, when "off-ramp criteria" are triggered, the minimum Nimbus Flow can be below the otherwise indicated MRR. The 2006 technical memorandum that is **Exhibit ARWA-103**, upon which the terms of the 2009 NMFS BiOp concerning the minimum release requirement for Nimbus Flow is based, states, at page six:

> Off-ramp criteria- are triggered if forecasted Folsom Resevoir storage at any time during the next 12 months is less than 200,000 AF.
>
> (i) From January 1 through September 15, the MFR [minimum flow requirement] may be reduced to as low as 250 cfs.
>
> (ii) From September 16 through December 31, the MFR may be reduced to as low as 500 cfs.

23. My experience is that, when the 2006 FMS was first incorporated into CalSim II models, the assumption was made that, if its off-ramp criteria were triggered as a result of forecasted Folsom Reservoir storage being below 200,000 AF within the next 12 months, then the model would assume that the MRR would drop from whatever would otherwise be indicated to the minimum considered to be allowed by Decision 893. For example, this modeled operation could result in modeled February Nimbus Flows being 1,500 cfs and, after the model determined that the off-ramp criteria were met, the modeled March Nimbus Flows being 500 cfs or even 250 cfs.

24. After Reclamation began implementing the 2006 FMS, the Water Forum analyzed possible water management measures to achieve its co-equal water-supply and environmental objectives, and the Water Forum technical team determined that

modeling the 2006 FMS's, and the 2009 NMFS BiOp's, off-ramp criteria as allowing streamflow to be reduced to the minimums considered to be allowed by the 2006 FMS as soon as the off-ramp criteria were met was not technically defensible. I have been a member of the Water Forum's technical team for many years and was a member of that team as the team considered how to properly model the off-ramp-criteria under the 2006 FMS and the 2009 NMFS BiOp.

25. The Water Forum's technical team determined that it was not technically defensible to operate a model to allow Nimbus Flows to be reduced to the minimums considered to be allowed by the 2006 FMS as soon as the off-ramp criteria were met because of a variety of concerns. Those concerns included the possibility of dewatering redds of steelhead and fall-run Chinook salmon, possible water temperature effects and possible stranding of steelhead and fall-run Chinook salmon juveniles.

26. As a result of these concerns, the Water Forum revised its modeling of the operation of the 2006 FMS and the 2009 NMFS BiOp to better reflect how their off-ramp criteria would be likely to be applied in the real world. I was the lead in preparing that update to the CalSim II modeling used by the Water Forum. Rather than allowing Nimbus Flows to be reduced to the minimum level considered to be allowed by the 2006 FMS as soon as the off-ramp criteria were triggered, the revised Water Forum modeling instead reduced the MRR for Nimbus Flows only to the extent necessary to ensure that the modeling would contain no forecasts of Folsom Reservoir storage being drawn below 200,000 AF in the following 12 months. In other words, in the revised Water Forum modeling, once the off-ramp criteria were triggered, the model would reduce the MRR for Nimbus Flow in succeeding months only to the extent necessary to ensure that the condition triggering the off-ramp criteria was resolved. In general, this adjustment resulted in the Water Forum's modeling results containing much less dramatic swings in Nimbus Flow than modeling under CalSim II otherwise would allow. In my professional experience, this sort of correction of a step-function in CalSim II frequently occurs as modelers use CalSim II.

27. As discussed above, in the California WaterFix modeling results depicted in **Exhibit ARWA-106**, after February 1933 in the With-Project scenarios relative to the NAA, Folsom Reservoir storage appears to recover from the prior drawdown caused by the With-Project scenarios relative to the NAA until the results for all of the scenarios reach roughly the same point at roughly 400,000 AF at the end of May 1933.

28. In my opinion, however, this recovery is not technically defensible because it reflects the step-function error in modeling of the operation of the 2006 FMS's and the 2009 NMFS BiOp's off-ramp criteria that was present in the initial CalSim II modeling of those criteria that the Water Forum later refined to ensure that modeling of those off-ramp criteria reflected more real CVP operations.

29. This problem in the California WaterFix modeling is most clearly indicated by the Nimbus Flows depicted for March 1933 for the NAA versus the With-Project scenarios. Based on my review of the California WaterFix modeling, all of the With-Project scenarios trigger the 2006 FMS's and the 2009 NMFS BiOp's off-ramp criteria in March 1933. In the Alternative 4A H3, Alternative 4A H4 and Boundary

2 scenarios, the modeling indicates that Nimbus Flows were reduced from approximately 1,500 cfs in February 1933 to approximately 392 cfs in March 1933. These releases are essentially the minimum Nimbus Flow possible that would meet the understood Decision 893 requirement that there be a minimum streamflow of 250 cfs throughout the American River. In the Boundary 1 scenario, the modeling indicates that Nimbus Flows were reduced from approximately 1,500 cfs in February 1933 to approximately 494 cfs in March 1933. These types of results were exactly the sort of dramatic step-function-driven reductions in lower American River streamflows that the Water Forum technical team decided were not technically defensible and therefore modified the modeling of the 2006 FMS's and the 2009 NMFS BiOp's off-ramp criteria to eliminate. In particular, I do not believe that it is defensible to model reductions in lower American River streamflows from approximately 1,500 cfs in February to approximately 250 or 350 cfs in March because it is my understanding that steelhead listed under the federal Endangered Species Act spawn in the lower American River in February and such a dramatic reduction in streamflows would dewater a large percentage of steelhead redds set in February.

30. These dramatic reductions in March 1933 Nimbus Flows are a key reason why, in the California WaterFix modeling, the With-Project scenarios' Folsom Reservoir storage recovers, relative to the NAA, in the spring of 1933 from the drawdown of that storage in the With-Project scenarios from June 1932 – in a below normal water year – to February 1933 – in the succeeding critically dry water year. In March 1933, the modeling of the NAA does not trigger the 2006 FMS's and the 2009 NMFS BiOp's off-ramp criteria, so the model did not reduce Nimbus Flow from the applicable MRR. The resulting differences in modeled March 1933 Nimbus Flows, with the amount of modeled Folsom Reservoir storage recovered relative to the NAA in the With-Project scenarios, are as follows:

    (a) NAA – 1,445 cfs;

    (b) Boundary 1 – 494 cfs (58,485 AF recovered relative to NAA);

    (c) Alternative 4A H3 – 392 cfs (64,748 AF recovered relative to NAA);

    (d) Alternative 4A H4 – 392 cfs (64,748 AF recovered relative to NAA); and

    (e) Boundary 2 – 392 cfs (64,748 AF recovered relative to NAA).

31. In the California WaterFix modeling, these inappropriate results for end-of-March 1933 Folsom Reservoir then drove the modeling of Folsom Reservoir operations in April 1933. The NAA and the With-Project scenarios all increased Nimbus Flows to attempt to achieve relative equality in end-of-April Folsom storage with end-of-April Shasta Reservoir storage. CalSim II attempts to maintain relatively equivalent storage within Folsom and Shasta reservoirs by adjusting releases for common operational objectives from each reservoir so that one reservoir is not excessively drawn-down compared to the other reservoir. The functional result of this balancing is, with a relative increase in Folsom Reservoir storage, there would be a corresponding increase in Folsom Reservoir release and decrease from Shasta

Reservoir, for common downstream objectives for Folsom and Shasta reservoirs. The discrepancies between the end-of-March storage in the NAA and the end-of-March storage in the With-Project scenarios, in April 1933, cause more water to be released from Folsom Reservoir in the NAA than in the With-Project scenarios. This discrepancy results in end-of-April Folsom storage being relatively close among all of the scenarios, with it being approximately 338,000 AF in the With-Project scenarios and 363,305 AF in the NAA.

32. The California WaterFix modeling reflects further inappropriate operations during the May through August 1933 period that appear to obscure possible effects of the California WaterFix project. Those inappropriate results include the following:

    (a) In May 1933, all of the With-Project scenarios triggered the off-ramp criteria in the 2006 FMS and the 2009 NMFS BiOp, but the NAA does not. This allows the With-Project scenarios to potentially recover Folsom Reservoir storage relative to the NAA based on the inappropriate amount of reduction in Nimbus Flows allowed by the manner in which the California WaterFix modeling allows for reductions in those Nimbus Flows, as described above. The modeling indicates that only the Boundary 2 scenario took advantage of that opportunity, allowing that scenario to recover approximately 24,000 AF of Folsom Reservoir storage relative to the NAA. The fact that the other With-Project scenarios did not take advantage of the available off-ramp indicates that modeling of factors outside of the American River basin were causing the California WaterFix modeling to maintain higher releases from Folsom Reservoir during this month of the critically dry 1933.

    (b) In June 1933, the Boundary 1, Alternative 4A H3 and Alternative 4A H4 scenarios triggered the off-ramp criteria, while the NAA and Boundary 2 scenarios did not. The Boundary 2 scenario did not trigger the off-ramp criteria as a result of that scenario's end-of-May Folsom Reservoir storage being relatively high. As described, however, that scenario's spring 1933 storage was inappropriately high due to how the California WaterFix modeling implements the off-ramp criteria in months before May 1933. In June 1933, however, the NAA and the With-Action scenarios all fail to take advantage of the available off-ramp criteria, indicating that modeling of factors outside of the American River basin are driving Folsom Reservoir releases in the critically dry 1933. In fact, in all scenarios except Alternative 4A H4, Folsom Reservoir releases increase Nimbus Flows from May Nimbus Flows, with the May-June Nimbus Flows being as follows:

        (i) NAA – 1,613 cfs in May (MRR of 1,445 cfs) → 3,742 cfs in June (MRR of 1,232 cfs);

        (ii) Boundary 1 – 1,550 cfs in May (MRR of 250 cfs)→ 2,119 cfs in June (MRR of 250 cfs);

        (iii) Alternative 4A H3 – 1,538 cfs in May (MRR of 250 cfs)→ 2,108 cfs in June (MRR of 250 cfs);

(iv) Alternative 4A H4 – 1,541 cfs in May (MRR of 250 cfs) → 2,117 cfs in June (MRR of 250 cfs);

(v) Boundary 2 – 1,227 cfs in May (MRR of 250 cfs)→ 3,853 cfs in June (MRR of 1,229 cfs).

As a result of these Nimbus Flows, Folsom Reservoir storage is reduced in all modeled scenarios in June of the critically-dry 1933, with the storage reduction being approximately 100,000 AF in the NAA and Boundary 2 scenarios.

(c) The July 1933 results assume a highly unrealistic operation of Folsom Reservoir relative to the June 1933 results. All of the scenarios trigger the 2006 FMS's and the 2009 NMFS BiOp's off-ramp criteria, but they implement those criteria differently. The NAA and Boundary 2 scenarios reduce Nimbus Flows from approximately 3,750 cfs in June to 500 cfs in July. In my experience, it is highly unlikely that Reclamation would operate Folsom Reservoir to reduce Nimbus Flows by over 3,000 cfs from one month to the next in conditions as are modeled to exist in the summer of 1933. This is particularly true in the summer, when the reduced streamflows might have significant water temperature effects in a critically dry year like 1933. While the reduction from June Nimbus Flows to July Nimbus Flows is less dramatic in the Boundary 1, Alternative 4A H3 and Alternative 4A H4 scenarios, it nonetheless is significant. Those scenarios depict a reduction of approximately 1,100 cfs, from approximately 2,100 cfs to approximately 1,000 cfs.

(d) The modeled August 1933 Folsom Reservoir operations reflect another dramatic and unrealistic operational shift, this time to increase Nimbus Flows from the relatively low levels in July to much higher levels in August. All of the scenarios triggered the 2006 FMS's and the 2009 NMFS BiOp's off-ramp criteria, but none of them maintain relatively low Nimbus Flows in response, but instead dramatically increase Nimbus Flows. In the NAA and Boundary 2 scenarios, the Nimbus Flows increase seven-fold from a very low 500 cfs in July to 3,500 cfs in August. In the Boundary 1, Alternative 4A H3 and Alternative 4A H4 scenarios, the Nimbus Flows increase approximately four-fold times, from approximately 1,000 cfs in July to approximately 4,000 cfs. The effects of these August Nimbus Flows are as follows:

(i) As modeled, in all scenarios, Folsom Reservoir is drawn down to the modeled "dead pool" of 90,000 AF by the end of August 1933;

(ii) As modeled, in all scenarios, Folsom Reservoir would remain at the modeled "dead pool" of 90,000 AF through September 1933;

(iii) As modeled, in September 1933 of all scenarios, Folsom Reservoir would only be bypassing inflow, so the Nimbus Flow in all scenarios would be approximately 500 cfs, and water supply diversions would be reduced to ensure lower American River flows continued to meet minimum flow requirements; and

(iv) Folsom Reservoir storage and Nimbus Flows would remain at similar minimal levels until significant precipitation occurred.

Conclusion

33. I focused my review of the California WaterFix modeling results on critically dry water years in the period of record and the water years preceding them. I identified the cycle of years 1932 and 1933 – a below normal year followed by a critically dry year – as particularly instructive. I then analyzed the modeling results for the calendar years 1932 and 1933 to analyze how Folsom Reservoir and Nimbus Dams were modeled to operate during that below normal-critically dry cycle.

34. Based on that analysis of the California WaterFix modeling, I reached the following conclusions:

(a) The California WaterFix project – as represented in the With-Project scenarios – would enable Reclamation to draw down Folsom Reservoir storage substantially going into a critically dry water year like 1933 and during the fall and winter months of such a water year, relative to the NAA;

(b) The California WaterFix modeling does not appropriately indicate how Reclamation would operate Folsom Reservoir in the spring of a critically dry water year like 1933 because the modeling contains an unrealistic step function concerning the operations of the off-ramp criteria contained in the 2006 FMS and the 2009 NMFS BiOp that allows for inappropriate reductions in lower American River streamflows as a result of projected future low Folsom Reservoir storage; and

(c) The California WaterFix modeling does not appropriately indicate how Reclamation would operate Folsom Reservoir during the summer of a critically dry year like 1933 because the modeled releases from the reservoir for 1933 swing dramatically from very low to very high releases in a manner that, in my experience, do not reflect a reasonable operation of the reservoir.