

USE OF ENSEMBLE DATA TOOL FOR DECISION SUPPORT ON LAHONTAN RESERVOIR

An effort to support LBAO and TCID

August 29, 2023

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US District Court Water Master's Office

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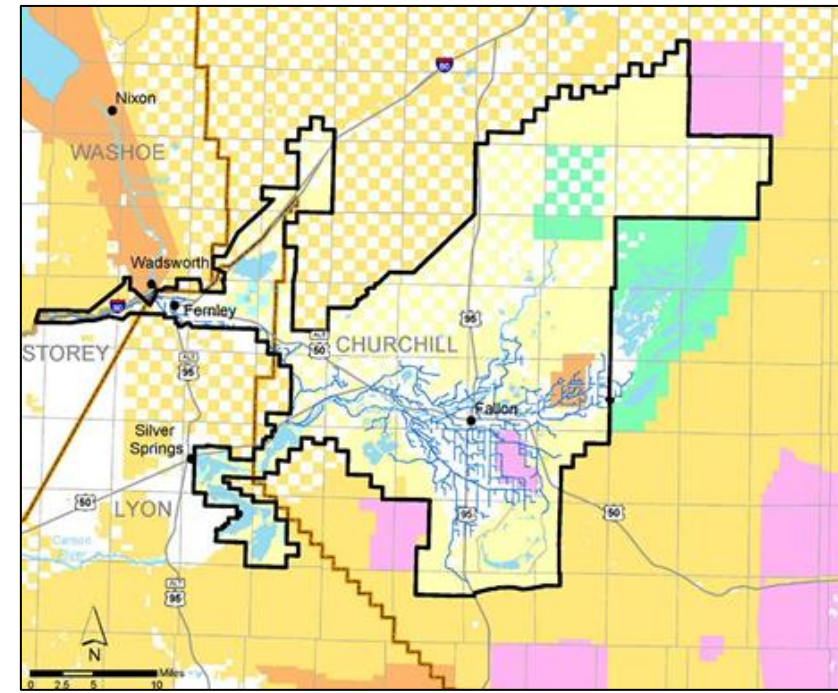
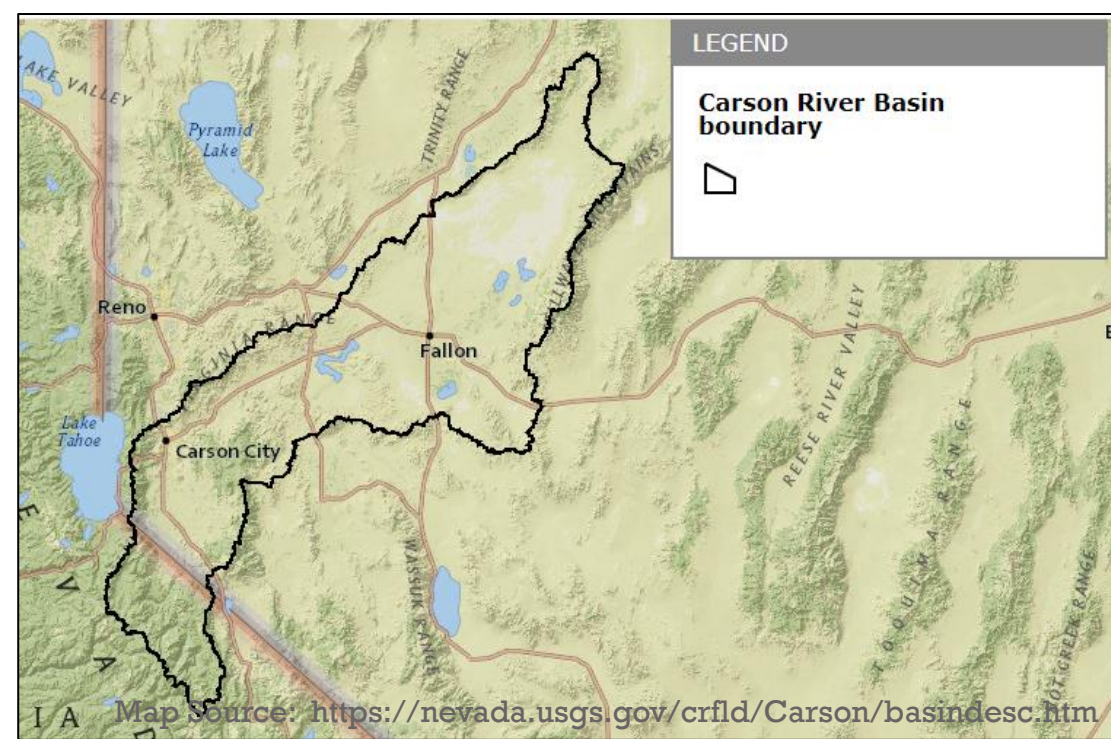
CARSON BASIN: OVERVIEW

Pre-2023 Stats

- ~4,000 sq mi
- Median April – July Volume: 167 kaf
- Median WY Volume: 256 kaf
- Peak April – July Volume: 570 kaf (2017)
- Peak WY Volume: 951 kaf (2017)

Newlands Project

- ~560 sq mi
- Major Project Features:
 - Lahontan Reservoir
 - Truckee Canal
 - Carson Diversion Dam

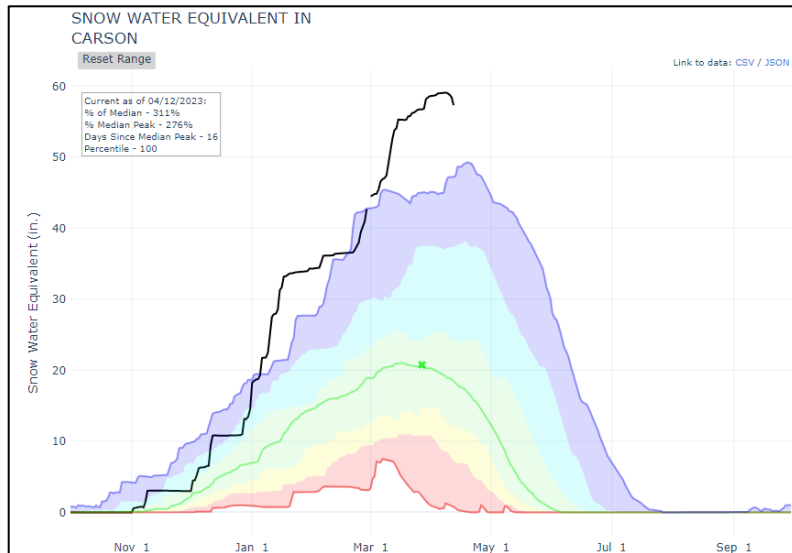
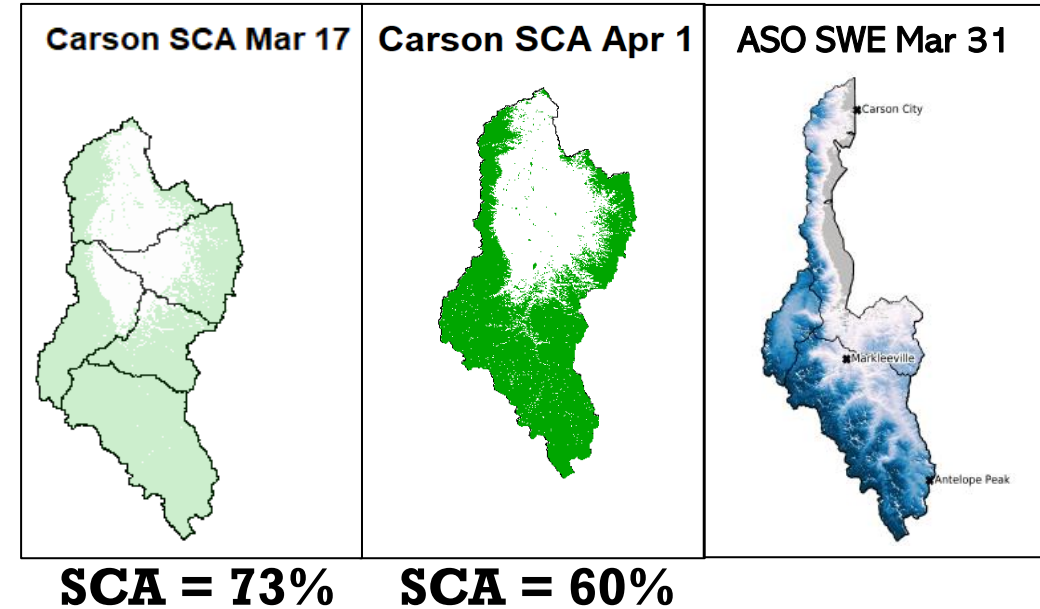


CARSON BASIN: WY2023

April 1 Knowns

- Record-breaking snowpack
- Large snow-covered area (SCA)
- 4/1 SWE ~14" higher than SNOTEL record
- ASO estimated SWE = 1,070 kaf
- Median RFC AJ Forecast = 580 kfa

Normalized Difference Snow Index



NRCS Basin-Wide Avg SWE

Table 1. Estimated SWE volume (TAF) for the full Carson River basin and subbasins for the current survey.

Basin	Estimated SWE (TAF) March 31
Full Basin	1070
Uncertainty Range	1033 - 1107
East Fork	705
West Fork	176

ASO Estimated SWE Vol

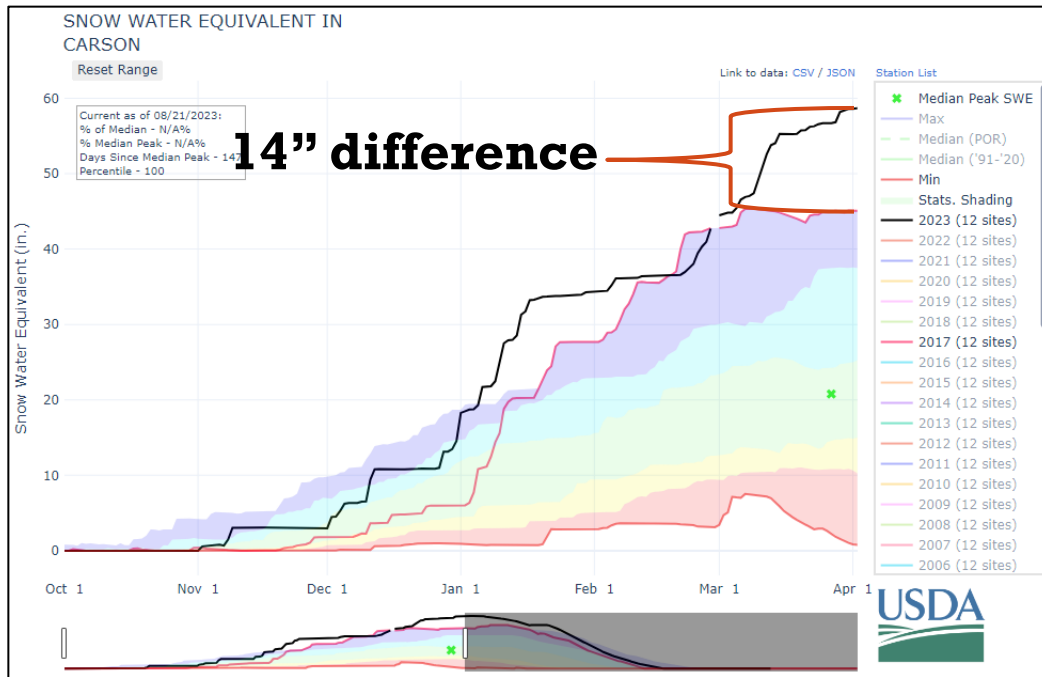
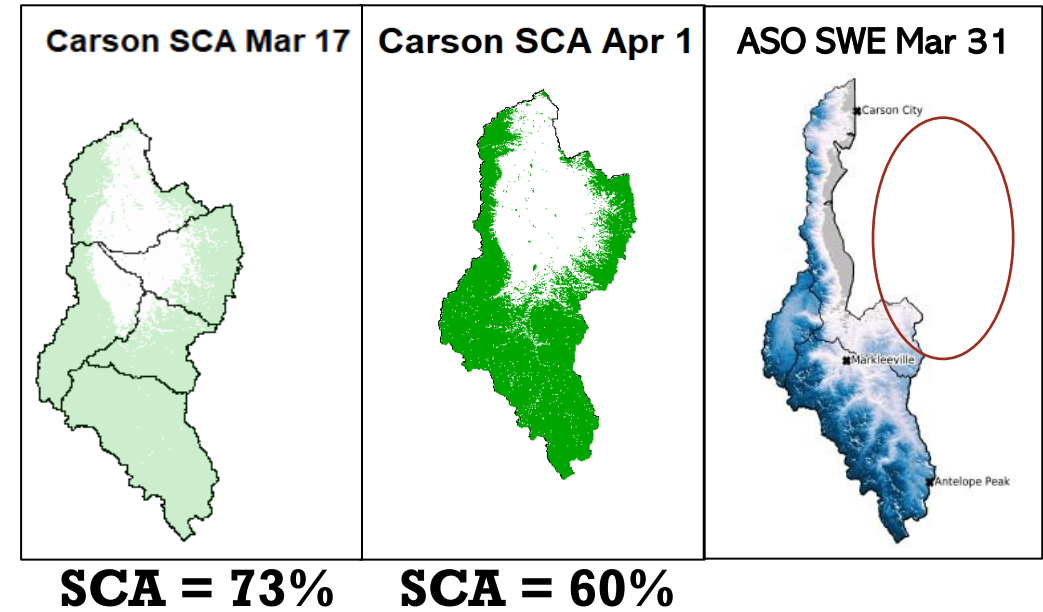
RFC Median Apr 1 AJ Forecast	
2017	2023
490 kaf	580 kaf

CARSON BASIN: WY2023

April 1 Concerns

- Snowpack much larger than 2017
- ASO estimated SWE = 1,070 kaf....
excludes +100 sq mi of SCA
- Experimental forecast ~ 131 kaf higher →
~1/2 of Lahontan's storage volume

Normalized Difference Snow Index



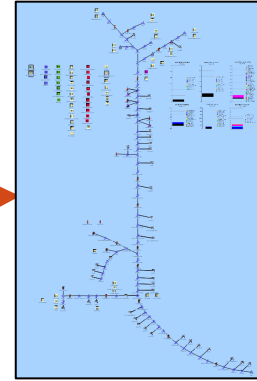
NRCS Basin-Wide Avg SWE

April 1 Values	2017	2023
SNOW-17 SWE (RFC's Snow Accumulation/Ablation Model)	805 kaf	965 kaf
ASO SWE	--	1,070 kaf Excluding 100 sq mi SCA
RFC AJ Median Forecast	490 kaf	580 kaf
ASO Informed RFC AJ Median Forecast	--	711 kaf

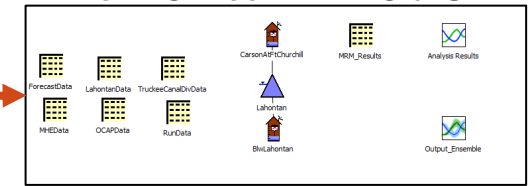
TROA MODEL → LAHONTAN OPS MODEL

TROA LAHONTAN MODEL

TROA Model



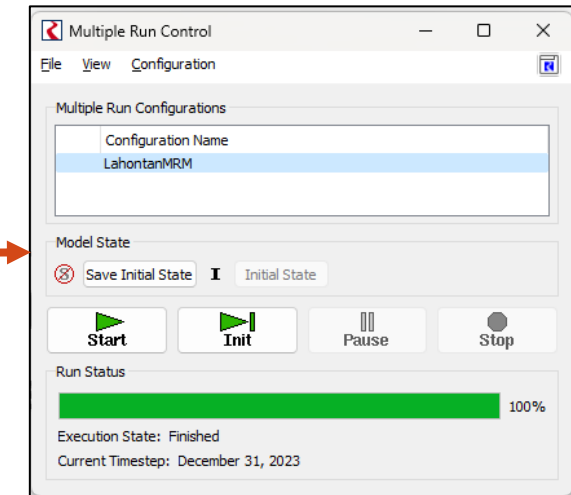
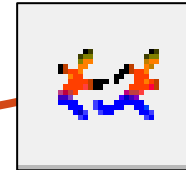
Lahontan Model



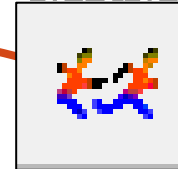
Model Design Criteria

- Fast enough to test multiple release strategies
- Integrate RFC and ASO-informed RFC Ensemble Forecast
- Automate the model result analysis (single platform effort)
- Model needs to be trusted

MRM



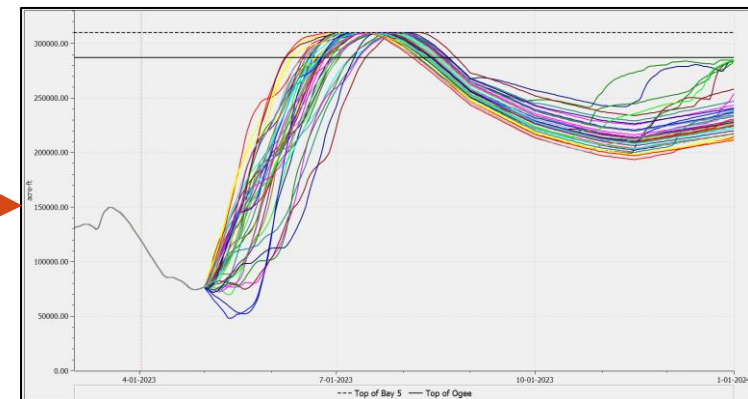
MRM



TROA Model

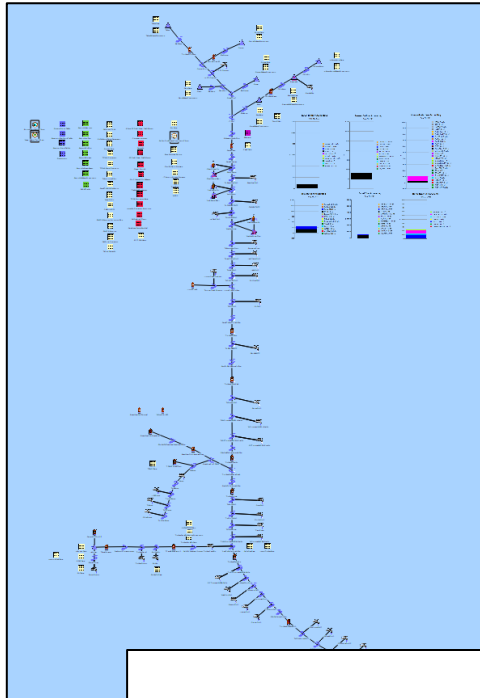
Used for:

- OCAP
- TROA
- Planning Studies

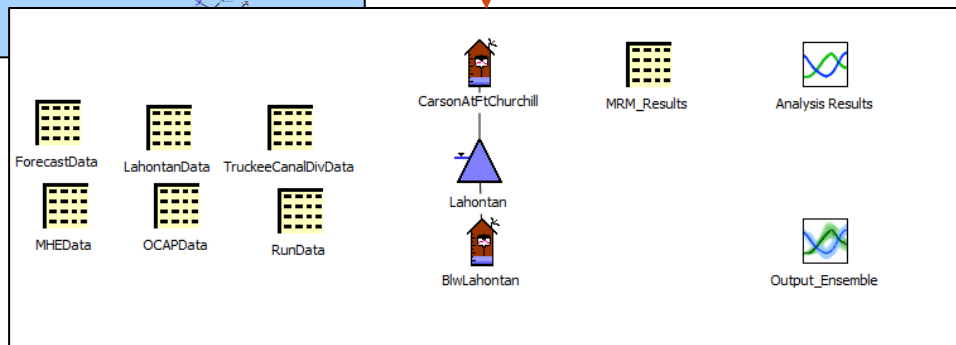


LAHONTAN OPS MODEL: NEED FOR SPEED

TROA Model



	TROA Model	Lahontan Model
# of Objects	215	12
# of Rules	498	13
Run Time	6-8 mins	1 sec
MRM Run Time	~45 min	~2 min
Modes	Inline Rulebased Simulation and Accounting	Rulebased

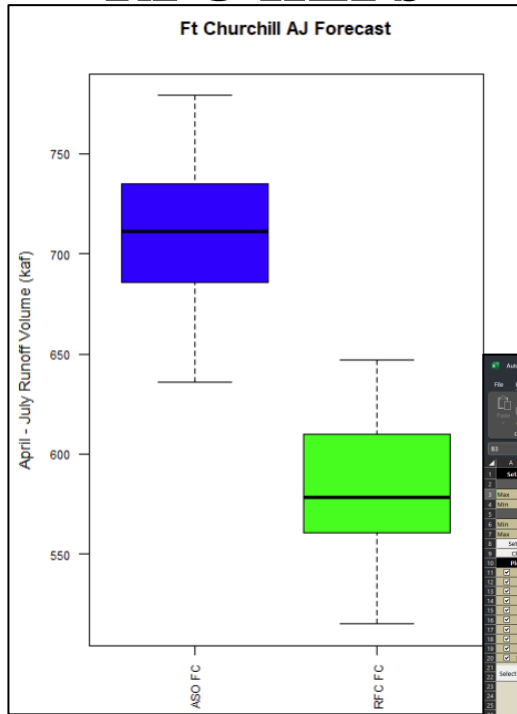


Lahontan Model

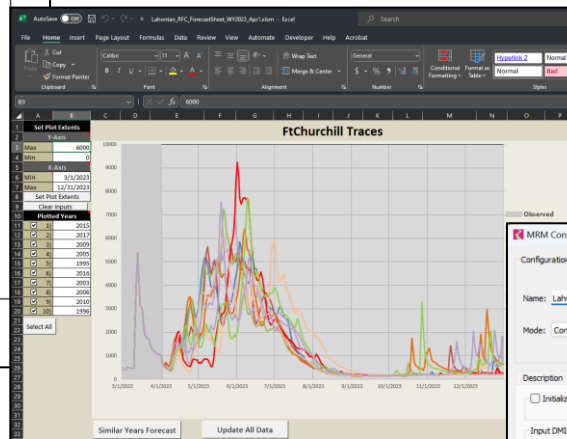
- **Objective:**
 - Build a decision support tool to test Lahontan release strategies in interactive management meetings
- **Steps:**
 - Export/Import Relevant Objects
 - Export/Import Relevant Rules
 - Export/Import Relevant Functions

LAHONTAN OPS MODEL: ENSEMBLE MRM

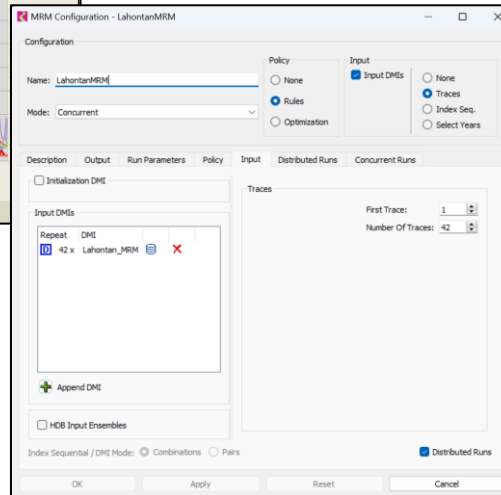
RFC HEFs



Excel



RW MRM



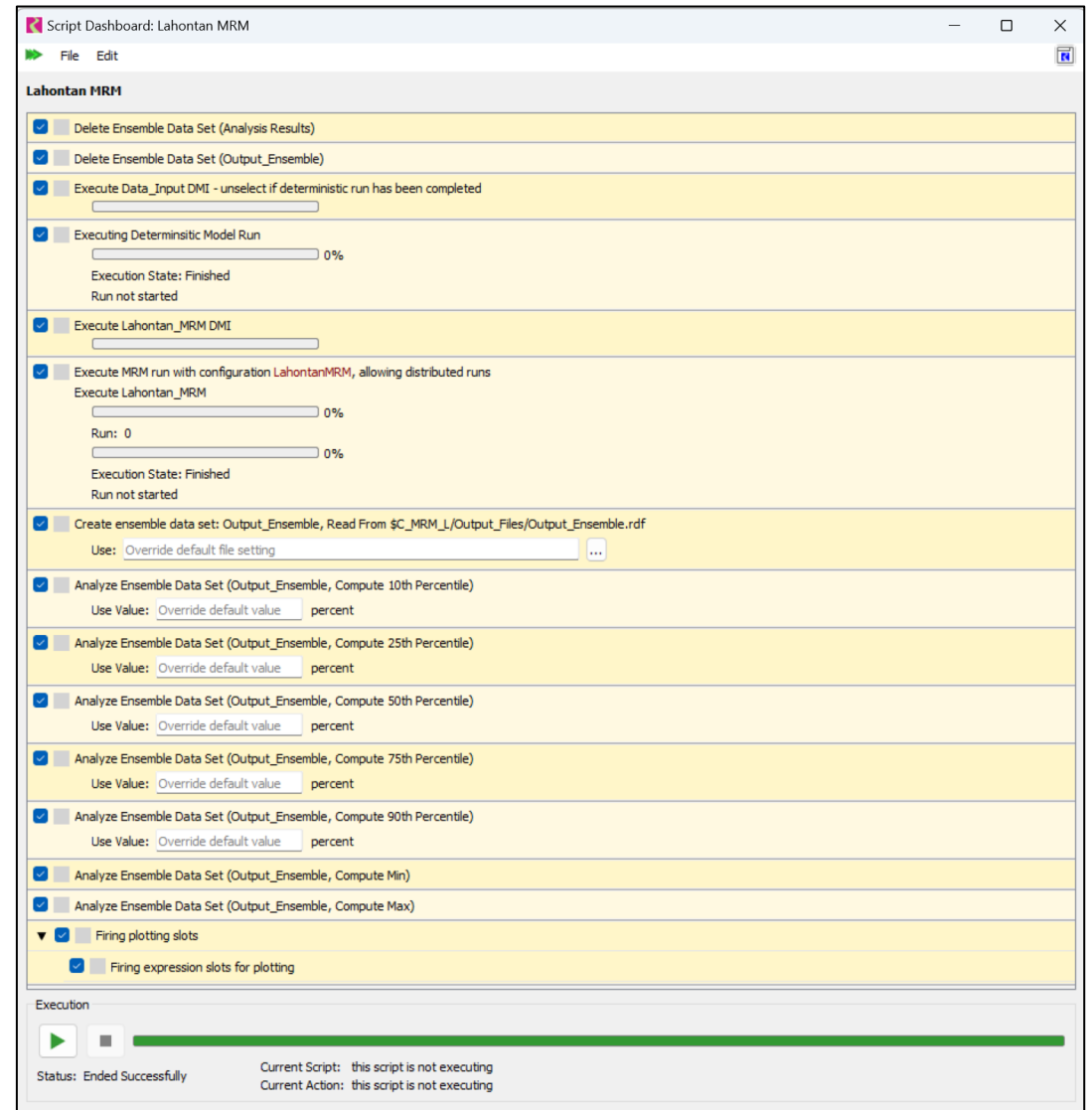
Integrate RFC Ensemble Forecast

- Forecasts used in the Truckee-Carson Basin:
 - RFC Hydrologic Ensemble Forecasts (HEFS)
 - NRCS Scaled RFC HEFS
 - Experimental* ASO Informed RFC HEFs

LAHONTAN OPS MODEL: RESULTS TO ANALYSIS

Automate Model Result Analysis

- Needed Steps:
 - Run the MRM
 - Crunch the numbers
 - Create plots
- The Plan: Lahontan MRM Script
 - Delete previous Ensemble Data Set
 - Run MRM
 - Fire Ensemble Data Tool (EDT)
 - Look at final plots



The screenshot displays the 'Script Dashboard: Lahontan MRM' interface. It features a menu bar with 'File' and 'Edit' options. The main area is titled 'Lahontan MRM' and contains a list of tasks, each with a checkbox and a progress bar. The tasks are:

- Delete Ensemble Data Set (Analysis Results)
- Delete Ensemble Data Set (Output_Ensemble)
- Execute Data_Input DMI - unselect if deterministic run has been completed
- Executing Deterministic Model Run (0% progress, Execution State: Finished, Run not started)
- Execute Lahontan_MRM DMI
- Execute MRM run with configuration LahontanMRM, allowing distributed runs (0% progress, Execution State: Finished, Run not started)
- Create ensemble data set: Output_Ensemble, Read From \$C_MRM_L/Output_Files/Output_Ensemble.rdf
- Analyze Ensemble Data Set (Output_Ensemble, Compute 10th Percentile)
- Analyze Ensemble Data Set (Output_Ensemble, Compute 25th Percentile)
- Analyze Ensemble Data Set (Output_Ensemble, Compute 50th Percentile)
- Analyze Ensemble Data Set (Output_Ensemble, Compute 75th Percentile)
- Analyze Ensemble Data Set (Output_Ensemble, Compute 90th Percentile)
- Analyze Ensemble Data Set (Output_Ensemble, Compute Min)
- Analyze Ensemble Data Set (Output_Ensemble, Compute Max)
- Firing plotting slots
- Firing expression slots for plotting

At the bottom, the 'Execution' section shows a green progress bar and the status: 'Status: Ended Successfully'. Below the progress bar, it states: 'Current Script: this script is not executing' and 'Current Action: this script is not executing'.

LAHONTAN OPS MODEL: RESULTS TO ANALYSIS

Automate Model Result Analysis

- The Plan: Lahontan MRM Script
 - Delete previous Ensemble Data Set
 - Run MRM
 - Fire Ensemble Data Tool (EDT)
 - Look at final plots
- Lessons Learned
 - Updating slots requires reinitialization of the model
 - Complete deterministic run, save the model, run the MRM
 - Pre-configured plot links break once objects are deleted
 - Added new object and interactive expression slots for each slot of interest
 - Build script to fire expression slots
 - Add sub-script to MRM Script



Script Dashboard: Lahontan MRM

File Edit

Lahontan MRM

- Delete Ensemble Data Set (Analysis Results)
- Delete Ensemble Data Set (Output_Ensemble)
- Execute Data_Input DMI - unselect if deterministic run has been completed
- Executing Deterministic Model Run
Execution State: Finished
Run not started
- Execute Lahontan_MRM DMI
- Execute MRM run with configuration LahontanMRM, allowing distributed runs
Execute Lahontan_MRM
Run: 0
Execution State: Finished
Run not started
- Create ensemble data set: Output_Ensemble, Read From \$C_MRM_L/Output_Files/Output_Ensemble.rdf
Use: Override default file setting
- Analyze Ensemble Data Set (Output_Ensemble, Compute 10th Percentile)
Use Value: Override default value percent
- Analyze Ensemble Data Set (Output_Ensemble, Compute 25th Percentile)
Use Value: Override default value percent
- Analyze Ensemble Data Set (Output_Ensemble, Compute 50th Percentile)
Use Value: Override default value percent
- Analyze Ensemble Data Set (Output_Ensemble, Compute 75th Percentile)
Use Value: Override default value percent
- Analyze Ensemble Data Set (Output_Ensemble, Compute 90th Percentile)
Use Value: Override default value percent
- Analyze Ensemble Data Set (Output_Ensemble, Compute Min)
- Analyze Ensemble Data Set (Output_Ensemble, Compute Max)
- Firing plotting slots
 - Firing expression slots for plotting

Execution

Status: Ended Successfully

Current Script: this script is not executing
Current Action: this script is not executing

WY2023 LAHONTAN OPERATIONS



WY2023 LAHONTAN OPERATIONS

Operational Objectives

1. Prevent flooding in Fallon, NV
2. Maximize carry-over water supply

Constraints

- Limited downstream Carson River capacity

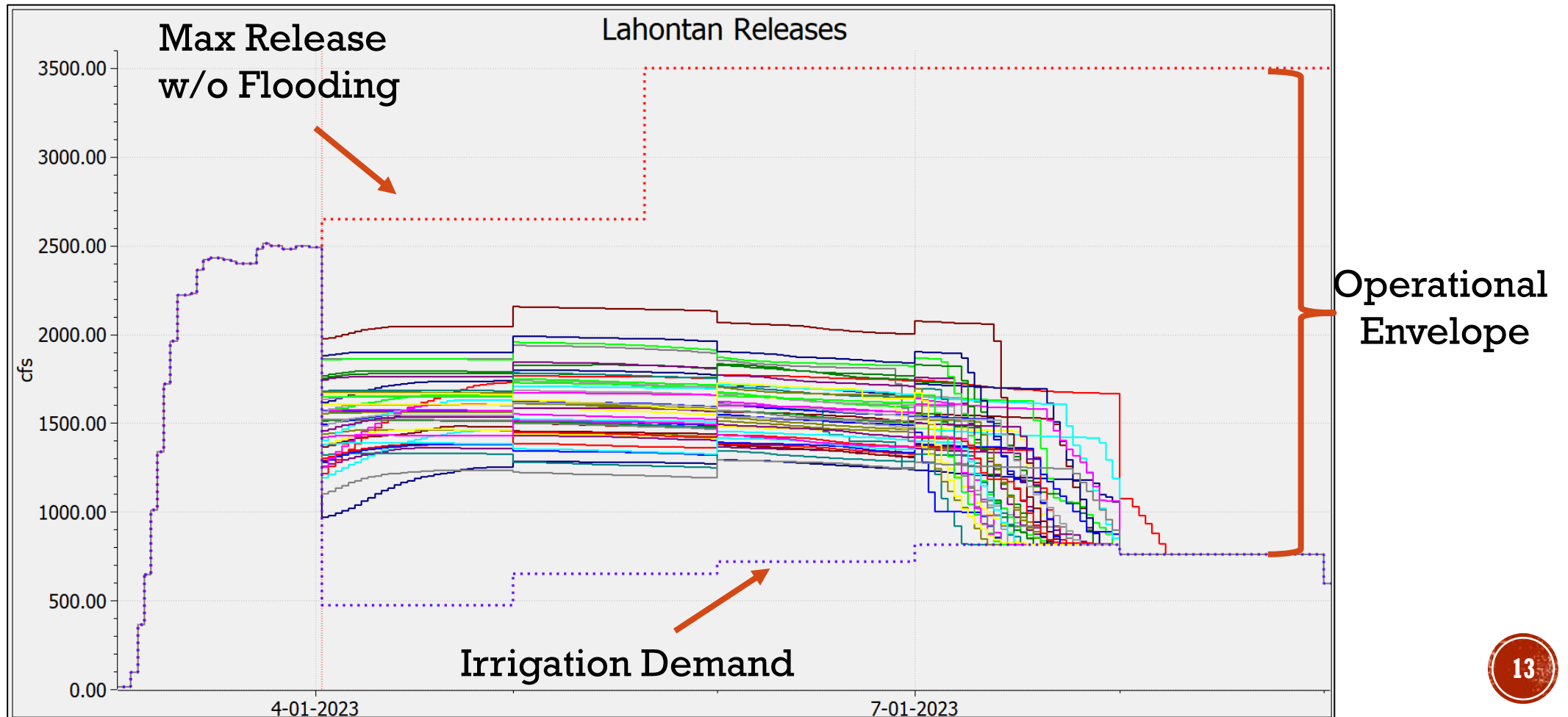


Feature	Capacity
Carson River	~900 cfs
T-Line	150 cfs
V-Line Pre/Post May 20	1,500 cfs / 2,500 cfs
Total Pre/Post May 20	2,500 cfs / 3,500 cfs

- Control releases as much as possible (i.e., reduce uncontrolled spills)

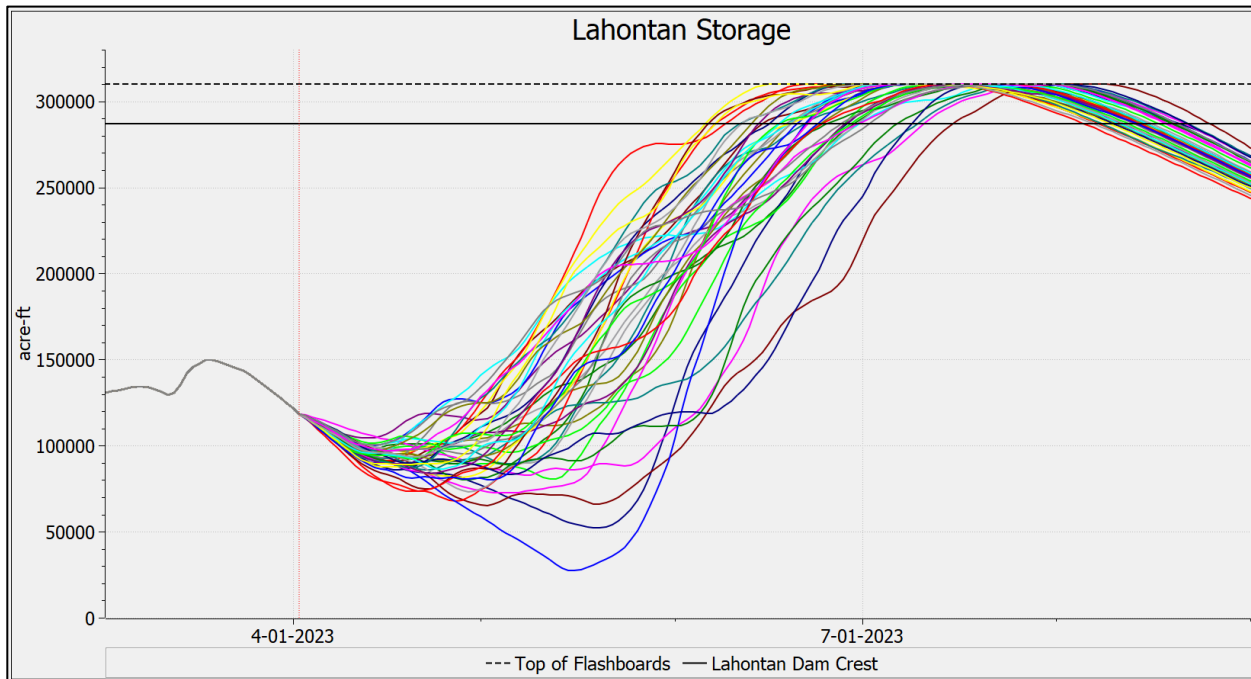
WY2023 LAHONTAN OPERATIONS IN ACTION

Feature	Capacity
Total Pre/Post May 20	2,500 cfs / 3,500 cfs



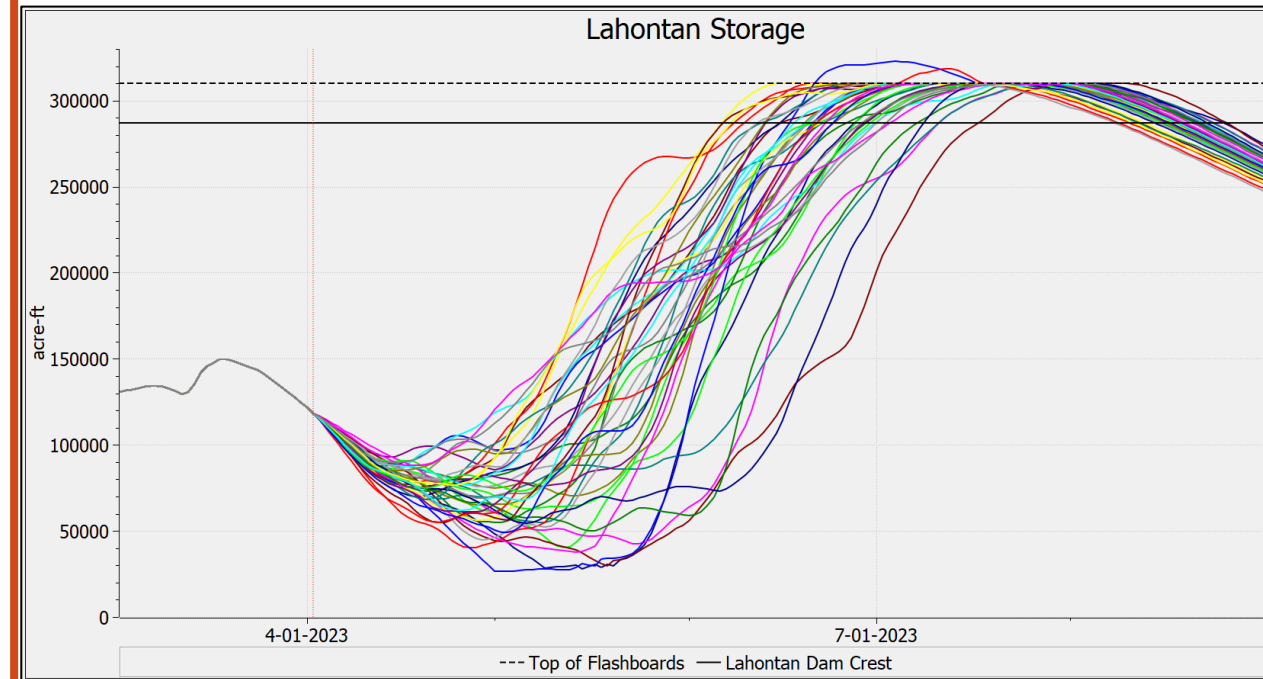
WY2023 LAHONTAN OPERATIONS IN ACTION: 4/1 FORECASTS

RFC HEFs Ops



- ~2-month window of storing on the flashboards
- No traces show uncontrolled spill

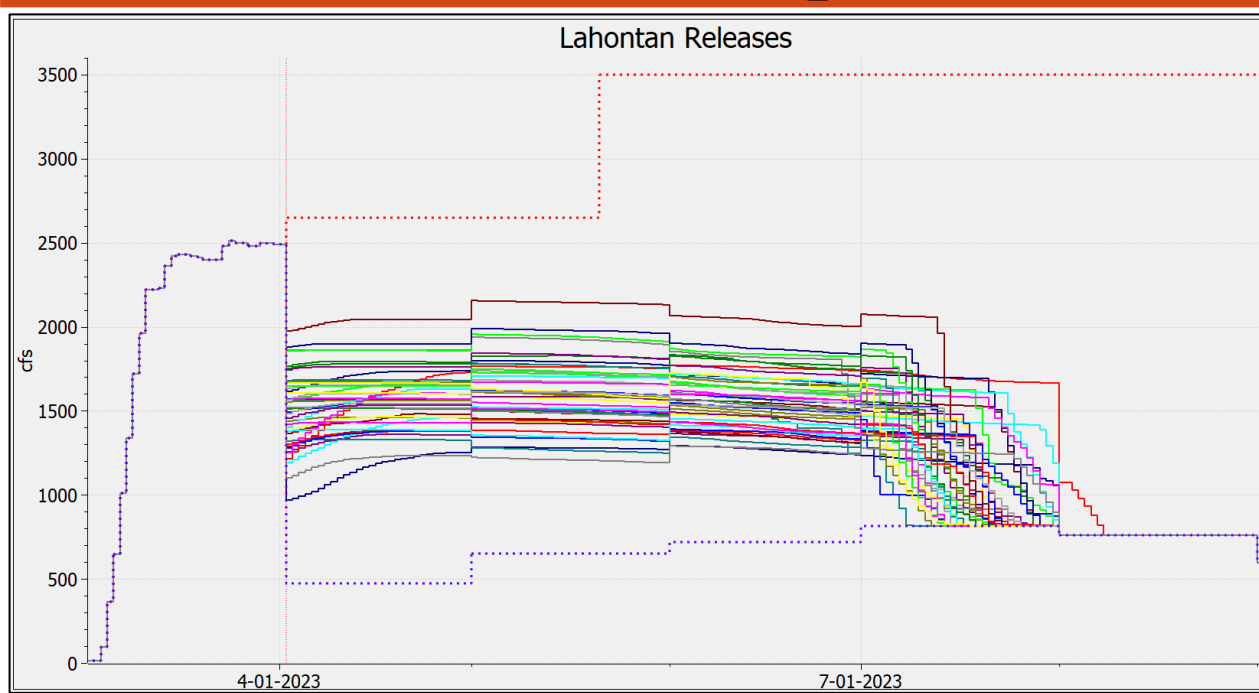
ASO Informed RFC HEFs Ops



- ~2-month window of storing on the flashboards
- 2 traces have uncontrolled spill

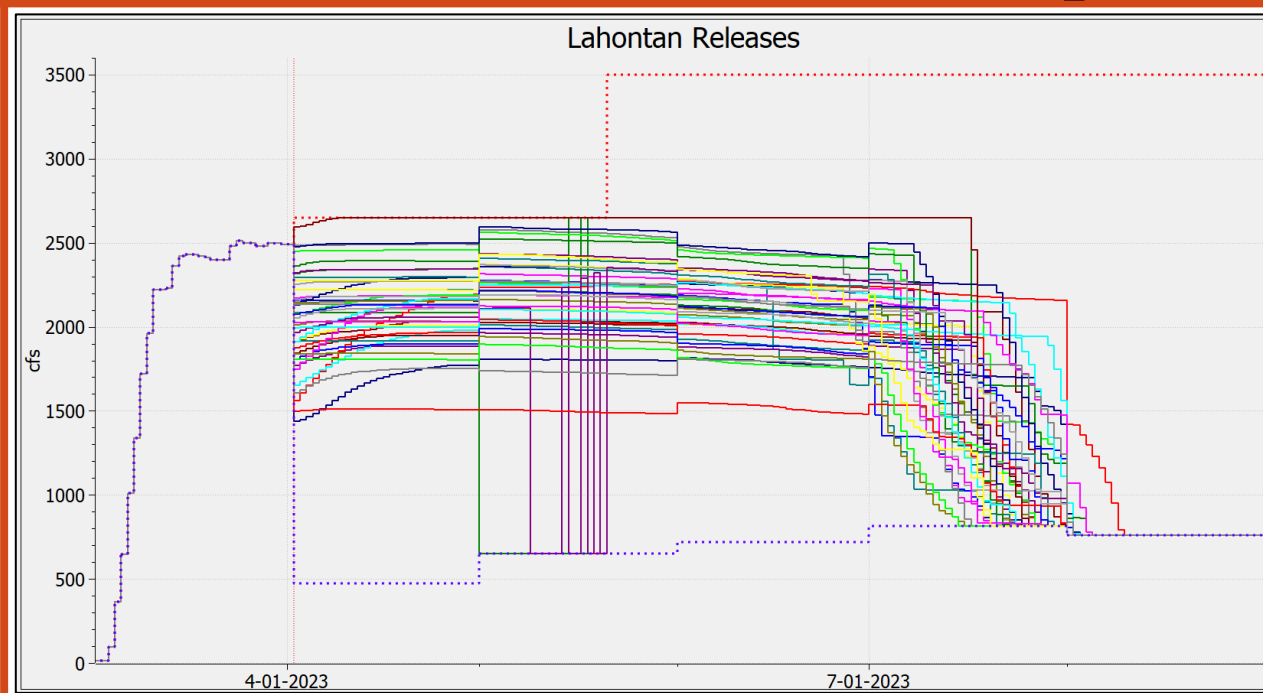
WY2023 LAHONTAN OPERATIONS IN ACTION: 4/1 FORECASTS

RFC HEF's Ops



- All traces within the operational envelope

ASO Informed RFC HEF's Ops



- All traces within the operational envelope
- ~ 2 traces max out releases to capacity

WY2023 LAHONTAN OPERATIONS: CONCLUSIONS

Operational Objectives

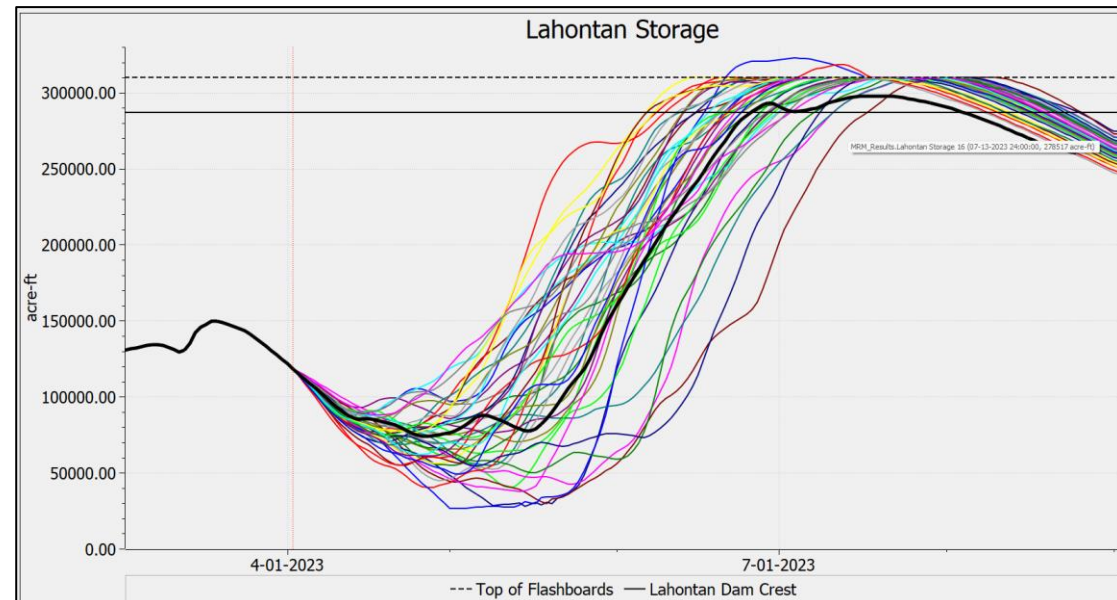
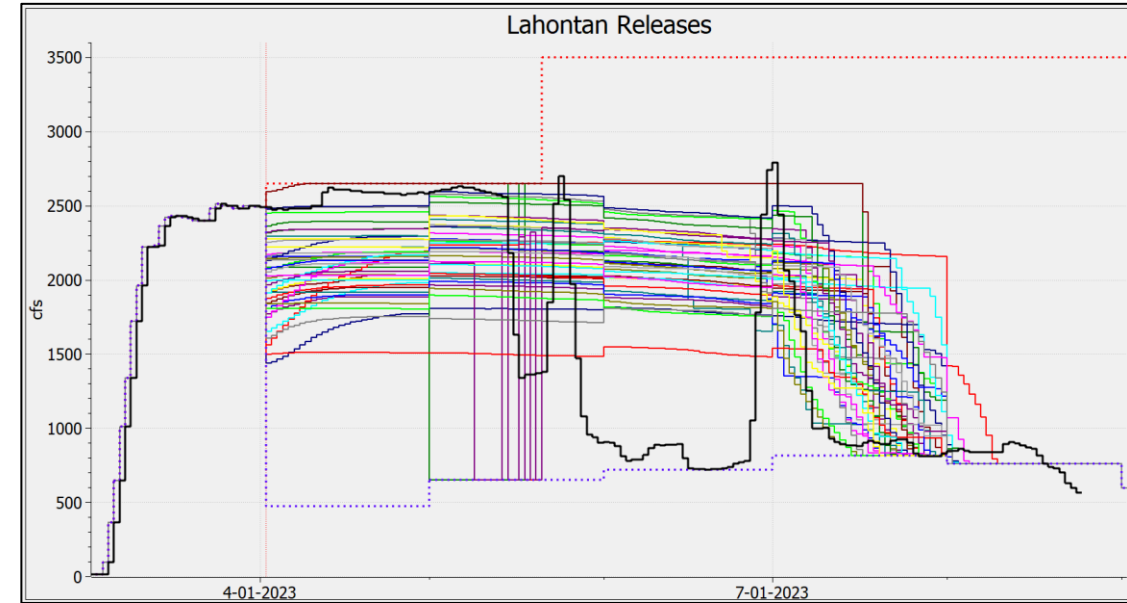
1. ✓ Prevent flooding in Fallon, NV
2. ✓ Maximize carry-over water supply

Operation Summary

- Snowpack ablation underestimated by RFC, shown by ASO Record
- Goldilocks runoff scenario—not too fast, not too slow

Lahontan Operations Model

- RiverWare MRM to EDT enhanced modeling/decision support tools
- EDT allowed for the automated analysis and testing of scenarios



QUESTIONS

Flood Ops Modeling w/EDT

Flood Ops Modeling 2017 - 2019

