# FORECAST-BASED OPERATIONS AT FOLSOM DAM AND LAKE

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### AGENDA

- Background of American River watershed and Folsom Dam
- Need for Joint Federal Project (JFP)
- New forecast-based operations at Folsom Dam



### **AMERICAN RIVER HYDROLOGY**

- Steep watershed
- Rain-on-snow potential
- Winter snowpack







## **FOLSOM DAM**

### Folsom Lake

- Gross Pool (100% full): 967,000 ac-ft
- Flood Control Space: up to 600,000 ac-ft
- Avg. Annual Unregulated Runoff: 2,788,000 ac-ft

### Folsom Dam

- Main spillway with eight radial gates
  - Elevation ~420 ft; Max release capacity ~567,000 cfs
- River outlets
  - Max release capacity ~28,000 cfs
- Auxiliary spillway (JFP)
  - Elevation ~370 ft; Max release capacity ~314,000 cfs

## NEED FOR JFP

- Problems with the existing dam:
  - Only 400,000 acre-feet of authorized flood storage (wasn't sized to include largest storms)
  - Can't pass the Probable Maximum Flood without overtopping
  - 30% of flood storage used when downstream objective release (115,000 cfs) can be achieved
- Proposed solutions:
  - Additional upstream flood storage
    - Expansion of existing outlets
  - Auxiliary spillway, additional 200,000 ac-ft of variable flood storage, and forecast-based operations potential





## **FORECAST-BASED OPERATIONS**

- Theory: foreknowledge of runoff volume and timing enables optimal use of storage and release decisions
- Concerns: forecast uncertainty generates risk
  - Insufficient releases (increased flood risk)
  - Excessive releases (increased water supply risk)
- Challenges:
  - Limited forecast data record
  - Never been done before





### **TWO BASELINES/THREE ALTERNATIVES**



### FOLSOM WCM SIGNED – JUNE 12, 2019



### **NEW FOLSOM WCD**





#### USE OF WATER CONTROL DIAGRAM

Folsom Dam and Lake shall be operated for flood control in accordance with the Water Control Diagram and the accompanying Emergency Spillway Release Diagram (ESRD). Water stored within the Flood Control Reserve (FCR) space shall be released as rapidly as possible subject to the Release Schedule, except when releases greater than 115,000 cfs are required by the ESRD. The Corps of Engineers may direct flood releases to be increased or decreased from the prescribed release when warranted by existing conditions or by high confidence forecast information provided by NWS-CNREC.

RELEASE SCHEDULE				
(Releases shall not exceed 115,000 cfs unless specified by the ESRD)				
SEASONAL RELEASES (EFFECTIVE MAR 1 THRU NOV 18)	TABLE A			
Release peak inflow for current event.	INFLOW FORECASTED VOLUME	RELEASE		
FORECAST-BASED RELEASES	120-HR > 300,000 ACRE-FEET	25,000 CFS		
(EFFECTIVE NOV 19 THRU FEB 28/29)	72-HR > 300,000 ACRE-FEET	50,000 CFS		
1. If FCR = 400,000 acre-feet, release peak inflow	48-HR > 300,000 ACRE-FEET	80,000 CFS		
<ol> <li>If FCR &lt; 500,000 acre-feet, Table A Release.</li> <li>If FCR ≥ 500,000 acre-feet, release the greater of peak inflow for the current event or Table A Release.</li> </ol>	24-HR > 300,000 ACRE-FEET AND INFLOW ≥ 115,000 CFS	115,000 CFS		
peak inflow for the current event or Table A Release.	AND INFEOW 2 113,000 CF3			

#### RAMPING RATES

Releases between 8,000 cfs and 30,000 cfs will not be increased by more than 10,000 cfs during any 2-hour period. Releases between 30,000 cfs and 115,000 cfs will not be increased by more than 30,000 cfs during any 2-hour period. Releases between 8,000 cfs and 115,000 cfs will not be decreased by more than 10,000 cfs during any 2-hour period.

#### COMPUTATION OF VARIABLE TOP OF CONSERVATION

From Nov. 19 to Feb. 28/29 the Top of Conservation (TOC) storage will vary based on forecasted inflow volumes. These are developed by the NWS-CNRFC for the purpose of supporting Folsom Dam flood operations, will reflect forecasted inflows over the next 24, 48, 72, and 120 hours, and will reflect a value of non-exceedence probability (NEP) specified by the Corps. Volumes will be provided once per day during normal operations, and every six hours once the 120-hour volume exceeds 300,000 acre-feet. Figure A provides relationships relating inflow forecast volume to variable TOC storage for each duration.

FIGURE A INSTRUCTIONS: Locate each of the four forecast volumes on the horizontal axis. Place the four forecast volumes on the respective duration curves. For each forecast volume, identify the corresponding candidate TOC storage value on the vertical axis. Of the four candidate TOC storage values, the lowest value is the adopted variable TOC storage value. The corresponding FCR value is given by: FCR = Gross Pool (966,823 acre-feet) - variable TOC storage.

> FIGURE A EXAMPLE: Inflow forecast volumes of 180, 330, 760 and 850 thousand acre-feet are provided, corresponding to 24, 48, 72, and 120 hours, respectively. As shown in Figure A, the volumes are located on the horizontal axis and placed on the corresponding curves (indicated by large dots). Corresponding candidate TOC storage values are read from the vertical axis. The lowest value is given by the 72-hour volume. This value (450,000 acre-feet) is therefore the adopted variable TOC storage value. The corresponding FCR value is:

FCR = 966 823 ac-ft - 450 000 ac-ft = 516 823 ac-ft



FOLSOM DAM AND LAKE

Prepared pursuant to Flood Control Regulations for Folsom Dam and Lake in accordance with the Code of Federal Regulations Title 33 Part 208.11



Revised June 2019



### **FORECAST INFLOW VOLUMES**

#### /0/72/FLOW-IN/01JAN1985 - 01JAN2002/1DAY/AVG-TRUTH-SERIES/

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## **ROBUSTNESS RESULTS**

Flood Performance Metric Event, Target Release	Minimum Successful NEP
1/100 1986 pattern, 115 kcfs	35%
1/100 1997 pattern, 115 kcfs	5%
1/200 1986 pattern, 160 kcfs	35%
1/200 1997 pattern, 160 kcfs	5%





## SENSITIVITY ANALYSIS RESULTS

- Evaluated susceptibility of the forecast-based operation not refilling in the short-term
- Modeled response of drastically overestimated inflow forecast when much lower inflow "actually" occurred

	Forecasted Event	Inflow Event
1986 pattern	1/130	1/2
1997 pattern	1/100	1/2





### **ASPECTS OF ADAPTIVE MANAGEMENT**

• Chapter 9 and Exhibit A of the WCM:

"The 75 percent non-exceedence probability (NEP) for the ensemble inflow forecast volumes are used to compute the required flood space reservation. **This value may be updated based on re-assessment of forecast skill.**"

• Note on WCD:

"These [forecasted inflow volumes] are **developed by the** NWS-CNRFC...and will reflect a value of **non-exceedence probability (NEP) specified by the Corps.**"





# **QUESTIONS?**