Attachment A

MBK ENGINEERS

Water Resources ● Flood Control ● Water Rights

DATE:	July 11, 2014
TO:	Dan Kelly, Ryan Bezerra, and Martha Lennihan
FROM:	Lee G. Bergfeld, Dan Easton, and Walter Bourez
SUBJECT:	Technical Comments on Bay-Delta Conservation Plan Modeling

This technical memorandum is a summary of MBK Engineers' ("Reviewers") findings and opinions on the hydrologic modeling performed in support of the draft environmental document for the Bay-Delta Conservation Plan (BDCP) for Folsom Reservoir and the American River Basin. The results of that modeling are summarized in Appendix 5A to the draft BDCP EIR/EIS.

The Reviewers' analysis of the BDCP modeling is summarized in categories: (1) assessment of general assumptions and operations; (2) assessment of American River demands; (3) assessment of climate change assumptions, implementation, and effects; (4) assessment of the assumptions and operational criteria for inclusion of the new BDCP facilities. The issues discussed in (1), (2) and (3) are relevant for all modeling scenarios, both baseline scenarios that do not include BDCP and with project scenarios that evaluate BDCP or the Alternatives. The issues discussed in (4) are specific to the inclusion of the BDCP as defined in the draft BDCP plan and identified as Alternative 4 in the Draft EIR/EIS.

This review focuses on water operations modeling using CalSim II. CalSim II is a computer program jointly developed by DWR and Reclamation. CalSim II presents a comprehensive simulation of State Water Project (SWP) and Central Valley Project (CVP) operations, and is used by DWR as a planning tool to predict future availability of water for the SWP. CalSim II is widely recognized as the most prominent water management model in California, and it is generally accepted as a useful and appropriate tool for assessing the water delivery capability of the SWP and the CVP.

Broadly speaking, CalSim II estimates, for various times of the year, how much water will be diverted, how much will serve as instream flows (e.g., flow in the rivers at various locations, such as Delta outflow), and how much will remain in the reservoirs. Within the context of the BDCP, CalSim II is used to estimate the amount of water that will be diverted from BDCP's proposed North Delta Diversion (NDD) facilities. Thus, for BDCP, the CalSim II model estimates how much water will be diverted at the NDD facilities, how much flow will remain in the Sacramento River below Hood (the approximate location of the NDD facilities), how much water will be diverted through the existing South Delta Diversion (SDD) facilities at Tracy, how much flow will leave the Delta by flowing out to the Bay, and how much water will remain in storage in upstream reservoirs (including Folsom Reservoir). The location and timing of the diversion and the amount of water remaining instream and in reservoirs are significant because they can cause impacts on species, water quality degradation, and the like.

The coding and assumptions included in the CalSim II model drive the results it yields. Data and assumptions, such as the amount of precipitation runoff at a certain measuring station or the demand for water by specific water users are input into the model. Criteria used to operate the CVP and the SWP (including current regulatory requirements) are included in the model as assumptions; because of the volume of water associated with the CVP and SWP, these operational criteria significantly influence the model's results. Additionally, operational logic is coded into the CalSim II model to simulate how DWR and Reclamation would operate the system under circumstances for which there are no regulatory or otherwise definitive rules (e.g., when to move water from upstream storage to south of Delta storage). This attempt to specify (i.e., code) the logic sequence and the relative weighting that humans will use as part of their "expert judgment" is a critical element to the CalSim II model.

The model's ability to reliably predict effects of a proposed action depends on the accuracy of its coding and its representation of operations criteria. In other words, the model's results will be only as good as its data, coding, assumptions, and judgment and the knowledge of the modelers. For this reason, a detailed operating plan of existing facilities and the proposed facility is essential to create an accurate model of how a proposed action will affect existing water operations. In reviewing the BDCP modeling, it became apparent that coding errors and operating assumptions are inconsistent with the actual purposes and objectives of the CVP and SWP, thus limiting the utility and accuracy of the results.

The CalSim II model is the foundational model for analysis of the BDCP, including the effects analysis in the Draft BDCP and the impacts evaluation in the Draft EIR/EIS. Results from CalSim II are used to examine how water supply and reservoir operations are modified by the BDCP, and the results are also used by subsequent models to determine physical and biological effects, such as water quality, water levels, temperature, Delta flows, and fish response. Any errors and inconsistencies identified in the underlying CalSim II model are therefore present in subsequent models that estimate impacts on water quality, hydrodynamics in the Delta, economics, hydropower, and other parameters and adversely affect the results of analyses based on those subsequent models.

No Action Alternative

Water operations modeling assumptions used in CalSim II for the BDCP No Action Alternatives (NAA) are defined in the December 2013 Draft BDCP[1] and associated draft EIR/S. Those assumptions include assumed changes to hydrology cause by climate change, so the NAA includes that assumed climate change. Assumptions affecting modeling results for Folsom Reservoir and the American River are the focus of this review. Because Folsom Reservoir is operated as an integral part of the CVP, system-wide assumptions affect conditions on the American River and these assumptions are included in this review. Demands for American River supplies also influence American River storage and flow conditions, therefore demand assumptions are included in this review. Because climate change assumptions not only affect system-wide operations, but have a significant influence on American River operations, these assumptions are reviewed to understand the basis for the NAA model results. In addition to input assumptions, the NAA operation depicted by CalSim II is reviewed for reasonableness.

[1] The detailed assumptions are stated in BDCP draft EIR/EIS Appendix 5A.

Each of the NAA assumes the same regulatory requirements, generally representing the existing regulatory environment at the time of study formulation (February 2009), including Stanislaus ROP NMFS BO (June 2009) Actions III.1.2 and III.1.3, Trinity Preferred EIS Alternative, NMFS 2004 Winter-run BO, NMFS BO (June 2009) Action I.2.1, SWRCB WR90-5, CVPIA (b)(2) flows, NMFS BO (June 2009) Action I.2.2, American River Flow Management NMFS BO (June 2009) Action II.1, no SJRRP flow modeled, Vernalis SWRCB D1641 Vernalis flow and WQ and NMFS BO (June 2009) Action IV.2.1, Delta D1641 and NMFS Delta Actions including Fall X2 FWS BO (December 2008) Action 4, Export restrictions including NMFS BO (June 2009) Action IV.11.2v Phase II, OMR FWS BO (December 2008) Actions 1-3 and NMFS BO (June 2009) Action IV.2.3v. The modeling protocols for the recent USFWS BO (2008) and NMFS BO (2009) have been cooperatively developed by Reclamation, NMFS, U.S. Fish and Wildlife Service (USF&WS), California Department of Fish and Wildlife (CDF&W), and DWR.

American River Basin Demands

BDCP model inputs were reviewed to understand demand assumptions for water purveyors in the American River Basin. Table 1 is a summary of average annual demands used in CalSim II by the BDCP modeling at both the existing (Existing Conditions) and future (NAA) levels of development. The Existing Conditions model run was not used in the analysis of project effects, but is provided for reference. A single level of demand was used to represent the two future conditions simulated, early long term (ELT) and late long term (LLT) that represent planning horizons of approximately 2025 and 2060, respectively.

There are several problems with the demands summarized in Table 1. Existing Conditions are approximately representative of current demands. Future demands for Placer County Water Agency (PCWA) are not representative of current projections. PCWA diverts water at the American River Pump Station and delivers water into Folsom Reservoir for diversion by San Juan Water District (SJWD), Sacramento Suburban Water District (SSWD), and the City of Roseville (Roseville). The total projected annual demand for these four entities is approximately 120,000 acre-feet. Demands represented in the BDCP modeling total between 64,000 and 81,000 acre-feet annually, depending on the annual demand of SSWD. One error that contributes to underestimating PCWA's future demand is the assumption that Roseville will take only 5,000 acre-feet of their 30,000 acre-feet of contract supply from PCWA. Most future level of development CalSim II studies, such as those produced for the 2013 State Water Project Delivery Reliability Report, assume Roseville's demand for water from PCWA is 30,000 acre-feet. Roseville's 2010 urban water management plan projects that Roseville will have a demand for its 30,000 acre-feet per year of PCWA water by 2025.[2]

A second concern is that the BDCP modeling assumes that demands will increase significantly over the next 11 years, from Existing Conditions to ELT at approximately 2025, but then remain unchanged over the next 35 years to LLT conditions in 2060. Issues with this assumption are in part illustrated by reference to the City of Sacramento's most recent (2010) Urban Water Management Plan which identifies water demands continuing to increase as a result of development through at least 2035. For example, that UWMP projects total year 2030 demands within the retail service area and wholesale demands to be 250,000 acre-feet and year 2035 demands to be 261,000 acre-feet.

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[2]Roseville's 2010 urban water management plan is available at https://www.roseville.ca.us/eu/water_utility/water_efficiency/plan.asp.

Another demand-related issue with the NAA and the with-Project scenarios is that BDCP modeling does not simulate diversion limitations at the Fairbairn water treatment plant when releases from Nimbus Reservoir are below the "Hodge Flows" limits that apply to the City of Sacramento's diversions at Fairbairn. These limitations are included as terms in the City of Sacramento water right permits, and therefore are known and should be accurately reflected in the BDCP modeling.[3] This omission affects modeling of flows in the lower American River downstream of Fairbairn and simulated diversions at Fairbairn and the Sacramento River Intake.

Table 1. American River Basin Demand Assumptions

Water Purveyor	Existing Conditions (1,000 acre-feet)	NAA (1,000 acre-feet)
Placer County Water Agency (PCWA)	35.5	35.5
PCWA – CVP contract	0.0	35.0
City of Folsom	27.0	27.0
City of Folsom – CVP contract	7.0	7.0
Folsom Prison	2.0	5.0
San Juan Water District (SJWD)	33.0	33.0
SJWD - from PCWA	17.0	24.0
SJWD – CVP contract	11.2	24.2
City of Roseville - from PCWA	5.0	5.0
City of Roseville – CVP contract	32.0	32.0
Sac. Suburban Water District (SSWD) - from PCWA	0.0 - 17.0	0.0 - 17.0
El Dorado Irrigation District (EID)	0.0	17.0
EID – CVP contract	7.55	7.55
El Dorado County – CVP contract	4.0	15.0
So. Cal. Water Company /Arden Cordova Water Service	5.0	5.0
California Parks and Recreation	1.0	5.0
Sacramento Municipal Utilities District (SMUD)	15.0	15.0
SMUD – CVP contract	5.0	30.0
City of Sacramento (Fairbairn and Sacramento River)	120.3	245.0
City of Carmichael	12.0	12.0
Sacramento County Water Agency Total (SCWA)	15.0	109.7
SCWA – CVP contract	10.0	45.0
East Bay Municipal Utilities District – CVP contract	N/A	up to 112.0

Climate Change

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[3] Water right permit numbers 11358, 11359, 11360, and 11361.

Analysis presented in the BDCP draft plan and draft EIR/EIS attempts to incorporate the effects of climate change at two future climate periods: ELT at approximately the year 2025; and LLT at approximately 2060. Although BDCP modeling includes both the ELT and LLT, the EIR/EIS relies on the LLT and only includes the ELT in Appendix 5. As described in the BDCP draft plan and draft EIR/EIS[4], other analytical tools were used to determine anticipated changes to precipitation and air temperature that is expected to occur under ELT and LLT conditions. Projected precipitation and temperature were then used to determine how much water is expected to flow into the upstream reservoirs over an 82-year period of variable hydrology; these time-series were then input to the CalSim II model.

A second aspect of climate change, the anticipated amount of sea level rise, is incorporated into the CalSim II model by modifying a subroutine that determines salinity within the Delta based on flows within Delta channels. Effects of sea level rise will manifest as a need for additional outflow when Delta water quality is controlling operations to prevent seawater intrusion. In this technical memorandum, we do not critique the climate change assumptions themselves, except in the limited manner described below.[5] This review is limited to evaluating how modified flows were incorporated into CalSim II and whether the operation of the CVP and SWP in response to modified flows and modified flow-salinity relationship is reasonable for ELT and LLT conditions. This review focuses on assumed underlying hydrology and simulated operation of the CVP and SWP, assumed regulatory requirements, and the resultant water deliveries.

To assess climate change, the three without Project ("baseline" or "no action") modeling scenarios were reviewed: No Action Alternative (NAA)[6], No Action Alternative at the Early Long Term (NAA – ELT), and No Action Alternative at the Late Long Term (NAA –LLT). Assumptions for NAA, NAA-ELT, and NAA-LLT are provided in the Draft EIR/EIS's modeling appendix[7]. The only difference between these scenarios is the climate-related changes made for the ELT and LLT conditions (Table 2).

Table 2. Scenarios Used to Evaluate Climate Change

	Climate Change Assumptions	
Scenario	**Hydrology**	**Sea Level Rise**
No Action Alternative (NAA)	None	None
No Action Alternative at Early Long Term (NAA-ELT)	Modified reservoir inflows and runoff for expected conditions at 2025	15 cm
No Action Alternative at Early Long Term (NAA-LLT)	Modified reservoir inflows and runoff for expected conditions at 2060	45 cm

Differences between the NAA and NAA-ELT reveal effects of climate change assumptions under ELT conditions; similarly, differences between the NAA and NAA-LLT reveal effects of climate change assumptions under LLT conditions.

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[4] BDCP EIR/EIS Appendix 5A, Section A and BDCP HCP/NCCP plan Appendix 5.A.2

[5] This should not be read to imply that climate change assumptions are reasonable or considered correct or incorrect; the limited review reflects the scope of this memorandum.

[6] NAA is also called the Existing Biological Conditions number 2 (EBC-2) in the Draft Plan.

[7] BDCP EIR/EIS Appendix 5A, Section B, Table B-8.

There is considerable uncertainty regarding the effects of climate change on future temperature and precipitation. Analysis of only one potential future condition at different planning horizons does not cover the range of potential effects. While other analyses attempt to bracket the range of climate change effects (e.g. 2008 OCAP analysis[8]) on proposed projects, BDCP's entire effects analysis is based on a single climate change scenario. Standard practice for modeling CVP and SWP operations is to impose future demand projections on historical hydrology to develop No Action Alternatives. BDCP did not follow the standard practice of evaluating effects of BDCP using historical hydrology, but relied solely on one climate change scenario to form the basis of their analysis.

The significance of changed hydrology between the three without project baselines (NAA, NAA-ELT, and NAA-LLT) is illustrated below in Figure 1. The figure illustrates the projected combined inflow of Trinity, Shasta, Oroville, and Folsom Reservoirs under the NAA and the change relative to the NAA for the NAA-ELT and NAA-LLT baselines. BDCP baselines show Trinity, Shasta, and Oroville inflow are projected to increase overall, but with a significant shift from spring runoff to winter runoff and increases in wetter years with decreases in drier years.

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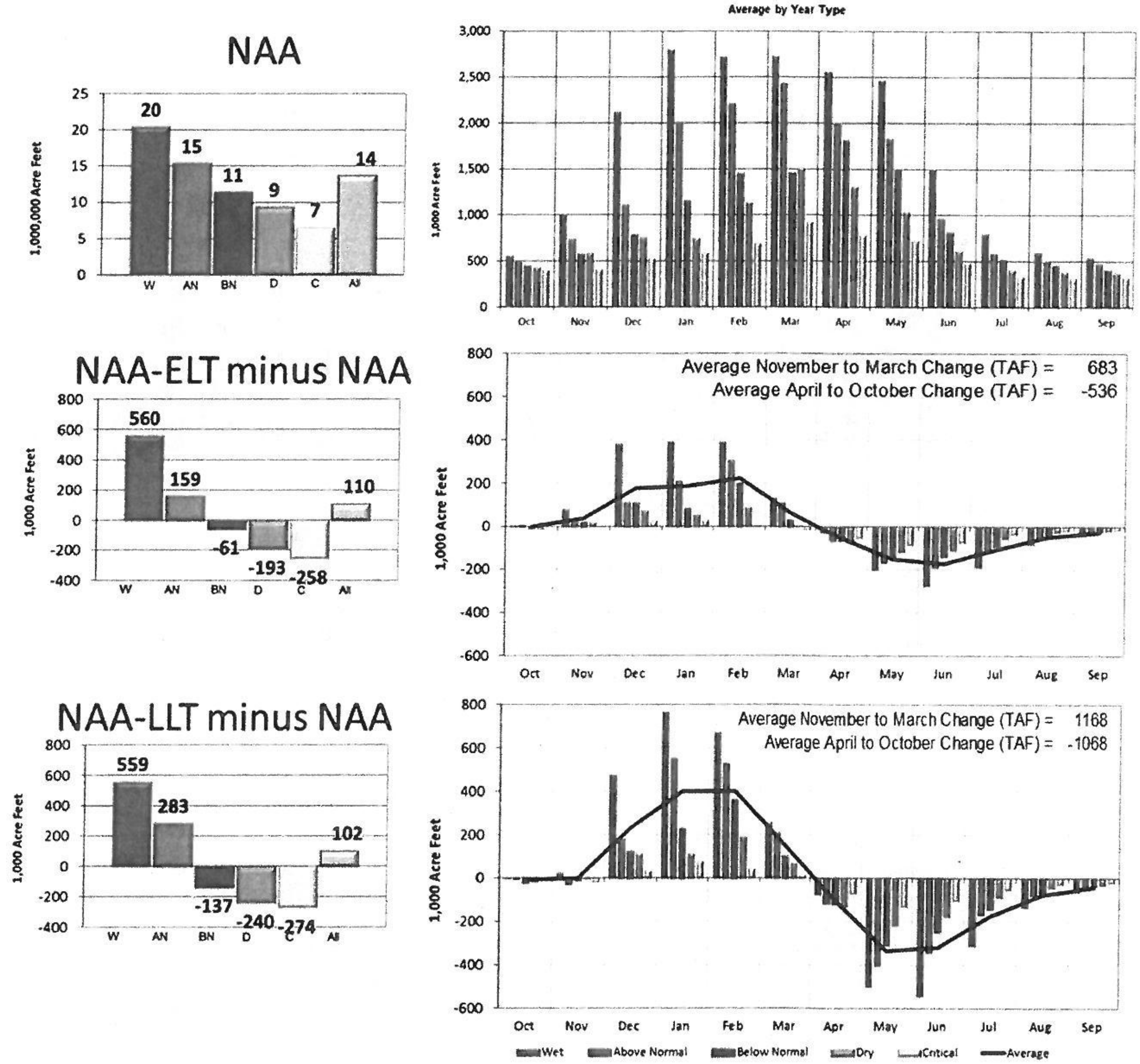
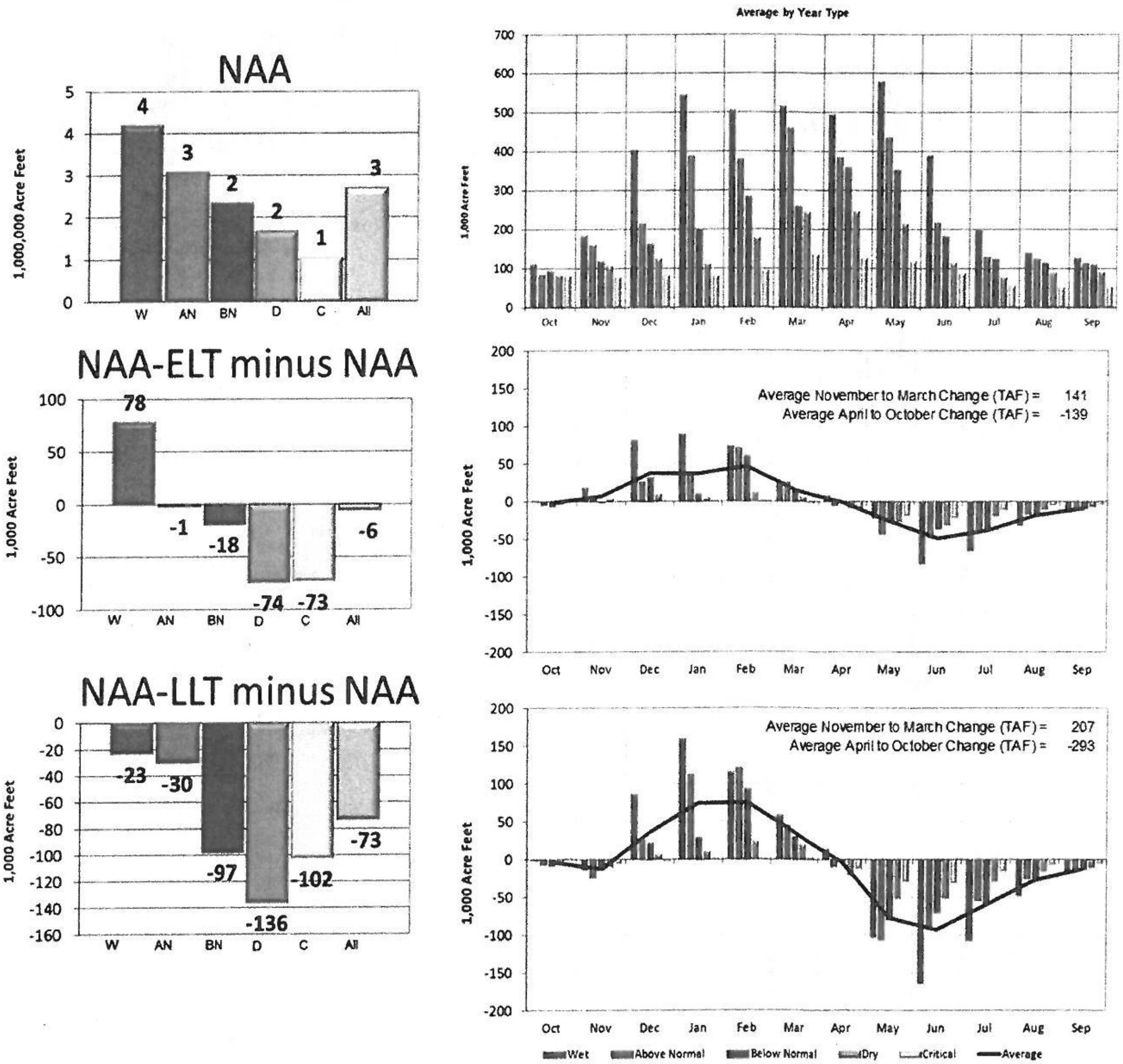
[8] USBR, 2008. Biological Assessment on the Continued Long-term Operations of the Central Valley Project and the State Water Project, Appendix R Sensitivity of Future Central Valley Project and State Water Project Operations to Potential Climate Change and Associated Sea Level Rise, U.S. Bureau of Reclamation, July 2008.

Figure 1. Inflow to Trinity, Shasta, Oroville, and Folsom Reservoirs – NAA, NAA-ELT and NAA-LLT



The effect of assumed climate change on average annual Folsom Reservoir inflow in the NAA-ELT scenario is minor, but causes decreases in inflow of about 70 TAF in the NAA-LLT scenario. The spring to winter shift in runoff is also projected for Folsom Reservoir inflow. Figure 2 is an illustration of Folsom inflow under the NAA and the change relative to NAA for the NAA-ELT and NAA-LLT baselines. To properly incorporate climate change into modeling of Folsom Reservoir and the American River, climate change effects must be applied to flows and reservoirs upstream from Folsom, which was not done. There is significant storage capacity in the upper American River watershed in PCWA's Middle Fork Project and the Sacramento Municipal Utility District's (SMUD) Upper American River Project. The operation of Folsom is significantly affected by changes in upstream conditions and operations.[9] Because climate change in BDCP modeling is imposed on the American River by adjusting only the inflow to Folsom only, however, the effect on the American River is likely misrepresented in the BDCP NAA-ELT and NAA-LLT scenarios.

Figure 2. Projected Inflow to Folsom Reservoir – NAA, NAA-ELT and NAA-LLT



Comparison of inflow changes illustrated in Figure 1 and Figure 2 show the effects of climate change are large in the American River Basin relative to changes in other river basins. Total changes illustrated in

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[9] SMUD's Upper American River Project alone is estimated to have water storage capacity of about 430,000 acre-feet. "The History of SMUD's UARP", Sacramento Municipal Utility District (2001).

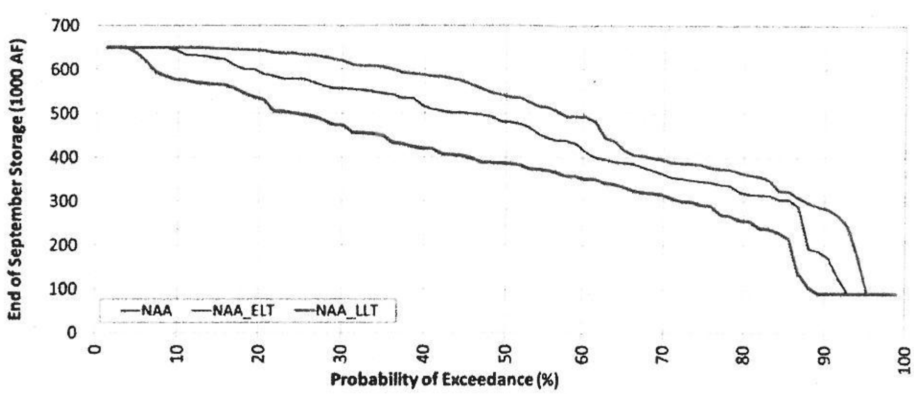
Figure 1 show wetter conditions in wet years and drier conditions in dry years when considering the four basins together. However, climate change in the American River Basin for the LLT shows drier conditions in all year-types. Additionally, a large percentage of the dry and critical year inflow reduction, 57 and 37 percent respectively, for the combined four basins occur in the American River Basin. By comparison, runoff from the American River at Folsom is approximately 20 percent of the sum of runoff of the Trinity, Sacramento, Feather, and American rivers.

Changes in Folsom inflow can affect American River operations in a variety of ways, such as changes in lower American River flows based on the June 2009 NMFS BO Action II.1 (American River Flow Management), availability of water to M&I purveyors in the American Region Basin, and flood control operations in Folsom Reservoir. Climate change is imposed on the American River Basin by adjusting Folsom inflow without adjustments to operations upstream from Folsom. Lower American River flow requirements are calculated and adjusted using several different indices that include forecasted inflow to Folsom, end-of-September storage in Folsom and upstream reservoirs, forecasted Folsom storage, and the Sacramento River Index. Water deliveries from Folsom are partially based on water supply in upstream reservoirs. Required flood reservation space in Folsom Reservoir is affected by storage in upstream reservoirs. Because Folsom Reservoir operation is affected by storage conditions upstream from Folsom, climate change must be applied to the entire American River basin to properly analyze conditions with climate change.

For Folsom and other upstream CVP and SWP reservoirs, the shift of in timing of inflows along with a continuing need to satisfy downstream environmental requirements and demands significantly affects carryover storage. Because of climate change's assumed effect on hydrology and the lack of CVP/SWP operational adaptations in the BDCP modeling, the CVP and SWP simply cannot satisfy water demands and regulatory criteria imposed on them in the NAA-ELT and NAA-LLT modeling scenarios. Figure 3 illustrates change in carryover storage in Folsom Reservoir. The relatively high frequency (approximately 10% of time) of minimum storage occurring at Folsom Reservoir leads us to question whether the NAAs reflect credible or defensible operations. The projected occurrences of low and dead storage conditions projected by the BDCP modeling result in severe reduction of flow available to sustain habitat in the Lower American River and severe reductions in water supply reliability.

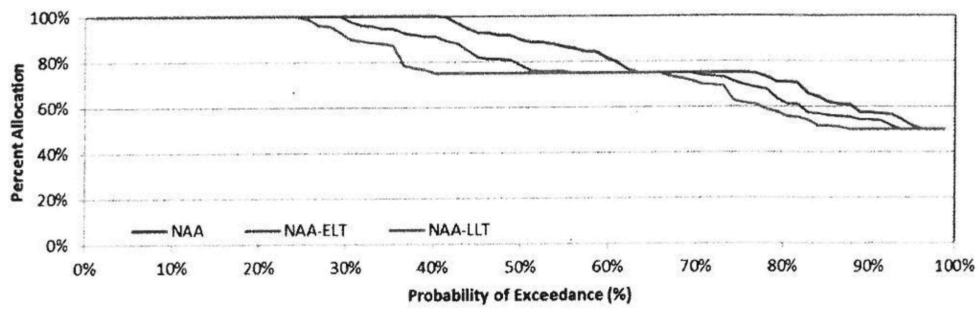
Figure 3. Folsom Reservoir Carryover Storage

	Year Type	NAA_ELT minus NAA	NAA_LLT minus NAA
Folsom	W	-42	-115
	AN	-54	-128
	BN	-58	-136
	D	-43	-112
	C	-43	-68
	All	-47	-113



Assumed effects of climate change and lack of adaptation reduces CVP water supply allocations to American River CVP Water Service Contractors. Figure 4 contains exceedance probability plots of CVP M&I allocations for the NAA, NAA-ELT, and NAA-LLT scenarios. Full allocations are made 40% of the time under the NAA, this is reduced to about 30% in the NAA-ELT, and full allocations are made about 25% of the time in the NAA-LLT. The occurrence of 50% allocation increases from about 4% in the NAA to about 7% in the NAA-ELT and to about 12% in the NAA-LLT. In addition to reduced water service contract allocations, water supply allocations under any right cannot be satisfied due to low storage levels in Folsom Reservoir and low flow in the Lower American River. It is not physically possible to divert water for M&I use from Folsom Reservoir when reservoir storage drops below about 100,000 acre-feet because, at that level, the M&I intake in the reservoir would be dry. In addition, flows in the lower American River below about 500 cfs make it impossible for the City of Sacramento to divert water at its Fairbairn diversion. The water-supply and other effects of these physical conditions occurring in the NAA scenarios are not identified or evaluated in the draft BDCP EIR/EIS.

Figure 4. CVP North of Delta M&I Water Service Contract Allocation



If climate change were to result in significant inflow changes, it is highly likely that certain underlying operating criteria such as instream flow requirements and flood control diagrams would also require changes. For example, the CVP and SWP are unlikely to draw reservoirs to dead pool as often as the NAAs depict. The NAA-ELT and NAA-LLT model scenarios show that, in 10% of years, Folsom Lake levels would drop to a "dead pool" condition where diversions to M&I use from the reservoir would not be physically possible. As a result, in this scenario, the modeling implies that American River M&I deliveries from the reservoir would be below what is needed for public health and safety in 10% of years. Additionally, low storage in Folsom would lead to water temperature conditions that would likely be detrimental for listed species and not achieve the temperature objectives in the June 2009 NMFS BO Action II.2 (Lower American River Temperature Management). In addition to affecting fishery habitat in the lower American River, increases in temperature cause problems with water treatment for urban water supplies. In short, the NAA-ELT and NAA-LLT do not provide reasonable underlying CVP and SWP operations on which to superimpose the BDCP and evaluate effects of Alternatives.

In the Reviewers' opinion, the CalSim II operations depicted in the NAA BDCP modeling that incorporate climate change do not represent a reasonably foreseeable future operation of the CVP and SWP. Although an argument is typically made that these NAAs will be used in a comparison analysis with Project Alternatives tiering from these NAAs, the Reviewers believe that the depicted NAA operations are so fundamentally flawed that there can be no confidence even in the comparative results. Therefore, results of the depicted operations are inappropriate as the foundation of technical analysis of a Project Alternative. As such, although the modeling approach may provide a relative comparison between equal foundational operations, little confidence can be placed in the computed differences shown between the NAA and Project Alternative Scenarios.

Conclusions Regarding No Action Alternatives

BDCP No Action Alternatives include errors and omissions in American River demands and Fairbairn diversion limitations. However, the most significant issues with the NAAs are in operation of the CVP/SWP with climate change. The BDCP Model uses assumed future climate conditions that obscure the effects of implementing the BDCP. The future conditions assumed in the BDCP model include changes in precipitation, temperature, and sea level rise. The result of these assumptions is that BDCP's modeled changes in water project operations and subsequent environmental impacts are caused by undefined combinations and inter-relations of three different factors: (1) sea level rise; (2) climate change; and (3) implementation of the alternative that is being studied.

The inclusion of climate change, without adaptation measures, results in insufficient water needed to meet all regulatory objectives and user demands. For example, the BDCP Model results that include climate change indicate that during droughts, water in reservoirs is reduced to the minimum capacity possible. Reservoirs have not been operated like this in the past during extreme droughts and the current drought also provides evidence that adaptation measures are called for long in advanced to avoid draining the reservoirs. In this aspect, the BDCP Model simply does not reflect a real future condition. Foreseeable adaptations that the CVP and SWP could make in response to climate change include: (1) updating operational rules regarding water releases from reservoirs for flood protection; (2) during severe droughts, emergency drought declarations could call for mandatory conservation and changes in some regulatory criteria similar to what has been experienced in the current and previous droughts;[10] and (3) if droughts become more frequent, the CVP and SWP would likely revisit the rules by which they allocate water during shortages and operate more conservatively in wetter years. The modifications to CVP and SWP operations made during the winter and spring of 2014 in response to the drought supports the likelihood of future adaptations. The BDCP Model is, however, useful in that it reveals that difficult decisions must be made in response to climate change. But, in the absence of making those decisions, the BDCP Model results themselves are not informative, particularly during drought conditions. With future conditions projected to be so dire without the BDCP, the effects of the BDCP appear positive simply because it appears that conditions cannot get any worse (i.e., storage cannot be reduced below its minimum level). However, in reality, the future condition will not be as depicted in the BDCP Model. The Reviewers recommend that Reclamation and DWR develop more realistic operating rules for the hydrologic conditions expected over the next half-century and incorporate those operating rules into any CalSim II Model that includes climate change.

Description of the BDCP Project

The BDCP contemplates a dual conveyance system that would move water through the Delta's interior or around the Delta through an isolated conveyance facility. The BDCP CalSim II files contain a set of studies evaluating the projected operation of a specific version of such a facility. Each Alternative was

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[10] See www.waterboards.ca.gov/waterrights/water_issues/programs/drought/tucp.shtml for information concerning the SWRCB's urgency drought orders for CVP/SWP operations this year.

imposed on two baselines: the NAA-ELT scenario and the NAA-LLT scenario. The BDCP Preferred Alternative, Alternative 4, has four possible sets of operational criteria, termed the Decision Tree. Key components of Alternative 4 ELT and Alternative 4 LLT are as follows:

> The same system demands and facilities as described in the NAA with the following primary changes: three proposed North Delta Diversion (NDD) intakes of 3,000 cfs each; NDD bypass flow requirements; additional positive OMR flow requirements and elimination of the San Joaquin River I/E ratio and the export restrictions during Vernalis Adaptive Management Program; modification to the Fremont Weir to allow additional seasonal inundation and fish passage; modified Delta outflow requirements in the spring and/or fall (defined in the Decision Tree discussed below); relocation of the Emmaton salinity standard; redefinition of the E/I ratio; and removal of current permit limitations for the south Delta export facilities. Set within the ELT environment.

The changes (benefits or impacts) of the operation due to Alternative 4 are highly dependent upon the assumed operation of not only the NDD and the changed regulatory requirements associated with those facilities, but also by the assumed integrated operation of existing CVP and SWP facilities. The modeling of the NAA Scenarios introduces significant changes in operating protocols suggested primarily to react to climate change. The extent of the reaction does not necessarily represent a likely outcome, and thus the Reviewers have little confidence that the NAA baselines are a valid representation of a baseline from which to compare an action Alternative. However, a comparison review of the Alt 4 to the NAA illuminates operational issues in the BDCP modeling and provides insight as to where benefits or impacts may occur.

BDCP Alternative 4 has four possible sets of operational criteria, termed the Decision Tree, that differ based on the "X2" standards that they contemplate:

- Low Outflow Scenario (LOS), otherwise known as operational scenario H1, assumes existing spring X2 standard and the removal of the existing fall X2 standard;
- High Outflow Scenario (HOS), otherwise known as H4, contemplates the existing fall X2 standard and providing additional outflow during the spring;
- Evaluated Starting Operations (ESO), otherwise known as H3, assumes continuation of the existing X2 spring and fall standards;
- Enhanced spring outflow only (not evaluated in the December 2013 Draft BDCP), scenario H2, assumes additional spring outflow and no fall X2 standards.

While it is not entirely clear how the Decision Tree would work in practice, the general concept is that, prior to operation of the NDD, implementing authorities would select the appropriate decision tree scenario (from amongst the four choices) based on their evaluation of targeted research and studies to be conducted during planning and construction of the facility.

For this analysis, the Reviewers analyzed the HOS (or H4) scenario because the BDCP[11] indicates the initial permit will include HOS operations that may be later modified at the conclusion of the targeted research studies. The HOS includes the existing fall X2 requirements but adds additional outflow

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[11] Draft BDCP, Chapter 3, Section 3.4.1.4.4

requirements in the spring. The model code was reviewed and discussed with DWR and Reclamation, who acknowledged that, although the SWP was bearing the majority of the responsibility for meeting the additional spring outflow in the modeling, the responsibility would need to be shared with the CVP under the CVP/SWP Coordinated Operations Agreement (COA)[12]. In subsequent discussions, DWR and Reclamation suggested the additional water for the HOS scenario may be purchased from other water users. However, the actual source of water for the additional outflow has not been defined. The actual source of the water will involve impacts that cannot be reflected in the modeling until the source is identified. While it is agreed that this is not how the projects would actually be operated, since the BDCP Model assumes that the SWP bears the majority of the responsibility for meeting the additional outflow, the Reviewers' analysis of the BDCP modeling results for HOS is limited to the evaluation of how the SWP reservoir releases on the Feather River translate into changes in Delta outflow and exports.

The Reviewers' remaining analysis examines the ESO (or H3) scenario (labeled Alt 4-ELT or Alt 4-LLT in this section) because it employs the same X2 standards as are implemented in the NAA-ELT and NAA-LLT. This allowed the Reviewers to focus the analysis on the effects of BDCP operations independent of the possible change in the X2 standard.

High Outflow Scenario (HOS or H4) Results

According to the Draft EIR/EIS[13], the HOS will reduce SWP south of Delta water deliveries for municipal and industrial (M&I) water users 7% below the level that they would receive without the BDCP (on average). During dry and critical years, SWP south of Delta water deliveries for M&I and agricultural water users will drop 17% below the level that they would receive without the BDCP. In other words, according to BDCP modeling, SWP contractors would get less water with BDCP than under the NAA.

The shared CVP and SWP obligation to provide flow to satisfy Delta outflow requirements is described in the COA. Because the CVP and SWP share responsibility for meeting required Delta outflow based on that specific sharing (rules under the COA), it is not reasonable to conclude that CVP water supplies would increase an average of 70 TAF while SWP water supplies decrease on average of 100 TAF under the HOS. These results, however, are what the BDCP modeling projects for the HOS-LLT scenario. The manner in which this alternative is modeled is inconsistent with existing agreements and operating criteria. If the increases in outflow were met based on COA, there would likely be reductions in Shasta and Folsom storage that would likely cause adverse environmental impacts, which have not been modeled or analyzed in the BDCP EIR/S.

Furthermore, there is no apparent source of water to satisfy the increased outflow requirements and pay back the COA debt that the CVP would incur if the SWP were used to meet HOS requirements. It appears, through recent public discussions regarding the High Outflow Scenario, that BDCP anticipates additional water to satisfy the increased Delta outflow requirement and to prevent the depletion of cold water pools will be acquired through water transfers from upstream water users. However, this approach is unrealistic. During most of the spring months, when BDCP proposes that Delta outflow be increased, agricultural water users are not irrigating. This means that there is not sufficient transfer

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[12] August 7, 2013 meeting with DWR, Reclamation, and CH2M HILL

[13] Draft EIR/EIS, Appendix 5A-C, Table C-13-20-2

water available to meet the increased Delta outflow requirements without releasing stored water from the reservoirs.

The overall effect of the HOS appears to be increases in Oroville releases to support both CVP and SWP exports in wetter years, with modest increases in Delta outflow. There is also a decrease in SWP reliability through large delivery reductions in drier years accompanied by Oroville storage increases. In addition to increases in dry and critical year storage in Oroville, total CVP dry and critical year carryover increases by 100 TAF and 380 TAF respectively with negligible reductions in wetter years types.

American River Changes with Proposed Project

The following section presents comparisons of model results and describes changes between the NAA-LLT and Alternative 4 H3 evaluated at LLT (referred to in this discussion as Alt 4-LLT) for key American River operations. These results focus on changes that directly impact American River water purveyors, flows, and temperatures in the American River downstream of Folsom Dam.

Based on a comparison of BDCP modeling of Alt4-LLT to NAA-LLT, there is a general trend for Folsom Reservoir to be drawn down more in Alt4-LLT during May and June and then remain lower until September. This change in storage is accompanied by increases in Lower American River flow in May and June and decreases from July through September. This shift in timing forms the basis of many concerns regarding impacts of BDCP on American River operations and environmental conditions.

BDCP modeling did not include a with-Project scenario without climate change. As a result of this omission it is impossible to clearly identify the effects of the Project separate from the effects of climate change.

Figure 5 is a comparison of simulated monthly Folsom Reservoir water surface elevations for the baseline and with-Project scenarios. A probability of exceedance chart for each month illustrates differences between the two model simulations and potential Project effects. Dashed horizontal lines indicate water surface elevations when groups of shutters on the intake device must be removed. For example, when the water surface elevation goes below approximately 430 feet, the first group of shutters must be removed. These lines are 30 feet above the top of shutter elevations for the three groups of shutters to account for water depth to prevent the formation of a vortex and cavitation at the intake which would prevent diversion.

Results presented in Figure 5 illustrate that Folsom Reservoir water surface elevation is lower under the with-Project scenario. The largest difference in Folsom elevation occurs from June through August and can affect temperature management by changing when shutters are removed. Shutters are removed from Folsom Dam's intakes in order to access colder water located lower in the reservoir. While removing shutters causes the temperature of water diverted and released from the reservoir to drop almost immediately, that effect does not cause release temperatures to remain cooler indefinitely. Accordingly shutters must be removed strategically.

The timing of shutter removal at Folsom Reservoir would change in the with-project condition. For example, in August the probability of all three shutters being in use is reduced from approximately 25 percent to 15 percent, and the probability of at least one shutter still in used is reduced from approximately 90 percent to 85 percent. Figure 6 is a comparison of simulated monthly Folsom

Reservoir storage for the baseline and with-Project scenarios. A probability of exceedance chart for each month illustrates differences between the two model simulations and potential Project effects. Dashed horizontal lines in Figure 6 represent storage levels below which M&I water purveyors cannot meet peak demands (322 TAF) with diversions from Folsom (illustrated for peak demand months only) or when M&I diversions are interrupted because water levels in Folsom are below the M&I intake (90 TAF). Results summarized in Figure 6 show that Folsom Reservoir storage is more likely to be lower under the BDCP Alt4-LLT than the NAA-LLT particularly in peak summer months. Lower storage impacts the ability of the water purveyors that divert directly from Folsom Reservoir, as well as downstream purveyors on the American River, to meet peak demands in the summer and increases the probability of M&I delivery interruptions.

Figure 5. NAA-LLT and Alt 4-LLT Simulated Folsom Reservoir Elevation

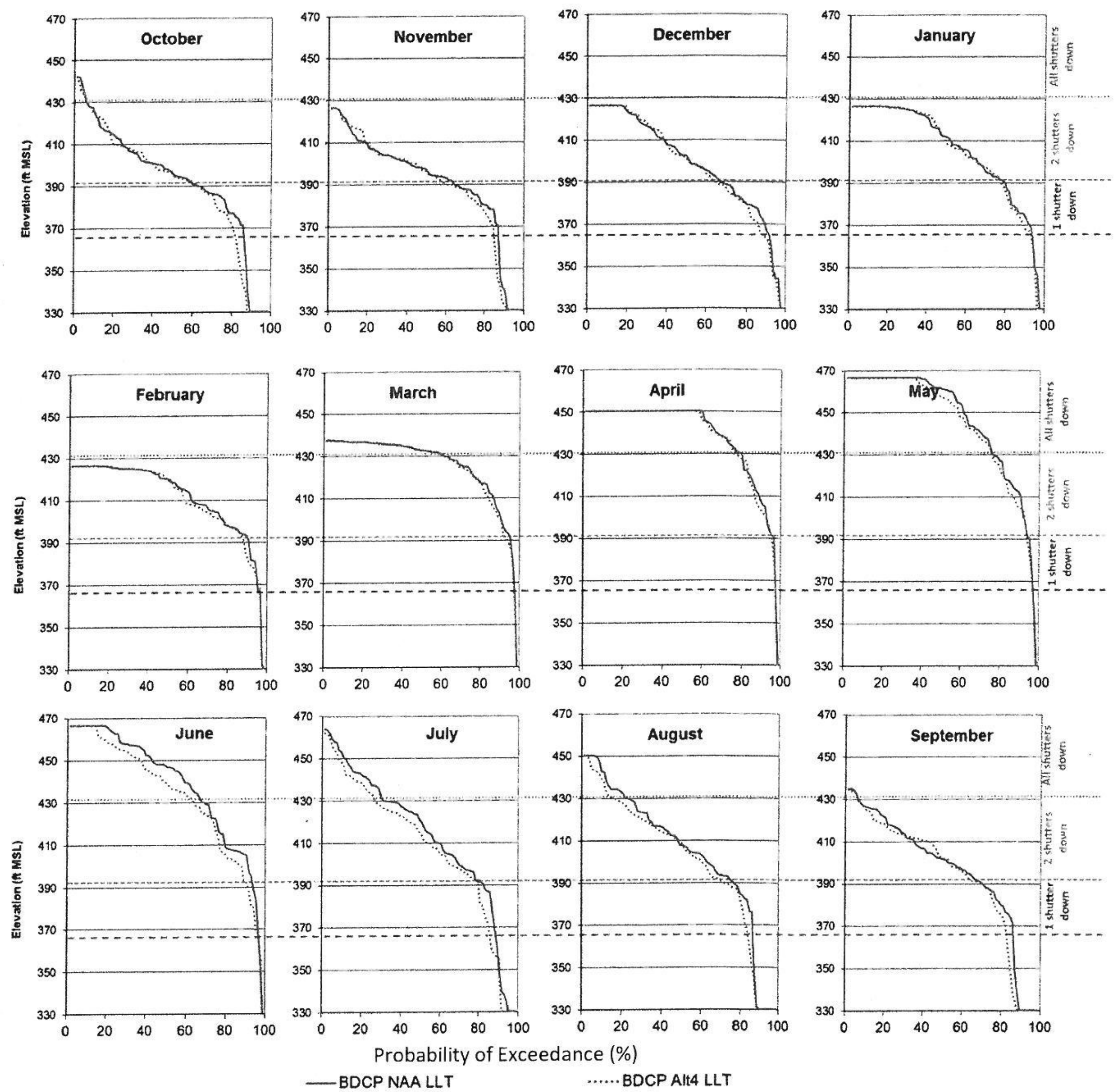


Figure 6. NAA-LLT and Alt 4-LLT Simulated Folsom Reservoir Storage

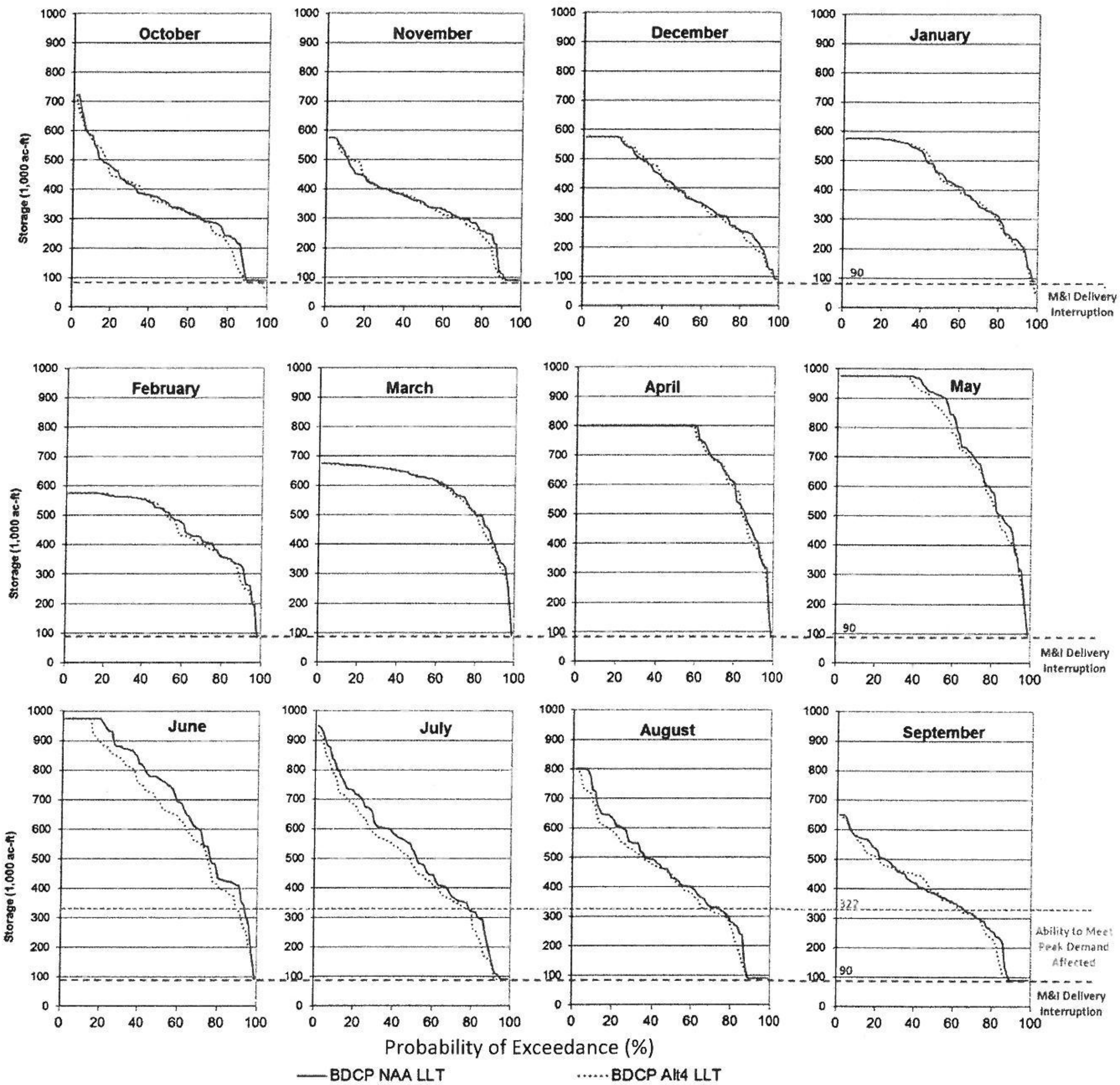


Figure 7 and Figure 8 contain comparisons of simulated monthly flow at Nimbus and H Street for the NAA-LLT and Alt4-LLT scenarios. Results show that under the Alt4-LLT American River flow is higher in the months of May and June, and lower in July, August, and September. Higher releases in May and June drive changes in Folsom storage and water surface elevation seen in previous figures. Likewise, lower releases from July through September bring simulated end-of-September storage between the baseline and with-Project scenarios closer. BDCP modeling shows a higher probability of Lower American River flows being above Hodge Flows in May and June and a higher probability of flows being below Hodge Flows in July, August, and September. When Nimbus releases are below Hodge Flows, diversion limitations under the City of Sacramento's American River water right permits for the Fairbarn Water Treatment Plant on the American River constrain the amount of water available to divert. The changes in American River flows will affect the location of the City of Sacramento's diversion, but this is not reflected in the BDCP modeling. There are also limitations on the City's Sacramento River diversion capability, which could interfere with any such shift in the location of diversions, and hence reduce the supply available to the City. This is not reflected in the BDCP modeling. In the Alt 4-LLT the City of Sacramento will be able to divert more water from the American River at Fairbairn during May and June and less during August and September.

Flow in the lower American River at H Street drops below 500 cfs in both the NAA-LLT and Alt4-LLT. This is critical for the City of Sacramento because their ability to divert water from the American River is affected when flow at H Street falls below 500 cfs due to the potential for pump cavitation. There are times when American River at H Street falls below 500 cfs more often in Alt 4-LLT than in the NAA-LLT. Water availability to the City of Sacramento, including under its settlement contract with Reclamation[14], would be curtailed or eliminated on the American River when water levels in Folsom Reservoir drop below to dead pool level of 90,000 AF.

Changes in Nimbus release under the Alt4-LLT would likely affect cold-water pool management and water temperatures downstream of Folsom Dam. Increased releases in May and June would reduce cold-water pool, lower reservoir water surface elevation, and require shutters to be removed earlier. Removing shutters earlier would drain Folsom Reservoir's limited cold-water pool more rapidly and potentially impact salmon and steelhead in the lower American River by resulting in warmer river temperatures. From July through September temperature management would be affected by the combination of a reduced cold-water pool and lower releases from Nimbus, i.e. lesser amounts of warmer water would be released and warm up quicker as it flows downstream.

The change in timing of release from Folsom Reservoir is caused in the Alt 4-LLT by BDCP using of different assumptions for balancing reservoirs upstream of the Delta with San Luis Reservoir in Alt 4-LLT relative to assumptions in the NAA. In other words, the BDCP operations triggered changes in the timing of Folsom Reservoir releases. These balancing rules attempt to move more water into San Luis Reservoir earlier in the year in the with-Project scenario. It is unclear why BDCP modeling changed these assumptions to simulate Project alternatives.

[14] Operating Contract No.14-06-200-6497.

Figure 9 contains comparisons of simulated monthly flow in the Sacramento River at the confluence of the American River for the NAA-LLT and Alt4-LLT scenarios. When Sacramento River elevation falls below two feet above sea level (NGVD 1929) the City of Sacramento's intake structure capacity is reduced. Elevation 2.0 occurs when the flow rate is between approximately 5,000 cfs and 9,000 cfs and depends on tidal variation. Moreover, flow rates below 5,000 cfs may result in cavitation or vortexing, causing significant pump damage. Based on CalSim II modeling results, the frequency of the Sacramento River falling below 6,000 cfs is similar in the NAA-LLT and Alt4-LLT.

Figure 7. NAA-LLT and Alt 4-LLT Simulated Nimbus Release

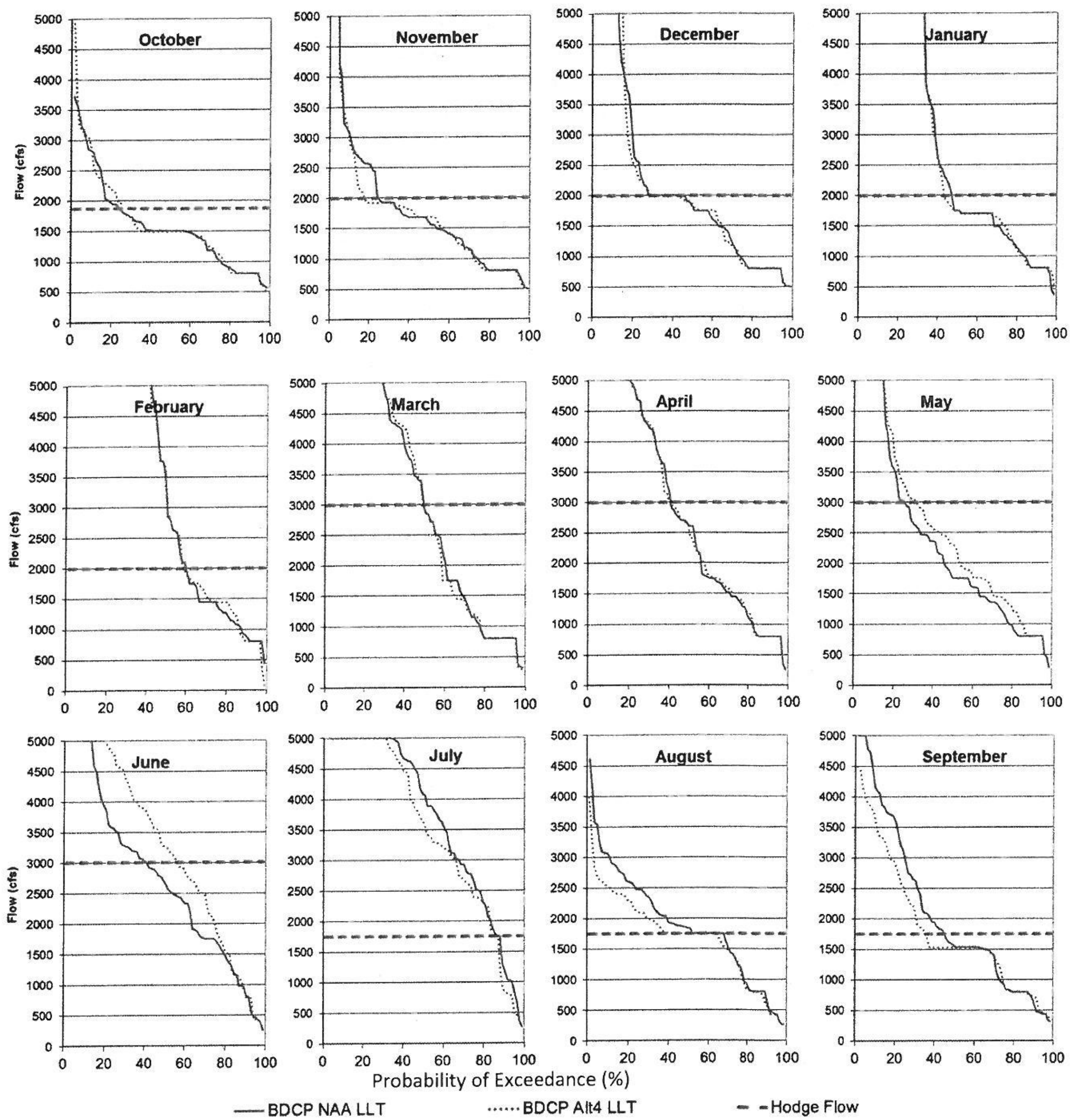


Figure 8. NAA-LLT and Alt 4-LLT Simulated H Street Flow

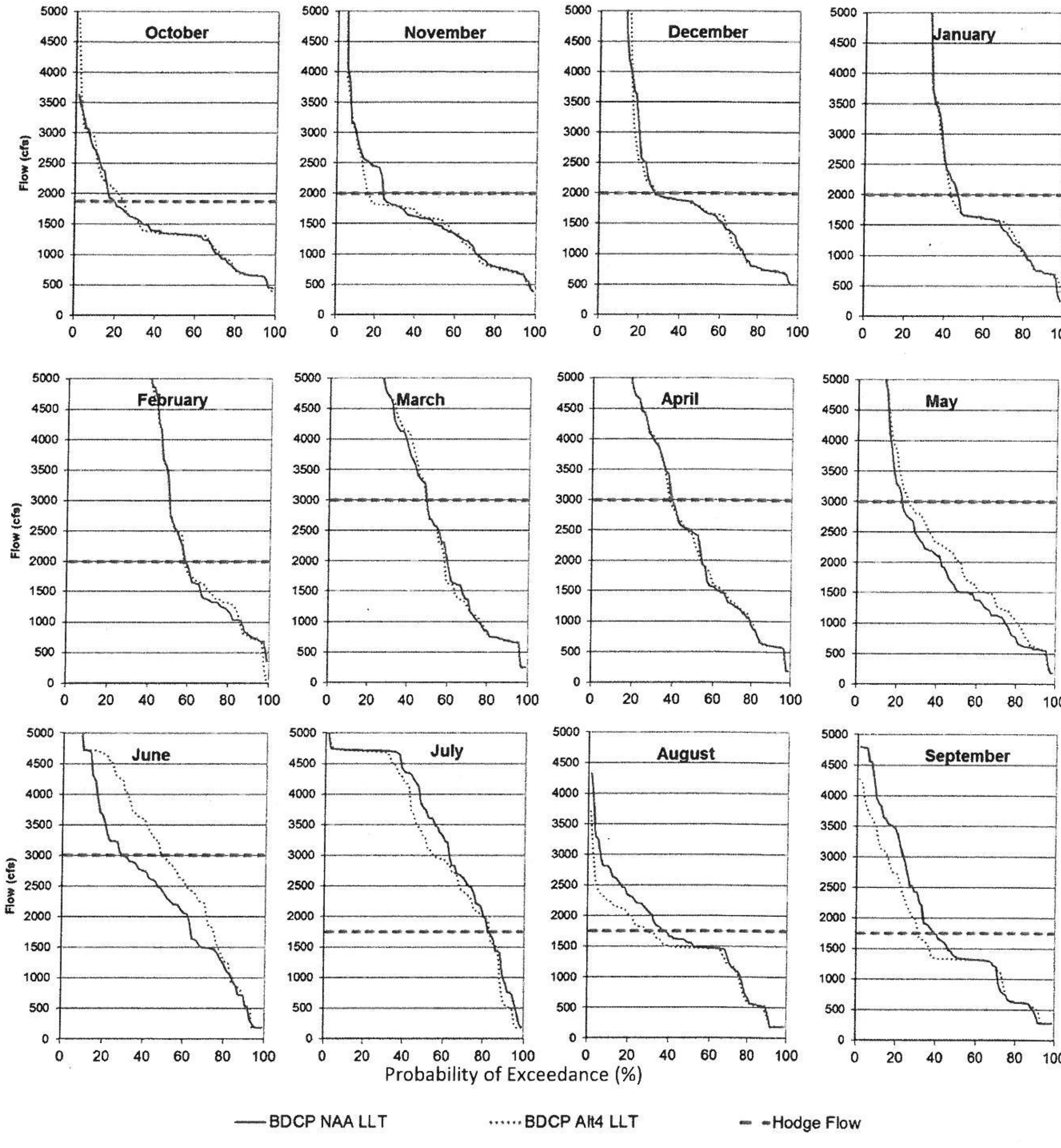


Figure 9. NAA-LLT and Alt 4-LLT Simulated Sacramento River Flow at the American River

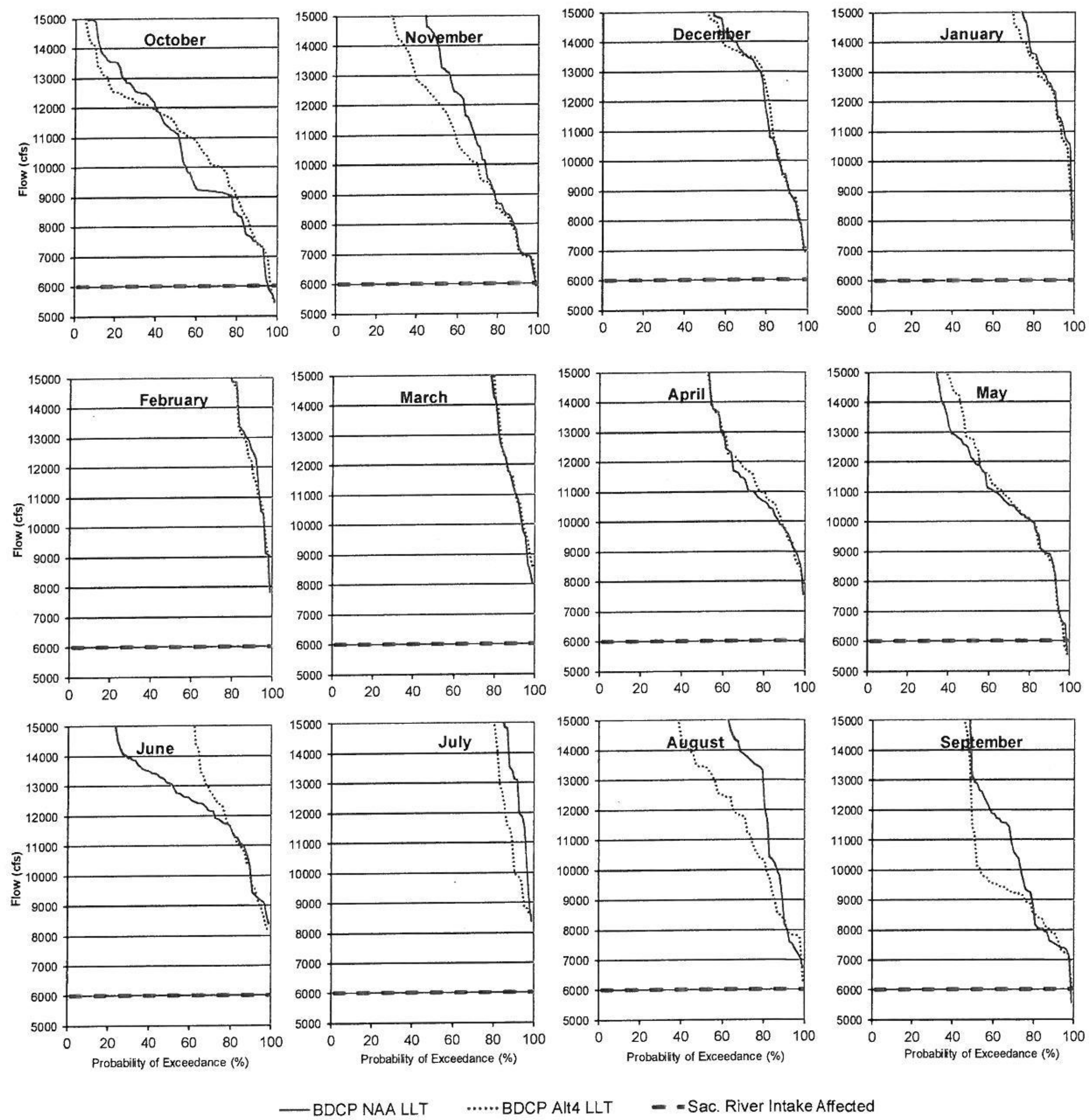
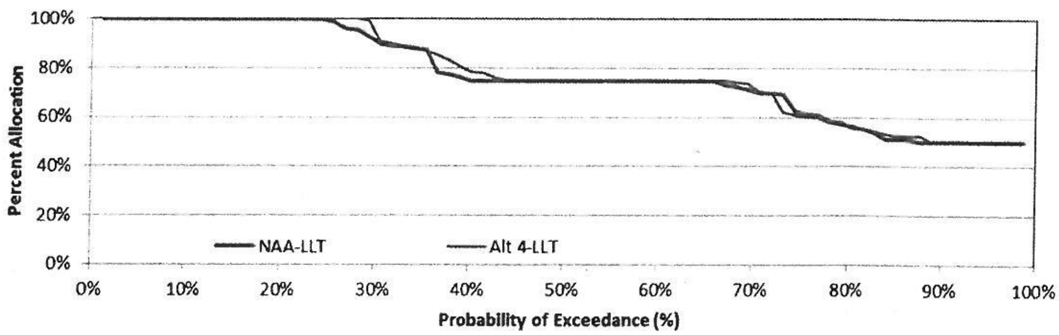


Figure 10 is an exceedance probability plot of CVP North of Delta M&I Water Service Contract Allocation for the NAA-LLT and Alt4-LLT. Changes in these allocations would affect the numerous CVP water-service contractors in the American River Basin, including the cities of Folsom and Roseville, Placer County Water Agency, SMUD and Sacramento County Water Agency. Average annual allocation to CVP M&I water service contractors is about 78% and increases by about one half of one percent in Alt 4-LLT compared to NAA-LLT. Although allocation never falls below 50%, deliveries are not always met due to low reservoir and river flows

Figure 10. CVP North of Delta M&I Water Service Contract Allocation



BDCP's "High Outflow Scenario" is not sufficiently defined for analysis.

The High Outflow Scenario (HOS) requires additional water (Delta outflow) during certain periods in the spring. The BDCP modeling places most of the responsibility for meeting this new additional outflow requirement on the SWP. However, the SWP may not actually be responsible for meeting this new additional outflow requirement. This is because COA would require a water allocation adjustment that would keep the SWP whole. Where one project (CVP or SWP) releases water to meet a regulatory requirement, the COA requires balancing to ensure the burden does not fall on only one of the projects. The BDCP modeling is misleading because it fails to adjust project operations, as required by the COA, to "pay back" the water "debt" to the SWP due to these additional Delta outflow requirements. Unless there is a significant revision to COA, the BDCP modeling overstates the impacts of increased Delta outflow on the SWP and understates the effects on the CVP, including Folsom Reservoir and the Lower American River.

Furthermore, based on the information made available from the BDCP environmental review process and after consulting with DWR and Reclamation project operators and managers, the Reviewers conclude that there is no apparent source of CVP or SWP water to satisfy both the increased Delta outflow requirements and pay back the COA "debt" to the SWP without substantially depleting upstream water storage. It appears, through recent public discussions regarding the High Outflow Scenario, that BDCP anticipates additional water to satisfy the increased Delta outflow requirement and to prevent the depletion of cold water pools will be acquired through water transfers from upstream water users. However, this approach may be unrealistic. During most of the spring, when BDCP proposes that Delta outflow be increased, agricultural water users, who are the only source of water in adequate volumes, are not irrigating. This means that they cannot transfer water during that time frame, and hence there is not sufficient transfer water available to meet the increased Delta outflow requirements without releasing stored water from the reservoirs. Releasing stored water to meet the increased Delta outflow requirements would deplete cold water pools and could potentially impact salmonids on the Sacramento and American River systems.