Claiborne and Millers Ferry Locks and Dams Fish Passage Study

Attachment H-3 – Hydrology and Hydraulics

HEC-ResSim Modeling

May 2023

US Army Corps of Engineers

The Nature Conservancy

APPENDIX-H: Table of Contents

List of Figures

List of Tables

Attachment H-3: Hydrology and Hydraulics

H.3. HEC- ResSim Modeling

H.3.1. Introduction

This report is an appendix to the "Claiborne and Millers Ferry Lock and Dams Fish Passage Study" Appendix- H: Hydrology and Hydraulics Preliminary Draft Feasibility Report. This supplement documents the HEC-ResSim reservoir operations models developed in support of the Fish Passage Study. The following excerpt offers insight to the background of this study:

"Eighteen major dams (six Federal and twelve non-Federal, Table H.3.1), which form sixteen reservoirs, are located in the ACT River Basin (Figure H.3.2). The ACT River Basin provides water resources for multiple purposes from northwestern Georgia down through central Alabama to the Gulf Coast at the mouth of Mobile Bay, extending approximately 320 miles and encompassing an area of approximately 22,800 square miles. Pursuant to Section 7 of the Flood Control Act of 1944, the USACE prescribes regulations for the operation of the USACE projects in the ACT River Basin for their authorized purposes, and for the non-federal projects that contain storage for the purposes of navigation or flood control (flood risk management), through water control plans and manuals.

Table H.3.1. List of reservoirs or dams in the ACT basin

Reservoir or Dam	Location	Year in Service	Owner
Allatoona	Etowah River	1965	USACE
Carters	Coosawattee River	1974	USACE
Carters Reregulation	Coosawattee River	1974	USACE
Claiborne	Alabama River	1969	USACE
H. Neely Henry	Coosa River	1966	APC
Harris	Tallapoosa River	1982	APC
Hickory Log Creek	Hickory Log Creek	2008	Private
Jordan	Coosa River	1928	APC
Lay	Coosa River	1914	APC
Logan Martin	Coosa River	1964	APC
Martin	Tallapoosa River	1926	APC
Millers Ferry	Alabama River	1970	USACE
Mitchell	Coosa River	1923	APC
Robert F. Henry	Alabama River	1971	USACE

Richland Creek*	Richland Creek	2019	Private
Thurlow	Tallapoosa River	1930	APC
Walter Bouldin*	Bouldin Canal	1967	APC
Weiss	Coosa River	1961	APC
Yates	Tallapoosa River	1928	APC

- *APC is Alabama Power Company*
- *Richland Creek is currently under construction and is not included in the above paragraph.*
- *Walter Bouldin is a second dam on Jordan Lake.*

The Mobile District is conducting the Claiborne and Millers Ferry Locks and Dams Fish Passage Feasibility Study to evaluate Federal interest in establishing fish passage around the two southernmost lock and dam structures on the Alabama River. The area of interest is show in Figure H.3.1. Fish passage around Claiborne and Millers Ferry Locks and Dams would restore historic connectivity in the Alabama and Cahaba Rivers and would reconnect over 230 miles of critical riverine spawning habitat for migratory species to the Mobile River Delta and the Gulf of Mexico. Increased access to upriver habitat should result in an increase in the size and distribution of native migratory fish populations. Construction of the Claiborne and Millers Ferry Locks and Dams severed this critical spawning habitat connectivity for several species including those listed as threatened and endangered species such as the Gulf Sturgeon and Alabama Sturgeon, respectively.

Initial modeling goals were to evaluate the availability of flows through the fish passage structures, the impact of the flows through Millers Ferry and Claiborne, and the hydropower impacts at Millers Ferry and the ACT hydropower system during the entire throughout the period of record Other modeling goals were to evaluate the drought zone impacts as well as impacts to the pool elevations at Millers Ferry and Claiborne. The main report contains details about the planning process, including planning constraints.

Figure H.3.1. ACT watershed shown in the ResSim model schematic

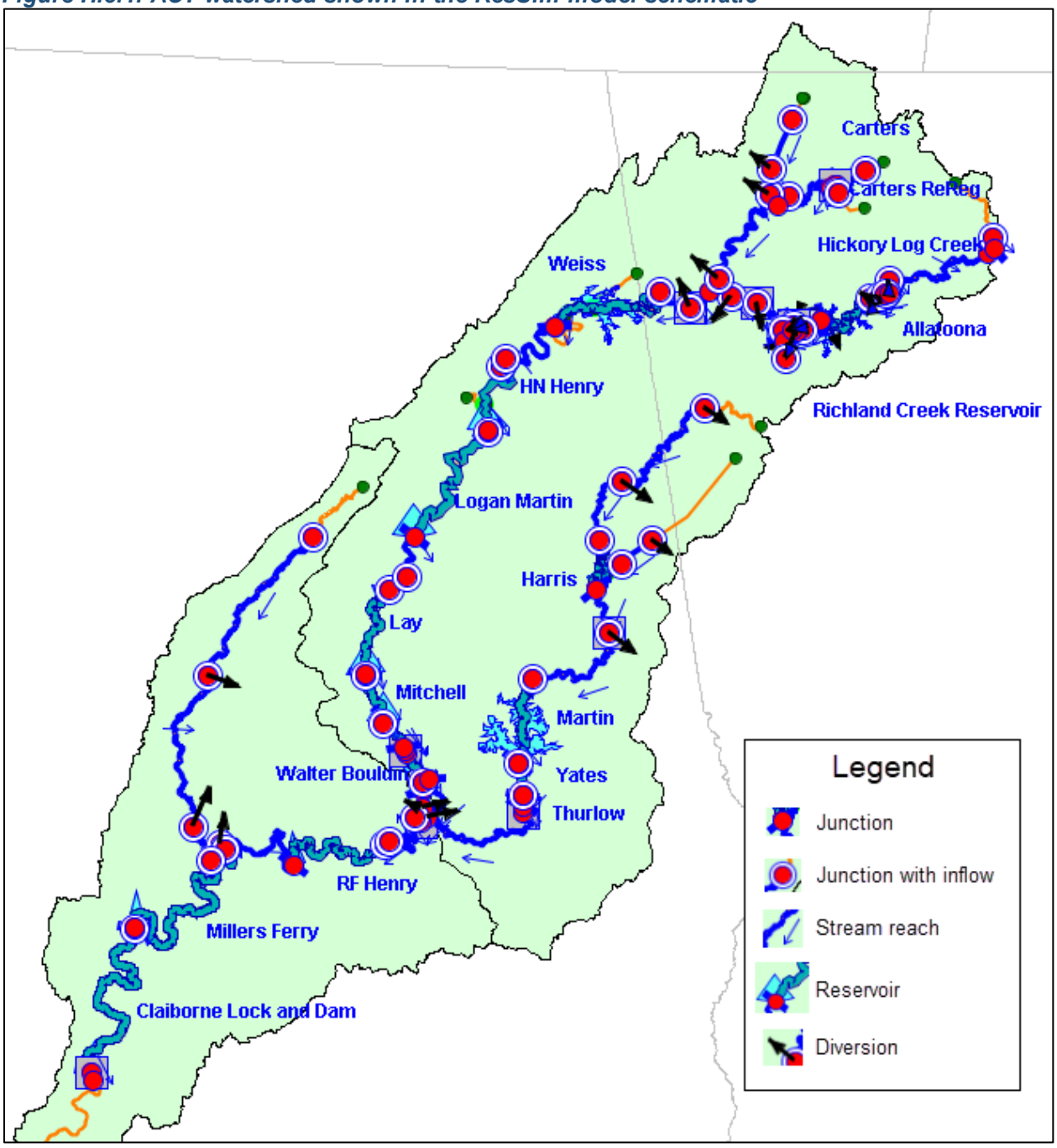
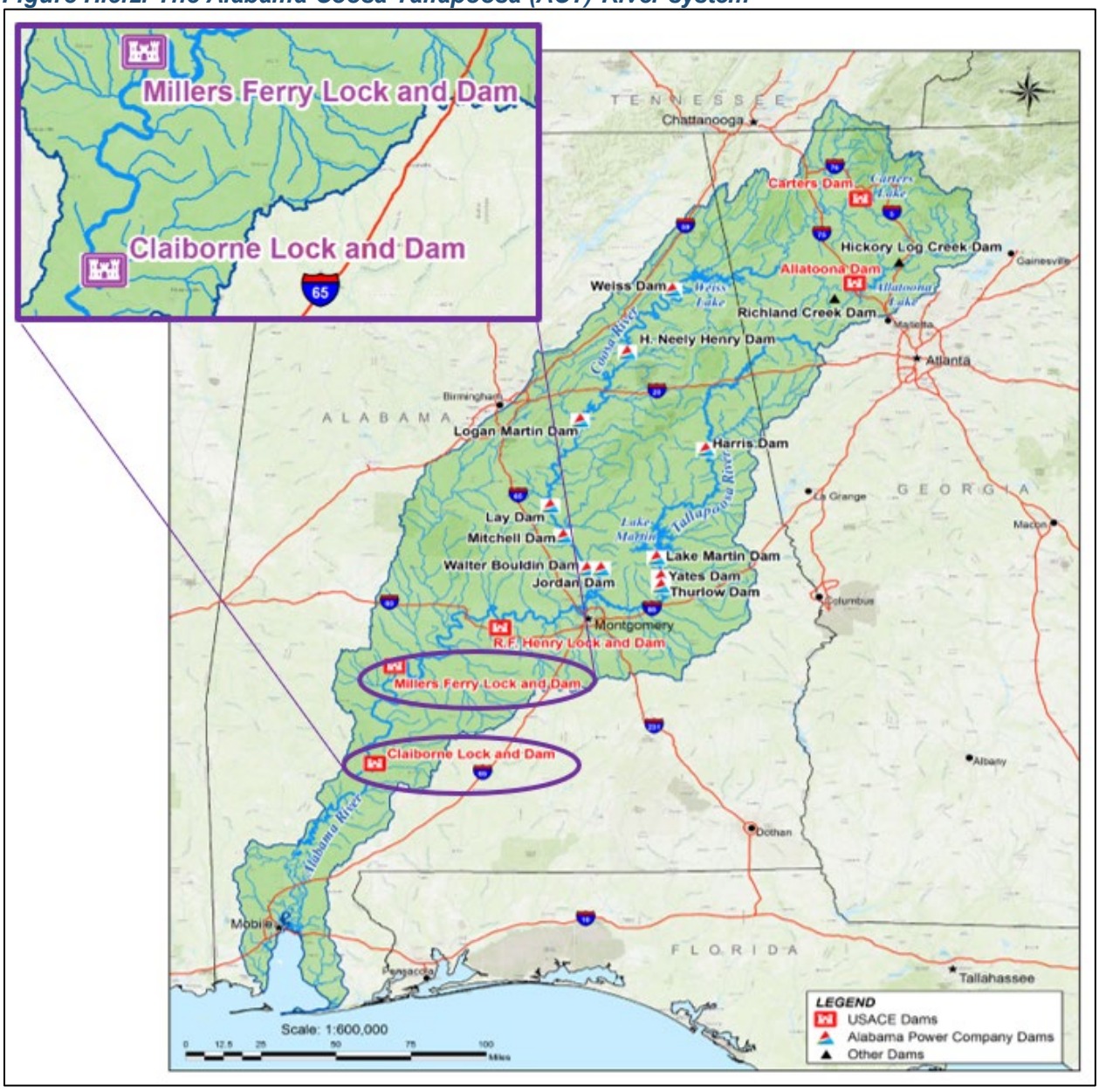


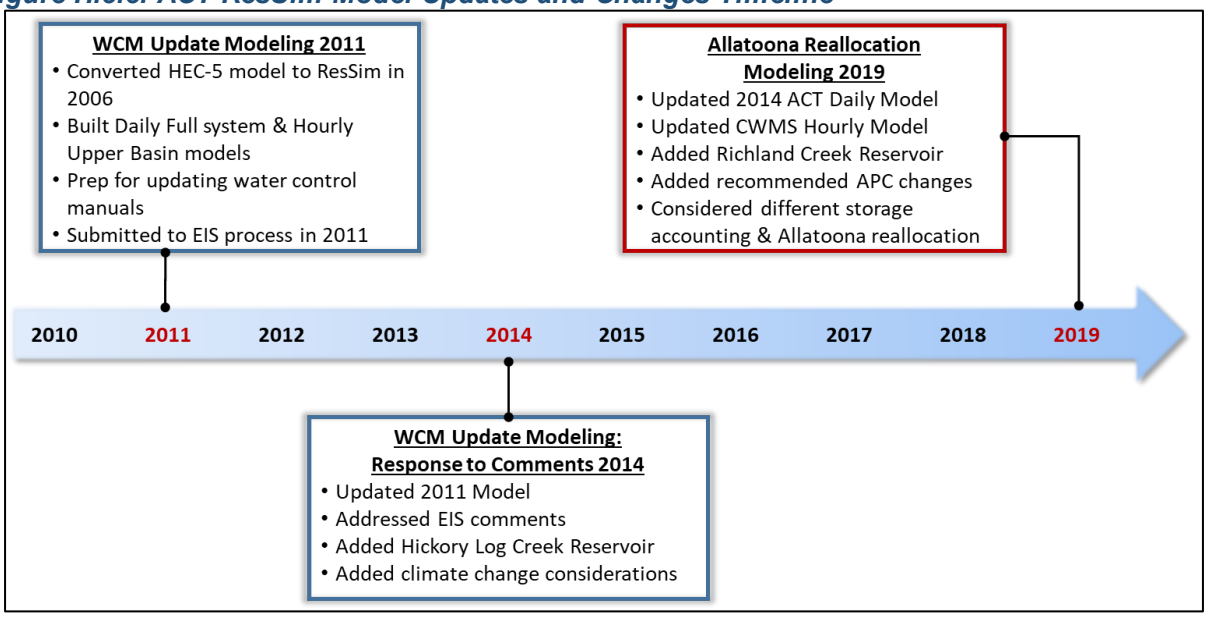
Figure H.3.2. The Alabama-Coosa-Tallapoosa (ACT) River system



H.3.2. ACT ResSim Modeling History

The ACT River Basin was modeled in early reservoir simulation software HEC-5. Transition from the HEC-5 model to the then new HEC-ResSim software was initiated in 2006 in preparation for the update of the basin Water Control Manuals. Since then, numerous improvements and changes have been made to the model and to the software itself. The major ACT ResSim modeling efforts are shown in Figure H.3

Figure H.3.3. ACT ResSim Model Updates and Changes Timeline



By 2011 the Mobile District Water Control Manual Update was in the process of completing an Environmental Impact Statement. In conjunction, a report was developed to describe the modeling activities performed. The March 2011 report, "ACT HEC-ResSim Modeling of Reservoir Operations in Support of Water Control Manual Update" details the initial design of the ACT ResSim model. An addendum to the March 2011 report was written to describe further changes to the system done during the EIS response to comments (USACE, Jul 2014). These documents are useful references that detail the assumptions and methods used to model the system and create the model that was the starting point for this work. That model, entitled "ACT-HLC_WCM_24Apr2014_HRPlansDFG", shall be referred to here as the 2014 model. It included 74 years (1939-2012) of continuously simulated, daily time step, lake levels and river flows throughout the ACT basin. The daily model was retitled "ACT-2018-daily". For this study, a modified ResSim model was created using the "ACT-2018-daily" model that was previously selected in the Allatoona- Coosa Reallocation Study. The changes and methods that were made to model the fish passage structures at Millers Ferry and Claiborne can be found in the Model Updates and Alternatives section.

H.3.3. Overview of this Report

No new baseline was developed during this study. The baseline for this study is the same as the final chose alternative for the Allatoona-Coosa Reallocation Study, A12_WS1MF. The changes to the model were to incorporate the alternative fish passage structures measures at Millers Ferry and Claiborne. These changes and updates to the physical and operational properties of the reservoir are described in Section H-9.

Also described in Section H-9 are the changes necessitated the development of a new network, new model input files, and new alternatives. These updates are described throughout this report.

The updates made to support results analysis are described in Section H-47 and Section H-50.

Examples of the results that were provided to Hydropower Analysis Center (HAC) for further hydropower analysis, to the Environmental team for availability of flows through the fish passage, and to the engineering team for pool duration impacts to the existing operations can be found in Section VI. Sample Post-Processing Results.

H.3.4. HEC-ResSim Version Selection

Because the HEC-ResSim software is being continually improved, it was important to establish a specific version to be used for the Millers Ferry and Claiborne Lock and Dam Fish Passage Study modeling. The ResSim build 3.4.1.32. was previously used for the 2019 Allatoona- Coosa River Water Reallocation study. The ResSim model that was utilized for the fish passage study was the updated ResSim model from the ACR study to which also reflects the 2022 updates for the ACT Water Control. HEC-ResSim 3.4.1.32 was initially used to extract the current ACT watershed files as well as model the alternative measures. The results that were produced for this study was in the HEC-ResSim 3.4.1.32, however after consultation with HEC, moving forward the model should be run in the latest ResSim model version 3.5.

H.3.5. Model Updates and Model Alternatives

The modeling for the Fish Passage Study began with the 2018 model that was used to study the system during the Allatoona-Coosa Reallocation study. The documentation of that work can be found in the 2022 report and the 2014 response to review comments. The ***HRPlanG*** alternative, which was the prior selected alternative, was updated to create a new baseline alternative, ***Base2018***, for this phase of modeling within the Allatoona-Coosa Reallocation study. The 2018 model network, titled "***2018***" was updated to create the ***"FPV1"*** network as well as the variations of the "FPV1" in sequential order, "FPV2", "FPV3", "FPV4", "FPV5". The fish passage study is focused on implementing two fish passage structures at two USACE projects along the Alabama River, Millers Ferry Lock and Dam and Claiborne Lock and Dam. Figure H.4.5 shows the original 2018 network in the ResSim stream alignment at Millers Ferry. Figure H.6.7 shows the original 2018 network in the ResSim stream alignment at Claiborne Lock and Dam.

The basic model updates for this study applied to the network and the baseline alternative are described in this section of the document. Other model updates that varied based on alternative are found in later sections. This section addresses the following alternatives:

A. Rock Weir Fish Passage Addition at Millers Ferry and Claiborne
B. Natural Bypass Channel Addition at Millers Ferry and Claiborne
C. Rock Weir Fish Passage Addition at Claiborne; Natural Bypass Channel Addition at Millers Ferry
D. Natural Bypass Channel at Claiborne and Rock Weir Fish Passage at Millers Ferry

The details of the changes are described below in separate sections.

H.3.5.1. Rock Weir Fish Passage Addition at Millers Ferry Lock and Dam and Claiborne Lock and Dam

The rock weir fish passage additions at Millers Ferry Lock and Dam and Claiborne Lock and Dam was simulated in alternative "A03_RwBd" in simulation "Fish Passage

Alternatives POR Updated". Alternative "A03_RwBD" stands for Alternative 3 rock weirs at both dams. "A03_RwBd" alternative's results were compared to the base condition alternative "A12_WS1MF".

H.3.5.1.1. Network Updates

A new network, "FPV5" was created to simulate the rock weir additions at Millers Ferry Lock and Dam and Claiborne Lock and Dam. Controlled outlets were added at both Millers Ferry and Claiborne within this new network to simulate the rock weir structure. The controlled outlet at Millers Ferry Lock and Dam represents the rock weir gated fish passage structure. The controlled outlet is connected from the Millers Ferry reservoir to the tailwater gage downstream of Millers Ferry in the modeling software. Figure H.4.5 shows the updated 2018 network with the addition of the controlled outlet in the ResSim schematic at Millers Ferry. There is no visible difference between the baseline network and alternative measures network. The controlled outlet was also created at Claiborne Lock and Dam to simulate an ungated rock weir fish passage structure. This controlled outlet is connected from Claiborne Lock and Dam Reservoir to the downstream tailwater gage. Figure H.6.7 shows the original 2018 network in the ResSim stream alignment at Claiborne Lock and Dam. Figure H.6.7 shows the updated 2018 network with the addition of the controlled outlet at the Claiborne Lock and Dam. There is no visible difference between the baseline network and alternative measures network.

Figure H.4.5: HEC-ResSim Network Module- Millers Ferry Lock and Dam

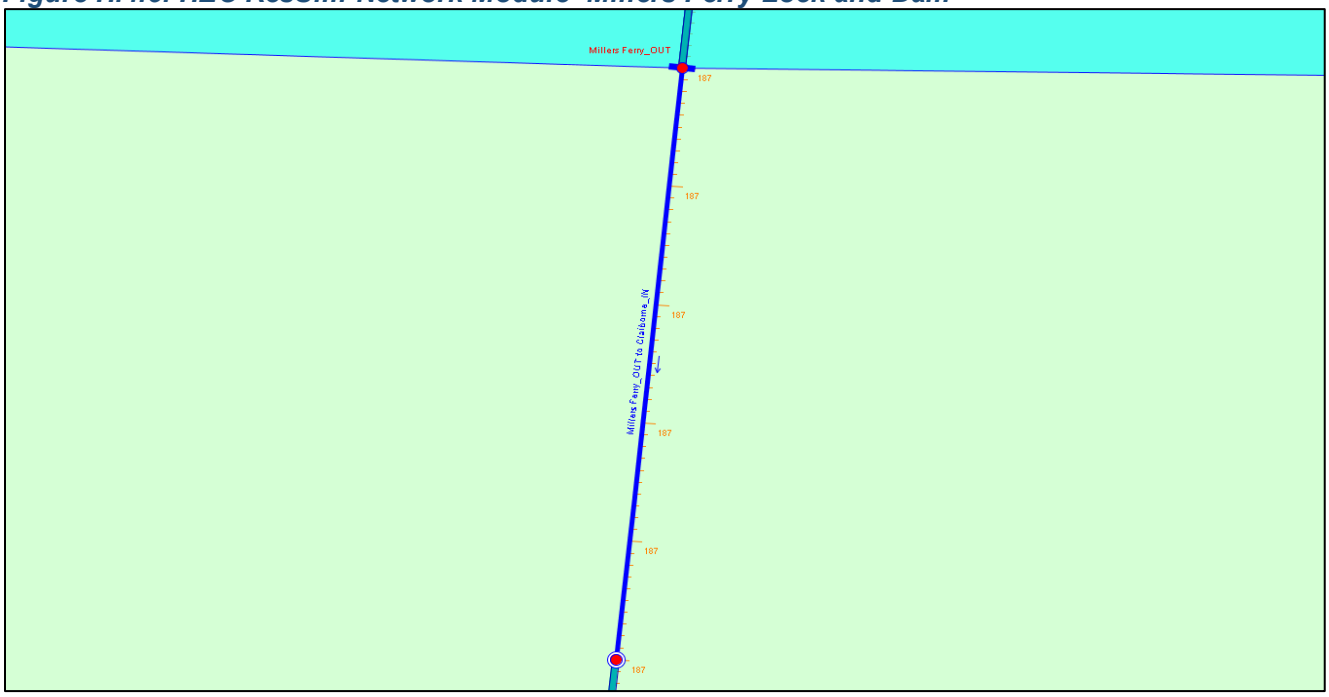
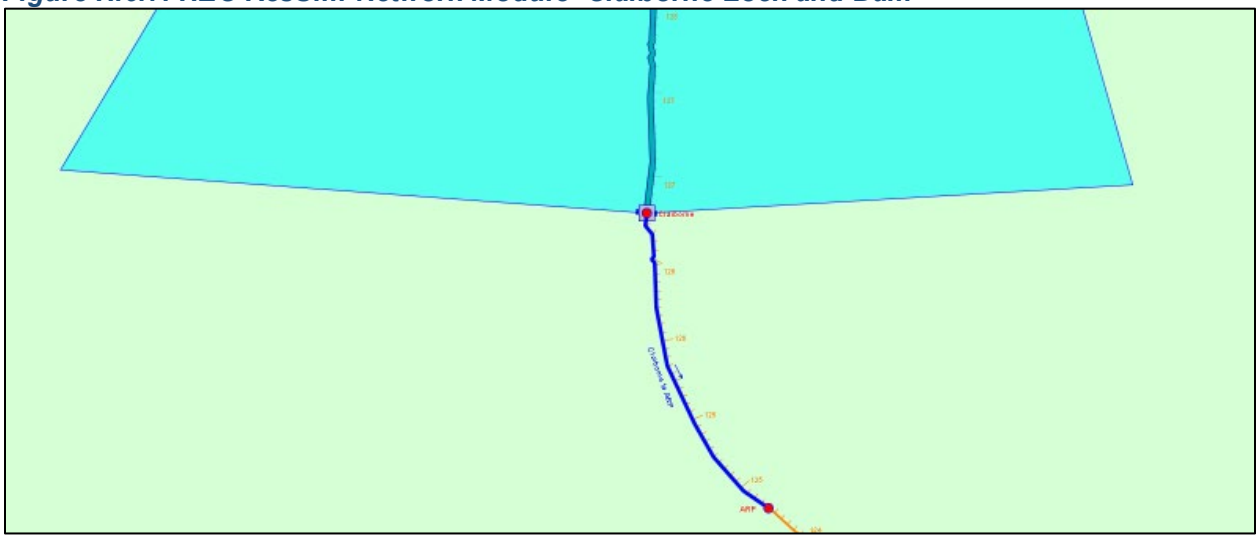


Figure H.6.7: HEC-ResSim Network Module- Claiborne Lock and Dam



H.3.5.1.2. Physical Data

H.3.5.1.2.1. Overall Dam Length

The rock weir variation at Millers Ferry alters the overall dam length given their designed position in the existing spillway structure. Currently at Millers Ferry, the overall dam length is 3360.0 ft. With the rock weir variation, the dam length is 3260.00 ft.

H.3.5.1.2.2. Capacity of the Controlled Outlet

The physical capacity of the Millers Ferry and Claiborne controlled outlet was provided by the results of the HEC-RAS model. To create a binary switch which represents a gated versus ungated operation for different variations of the fish passage structure designs within the same simulation, the physical capacity of the controlled outlet of the rock weir fish passage was determined to be the maximum capacity of the physical structure at the lowest pool elevation where the structure ties into the reservoir and the highest spillway gate elevation. After the initial assessment of determining a gated or an ungated operation, the ungated operation sets at Millers Ferry were screened out due to the high risk and high impacts to the present authorized project purposes of hydropower and the overall structure of the dam. For Claiborne, the gated operation sets were screened out due to the initial design of the physical structure which tied into the top elevation of the fixed crest spillway.

For Millers Ferry, the total maximum capacity is 5800 cfs at headwater pool elevations of 75.0 ft. and 88.0 ft. Figure H.8.9 shows the physical capacity rule curve for the Millers Ferry controlled outlet. For Claiborne, the total maximum capacity is 12,000 cfs at headwater pool elevations of 33.1 ft. and 62.0 ft. Figure H.3.10 shows the capacity rule curve for the Claiborne controlled outlet.

Figure H.8.9: Alternative A03_RwBD Millers Ferry Lock and Dam Controlled Outlet Physical Capacity

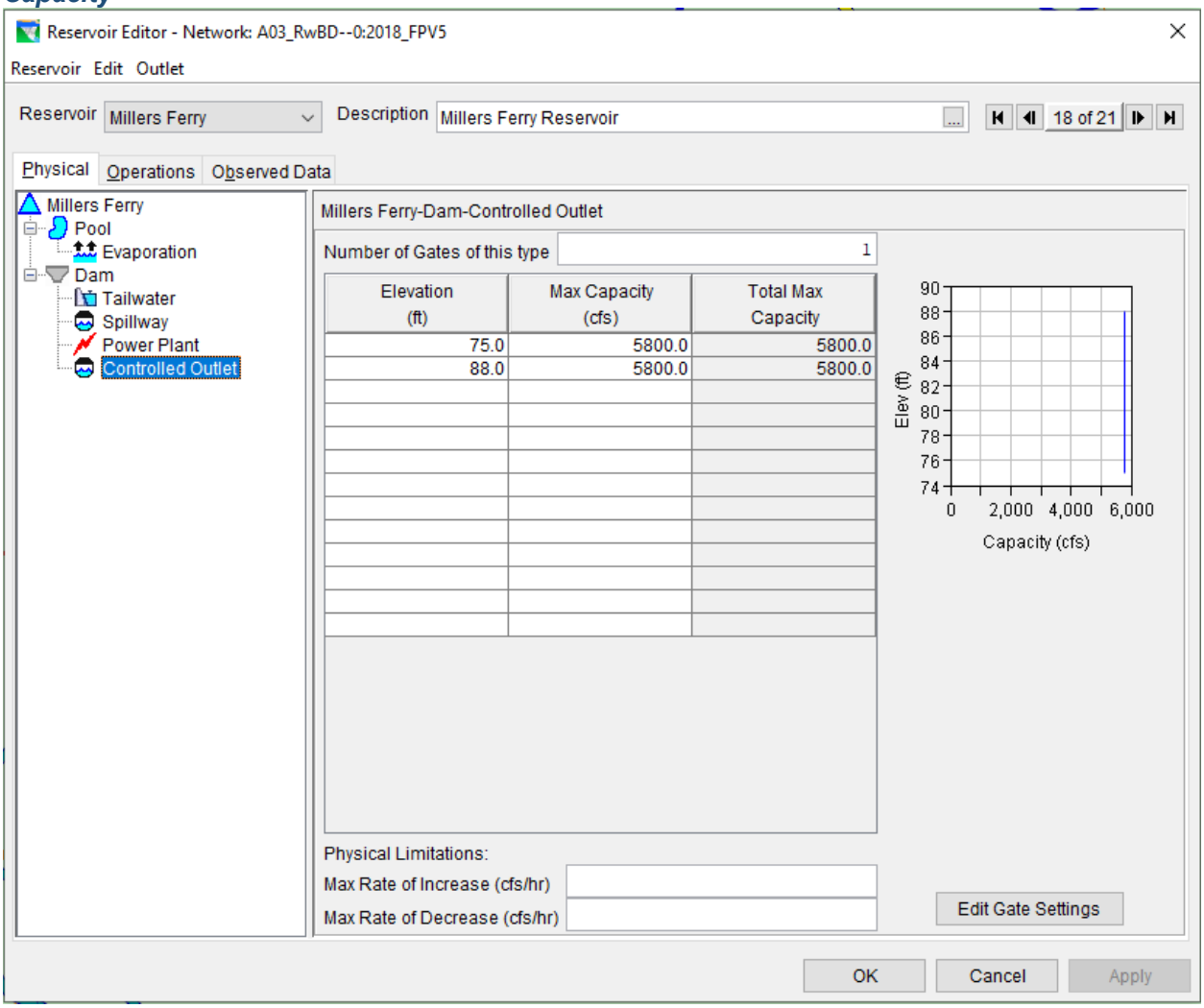
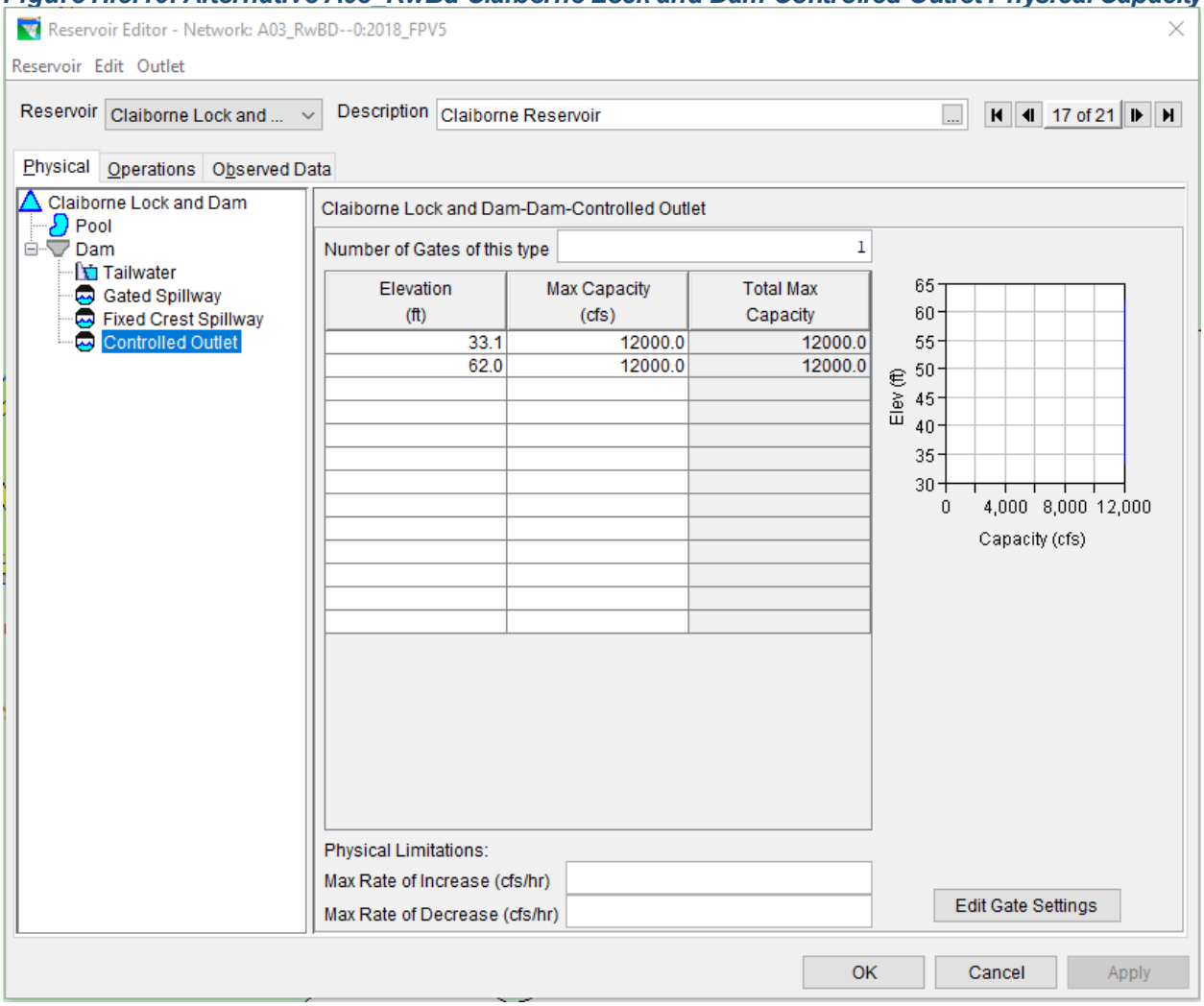


Figure H.3.10: Alternative A03_RwBd Claiborne Lock and Dam Controlled Outlet Physical Capacity



H.3.5.1.2.3. Capacity Rating Curve

There were no changes to the spillway rating curve at Millers Ferry Lock and Dam. Adjustments were made to the fixed crest spillway rating curve at Claiborne Lock and Dam (Figure H.3.12). The baseline fixed crest spillway rating curve is shown in Figure H.3.14. The gated spillway rating curve remained unchanged from the baseline to the alternative (Figure H.3.11,Figure H.3.13).

Figure H.3.11: Alternative A03_RwBd Gated Spillway Rating Curve

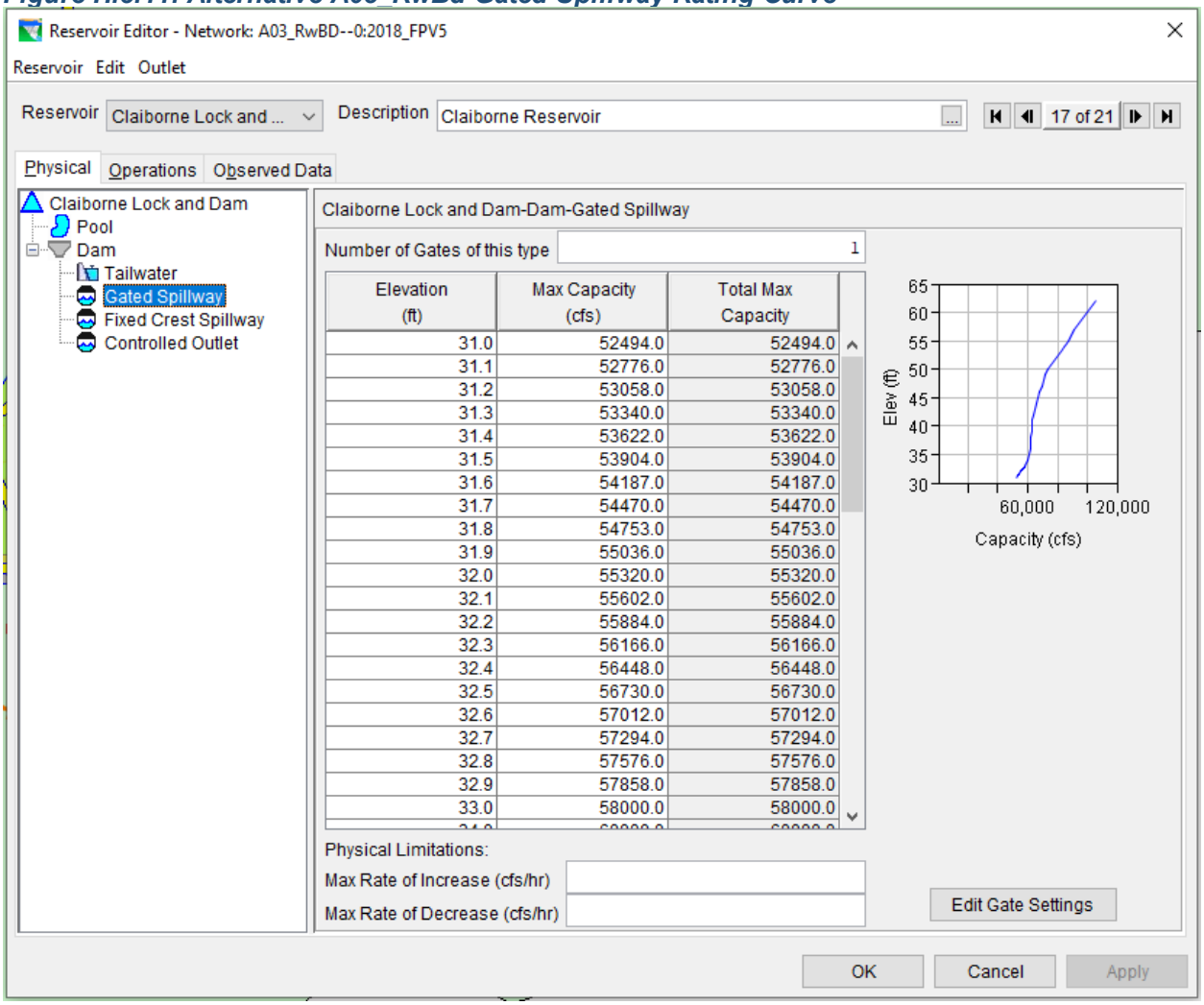


Figure H.3.12: Alternative A03_RwBd Fixed Crest Spillway Rating Curve

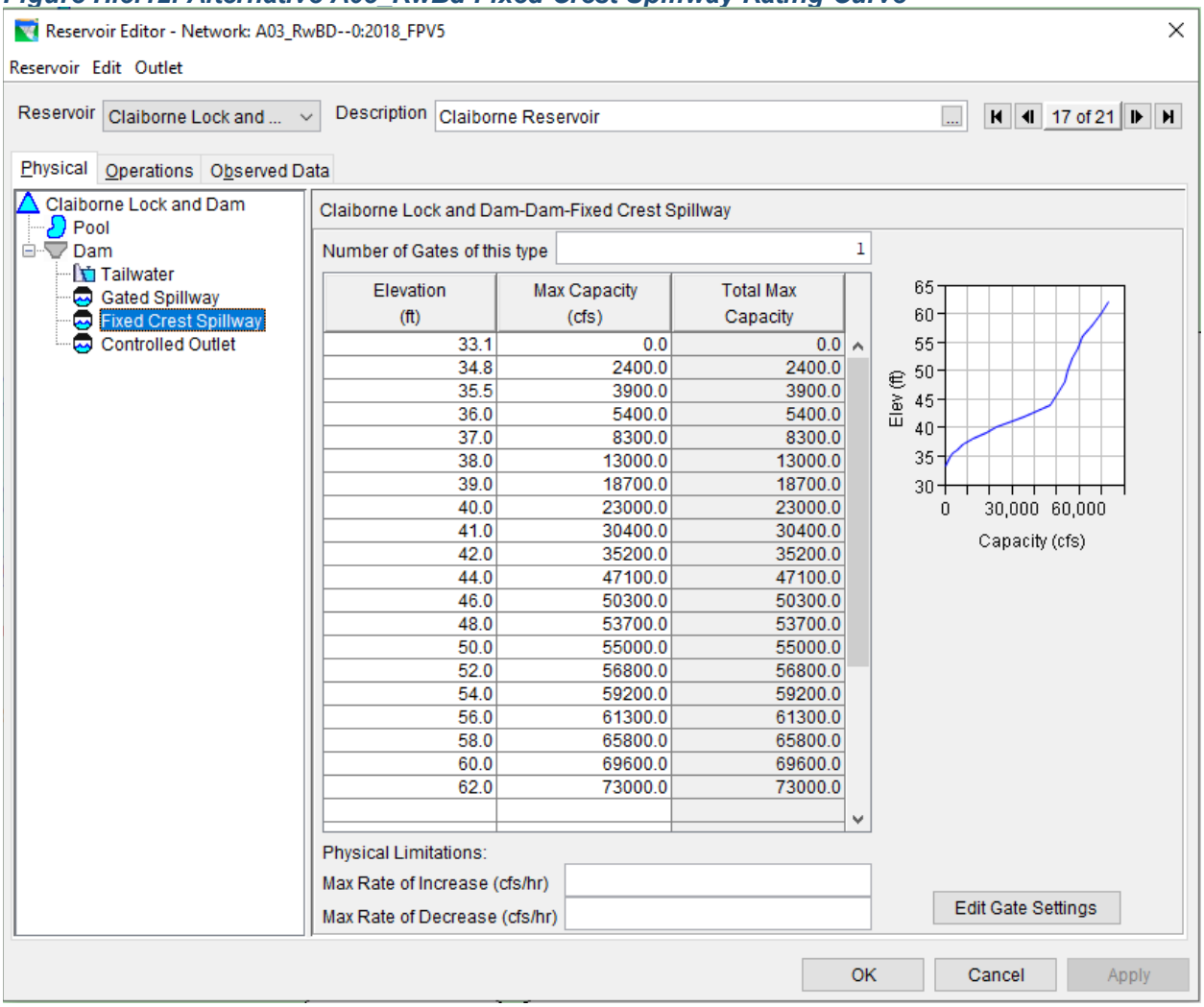


Figure H.3.13: Base Condition A12_WS1MF Gated Spillway Rating Curve

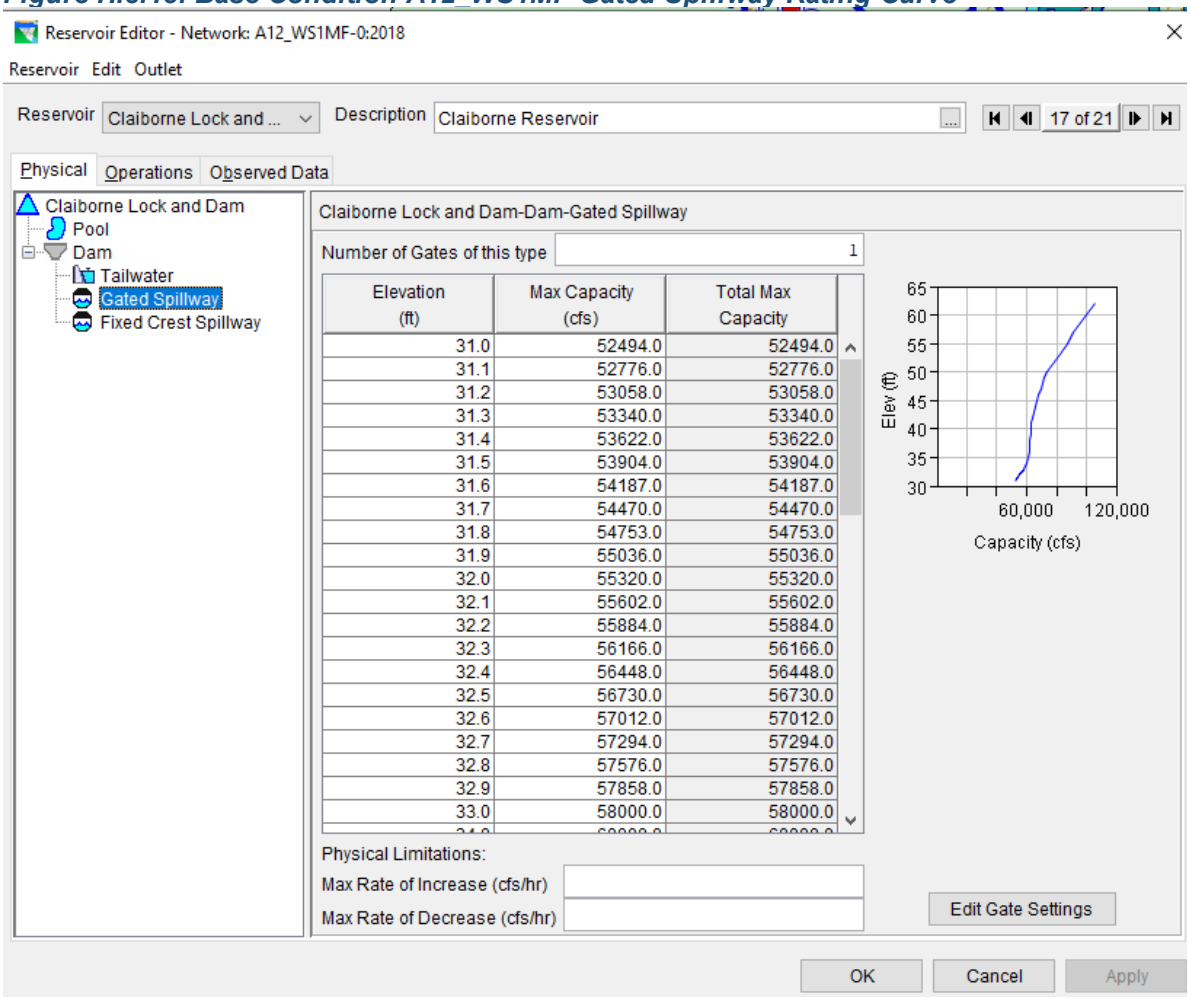
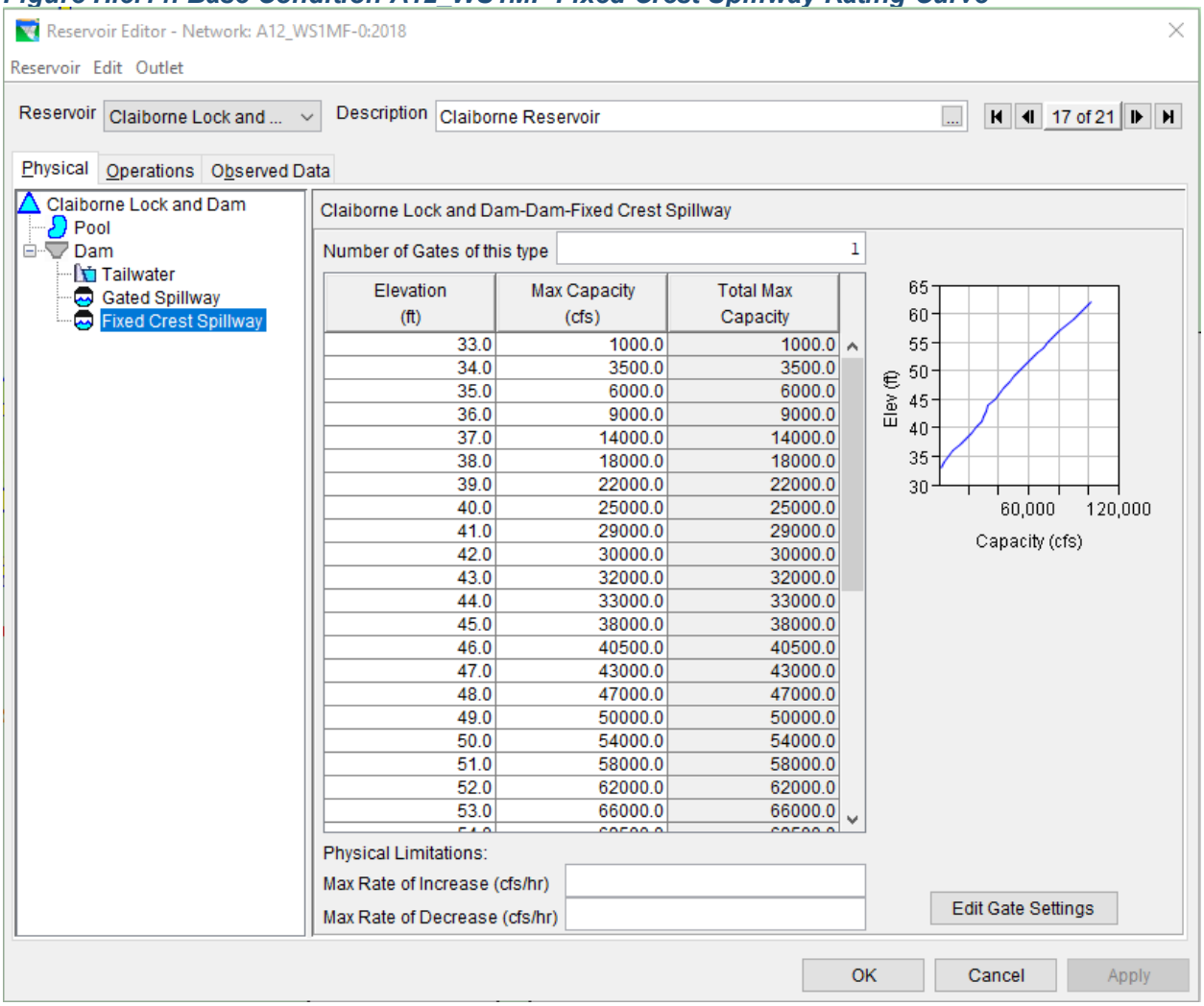


Figure H.3.14: Base Condition A12_WS1MF Fixed Crest Spillway Rating Curve



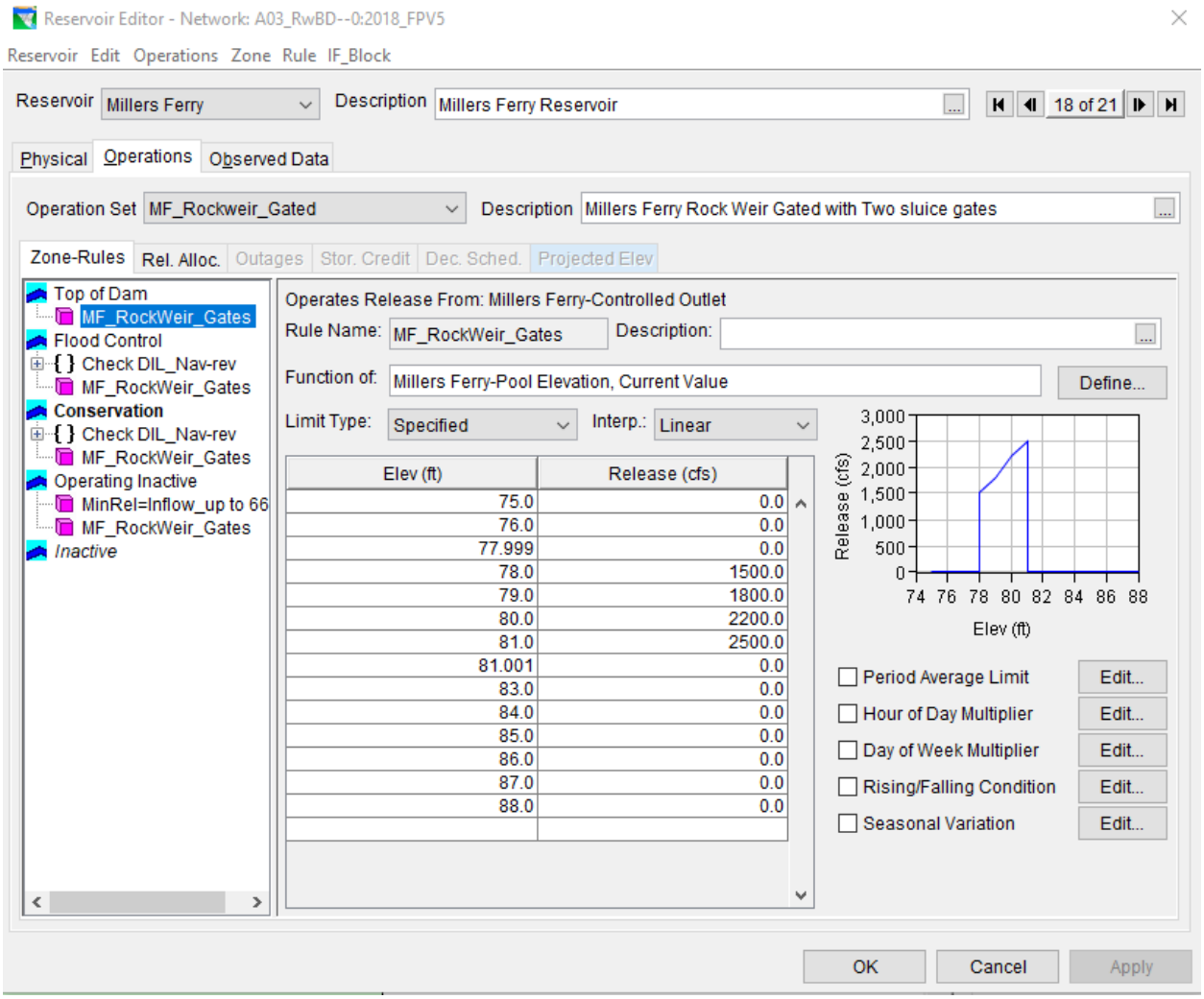
H.3.5.1.3. Reservoir Operations

Two new operation sets were created to simulate flow through the controlled outlet. Figure H.3.15 shows the gated operation set with a gated rule at Millers Ferry named "MF_RockWeir_Gates". Figure H.3.16 represents the ungated operation set at Claiborne "CL_RockWeir_NoGate". The rating curves were provided by HEC-RAS modeling for the physical rock weir variations at each of the individual project.

H.3.5.1.3.1. Gated operations at Millers Ferry

Within the gated operations at Millers Ferry, a new rule named "MF_RockWeir_Gates" was created to reflect the gated operations of the fish passage structure. The "MF_RockWeir_Gates" rule is a function of the current value of the Millers Ferry pool elevation. To simulate the fish passage rock weir gate closing during high flow events, at headwater pool elevation 81.01, the flow is set to 0 cfs. To simulate the gate closing during a low flow period, at pool elevation 79.999 ft., the flow is also set to 0 cfs. This rule assists Water Management to control the fish passage structure during emergency time periods of either low flows or high flows. Figure H.3.15 depicts the corresponding releases with the headwater pool elevation(ft.) as an operational rule within ResSim.

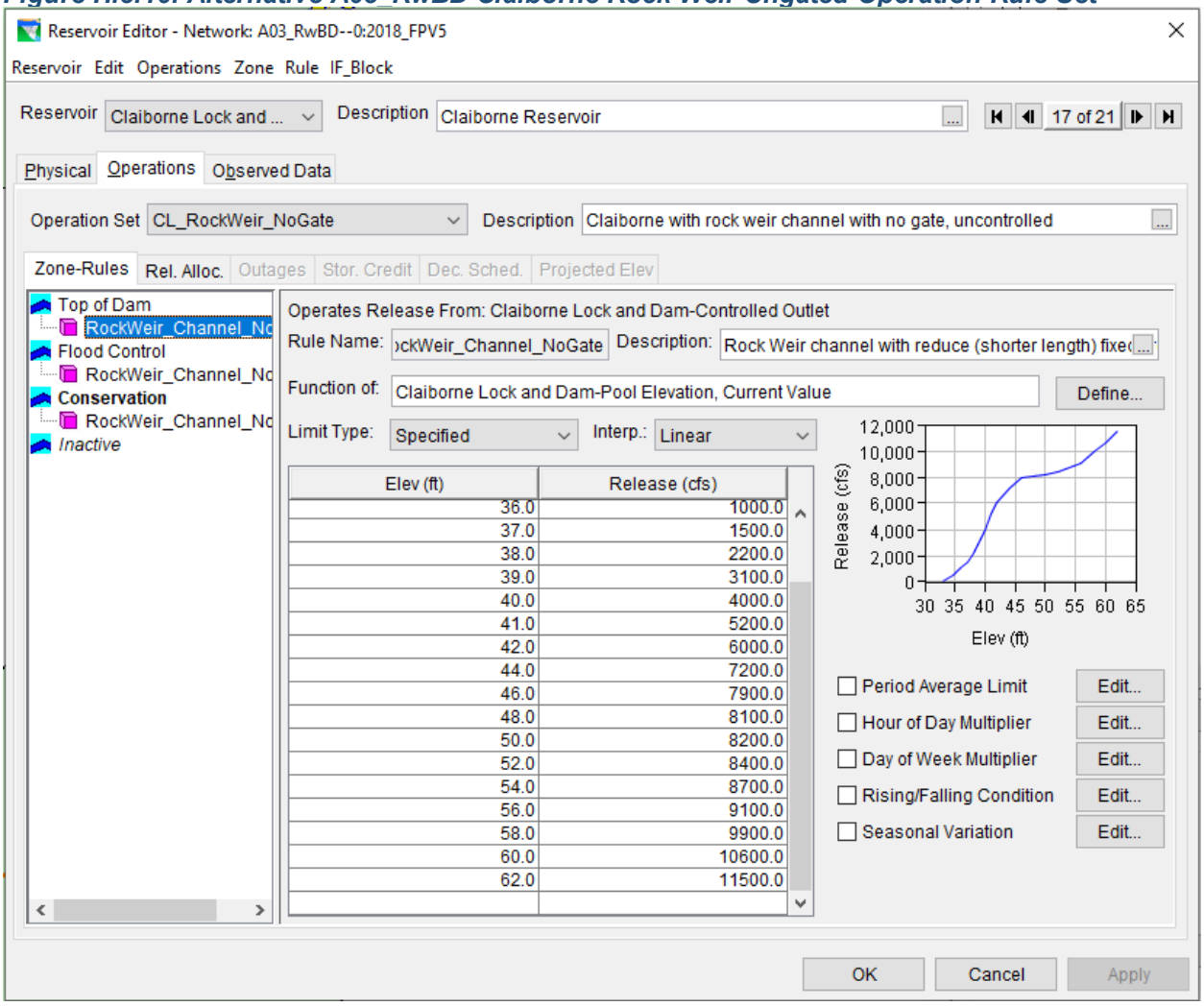
Figure H.3.15: Alternative A03_RwBD Millers Ferry Rock Weir Gated Operation Rule Set



H.3.5.1.3.2. Ungated Operations at Claiborne

To simulate the ungated operation rule set at Millers Ferry, a new rule name "CL_RockWeir_NoGate" was created to reflect the ungated operations of the fish passage structure. The "CL_RockWeir_NoGate" rule is a function of the current value of the Claiborne's pool elevation. To simulate the uncontrolled gate operations, a rating curve with pool elevations within the range of 33.1 ft. and 62.0 ft. and the corresponding releases are implemented into the rule with a linear interpolation. Figure H.3.16 shows the ungated operation rating curve of the rock weir structure at Claiborne.

Figure H.3.16: Alternative A03_RwBD Claiborne Rock Weir Ungated Operation Rule Set



H.3.5.2. Natural Bypass Channel Addition at Millers Ferry and Claiborne

The rock weir fish passage additions at Millers Ferry Lock and Dam and Claiborne Lock and Dam was simulated in alternative "A05_BcBD" in simulation "Fish Passage Alternatives POR Updated". Alternative "A05_RwBD" stands for Alternative 5 bypass channel at both dams. "A05_RwBd" alternative's results were compared to the base condition alternative "A12_WS1MF".

H.3.5.2.1. Network Updates

A new network, "FPV2" was created to simulate the bypass channel structures at Millers Ferry Lock and Dam and Claiborne Lock and Dam. Controlled outlets were added at Millers Ferry and Claiborne within this new network to simulate the bypass channel structures. The controlled outlet at Millers Ferry Lock and Dam represents the bypass channel gated fish passage structure. The controlled outlet is connected from the Millers Ferry reservoir to the tailwater gage downstream of Millers Ferry in the modeling software. Figure H.3.17 shows the updated 2018 network with the addition of the controlled outlet in the ResSim schematic at Millers Ferry. The controlled outlet was also created at Claiborne Lock and Dam to simulate an ungated bypass channel fish passage structure.

This controlled outlet is connected from Claiborne Lock and Dam Reservoir to the downstream tailwater gage. Figure H.3.18 shows the updated 2018 network with the addition of the controlled outlet at the Claiborne Lock and Dam.

Figure H.3.17: HEC-ResSim Network Module- Millers Ferry Lock and Dam with Controlled Outlet

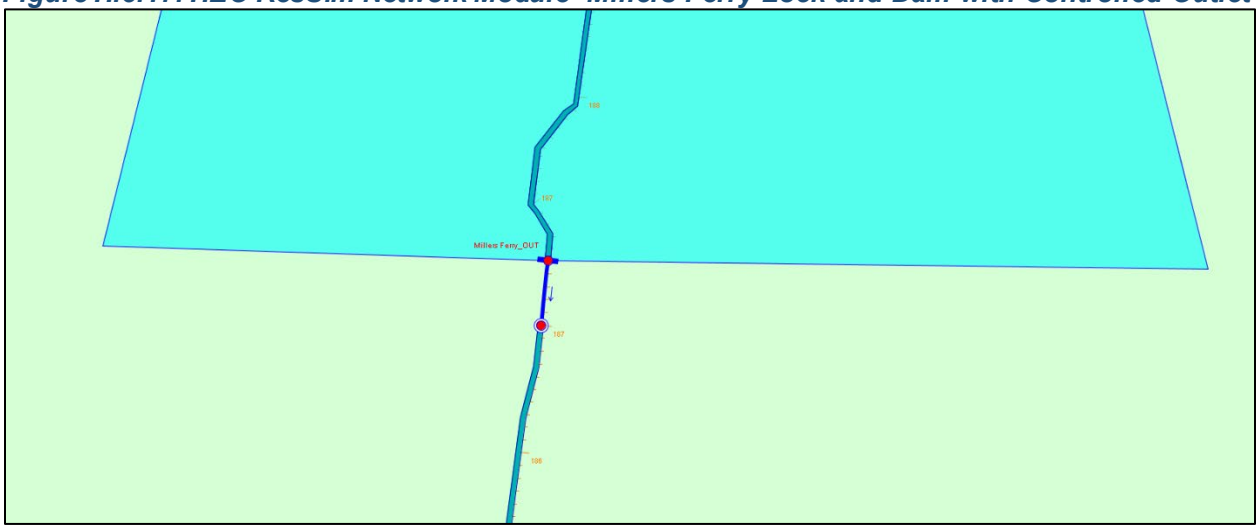
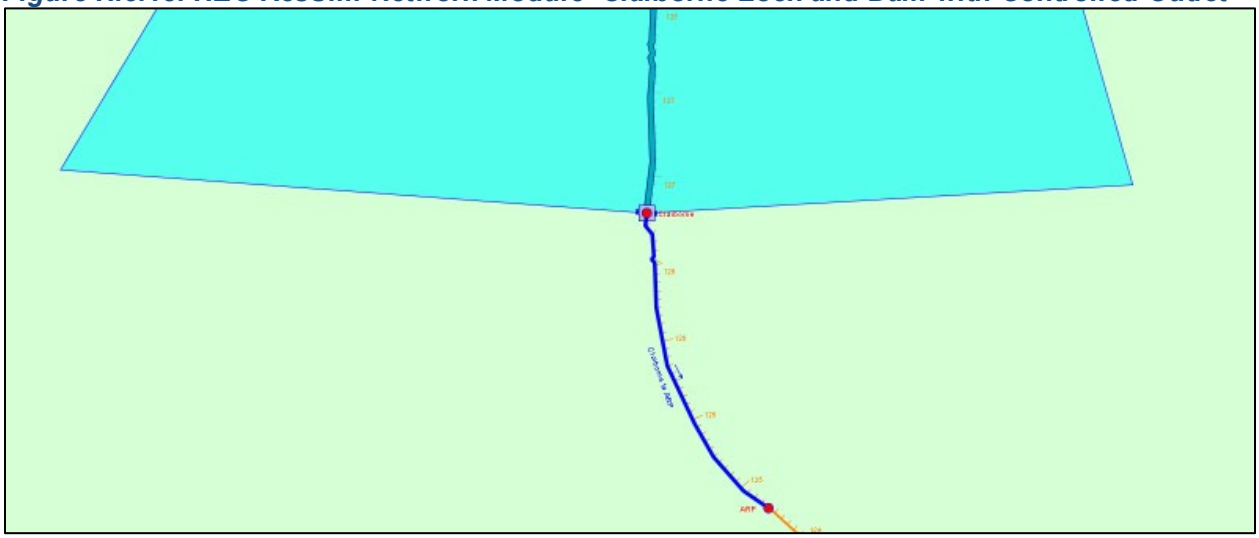


Figure H.3.18: HEC-ResSim Network Module- Claiborne Lock and Dam with Controlled Outlet



H.3.5.2.2. Physical Data

H.3.5.2.2.1. Overall Dam Length

The bypass channel variation at Millers Ferry alters the overall dam length given its designed position within the right bank emergency spillway. Currently at Millers Ferry, the overall dam length is 3360.0 ft. With the bypass channel variation, the dam length is 3110.00 ft.

H.3.5.2.2.2. Capacity of the Controlled Outlet

The physical capacity of the Millers Ferry and Claiborne controlled outlet was provided by the results of the HEC-RAS model. To create a binary switch which represents a gated versus ungated operation for different variations of the fish passage structure designs within the same simulation, the physical capacity of the controlled outlet of the rock weir fish passage was determined to be the maximum capacity of the physical structure at the lowest pool elevation where the structure ties into the reservoir and the highest spillway gate elevation. After the initial assessment of determining a gated or an ungated operation, the ungated operation sets at Millers Ferry were screened out due to the high risk and high impacts to the present authorized project purposes of hydropower and the overall structure of the dam. For Claiborne, the gated operation sets were screened out due to the fish passage's design tying into the existing spillway structure.

For Millers Ferry, the total maximum capacity is 2600 cfs at pool elevations of 75.0 ft. and 88.0 ft. Figure H.3.19 shows the physical capacity rule curve for the Millers Ferry controlled outlet. For Claiborne, the total maximum capacity is 12,000 cfs at pool elevations of 33.1 ft. and 62.0 ft. Figure H.3.20 shows the capacity rule curve for the Claiborne controlled outlet.

Figure H.3.19: Alternative A05_BcBd Millers Ferry Lock and Dam Controlled Outlet Physical Capacity

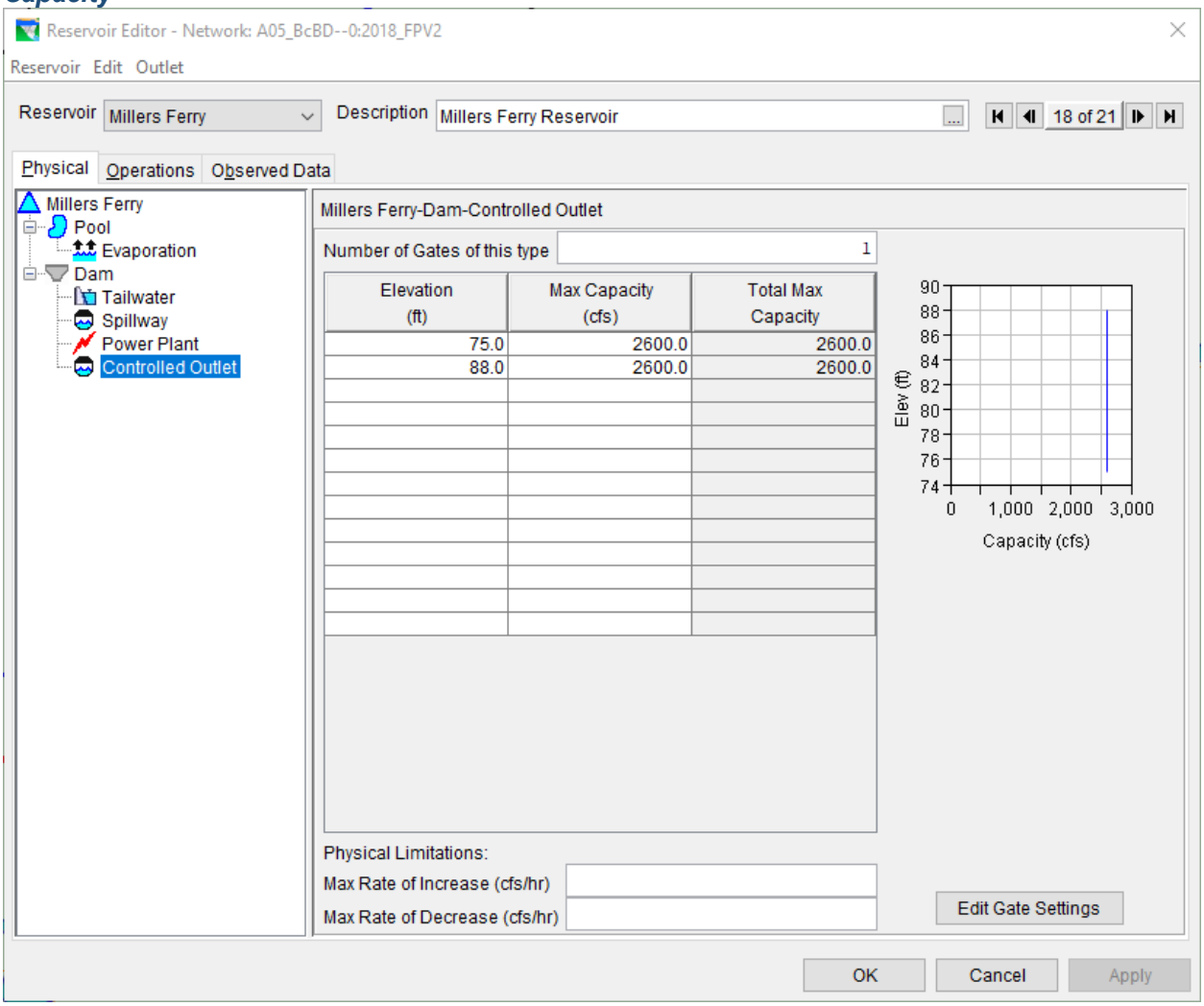
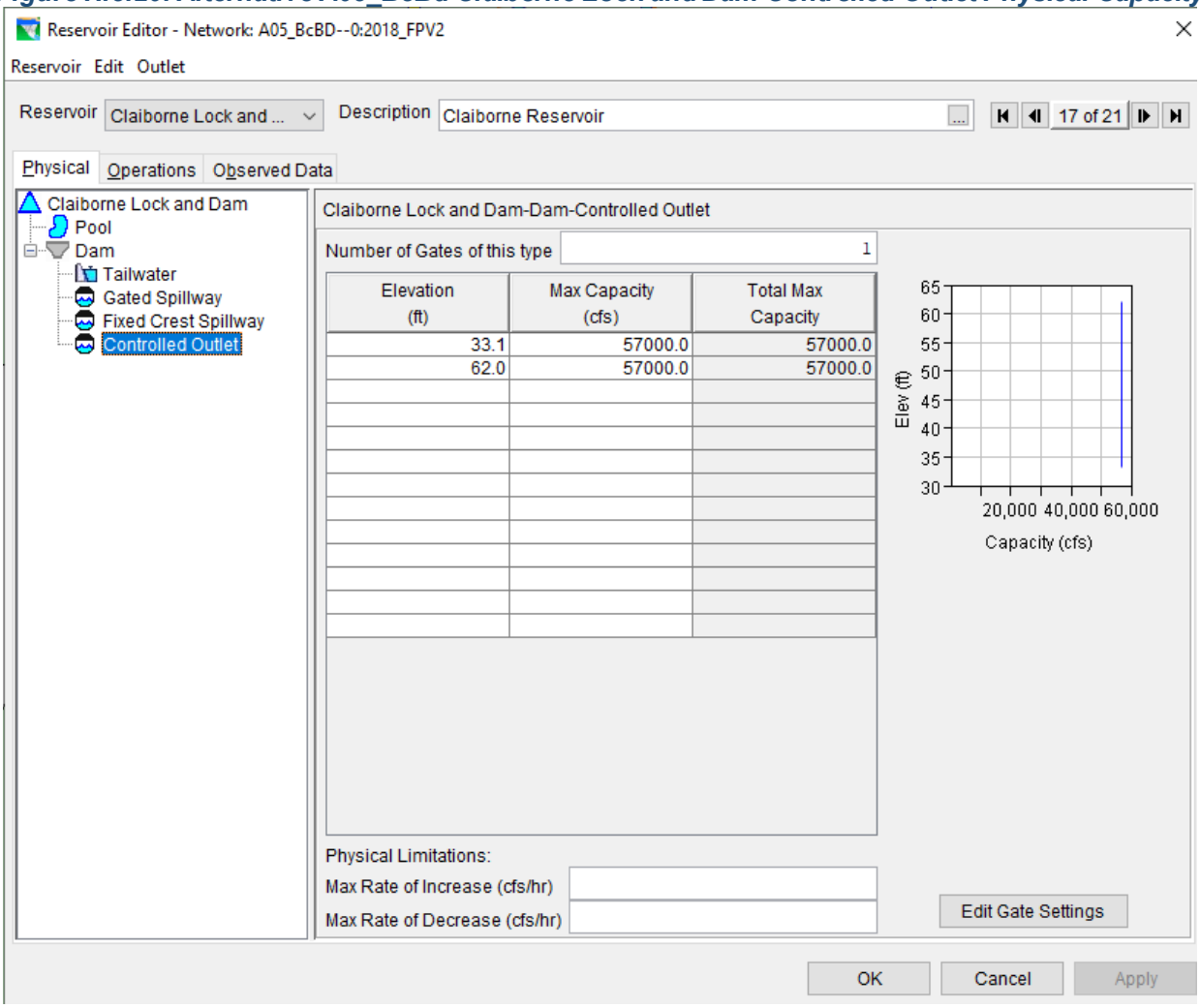


Figure H.3.20: Alternative A05_BcBd Claiborne Lock and Dam Controlled Outlet Physical Capacity



H.3.5.2.2.3. Capacity Rating Curve

There were no changes to the spillway rating curve at Millers Ferry Lock and Dam. Adjustments were made to the fixed crest spillway rating curve at Claiborne Lock and Dam to encompass the ungated fish passage structure within the spillway. The updated fixed crest spillway rating curve to incorporate the fish passage structure is show in Figure H.3.22.

Figure H.3.21: Alternative A05_BcBd Claiborne Lock and Dam Gated Spillway Rating Curve

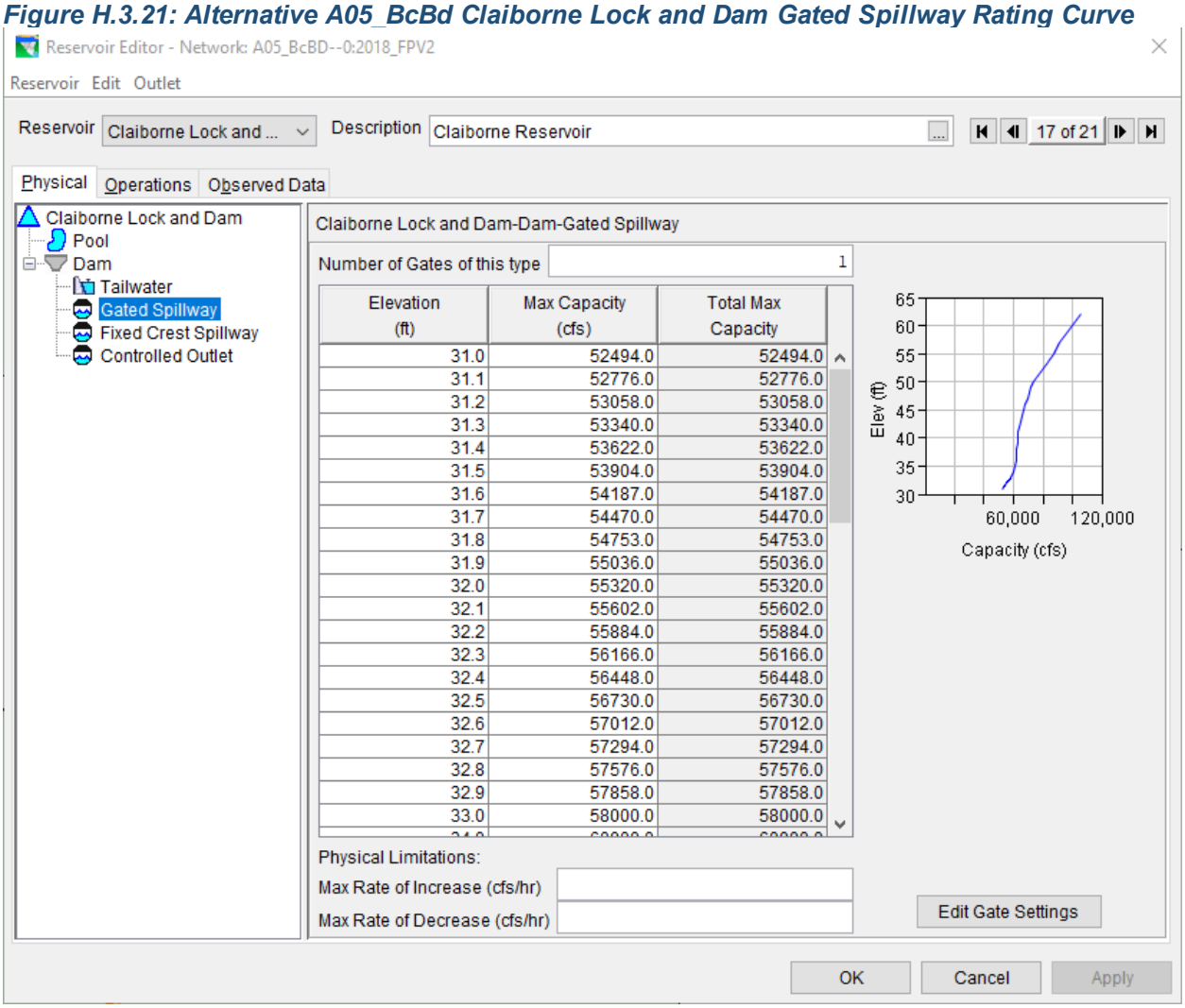


Figure H.3.22: Alternative A05_BcBd Claiborne Lock and Dam Fixed Crest Spillway Rating Curve

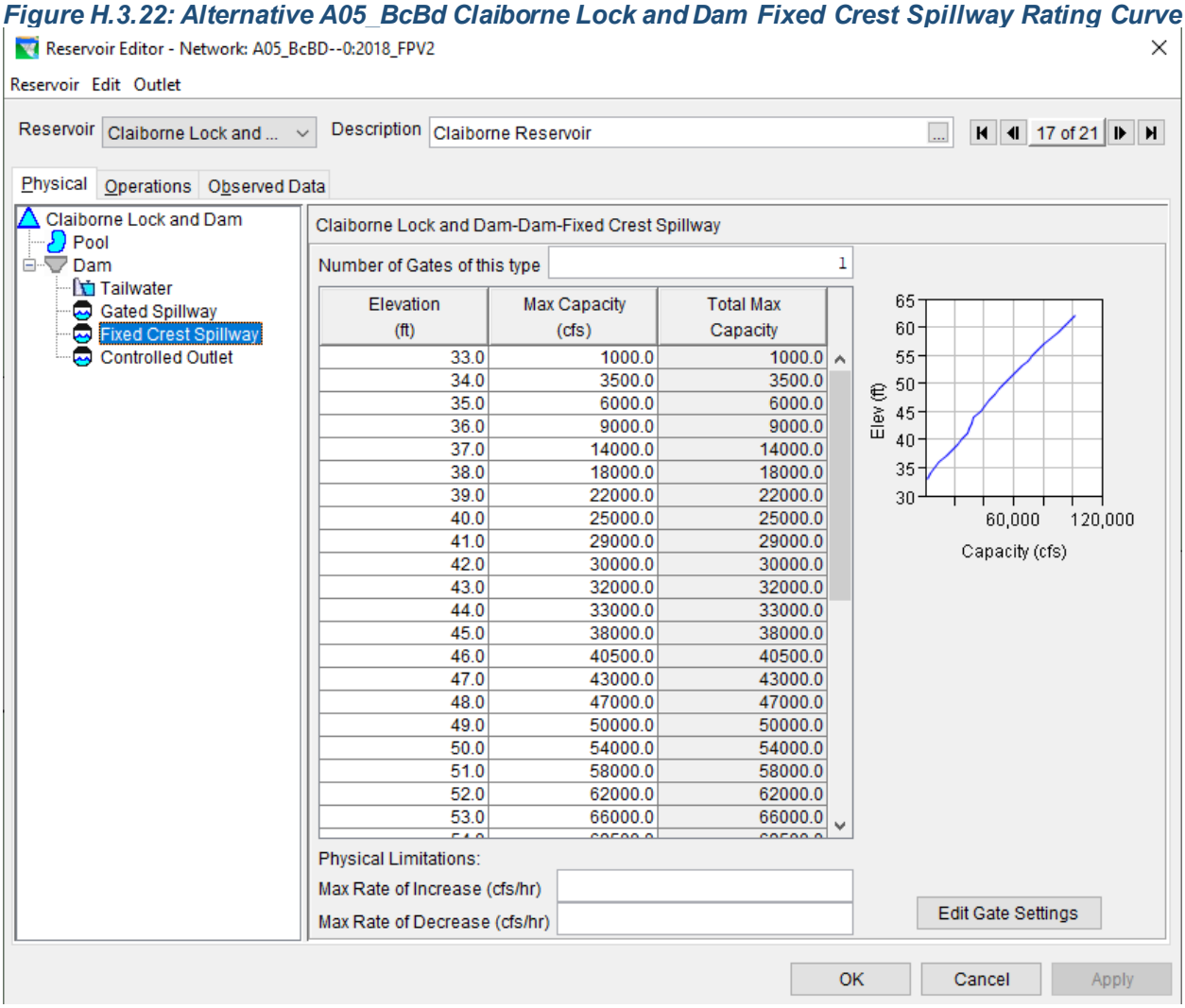


Figure H.3.23: Base Condition A12_WS1MF Fixed Crest Spillway Rating Curve

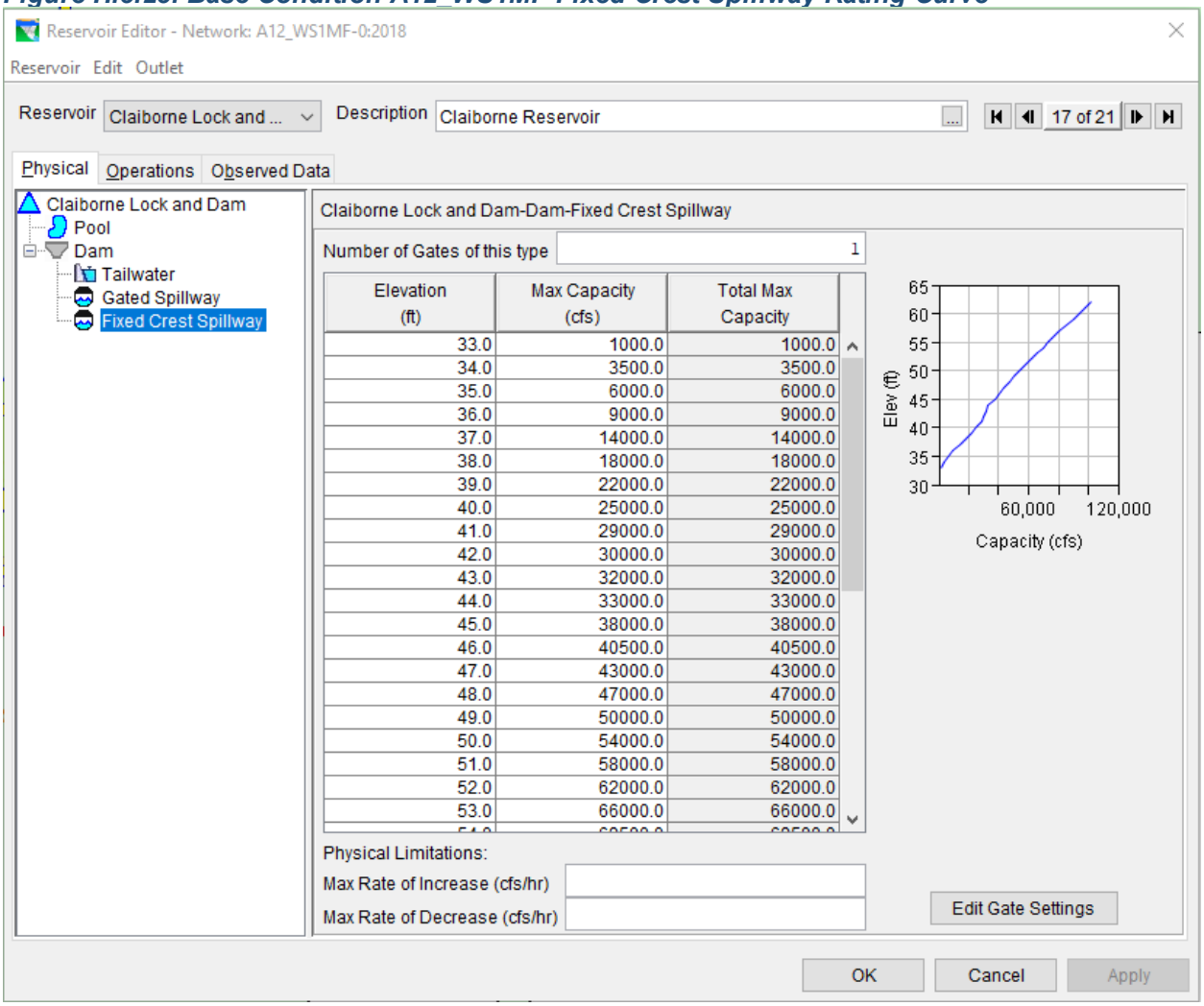
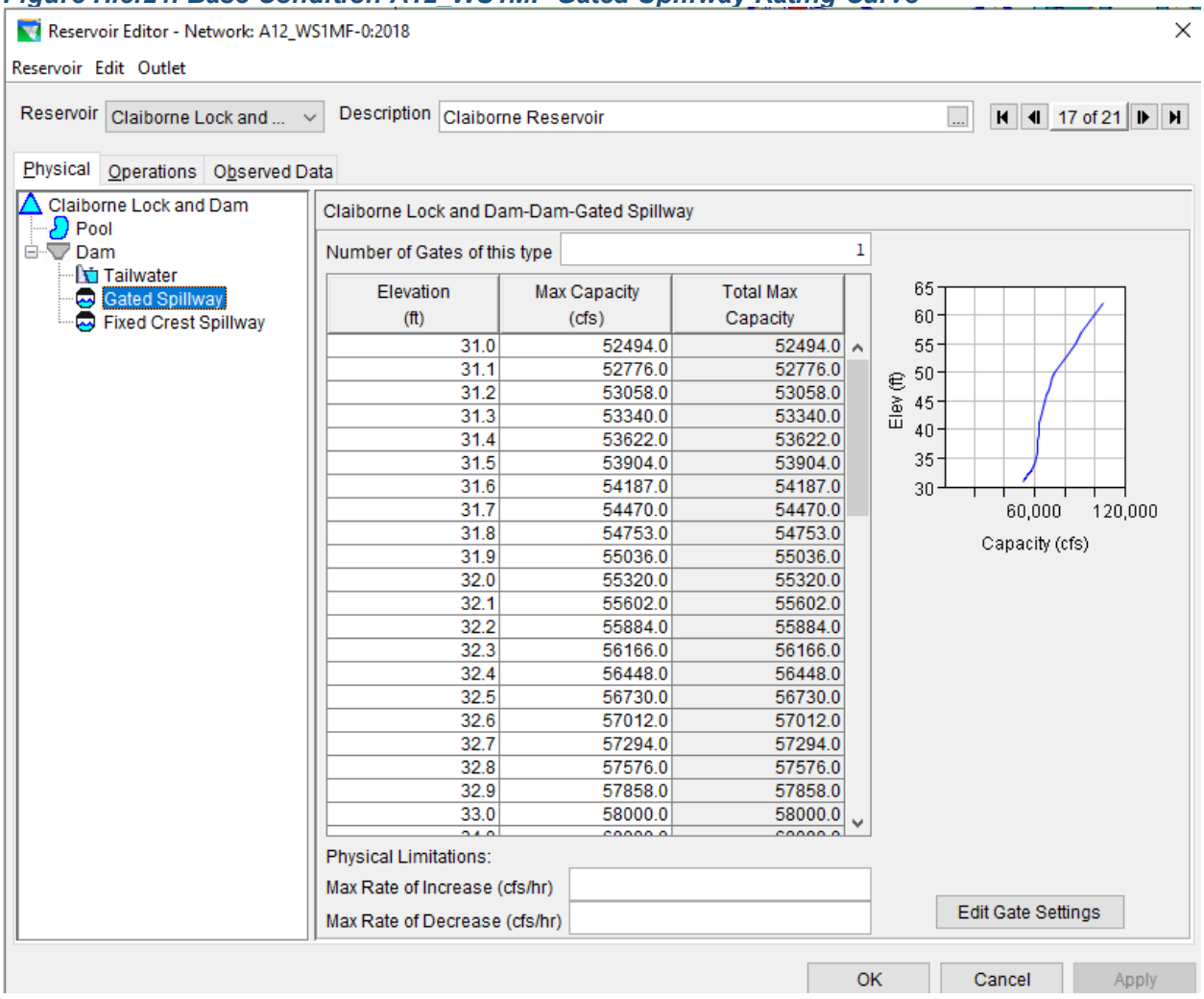


Figure H.3.24: Base Condition A12_WS1MF Gated Spillway Rating Curve



H.3.5.2.3. Reservoir Operations

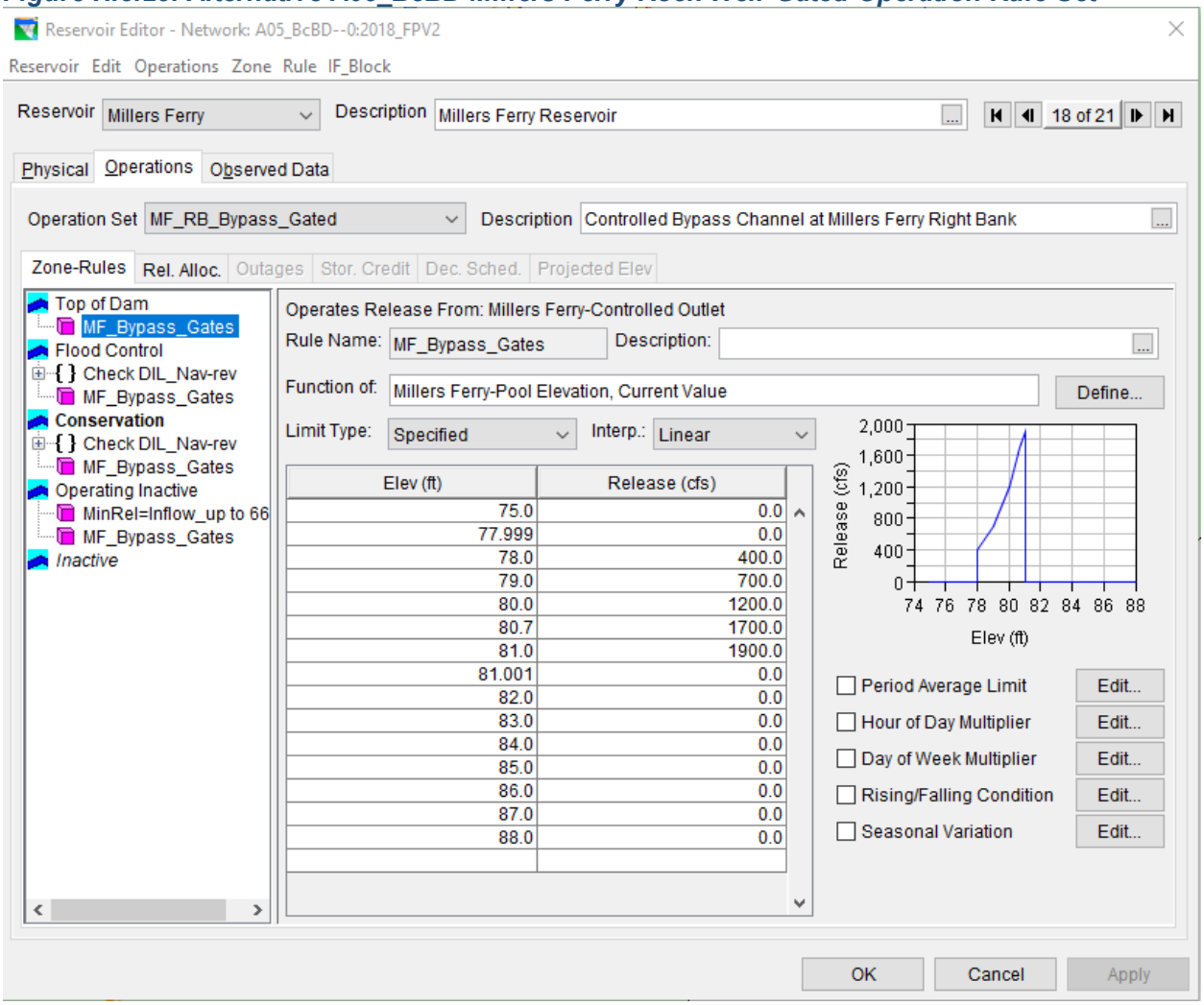
Two new operation sets were created to simulate flow through the controlled outlet. Figure H.3.25 shows the gated operation set with the gated rule at Millers Ferry with the right bank variation of the bypass channel named "MF_RB_Bypass_Gated". Figure H.3.26 represents the ungated operation set with the gated rule at Claiborne with the right bank variation of the bypass channel named "CL_RB_Bypass_NoGate". The rating curves were provided by HEC-RAS modeling for the physical rock weir variations at each of the individual project.

H.3.5.2.3.1. Gated Operations at Millers Ferry

Within the gated operations at Millers Ferry, a new rule named "MF_RB_Bypass_Gated" was created to reflect the gated operations of the fish passage structure. The "MF_RB_Bypass_Gated" rule is a function of the current value of the Millers Ferry pool elevation. To simulate the gate closing during high flow events, at pool elevation 81.001, the flow is set to 0 cfs. To simulate the gate closing during a low flow period, at pool elevation 77.999 ft., the flow is also set to 0 cfs. This rule assists Water Management to control the fish passage structure during emergency time periods of either low flows or

high flows. Figure H.3.25 shows the operation rule of the corresponding releases (cfs) with the pool elevation (ft).

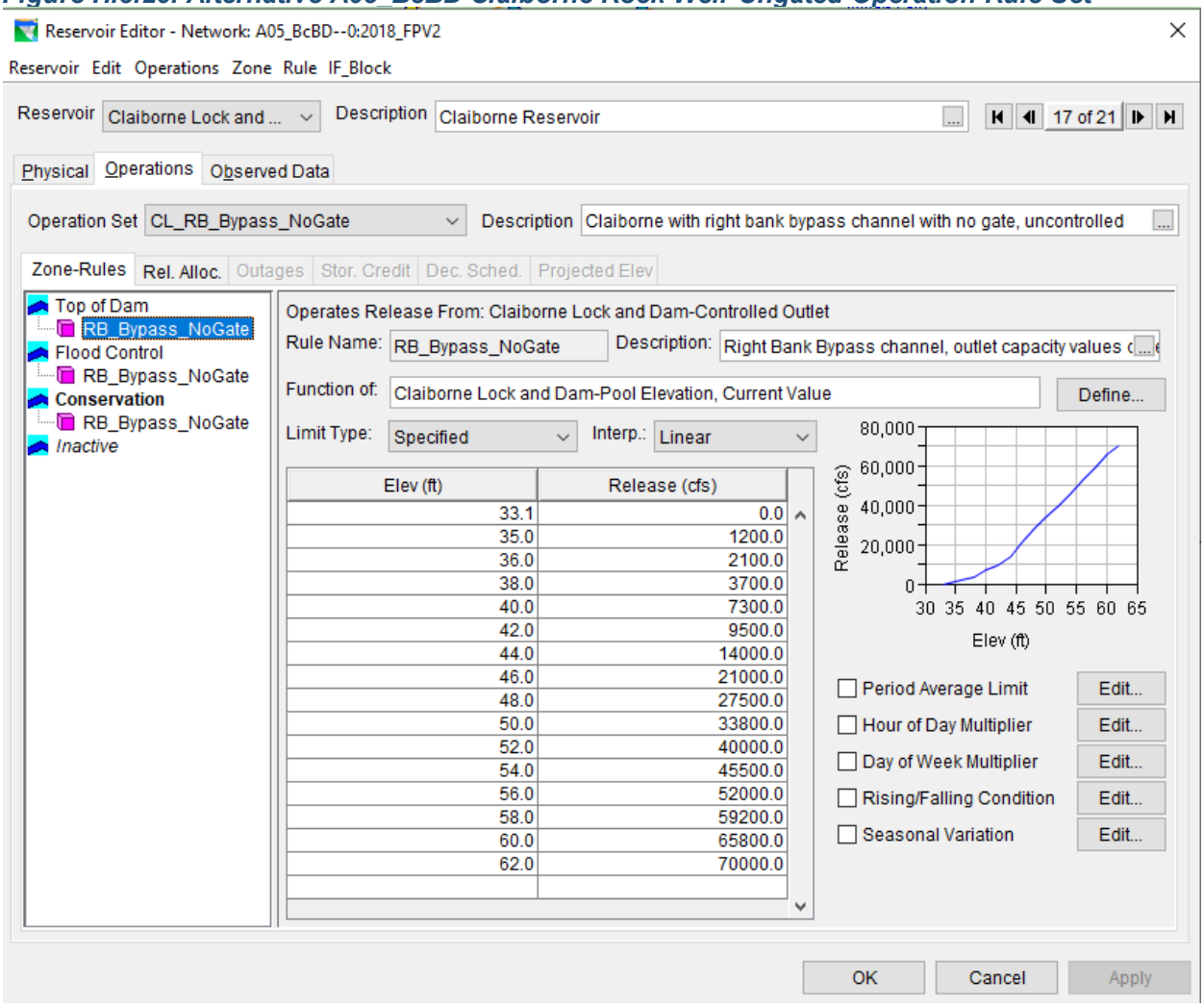
Figure H.3.25: Alternative A05_BcBD Millers Ferry Rock Weir Gated Operation Rule Set



H.3.5.2.3.2. Ungated Operations at Claiborne

To simulate the ungated operation rule set at Millers Ferry, a new rule name "CL_RB_Bypass_NoGate" was created to reflect the ungated operations of the fish passage structure. The "CL_RB_Bypass_NoGate" rule is a function of the current value of the Claiborne's pool elevation. To simulate the uncontrolled gate operations, a rating curve with pool elevations within the range of 33.1 ft. and 62.0 ft. and the corresponding releases are implemented into the rule with a linear interpolation. Figure H.3.26 shows the ungated operation rating curve of the rock weir structure at Claiborne.

Figure H.3.26: Alternative A05_BcBD Claiborne Rock Weir Ungated Operation Rule Set



H.3.5.3. Rock Weir Fish Passage Addition at Claiborne; Natural Bypass Channel Addition at Millers Ferry

The rock weir fish passage additions at Millers Ferry Lock and Dam and Claiborne Lock and Dam was simulated in alternative "A12_rCLbMF" in simulation "Fish Passage Alternatives POR Updated". Alternative "A12_rCLbMF" stands for Alternative 3 rock weirs at both dams. "A12_rCLbMF" alternative's results were compared to the base condition alternative "A12_WS1MF".

H.3.5.3.1. Network Updates

A new network, "FPV3" was created to simulate the bypass channel structures at Millers Ferry Lock and Dam and Claiborne Lock and Dam. To reflect the alternate fish passage measures at both Millers Ferry Lock and Dam and Claiborne Lock and Dam, controlled outlets were added at both Millers Ferry and Claiborne Lock and Dam. The natural bypass channel measure at Millers Ferry is reflected via the added controlled outlet in the HEC-ResSim simulation. The rock weir fish passage measure was added as a controlled outlet at Claiborne. The controlled outlet is connected from the Millers Ferry reservoir to the

tailwater gage downstream of Millers Ferry in the modeling software. A controlled outlet is connected from Claiborne Lock and Dam Reservoir to the downstream tailwater gage.

H.3.5.3.2. Physical Data

H.3.5.3.2.1. Overall Dam Length

The bypass channel variation at Millers Ferry alters the overall dam length given its designed position within the right bank emergency spillway. Currently at Millers Ferry, the overall dam length is 3360.0 ft. With the bypass channel variation, the dam length is 3110.00 ft. There is no change in the dam length at Claiborne.

H.3.5.3.2.2. Capacity of the Controlled Outlet

The physical capacity of the Millers Ferry and Claiborne controlled outlet was provided by the results of the HEC-RAS model. To create a binary switch which represents a gated versus ungated operation for different variations of the fish passage structure designs within the same simulation, the physical capacity of the controlled outlet of the rock weir fish passage was determined to be the maximum capacity of the physical structure at the lowest pool elevation where the structure ties into the reservoir and the highest spillway gate elevation. After the initial assessment of determining a gated or an ungated operation, the ungated operation sets at Millers Ferry were screened out due to the high risk and high impacts to the present authorized project purposes of hydropower and the overall structure of the dam. For Claiborne, the gated operation sets were screened out due to the fish passage's design tying into the existing spillway structure.

For Millers Ferry, the total maximum capacity of the fish passage structure is 2600 cfs at pool elevations of 75.0 ft. and 88.0 ft. Figure H.3.27 shows the physical capacity rule curve for the Millers Ferry controlled outlet. For rock weir fish passage structure at Claiborne, the total maximum capacity is 12,000 cfs at pool elevations of 33.1 ft. and 62.0 ft. Figure H.3.28 shows the capacity rule curve for the Claiborne controlled outlet.

Figure H.3.27: Alternative A12_rCLbMF Millers Ferry Lock and Dam Controlled Outlet Physical Capacity

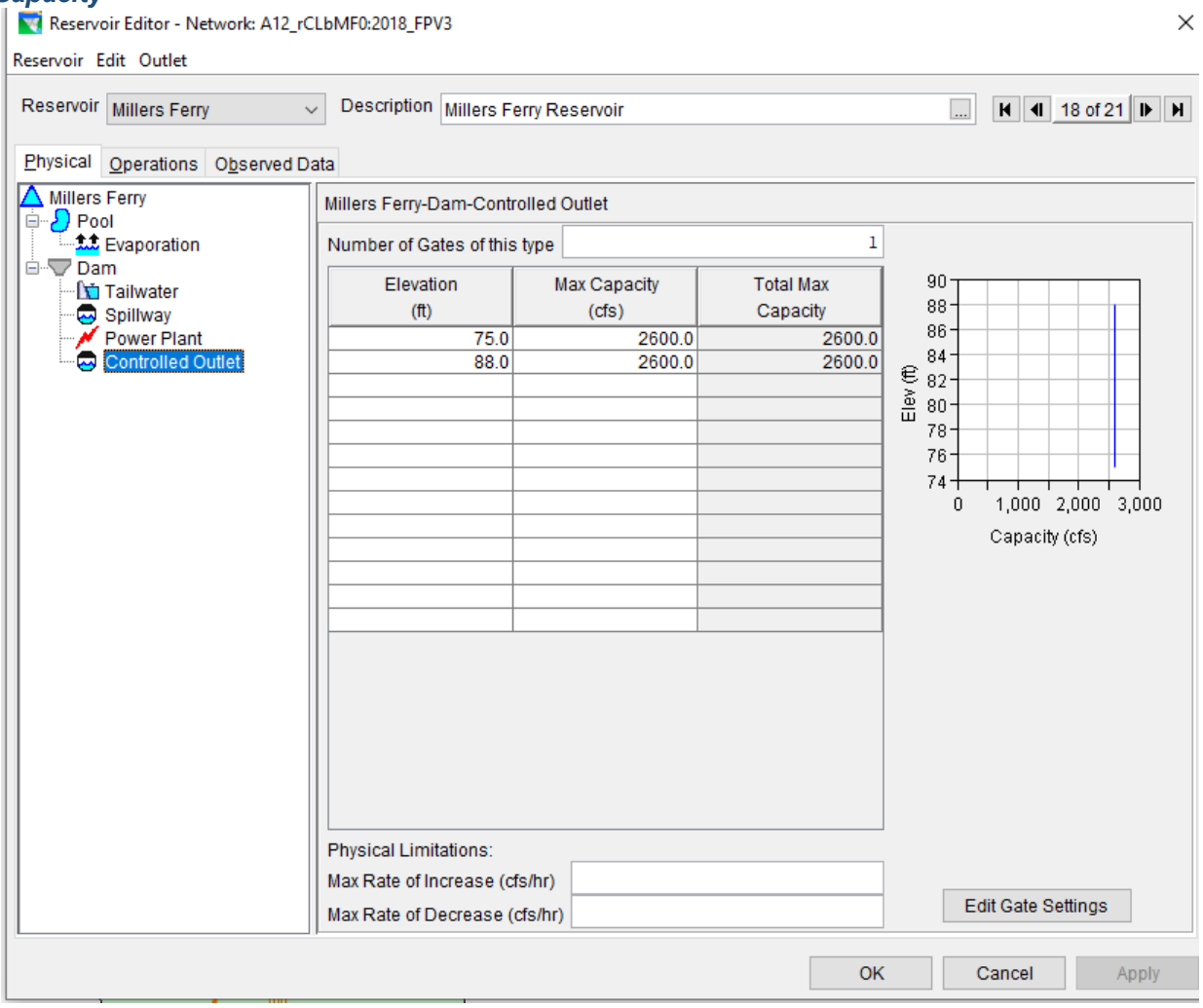
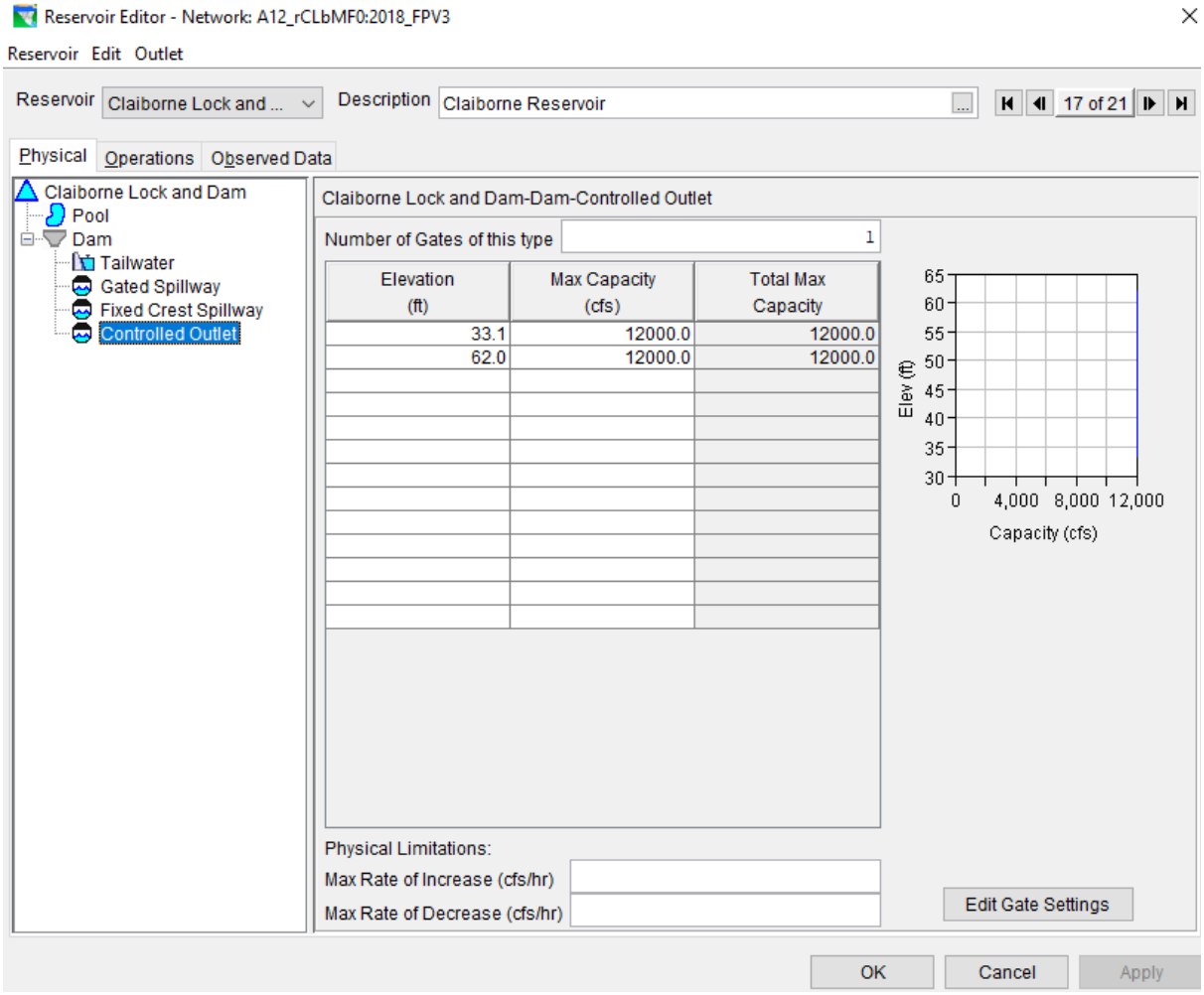


Figure H.3.28: Alternative A12_rCLbMF Claiborne Lock and Dam Controlled Outlet Physical Capacity



H.3.5.3.2.3. Capacity Rating Curve

There were no changes to the spillway rating curve at Millers Ferry Lock and Dam. Adjustments were made to the fixed crest spillway rating curve at Claiborne Lock and Dam to encompass the ungated fish passage structure within the spillway. The updated fixed crest spillway rating curve to incorporate the fish passage structure is show in Figure H.3.30 .

Figure H.3.29: Alternative A12_rCLbMF Claiborne Lock and Dam Gated Spillway Rating Curve

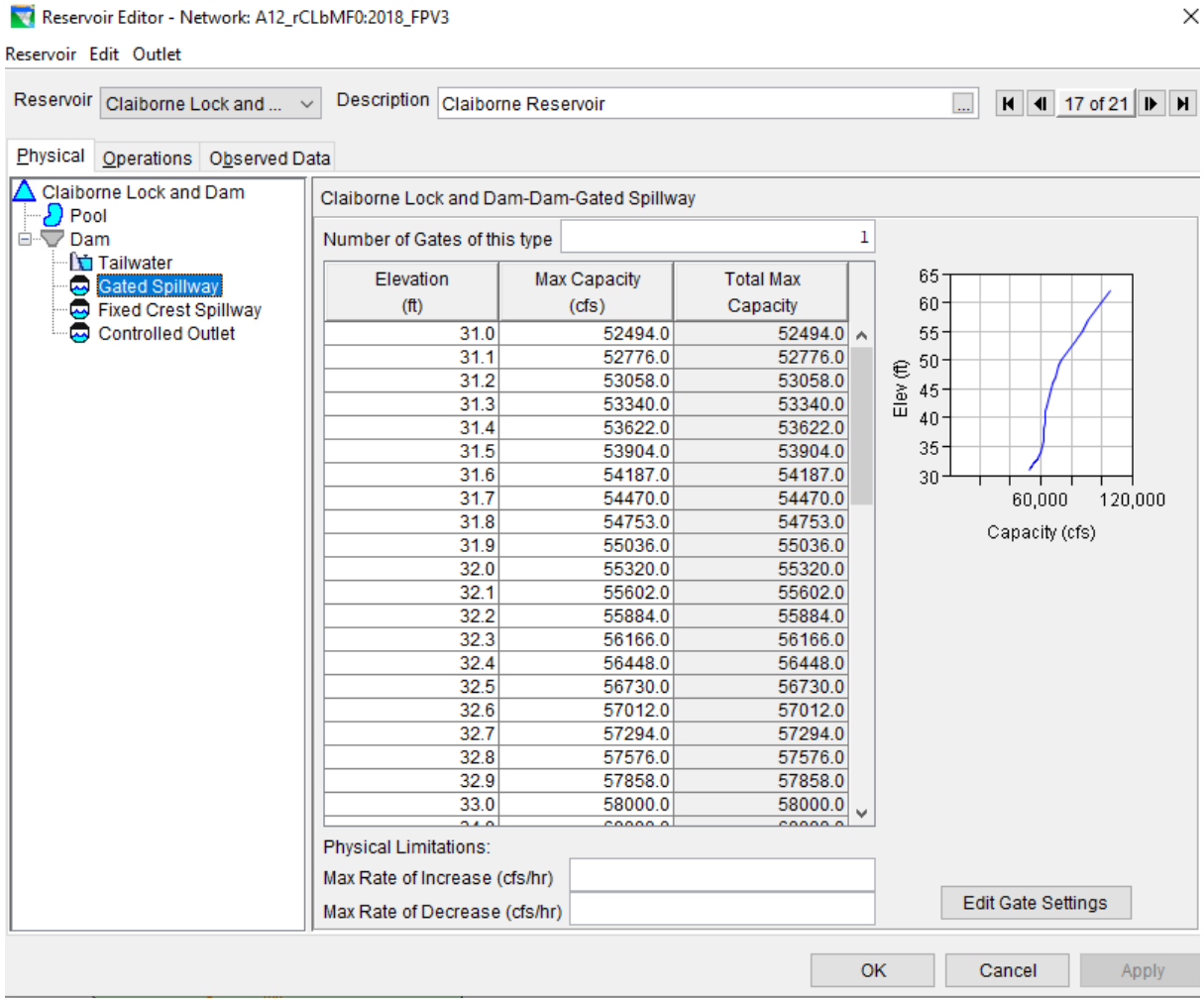


Figure H.3.30: Alternative A12_rCLbMF Claiborne Lock and Dam Fixed Crest Spillway Rating Curve

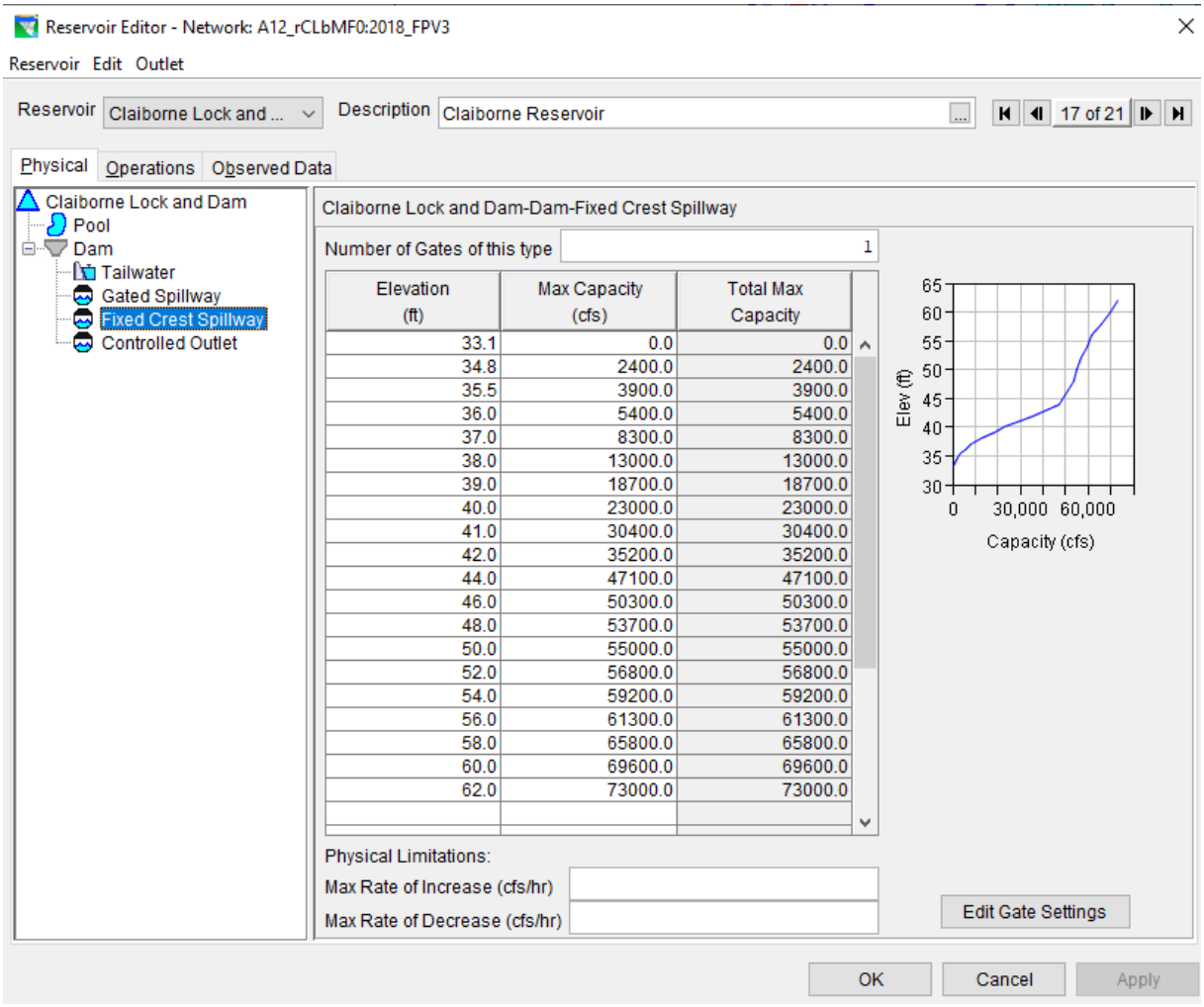


Figure H.3.31: Base Condition A12_WS1MF Fixed Crest Spillway Rating Curve

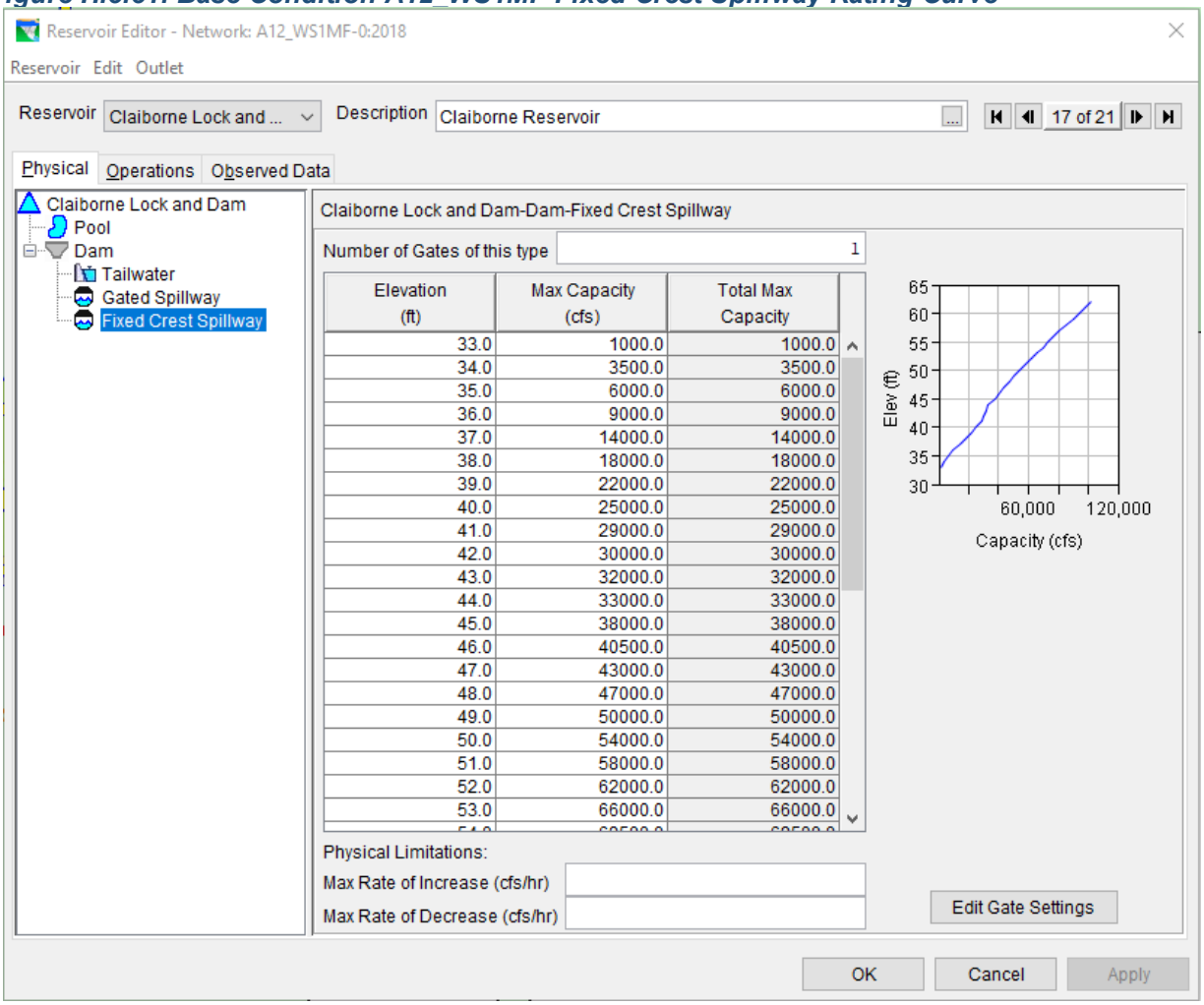
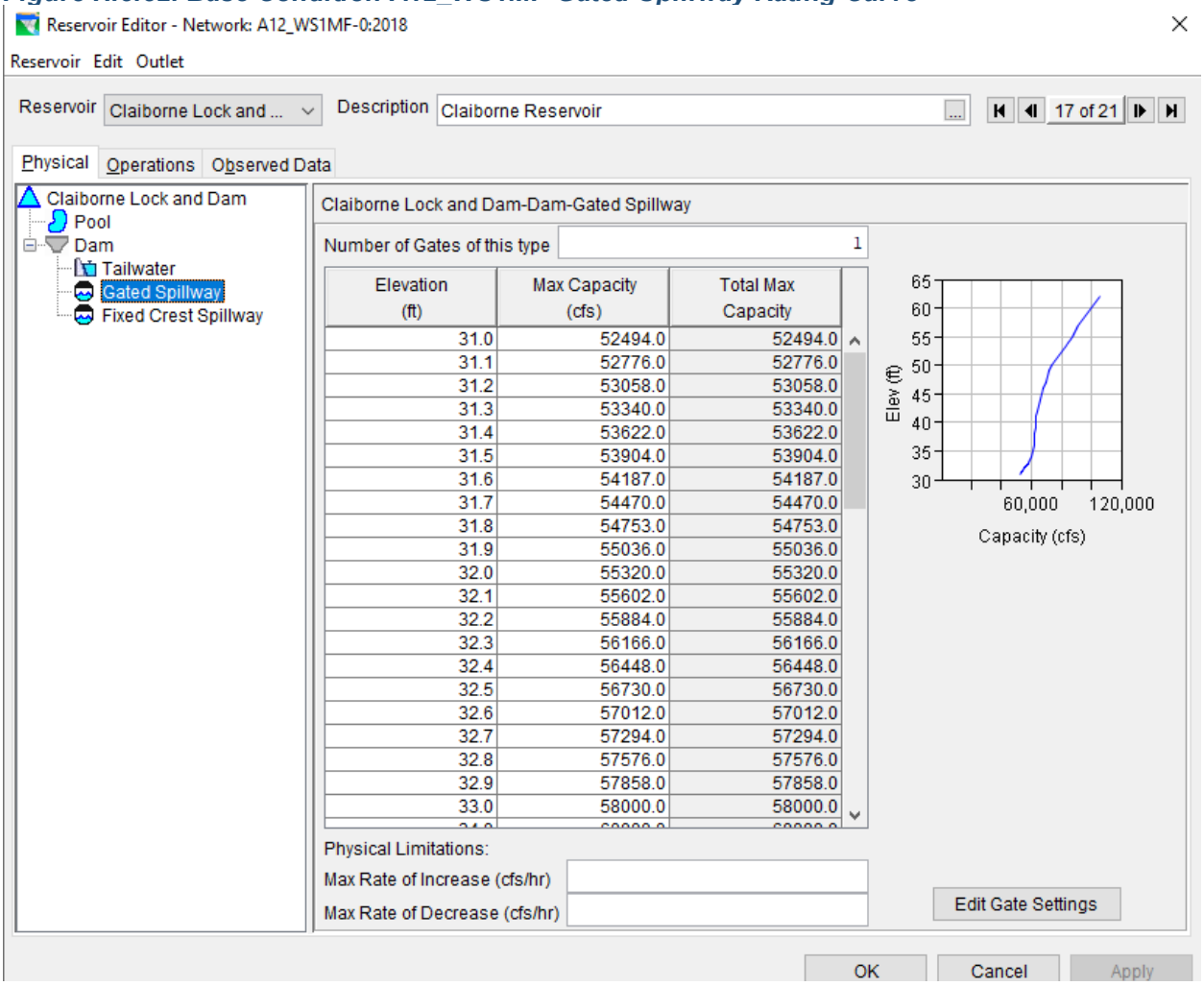


Figure H.3.32: Base Condition A12_WS1MF Gated Spillway Rating Curve



H.3.5.3.3. Reservoir Operations

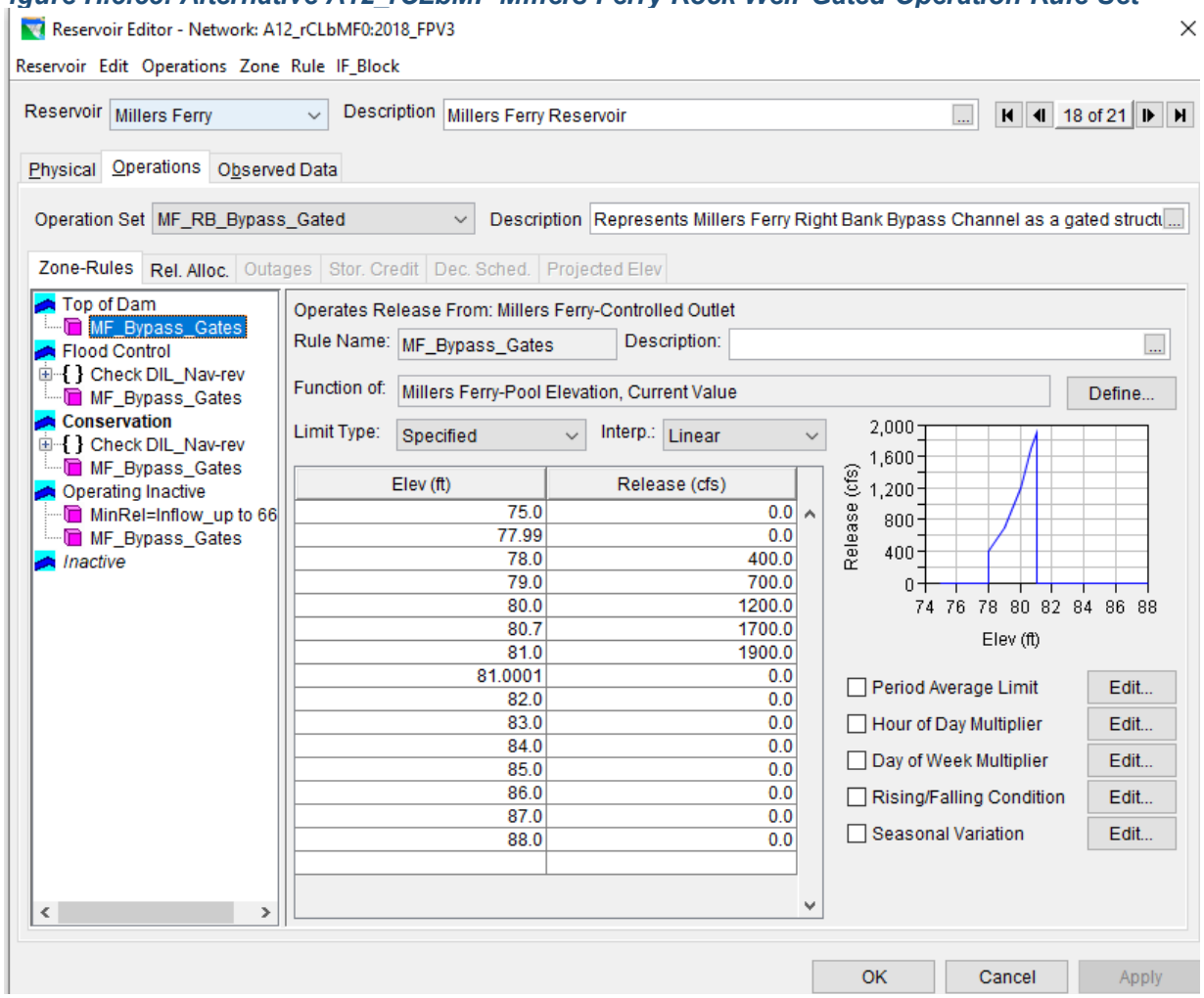
The operation sets that were previously created were used to simulate the reservoir operations. The operation set that was used to simulate the bypass channel fish passage structure was " MR_RB_Bypass_Gated". Figure H.3.33 shows the gated operation set with the gated rule at Millers Ferry with the right bank variation of the bypass channel named "MF_RB_Bypass_Gated". Figure H.3.34 represents the ungated operation set with the gated rule at Claiborne with the right bank variation of the bypass channel named "CL_RockWeir _NoGate". The rating curves were provided by HEC-RAS modeling for the physical rock weir variations at each of the individual project.

H.3.5.3.3.1. Gated Operations at Millers Ferry

Within the gated operations at Millers Ferry, a new rule named "MF_RB_Bypass_Gated" was created to reflect the gated operations of the fish passage structure. The "MF_RB_Bypass_Gated" rule is a function of the current value of the Millers Ferry pool elevation. To simulate the gate closing during high flow events, at pool elevation 81.001, the flow is set to 0 cfs. To simulate the gate closing during a low flow period, at pool elevation 77.999 ft., the flow is also set to 0 cfs. This rule assists Water Management to

control the fish passage structure during emergency time periods of either low flows or high flows. Figure H.3.33 shows the operation rule of the corresponding releases (cfs) with the pool elevation (ft).

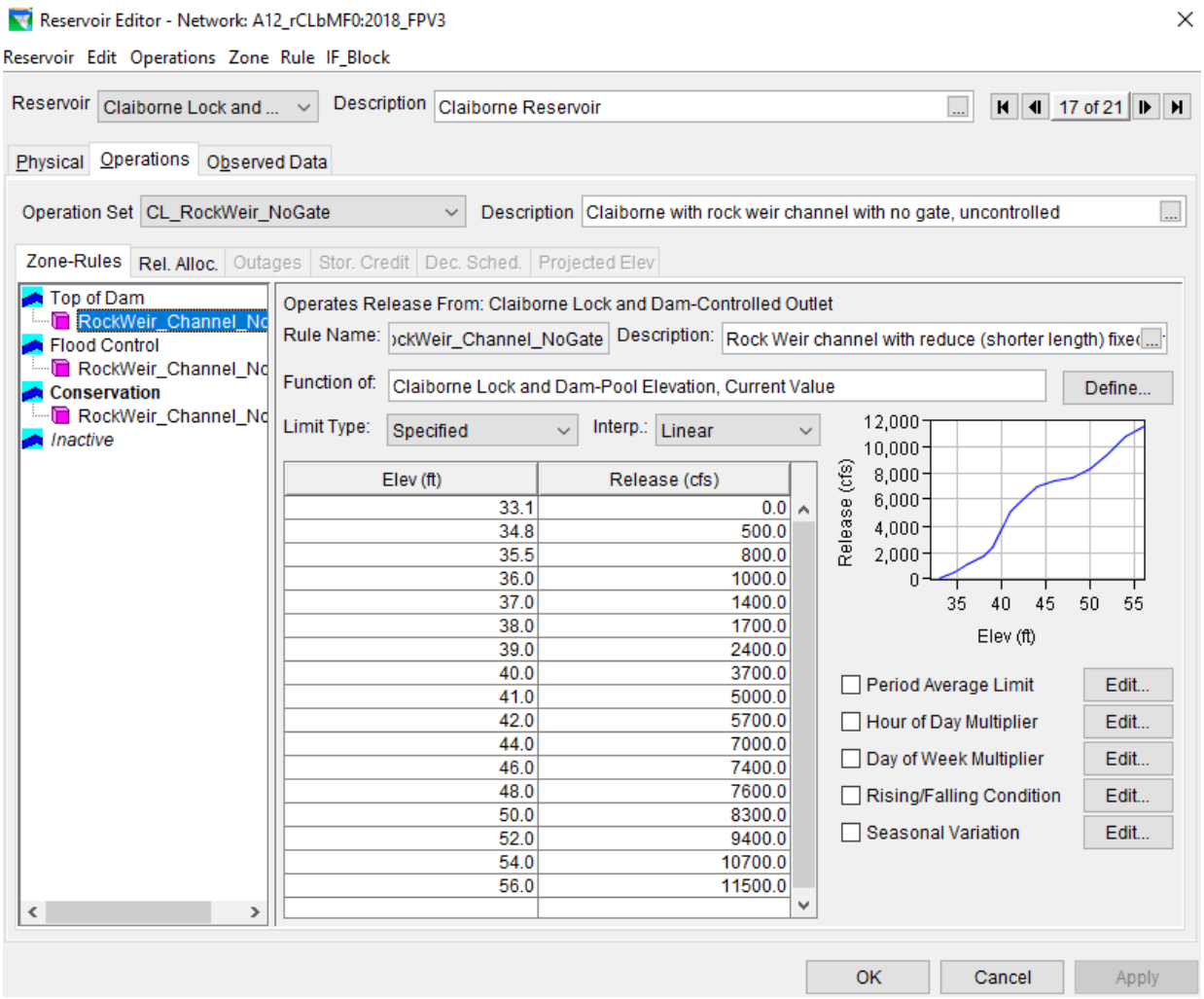
Figure H.3.33: Alternative A12_rCLbMF Millers Ferry Rock Weir Gated Operation Rule Set



H.3.5.3.3.2. Ungated Operations at Claiborne

To simulate the ungated operation rule set at Millers Ferry, a new rule name "CL_RockWeir_NoGate" was created to reflect the ungated operations of a rock weir fish passage structure. The "CL_RockWeir _NoGate" rule is a function of the current value of the Claiborne's pool elevation. To simulate the uncontrolled gate operations, a rating curve with pool elevations within the range of 33.1 ft. and 62.0 ft. and the corresponding releases are implemented into the rule with a linear interpolation. Figure H.3.34 shows the ungated operation rating curve of the rock weir structure at Claiborne.

Figure H.3.34: Alternative A12_rCLbMF Claiborne Rock Weir Ungated Operation Rule Set



H.3.5.4. Natural Bypass Channel Addition at Claiborne; Rock Weir Fish Passage Addition at Millers Ferry

The rock weir fish passage additions at Millers Ferry Lock and Dam and Claiborne Lock and Dam was simulated in alternative "A13_bCLrMF" in simulation "Fish Passage Alternatives POR Updated". Alternative "A13_bCLrMF" stands for Alternative 3 rock weirs at both dams. "A13_bCLrMF" alternative's results were compared to the base condition alternative "A12_WS1MF".

H.3.5.4.1. Network Updates

A new network, "FPV4" was created to simulate the bypass channel structures at Millers Ferry Lock and Dam and Claiborne Lock and Dam. To reflect the alternate fish passage measures at both Millers Ferry Lock and Dam and Claiborne Lock and Dam, controlled outlets were added at both Millers Ferry and Claiborne Lock and Dam. The rock weir measure at Millers Ferry is reflected via the added controlled outlet in the HEC-ResSim simulation. The bypass channel fish passage measure was added as a controlled outlet

at Claiborne. The controlled outlet is connected from the Millers Ferry reservoir to the tailwater gage downstream of Millers Ferry in the modeling software. A controlled outlet is connected from Claiborne Lock and Dam Reservoir to the downstream tailwater gage.

H.3.5.4.2. Physical Data

H.3.5.4.2.1. Overall Dam Length

The rock weir variation at Millers Ferry alters the overall dam length given its designed position within the right bank emergency spillway. Currently at Millers Ferry, the overall dam length is 3360.0 ft. With the rock weir variation, the dam length is 3260.00 ft. There is no change in the dam length at Claiborne.

H.3.5.4.2.2. Capacity of the Controlled Outlet

The physical capacity of the Millers Ferry and Claiborne controlled outlet was provided by the results of the HEC-RAS model. To create a binary switch which represents a gated versus ungated operation for different variations of the fish passage structure designs within the same simulation, the physical capacity of the controlled outlet of the rock weir fish passage was determined to be the maximum capacity of the physical structure at the lowest pool elevation where the structure ties into the reservoir and the highest spillway gate elevation. After the initial assessment of determining a gated or an ungated operation, the ungated operation sets at Millers Ferry were screened out due to the high risk and high impacts to the present authorized project purposes of hydropower and the overall structure of the dam. For Claiborne, the gated operation sets were screened out due to the fish passage's design tying into the existing spill way structure.

For Millers Ferry, the total maximum capacity is 5800 cfs at pool elevations of 75.0 ft. and 88.0 ft. Figure H.3.35 shows the physical capacity rule curve for the Millers Ferry controlled outlet. For Claiborne, the total maximum capacity is 12,000 cfs at pool elevations of 33.1 ft. and 62.0 ft. Figure H.3.36 shows the capacity rule curve for the Claiborne controlled outlet.

Figure H.3.35: Alternative A13_bCLrMF Millers Ferry Lock and Dam Controlled Outlet Physical Capacity

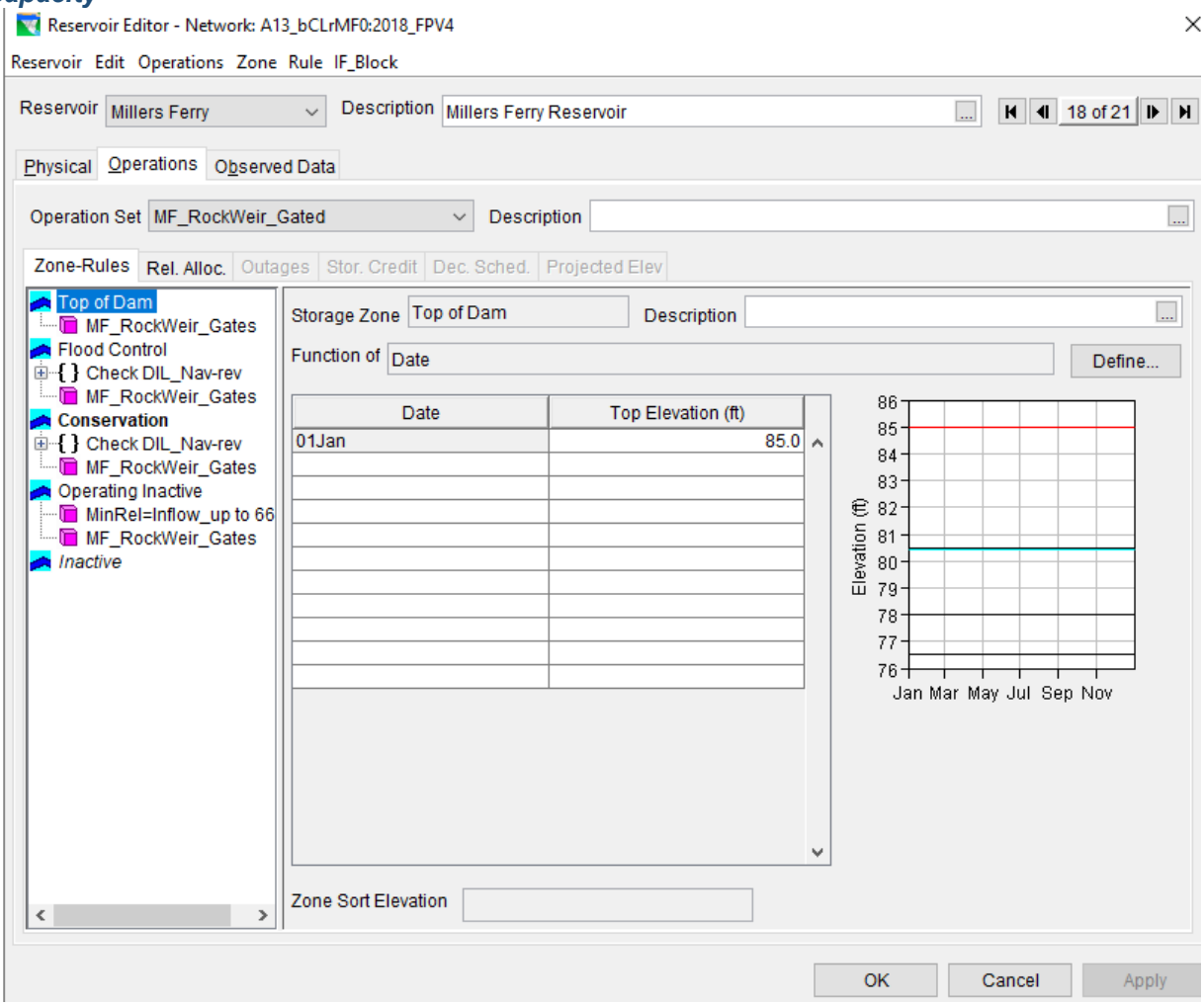
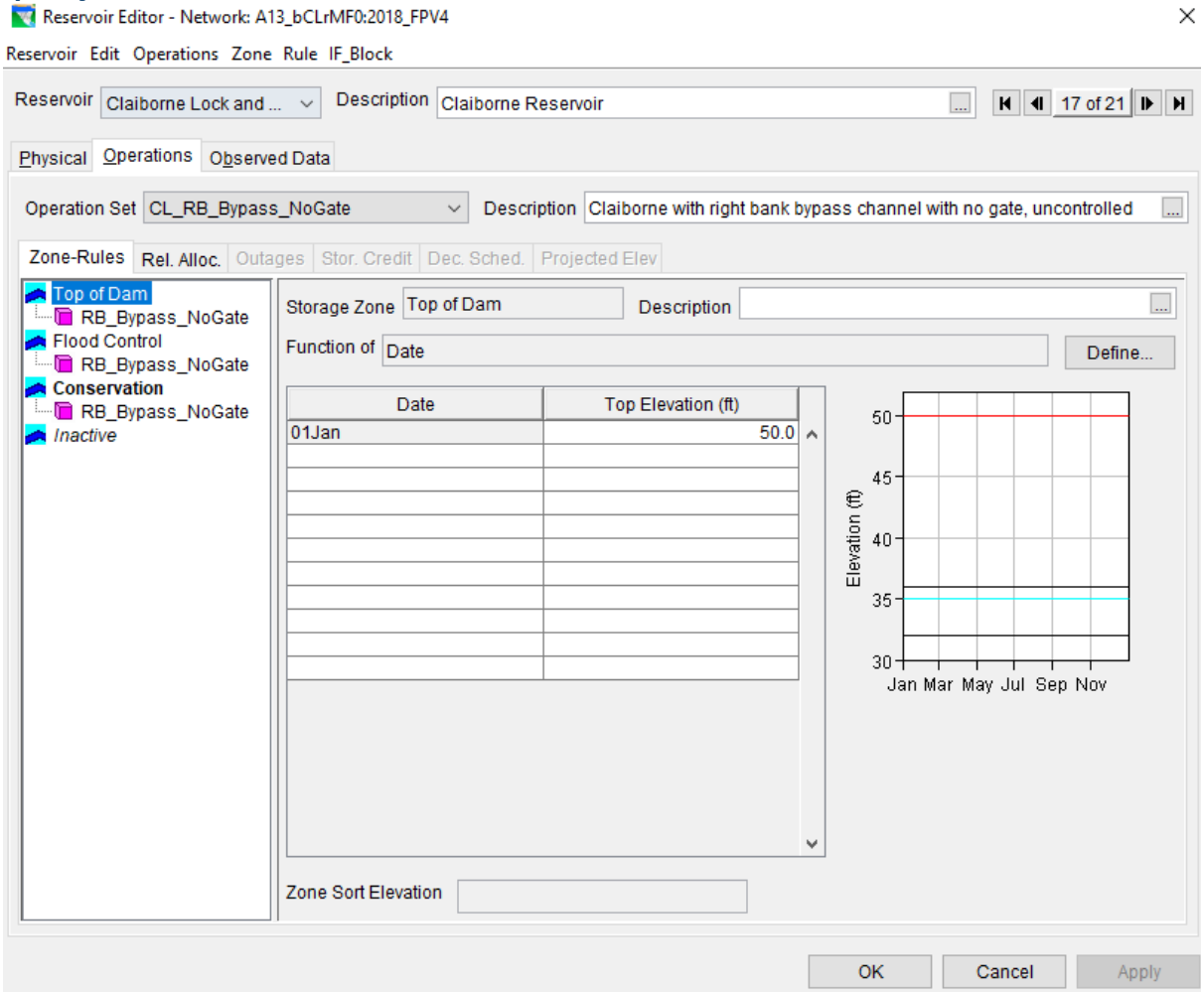


Figure H.3.36: Alternative A13_bCLrMF Claiborne Lock and Dam Controlled Outlet Physical Capacity



H.3.5.4.2.3. Capacity Rating Curve

There were no changes to the spillway rating curve at Millers Ferry Lock and Dam. Adjustments were made to the fixed crest spillway rating curve at Claiborne Lock and Dam to encompass the ungated fish passage structure within the spillway. The updated fixed crest spillway rating curve to incorporate the fish passage structure is show in Figure H.3.38.

Figure H.3.37: Alternative A13_bCLrMF Claiborne Lock and Dam Gated Spillway Rating Curve

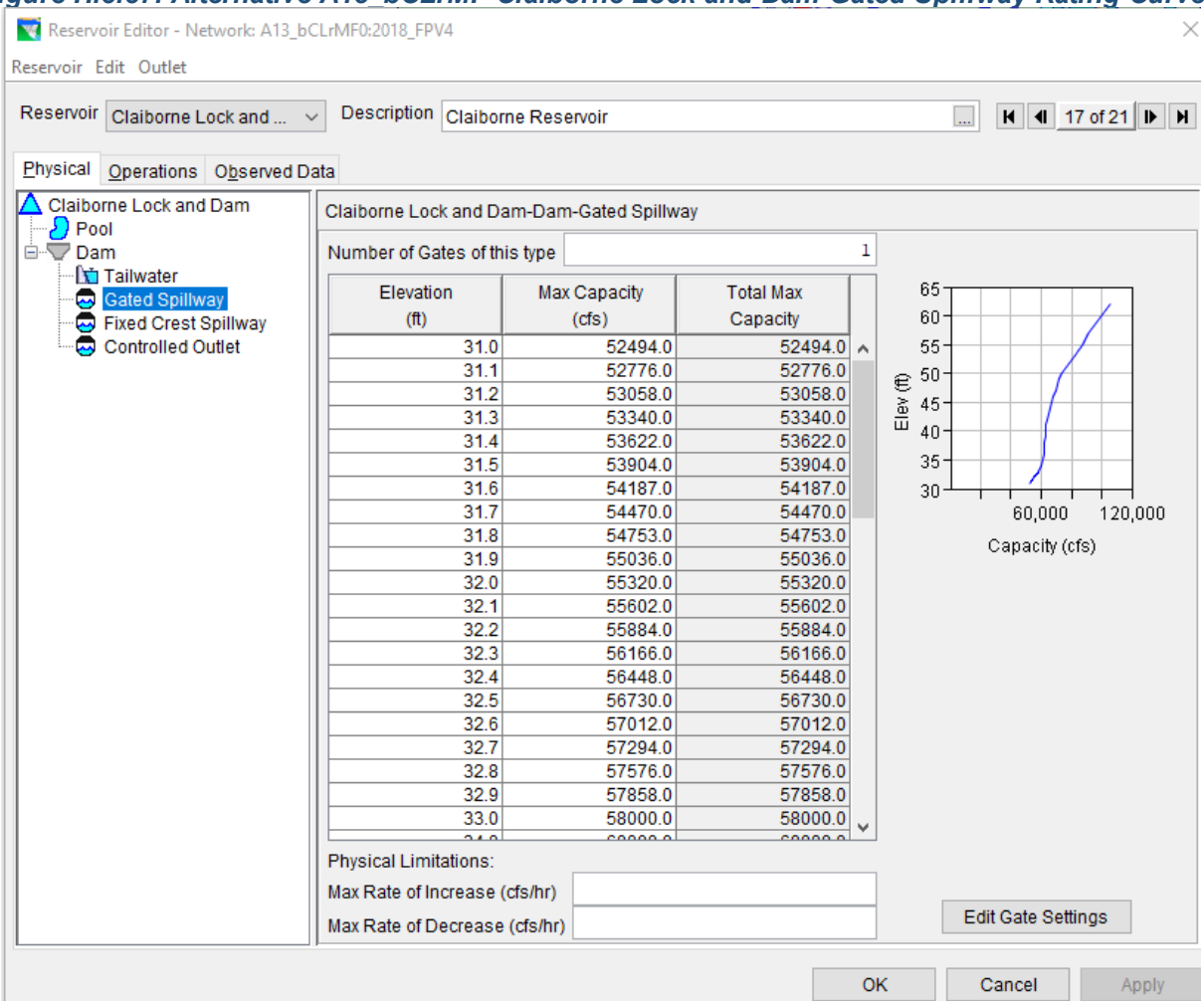


Figure H.3.38: Alternative A13_bCLrMF Claiborne Lock and Dam Fixed Crest Spillway Rating Curve

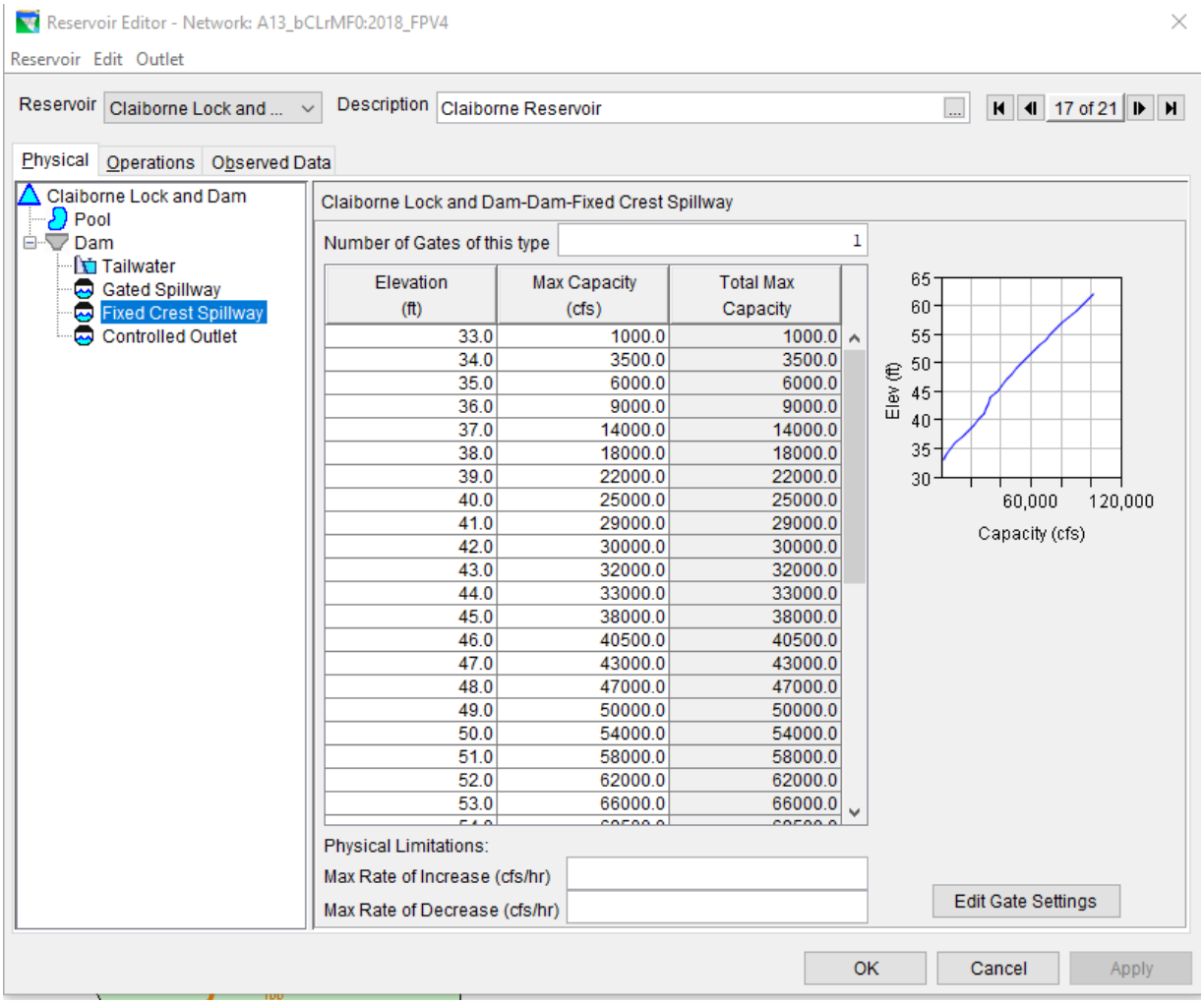


Figure H.3.39: Base Condition A12_WS1MF Fixed Crest Spillway Rating Curve

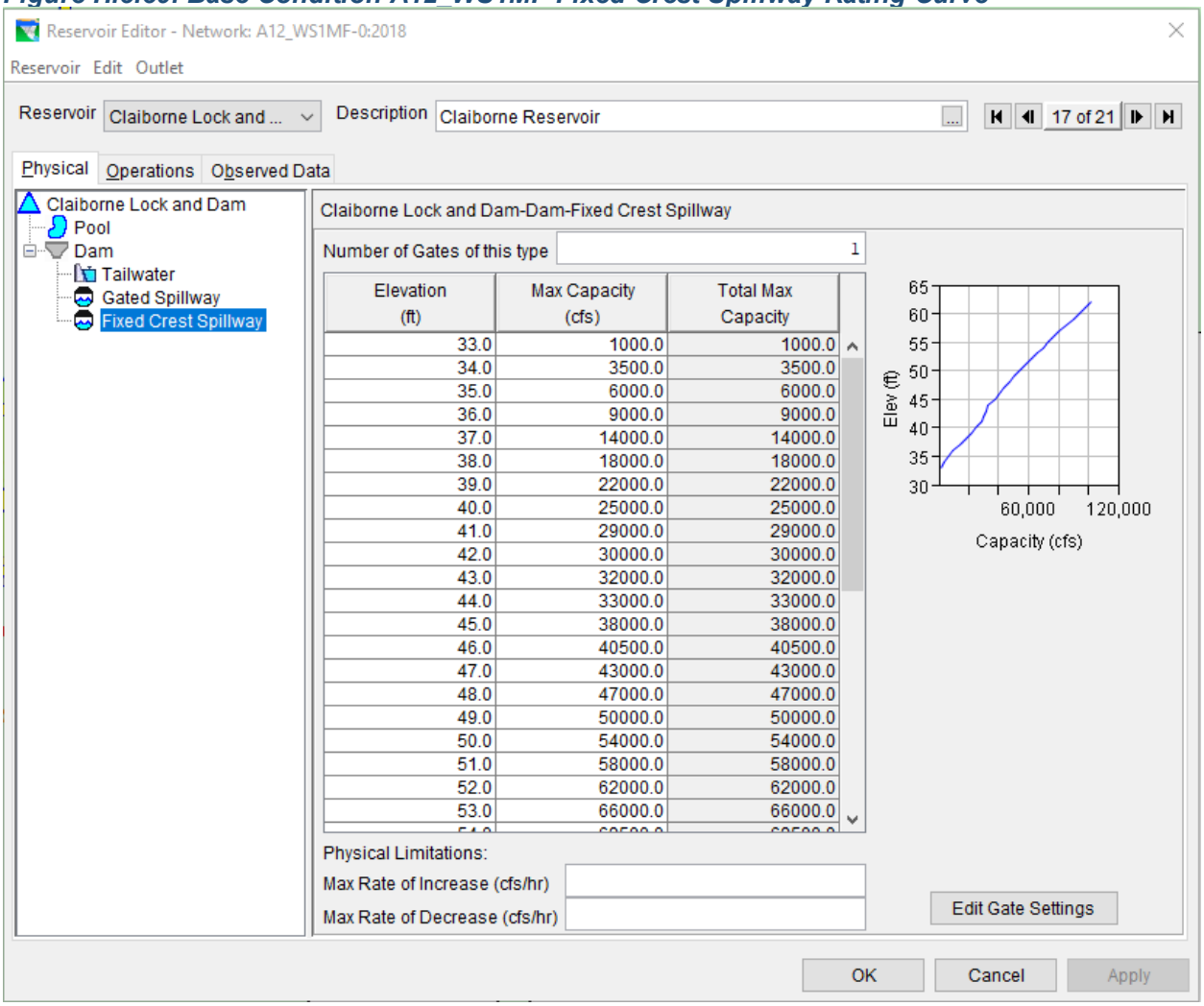
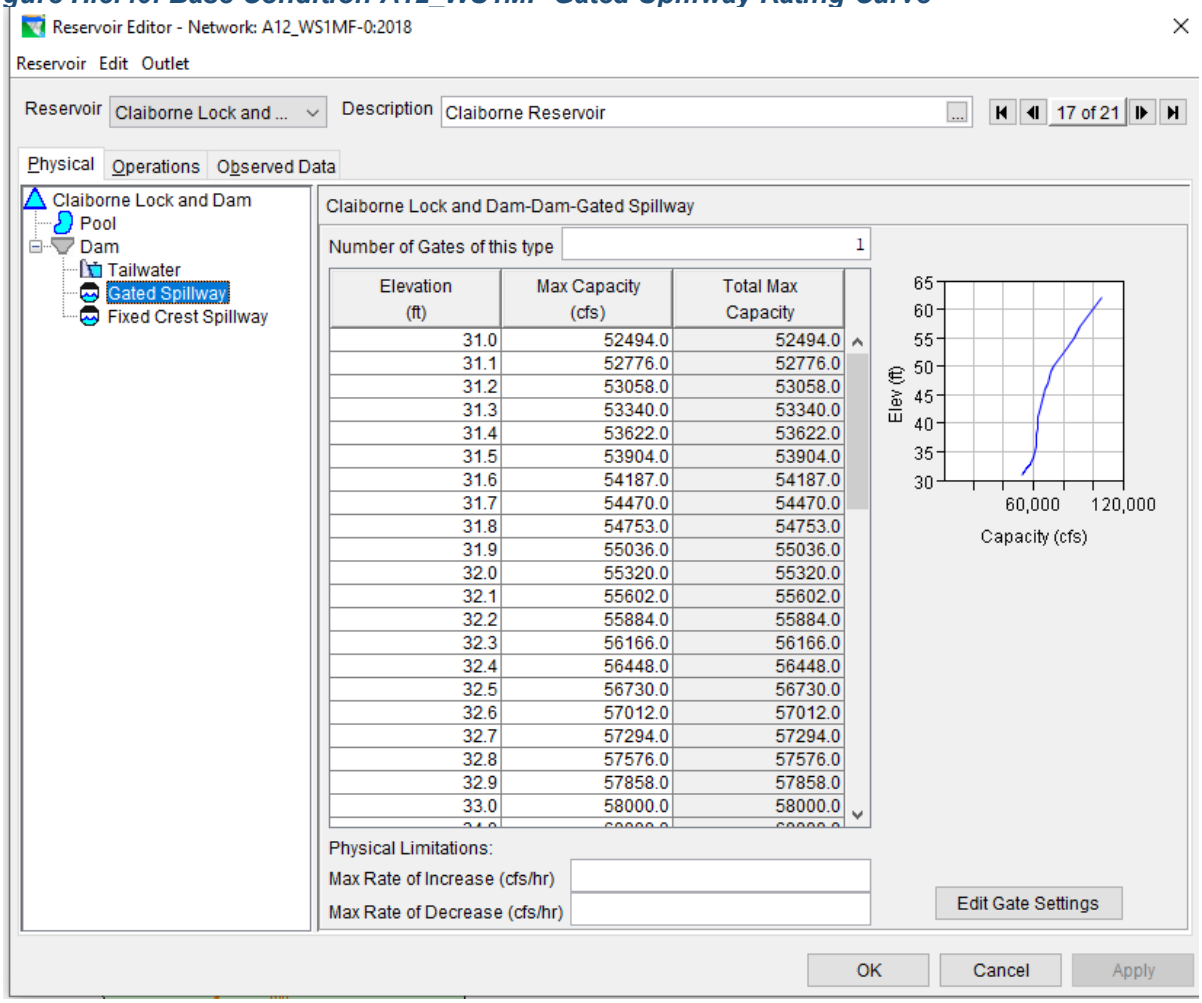


Figure H.3.40: Base Condition A12_WS1MF Gated Spillway Rating Curve



H.3.5.4.3. Reservoir Operations

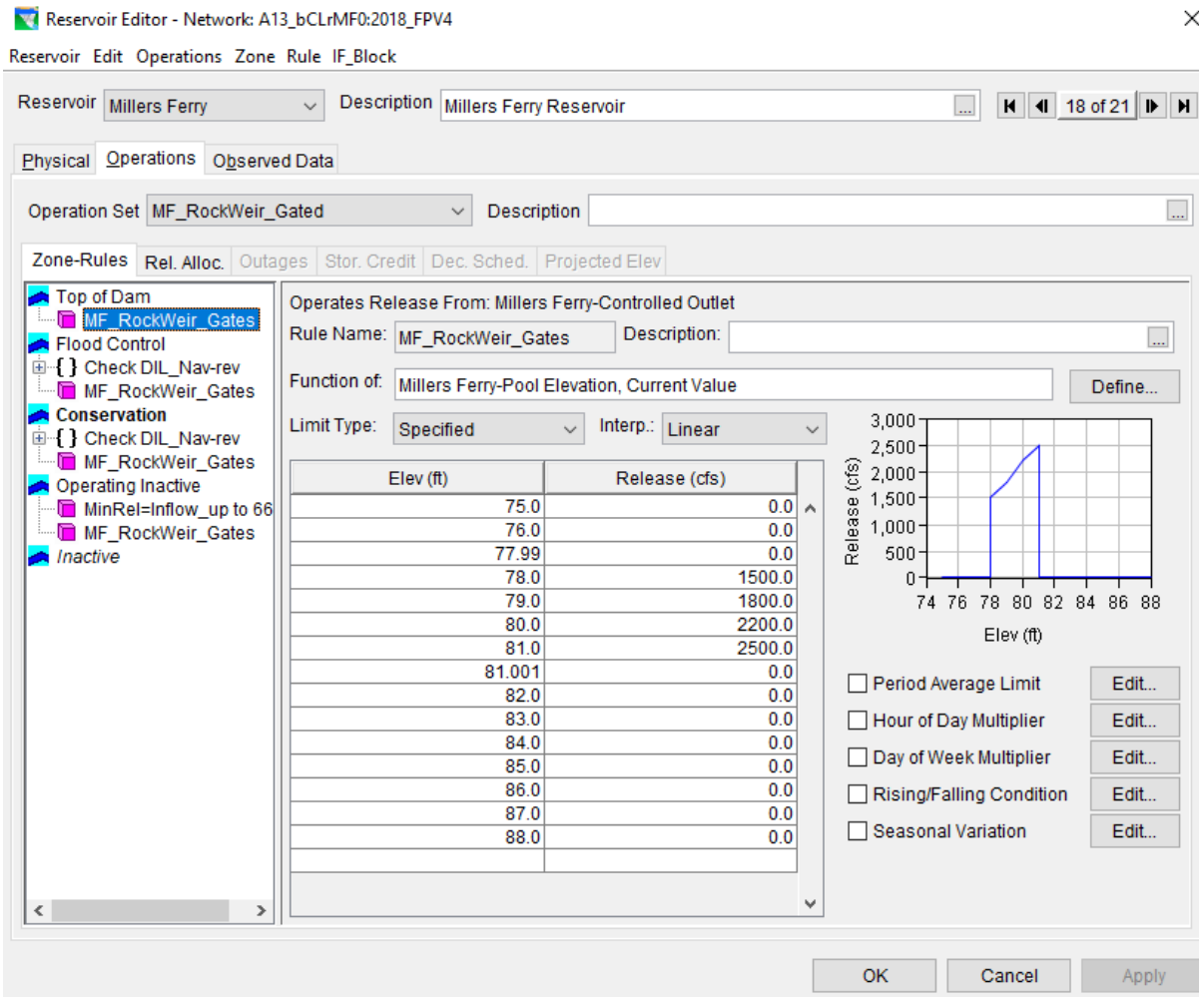
Two new operation sets were created to simulate flow through the controlled outlet. Figure H.3.41 shows the gated operation set with the gated rule at Millers Ferry with the right bank variation of the bypass channel named "MF_RockWeir_Gates". Figure H.3.42Figure H.3.41 represents the ungated operation set with the gated rule at Claiborne with the right bank variation of the bypass channel named "CL_RB_Bypass_NoGate". The rating curves were provided by HEC-RAS modeling for the physical rock weir variations at each of the individual project.

H.3.5.4.3.1. Gated Operations at Millers Ferry

Within the gated operations at Millers Ferry, a new rule named "MF_RockWeir_Gates" was created to reflect the gated operations of the fish passage structure. The "MF_RockWeir_Gates" rule is a function of the current value of the Millers Ferry pool elevation. To simulate the gate closing during high flow events, at pool elevation 81.001, the flow is set to 0 cfs. To simulate the gate closing during a low flow period, at pool elevation 77.999 ft., the flow is also set to 0 cfs. This rule assists Water Management to control the fish passage structure during emergency time periods of either low flows or

high flows. Figure H.3.41 shows the operation rule of the corresponding releases (cfs) with the pool elevation (ft).

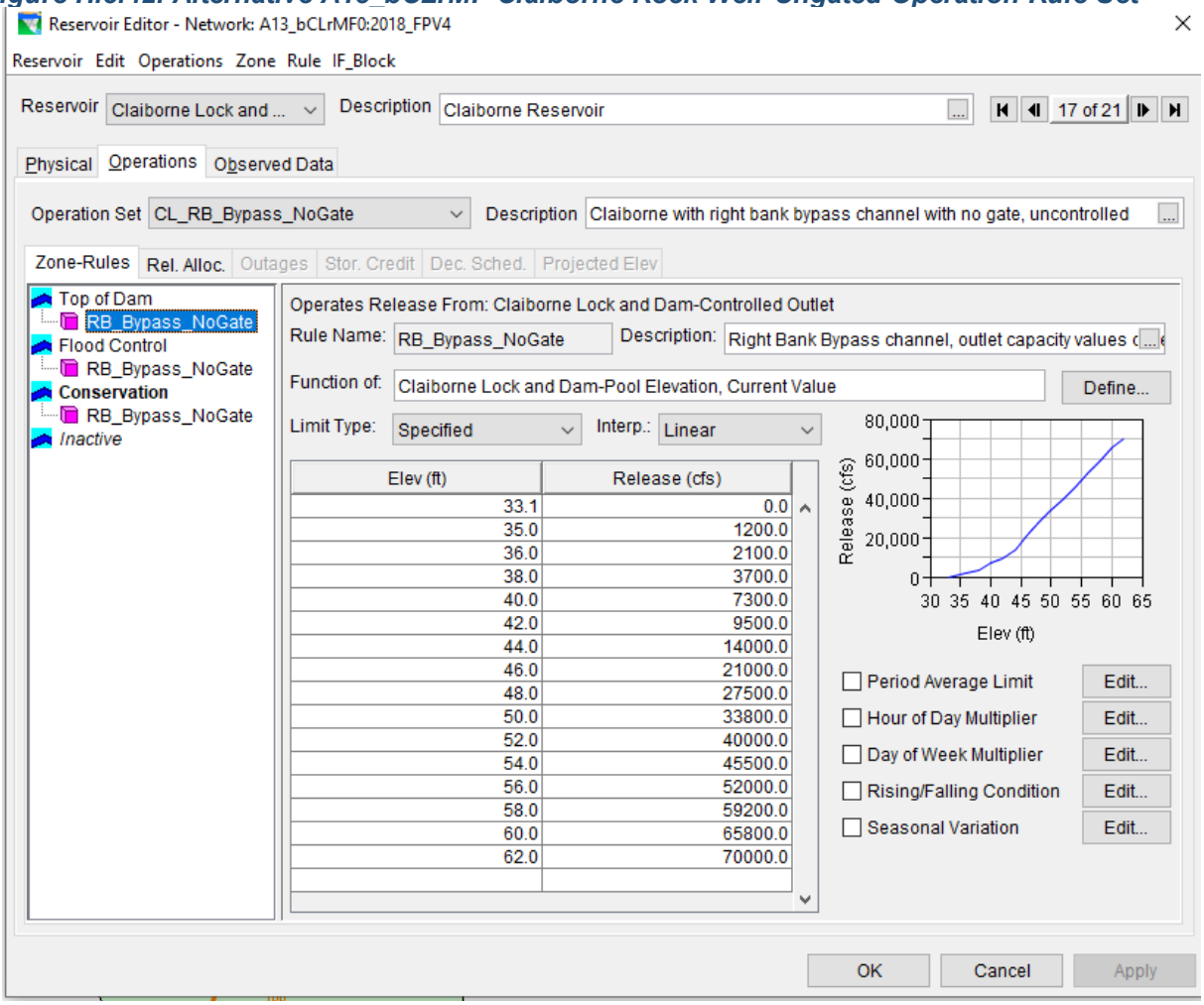
Figure H.3.41: Alternative A13_bCLrMF Millers Ferry Rock Weir Gated Operation Rule Set



H.3.5.4.3.2. Ungated Operations at Claiborne

To simulate the ungated operation rule set at Millers Ferry, a new rule name "CL_RB_Bypass_NoGate" was created to reflect the ungated operations of the fish passage structure. The "CL_RB_Bypass_NoGate" rule is a function of the current value of the Claiborne's pool elevation. To simulate the uncontrolled gate operations, a rating curve with pool elevations within the range of 33.1 ft. and 62.0 ft. and the corresponding releases are implemented into the rule with a linear interpolation. Figure H.3.42 shows the ungated operation rating curve of the rock weir structure at Claiborne.

Figure H.3.42: Alternative A13_bCLrMF Claiborne Rock Weir Ungated Operation Rule Set



H.3.6. Sample ResSim Results and Reporting Updates

Each simulated alternative produced daily time step results reports including reservoir release (distributed by outlet) and storage, and streamflow at all junctions throughout the model. To assist with the analysis of so many results, scripted plot templates and report generation templates were created to provide on-demand illustrations of the state of various reservoir systems operations, including the interested reservoirs.

This section describes updates made related to the storing and processing of results. Model time series outputs were reduced to reduce the output file size. Updates were made to the post processing reports.

H.3.6.1. DSS Outputs

The DSS file encompassed one simulation which encompassed all the alternatives for the entire period of record of 01January 1939 to 01January2011.

H.3.6.1.1. Release Decision Report

Figure H.3.43 shows the release decision report for Millers Ferry Lock and Dam from 01Oct2004 to 22Oct2004, simulating the A05_BcBD fish passage alternative. The report

shows the Active Zone Pool Elevations where the reservoir moves from the Conservation zone to an Operating Inactive Zone during a low flow period within the period of record. It also shows the net inflow, the active rules, and the release from each outlet at each time step, including the fish passage structure which is named in the simulation as the "Controlled Outlet Active Rule Flow (cfs)". This report type is available for each reservoir for every alternative in the "Fish passage Alternatives POR Updated" simulation.

Figure H.3.43: Millers Ferry Reservoir Alternative A05_BcBD Release Decision Report

Release Decision Report: Millers Ferry

File Options

Alternative: A05_BcBD--0:A05_BcBD
Run: A05_BcBD--0

Lookback: 06 Jan 1939, 0000
Start Time: 20 Jan 1939, 0000
End Time: 01 Jan 2012, 0000
Rule Key: GC=Guide Curve, RO=Release Override, EO=Elevation Override, ZB=Zone Boundary

Date-Time	Millers Ferry							
	Active Zone Elev (ft)	Net Inflow (cfs)	Millers Ferry Active Rule Flow (cfs)	-Dam Active Rule Flow (cfs)	-Dam L&O Uncontrolled Flow (cfs)	-Spillway Active Rule Flow (cfs)	-Power Plant Active Rule Flow (cfs)	-Controlled Outlet Active Rule Flow (cfs)
	Conservation		Min@Claiborne...	Min@Claiborne...	Unctrl	Min@Claiborne...	Min@Claiborne...	MF Bypass Gates
01Oct2004, 24:00	80.33	12,260.28	12,909.12	12,909.12	0.00	0.00	11,474.39	1,434.73
	Conservation		Min@Claiborne...	Min@Claiborne...	Unctrl	Min@Claiborne...	Min@Claiborne...	MF Bypass Gates
02Oct2004, 24:00	80.20	12,172.92	13,311.13	13,311.13	0.00	0.00	11,965.84	1,345.29
	Conservation		Min@Claiborne...	Min@Claiborne...	Unctrl	Min@Claiborne...	Min@Claiborne...	MF Bypass Gates
03Oct2004, 24:00	79.93	12,060.71	14,503.79	14,503.79	0.00	0.00	13,339.09	1,164.70
	Conservation		Min@Claiborne...	Min@Claiborne...	Unctrl	Min@Claiborne...	Min@Claiborne...	MF Bypass Gates
04Oct2004, 24:00	79.55	11,020.44	14,230.55	14,230.55	0.00	0.00	13,256.60	973.95
	Conservation		Min@Claiborne...	Min@Claiborne...	Unctrl	Min@Claiborne...	Min@Claiborne...	MF Bypass Gates
05Oct2004, 24:00	79.17	11,064.78	14,256.66	14,256.66	0.00	0.00	13,472.37	784.29
	Conservation		Min@Claiborne...	Min@Claiborne...	Unctrl	Min@Claiborne...	Min@Claiborne...	MF Bypass Gates
06Oct2004, 24:00	78.89	10,297.39	12,593.23	12,593.23	0.00	0.00	11,926.72	666.51
	Conservation		Min@Claiborne...	Min@Claiborne...	Unctrl	Min@Claiborne...	Min@Claiborne...	MF Bypass Gates
07Oct2004, 24:00	78.58	10,963.01	13,351.59	13,351.59	0.00	0.00	12,776.24	575.34
	Conservation		Min@Claiborne...	Min@Claiborne...	Unctrl	Min@Claiborne...	Min@Claiborne...	MF Bypass Gates
08Oct2004, 24:00	78.38	10,975.06	12,566.52	12,566.52	0.00	0.00	12,051.92	514.60
	Conservation		Min@Claiborne...	Min@Claiborne...	Unctrl	Min@Claiborne...	Min@Claiborne...	MF Bypass Gates
09Oct2004, 24:00	78.16	9,895.95	11,677.23	11,677.23	0.00	0.00	11,230.62	446.61
	Conservation		Min@Claiborne...	Min@Claiborne...	Unctrl	Min@Claiborne...	Min@Claiborne...	MF Bypass Gates
10Oct2004, 24:00	78.01	9,232.82	10,384.34	10,384.34	0.00	0.00	9,981.68	402.66
	Conservation		ZB	ZB	Unctrl	ZB	ZB	MF Bypass Gates
11Oct2004, 24:00	78.00	7,783.91	7,853.64	7,853.64	0.00	0.00	7,460.58	393.06
	Operating Ina...		Min@Claiborne...	Min@Claiborne...	Unctrl	Min@Claiborne...	Min@Claiborne...	MF Bypass Gates
12Oct2004, 24:00	78.11	9,920.51	9,028.55	9,028.55	0.00	0.00	8,594.51	434.04
	Conservation		Min@Claiborne...	Min@Claiborne...	Unctrl	Min@Claiborne...	Min@Claiborne...	MF Bypass Gates
13Oct2004, 24:00	78.21	10,063.69	9,309.34	9,309.34	0.00	0.00	8,846.50	462.84
	Conservation		Min@Claiborne...	Min@Claiborne...	Unctrl	Min@Claiborne...	Min@Claiborne...	MF Bypass Gates
14Oct2004, 24:00	78.09	8,732.66	9,696.45	9,696.45	0.00	0.00	9,270.40	426.05
	Conservation		ZB	ZB	Unctrl	ZB	ZB	MF Bypass Gates
15Oct2004, 24:00	78.00	8,080.43	8,762.96	8,762.96	0.00	0.00	8,362.95	400.01
	Operating Ina...		ZB	ZB	Unctrl	ZB	ZB	MF Bypass Gates
16Oct2004, 24:00	78.00	7,926.35	7,926.35	7,926.35	0.00	0.00	7,541.82	384.52
	Operating Ina...		MinRel=Inflow...	MinRel=Inflow...	Unctrl	MinRel=Inflow...	MinRel=Inflow...	MF Bypass Gates
17Oct2004, 24:00	78.61	11,374.51	6,600.00	6,600.00	0.00	0.00	6,017.77	582.23
	Conservation		Min@Claiborne...	Min@Claiborne...	Unctrl	Min@Claiborne...	Min@Claiborne...	MF Bypass Gates
18Oct2004, 24:00	79.16	14,310.60	9,915.48	9,915.48	0.00	0.00	9,137.66	777.82
	Conservation		Min@Claiborne...	Min@Claiborne...	Unctrl	Min@Claiborne...	Min@Claiborne...	MF Bypass Gates
19Oct2004, 24:00	79.98	17,024.78	10,087.02	10,087.02	0.00	0.00	8,896.95	1,190.07
	Conservation		GC	GC	Unctrl	GC	GC	MF Bypass Gates
20Oct2004, 24:00	80.40	19,828.48	16,025.33	16,025.33	0.00	0.00	14,539.64	1,485.70
	Conservation		GC	GC	Unctrl	GC	GC	MF Bypass Gates
21Oct2004, 24:00	80.40	24,438.65	24,438.65	24,438.65	0.00	0.00	22,952.91	1,485.74
	Conservation		GC	GC	Unctrl	GC	GC	MF Bypass Gates
22Oct2004, 24:00	80.40	26,776.49	26,776.49	26,776.49	0.00	0.00	25,290.77	1,485.72
	Conservation		GC	GC	Unctrl	GC	GC	MF Bypass Gates
23Oct2004, 24:00	80.40	26,291.79	26,291.79	26,291.79	0.00	0.00	24,806.08	1,485.71
	Conservation		GC	GC	Unctrl	GC	GC	MF Bypass Gates
24Oct2004, 24:00	80.40	24,303.08	24,303.08	24,303.08	0.00	0.00	22,817.37	1,485.71
	Conservation		GC	GC	Unctrl	GC	GC	MF Bypass Gates

H.3.6.1.2. ResSim Default Plots

ResSim allows easy viewing via built in plot types that can be opened directly from the simulation module. Below are default reservoir plots for Millers Ferry (Figure H.3.44) and Claiborne (Figure H.3.45). Results from the A12WSF, our baseline alternative (green) and the fish passage alternative measures (blue) are shown in each plot, along with observed data (red). Likewise, the Claiborne pool elevation plot is shown in Figure H.3.46 with the same alternatives and observed data timeseries. The dotted lines represent the

minimum and maximum operating limits for each respective project. This plot is important for determining when changed operations may affect the flows at the projects. In the plots below, the results of the fish passage alternatives on top of the baseline alternative indicates that the pool elevation at the projects have very little changes. Discharge plots were also generated to indicate that the baseline alternative and the fish passage alternatives will have no impact to the downstream minimum navigation flow requirements.

Figure H.3.44: Millers Ferry Reservoir Plot

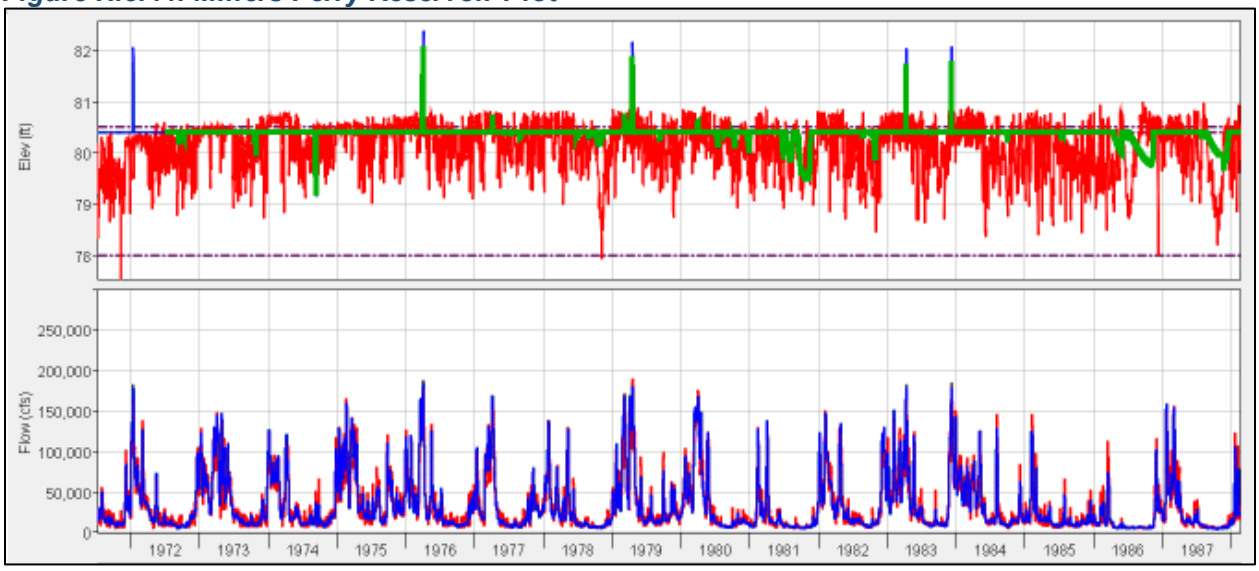
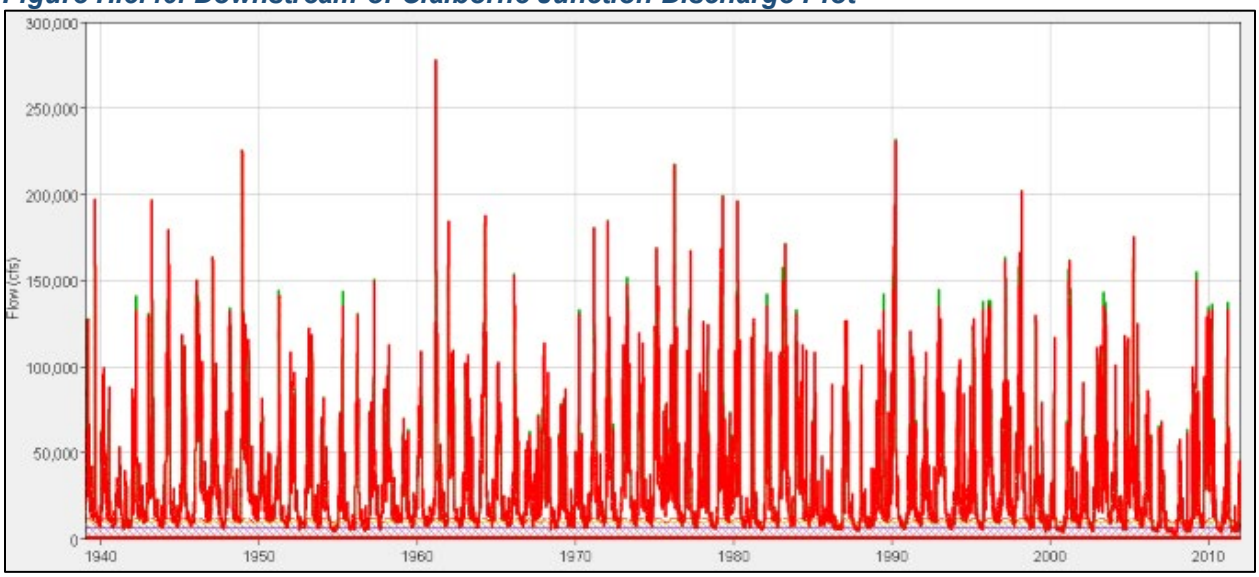


Figure H.3.45: Claiborne Reservoir Plot

Figure H.3.46: Downstream of Claiborne Junction Discharge Plot



H.3.6.1.3. Jeh Report

The "jeh Report" is a ResSim results report that is generated for alternatives in batch using the "jeh_reports_2018" post-processing script contained in the watershed. The report includes time series results that were requested by James Hathorn (jeh) to easily conduct his results analysis.

The report is updated to show Allatoona-Dam Tailwater/FLOW instead of Allatoona_OUT/FLOW. This change should have no impact. Unlike the other reservoirs, which use their Pool/FLOW-OUT time series, Allatoona's flow was taken from its out node. This ensured the diverted outlet flows were not included. Switching to take the flow from the Dam Tailwater/FLOW will have the same effect.

The reports generated by this script were used to create post processing graphs which were presented to the PDT. The reports assisted int transferring data to the Hydrologic Analysis Center (HAC) for hydropower impacts analysis.

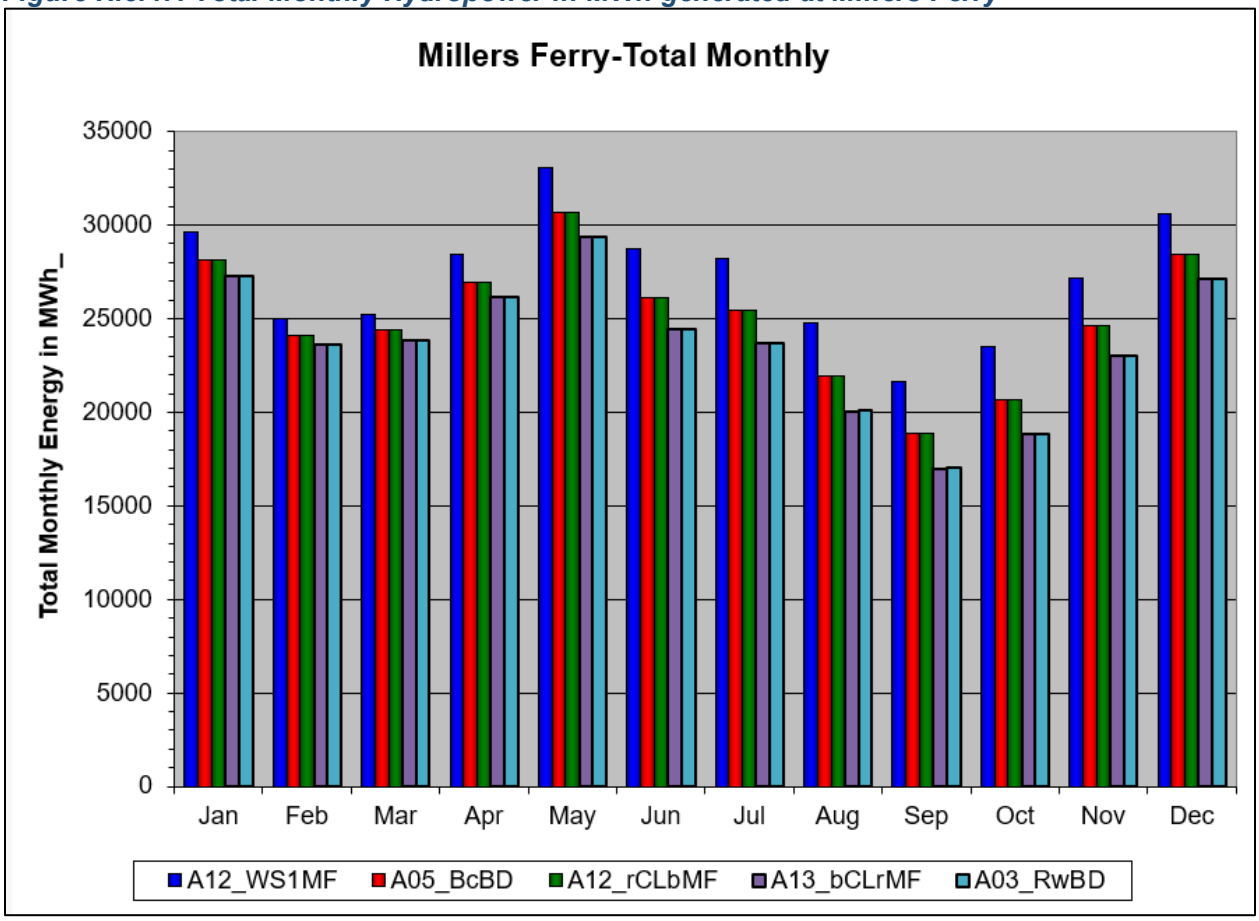
H.3.7. Post Processing Results

The data sets that were generated by the ResSim model of all modeled alternatives were placed into post-processing reports generated by the script "jeh Report". The output extension file for the post-processing reports by the "jeh Report" script was .csv file. The data was then copied into a post-processing .xlsm excel file to generate clear charts for presentations. Examples of such data set results and charts are shown below.

H.3.7.1. Hydropower Flows Results

The raw data from the ResSim model presented the data in a .csv file format to be extracted and post-processed into a .xlsx format. The charts that were produced to represent the hydropower generated for each alternative and the baseline are show in Figure H.3.47. Similar charts were produced for all hydropower projects within the ACT basin to show the effects of the different measures at both Millers Ferry and Claiborne. The raw hydropower data was passed forward to the Hydropower Analysis Center (HAC) for further analysis.

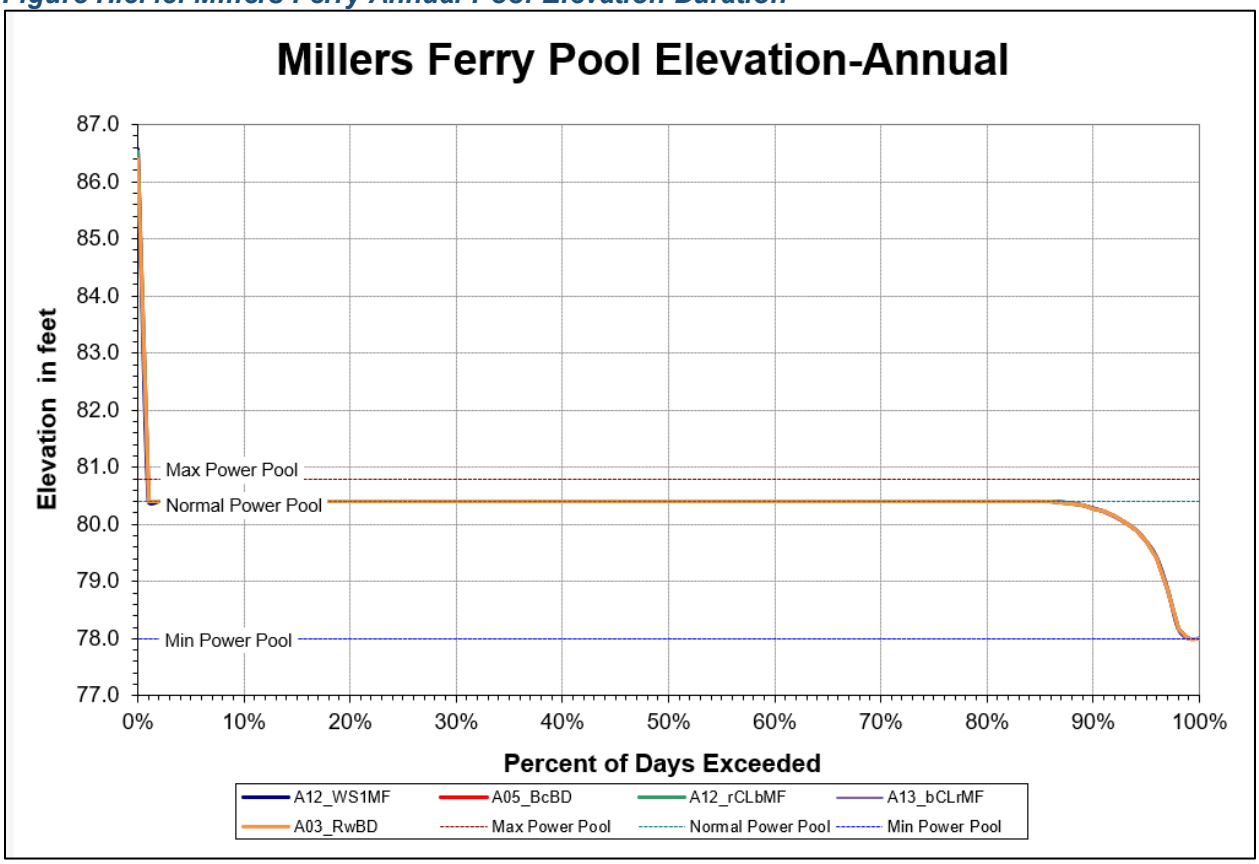
Figure H.3.47: Total Monthly Hydropower in MWh generated at Millers Ferry



H.3.7.2. Pool Duration Results

The pool duration charts were produced to demonstrate the fluctuations of the pool elevations of the alternatives from the baseline. It also demonstrates the percentage of days the pool elevation is exceeded at the reservoirs as shown in Figure H.3.48. Claiborne's pool elevation duration charts were also generated.

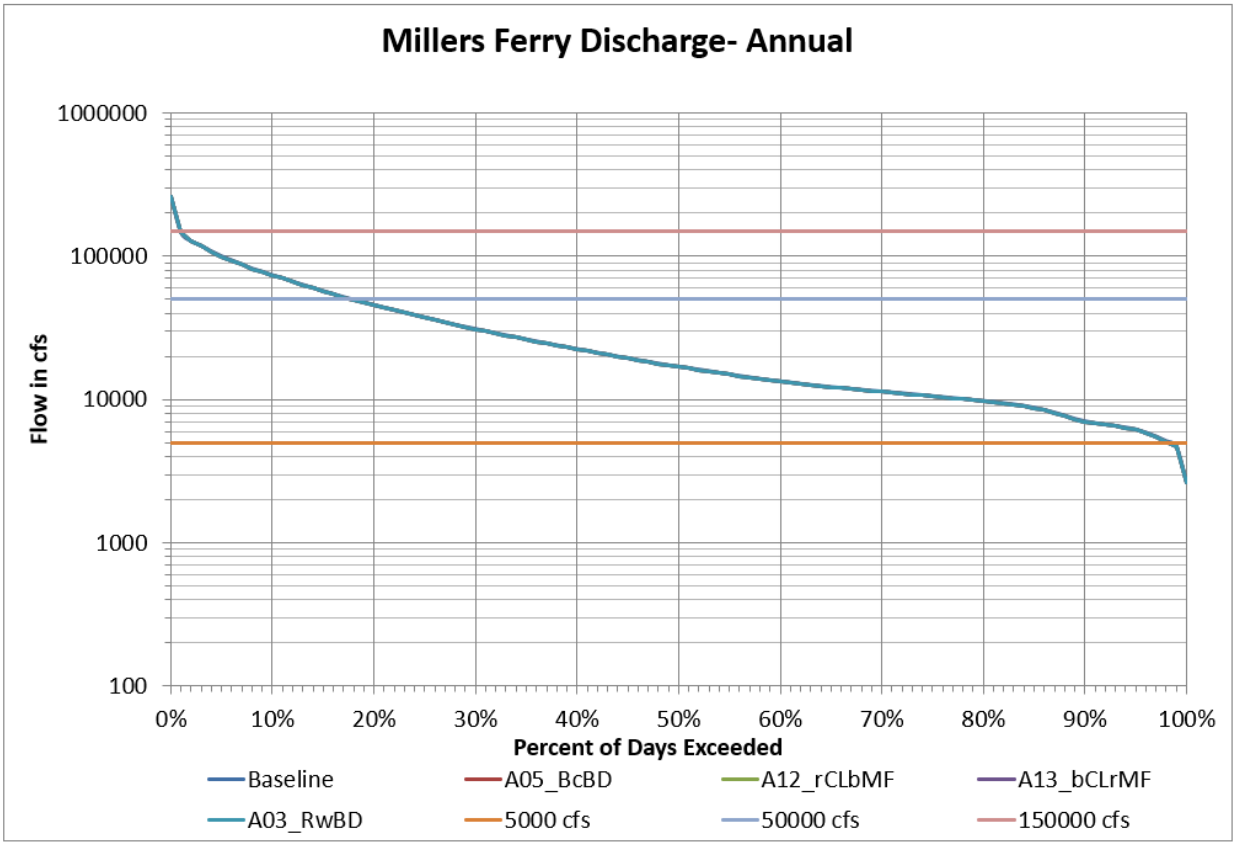
Figure H.3.48: Millers Ferry Annual Pool Elevation Duration



H.3.7.3. Percent Flow Duration through Millers Ferry and Claiborne

The percent flow duration charts were generated to demonstrate the percentage of days certain flows would be flowing through Millers Ferry and Claiborne. Monthly and annual charts were produced with 5000 cfs, 50,000 cfs, and 150,000 cfs markers. An example of an annual chart is Figure H.3.49. The discharge chart shows only one blue line since the results of the discharge at Millers Ferry have very little differences between the alternatives and the baseline. These charts and raw data were disseminated to our environmental team to support their habitat unit modeling analysis.

Figure H.3.49: Millers Ferry Annual Pool Elevation Duration



H.3.7.4. Percent Flow through Fish Passage Structures

The percent flow through the fish passage structures chart were also produced to visually present the availability of flows if the structure was to be implemented. The annual charts and the monthly charts depicted the percentage of days a certain flow would be available. The most noticeable difference is the rock weir measures (inblue) versus the bypass measures (in green) at Millers Ferry in Figure H.3.50. The blue line is shown, but has the same results for any rock weir fish passage measure at Millers Ferry while the green shows the results of the alternatives that have a bypass structure measure at Millers Ferry.

Figure H.3.50: Millers Ferry Annual Fish Passage Bypass Discharge Duration