Final Environmental Assessment and Finding of No Significant Impact

Level 4 Drought Operations Savannah River Basin

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US Army Corps of Engineers
Savannah District

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ACRONYMS

CFR---------- Code of Federal Regulations
cfs---------- cubic feet per second
DCP----------Drought Contingency Plan
DHEC ---------- Department of Health and Environmental Control
DNR ---------- Department of Natural Resources
DO ---------- Dissolved Oxygen
EA ---------- Environmental Assessment
EFM ---------- Ecosystems Function Model
EPA---------- Environmental Protection Agency
EPD---------- Environmental Protection Division
FNSI----------Finding of No Significant Impact
HEC ---------- US Army Corps of Engineers Hydrologic Engineering Center
HTRW ---------- Hazardous, Toxic and Radioactive Waste
JST---------- J. Strom Thurmond
msl ---------- mean sea level
NAA---------- No Action Alternative
NEPA ---------- National Environmental Policy Act of 1969
NMFS ---------- National Marine Fisheries Service
NOAA---------- National Oceanic and Atmospheric Administration
NSBL&D -------- New Savannah Bluff Lock and Dam
NWR ---------- National Wildlife Refuge
PDT---------- Project Delivery Team
RBR ---------- Richard B. Russell
SEPA ---------- Southeastern Power Administration
SHPO---------- State Historic Preservation Officer
SRBDCP--------- Savannah River Basin Drought Contingency Plan
USFWS ---------- United States Fish and Wildlife Service
USGS---------- United States Geologic Survey
WY ---------- Water Year

FINDING OF NO SIGNIFICANT IMPACT

Name of Action: Drought Contingency Plan Modification for the Savannah River Basin

1. Description of the Proposed Action

The proposed action consists of refining the 1989 Savannah River Basin Drought Contingency Plan (SRBDCP) for drought Level 4 operations. The daily average release at J. Strom Thurmond Dam would be adjusted from 3,600 to 3,100 cubic feet per second (cfs) in drought Level 4 conditions from November 1 through the end of February (February only after receiving separate approval from NOAA-Fisheries due to concerns about potential impacts to shortnose sturgeon), before transitioning to daily average outflow equals daily average inflow when the pools reach the bottom of their inactive storage. This change would preserve water in the US Army Corps of Engineers reservoirs and delay the time at which those reservoirs would reach the bottom of their inactive storage. The Corps would restore the water flows up to the 3,600 cfs per day on average if requested by either the State of Georgia or South Carolina.

2. Other Alternatives Considered

Alternatives to the Proposed Action were developed as part of the planning process. The alternatives that were considered include:

a. No Action Alternative (Continue with the 1989 Savannah River Basin Drought Contingency Plan (SRBDCP) as updated in 2006)

b. Alternative 1 (Selected Alternative): Retain the major components of the 1989 SRBDCP drought Level 4 operations and adjust one feature. The minimum daily average release at Thurmond Dam would be adjusted from 3,600 to 3,100 cfs for the period November 1 through the end of February (February only after receiving separate approval from NOAA-Fisheries due to concerns about potential impacts to shortnose sturgeon) while in drought Level 4 conditions.

c. Alternative Considered but Eliminated from Detailed Consideration: A preliminary alternative was initially considered to discharge at a rate where outflow equals inflow beginning at the point where the reservoir pools are at the bottom of their conservation pools (top of the inactive storage). This alternative was determined to have unacceptable adverse impacts downstream of JST to threatened and endangered species, water quality and water supply.

3. Coordination

Savannah District has coordinated this action with Federal, State and local agencies, including public review of a Draft Environmental Assessment.

4. Conclusions

Based on a review of the information contained in this Environmental Assessment (EA), I have determined that the preferred alternative is the best course of action. I have also determined that this Drought Contingency Plan Modification for the Savannah River Basin is not a major Federal action within the meaning of Section 102(2)(c) of the National Environmental Policy Act of 1969. Accordingly, the preparation of an Environmental Impact Statement is not required. My determination was made considering the following factors discussed in the EA to which this document is attached:

a. The proposed action would not have significant adverse effects on any threatened or endangered species (may affect, but not likely to adversely affect shortnose sturgeon, manatee, and wood stork).

b. The proposed action will have an unknown affect upon historic properties. Savannah District will enter into a Programmatic Agreement with the Georgia and South Carolina State Historic Preservation Officers and interested Native American Tribes to identify activities necessary to identify, evaluate, and mitigate affects to historic properties and achieve compliance with Section 106 of the National Historic Preservation Act (P.L. 89-665, as amended).

c. The proposed action would not adversely impact air quality.

d. The proposed action complies with Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations."

e. The proposed action would not cause any significant long term adverse impacts to wetlands.

f. No unacceptable adverse cumulative or secondary impacts would result from the implementation of the proposed action.

5. Findings

The proposed action to modify the Drought Contingency Plan for the Savannah River Basin during Level 4 droughts would result in no significant environmental impacts and is the alternative that represents sound natural resource management practices and environmental standards.

31 Oct 2011
Date

Jeffrey M. Hall
Colonel, US Army
Commanding

FINAL ENVIRONMENTAL ASSESSMENT

1.0 PURPOSE AND NEED FOR THE PROPOSED ACTION

1.1. INTRODUCTION

1.1.1. History

The Savannah River Basin experienced a severe drought that began in early 2006. Rainfall and resulting stream flow were particularly low, causing the reservoirs to drop faster than any previous drought on record. Hartwell and Russell Lakes experienced their lowest pool elevations since they were initially filled. This latest drought has become the new drought-of-record for the basin.

The Corps manages the three Federal impoundments on the Savannah River as a system and uses a Water Control Manual (Manual) to describe how it will operate these projects. The 1989 DCP is a component of that Manual and was developed (1) to address the effects of the Corps' operation on those impoundments and the downstream portion of the river, and (2) to assist the States of Georgia and South Carolina in drought contingency planning in their water management responsibilities for the Savannah River Basin.

The Corps' 1989 DCP and the associated 2006 Environmental Assessment (EA) for modifications to that plan describe activities that would be conducted during four stages of a continuing drought. Those four stages correspond to different lake levels. When the reservoirs reach the Level 1 trigger elevation, the Corps issues a public safety advisory concerning recreational use of the reservoirs. When Levels 1-3 are reached, the Corps reduces reservoir discharges. When Level 4 is reached, the conservation pools are empty. If drought conditions persist after Level 4 is reached, a discharge of 3600 cubic feet per second (cfs) would be maintained for as long as possible and then further reduced to the point where the outflow from the lakes equals the net inflow.

The actions the Corps would take surrounding the Level 4 trigger were not evaluated in detail when the plan was originally developed or during the 2006 EA. The Reservoir System Simulation modeling conducted to analyze the effects of the various operational scenarios during development of the 1989 DCP and the 2006 EA always indicated that the lakes would not reach the bottom of conservation pool. This modeling was conducted using inflows that were the drought of record at that time. Sensitivity analyses revealed that the drought would need to extend at least three additional years to reach Level 4. Therefore, detailed consideration was never given for the best way to operate once that trigger was reached.

A major objective of the Corps' Drought Contingency Plan is to avoid reaching the bottom of the conservation pool.

In 1986, the Savannah District developed a Short-Range Drought Water Management Strategy to address the worsening water shortage conditions in the Savannah River Basin. That document served as a guide for using the remaining storage in the Corps-operated Savannah River impoundments for the duration of the drought. The short-range strategy also served as a prelude to the development of a long-term drought strategy, the Savannah River Basin Drought Contingency Plan (SRBDCP) of March 1989. That plan was modified in 2006 by revising the actions that would be taken at various drought trigger levels. The intent of those modifications was to act earlier in a drought to preserve additional water in the lakes, thereby delaying the time when the conservation pools would be depleted and outflows would reflect only the inflows that the lakes received. The severity of the latest drought created conditions that stressed the traditional management concepts which Savannah District followed to regulate the individual Corps impoundments and the integrated water management of the three lakes. Concerns and conflicts over competing water issues intensified as drought conditions became more severe and lake levels continued to fall.

In October 2007, the Federal and State natural resource agencies agreed with Savannah District's request to temporarily reduce the minimum daily average discharge from Thurmond Dam from the 3,800 cfs level specified in the 2006 EA back to the 3,600 cfs level that was in the original DCP. The Corps' South Atlantic Division office approved that temporary deviation to the DCP that same month. This action was taken in response to the continued drought as a means of preserving water in the lakes and delaying the time when the conservation pools would be depleted. As a result, downstream resources experienced slightly more impacts than would have occurred with strict adherence to the Drought Contingency Plan.

As the latest drought in the southeastern US completed its third year, the Savannah River reservoir system operated by the Army Corps of Engineers (hereafter referred to as the Savannah System) experienced extreme pressure and difficulties. In December 2008, the Savannah System had less than 25% of its conservation storage remaining. Hartwell Lake had about 33% of its conservation storage left, while Thurmond had only 10% of its conservation storage remaining.

Arrival of the spring 2009 recharge season brought relief to the drought conditions. Lake levels and conservation storage began to return to near normal levels and by November 2009 they were completely restored.

This EA was developed so the District could evaluate different options for operating the reservoirs should the Savannah System reach drought Level 4 conditions.

1.1.2. Requirement for Environmental Documentation

An Environmental Assessment (EA) is prepared in conformance with procedures established by the National Environmental Policy Act of 1969 (NEPA) to identify impacts expected to result from implementation of a proposed action. The assessment ensures that the decision-maker is aware of the environmental impacts of the action prior to the decision to proceed with its implementation. This Act requires the consideration of the environmental impacts associated with a "Proposed Action" and its alternatives prior to implementing the action. This EA addresses proposed revisions to the SRB Drought Contingency Plan.

1.1.3. General Objectives

The objectives of the Proposed Action are to:

- ⇨ determine the best way to operate the Corps reservoirs on the Savannah River after they reach Level 4 drought conditions.
- ⇨ comply with all applicable environmental laws, regulations, and policies

1.2. PURPOSE AND NEED

The Savannah River Basin experienced a major drought from 2006 to 2009. Rainfall and resulting stream flow were particularly low, causing the reservoirs to drop faster than during previous droughts. The pools in the Corps' reservoirs approached the bottom of their conservation pool, levels that had never been seen before. As a result, the Savannah District determined it should examine in greater detail the best way to operate those reservoirs should a future drought empty the conservation pools and reach Level 4 conditions. The purpose of the Proposed Action is to define a set of system operations when operating in Level 4 drought from 1 November through the end of February (February only after receiving separate approval from NOAA-Fisheries due to concerns about potential impacts to shortnose sturgeon). The Proposed Action is needed in order to operate the lakes so that the inactive storage within the lakes would be preserved for drinking water supply as long as possible.

1.3. SCOPE

The scope of this EA is limited to assessing the potential environmental and socio-economic effects resulting from implementing the Proposed Action and the No Action Alternative (NAA). After eliminating alternatives that are not considered feasible or effective, the potential environmental impacts associated with the NAA are compared to the Proposed Action. The action is limited to operations at the Corps' Savannah River Basin projects while operating in Level 4 drought.

1.4. STUDY METHODOLOGY

Water managers for the States of Georgia and South Carolina jointly performed a volume analysis of the storage remaining within the conservation pools of the three Corps-managed lakes on the Savannah River. In 2007, they considered several different drought inflow and outflow scenarios, and computer modeling focused on how long the conservation storage could be preserved within the three-lake system.

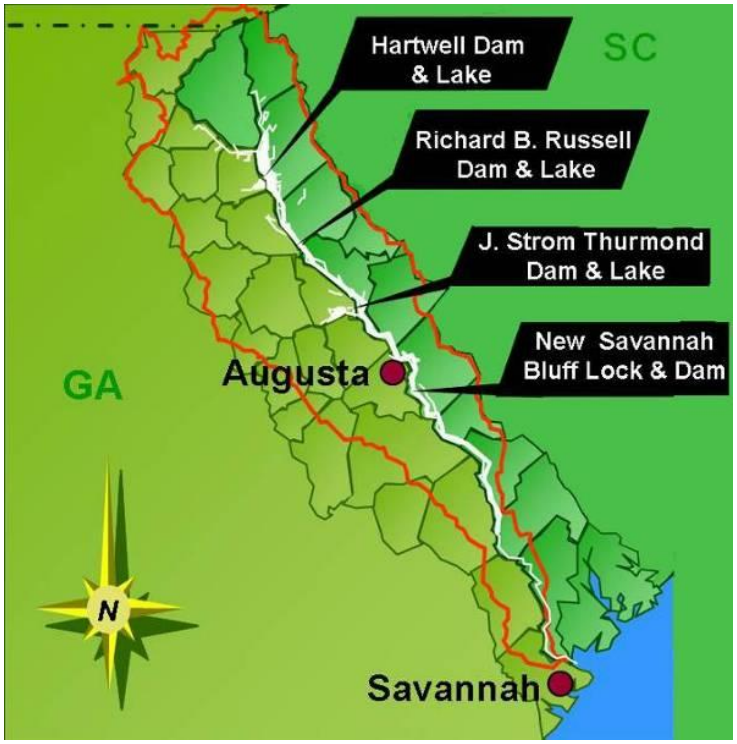
The States initially considered several hydrologic and operating scenarios. Among other factors, those scenarios reflected the range of potential inflow amounts that could be expected in the basin. Those alternatives and hydrologic conditions were refined after more data became available from the National Weather Service and lake levels declined over the 2008 summer months. The hydrologic conditions they ultimately chose as inputs for the analysis were a 10 percent reduction from the 2007 inflows.

The goal of the alternatives analysis for the previous 2008 EA was to identify an operating approach that would allow the conservation storage within the lakes to decline at a slower rate, while balancing the authorized project purposes of water supply, water quality, fish and wildlife, and hydropower. If such an alternative could be found, the point at which the conservation storage within the lakes would be depleted would be postponed, delaying Level 4 conditions.

For this analysis concerning inactive storage, hydrodynamic modeling was performed using inflows from 2008 with a 10% reduction. The intent was to identify the impacts of the outflow scenarios on the various project purposes. The proposed alternative consists of a targeted release of 3,100 cfs from Thurmond Dam for the cooler months of November 1 through February (February only after receiving separate approval from NOAA-Fisheries due to concerns about potential impacts to shortnose sturgeon) when the lakes are experiencing Drought Level 4 conditions, but before going to outflow equals inflow. The No Action Alternative follows the water release procedures described in the previously-approved Savannah River Basin Drought Contingency Plan, including previously-approved deviations. A methodology was developed in which the remaining inactive storage in the reservoirs would be used to minimize impacts on drinking water supply populations.

2.0 AFFECTED ENVIRONMENT

2.1. DESCRIPTION OF THE SAVANNAH RIVER BASIN



The Savannah River basin has a surface area of approximately 10,577 square miles, of which 5,821 square miles are in Georgia, 4,581 square miles are in South Carolina and 175 square miles are in North Carolina. The basin includes portions of 27 counties in Georgia, 13 counties in South Carolina and four counties in North Carolina. Although the basin is predominantly rural, metropolitan areas are experiencing significant growth and development pressures. The growth is occurring primarily in the areas of Augusta and Savannah, Georgia, although many smaller cities and towns are also growing. The study area drains portions of three physiographic provinces: the Blue Ridge Mountains, the Piedmont and the Coastal Plain. In its middle and upper reaches the river flow is regulated by several reservoirs, including three large multipurpose Corps projects (Hartwell Lake, Richard B. Russell (RBR) Lake and J. Strom Thurmond (JST) Lake) and two large private

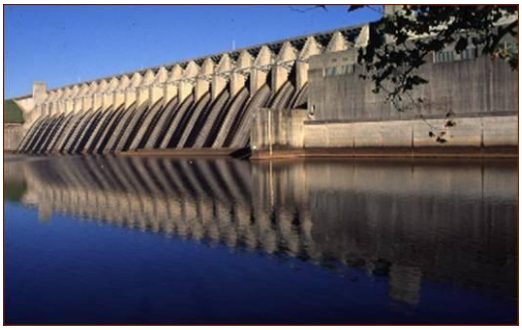
power reservoirs (Lakes Keowee and Jocassee). Other structures include the New Savannah Bluff Lock and Dam, the Stevens Creek Dam and the Old Lock and Dam at the Augusta Canal.


Hartwell Lake and Dam

The Tugaloo River and the Seneca River meet at what is known as "The Forks" and form the Savannah River at River Mile 312. Lakes Keowee and Jocassee are upstream on the Seneca River System and Burton Powerhouse, Nacoochee Powerhouse, the Mathis-Terrora development and Tallulah Falls Powerhouse are upstream on the Tugaloo River System.


R. B. Russell Lake and Dam

Water discharge in the Savannah River varies considerably both seasonally and annually, even though it is largely controlled by releases from the Corps' JST Dam located about 20 miles northwest of Augusta, Georgia. Discharge is typically high in winter and early spring and low in summer and fall, but regulation by upstream reservoirs has reduced natural flow variations. At the New Savannah Bluff Lock and Dam located 12 miles downstream of Augusta, average annual discharge is about 10,000 cfs. Average discharge at Clyo (Effingham County, Georgia) is 12,040 cfs. Tidal effects extend upstream to approximately river mile 45 (Reconnaissance Planning Aid Report on the Savannah River Basin Study, US Fish and Wildlife Service, July 1999).


J. S. Thurmond Lake and Dam

2.2. DESCRIPTION OF CORPS PROJECTS

The Corps maintains and operates three large multipurpose projects in the basin. Hartwell Dam and Lake (55,950 acres at summer Guide Curve) is located 89 miles upstream of Augusta and was filled in 1962. RBR Dam and Lake (26,650 acres at summer Guide Curve) is located 59 miles upstream of Augusta and was filled in 1984. JST Dam and Lake (70,000-acres at summer Guide Curve) is located 22 miles upstream of Augusta and was filled in 1954.


New Savannah Bluff Lock and Dam

The upper zone of each pool, the area above the guide curve is specifically designated as Flood Storage. This portion of the pool has been reserved for managing high inflows due to storm events. The flood management objective is to store the inflow from these events while making releases during and after these storms at non

damaging rates. The amount of flood storage required at each project was determined in the initial design. Whenever storm events cause pool elevations to rise into this zone, flood management takes priority, and all other project purposes become secondary or incidental.

The middle zone of each pool, the storage residing between the guide curve and the top of the inactive storage, is designated conservation storage. The water stored in the conservation zone is used to meet all of the authorized project purposes other than Flood Control.

The authorized project for the Savannah River between Augusta and Savannah, Georgia, provides for a navigation channel 9 feet deep and 90 feet wide from the upper end of Savannah Harbor (mile 21.3) to the head of navigation just below the 13th Street bridge in Augusta (mile 202.2). This is a distance of 180.9 miles. The project also includes the lock and dam at New Savannah Bluff, located about 12 miles downstream from Augusta. Channel modifications, including deepening, widening, snagging, construction of bend cutoffs, and construction of pile dikes, were made on the river to provide the 9-foot depth. However, by 1980, shipping on the river had virtually ceased, and channel maintenance was discontinued.

The existing authorized Savannah Harbor Navigation Project provides a channel 44 feet deep and 600 feet wide across the ocean bar; 42 feet deep and 500 to 600 feet wide to the vicinity of Kings Island Turning Basin; and 30 feet deep and 200 feet wide to a point l,500 feet downstream of the Houlihan Bridge (US Highway 17). The terminus of the deep-draft channel in Savannah Harbor is at approximately river mile 21. The project provides turning basins for vessels at various locations in the harbor (Reconnaissance Planning Aid Report on the Savannah River Basin Study, US Fish and Wildlife Service, July 1999).

The storage at each of the Corps of Engineers three multipurpose projects on the Savannah River is Congressionally authorized to be used for specific purposes including Flood Control, Recreation, Fish and Wildlife Management, Hydropower, Water Supply, Water Quality, and Navigation. The storage at each multipurpose project is divided into three zones: Flood Control, Conservation, and Inactive Storage. Figure 1 below shows the Flood Control Storage, Conservation Storage and Inactive Storage in acre feet for each of the lakes in the Savannah River System. Figures 2 and 3 below introduce what are referred to as Action Levels. The Inactive Storage shown in Figure 1 corresponds to Level 4 shown in Figures 2 and 3. These will be referred to throughout this document.

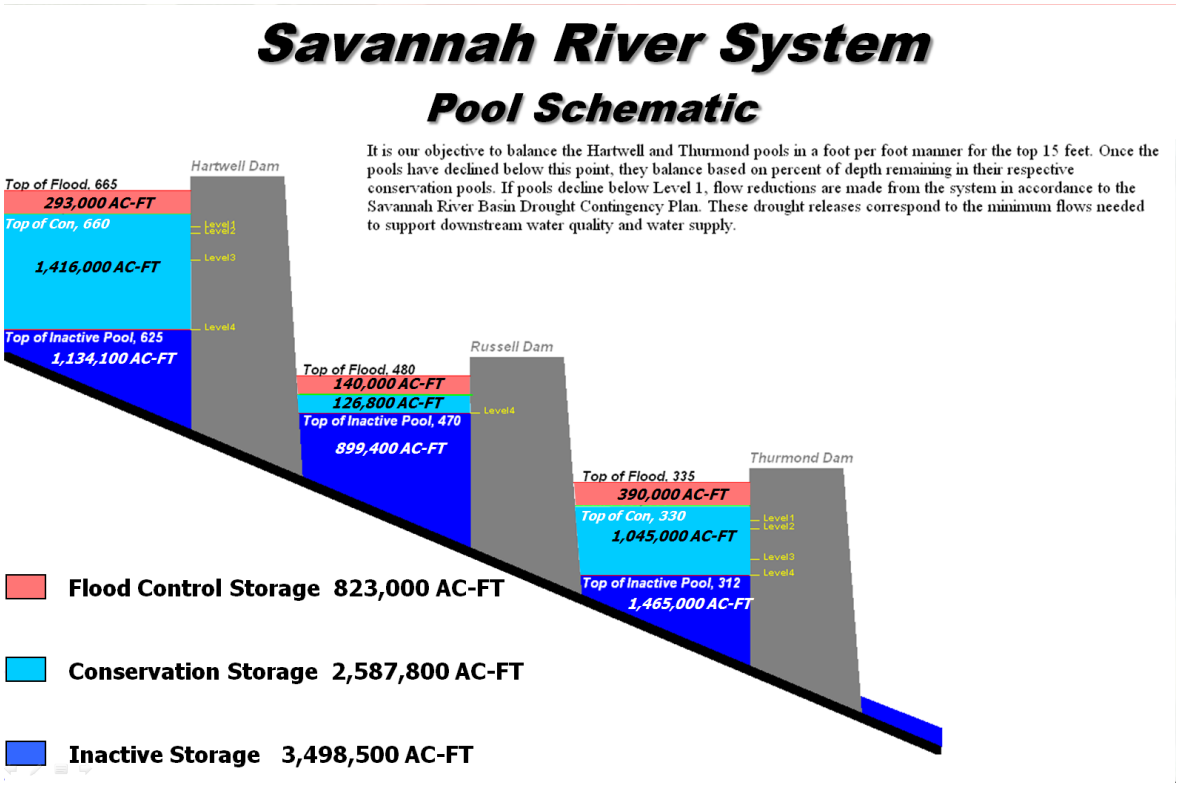


Figure 1: Savannah River System Pool Schematic

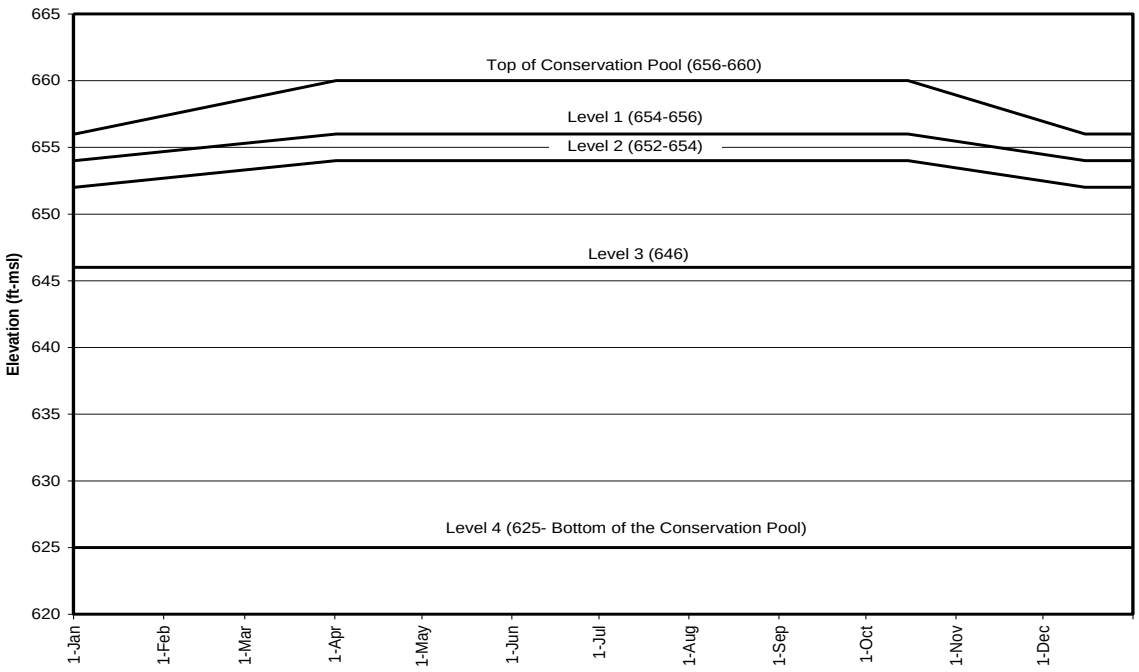


Figure 2: Hartwell Action Levels for the No Action Alternative

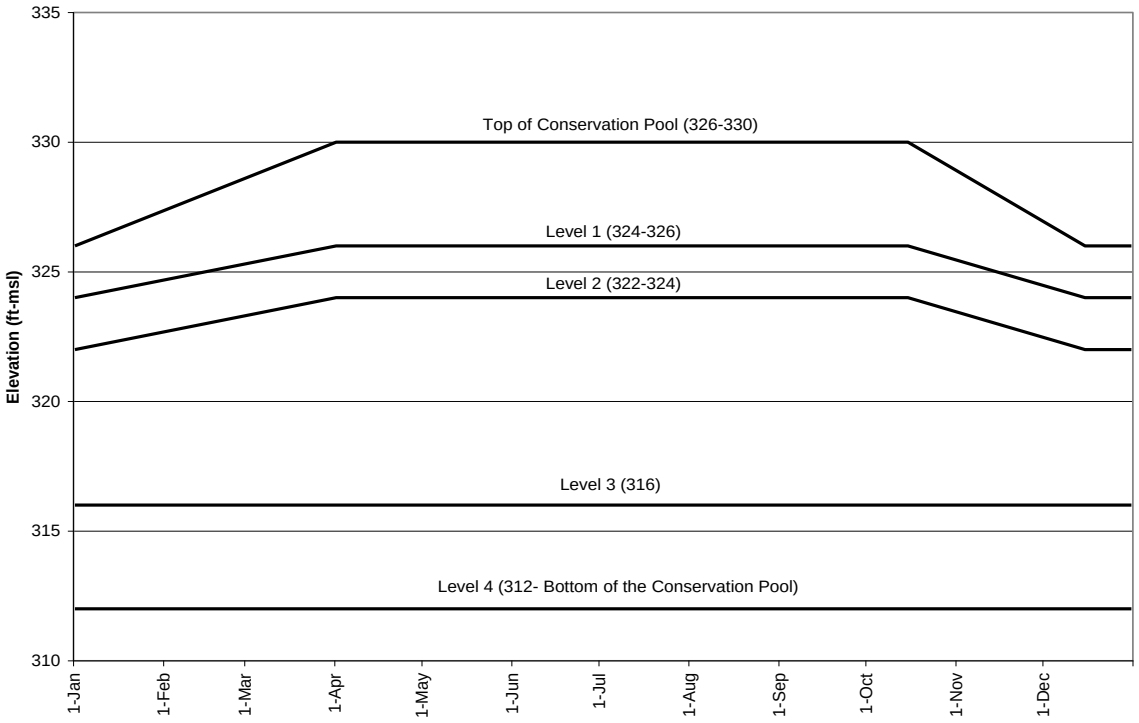


Figure 3: Thurmond Action Levels for the No Action Alternative

There are various structures in the dams that are used to release water. See Table 1 below for pertinent outlet information, Table 2 for minimum generating elevations and Figures 4-6 for additional pertinent information for each of the dams. The normal method of releasing water at the projects is through the hydropower turbines during generation of electricity. As the pools decline into inactive storage, releases from the projects would continue through generation for as long as possible. A report by the Hydroelectric Design Center of Expertise, dated September 04, 2009, analyzes generation into the inactive storage pool and estimates impacts to generation below the design limits. Estimates have been made that release by generation could continue, below the minimum design depth for generation, for a significant depth into the inactive storage pool. This report suggests that water can be released well below the spillway crest through generation. Therefore, spillway gate releases would not be required for Level 4 operations. However, at a certain point, generation will no longer be an option, and the generating units will switch to "Speed no Load" (release through turbines without generation), to prevent destroying the generator. Speed no Load operations could continue for some additional depth until vortices form, potentially damaging the turbines. At that point releases through the turbines would cease and releases through the sluices would be initiated. See HDC Report, Appendix J for details.

Table 1: Reservoir Outlet Information

	Riverbed Elevation	Spillway Gates	Spillway Crest	Sluice Invert	Sluice Quantity	Sluice Size
Hartwell	475/479	12	630	500	2	5.7'wide x 10' tall
Russell	300/304	10	436	320	5	5.7'wide x 10' tall
Thurmond	176	23	300	190	8	4'wide x 9' tall

Table 2: Summary of Turbine Operations

Summary of Turbine Operations at Various Forebay Levels					
		Minimum Forebay Level (FMSL)			Assumed Tailwater Level
Powerhouse	*Units*	*Design*	*Generation*	*Speed-no-Load*	(FMSL)
Hartwell	1-4	625	596	574	473
Hartwell	5	625	591	573	473
R. B. Russell	1-4	470	434	418	310
R. B. Russell	5-8	470	430	415	310
J. Strom Thurmond	1-7	312	294	275	184

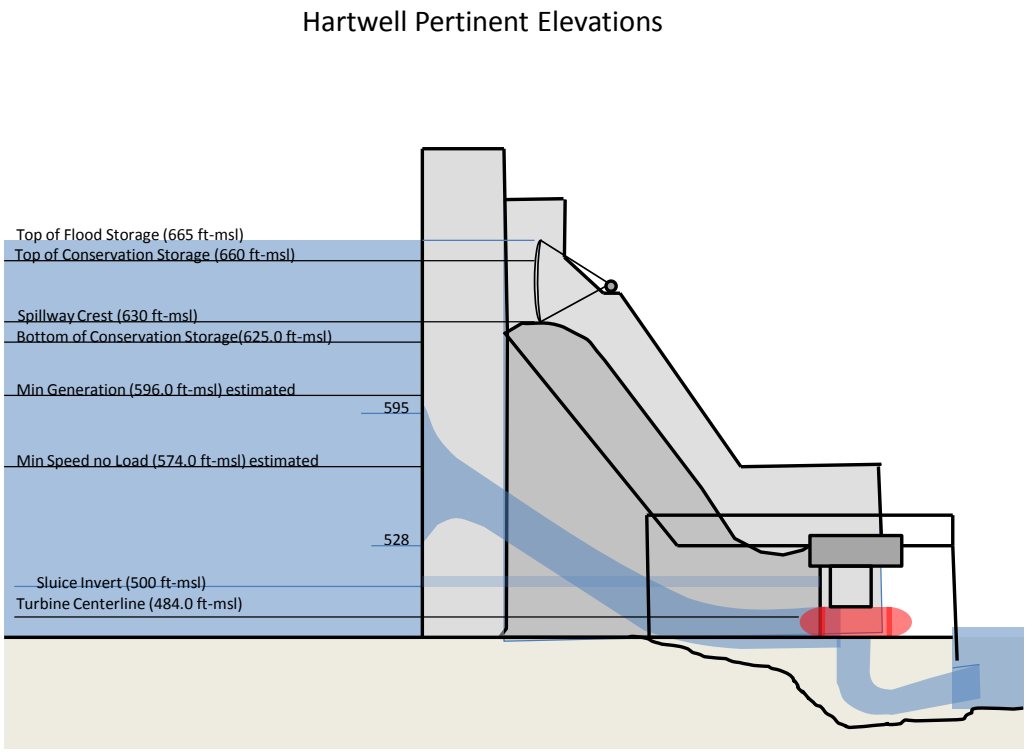


Figure 4: Hartwell Pertinent Elevations

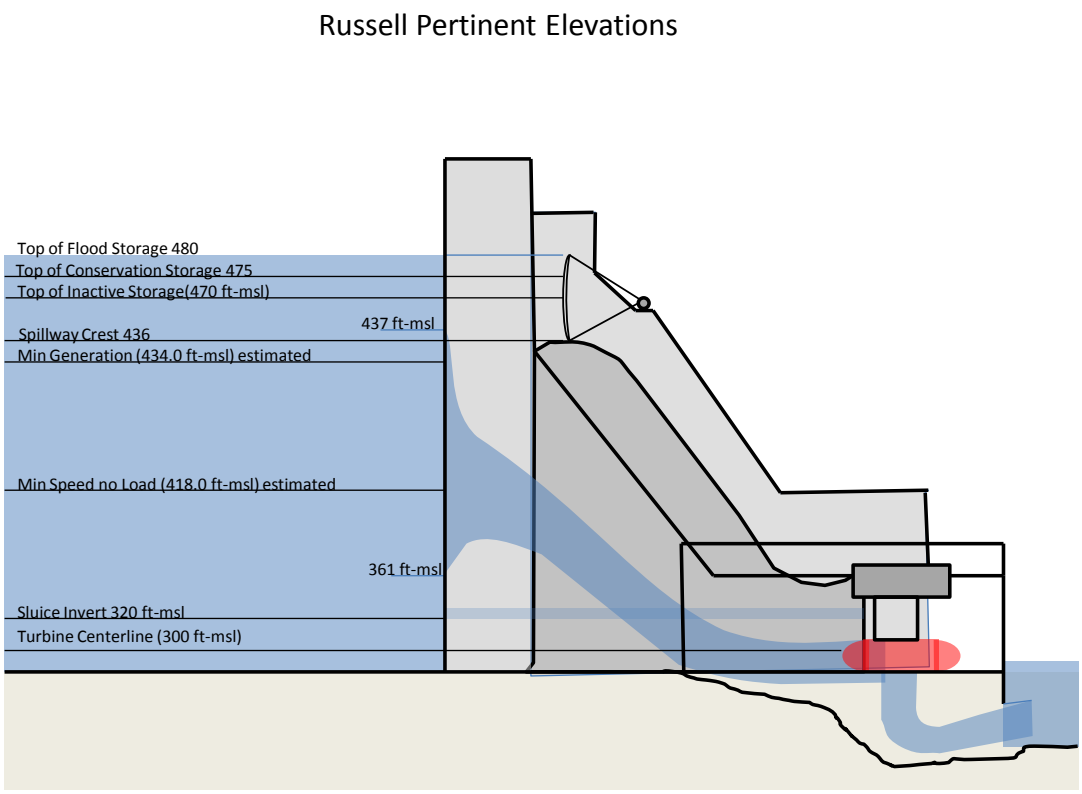


Figure 5: Russell Pertinent Elevations

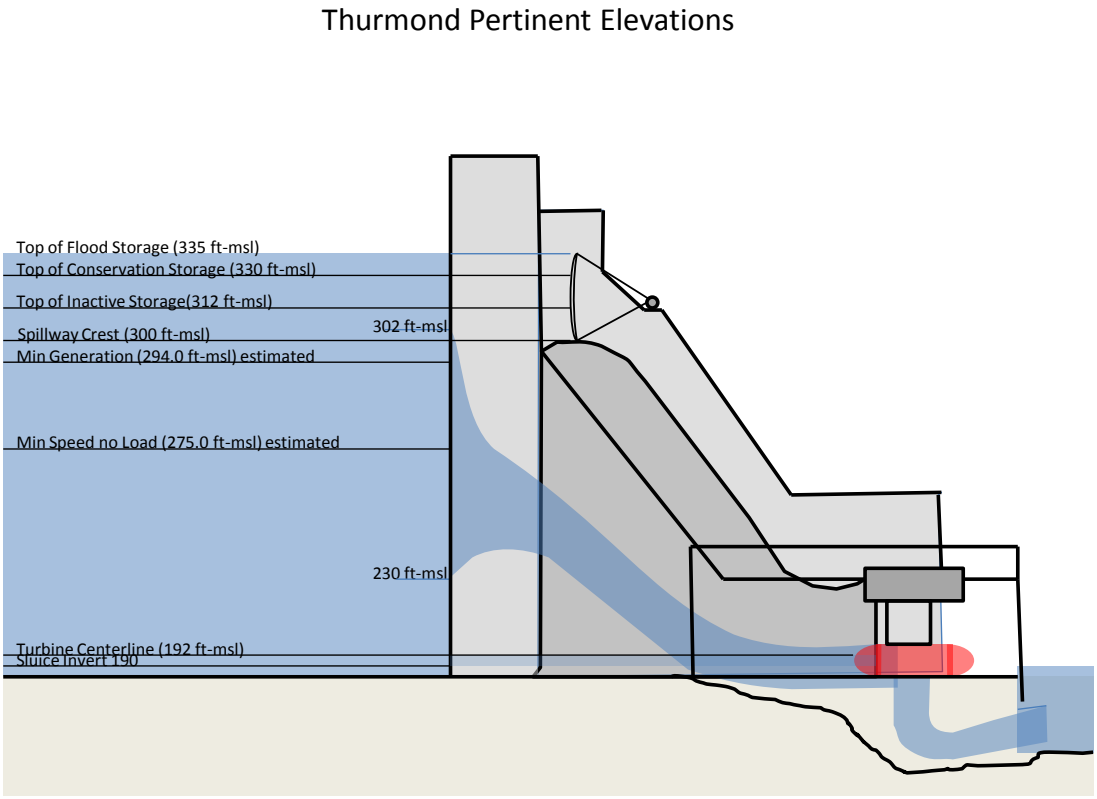


Figure 6: Thurmond Pertinent Elevations

2.3. RECREATION

The lakes of the Savannah River Basin provide excellent opportunities for water resource-based recreation. However, in times of drought, when the lake levels of Hartwell and JST Lake drop 6 feet below summer Guide Curve elevations, drought information sheets are disseminated to the public. These sheets instruct the public to only use marked navigation channels, since unmarked hazards become more prevalent increasing risks of boating accidents outside the channel. In addition, at 6 feet below summer Guide Curve elevations, designated swimming areas become dry. However, adverse impacts become noticeable at designated swimming areas when lake levels drop 3 feet below summer Guide Curve elevations.

According to the Savannah River Basin Water Use Data Collection Presentation of Findings, June 2004, conducted by Zapata Engineering. P.A., for the US Army Corps of Engineers, Savannah District, during periods of low water, approximately 39 percent of the recreational users surveyed said that they would make a water-based recreational trip to the same lake, 41 percent would make a water-based recreation trip elsewhere, and 20 percent would not make a

water-based recreation trip. Therefore, during periods of drought, 61 percent of non-drought visitors do not make a water resource-based recreation trip to Hartwell and JST Lakes. Respondents of this survey also indicated that their recreational activities are seriously impacted when lake levels drop an average of 7.5 feet below full pool. According to some lake managers, water recreation is more difficult and less convenient during periods of drought because recreationists may have to travel further distances to a useable ramp for access to the lake, they may consider the lake aesthetically unpleasing and they may recognize the increased risk of damaging their boat and person.

2.3.1. Public Boat-Launching Ramps and Private Docks

Public boat-launching ramps and private docks provide recreational access to the lakes of the Savannah River Basin. The following paragraphs discuss the facilities that exist on the three Corps reservoirs.

Hartwell Lake

There are 95 public boat-launching ramps and marinas located on Hartwell Lake. From lake elevation 660 to 658.01 feet mean sea level (msl) all ramps are useable. At and below lake level 658 feet msl, the first 6 boat-launching ramps become unusable. At and below lake level 657 feet msl, 6 more or a total of 12 boat-launching ramps become unusable. At and below lake level 656 feet msl, one more or a total of 13 boat-launching ramps become unusable. At and below lake level 655 feet msl, 3 more or a total of 16 boat-launching ramps become unusable. At and below lake level 654 feet msl, 1 more or a total of 17 boat-launching ramps become unusable. At and below lake level 653 feet msl, 6 more or a total of 23 (24.2 percent) public boat ramps become unusable, but 72 (75.8 percent) remain serviceable. When lake levels drop to 646 feet msl, 43 (45.2 percent) boat-launching ramps become unusable. If lake levels were to ever drop to 638 feet msl, then all the ramps are unusable. The below Table 3 shows that all listed ramps are unavailable in Level 4, which begins at 625 feet msl.

Table 3: Hartwell Lake - Unusable Ramps by Lake Level 658 to 652 feet msl

NAME OF BOAT RAMP	LAKE LEVEL RAMP BECOMES UNUSABLE (feet msl)
Sadlers Creek State Park.	658.0
Tugaloo State Lower	658.0
Jacks Landing, SC	658.0
Holders Access, SC	658.0
Lakeshore	658.0
Mountain Bay	658.0
Reed Creek, GA	657.5
Rocky Ford, GA	657.5
Brown Road, SC	657.0
Hurricane Creek, SC	657.0
Seneca Creek, SC	657.0
Walker Creek, GA	657.0
Cove Inlet, SC	656.5
Durham, SC	655.7
South Union, SC	655.5
Bradberry, GA	655.0
Timberland, SC	654.0
Darwin Wright City Park.	653.0
Tillies, SC	653.0
White City, SC	653.0
Barton Mill, SC	653.0
Port Bass, SC	653.0
Seymour, GA	653.0
Paynes Creek (inner right)	652.6
Paynes Creek (left)	652.6
Big Oak Left Lane (New)	652.5
Tabor, SC	652.5
Townville, SC	652.3
Twelve Mile (new left lane)	652.0
Eighteen Mile Creek	652.0

Since 1985, Lake Hartwell has a record low of 637.5 feet msl on 9 Dec 2009. As a result of the low water, Savannah District closed all of its boat ramps on Hartwell Lake on October 25, 2008. The District's policy is that three feet of water should be present at the end of a ramp for the safe launching of recreational boats. Gravel had been placed at the end of five ramps to allow their continued use. However, such use is at the boat owner's risk.

There are approximately 10,500 private boat dock permits issued on Hartwell Lake. This number is almost double of what was reported in the March 1989 SRBDCP. In that report, it was roughly estimated that about 50 percent of the private docks were unusable below lake level 652 feet msl and about 90 percent were unusable at 643 feet msl. Since the 1989 SRBDCP report, development has expanded to areas adjacent to shallow coves; therefore, it is probable that more than 50 percent of private docks would be rendered unusable at 652 feet msl.

RBR Lake

RBR Lake had a record low of 469.5 feet msl on 20 Jan 2009. There are approximately 30 public boat-launching ramps on RBR Lake. All of these ramps are useable until lake levels reach 466 feet msl. Lake levels at RBR Lake are not projected to drop more than five feet below full pool through drought Level 3 and early into Level 4. Therefore, public boat-launching ramps on RBR Lake were not adversely impacted during the drought of record. Since RBR is the first lake to be drained in a Level 4 water management scenario, all 30 public boat-launching ramps would be unusable.

JST Lake

Since 1985, JST Lake has a record low of 312.79 feet msl on 15 Feb 1989. There are 84 public boat-launching ramps and marinas located on JST Lake. Above lake elevation 326 feet msl to 330 feet msl all ramps are useable and allow for the launching of boats with up to 3 feet of draft. At and below lake level 326 feet msl, the first boat-launching ramp becomes unusable. At and below lake level 325 feet msl, 4 more or a total of 5 boat-launching ramps become unusable. At and below lake level 324 feet msl, 7 more or a total of 12 boat-launching ramps become unusable. At and below lake level 323 feet msl, 5 more or a total of 17 (20 percent) boat-launching ramps become unusable while 67 (80 percent) remain useable. At and below lake level 317 feet msl, 33 (39 percent) boat-launching ramps become unusable. At and below lake level 315 feet msl, 46 (55 percent) boat-launching ramps become unusable. All boat-launching ramps are unusable at 306 feet msl. The below Table 4 shows that all listed ramps are unavailable in Level 4, which begins at 312 feet msl. Six boat ramps are usable between 312 and 306 feet msl.

Table 4: J.Strom Thurmond - Unusable Ramps by Lake Level 326 to 317 feet msl

NAME OF BOAT RAMP	LAKE LEVEL RAMP BECOMES UNUSABLE (feet msl)
Wildwood Park (5 ramps)	326.0
Hwy 28 Access Ramp	326.0
Long Cane Creek Ramp	325.7
Catfish Ramp	325.5
Calhoun Falls Ramp	325.0
Broad River Campground	325.0
Double Branches Ramp	324.8
Cherokee Recreation Area (2 lanes)	324.7
Mistletoe State Park (2 lanes)	324.2
Soap Creek Park	324.0
Little River Quarry Ramp	324.0
Scotts Ferry (New Ramp)	323.8
Leroys Ferry Campground	323.6
Clay Hill Campground	323.5
Winfield Subdivision (2 lanes)	323.1
Mt Pleasant Ramp	322.4
Bussey Point	321.0
Chamberlain Ferry Ramp	321.0
Modoc Campground	321.0
Murray Creek Ramp	321.0
Parkway Ramp	321.0
Fishing Creek/Hwy 79 Ramp	320.7
Soap Creek Subdivision	320.0
Scotts Ferry (New Ramp)	318.8
Wildwood Park (2 lanes)	315.0
Wildwood Park (2 lanes)	317.0
Wildwood Park (2 lanes)	320.0
Cherokee Recreation Area (2 lanes)	318.2
Soap Creek Marina	318.0
Raysville Marina	317.6
Soap Creek/Hwy 220 Ramp	317.0

There are approximately 1,851 private boat docks on the JST Lake. This is a 25 percent increase from the SRBDCP report. In that report, at 322 feet msl, about 50 percent of the docks were considered unusable. At 313 feet msl, 95 percent of the private docks were considered unusable. Since the 1989 SRBDCP report, development has expanded to areas adjacent to shallow coves; therefore, it is probable that more than 50 percent of private docks would be rendered unusable at 322 feet msl.

2.3.2. Swimming

Swimming areas on the Corps reservoirs are mainly used from May through September. The following paragraphs discuss the facilities that exist on the three Corps reservoirs.

Hartwell Lake
At Hartwell Lake, there are 22 Corps operated swimming beach areas located in 13 recreation areas. When lake levels reach 654 feet msl, all designated swimming areas are dry. However, when the lake level drops below 657 feet msl, swimming areas become less desirable due to the reduced water area available for swimming. When this happens, swimming occurs outside the designated swimming area, increasing the risk of fatalities or injury. During the 1986 drought, when swimming beaches were unusable, recreation fatalities associated with swimming activities increased from three to nine. When the beaches were back in service in 1987, no recreation fatalities associated with swimming activities occurred.

RBR Lake
There are no Corps operated designated swimming areas at RBR.

JST Lake
At JST Lake, there are 18 Corps operated swimming beach areas. When lake levels reach 324 feet msl, the designated swimming areas are dry. However, when the lake level drops below 327 feet msl, swimming beaches become less desirable due to the reduced water area available for swimming. When this happens, swimming occurs outside the designated swimming area, increasing the risk of fatalities or injury.

2.4. WATER SUPPLY

"Estimated" service populations were developed by the Georgia EPD and South Carolina DHEC. These numbers were used to calculate the total impact on water supply populations on the reservoirs. "Reported" service populations were provided by the water plant officials with this knowledge.

Hartwell Lake
There are 7 water supply users on Hartwell Lake. The highest intake elevation is 645 feet msl, while the lowest is 610.00. The intakes total reported service population is approximately 221,000-321,000. The estimated service population for drinking water is 148,000.

RBR Lake
There are 4 water supply users on RBR. The highest intake elevation is 464 feet msl, while the lowest is 454.75. The intakes total reported service population is approximately 17,050. The estimated service population for drinking water is 15,127.

JST Lake
There are 5 water supply users on JST Lake. The highest intake elevation is 313.0 feet msl, while the lowest is 304.0. The intakes total reported service population is approximately 43,596. The estimated service population for drinking water is 110,500.

Downstream of JST Lake

Sixteen major water supply users exist downstream of Thurmond Dam. The major municipal users include Augusta and users near the coast. The City of Augusta operates and withdraws water from the Augusta Canal. The City of North Augusta withdraws water from the pool upstream of the New Savannah Bluff Lock and Dam (roughly river mile 187.5). The Beaufort-Jasper County Water Supply Authority withdraws water at river mile 39.3, while the City of Savannah's M&I Plant is located on Abercorn Creek, approximately at river mile 29. The other municipal users consist of Columbia County and Edgefield County.

Industrial users with intakes in the New Savannah Bluff Lock and Dam (NSBL&D) pool include North Augusta, Mason's Sod, Kimberly Clark, Urquhart Station, PCS Nitrogen, DSM Chemical and General Chemical, and South Carolina Electric and Gas. Users below NSBL&D include International Paper, Savannah River Site, Savannah Electric – Plant McIntosh, Georgia-Pacific, the Savannah National Wildlife Refuge and Plant Vogtle. Plant Vogtle currently withdraws 60 cfs from the Savannah River Basin and an expansion project is currently under construction and will require an additional consumptive use withdrawal of approximately 60 cfs in several years. This additional withdrawal will eventually come out of the usual local flows that are often 4,000 to 5,000 cfs during a drought. The intakes reported service population is 243,300. The Corps' operations directly impact water supply downstream of JST and we operate to provide water supply. Savannah District does not have storage contracts for downstream water supply needs.

2.5. HYDROPOWER AND PUMPED STORAGE

The Southeastern Power Administration (SEPA) markets hydropower generated at Hartwell, RBR and JST lakes and dams. SEPA markets the energy through contracts negotiated between SEPA and certain preference customers. Ten hydropower facilities provide the energy and capacity requirements of the contract. These projects are located in the Savannah, Alabama-Coosa-Tallapoosa, and Apalachicola-Chattahoochee-Flint Basins. Under normal conditions, if a certain basin or portion of a basin is unable to meet the demands expected, then that shortage can usually be transferred to, or "made up" in, another basin. However, a drought of record situation that adversely impacts all three basins affects SEPA's ability to meet the minimum contract requirements. SEPA may purchase replacement energy for the system generation when the Corps does not generate enough power to meet the requirements of SEPA's contract. SEPA purchased substantial amounts of power in 2007 and 2008 to meet their contract requirements.

The RBR Pumped Storage Project began commercial operation in July 2002. Pumped Storage consists of pumping water from below the RBR dam into the RBR reservoir during times of low demand for electricity and using this water to generate during times of high demand. Pumped Storage is not possible when JST lake levels fall to approximately 312 feet msl. Current operation of the four pumped storage units includes several operational restrictions to minimize fish entrainment and fishery habitat impacts. These operational restrictions include:

- Pumped storage operations will occur only during the hours beginning one hour after official sunset to one hour before official sunrise.

- Pumped storage operations will include a maximum of one unit operation in March and no pumped storage operations in April (not applicable to Drought Level 2 and below).
- Pumped storage operations will include a maximum of one unit operation from May 1 to May 15; a maximum of one unit operation from May 16 to May 31, except when a Level I drought is declared in accordance with this plan, during which time a maximum of two pumped storage units may be used. There shall be no seasonal pumped storage operational restrictions when a Level II drought is declared in accordance with this plan.
- From May 16 to May 31, the Corps will conduct a minimum of six unit hours of generation, of not less than 60 megawatts, within the twelve hours preceding any two unit pumped storage operation. From June 1 to September 30, the Corps will conduct a minimum of six unit hours of generation, of not less than 60 megawatts, within the twelve hours preceding any pumped storage operation.

In addition to the restrictions above, all other operational and monitoring restrictions outlined in the August 1999, Final Environmental Assessment and FONSI for the Richard B. Russell Dam and Lake Project, Pumped Storage, will remain in effect.

2.6. WATER QUALITY IN THE LAKES

Generally, water quality in the lakes is at or above State Water Quality Standards. However, like most deep reservoirs in the southeastern United States, they experience thermal stratification. This natural phenomenon results from the difference in densities between the surface and subsurface water caused by the temperature variation in the water column. As the tributary and surface waters warm, the difference in density between the surface and bottom waters begins to restrict vertical circulation of the lake. The result of this restriction of circulation is the development of three layers of water: the epilimnion, the well-mixed surface layer which receives oxygen from interaction with the atmosphere; the hypolimnion, the bottom strata which is essentially stagnant water in which the dissolved oxygen (DO) is slowly depleted by the respiration and decomposition of organic matter; and the thermocline, which is the transition between the upper and lower strata and which exhibits the maximum temperature gradient.

The stability of the lake during stratification increases throughout the summer months as the density gradient intensifies. As winter approaches, cooling of the surface waters causes them to become denser. When temperatures are sufficiently reduced, these waters fall below the thermocline, thereby breaking the stratification. After the fall "overturn," the lake becomes isothermal, with free circulation of water throughout the lake (Hartwell Major Rehabilitation Program Evaluation Report, US Army Corps of Engineers, Savannah District, 1995).

For example, thermal stratification begins in Hartwell Lake in late April and early May of each year. The thermocline is established at a depth of about 30 feet and is maintained at that depth through early August. The thermocline moves to a depth of about 40 feet in late August/early September and to about 50 feet in late September/early October. In late October/early November, as the lake "overturns," the thermocline moves to a depth of about 70 feet and the lake becomes isothermal by early December.

The hypolimnion is typically below the euphotic zone (where sufficient light penetrates to permit growth of green plants) and, lacking free circulation with surface waters, has no potential to renew DO concentrations which are gradually exhausted through respiration and decomposition. As the DO concentrations decrease, a maximum DO gradient develops in the area of the thermocline.

As the DO of the bottom layer decreases, the DO of the top layer remains relatively constant, at approximately 7 mg/l. The level of the maximum DO concentration gradient is established at a depth of about 30 feet in July, about 40 feet in August, and about 55 or 60 feet in late September. By the first of August, there is usually a 3 mg/l difference between the DO in the upper and lower layers, and by the middle of September, the DO in the lower layer can range between 0 and 2 mg/l. The water quality of the lower layer continues to deteriorate until the fall "overturn" occurs. As "overturn" occurs, the level of the maximum DO concentration gradient falls to 80 feet in October and near the lake bottom in early December, after which the DO concentration is nearly the same at all levels until the following spring (Hartwell Major Rehabilitation Program Evaluation Report, US Army Corps of Engineers, Savannah District, 1995).

RBR Lake uses a hypolimnetic DO system that maintains DO concentrations at or above 5 mg/l throughout the year. Because water released through Hartwell Dam for hydropower comes from the low DO layer, negative effects on the aquatic environment in the Hartwell tailwater area can occur. The Corps has installed modifications, referred to as “turbine venting”, that allow air to be diffused into the water as it flows past the turbines during generation. The result is a much needed increase of at least 2 mg/l in dissolved oxygen levels in the tailwater. DO concentrations of the release waters from Hartwell can be expected to be below 5 mg/l from late summer through early fall, with the lowest readings from August through September.

The turbines at Thurmond Dam were recently replaced during a major rehabilitation effort that began with the first new turbine being installed in 2002. The new turbines include a self-aspirating design that is a form of turbine venting. The new turbines now add as much as 3 mg/l of DO to the waters as they pass through the dam. Since the completion of the rehabilitation in 2007, discharges from Thurmond Dam possess at least 3 mg/l of DO throughout the year. Construction of an oxygen injection system is underway at Thurmond Lake. Operation of this system will increase the DO of waters within the lake, as well as those which pass through the dam to flow downstream. When the DO injection system becomes operational in 2011, the release waters from Thurmond can be expected to possess at least 5 mg/l of DO throughout the year, which will meet the daily average requirement of 5.0 mg/l in support of warm water species of fish that are mentioned in the following Section.

2.7. WATER QUALITY IN THE SAVANNAH RIVER

The Savannah River below JST Dam is classified as “Freshwater” by the South Carolina Department of Health and Environmental Control (DHEC) (Watershed Water Quality Assessment-Savannah River Basin, August 2010, Technical Report No. 02F-10). This designation is defined as:

> "Freshwaters suitable for primary and secondary contact recreation and as a source for drinking water supply after conventional treatment in accordance with the requirements of the Department. These waters are suitable for fishing and the survival and propagation of a balanced indigenous aquatic community of fauna and flora. This class is also suitable for industrial and agricultural uses."

The Environmental Protection Division (EPD) of the Georgia Department of Natural Resources (DNR) has classified the designated use of the main river as "Fishing" waters. The water quality standards for dissolved oxygen, as stated in Georgia's Rules and Regulations for Water Quality Control (GA EPD, 2004), Chapter 391-3-6-.03(6)(c)(i), that this classification requires are:

> "A daily average of 5.0 mg/L and no less than 4.0 mg/L at all times for waters supporting warm water species of fish".

Aquatic life and recreational uses are not fully supported along the main length of the Savannah River. Both South Carolina (2010 Section 303d list) and Georgia (2008 Section 303d list) have at least portions of the Savannah River (Thurmond Dam to Interstate 95) on their List of Impaired Waters.

SC states that aquatic life is impaired at two sites due to levels of zinc and at one site for turbidity while recreation is impaired at two sites due to fecal coliform. South Carolina DHEC issued a fish consumption advisory in 1996 for the main Savannah River (Thurmond Dam to Interstate 95) because of concerns about mercury, Cesium-137, and Strontium-90. The advisory also states that some fish also contain cesium-137 and strontium-90. The levels of these radioisotopes in fish are low and have decreased over time.

The GA Section 303(d) list states that drinking water is impaired from J. Strom Thurmond Dam to the Stevens Creek Dam due to low levels of dissolved oxygen, most likely as a result of releases from the dam. Savannah District has completed installation of a DO injection system within Thurmond Lake. Discharges from Thurmond Dam contain at least 5 ppm of DO throughout the year. That level meets both the Georgia and South Carolina standard for DO levels for those waters. The DO system is not designed to function in Level 4 drought.

The GA Section 303(d) list includes numerous tributaries as not meeting the designated use of Fishing for a variety of reasons, including primarily low DO or high levels of fecal coliform. GA lists the main river (Stevens Creek Dam to Tidegate) as meeting its designated uses of Drinking Water, Fishing, or Coastal Fishing. It states that Coastal Fishing is impaired from GA Highway 25 (Houlihan Bridge) to Elba Island Cut (roughly RM 4) due to low levels of DO.

The Environmental Protection Agency (EPA) has prepared the following Total Maximum Daily Loads (TMDLs) for portions of the Savannah River:

- Fecal coliform – Savannah River in Richmond County
- Lead – Savannah River between Butler & McBean Creeks

- Dissolved Oxygen – Savannah River from the Seaboard Coastline Railroad Bridge (RM 27.4 to the coast). The existing zero discharge TMDL is currently being revised by EPA's 2010 draft TMDL based on Georgia's recently revised dissolved oxygen standard.

Seasonal DO sags occur in the summer months in the estuarine portion of the river. EPA's TMDL for dissolved oxygen calls for zero discharge of oxygen-depleting substances from Augusta to the coast.

South Carolina DHEC classifies the estuarine portion of the river as SB: "Tidal saltwaters". This designation is defined as:

> "… suitable primarily for primary and secondary contact recreation, crabbing and fishing. These waters are not protected for harvesting of clams, mussels, or oysters for market purposes or human consumption. The waters are suitable for fishing and the survival and propagation of a balanced indigenous aquatic community of marine fauna and flora."

The Georgia DNR-EPD has classified the designated use of the estuarine portion of the river as "Coastal Fishing."

The DO requirement for South Carolina is a daily average of 5.0 mg/L and a daily minimum of 4.0 mg/L for all of the year. The DO requirement for Georgia recently changed to effectively match that of South Carolina.

The State of South Carolina uses the current drought plan Level 3 flow of 3,600 cfs (Larry Turner, South Carolina DHEC) at the Savannah River Augusta gage for the permitting of point source discharges in the Augusta area. This flow is adjusted upward to account for tributary input as one moves down the river. The State of Georgia uses the 7Q10 values of 3,800 cfs at the Augusta gage, 4,160 cfs further downstream at the Millhaven gage and 4,710 cfs at the Clyo gage for the permitting of point source discharges (Paul Lamarre, Georgia DNR-EPD).

2.8. BIOTIC COMMUNITIES AT THE LAKES

2.8.1. Fishery Resources at Hartwell Lake

Hartwell Lake and its tailrace provide a vast habitat for both warmwater and coldwater fisheries. The lake area supports a large warmwater fishery including species such as white and striped bass, hybrid bass, largemouth bass, bluegill, pumpkinseed, redear sunfish, yellow perch, sauger, walleye, and catfish. Nongame species found within the lake include blueback herring, carp, longnose gar, redhorse and spotted sucker. The GADNR and SCDNR both actively stock, on average, 500,000 to 1,000,000 striped bass and hybrid bass in Hartwell Lake.

The Hartwell tailrace supports a coldwater put-and-take trout fishery that is supported by stocking from both States. The State of Georgia DNR-EPD classifies the Savannah River in Hart County (which includes the Hartwell tailrace) as Secondary Trout Waters. Secondary Trout Waters are

described as waters capable of supporting trout throughout the year despite no evidence of natural trout reproduction. Striped bass and walleye are also found in this coldwater fishery.

Study findings indicate that blueback herring habitat becomes quite restricted during lake stratification due to the DO and temperature requirements of the fish. The results of these stratification conditions are the congregation of herring in the penstock area and fish kills from entrainment (Alexander, et.al., 1991). Operational procedures are followed by the Savannah District to minimize this entrainment.

2.8.2. Fishery Resources at RBR Lake

The fishery resources of RBR have been extensively studied. Savannah District and the University of Georgia Cooperative Fish and Wildlife Research Unit (GA COOP), began baseline studies of fishery resources in RBR Lake in 1990. These studies included cove rotenone sampling, gill net sampling, electrofishing, and telemetry. Savannah District has also conducted hydroacoustic surveys of the fishery resources in the RBR tailrace since 1986, and lakewide hydroacoustic surveys of RBR Lake in 1997. South Carolina DNR has conducted fisherman creel surveys on RBR since 1991. Georgia DNR has conducted fisherman creel surveys in the RBR tailrace since 1988.

RBR Lake supports a wide variety of fish species. The more common species include: largemouth bass, spotted bass, redeye bass, threadfin shad, gizzard shad, blueback herring, bluegill, redear sunfish, channel catfish, brown bullhead, black crappie, yellow perch, white perch, spotted sucker and common carp. Small numbers of hybrid bass (striped bass x white bass) and striped bass are caught each year in RBR Lake.

2.8.3. Fishery Resources at JST Lake

The fishery resources of JST have been extensively studied. Savannah District and the GA COOP began baseline studies of fishery resources in JST Lake in 1986. These studies included cove rotenone sampling, gill net sampling, electrofishing, and telemetry. The Clemson University Cooperative Fish and Wildlife Research Unit (CU COOP) conducted a commercial creel estimate and a population estimate of blueback herring. Savannah District has conducted lakewide hydroacoustic surveys of the forage fish populations in 1996. South Carolina DNR has conducted fisherman creel surveys on JST since 1991.

The more common fish species in JST Lake include; largemouth bass, bluegill, redear sunfish, hybrid bass, striped bass, black crappie, brown bullhead, channel catfish, flathead catfish, white perch, yellow perch, threadfin shad, gizzard shad, and blueback herring. South Carolina DNR and Georgia DNR both actively stock hybrid bass and striped bass in JST Lake. On average, 750,000 to 1,000,000 striped and hybrid bass have been stocked annually in JST Lake. Robust redhorse can also be found in the JST reservoir.

The RBR tailrace supports a substantial fishery for striped bass, hybrid bass, and white perch. This area makes up only 2 percent of the surface area of JST Lake, but accounts for 9-11 percent of the total harvest of these species. Fish abundance in the RBR tailrace generally peaks in the summer and is lower in the winter. A commercial fishery for blueback herring exists in the RBR

Tailwater. Blueback herring are used by fishermen as bait in both Georgia and South Carolina. Recreational fishermen net blueback herring in the RBR tailrace and in JST Lake.

2.8.4. Aquatic Plants at Hartwell Lake

Aquatic plants are not abundant in Hartwell Lake. Periodic boat surveys of the lake were performed throughout the 2007 growing season. The distribution and abundance of water primrose in Eighteen Mile Creek does not appear to have increased relative to previous years. However, there is concern that hydrilla will be introduced from J. Strom Thurmond Lake or Keowee Lake into Hartwell Lake. During a routine patrol of the Seneca River, a small 4' X 4' patch of hydrilla was located between the Hwy 93 Bridge and Hwy 123 Bridge in Pickens County, SC. Due to dropping water levels, the hydrilla was exposed within a week of it first being discovered and it was not treated. The area was monitored for several days and the hydrilla appeared to have died due to desiccation. The entire area between the two bridges was surveyed thoroughly and no additional hydrilla was found. Aquatic plant growth has not reached nuisance levels requiring treatment.[1]

2.8.5. Aquatic Plants at RBR Lake

Boat surveys are conducted periodically throughout the summer and fall to determine plant distribution and abundance. Less than one acre of hydrilla was present in RBR Lake in the Bond Creek area during the 2009 growing season. Also, sparse patches of Brazilian Elodae (Egeria densa) were present on the Savannah River one to five miles below Hartwell Dam.

Aquatic plant growth has not reached nuisance levels requiring treatment.

2.8.6. Aquatic Plants at JST Lake

The Thurmond Project staff monitors the abundance and migration of hydrilla in the reservoir. One of two herbicides are selected and used for control based upon site location, desired level of control, and cost per acre. Changes in the proposed treatment program are coordinated with the GA DNR, SC DNR, and affected outgrantees prior to implementation.

The persistent drought from 2006 through September 2009 greatly reduced the abundance of hydrilla. The lake level remained four to six feet below normal pool level for most of the 2009 growing season. Plant growth varied greatly from area to area. In many areas with adequate water depth, the hydrilla seldom exceeded three feet in height and was not problematic during the peak of the recreation season.

Hydrilla is present in areas of suitable substrate throughout Little River, GA from the confluence of the Savannah River to upstream of Raysville Campground including most tributaries. Along the Savannah River portion of the lake, hydrilla is present from the dam to Murray Creek Peninsula in Georgia and from the dam to Hickory Knob Subdivision in South Carolina including most tributaries. Hydrilla was found along both sides of Little River, SC from the

[1] Exec. Order No. 13,112, 64 F. R. 6183 (1999) (Executive Order 13112 directs federal agencies to take actions to prevent the introduction of invasive species and control populations of invasive species in a cost-effective and environmentally sound manner. Executive Order 13112 is applicable actions taken at Hartwell Lake, RBR Lake and JST Lake).

Savannah River to Highway 378. A small amount of hydrilla was found adjoining Baker Creek State Park.

The growth rate and distribution of hydrilla was monitored from May through October of 2009. Throughout most of the growing season, the lake level was 4 to 6 feet below normal summer Guide Curve elevations. All designated beach areas and some boat ramps were not usable during most of the summer. The abundance of hydrilla varied greatly from area to area.

In 2009, hydrilla was treated at 24 boat ramps and/or marina basins to minimize user impacts. A total of 23.8 acres was treated. During mid-October of 2009, inspections of the shoreline areas were made in areas where hydrilla had not been previously found. The lake level had risen almost five feet from the summer low point. As a result, finding newly established plant populations was very difficult. An additional 38 acres of hydrilla was located in the following locations:

Location	County	State
Savannah River between Hwy 378 and Hickory Knob State Park	McCormick	SC
Little River, SC between Hwy 378 and Baker Creek State Park	McCormick	SC

2.8.7. Aquatic Plants at New Savannah Bluff Lock and Dam

Aquatic plant populations in the upstream embayment were monitored periodically throughout the 2008 growing season. The following aquatic plants were identified: waterhyacinth, elodea, fanwart, pickerelweed, and cattail. None appeared to pose any problems to operation of the structure or uses of the area.

2.8.8. Largemouth Bass Spawning

State natural resource agencies have identified largemouth bass spawning at the three Corps Savannah River lakes as being a priority in water management decisions. The spawning period is defined as beginning when water temperatures reach 65 degrees Fahrenheit and lasts until three weeks after water temperatures reach 70 degrees. The water temperatures are taken each day throughout this period in a sunny cove between 1000 and 1630 hours by submersing a thermometer six inches where the water is approximately three to five feet deep. The spawning period usually starts around the first of April and lasts 4 to 6 weeks (Lake Regulation and Coordination for Fish Management Purposes, South Atlantic Division, US Army Corps of Engineers, March 30, 2001).

Past studies indicate that the 4-week period of April 1-28 is the peak spawning period. Stable lake levels should be provided during this peak spawning period to prevent the stranding of eggs and abandonment of nests. Throughout the spawning season, water levels should not be lowered more than six inches below the highest lake elevation recorded during the operational spawning

window. If inflows during the spawning season cause lake levels to rise to flood levels, managers have the authority to lower lake levels more than 6 inches, since flood control takes precedence over fish spawn. Maintaining these stable lake levels may not be possible during drought.

2.9. BIOTIC COMMUNITIES IN THE LOWER SAVANNAH RIVER

2.9.1. Fish

Riverine fish habitats in the Savannah River have been highly modified or converted to lacustrine habitat by construction of major dams and reservoirs that inundate the upper half of the River Basin. This large-scale habitat conversion has changed the relative abundance and diversity of fish species from a system dominated by migratory diadromous fish to more localized riverine and lacustrine-dominated fish communities. A comprehensive five-year fishery survey of existing coastal plain habitats concluded that the lower Savannah River supports an abundant, diversified fish community, but has a low to moderately used fishery (Schmitt and Hornsby 1985). Based on numbers and weight collected the most abundant game fish were largemouth bass, chain pickerel, black crappie, yellow perch, redbreast sunfish, bluegill, redear sunfish, warmouth, flier, and pumpkinseed. Important non-game fish include longnose gar, bowfin, white catfish, channel catfish, common carp, spotted sucker, silver redhorse, robust redhorse, striped mullet, and brown bullhead. In numerical terms the most important forage fish are gizzard shad and a number of minnow species. Diadromous fishes inhabiting the lower Savannah River include striped bass, American shad, hickory shad, blueback herring, shortnose sturgeon, Atlantic sturgeon, and the catadromous American eel. The present-day Savannah River population of striped bass appears to be more riverine in its habitat use patterns than more northern populations that are truly anadromous.

Prior to construction of mainstem Savannah Dams from 1840 to 1984, diadromous fish migrations extended throughout the Piedmont. Historical records document the upstream migration of shad and striped bass to the headwaters of the Savannah River, through the Tugaloo River and up the Tallulah River to Tallulah Falls, Georgia, approximately 384 river miles from the ocean. Sturgeon is known to have migrated well into the Piedmont. A portion of the river was diverted in 1846 at the site of the Augusta Diversion Dam. In 1875, that structure was extended to the entire channel width to create the present Augusta Diversion Dam. That structure restricted inland migration of diadromous species except during high flow periods when the Dam was overtopped. When those conditions occurred, some fish species could continue their upstream migrations. A fish ladder was installed in 1886, but it is presently not considered to be effective in passing fish upstream. Completion of the New Savannah Bluff Lock and Dam (NSBLD) in 1937 further restricted spawning migrations in many years to below river mile 265, with the exception of high flow periods that occurred during the spawning season. During the late 1950's through the early 1960's, the Corps' Savannah River navigation project constructed 38 cuts across meander bends that shortened the river by 78 miles. As a result of these cutoffs, the NSBLD is now located at river mile 187.3. The Stevens Creek Dam, a South Carolina Electric and Gas hydroelectric facility, was constructed 0.9 miles upstream of the Augusta Diversion Dam in 1914, blocking all diadromous fish migrations past that point.

Although greatly reduced from former abundance, diadromous fish are an important and increasing component of the River's sport and commercial fisheries. American shad, blueback herring, and lesser numbers of striped bass and sturgeon migrate to the NSBLD facility, which is the first major obstruction to passage on the river. Some fish have continued to migrate to historical spawning grounds above the facility. Some species pass upstream by swimming through fully-opened dam gates at flows of 24,000 cfs or higher, and by swimming through the navigation lock when it is operated in a manner suitable for fish passage. The NSBLD restricts passage of sturgeon to periods when high flows overtop the riverbanks during the spawning season. In 2006, The Nature Conservancy monitored the movement of tagged shortnose sturgeon fish when flows exceeded the height of the dam but stayed within the river banks. TNC could not identify any passage of shortnose sturgeon upstream of the NSBLD under those flow conditions. Without access to the upstream shoal spawning habitat, gravel bars downstream of the NSBLD likely represent the only remaining spawning habitat for shortnose sturgeon in the Savannah River. Shortnose sturgeon and other important species have been identified at gravel bars downstream of the NSBLD (river miles 179-190, 275-278, and 286) during spawning months of February and March (Hall and Lamprecht, 1991, Grabowski and Isely, 2006, and Wrona, unpublished data). Research conducted in 1999-2000 (Collins et al 2002) indicate there has been no increase in recruitment of shortnose sturgeon into the population over the previous 8 years, but that an observed increased number of shortnose in the river was due to the stock enhancement program conducted by SC DNR from 1990-1992.

Presently, the lower Savannah River provides extremely important striped bass habitat. Although the majority of historical upstream spawning habitat for striped bass has been inundated by major reservoirs, some remaining rocky rapids habitat exists in the Augusta Shoals from just below NSBLD up to Stevens Creek Dam. After construction of mainstem dams and prior to initiation of a Tidegate operation in 1977, the primary spawning area for striped bass in the Savannah River system was the tidal fresh water zone approximately 18-25 miles from the river mouth, specifically the Little Back River (McBay 1968; Rees 1974). Salinity changes due to the Tidegate operation (1977-1992) reduced the extent of this tidal freshwater zone. Studies indicated significant declines in numbers of striped bass eggs and larvae in the lower Savannah River system during this period. These declines were related to increased salinity and modified transport patterns caused by the Tidegate and associated hydrologic modifications (Van Den Avyle et al. 1990, Winger and Lasier 1990).

The Little Back River, adjacent to the lower Savannah River, had unique physical characteristics that made it the primary source in the Savannah River System for efficient collection of brood fish for the Georgia statewide propagation and stocking program of striped bass and hybrid bass (white bass x striped bass). It has not served in that capacity since the 1980's. The GADNR adopted a striped bass harvest moratorium in 1988. In the early 1980's, an average of 4,291 kilograms of striped bass were harvested annually by sport fishermen in the Savannah River downstream of the NSBLD (Schmitt and Hornsby 1985). As a result of increasing numbers of mature striped bass being observed in the estuary, both SC and GA recently opened the fishery for that species in the estuary.

The Army Corps of Engineers, Georgia Department of Natural Resources, South Carolina Department of Natural Resources, US Fish and Wildlife Service, and the National Oceanic and Atmospheric Administration Fisheries Service are actively coordinating with private sector partners to address enhancement and restoration of diadromous fisheries, wetlands, and other aquatic resources in the Savannah River.

Essential Fish Habitat in the Savannah River estuary includes saltmarsh. The structure and function of a saltmarsh are influenced by tide, salinity, nutrients and temperature. Saltmarsh can be a stressful environment to plants and animals, with rapid changes occurring in these abiotic variables (Gosselink 1980; Gosselink et al. 1974). Although species diversity may be lower than in other systems, saltmarsh is one of the most biologically productive ecosystems in the world (Teal 1962; Teal and Teal, 1969). The high primary productivity that occurs in the marsh, and the transfer of detritus into the estuary from the marsh, provides the base of the food chain supporting many marine organisms.

2.9.2. Wetlands

Palustrine forested wetlands dominate the extensive alluvial plain of the Savannah River. The wettest parts of the flood plain, such as swales, sloughs, and back swamps are dominated by bald cypress, water tupelo, and swamp tupelo. Slightly higher areas, which are usually flooded for much of the growing season are often dominated by overcup oak and water hickory. Most of the Savannah River floodplain consists of low relief flats or terraces. These areas are flooded during most of the winter and early spring and one or two months during the growing season. Laurel oak is the dominant species on these flats and green ash, American elm, sweetgum, spruce pine, sugarberry, and swamp palm are often present. Swamp chestnut oak, cherrybark oak, spruce pine, and loblolly pine are found on the highest elevations of the flood plain, which are only flooded infrequently during the growing season.

On the Savannah River downstream of Interstate Highway 95, tidal palustrine emergent wetlands, also known as tidal freshwater marsh, become prevalent. Tidal palustrine emergent wetlands are flooded twice daily by tidal action in the study area. These marshes are vegetated with a diverse mixture of plants including giant cutgrass, spikerushes, and up to 58 other plant species (Pearlstine et al. 1990, Applied Technology and Management 1998).

In palustrine emergent wetlands, primary productivity is high, falling in the range of 500 to 2,000 grams/square meter/year (Odum et al. 1984). The quality of primary production is also high. Major primary producers in the salt marsh community are grasses that have little immediate nutritional value to fish and wildlife but support an important detritus based food web (Teal 1962). In contrast, the fleshy broad-leaf plants characteristic of fresh marshes generally are high in nitrogen and low in fiber content and there is a high incidence of direct grazing or feeding on these plants (Odum et al. 1984).

Freshwater marsh vegetation also contributes to the food web base that supports the study area's freshwater fishery. The leaves of the larger macrophytes in this community are used as attachment places by mollusks, insect nymphs, rotifers, hydra, and midge larvae. These are all important fish foods. The submerged littoral zone is vital to the development of freshwater fish,

as well as some marine and estuarine species, as these areas are the principal spawning sites and provide nursery and juvenile habitats.

2.9.3. Wildlife

Wildlife associated with forested wetlands is numerous and diverse. The furbearers are an important component of these wetlands and include beaver, muskrat, mink, otter, bobcat, gray fox, raccoon, and opossum. Deer, turkey, and even black bear in the more isolated areas, use the bottomlands. Palustrine emergent wetlands also provide excellent habitat for furbearers including the mink, beaver, and river otter. Terrestrial species from surrounding areas often utilize the fresh marsh edge for shelter, food, and water. These include raccoon, opossum, rabbit, and bobcat.

The study area is part of the Atlantic Flyway. Forested wetlands provide important wintering habitat for many waterfowl species and nesting habitat for wood ducks. Many species of woodpeckers, hawks, and owls use the bottomlands and swamps. Neotropical migratory birds, many of which are decreasing in abundance, depend upon contiguous tracts of forested swamps for breeding and as corridors during migration. Robbins et al. (1989) found that the most area-sensitive bird species required at least 2,800 acres of contiguous forest to be present. The extensive forested wetlands of the Savannah River flood plain provide very valuable habitat for these birds. The American swallow-tailed kite, a state (South Carolina) listed endangered species, can be observed in the study area. Swallow-tailed kites nest in and are closely associated with palustrine wetlands.

Palustrine emergent wetlands also provide habitat for many bird species. Resident, transient, and migrating birds of both terrestrial and aquatic origin utilize food and shelter found in this community. Some species use freshwater marshes for nesting and breeding. Waterfowl feed upon fresh marsh vegetation, mollusks, insects, small crustaceans, and fish found in the fresh marsh community. Wading birds such as the wood stork, great blue heron, little blue heron, green heron, snowy egret, and great egret also heavily utilize the tidal freshwater marsh.

The study area provides excellent habitat for a large number of reptiles and amphibians. Wetland habitats support many kinds of frogs including the bullfrog, bronze frog, southern leopard frog, several species of tree frogs, cricket frogs, and chorus frogs. Turtles found in the wetlands include the river cooter, Florida cooter, pond slider, eastern chicken turtle, snapping turtle, mud turtle, and stinkpot. Snakes found in the wetlands include the red-bellied water snake, banded water snake, brown water snake, eastern mud snake, rainbow snake, and eastern cottonmouth. The American alligator can be observed in streams and ponds of the Coastal Plain study area.

In 2006, the Fish and Wildlife Service conducted a freshwater mussel survey in the Savannah River to determine species composition and distribution of mussels. The objective of the 2006 mussel survey was to estimate species composition and distribution in the Savannah River; however, the surveyors only visited a small portion of the available habitat in the river. Specifically, the study encompassed the portion of the river from the Augusta Shoals region (river mile 203) near the Fall Line downstream to the tidewater region (river mile 22.8) near Savannah. The survey evaluated 39 sites using both shallow water (snorkeling and grubbing)

and deep water (SCUBA) survey techniques. A total of 26 freshwater mussel species were identified during the survey efforts. The 2006 discovery of four species not previously known to occur in South Carolina demonstrates the gross lack of knowledge regarding the mussel fauna of the Savannah River. With the exception of sites within the Augusta Shoals area, mussels were generally unevenly distributed in the surveyed areas, which is reflective of the distribution and quality of microhabitats within a particular river segment. In general mussels were most abundant in the thalwag habitats at the base of the river bank, and rare to absent in the shifting sand dominated runs in the center of the channel.

Atlantic pigtoe (*Fusconaia masoni*) and Savannah liliput (*Toxolasma pullus*) were both observed in the 2006 mussel survey. Both of these species are experiencing range-wide declines. Atlantic pigtoe was found only in the Augusta shoals. This species has not been observed in any other Georgia or South Carolina Rivers in the many years. The population of Savannah liliput upstream of Little Hell boat landing (Allendale County) may be the largest remaining population of this species. Savannah liliput in the Savannah River is found primarily in cutoff bends and sloughs. Preliminary observations indicate that much of this habitat is lost or degraded due to loss of connectivity with the main river at flows below 4,000 cfs at Augusta. Even when some water is present, low dissolved oxygen levels are probable during the warmer seasons because of lack of river flows and stagnant conditions in those specific sites.

2.9.4. Endangered Species


Wetland Habitat

Federal Endangered, Threatened, and Candidate species that are likely to occur in the Savannah River Basin Study area are listed in Table 5 (Reconnaissance Planning Aid Report on the Savannah River Basin Study, US Fish and Wildlife Service, July 1999). State species are listed in Table 6. The robust redhorse, shoals spider lily, Altamaha arcmussel, brother spike and the federally-listed shortnose sturgeon, manatee, and wood stork are the only Threatened or Endangered Species that may possibly be affected by small changes in flow. Low flows can restrict spawning of the shortnose sturgeon and robust redhorse on gravel bars in the areas downstream of NSBLD. Low flows can also expose the shoals spider lily to deer grazing at the Augusta Shoals. The Altamaha arcmussel can be exposed in oxbows.

2.9.5. Special Biological Areas

The tidal fresh marsh at the Savannah National Wildlife Refuge (NWR) supports an extremely diverse plant community providing food, cover and nesting habitat for a wide variety of wildlife species. Tidal freshwater marsh is relatively scarce in comparison to coastal brackish and salt marshes. Past harbor modifications, including harbor deepening, have greatly increased salinity levels throughout much of the Savannah NWR and reduced the quantity of tidal freshwater marsh. According to the USFWS, the Savannah NWR contained about 6,000 acres of tidal freshwater marsh when it was established in 1927. By 1997, due to the cumulative impacts of development, harbor deepening, and sea level rise, tidal freshwater marsh had declined to 2,800

acres, a reduction of 53 percent (Reconnaissance Planning Aid Report on the Savannah River Basin Study, US Fish and Wildlife Service, July 1999). The freshwater marsh areas had historically been bottomland hardwoods, but were cleared in the 1800's for agricultural purposes, such as the rice culture. The leveled and diked areas were abandoned when the rice culture was no longer profitable after the Civil War. Those sites partially filled and now support a wide variety of plant and animal species.

Prior to 1977, the Savannah River supported the most important naturally-reproducing striped bass population in the State of Georgia, but production of striped bass eggs in the Savannah River estuary declined by about 95 percent. This was at least partially the result of increases in salinity and loss of suitable spawning habitat throughout most of Little Back River and the lower Savannah River (Reconnaissance Planning Aid Report on the Savannah River Basin Study, US Fish and Wildlife Service, July 1999). It was hoped that the Tidegate restoration project would improve most of these conditions. The Corps' cessation of operation of the Tidegate (leaving the Tidegate open beginning in 1990) restored salinity levels in Back River to those experienced in the 1980's. Annual stocking efforts by the GA DNR have been very successful in increasing the number of striped bass in the lower Savannah River, and current population levels approach historic levels. After a 17-year closure, the striped bass fishery was partially reopened in October 2005.

Table 5: Federal Endangered, Threatened and Candidate Species Likely to Occur in the Savannah River Basin Study Area

SPECIES	SCIENTIFIC NAME	FEDERAL STATUS
MAMMALS		
Indiana Bat	*Myotis sodalis*	E*
West Indian manatee	*Trichechus manatus*	E
BIRDS		
Red cockaded woodpecker	*Picoides borealis*	E
Piping plover	*Charadrius melodus*	T**
Wood stork	*Mycteria americana*	E
Kirtland's warbler	*Dendroica kirtlandii*	E
REPTILES		
Eastern indigo snake	*Drymarchon corais couperi*	T
AMPHIBIANS		
Flatwoods salamander	*Ambystoma cingulatum*	T
Fish		
Shortnose sturgeon	*Acipenser brevirostrum*	E
Atlantic sturgeon	*Acipenser oxyrinchus*	C***
PLANTS		
Canby's dropwort	*Oxypolis canbyi*	E
Chaff seed	*Schwalbea americana*	E
Schweinitz's sunflower	*Helianthus schweinitzii*	E
Small whorled pogonia	*Isotria medeoloides*	T
Pondberry	*Lindera melissifolia*	E
Rough leaved loosestrife	*Lysimachia asperulaefolia*	E
False Poison Sumac	*Rhus michauxii*	E
Bunched arrowhead	*Sagittaria fasciculata*	E
White irisette	*Sisyrinchium dichotomum*	E
Dwarf flowered heartleaf	*Hexastylis naniflora*	T
Mountain sweet pitcher plant	*Sarracenia rubra ssp. jonesii*	E
Harperella	*Ptilimnium nodosum*	E
Swamp pink	*Helonias bullata*	T
Smooth coneflower	*Echinacea laevigata*	E
Seabeach amaranth	*Amaranthus pumilus*	T
Persistent trillium	*Trillium persistens*	E
Relict trillium	*Trillium reliquum*	E
Little amphianthus	*Amphianthus pusillus*	T
Miccosukee gooseberry	*Ribes echinellum*	T
Bog asphodel	*Narthecium americanum*	C***

* Endangered

** Threatened
*** Candidate

Table 6: Georgia and South Carolina Rare, Threatened and Endangered Species Occurring in Counties Adjacent to the Savannah River

SCIENTIFIC NAME	COMMON NAME	GA STATE STATUS	SC STATE STATUS
Acipenser brevirostrum	Shortnose Sturgeon		FE[1]/SE[2]
Aimophila aestivalis	Bachman's Sparrow	R[3]	
Alasmidonta arcula	Altamaha Arcmussel	T	
Amblyscirtes reversa	Reversed Roadside Skipper		N3N4
Ambystoma cingulatum	Flatwoods Salamander		FT[4]/SE
Aneides aeneus	Green Salamander	R	
Autochton cellus	Golden-Banded Skipper		N4
Caretta caretta	Loggerhead		FT/ST[5]
Carex biltmoreana	Biltmore Sedge	T	
Carex manhartii	Manhart's Sedge	T	
Carex misera	Wretched Sedge	T	
Ceratiola ericoides	Rosemary	T	
Chamaecyparis thyoides	Atlantic White-Cedar	R	
Charadrius wilsonia	Wilson's Plover	R	
Clemmys guttata	Spotted Turtle	U	
Clemmys guttata	Spotted Turtle		ST
Corynorhinus rafinesquii	Rafinesque's Big-Eared Bat	R	SE
Cymophyllus fraserianus	Fraser's Sedge	T	
Cyprinella callitaenia	Bluestripe Shiner	T[6]	
Cypripedium acaule	Pink Ladyslipper	U[7]	
Cypripedium parviflorum var. Parviflorum	Small-Flowered Yellow Ladyslipper	U	
Cypripedium parviflorum var. Pubescens	Large-Flowered Yellow Ladyslipper	U	
Draba aprica	Open-Ground Whitlow-Grass	E[8]	
Echinacea laevigata	Smooth Coneflower		FE/SE
Elanoides forficatus	Swallow-Tailed Kite	R	
Elliottia racemosa	Georgia Plume	T	
Elliptio fraterna	Brother Spike		SE
Epidendrum conopseum	Green-Fly Orchid	U	
Fusconaia masoni	Atlantic Pigtoe Mussel	E	
Gopherus polyphemus	Gopher Tortoise		SE
Haematopus palliatus	American Oystercatcher	R	
Hydrastis canadensis	Goldenseal	E	
Hymenocallis coronaria	Shoals Spiderlily	E	
Isoetes tegetiformans	Mat-Forming Quillwort	E	
Isotria medeoloides	Small Whorled Pogonia		FT/ST
Lasmigona decorata	Carolina Heelsplitter		FE/SE
Lindera melissifolia	Pondberry		FE/SE
Lindernia saxicola	Rock False Pimpernel	E	
Litsea aestivalis	Pondspice	T	
Lysimachia fraseri	Fraser's Loosestrife	R	
Marshallia ramosa	Pineland Barbara Buttons	R	
Moxostoma robustum	Robust Redhorse	E	
Mycteria americana	Wood Stork		FE/SE
Myotis leibii	Eastern Small-Footed Myotis		ST

SCIENTIFIC NAME	COMMON NAME	GA STATE STATUS	SC STATE STATUS
Myotis sodalis	Indiana Myotis		FE/SE
Nestronia umbellula	Indian Olive	T	
Notropis hypsilepis	Highscale Shiner	T	
Notropis photogenis	Silver Shiner	E	
Notropis scepticus	Sandbar Shiner	R	
Oxypolis canbyi	Canby's Dropwort	E	
Oxypolis canbyi	Canby's Dropwort		FE/SE
Phenacobius crassilabrum	Fatlips Minnow	E	
Physostegia leptophylla	Tidal Marsh Obedient Plant	T	
Picoides borealis	Red-Cockaded Woodpecker		FE/SE
Plethodon websteri	Webster's Salamander		SE
Pseudobranchus striatus	Dwarf Siren		ST
Ptilimnium nodosum	Harperella		FE/SE
Quercus oglethorpensis	Oglethorpe Oak	T	
Rana capito	Gopher Frog		SE
Ribes echinellum	Miccosukee Gooseberry		FT/ST
Sanguisorba canadensis	Canada Burnet	T	
Sarracenia flava	Yellow Flytrap	U	
Sarracenia minor	Hooded Pitcherplant	U	
Sarracenia purpurea	Purple Pitcherplant	E	
Sarracenia rubra	Sweet Pitcherplant	E	
Schisandra glabra	Bay Starvine	T	
Schwalbea americana	Chaffseed		FE/SE
Scutellaria ocmulgee	Ocmulgee Skullcap	T	
Sedum pusillum	Granite Stonecrop	T	
Senecio millefolium	Blue Ridge Golden Ragwort	T	
Shortia galacifolia	Oconee Bells	E	
Speyeria diana	Diana		N3
Sterna antillarum	Least Tern		ST
Stewartia malacodendron	Silky Camellia	R	
Stylisma pickeringii var. Pickeringii	Pickering's Morning-Glory	T	
Toxolasma pullus	Savannah Lilliput	T	
Trichechus manatus	Manatee		FE/SE
Trillium persistens	Persistent Trillium		FE/SE
Trillium reliquum	Relict Trillium		FE/SE
Waldsteinia lobata	Piedmont Barren Strawberry	T	
Xerophyllum asphodeloides	Eastern Turkeybeard	R	

Sources: Georgia EPD and South Carolina DNR

1 FE - Federal Endangered

2 SE - State Endangered (official state list-animals only)

3 R - Rare

4 FT - Federal Threatened

5 ST – State Threatened (official state list-animals only)

6 T - Threatened

7 U - Unusual (thus deserving of special consideration)

8 E – Endangered

2.10. SOCIOECONOMIC ISSUES

2.10.1. Environmental Justice

The concept of environmental justice is based on the premise that no segment of the population should bear a disproportionate share of adverse human health or environmental effects. To address these concerns, Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority and Low Income Populations* was issued. It requires each Federal agency to "make the achievement of environmental justice part of its mission by identifying and addressing disproportionately high and adverse human health and environmental effects on minority and low-income populations."

2.10.2. Protection of Children

The concept of protecting children arises out of a growing body of scientific knowledge, which demonstrates that children may suffer disproportionately from environmental health and safety risks. To address these concerns, Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks* was issued. It requires each federal agency to identify and assess environmental health and safety risks that may disproportionately affect children; and, ensures that policies, programs, activities, and standards address disproportionate risk to children that results from environmental health or safety risks.

2.11. SOILS AND SEDIMENT

Like other basins of large rivers in the Southeast which flow into the Atlantic Ocean, the Savannah River Basin embraces three distinct areas: the mountain section, the Piedmont Province and the Coastal Plain. The rocks of the mountain section and the Piedmont Plateau are indurated and largely crystalline. They are of igneous or metamorphic origin and include granites, gneisses, schists, basic eruptives, and highly metamorphosed shales, sandstones and limestones. These rocks constitute the oldest within these states and are probably, in the main, of pre-Cambrian age. They have been subjected to great organic movement and have been folded and faulted to considerable degree. On most level or gently sloping areas, the rocks have disintegrated to a depth of many feet and the surface is largely formed of residual material. This section includes some mountainous areas and deep valleys, but no lowlands or general highlands. The Coastal Plain differs from the Piedmont Plateau chiefly in the character of the terrain and in the kind of rocks that underlie it. It is built on much younger water-lain deposits of sand, clay, and limestone, and rests on a foundation which is the buried continuation of the crystalline rocks of the Piedmont belt. It is difficult to determine from the ground surface where the Piedmont belt ends and the Coastal Plain begins. However, in the river beds, the distinction is noticeable, as the hard crystalline rocks give rise to falls or rapids.

The problem of sediment in the Savannah River Basin has been greatly reduced since the early 1900's by the conversion of much former cropland to silviculture and pasture. Cotton farming, considered a highly erosive land use, greatly declined in central Georgia and western South Carolina during the last century. This and widespread implementation of soil conservation

practices have resulted in lessened stream sediment loads. Deposits of silt in the reservoirs and channel retrogression below the dams are not major problems.

2.12. HTRW

The documented accounts of HTRW in the Savannah River Basin at and below drought river and lake levels are limited. The presence of PCBs in Twelvemile Creek/Lake Hartwell was discovered when surface water, sediment, and fish from the area were sampled in the mid-1970s. The source of this contamination was determined to be the Sangamo-Weston, Inc. capacitor manufacturing plant in Pickens, South Carolina. Sangamo-Weston, Inc. operated the plant from 1955 to 1987. The liabilities associated with that operation were subsequently assumed by Schlumberger Technology Corporation (STC). Dielectric fluids, used in the manufacture of capacitors until 1977, contained PCBs, and materials containing these fluids were disposed via land burial. In addition, PCBs were present in discharges from the plant to Town Creek (a tributary of Twelvemile Creek). Surface water and sediment contaminated by the discharged PCBs eventually migrated downstream to Twelvemile Creek and Lake Hartwell.

In 1994, the United States Environmental Protection Agency (EPA) issued a Record of Decision (ROD) for the Twelvemile Creek/Lake Hartwell area that included natural recovery of PCB-contaminated sediments. This alternative was supported by studies showing that PCB-contaminated sediments are expected to be continually buried by sediment entering Twelvemile Creek and Lake Hartwell. In addition, the ROD called for ongoing monitoring of biota, adoption of risk-based guidelines for human consumption of Lake Hartwell fish, and a public education program designed to increase public awareness of the fish consumption advisory. The EPA-mandated cleanup of Twelvemile Creek is presently underway.

2.13. CULTURAL RESOURCES

Comprehensive archaeological surveys were not conducted within the flood pools of the lake projects prior to inundation. Only small scale, site specific investigations were carried out on a handful of sites within the flood pool. No archaeological surveys have been conducted of the fluctuation zones since inundation. Surveys have been conducted of the upland areas at Thurmond Reservoir and of small portions of the upland areas of Hartwell Lake.

While intensive surveys have not been conducted of the fluctuation zones, sites are known to exist within these areas. Examples include two Native American villages, each with a mound, that were tested in the 1950s, as well as a previously unrecorded mill site.

2.14. FLOOD CONTROL

Hartwell, Richard B. Russell and J. Strom Thurmond Lakes each have 5 feet of flood control storage with the top of the flood control pools at elevation 665.0, 480.0 and 335.0 respectively.

The combined storage is 810,000 acre-feet. The action proposed in this document deals with water management during drought conditions, so flood control is not an issue.

3.0 DESCRIPTION OF THE PROPOSED ACTION AND OTHER ALTERNATIVES

3.1. ALTERNATIVE FORMULATION

A minimum downstream flow of 3,600 cfs in the Savannah River has become the standard upon which both Georgia and South Carolina base their permitting and upon which downstream public and private infrastructure has built their intakes. Through extensive collaboration it has been determined that it is possible to deviate below 3,600 cfs for severe drought management purposes during specific times of year which are likely to have less of an impact on water quality, water supply, and habitat.

The Georgia Department of Natural Resources, Environmental Protection Division (GA DNR-EPD), South Carolina Department of Health and Environmental Control (SC DHEC) and the South Carolina Department of Natural Resources (SC DNR) all made similar requests in 2008 for the Corps to temporarily deviate from its Drought Contingency Plan and to reduce discharges to 3,100 cfs during the cooler months while in drought Level 3. This EA takes into account those temporary requests and considers making a similar operational change for November 1 through the end of February (February only after receiving separate approval from NOAA-Fisheries due to concerns about potential impacts to shortnose sturgeon) while in drought Level 4.

3.2. ALTERNATIVES ANALYSIS

Alternatives were developed for consideration as part of the planning process and include:

a. NAA (Continue with the SRBDCP, March 1989 with 2006 EA changes)
b. Alternative 1 (Selected Alternative)
c. Other Alternatives Considered But Eliminated From Detailed Consideration

3.2.1. No Action Alternative

This alternative consists of the Corps taking no action to modify its existing SRBDCP of 1989 for drought Level 4 operations. This alternative is considered in detail and is evaluated in regard to all environmental concerns**.**

Above Drought Trigger Level 4, the operating procedures described in the 2006 SRBDCP Update would continue to be implemented. Action levels were established in the 1989 SRBDCP and are based on pool elevations at Hartwell and Thurmond Lakes. See the below Figures 7 and 8 and Tables 9 and 10 for more presentation of the Action Levels and the associated Action. Russell Lake has a relatively small conservation pool; therefore, it does not have delineated action thresholds. Due to the nature of pumped storage operation, Russell Lake may vary throughout its five-foot conservation pool through drought Level 3. The previously developed strategy describing operations in Level 4 was never fully examined in previous drought studies.

The priority on the use of Level 4 storage in the three project system will be based on minimizing impacts to drinking water supplies. See Table 7 for the pool balancing strategy.

As described in the 1989 SRBDCP, the Corps would monitor salinity levels in the estuary. During "critical water periods" Savannah District would perform roving salinity sampling at several locations in the estuary to determine and document the extent of salinity intrusion. The Savannah River Basin projects have never reached Level 4 in the 21 years that the Plan has been operational.

Four pumped storage units are available at RBR. Eighty unit hours of pumping per week is required to support the current hydropower contract. Pumping beyond 80 unit hours up to the maximum allowed by the Richard B. Russell Dam and Lake Project Pumped Storage Environmental Assessment of August 1999 can still occur when economically feasible. The RBR pump units were not designed to be used in pump mode when JST pool elevations are below 312 feet msl. The operational range of the generators and pumps will continuously be evaluated in Level 4.

The likelihood of drought conditions ever persisting to the point that the pools decline into inactive storage is very remote. Such drought conditions would be the worst recorded in the basin. However, as a precautionary measure an analysis was conducted to determine the inactive storage depletion time in the event that the conservation storage is fully depleted and the pools are at Level 4. Monthly average inflows equaling those observed in 2008 (no storage reduction) were used for the analysis that produced the below Table 7 and Figure 7. Monthly average inflows equaling 90% of those observed in 2008 (10% storage reduction, this is more conservative) were used for the analysis that produced the below Table 8 and Figure 8. Tables 7 and 8 and Figures 7 and 8 contain information relating Level 4 lake levels and time and they also relate numbers of impacted people and time. An attempt to refine the storage-elevation relationship through modernized bathymetric survey methods proved problematic. Therefore, the storage-elevation relationship was based on the original storage-capacity curves developed in the original General Design Memorandums for each project. The transition points of impact are noted below.

Table 7: Base Case, Maintain 3,600 cfs Year Round (No Storage Reduction)

Day	Years	Hartwell Elevation	Hartwell Impacts	Russell Elevation	Russell Impacts	Thurmond Elevation	Thurmond Impacts	Total Impacts
1	0.00	624.7	5200	469.9	0	311.9	4900	10100
83	0.22	617	5200	463.7	6500	310.1	4900	16600
102	0.27	617	5200	457.8	14627	310	4900	24727
111	0.30	617	5200	454.7	15127	310	4900	25227
230	0.63	617	5200	455	14627	310	4900	24727
241	0.66	617	5200	458	6500	310	4900	16600
259	0.70	617	5200	464.3	0	310	4900	10100
350	0.95	617	5200	463.9	6500	310	4900	16600
367	1.00	617	5200	457.8	14627	310	4900	24727
375	1.02	617	5200	454.9	15127	310	4900	25227
792	2.16	617	5200	320	15127	307.9	97500	117827
823	2.25	617	5200	320	15127	303.9	110500	130827
978	2.67	617	5200	320	15127	304	97500	117827
1003	2.74	617	5200	320	15127	308	4900	25227
1066	2.92	617	5200	320	15127	307.8	97500	117827
1095	3.00	617	5200	320	15127	303.8	110500	130827
1897	5.19	614.7	143200	320	15127	190	110500	268827
1905	5.21	612.8	148000	320	15127	190	110500	273627
2086	5.71	613.2	143200	320	15127	190	110500	268827
2093	5.73	615.2	5200	320	15127	190	110500	130827
2169	5.94	614.9	143200	320	15127	190	110500	268827
2177	5.96	612.9	148000	320	15127	190	110500	273627
2900	7.94	500	148000	320	15127	190	110500	273627

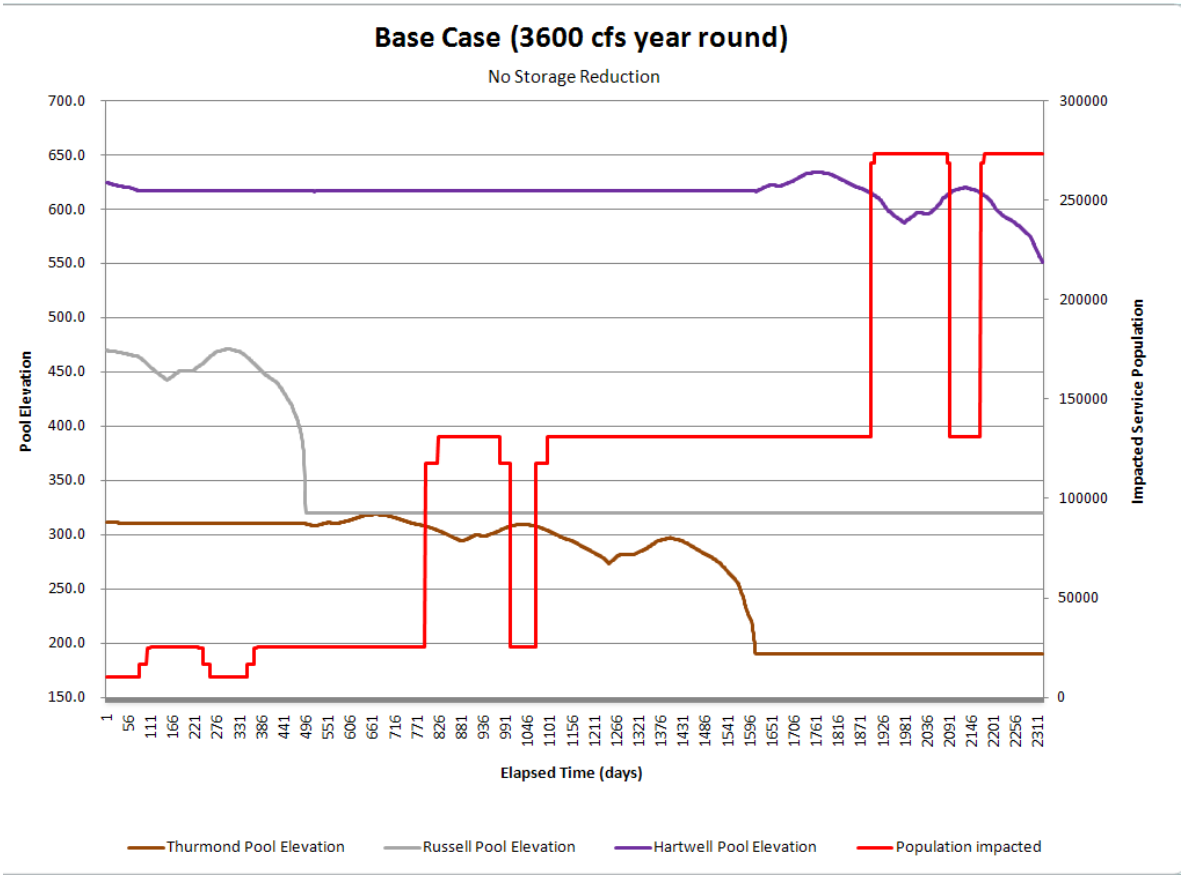


Figure 7: Base Case (3600 cfs year round) (No Storage Reduction)

Table 8: Base Case, Maintain 3600 cfs Year Round (10% Storage Reduction)

Day	Years	Hartwell Elevation	Hartwell Impacts	Russell Elevation	Russell Impacts	Thurmond Elevation	Thurmond Impacts	Total Impacts
1	0.00	624.7	5200	469.8	0	311.9	4900	10100
75	0.20	617	5200	463.9	6500	310.1	4900	16600
92	0.25	617	5200	457.8	14627	310.1	4900	24727
100	0.27	617	5200	454.7	15127	310.1	4900	25227
244	0.66	617	5200	455.2	14627	310.1	4900	24727
251	0.68	617	5200	458.3	6500	310.1	4900	16600
266	0.72	617	5200	464.3	0	310.1	4900	10100
343	0.93	617	5200	463.9	6500	310.1	4900	16600
358	0.98	617	5200	457.8	14627	310.1	4900	24727
365	1.00	617	5200	454.7	15127	310.1	4900	25227
487	1.33	617	5200	320	15127	307.8	97500	117827
549	1.50	617	5200	320	15127	308	4900	25227
556	1.52	617	5200	320	15127	307.9	97500	117827
581	1.59	617	5200	320	15127	308	4900	25227
756	2.07	617	5200	320	15127	307.9	97500	117827
795	2.17	617	5200	320	15127	303.8	110500	130827
1001	2.74	617	5200	320	15127	304	97500	117827
1068	2.92	617	5200	320	15127	303.8	110500	130827
1563	4.28	614.9	143200	320	15127	190	110500	268827
1571	4.30	612.8	148000	320	15127	190	110500	273627
1689	4.62	613	143200	320	15127	190	110500	268827
1698	4.65	615	5200	320	15127	190	110500	130827
1836	5.03	614.8	143200	320	15127	190	110500	268827
1843	5.04	612.8	148000	320	15127	190	110500	273627
2550	6.98	500	148000	320	15127	190	110500	273627

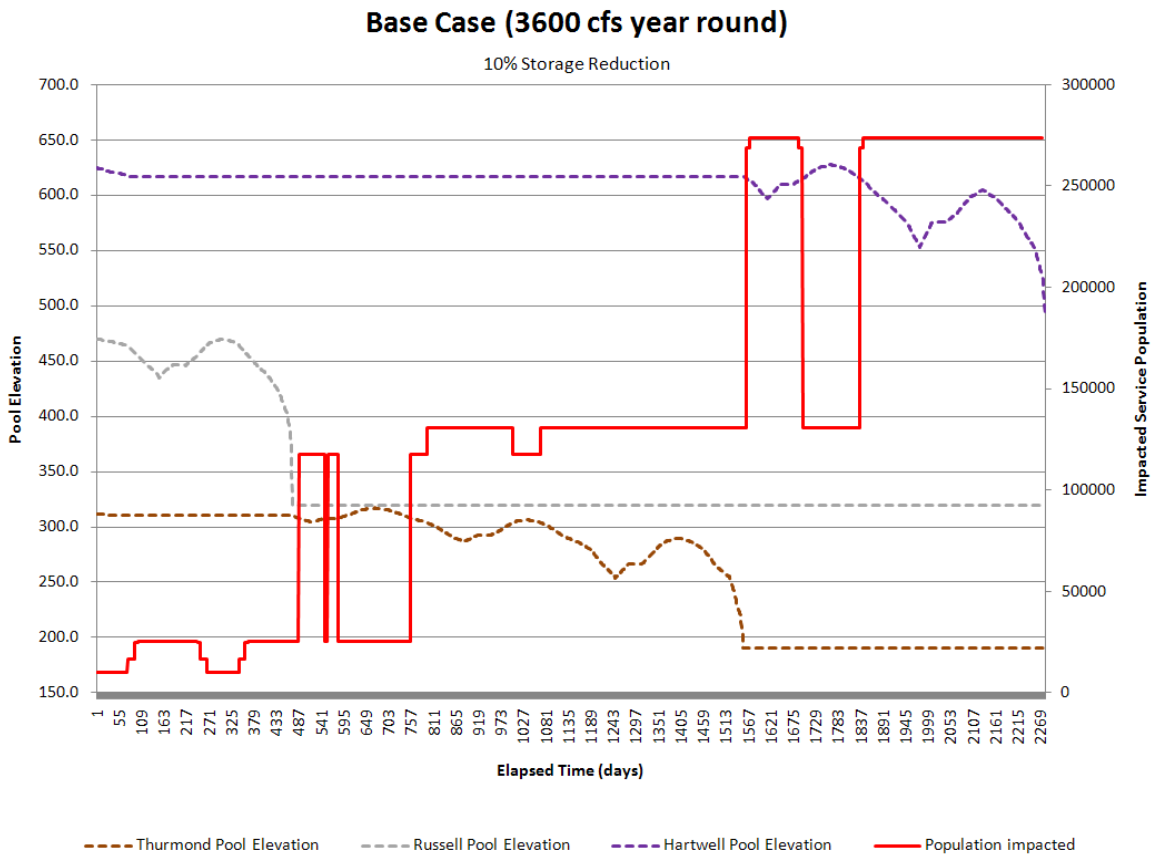


Figure 8: Base Case (3600 cfs year round) (10% Storage Reduction)

Table 9: Hartwell Action Levels for the NAA

LEVEL*	1 APR – 15 OCT (feet msl)	15 DEC – 1 JAN** (feet msl)	ACTION
1	656	654	Public safety information. Reduce Thurmond discharge to 4,200 cfs weekly average, reduce Hartwell discharge as appropriate to maintain balanced pools.
2	654	652	Reduce Thurmond discharge to 4,000 cfs weekly average, reduce Hartwell discharge as appropriate to maintain balanced pools.
3	646	646	Reduce Thurmond discharge to 3,800 cfs daily average, reduce Hartwell discharge as appropriate to maintain balanced pools.
4	625	625	Maintain 3,600 cfs as long as possible, thereafter transition to outflow = inflow

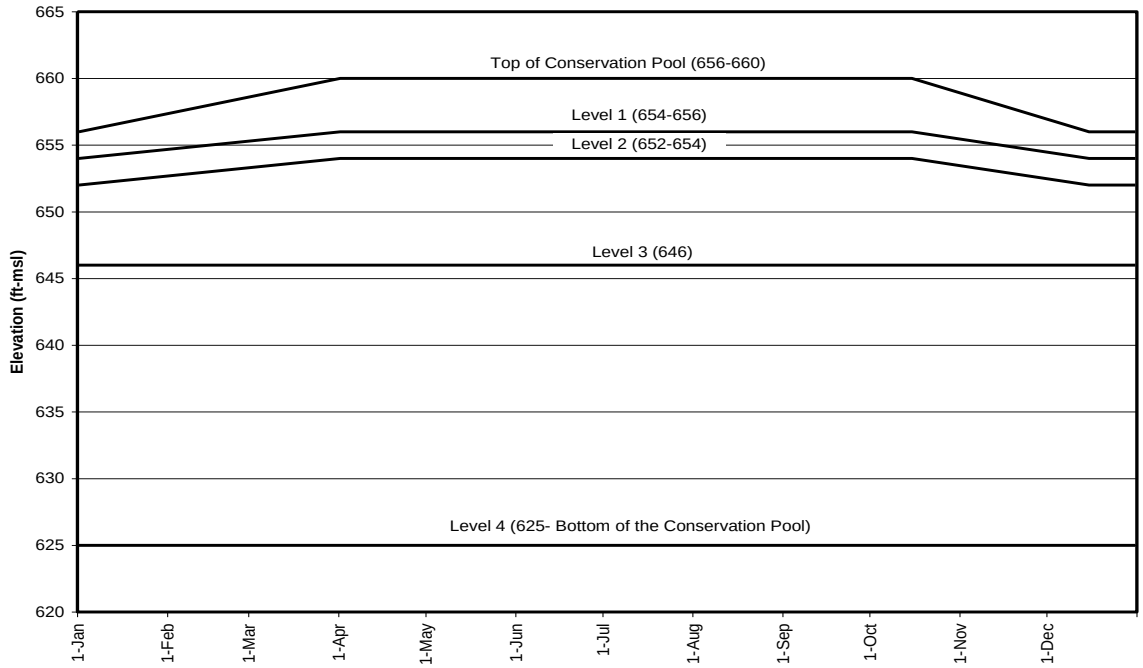


Figure 9: Hartwell Action Levels for the No Action Alternative

* Level as shown in Figure 1

** Lake elevations for the periods January 1 to April 18 and October 15 to December 1 are linearly interpolated from this data as shown in Figure 1

Table 10: J. Strom Thurmond Action Levels for the No Action Alternative

LEVEL*	1 APR – 15 OCT (FEET MSL)	15 DEC – 1 JAN** (FEET MSL)	ACTION
1	326	324	Public safety information. Reduce Thurmond discharge to 4200 cfs weekly average, reduce Hartwell discharge as appropriate to maintain balanced pools.
2	324	322	Reduce Thurmond discharge to 4000 cfs weekly average, reduce Hartwell discharge as appropriate to maintain balanced pools.
3	316	316	Reduce Thurmond discharge to 3800 cfs daily average, reduce Hartwell discharge as appropriate to maintain balanced pools.
4	312	312	Maintain 3600 cfs as long as possible, thereafter transition to daily average outflow = daily average inflow

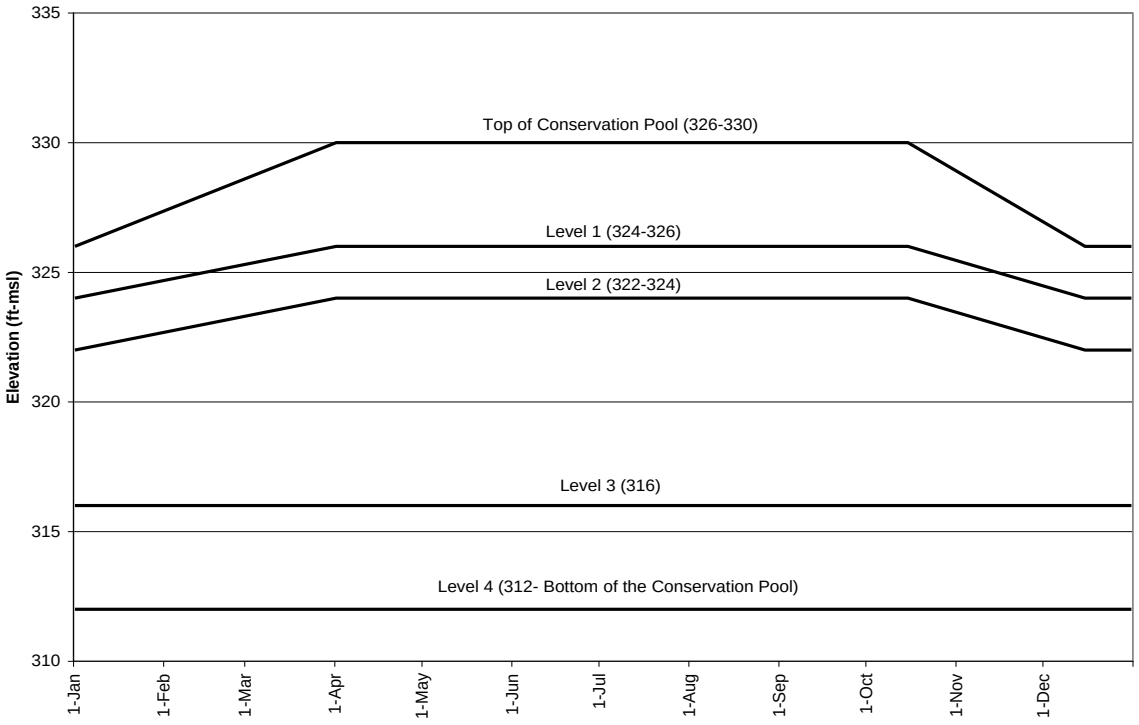


Figure 10: Thurmond Action Levels for the No Action Alternative

* Level as shown in Figure 1

** Lake elevations for the periods January 1 to April 1 and October 15 to December 1 are linearly interpolated from this data as shown in Figure 1

3.2.1.1. Intake Elevations and Served Populations

Some water withdrawal users would experience adverse impacts to their service population prior to reaching Level 4. Some impacts might be mitigated by the intake owner extending or relocating their intakes. As part of this study, the Corps analyzed the bathymetry in the vicinity of these intakes to aid owners in determining the feasibility of relocating an intake. Bathymetric surveys in the vicinity of the water supply intakes are attached in Appendix I. This EA does not address the possibility of extending or relocating intakes. This analysis is based on the existing elevations of the intakes.

Table 11 details the minimum reservoir levels and impacted populations for each intake at the Hartwell, Russell, and Thurmond reservoirs. The table also details downstream water supply users and their constraints.

Table 11: Lake Level and Impacted Population for Each Intake

User	Source	User Type Municipal or Industrial	Lowest Lake Level or at which WS Becomes Inoperable	Intakes Reported Service Population	Drinking Estimated Service Population
Clemson University Heating and Cooling	Hartwell Lake		638		
Clemson Uni Ag Dept	Hartwell Lake		645		
Anderson County Joint Municipal Water	Hartwell Lake	Municipal	615	200-300k	138,000
City of Hartwell Water Treatment Plant	Hartwell Lake	Municipal	612	7500	4800
City of Lavonia	Hartwell Lake	Municipal	636	12000	5200
JP Stevens Company (Closed, now Knop	Hartwell Lake		610		
Hart County Water and Sewer Utility	Hartwell Lake	M&I		2267	
City of Elberton (Elberton Utilities)	RBR Lake	Muicipal	464	8500	6500
Santee Cooper Rainey Generating Station	RBR Lake	Cooling	462	50	
City of Abbeville	RBR Lake	Municipal	458	8500	8127
Mohawk Industries	RBR Lake	Industrial	454.75		500
City of Lincolnton, GA	JST Lake	M&I	307	2700	4600
City of Washington, GA - Aonia Plant	JST Lake	M&I	307	6250	5200
City of McCormick, SC	JST Lake	M	313	12646	4900
City of Thompson/McDuffie County, GA	JST Lake	M	304	16000	13000
Columbia County, GA Water Utility	JST Lake	M	308	6000	82800
Columbia County Water System	Stevens Creek	M	182		
SCE&G Stevens Creek	Stevens Creek				
Edgefield County W&SA	Augusta City Dam & Augusta Canal	M&I	154.5	23,300	
Augusta-Richmond County (Hydromechanical)	Augusta City Dam & Augusta Canal	M&I		180,000	
Augusta Canal Authority	Augusta City Dam & Augusta Canal				
Avondale Mills - Augusta Canal (Sibley Mill)	Augusta City Dam & Augusta Canal	I			
Standard Textile - King Mill	Augusta City Dam & Augusta Canal				
Enterprise Mill or Hawk Gully	Augusta City Dam & Augusta Canal				
Augusta-Richmond County (Diesel Pumps)	NSBL&D	M&I	119.5		
City of North Augusta	NSBL&D		108	30000	
Kimberly Clark Corporation Beech Island	NSBL&D		109		
SCE&G Urguhart Station	NSBL&D		111		
DSM Chemicals Augusta, Inc.	NSBL&D	I	103.9		
PCS Nitrogen Fertilizer, L.P.	NSBL&D	I	103.9		
General Chemical Corp., Augusta Plant	NSBL&D	I	111		
D/S of NSBL&D (Cretaceous Sand)					
International Paper Corporation - Augusta	SRBA (Cretaceous Sand)	I	94		
DOE Savannah River Operation (Westinghouse SRS G Area Misc Ind)	SRBA (Cretaceous Sand)	I	79		
Southern Nuclear Operating Co., Inc. (Vogtle)	SRBA (Cretaceous Sand)	I	324.70		
D/S of NSBL&D (Floridian Aquifer)	SRBA (Floridian Aquifer)				
Georgia Power Co - Plant McIntosh	SRBA (Floridian Aquifer)	I	7.5		
GA Pacific (Fort James Operating Company)	SRBA (Floridian Aquifer)	I	5.16		
Beaufort Jasper W&SA Main Plant	SRBA (Floridian Aquifer)		3		
Savannah City Water Supply	SRBA (Floridian Aquifer)		-10.22	10000	
Tronox Pigments (Savannah), Inc.	SRBA (Floridian Aquifer)	I	-4.1		
Weyerhaeuser Company	SRBA (Floridian Aquifer)	I	-10.5		
International Paper Corporation	SRBA (Floridian Aquifer)	I	-5		

3.2.1.2. Standard Level 4 Drawdown Approach

Storage from each of the Hartwell, Russell, and Thurmond projects will be drawn in an order that impacts the smallest overall population. Potentially affected intakes should be extended or relocated at user expense if practical.

A model was developed using a spreadsheet mass-balance approach. Ninety percent of the inflows observed in 2008 were repeated for the duration of the analysis. Discharges for each of the three projects were developed which maintained the target release at Thurmond and also maintained a prioritized balance strategy between the projects. Table 12 below details the balancing strategy between the projects and the overall impacted populations. Again, it is important to note that some populations would be impacted prior to the projects reaching Level 4, the bottom of their conservation pools.

Table 12: Balancing Strategy between the Project and Those Impacted

HARTWELL		RUSSELL		THURMOND		
Elevation	Hartwell Impacted Population	Elevation	Russell Impacted Population	Elevation	Thurmond Impacted Population	Total Impacted Population
636	5200					5200
635	5200					5200
634	5200					5200
633	5200					5200
632	5200					5200
631	5200					5200
630	5200					5200
629	5200					5200
628	5200					5200
627	5200					5200
626	5200			313	4900	10100
625.0	5200	**470**		**312.0**	4900	10100
623.7	5200	469		**311.7**	4900	10100
622.3	5200	468		**311.3**	4900	10100
621.0	5200	467		**311.0**	4900	10100
619.7	5200	466		**310.7**	4900	10100
618.3	5200	465		**310.3**	4900	10100
617.0	5200	464	6500	**310.0**	4900	16600
617	5200	463	6500	**310**	4900	16600
617	5200	462	6500	**310**	4900	16600
617	5200	461	6500	**310**	4900	16600
617	5200	460	6500	**310**	4900	16600
617	5200	459	6500	**310**	4900	16600
617	5200	458	14627	**310**	4900	24727
617	5200	455	15127	**310**	4900	25227
617	5200		15127	**310**	4900	25227
617	5200		15127	**310**	4900	25227
617	5200		15127	**310**	4900	25227
617	5200		15127	**310**	4900	25227
617	5200		15127	309	4900	25227
617	5200	360	15127	308	87700	108027
617	5200	360	15127	307	97500	117827
617	5200	360	15127	306	97500	117827
617	5200	360	15127	305	97500	117827
617	5200	360	15127	304	110500	130827
617	5200	360	15127	286.9	110500	130827
617	5200	360	15127	269.7	110500	130827
617	5200	360	15127	252.6	110500	130827
617	5200	360	15127	235.4	110500	130827
617	5200	360	15127	218.3	110500	130827
616	5200	360	15127	201.1	110500	130827
615	143200	360	15127	184	110500	268827
614	143200	360	15127	184	110500	268827
613	143200	360	15127	184	110500	268827
612	148000	360	15127	184	110500	273627
601.3	148000	360	15127	184	110500	273627
590.6	148000	360	15127	184	110500	273627
579.9	148000	360	15127	184	110500	273627
569.2	148000	360	15127	184	110500	273627
558.5	148000	360	15127	184	110500	273627
547.8	148000	360	15127	184	110500	273627
537.1	148000	360	15127	184	110500	273627
526.4	148000	360	15127	184	110500	273627
515.7	148000	360	15127	184	110500	273627
505	148000	360	15127	184	110500	273627

Several smaller impacts occur prior to the reservoirs declining to Level 4, the bottom of their conservation pools. The Level 4 strategy initially allows all three reservoirs to decline to a level just above the point that major impacts begin to occur. Hartwell will initially be allowed to decline to 617 ft-msl and Thurmond to 310 ft-msl prior to allowing Russell to decline below 464 ft-msl at which point mid-level impacts (the first 10,000-20,000 people affected) begin to occur. Hartwell and Thurmond would be maintained at these levels, just above the point that they would encounter major impacts, during which time Russell would be allowed to continue to decline to provide a sufficient rate of flow for downstream populations and habitat. Once Russell's inactive storage is fully depleted, Thurmond's storage would be allowed to decline further, since it produces the next smallest impact. At a Thurmond elevation of 308 ft-msl, a population of over 100,000 will be impacted. Thurmond's storage would be fully depleted at elevation 184 ft-msl and Hartwell would then be allowed to decline again. At elevation 615 ft-msl at Hartwell, the impacted population for the system would jump to over 250,000. If conditions were to persist, Hartwell would continue to decline until its inactive storage was fully exhausted at elevation 505 ft-msl.

As a drought ends and conditions begin to improve, the reservoirs would be refilled in the opposite order that they were drafted. The objective would be to supply drinking water to the largest population as soon as possible by refilling the reservoirs in an order which meets that goal.

3.2.2. Alternative 1

Correspondence from various State agencies has suggested a "wintertime flow reduction strategy" whereby the minimum daily average release at Thurmond Dam would be adjusted from 3,600 cfs to 3,100 cfs during the cooler months. This suggestion was incorporated in the 2008 Temporary Deviation EA produced by the Corps. The 2008 EA determined that it is possible to release as little as 3,100 cfs under specific conditions with an acceptable level of impact. The 2008 EA was titled a Temporary Deviation and was only intended to apply to the wintertime months in 2008-2009.

Alternative 1 follows the wintertime flow reduction strategy recommended by the various State agencies and is similar to those initiated by the 2008 Temporary Deviation EA. Alternative 1 consists of modifying one feature of the existing DCP. It is essentially the same as the NAA except the minimum daily average release at Thurmond Dam would be adjusted from 3,600 to 3,100 cubic feet per second (cfs) during the cooler months from November 1 through the end of February (February only after receiving separate approval from NOAA-Fisheries due to concerns about potential impacts to shortnose sturgeon) while in drought Level 4. The Alternative 1 flow reduction would remain in effect until it is determined that drought Level 4 conditions no longer exist.

Once the 3,100 cfs discharge is targeted at Thurmond in a given year, monitoring efforts would also be initiated and coordinated with the Savannah River Basin Drought Coordination Committee (SRBDCC). This Committee consists of representatives from each of the following organizations: Savannah District Engineering Division, South Atlantic Division Engineering

Division, Georgia DNR and South Carolina DNR. The flow reduction would be maintained through the end of February or until such time that a monitoring parameter, as defined in Table 13, is outside of acceptable levels. If concerns arise, the monitoring organization would notify the State, who would review the information and discuss the results with the SRBDCC. If appropriate, the State would recommend to the Savannah District adjustments to Thurmond release levels. If requested by either the State of Georgia or South Carolina, the Corps will make a decision about restoring the Thurmond discharge to as much as the 3,600 cfs daily average. NOAA-Fisheries will also be involved in monitoring and will initiate discussions with the SRBDCC concerning the potential impact to spawning shortnose sturgeon or other aquatic resources. Savannah District will accept a request from Savannah River Site to increase flows during a 3,100 cfs flow window. If the District receives such a request, it would coordinate with the States as part of its evaluation of whether to increase flows at that time. The critical monitoring objectives and monitoring organizations are described in Table 13 below.

Table 13: Critical Monitoring Objectives and Responsible Parties

Location	Target	Monitoring Organization
Augusta Canal	Flow < 2,900 cfs	City of Augusta
USGS 021989773 (USACE Dock)	DO > 5.0 mg/L daily average DO > 4.0 mg/L instantaneous Temperature ≤ 90 ºF pH 6.5-8.5	GA DNR-EPD
USGS 02198840 (I-95 Bridge)	Conductivity < 10,000 µS/cm	GA DNR-EPD
Abercorn Creek	Chloride < 16 ppm	City of Savannah
USGS 02198500 (Clyo)	Flow > 4,500 cfs	SC DHEC
Various	Water level at the intakes	Intake operators
Various	Sturgeon migration	SC DNR and NOAA Fisheries

The values shown above in Table 13 are general performance targets and are not intended to be mandatory requirements. Failure to achieve the desired targets would initiate an evaluation of impacts, which could lead to a request by the State of Georgia, the State of South Carolina, or NOAA-Fisheries to the Corps to restore the discharges from Thurmond Dam to 3,600 cfs. The District expects the following offices in Table 14 to represent their agencies.

Table 14: Offices Representing Agencies

Agency	Office	Individual
GA DNR-EPD	Watershed Protection Branch	Jeff Larson, Assistant Branch Chief
SC DNR	Office of Environmental Programs	Bob Perry, Director
SC DHEC	Bureau of Water	David Baize, Assistant Bureau Chief
NOAA Fisheries, Southeast Regional Office	Protected Resources Division	Stephania Bolden, Fishery Biologist

Table 15: Alternative 1, Maintain 3,600 cfs with 3,100 cfs (No Storage Reduction)

Day	Years	Hartwell Elevation	Hartwell Impacts	Russell Elevation	Russell Impacts	Thurmond Elevation	Thurmond Impacts	Total Impacts
1	0.00	624.7	5200	469.9	0	311.9	4900	10100
83	0.23	617	5200	463.7	6500	310.1	4900	16600
102	0.28	617	5200	457.7	14627	310	4900	24727
111	0.30	617	5200	454.6	15127	310	4900	25227
187	0.51	617	5200	455	14627	310	4900	24727
219	0.60	617	5200	458.1	6500	310	4900	16600
239	0.65	617	5200	464.2	0	310	4900	10100
370	1.01	617	5200	463.8	6500	310	4900	16600
388	1.06	617	5200	457.9	14627	310	4900	24727
397	1.09	617	5200	454.8	15127	310	4900	25227
649	1.78	617	5200	455	14627	310	4900	24727
689	1.89	617	5200	454.8	15127	310	4900	25227
839	2.30	617	5200	320	15127	307.9	97500	117827
880	2.41	617	5200	320	15127	303.9	110500	130827
886	2.43	617	5200	320	15127	304.1	97500	117827
918	2.52	617	5200	320	15127	308	4900	25227
1135	3.11	617	5200	320	15127	307.9	97500	117827
1174	3.22	617	5200	320	15127	303.8	110500	130827
1335	3.66	617	5200	320	15127	304	97500	117827
1361	3.73	617	5200	320	15127	308.1	4900	25227
1439	3.94	617	5200	320	15127	307.9	97500	117827
1468	4.02	617	5200	320	15127	303.9	110500	130827
2320	6.36	614.9	143200	320	15127	190	110500	268827
2334	6.39	612.8	148000	320	15127	190	110500	273627
2351	6.44	613	143200	320	15127	193.5	110500	268827
2360	6.47	615	5200	320	15127	198	110500	130827
2622	7.18	614.8	143200	320	15127	190	110500	268827
2630	7.21	612.9	148000	320	15127	190	110500	273627
2802	7.68	613	143200	320	15127	202.9	110500	268827
2809	7.70	615	5200	320	15127	202.9	110500	130827
2917	7.99	614.9	143200	320	15127	190	110500	268827
2925	8.01	612.9	148000	320	15127	190	110500	273627
3401	9.32	500	148000	320	15127	190	110500	273627

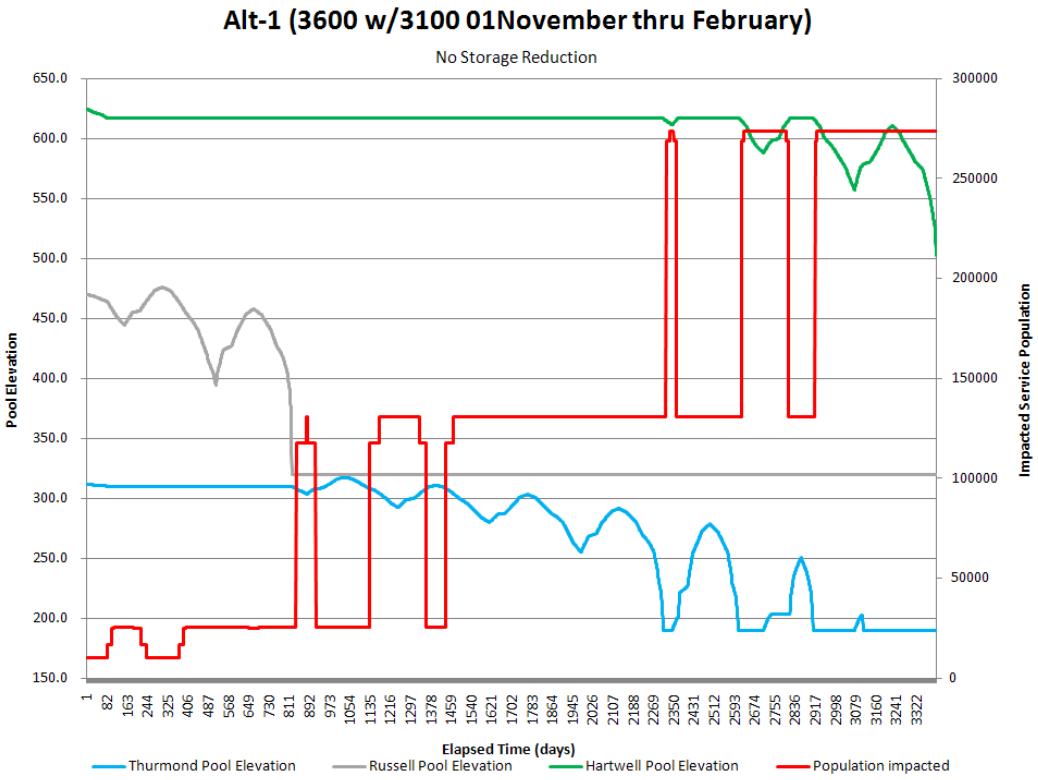


Figure 11: Alternative 1 (3600 with 3100) (No Storage Reduction)

Table 16: Alternative 1, Maintain 3600 cfs with 3100 cfs (10% Storage Reduction)

Day	Years	Hartwell Elevation	Hartwell Impacts	Russell Elevation	Russell Impacts	Thurmond Elevation	Thurmond Impacts	Total Impacts
1	0.00	624.7	5200	469.8	0	311.9	4900	10100
75	0.21	617	5200	463.9	6500	310.1	4900	16600
92	0.25	617	5200	457.8	14627	310.1	4900	24727
100	0.27	617	5200	454.7	15127	310.1	4900	25227
221	0.61	617	5200	455.1	14627	310.1	4900	24727
229	0.63	617	5200	458.1	6500	310.1	4900	16600
246	0.67	617	5200	464	0	310.1	4900	10100
363	0.99	617	5200	463.6	6500	310.1	4900	16600
379	1.04	617	5200	457.6	14627	310.1	4900	24727
386	1.06	617	5200	454.9	15127	310.1	4900	25227
649	1.78	617	5200	455	14627	308.5	4900	24727
668	1.83	617	5200	458	6500	308.5	4900	16600
671	1.84	617	5200	457.9	14627	308.5	4900	24727
689	1.89	617	5200	454.8	15127	308.5	4900	25227
815	2.23	617	5200	320	15127	307.8	97500	117827
842	2.31	617	5200	320	15127	303.8	110500	130827
913	2.50	617	5200	320	15127	304.1	97500	117827
965	2.64	617	5200	320	15127	308	4900	25227
1108	3.04	617	5200	320	15127	307.9	97500	117827
1139	3.12	617	5200	320	15127	303.9	110500	130827
1359	3.72	617	5200	320	15127	304.1	97500	117827
1442	3.95	617	5200	320	15127	303.8	110500	130827
1972	5.40	614.8	143200	320	15127	190	110500	268827
1985	5.44	615.2	5200	320	15127	192.8	110500	130827
2267	6.21	614.8	143200	320	15127	190	110500	268827
2275	6.23	612.7	148000	320	15127	190	110500	273627
2427	6.65	613.2	143200	320	15127	190	110500	268827
2434	6.67	615.1	5200	320	15127	190	110500	130827
2562	7.02	614.7	143200	320	15127	190	110500	268827
2569	7.04	612.7	148000	320	15127	190	110500	273627
3027	8.29	500.0	148000	320	15127	190	110500	273627

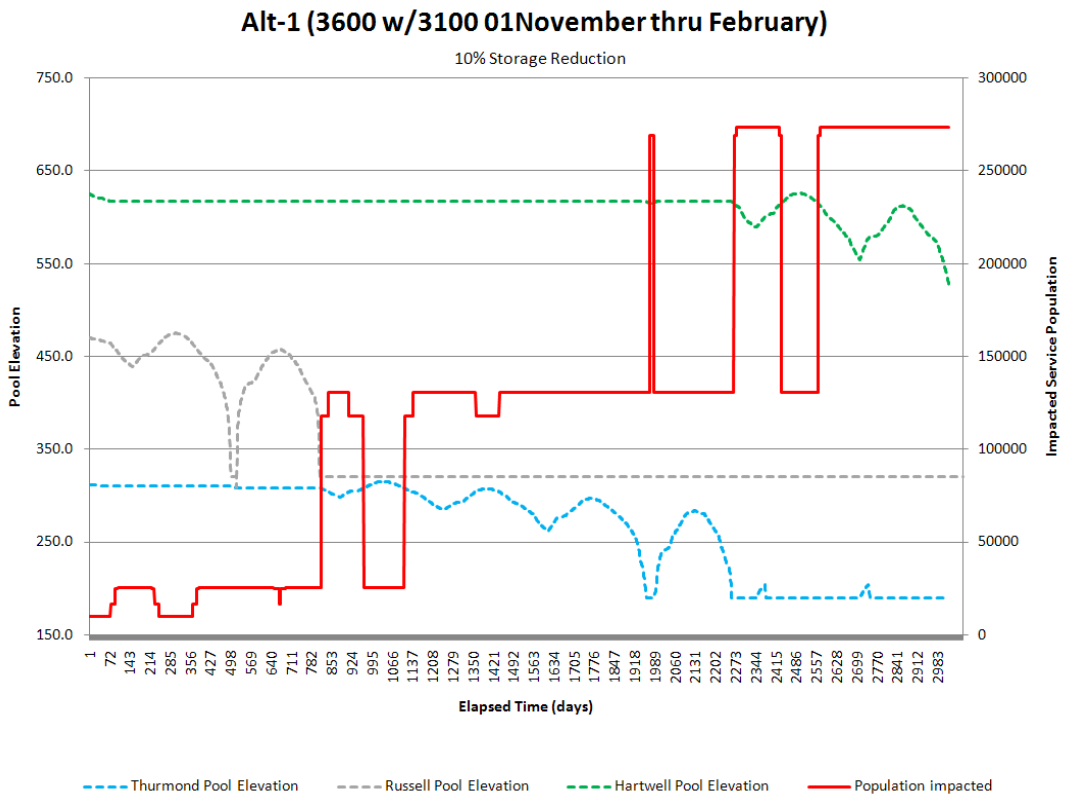


Figure 12: Alternative 1 (3600 with 3100) (10% Storage Reduction)

3.2.3. Alternative Considered But Eliminated From Detailed Consideration

A preliminary alternative was initially considered to discharge from Thurmond Dam at a rate where outflow equals inflow, from the start of Level 4 drought conditions. This scenario would keep the reservoir pools from declining into their inactive storage; however, this alternative would have major adverse impacts to resources downstream of JST. The resulting intermittent low flows, possibly approaching no flow, would be expected to impact threatened and endangered Species, including shortnose sturgeon habitat and exposing the shoals spiderlily to consumption by deer. These flows would have impacts on water supply and safety at the Savannah River Site, as intakes become exposed as river flows decrease. Water quality impacts (DO, chloride, etc.) would also be expected as flows decreased.

3.2.4. Recommended Alternative

The Recommended Action is Alternative 1. This Alternative modifies one feature of the approved Drought Contingency Plan. The minimum daily average release at Thurmond would be reduced from 3,600 cfs to 3,100 cfs in drought Level 4 for the cooler months from November 1 through the end of February (February only after receiving separate approval from NOAA-Fisheries due to concerns about potential impacts to shortnose sturgeon). The Corps would restore the Thurmond discharge up to the 3,600 cfs daily average if requested by either the State

of Georgia or South Carolina. The solid lines in Figure 13 below show the estimated times for inactive pool depletion for each alternative at Thurmond and Hartwell. The dashed lines in Figure 14 are included for comparison in the event that there is a 10% storage reduction due to any calculation errors or lower inflows than have been experienced to date. The elapsed time is from the date the projects reach Level 4 Conditions. The below Figures 13 and 14 predict that under Alternative 1, pool emptying would be delayed over 600 days when compared to the NAA.

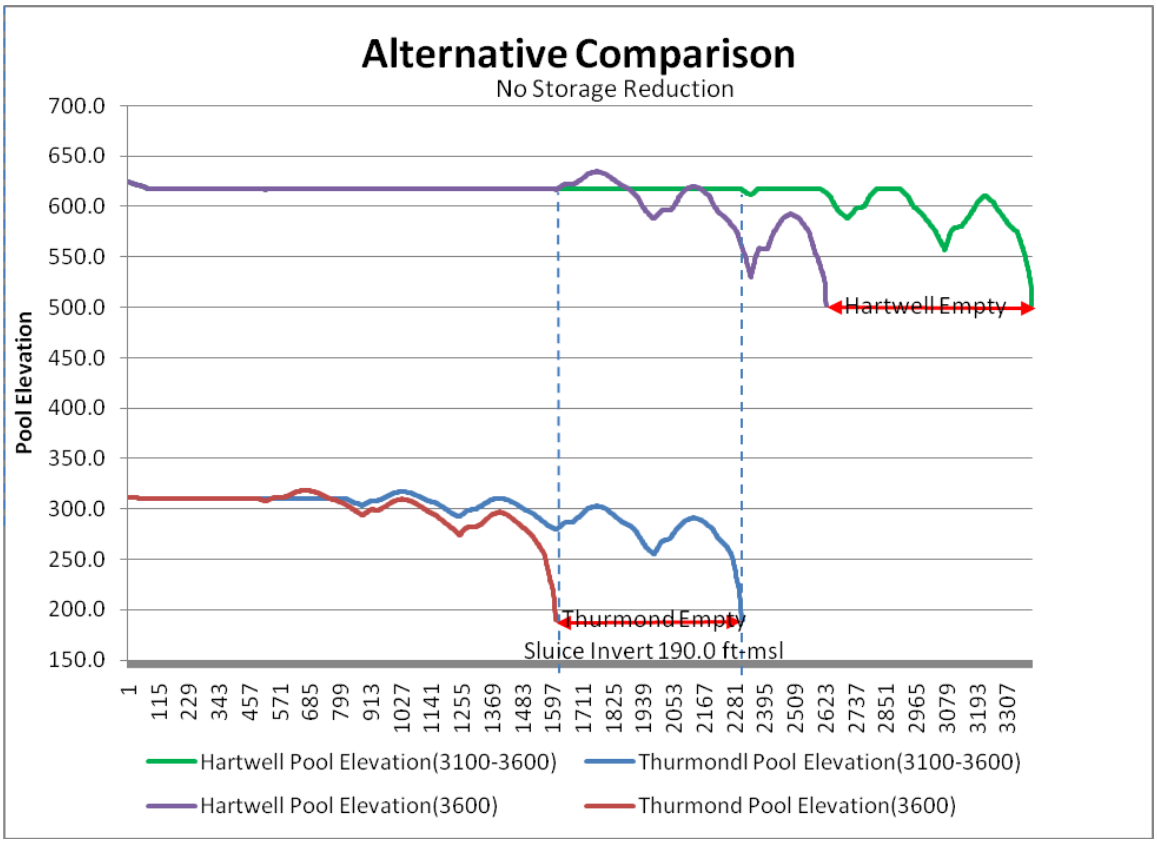


Figure 13: Comparison of Alternatives (No Storage Reduction)

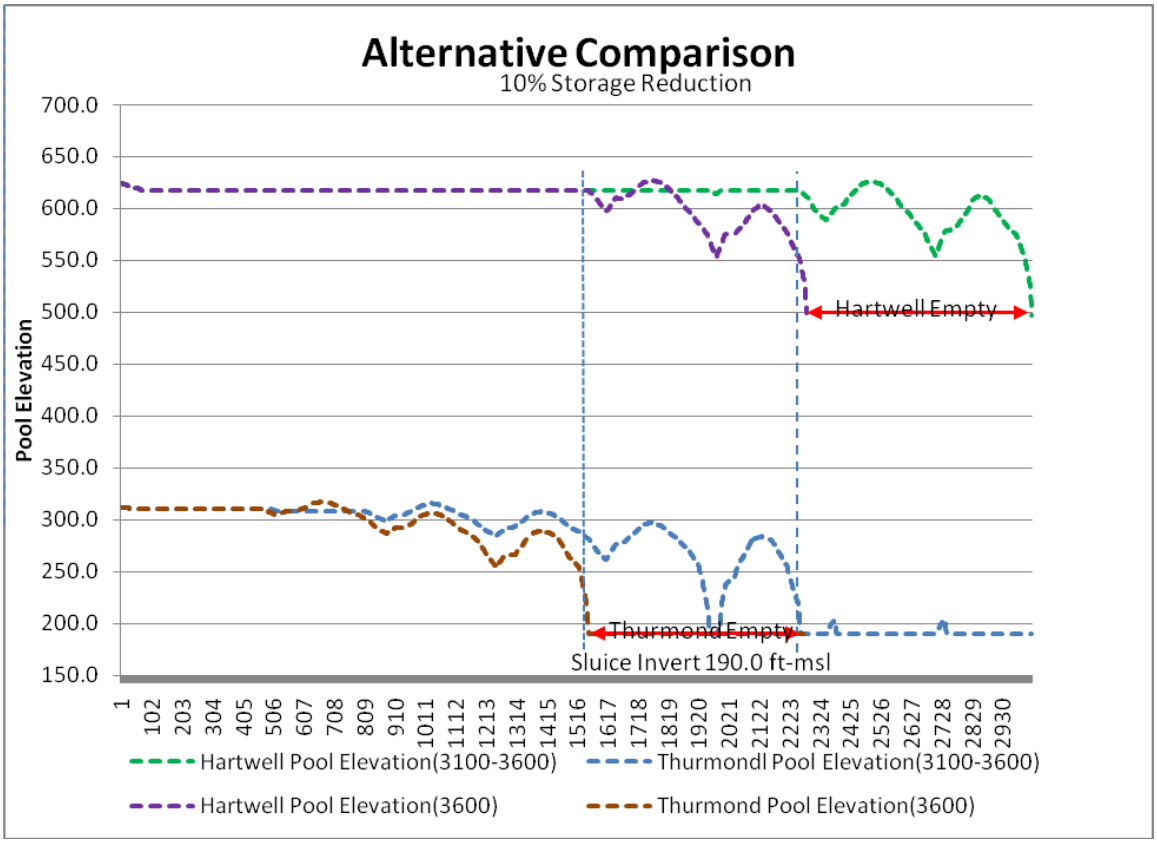


Figure 14: Comparison of Alternatives (10% Storage Reduction)

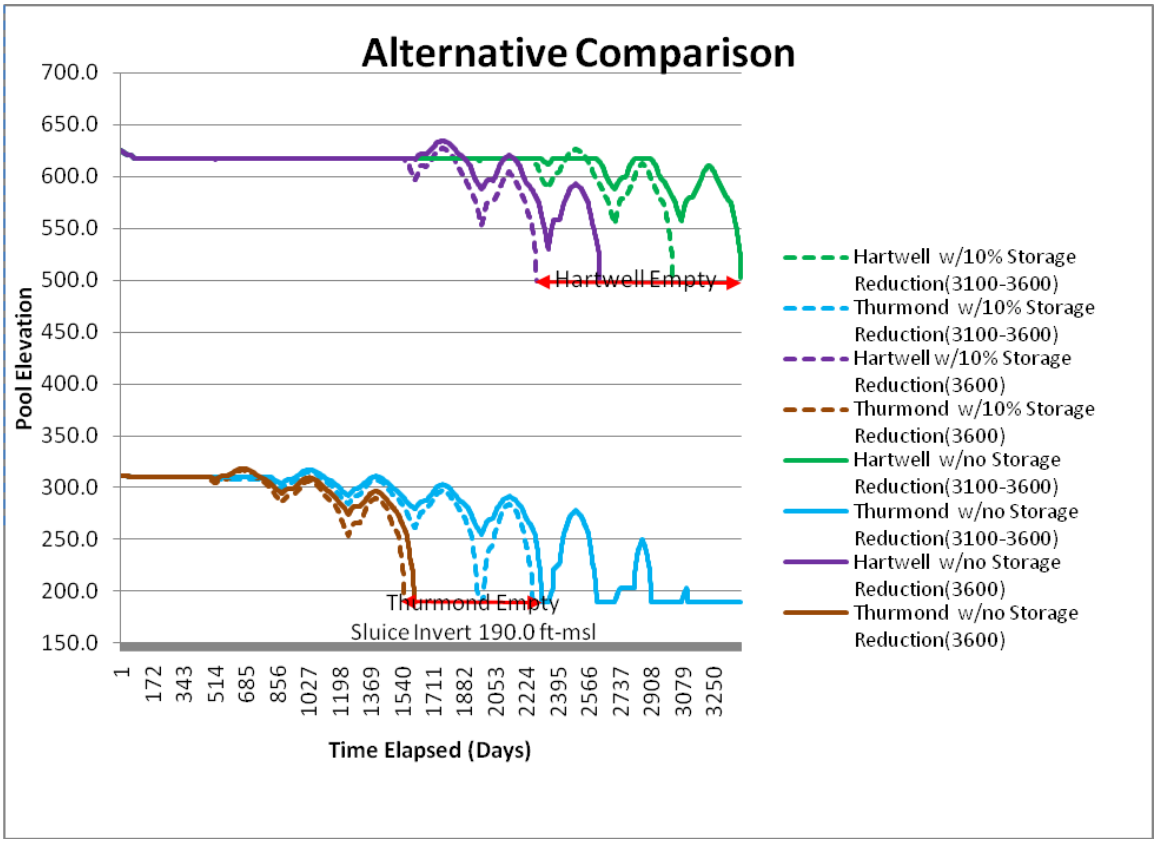


Figure 15: Alternative Comparison

Maintaining a minimum daily average release of 3,600 cfs from Thurmond with a seasonal reduction to 3,100 cfs from November 1 through the end of February (February only after receiving separate approval from NOAA-Fisheries due to concerns about potential impacts to shortnose sturgeon) would result in: (1) the extension of minimal environmental flows needed downsteam of JST, (2) a reduction in the rate at which the pools would be depleted, and (3) a reduction in recovery time for the three reservoirs.

4.0 ENVIRONMENTAL AND SOCIO-ECONOMIC CONSEQUENCES

The Savannah District does not anticipate any effects to air quality, climate change, noise, non-renewable resources, mineral resources, HTRW (hazardous, toxic and radioactive wastes including past PCB issues at Hartwell Lake), farmland, wetlands, water quality in the lakes, flood control, hydrology, soils, sediment or to fishery resources from either the No Action Alternative or the selected alternative. Nor does the Savannah District envision any irretrievable commitments of resources from either alternative. The Savannah District believes the proposed project is consistent with both the Georgia and South Carolina Coastal Zone Management Program to the maximum extent practicable (See Section 4.10).

As discussed in Section 4.4, flows up to 10,000-15,000 cfs, are expected to remain within the stream channel. Flows discussed in the drought alternatives range between 3,600 and 3,100 cfs, so they would be contained within the stream channels. Fluctuating these flows within these low ranges would produce no measurable impacts on adjacent floodplain wetlands along the river (upstream of the estuary).

4.1. WATER QUALITY

4.1.1 Overview

When discharges are reduced from Thurmond Dam, impacts could occur to downstream water quality. Lower discharges could increase water temperature and reduce the quality of the river downstream of point source discharges. The summer months are the most critical to aquatic resources; therefore, reduced river flows during the summer months are likely to cause greater adverse impacts than reduced river flows during the winter months.

The State of South Carolina uses the current drought plan Level 3 flow of 3,600 cfs (Larry Turner, South Carolina DHEC) at the Savannah River Augusta gage for the permitting of point source discharges in the Augusta area at the Savannah River Augusta gage for the permitting of point source discharges in the Augusta area and this flow is adjusted upward to account for tributary input as one moves down the river. The State of Georgia uses the 7Q10 flow values of 3,800 cfs at the Augusta gage, 4,160 cfs at the Millhaven gage, and 4,710 cfs at the Clyo gage in its point source discharge permit decisions. In the following analysis, the flows of the modeled alternative were compared to the flows of the modeled No Action Alternative to determine the impacts of modifying the SRBDCP.

The Georgia Department of Natural Resources, Environmental Protection Division (EPD) analyzed the potential effects on water quality for this same proposed winter flow reduction in an EA in 2008. EPD evaluated the potential impacts in both the river and the estuary/harbor area. They concentrated on DO levels since the States and EPA had previously identified DO as a critical water quality parameter in this basin.

For the river portion (Thurmond Dam to Clyo) of the basin, GA DNR-EPD used the RIV1 Model to identify potential point source discharge problems along the river if the river flow was reduced. For the estuary/harbor portion of the basin (Clyo to ocean), GA DNR-EPD used the EFDC and WASP Models which were developed by EPA and used for EPA's TMDL analysis. The States concluded that the modeling indicated that the proposed temporary seasonal reduction of Thurmond releases would not cause water quality problems in the river or the harbor. The following paragraphs contain details of the water quality analyses:

4.1.2 Savannah River downstream of Thurmond Dam

The first model simulation was conducted with 2007 meteorological data, tributary inflows, and Thurmond release data and 2006 wasteload discharges and water withdrawals. This simulation was developed to assess how well the model was calibrated to observed DO data. Figures 16 and 17 below show the observed DO data (red squares) measured in 2007, which never went below

6.5 mg/L and 6.29 mg/L at River Mile (RM) 119 (US Highway 301) and RM 61 (Clyo Gage), respectively, versus the approximate calibration run. It is an approximate calibration run, since the model did not include 2007 discharge and withdrawal data, but rather that of 2006. Despite the approximation of this model run, the results indicate that the model was calibrated relatively well.

Figure 16 - Calibration of Savannah River water quality model at River Mile 119

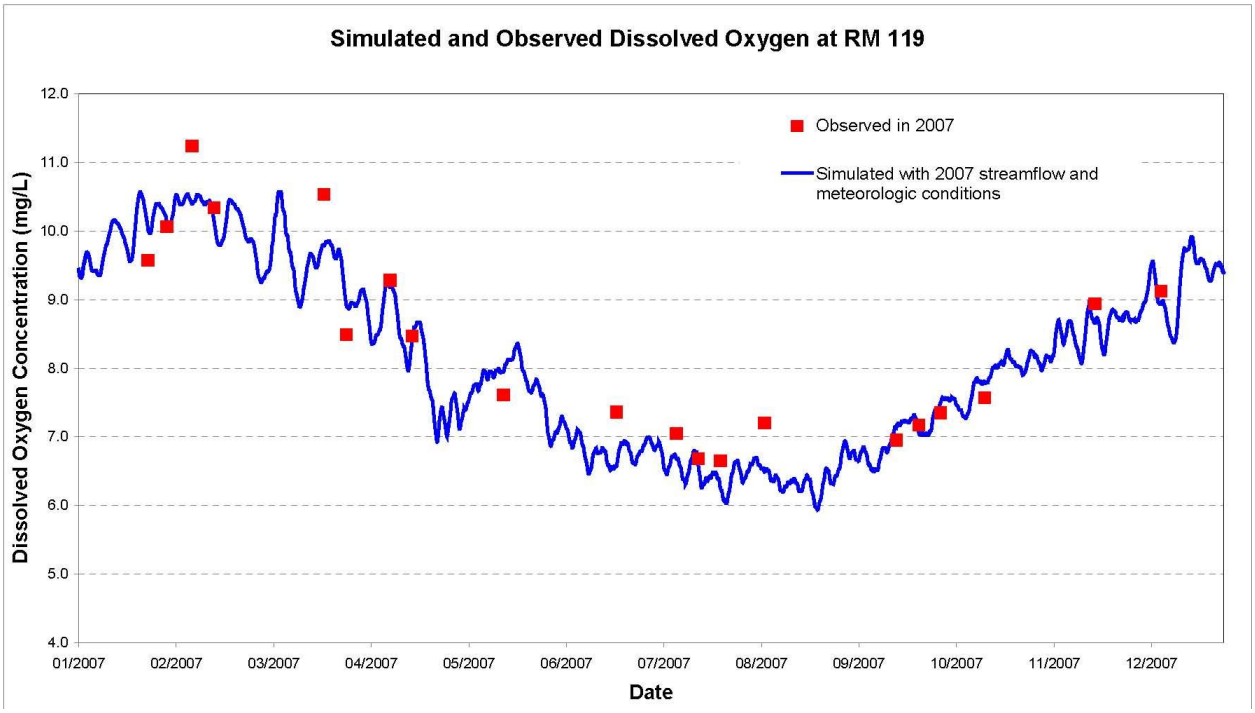
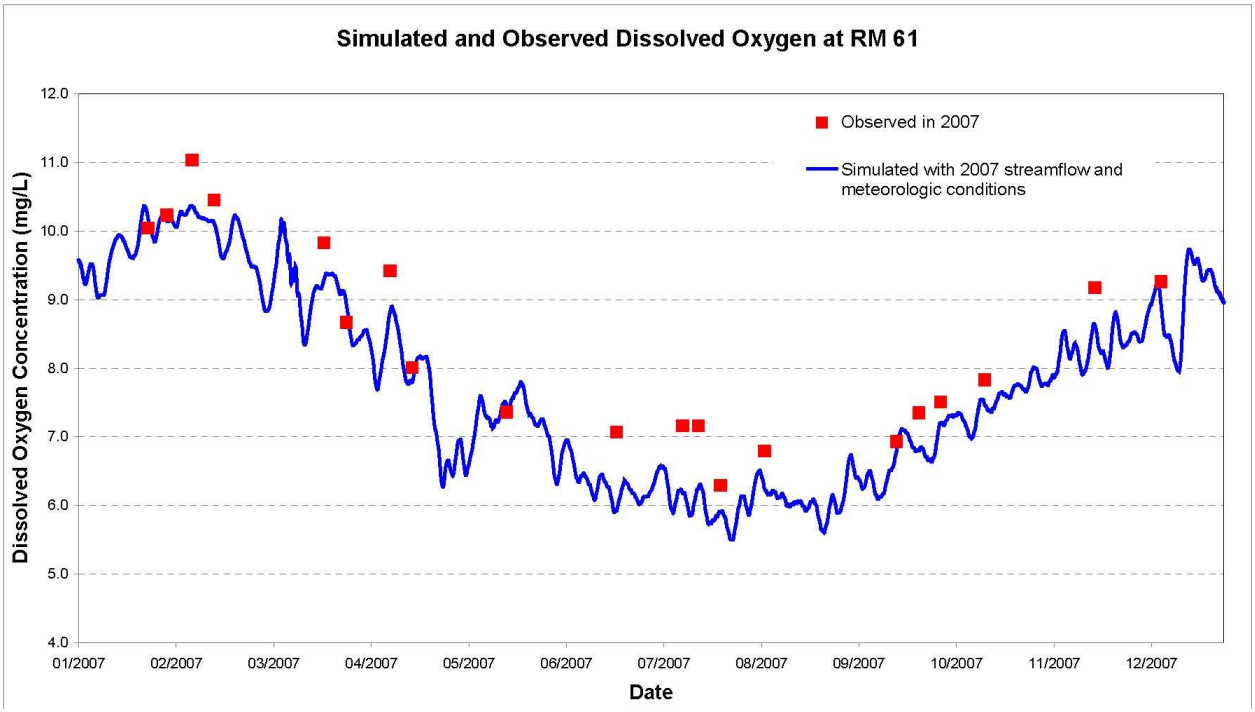


Figure 17 - Calibration of Savannah River water quality model at River Mile 61

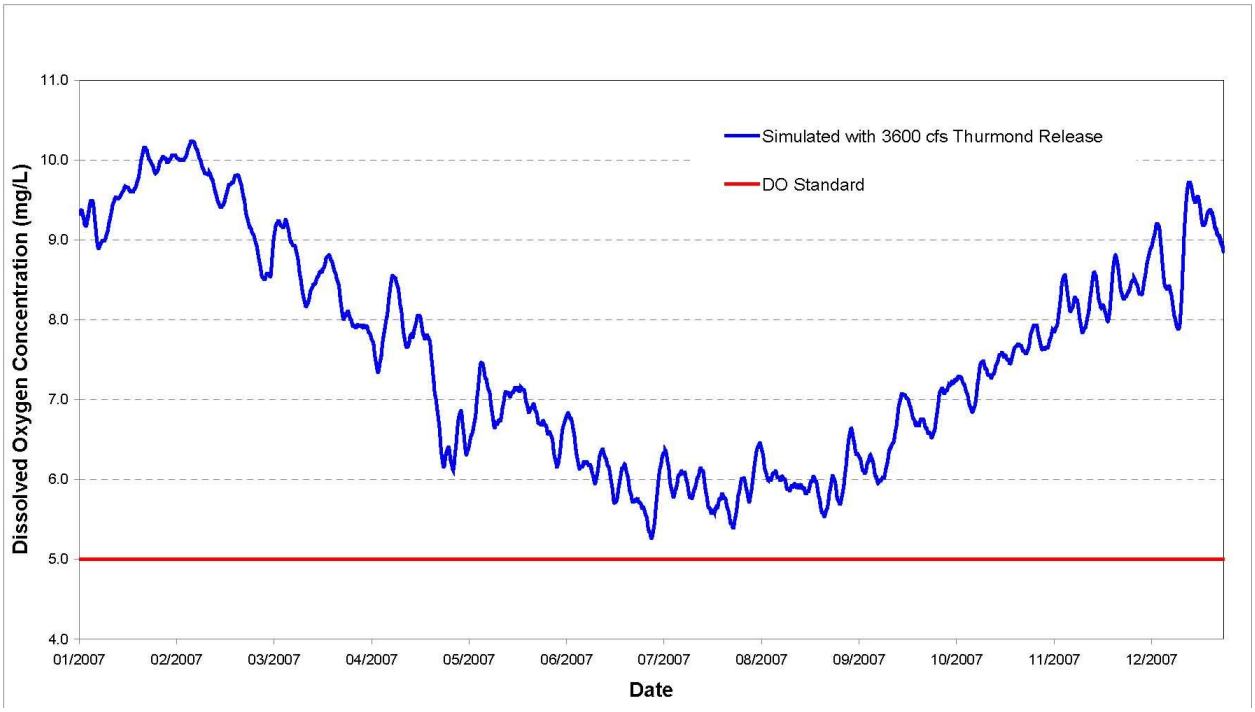


GA DNR-EPD conducted additional model simulations using 2007 meteorological data and tributary inflows, and 2006 wasteload discharges and water withdrawals. These model simulations incorporated varying amounts of discharges from Thurmond Dam (3,600 and 3,100 cfs).

Figures 18 and 19 below show the results of the 3,600 cfs simulation (No Action Alternative). Under a Thurmond release of 3,600 cfs, the simulated DO concentrations at RM 119 (US Highway 301) are predicted to be above 5 mg/L throughout the year (Fig. 16). Figure 17 shows simulated DO concentration at River Mile 61 (Clyo) under a Thurmond release of 3,600 cfs. Again, the simulated DO concentrations are predicted to be higher than 5 mg/L throughout the year. The riverine water quality model shows that the 5.0 mg/L DO standard would not be breached by a Thurmond release of 3,600 cfs.

Figure 18 – Dissolved Oxygen at RM 119

Figure 19 - Dissolved Oxygen at RM 61



Figures 20 and 21 below show the simulated DO concentrations at River Mile 119 and River Mile 61 respectively, under a Thurmond release of 3,100 cfs. The model indicates that the DO would remain above the standard of 5 mg/L throughout the year. For the cooler months of October through February, DO concentrations would remain higher than 6.0 mg/L and almost always be higher than 7.0 mg/L at both River Mile 119 and River Mile 61.

Figure 20 – Simulated Dissolved Oxygen at RM 119

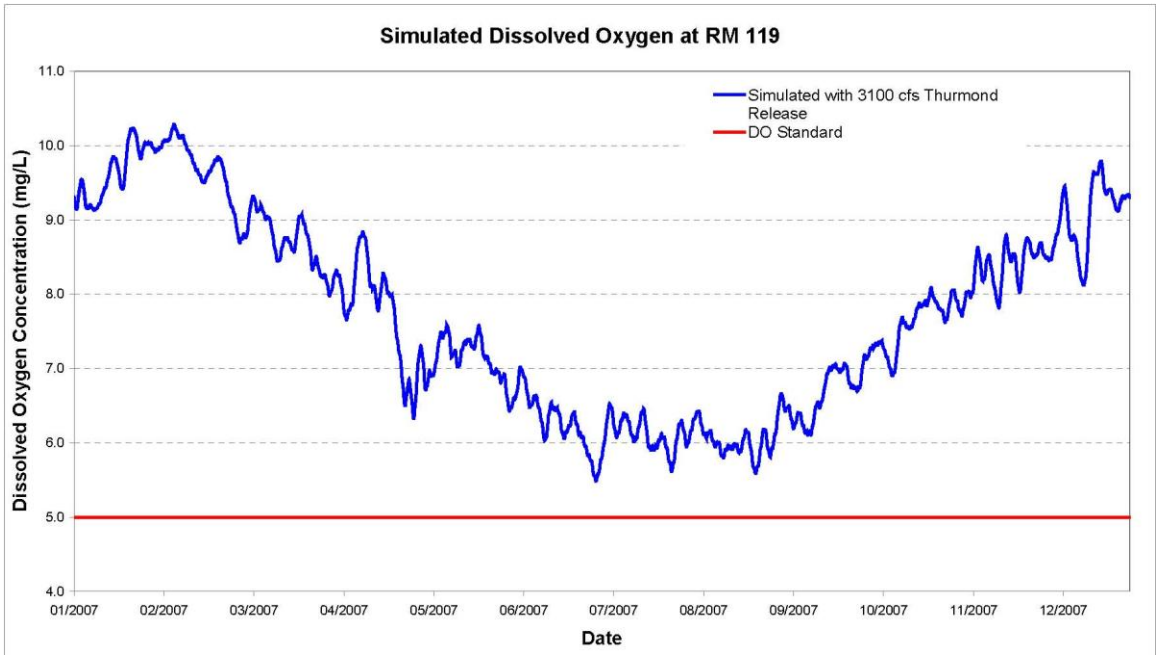
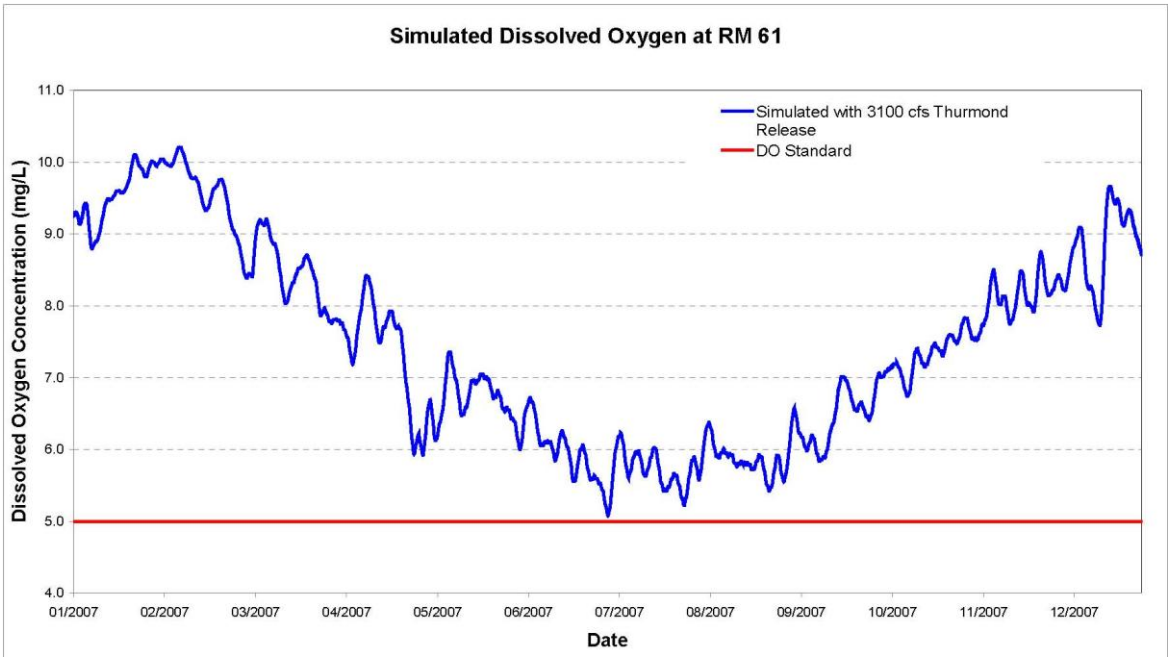


Figure 21 – Simulated Dissolved Oxygen at RM 61



One should note that the water quality model used in this analysis does not contain any modules simulating algal activity in the river. This lack of simulated algal activity means that the model may give overly pessimistic DO concentrations. Algal activity typically increase DO concentrations during the day, while algal respiration and decay of the algal biomass tend to decrease DO at night. It is likely that field data would document higher DO concentrations than the model predicts.

The proposed action includes a continuation of 3,600 cfs release from Thurmond Dam in the months of March through October and a reduced release from Thurmond Dam of 3,100 cfs in the cooler months (November through February, with February only after receiving separate approval from NOAA-Fisheries due to concerns about potential impacts to shortnose sturgeon). This action would not result in any adverse change in DO concentration in the warmer months.

GA DNR-EPD has indicated in the past that monitoring would occur at locations along the river to identify changes in DO concentration along the lower reaches if similar proposed operations were adopted. The Corps proposes to use adaptive management as part of the proposed action. If field observations indicate a substantial problem with DO concentration, GA DNR-EPD or SC DHEC would notify the Corps and Savannah District would then increase flows up to a 3,600 cfs discharge to mitigate the adverse conditions.

Once initiated in a given year, the 3100 cfs targeted release would be maintained through February (November through February, with February only after receiving separate approval from NOAA-Fisheries due to concerns about potential impacts to shortnose sturgeon). If during this period, a listed monitoring site fails to meet its general environmental target as defined in table 13, or sturgeon spawning appears to be adversely impacted, an evaluation of the impacts

would be initiated. This could lead to a request by the State of Georgia, the State of South Carolina, or NOAA-Fisheries to the Corps of Engineers to increase the targeted release at Thurmond Dam from 3100 cfs to as much as 3600 cfs. A decision would be made by Savannah District to modify the release target consistent with the adaptive management strategy as defined in Alternative 1, the chosen alternative.

4.1.3 Savannah Harbor

Two potential water quality related effects in the estuary were evaluated from reduced discharges from Thurmond Dam in the 2008 Temporary Deviation EA. The two water quality related effects include elevated chloride concentrations at the City of Savannah municipal water intake on Abercorn Creek, and dissolved oxygen concentrations in the Savannah Harbor.

The City of Savannah's municipal and industrial water intake is located on Abercorn Creek, upstream of the harbor near river mile 29, approximately two miles from the Savannah River. The City of Savannah is concerned about distributing water to its industrial customers when chloride concentrations in Abercorn Creek are greater than roughly 12 milligrams per liter (mg/L). Such concentrations have been shown to cause scaling in boilers.

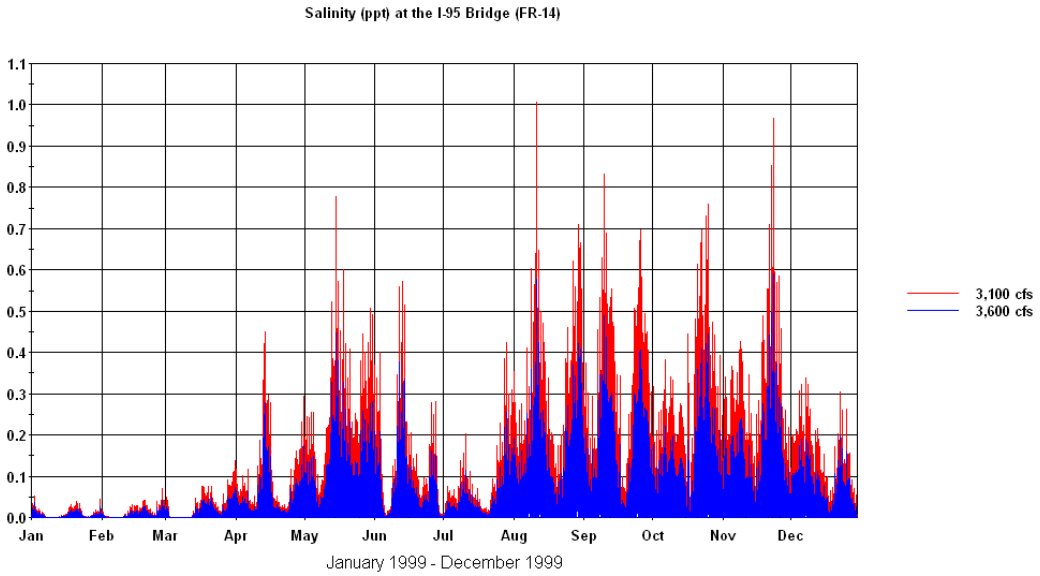
Sources of chloride in Abercorn Creek include upstream inflows from the Savannah River and salinity intrusion from the downstream Savannah Harbor. Studies have shown a correlation between river flows at the US Geological Survey's Clyo stream gage location and chloride concentrations in Abercorn Creek. Results have shown that the Savannah River contains approximately 10 mg/L of chloride during low flows and 4 mg/L during high flows, when there is greater dilution. Therefore, it is during low flow periods where river chloride concentrations are as high as 10 mg/L when salinity intrusion from downstream can add additional chlorides in the vicinity of the intake and cause the water to exceed the 12 mg/L threshold. Analysis of the historical chloride data collected at the City's intake shows that during drought years the number of samples with chlorides exceeding 12 mg/L ranges from 21 to 58 percent and concentrations have approached 19 mg/L.

Reducing releases from Thurmond Reservoir, by itself, would not create higher chloride concentrations at the City of Savannah's water withdrawal. Rather, it is the combination of low releases from Thurmond Reservoir, low runoff from the downstream watershed, and high (spring) tides that create a condition for elevated chloride concentrations at the City's withdrawal. With sufficient downstream inflows and normal tidal conditions, chloride levels at the City's intakes should remain unchanged. However, given the sensitivity of the City's intake to chloride concentrations greater than 12 mg/L, the proposed reservoir operation (Alternative 1) combined with low downstream inflows could increase the number and magnitude of chloride concentrations greater than 12 mg/L at the City of Savannah's M&I water withdrawal. The City of Savannah monitors chloride concentrations each day for the water they withdraw from Abercorn Creek. If they identify unusual values after implementation of the proposed action, they would notify the Corps and GA DNR-EPD. If the observations by the City of Savannah indicate a substantial problem with chloride concentrations, GA DNR-EPD would recommend an

appropriate action to Savannah District, possibly including the resumption of the 3,600 cfs discharge.

As part of the chloride level impacts review concerning the City's intake, GA DNR-EPD used the Savannah Harbor EFDC Model to identify expected changes in salinity levels at the upper end of the harbor for the 2008 Temporary Deviation EA. Figure 22 shows the effects on salinity levels at the Interstate 95 Bridge, located at river mile 27.8. The results indicate that salinity should remain below 1 ppt at the I-95 Bridge during the winter months, even with the proposed reduction in discharge to 3,100 cfs.

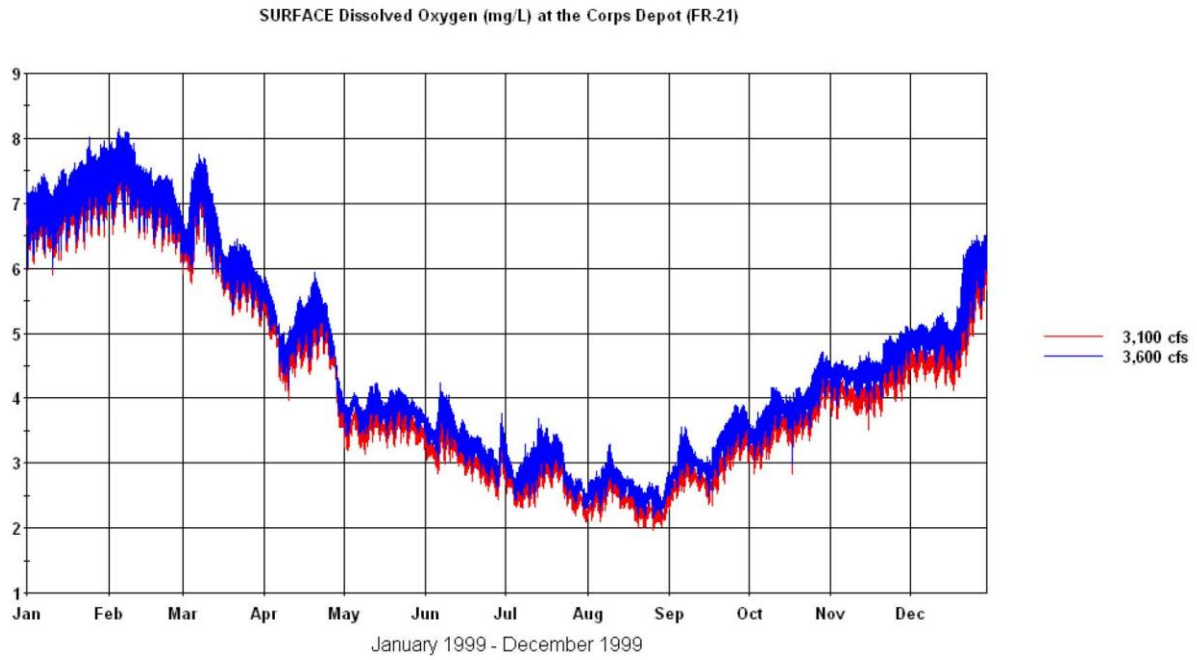
Figure 22 – Salinity at I-95 Bridge



GA DNR-EPD evaluated the effect of the proposed Thurmond reservoir operation on dissolved oxygen concentrations in Savannah Harbor using the Savannah Harbor EFDC and WASP Models for the 2008 Temporary Deviation EA. The RIV1 Model streamflow and water quality results provided input for the upstream boundary of the harbor models. GA DNR-EPD evaluated model results and the effects on dissolved oxygen concentrations at the USGS monitoring station located at the U.S. Army Corps of Engineers' dock on Hutchinson Island in the harbor. EPD compared the results to the then existing coastal fishing classification, whose dissolved oxygen criteria is no less than 3.0 mg/L during June through October, no less than 3.5 mg/L in May and November, and no less than 4.0 mg/L during December through April. The results are shown in Figure 23. GA DNR-EPD concluded that the modeling indicates that the proposed seasonal reduction of Thurmond releases would not result in substantial adverse impacts to dissolved oxygen levels in the harbor. Therefore, no substantial effects would be expected to EPA's TMDL for dissolved oxygen in the harbor. The Dissolved Oxygen requirement for Georgia recently changed to a daily average of 5.0 mg/L and a daily minimum of 4.0 mg/L for all of the year. The requirement is in effect throughout the water column. In applying these requirements to Figure 21, the proposed seasonal reduction of Thurmond releases would result in minor impacts that are not significant from early November through mid-December to the dissolved

oxygen levels in the harbor. Since dissolved oxygen levels are generally not at critical levels during those months, the Corps does not believe that mitigation is warranted for these effects.

Figure 23 – Simulated Surface Dissolved Oxygen in Savannah Harbor



Once initiated in a given year, the 3100 cfs targeted release would be maintained through February. If during this period, a listed monitoring site fails to meet its general environmental target as defined in table 13, or sturgeon spawning appears to be adversely impacted, an evaluation of the impacts would be initiated. This could lead to a request by the State of Georgia, the State of South Carolina, or NOAA-Fisheries to the Corps of Engineers to increase the targeted release at Thurmond Dam from 3100 cfs to as much as 3600 cfs. A decision would be made by Savannah District to modify the release target consistent with the adaptive management strategy as defined in Alternative 1, the chosen alternative.

4.1.4 Effects on EPA TMDLs

At EPA's request for the 2008 Temporary Deviation EA, the Corps reviewed the below TMDL's that EPA previously issued for Dissolved Oxygen, Fecal Coliform and Lead on the Savannah River.

Please see the previous section on impacts in the estuary for the discussion on the potential effects of the reduced discharge on dissolved oxygen.

The 2000 TMDL for Fecal Coliform indicates that the 23-mile river segment that is impaired is located directly downstream of the City of Augusta's wastewater treatment plant, between the Butler Creek and McBean Creek. The City of Augusta improved their stormwater conveyance system and separated their stormwater and sanitary sewer systems. The improvements led to dramatic decreases in fecal coliform loading into the Savannah River. The TMDL evaluated three different river flow conditions. However, the TMDL of 1.37 x 1013 Counts/day was established using the minimum daily average flow of 2,810 cfs. That flow would be exceeded under both the No Action Alternative and Alternative 1; therefore, the TMDL for Fecal Coliform would not be affected by either alternative that is under consideration.

The 1999 TMDL for Lead indicates that the impaired 53-mile river segment is located between Brier Creek and Ebenezer Creek. The TMDL could not identify any sources of lead within the watershed. It stated that the latest sampling did not identify any lead in that segment of the river. The lower river flows associated with Alternative 1 could increase the concentration of lead in the water, if any is still present. Since there is uncertainty in whether lead is still present, the Corps believes that the 4-month reduction in flow by 500 cfs (14%) in possibly consecutive years would not significantly affect the long term ability of the segment to meet the water quality standard of 0.54 ug/l of lead.

EPA issued a TMDL for Lead in 2000 for the 23-mile segment directly downstream of the City of Augusta's wastewater treatment plant, between the confluence of Butler and McBean Creek. Again, the TMDL could not identify any sources of lead within the watershed. The TMDL assumed that there was a legacy load of lead either in contaminated sediments or nonpoint source runoff. For this river segment, the TMDL used the critical low flow of 2,810 cfs. That flow would be exceeded under both the No Action Alternative and Alternative 1; therefore, the TMDL for Lead in this river segment would not be affected by either alternative that is under consideration.

4.2. BIOTIC COMMUNITIES-LAKES

4.2.1. Largemouth Bass Spawning


Largemouth bass

Past studies indicate that the 4-week period of April 1-28 is the peak spawning period. Stable lake levels should be provided during this peak spawning period to prevent the stranding of eggs and abandonment of nests. Throughout the spawning season, water levels should not be lowered more than six inches below the highest lake elevation recorded during the operational spawning window. If inflows during the spawning season cause lake levels to rise to flood levels, managers have the authority to lower lake levels more than 6 inches, since flood control takes precedence over fish spawn. Maintaining these stable lake levels may not be possible during drought.

In both the NAA and Alternative 1, stable lake levels would be provided during this peak spawning period as much as possible. The difference between the two alternatives is that the lakes would be somewhat higher if Alternative 1 is implemented, since they would have retained more water during the winter months. The NAA would result in less stable pool levels, thus having a higher potential to impact fish spawning. Alternative 1 would provide more flexibility to water managers, resulting in a greater potential to manage continued drought flows without adversely impacting spawning seasons.

4.2.2. Aquatic Plants

Effects of the NAA

The NAA would have no adverse impacts on aquatic plants (including invasive species, such as hydrilla) as the existing SRBDCP of March 1989 with pumped storage operation would continue to be used.

Effects of Recommended Alternative

The persistent drought from 2006 through September 2009 significantly reduced the abundance of aquatic vegetation in JST Lake (including invasive species, such as hydrilla) (Aquatic Plant Treatment Plan, US Army Corps of Engineers, Savannah District, Calendar Year 2010 Update), which is the only lake of the three with an active aquatic vegetation treatment program. Therefore, the proposed action and the associated small variations in lake levels when compared to the NAA are expected to have no adverse impact on aquatic plants in the lakes. No downstream effects are anticipated to occur within the main channel. Potential effects to aquatic plants in the shoals, estuary, and flood plain are discussed in the following sections.

4.3. BIOTIC COMMUNITIES-SHOALS

Past studies and coordination have listed shad, robust redhorse, Atlantic sturgeon, the shoals spider lily (*Hymenocalis coronaria*) and juvenile out-migration as being high priorities for the Shoals during dry years. The brother spike can also be found at the Shoals. The Shoals are defined as the 7.2 kilometer stream segment that is upstream of Augusta and downstream of the Augusta Canal Diversion Dam. High priority fish species benefit from higher flows across the shoals from January to May, since such flows support seasonal spawning and passage. The state-listed endangered Shoals spider lily benefits from higher flows from June to December, as such flows provide protection from grazing deer. Undefined very high flows could be detrimental to the Shoals spider lily; however, such flows are not expected during times of drought. Therefore, the impacts associated with very high and undefined flows are not considered in depth here.


Shoals

The flow regime in the Augusta Shoals is controlled by flow releases from Thurmond Dam, reregulation of flows at Stevens Creek Dam, and the diversion of water into the Augusta Canal by the City of Augusta at the Augusta Diversion Dam. USGS data indicates that in 2008 when discharges from Thurmond were at 3,600 cfs, the City maintained the canal gates at levels that resulted in an average of 3,150 cfs passing down the Canal and 450 cfs passing over the Shoals.

Augusta has a pending license application with the Federal Energy Regulatory Commission (FERC) which has not been formally approved by the Augusta-Richmond County Commission, pending resolution of appeals with regard to the Georgia Section 401 water quality certification. A Settlement Agreement concerning the split of water between the Augusta Canal and the Shoals was negotiated as part of the processing of the FERC license. That Agreement has not yet been finalized.

Effects of the NAA

Selection of the NAA and continuing with the existing SRBDCP and subsequent coordinated revisions would have acceptable effects on these biotic communities.

Effects of Recommended Alternative

In a letter dated October 22, 2008, the City of Augusta notified the Corps that they commit "to the methodology set forth in the proposed Settlement Agreement for determining the Aquatic Base Flow and reserving for the Shoals those amounts set forth in Section 4.3 of the Settlement Agreement for the respective periods and tiers set forth therein." That section contains the following information:

4.3 Agreed Aquatic Base Flows:

	FEB/MAR	APR	MAY 1-15	MAY 16-31	JUNE- JAN
Tier 1 ≥5400	3300	3300	2500	1900	1900
Tier 2 4500-5399	2300	2200	1800	1800	1500
Tier 3 3600-4499	2000	2000	1500	1500	1500
Tier 4 <3600	1800	1800	1500	1500	1500

Although the City is not required to implement the provisions of the yet-to-be finalized Settlement Agreement, it states that it will "use its best efforts to meet the terms for flows as set forth therein, including the higher flows during the month of February as set forth in the respective tiers." If the City fulfills this commitment, the impacts of the proposed flow reduction on biota within the Shoals would be minimal. If the City does not fulfill its commitment, impacts to the Shoal communities would be greater. The Corps believes that a 50/50 split in the 500 cfs flow reduction is probably a good assumption for prediction of future impacts. Under that scenario, the Shoals would experience a 250 cfs reduction in flow from what they presently receive with the 3,600 cfs average daily discharge from Thurmond Dam. This amount of flow reduction is expected to result in minor effects to those biotic communities.

The flow reduction would occur from November 1 through February (February only after receiving separate approval from NOAA-Fisheries due to concerns about potential impacts to shortnose sturgeon). Since the decrease in flows would occur during the cooler months, no

impacts to seasonal fish spawning or upstream fish passage are expected. However, low flow conditions in the Shoals could harm resident fishes by inhibiting movement, reducing cover, and foraging habitat. Drought-induced low flows cause some fish to leave the Shoals for locations that provide more water depth. Fish are more susceptible to stranding and predation under low flow conditions. Anadromous species, including out-migrating juveniles, are unlikely to be within the Shoals during the time of the proposed flow reduction. The decrease in flows could increase the susceptibility of Shoals spider lily to grazing by deer. Atlantic pigtoe could also be impacted by insufficient water depth, exposure and increased predation. However, it is not anticipated that the reduction of flow from 3,600 to 3,100 cfs would result in significant long term adverse effects to this species.

Once initiated in a given year, the 3100 cfs targeted release would be maintained through February. If during this period, a listed monitoring site fails to meet its general environmental target as defined in table 13, or sturgeon spawning appears to be adversely impacted, an evaluation of the impacts would be initiated. This could lead to a request by the State of Georgia, the State of South Carolina, or NOAA-Fisheries to the Corps of Engineers to increase the targeted release at Thurmond Dam from 3100 cfs to as much as 3600 cfs. A decision would be made by Savannah District to modify the release target consistent with the adaptive management strategy as defined in Alternative 1, the chosen alternative.

4.4. BIOTIC COMMUNITIES-FLOODPLAIN


Floodplain

The floodplain reach is defined as beginning downstream of the Augusta Shoals and extending to Ebenezer Landing (approximate river kilometer 65). Seedling establishment is a high priority for the floodplain reach during dry years. The establishment of seedlings is promoted by low flows (3,000 cfs or less was recommended in the 2003 Ecosystem Flow Workshop to occur every 10 to 20 years and not last longer than 3 years) between April and October for 3 consecutive years. However, flows up to an estimated 10,000 to 15,000 cfs remain within the stream channel at nearly all locations (15,000 cfs near the Millhaven Gage) and would not be expected to affect the floodplain.

Flows from both the No Action Alternative and Alternative 1 are expected to remain within the channel banks during the winter months. Neither plan would affect the establishment of seedlings in the floodplain. Therefore, there would be no difference between the two alternatives on potential impacts to this resource.

Modeling indicates that river levels will be reduced by approximately 6-inches downstream of Thurmond Dam if Alternative 1 is selected. It is possible that this reduction will have a localized effect on mussel populations and other non-motile species that may be found in shallow sloughs and cutoff bends along the river. Many of these areas would have already separated from the main river due to low flow conditions, and will see no additional impact from the reduction. However, areas still connected by shallow cuts may be affected by the additional flow reduction.

These areas comprise a small percentage of the overall river system. Therefore, impacts to these areas will not result in a significant impact to the river system.

No other effects were identified to flood plain communities.

4.5. BIOTIC COMMUNITIES-ESTUARY


Estuary

There was a scientific stakeholders workshop concerning ecosystem flow recommendations for the Savannah River below Thurmond Dam at Augusta, Georgia in April of 2003. The report from the April 2003 workshop listed freshwater marsh habitat and the salinity gradient as being high priorities for the estuary reach during dry years. The estuary has been defined as extending from Ebenezer Landing (approximate river kilometer 65) down to the mouth of the river. Historically, river flows of 4,000 to 5,000 cfs, and less at the USGS Clyo gage, have resulted in a stressed freshwater marsh plant community and an associated upriver shift of the salinity gradient (higher salinity zones). Higher flows throughout the year would provide a healthier freshwater marsh plant community and allow more fish access. The estuary provides habitat for some species for which Management Plans have been prepared by the South Atlantic Fishery Management Council. The managed species that could be affected by the proposed action include oyster, white shrimp, brown shrimp, and red drum. Other habitats that could be affected consist of saltmarsh, brackish marsh, oyster reefs, shell banks, tidal flats and freshwater wetlands.

The Atlantic States Marine Fisheries Commission (ASMFC) has Management Plans for river herrings and American shad, Atlantic sturgeon, and American eel. Shortnose sturgeon are managed under a recovery plan by NOAA-Fisheries. GA DNR-WRD and SC DNR have a Striped Bass Management Plan for the Lower Savannah River. Alewife and hickory shad are other managed species for which Management Plans have not been prepared that commonly occur in the Savannah River or its estuary.

The Savannah National Wildlife Refuge contains both tidal wetlands and managed wetland impoundments. The Refuge was established in 1927 to provide waterfowl habitat. Since then, it has broadened its mission to the following:

- To provide habitat and sanctuary for migratory birds consistent with the objectives of the Atlantic Flyway.
- To provide habitat and protection for plants and animals whose survival is threatened or endangered.
- To use Refuge property as "a refuge and breeding ground for native birds and wild animals".
- To maintain and enhance the habitats of all other species of indigenous wildlife and fishery resources.

The Refuge manages its impoundments as "managed wetlands". These lands are diked and the habitats within the diked areas are managed for migratory birds, including wintering waterfowl. The USFWS uses prescribed burning and water level control to increase vegetation that provides food for migrating ducks, as well as suppress vegetation that is of less value to waterfowl. According to the USFWS, the moist soil management practices that are used in most of the management units on the Refuge produce the most productive waterfowl habitat. Fresh water is provided to the managed wetlands through a supply canal located off of Little Back River (about river mile 24). In the Savannah NWR, the managed wetlands provide the most heavily used habitat for wintering waterfowl and wading birds. Based on mid-winter waterfowl surveys from 1990-2002, the Refuge provided habitat for 23 percent of the waterfowl in South Carolina.

Freshwater management (salinity < 0.5 ppt) is necessary to maintain maximum waterfowl habitat use of the Refuge's managed wetlands. Studies have concluded that freshwater coastal impoundments in SC produce a greater variety of marsh plants, many of which are desirable waterfowl food, than brackish impoundments. Therefore, continued provision of fresh water at the supply canal is important to the Refuge's ability to maximize its ability to provide quality waterfowl habitats.

Private lands located oceanward of the Refuge also use moist soil management to provide waterfowl habitats within their impoundments. They obtain fresh water to flood those lands from the same supply canal which serves the Savannah NWR.

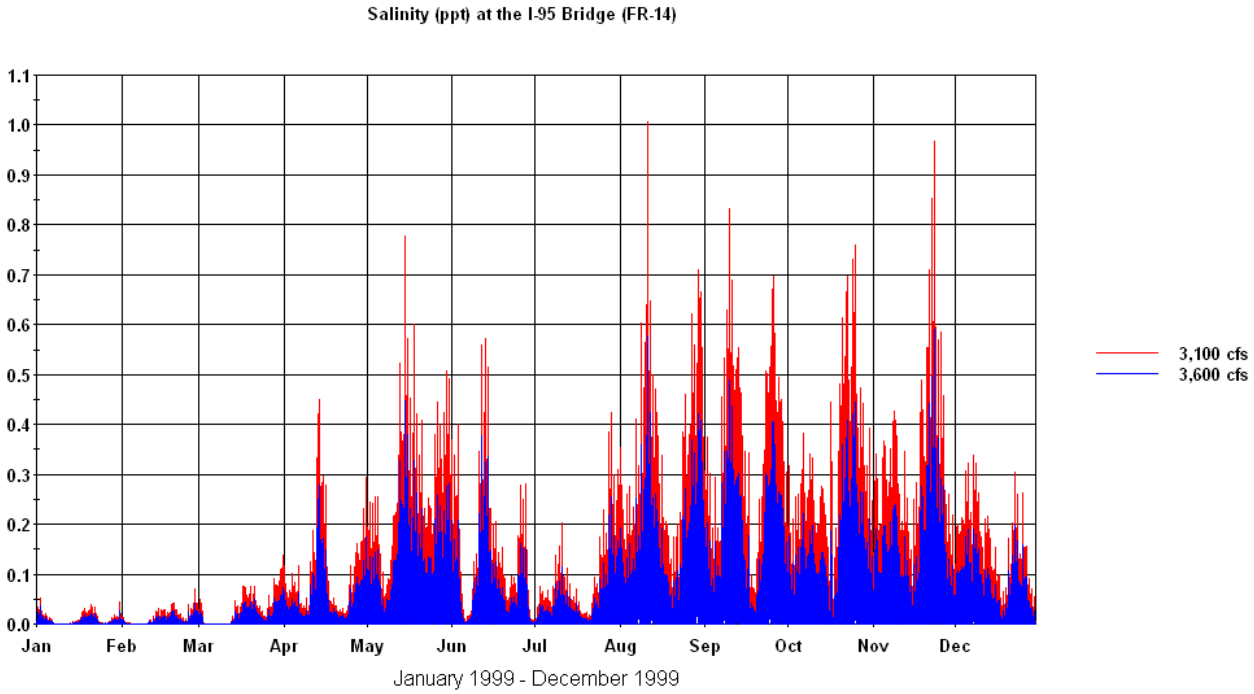
Effects of the NAA

Selection of the NAA and continuing with the existing SRBDCP would have acceptable impacts on these biotic communities. Under the NAA conditions, the freshwater / salt water interface is located downstream of the supply canal which feeds the Savannah NWR impoundments. Therefore, the Refuge and the downstream private lands would be able to provide fresh water to their managed impoundments.

Effects of Recommended Alternative

Modeling conducted prior to the 2008 Temporary Deviation EA by GA DNR-EPD suggests that salinity differences of less than 1 ppt would occur at the I-95 Bridge for flow reductions from 3,600 cfs to 3,100 cfs. This is shown in Figure 24 below. That amount is generally within the natural variation seen in the estuary.

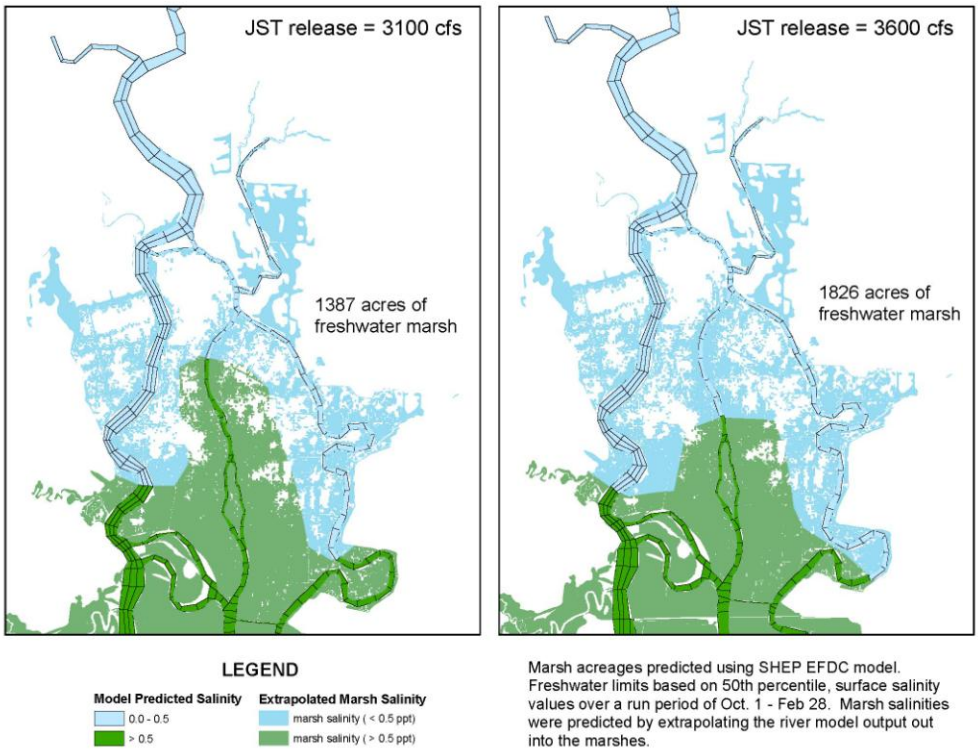
Figure 24 – Salinity Modeling at I-95 Bridge



Savannah District used the Savannah Harbor EFDC model to evaluate the potential impact of salinity changes on freshwater wetlands in the estuary. The technique followed by the District slightly modified the technique used to evaluate potential impacts from the proposed Savannah Harbor Expansion Project. In the SH Expansion Project, the natural resource agencies had stated that the location of the 0.5 ppt surface contour across the marsh during the summer growing season was critical to determining the species composition in the estuary. In the evaluation for the 2008 Temporary Deviation Environmental Assessment, the District used the surface salinity levels that occur during the winter months. The winter month surface salinity levels are the only levels that would change as a result of Alternative 1 for the former and present EA. With that difference in technique being understood, the analysis indicates that 439 acres of freshwater marsh could undergo temporary adverse effects due to higher salinity as a result of Alternative 1. This is shown in Figure 25 on the following page. The direct effect would be short-term, as salinity levels would be restored in the spring when flows are increased to 3,600 cfs or when normal rainfall and river flows are experienced.

To place the 439 acres in context, the same analysis technique predicts that 4,072 acres of freshwater marsh would exist under average river flows (1997 flows). The Corps' previous analyses indicate that a typical, but severe drought (20-year recurrence interval) would result in the existence of 2,208 acres of freshwater marsh.

Figure 25 – Surface Salinity Modeling in the Estuary

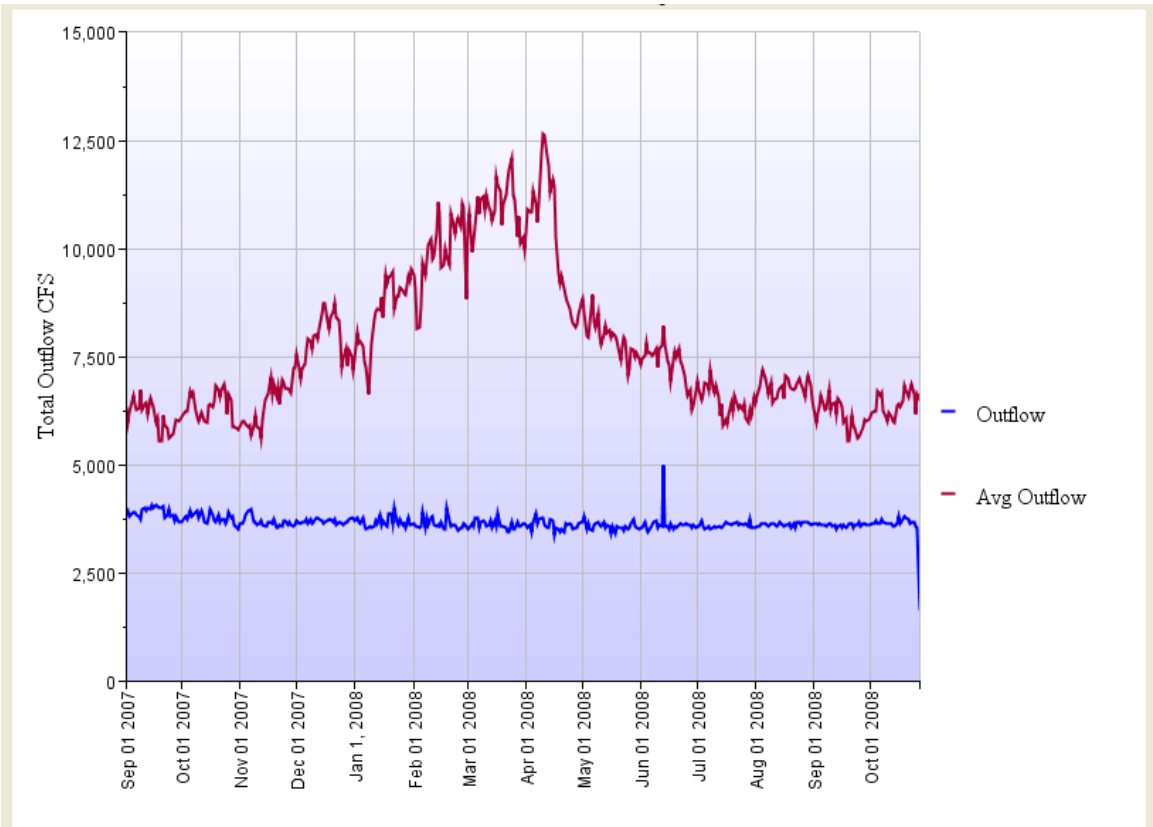


The 439-acre impact likely overstates the changes in marsh vegetation, since the reduced flows and the resulting additional salinity would occur during the winter months, which is not the primary growth season for the plants. Under those conditions, the extent of the conversion of one marsh plant species to another at a site is uncertain.

The District also used the US Geological Survey (USGS) decision support system Model-to-Marsh (M2M) to evaluate the potential impacts to tidal marsh in the estuary for the 2008 EA. This tool was developed by USGS in cooperation with the Georgia Ports Authority to simulate "the water level and salinity of the rivers and tidal marshes in the vicinity of the Savannah National Wildlife Refuge" (Conrads, 2006). Details of the model development and application can be found in the USGS Scientific Investigations Report 2006–5187 titled "*Simulation of water levels and salinity in the rivers and tidal marshes in the vicinity of the Savannah National Wildlife Refuge, Coastal South Carolina and Georgia*."

The District specified a hydrograph for consideration in the model. The hydrograph was developed based on observed flow data recorded at USGS gage station 02198500 near Clyo, GA for the period from September 1, 2007 through October 27, 2008. Over this time period, releases from Thurmond Dam were targeted at 3,600 cfs, which corresponds to the present EA. The actual daily average discharge for the period was 3,672 cfs. Maximums and minimums for the period are 5,018 cfs and 1,688 cfs, respectively. Figure 26 shows a graphical depiction of the actual discharge from the dam (plotted in blue) and long term average discharges (plotted in burgundy).

Figure 26 – J. Strom Thurmond Dam Releases (Actual and Long Term Average)



The average monthly observed freshwater flow data coming into the estuary, determined from USGS gage data (Station 02198500) recorded near Clyo, GA for this period is shown in Table 17 on the following page. This dataset represents freshwater flows during target release from Thurmond Dam of 3,600 cfs. To predict the freshwater flows into the estuary under Alternative 1, 500 cfs was subtracted from the flow data observed under releases of 3,600 cfs. These modifications were made only during the period of October through February. At other times of the year, flows near Clyo would be the same as the existing 3,600 cfs releases.

Table 17 – Freshwater Flows near Clyo, GA (USGS 02198500), Observed & Predicted

Year	Month	Average Flow (cfs) (JST = 3,600 cfs)	Predicted Flow (cfs) (JST = 3,100 cfs)*
2007	September	5207	5207
	October	4767	**4267**
	November	4574	**4074**
	December	5161	**4661**
2008	January	6827	**6327**
	February	7009	**6509**
	March	7610	7610
	April	6841	6841
	May	5352	5352
	June	4790	4790
	July	4340	4340
	August	4450	4450
	September	4530	4530
	October	4577	4577

** Flows shown in bold have been modified to predict flows during target releases of 3,100 cfs. All other flows remain unchanged.*

The M2M model was run using each of the datasets outlined in the previous section to determine impacts to the tidal marshes with implementation of the proposed action. Graphical results of the output generated are shown in Figures 27 and 28. The M2M Visualization Tool was used to develop the graphic. Yellow represents tidal marsh with pore water salinities greater than 0.5 ppt and the black and green areas represent tidal marsh pore water salinities less than 0.5 ppt. Other colors represent the river, ponds, uplands, and gaging stations.

Under both the NAA and Alternative 1, the majority of the marshes have pore water salinities greater than 0.5 ppt. Front and Middle River would have almost no freshwater marshes adjacent to the waterway, while the upper portion of Back River and the area around McCoy Cut have the largest portion of freshwater marsh.

The changes between the figures can be difficult to see due to color schemes, lack of reference objects, and pixel size. Circled on Figure 28 in red are three areas of change that were noted as a result of the model run. The areas that would be impacted appear to be minor.

Figure 27 – Marsh Pore Water Salinity (JST = 3,600)

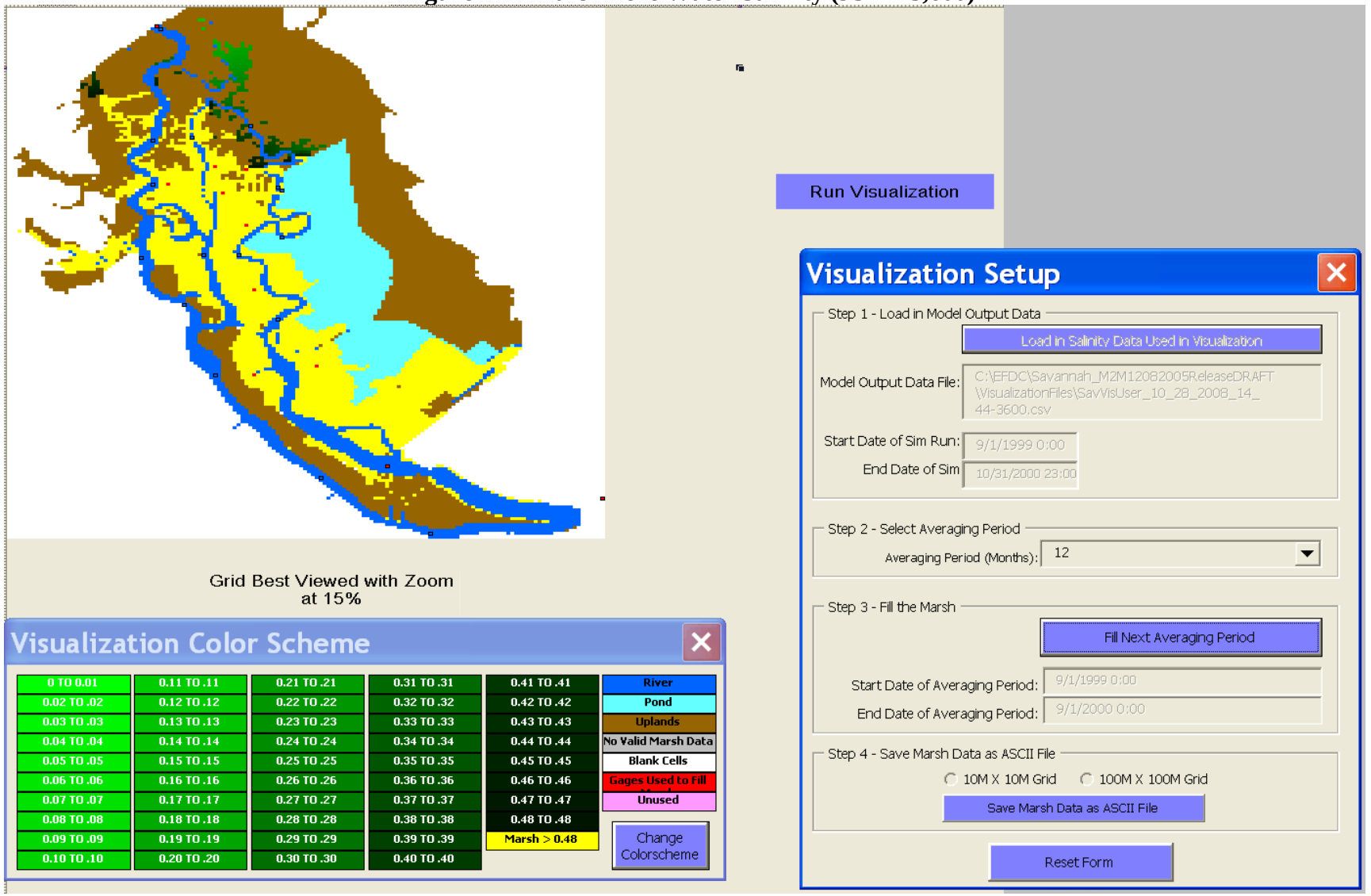
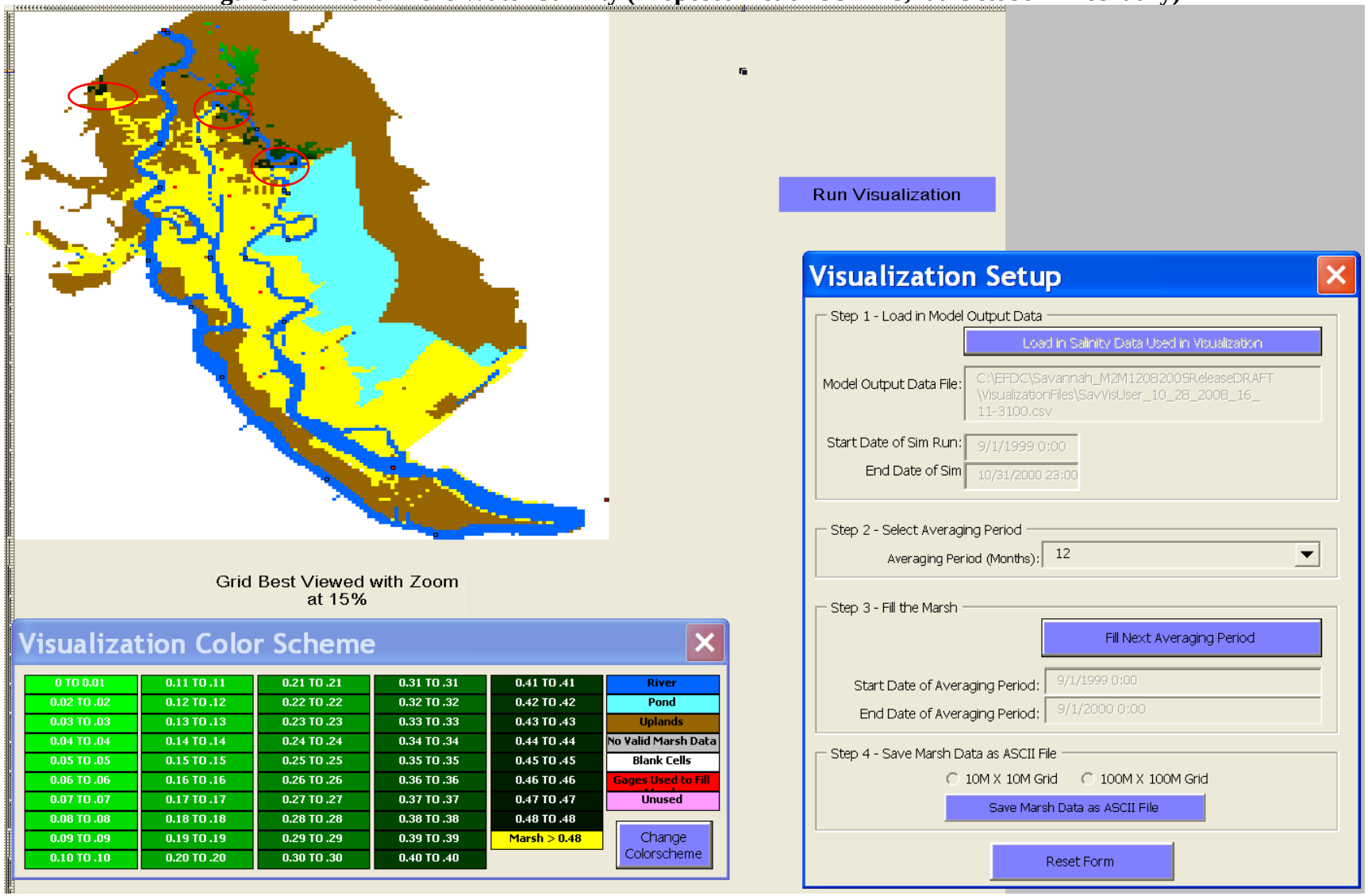


Figure 28 – Marsh Pore Water Salinity (Proposed Action JST = 3,100 October – February)



In summary, the District used the USGS M2M model to evaluate potential impacts to the tidal marshes adjacent to the estuary under implementation of the proposed flow reduction. The proposed action would limit average releases from J. Strom Thurmond Dam to 3,100 cfs during the winter season from November 1 through February (February only after receiving separate approval from NOAA-Fisheries due to concerns about potential impacts to shortnose sturgeon). The M2M model indicates that the Recommended Alternative would have a very small impact on the upper portion of the study area. Under the No Action Alternative, most of the freshwater marshes already experience salinity > 0.5 ppt and very little marsh areas could be considered as fresh.

As with any predictive tool, the M2M model has limitations. It is an empirical model and "the reliability of the model is dependent on the quality of the data range of measured conditions used for training or calibrating the model" (Conrads, 2006). USGS used a large dataset to develop the model, covering 4 gaging networks over multiple year periods with flows ranging from 4,320 to 39,600 in the marsh and 4,320 to 52,600 in the river. Considering the quality of the dataset and its large range, the M2M model is considered an appropriate tool to effectively analyze this issue.

Based partially on the increase in salinity occurring only in the fall/winter months (outside the main growing season) and the low impact predicted by the USGS M2M model, Savannah District believes that the proposed flow reduction would not result in substantial or significant impacts to tidal freshwater marshes in the estuary, unless the drought becomes persistent after reaching Level 4.

An adaptive management plan is in place to mitigate impacts should any significant increases in salinity be observed.

With Alternative 1, the freshwater / salt water interface would continue to be located downstream of the supply canal which feeds the Savannah NWR impoundments. Therefore, the alternative would not affect the Refuge or private lands' ability to provide fresh water to their managed impoundments.

4.6. THREATENED AND ENDANGERED SPECIES

The robust redhorse, shoals spider lily, Altamaha arcmussel, brother spike, Savannah lilliput and the federally-listed shortnose sturgeon, manatee, and wood stork are the only Threatened or Endangered Species that may possibly be affected by small changes in flow.

Robust redhorse

Spider lily

Shortnose sturgeon

Effects of the NAA

Selection of the NAA and continuing with the existing Drought Contingency Plan would have no effects on threatened and endangered species above those that were previously approved. The NAA provides an average daily minimum flow of 3,600 cfs.

Effects of Recommended Alternative

As discussed earlier, this alternative provides an average daily minimum flow of 3,100 cfs from November 1 through February (February only after receiving separate approval from NOAA-Fisheries due to concerns about potential impacts to shortnose sturgeon). The decrease in predominant flows would occur during the cooler months, so potential impacts to seasonal fish spawning and fish passage should be minimal. The lower river levels could make the shoals spider lily more susceptible to grazing from deer; however, the impacts to the shoals spider lily should also be minimal. The Altamaha arcmussel could also be more exposed in the oxbows.

Spawning for the robust redhorse typically occurs from April through June. Flows of 3,600 cfs would be restored by that time under Alternative 1. Shortnose sturgeon spawning is believed to occur in February and March. Flows of 3,100 cfs during February may slightly reduce the spawning habitat that is available. Without separate approval from NOAA-Fisheries, the Corps would restore flows to 3,600 cfs in February due to concerns about potential shortnose sturgeon spawning. In the Congaree River in SC, sturgeon have been found to spawn downstream of gravel bars that are covered by 6 to 15 feet of water (Collins et al. 2003). The roughly 0.5 foot decrease in water depth resulting from the proposed flow reduction could reduce the amount of spawning habitat for the Shortnose sturgeon. However, the small change in water depth compared to the recorded range of depth of sturgeon spawning habitat indicate that this impact is likely to be minimal and immeasurable.

Anadromous species are unlikely to be within the shoals or upper river areas during the time of the proposed flow reduction; therefore, no adverse effects are anticipated to these species. Staging and foraging areas for these species may see slight alterations in salinities, but modeling indicates those effects would be small, so these highly motile species should easily adapt to these fluctuations.

Changes in river flow, salinity levels, and dissolved oxygen levels and the associated impact on the shortnose sturgeon and manatee are expected to be minimal and within the variation produced by the tides on a regular basis. The lower river levels could make fish more susceptible to predation from wood stork.

The Corps has determined that the proposed action may affect, but is not likely to adversely affect shortnose sturgeon, manatee, and wood stork. No effects to any other federally listed species were identified.

4.7. ESSENTIAL FISH HABITAT

The proposed flow reduction would alter Essential Fish Habitats in the estuary. Although the reduced flow volume would change velocities, the extent of those changes would be too small to measure and impacts would not be significant. The primary noticeable effect would be an increase in salinity at the freshwater/saltwater interface. Implementation on the recommended action would result in salinity moving further into the estuary. This change would be temporary and would disappear when flows are increased in March or when normal rainfalls occur, whichever comes first. Savannah District believes that these temporary changes to Essential Fish Habitats do not warrant mitigation. No adverse impacts would result from the NAA.

4.8. RECREATION

As evident in past droughts, recreation experiences diminish on Hartwell and J. Strom Thurmond Lakes as the lake levels drop. Public boat ramps and private docks become unusable as the lakes recede. In addition, tree stumps and sand bars are exposed in the lakes. For some boaters, continued use of the lakes poses a serious threat to damaging boats and injuring persons. Swimming outside the Corps of Engineers' designated areas increases the potential for swimming fatalities. Implementation of the recommended action is expected to decrease the water depth in the river by half a foot. Such a decrease could result in minor adverse impacts to boaters and fishermen using the river.

4.8.1. Boat-Launching Ramps and Private Docks

The NAA will result in further impacts to boat ramps and private docks on the Corps reservoirs as the water continues to recede from the normal pool shoreline. The relative stabilizing effect resulting from Alternative 1 would increase the duration of use for the currently functioning structures within the inactive pool at JST. Hartwell and RBR do not have public boat ramps within their inactive pools. Boat ramps along the river could be impacted by the expected half foot decrease in water depth associated with Alternative 1. This impact is minimized by the winter timing of the proposal, a season when there are fewer users of those facilities. No adverse impacts to ramps or docks are expected.

4.8.2. Swimming

Swimming at beach areas usually occurs from May to September. Therefore, the recommended alternative is occurring outside the normal season for swimming activities. Corps operated designated swimming areas are dry before reaching the inactive storage, so no adverse impacts are expected.

4.9. WATER SUPPLY

Water shortages during drought are the performance measure used to determine the impacts of Alternative 1 in comparison to the NAA.

Hartwell Lake

There are eight water supply users with intakes in Hartwell Lake. Two (Anderson County Joint Municipal Water System and the City of Lavonia) currently hold water storage contracts with the US Army Corps of Engineers, Savannah District. Although Hart County Water and Sewer Utility Authority does not have an intake, it does have a water storage contract. Hart County currently uses water from intakes owned by the Cities of Lavonia and Hartwell. The amount of water that they use from these two cities is charged against their water storage contract with the Corps of Engineers. The other six water supply users with intakes have riparian rights (City of Hartwell; Clemson University Musser Fruit Farm; Clemson University; Clemson Golf Course; Point West, Inc. formerly known as J. P. Stevens; and Milliken Company). Clemson University's Musser Fruit Farm intake becomes inoperable at 653 feet msl. Irrigation occurs between the months of June and August. When the intake is inoperable, they use water from the City of Seneca, but only if it is absolutely necessary because of the increased cost. The recommended alternative will increase the amount of water remaining in the inactive pool, resulting in positive effects to the water users in Hartwell Lake by increasing the number of days they can withdraw water. The NAA is the baseline condition or the current status of the environment and would result in less water being available to users.

RBR Lake

There are 6 water supply intakes on RBR Lake. Two (City of Elberton and Santee Cooper) currently hold water storage contracts in RBR Lake with the US Army Corps of Engineers, Savannah District. Three have riparian rights (RBR State Park Golf Course, Mohawk Industries, and Calhoun Falls). One, the City of Abbeville, stems from mitigation for RBR construction. The highest intake elevation is 468.8 feet msl. The recommended alternative would increase the amount of water remaining in the inactive pool, resulting in positive effects to the water users in RBR Lake by increasing the number of days they can withdraw water. The NAA would result in less water being available to users.

JST Lake

There are 8 water supply users with intakes on JST Lake. Seven (City of Lincolnton, City of Washington, City of McCormick, City of Thomson, Columbia County, Savannah Lakes POA Monticello Golf Course and Savannah Lakes POA Tara Golf Course) currently hold water storage contracts with the US Army Corps of Engineers, Savannah District. Hickory Knob State Park Golf Course has riparian rights. The City of Lincolnton has three intakes, one each at 321, 314 and 307 feet msl. If the highest intake at 321 feet msl is exposed, then the other two intakes can meet the water needs until the reservoir drops to that lower elevation. This condition is the same for the City of Thomson and Columbia County that have three intakes, one each at 320, 312 and 304. The golf courses have intake elevations of 324 feet msl and experience water shortages during drought periods. The recommended alternative will increase the amount of water remaining in the inactive storage pool, resulting in positive effects to the water users in JST Lake by increasing the number of days they can withdraw water. The NAA would result in less water being available to users.

Downstream of JST Lake

Water supply users downstream of the JST Lake include the Augusta/Richmond County (Canal and Shoals) and users with intakes in the NSBL&D pool including North Augusta, Mason's Sod, Kimberly Clark, Urquhart Station, PCS Nitrogen, DSM Chemical and General Chemical. Users below NSBL&D include International Paper, the Beaufort-Jasper County Water Supply Authority, Plant Vogtle, the City of Savannah M&I Plant, the Savannah National Wildlife Refuge and many other cities and municipalities. The NAA would not result in any changes for the current water users downstream of the JST Lake. Some users have experienced difficulties using their intakes under the flows associated with discharges of 3,600 cfs.

Water users along the Augusta Canal have expressed concern about the recommended alternative flows in the past. Diversions into the Augusta Canal are managed by the City of Augusta. The City operates three controllable gates to control flow to the Canal. Water in the Canal is used by four entities, as described in the following paragraphs.

Based on current permit information on the City of Augusta intake, the City is allowed to withdraw no more than 45 MGD (about 70 cfs). The City uses that water to operate four turbines for water supply operations. These turbines provide the mechanical energy to drive pumps that lift water from the river for water supply purposes. The City requires 1,364 cfs to drive the hydro-mechanical pumps. This amount is passed through the turbines and returned entirely to the main stem Savannah River (about two thirds of the length of the shoals).

There are three mills on the Augusta Canal located downstream of the City's intake. They are Sibley, King, and Enterprise. All of these mills have turbines that are driven by water in the Canal. All return the water used back to the main stem of the Savannah River downstream of the Shoals. Sibley Mill needs a flow of 1,024 cfs; King Mill needs approximately 880 cfs; and Enterprise Mill needs a flow of approximately 560 cfs. The King Mill is the only operating manufacturing facility. The Sibley Mill has closed and generates income from its use of the water to generate electrical power. The Enterprise Mill has been converted to commercial and residential use, houses the Interpretative Center for the Augusta Canal National Heritage Area, and uses its allocation of water to generate electrical power for its tenants.

At the current level of Thurmond discharges (3,600 cfs), during Level 4 drought conditions and before going to outflow=inflow, if there is no incremental flow between the dam and the Canal inlet, then 3,600 cfs would flow to the Augusta Diversion Dam. USGS data indicates that in 2008 when discharges from Thurmond were at 3,600 cfs, the City maintained the canal gates at levels that resulted in an average of 3,150 cfs passing down the Canal and 450 cfs passing over the Shoals. After the City's turbines (1,364 cfs), there was roughly 1,786 cfs remaining in the Canal for the mills.

Under the recommended alternative, Thurmond releases would be reduced from 3,600 to 3,100 cfs from November 1 through February (February only after receiving separate approval from NOAA-Fisheries due to concerns about potential impacts to shortnose sturgeon). The U S Army Corps of Engineers has no authority to require the City of Augusta to divert less water.

All water supply users downstream of the NSBL&D may need to modify their intakes during Level 4 drought conditions. Some users indicate they are experiencing difficulties with discharges of 3,600 cfs. The extent of the environmental and economic impacts resulting from

these future modifications is unknown. In general, the owners have yet to determine what actions they would need to take if river flows declined to the point that they are not supplemented by storage from the Corps reservoirs. Those modifications would be needed if the lakes reach the bottom of Level 4 and outflows equal inflows. During a drought in 2008, the Savannah District issued a public notice for a Draft EA involving a one-year action similar to the proposed Alternative 1. During the public review period, some owners submitted comments indicating that they would monitor conditions at their individual intakes and seek to implement measures that would allow them to continue to withdraw their allotted amount from the river.

4.10. COASTAL ZONE CONSISTENCY

The proposed reduction of discharges from J. Strom Thurmond Lake would alter flows down the river to the estuary and the coastal zone. The flow reduction would affect salinity and dissolved oxygen levels in the estuary. It could also affect chloride levels at the City of Savannah's municipal and industrial water intake on Abercorn Creek. These potential changes were identified and discussed in Section 4.1 (Water Quality). The potential effects on freshwater vegetation in the estuary were identified and discussed in Section 4.5 (Biotic Communities - Estuary). The potential effects on endangered species were identified and discussed in Section 4.6 (Threatened and Endangered Species).

Recognizing the expected impacts identified and described in other sections of this document, Savannah District believes that the proposed seasonal flow reduction is consistent to the maximum extent practicable with the enforceable provisions (such as those related to saltwater intrusion, other water quality and fisheries resources) of both the Georgia and South Carolina Coastal Management Plans.

4.11. HYDROPOWER

There are no contractual requirements associated with hydropower generation in the inactive storage pool. A 500 cfs flow reduction from the three Corps dams over a 4-month period would result in 13,000 MegaWatt Hours per year of additional shortage in meeting the contract hydropower generation energy requirement. That additional shortage is approximately 0.1% of the contractual energy requirement for the seasonal flow reduction period.

If sufficient water is available in the Mobile-managed basins, this power could possibly be generated by additional run time of hydropower units on those rivers. SEPA could also purchase the additional power on the spot market to meet the additional contract requirements. That would increase SEPA's operating costs. The extent of that increase is unknown. No immediate changes to hydropower are expected with the NAA.

4.12. CULTURAL RESOURCES

Effects of the No Action Alternative

Comprehensive archaeological surveys were not conducted within the flood pools of the lake projects prior to inundation. Only small scale, site-specific investigations were carried out on a handful of sites within the flood pool. No archaeological surveys have been conducted of the fluctuation zones since inundation. Surveys have been conducted of the upland areas at Thurmond Reservoir and of small portions of the upland areas of Hartwell Lake.

While intensive surveys have not been conducted of the submerged zones, sites are known to exist within these areas. Examples include two Native American villages, each with a mound, that were tested in the 1950s, as well as a previously unrecorded mill site. All three sites were exposed during the most recent drought and were adversely affected by changes in pool elevation. These adverse affects include erosion and the destruction of artifact resulting from the continually wetting and drying of the sites.

The number of other potentially significant prehistoric and historic resources that are located within the fluctuation zone and are adversely affected by changing pool elevations is unknown. The effect of fluctuations in water surface elevations upon these resources as the pools decline is also unknown.

The NAA would have no additional adverse impacts to historic properties.

Effects of Recommended Alternative

The proposed action would extend the decline of the Cops reservoirs. As a result, the presently submerged historic resources would be subject to wetting and drying for a longer period of time than in the NAA.

The Corps believes that a 50/50 split between the shoals and Augusta Canal for the 500 cfs flow reduction is probably a good assumption for prediction of future impacts. The Augusta Canal and associated industrial properties are listed in the National Register of Historic Places as a National Historic Landmark. The proposed alternative will have no effect upon the canal district.

The Georgia State Historic Preservation Office and several Native American Tribes concurred in the District's determination of no effect upon historic properties. The South Carolina State Historic Preservation Office did not concur with this finding. After a review of the South Carolina comments and the status of historic property identification efforts at J. Strom Thurmond and Hartwell Lakes, Savannah District concurs with the South Carolina determination. The District will reinitiate consultation with the states of Georgia and South Carolina and Native American Tribes prior to implementing the proposed action. The District has prepared a Programmatic Agreement (Appendix O) that identifies procedures to comply with the National Historic Preservation Act (P.L. 89-665) and 36 CFR, Part 800. The agreement addresses all drought levels at Hartwell and Thurmond Lakes.

4.13. ENVIRONMENTAL JUSTICE

Effects of the NAA

The NAA would have no adverse impacts on environmental justice as the existing SRBDCP of March 1989 with the 2006 modifications would continue to be followed.

Effects of Recommended Alternative

Implementation of the recommend alternative would affect the entire length of the Savannah River Basin. The adverse effects would be minimal in scope and relatively evenly distributed along the 238 miles of river downstream of Thurmond Dam. The high ground adjacent to the river does not support disproportionate concentrations of minority or low-income communities. Minority or low-income populations do not recreate on the river in disproportionate numbers. As a result, this alternative would not result in disproportionately high and adverse human health or environmental impacts on minority or low-income populations. No adverse effects to humans would occur on or adjacent to the Corps' three reservoirs. Therefore, the recommended alternative complies with Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations".

4.14. PROTECTION OF CHILDREN

Effects of the NAA

The NAA would have no adverse impacts on the protection of children as the existing SRBDCP of March 1989 with the 2006 modifications would continue to be followed.

Effects of Recommended Alternative

Implementation of the recommended alternative would affect the entire length of the Savannah River Basin. The adverse effects would be minimal in scope and relatively evenly distributed along the 238 miles of river downstream of Thurmond Dam. The high ground adjacent to the river does not support disproportionate concentrations of children and children do not recreate on the river in disproportionate numbers. No adverse effects to children would occur on or adjacent to the Corps' three reservoirs. The proposed action would not result in a disproportionate risk or environmental impact to children that result from environmental health or safety risks within the meaning of Executive Order 13045; therefore, the recommended alternative complies with Executive Order 13045, "Protection of Children from Environmental Health Risks and Safety Risks".

4.15. CUMULATIVE EFFECTS

Council on Environmental Quality regulations (40 CFR 150.7) require an analysis of the cumulative impacts resulting from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions, regardless of who undertakes these other actions. Cumulative impacts can result from individually minor, but collectively significant, actions. This cumulative impacts section of the EA addresses only the cumulative effects arising from considering the Proposed Action in combination with other past, ongoing and proposed actions in the Savannah River Basin.

The Savannah River does not function as it originally did due to various changes. Several dams cross its flow, holding back high spring flows and raising low summer flows. Peaking operations

at hydropower plants make the flows irregular during the course of day and week in some areas, rather than being primarily in response to rainfall events and seepage from adjacent wetlands. Numerous withdrawals of water occur, some for municipal use, some for industrial purposes, and others to aid adjacent recreation. The number of users of the river has increased dramatically. The ponded lakes that occur upstream of the dams provide sources for several types of recreation, and those sites are used heavily for those purposes. Fishermen use the free-flowing portions of the river, and their numbers have continued to increase with the overall growth in regional population.

If it were not for the multiple users of the river and lakes as they now exist, there would be little concern about the amount of water flowing in the river during a drought; however the amount discharged from JST Lake effects the competing uses of the river and lakes. Those users are expected to continue to conduct their activities on the lake and in the river in the future.

Although Savannah District is not aware of any specific plans to substantially increase the use of waters in the Savannah River Basin, we do expect some growth in both the number of users and the amount of water that is desired to be withdrawn from the lakes and river. The District is aware that Georgia Power would like additional water from the Savannah River for the proposed expansion of Plant Vogtle, near Waynesboro, Georgia.

The Savannah River is viewed by some located in other river basins as a ready source of clean water for their needs. If the regulating government agencies agree that additional inter-basin transfers can occur, stresses on existing uses along the entire length of the Savannah River basin would increase to some degree.

Savannah District, U.S. Army Corps of Engineers is evaluating deepening Savannah Harbor. If that project is implemented, salinity would move further up the estuary, converting marshes to more saline communities. The temporary winter flow reductions proposed as part of this Level 4 drought plan would produce similar effects. However, the proposed winter flow reductions would be implemented in extreme droughts only during the winter months when the marsh is not actively growing. No long term significant adverse cumulative impacts are expected.

In summary, flows in the Savannah River have been substantially modified over time, but the basin still presents a multitude of opportunities for the use and enjoyment of this valuable resource. The number of people desiring to use or benefit from this resource continues to increase. The uses vary seasonally, with lower demands placed on the aquatic ecosystem during the winter months. Long term adverse cumulative impacts would result primarily from increases in water usage and an accompanying loss of water from the river basin.

5.0 CONCLUSIONS

This Environmental Assessment considers the potential environmental impacts of the proposed action. The impacts listed for most of the resources in the table below are similar for the NAA and Recommended Alternative. However, the NAA has adverse impacts on inactive pool levels, water usage, recreation, boat-launching ramps and docks at Hartwell and J. Strom Thurmond

Lakes, while the Recommended Alternative has minor positive impacts on these resources. The Recommended Alternative would have minor effects on downstream biological resources. These minor impacts would primarily occur to mussels in cut-off bends and species in the Augusta Shoals area. Temporary adverse impacts would also occur to freshwater wetlands in the estuary. However, failure to implement the Recommended Alternative could result in earlier depletion of the inactive pool and an earlier onset of discharges from Thurmond Dam where the outflow = net inflow. The Recommended Alternative would modify the existing Savannah River Basin Drought Contingency Plan. The conclusion of this Environmental Assessment is that the proposed action – reducing the minimum daily average release at J. Strom Thurmond Dam from 3,600 to 3,100 cubic feet per second with an adaptive management strategy while in drought Level 4 from November 1 through February (February only after receiving separate approval from NOAA-Fisheries due to concerns about potential impacts to shortnose sturgeon) would result in no significant environmental impacts. The District is reinitiating consultation with the South Carolina and Georgia State Historic Preservation Offices and interested Native American Tribes to complete compliance with the National Historic Preservation Act and 36 CFR, Part 800.

Based on a review of the information contained in this EA, the District determined that a modification to the Savannah River Basin Drought Contingency Plan would not constitute a major Federal action significantly affecting the quality of the human environment within the meaning of Section 102(2)(c) of NEPA. Accordingly, preparation of an Environmental Impact Statement is not required.

Table 18: Impact Summary

RESOURCE	NO ACTION ALTERNATIVE	ALTERNATIVE 1
Water Quality	No immediate adverse impact	Previous modeling by GA DNR-EPD suggested no adverse impacts will occur, but in applying new Dissolved Oxygen Standards minor impacts to dissolved oxygen levels would result from early November through mid-December. An adaptive management plan would be implemented to address any unacceptable impacts, should they occur.
Biotic Communities-Lakes, Largemouth Bass Spawning, by observing the Pool Elevation Tables	Acceptable impacts, because the existing Drought Contingency Plan would continue to be followed	Will slow the lowering of the level of the inactive pool and improve refill capability. Therefore minor positive impacts were identified.
Biotic Communities-Lakes, Aquatic Plants	No adverse impact	No adverse impact
Biotic Communities-Shoals	Acceptable impacts for the short-term. Could have additional impacts if drought persists.	Will reduce flows in the Shoals area. This could affect fish movement. Impacts would be attenuated due to the flow reduction occurring in the cooler months outside of spawning season. The cities agreement being followed would benefit the shoals.
Biotic Communities-Floodplain	Acceptable impacts for the short-term. Could have additional impacts if the drought persists.	No impact to wetlands identified. Some sloughs and cutoff bends could be impacted by reduced flows. Mussels and other organisms in these areas could experience adverse effects. Given the overall project area, these localized occurrences would be minimal.

RESOURCE	NO ACTION ALTERNATIVE	ALTERNATIVE 1
Biotic Communities-Estuary	Acceptable impacts for the short-term. Could have additional impacts if the drought persists.	Previous modeling suggests that salinity increases of less than 1ppt will occur at the I-95 bridge. This could adversely affect freshwater wetlands, especially with a persistent drought. An adaptive management plan is in place should any significant increases in salinity be observed.
Threatened and Endangered Species	Acceptable impacts	May affect, but not likely to adversely affect listed T&E species (shortnose sturgeon, manatee, and wood stork).
Essential Fish Habitat	No adverse impact.	No significant impacts.
Recreation, Boat-Launching Ramps and Docks	No immediate adverse impacts	No Adverse Impacts
Recreation, Swimming	No immediate adverse impacts	No Adverse Impacts
Water Supply	Will impact water users on impoundments as this alternative will negatively impact the long-term stability of the conservation pools.	Some users in the Augusta Canal may experience a slight reduction in available water (possibly 250 cfs) during the winter period, but the effects would be minimal.
Hydropower	No effect immediately. Persistent drought may induce prolonged shortages.	No impact, no contract requirements in inactive storage pool.
Biological Resources	No immediate effect. Long-term impacts would occur if the drought persists.	No significant impacts identified. An adaptive management plan would be implemented should any significant impacts be observed.
Cultural Resources	No additional adverse impacts.	Submerged cultural-historic resources would experience wetting and drying for a longer period as the lakes' descent are extended. This District has prepared a Programmatic Agreement with the Georgia and South Carolina State Historic Preservation Offices and interested Native American Tribes that specifies procedures for compliance with the National Historic Preservation Act (P.L. 89-665) and 36 CFR, Part 800.

RESOURCE	NO ACTION ALTERNATIVE	ALTERNATIVE 1
Environmental Justice	No adverse impact.	No disproportionately high and adverse impacts.
Protection of Children	No adverse impact.	No disproportionately high and adverse impacts.

6.0 RELATIONSHIP OF PROJECT TO FEDERAL AND STATE AUTHORITIES

The following table summarizes the status of the compliance of the proposed action (Recommended Alternative) with applicable Federal and State environmental laws.

Table 19: Summary of Requirements

FEDERAL POLICIES	PROPOSED ACTION
Anadromous Fish Conservation Act, 16 U.S.C. 757, et. seq.	In compliance.
Archaeological and Historic Preservation Act, as amended, 16 U.S.C. 469, et. seq.	District is reinitiating consultation to reach agreement on a Programmatic Agreement with the States of South Carolina and Georgia and interested Native American Tribes to comply with the Act and with 36 CFR, Part 800.
Clean Air Act, as amended, 42 U.S.C. 1857h-7, et. seq.	In compliance. Draft EA was reviewed by EPA.
Clean Water Act, as amended (Federal Water Pollution Control Act) 33 U.S.C. 1251, et. seq.	In compliance. Draft EA was reviewed by GA, SC, and EPA.
Coastal Zone Management Act, as amended, 16 U.S.C. 1451 et seq.	In compliance. Both GA and SC have been asked for concurrence in the District's CZM Consistency Determination. SC DHEC concurs with CZM Consistency. GA has not responded.
Endangered Species Act, as amended, 16 U.S.C. 1531, et. seq.	In compliance. The District determined the project may affect, but not likely to adversely affect shortnose sturgeon, manatee, and wood stork. The USFWS concurred with the District's determination of May Effect But Not Likely To Adversely Affect for manatee and wood stork. NOAA Fisheries concurred with the District's determination of May Effect But Not Likely To Adversely Affect for shortnose sturgeon if the flow reduction occurred November through January. Separate approval from NOAA Fisheries is needed before the Corps reduces the flow reduction in February.
Federal Water Project Recreation Act, as amended, 16 U.S.C. 4601-12, et. seq.	In compliance.
Fish and Wildlife Coordination Act, as amended 16 U.S.C. 661, et. seq.,	In compliance. Draft EA was coordinated with the GA DNR, SC DNR, USFWS, and NOAA-Fisheries.
Fishery Conservation and Management Act of 1976, Public Law 99-659.	In compliance.
Magnuson-Stevens Act, as amended, Public Law 104-297.	Draft EA with its EFH assessment was coordinated with NOAA Fisheries.

National Historic Preservation Act of 1966, as amended, 16 U. S. C. 470f, et seq.	District is reinitiating consultation to reach agreement on a Programmatic Agreement with the States of South Carolina and Georgia and interested Native American Tribes to comply with the Act and with 36 CFR, Part 800.
Protection of Wetlands, E.O. 11990	In compliance.
Environmental Justice, E.O. 12898	In compliance.
Protection of Children, E. O. 13045	In compliance.
Invasive Species, E. O. 13112	In compliance.

7.0 COORDINATION

Savannah District has coordinated with Federal and state officials for several years concerning information closely related to this Savannah River Basin action. Some of the coordination has included the participation of other stakeholders. The meetings have increased the understanding of the monitoring which various stakeholders have performed and identified the resources which could be affected by various alternatives.

A Public Notice of Availability was issued on 14 June 2011 notifying the public of the availability of the Draft EA. This Notice served as the formal advertisement of the proposed modification to the 1989 Savannah River Drought Contingency Plan, as amended.

A Notice of Availability was published in the following local newspapers to inform the public of the availability of the Draft EA and invite their comments:

- Savannah Morning News
- Augusta Chronicle
- Elberton Star
- Anderson Independent Mail
- Aiken Standard
- The Island Packet

The following natural resource agencies were provided a copy of the Draft EA:

- Georgia Department of Natural Resources, Environmental Protection Division
- Georgia Department of Natural Resources, Wildlife Resources Division
- Georgia Department of Natural Resources, Coastal Resources Division
- Georgia Deputy State Historic Preservation Officer
- Georgia State Clearinghouse

- South Carolina Department of Natural Resources
- South Carolina Department of Health and Environmental Control
- South Carolina Department of Health and Environmental Control, Office of Ocean and Coastal Resource Management
- South Carolina State Budget and Control Board
- South Carolina Department of Archives and History

- US Environmental Protection Agency, Region 4
- US Fish and Wildlife Service, Field Supervisor
- US Department of Interior, Regional Environmental Officer
- National Marine Fisheries Service, Habitat Protection Division
- National Marine Fisheries Service, Assistant Regional Administrator

A copy of the Draft EA was sent to eighteen representatives of Native American groups that previously lived in the project area to inform them of the proposed action and invite their comments.

The District accepted comments on the proposal by mail, email, FAX and over the telephone through 14 July 2011. The received Comment Letters can be found in Appendix M. A Summary of Comments Received and Responses to Comments can be found in Appendix N.

8.0 LITERATURE CONSULTED

Applied Technology and Management, 1998. Savannah Harbor Expansion Environmental Impact Statement. Georgia Ports Authority. Savannah, Georgia. 244 pp.

Aquatic Plant Management Plan, US Army Corps of Engineers, Savannah District, Calendar Year 2006 Update.

Aquatic Plant Management Plan, US Army Corps of Engineers, Savannah District, Calendar Year 2010 Update.

Collins, M.R., W.C. Post, D.C. Russ, and T. I. J. Smith. 2002. Habitat use and movements of juvenile shortnose sturgeon in the Savannah River, Georgia-South Carolina. Transactions of the American Fisheries Society. 131:975-979

Collins, M.R., D. Cooke, B. Post, J. Crane, J. Bulak, T. Grieg, and J. Quattro. 2003. Shortnose sturgeon in the Santee-Cooper Reservoir system, South Carolina. Transactions of the American Fisheries Society. 132:1244-1250.

Conrads, P. A., E. A. Roehl, R. C. Daamen, and W. M. Kitchens, 2006. Simulation of water levels and salinity in the rivers and tidal marshes in the vicinity of the Savannah National Wildlife Refuge, Coastal South Carolina and Georgia. U.S. Geological Survey Scientific Investigations Report 2006–5187, 134 p.; available online at *http://pubs.usgs.gov/sir/2006/5187/*

Cooney, T. W., K. H. Jones, P. A. Drews, S. W. Ellisor and B. W. Church, 1998. Water Resources Data for South Carolina - Water Year 1998. US Geological Survey Report SC-98-1. Columbia, South Carolina. 546 pp.

Draft Fish and Wildlife Coordination Act Report on the Savannah River Basin Comprehensive Study, US Fish and Wildlife Service, October 2003.

Ecosystem Flow Recommendations for the Savannah River below Thurmond Dam, Final Report from April 1-3, 2003, Scientific Stakeholders Workshop, September 2003.

Ecosystem Functions Model Users Manual, US Army Corps of Engineers, Hydrologic Engineering Center, August 2002.

Environmental Assessment for Savannah River Basin Drought Contingency Plan Update, US Army Corps of Engineers, Savannah District, August 2006.

Environmental Assessment for Temporary Deviation, Drought Contingency Plan, Savannah River Basin, US Army Corps of Engineers, Savannah District, November 2008.

Grabowski, T.B., and J.J. Isely, 2006. Seasonal and Diel Movements and Habitat Use of Robust Redhorses in the Lower Savannah River, Georgia and South Carolina. Transactions of the American Fisheries Society: Vol. 135, No. 5 pp. 1145–1155.

Hall, J.W., T.I.J. Smith, and S.D. Lamprecht, 1991. Movements and habitats of shortnose sturgeon, *Acipenser brevirostrum* in the Savannah River. Copeia. pp. 695-702

Lake Regulation and Coordination for Fish Management Purposes, South Atlantic Division, US Army Corps of Engineers, 30 March 2001.

Lamarre, Paul, Georgia EPD, e-mail of 11 Aug 2005.

McBay, L. G., 1968. Location of Sexually Mature Striped Bass. GA Game and Fish Comm. Coastal Region Fish Invest. Report. Job II-1:27-48.

Odum, W. E., T. J. Smith III, J. K. Hoover, and C. C. McIvor, 1984. The Ecology of Tidal Freshwater Marshes of the United States East Coast: a Community Profile. US Fish and Wildlife Service. FWS/OBS-83/17.

Pearlstine, L., W. Kitchens, P. Lathem, and R. Bartleston, 1990. Application of a Habitat Succession Model for the Wetlands Complex of the Savannah National Wildlife Refuge. Florida Cooperative Fish and Wildlife Research Unit, University of Florida, Gainesville.

Reconnaissance Planning Aid Report on the Savannah River Basin Study, US Fish and Wildlife Service, July 1999.

Rees, R. A. 1974. Statewide Fish. Invest. GA. Game and Fish Div. Final Rept. Fed. Aid Proj. F-21-5 study 14 job 1. 11 pp.

Robbins, C. S., D. K. Dawson, and B. A. Dowell, 1989. Habitat Area Requirements of Breeding Forest Birds of the Middle Atlantic States. Wildlife Monograph No. 103. 34 pp.

Savannah River Basin Drought Contingency Plan, US Army Corps of Engineers, Savannah District, March 1989.

Schmitt, D. N. and J. H. Hornsby, 1985. A fisheries Survey of the Savannah River. Georgia Department of Natural Resources Final Report for Project Number F-30-12. Atlanta, Georgia. 91 pp.

Spawning Habitat Suitability Index Model and Instream Flow Suitability Curves, Shortnose Sturgeon, March 2003, Revised January 2007, National Marine Fisheries Service, South Atlantic Branch, Habitat Conservation Division, Charleston, South Carolina.

Summary Report Supporting the Development of Ecosystem Flow Recommendations for the Savannah River below Thurmond Dam, June 2003. University of Georgia Team.

Teal, J. M. 1962. Energy Flow in the Salt Marsh Ecosystem of Georgia. Ecology, 43(4): 614-624.

Van Den Avyle, M., M. Maynard, R. Klinger, and V. Blazer, 1990. Effects of Savannah Harbor Development on Fishery Resources Associated with the Savannah National Wildlife Refuge, Georgia Cooperative Fish and Wildlife Research Unit, University of Georgia, Athens.

Wachob, Andrew, South Carolina DNR, phone conversation of 4 Aug 2005.

Winger, P. V. and P. J. Lasier, 1990. Effects of Salinity on Striped Bass Eggs and Larvae. US Fish and Wildlife Service, National Fisheries Contaminant Research Center, University of Georgia, Athens. Report submitted to US Army Corps of Engineers, Savannah District.