ADAPTIVE MANAGEMENT PLAN

FLOW FLUCTUATIONS DOWNSTREAM OF PARR SHOALS DAM

SOUTH CAROLINA ELECTRIC & GAS COMPANY

FERC NO. 1894

Prepared by:

South Carolina Electric & Gas Company

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FOR THE
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DEFINITIONS OF TERMS, ACRONYMS, AND ABBREVIATIONS

AMP	Adaptive Management Plan
AR	American Rivers
CFR	Code of Federal Regulations
cfs	cubic feet per second
Commission	Federal Energy Regulatory Commission
CRK	Congaree Riverkeeper
CRSA	Comprehensive Relicensing Settlement Agreement
DLA	Draft License Application
FERC	Federal Energy Regulatory Commission
FLA	Final License Application
ft	foot
Generator capacity	the maximum amount of electricity that can be produced within the safety limitation of a generator
Head	the difference in the elevation of the upstream reservoir in relation to the tailrace elevation
Hydraulic capacity	the maximum amount of water that can be passed through the Project turbines
IFIM	Instream Flow Incremental Methodology
installed capacity	the nameplate megawatt rating of a generator or group of generators
interested parties	individuals and entities that have an interest in a proceeding
kW	Kilowatt
kWh	kilowatt-hour
Licensee	South Carolina Electric & Gas Company
Licensing/Relicensing	the process of acquiring an original FERC license for a new proposed hydropower project; or, the process of acquiring a new FERC license for an existing hydropower project after the previous license has expired.
Minimum Flow	A continuous flow, measured in CFS that is required to be released from the Project dam during specified periods of time.
Msl	mean sea level
MW	megawatt
MWh	megawatt-hour
Net inflow	The previous day's daily average inflow as calculated using the sum of the three upstream USGS gages (USGS 02156500, Broad River near Carlisle, SC; USGS 02160105, Tyger River near Delta, SC; and USGS 02160700, Enoree River at Whitmire, SC) minus evaporation from the reservoirs.
NGO	non-governmental organization
NMFS	National Marine Fisheries Services, also known as NOAA Fisheries
NOAA	National Oceanic and Atmospheric Administration, including NMFS
normal operating capacity	The maximum MW output of a generator or group of generators under normal maximum head and flow conditions
PM&E	protection, mitigation and enhancement measures

Project	Parr Hydroelectric Project (FERC No. 1894)
Project Area	Zone of potential, reasonably direct project effects within the FERC Project Boundary.
Project Boundary	The boundary line defined in the license issued by FERC that surrounds areas needed for Project purposes.
Review Committee	A group, including SCE&G and stakeholders, formed to direct the implementation of the Downstream Flow Fluctuation AMP. Members of the Review Committee must be signatories to the Comprehensive Relicensing Settlement Agreement.
SCDHEC	South Carolina Department of Health and Environmental Control
SCDNR	South Carolina Department of Natural Resources
SCE&G	South Carolina Electric & Gas Company
SHPO	State Historic Preservation Officer
Tailrace	Channel through which water is discharged from the turbines
TLP	Traditional Licensing Process
Turbine capacity	maximum shaft horsepower for an individual turbine at full gate
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WQFW RCG	Water Quality, Fish and Wildlife Resource Conservation Group
WUA	Weighted Usable Area

1.0 INTRODUCTION

South Carolina Electric & Gas Company (SCE&G) must file an application for a new license for its Parr Hydroelectric Project (Project) (FERC No. 1894) on the Broad River with the Federal Energy Regulatory Commission (FERC) by June 2018. SCE&G is currently involved in a multi-year relicensing process that requires a cooperative effort between SCE&G and stakeholders, including state and federal resource agencies, non-governmental organizations (NGOs) and concerned citizens, to address operational, recreational and ecological concerns associated with Project operations. During relicensing, the issue of downstream flow fluctuations associated with Project operations was identified by the Water Quality, Fish and Wildlife Resource Conservation Group (WQFW RCG) as an issue that needed to be resolved. The WQFW RCG includes representatives from SCE&G, South Carolina Department of Natural Resources (SCDNR), U.S. Fish and Wildlife Service (USFWS), South Carolina Department of Health and Environmental Control (SCDHEC), National Oceanic and Atmospheric Administration (NOAA), American Rivers and Congaree Riverkeeper. The WQFW RCG discussed and determined necessary changes to Project operations to stabilize downstream flows. Over the course of several WQFW RCG meetings, a framework for a Downstream Flow Fluctuation Adaptive Management Plan (AMP) was developed to address downstream flow stabilization during the new license term (Appendix A). This AMP outlines SCE&G's proposed actions for stabilizing downstream flows and will be implemented during the term of the new Project license.

1.1 PROJECT DESCRIPTION

The Parr Hydroelectric Project includes the 14.88-megawatt (MW) Parr Shoals Development (Parr Development) and the 511.2-MW Fairfield Pumped Storage Development (Fairfield Development) located in Fairfield and Newberry counties, South Carolina. Parr Reservoir is a 4,400-acre impoundment formed by the Broad River and the Parr Shoals Dam and serves as the lower reservoir for the Fairfield Development's pumped storage operations. Monticello

Reservoir is a 6,800-acre impoundment formed by a series of four earthen dams and serves as the upper reservoir for the Fairfield Development's pumped storage operations. The existing Project license was issued by FERC on August 28, 1974 for a period of 46 years, terminating on June 30, 2020. SCE&G intends to file for a new license with FERC on or before May 31, 2018.

2.0 DOWNSTREAM FLOW FLUCTUATION AMP REVIEW COMMITTEE

2.1 COMMITTEE MEMBERS

A Review Committee will be formed to direct the implementation of the AMP. Members of the Review Committee must be signatories to the Comprehensive Relicensing Settlement Agreement (CRSA) with the exception of NOAA Fisheries, USFWS, US Forest Service, South Carolina State Historic Preservation Office, SCDHEC and SCDNR.

SCE&G will serve as chairperson of the Review Committee, and be responsible for organizing meetings and distributing documents to committee members. Each entity will have the opportunity to select a representative to the Review Committee from within their organization.

The Review Committee will ultimately work to guide the decision-making processes specified in the Downstream Flow Fluctuation AMP. The Review Committee will not make decisions that supersede state or federal law. The Review Committee's responsibilities may include, but are not limited to:

- Evaluating baseline information and study plans;
- Providing overall guidance for the AMP process;
- Evaluating other study (i.e., existing) information or information which becomes available during the time period of evaluations and would be applicable to the AMP;
- Establishing and documenting the goals and objectives of each action undertaken as part of the AMP and advising when modifications to metrics used for evaluation purposes are needed;
- Reviewing and considering long term impacts of operational modifications on the Project and Project economics when evaluating the feasibility of implementing modifications; and
- Advising on modifications to the AMP to be presented to FERC and advising if any amendment action is necessary during the term of the license.

2.2 BUDGET/RESOURCES

The responsibility for implementation of this AMP, including its funding, will rest primarily with SCE&G, as licensee for the Parr Project. SCE&G will also rely on other resources outside of its establishment including, but not limited to, the following:

- federal, state and local grants
- donated services (federal and state agency involvement)
- expertise (governmental, non-governmental, private)

2.3 COMMITTEE MEETINGS

The Review Committee is tentatively scheduled to consult once per year via an in-person meeting or conference call. The meetings would be held to review current procedures, set future targets, and continue to provide input on operating guidelines. These annual meetings would assess how closely SCE&G matched outflows to inflows during spring stabilization periods, and to evaluate whether the stabilization goals were met year-round and/or seasonally.

The frequency of meetings may be adjusted based on need. The tentative schedule is provided in Section 6.0 of this plan. Minutes from each meeting, as well as any pertinent materials discussed in the meetings will be filed with FERC as an appendix to the annual report of AMP activities, as described in Section 7.0 of this plan.

3.0 GOALS AND OBJECTIVES

The WQFW RCG has requested that SCE&G reduce the fluctuations downstream of Parr Shoals Dam that result from Project operations. Specifically, they requested two levels of reduced fluctuations. The first goal is to reduce year-round downstream flow fluctuations. This goal would benefit the aquatic resources in the Broad River downstream of Parr Shoals Dam by stabilizing wetted habitat and reducing large daily fluctuations by some amount. The second goal is to stabilize flows during two 14-day spawning periods. During the spawning periods, SCE&G would attempt to match inflow and outflow to potentially improve spawning conditions for several species of fish, including anadromous American shad, striped bass and the Congaree River population of shortnose sturgeon.

4.0 CURRENT OPERATIONS

During the current license, SCE&G has operated the Project to meet the requirements of the current license articles and FERC regulations. Under current operation guidelines, Parr Reservoir can fluctuate up to 10 feet daily and Monticello Reservoir can fluctuate up to 4.5 feet daily as part of the pumped storage operations of the Fairfield Development. SCE&G operators also do not allow Parr Reservoir to rise above full pool and pass water over the spillway crest gates in the closed position. The operators only have two options for managing Parr Reservoir level under variable inflow conditions. They can pass water through the Parr Shoals turbines or lower the spillway crest gates. The ten crest gates are operated in pairs, with each pair being 400 feet long. The crest gates can be lowered in 0.1 foot increments over a ten foot operating range to allow inflow in excess of Parr Shoals Hydro's hydraulic capacity to spill over the gates.

Article 39 of the current license requires SCE&G to operate the Project reservoirs in such a manner that releases from Parr Reservoir (during flood flows) are no greater than flows which would have occurred in the absence of the Project. Assessments conducted during the late 1970's and in 2014 both indicate that flows of 40,000-45,000 cfs would begin to inundate and flood lands downstream of Parr Shoals Dam. Several measures have been implemented during the current license to ensure that only natural inflows above 40,000 cfs pass downstream of the Parr Development, and that releases from the Fairfield Development do not increase the magnitude or frequency of downstream flooding. These measures include incrementally lowering spillway gates when inflow, as measured at the three upstream USGS gages (see Section 5.1.2) is between 6,000-8,000 cfs, and continuing until all ten gates are in the open (lowered) position by the time that inflows reach 40,000 cfs. Additionally, generation at the Fairfield Development is reduced as inflow increases and is completely curtailed by the time inflows reach 40,000 cfs. By the time that the 40,000 cfs threshold has been met, all gates must be lowered to the full open position and Fairfield Development generation must be curtailed. However, pump back operations at Fairfield may occur during high flow events, as these operations actually reduce the amount of flow passing through the Parr Development. This operating regime has proved to be successful in the past and SCE&G intends to continue operating in this manner during future high flow events.

During relicensing, stakeholders noted that when inflow to the Project is less than 40,000 cfs, frequent fluctuation events occur throughout the year that sometimes increase and decrease releases from the Project by 5,000 to 10,000 cfs daily. This issue was addressed during the relicensing process by the WQFW RCG. The RCG held meetings on August 26, 2015, January 1, 2016, August 17, 2016 and October 18, 2016 to discuss the magnitude of this issue. The notes from each meeting and additional information provided to the RCG are included in Appendix A. As part of these RCG discussions, SCE&G determined that two operational practices contribute to downstream flow fluctuations. First, current operations include daily or weekly "reservoir inventory management releases" through the Parr Shoals Dam spillway crest gates that causes some of the fluctuations in downstream flow. When inflow to Parr Reservoir is greater than the flows that the Parr Shoals powerhouse can pass, the reservoir level slowly rises during the week and water is then released by lowering crest gates. Current inventory management operations result in large, short duration pulses being released downstream. Second, some or all of the spillway gates are sometimes lowered and left in that position for several days to spill excess inflow, which increases the influence of Fairfield generation and pumping on downstream flows due to water spilling over the lowered gates as Parr Reservoir rises and falls during pumped storage operations. SCE&G plans to develop and begin to implement operational guidelines and procedures during the term of this AMP that will reduce the frequency and duration of these pulses and fluctuations and allow SCE&G to manage reservoir inventory more proactively.

5.0 AMP IMPLEMENTATION

The WQFW RCG identified the need to reduce downstream flow fluctuations in the Broad River caused by Project operations year-round. The WQFW RCG also identified the need for stable flows during specific fish spawning periods during the spring. The success of flow fluctuation reductions will be measured by comparing inflow to outflow at the Project, both qualitatively and using metrics such as deviation of outflow from inflow as described below in Section 5.1.2. Additionally, WUA data from the IFIM study performed during relicensing may potentially be used to evaluate the habitat improvements which may result from reductions in fluctuations. Because this AMP covers a five-year period, SCE&G will work with the Review Committee to set appropriate evaluation and compliance criteria each year. Compliance criteria will consider the effects of mechanical restrictions (turbines down for repair), high inflow event information for each year and will also include deviation criteria during the four weeks of spring spawning season.

5.1 GENERAL YEAR-ROUND DOWNSTREAM FLOW FLUCTUATION REDUCTIONS

System control operators will modify year-round inventory management release operations to reduce downstream flow fluctuations during all months. Parr spillway gates are currently only operated when the Project is manned (i.e. weekdays during daytime hours). This can result in flows being built up overnight or gates being left down, both of which contribute to downstream flow pulses. Additional guidelines will be developed for use by system control and plant operators to ensure that flows are released on a more even schedule.

A remote-control camera will be installed on the west side of the Parr Shoals Dam. This camera will allow offsite system control operators to determine if conditions are safe to raise or lower crest gates 1 and 2 when the plant is unmanned. Along with the remote-control camera, the capability for remote-control operation of crest gates 1 and 2 will be added. This will allow system control to make around the clock gate adjustments based on real time inflow and reservoir level data, as opposed to gate adjustments being limited to daytime hours when the powerhouse is manned.

SCE&G has agreed to investigate the potential for automating the crest gate operation using a Programmable Logic Controller (PLC) based system. A PLC is already used to position the

gates, and it may be possible to incorporate inputs of inflow, reservoir level, and outflow and develop logic that will allow the gates to track changes in Parr Reservoir level so as to provide a more constant outflow during periods of spillage. Automated gate operation will be subject to SCE&G's ability to effectively monitor the gates for debris accumulation and other safety related conditions when gates are positioned.

Modifications or replacement of generators at the Parr Development may also be implemented during the new license if it is determined that these changes are mechanically and economically feasible. This change would allow increased hydraulic capacity through the powerhouse and would assist in regulating reservoir inventory and reduce the frequency of spillage at Parr Shoals Dam.

While the original hydraulic capacity (the maximum amount of water that can be passed through the Project turbines) of the Parr Development powerhouse was 6,000 cfs, the increase in head (the difference in the elevation of the upstream reservoir in relation to the tailrace elevation) during the construction of the Fairfield Development resulted in a turbine capacity (maximum shaft horsepower for an individual turbine at full gate) that exceeded the generator capacity (the maximum amount of electricity that can be produced within the safety limitation of a generator). The generator limitations actually limit the hydraulic capacity of the project to approximately 4,800 cfs, due to the need to operate the turbines at a reduced gate opening. Increasing the generator capacity would allow higher turbine flows, with a Project hydraulic capacity of approximately 6,000 cfs at low pond to 7,000 cfs when the Parr Reservoir is full.

Increasing the powerhouse hydraulic capacity will reduce the need to pass inflows using spillway gates, which will aid in reducing downstream flow fluctuations. To quantify the benefit of this increased control, the flow duration data was used to compare the existing and anticipated increase in hydraulic capacities. The difference between these represents the "benefit" of turbine-controlled releases.

For example, in Table 5-1, under current conditions the existing hydraulic capacity is exceeded 64.2 percent of the time during the month of March. By comparison, after all generators are upgraded, hydraulic capacity at minimum and maximum pond would be exceeded 48.3 and

38.2 percent of the time. This generator upgrade program results in spillway gate control of downstream flows being reduced 15.9 to 26.0 percent of the time.

TABLE 5-1 PERCENT OF TIME SPILLWAY FLOW CONTROL IS REDUCED

Station	Percent of Time Flow Exceeded												
Flow (cfs)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
4,800	52.2%	58.0%	64.2%	50.5%	31.9%	23.1%	14.9%	16.4%	9.5%	13.3%	21.3%	43.0%	33.0%
6,000	35.0%	41.3%	48.3%	38.5%	19.7%	12.7%	7.5%	10.8%	4.8%	9.0%	14.2%	26.8%	22.2%
7,000	28.6%	34.1%	38.2%	29.0%	14.2%	8.7%	6.5%	8.8%	3.6%	7.6%	11.4%	21.7%	17.5%
	Percent of Time Spillway Flow Control is Reduced												
6,000	17.1%	16.7%	15.9%	12.0%	12.2%	10.5%	7.5%	5.6%	4.8%	4.2%	7.1%	16.2%	10.8%
7,000	23.6%	23.9%	26.0%	21.4%	17.7%	14.5%	8.5%	7.6%	5.9%	5.6%	9.9%	21.4%	15.5%

5.2 SPRING SPAWNING STABILIZATION

Operational practices will be further modified during two 14-day spring spawning periods to further reduce downstream flow fluctuations. During these timeframes, the Project's operational goal will be to provide outflows that more closely match inflows. SCE&G will staff the Parr Shoals facility 24 hours/day during these periods to manipulate crest gates to more closely track Parr reservoir level and maintain a more constant discharge. Exceptions will be during periods when the inflow is less than the hydraulic capacity of the Parr Shoals turbines (when crest gates can be maintained in the raised position) and/or during flood events (when gates must be lowered progressively to limit backwater effects upstream of the dam). The periods of spawning flow stabilization will be determined annually by the Review Committee prior to the spawning period. Exact timing may vary from year to year but will generally be as follows:

- For 14 days during the last two weeks of March (March 15 through March 31) - flow stabilization for shortnose sturgeon in the Congaree River.
- Two 7-day blocks during April 1 through May 10 - flow stabilization for numerous species including striped bass, American shad, and robust redhorse.

During these stabilization periods, hourly inflow and mean deviation of outflow vs. inflow will be computed and tracked as a running measure each year. An example of how the mean deviation would be computed is included in Appendix B. Annual target reductions in mean deviation (correlated to mean inflow) will be set by the Review Committee each year during the 5-year monitoring period. This will guide operations with the goal of reducing downstream fluctuations. Project inflow will be computed as the sum of flows measured at the three USGS gage stations upstream of Parr Shoals Dam minus estimated evaporation from the Project

reservoirs. Evaporation estimates used by SCE&G are based on standard methodology and are presented in Appendix C.

The three gages used to calculate inflow are:

- 02156500 Broad River near Carlisle, SC
- 02160105 Tyger River near Delta, SC
- 2160700 Enoree River near Whitmire, SC

As inflow increases, backwater restrictions (potential of flooding the railroad tracks at Section 13 of the USGS backwater profile as shown on drawing Exhibit G-9) will limit how far the crest gates can be raised as Parr Reservoir rises. At some level of inflow Fairfield operations may need to be curtailed, or it may be determined by the Review Committee that certain releases during periods of higher inflow will not negatively impact the species in the river and that adjusting the gates to track the reservoir level may not be necessary. When computing inflow, no correction will be made for travel time, and the measured discharge (total inflow) will not be prorated to account for un-gaged areas between the gage stations and Parr Shoals Dam.

5.3 ANNUAL ANALYSIS

A Review Committee meeting will be held annually to review the results of downstream flow fluctuation reductions, set compliance targets for the following year, and suggest additional changes to operating guidelines. For this meeting, SCE&G will prepare a summary report on the success of the downstream flow fluctuation efforts during the year. This assessment will be performed using metrics such as deviation of outflow from inflow, or other measures such as the percent of time that outflow was within "X" percent of inflow. The report will also include an assessment of flow fluctuation reductions both year round and during the two 14-day spawning periods. The annual report, along with Review Committee meeting notes, will be filed with FERC following each annual meeting.

Potential metrics being considered for evaluating reductions in flow fluctuation include:

- Computing the mean hourly deviation of outflow from inflow over a specific time period, i.e. the entire year, the spring flow stabilization period, or monthly. This computation would involve comparing hourly values of outflow and inflow, computing the absolute

value of the difference each hour (the deviation), and taking the mean of the deviation values over the time period being evaluated. An example computation using actual inflow and outflow data is presented in Appendix B, along with a discussion of the relevance of this metric for evaluating the magnitude of fluctuations relative to inflow.

- Examining graphs of inflow and outflow to determine how closely the outflow hydrograph compares to the inflow hydrograph. Example graphs are included as Figure 1 and Figure 2.

Figure 1 shows a period during March 2012 when inflow to the Project was less than the hydraulic capacity of Parr Hydro, and the crest gates were maintained in a fully raised position (no spillage). Even with Fairfield Pumped Storage (FFPS) operating throughout the period, the crest gates were maintained in the fully raised position and the overall pattern of Project releases matched well with the overall pattern of inflow to the Project. Mean hourly deviation of outflow from inflow over this period was 567 cfs.

Figure 2 shows a period during March 2010 when inflow to the Project was greater than the hydraulic capacity of Parr Hydro, and several crest gates were maintained in a partly or fully lowered position (spillage occurred). With Fairfield Pumped Storage (FFPS) operating throughout the period, the overall pattern of Project releases did not match well with the overall pattern of inflow to the Project. Mean hourly deviation of outflow from inflow over this period was 1,641 cfs, nearly three times the mean hourly deviation shown in Figure 1. Figure 2 also shows that the amount of fluctuation becomes greater as inflow increases, due to the need to spill more of the inflow using the crest gates. This correlation of greater fluctuation with increasing inflow is discussed in more detail in Appendix B.

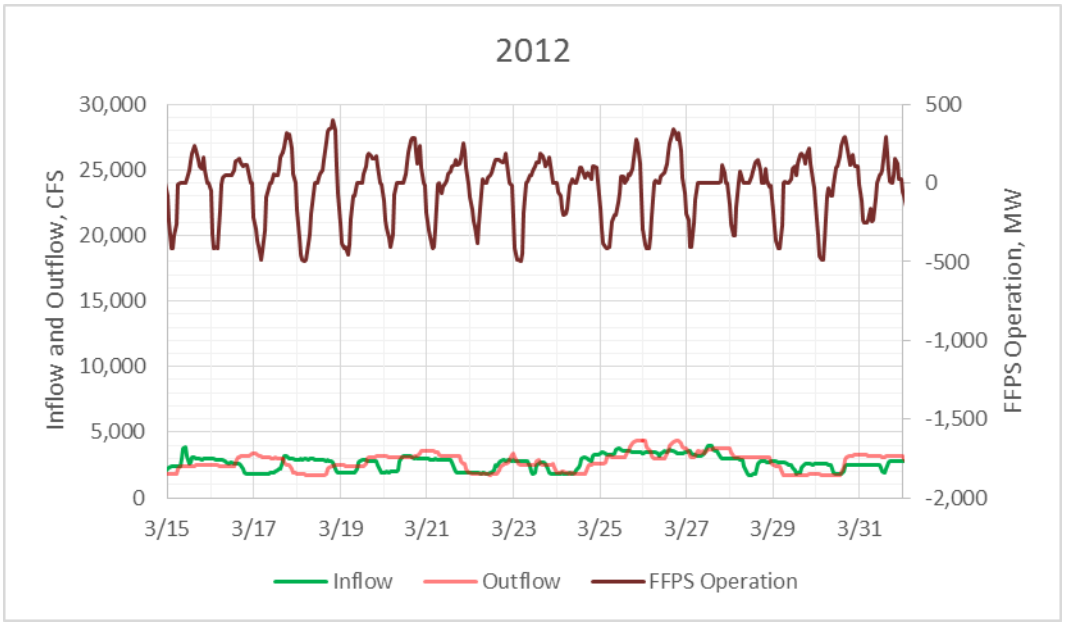


FIGURE 1 GRAPH ILLUSTRATING A PERIOD OF SMALLER FLUCTUATIONS (INFLOW < PARR HYDRO HYDRAULIC CAPACITY)

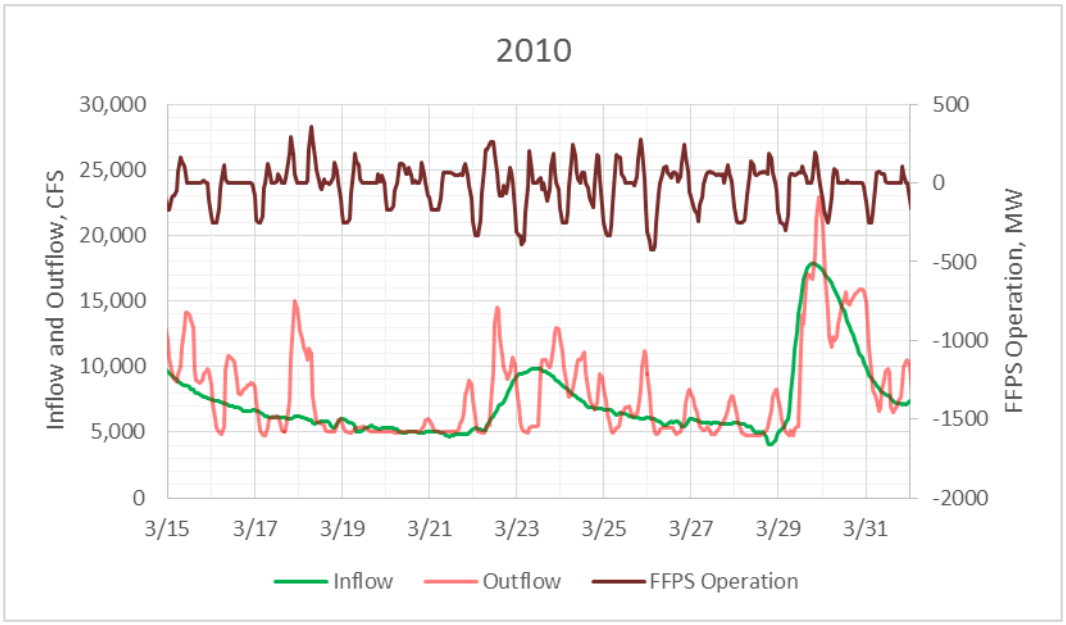


FIGURE 2 GRAPH ILLUSTRATING A PERIOD OF LARGER FLUCTUATIONS (INFLOW > PARR HYDRO HYDRAULIC CAPACITY)

6.0 SCHEDULE

The AMP schedule is described in the table below in relation to the issuance of the license by FERC.

TABLE 6-1 AMP IMPLEMENTATION SCHEDULE

Period	Item
90 days of license issuance	Submit updated Downstream Flow Fluctuation AMP to FERC
120 days of license issuance	Form Review Committee – develop "compliance criteria"
*Year 1- of new license	• Modify inventory management releases using guidelines to be developed by SCE&G • System Control implements new operating guidelines to reduce flow pulses throughout the year • Implement spring spawning flow stabilization (March and April-May) • Review Committee meeting to review results and set compliance criteria – February of the following year • File Annual Report with FERC – April 30 after Review Committee meeting
End of first calendar year following the year of license issuance	• Addition of remote control camera to west abutment of Parr Shoals Dam and provide System Control operators the ability to operate the camera • Add remote control operation of crest gates 1 and 2 and provide System Control operators the ability to operate these two gates
*Year 2 of new license	• System Control implements any modifications of operating guidelines to reduce flow pulses throughout the year • Implement spring spawning flow stabilization (March and April-May) • Review Committee meeting to review results and set compliance criteria for following year – February of the following year • File Annual Report with FERC – April 30 after Review Committee meeting
*Year 3 of new license	• System Control implements any modifications of operating guidelines to reduce flow pulses throughout the year • Implement spring spawning flow stabilization (March and April-May) • Review Committee meeting to review results and set compliance criteria for following year – February of the following year • File Annual Report with FERC – April 30 after Review Committee meeting
*Year 4 of new license	• System Control implements any modifications of operating guidelines to reduce flow pulses throughout the year

	• Implement spring spawning flow stabilization (March and April-May) • Review Committee meeting to review results and set compliance criteria for following year – February of the following year • File Annual Report with FERC – April 30 after Review Committee meeting
*Year 5 of new license	• System Control implements any modifications of operating guidelines to reduce flow pulses throughout the year • Implement spring spawning flow stabilization (March and April-May) • Review Committee meeting to review results and set compliance criteria for following year – February of the following year • Develop recommendation for completion or continuation of the AMP • File Annual Report with FERC – April 30 after Review Committee meeting

*Year 1 through 5 - Upgrade generators and expand hydraulic operating range, this could continue through year 10 after license issuance

7.0 COMPLIANCE

Compliance will be based on following the schedule in Section 6.0 and submission of an annual AMP report each year to FERC. The annual report will contain a summary of all AMP activities and data, including an assessment of the extent to which goals and objectives were achieved. The report will be made available to appropriate entities for review and comment at least 30 days prior to being submitted to FERC. All comments on the report, pertinent correspondence, and Review Committee meeting minutes will be appended to the annual report.

At the end of the 5-year AMP period, the Review Committee will provide final recommendations to FERC on extension or completion of the AMP. If the AMP is completed, then final compliance criteria will be proposed by the Review Committee for use during the remainder of the license.

8.0 REFERENCES

Federal Power Commission (FPC). 1974. Order Issuing New License (Major). Authorizing Project Redevelopment, Permitting use of Project Waters for Condenser Cooling Purposes, Vacating Hearing Order, and Permitting Withdrawal of Intervention. (Project No. 1894). Issued August 28, 1974.

APPENDIX A

SUMMARY OF CONSULTATION

Appendix A – Summary of Consultation

The Water Quality, Fish and Wildlife RCG convened often throughout the relicensing process to discuss the development of the Downstream Flow Fluctuations AMP. A list of meeting dates pertinent to the development of this AMP is included below. The complete consultation record for the development of this AMP, including notes from the meetings listed below, can be found in Appendix A of the Final License Application's Exhibit E.

- WQFW RCG Meeting – August 26, 2015
- WQFW RCG Meeting – January 21, 2016
- WQFW RCG Meeting – August 17, 2016
- WQFW RCG Meeting – October 18, 2016
- Joint[1] RCG Meeting – March 28, 2017
- Joint RCG Meeting – July 13, 2017

[1] A Joint RCG Meeting refers to a meeting where all RCGs are present, including the Water Quality, Fish and Wildlife RCG, the Lake and Land Management and Recreation RCG, and the Operations RCG.

APPENDIX B

MEAN DEVIATION EXAMPLE

Appendix B – Mean Hourly Deviation Example Calculations

Inflow to Parr Reservoir is computed as the sum of three upstream USGS gage station readings: Broad River near Carlisle, Tyger River near Delta, and the Enoree River near Whitmire. No adjustment is made for travel time of flow from the gages, and no scaling for ungaged area is applied. The discharge values for the three gages are provided in columns A – C of the tables below. Outflow from Parr Reservoir is measured at the Broad River at Alston USGS gage, located about one mile downstream of Parr Shoals Dam.

Using hourly Project inflow and outflow data for March 15, 2012 (first day of Figure 1 in Section 5.3), mean hourly deviation for the day (24 hourly values) is computed to be **568 CFS** as shown in the table below:

	A	B	C	D	E	F
Date/Time	Broad River CFS	Tyger River CFS	Enoree River CFS	Total Inflow (A+B+C) CFS	Outflow CFS	Deviation ABS(D-E) CFS
3/15/2012 0:00	1,470	411	311	2,192	1,850	342
3/15/2012 1:00	1,580	411	311	2,302	1,820	482
3/15/2012 2:00	1,650	409	311	2,370	1,810	560
3/15/2012 3:00	1,710	406	311	2,427	1,770	657
3/15/2012 4:00	1,730	406	309	2,445	1,770	675
3/15/2012 5:00	1,700	406	309	2,415	1,790	625
3/15/2012 6:00	1,730	406	307	2,443	2,190	253
3/15/2012 7:00	1,730	400	307	2,437	2,350	87
3/15/2012 8:00	2,320	406	307	3,033	2,380	653
3/15/2012 9:00	3,010	403	307	3,720	2,380	1,340
3/15/2012 10:00	3,110	406	307	3,823	2,400	1,423
3/15/2012 11:00	2,510	406	307	3,223	2,380	843
3/15/2012 12:00	1,890	409	307	2,606	2,400	206
3/15/2012 13:00	1,970	406	307	2,683	2,400	283
3/15/2012 14:00	2,320	409	307	3,036	2,410	626
3/15/2012 15:00	2,330	406	307	3,043	2,430	613
3/15/2012 16:00	2,320	406	305	3,031	2,450	581
3/15/2012 17:00	2,260	395	307	2,962	2,460	502
3/15/2012 18:00	2,300	400	305	3,005	2,460	545
3/15/2012 19:00	2,210	398	305	2,913	2,480	433
3/15/2012 20:00	2,280	398	305	2,983	2,480	503
3/15/2012 21:00	2,260	400	305	2,965	2,500	465
3/15/2012 22:00	2,280	395	305	2,980	2,510	470
3/15/2012 23:00	2,280	395	303	2,978	2,510	468
Mean Values:	**2,123**	**404**	**307**	**2,834**	**2,266**	**568**

This same calculation can be performed for any time period. For the 17 day (408 hour) period shown in Figure 1 in Section 5.3, the calculation of mean hourly deviation gives a value of **567 CFS**.

Appendix B – Mean Hourly Deviation Example Calculations

Using hourly Project inflow and outflow data for March 15, 2010 (first day of Figure 2 in Section 5.3), mean hourly deviation for the day (24 hourly values) is computed to be **2,228 CFS** as shown in the table below:

	A	B	C	D	E	F
Date/Time	Broad River CFS	Tyger River CFS	Enoree River CFS	Total Inflow (A+B+C) CFS	Outflow CFS	Deviation ABS(D-E) CFS
3/15/2010 0:00	7,600	1,210	844	9,654	12,100	2,446
3/15/2010 1:00	7,510	1,200	832	9,542	10,700	1,158
3/15/2010 2:00	7,380	1,190	819	9,389	9,700	311
3/15/2010 3:00	7,290	1,180	807	9,277	9,320	43
3/15/2010 4:00	7,200	1,160	798	9,158	9,040	118
3/15/2010 5:00	7,100	1,140	789	9,029	8,850	179
3/15/2010 6:00	6,990	1,130	780	8,900	9,400	500
3/15/2010 7:00	6,880	1,120	771	8,771	10,000	1,229
3/15/2010 8:00	6,740	1,120	762	8,622	11,500	2,878
3/15/2010 9:00	6,720	1,090	756	8,566	13,000	4,434
3/15/2010 10:00	6,740	1,090	748	8,578	14,100	5,522
3/15/2010 11:00	6,700	1,080	739	8,519	14,100	5,581
3/15/2010 12:00	6,630	1,070	733	8,433	13,900	5,467
3/15/2010 13:00	6,520	1,050	730	8,300	13,500	5,200
3/15/2010 14:00	6,440	1,060	727	8,227	13,000	4,773
3/15/2010 15:00	6,330	1,040	719	8,089	9,730	1,641
3/15/2010 16:00	6,260	1,040	716	8,016	8,970	954
3/15/2010 17:00	6,200	1,030	710	7,940	8,850	910
3/15/2010 18:00	6,150	1,020	704	7,874	8,800	926
3/15/2010 19:00	6,110	1,010	699	7,819	8,970	1,151
3/15/2010 20:00	6,030	999	693	7,722	9,470	1,748
3/15/2010 21:00	5,980	988	693	7,661	9,680	2,019
3/15/2010 22:00	5,960	980	687	7,627	9,810	2,183
3/15/2010 23:00	5,900	973	684	7,557	9,650	2,093
Mean Values:	**6,640**	**1,082**	**748**	**8,470**	**10,673**	**2,228**

Again, the same calculation can be performed for any time period. For the 17 day (408 hour) period shown in Figure 2 in Section 5.3, the calculation of mean hourly deviation gives a value of **1,641 CFS**.

The proposed use of mean hourly deviation of outflow from inflow as a metric for evaluating the effectiveness of reductions in downstream flow fluctuations is based on the strong correlation that exists between Project inflow and the mean hourly deviation of outflow from inflow. This can be shown using inflow and outflow data from the period 2000 – 2016 for three periods during the year: March 1 – May 31, March 15 – March 31, and April 1 – May 10. Mean hourly deviation was computed for these periods each year, and the results plotted against inflow.

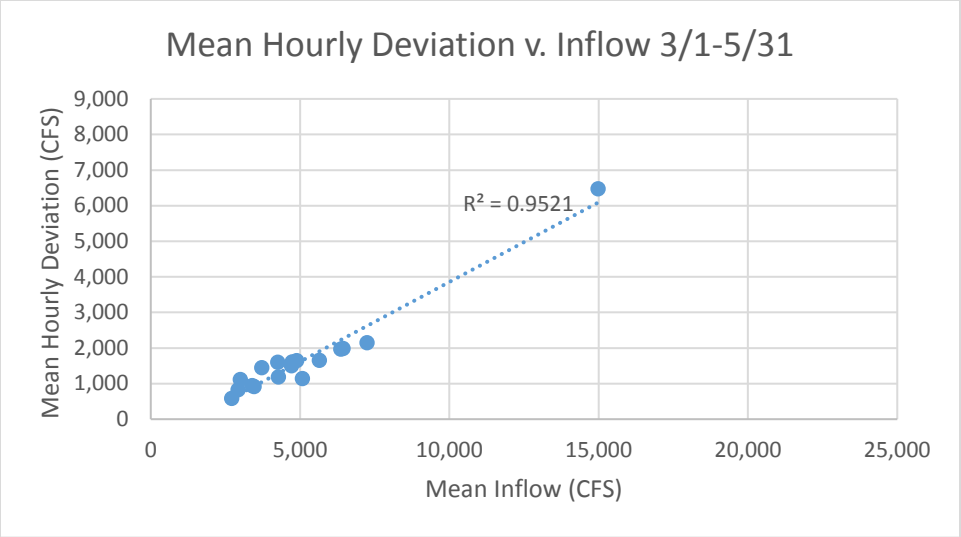
Appendix B – Mean Hourly Deviation Example Calculations

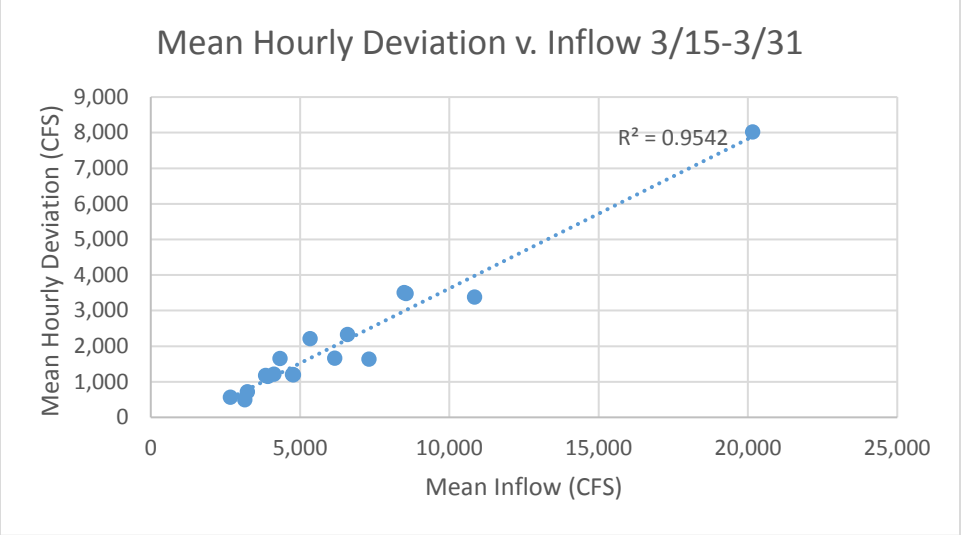
Year	Mean Inflow 3/1-5/31	Mean Hourly Deviation 3/1-5/31	Mean Inflow 3/15-3/31	Mean Hourly Deviation 3/15-3/31	Mean Inflow 4/1-5/10	Mean Hourly Deviation 4/1-5/10
2000	4,250	1,600	8,553	3,483	3,943	1,350
2001	3,716	1,446	8,491	3,506	3,034	1,212
2002	2,996	1,114	4,127	1,215	2,817	1,098
2003	14,980	6,472	20,161	8,018	14,730	6,232
2004	3,458	916	3,240	720	3,808	996
2005	6,438	1,991	10,841	3,384	6,047	2,003
2006	2,715	586	3,146	494	2,777	678
2007	4,889	1,642	4,327	1,655	3,573	911
2008	2,928	823	3,917	1,154	2,789	753
2009	5,644	1,650	6,158	1,667	4,931	1,428
2010	5,073	1,140	7,307	**1,641**	4,465	931
2011	4,278	1,186	4,780	1,197	3,917	1,061
2012	3,399	944	2,667	**567**	2,647	595
2013	7,247	2,147	4,750	1,202	9,943	3,190
2014	6,368	1,970	6,588	2,326	6,936	2,274
2015	4,717	1,499	3,845	1,181	6,542	2,235
2016	4,732	1,614	5,334	2,215	4,630	1,557
Mean	5,166	1,691	6,367	2,096	5,149	1,677

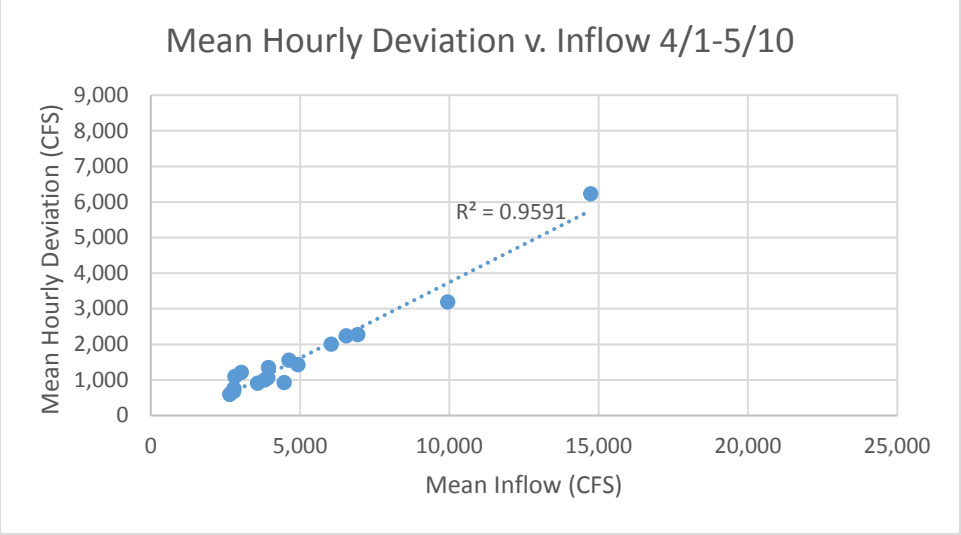
Graphs of mean inflow versus mean hourly deviation for the three time periods in the table above are included on the following page. The best fit linear regression line is shown along with the square of the correlation coefficient, indicating a greater than 95% correlation between mean inflow and mean hourly deviation of outflow from inflow.

In order to use this metric to evaluate the effectiveness of the proposed mitigation measures in reducing downstream flow fluctuations, the mean hourly deviation will be computed from hourly inflow and outflow data, and compared with the deviation that has occurred historically at the same mean inflow. This comparison will be a measure of the amount of fluctuation reduction being achieved. For example, during a future year's evaluation period of March 15 – March 31, use of the proposed fluctuation mitigation measures results in a mean hourly deviation of 1,500 cfs, and mean inflow during this period was 8,000 cfs. The relationship shown in the second graph on the next page indicates that a mean inflow of 8,000 cfs can be expected to result in a mean deviation of 3,000 cfs historically. For the future year in question, the mean hourly deviation was reduced by 50 percent during the evaluation period.

Appendix B – Mean Hourly Deviation Example Calculations







APPENDIX C

EVAPORATION METHODOLOGY

Estimated Evaporation from Parr and Monticello Reservoirs

Evaporation, Central SC			Reservoir Evaporation Loss Estimates in CFS					
	Avg. Monthly FWS Evap. (in).	Evap. Rate (CFS/1000 ac.)	Monticello Evap. Rate (CFS)	VCS Increased Evap. Rate (CFS)	Parr Evap. Rate, (CFS)	**Total Evap. Rate Incl. VCS (CFS)**	**Total Evap. Rate Not Incl. VCS (CFS)**	**Total Evaporation (ac-ft)**
January	1.29	1.75	12	20	8	**40**	**20**	**2,462**
February	1.82	2.74	19	21	12	**51**	**31**	**2,845**
March	3.19	4.33	29	21	19	**70**	**48**	**4,282**
April	4.50	6.31	43	23	28	**93**	**71**	**5,553**
May	5.24	7.10	48	24	31	**103**	**79**	**6,356**
June	5.53	7.75	53	25	34	**112**	**87**	**6,656**
July	5.77	7.82	53	26	34	**113**	**88**	**6,953**
August	5.00	6.78	46	25	30	**101**	**76**	**6,231**
September	4.03	5.64	38	24	25	**88**	**63**	**5,207**
October	3.08	4.18	28	23	18	**70**	**47**	**4,276**
November	2.00	2.80	19	21	12	**53**	**31**	**3,127**
December	1.37	1.85	13	20	8	**41**	**21**	**2,523**
Whole Year	**42.8**	**4.92**	**33**	**23**	**22**	**78**	**55**	**56,473**
May-October	**28.7**	**6.54**	**45**	**24**	**29**	**98**	**73**	**35,680**
	(Sum)	(Average)	(Average)	(Average)	(Average)	(Average)	(Average)	(Sum)

Source: Pan Evaporation Records for the South Carolina Area, John C. Purvis, South Carolina State Climatology Office
FWS values were computed as 75 percent of pan evaporation values.
This factor was estimated from a discussion in NOAA Technical Report NWS 33, Evaporation Atlas for the 48 Contiguous States.

Reservoir evaporation loss estimates are based on surface areas of 6,800 acres for Monticello and 4,400 acres for Parr.

The conversion from evaporation in inches to evaporation rate in CFS per thousand acres is:

(inches) x (1 ft/12 in) x (1 month/31 [or 30 or 28] days) x (43,560 SF/acre) x (1 day/86,400 sec) x (1,000 acres/thousand acres)

Increased evaporation from V.C. Summer Station is estimated using information provided by VCS, and is based on average ambient temperature for each month.