

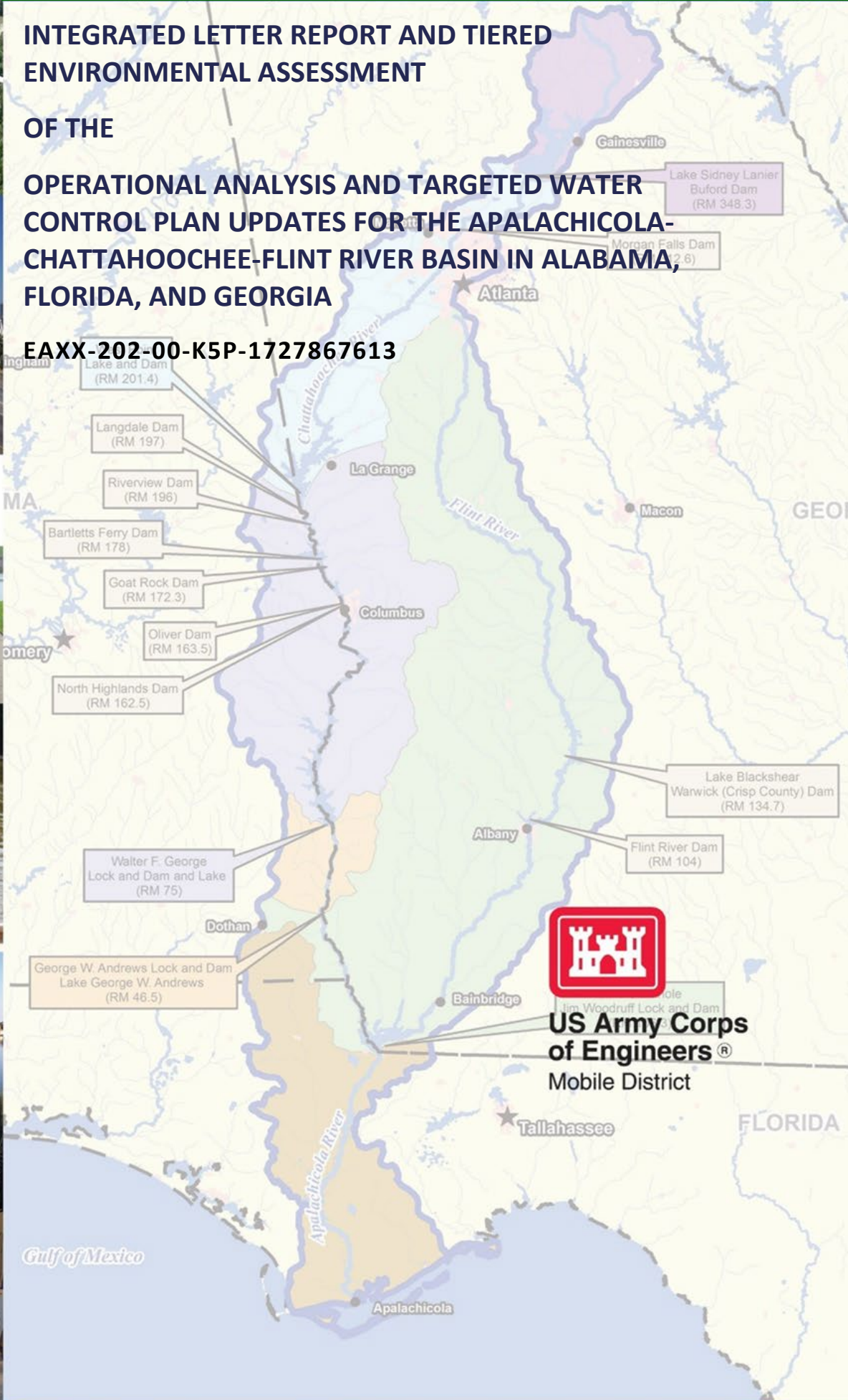


INTEGRATED LETTER REPORT AND TIERED ENVIRONMENTAL ASSESSMENT

OF THE

OPERATIONAL ANALYSIS AND TARGETED WATER CONTROL PLAN UPDATES FOR THE APALACHICOLA-CHATTAHOOCHEE-FLINT RIVER BASIN IN ALABAMA, FLORIDA, AND GEORGIA

EAXX-202-00-K5P-1727867613



US Army Corps of Engineers®
Mobile District

Appendix B
HEC-ResSim Report

Apalachicola-Chattahoochee-Flint River (ACF) Watershed

HEC-ResSim Modeling of Reservoir
Operations in Support of the ACF
Operational Analysis and Environmental
Assessment

14AUG2024

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1.0 Introduction

This report is a supplement to the Apalachicola Chattahoochee Flint River Basin Operational Analysis and Environmental Assessment as part of the 2023 Stay Agreement. In this report, the analysis of reservoir operations based on two alternatives to demonstrate the difference in the current operations and operations based on the objectives outlined in the Stay Agreement. The alternatives considered for this effort are limited to the “No Action Alternative (NAA) and the Stay Agreement Alternative (SAA) since the one proposed action in this study is the product of settlement negotiations. No additional alternatives were considered.

The HEC-ResSim (RSS) model from the 2017 Water Control Manual update was used and Proposed Action Alternative (Alternative 7K) from the 2016 EIS, which is also the No Action Alternative in this analysis. No Action. The primary output of the reservoir system model consists of 73 years (1939-2011) of continuously simulated reservoir operations, lake levels and river flows throughout the ACF basin for both a No Action condition and the four operational objectives outlined in the Stay Agreement. HEC-ResSim version 3.5, August 2022, was used for the modeling.

2.0 Analysis

Using the HEC-ResSim modeling software and the model that was used for the 2017 Water Control Manual, a new alternative was created with the 2016 Reservoir Network to implement the flow objectives outlined in the Stay Agreement and named ACFSTY2023. A simulation was created with the ACFSTY2023 alternative and named ACFSTY2023_POR to reflect the analysis of the period of record data for the ACF basin. Within the simulation, two alternatives were used to compare the effects of the flow objectives from the 2023 Stay Agreement (1) ACFWCM2017 (NAA) and (2) ACFSTY2023 (SAA).

2.1 Description of No Action Alternative Operation Set

This Integrated Letter Report and Tiered Environmental Assessment (ILR/TEA) (unique identification number: EAXX-202-00-K5P-1727867613) evaluates the operational changes on the Apalachicola, Chattahoochee, and Flint (ACF) River Basin and facilitates proposed updates of the Water Control Plans within the Master Water Control Manual for the ACF River Basin, Alabama, Florida, Georgia. This requires comparison of anticipated effects due to a proposed new plan against those of the No Action condition.

The No Action Alternative (NAA) titled as “ACFWCM2017” was used to provide a baseline in this analysis. Based on the nature of the Stay Agreement requirements (adopting a new flow requirements to the reservoir operations on the AC), the No Action alternative represents a continuation of the current water control operations implemented in 2017 at each of the Federal projects in the ACF system. The current operations are a set of project operations and water management policies and priorities in place since March 2017. Consequently, the project action zones and composite storage zones specified in the 2017 WCM will remain in effect.

2.2 Description of Stay Agreement Operation Set

The 2023 Stay Agreement outlined four (4) objectives that are required to be met. These objectives are:

- 1) maintain a minimum average daily flow of 1,350 cfs over any 7-day period at the gage located on the Chattahoochee River at 14th Street at Columbus, Georgia (Gage No. 02341460) when the ACF Basin is not in “Drought Zone Operations” as that term is defined in the 2017 ACF Master Manual

- 2) maintain a minimum average weekday flow of 2,000 cfs at the gage located on the Chattahoochee River near Columbia, Alabama (Gage No. 02343801) when the ACF Basin is not in "Drought Zone Operations" as that term is defined in the 2017 ACF Master Manual
- 3) maintain the minimum average flows at Columbus, Georgia and Columbia, Alabama described in items (1) and (2) above, on two days each calendar week starting each Monday when the ACF Basin is in "Drought Zone Operations" as that term is defined in the 2017 ACF Master Manual
- 4) maintain Lake Seminole at or above an elevation of 76 feet NVGD in the same manner and to the same extent as provided in the 2017 ACF Master Manual, and in particular the following paragraphs from Appendix A

In the alternative, ACFSTY2023, at West Point, the reservoir operation set was updated from the Silver (2017) set to the Silver+1350 set. The Silver+1350 set includes the same operations from 2017 plus a rule that calculates the 1350 cfs rolling 7-day average at Columbus as a release from West Point during the non-EDO (Extreme Drought Operations) and two day a week release of 1350 cfs during EDO. The operation sets are shown in Figure 1. An IF-ELSE block is used to implement the two new rules.

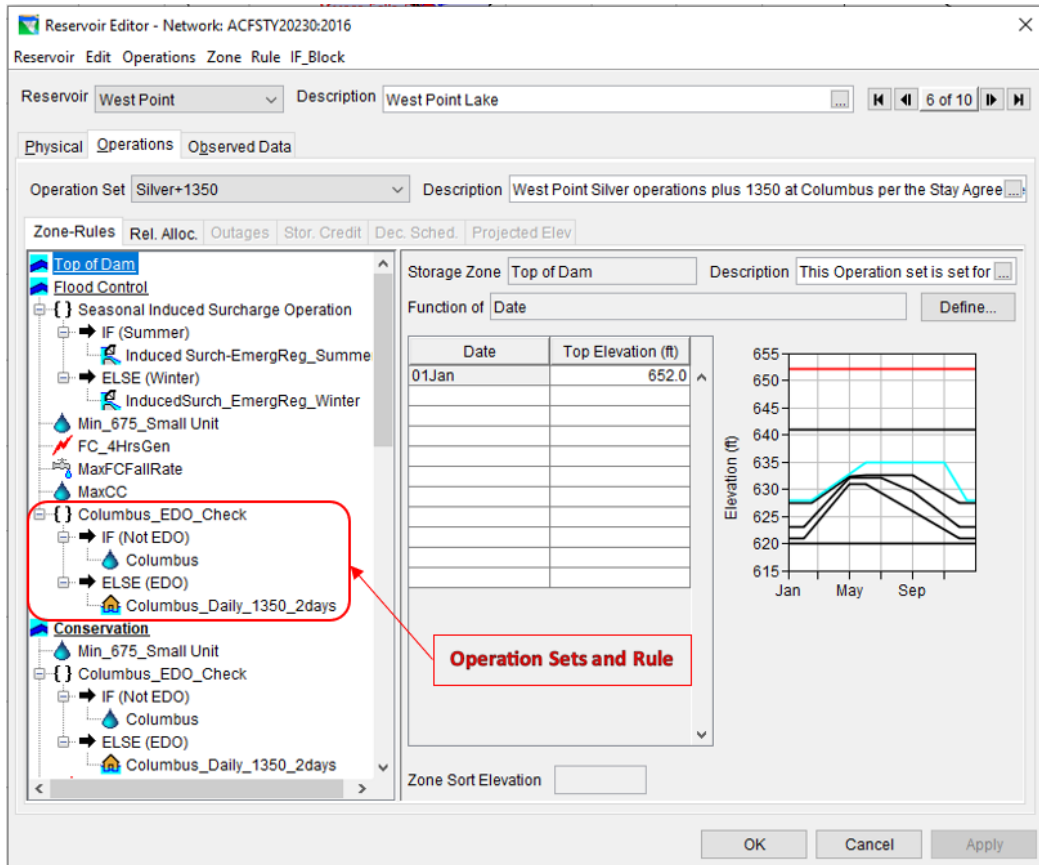


Figure 1: Silver+1350 Operation Set

In order to calculate the 1,350 cfs rolling 7-day average, a script was developed by HEC (Hydrologic Engineering Center, Davis, CA) and created a state variable for the simulation. The state variable was named “WestPointQreq_forColumbusWklyAvgMin”. The variable’s Parameter Name was “Flow” and the Parameter Type was “Flow”. The rule is implemented as a function of the composite storage zone. The script is shown in Figure 2.

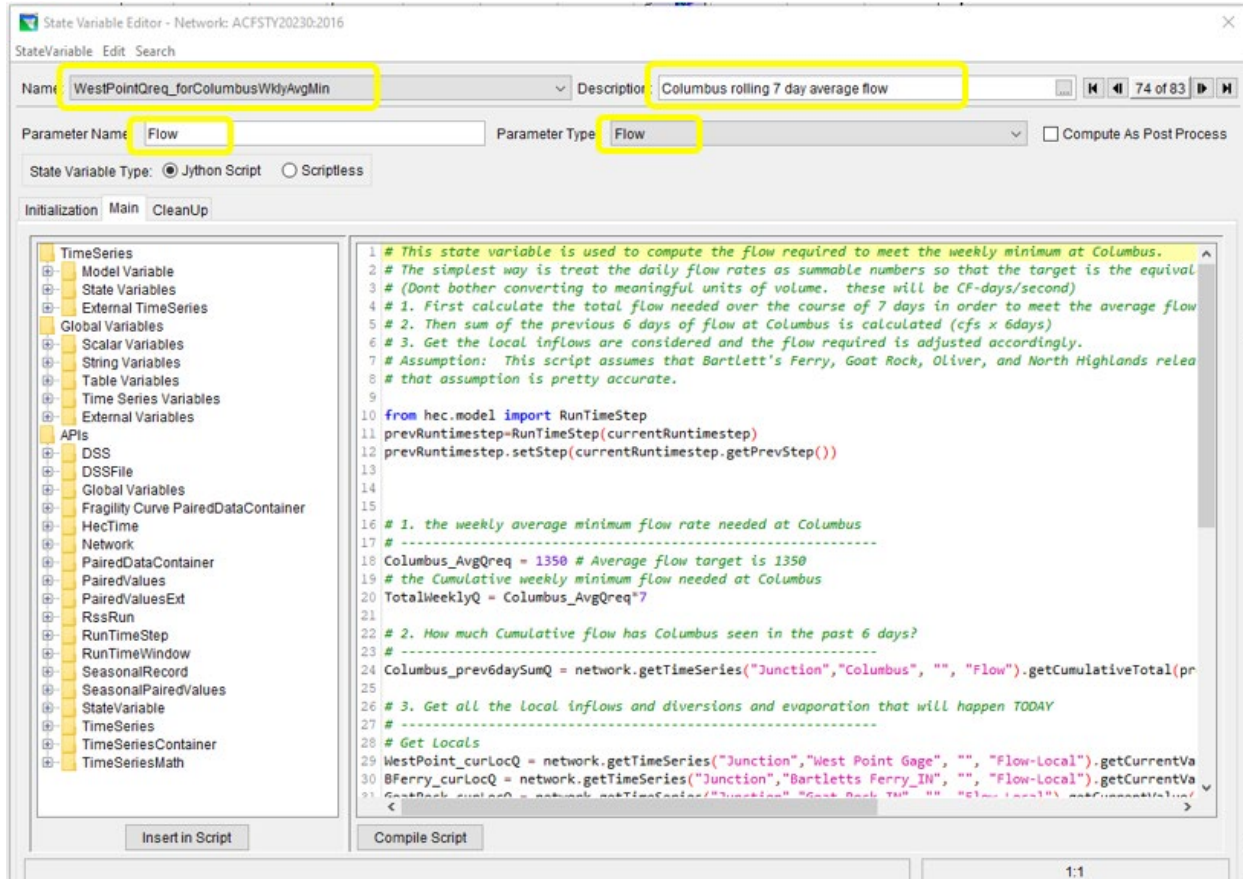


Figure 2: WestPointQreq_forColumbusWklyAvgMin Script

A new release function rule was created in the West Point reservoir operation set using the 7-day rolling average script (Figure 2) and named "Columbus". The Columbus rule was made a function of the new state variable WestPointQreq_forColumbsWklyAvgMin Current Value. The Columbus rule was included in the Columbus_EDO_Check rule in the Silver+1350 operating set and placed in each zone of the operating set. The rule is shown in Figure 3. This If-Then rule in all of zones within the operation set ensure that flow objective 1 outlined in the Stay Agreement are met.

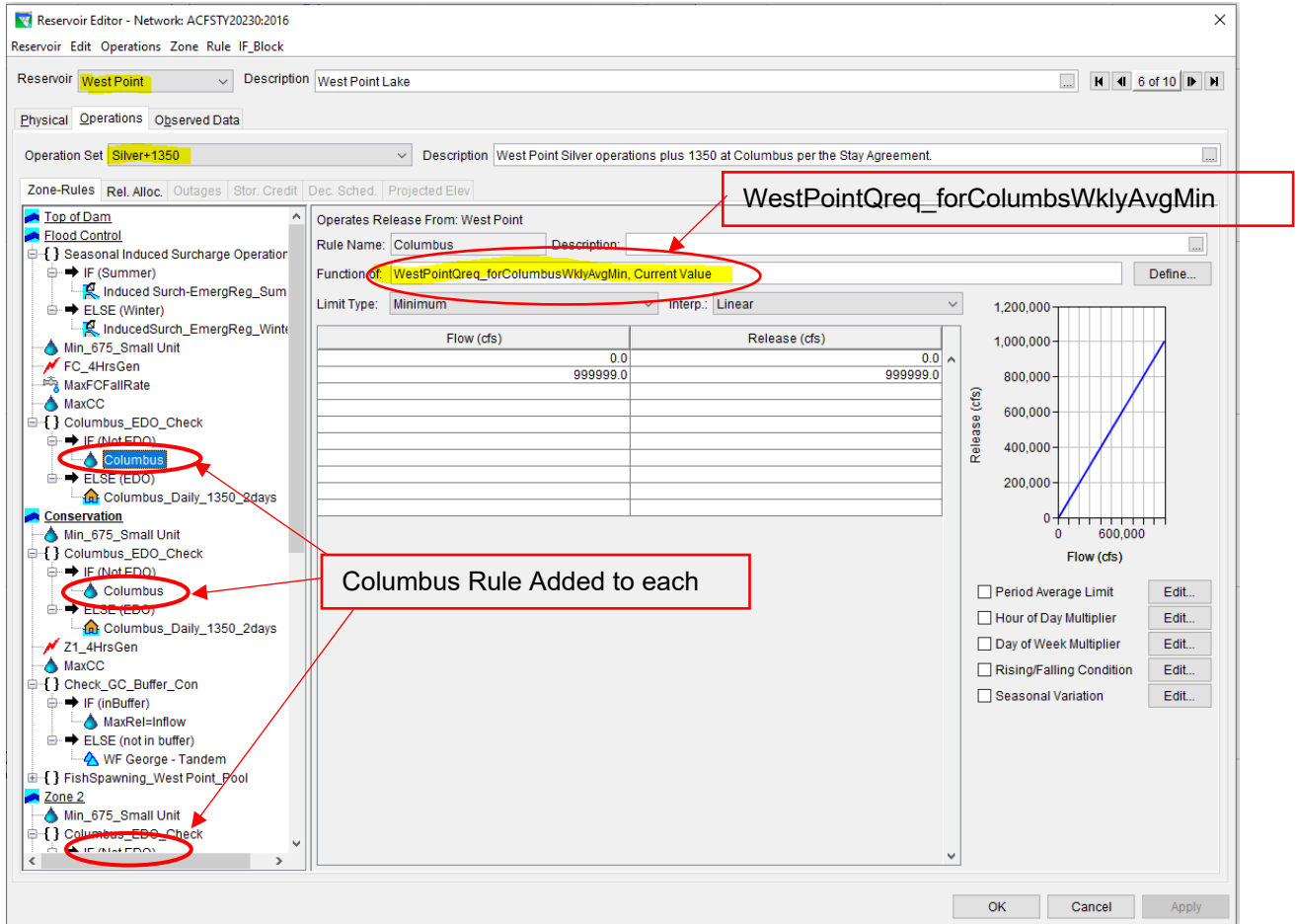


Figure 3: West Point Release Function Rule for Columbus 7-day Rolling Average and EDO operations

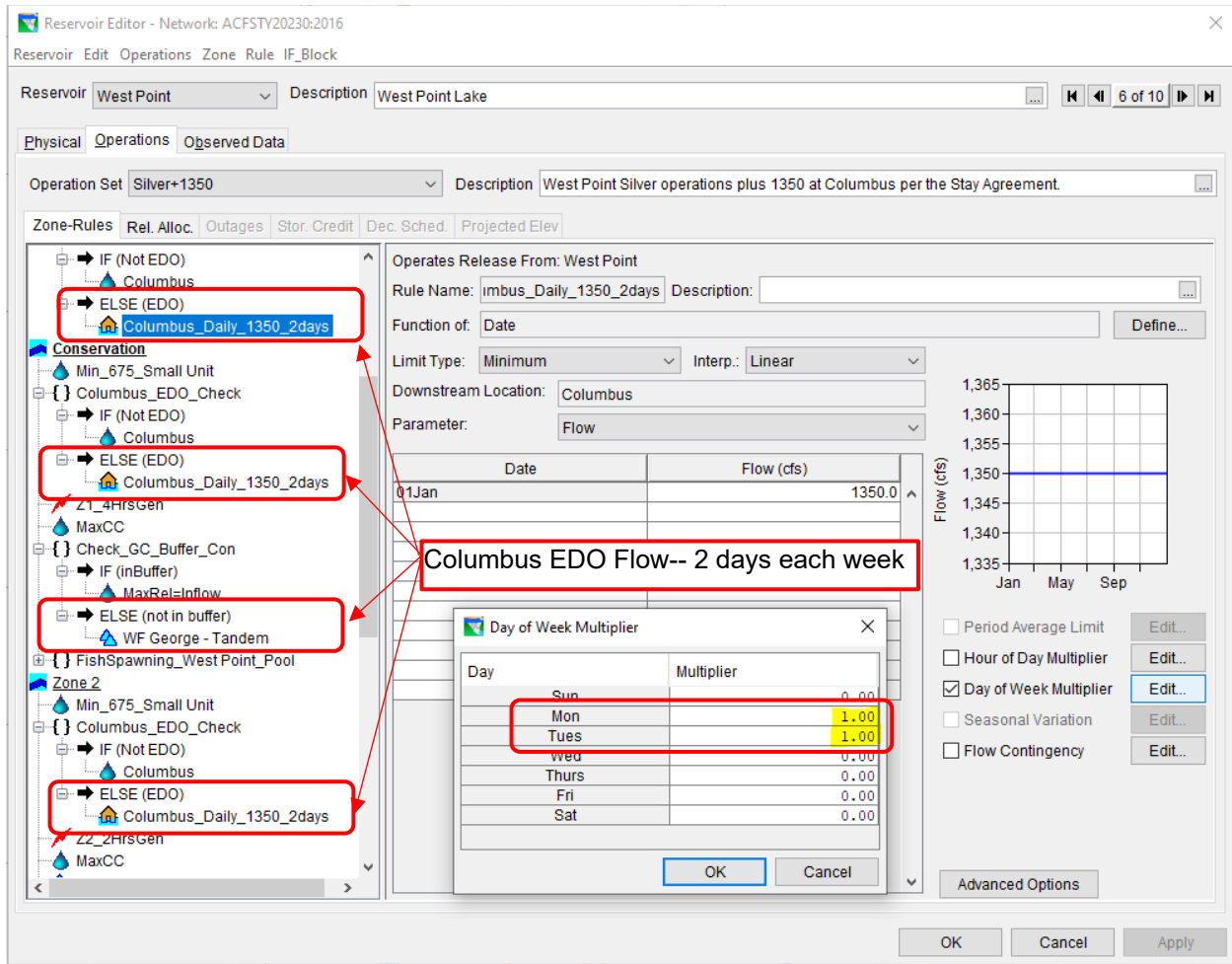


Figure 4: Extreme Drought Operations (EDO) Columbus 2-day Flow Rule

When the ACF basin enters Extreme Drought Operations, the daily average flow at Columbus, as outlined in the Stay Agreement, will be 1,350 cfs for two days each calendar week starting each Monday. This is shown in Figure 4. To implement this rule the "Day of the Week Multiplier" option was selected. To indicate two days of each calendar week starting each Monday, a multiplier of 1.00 was selected on Monday and Tuesday to meet the flow requirement during EDO. (Figure 4). The two days should be consecutive but are not required to be concurrent with the two days selected for the 2,000 cfs Columbia flow below Walter F. George. For modeling purposes, Monday and Tuesday were selected as the two days to meet 1,350 cfs flow target at Columbus.

At Walter F. George, the reservoir operation set was updated from the Silver (2017) set to the Silver+2000 set. The Operation Set is shown in Figure 5. The Silver+2000 operation set includes the same operations from the 2017 WCM with the addition of the two new rules. The rules specify the minimum daily average of 2,000 cfs weekday flow at the Columbia gage during non-EDO and 2 days a week during EDO in concurrence with Flow Objective 2 and Flow Objective 3.

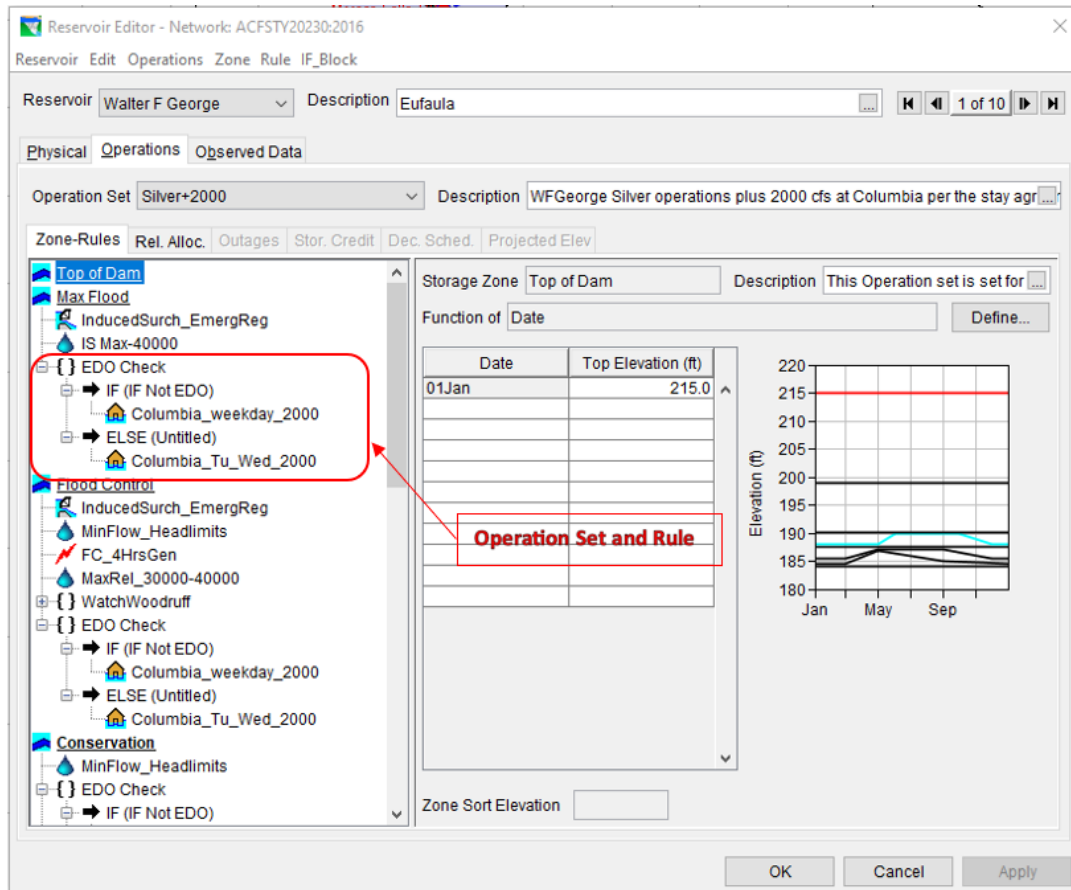


Figure 5: Silver+2000 Operation Set

The non-EDO (Extreme Drought Operation) rule in the operation set that ensures the 2000 cfs weekday average flow objective is met is shown in Figure 6. The rule instructs the model to meet the 2,000 cfs flow at Columbia during the weekdays, Monday through Friday, when the ACF basin is in a non-EDO operation. This is indicated by selecting the "Day of the Week Multiplier" option and indicating the weekday with a multiplier of 1.00 (Figure 6).

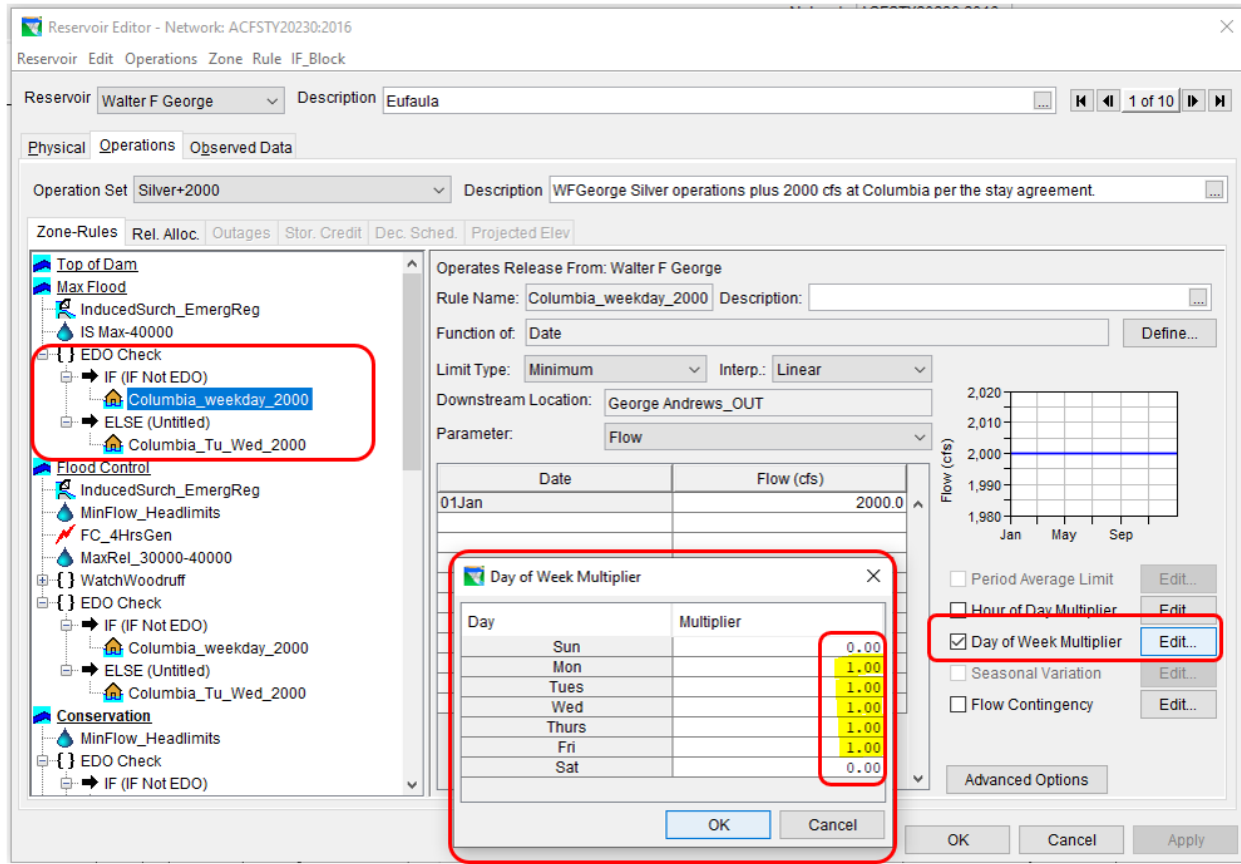


Figure 6: Non-EDO Rule for Columbia Weekday Flow

When the basin enters Extreme Drought Operations, the daily average flow at Columbia, as outlined in the Stay Agreement, will be 2,000 cfs for two days each calendar week starting each Monday. This is shown in Figure 7. The two days should be consecutive but are not required to be concurrent with the two days selected for the 1,350 cfs Columbus flow below West Point. For modeling purposes, Tuesday and Wednesday was selected as the two days to meet 2,000 cfs flow target at Columbia.

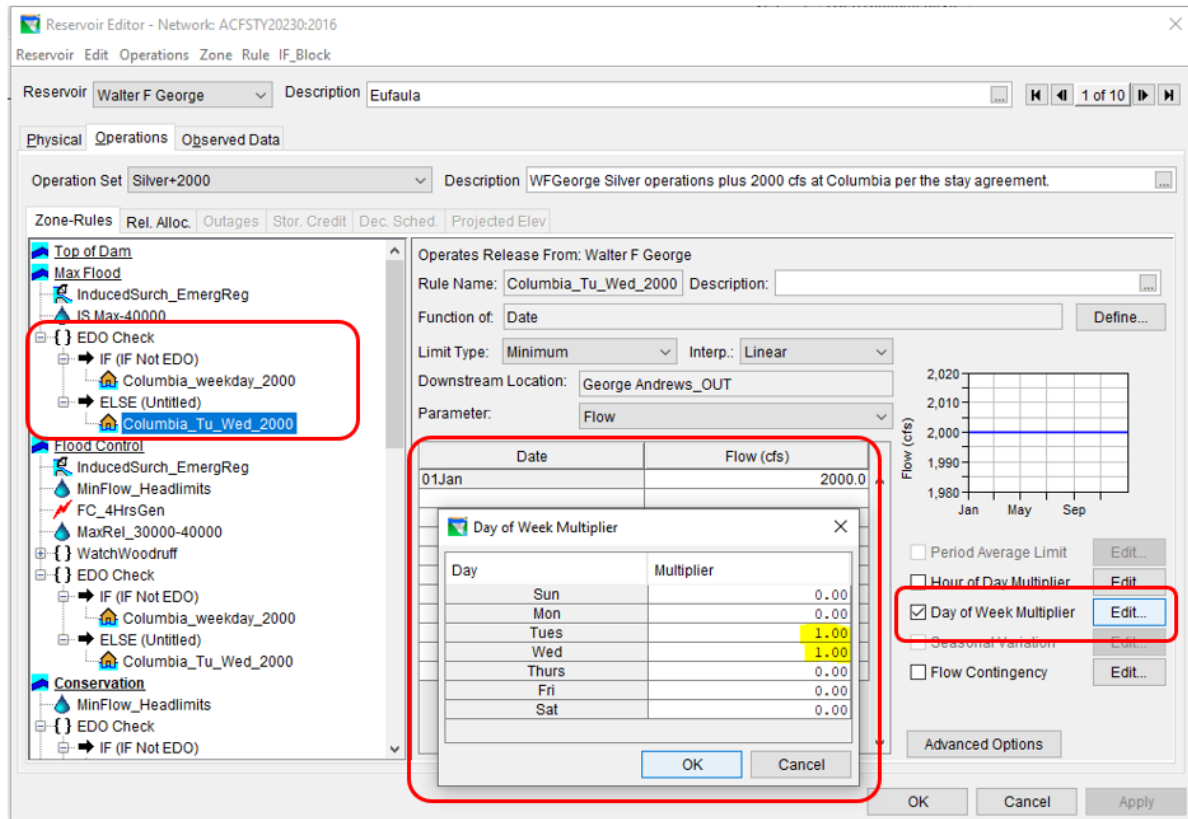


Figure 7: Extreme Drought Operations Columbia 2-day Flow Rule

It should be noted that no changes to the Jim Woodruff operation were required to implement flow objective 4 of the Stay Agreement.

2.3 Alternatives/Operation Plans

Alternatives used for the simulation were the ACF 2017 Water Control Manual (ACFWCM2017) and a new alternative for the Stay Agreement (ACFSTY2023). The alternatives specify the model's timestep, input timeseries, lookback values, and the operations sets for each reservoir.

1) ACFWCM2017 - ACF Water Control Manual Analysis from 2017 – This alternative includes the current basin operations as indicated by the ACF Water Control Manual Update in 2017 and was used as the baseline. Figure 8 lists the operation sets selected. The original operation sets for West Point and WF George are highlighted.

2) ACFSTY2023 – This alternative included operation sets for conditions that satisfy flow objectives of the Stay Agreement. This alternative included the rules in the operation sets that use the new State Variable to calculate the 1,350 cfs rolling 7-day average flow at Columbus, the 2,000 cfs daily average weekday flow at Columbia and the Extreme Drought Operation Flow requirements for both Columbus and Columbia. Figure 9 lists the operation sets and the changes made for West Point and WF George are highlighted.

The simulation ACFSTY2023_POR was created with the period of record data from January 4, 1939, 0000 – January 1, 2012, 0000. The simulation contained two trials, ACFWCM2017 (No Action) and ACFSTY2023 (Stay Agreement) that reflect the use of the two alternatives. (Figure 10)

Each alternative of the simulation was computed, and the results populated in post processing spreadsheets.

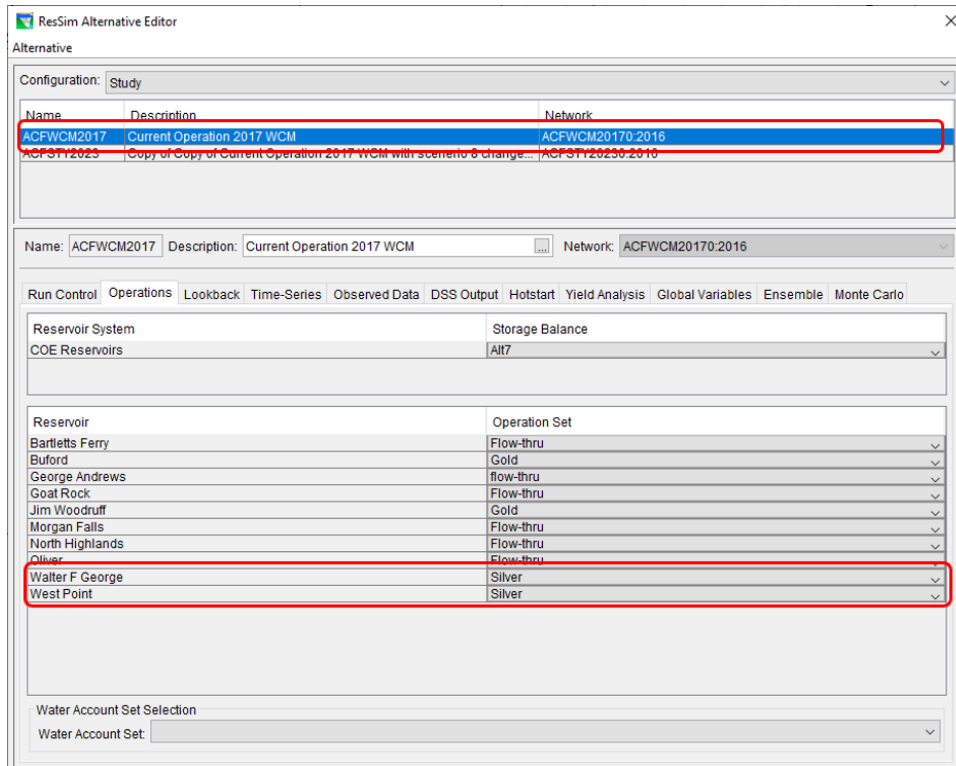


Figure 8: 2017 Water Control Manual Alternatives

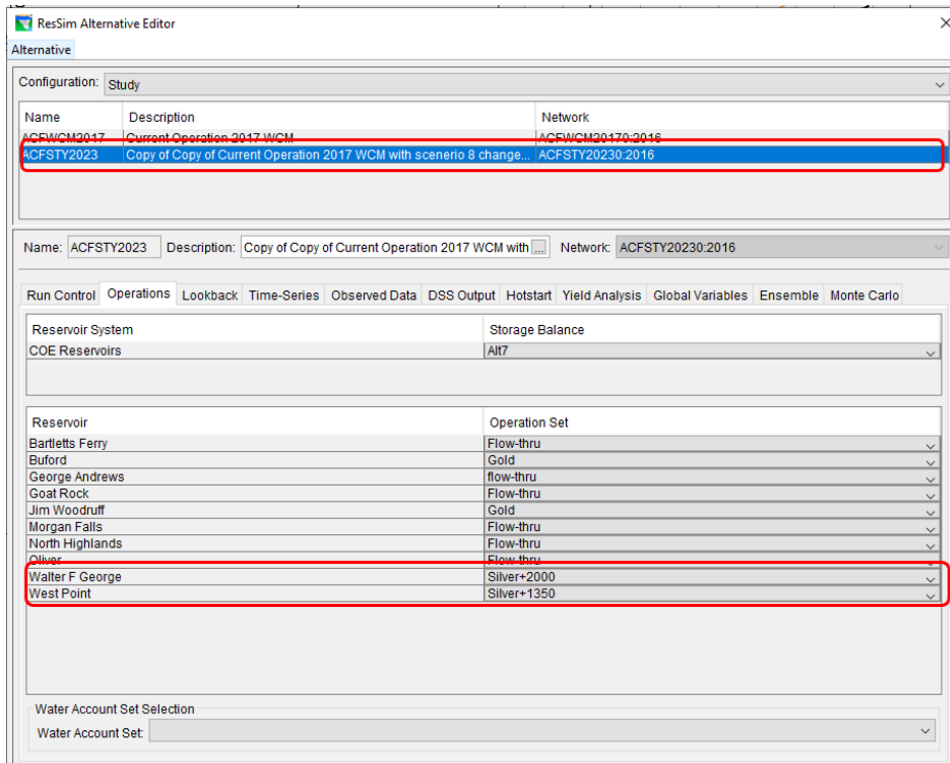


Figure 9: ACF Stay Agreement 2023 Model Alternative

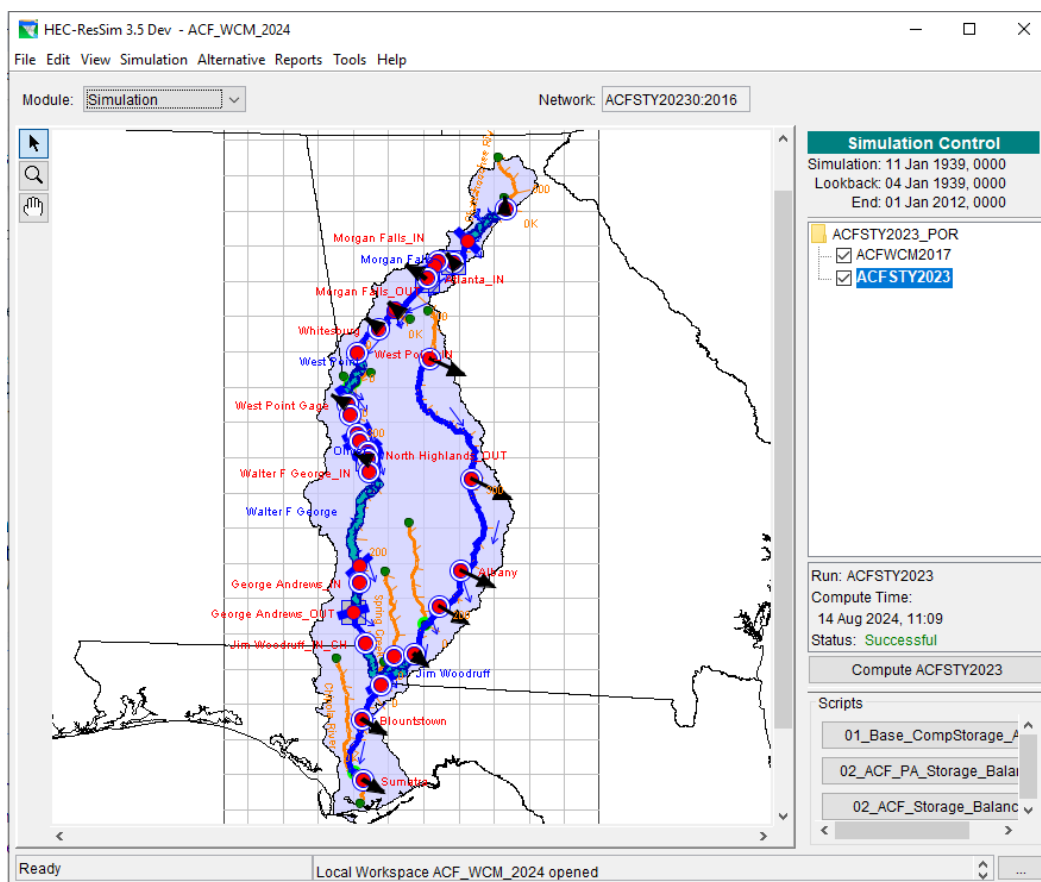


Figure 10: Simulation with Trials

3.0 Results of Modeling

The ResSim modeling results showed a *de minimus* change from the NO Action Alternative (NAA) and the Stay Agreement Alternative (SAA) when all four objectives are computed simultaneously as a complete package. The results of operating the system to meet each of the flow objectives are detailed below.

Flow Objective 1 – maintain a minimum average daily flow of 1,350 cfs over any 7-day period at the gage located on the Chattahoochee River at 14th Street at Columbus, Georgia (Gage No. 02341460) when the ACF Basin is not in “Drought Zone Operations”. The flow objective is met 99.9% of the time for the NAA and 100% of the time for the SAA (Table 1). The West Point release decision report for the simulation was used to evaluate the active rule for each daily time step. The operational rule to meet the objective is triggered only 8 days during the 73-year simulation or 0.03% of the time (Table 2). Figure 11 indicates the annual Columbus flow duration for both alternatives are identical.

Table 1: Percent of Time Flow Objective 1 Achieved

Percent of Time Flow Objective 1 Achieved		
Flow Value	NAA	SAA
1350 cfs over any 7-day period	99.9%	100.0%

Table 2: ResSim Operational Details on Flow Objective 1

ResSim operational details on Flow Objective 1					
Flow Target	% Percent of time rule active*	Number of Days	Number of Consecutive days	Number of Events	
1350 cfs over any 7-day period	0.030%	8	4	3	

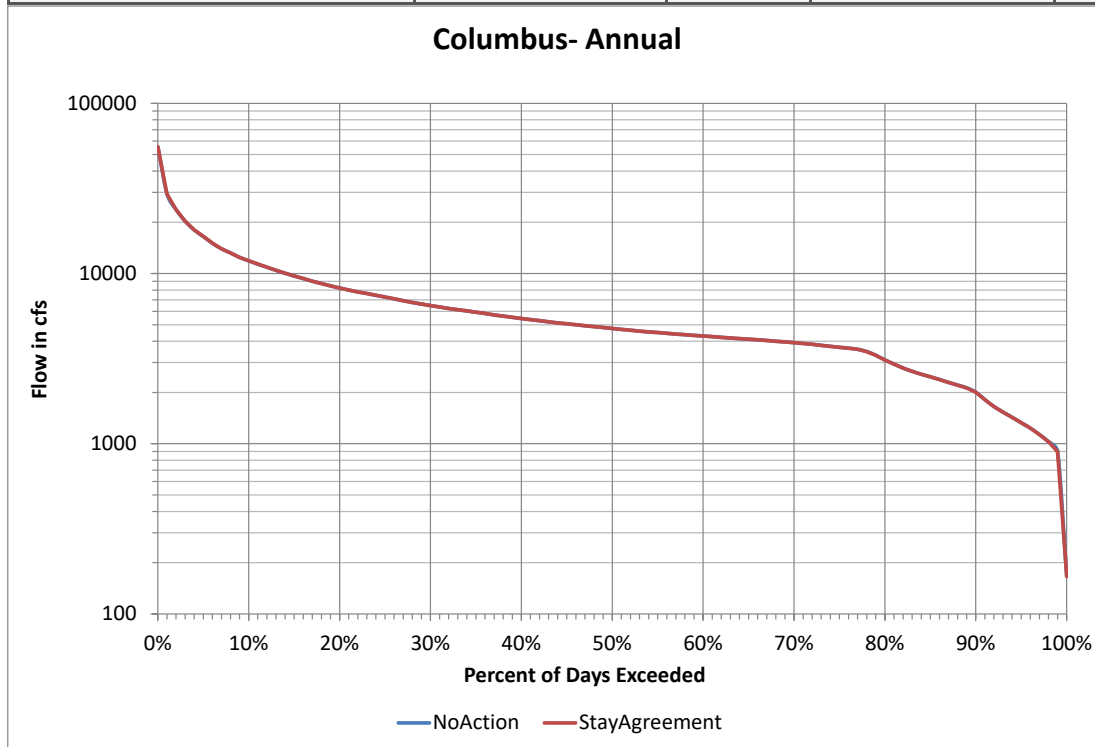


Figure 11: Columbus Annual Flow Duration Curve for both Alternatives

Flow Objective 2 - maintain a minimum average weekday flow of 2,000 cfs at the gage located on the Chattahoochee River near Columbia, Alabama (Gage No. 02343801) when the ACF Basin is not in "Drought Zone Operations". The flow objective is met 99.9% of the time for the NAA and 100% of the time for the SAA. The Walter F George release decision report for the simulation was used to evaluate the active rule for each daily time step. The operational rule to meet the objective is triggered only 10 days during the 73-year simulation or 0.038% of the time. Figure 12 indicates the annual Columbia flow duration for both the Stay Agreement Alternative and the No Action Alternative are identical. The Columbia gage represent the total discharge (outflow) from George Andrew L&D.

Table 3: Percent of Time Flow Objective 2 Achieved

Percent of Time Flow Objective 2 Achieved		
Flow Value	NAA	SAA
2,000 cfs Monday - Friday	99.9%	100.0%

Table 4: ResSim Operational Details on Flow Objective 2

ResSim operational details on Flow Objective 2				
Flow Target	% Percent of time rule active*	Number of Days	Number of Consecutive days	Number of Events
2,000 cfs Monday - Friday	0.038%	10	3	5

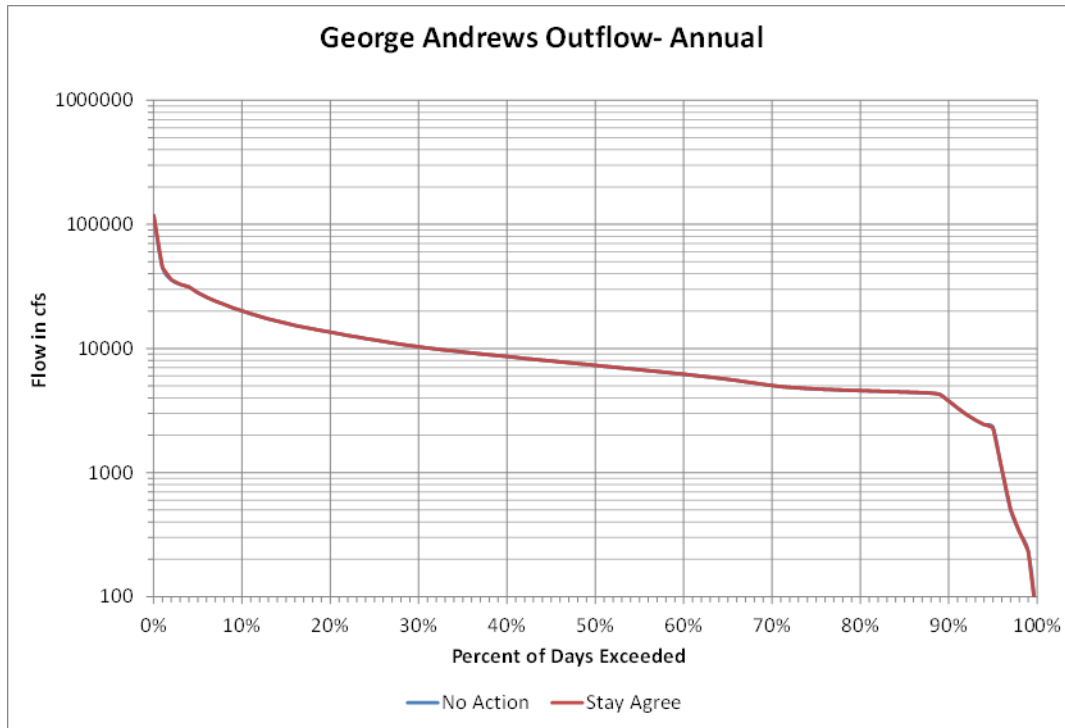


Figure 12: George Andrews (Columbia) Flow Duration Curve for both Alternatives

Flow Objective 3, maintain the minimum average flows at Columbus, Georgia and Columbia, Alabama described in items (1) and (2) above, on two days each calendar week starting each Monday when the ACF Basin is in “Drought Zone Operations”. Both West Point and WF George release decision reports for the simulation was used to evaluate the active rule for each daily time step. The operational rule to meet the Columbus objective is triggered only 5 days during the 73-year* simulation or 0.019 % of the time; for Columbia objective is triggered only 7 days during the 73-year simulation or 0.026 % of the time. Table 5 shows the operational details of Flow Objective 3. Figure 13 and 14 indicates the number of times a release was triggered due by the EDO operational rule.

Table 5: ResSim Operational Details on Flow Objective 3

ResSim operational details on Flow Objective 3				
Flow Target	% Percent of time rule active*	Number of Days	Number of Consecutive days	Number of Events
1350 cfs 2 days a week during EDO	0.019%	5	2	4

ResSim operational details on Flow Objective 3				
Flow Target	% Percent of time rule active*	Number of Days	Number of Consecutive days	Number of Events
2000 cfs 2 days a week during EDO	0.026%	7	2	4
Total	0.045%	12		

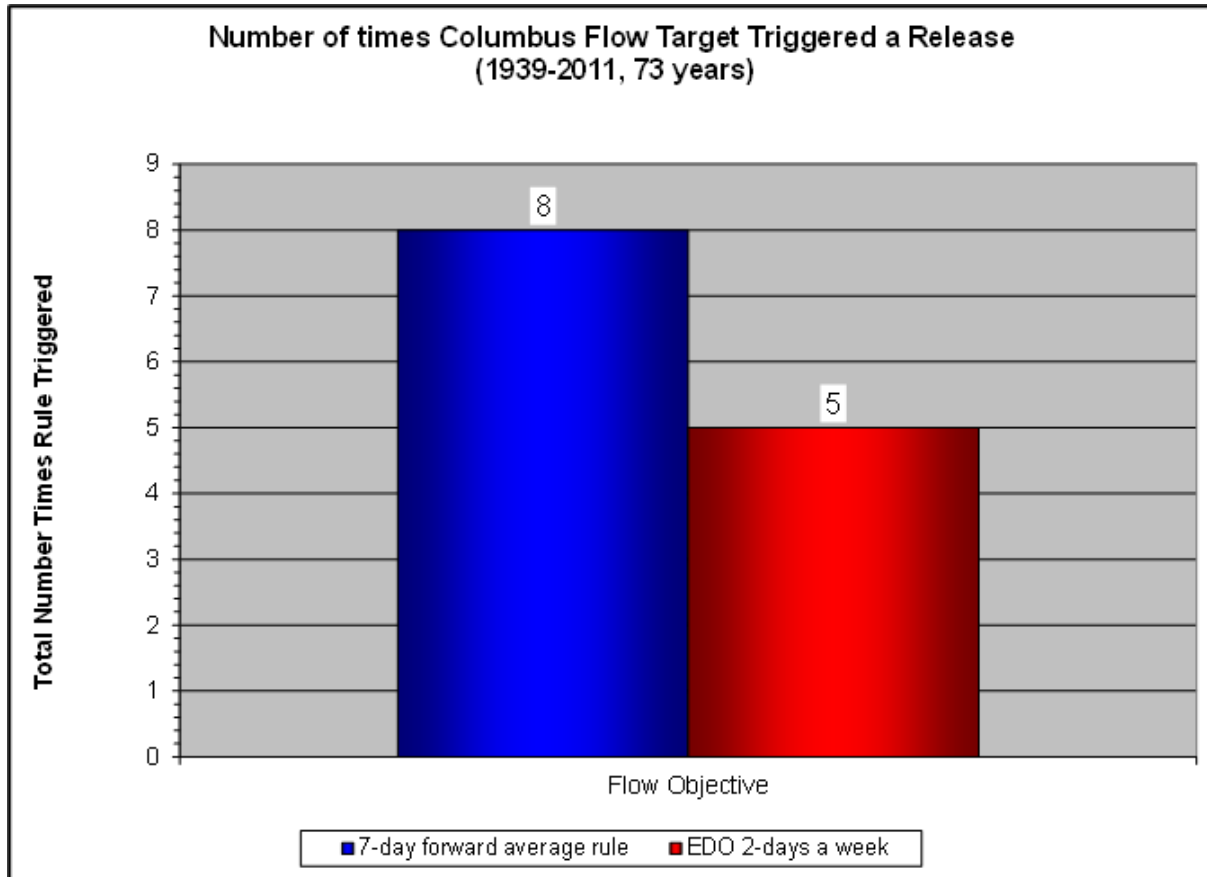


Figure 13: Flow Release Triggered at Columbus

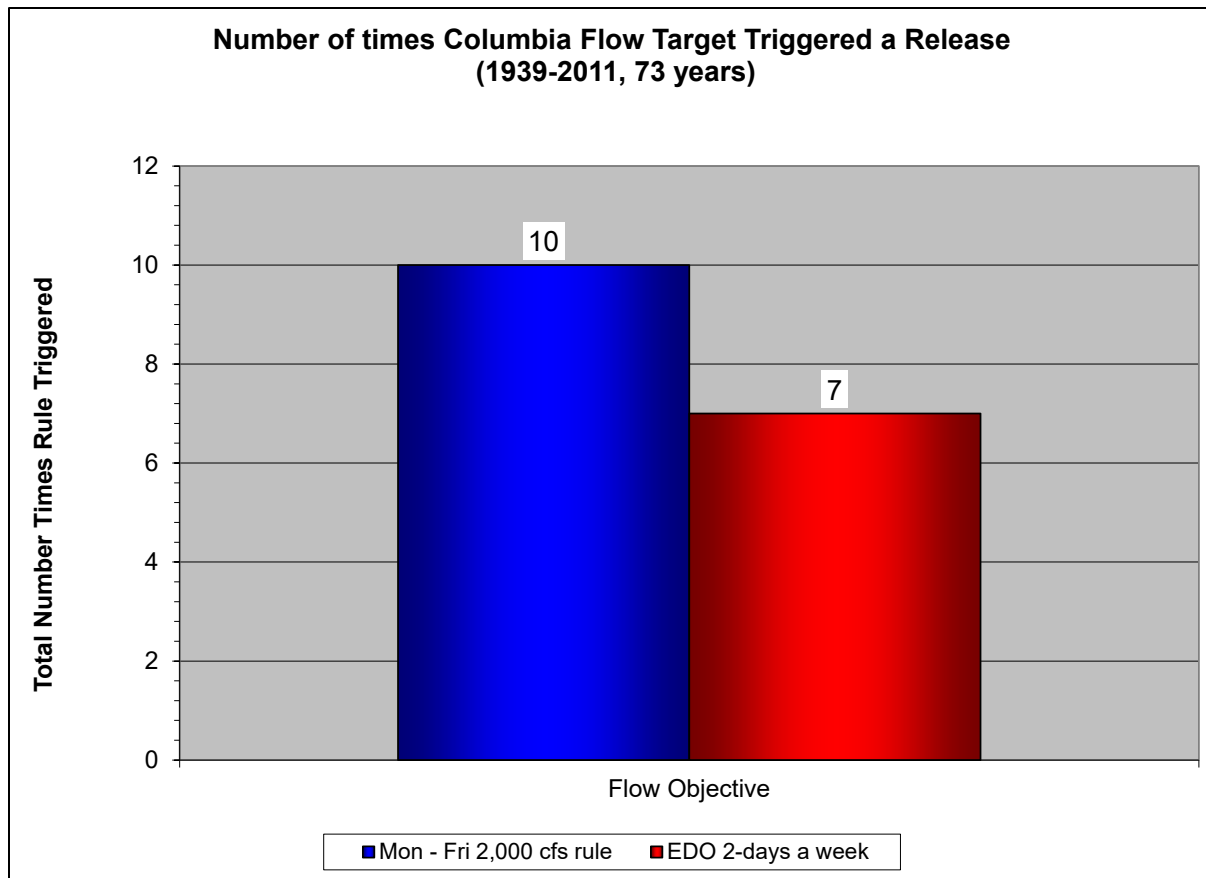


Figure 14: Flow Release Triggered at Columbia

Flow Objective 4, maintain Lake Seminole at or above an elevation of 76 feet NVGD in the same manner and to the same extent as provided in the 2017 ACF Master Manual. This flow objective is a component of both the NAA and the SAA. The objective is met the same percent of time for each alternative. Table 6 contains the details of the Flow Objective 4. Figure 15 indicates the annual Lake Seminole (Jim Woodruff) pool elevation duration for both alternatives are identical.

Table 6: Percent of Time Jim Woodruff Pool Elevation Exceeded

Percent of Time Jim Woodruff Pool Elevation Exceeded		
Elevation Value	NAA	SAA
76.0	98.89%	98.89%

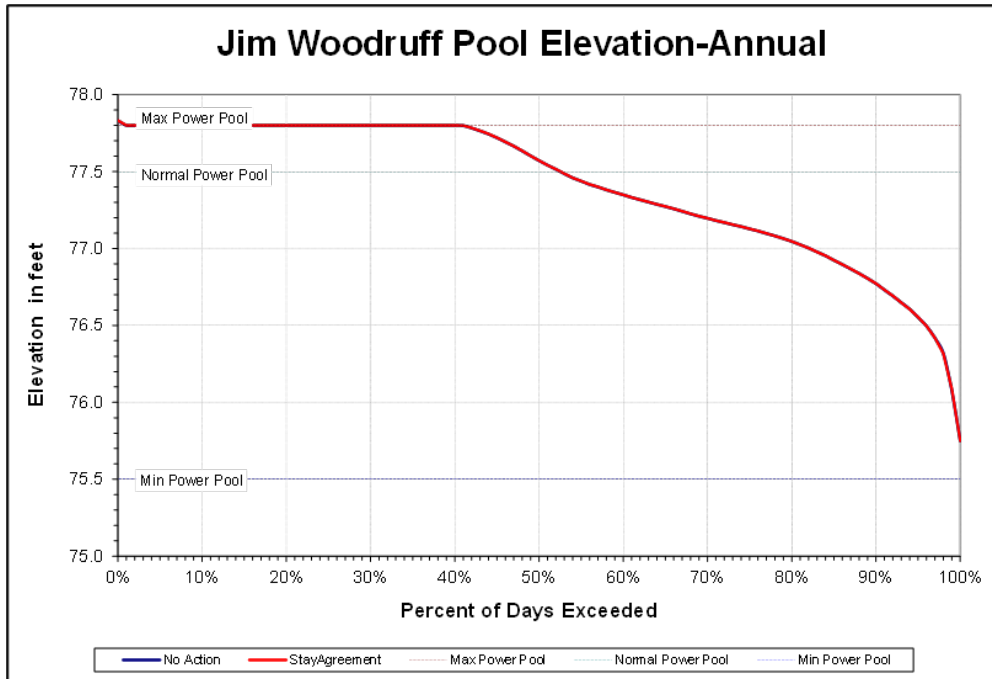


Figure 15: Jim Woodruff Pool Elevation Annual Duration Curve for Both Alternatives

*Note: 73-year simulation with total of 26,654 days.

The Pool Elevation Annual Duration Curves for the remaining projects in the system, Buford, West Point, and Walter F. George, are depicted Figure 16, Figure 17, and Figure 18. These curves show demonstrate the period of record impact of implementing the flow objectives of the Stay Agreement. The curves are exactly the same for the No Action Alternative and Stay Agreement. There are no impacts to the reservoir elevations for the Flood Risk Management projects.

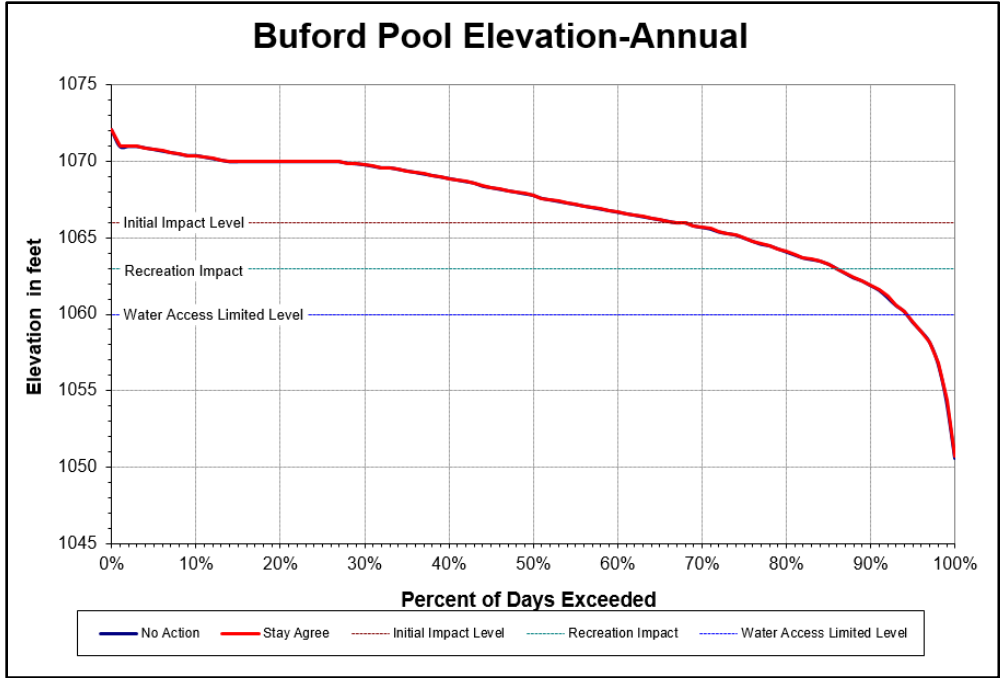


Figure 16: Buford Pool Elevation Annual Duration Curve for Both Alternatives

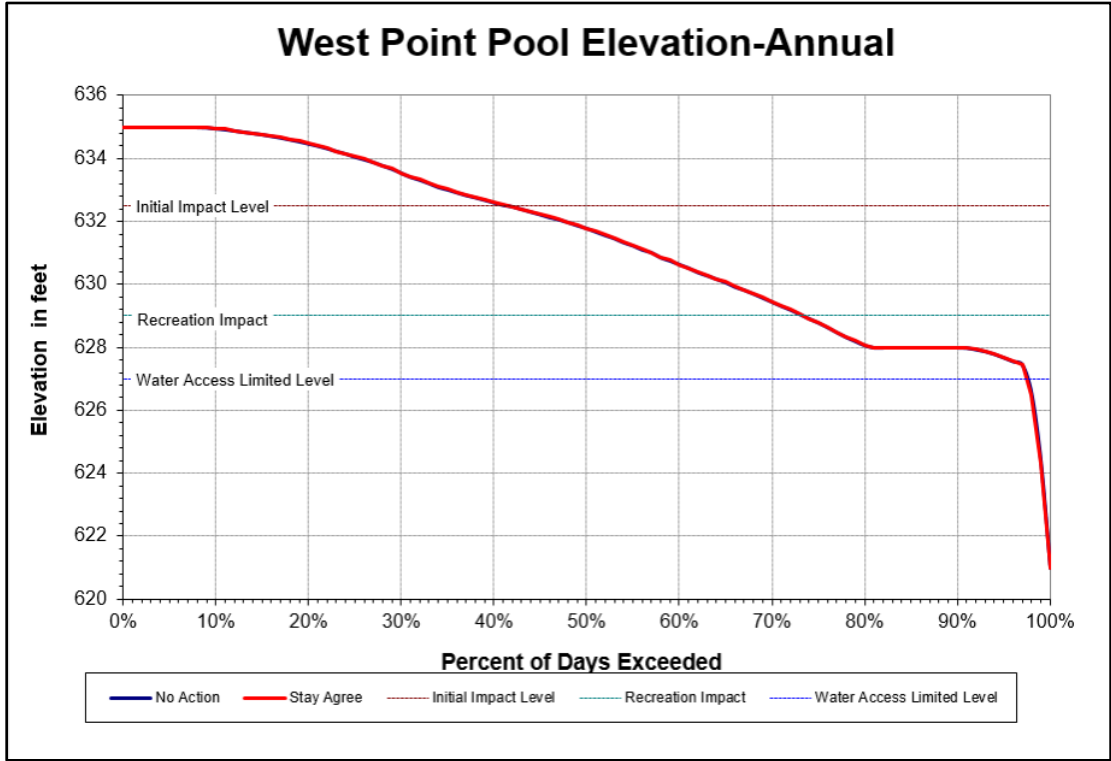


Figure 17: West Point Pool Elevation Annual Duration Curve for Both Alternatives

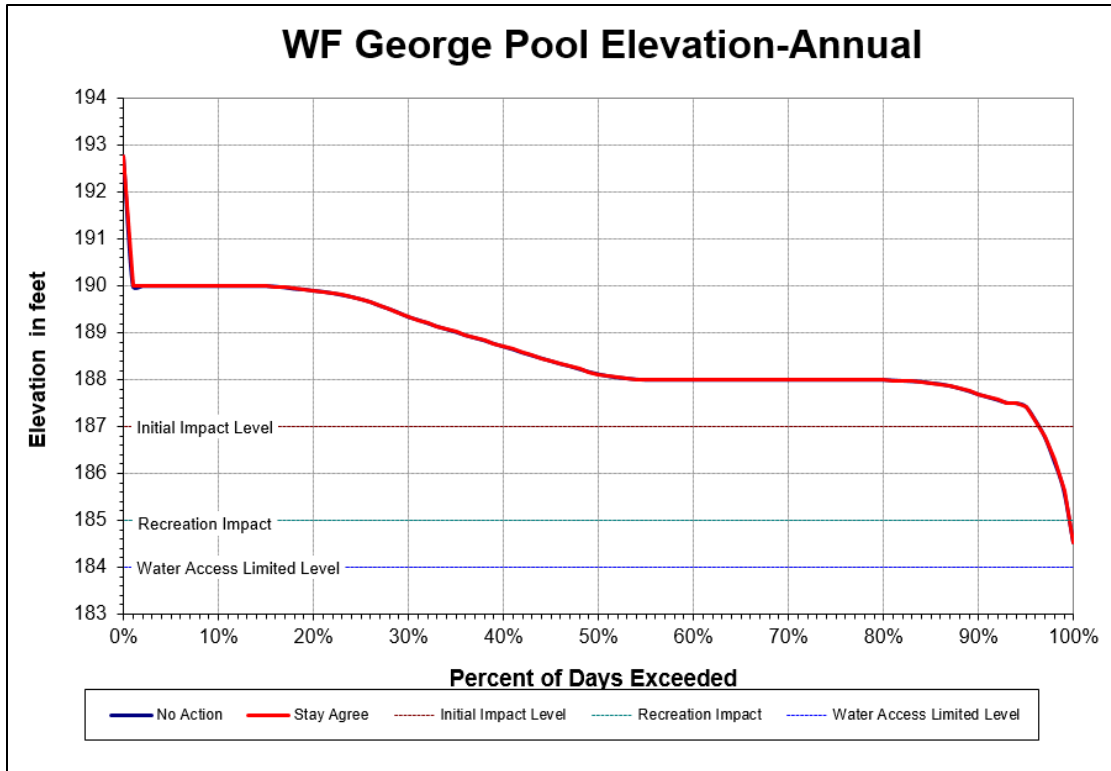


Figure 18: Walter F. George Pool Elevation Annual Duration Curve for Both Alternatives

Three of the key locations in the ACF Basin monitored during all basin conditions are USGS gages at Atlanta (Chattahoochee River at Atlanta, GA – 02336000), Chattahoochee (Apalachicola River at Chattahoochee Fla – 02358000) and Bainbridge (Flint River at Bainbridge, GA – 02356000). The Annual Duration Curves for these locations in Figures 19, 20 and 21, show that the effects of the four (4) flow Objectives of the Stay Agreement have no impact to the flow as compared to current operations outlined in the 2017 Water Control Manuals.

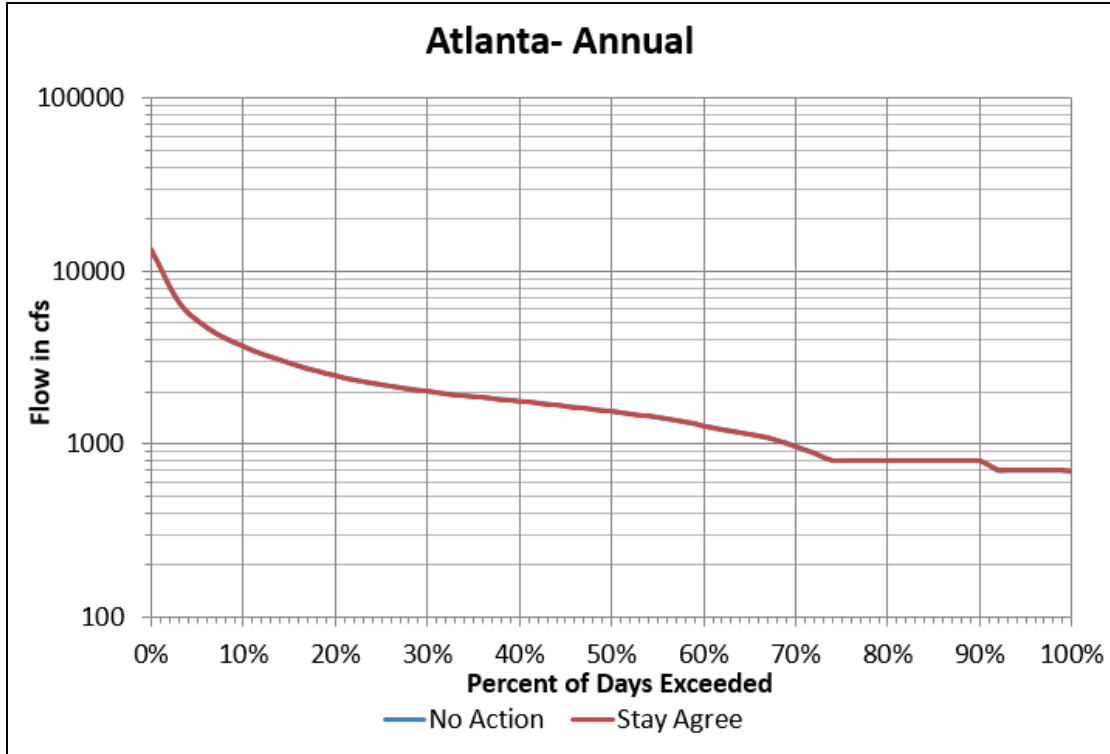


Figure 19: Chattahoochee River Gage at Atlanta (02336000) Annual Flow Duration Curve

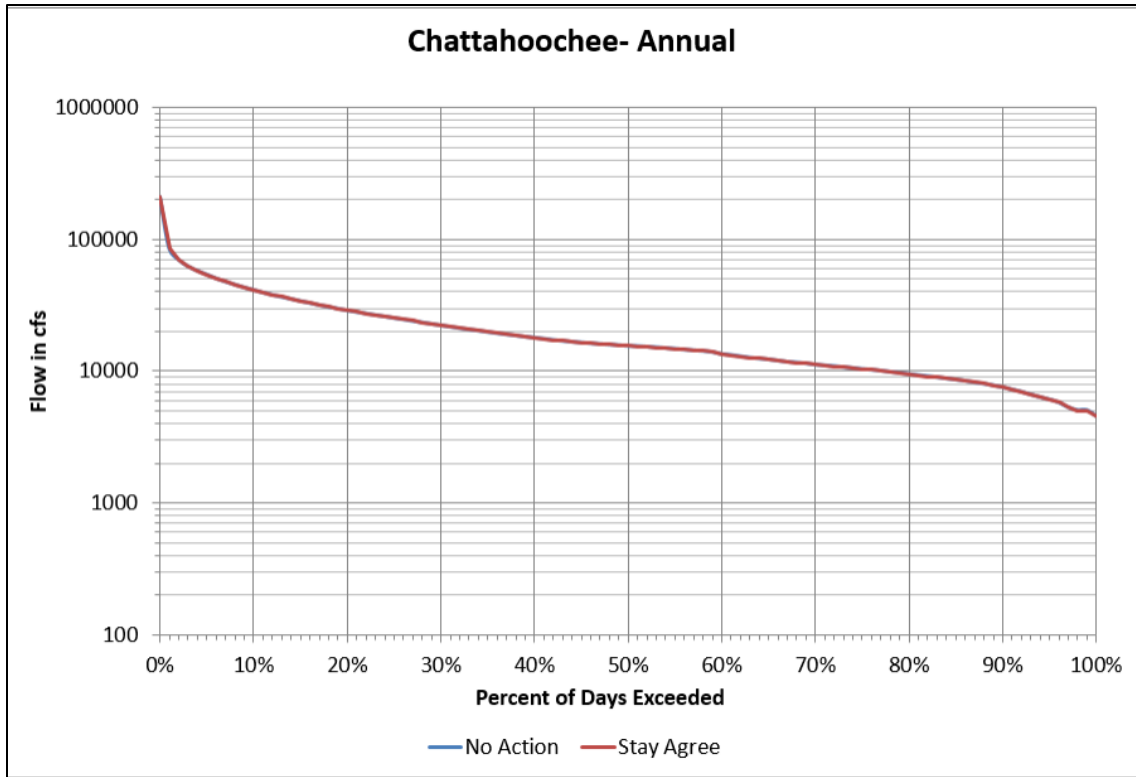


Figure 20: Apalachicola River at Chattahoochee, FI (02358000) Annual Flow Duration Curve

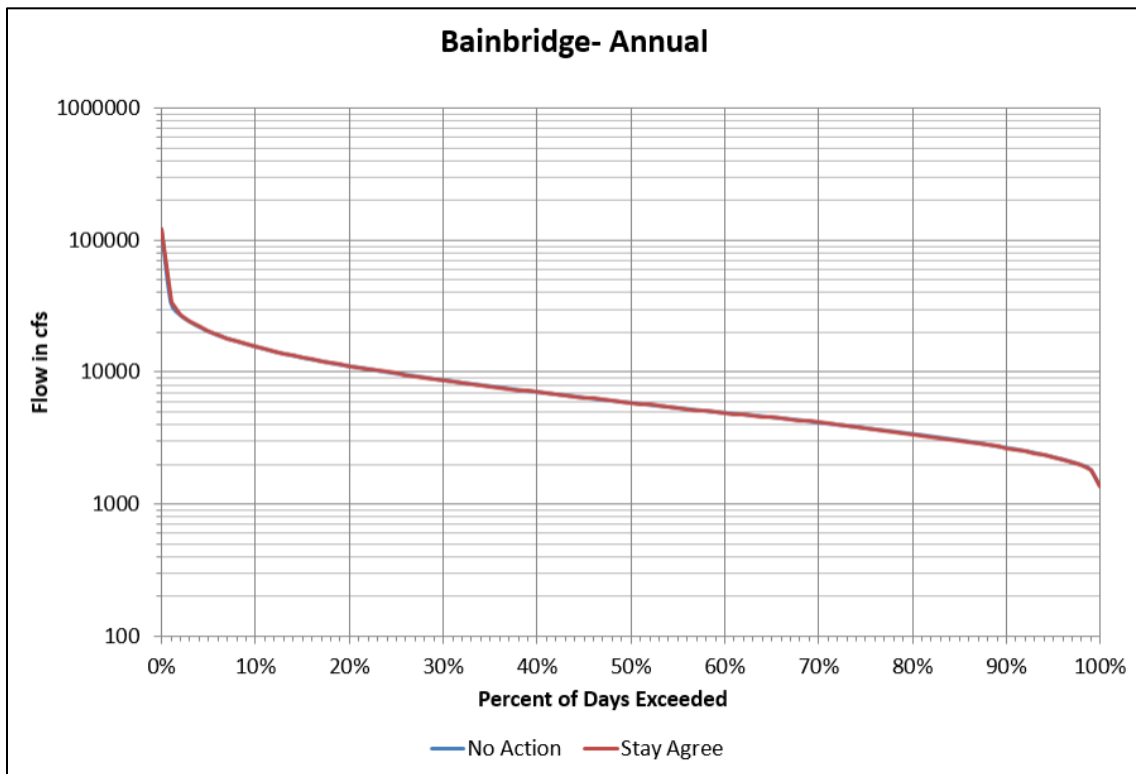


Figure 21: Flint River at Bainbridge, GA (02356000) Annual Flow Duration Curve

The Federal projects in the ACF Basin are operated to provide for the following authorized purposes:

- flood control
- fish and wildlife
- navigation
- hydropower
- water supply
- water quality
- recreation

Each of these authorized project purposes is considered when making operational decisions which affect how water is stored and released from the projects. To determine the effects of the flow objectives outlined in the Stay Agreement on operations of the three flood risk management projects, Buford, West Point and Walter F. George, the 73-year period of record reservoir elevations were analyzed. The analysis determined the period with the maximum delta between the observed reservoir elevation and the calculated elevation based on satisfying each of the Stay Agreement flow objectives.

The period with the maximum delta for Lake Lanier (Buford) occurred October 2007 to November 2007. The maximum delta for this period was 0.05 ft (0.6 inches) as shown in Figure 22. The period with the maximum delta for West Point Lake (West Point) elevation was 0.28 ft (3.36 inches) June 2000 to September 2000. (Figure 23) Walter F. George Reservoir showed a maximum delta of 0.12 ft, 1.44 inches June 2000 to September 2000. (Figure 24)

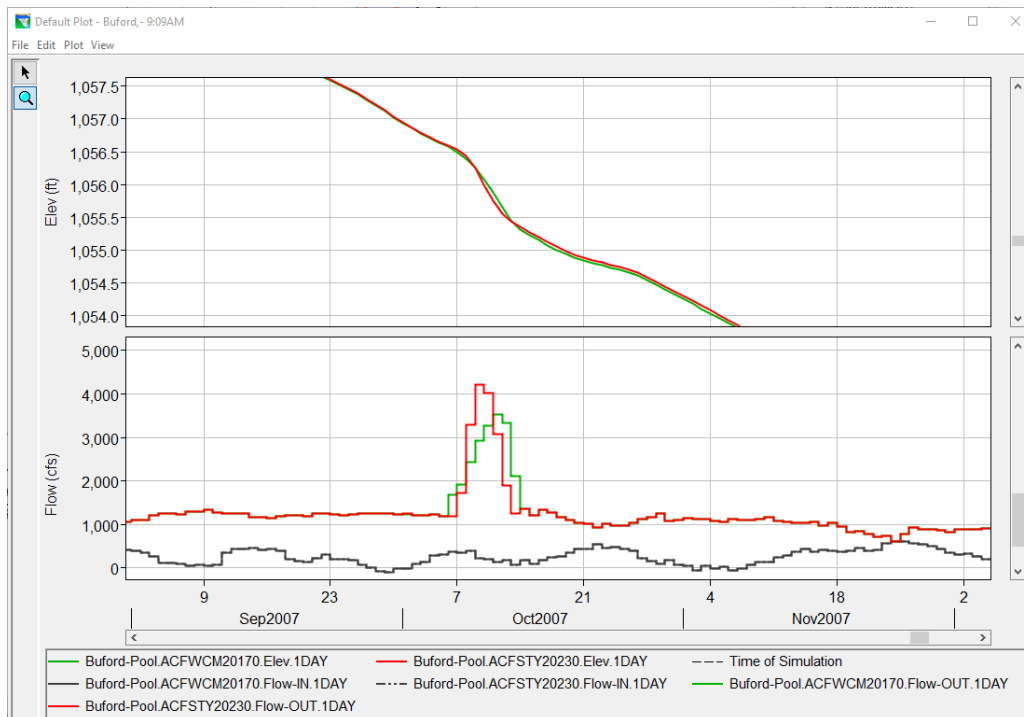


Figure 22: Lake Lanier (Buford) Elevation Comparison

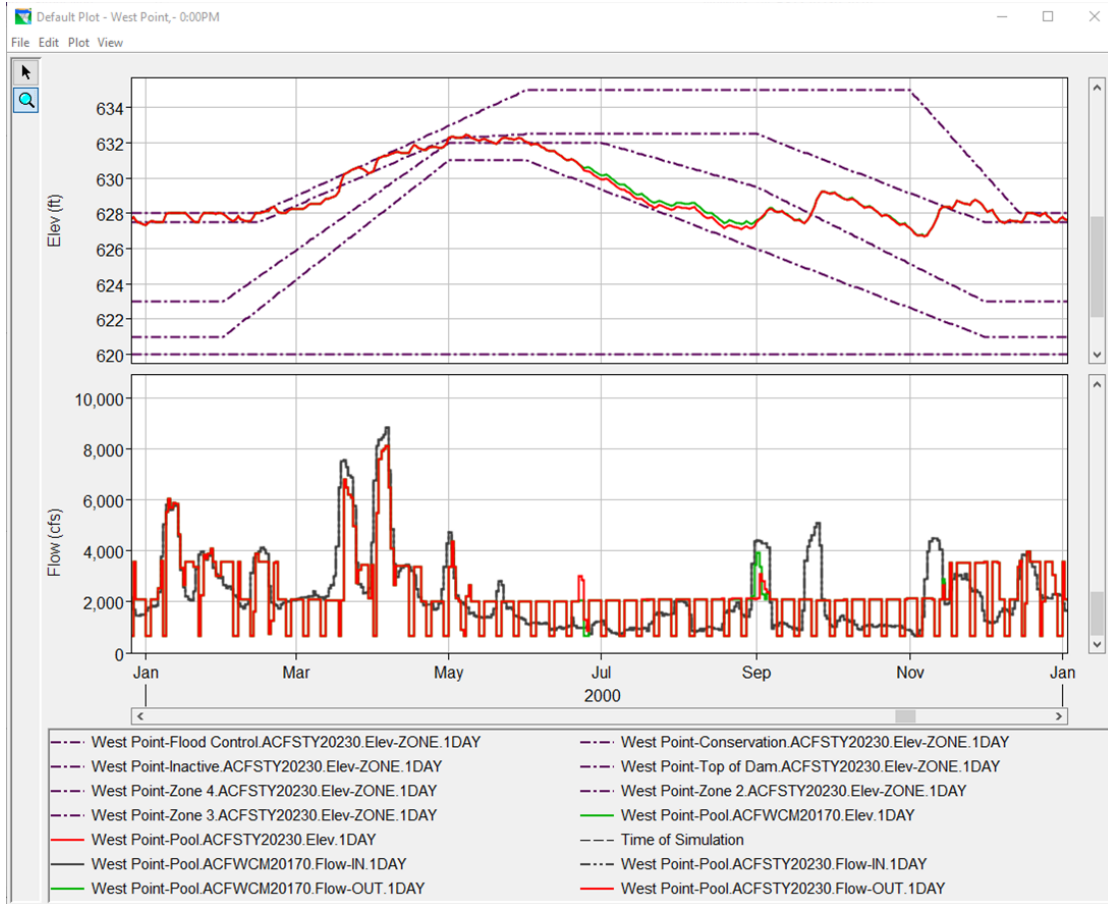


Figure 23: West Point Lake (West Point) Elevation Comparison

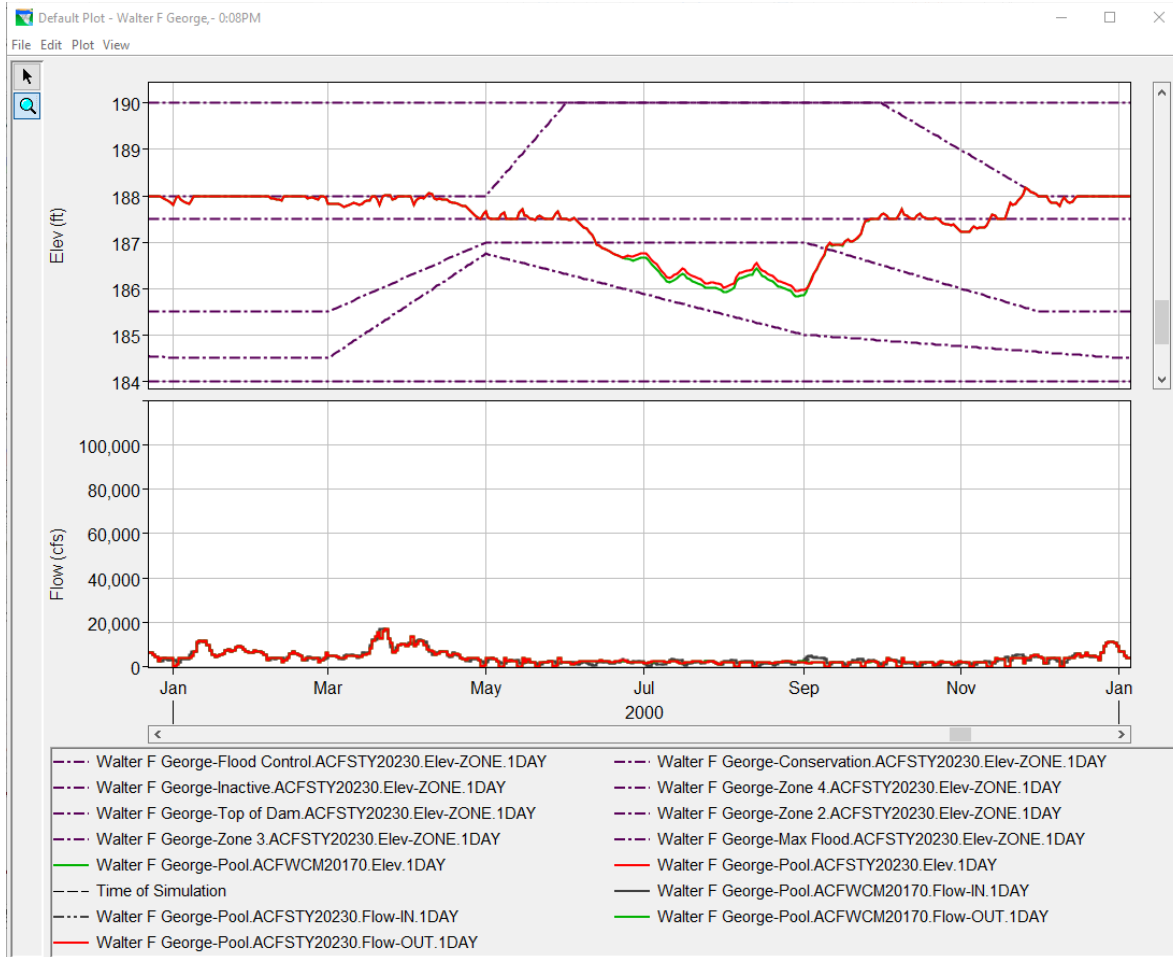


Figure 24: Walter F. George Reservoir (Walter F. George) Elevation Analysis Comparison

The portion of the analysis for determining the effects to hydropower by implementing the Flow Objectives outlined in the Stay Agreement found no impacts. In Figure 25, Figure 26, Figure 27, and Figure 28, the Total Monthly Hydropower for each project is shown for the No Action Alternative and the Stay Agreement Alternative. The charts depict the seasonality of the hydropower operations at Buford, West Point, Walter F. George, and Jim Woodruff. The hydropower demand within the model was same for both alternatives.

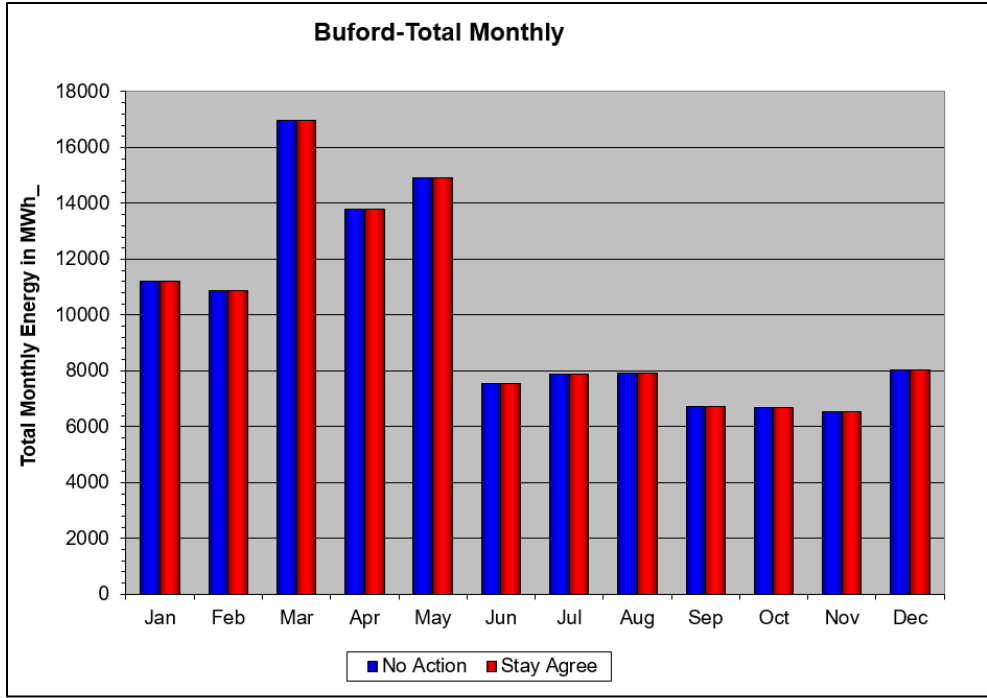


Figure 25: Buford Total Monthly Hydropower

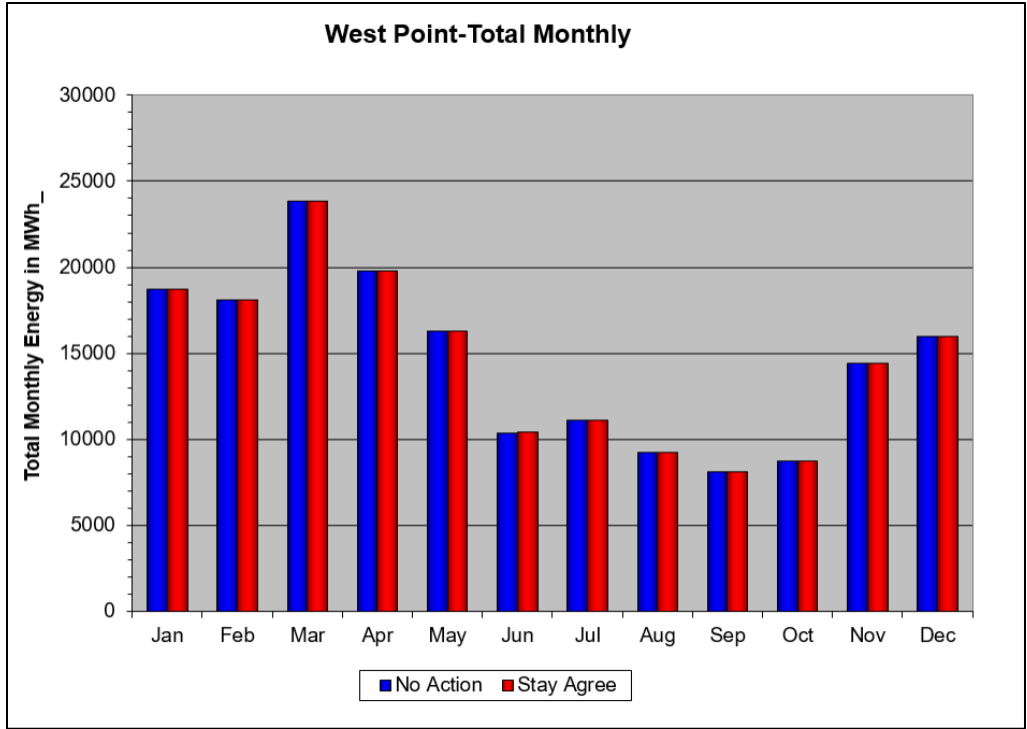


Figure 26: West Point Total Monthly Hydropower

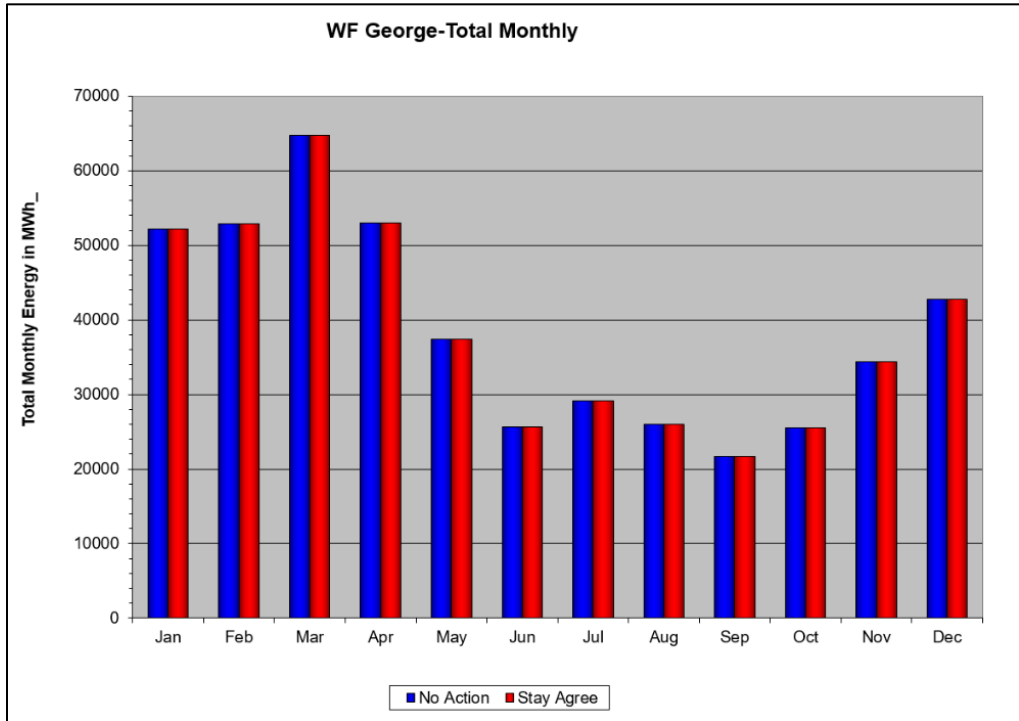


Figure 27: Walter F. George Total Monthly Hydropower Generation

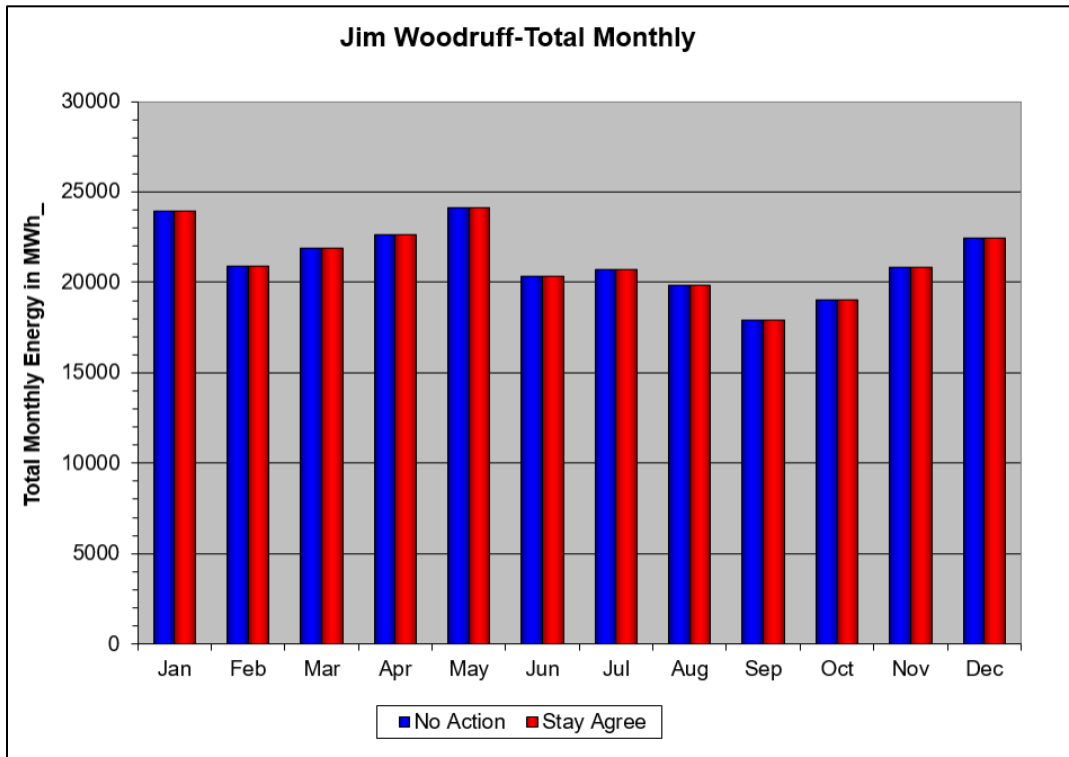


Figure 28: Jim Woodruff Total Monthly Hydropower Generation

As outlined in the 2017 Water Control Manual, releases from Jim Woodruff Dam are made January – May to provide a 7 ft channel to support navigation, as an authorized purpose. Navigation was included in the analysis to determine the impacts of the Flow Objectives outlined in the Stay Agreement. The analysis utilized the period of record flows at Blountstown (Apalachicola River NR Blountstown, Florida – 02358700). Results of the analysis are shown in Figure 29. The chart indicates no difference in the percentage of time for Channel Reliability, with no dredging occurring in the Apalachicola River, between the No Action Alternative and the Stay Agreement Alternative.

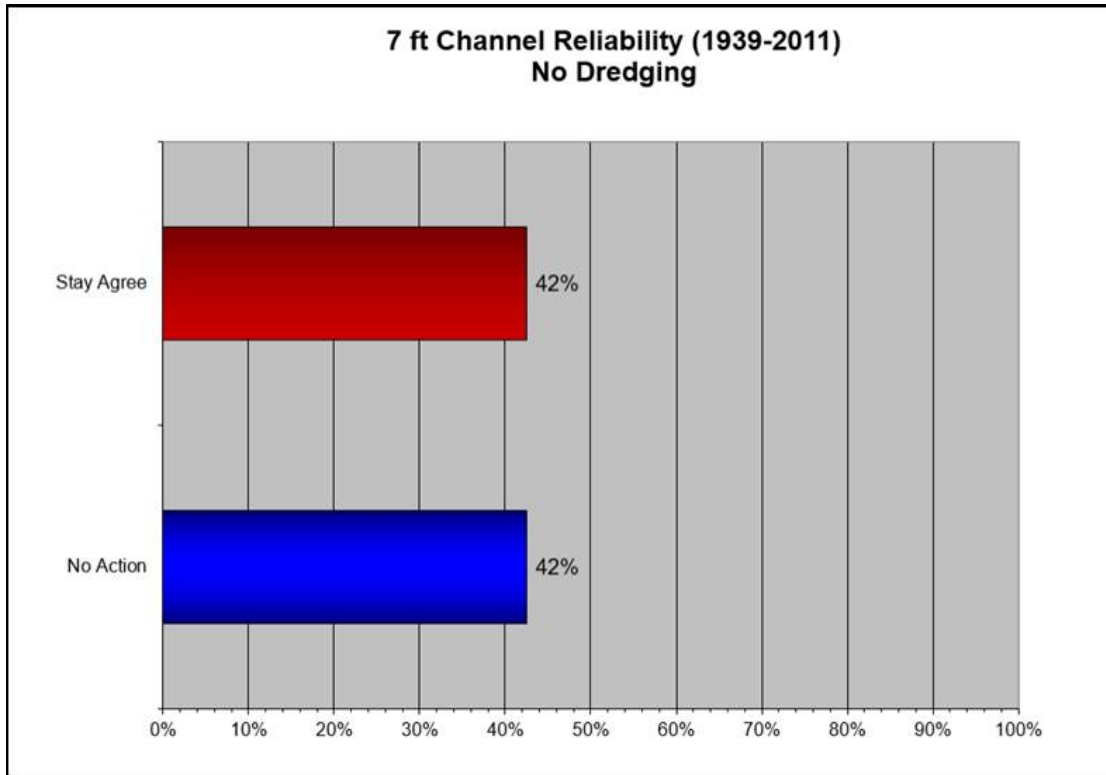


Figure 29: Period of Record Channel Reliability with No Dredging Analysis

The guidelines in the Water Control Manual reduce the amount of water available for augmenting navigation flows and other project purposes as drought conditions intensify in the basin. Ultimately, during times of drought, operations in support of navigation and hydropower may become very limited and recreation will be affected. An important component of the Stay Agreement was the addition of two new flow objectives. Additional water being released could possibly trigger drought operations more often. The model included analysis of the Stay Agreement Alternative compared to the No Action Alternative in regard to the amount of time drought operations would be triggered. Figure 30 provides a bar chart indicating the total number times drought operation is triggered for the POR simulation. The results concluded that drought operations are triggered 21 times in both the SAA and NAA.

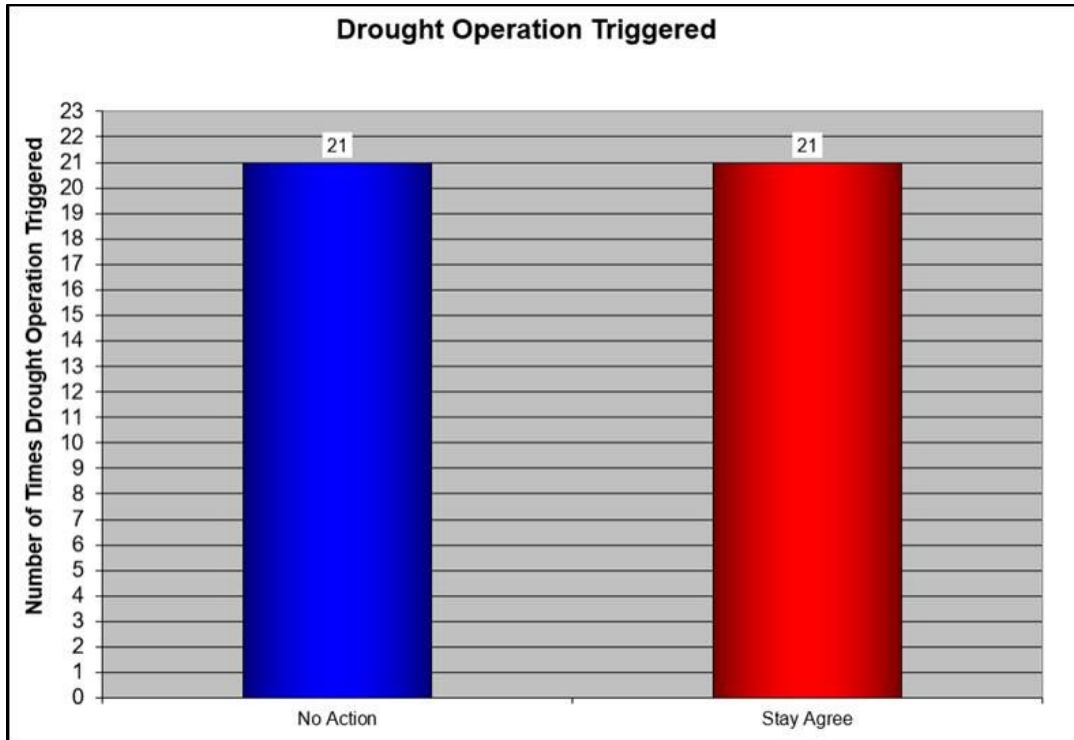


Figure 30: Drought Operations Triggered Analysis

4.0 Conclusion

Based on the analysis and results of the HEC-ResSim Modeling of the ACF Basin to meet the Flow Objectives outlined in the 2023 Stay Agreement, all four objectives were met with *de minimus* impacts to the ACF system as compared to the current operations.