Summary of Flexible D-1641 X2 Standard Gaming Scenarios – Common Scenarios

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Introduction

A broad stakeholder group consisting of representatives from California Department of Water Resources (DWR), California Department of Fish and Game (DFG), U.S. Bureau of Reclamation (USBR), U.S. Fish and Wildlife Service (USFWS), U.S. Environmental Protection Agency (USEPA), NOAA Fisheries, Metropolitan Water District of Southern California (MWDSC), San Luis Delta Mendota Water Authority (SLDMWA), Westlands Water District (WWD), and the American River Water Forum convened on April 28th to participate in a one-day interactive modeling exercise to evaluate opportunities and environmental benefits/concerns with providing more flexibility to the implementation of the D-1641 X2 standard. An interactive daily gaming model was utilized to display historical operations and Delta conditions, to allow for re-operation of SWP/CVP facilities by the stakeholders, and to dynamically simulate the system response to the operational changes. This technical memorandum provides a description of the data and the gaming tool that were used for the exercise, followed by an analysis of the gaming scenarios and results.

Summary of Gaming Scenarios

Two gaming scenarios were developed and simulated during the one-day exercise. The overall objective of these scenarios was to identify times when the historical operation for the X2 Roe Island (Port Chicago) standard caused high releases from reservoirs and subsequently adversely impacted upstream fishery conditions. Under these conditions, the stakeholders attempted to manage river flows to the most appropriate levels for upstream fishery benefit while reducing Delta outflow. The water conserved in reservoir storage, through reduction in releases, was then utilized for river flow enhancement in subsequent days or months. In these gaming scenarios, flexible compliance with the X2 standard was only considered when a fishery concern was identified on the *American River*. For tracking purposes this was labeled as **flex option 1**.

Two options were considered for the release of the conserved water in reservoir storage. **Usage option 1** consisted of an “immediate and full release” of all conserved water. This option evaluated the environmental benefits of shifting X2 outflow from one month to another, but maintaining the same total volume of Delta outflow during the seasonal periods. **Usage option 2** consisted of a “delayed, but full release” of all conserved water.

This option allowed for any water savings to accrue, to the extent feasible, in upstream storage and be used later in the same calendar year for upstream instream fishery benefits.

The gaming scenarios, for sake of simplicity, are referred to as Games 1.1 and 1.2, where the first number refers to the flex option and the second number refers to the usage option.

Period of Analysis and Data Sources

The recent historical period of water years 2002, 2003, and 2004 was selected as the model simulation period for the gaming scenarios. This period was selected to be consistent with recent operations, including the CVPIA (b)(2) and the Environmental Water Account programs, current Delta standards, and the availability of daily hydrologic and operational data.

Daily hydrologic and operational data for the Sacramento Valley, San Joaquin Valley, and Delta were compiled from a variety of sources. Reservoir operational reports containing daily values for inflow, storage, and release were obtained electronically from the California Data Exchange Center (CDEC). Daily river flow data were generally obtained from the U.S. Geological Survey (USGS) gage records. Historic Delta flows, cross-channel gate operations, exports, and estimates of island consumptive use and drainage were obtained from the IEP DAYFLOW database. DWR and USBR operators provided daily electrical conductivity measurements for the Delta, additional reservoir operational conditions, and historical (b)(2) accounting sheets.

Gaming Tool

A spreadsheet-based gaming tool, developed by CH2M HILL, was employed for the gaming exercises. The tool utilizes historical daily facility operations, river flows, and Delta conditions to develop the Base scenario. The historic conditions are displayed graphically on a schematic of the Central Valley water resources system. The model schematic is shown in Figure 1. Various timeline graphics of reservoir storage levels, river flows, exports, Delta salinity, and other system parameters are included in the gaming tool for review of baseline conditions.

Gaming scenarios are developed by tiering off of the Base (historical) scenario and modifying facility operations to suit the guidelines of the particular game. The system response to changes in facility operations is dynamically simulated and results are automatically displayed on the schematic and timeline graphs. Based on discussions in meetings prior to the gaming, a simplified hydrologic routing technique was implemented in the model to approximate the time lag of flows from upstream reservoirs to the Delta. Changes to facility operations can be made on a daily basis or can span a period of any number of days.

The gaming tool incorporates computations of all major Delta constraints and standards. The salinity at various locations in the Delta is simulated through the use of the G-Model (Denton and Sullivan 1993) and is also compared to historic salinity conditions. The X2 position is computed based on the equation developed by Jassby et al (1995) relating Delta outflow and antecedent position to the current day position. The X2 position can also be approximated by interpolation of simulated salinity values at several stations in the Delta. As part of this gaming exercise, the gaming tool was integrated with a separate spreadsheet tool that provides greater assessment of the daily compliance of the X2 standard given that the standard can be achieved through either a 3-day running average of net Delta outflow, daily EC, or 14-day running average of EC values. In addition this tool, provides a dynamic computation of species abundance indices as related to change in X2 over the specific averaging period (Kimmerer 2002)

Historic (Base) Conditions

While historical data was compiled for water years 2002-04, only water years 2003 and 2004 exhibited the X2 conditions that were the focus of this gaming exercise. During early January 2003, uncontrolled runoff from the Sacramento Valley watershed flowed out of the Delta and pushed the X2 line westward. As a result of the large westward swing in the X2 position, the Roe Island standard was triggered and required 25 days of compliance. Beginning around the 10^{th} or 11^{th} of February, SWP and CVP operators began making increased releases from Folsom, Shasta, and Oroville reservoirs to target the Delta outflow standard. Flows on the American River, in particular, went from a nearly constant 4000 cfs prior to the 10^{th} to nearly 5500 cfs for 5-7 days following the 10^{th} before returning to 4000 cfs. Flows subsequent to the 20^{th} began dropping down to 2000 cfs. All reservoirs went into flood control operation within a few months of this X2 Roe Island occurrence.

Similar to water year 2003, early April 2004 exhibited X2 Roe Island triggering that produced rather erratic flow conditions on the American River. Extremely high uncontrolled runoff in March caused a triggering of 18 days of X2 compliance at Roe Island. As a response to the triggering, rapid releases were made from Nimbus to support Delta outflow. Flows below Nimbus went from approximately 4000 cfs on April 6^{th}, to nearly 8000 cfs on the 8^{th}, and back down to 4000 cfs on the 20^{th}. Flows subsequent to the 20^{th} began dropping below 2000 cfs. Substantial stranding of juvenile Chinook salmon and isolation of Steelhead redds occurred during this event. A similarly erratic operation occurred at Keswick and Oroville facilities. Contrasting with 2003 conditions, however, none of the reservoirs went into flood control operations in 2004. See Figures 2a-d for a graphical display of conditions in 2003-04.

Summary of Game 1.1 Actions and Impacts

The following is a synopsis of the actions taken by the participants in Game 1.1 and the result of these actions. A graphical representation of the operational impacts to storage and river flows is shown in figures 3a and 4a.

WY 2003

Actions

- February 10-20. Reduced releases from Nimbus to maintain 4000 cfs. A total of 27 kaf was conserved in Folsom by the 20th.
- February 23-March 7. In order to provide a better ramping of flows, Nimbus releases were increased to 3500 cfs. A total of 23 kaf was used in this flow augmentation.
- March 8-11. The participants sought to achieve ramping from 3500 cfs to the baseline flows with the remaining conserved water in storage. Flows ramped down to approximately 2000 cfs over the span of 4 days.

Impacts

- X2 changes due to actions: No change in days of X2 compliance (25 days required/26 days satisfied at Roe). Period average X2 changes: Feb-Jun (-0.07 km), Jan-Jun (-0.04 km), Feb-May (-0.06 km), Jan-Apr (-0.06 km), Mar-May (-0.12 km)
- Change in fish abundance indices due to actions: Longfin smelt (+0.50%), American shad (+0.19%), Pacific herring (+0.03%), Crangon (+0.64%)

WY 2004

Actions

- April 6-20. Reduced releases from Nimbus to maintain 4000 cfs. A total of 51 kaf was conserved in Folsom by the 20th.
- May 1 – June 17. Increase Nimbus releases to 2600 cfs to stabilize flows while re-releasing the full 51 kaf. Limited ability to export addition supplies in Delta due to export-inflow constraint.

Impacts

- X2 compliance: Dropped 2 days of X2 compliance at Roe, but still exceeded required days (18 days required/21 days satisfied at Roe -- 23 days satisfied in baseline).
- Period average X2 changes: Feb-Jun (-0.08 km), Jan-Jun (-0.06 km), Feb-May (+0.03 km), Jan-Apr (+0.05 km), Mar-May (+0.05 km)
- Change in fish abundance indices: Longfin smelt (+0.75%), American Shad (-0.11%), Pacific herring (-0.03%), Crangon (-0.25%). Note that the Longfin smelt index rises slightly while the other indices fall slightly . This is a result of having different averaging periods for the various X2 correlations. Thus, reducing outflow in April while increasing May and June outflow moves average X2 downstream slightly for

the Longfin smelt averaging period (January – June) while moving average X2 upstream slightly for Pacific herring (January – April)

Summary of Game 1.2 Actions and Impacts

The following is a synopsis of the actions taken by the participants in Game 1.2 and the result of these actions. A graphical representation of the operational impacts to storage and river flows is shown in figures 3b and 4b.

WY 2003

Actions

- Same as Game 1.1. Delayed release would not be possible due to flood control operations by May. If attempted, the 27 kaf of conserved water would be spilled if not used prior to flood control operations.

Impacts

- Same as Game 1.1.

WY 2004

Actions

- April 6-20. Same as Game 1.1.
- August 1 – November 30. Discussed how to re-release later in year and following fall for American River flow objectives. Increased releases from Nimbus to satisfy desired flow targets for the lower American: 1750 cfs in Aug, 1500 cfs in Sep and Oct, and 1750 cfs in Nov. At end of Nov, 22 kaf of conserved water still remaining in storage. Estimated export of water (not gamed due to inadequate data for Delta in WY 2005) is 0 kaf in Aug, 4 kaf in Sep, 8 kaf in Oct, and 10 kaf in Nov.

Impacts

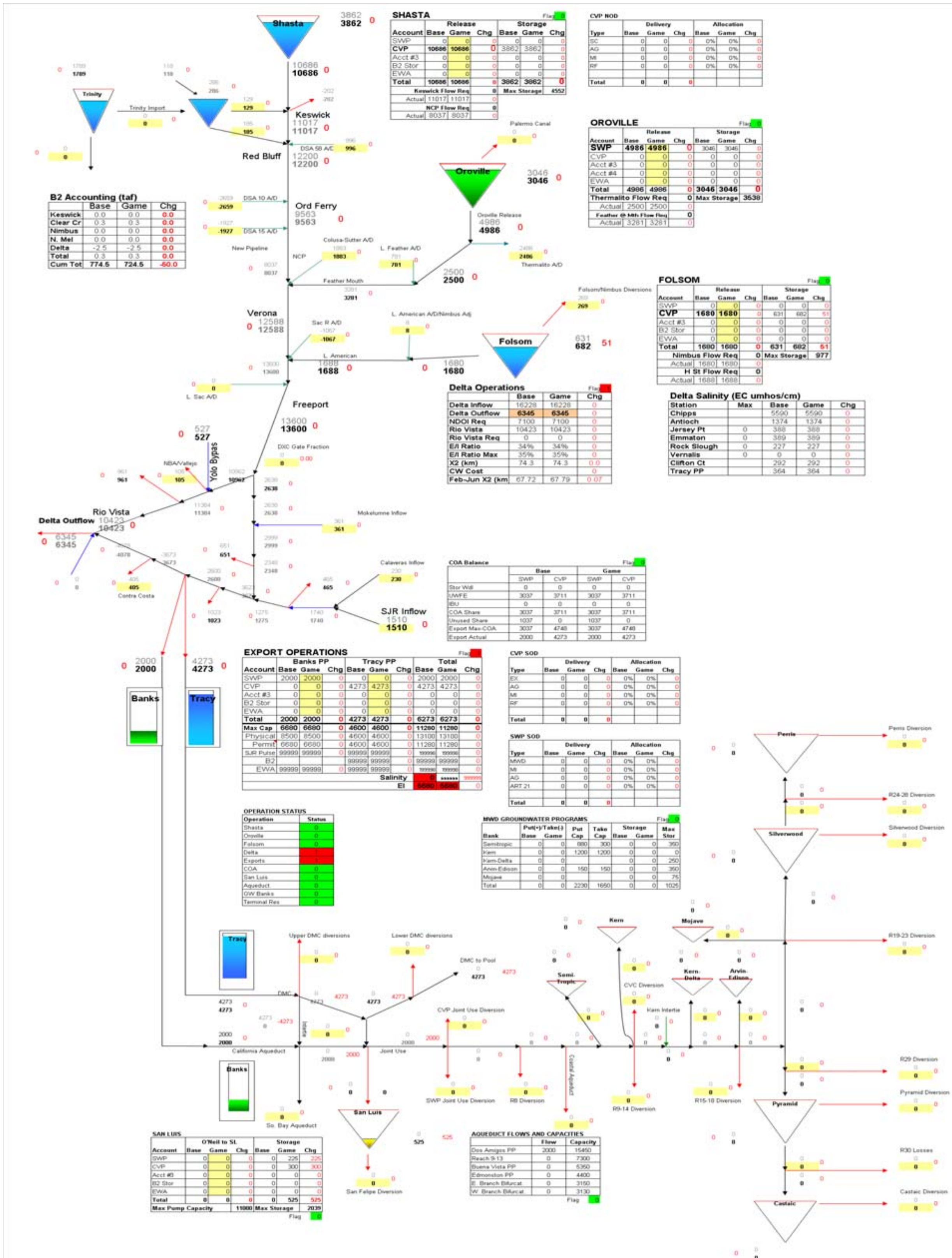
- X2 compliance: Dropped 2 days of X2 compliance at Roe, but still exceeded required days (18 days required/21 days satisfied at Roe -- 23 days satisfied in baseline).
- Period average X2 changes: Feb-Jun (+0.06 km), Jan-Jun (+0.06 km), Feb-May (+0.08 km), Jan-Apr (+0.05 km), Mar-May (+0.11 km)
- Change in fish abundance indices: Longfin smelt (-0.68%), American Shad (-0.25%), Pacific herring (-0.03%), Crangon (-0.58%)
- Increased storage in Folsom in April may have positive benefits for coldwater pool management.

References

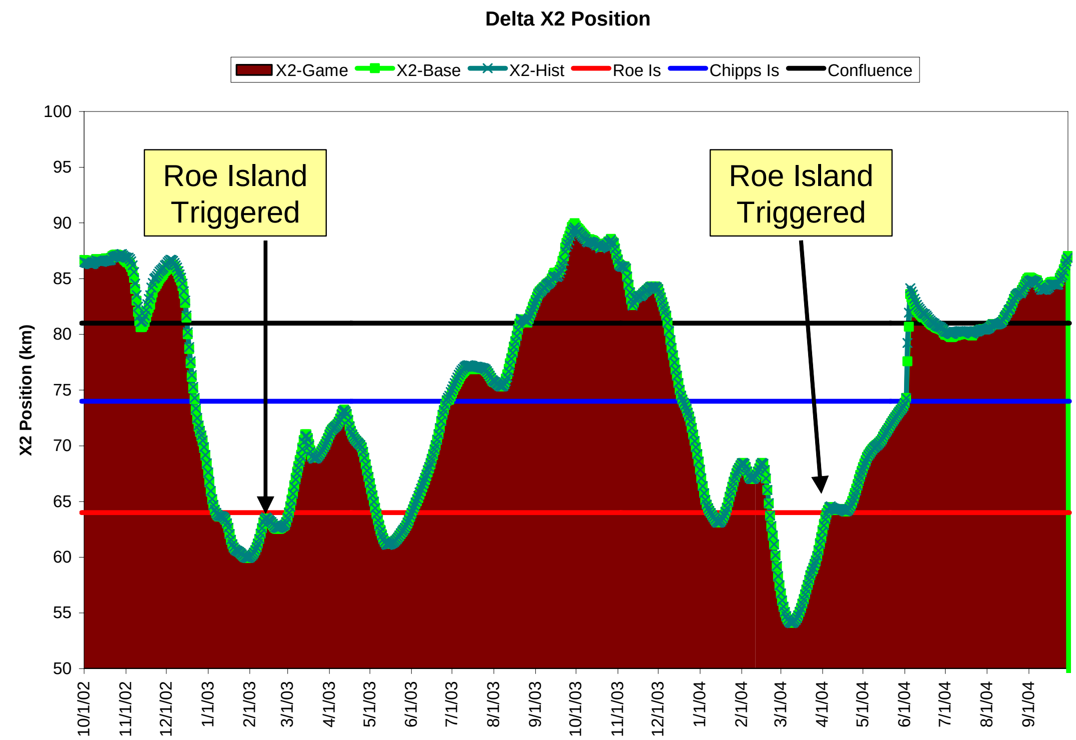
Denton RA and Sullivan GD. 1993. Antecedent Flow-Salinity Relations: Application to Delta Planning Models.

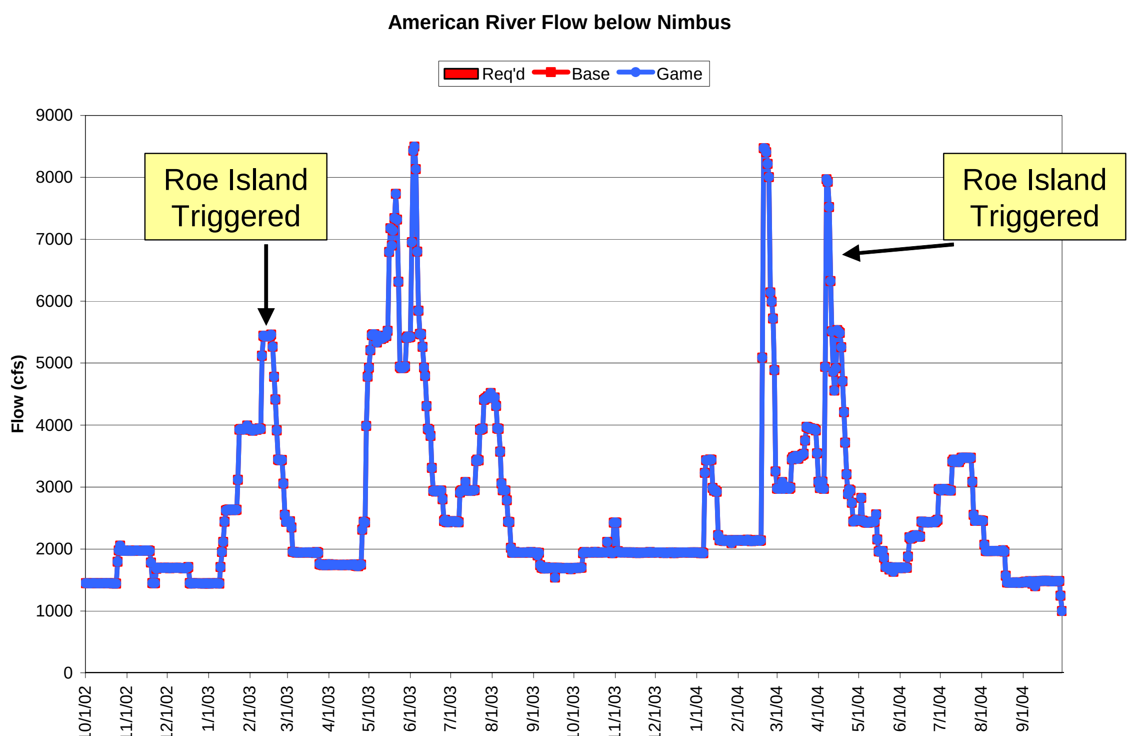
Jassby AD, Kimmerer WJ, Monismith SG, Armor C, Cloern JE, Powell TM, Schubel JR, Vendlinski TJ. 1995. Isohaline position as a habitat indicator for estuarine populations. Ecological Applications 5:272-289.

Kimmerer WJ. 2002. Effects of freshwater flow on abundance of estuarine organisms: physical effects or trophic linkages? Marine Ecology Progress Series 243: 39-55.

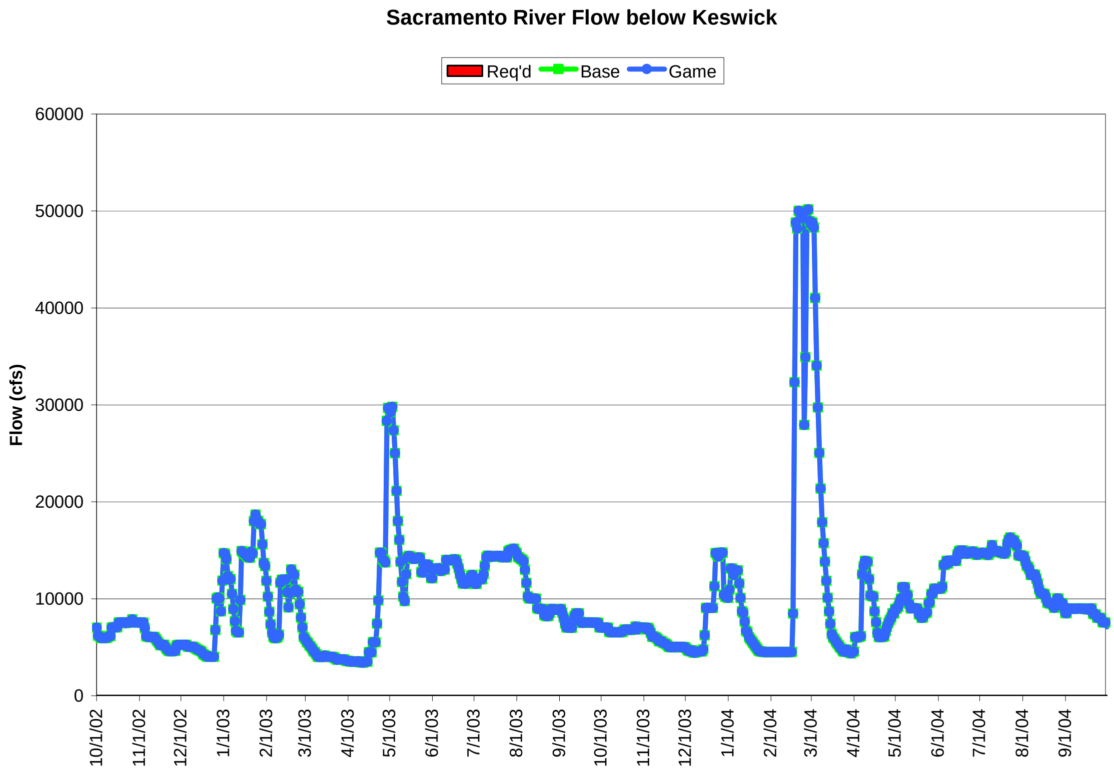


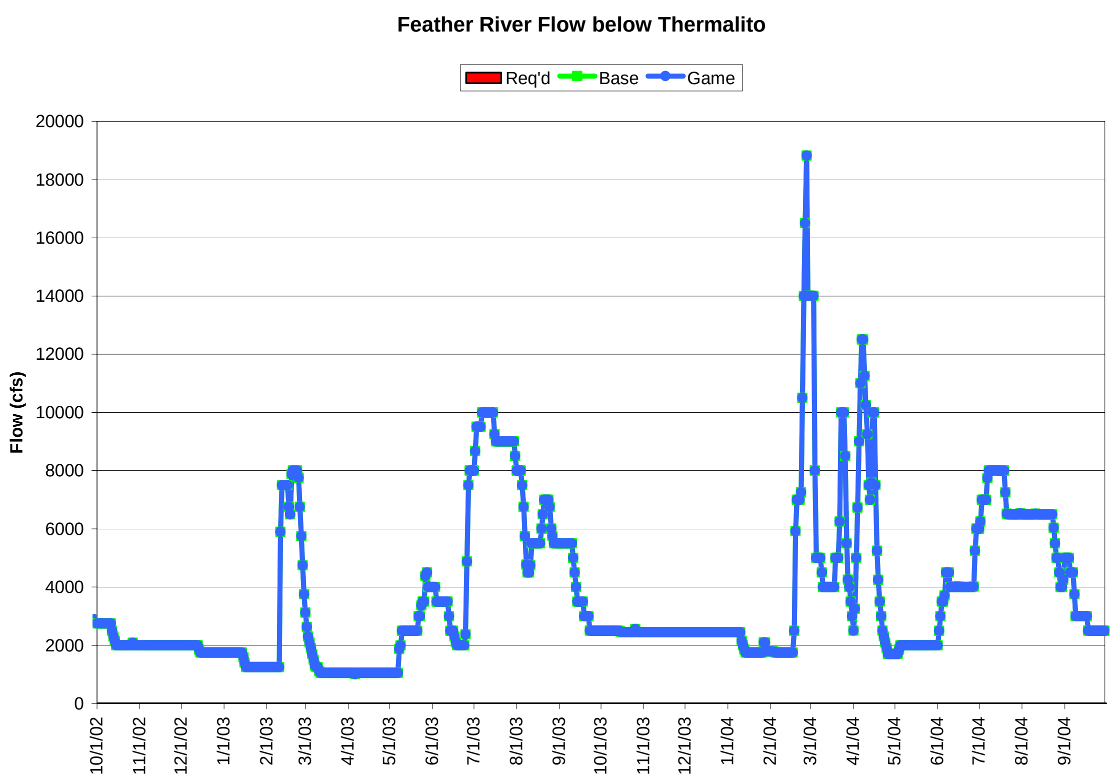
Figures 1. Gaming model schematic.



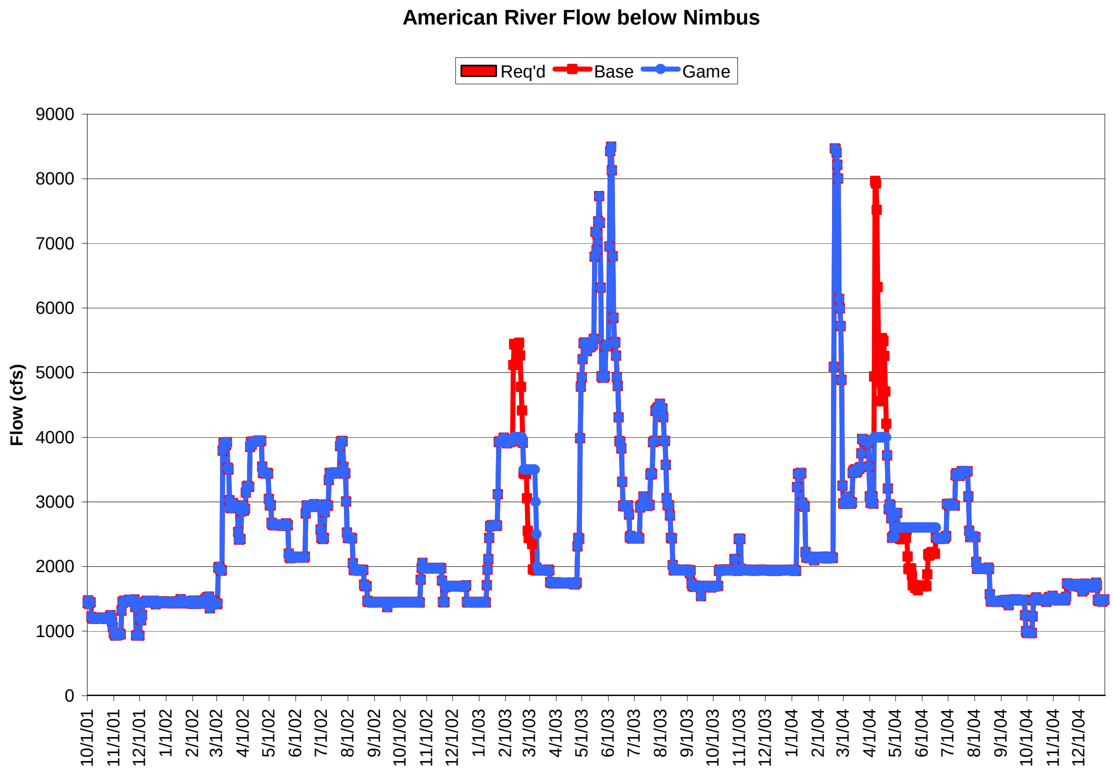


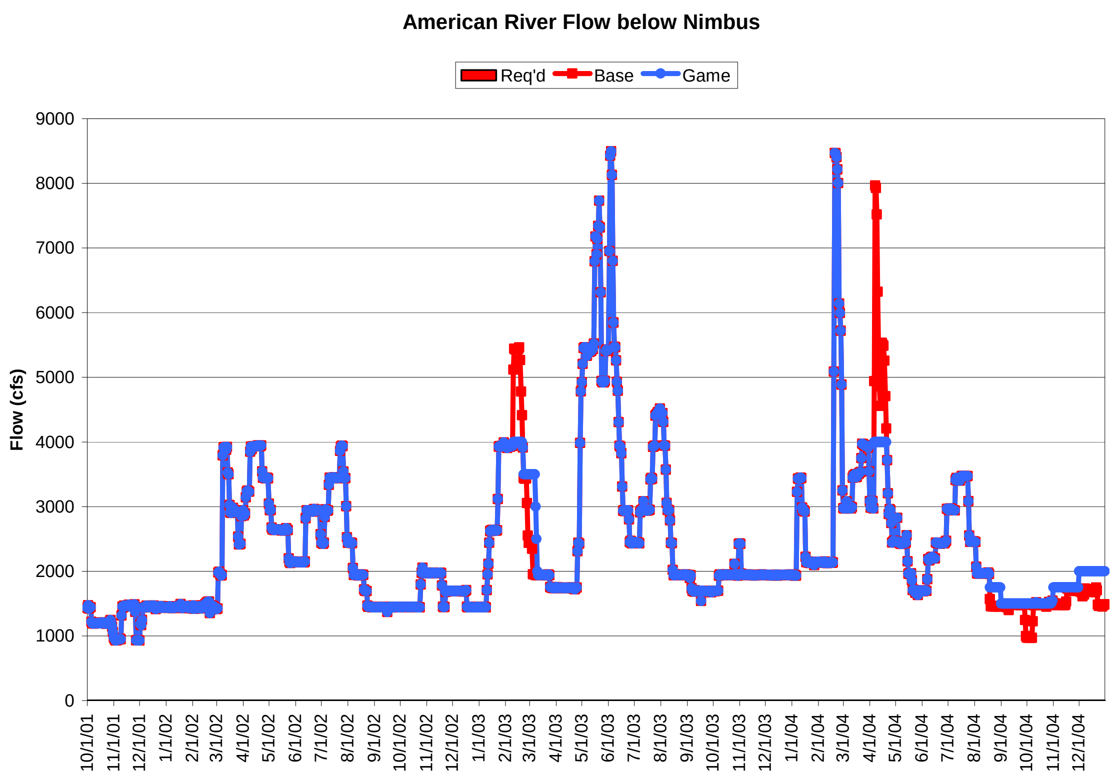
Figures 2a (top) and 2b (bottom). Historical X2 position and American River flows for water years 2003-04.



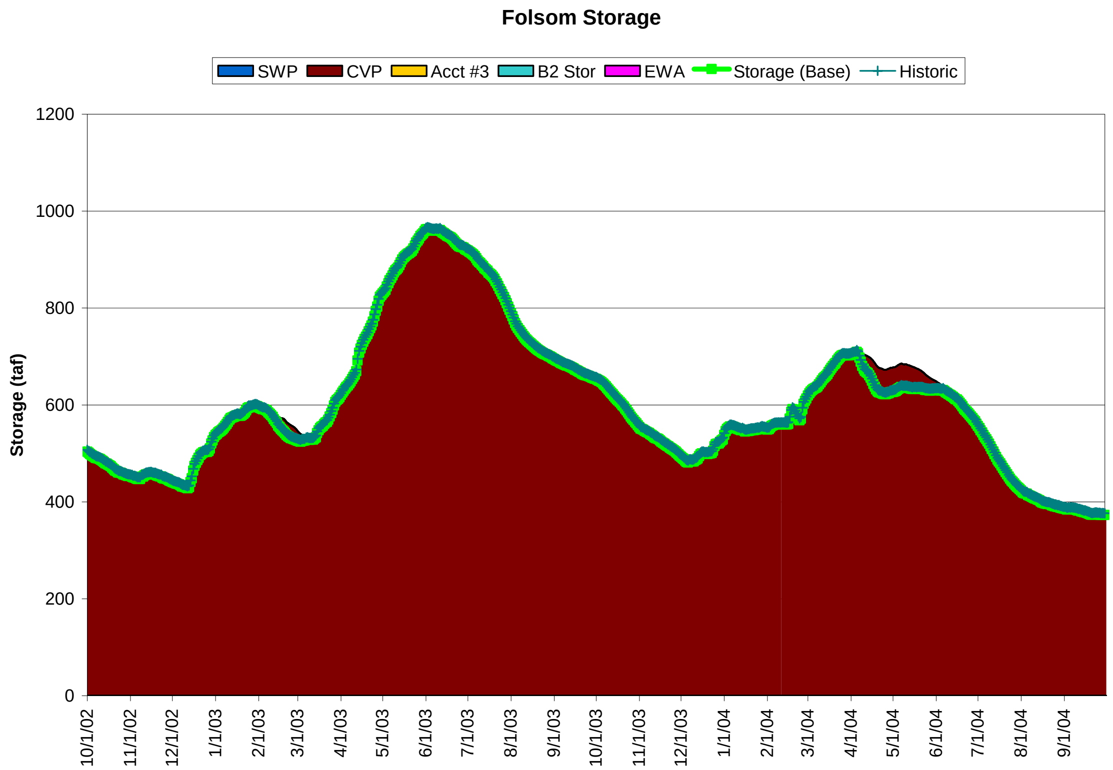


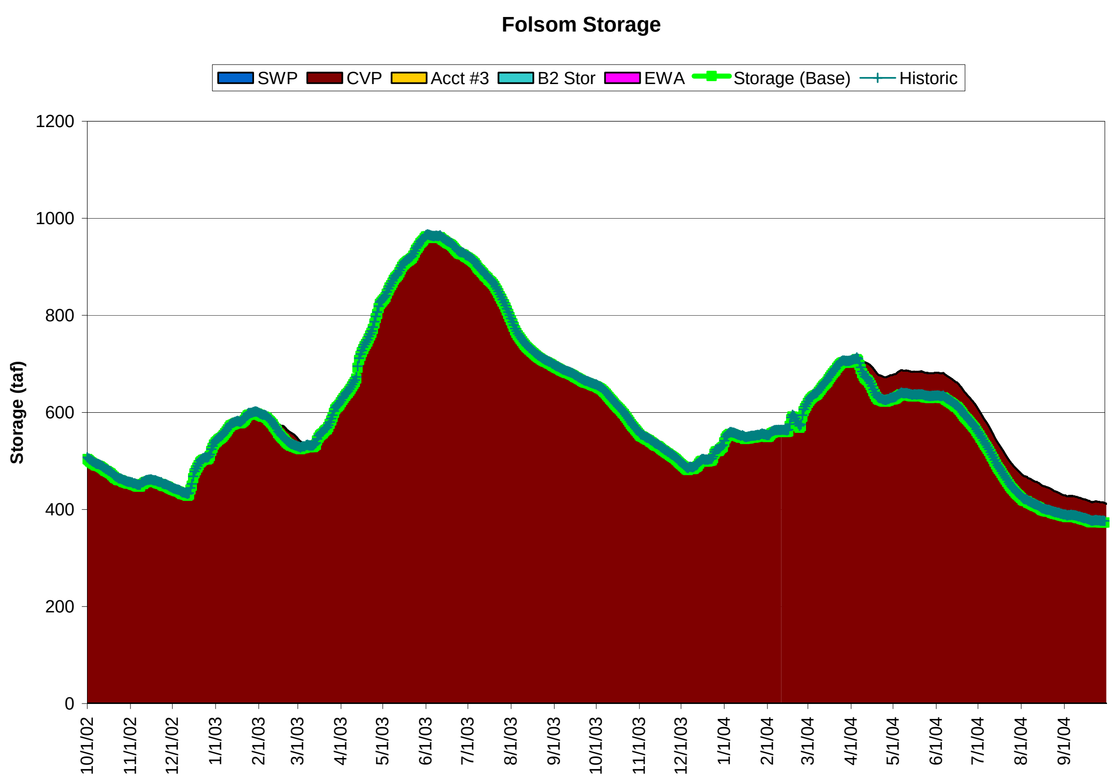
Figures 2c (top) and 2d (bottom). Historical Sacramento River and Feather River flows for water years 2003-04.





Figures 3a (top) and 3b (bottom). Flow changes on the American River due to actions taken in Game 1.1 (3a) and Game 1.2 (3b) for water years 2003-04.





Figures 4a (top) and 4b (bottom). Folsom storage changes due to actions taken in Game 1.1 (4a) and Game 1.2 (4b) for water years 2003-04.