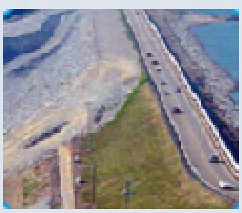
INITIAL CONSULTATION DOCUMENT



Saluda Hydroelectric Project Relicensing

FERC No. 516

SCE&G A SCANA COMPANY

Kleinschmidt Energy & Water Resource Consultants

SOUTH CAROLINA ELECTRIC & GAS COMPANY

COLUMBIA, SOUTH CAROLINA

SALUDA HYDRO

FERC PROJECT NO.516

SALUDA HYDRO
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APRIL 2005

Prepared by:

Kleinschmidt
Energy & Water Resource Consultants

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INTRODUCTION

South Carolina Electric & Gas Company (SCE&G) is initiating the process of *relicensing (see glossary for definitions of italicized terms)* the Saluda Hydro *Project* (Project) (Federal Energy Regulatory Commission [FERC] Project No. 516). The current operating *license* expires on August 31, 2010. This Initial Consultation Document (ICD) provides information relative to all project resources to interested state and federal *resource agencies*, non-governmental organizations and interests (NGOs), and the general, unaffiliated public for review and comment. This comment period officially begins the Stage 1 Consultation efforts required under the traditional licensing process pursuant to FERC regulation in 18 Code of Federal Regulations (CFR) § 4.38. Due to the complexity of the Project, SCE&G is using what is termed an Enhanced Traditional Relicensing Process.

This ICD for Saluda Hydro provides information relative to the site, the Project Works (structures, equipment, and facilities), and current and future operations. There are three distinct phases in the enhanced traditional licensing process, of which preparation of the ICD is the first. SCE&G anticipates working closely and cooperatively with all interested parties through each stage of the process in order to address and resolve collaboratively, as many issues as possible. The information in this document is presented in the order suggested in FERC's regulations for relicensing major projects at 18 CFR § 4.51 as follows:

Section A:	Project Design
Section B:	Project Operations and Resource Utilization
Section C:	Project History
Section D:	Project Costs (not included in this document)
Section E:	Project Environmental Resources
Section F:	General Design Drawings of Primary Project Works
Section G:	Project Maps

SOUTH CAROLINA ELECTRIC & GAS COMPANY
COLUMBIA, SOUTH CAROLINA

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SALUDA HYDRO ICD

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

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A. PROJECT DESIGN

The Saluda *Hydroelectric Project* is located on the Saluda River and lies within the boundaries of Richland, Lexington, Saluda, and Newberry Counties of South Carolina, near the towns of Irmo and Chapin, approximately 10 miles west of the city of Columbia. The 2,420 square mile *watershed* area, drained by the Saluda River and its tributaries above Saluda Dam, provides water for the project's impoundment, Lake Murray, and the Saluda *Hydroelectric Plant*. The location of the Project is shown on Figure A-1.

1.0 PROJECT STRUCTURES

The Saluda Hydroelectric Project includes Lake Murray, the Saluda Dam and its *spillway*, the back-up Saluda Berm[1], Saluda *Powerhouse*, intake towers and associated penstocks. Descriptions of individual Project components are provided below. Details for Project standard numbers are reported in Table A-1.

1.1 Reservoir

Lake Murray covers a normal maximum water surface area of approximately 75 square miles or approximately 48,000 acres. The normal maximum water surface (pool) elevation is 360' Plant Datum (PD)[2]. Lake Murray is 41 miles long and about 14 miles wide at its widest point, and upon its completion, provided storage for as much as 763 billion gallons of water. It has a shoreline of approximately 691 miles, including islands.

The lake shoreline is irregular and coursed by many creek beds and drainage ways cut through the terrain (FERC 2002). Inflow is generally cooler than the upper strata of lake water, and often carries high sediment loads. The lake undergoes thermal *stratification* annually, typically July though November, with the thermocline occurring between 20 and 40 feet deep. The *reservoir* serves as a source of drinking water for the communities in and around Columbia, West Columbia, Lexington and Newberry.

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[1] As will be discussed further at a later point in the ICD, a backup dam is currently under construction immediately downstream of the original, earthen Saluda Dam. It is scheduled to be complete in 2005.

[2] This equates to an elevation of 358.5' based on the 1988 North American Vertical Datum (NAVD).

The lake contains approximately 2,200,000 *acre-feet* of *gross storage* (FERC 1984) and has a useable storage capacity of 1,056,000 acre-feet of water at 360 feet PD. The average annual discharge from the Dam *("Dam" is capitalized when referring to the Saluda Dam)* is 1,930,000 acre-feet, and the turnover time[3] for the lake is about 13 to 14 months (FERC 2002).

1.1.1 Saluda Dam, Spillway, and Spillway Gates

The Saluda Dam is an earth fill dam with an additional steel sheet pile wall on the upstream edge of the crest. From the foundation bottom to the top of the sheet pile wall is 213 feet. The Saluda Dam is nearly a mile and a half long. The maximum width of the Dam at the bottom, from upstream edge to downstream edge, is 1,210 feet, and is 36 feet at the crest. A state highway, SC Route 6, is built along the top of the Dam. About 500 feet from the south end of the Dam is the beginning of a concrete spillway equipped with six welded steel *Tainter gate*s, four of which are 37' 6" long x 25' 0" high with sill elevations of 340' PD, and two of which are 44' 0" long x 32' 0" high with sill elevations of 330' PD. The discharge from the spillway enters the 2,900-foot long man-made channel, which empties into the Saluda River below the powerhouse. In 2002, construction began on a new berm immediately downstream of and adjacent to the existing Dam. The selected remediation consists of constructing a combination Roller Compacted Concrete (RCC)[4] and Rock Fill[5] dam along the downstream toe of the existing Dam. The RCC Berm is founded on bedrock and the Rockfill Berm is founded on residual soil. This seismic remediation project involves the

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[3] The time it takes water entering the project from above to travel through the project and be discharged through the penstocks and into the lower Saluda River – also sometimes referred to as "residence time."

[4] The RCC portion of the backup berm at Saluda Dam is designed as a concrete gravity dam, and is approximately 2,300 feet long, with a crest elevation of 372.0 NAVD. The RCC berm has a maximum base width of approximately 140 feet. The upstream face of the RCC berm is vertical and incorporates precast concrete finish panels. The downstream face is stepped, using precast finish panels on the vertical faces of the 6 foot high steps. The crest width of the RCC berm varies from 25 feet to 40 feet, and the downstream face slope varies from 0.55H:1V to 0.42H:1V. The RCC berm is founded on competent bedrock, with a conventional mass concrete foundation, constructed on bedrock, in some areas.

[5] The rockfill portions of the backup berm at Saluda Dam consist of a north rockfill berm approximately 2,500 feet long, and a south rockfill berm approximately 3,300 feet long. Both the north and south rockfill berms have a crest width of 20 feet at elevation 372.0 NAVD. The north rockfill berm has a maximum width (at the base) of approximately 300 feet, and the south rockfill berm has a maximum base width of approximately 375 feet. Both are constructed as a zoned rockfill with a central clay transition zone (core) and internal sand and gravel filters. The outer rockfill shells are constructed with 1.5H:1V outer slopes.

placement of 1.3 million cubic yards of RCC and 3.5 million cubic yards of Rockfill. When completed, the new back-up dam will be 213 feet high with the RCC Berm section, in the center, approximately 2,300 feet long and the Rockfill berm sections, on the north and south ends, a total of approximately 5,700 feet long. The maximum upstream to downstream width of the foundation of the back-up berm is approximately 150 feet for the RCC and 337 feet for the Rockfill sections. The maximum crest (top of berm) is 40 feet for the RCC section and 20 feet for the Rockfill section. Additional material will be added to the downstream slope of the original Saluda Dam to provide a base for two additional lanes of SC Route 6.

1.1.2 Intake Towers and Penstocks

Water is supplied to the powerhouse through five intake towers, four of which are 30 feet in diameter and 223 feet in height, and the fifth which is 60 feet in diameter and 223 feet high. The intake towers are connected to the Dam at the top by an aerial cableway. The 30' diameter intake towers for Units 1, 2, 3, and 4 each have two Broome Roller Gates - 9' x 14'. The 60' diameter intake tower for Unit 5 contains six Broome Roller Gates, each 10' x 10'. Connecting the intake towers and the powerhouse are five penstocks. The 16-foot diameter penstocks for Units 1, 2, 3, and 4 are each 1091 feet long and at the *turbine* inlet of each is a 16-foot diameter S. Morgan Smith electrically operated butterfly valve. Water entering the Unit 5 Intake Tower passes first through a 491-foot length of open concrete arch conduit, then through a 227-foot divided length of arch conduit containing two 14-foot diameter penstocks followed by a 42-foot length bifurcation, and finally through a 364-foot section of single, 20-foot diameter penstock to the powerhouse.

1.1.3 Powerhouse

The Saluda Hydro Powerhouse is constructed of concrete, steel and brick, and is 57 feet wide, 250 feet long and 100 feet high, with a reinforced concrete extension for Unit 5, which is 68 feet wide and 77 feet long. The original powerhouse, containing Units 1 to 4, is of conventional indoor-type design, while the extension is of a fully outdoor design with the generator enclosed in a weather-tight housing on an open deck. Auxiliary equipment is located on the turbine floor inside (FERC 1984).

The powerhouse contains 4 generating units. Three units have a nameplate rating at 32.5 MW each and the fourth at 42.3 MW totaling 207.3 MW. The exterior unit located to the south of the existing powerhouse is the fifth unit and is rated at 67.5 MW. At 180 feet of *head*, the system can produce 202.6 MW of power (FERC 2002) and has a licensed[6] *capacity* of 202.6 MW. The combined *hydraulic* capacity of all five hydro units at normal gate opening is 18,000 *cubic feet per second* (cfs). The hydraulic capacity of each of the Units 1 to 4 is 3,000 cfs, and the hydraulic capacity of Unit No. 5 is 6,000 cfs.

Water is supplied through 5 intake towers upstream of the Dam and routed through individual penstocks to the powerhouse turbines (FERC 2002). Unit Nos. 1 through 4 take water from near the bottom of the lake at a depth of about 190 feet, while Unit No. 5 takes water from a depth of about 80 feet. All Units have had additional vents installed to improve *dissolved oxygen* (DO) concentrations in the turbine discharges from the Project. Additionally, Unit No. 5 is fitted with hub baffles to enhance air intake efficiency.

The emergency spillway is 500 feet from the south end of the Dam and includes a concrete structure with six steel tainter gates (FERC 2002). Water from the spillway follows a man-made channel which connects with the Saluda River approximately three quarters of a mile downstream of the Dam. The

[6] The generating equipment does not operate under ideal conditions for which they were most efficiency designed. Therefore, this explains the lower licensed capacity rating of 202.6 MW versus the nameplate rating of 207.3 MW.

spillway gates may be raised to prevent the lake level from exceeding 360 feet PD. At a flood level of 370 feet, the spillway capacity is approximately 154,000 cfs. Under *Probable Maximum Flood (PMF)* conditions, the spillway outflow is projected to be about 197,000 cfs.

1.1.4 Tailrace Water Level

The water level in the *tailrace* typically fluctuates between 171 and 181 feet PD due to the intermittent operation of the hydro plant (FERC 2002). Normal *tailwater* level is 177 feet PD, corresponding to a total head of 180 feet. At flood stage, with the spillway fully open, the tailwater could rise to an elevation of 202 feet PD or higher.

1.1.5 Bypass Reach

There is no *bypass reach* associated with this Project.

2.0 PROJECT GENERATING EQUIPMENT

The Project generating equipment consists of the following:

2.1 Turbines

Units 1, 2, 3, and 4 are S. Morgan Smith Francis-type turbines each rated at 55,650 HP at 180' head. Synchronous speed is 138.5 RPM.

Unit 5 is a Baldwin-Lima-Hamilton Francis-type turbine rated at 98,300 HP at 156' head. Synchronous speed is 128.6 RPM.

2.2 Generators

Units 1, 2, and 4 are 3-phase, 60-cycle, 13,800 V, 40,625 KVA, 0.8 power factor Westinghouse generators. Unit 3 is a 3-phase, 60-cycle, 13,800 V, 47,000 KVA, 0.9 power factor Westinghouse generator. These four units are conventional indoor-type design.

Unit 5 is a 3-phase, 60-cycle, 13,800 V, 75,000 KVA, 0.9 power factor General Electric generator. Unit 5 is fully outdoor design with the generator enclosed in a weather-tight housing on an open deck.

2.3 Exciters

Units 1-4 are each equipped with an exciter and a Permanent Magnet Generator (PMG), both direct connected above the generator rotor.

Unit 5 is equipped with an AC exciter and rotating rectifier.

2.4 Governors

Units 1-4 have governors that are interconnected in pairs.

Unit 5 has its own governor actuator and pressure tank.

2.5 Power Transformers

Units 1, 3, and 4 power *transformers* are 3-phase, 41,667/46,667 KVA with $55^o/65^o$ C temperature rise, type O.I.W.C., 115/13.2 KV. The Unit 2 power transformer is 3-phase, 40,000 KVA with 55^o C temperature rise, type O.I.W.C., 115/13.2 KV.

The power transformer for Unit 5 is 3-phase, 76,785/86,000 KVA, type F.O.A., 115/13.2 KV with $55^o/65^o$ C temperature rise.

3.0 PROJECT TRANSMISSION LINE

There is no *transmission* line associated with the Saluda Hydroelectric Project. The electric power is generated at 13,200 *volts* and is transformed to 115 KV. The power enters the Applicant's transmission system through the nearby Saluda Substation, which is not a part of the Project.

4.0 MISCELLANEOUS EQUIPMENT

Miscellaneous equipment includes a 175-ton, traveling Bedford bridge crane and all accessory electrical equipment, including instrumentation, batteries, switchgear, etc.

5.0 McMEEKIN STATION

McMeekin Station is a coal fired power plant located adjacent to the hydro powerhouse on the north side of the Saluda River (FERC 2002). It is operated by SCE&G, but is not part of the Project. Cooling water for the McMeekin condensers is taken from and returned to the Saluda penstocks.

6.0 PROJECT DRAWINGS AND RECORDS

Drawings of Project structures and features are provided in Section G.

Table A-1: Saluda Project Standard Numbers (FERC Project No. 516)

DESCRIPTION			NUMBER OR FACT			
	Project Location		10 mi west of City of Columbia; Richland, Lexington, Saluda and Newberry Counties			
	Spillway Gates	Width	4@37ft 6in long x 25ft high w/sill elevation of 340 msl 2@44ft long by 32ft high w/sill elevation of 330 msl			
	Reservoir	Normal level	2,100,000 acre-feet			
	Minimum daily average flow in the river		285 cfs (measured @ USGS gauging station near Riverbanks Zoo)			
		Construction type	concrete block, brick, steel			
		Construction type	reinforced concrete			
			Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
	Intake towers						
		Diameter	30 ft	30 ft	30 ft	30 ft	60 ft
		Height	223 ft	223 ft	223 ft	223 ft	223 ft
	Penstocks						
		Diameter	16 ft	16 ft	16 ft	16 ft	20 ft
		Length	1091 ft	1091 ft	1091 ft	1091 ft	1124 ft
TURBINES							
	Rated net head (gross static)						
	Rated maximum discharge capacity						
			Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
	Draft tube invert elevation		158.5 ft msl	158.5 ft msl	158.5 ft msl	158.5 ft msl	151.12 ft msl
	HP Rating at 180ft head		55,650 (32,500 kW)	55,650 (32,500 kW)	55,650 (32,500 kW)	55,650 (32,500 kW)	
	HP Rating at 156ft head						98,300 (67,500 kW)
	Synchronous speed (rpm)		138.5	138.5	138.5	138.5	128.6
	Type		Francis-type	Francis-type	Francis-type	Francis-type	Francis-type
	Manufacturer		S. Morgan Smith	S. Morgan Smith	S. Morgan Smith	S. Morgan Smith	Baldwin-Lima-Hamilton
GENERATORS							
	Annual generation		245 million kWh or 245,200 Mwh				
			Unit 1	Unit 2	Unit 3	Unit 4	Unit 5

DESCRIPTION		NUMBER OR FACT				
	Manufacturer	Westinghouse	Westinghouse	Westinghouse	Westinghouse	General Electric
	Name plate rating (202,600 kW for the Project)					
	Power factor	0.8	0.8	0.9	0.8	0.9
	Voltage	13,800 V	13,800 V	13,800 V	13,800 V	13,800 V
	Number of phases	3	3	3	3	3
	Frequency	60-cycle	60-cycle	60-cycle	60-cycle	60-cycle
	Output	32,500kW	32,500kW	42,300kW	32,500kW	67,500kW
	KVA	40625	40625	47000	40625	75000
TRANSFORMERS						
	Number	5				
	Voltage	13.2/115-kV				
FLOOD FLOWS						
	Other info:					
	Maximum generating capacity	207,300 kW				
	Total Capacity	202,600 kW				
	Discharge at rated capacity	18,000 cfs				

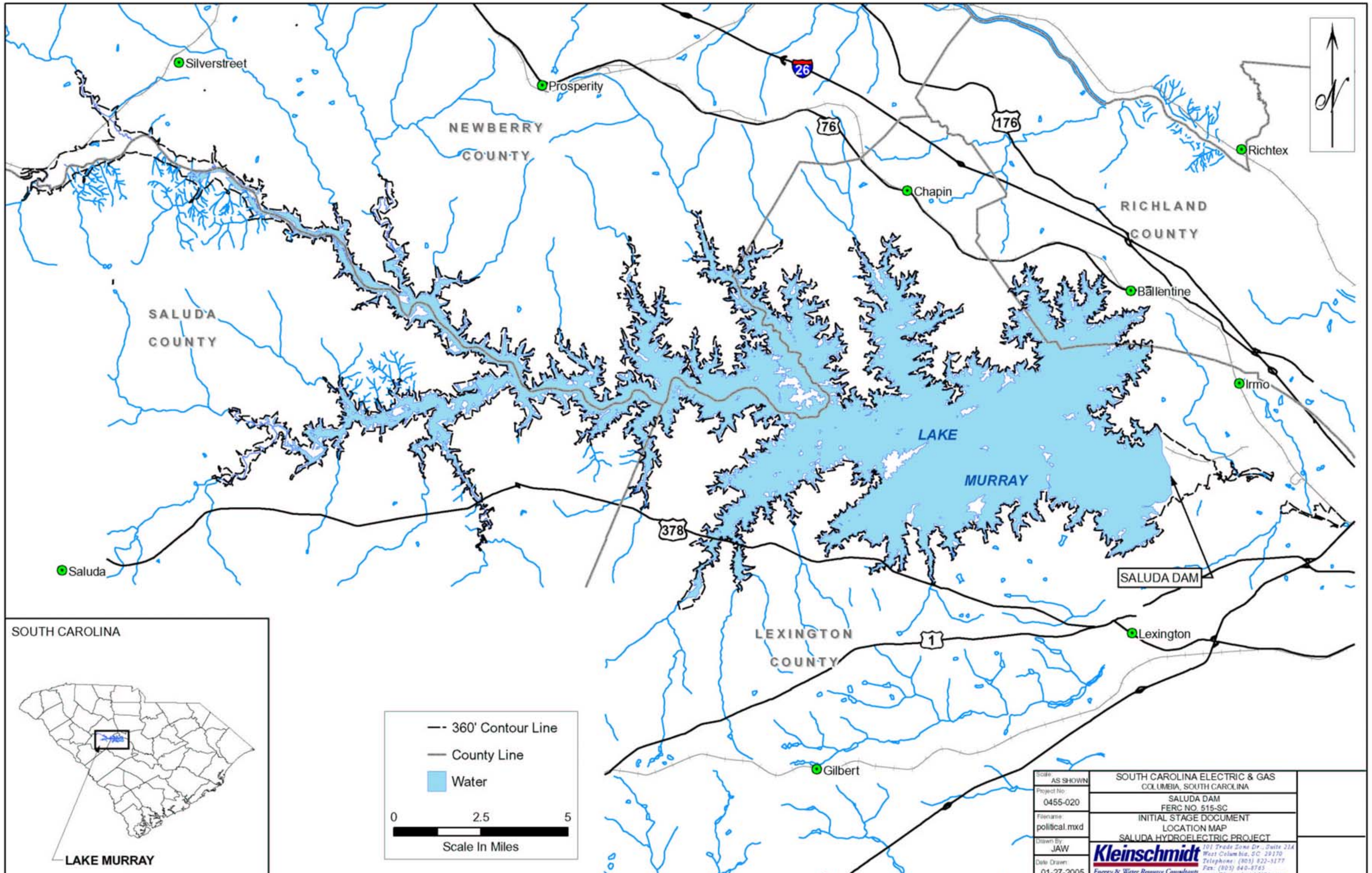


Figure A-1: Project Location Map

B: PROJECT OPERATIONS AND RESOURCE UTILIZATION

7.0 RESOURCE UTILIZATION

SCE&G uses its existing resources in as efficient a manner as reasonably possible. SCE&G conducts annual maintenance at the Saluda Project to ensure the efficiency of the units. Existing resources are periodically evaluated to determine if Project upgrades are needed. The Project has a hydraulic design flow of 18,000 cfs, exceeding the average annual flow of 2,595 cfs. This flow capacity, combined with the storage capability of Lake Murray, allows the Project to make effective use of essentially all net inflows to the site.

In accordance with FERC regulations, and in order to ensure the efficient management of Project waters, a resource utilization study was conducted by SCE&G as a part of the relicensing process. At a minimum, a reconnaissance level study must be preformed to demonstrate that the project is in conformance with a comprehensive development plan for the waterway. A flow utilization equal to or greater than the 25 percent exceedance flow, as based on the annual *flow duration curve*, is typically used as an indicator that the project is making comprehensive use of the resource. The 25 percent flow exceedance value approximates the average annual flow at the project location. Based on the flow duration curve developed for the site, the 25 percent exceedance flow was determined to be about 2,000 cfs.

7.1 Project Modification for Consideration

Currently, beyond completing the construction of the backup dam, SCE&G is not proposing any specific engineered modifications of Saluda Hydro. However, during the relicensing process, in response to issues and concerns, SCE&G expects that it will find it necessary to examine Project modifications that might enhance the operational, environmental and economic value of Saluda Hydro.

7.2 Streamflow and Water Regime Information

7.2.1 Flow Rates and Duration Curves

The monthly and annual flow regime data was collected from USGS gages located along the LSR. Gage number 02169000 is located on the Saluda River near Columbia. It has remained in this location from the time it was first installed in 1925. The contributing drainage area for this gage is 2,520 square miles and has an average annual flow of 2,569 cfs. A second gage, number 02168504, was installed along the Lower Saluda by USGS in 1988. This gage records data immediately downstream from the Saluda Dam. One can make comparisons of flows from Lake Murray based on the data retrieved from these gages. This data has shown that from the time period of 1980 to 2003, flows from Lake Murray have varied from a low of 185 cfs to a recorded high of 24,000 cfs. Flow measured from gage number 02168504 has an annual average of 2,595 cfs. The contributing drainage area is 2420 square miles. Monthly and annual duration curves were made for the project using the mean daily flow data from the respective gages. The data from the two gages were combined to form the graphs shown in Figures B-1 through B-13. The data from the gages was pro-rated to their respective contributing drainage areas to make the mean daily flow site-specific. The period of record for the data that is used in these graphs dates from 1979 through 2003. Since gage number 02168504, directly downstream from the Dam, was installed in 1988, data from gage 02169000 was used and pro-rated to that particular drainage area.

7.3 Project Operation

7.3.1 Description of Power Operation

7.3.1.1 Typical Operations

Saluda Hydro occupies a specific, very important niche in SCE&G's generating portfolio in that it is a facility in the SCE&G system that provides *reserve capacity*. Reserve capacity means the Project generators are typically online and synchronized to the electrical grid and can increase output immediately in response to a major generator or transmission *outage* and can reach full output within 15 minutes to comply with the North American Electric Reliability Council's Control Performance Standard.

Electric *load-generation* balancing, and management of local voltages and system frequency on a bulk power system, is done in real time. Generators sometimes fail, and generation failures may be unpredicted and sudden, upsetting the *load-generation* balance. Because electricity cannot be stored, any sudden reduction in generation cannot be handled by an inventory, as might happen in most other kinds of business. Instead, generation losses must be met by reserve generation that can be dispatched instantly, before voltage sags or frequency excursions lead to local or widespread blackouts. SCE&G is a member of the Virginia-Carolinas Southeastern Electric Reliability Council sub-region (VACAR), whose members are bound in a reserve-sharing agreement by which each has agreed to assist any other member in generation emergencies. SCE&G must employ its reserves (Saluda Hydro) to meet its own generation emergencies before calling on assistance from other VACAR members, but it also must be constantly ready to provide reserve generation to other VACAR members to meet SCE&G's contractual reserve obligations.

Because of SCE&G's obligations as a member of VACAR, Saluda Hydro operations are particularly important. This is due to the fact that Saluda can operate almost instantly in response to system emergencies. System emergencies, an unfortunate by-product of electrical power generation, can best be described as follows: any unplanned or unscheduled event that threatens, without prompt initiation of generation, to adversely impact system operations or reliability. The Saluda Hydro Project's greatest single value in support of SCE&G's system obligations is to provide this reserve generation in order to meet system emergencies. Emergencies can be initiated within SCE&G's system, or in the regional grid for which SCE&G is bound by cooperative agreement. In case of an out-of-system emergency Saluda Hydro must be able to supply approximately 200 *megawatts* (MW) (Saluda Hydro's rated capacity is 202 MW). What might trigger a system emergency will vary from day-to-day. On a mild day during off-peak hours, a large plant can trip off without necessarily causing a system emergency. Conversely, at peak time, or during a particularly hot or cold day, the tripping off of even a small unit may constitute an emergency. It also may depend upon the regional grid circumstances at the time of the initiating event. In the case of any system emergency, Saluda Hydro may be dispatched for up to full capacity generation for minutes or even hours.

7.3.1.2 Flood Control Operations

Saluda Hydro is not operated as a flood control reservoir. However, in times when tropical storms and hurricanes are predicted to affect inflow to the reservoir, operations of Saluda Hydro are increased to maintain the operating level of Lake Murray.

7.3.2 Description of Non-Power Operations

In addition to power production, the Saluda Hydro Project provides other benefits to the region and immediate vicinity, including recreational and environmental benefits.

7.3.3 Project Operations during a New License Term

SCE&G intends to use Saluda Hydro as a reserve capacity facility under the terms of a new license.

7.3.4 Project Maintenance

Under normal operations, Project plant personnel consist of a plant supervisor and an operations and maintenance crew. Crews are typically onsite for 8 hours a day Monday through Friday, and the plant is monitored 24 hours a day through SCE&G's system control. All Project personnel are trained in regulatory compliance, safety, dam surveillance, and emergency action procedures.

7.4 Project Safety

A combination of federally imposed requirements and voluntary measures conducted by SCE&G provide a high level of safety at the Saluda Hydroelectric Project. The FERC conducts annual inspections of the Project; they also require independent safety inspections, annual spillway gate tests, and the maintenance of an updated Emergency Action Plan. SCE&G performs regular Project inspections and monitors various types of instrumentation at the Dam. A backup dam is being constructed to prevent massive downstream flooding in the unlikely event of a seismically-induced primary dam failure. A siren warning system is in place to alert residents and businesses of a dam emergency; another system informs recreational users along heavily used stretches of the river that the water level is rising due to changes in plant operation. Buoys, signs, and fences are placed throughout the Project as part of the Public Safety Plan on file with the FERC.

7.4.1 Dam and Safety Inspections, Instrumentation Monitoring

Every year, an inspection is performed by a representative of the FERC to insure safety of a project's features and operation. Another inspection is required every five years by an independent consultant approved by the FERC. Mandatory annual spillway gate testing ensures the ability to regulate flooding. Also, any modifications to the Project or significant operational changes are required to be submitted to the FERC.

SCE&G conducts a number of regular in-house inspections of the Dam and plant, and a monitoring program indicates any changes in the conditions at the Project. Numerous network *piezometer*s, saturation wells, drains, weirs, and other apparatuses at the Dam and spillway permit the measurement of hydraulic pressures, *seepage* or leakage, and any movement of the water-retaining structures. These instrumentation readings are recorded in a surveillance report; their measurement frequency, as with regular Project inspections, varies from daily to annually.

7.4.2 Back-Up Dam

Studies have concluded that an occurrence of a seismic event of the magnitude of the 1886 Charleston earthquake could cause extensive liquefaction of the earthen dam, potentially resulting in great loss of life and property. Although the possibility of such an event is remote, SCE&G is required to prepare for it. SCE&G is accomplishing this by building a back-up dam behind the 1.5 mile primary Dam. Constructed of composite rock-fill and roller compacted concrete, this new dam is designed to withstand the forces associated with a seismically induced primary Dam failure, and subsequently to serve as the new primary dam. The construction phase of this project began in August 2002 and is scheduled to be completed in the spring of 2005. Due to construction requirements for the new dam, a temporary *drawdown* of Lake Murray was necessary to reduce loads on the existing Dam.

7.4.3 Warning Systems

SCE&G has installed an early warning system consisting of ten large sirens below the Dam. In the unlikely event of a dam failure, this system would be activated to alert people in areas that could be flooded to seek information from television or radio media sources for further instruction. A brochure containing evacuation routes and emergency preparedness information is mailed to businesses and residents in these areas on an annual basis. The information contained in the brochure can also be obtained from SCE&G's website.

SCE&G also owns and operates a warning system on the Saluda River below the Dam, consisting of sirens, strobe lights, and warning signs in two locations frequented by river users: the Hope Ferry boat ramp near Saluda Shoals Park, and upstream of the zoo at the Mill Race rapids. Operational changes at the hydroelectric plant cause fluctuations in the river levels. As the river level rises, level transducers automatically activate the sirens and strobe lights to alert people on or near the river that the flows are increasing. Prominent warning signs posted near the strobe lights warn people that the activation of the sirens and/or the light signals potentially dangerous conditions caused by a rising water level.

7.4.4 <u>Emergency Action Plan</u>

In accordance with FERC requirements, SCE&G developed and maintains an Emergency Action Plan (EAP). The purpose of an EAP is to determine the results of a dam failure, and create procedures to minimize the loss of life and property. Breach parameters, peak discharges, depth of flow, and travel time are part of the dambreak analyses. Inundation maps coordinate the results of the breach analyses with topographic maps to determine the time and extent of flooding. Breach analyses must be and have been performed for two situations: "fair weather," with *normal operating* condition and maximum normal reservoir level; and flood, where the maximum inflow condition is attained prior to the onset of dam failure.

The EAP contains essential elements, including a notification flowchart showing a priority of who is to be notified, and by whom. The detection, evaluation, and classification component determines the events that indicate an emergency is happening, as well as the extent of the situation (failure has occurred, conditions for potential failure exist, etc). The responsibilities section lists who will carry out various duties of the EAP. Responsibilities of the licensee include contacting the emergency and local agencies, who then have the duty of warning and evacuating affected areas. Preparedness consists of actions taken prior to a potential emergency to avoid or reduce the effects of a failure, such as spillway gate operational procedures. Inundation maps show areas requiring evacuation and the time available to do so. Appendices contain supporting information used to create the EAP, perform the breach analyses, and develop the inundation map.

7.4.5 Public Safety Plan

Public safety measures include warning signs near hazardous areas of the Project, buoys in the *impoundment* to serve as navigational aides or notify of dangerous conditions, and restraining devices such as fences around the powerhouse and downstream Project area. The Public Safety Plan, currently being updated, contains descriptions and locations of these public safety devices.

Figure B-1 Saluda Project FERC No. 516, South Carolina Electric & Gas Co., January Flow Duration Curve

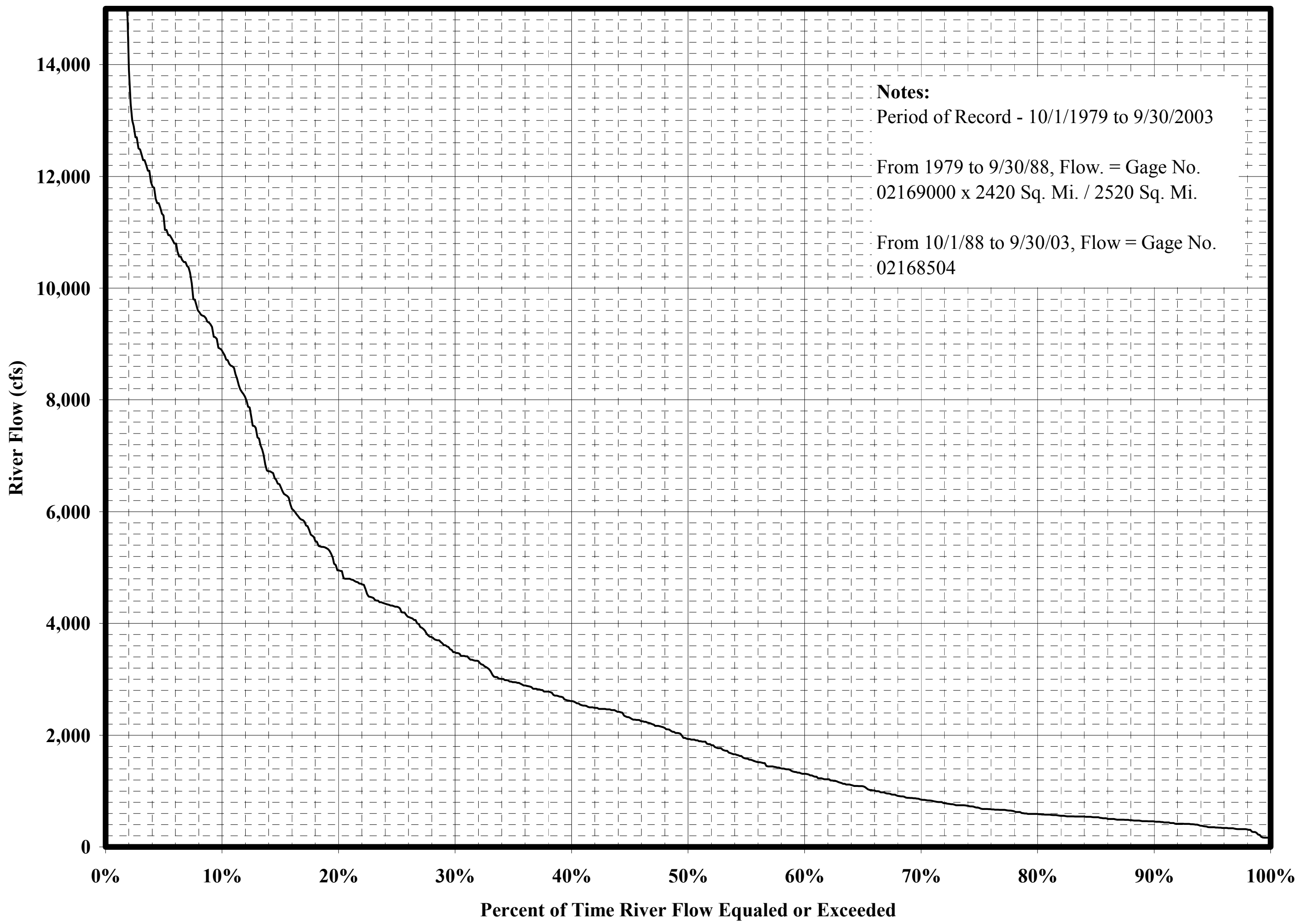


Figure B-2 Saluda Project FERC No. 516, South Carolina Electric & Gas Co., February Flow Duration Curve

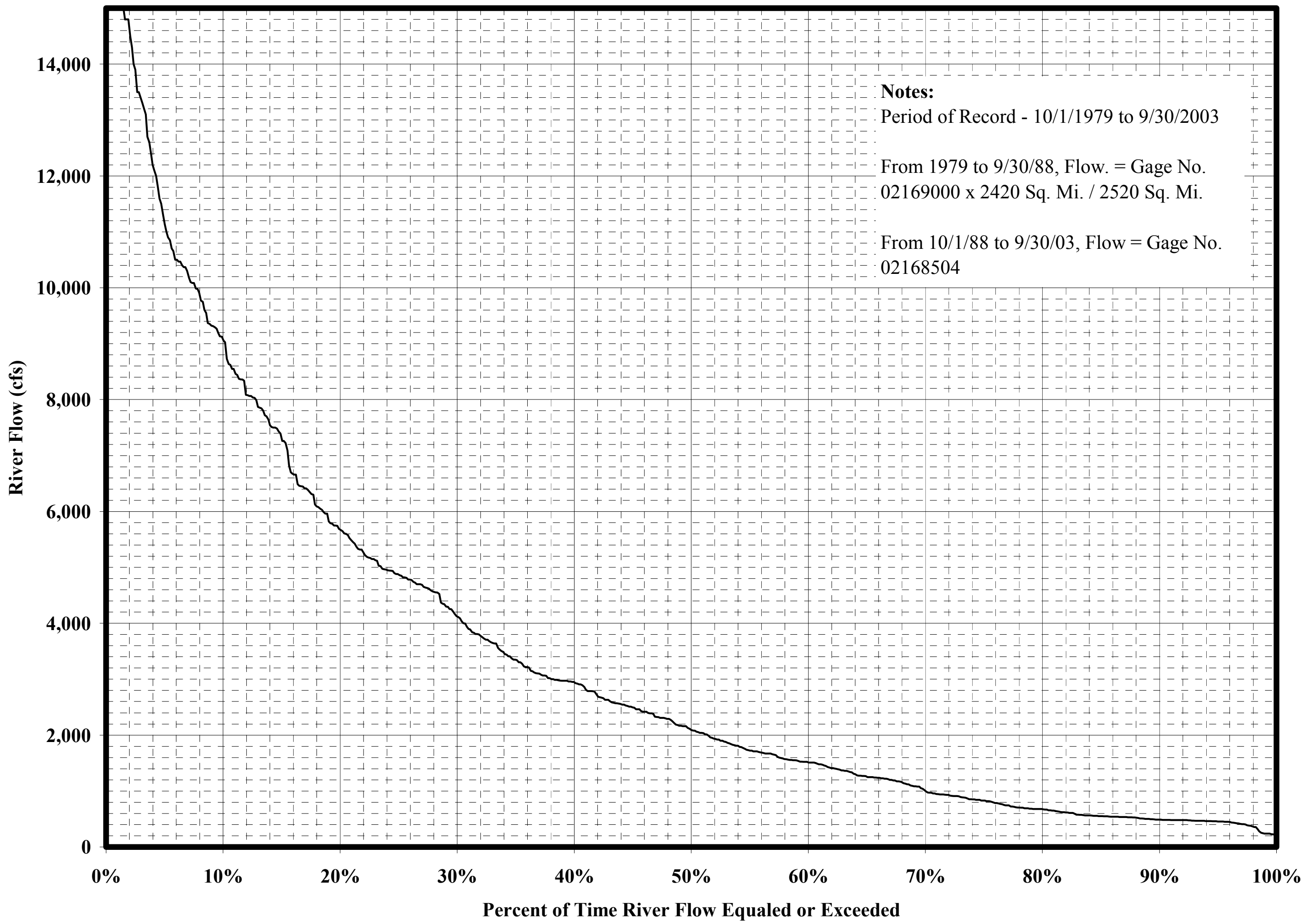


Figure B-3 Saluda Project FERC No. 516, South Carolina Electric & Gas Co., March Flow Duration Curve

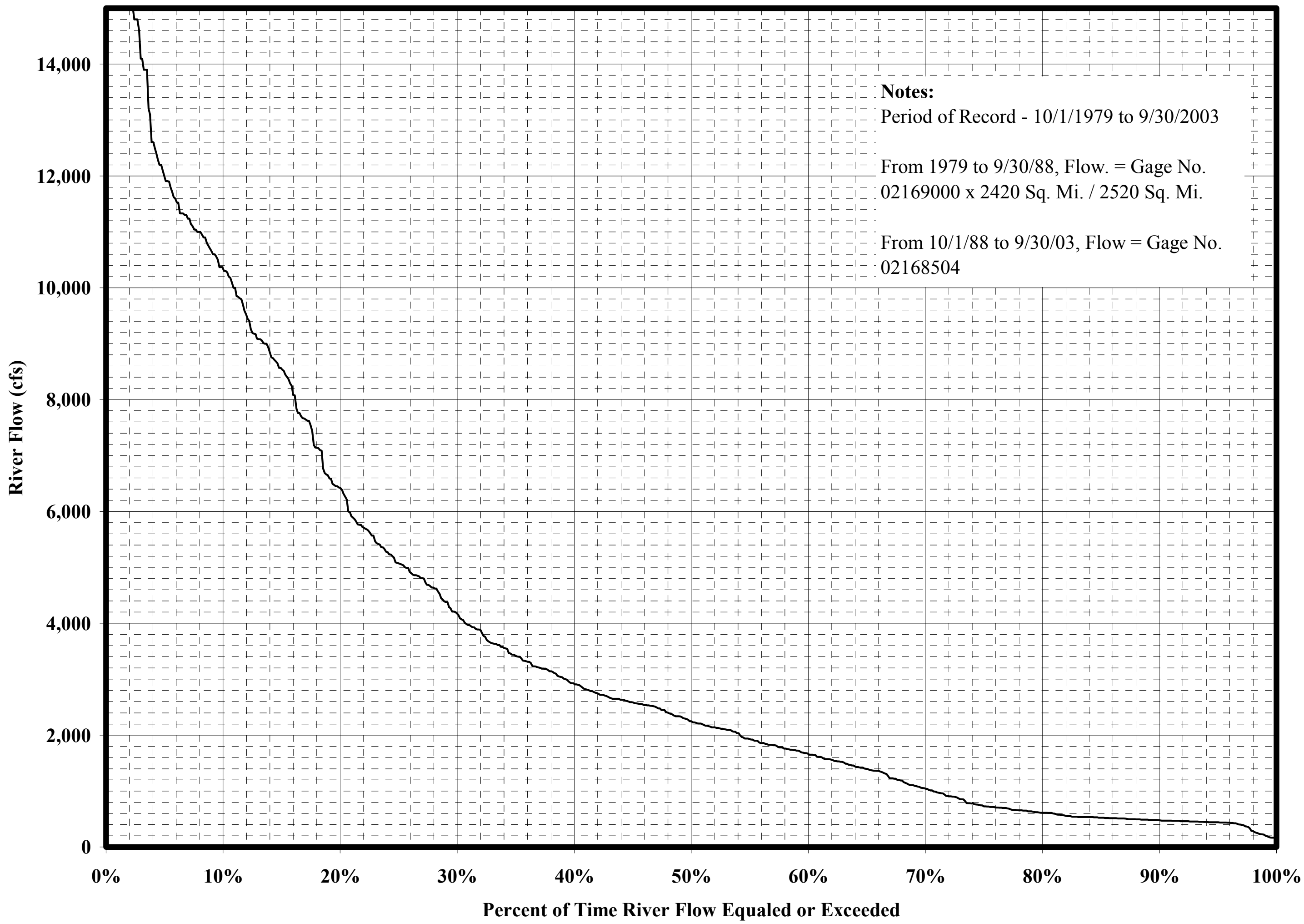


Figure B-4 Saluda Project FERC No. 516, South Carolina Electric & Gas Co., April Flow Duration Curve

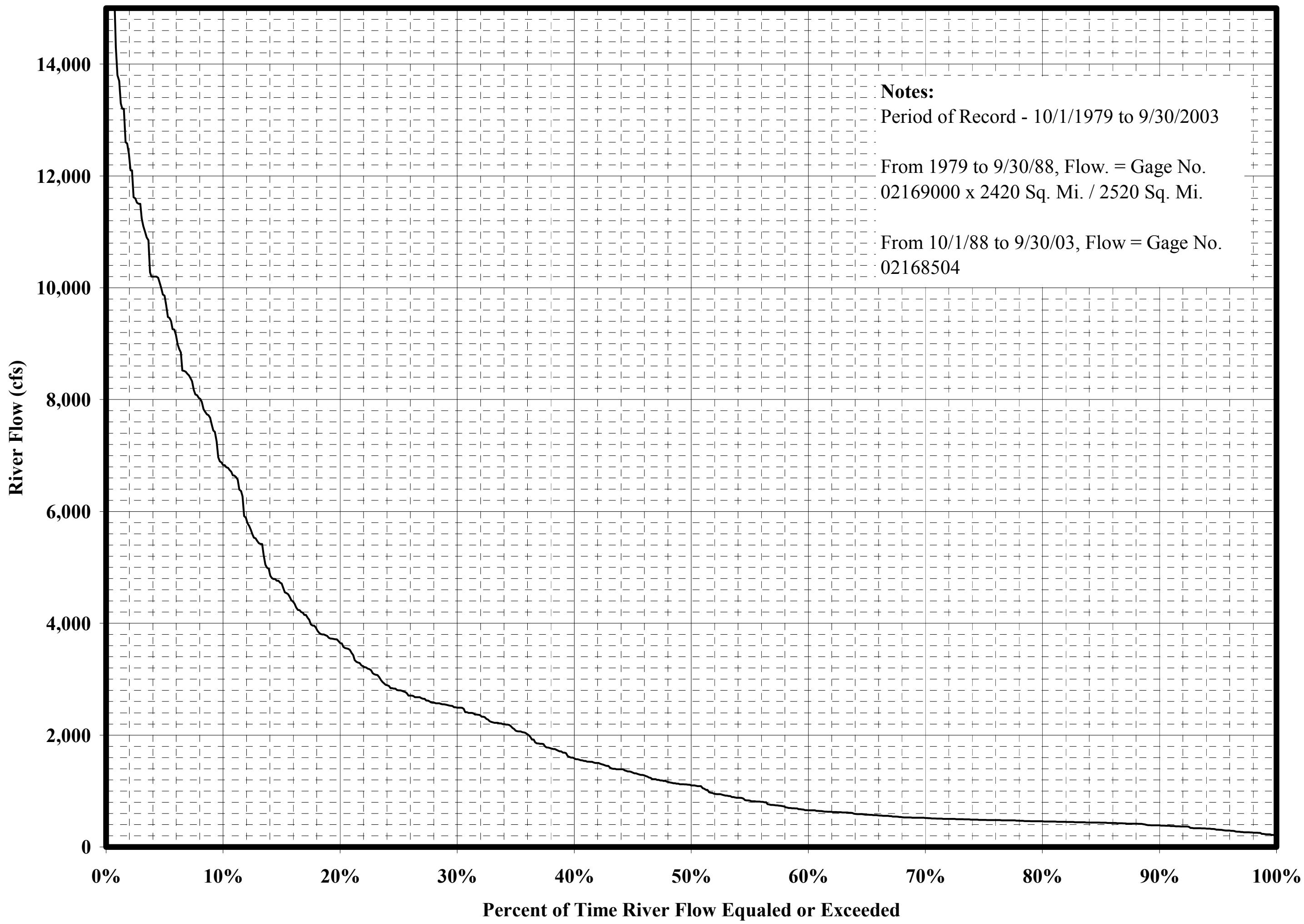


Figure B-5 Saluda Project FERC No. 516, South Carolina Electric & Gas Co., May Flow Duration Curve

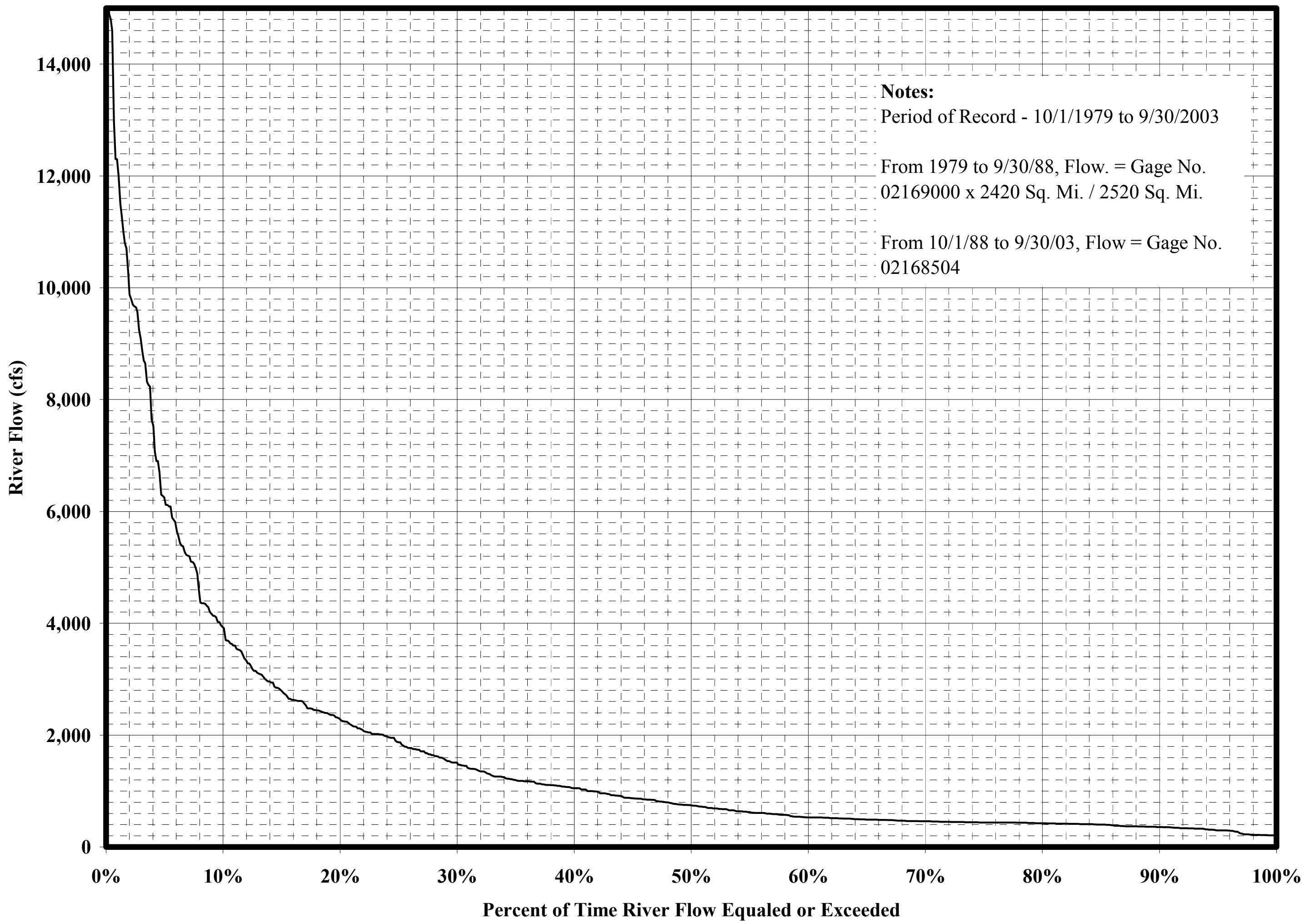


Figure B-6 Saluda Project FERC No. 516, South Carolina Electric & Gas Co., June Flow Duration Curve

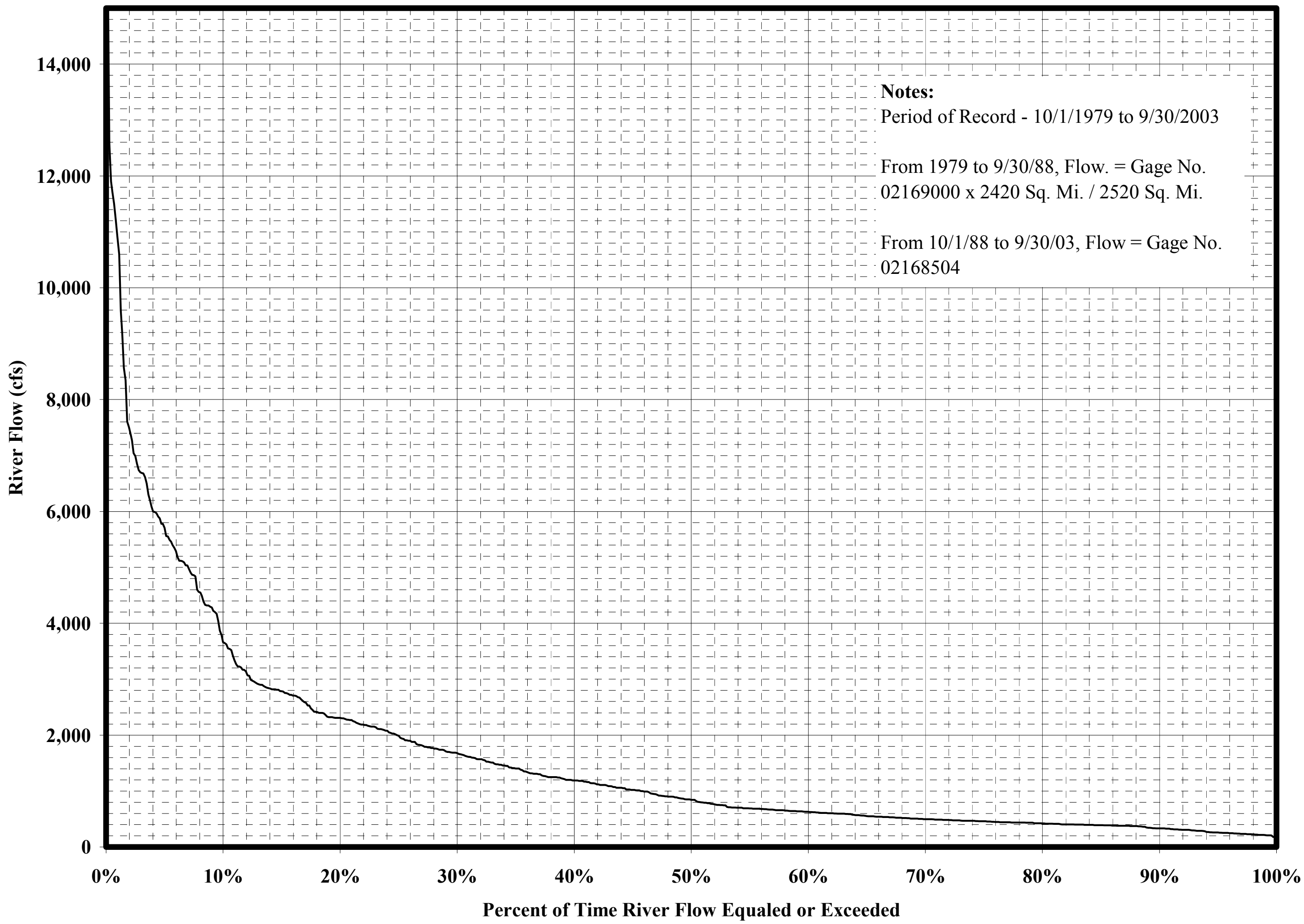


Figure B-7 Saluda Project FERC No. 516, South Carolina Electric & Gas Co., July Flow Duration Curve

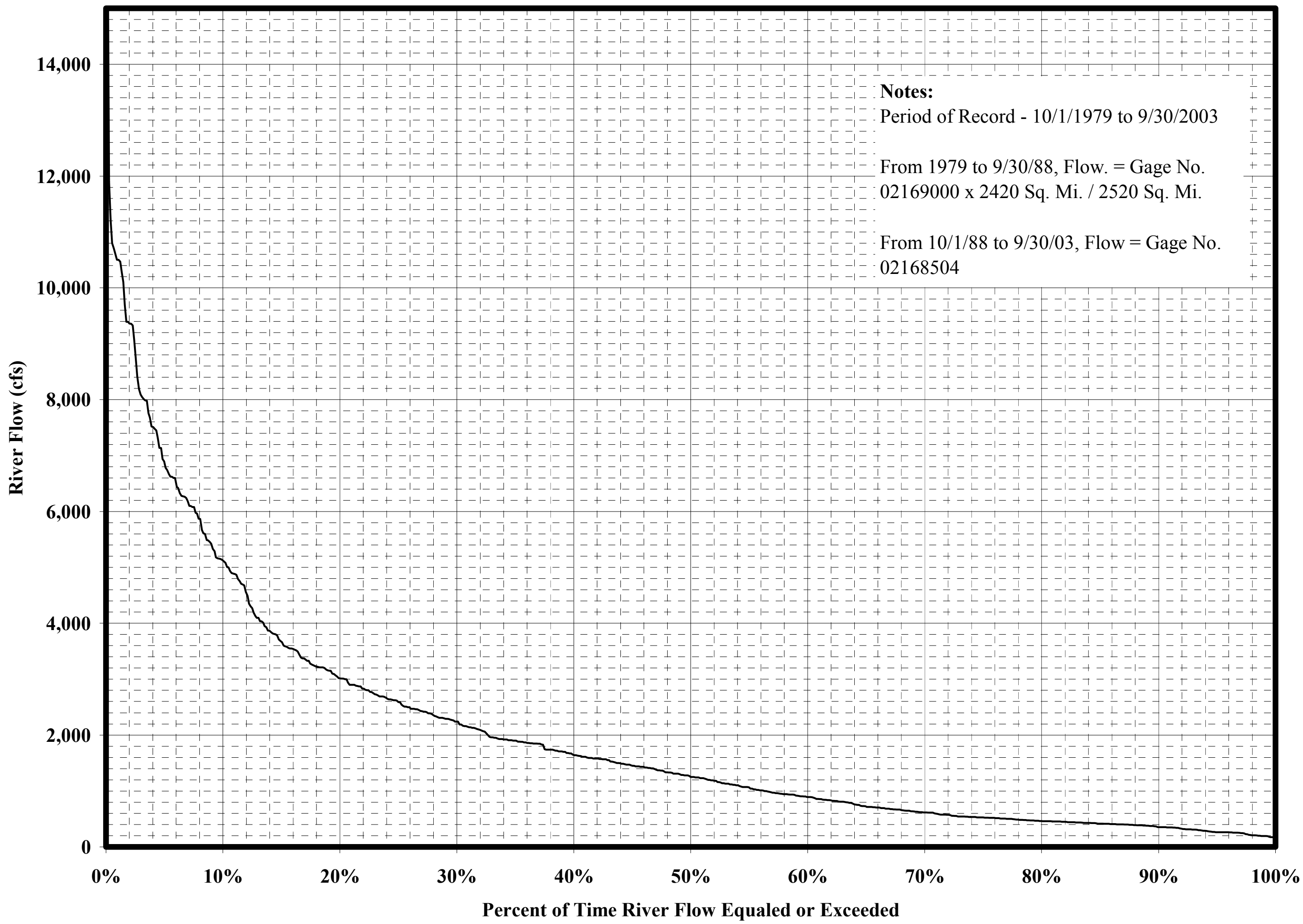


Figure B-8 Saluda Project FERC No. 516, South Carolina Electric & Gas Co., August Flow Duration Curve

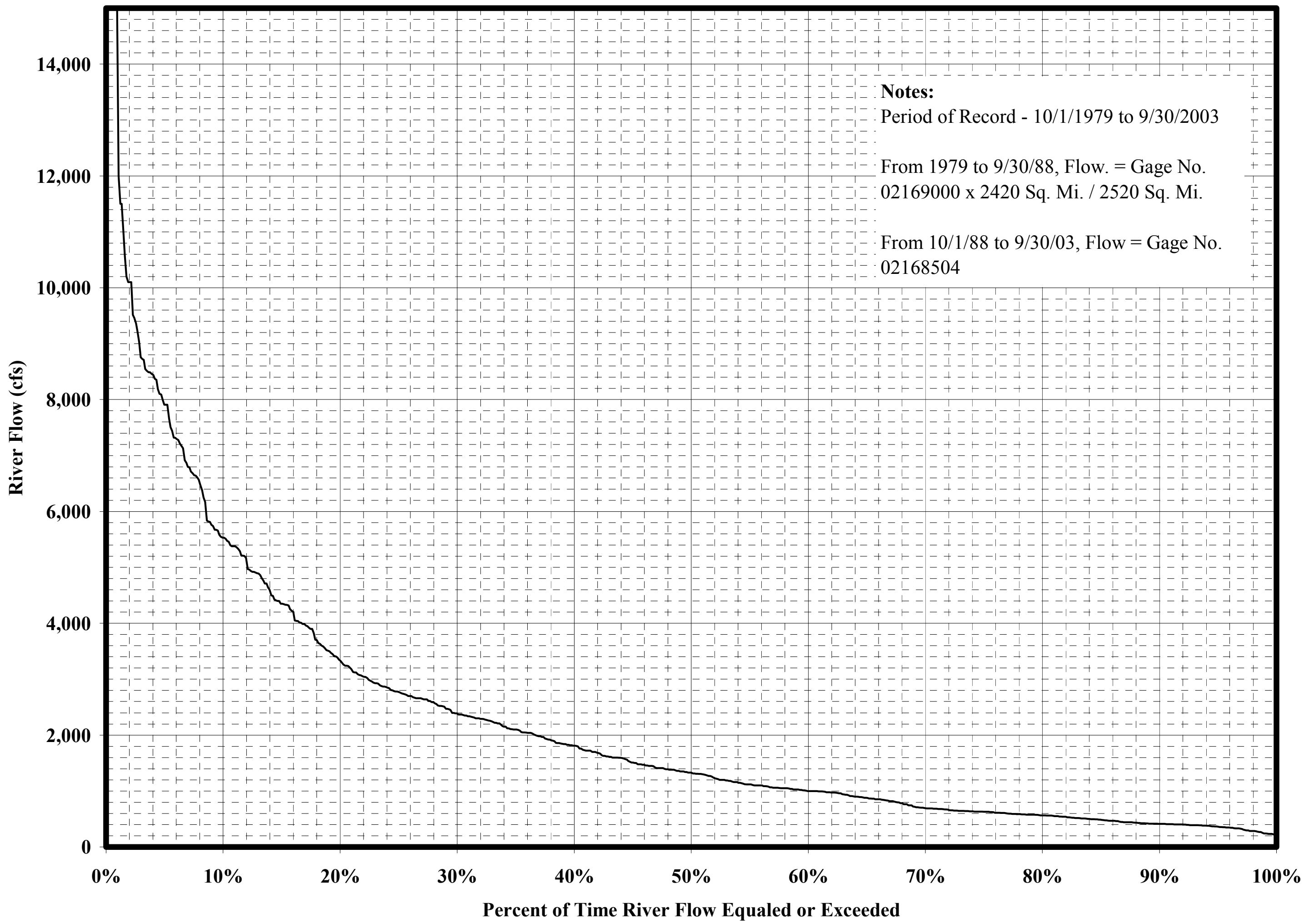


Figure B-9 Saluda Project FERC No. 516, South Carolina Electric & Gas Co., September Flow Duration Curve

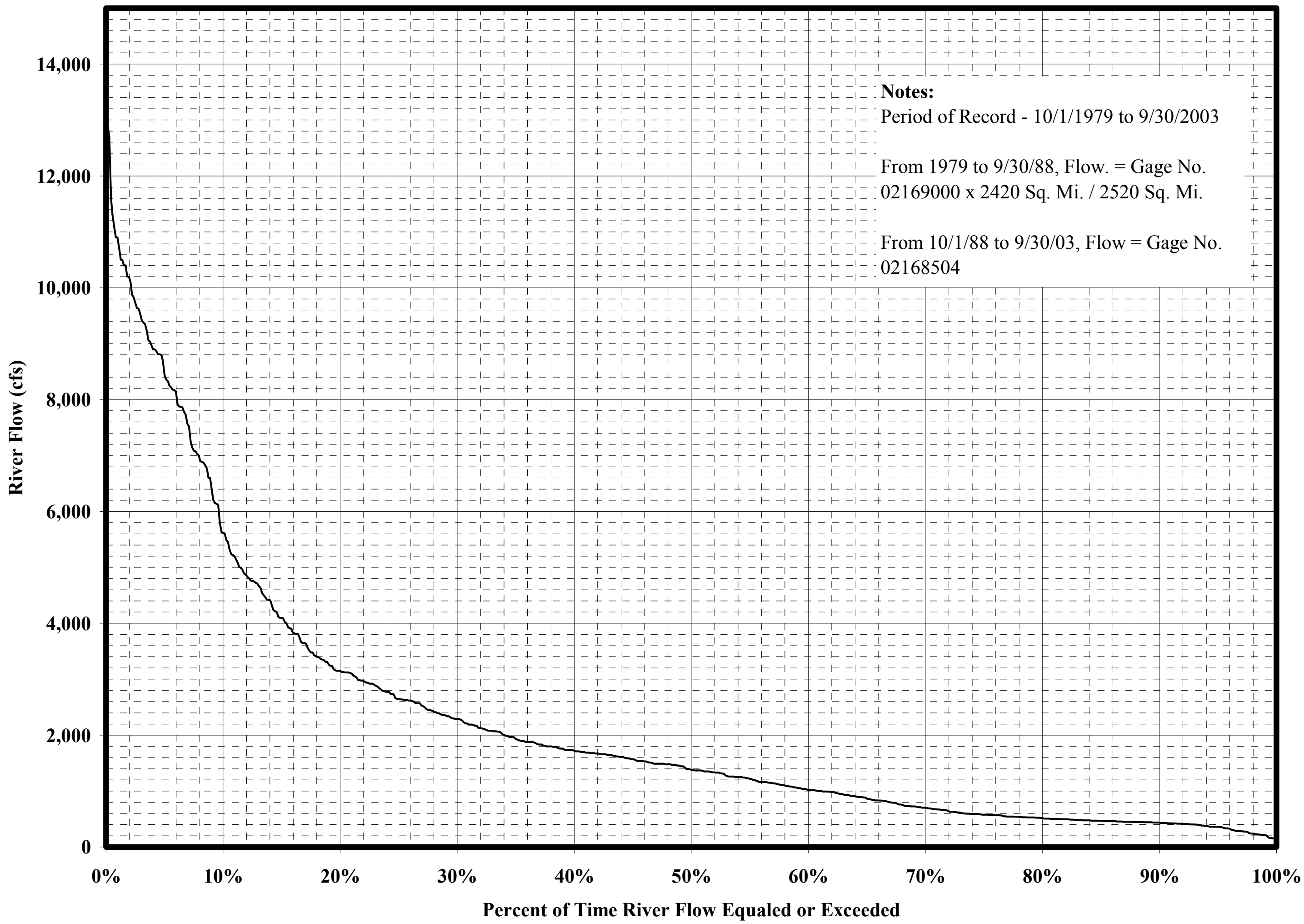


Figure B-10 Saluda Project FERC No. 516, South Carolina Electric & Gas Co., October Flow Duration Curve

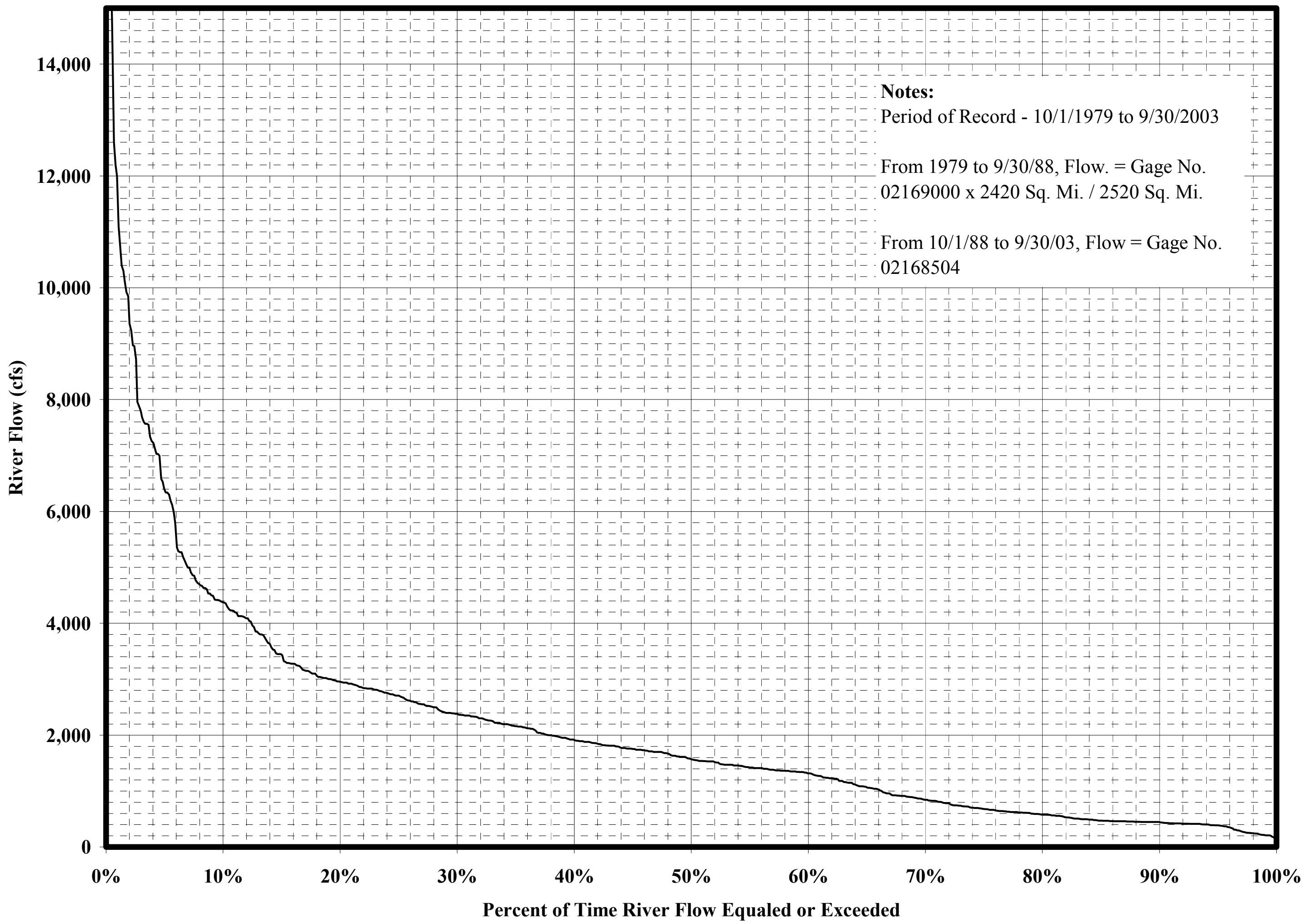


Figure B-11 Saluda Project FERC No. 516, South Carolina Electric & Gas Co., November Flow Duration Curve

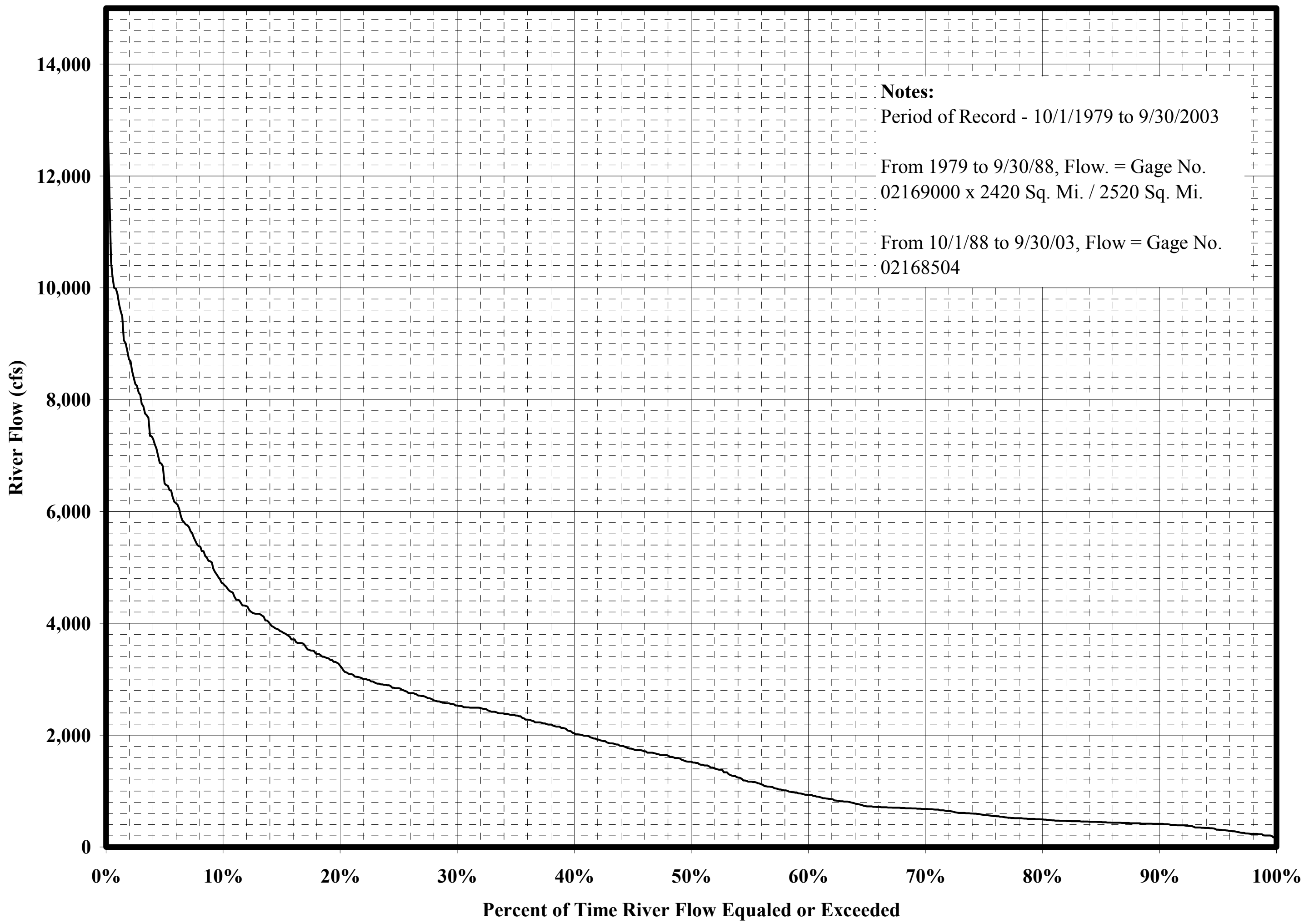


Figure B-12 Saluda Project FERC No. 516, South Carolina Electric & Gas Co., December Flow Duration Curve

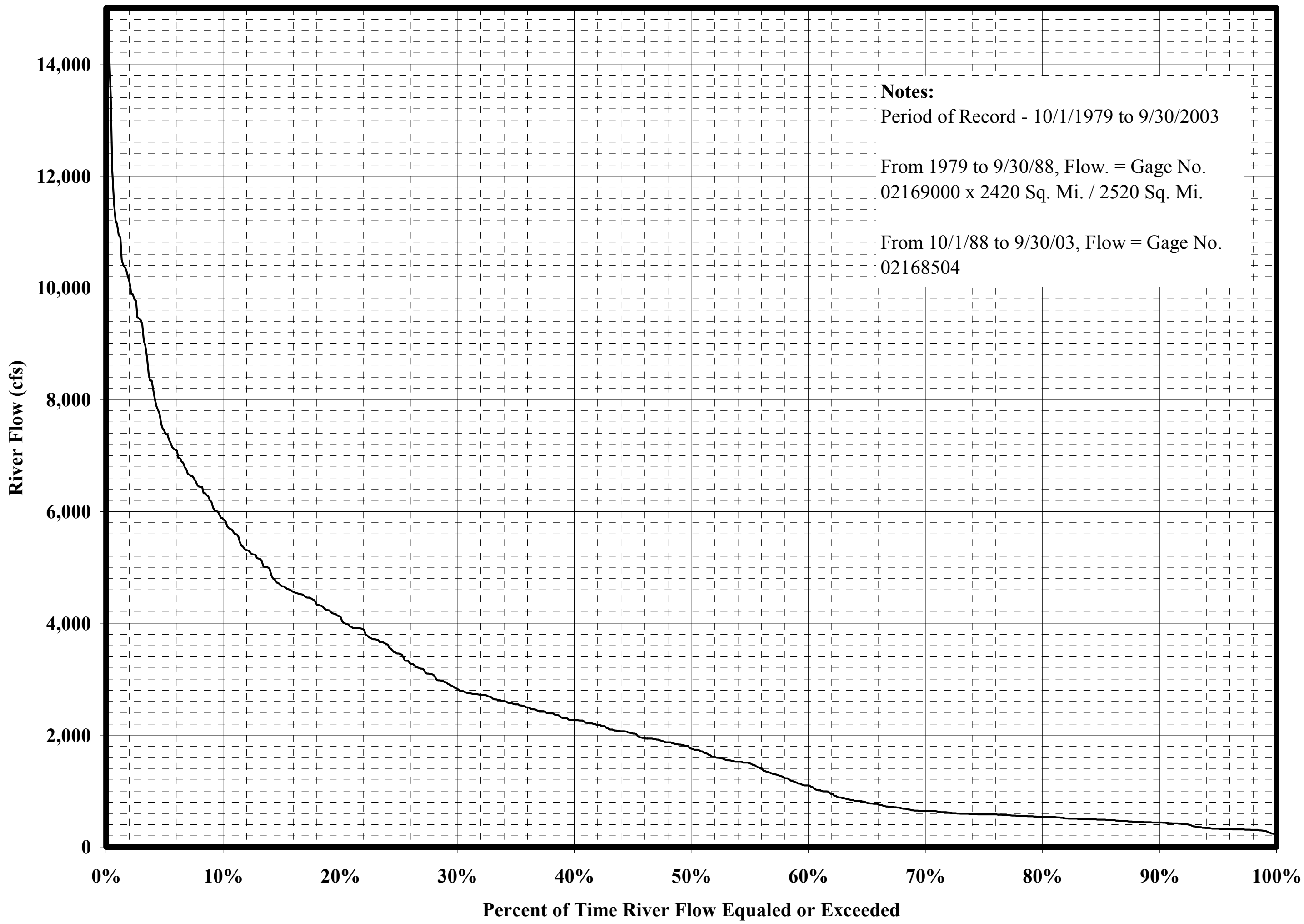
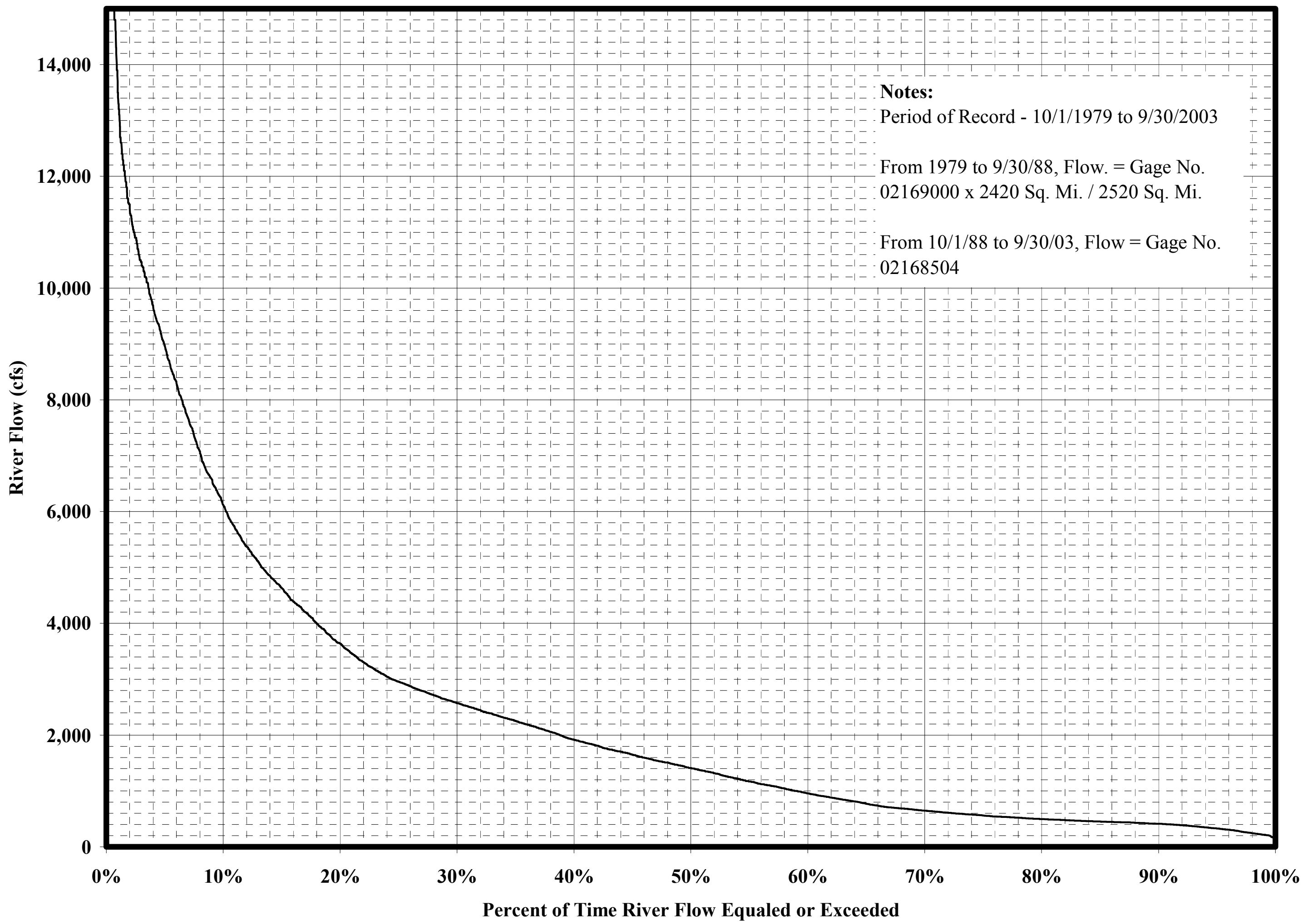


Figure B-13 Saluda Project FERC No. 516, South Carolina Electric & Gas Co., Annual Flow Duration Curve



C: THE SALUDA HYDROELECTRIC PROJECT HISTORY

The Saluda Hydroelectric Project was constructed in 1927 - 1930 by the Lexington Water Power Company, which merged in 1943 with SCE&G.

G. A. Guignard of Columbia incorporated Lexington Water Power Company in 1903. Guignard acquired the flowage rights on the Saluda River at Dreher Shoals, the present site of the Saluda Hydroelectric Project, and 20 miles upstream. He planned to build two dams - one at Dreher Shoals and another at Bear Creek five miles up the Saluda River.

Guignard sold the Dreher Shoals portion of the property in 1907. In 1925 the land became the property of General Gas & Electric Corporation, parent of Broad River Power Company and a unit of W. S. Barstow & Company, Inc. Guignard retained control of the Bear Creek site until May 1926 when the common stock of Lexington Water Power Company was purchased by the New York engineering firm of Murray & Flood.

Murray & Flood entered into an agreement with W. S. Barstow & Company for a mutual development of the Saluda Hydroelectric Project. On July 8, 1927 the *Federal Power Commission* (FPC) granted a license to Lexington Water Power Company for construction of a dam and powerhouse at Dreher Shoals. At this point control of the company passed principally from Murray & Flood to General Gas & Electric Corporation.

Construction of the Project began in April 1927 with the Arundel Corporation in charge of construction of the Dam. W. S. Barstow & Company, general contractor, was in charge of clearing work, spillway, power plant structures, machinery installations, substations, temporary and permanent housing, and the cableway connecting the Dam and intake towers. Hydraulic works design was by J. G. White Engineering Corporation.

Lake Murray reached an elevation of 300 feet PD in July of 1930. In 1931 Lake Murray reached an elevation of 350 feet PD, and in 1933 it reached 360 feet PD. In December of 1930 the first electric power was delivered to Duke Power Company. Lexington Water Company was a production company only, and as such did not own any *transmission lines*. The Saluda Project was financed primarily through sales contracts with Carolina Power & Light Company, Duke Power Company and Broad River Power Company, all of which built their own transmission lines to the Saluda Hydro Plant.

When the hydro plant was completed it had four turbines, each capable of producing 32,500 Kilowatts (KW). When the Dam was built, plans were formulated to later add fifth and sixth turbines. The intake tower and the associated tunnels to carry lake water under the Dam to the future unit were constructed when the Dam was originally built.

In 1936 heavy rains and insufficient spillway capacity caused the lake to reach its maximum elevation of record – 361.38 feet PD. As a safety measure the FPC directed that the lake be lowered to an elevation of 350 feet PD. After further study the FPC then allowed the maximum lake elevation to be increased to 355 feet PD. This maximum elevation was maintained until the spillway capacity could be increased and better drainage achieved on the downstream face of the Dam.

Between 1943 and 1946 two additional spillway gates were added, the spillway discharge channel was enlarged and partially rerouted, and the Dam was strengthened by raising the crest elevation by 3 feet and adding rock excavated from the spillway channel to the downstream face of the Dam. When these measures were complete, the FPC permitted the increase of the lake elevation to its current maximum operating level of 360 feet PD.

In 1943, Lexington Water Power Company merged with SCE&G, in whose service area the Project was located. The FPC approved the Consolidation in an order issued in July 1943 [3 FPC 1046 (1943)].

Since the late 1950s, Lake Murray has also been used as a source of cooling water for the McMeekin steam electric generating plant. The FPC issued a finding and order on June 15, 1956 [15 FPC 1544 (1956)] approving the use of the Project reservoir (Lake Murray) for supplying circulating cooling water to McMeekin Station. McMeekin Station, which is located near the Saluda Hydro Plant, was completed and began commercial operation in 1958.

Engineering studies for adding a fifth generating unit at Saluda Hydro began in 1966. The FPC issued an amendment to the Project License, to include Unit No. 5, in December 1967 and construction began in 1968. The fifth unit, which is larger than the original four and can produce 70,000 KW, was put into commercial operation during the summer of 1971, making the total capacity of the Saluda Hydro Plant 216,000 KW. Computers from the dispatching office in Columbia control all five generating units.

In 1984, the FERC (formerly Federal Power Commission) issued a new license for the continued operation of the Saluda Hydroelectric Project (retroactive to the date of the original license expiration, August 1977).

As the Saluda Hydroelectric Project neared its 60^{th} year of operation, a number of modifications were undertaken to insure its continued safe operation. Among these were removal of the surge tanks and improvements to the intake towers and spillway.

In 1988, studies began to determine whether the badly deteriorated surge tanks on Saluda Unit Nos. 1 and 3 could be safely removed. Over the years since the original construction of Saluda Hydro, the electric system in which it operates had changed, alleviating the need for the quick (about 6-second) on-and-off response time which the two surge tanks provided. Following analysis and testing that showed they could be safely removed; the tanks were demolished in late 1991.

In early 1990 man-doors were installed in the five intake towers to prepare them for epoxy grouting of cracks in the concrete walls between elevations 345 and 360 feet PD. The crack grouting was accomplished in the fall of 1990 with Lake Murray at elevation 345 feet PD. Also in the fall of 1990, Spillway Gate Nos. 5 and 6 were painted, gate seals were replaced, and damaged structural members of Gate No. 6 were replaced.

Installation of post-tensioned anchors in the south abutment wall of the spillway was begun in late 1991 and completed in February 1992. This work was done to stop rotation of the wall.

The four original riveted steel spillway gates (Gate Nos. 1 - 4), which were badly deteriorated, were replaced in 1994 with new welded steel gates of similar design. Installation was complete and all four gates tested in December 1994.

As a result of two of the articles in the license issued in 1984, two major modifications of the Dam have been required. In 1989, a sheet pile wall was added to the crest of the Dam at the upstream side of SC Highway 6, to protect the Dam from overtopping in the event of a new, larger PMF.

In 2002, construction activities began on a new dam immediately downstream of the existing Dam, which had been determined to be subject to possible failure during an occurrence of a seismic event of the magnitude of the 1886 Charleston earthquake. The new dam will consist of rock fill sections on the north and south ends, with a roller-compacted concrete section in the center. The existing Dam will remain in place, and during construction, additional material will be added to it to provide a base for two additional lanes of SC Highway 6. The new dam is scheduled to be complete in the spring of 2005.

The Project is subject to the Applicant's lien of the Indenture dated as of January 1, 1945 of South Carolina Power Company (SCE&G, as successor corporation) to Central Hanover Bank and Trust Company (J P Morgan Chase Bank, successor trustee), as Trustee, as amended and supplemented.

E: ENVIRONMENTAL RESOURCES

8.0 GEOLOGY AND SOILS

8.1 Geological Setting of the Saluda Dam

Saluda Dam is located along the Eastern Piedmont Fault zone (Hatcher, 1977) in west central South Carolina. This Fault Zone extends from Western Georgia through Virginia and can be seen as a strong lineament on the Aeromagnetic Map on Figure E-1. The magnetic anomaly illustrated indicates presence of a deep basement structure. At the surface near Saluda Dam, this structure is mapped as the Modoc Shear Zone (MZ), as shown on Figure E-2. The foundation bedrock at Saluda Dam is composed of metamorphosed mid to upper-level amphibolite grade facies rocks. The foundation lies along the Modoc Shear Zone, a 4-5 km wide fault zone characterized by a steep metamorphic gradient, indication of intense plastic strain, and presence of lenticular granitic bodies (Snoke and Frost, 1990). Generally, the Zone extends from the Shull Island Peninsula of Lake Murray to Clark Hill Reservoir on the Savannah River (Secor and Snoke, 1978) and continues to the south until overlapped by Coastal Plain sediments. The fault zone occurs between the southern flank of the Carolina Slate Belt, a zone of greenschist facies metasedimentary and metavolcanic rocks deposited during late Precambrian to Cambrian (630ma), and the northwestern flank of the Kiokee Belt, also known as the Dreher Shoals Terrane (Hibbard et al., 2002). The latter has amphibolite facies metasedimentary and metavolcanic rocks with stratiform masses of plutonic orthogneiss (Secor and Snoke, 1978). The Carolina Slate Belt borders the northeastern terminus of the Dreher Shoals/Kiokee belt outcrop to the east of Lake Murray. The location of the Modoc Zone in relation to the two belts is shown on Figure E-3. Rocks of the Modoc Shear Zone are dominantly a metamorphic assemblage of schist and gneiss in an antiform structure with schist mantling the gneiss on the north, east and south. Many interpret that the protolith of the gneiss was granite and the source material for the schist was sedimentary (Carr, 1978).

Unlike the Carolina Slate Belt, the Modoc Zone experienced late Paleozoic high-grade metamorphism (Secor and Snoke, 1978), and overprinted evidence of earlier Taconic and/or Alleghanian greenschist events.

8.2 Late Paleozoic Orogeny Deformation Patterns

At least two episodes of the late Paleozoic Orogeny affecting the eastern Piedmont are considered to be associated with movement along the Modoc Shear Zone. The deformational events relevant to the area are known as D1 (Delmar Deformation), D2 (Lake Murray Deformation), D3 (Clarks Hill Deformation), and D4 (Irmo Deformation) (Clendenin and Niewendorp, 1997).

Evidence for D1 deformation in the Kiokee Belt has been largely destroyed by later Paleozoic events. D1 in the Slate Belt is synchronous with regional greenschist facies metamorphism and resulted in slaty cleavage and foliation. This deformational event occurred approximately 520-300 (Pre-Alleghanian) million years ago (ma) as described in Secor and Snoke, 1978.

D2 took place during the late Carboniferous to Early Permian, 290-250ma, (Clendenin and Niewendorp, 1997), 315-292ma, (Snoke and Frost, 1990) and is characterized in the Modoc Zone by high- grade amphibolite facies metamorphism with regional folding. D2 is seen only locally in the Carolina Slate Belt. It is thought that rapid cooling after the Lake Murray deformation caused crustal omission across the Modoc Zone boundary, allowing for juxtaposition of the high-grade rocks of the Modoc Zone with the mid-grade rocks of the Carolina Slate Belt.

D3 resulted in vertically dipping dextral shear bands and mostly dextral folds. Shear bands strike approximately N10E-N40E. D3 deformation occurred approximately 255ma (Secor and Snoke, 1978). It was during this time that formation of the steeply plunging (NE) Irmo Antiform was initiated (Secor et al., 1986). The nose of the fold near Irmo marks the eastern terminus of the Modoc Zone/Kiokee Belt. The boundary between this fold and the Carolina Slate Belt is narrow and marked by intense mylonitization, similar to what was mapped in areas within the Dam foundation, and an almandine garnet isograd (Secor and Snoke, 1978). The outcrop mapped in the excavation for the RCC Berm may contain a near complete exposure of the northern limb (NE-dipping) of the Irmo antiform (Hare, et al., 2004). Howard (2004) describes D-3 structures in rocks located less than three miles north of Saluda Dam; however, no D-3 structures were observed in the Berm excavation.

The late Paleozoic D4 deformational event produced early ductile structures (asymmetric dextral folds) and transitioned to late brittle fold-fault features. D4 occurred predominantly under retrograde metamorphic conditions (Clendenin and Niewendorp, 1997). The steeply plunging (NE) Irmo Antiform, while initiated during D3, is predominantly a result of D4 deformation (Secor, et al., 1986). Major lithologies mapped in the foundation of the Saluda Dam are:

- mylonitized quartzo-feldspathic microcline gneiss, or the Lake Murray Gneiss (MGN);
- mylonitized quartz biotite plagioclase schist (QMS);
- hornblende schist (HBS);
- kyanite schist (KS);
- leucocratic schist (LS);
- biotite schist (BS);
- garnetiferous schist (GT);
- quartz biotite plagioclase schist-gneissic phase (GP);
- alkali feldspar granite intrusive (AFG);
- deformed amphibolite (AMP);
- potassium and two-feldspar pegmatites (P);
- mafic (MD) and felsic dikes (FD) (previously mapped as lamprophyre or camptonite dikes by others);
- aplite (A); and
- anatectic granite/plagio-granitic sheets (GS).

The geologic map of these rocks is presented in RIZZO, 2005.

Common ductile deformation structures seen in the bedrock include sheath folds, boudinage, shear bands, tight to isoclinal (D2) folds, riedel shears, and mesoscopic kinematic indicators such as rotated porphyroblasts and sigmoidal fabric. Evidence of late brittle deformation is seen in numerous fractures and faults (striking NNW to NNE) and zones of brecciated material (Hare et al., 2004). Temperatures of 645 to 695^{O}C degrees with pressures between 7.2 to 8.2 kb (30 km depth) are estimated for the garnetiferous pelitic schist in the spillway to the south of the Saluda Dam (Snoke and Frost, 1990).

As described in Hare et al., (2004), exposed rock in the foundation excavation consists of metamorphosed middle to upper amphibolite facies schist and gneiss that record multiple deformational events consistent with those exposed in the Lake Murray spillway. The geology of the spillway, approximately 1000 feet to the south of the Dam, has been studied by a number of researchers over the past 40+ years, most notably by D. T. Secor (Hare, et al., 2004) and is consistent with the geology seen in the Dam foundation.

8.3 Tectonic History of the Saluda Dam Area

During the Devonian through Carboniferous Periods, Africa and Europe were colliding with North America to begin the formation of the Appalachian Mountains. This mountain building event culminated with the Alleghanian Orogeny. Throughout this time, small micro-continents slid past and accreted onto North America. The Modoc Zone records at least part of this movement. Pervasive right lateral deformation is the most common structural feature displayed in the rocks of the Modoc Zone. This deformation is the result of at least tens of kilometers, but more likely several hundreds of kilometers of movement, and is direct evidence that two landmasses were sliding past each other. Modoc Zone rocks exposed at the Dam site were deformed at depths of 28 to 32 kilometers. This depth is far below the depth of possible seismic activity as rock is too ductile for brittle failure to occur.

In the past, rocks beneath the Rockfill and RCC Berms were generally called either schist or gneiss with some younger intrusives; however, detailed mapping has resulted in a more complex description. The ductile deformation of these rocks is tightly constrained by radiometric dating and may have occurred within a 50 million year period during late Pennsylvania and Permian time (Dallmeyer et al., 1986). Rock at numerous locations demonstrates a range of anatectic processes from differential melting, resulting in migmatization of the schistose units, to complete recrystallization. This range of processes produces tabular masses of differential melt derived "plagio-granites".

The rocks in the Dam foundation retain strong evidence of D-2 and D-4 (Lake Murray and Irmo) deformations. D-2 deformation includes migmatization and mylonitization. D-4 deformation is characterized by dextral shear, folding and faulting. These ductile structures are consistent with those reported by Dennis, et. al., and others (1987) for late-Alleghanian deformation in the area.

The mylonitized gneiss, schist and amphibolite units exhibit similar evidence of ductile deformation, which indicates that these rocks were deformed under comparable pressure and temperatures. Specifically, the dominant lithologies (Lake Murray gneiss and quartz biotite plagioclase schist) are S-C mylonites and have similar duplexes, boudinage, and disrupted fold sets. They also exhibit the same kinematic features – generally right lateral shearing. Contacts between the plagio-granites and surrounding gneiss or schist are sharp and exhibit little melting of the surrounding rock; however, the grain size is commonly coarser near the margin and finer in the interior of the plagio-granites.

All of the ductile deformation described in the preceding paragraphs occurred between 315 and 270 to 250 million years ago. From approximately 260 million years to 100 million years ago, the region was subjected to erosion and approximately 20 to 30 kilometers of material was stripped off. The east coast of North America evolved from being an active plate boundary to a passive continental margin. This is an important constraint upon the timing of seismic activity. Plate convergence ceased in this region at approximately 260 million years ago. After this time, seismic activity was predominantly related to basement readjustment. As material is eroded and transported across the land surface, the stress state within the crust changed. These processes do not apply to one particular fault or fracture as much as they apply to all of the faults and fractures in the region.

During the Triassic Period, Africa and Europe decoupled from North America. Intrusives filled some fractures created during this extensional event, forming dikes. Triassic extension and subsequent infilling with igneous materials are processes that continue today at the Mid-Atlantic ridge. Dikes within the rock in the Berm foundation have various compositions ranging from diabasic to felsic and mafic. These dikes have not been age dated, but based on cross cutting relationships and a lack of strong ductile deformation, it is concluded that they are younger than the gneiss and schist rocks that they intrude. Other similar dikes within the Atlantic Coastal plain have been dated at 210 million years to 168 million years (upper Triassic to Jurassic age). Some dikes are offset and are associated with later seismic activity. However, as discussed in the preceding paragraph, the region was no longer a convergent plate boundary and most seismic activity was caused by extension as Africa pulled away from North America.

Following initial rifting, the predominant source of seismic activity was basement readjustment as 20 kilometers of crust was eroded. Large-scale erosion and deposition occurred contemporaneously, which contributed to differential loading and unloading and fracturing of the rock below.

During the Upper Cretaceous period, sediments of the Middendorf Formation were deposited on top of the erosional surface. Outcrops of the Middendorf can be found within a mile southeast of the Dam site. Middendorf and younger sediments are terrestrial (and deltaic) sands and gravels. They are the product of an eroding mountain range to the west. These sediments probably overlaid the area of the Dam site until relatively recently and would have protected the underlying rock from physical erosion. It is unlikely that the Coastal Plain sediments were more than a few hundred meters thick. This is due to the fact that sediments were continually migrating seaward and being deposited off of the continental margin. Lithification and/or diagenesis typically occur below 200°C and 3 kb (300 Mpa), so we can assume that burial conditions did not exceed these values if no cementation or crystal growth has been observed in the Coastal Plain

Sediments. Where exposed, these sediments are comprised of unconsolidated sands and often have a basal gravel layer.

Concretions are common within the Middendorf Formation due to ground water flow; however, grain-to-grain cementation has not been documented. Lack of cementation is evidence of shallow burial of the Coastal Plain Sediments. It also provides an explanation for the deep weathering profile observed in the Berm excavations.

Physical erosion of rocks halted 100 million years ago and chemical weathering processes dominated. This halting of physical erosion prior to 100 million years constrains the time of faulting prior to 100 million years as the faults include mineralization that only forms at depth. We note that seismic activity due to basement readjustment is always possible. We found no evidence of faulted Coastal Plain Sediments, however there is evidence that basement readjustment continued after deposition of Coastal Plain sediments within the Cretaceous.

8.4 Soils

The soils of the Project Area are predominantly Ultisols of the Carolina Slate Belt. These soils are described as the highly weathered soils of humid regions, with very low fertility, and a great deal of leeching. Their low fertility makes Ultisols well-suited for pasture or forest use (Mead and Hunt, 2000). Due to a subsurface accumulation of illuvial clay, these soils are often reddish or yellowish in nature. The Ultisols of this region generally have an *argillic horizon*. Due in part to weathering and climatological influences, ultisols have a low base saturation, usually less than 35 percent in the lower part of the soil profile.

The predominant soil association of the Project area is the Georgeville-Herndon-Almance association. These soils were mainly developed in residuum, from the fine-grained slate rock of the Carolina Slate Belt (USDA, 1962). They generally have moderate permeability with medium to high available water capacity and medium amounts of runoff (USDA, 1976). The predominant texture class is a silt-loam surface soil, with a clayey subsoil (USDA, 1962). These gently sloping upland soils are highly dissected with drainage ways (Mead and Hunt, 2000; USDA, 1962). Wave action on the exposed shorelines of Lake Murray creates soil erosion problems in some areas, and in areas where bedrock is located close to the surface, soil slumping may occur. However, over the past 20 years, shoreline stabilization projects have been put in place to reduce the effects of such erosion on Project Areas (Mead and Hunt, 2000).

The thickness of the soils is dependent upon the rock type with the soils overlying the Gneiss unit being very thick (30 to 90 feet) and the soil over the schist unit being thinner (10 to 30 feet). The thinnest soil zones are on the tops of hills and very thin soils can be found at the abutments of the Saluda Dam.

8.5 Climate

The Project Area experiences a moderate climate year-round with long hot summers and short mild winters. July and August are typically the hottest months, with temperatures reaching above 90 degrees on an average of 49 days per year. Temperatures may reach 100 degrees or more on about two or three days. Summer is typically the wettest season, with 1/3 of the total annual rainfall occurring during this time. This is due to the frequent occurrence of showers and thunderstorms throughout the season. Masses of warm, fairly unstable, maritime tropical air typically persist in the atmosphere during the summer. However, the daily weather during the winter, fall, and spring is greatly influenced by the west to east motion of fronts and air masses (USDA, 1976).

Fall is characteristically the driest season, with warm, comfortable weather. Typically only 19 percent of the total annual rainfall occurs during this time. However, occasionally, tropical storms and hurricanes travel through the area during this season. The earliest killing frost may occur in late October, but occurs more frequently in early November. On about 60 percent of winter days, temperatures reach 32 degrees, and usually fall to 20 degrees or less on about 6 days out of the year (USDA, 1976). Soils occasionally freeze to a depth of 3-5" (USDA, 1962). Significant amounts of snowfall in the Project Area occur infrequently. When they do occur the snow seldom remains longer than 1 day. Winter rainfall accounts for about 22 percent of the annual total (USDA, 1976).

March brings about heavy rains that gradually fade into a dry period that lasts from late April to June. Thunderstorms occur frequently during the spring, adding greatly to a yearly average rainfall of 46 to 48”. The average date of the last freezing temperature in the spring is March 22 (USDA, 1976).

9.0 WATER QUALITY

This section includes a review of the data that has been collected over the last 30 years for the tributaries, Lake Murray, and the tailwaters associated with the Saluda Hydroelectric Project. The tailwaters refer to the section of the Saluda River immediately downstream of the Dam. First, a brief summary of the water quality standards applicable to each water body associated with the Project is necessary, and is given below.

9.1 Applicable Water Quality Standards

All waters entering and within Lake Murray are classified as "freshwaters (FW)." FW waters are considered suitable for primary and secondary contact, recreation, and as a drinking water supply using conventional treatment (based on requirements set forth by SCDHEC). FW waters are also suitable for industrial and agricultural uses, fishing, and the survival and propagation of a balanced indigenous aquatic community of flora and fauna.

SCDHEC water quality standards for FW waters (all waters entering and within Lake Murray) include (SCDHEC - Chapter 61, 2001):

DO	Daily average not less than 5.0 mg/L with a low of 4.0 mg/L
Fecal Coliform	Not to exceed a geometric mean of 200/100mL, based on five consecutive samples during any 30-day period; nor shall more than 10% of the total samples during any 30-day period exceed 400/100mL
pH	Between 6.0 and 8.5
Temperature	Not to vary from levels existing under natural conditions, unless determined that some other temperature shall protect the classified uses
Turbidity	Not to exceed 50 Nephelometric Turbidity Units (NTUs) (25 NTUs for lakes) or 10% above natural conditions, provided existing uses are maintained

In addition to the above standards, numeric nutrient criteria exists for lakes of 40 acres or larger, and are based on an ecoregional approach that takes into account the geographic location of the lake within the state. Lake Murray is situated in the Piedmont and Southeastern Plains ecoregion of the state. Nutrient criteria for this ecoregion include the following:

Total Phosphorous	Shall not exceed 0.06 mg/L
Chlorophyll ***a***	Shall not exceed 40 µg/L
Total Nitrogen	Shall not exceed 1.50 mg/L

The section of the Saluda River downstream of the Saluda Dam was classified as "trout put, grow, and take" (TPGT) in 1990. TPGT waters are considered suitable for supporting the growth of stocked trout populations and a balanced indigenous aquatic community of flora and fauna.

SCDHEC water quality standards for TPGT waters (section of Saluda River downstream of the Saluda Dam) include (SCDHEC - Chapter 61, 2001):

DO	Daily average of not less than 6.0 mg/L
Fecal Coliform	Not to exceed a geometric mean of 200/100mL, based on five consecutive samples during any 30-day period; nor shall more than 10% of the total samples during any 30-day period exceed 400/100mL
pH	Between 6.0 and 8.0
Temperature	Not to vary from levels existing under natural conditions, unless determined that some other temperature shall protect the classified uses
Turbidity	Not to exceed 10 Nethelometric Turbidity Units (NTUs) or 10% above natural conditions, provided existing uses are maintained

Up until 2002, a site specific DO standard for the lower Saluda River (LSR) existed which was a daily average of 5.0 mg/l with no instantaneous minima. In that same year, the SCDHEC proposed changes to the existing DO site-specific standard for the LSR downstream of the Saluda Dam/Lake Murray. SCE&G working cooperatively with the SCDHEC, South Carolina Department of Natural Resources (SCDNR) and the Environmental Protection Agency (EPA) developed a study plan that would:

1. Describe the methodology to be used to identify a scientifically-based alternate DO standard for the LSR, and;
2. Develop and present a proposed numerical site-specific standard to the SCDHEC and SCDNR.

The study plan proposed distinct elements that are all integrated and critical in determining a site specific DO standard for the LSR. The studies in the plan address the designated use which is trout put, grow, and take. Those elements include:

1. In-situ trout growth study.
2. Turbine venting modeling.
3. Tailwater modeling.
4. Bio-energetics modeling.

Upon completion of the identified studies, a detailed report was prepared which documents results of scientific investigations necessary to formulate that proposed site-specific standard. These investigations included a trout growth study conducted during 2002-2003 and extensive modeling related to tailwater water quality, fish growth, and turbine venting effectiveness.

The fish growth study on the LSR indicated that an excellent trout fishery exists on the river. This fishery exists even though DO concentrations on occasion fall below 2 mg/L. The fish growth model showed that the good trout growth is due in part to the relatively high average DO concentrations that have occurred in the river due to the aeration system (implemented by SCE&G in 1999), in conjunction with the reduced incidence of high flows due to recent drought years, and a favorable temperature regime. It is estimated that the fishery would do nearly as well during normal hydrologic years using the current aeration system; however, in wet years or in years when the *pool* level of Lake Murray is drawn down for special purposes in September or October, the difference in fish growth might be measurable (i.e., a difference greater than 1/2 ounce or 1/16 inch was considered measurable for fish weighing over 2 pounds and having a length of about 18 inches).

In order to estimate the range of DO conditions the fishery might be exposed to in the future, a turbine aeration model was developed to predict the effects of using various aeration alternatives. This model was then used to predict DO conditions in the river for the years 1990 (wet), 1992 (normal), 1996 (normal with a special drawdown of Lake Murray), and 1999 (dry). The results of the turbine aeration model were summarized as DO metrics (e.g., minimum daily DO, average daily DO, 30-day average DO, etc) that represented potential measures of DO that could be considered for setting DO standards.

A tailwater hydrodynamic water quality model was calibrated using actual onsite water quality data. A fish bioenergetics model was calibrated using tailwater model results and results of the growth study. The fish bioenergetics model was then used to estimate trout growth for various aeration scenarios for each of the years. The results showed that growth was best correlated to the moving 30-day average DO. This finding is consistent with the recommendations in the EPA criteria document for DO.

A central concern was found to be the minimum DO level that occurs with the current aeration system. A minimum DO of 3 mg/L is considered to be protective for trout survival, and this same level likely would be sufficient for other aquatic life that serves as food supply for the fishery. However, a minimum of 4 mg/L has been set by SCDHEC for application to all waters of the State, and SCDHEC made it clear that nothing less than that standard would be accepted by them. SCE&G had little choice but to propose 4 mg/L as the minimum DO for the site-specific standard.

The results of the scientific studies, in addition to SCDHEC's admonition regarding an acceptable minimum, supported the following site-specific standard for the lower Saluda River:

- Instantaneous DO 4 mg/L minimum
- Daily average DO 5 mg/L minimum
- 30 day average DO 5.5 mg/L minimum

These levels of DO were shown to be protective of the fishery and would achieve trout growth objectives equivalent to those that would result from application of the DO standard previously proposed by SCDHEC.

After going through extensive state and federal regulatory review and legislative processes the above site specific DO standard was adopted for the LSR in 2004.

9.2 Lake Murray Water Quality Conditions

9.2.1 Tributaries to Lake Murray

When considering which water quality parameters are important for Lake Murray, it is essential to consider those that may impact the designated uses, such as recreation, fishing, and drinking water supply. The most important parameters to consider include pathogens (*i.e.* fecal and total coliform), temperature, DO, nutrients (*e.g.*, phosphorous), chlorophyll ***a***, and water clarity. Major factors that may affect these water quality parameters are significant point source discharges (*e.g.*, wastewater treatment plant effluents), septic systems around the lake, and other miscellaneous activities within the watershed. Therefore, it is important to consider water quality not only in the lake/reservoir, but also in the tributaries or inflows to the lake, and in the tailwaters or section of Saluda River downstream of the Saluda Dam.

Lake Murray has several tributaries that contribute to the large volume of water that is stored in the reservoir. Some of the major tributaries are the Saluda River, Little Saluda River, Bush River, Little River, Clouds Creek, Rocky Creek, and Ninety-Six Creek. The Saluda River is the primary source of water to the lake, contributing approximately 68% of the mean *streamflow* into Lake Murray. The other six tributaries make up the remaining 32% of the inflow. While the lake itself covers approximately 75 square miles, the drainage area for Lake Murray encompasses 2420 square miles.

As stated above, Saluda River is the main flow entering Lake Murray. Nearly 55 miles upstream of the Saluda Dam on the Saluda River is the Buzzard's Roost Dam. Water from behind this dam (Lake Greenwood) is the primary source of water that enters Lake Murray. In the late 1980's, the level of nutrients and organic matter released from the Buzzards Roost Dam (Buzzards Roost) was reduced.

With the exception of the Dreher Island State Park, wastewater discharge, there are no direct point source discharges into Lake Murray. Table E-1 lists the major wastewater discharges and the number of minor discharges in each of the tributary watersheds of Lake Murray, downstream of Buzzards Roost on the upper Saluda River. Run-off and other non-point sources are considered significant in such a large watershed, with residential and commercial development at such high levels. SCDHEC has monitored water quality in both Lake Murray and its tributaries on a monthly basis since 1973. The primary water quality parameters of concern in the tributaries include nutrients, with respect to their loading into Lake Murray, specifically total phosphorous, 5-day biochemical oxygen demand (BOD_5), a measure of the organic pollution in a surface water, total kjeldahl nitrogen (TKN), a measure of the organic nitrogen and ammonia nitrogen, nitrate+nitrite, chlorophyll ***a*** (popular measure of biological productivity in water bodies), and fecal coliform. Phosphorous is normally the limiting nutrient in freshwater systems. Sources of phosphorous include both point (*e.g.*, wastewater treatment plants) and non-point sources (*e.g.*, agricultural run-off and septic system leachate).

According to a 1998 report from SCDHEC, the SCDNR led an intensive watershed study on the Bush River and Camping Creek to address non-point sources. This is primarily an agricultural watershed that drains into Lake Murray. The study began in 1990 and continued through August of 1998. The study funded the implementation of Best Management Practices (BMPs) for farmers in the watershed, related to row-cropping and confined animal operations. BMPs involved manure nutrient testing, portable animal waste lagoon pump-out and spray irrigation equipment available for rent, as well as effective pesticide management.

Phosphorous

Four of the tributaries to Lake Murray, including Ninety-Six Creek, Bush River, Little Saluda River, and Clouds Creek, contribute approximately 73 percent of the total phosphorous to Lake Murray; while their stream flows contribute only 20 percent of the flow into the lake (see Table E-3). The total phosphorous concentrations in these smaller tributaries are likely caused by point sources (*e.g.*, wastewater treatment plants) and development in the watershed. If the total phosphorous concentrations were reduced in these streams, the upper lake area would have less algal growth and improved water clarity. Because of the reduced algae levels, the DO levels in Lake Murray and the releases from the Saluda Project would increase. In order to reduce nutrient loading into the lake, specifically phosphorous, the SCDHEC recommended implementing watershed management practices with an emphasis on the Rocky Creek and Bush River sections of Lake Murray.

Data from just downstream of Buzzard's Roost Dam on the Saluda River indicate that total phosphorous levels have steadily decreased since 1985, due to the implementation of tertiary treatment at the Greenville wastewater treatment facility (point source discharge to the Saluda River). The current mean concentration of total phosphorous at this station is roughly 0.02 mg/L. Total phosphorous concentrations seem to increase drastically from the station just below Greenwood Dam, to the station on Saluda River located at SC 39 near Chappells. Approximately 3.5 miles downstream of the Greenwood Dam at the Chappells station, concentrations were averaging 0.06 mg/L. This may promote a significant amount of organic loading to Lake Murray due to the relationship between total phosphorous and algal growth. Ninety-Six Creek, which empties into the Saluda River downstream of Buzzards Roost, has a mean total phosphorous concentration of approximately 0.7 to 1.0 mg/L and this water body is most likely responsible for the increase in total phosphorous levels on the Saluda River from the station downstream of Buzzards Roost to the station near Chappells.

Bush River, near its inflow point to Lake Murray, contains high concentrations of total phosphorous, about 0.8 mg/L. The Bush River had the highest total phosphorous concentration in 9 of the 12 months sampled during the comprehensive assessment conducted in 1974 to 1975. The Little Saluda River near the inflow to Lake Murray has been monitored by SCDHEC since 1974. The SCDHEC data show a significant decreasing trend of total phosphorous concentrations since 1974, with a major decline in 1989. These major declines observed in 1989 correspond to improvements of the Western Carolina Regional Authorities treatment plant serving the city of Greenville, SC. The current total phosphorous levels in the Little Saluda River, near the mouth, are 0.2 mg/L. Clouds Creek, which feeds into the Little Saluda River, shows the exact opposite trend of the Little Saluda, with increasing concentrations since 1979. Near the Clouds Creek mouth, average total phosphorous concentrations are about 0.3 mg/L.

BOD_5, TKN, Nitrate+Nitrite, Chlorophyll a, and Fecal Coliform

With respect to the other water quality parameters, information is provided for the Saluda River, specifically from the monitoring station located just downstream of Buzzard's Roost and is considered representative of the primary input of each to Lake Murray. The BOD_5 levels in the Saluda River have decreased from a mean of 2.5 mg/L from 1969 to 1986, to a mean of 1.3 mg/L from 1987 to 1998. TKN levels followed a similar pattern to total phosphorous, due to the TKN associated with algal growths. Nitrate+Nitrite concentrations appear to have decreased since 1985. It is also important to note that each year the nitrate+nitrite concentrations decrease to near zero during the summer and fall months, which may limit the type of algal growth that may occur in the upper end of the lake to the troublesome blue-green algae species. The upper lake tributaries were found to have the highest chlorophyll ***a*** concentrations, such as the Saluda River, Little Saluda River, Bush River, and Clouds Creek.

9.2.2 Lake Murray

Lake Murray covers approximately 78 square miles and is approximately 41 miles long, with a maximum width of 14 miles, and a maximum depth of 180 feet (mean depth = 46 feet). Because of its size and the hydrology of the system, Lake Murray has a long retention time of approximately 417 days. It is this characteristic that causes the lake to thermally stratify each year, resulting in water quality conditions that have been extensively studied and monitored.

9.2.2.1 Past Studies

A significant effort has been placed on collecting water quality data in Lake Murray for the past 60 years. Different agencies, including the South Carolina Pollution Control Authority (SCPCA), SCDHEC and U.S. Geological Survey (USGS), have made various water quality measurements for the reservoir during the 1950s, 1960s, and early 1970s. SCDHEC has continued to monitor water quality in both the lake and its tributaries on a monthly basis since 1973. In 1974, the EPA included Lake Murray in the National *Eutrophication* Survey, which collected data from specific lakes and reservoirs all over the U.S. Most recently, SCE&G coordinated with USGS to collect data on Lake Murray from 1990 to 1996, using 13 water quality monitoring stations (12 are located on Lake Murray and one is downstream from the Saluda Dam). SCE&G has continued the water quality monitoring effort since 1996, collecting monthly field samples at all 13 locations and chemical samples twice a year at seven of the stations.

Comprehensive Assessment of Lake Murray (1974 – 1975)

In preparation of relicensing for the current FERC license, a comprehensive assessment of Lake Murray was conducted from September 1974 through August 1975. Using a total of 33 different stations in and around the lake, 24 different physical and chemical parameters were sampled and tested during the one-year period. The comprehensive study determined that:

1. Total alkalinity levels in Lake Murray were low;
2. pH levels were rarely outside of the Class A limits for waters of 6.0 to 8.0 (SCPCA), with pH levels ranging from 5.3 to 9.1 during the 12-month study period;
3. The highest chlorophyll ***a*** levels were found in the upper lake tributary stations;
4. Total phosphorous concentrations were highest in the upper lake, near the inflows/tributaries, and lowest near the Dam, with a mean concentration for the lake of 0.10 mg/L;
5. Fecal and total coliform levels were occasionally high in the Lake, exceeding the standards at some of the upper lake stations on occasion, specifically after periods of heavy run-off in the watershed (storm

events);

6. 12 of the 24 trophic status determinations classified the lake to be mesotrophic and 11 of the 24 determinations classified the lake as eutrophic. The comprehensive assessment report stated that because of the potential for increased shoreline development and additional nutrient inputs from the watershed and septic systems, Lake Murray will show signs of greater eutrophication.

Comprehensive Water Quality Report (1974-1998)

SCE&G has worked with SCDHEC and USGS for a number of years monitoring the water quality in Lake Murray. These water quality monitoring efforts serve as a continuation of work that was first begun by the SCPCA, SCDHEC and the USGS in the mid 1940's. The data collected from 1974 to 1998 was recently compiled into a database that was prepared to evaluate historical trends in water quality of Lake Murray and its drainage area up to Lake Greenwood. Water quality information was compiled using a specialized computer software program and then put together into a comprehensive water quality report. This report and respective database serve as a pertinent source of information about present and past water quality trends. Since Lake Murray serves as an important economic and recreational resource, the water quality parameters that have the highest effect on these economic and recreational activities are considered the most important. Various plots and charts were generated in order to aid in the assessment of the results from these studies. Summaries of various components of this report are presented below with the report presented as Appendix E.

SCDHEC Saluda River Basin Water Quality Reports

The SCDHEC has published two reports related to the water quality in the Saluda River basin, including:

1. Watershed Water Quality Management Strategy - Saluda-Edisto Basin, Technical Report No. 003-95, June 1995, Bureau of Water Pollution Control
2. Watershed Water Quality Assessment - Saluda River Basin, Technical Report No. 005-98, December 1998, Bureau of Water

In these reports, seasonal trends and changes in water quality over the entire length of Lake Murray were evaluated. Generally, differences were seen between upper and lower stations in the lake. Concentrations of nitrates, phosphates, fecal coliforms, and biochemical oxygen demand (BOD) were typically higher at the upstream lake stations compared to the lower stations (closer to the Dam). This condition could be attributed to the faster flowing waters in the upper lake (convergence of several of the main tributaries into the *headwater*s of the lake) in contrast to the slower moving waters in the lower part of the lake. In addition, sedimentation was most prominent in the upper part of the lake, specifically between Rocky Creek and Blacks Bridge, which are located 19 to 25 miles upstream of the Saluda Dam. This seven-mile stretch of the lake primarily contained a high percentage of small particle sediments compared to other sections of the lake, with the exception of the lower part of the Little Saluda embayment (near the Highway 391 bridge).

Both SCDHEC reports are similar; however, the 1998 report indicated that a greater number of locations in Lake Murray are 'not supporting' and 'partially supporting' for their designated uses, specifically aquatic life and recreation. Table E-2 lists the number of locations in the lake, embayments, inflows, and tailwater and how water uses were supported based on the SCDHEC reports. Within the Lake Murray watershed, 18 locations were labeled as fully supporting their designated uses in 1995 compared to only 9 locations in 1998. Based on the 1998 report, SCDHEC found 7 of the 12 stations on Lake Murray to be either 'not supporting' or 'partially-supporting' their respective water uses. Metals were listed as the cause for 6 of the 7 stations not meeting their designated uses, while nutrients were listed as the cause for 2 of the 7 stations (one station had both metals and nutrients listed as the cause).

9.2.2.2 Metals

Copper concentrations were found to exceed the acute water quality criteria for aquatic life at 5 stations on the lake. Two stations listed copper as the cause for the 'partially supporting' status for aquatic life. However, SCDHEC noted that copper concentrations are high in many locations throughout the state, but do not seem to cause toxic conditions in those waters. Increased metals concentrations in the lake seem to be related to the elevated concentrations in the inflows, which may be originating from the natural geology of the watershed.

9.2.2.3 Pathogens

Fecal coliform was identified as the cause for impacting recreation at 6 locations in 1995 and 8 locations in 1998 in the inflows/tributaries to the lake and in the tailwater of Saluda Dam. These conditions were all attributed to point and/or non-point sources in the watershed. However, all locations in Lake Murray were found to fully support the recreational use designation based on fecal coliform data.

Fecal coliform is listed as the cause for Total Maximum Daily Loads (TMDL) at three sites in the Lake Murray watershed, including two sites on the Bush River and one site on Rawls Creek, which discharges into the Saluda River downstream of the Dam. Another eight sites are designated as potential TMDL sites, with six of the site designations caused by fecal coliform. There are a total of 51 TMDL-designated sites in the watershed listed on the state 303(d) list. Fecal coliform is the most significant water quality indicator and is responsible for TMDL designation for 21 of the sites. Most of these 21 sites indicate a significant potential concern to recreation where the streams enter Lake Murray (i.e. the headwaters) or the Saluda River. Lake recreational uses may potentially be impacted at the inflow areas from these sites following significant rainfall/runoff events.

9.2.2.4 Phosphorous

Elevated phosphorous levels are the cause for listing two sites on the state 303(d) list, including the Bush River arm and the Rocky Creek area of Lake Murray. However, neither site is listed as a potential TMDL site despite the high priority listing. Total phosphorous concentrations in Lake Murray tend to be highest in the upstream section of the lake, near the main tributaries/inflows. The downstream part of the lake, near the Dam (*forebay*) has historically had the lowest concentrations of total phosphorous. Most of the phosphorous is either utilized by the plants and algae in the lake or settles out onto the bottom of the lake. In general though, total phosphorous concentrations have shown a decreasing trend in the lake, since the mid-1980s. By way of example, Figure E-5 shows total phosphorous concentrations in the area of the lake by the Dam (forebay) from 1972 to 1998.

9.2.2.5 Trophic Status

Eutrophication refers to the level of nutrients in a lake and the resulting level of productivity by the organisms (*e.g.*, plants and *phytoplankton*) that utilize the nutrients, such as phosphorous and nitrogen. A lake that has low concentrations of nutrients and low levels of productivity (*i.e.* limited algal blooms and plant growth) is referred to as oligotrophic. On the other hand, a lake that is high in nutrients and has levels of productivity (significant algal blooms and plant growth, resulting in poor water clarity) is classified as eutrophic. The mesotrophic classification falls in the middle of oligotrophic and eutrophic, characterizing a lake containing moderate levels of nutrients and moderate productivity.

In the SCDHEC 1995 and 1998 reports, a multiple parameter index was used to assess eutrophication in Lake Murray. The multiple parameter index is based on measurements of water clarity, total phosphorous, total inorganic nitrogen, chlorophyll ***a***, and DO. Based on a baseline assessment in 1980-1981, conditions in the upper lake had improved, with the exception of Rocky Creek and the Bush River section of the lake, which were stated as some of the most eutrophic sites on large lakes in South Carolina. The 1998 report indicated that two upstream locations on the Saluda River arm and the Little Saluda River arm had improved to intermediate trophic status (*i.e.* mesotrophic). The 1998 report also indicated that all locations between Rocky Creek and the Saluda Dam were some of the least eutrophic sites in the state, with decreased levels of total phosphorous and decreasing trends of nitrogen and BOD.

9.2.2.6 <u>DO and Temperature – Lake Murray</u>

Water quality profiles, including DO and temperature have been performed in Lake Murray throughout the 1990s. As an example, Figures E-6 through E-11 illustrate longitudinal contour plots of DO in Lake Murray during the months from May to October of 1998. The plots use DO profiles from seven different locations in the lake, which are plotted at their location relative to the Dam (x-axis) versus elevation or meters above sea-level.

Lake Murray thermally stratifies each year, forming three different layers in the water column during the months of May through October. The water column stratifies because of the change in temperature and density of each layer. The epilimnion is the upper layer of the lake, which is the only one to remain in contact with the surface and is characterized by high DO and temperature levels. The hypolimnion is the bottom layer of the lake that remains isolated from the atmosphere during the stratification period. The hypolimnion contains the coolest waters (down to 11˚C in 1996) and some of the lowest DO waters, even having anoxic conditions (no DO) during September and October. The metalimnion is the middle layer of the water column, which contains the controlling region known as the thermocline. The thermocline is referred to as the waters having the greatest temperature change over depth. This layer is basically the transition layer between the epilimnion and hypolimnion. In Lake Murray, this layer can have the lowest DO levels, depending on flows entering the lake.

The magnitude of flows or hydrology for each year controls the level of nutrients, algae, and other organic matter that enter the lake. The nutrients, algae, and other organic matter contribute significantly to DO demand, which relates to the amount of oxygen required to decompose the organic matter that is ultimately produced by the nutrients and algae. In addition, sediment oxygen demand can contribute to the DO demand in the lake bottom waters. Sediment oxygen demand can result from several things, one of which is from the deposition of organic matter on the lake bottom.

The water column in the lake becomes thermally stratified during the summer months and the bottom waters do not come into contact with the surface to replenish DO levels, thus eventually becoming void of oxygen or anoxic, depending on annual flows. In a low flow year, for example, the magnitude of nutrient input to the lake would be lower, resulting in a limited DO demand and higher DO levels in the bottom waters of the lake, particularly downstream towards the Dam. Higher flow years would result in an increased loading of nutrients, algae, and organic matter to the lake that would create a high DO demand and lower DO conditions in the bottom of the lake, specifically during the summer months. These effects were most recently noticed in 2003. DO levels at the upstream portion of the lake, where most of the inflows enter, are less dependent on flow conditions. Flow conditions in the watershed primarily control the distribution of the water quality at the upstream portion throughout the lake.

Referencing Figures E-6 through E-11, it is readily apparent that DO levels start to decrease in the upper part of the lake in May and June of each year. DO levels are less than 2.0 mg/L in the metalimnion and near the bottom in the upper part of the lake by June of each year. However, DO levels are often lower at different points in the water column compared to near the bottom, which indicates a high DO demand in the water (*e.g.*, nutrients, algae). As previously mentioned, the low DO conditions in the upper lake are caused by the decomposition of algae and other organic matter entering the lake as well as the effects of sediment oxygen demand in the lake bottom. Depending on flow conditions, this poor water quality may cause the same low DO conditions in the metalimnion and hypolimnion throughout the lake, down to the Dam.

In July, DO levels become much more dependent on the annual hydrology, particularly in the area of the lake by the Dam, referred to as the Dam forebay. In low flow years, the DO was typically greater than 5.0 mg/L at all depths in the Dam forebay, while normal flow years are marked by reduced DO levels, normally less than 5.0 mg/L at most depths in the forebay. The pattern for DO levels in the Dam forebay during the month of August is similar to July. In low flow years, the DO is normally greater than 3.0 mg/L at all depths, while normal flow years have DO levels less than 3.0 mg/L at nearly all depths of the Dam forebay. This pattern of DO behavior, based on flow conditions, for the months of July and August, indicates that water displacement within the reservoir affects the DO distribution in the reservoir.

In September, the DO in the forebay area is typically 0.5 mg/L or less at most depths during normal flow years. In low flow years, the DO is usually greater than 1.5 mg/L at all depths in the forebay. Finally, in October, the DO in the hypolimnion of the lake is normally less than 0.5 mg/L at all locations.

9.2.2.7 Current Studies

As previously stated, in 2002 SCDHEC issued a formal notice that the DO standard for the LSR would be revised. Upon review of the comprehensive water quality report for the Saluda Hydroelectric Project relicensing, it was shown that phosphorous trend data indicates potential problems with nutrient loading into Lake Murray. In order to comply with a new DO standard, SCE&G sought to evaluate the potential effects of what a nutrient reduction would have on the DO levels in Lake Murray and the discharges from Saluda Hydro. SCE&G proposed a battery of industry accepted models and studies, including a two-dimensional water quality model, CE-QUAL-W2. The CE-QUAL-W2 model has been shown to be quite accurate in predicting water quality conditions. It is an extremely useful tool when analyzing the effects that inflow water quality has on the receiving lake water quality, as well as the discharges from the lake. After an extensive review of the water quality data gathered for Lake Murray and its inflows by SCDHEC, USGS and SCE&G, a CE-QUAL-W2 model was developed for Lake Murray (Ruane, 2004).

Data was combined and used in the calibration of the model for the year 1996. This calibration year was chosen based upon available data and hydrologic conditions. Moreover, this year does not reflect the effects of the aeration system implemented by SCE&G in 1998, which would hinder the comparison of Lake Murray inflow and outflow data.

Temperature, DO, algal levels, and phosphorus were the primary water quality constituents studied using this modeling technique. The model was tested using statistical and graphical analysis, which subsequently showed that it was well calibrated for this year and conditions. The model was then tested for the years 1992 and 1997. Even though the model was not calibrated for these years, the results were still good. Phosphorus data achieved from conducting the CE-QUAL-W2 model provided more precise and detailed results than did the data from the previous phosphorus studies (Ruane, 2004).

When predicting water quality conditions in Lake Murray using the CE-QUAL-W2 model, results were achieved assuming that the phosphorus concentrations occurring in the inflows to Lake Murray contained the maximum allowable concentrations that were still in compliance with SCDHEC standards. When reducing the phosphorus loads to these maximum allowable levels, the model showed substantial improvements in water quality conditions on Lake Murray. The DO levels in the turbine discharges from Saluda Hydro were also shown to increase to such an extent that alternative aeration of the water may not be needed for the DO in the turbine discharges consistently to meet state standards for the lower Saluda River. Furthermore, it is inferred that as a result of phosphorus reductions, striped bass habitat would be greatly improved, as well as the pH levels on the LSR (Ruane, 2004).

Results from the Lake Murray study were compared to results achieved by modeling projects similar to Saluda Hydro. Data derived from the CE-QUAL-W2 model predicted that the most likely cause for water quality problems in Lake Murray stem from the point source discharges of phosphorus into Ninety-Six Creek and the Bush River; the discharge of phosphorus at these locations is very high. The Saluda River is responsible for 68% of the mean *streamflow* into Lake Murray; however, it only contributes 15% of the total phosphorus load. Moreover, the other smaller tributaries together only make up 32% of the mean streamflow into Lake Murray, however, they contribute 85% of the total phosphorus load (Table E-3). Another indication that point source pollution is a major contributor to water quality issues in Lake Murray is that phosphorus discharges from Lake Greenwood are relatively low due to tertiary waste treatment upstream. In turn, model results estimated that 60% of the phosphorus input into Lake Murray occurs as a result of discharge from point sources. Additionally, if sources of point pollution into Lake Murray were in compliance with SCDHEC standards, the phosphorus discharges into Lake Murray would be reduced by about 66% (Ruane, 2004).

Reducing phosphorus levels in point source discharges into Lake Murray may be a cost effective and practical way of improving the overall water quality of the lake. A review of projects similar to Saluda Hydro indicates that a reduction in lake phosphorus levels contributed to an increase in the DO levels. The CE-QUAL-W2 model accurately indicates that most of the water quality problems could be solved by implementing point source phosphorus controls. The final report on the CE-QUAL-W2 model is currently being finalized and should be concluded in the up-coming months (Ruane, 2004).

9.2.3 Saluda Dam Tailwater

SCE&G began monitoring DO and temperature in the Saluda Project turbine releases in 1989 and continues the effort to the present day. These monitoring efforts have determined that nutrient loading from the tributaries and the thermal stratification of Lake Murray from May to November of each year result in the depletion of DO levels in the metalimnion and hypolimnion layers of the lake. These anoxic conditions during the summer months in the lake can translate into low DO concentrations in the water released through the Project turbines. The anoxic conditions and low alkalinity levels in the bottom waters of the lake can also result in moderately low pH conditions ($pH < 7.0$), because of the lack of oxygen and the production of carbon dioxide from the various decomposition processes.

9.2.3.1 Past Studies – SCDHEC Reports

The 1995 and 1998 SCDHEC reports indicated that in the Saluda Dam tailwater, the section of the Saluda River immediately below the Project, ratings were 'not supporting' and 'partially supporting' for aquatic life uses at the first station downstream of the Dam. The listed cause for this impairment was the low DO levels measured in the Project releases from the turbines. Conditions at the downstream station were reported to have improved (1998 report) based on a lower percentage of the DO data that was less than the standards. Lower pH levels were also reported as a cause for the 'not supporting' conditions for aquatic life use in the tailwater.

Another water quality concern indicated by SCDHEC is the pH levels in the Saluda Project releases. The low pH associated with the reservoir releases is caused by the decomposition of organic matter in the lake, which commonly occurs in lake waters with low alkalinity conditions, such as Lake Murray. The pH excursions outside of the state standards (6.0 to 8.0) appear limited in magnitude and duration.

9.2.3.2 DO Enhancement of the Project Turbine Releases

In an effort to increase the DO levels in the releases from the Project turbines, SCE&G installed turbine vents and modified operations starting in 1999. Figure E-12 illustrates how turbine venting in conjunction with modified operational patterns has improved the project release DO levels since 1999. Turbine venting, in conjunction with modified operational patterns, has improved the Project release DO levels since 1999. The median DO concentration of the Project release has increased from 2.7 mg/L (before implementing turbine venting) to 7.2 mg/L (with turbine venting - 1999 to present). Ultimately, this has resulted in less frequent occurrences of DO levels in the release below 5.0 mg/L, from 88% to about 12% of the time. The percentage of time the DO levels from the Project releases were below 3.0 mg/L has decreased from 55% to 3% since turbine venting and modified operations were implemented in 1999.

Daily average DO levels in the Project releases from 1999-2000 were periodically below 4.0 mg/L, particularly on days when flows through the turbines were high. The amount of water that passes through the turbines controls the amount of air drawn into the turbine system. A lower flow or gate setting will allow more air to be aspirated into the turbine system resulting in a greater degree of DO increase in the Project release. Once the planned hub baffles are installed on units 1 - 4, it is believed the daily average DO levels will improve, even under high turbine flows.

In 2004 SCE&G implemented operational protocols that further assist in maintaining enhanced DO levels in the LSR. These protocols were based on a detailed turbine venting model. To ensure continuing enhancement of DO levels, this model is reviewed on an annual basis.

9.2.3.3 Water Uses

Lake Murray and the LSR provide an exceptional source of high quality waters that can be used for both consumptive and non-consumptive uses. The reservoir serves as a source of drinking water and water for industrial uses for the cities of Columbia, West Columbia, Newberry and Lexington, and the surrounding areas. The Saluda Hydroelectric Project functions as a reserve capacity plant, meaning it runs on an “as needed basis.” The McMeekin Station consumptively uses an insignificant amount of water, normally only about 35gpm and the event of a spillway discharge is very infrequent. There is water loss due to the natural occurrences of evaporation and ground water uptake. The agricultural developments around Lake Murray generally meet their water demands through the uses of farm ponds. However, there is a small amount of water that is taken up by these operations. There are also small amounts of water that are taken up from Lake Murray by individual landowners for domestic uses. These water withdrawals are permitted by SCE&G's land management department. Honeywell is the sole industrial user of water from the LSR for non–consumptive purposes.

The reservoir and the LSR are used extensively by the public for recreational activities. Fishing alone accounts for much of the recreational water use of the area. These uses are discussed in further detail in the recreation section of this document.

Table E-1: Major Wastewater Dischargers and Number of Minor Dischargers in the Watersheds of Lake Murray (downstream from Greenwood Dam)

	MILLION GALLONS/DAY	NUMBER OF MINOR DISCHARGES
Ninety-Six Creek Watershed		12
City of Greenwood/Wilson Creek Plant	12.0	
Bush River Watershed		2
City of Newberry/Bush River Plant	3.22	
Laurens County WRC/Clinton	2.75	
Little River Watershed		10
City of Laurens	4.5	
Little Saluda River Watershed		3
Lake Murray Watershed		3

Table E-2: Number of Locations and How Water Uses Were Supported Based on the 1995 and 1998 SCDHEC Reports

	1995		1998	
	Aquatic Life	**Recreation**	**Aquatic Life**	**Recreation**
LAKE MURRAY				
Fully supporting	5	6	1	6
partially supporting	1, M*		2, M*	
Not supporting			3, M*	
EMBAYMENTS				
Fully supporting	6	6	4	6
partially supporting				
Not supporting			2, M*, N**	
SELECTED INFLOWS				
Fully supporting	6	3	4	3
partially supporting	3, DO	2, FC***	2, M*, DO	2, FC***
Not supporting		4, FC***	3, M*	4, FC***
TAILWATER				
Fully supporting	1	2		1
partially supporting		1, FC***	1, DO	2, FC***
Not supporting	2, DO		2, DO, pH, M*	
SUMMARY OF USES & CAUSES				
Fully supporting	18	17	9	16
partially supporting	4	3	5	4
Not supporting	2	4	10	4
Metals	1		11	
Fecal Coliform		7		8
DO	5		3	
Nutrients			1	

* M indicates metals are the cause;

** N indicates nutrients are the cause;

*** FC indicates fecal coliform were the cause

Table E-3: Percent Contributions to the Upper Regions of Lake Murray of Total Phosphorus Loadings and Mean Stream Flows Found Conducting CE-QUAL-W2 Model (Ruane, 2004)

Lake Murray Tributary	Mean Streamflow, (percent)	Phosphorus Load, (percent)	Ratio of Phosphorus Load to Flow (percent)
Bush River	4	18	4.5
Little Saluda River	7	12	1.7
Clouds and West Creeks	4	9	2.2
Ninety-Six Creek	5	34	6.8
Little River	7	6	0.9
Saluda River	68	15	0.2
All Other Flows	5	6	1.2

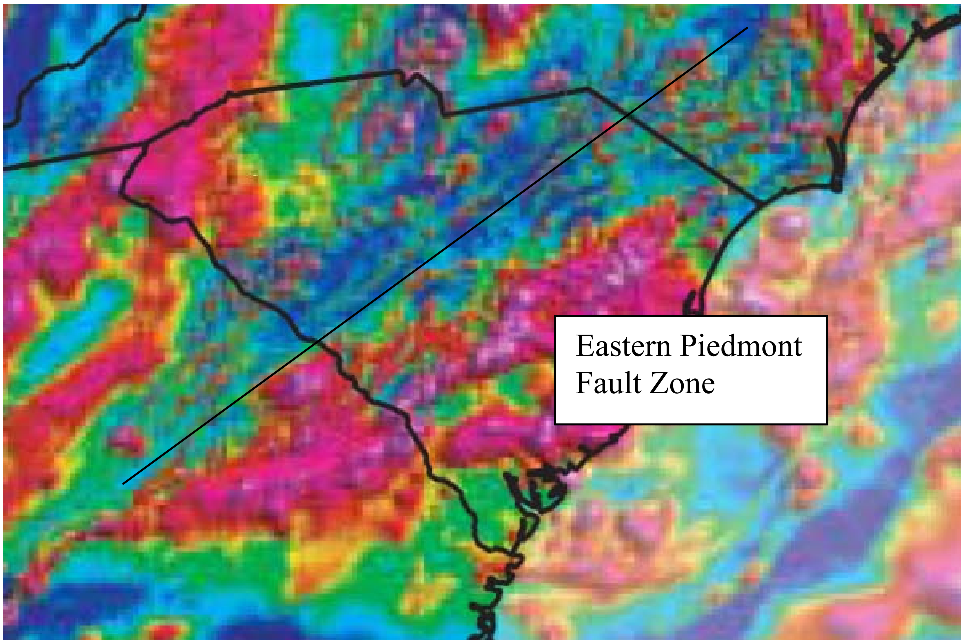


Figure E-1: Aeromagnetic Map of South Carolina

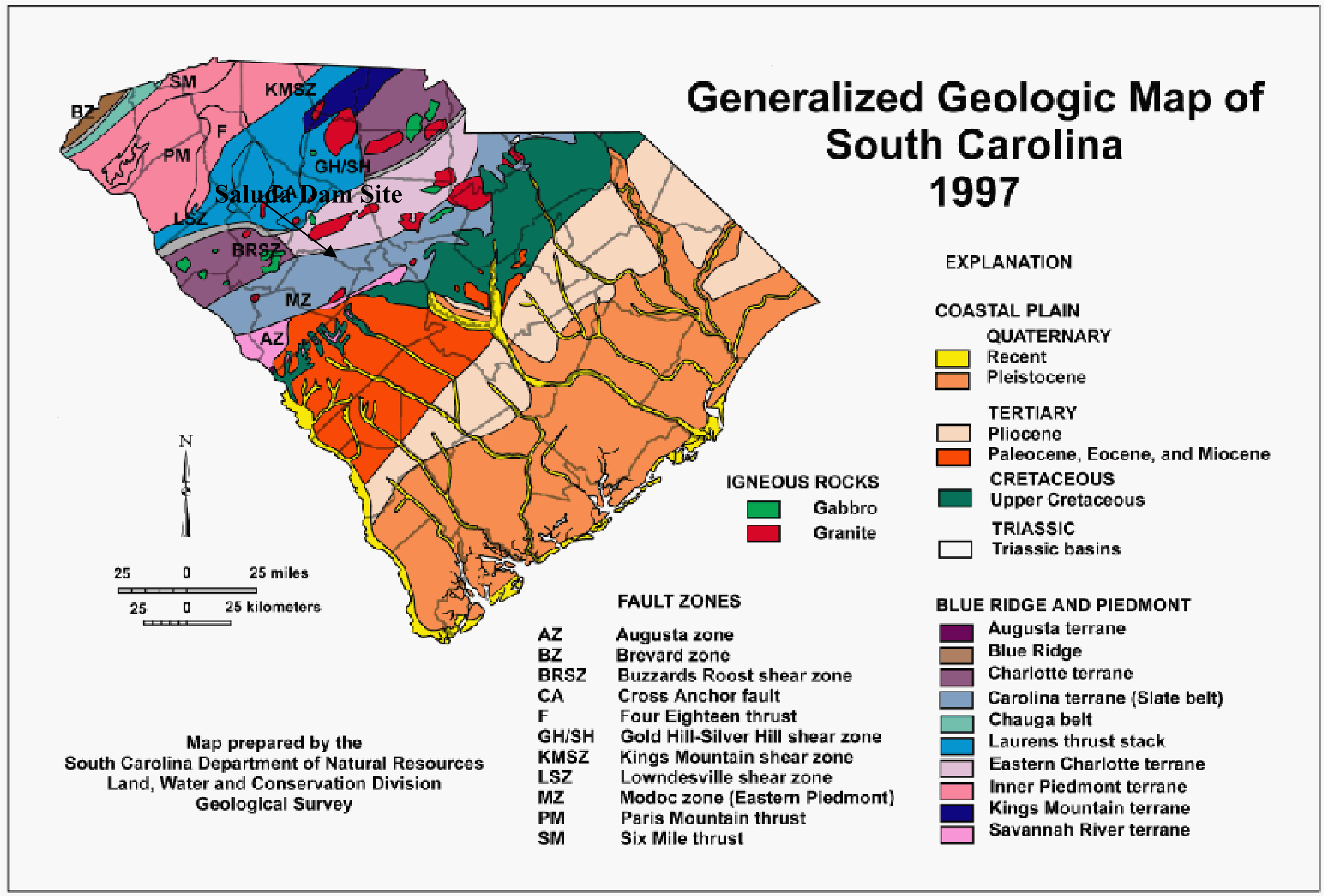


Figure E-2: Generalized Geologic Map of South Carolina

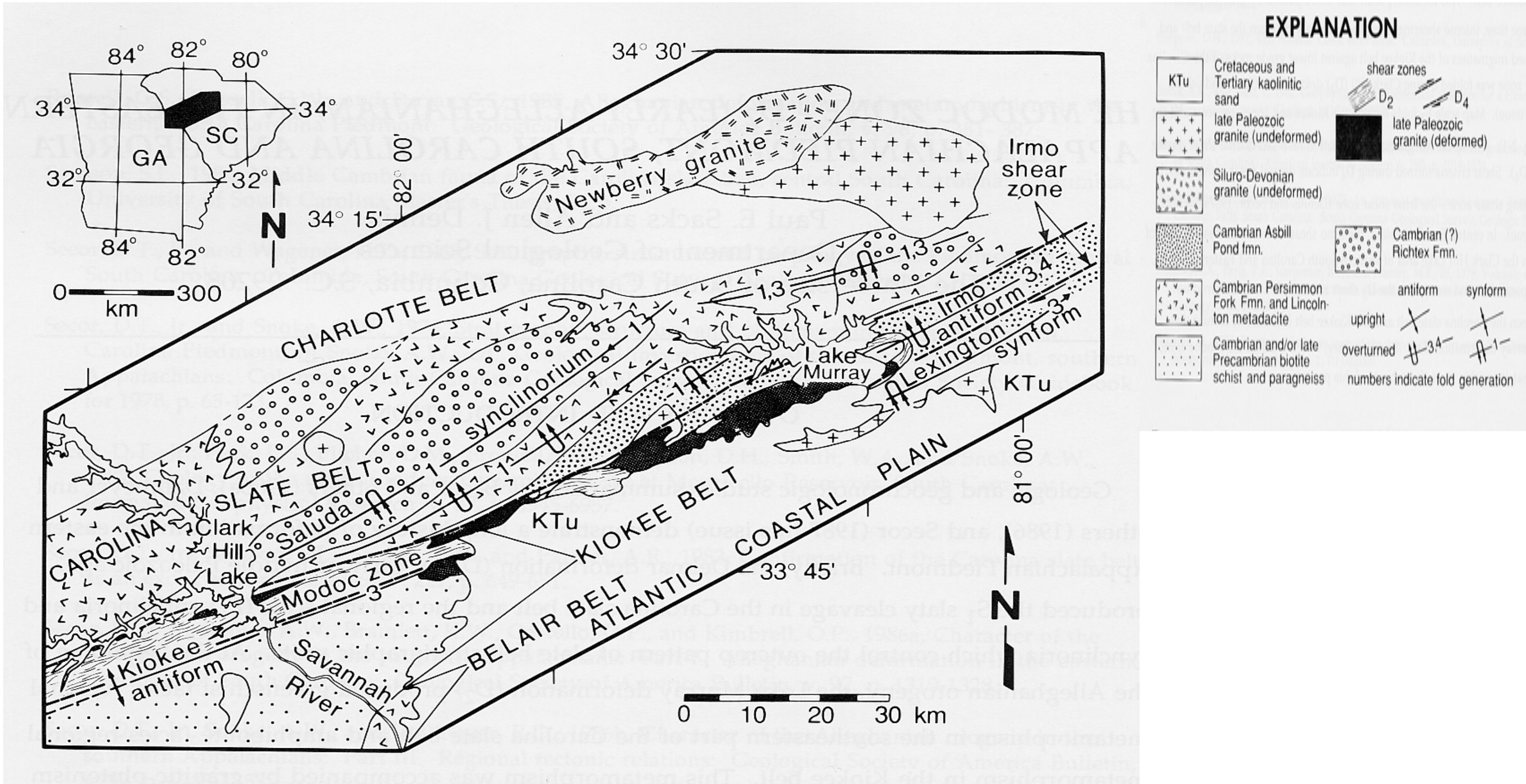


Figure E-3: Map of Eastern Piedmont Fault Zones and TERRANES (Reference: Sacks and Dennis, 1989)

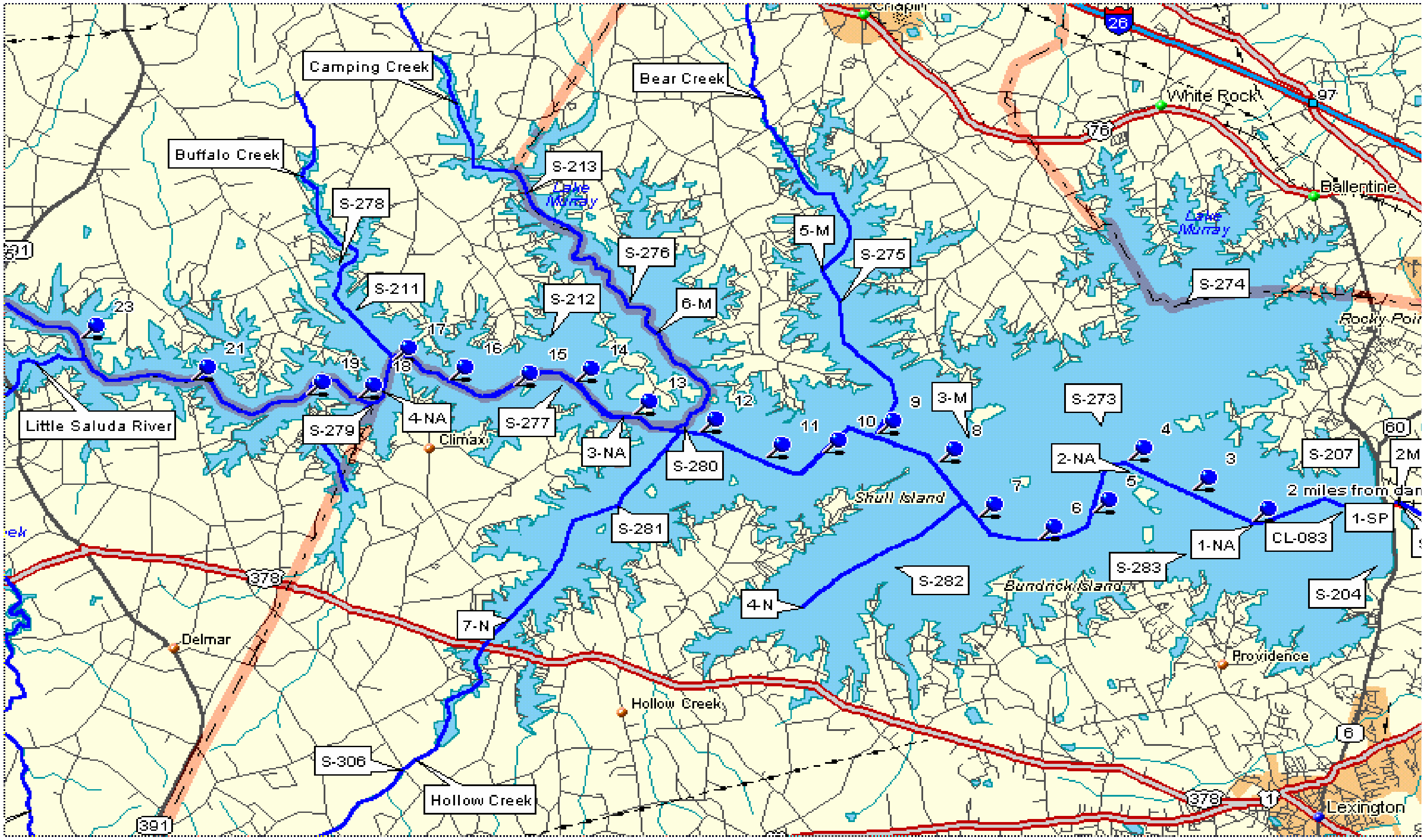


Figure E-4: Saluda River From Its Confluence with the Little Saluda River to the Saluda Hydroelectric Project Dam, Including Lake Murray and Mile Markers Showing Distance Upstream from Dam

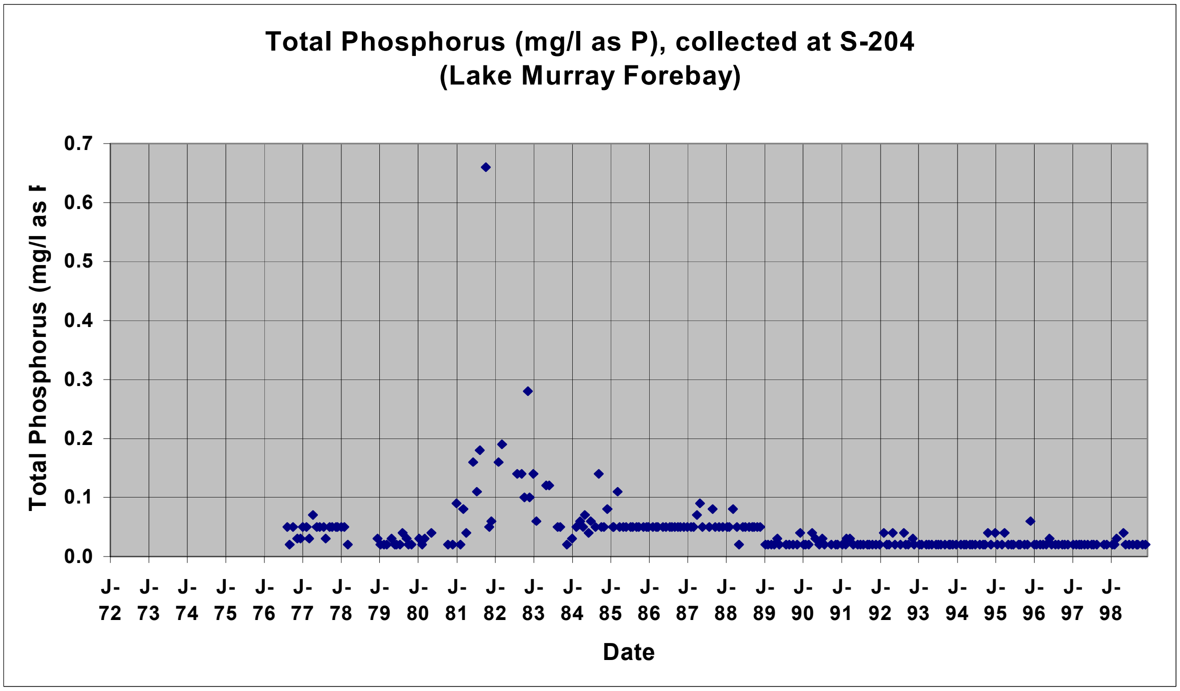


Figure E-5: Total Phosphorous Concentrations at the Dam Forebay of Lake Murray - 1972 to 1998

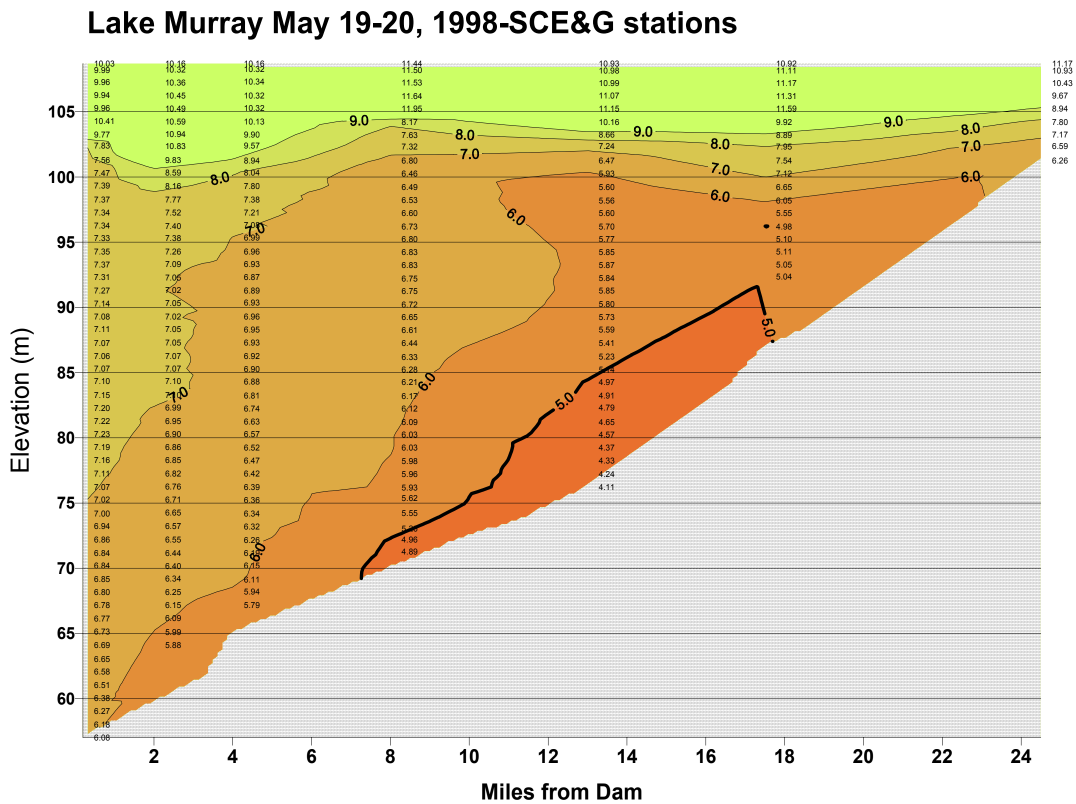


Figure E-6: Longitudinal Contour Plot of DO in Lake Murray for May 1998

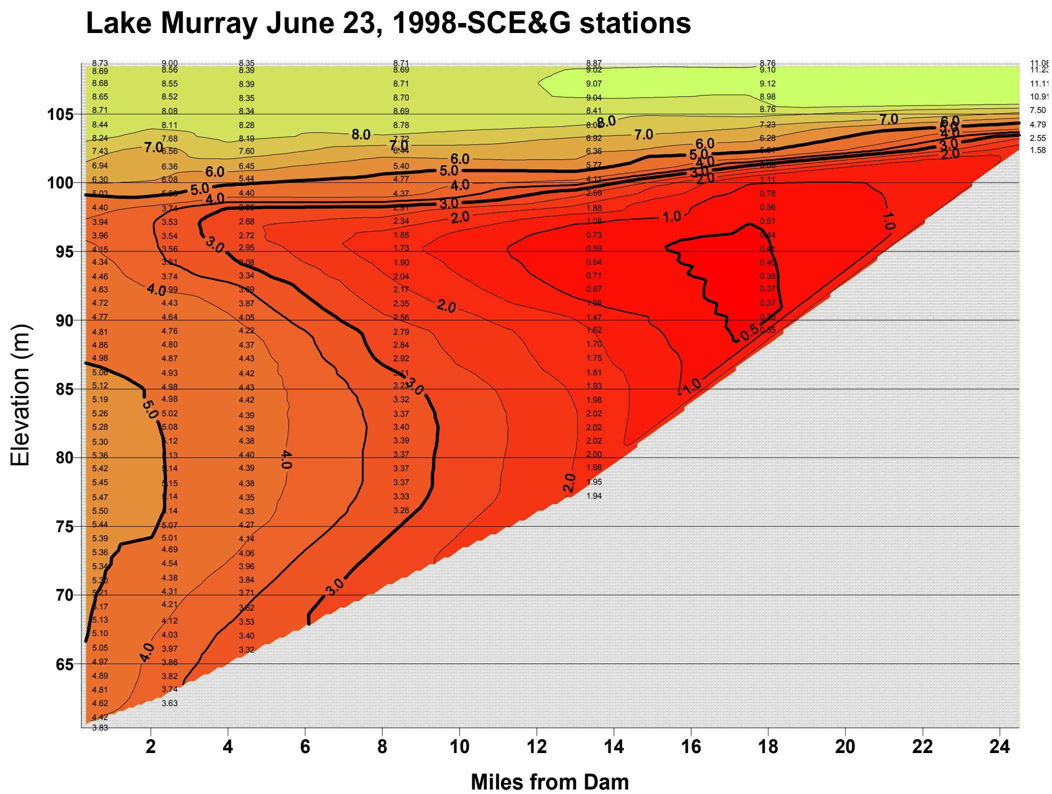


Figure E-7: Longitudinal Contour Plot of DO in Lake Murray for June 1998

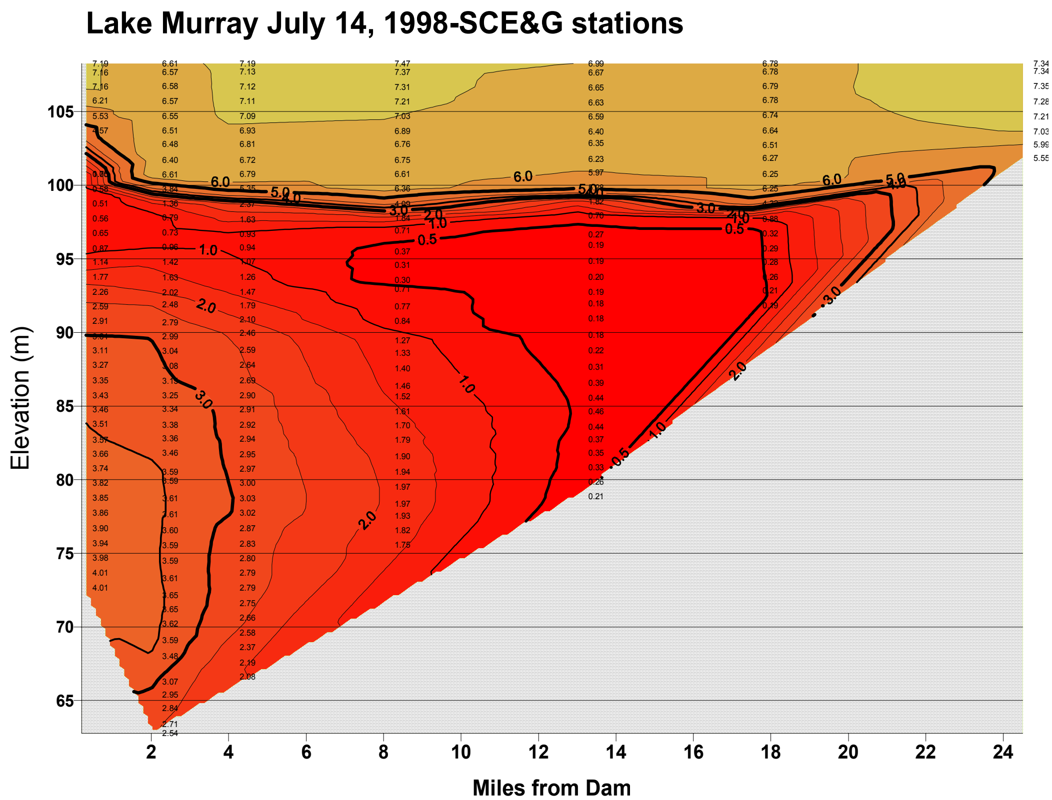


Figure E-8: Longitudinal Contour Plot of DO in Lake Murray for July 1998

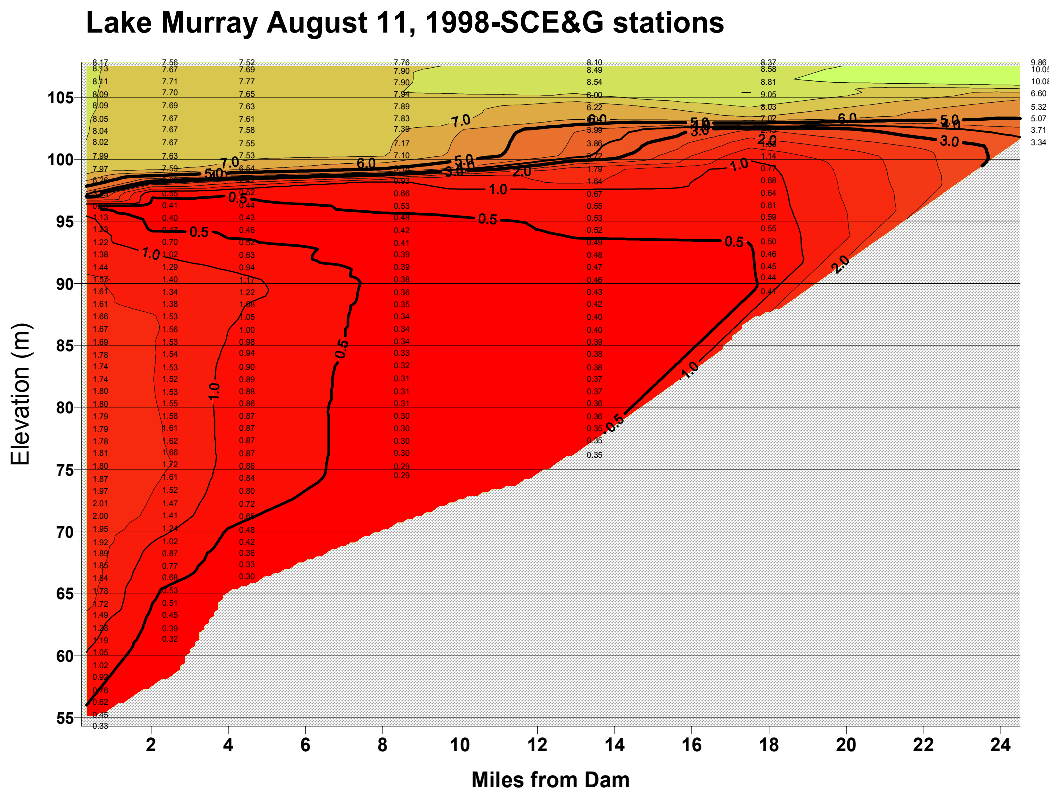


Figure E-9: Longitudinal Contour Plot of DO in Lake Murray for August 1998

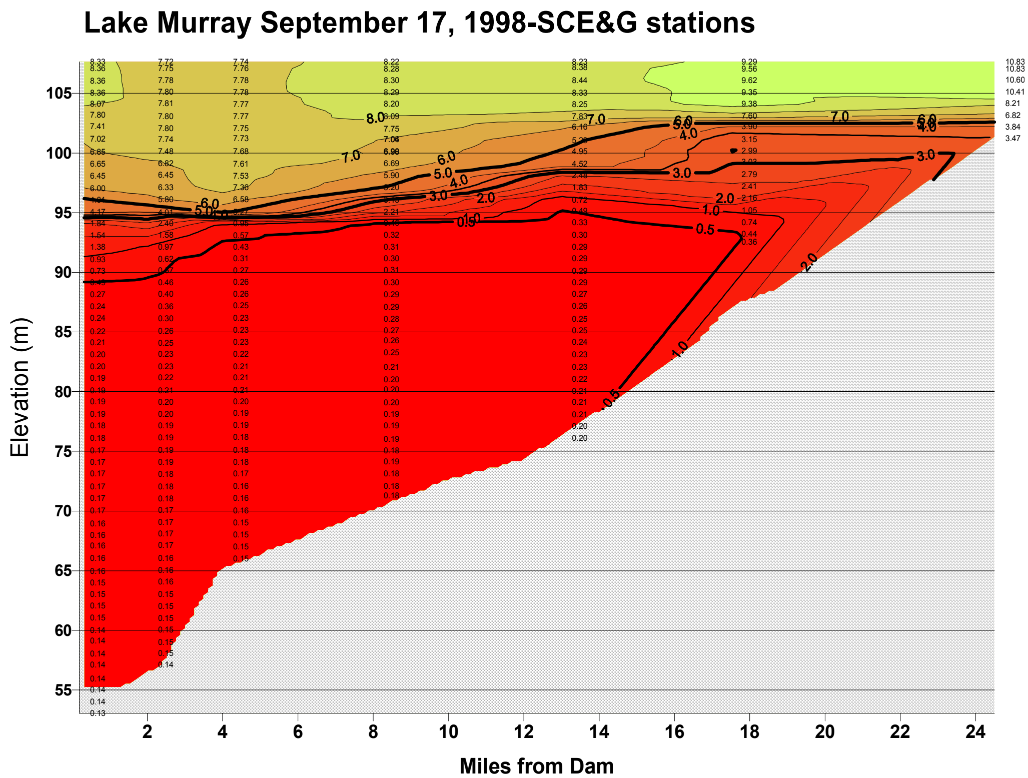


Figure E-10: Longitudinal Contour Plot of DO in Lake Murray for September 1998

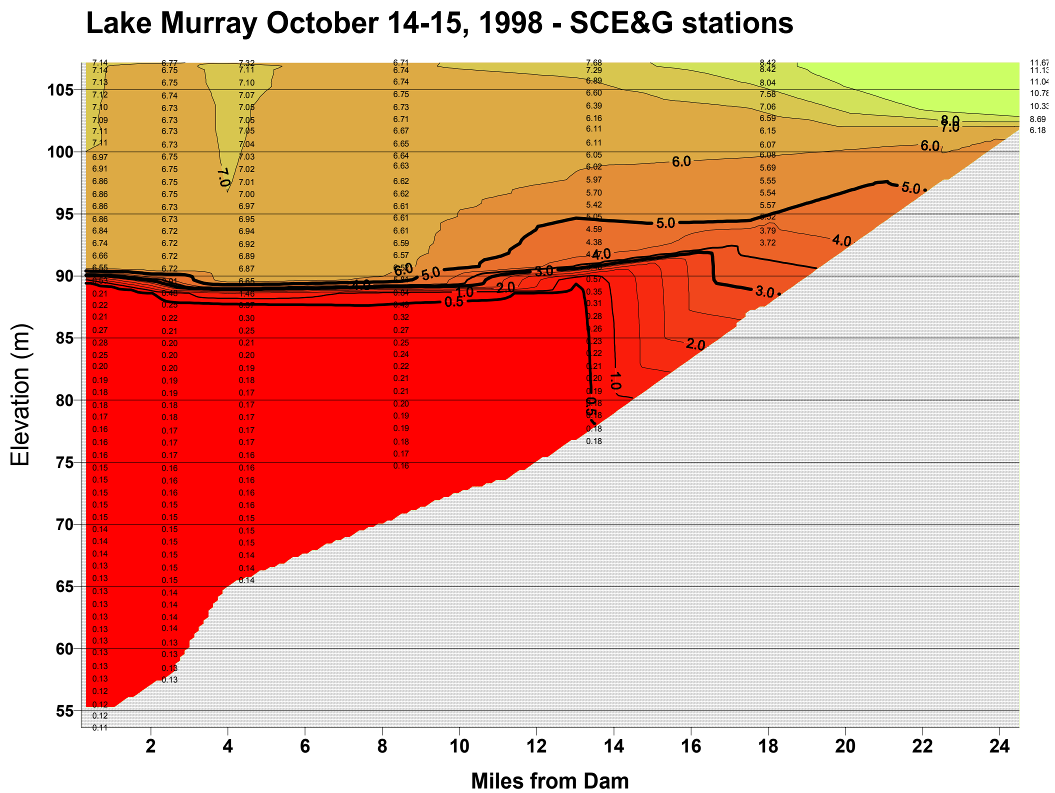


Figure E-11: Longitudinal Contour Plot of DO in Lake Murray for October 1998

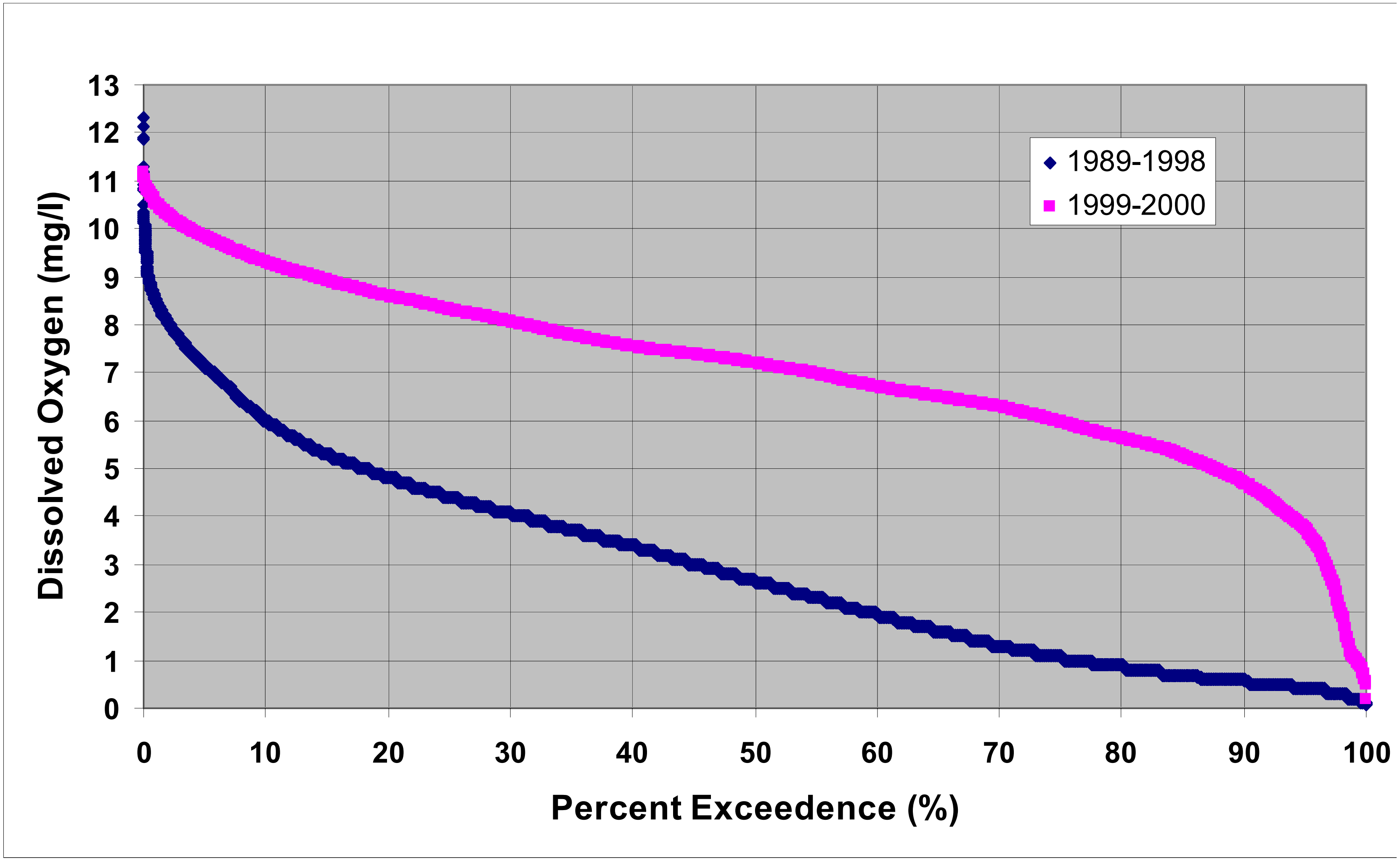


Figure E-12: Percent Exceedance for DO in the Saluda Dam Tailwater - All Hourly Data from the Low DO Period (approximately July 1 to November 15 of each year)

10.0 AQUATIC RESOURCES

With the exception of wildlife resources, we have divided the following discussions of the Project area into two distinct sections, Lake Murray and the lower Saluda River (LSR) (from the Saluda Dam downstream to the confluence with the Broad River). These areas, while containing some similarities in aquatic and terrestrial flora and fauna are frequently quite different - this is especially the case with aquatic resources. These two areas are briefly described below.

10.1 Lake Murray

Lake Murray is an approximately 48,000-acre multipurpose reservoir formed in 1930 primarily for power production purposes; additional uses such as municipal water consumption and recreation have been developed during the more recent life of the Project. It is the largest of a series of seven impounded water bodies in the Saluda River Sub-basin and drains nearly 1,447,420 acres. Lake Murray covers approximately 78 square miles with a total shoreline length of 650 miles. Bordered by Newberry, Saluda, Lexington, and Richland Counties in the midlands of South Carolina, Lake Murray's proximity to the capital city of Columbia places it in one of the most rapidly growing areas of the state (Hayes, 1994). The lake is situated in two geographic provinces: the lower Piedmont and Sand Hills physiographic regions.

10.2 Saluda River

The LSR originates at the base of Saluda Dam and consists of a 10 mile stretch of free flowing river before merging with the Broad River and forming the Congaree River in downtown Columbia. This river segment was designated as a State Scenic River Segment in 1991. Water depths in the LSR are highly variable and dependent upon water releases from the Saluda Project, but typically range from 3 to 15 feet. As with depth, stream flow is highly influenced by releases from the Saluda powerhouse.

10.3 Fisheries Resources

An enormous database of information exists on the fishery resources of Lake Murray. Survey and inventory information has been collected on nearly all major sport and prey fish species in the lake (Hayes, 1994). Through the efforts of the SCDNR, scientific data gathered in Lake Murray include standing crop estimates, survival, reproductive potential, food habits, age and growth, length/weight relationships, proportional *stock* densities, relative condition, population size, and structure.

By the mid 1950's the South Caroling Wildlife and Marine Resources Department, now SC Department of Natural Resources (SCDNR) was established to formulate sound management practices for the lakes of South Carolina (Campbell and Dean, 1976). The agency began conducting studies and producing annual progress reports since the 1980's that are useful for characterizing the Lake Murray ecosystem and fish population assemblages. These early management efforts coincided with the SCDNR's intense involvement in establishing striped bass *(scientific names are listed in Table E-4)* populations in Lake Murray. Through the efforts of the SCDNR, Lake Murray continues to be one of the most monitored and studied Lakes within the State of South Carolina.

10.3.1 Lake Murray

Lake Murray varies substantially in habitat from shallow coves and *wetlands* to vast open water with an abundance of diverse structure. The lake has a maximum depth of around 200 feet, but also has an extensive, shallow *littoral* fringe. This varied habitat within the Project boundary supports a diverse fish population and a valuable sport fishery. Approximately forty species representing 12 families have been documented in Lake Murray over the years (Hayes and Penny, 1993; Campbell and Dean, 1976). Of these, seven are considered game fish. At least 16 resident species of forage fish occur in the Project waters, with 10 of these species belonging to either the minnow or perch families. Fish growth in these waters is generally considered to be excellent and has produced several current state record fish (Mead and Hunt, 2002a).

As early as 1976, a number of important fish species were identified as having both ecological and economic importance to the sport fishery in Lake Murray. Campbell and Dean (1976) identified approximately 10 species including but not limited to spotted gar, common carp, largemouth bass and striped bass.

In 1994, the SCDNR prepared a comprehensive fishery management plan (discussed below) for Lake Murray identifying a number of fish species as having importance to the sport fishery in Lake Murray. Due to the relative importance of these fish to Lake Murray, a brief narrative on each species is included below.

Threadfin Shad

Threadfin shad are the primary prey species and dominate the clupeid prey base in Lake Murray (Hayes, 1994). The importance of these species as a food source for striped bass has been documented by the SCDNR in food habit studies (Hayes and Penny, 1991). Since threadfin shad are relatively small (rarely exceeding 3 inches), and very prolific, they provide a stable and readily available food source for most predatory species in Lake Murray. Ichthyoplankton studies conducted in the 1990’s suggest that threadfin shad make up approximately 80 % of the lake’s larval fish densities (Hayes, 1994).

Evidence suggests that in southeastern reservoirs threadfin shad typically become thermally stressed at water temperatures around 45 ^{o} F. The SCDNR reports that, while possible, none of these die-offs have occurred in Lake Murray. Predation of moribund individuals by migrating gulls as well as fish species is known to occur. The late fall and early winter period is typically when temperatures reach a critical point for threadfin shad and this coincides with periods of significant surface schooling of striped bass. Local anglers have begun to “follow the gulls” to areas where the birds and the striped bass are heavily feeding on the thermally stressed shad (Hayes, 1994).

Gizzard Shad

The gizzard shad is the second most abundant clupeid found in Lake Murray and has historically comprised a significant portion of total biomass of fishes in cove rotenone studies conducted by the SCDNR (Hayes and Penny, 1992). Due to the rapid growth rates of the gizzard shad, only the larger predatory species can use this species as prey. During the late 1980's, the SCDNR reported that negligible spawning of this species occurred and overall abundance was low (Hayes, 1994).

Historically, the gizzard shad had been used as a source of live and cut bait for striped bass fisherman, but within recent years due to the introduction of blueback herring, usage appears to have been drastically reduced. Gizzard shad however are still used to a degree when blueback herring are unavailable or too costly (Hayes, 1994).

Blueback Herring

Blueback herring occurrence was initially documented in 1985 during winter gill net surveys on Lake Murray (Hayes, 1986). By 1989, Hayes and Penny reported that this species had totally adapted to a freshwater water environment. It is unclear how this species was introduced into Lake Murray, although the SCDNR postulated that the bait fishery, which provided herring for striped bass fishermen, is the likely source of introduction.

A commercial bait fishery for blueback herring exists on Lake Murray. However, the SCDNR reports that this fishery is seasonal and does not meet the demand of the market (Hayes, 1990). The SCDNR has indicated that Lakes Russell and Thurmond contribute significantly more to the statewide blueback fishery than currently occurring on Lake Murray (personal comm. Gene Hayes, SCDNR, 2002).

Blueback herring tend to congregate near the Saluda (Lake Murray) Dam in the late summer months searching out cool water habitats. In September 1990, a significant entrainment event of blueback herring occurred at Saluda Hydro Plant (Hayes, 1994). This entrainment event was attributed to blueback herring water quality habitat preferences which placed them in the vicinity of the intake tower for Unit 5. Although reported as "significant", an exact number of fish entrained or resulting mortality was never documented.

As a result of this reported entrainment event, SCE&G instituted measures to eliminate the potential for blueback herring entrainment at the Saluda (Lake Murray) Dam. In July 1992 SCE&G installed hydroacoustic transducers near intake tower number 5 to monitor late season movements of blueback herring. When acoustics show that blueback herring are congregated near the Unit 5 intake, SCE&G ceases operation of the unit. Since its installation, no significant blueback herring entrainment events have been reported by the SCDNR.

Largemouth Bass

The largemouth bass is one of the single most sought after game fish species in Lake Murray. Studies conducted in the early 1990's showed a healthy population with high recruitment and a stock size distribution well represented by large fish, > 14 inches (Hayes, and Penny 1990; Hayes and Penny 1991). Forty-six percent of the total fish pressure was directed at this species based on a 1991 creel census. Creel data collected in 2000 and 2001 suggest similar trends with forty percent of anglers targeting largemouth bass in Lake Murray (Hayes and Penny, 2001).

Recent trends suggest that while largemouth bass continues to be one of the most sought after fish species, angler efforts directed at this species are on the decline. The SCDNR noted in their 2001 – 2002 creel census that anglers targeting this species had dropped to approximately 29 % of total angling efforts. The SCDNR noted in their report that overall angling effort was down compared to previous years, and they speculated that downward economic conditions may have contributed to the differences in angler effort and target species than those historically observed on Lake Murray (Hayes et al, 2002).

Lake Murray is ranked by Bass Anger Sportsman Society as one of the top bass fishing lakes in the United States (BASS, 2003). Historically, growth rates observed in Lake Murray were greater than those observed in other reservoirs in South Carolina (Hayes et al, 1995). However, since 1991, trends in fish condition factors for largemouth bass have steadily declined (Hayes *et al*, 1995). Data collected from a 1999 study suggested a decrease in fish condition with increasing length, a trend that was opposite to that observed in the 1991 studies (Hayes, 1995). SCDNR has speculated that the reason for declining condition factors in recent years could be due to lake drawdowns undertaken in 1990/91 for Project structure maintenance and in 1996/97 to control hydrilla. It is surmised by SCDNR that the prey fish community may have been restructured by reducing hydrilla in the littoral zones of the reservoir. An additional factor that may be adversely influencing largemouth bass populations in Lake Murray could be competition with a continuously growing striped bass population (Hayes, 1999).

Studies conducted in 2000 however noted a reversal of those declining largemouth bass condition factors observed in 1999. While there was still a trend of decreasing condition factors at increasing length, which has almost always been the pattern for Lake Murray bass, all size groups except one had condition values above 1.0 (SCDNR, 2001). The SCDNR speculates that these improved conditions may be attributable to an increased Lepomid population resulting from a resurgence of the aquatic plant community since 1999.

Due to early exploitation of this species, the SCDNR has a daily limit on largemouth bass that can be fished from Project waters. The limit imposed by the SCDNR allows for a total of 10 fish per day with no minimum length required. The SCDNR continues to monitor largemouth bass populations within Lake Murray on an annual basis.

Redear Sunfish

The SCDNR contends that Lake Murray has developed into a premier redear sunfish fishery, unlike any other reservoir in the state (Hayes, 1994). Within Lake Murray, the redear sunfish or "shellcracker" is the second most targeted species. A *creel census* conducted in 1990 indicated 5.88 angler-hrs/acre of fishing pressure was directed at this species, with catch rates of one fish per/hour resulting in a total harvest of 79,811 lbs (Hayes and Penny, 1992).

Information gathered by the SCDNR suggests that the redear sunfish populations have experienced a major expansion since the late 1950's. Surveys conducted in 1982 and 1992 revealed continued increases in the numbers and total weight of redear sunfish (Hayes, 1994). The SCDNR speculates that the increase in redear populations maybe the result of the introduction of an exotic/invasive species, the Asiatic clam (*Corbicula fluminea)*. Campbell and Dean reported in 1976 that stomach analyses revealed the Asiatic clam to be the only food source used by the redear sunfish. This information was confirmed in studies conducted in 1996 by the SCDNR, which demonstrated that mollusks predominantly comprise the stomach contents, especially in fish greater than five years old (Beard, 1996). The 1996 studies indicated full development of the pharyngeal teeth and an overall increase in fish size which may have allowed the fish to expand their diet to include the larger more difficult to digest Asiatic clam. Today, the redear sunfish remains one of the most sought after game fish in Lake Murray (Hayes et al, 2002).

Bluegill Sunfish

The bluegill sunfish was reported to be the third most sought after fish species in Lake Murray. Creel data collected in 1990 suggest that anglers directed approximately 250,000 hours of effort at this game fish, resulting in a harvest of 61,232 lbs (Hayes and Penny, 1992). Recent information suggests that the bluegill sunfish continues to be one of the most sought after game fish species in Lake Murray (Hayes et al, 2002).

Striped Bass

Since its original stocking in 1960, Lake Murray has come to support a significant striped bass fishery. Lake Murray was one of the first upstate reservoirs stocked with striped bass. When originally stocked by the SCDNR, two main objectives were defined 1) introduce a predator base that could feed on the large gizzard shad population and 2) provide anglers with a highly prized game fish with large growth potential (Hayes, 1994).

Early stockings in the 1960's to produce a viable striped bass fishery met with unsuccessful results. By the early 1970's, innovations in hatchery production made it possible to produce sufficient numbers of fingerling striped bass for stocking into Lake Murray. Since 1971 over 30 million striped bass have been stocked in Lake Murray. These fish have been stocked into Lake Murray to a varying degree ranging from a low of 8,800 in 1986 to a high of 1,771,761 in 1983.

Due to a perception in the angler community in the late 1980's that the quality and size of striped bass had diminished, the SCDNR conducted investigations into the size structure of striped bass population in Lake Murray. Studies showed a downward trend in the length distribution of the population and mean weight of fish (Hayes and Penny, 1989). As a result of these downward trends the SCDNR imposed a 21-inch minimum length limit and the creel limit was reduced from 10 to 5 fish per day.

After posting these regulations, the SCDNR initiated studies to determine how the regulations were affecting the size distribution of striped bass in Lake Murray. Prior to the 5 fish - 21 inch restriction, striped bass in Lake Murray were predominately 16- 19 inches. Studies conducted in 1993 indicated a shift in size distributions of striped bass to the 20-22 inch range (Hayes et al, 1999).

The striped bass fishery in Lake Murray is a non-self sustaining fishery and must be maintained through stocking efforts. Until recently, Lake Murray was considered to have no natural reproduction of striped bass. May (1963) identified egg transport time as the single most limiting factor in striped bass reproduction.

As a result of their 1999 sampling efforts, the SCDNR postulated that the recent increase in striped bass densities, despite the decrease in stocking rates, may be due to an increase in minimum flows from the Buzzards Roost Hydroelectric Project located upstream creating favorable conditions for natural reproduction (Hayes et al, 2000). Additionally, Duke Power has implemented DO enhancements in the tailwaters of the Buzzards Roost, which contribute favorably to fishery habitat.

In 2000, the SCDNR initiated studies to document the occurrence of natural striped bass reproduction within Lake Murray. In the first year of the study, a total of 108 beach seine collections where made, resulting in the capture of 4 juvenile striped bass (CPUE = 0.04 striped bass/seine). In 2001 a total of 10 young-of-year striped bass were collected. This equated to a CPUE of 0.05 striped bass/seine haul, which was similar to the catch rate for 2000-01 (Hayes et al, 2002).

All stocked striped bass stocked into Lake Murray are treated with oxytetracycline (OTC). OTC causes identifiable marks on treated fishes' otoliths (*i.e.* earbones). The SCDNR processed otoliths from 8 of the 14 juvenile fish collected to determine whether the fish were of hatchery origin or naturally reproduced in Lake Murray. Although the sample size was relatively small, all 8 juvenile striped bass possessed OTC markings indicating they were *spawn*ed in the hatchery and stocked into Lake Murray (pers. Comm. Jenni Chrislip, SCDNR 2003). The SCDNR plans to continue evaluating the potential for natural reproduction of striped bass in Lake Murray. However, due to the drawdown of the lake for remedial repairs to the Dam and the resulting lack of suitable seining areas, the program has been suspended until Lake Murray is refilled (pers Comm. Jenni Chrislip, SCDNR, 2003).

Striped bass stockings in Lake Murray have not been without some controversy. Panfish anglers in the early 1990's raised concerns that striped bass predation was having an adverse effect on the crappie populations in Lake Murray. The SCDNR initiated a two year food habit assessment in 1990 to alleviate the concerns of the panfish anglers. The studies revealed that the predominate food item of striped bass in Lake Murray was threadfin shad. Of the 107 striped bass stomachs analyzed, only 4 contained fish species other than threadfin shad, and those contained lepomids and yellow perch (Hayes and Penny, 1992).

Lake Murray has been historically plagued with annual striped bass mortalities from the early 1970's up to around 1994 in the areas of Spence Islands and the Saluda (Lake Murray) Dam. During the late summer and early fall, natural thermal gradients establish a strong stratification in Lake Murray which results in the production of a warm water epilimnion on the surface of the lake and a cool water hypolimnion in the deeper portions of the lake. Since striped bass prefer cooler water temperatures they become restricted to the thermal refuges in the hypolimnion zone. During the summer and early fall, DO levels slowly decline in the hypolimnion thus reducing the amount of preferred habitat for striped bass. The decreasing DO stresses associated with these thermal refuge areas of adult fish appears to be the primary cause for striped bass mortalities (Hayes, 1994). The magnitude of fish kills related to temperature and DO stress has been variable and was not extensively assessed until 1990. The biggest die-off of striped bass was observed in 1991, when 3,139 striped bass were estimated to have died.

The SCDNR had speculated that operation of the Saluda Unit 5 might have been a contributing factor in the mortality events. Since the Unit 5 intake is located at approximately the same depth as striped bass thermal refuge areas, it was postulated that operation of Unit 5 might actually reduce the size of thermal refuge areas and increase stress levels on striped bass. In the mid 1990's, SCDNR and SCE&G agreed to an operational scenario for reduction in the use of Unit 5 during the late summer and early fall to help prevent blue-back herring entrainment events, which may have helped reduced die-offs in recent years.

10.3.2 Lower Saluda River Fishery

Several studies have been conducted in recent years to assess the fish community structure of the LSR. The LSR prior to 1996 had experienced short periods (July – October) of low DO levels resulting from *hypolimnetic* releases from Lake Murray Dam. Much emphasis has been placed in recent years on maintaining and improving water quality conditions in the LSR. Resource agencies and citizen groups have expressed concerns over the possible negative impacts that degraded water quality may have on the river's fish community and associated habitats (Beard, 2000).

In 1996 SCE&G implemented a fish sampling program to characterize the fishery resource and to assess the potential impacts of low DO levels in the LSR. In addition to the SCE&G data, the SCDNR continues to conduct fish sampling on the LSR as part of their statewide monitoring program.

10.3.2.1 Fisheries Community

Currently, the LSR supports a diversity of species and has a reputation for providing a variety of fishing opportunities (Beard, 1997). The LSR is unique in that it has the ability to support both coldwater and warm water species of fish. Through the trout stocking efforts of the SCDNR, this two-story fishery has been established to enhance recreational fishing opportunities on the LSR. In 1995, the SCDNR investigated the potential to establish a smallmouth bass fishery in the LSR. The SCDNR evaluated the river's ability to meet this species' requirements for food, cover, water quality and reproduction as well as growth, survival, and abundance, based on the habitat suitability criteria for smallmouth bass as described in the literature (Beard, 1996). The SCDNR's findings suggested that while many of the criteria to support a smallmouth bass fishery were present, it was not feasible to implement this strategy as a fishery management goal in the LSR because suitable habitat was found to be inadequate to support species needs.

10.3.2.2 Resident Fish

The *resident fishery* resource of the LSR is typical of many southern tailwater systems. The fishery resources of the LSR include an assortment of resident game and non-game species (Table E-4). Studies conducted as early as 1991 found approximately 50 species of fish, 48 of which are considered endemic to the region (Jobsis, 1991). Redbreast sunfish, a species typically found in healthy riverine environments, were the most abundant game fish species found in the LSR 1991 study. Bluegill sunfish were typically found in relatively high abundance as well but were highly variable in numbers based on specific habitat types (Jobsis, 1991).

Based on work performed in the late 1980's and early 1990's, catch per unit of effort (CPUE) and number of species collected were generally lower in the upper portion of the LSR (Crane 1987; Jobsis, 1991). However in the 1991 study, when total CPUE's were compared from the upper and the middle section, CPUE's (number/ 100 meters electrofished) were lowest in the middle sections (38.1 fish/hour) of the LSR as compared to lower (66.8 fish/hour) and upper (50.9 fish/hour) sections. In terms of relative abundance, redbreast sunfish were dominant in the upper sections as compared to the lower and middle sections.

It is not uncommon to experience lower CPUE or relative abundance values immediately below hydropower Projects. In tailrace areas subject to hydropower releases, scouring *peaking* flows often limit habitat diversity and colonization of macroinvertebrate species, produce periods of lower DO concentrations, and result in lower abundance of fish species (Bednairak, 2002).

Growth studies conducted on redbreast sunfish in the LSR during 1991 indicated that these species of fish grow more slowly when compared to other rivers in the southeast (Jobsis, 1991). However, this is not surprising since coldwater temperatures have been shown to limit growth of *warmwater fish* in similar watersheds (Ruane, *et al.*, 1986).

Fish sampling data gathered by SCE&G suggests some unique trends in terms of the fish community structure. Total catch in 1995 and 1996 was dominated by gizzard shad. Gizzard shad comprised approximately 25% of the catch. After 1997, which corresponds to the onset of SCE&G's turbine venting program, a marked decline was observed in the harvest of gizzard shad in the LSR, while increases in sportfish species were noted.

Recent sampling conducted in 2001 -2002 by the SCDNR support similar trends as those observed in the SCE&G data. Of special note, the SCDNR data suggests a significant increase in the chain pickerel populations. The SCDNR theorized that these increases are due to a significant increase in the aquatic macrophyte community in the LSR over the last few years (personal communication. H. Beard, 2003).

10.3.2.3 Trout Stocking

The LSR trout fishery has been in existence since the early 1950's and the river continues to support a put, grow, and take rainbow trout and brown trout fishery. Trout stockings vary in number depending primarily on availability of fish from the Walhalla Fish Hatchery. Stocking records suggest that typically the SCDNR stock approximately 28,000 to 30,000 trout annually in the LSR, with a 3:1 ratio of brown trout to rainbow trout, respectively. The length of the fish at the time of stocking is typically 7-8" for brown trout and 9-10" for rainbow trout.

Trout are typically stocked from November – March throughout the LSR. The initial stocking event is typically done by the use of helicopter to facilitate distribution of both species along the LSR. Subsequent stockings are conducted by truck with stocking locations limited to 3 locations along the LSR. Access to the river appears to be the most limiting factor affecting stocking of trout.

Intense fishing pressure, predation by striped bass, and late-summer low DO concentrations require that these trout populations continue to be restocked annually to maintain this fishery. However the local Saluda River Chapter of Trout Unlimited and SCDNR knew prior to 1985 from angler reports that some rainbow trout survive up to several years to become trophy fish of 4 to 8 pounds (Study Plan, 1985). This information was confirmed very recently when the SCDNR captured several large rainbow trout in electrofishing efforts in 2002 (personal communication, H. Beard SCDNR, 2002).

10.3.2.4 Trout Growth Studies on the Lower Saluda River

The LSR is known for its productive striped bass and trout fisheries. In order to maintain healthy and robust fish there are certain criteria that need to be met in regards to available DO, food, and water temperatures. To determine the extent to which the needs of fish, trout in particular, were being met on the Lower Saluda River, In 2003 LSR, SCE&G performed a trout growth study in association with a study to propose a site-specific standard for DO for the LSR downstream of Saluda Hydro. The fish growth study on the LSR indicated that an excellent trout fishery exists on the river.

A FISH model was used to compare annual trout growth under a range of DO patterns in the LSR. Among other comparisons, the growth predictions can be compared with growth achievable at the EPA dissolved oxygen criteria concentration of 6.5 mg/L. Model predictions also allow comparison of trout growth under any other patterns of DO dynamics. Making such comparisons was the goal of the EPA-TVA model development (Kleinschmidt, 2003).

To predict trout growth in the LSR, the model requires information on the effects of both temperature and DO on appetite and an estimation of the amount of food available to trout in their natural environment. The effects of temperature on appetite are well documented for use in growth models, and the data from the EPA criteria document were used for determining the effects of DO on appetite. Food availability in the LSR can be estimated by measuring the growth of trout in the river and knowing the temperature and DO during the period that growth is measured. Site-specific data on trout growth were gathered through a study of trout planted into the LSR in 2002-2003 (Kleinschmidt, 2003).

Approximately 11,000 rainbow trout were released into the LSR between December 2002 and March 2003.

The growth data collected, along with temperature and DO data from the USGS gages and the tailwater model for the LSR, were used to calculate the amount of food available to the fish. As is common to such studies, the results indicated that the amount of food available was less than the appetite of the fish. In this case, about 68% of maximum appetite was available, based on model calibration. After determining food availability, the model was used to predict trout growth under a range of temperature and DO conditions for various hydropower, meteorological, and regulatory conditions (Kleinschmidt, 2003).

The measured average trout growth rate (0.7 percent weight gain per day, 0.67 inches per month) is higher than that found in most other tailwater trout growth studies (see Table E-7). Analysis of the growth data indicated that data from all 111 fish could be pooled and used in the model, as there was no significant difference in growth as a result of fish size or condition at release, site of release, date of release, date of capture, direction and distance of movement in the stream, or site of capture (Kleinschmidt, 2003).

Additional information collected during the growth study revealed significant numbers of rainbow and brown trout that appear to be carryovers from previous stockings. A total of 441 tagged and untagged trout were collected from the LSR, with 253 rainbow and 188 brown trout comprising the total catch (Kleinschmidt, 2003).

Of the 441 rainbow and brown trout collected, 74 exceeded 16 inches in length. The largest rainbow and brown trout collected during these surveys were 22 and 24 inches, respectively, with all fish appearing robust and healthy. This may be attributable to higher DO levels since the inception of SCE&G's turbine venting program than those DO levels historically observed in the LSR (Kleinschmidt, 2003).

10.3.2.5 Fish Consumption Advisories

Currently, there are no fish consumption advisories issued by SCDHEC for the Project area, which includes both Lake Murray and the LSR. Further information regarding water quality of Lake Murray can be found in Section 9.2.

10.3.2.6 Fisheries Management Goals

Lake Murray

The SCDNR's current Lake Murray management plan was prepared based on the database of information for the Lake Murray fishery with a focus on major sport and prey species inhabiting the lake. The management plan cited that the longest running management activity on

Lake Murray has been the construction and annual maintenance of fish concentration areas (artificial reefs). In 1975, the fish concentration program began with the installation of 20 fish attractors constructed of brush and trees (May 1976). By 1994, the program expanded to include 22 fish concentration areas that had been established on the lake. Today, the program currently comprises over 29 fish concentration areas managed by the SCDNR (personal Communication, Jenni Chrislip, SCDNR, 2003).

The management plan also identified approximately 11 future activities and management objectives that the SCDNR would like to see implemented:

1. Develop or use existing techniques to determine the extent of blueback herring spawning in Lake Murray. Determine the contribution that blueback herring make to the total prey base of the Lake.
2. Work with the Department's environmental staff and regulatory agencies to protect the important littoral habitat of Lake Murray from further destruction by developmental interests.
3. Gather information on redear sunfish including life history.
4. Continue long-term monitoring of crappie populations.
5. Conduct a significant fall and winter drawdown on Lake Murray every fifth year.
6. If Duke Power Company is forced by FERC to generate minimum flows at Buzzards Roost Hydro to attain relicensing of the facility, efforts should be made to assess if transport time is sufficient for the development and hatching of striped bass eggs.
7. Establish additional fisherman mooring device areas at suitable bridge crossings in Newberry and Lexington counties.

8. Continue to document and enumerate the loss of the striped bass in the downlake region each summer to develop a database of these mortality events. This information can be used to evaluate and encourage operational changes at the Saluda Project that may be impacting the thermal refuges of striped bass.

9. Improve and increase recreational and access facilities on Lake Murray.

10. Continue a rotational schedule of cove rotenone sampling, spring electrofishing and creel census.

11. Continue to stock only Phase 1 striped bass fingerlings to maintain the current level of the fishery.

To date, many of these objectives have been implemented. The SCDNR is continuing to develop and consider additional changes to the plan but to date no final recommendations have been made.

Lower Saluda River

A fishery management plan for the LSR is currently being revised by the SCDNR. However, the LSR fishery has been identified as important to the local economy. A creel census conducted by the SCDNR indicated that the fishery generates approximately 1.8 million dollars annually, with the trout fishery being responsible for the majority of the revenues (Beard, 2000).

10.3.2.7 Anadromous Fish

Anadromous fish are species that live in the ocean but migrate into freshwater environments to spawn. Reports as early as the mid 1800's have suggested that historical migrations of such species as American shad, blueback herring, shortnose and Atlantic sturgeon have ascended rivers included in the Santee River basin with many species reaching the upper terminus into the Piedmont regions of North and South Carolina. By the late 19th and early 20th centuries, many rivers in the Santee Basin began to see a marked decline in the numbers of anadromous fish species due to the construction of dams and intense exploitation of the fisheries (USFWS, 2001).

Historical evidence suggests that many of these species heavily used the Broad and Congaree Rivers and to lesser degrees the smaller rivers including the Saluda River for these spawning runs. The Santee Cooper dams, constructed in 1942, have become a major impediment in historical runs of diadromous fish up the Santee River basin (USFWS, 2001). Fish passage facilities installed at Santee Cooper have allowed for successful passage of certain anadromous fish species upstream of the Dam.

American shad, striped bass, Atlantic and shortnose sturgeon have historically used Project waters. Mills reported as early as 1826 that American shad and sturgeon ascended rivers above the fall-line, more specifically the Saluda River (USFWS, 2001). Noticeably absent from the list of anadromous fish historically documented from the Saluda River is the blueback herring. While historical data regarding distribution is sparse, Mills reported herring in waterways of the Charleston District. There are reports of blueback herring moving as far up as Santee-Cooper Dam and successfully passing upstream to Lakes Marion and Moultrie. Fisheries surveys conducted in support of the Columbia Project have found no occurrence of blueback herring in the Broad River (adjacent to the Saluda River) (SCE&G, 1999).

Striped bass are the only known anadromous fish to consistently use the LSR. Striped bass migrate up from the Santee Cooper lakes in the early spring and use areas of the LSR in late summer as thermal refuge areas. Anglers on the LSR have reported catching trophy size striped bass, with many individuals reaching in excess of 50 pounds (personal Communication, Hal Beard, SCDNR, 2002).

Spring electrofishing sampling conducted by SCE&G from 1995 – 2003 revealed only sporadic catches of striped bass. As in previous sampling, the SCDNR has reported no presence of diadromous species such as blueback herring or American shad (Beard, 2002). However, sampling conducted by SCE&G in the spring of 2003 detected the presence of three American shad in the LSR.

10.3.2.8 Catadromous Fish

Catadromous fish are species that live most of their lives in freshwater environments and upon reaching sexual maturity, migrate to the ocean to spawn. The juvenile offspring of catadromous fish migrate through the ocean to the mouth of rivers and move upstream to various habitats to live until adulthood.

The American eel is the only know catadromous fish to inhabit Project waters (Beard, 2002). The presence of this fish species has been documented however, based on sampling information, their numbers in the LSR appear limited.

Current Diadromous and Catadromous Fish Studies

On November 10th 2004, SCE&G and Kleinschmidt Associates hosted a meeting with the SCDNR, USFWS, and NOAA fisheries concerning early diadromous fish studies requested by their agencies. Subsequently, a diadromous fish study plan was developed in conjunction with, and approved by, the above noted resource agencies. The purpose of this study plan is to document the relative abundance and distributions of historically present diadromous fish species on the LSR and the Upper Congaree, as well as the degree to which these species are spawning.

Target species will include the anadromous American shad, hickory shad and blueback herring, and the catadromous American eel. Sampling is scheduled to commence during the 2005 spring spawning season. The sampling strategies that are to be used include gillnetting, ichthyoplankton sampling, and American eel sampling using eel pots. A more precise description of the methodologies used in the sampling regimes is listed in the Final Saluda Diadromous Fish Study Plan (can be found at www.saludahydrorelicence.com). All of the information that is collected during these sampling efforts will be recorded and used as an informational resource during the relicensing process for resource agencies, *stakeholder*s, and issue working groups during the relicensing process.

10.3.2.9 Fish Restoration

Anadromous fish restoration efforts for the Santee Basin appear geared more toward establishing historic runs of anadromous fish up the Congaree and Broad Rivers than the Saluda. The Anadromous Fish Restoration Plan (Plan) reports that the Broad River and its tributaries is the most promising sub-basin for diadromous fish restoration (USFWS, 2001). The restoration plan evaluated Project waters and suggests that the hydraulically altered Saluda River ranked low on the efforts for anadromous fish restoration. The Plan states that the cold hypolimnetic water significantly reduces the ambient temperature of the LSR water and migrating fish may choose to use the warmer waters of the Broad and not the Saluda River (USFWS, 2001). Furthermore, alteration of the existing thermal regime of the LSR would be an engineering challenge and likely adversely affect the coldwater trout fishery in the tailwater.

10.3.2.10 Macroinvertebrates

The *benthic macro-invertebrate* community was last sampled from the lower Saluda in the summer of 2004. Hester Dendy samplers (multi-plate substrate sampler which mimic narrow substrates such as leaves or woody debris) were placed in six different locations on the LSR. They were then allowed to be colonized for seven weeks before they were removed and the benthic macroinvertebrate community was analyzed (Shealy, 2004).

This study was preformed in order to determine if there are significant differences in the benthic macroinvertebrate community as the distance from the Dam increases. However, it is not possible to determine if the Saluda Dam has actually *caused* a change in the levels of macroinvertebrates due to the lack of reference or control stations (Shealy, 2004).

The sampling stations were located in various increments along the Saluda River. The uppermost station being located directly downstream of the Dam and the furthermost station being 10.5 kilometers from the Dam. At each station three Hester Dendy samplers were placed. There were several stations at which samplers were not recovered. The available habitat in these locations varies from submerged logs and snags to vegetated banks (Shealy, 2004).

Studies during 2004 showed that as the distance from the Dam increased the relative numbers and richness of taxa increases. However this is to be expected due to the general characteristics of dams. The water level fluctuations and flow regimes of dams in general tend to cause a decrease in suitable macroinvertebrate habitat. Statistical analysis showed only small differences between the stations. They all had a NCBI rating of fair except only one replicate at station TR (located near the Dam) that had a rating of poor. Table E-8 shows the relative richness and abundance of Macroinvertebrate species on the LSR (Shealy, 2004).

10.3.2.11 Mussels

SCDNR is still in the process of compiling data on mussel distribution throughout South Carolina. However, through discussions with Jennifer Price of SCDNR, there were two survey points sampled on the LSR. Neither of these sites yielded any signs of mussels during sampling (Per. Corr. with Jennifer Price). This was further illustrated in the 2004 *Macroinvertebrate Assessment of the Lower Saluda River*. Six sites were surveyed along the LSR and no mussels in the order Unionoidia were found (Shealy, 2004). Furthermore, extensive surveys have shown that the Carolina Heelsplitter (*Lasmigona decorata*), which was designated as endangered throughout North and South Carolina in 1993, has no cited populations in the Saluda River (USFWS, 2003).

10.3.2.12 Threatened and Endangered Species

As indicated, shortnose sturgeon historically have inhabited the Congaree River basin. Recent information suggests that the shortnose sturgeon may migrate up the Congaree River. Shortnose sturgeon movements have been tracked as far as the Rosewood Boat Ramp on the Congaree River approximately 3 miles downstream from the confluence of the Broad and Saluda Rivers (pers Comm. Doug Cooke, SCDNR 2003). This is the farthest upstream movement of this species within recent years. To date no data supports the theory that shortnose sturgeon currently use the LSR. SCE&G is cooperating with current SCDNR studies to determine movements of shortnose sturgeon in the Congaree, Broad, and Saluda Rivers (pers. Comm. Steve Summer, SCE&G, 2003). Based on tracking information provided by the SCDNR, no sturgeon have been monitored moving into the Saluda River (pers. comm., Steve Summer SCANA Services, 2003).

Table E-4: Fish Species Typical of Lake Murray and the Lower Saluda River

Common Name	Scientific Name	Lake Murray	Lower Saluda River
Amiidae			
bowfin	*Amia calva*	X	X
Anguillidae			
American eel	*Anguilla rostrata*		X
Aphredoderidae			
pirate perch	*Aphredoderus sayanus*		X
Atherinidae			
brook silverside	*Labidesthes sicculus*	X	
Catastomidae			
Northern hog sucker	*Hypentelium nigricans*		X
creek chubsucker	*Erimyzon oblongus*		X
spotted sucker	*Minytrema melanops*	X	X
striped jumprock	*Moxostoma rupiscartes*		X
silver redhorse	*Moxostoma anisurum*		X
smallfin redhorse	*Moxostoma robustum*		X
shorthead redhorse	*Moxostoma macrolepidotum*	X	X
v-lip redhorse	*Moxostoma pappillosum*		X
river carpsucker	*Carpiodes carpio*	X	
Centrarchidae			
black crappie	*Pomoxis nigromaculatus*	X	X
white crappie	*Pomoxis annularis*	X	X
bluegill	*Lepomis macrochirus*	X	X
dollar sunfish	*Lepomis marginatus*	X	
pumpkinseed	*Lepomis gibbosus*	X	X
green sunfish	*Lepomis cyanellus*	X	
Lepomis hybrid	*Lepomis sp.*	X	
redbreast sunfish	*Lepomis auritus*	X	X
redear sunfish	*Lepomis microlophus*	X	X
warmouth	*Lepomis gulosus*	X	X
largemouth bass	*Micropterus salmoides*	X	X
smallmouth bass	*Micropterus dolomeiu*		X
Cluepeidae			
gizzard shad	*Dorosoma cepedianum*	X	X
threadfin shad	*Dorosoma petenense*	X	X
blueback herring	*Alosa aestivalis*	X	X

Common Name	Scientific Name	Lake Murray	Lower Saluda River
Cyprinidae			
dusky shiner	*Noropis cummingsae*		X
spottail shiner	*Notropis hudsonius*	X	X
rosyface chub	*Notropis rubescens*		X
sandbar shiner	*Notropis scepticus*		X
swallowtail shiner	*Notropis procne*	X	X
yellowfin shiner	*Notropis lutipinnis*		X
coastal shiner	*Notropis petersoni*	X	
highfin shiner	*Notropis altipinnis*		X
ironcolor shiner	*Notropis chalybaeus*		X
Eastern silvery minnow	*Hybognathus regius*	X	X
whitefin shiner	*Cyprinella nivea*		X
thicklip chub	*Cyprinella labrosa*		X
golden shiner	*Notemigonus crysoleucas*	X	X
bluehead chub	*Nocomis leptocephalus*		X
carp	*Cyprinus carpio*	X	X
Esocidae			
chain pickerel	*Esox niger*	X	X
Cyprinodontidae			
lined topminnow	*Fundulus lineolatus*		X
Ictaluridae			
snail bullhead	*Ameiurus brunneus*	X	X
flat bullhead	*Ameiurus platycephalus*	X	X
brown bullhead	*Ameiurus nebulosus*	X	X
yellow bullhead	*Ameiurus natalis*	X	X
white catfish	*Ameiurus catus*	X	X
channel catfish	*Ictalurus punctatus*	X	X
Lepisosteidae			
longnose gar	*Lepisosteus osseus*	X	X
Moronidae			
white bass	*Morone chrysops*	X	X
striped bass	*Morone saxatilis*	X	X
white perch	*Morone americana*	X	X
Percidae			
carolina darter	*Etheostoma collis*		X
piedmont darter	*Percina crassa*		X
tessellated darter	*Etheostoma olmstedi*	X	X
yellow perch	*Perca flavescens*	X	X
swamp darter	*Etheostoma fusiforme*	X	

Common Name	Scientific Name	Lake Murray	Lower Saluda River
Poeciliidae			
eastern mosquitofish	*Gambusia holbrooki*	**X**	**X**
Salmonidae			
brown trout	*Salmo trutta*		**X**
rainbow trout	*Oncorhynchus mykiss*		**X**

Table E-5: Spring Electrofishing Data Collected in the Lower Saluda River by SCE&G (1996-2001)

SPECIES	1996	PERCENT COMPOSITION	1997	PERCENT COMPOSITION	1998	PERCENT COMPOSITION	1999	PERCENT COMPOSITION	2001	PERCENT COMPOSITION
American eel			1	0.2						
black bullhead									1	0.8
black crappie	4	1.3								
Bluegill	46	14.8	54	14.9	17	13.4	3	33.3	4	3.2
Bluegill x redear sunfish			1	0.2						
bluehead chub									1	0.8
Bowfin									1	0.8
brook silversides										
brown trout	28	9.0	21	5.8	4	3.1			7	5.6
catasomidae unid.										
chain pickerel	1	0.3	6	1.6					5	4.0
Channel catfish	1	0.3	6	1.6						
common carp	10	3.2	7	1.9					2	1.6
creek chubsucker	2	0.6	9	2.4	1	0.7			17	13.6
eastern silvery minnow	9	2.9								
flat bullhead	1	0.3							1	0.8
gizzard shad	32	10.3	72	19.8	26	20.6				
golden shiner	1	0.3	1	0.2	1	0.7			1	0.8
grass carp	8	2.5	2	0.5						
greenfin shiner									7	5.6
highback chub									1	0.8
highfin shiner										
ironcolor shiner										
largemouth bass	13	4.2	10	2.7	3	2.3	2	22.2	7	5.6
longnose gar			2	0.5					1	0.8
mosquitofish										
northern hogsucker	2	0.6	1	0.2					1	0.8

SPECIES	1996	PERCENT COMPOSITION	1997	PERCENT COMPOSITION	1998	PERCENT COMPOSITION	1999	PERCENT COMPOSITION	2001	PERCENT COMPOSITION
Notropis sp			7	1.9						
pirate perch	5	1.6								
pumpkinseed					1	0.7				
quillback									2	1.6
quillback carpsucker	3	0.9								
rainbow trout	13	4.2	8	2.2	3	2.3			8	6.4
redbreast sunfish	9	2.9	13	3.5	8	6.3	1	11.1	3	2.4
redear sunfish	40	12.9	60	16.5	29	23.0	1	11.1	10	8.0
sandbar shiner					1	0.7				
satinfin shiner										
shorthead redhorse	1	0.3								0.8
silver redhorse	1	0.3								
silvery minnow										
snail bullhead			2	0.5						
spottail shiner									1	0.8
spotted sucker	31	10.0	20	5.5	9	7.1			23	18.4
striped bass	2	0.6	12	3.3					10	8.0
tesselated darter										
turquoise darter	2	0.6								
unid. *Alosa*			1	2.0						
unidentified shiner									1	0.8
v-lip sucker										
warmouth										
white catfish	16	5.1	3	0.8	2	1.5				
white perch										
whitefin shiner									6	4.8
yellow perch	28	9.0	43	11.8	20	15.8	2	22.2	4	3.2
yellowfin shiner										
TOTAL	**309**		**362**		**125**		**9**		**125**	

Table E-6: Fall Electrofishing Data Collected in the Lower Saluda River by SCE&G (1995-2000)

SPECIES	1995	PERCENT COMPOSITION	1996	PERCENT COMPOSITION	1997	PERCENT COMPOSITION	1998	PERCENT COMPOSITION	1999	PERCENT COMPOSITION	2000	PERCENT COMPOSITION
American eel			1	0.4	3	0.8	1	0.3				
black bullhead												
black crappie			1	0.4			3	1.1	1	0.3		
bluegill	24	9.4	58	23.4	112	31.8	38	14.1	51	19.6	37	13.3
bluegill x redear sunfish												
bluehead chub											1	0.3
bowfin												
brook silversides											24	8.6
brown trout	1	0.3							1	0.3	1	0.3
Catasomidae unid.			1	0.4								
chain pickerel	6	2.3	5	2.0	9	2.5			21	8.1	13	4.6
channel catfish							1	0.3				
common carp	19	7.4	9	3.6	7	1.9	10	3.7	12	4.6	2	0.7
creek chubsucker	10	3.9	4	1.6	14	3.9	1	0.3	13	5.0	21	7.5
eastern silvery minnow					8	2.2						
flat bullhead												
gizzard shad	77	30.1	56	22.6	1	0.2	60	22.3	2	0.7	28	10.0
golden shiner									1	0.3		
grass carp									1	0.3		
greenfin shiner												
highback chub												
highfin shiner											4	1.4
ironcolor shiner											18	6.4
largemouth bass	9	3.5	16	6.4	12	3.4	13	4.8	12	4.6	16	5.7
longnose gar												
mosquitofish							2	0.7	2	0.7		
northern hogsucker	1	0.3	1	0.4	1	0.2					6	2.1
Notropis sp												
pirate perch					6	1.7			4	1.5		

SPECIES	1995	PERCENT COMPOSITION	1996	PERCENT COMPOSITION	1997	PERCENT COMPOSITION	1998	PERCENT COMPOSITION	1999	PERCENT COMPOSITION	2000	PERCENT COMPOSITION
pumpkinseed												
quillback												
quillback carpsucker												
rainbow trout												
redbreast sunfish	10	3.9	13	5.2	34	9.6	23	8.5	47	18.1	18	6.4
redear sunfish	18	7.0	16	6.4	24	6.8	31	11.5	16	6.1	28	10.0
sandbar shiner			4	1.6	24	6.8					6	2.1
satinfin shiner	1	0.3									2	0.7
shorthead redhorse	1	0.3	4	1.6	4	1.1			1	0.3	1	0.3
silver redhorse			1	0.4	1	0.2						
silvery minnow	1	0.3										
snail bullhead												
spottail shiner	1	0.3	11	4.4								
spotted sucker	24	9.4	29	11.7	34	9.6	33	12.3	13	5.0	40	14.3
striped bass	1	0.3			9	2.5			3	1.1	2	0.7
tesselated darter									2	0.7		
turquoise darter												
unid. Alosa			1	4.0								
unid.catastomid	14	5.4					10	3.7			3	1.1
unid. shiner												
v-lip sucker												
warmouth			3	1.2	1	0.2	1	0.3	3	1.1	3	1.1
white catfish					1	0.2	9	3.3				
white perch	3	1.1					7	2.6				
whitefin shiner												
white perch			2	0.8					49	18.9		
whitefin shiner	34	13.3	11	4.4	45	12.7			2	0.7	4	1.4
yellow perch												
yellowfin shiner					2	0.5	25	9.3	2	0.7		
TOTAL	**255**		**247**		**352**		**268**		**259**		**278**	

Table E-7: Comparison of Saluda Trout Growth Study Results Versus Other Southeastern Hydropower Tailwaters (Kleinschmidt, 2003)

Growth Rate Comparison – SE Tailwaters								
Dam	**State**	**Length (mi)**	**Period**	**Start size (in)**	**T (deg C)**	**DO (mg/L)**	**Grow rate (in/mo)**	**Notes**
Saluda	SC	10	Nov 1988-Apr 89 **Dec 2002-Jun 2003**	6 (40g) 10 (150g)	10-18 8-15	0.5-12 4-12	0.25 **0.67**	Before aeration - RBT **Current aeration - RBT**
various	KY	--	current				0.5	per KDFWR staff – BT, RBT
Wolf Creek	KY	50	Apr-Nov 1997 Apr-Nov 1998 Apr-Nov 1999 Apr-Nov 2000 Apr-Nov 2001 Apr-Nov 2002	7.5 8.2 8.2 7.0 7.4 7.7	9-27 9-27 9-27 9-27 9-27 9-27	3-10 3-10 3-10 3-10 3-10 3-10	0.52 0.48 0.49 **0.71** **0.69** 0.54	Dreves (2003) KDFWR - BT
Center Hill	TN	26	Mar-Jul 1997	9.4		4-7	0.51	Devlin (1999) TTU - RBT
Norris	TN	30	Jan-May 1975 Jan-May 1985 abv weir Jan-May 1985 bl weir Jan-May 1986 abv weir Jan-May 1986 bl weir	9.3 7.5-8.0 7.5-8.0 7.0-7.5 7.0-7.5	7-10 5-9 5-9 6-10 6-10	>8 >8 >8 8-10 8-10	0.62 0.48 0.30 0.38 0.43	1993 TVA data - RBT Shiao, et. al (1993) weights using CF=1.1; growth probably T limited
South Holston	TN	14	Mar-July 1992 July-Sep 1992 Mar-Sep 1992 1997 – Mar. stocking 1997 – Sep stocking 1997	4.72 7.64 4.72	6-8 6-8 6-8 <22 <22 <22	8-12 8-12 8-12 >6 >6 >6	0.58 **1.69** **0.90** 0.35 0.63 0.43	1992 TVA - RBT data Shiao, et. al (1993) Yeager, et. al (1993) Bettoli (2003) TTU - RBT Bettoli (2003) TTU - RBT Bettoli (2003) TTU - BT
Wilbur	TN		1998 – Mar stocking 1998 – July stocking				0.27 0.19	Bettoli (2003) TTU - RBT
Growth Rate Comparison – Non-Tailwater Locations								
Sierra Nevada streams	CA		Avg 1987-1996 site #1 (fall-spring) Avg 1987-1996 site #2 (fall-spring) Avg 1987-1996 site #1 (summer) Avg 1987-1996 site #2 (summer)	Age 0 Age 0 Age 1 Age 1	Avg 7.2 Avg 10.2 Avg 14.9 Avg 18.1		0.44 0.54 0.20 0.06	Railsback and Rose (1999) - RBT

Table E-8: Bioassessment Metrics for the 5 Saluda River Hester Dendy Stations Downstream from the Lake Murray Hydroelectric Dam, Operated by South Carolina Electric and Gas Company. Lexington County, SC. 01 July, 2004 (Shealy, 2004)

	Station										
Metric	TR1	TR2	TR3	SPW1	SPW2	SPW3	LR1	LR2	LR3	OPC2	OPC3
Taxa Richness	15	21	20	30	27	38	31	30	27	24	26
Number of Species	166	156	178	171	176	189	107	138	68	231	298
EPT Index	2	2	2	3	3	4	5	5	4	5	6
EPT Abundance	27	26	22	31	34	27	30	49	5	170	204
Chironomidae Taxa	5	9	8	14	13	17	11	14	10	12	11
Chironomidae Abundance	15	35	29	70	43	87	38	47	33	36	41
EPT/Chironomidae Abundance	1.80	0.74	0.76	0.44	0.79	0.31	0.79	1.04	0.15	4.72	4.98
North Carolina Biotic Index	7.93	7.31	7.62	7.02	7.47	6.97	7.50	7.38	7.53	7.17	6.91
Percent Collector-Filterers	6.02	10.26	8.43	22.22	11.93	16.40	32.10	31.33	36.48	24.30	38.22
Percent Collector-Gatherers	1.20	1.92	1.69	14.04	3.98	7.41	1.33	1.29	1.64	2.78	1.04
Percent Omnivores	7.23	8.97	3.37	7.60	13.64	7.41	6.37	18.45	7.38	2.53	2.37
Percent Predators	0.60	5.77	1.12	6.43	4.55	5.82	11.41	5.58	8.20	4.05	5.78
Percent Scrapers	78.92	57.69	74.72	38.01	57.95	38.62	48.28	41.20	44.26	65.82	52.30
Percent Shredders	6.02	15.38	10.67	11.70	7.95	24.34	0.53	2.15	2.05	0.51	0.30
Scraper/Scraper & Collector-Filterers	13.10	5.63	8.87	1.71	4.86	2.35	1.50	1.32	1.21	2.71	1.37
Percent Dominant Taxon	34.94	17.95	30.90	15.79	17.61	12.70	29.97	30.04	35.25	21.27	35.85
Number of Dominant Taxa	4	8	6	7	6	6	3	4	2	6	5

11.0 BOTANICAL RESOURCES

11.1 Upland Habitat

The botanical and forestry resources of the Project area consist mainly of the dominant woody pioneer or climax species of the southern Piedmont hardwood forests. Forested areas of the Project function mostly in support of forestry, wildlife or game management, and recreational or aesthetic values. Various combinations of the tree and shrub species cover 4,513.5 acres of Project lands over a shoreline distance of 92.9 miles (Mead and Hunt, 2002a). One of the most common trees is loblolly pine *(see table E-9 for scientific names)*, coming in early after disturbance of most well-drained sites and dominating for up to 40 years afterwards. This tree is also the species of choice for the regional forestry industry, growing rapidly and generating clear, straight wood for a number of uses.

SCE&G manages forest resources on total of 10,532 acres (within a quarter mile of Lake Murray) of its land according to an official Forest Management Plan. The plan provides for selective harvesting of pines and hardwoods, and maintenance of a 100-foot-wide shoreline buffer to protect water quality, wildlife, fishery, and aesthetic values. In certain areas such as cliffs, steep slopes, or atypical groups of trees, no logging is allowed. On private riparian lands sold by SCE&G since 1984, a 75-foot vegetated buffer zone above the 360-foot contour is maintained in accordance with current FERC license conditions. In this zone, brushing or clearing of vegetation is limited to trees or shrubs of 3 inches in diameter or less. Enforcement of buffer zone compliance is by written agreement, with penalties imposed by SCE&G through denial or revocation of dock permits for violators (SCE&G, 1994).

11.1.1 Lake Murray

Along the forested slopes in the upper region of the lake, mature oak-dominated forest can be found with a diverse canopy and sub-canopy layer (SCE&G, 1994). Species differ between the upper and lower slopes and because of the dense canopy, the herbaceous layer is sparse. These forests are important mainly as wildlife habitat. They cover 20.6 acres of land and over a mile of shoreline (Mead and Hunt, 2002a).

Rocky Shores are located along the shoreline adjacent to rock outcroppings. They are usually devoid of vegetation but do provide a stable vertical structure to otherwise uniform bottom relief. They attract littoral fish species and, if located in open water, are equally attractive to pelagic fishes (SCE&G, 1994).

11.1.2 <u>Lower Saluda River</u>

Habitat diversity found in the LSR is more homogeneous than the highly diversified habitats of Lake Murray. In the areas below the Dam, vegetation consists of mesic (environments midway between extremes) hardwood forests, wetlands, pine plantations, and open, disturbed herbaceous plant communities on the berms surrounding the former ash ponds for McMeekin Station and areas impacted by the remediation work associated with the Dam. These areas are highly disturbed and contain little in the way of botanical resources. The mixed hardwood forest cover type dominates much of the available habitat along the LSR, especially near the rivers edge (pers. observation).

The forest edge habitat of the LSR, which is located in the transitional area between open and forested cover types, comprises approximately ten percent of the total habitat along the LSR. This cover type is the interface between the forested and field habitats and provides a great deal of vegetative diversity and height class complexity (Colinvaux, 1986).

Open field habitat makes up approximately fifteen percent of the available habitat along the LSR. Open field habitat is limited to those areas that are periodically mowed and maintained and are typically dominated by assorted grasses. These cover areas are confined to a narrow strips in agricultural areas along the river corridor (pers observation A. Stuart Kleinschmidt, 2003).

Based on visual estimates made by Kleinschmidt Associates, river edge cover type makes up approximately sixty-five percent of the available habitat along the LSR. These areas are highly diverse in terms of botanical resources (pers. comm. David Haddon SCE&G 2003).

11.1.3 Islands

The 61 islands within the Project boundary support a variety of plant communities depending on elevation and land-use history. The riverine islands primarily support bottomland hardwood forests. The herbaceous layer on the islands consists of a mixture of forbs and graminoid plants and may be patchy depending on the canopy cover.

Loblolly pine-mixed hardwood islands are found on the middle and lower portions of the lake. However, most of these islands have been subjected to periodic burning and have a dense canopy composed of loblolly and shortleaf pine, water oak, and sweetgum, which does not allow for a significant herbaceous understory to develop. Open, disturbed islands support scattered trees and shrubs and, in the more open areas, dense herbaceous layers consisting of a diversity of grasses and forbs. The vegetation is dominated by successional species. Successional describes a species or community that is ephemeral in that it will be replaced by species that will form the climax community. An abandoned farm field for example contains successional species. These species will be replaced by a more stable long-term community unless regular disturbance such as annual mowing keeps it in a successional state.

Continued natural and anthropogenic disturbances in the form of wind and wave action, prescribed burning, past agricultural use and present recreational use serve to maintain the open aspect of these islands (Mead and Hunt, 2002a). The herbaceous layer on the open and disturbed islands is dominated by grasses and composites in the autumn, many of which are typical species of old field succession. Old field succession is typically when herbal communities of old fields succeed each other and give way to pines, the organic layer of the soil deepens and the water retaining capacity of the soil increases (Colinvaux, 1986).

The most ecologically distinct island is Lunch Island, located approximately 4.5 miles upstream of the Dam, which has a dense stand of switch cane and abundant pokeberry. As mentioned in more detail in the Wildlife section, this island is home to one of the largest colonies of nesting purple martins in the world. Lunch Island is also covered by an open habitat of scattered trees and shrubs over a dense herbaceous layer of grasses and composite forbs very similar to a number of other small islands in the lake (SCE&G, 1994).

The islands provide important wildlife habitat for a number of species and are a major recreational and aesthetic asset for the lake. The islands total approximately 617.7 acres, with a combined shoreline length of 36.9 miles (Mead and Hunt, 2002a).

11.1.4 Wetlands

In March 2000, the SCE&G staff delineated wetlands in 31 different locations immediately downstream of the Project Dam comprising approximately 55 acres. The hydrology of these areas varies from an intermittent or seasonal inundation to perennial flow. The vegetation in the wetlands includes a wide variety of forested, shrub, vine, and herbaceous cover types. The different types of wetlands downstream of the Dam include small, seasonally flooded forests, abandoned borrow pits/quarries that have developed ponded and *palustrine* habitats, a narrow riverine forested wetland, seasonally flooded areas of scrub/shrub, seasonally flooded bottomland hardwoods, and emergent wetlands (Mead and Hunt, 2002a). These are the only wetlands downstream of the Project Dam to be delineated. However NWI maps for the Project Area depict wetlands within the Project boundary. Information on wetlands in the *project vicinity* is currently in the process of being developed digitally by the USFWS National Wetlands Inventory.

Wetlands upstream of the Project Dam, specifically those around the Lake Murray shoreline, consist primarily of *lacustrine* fringe communities and *submerged aquatic vegetation* (SAV). The predominant lacustrine fringe communities on the lake include emergent aquatic species at the lower elevations and emergent and shrub species at the higher elevations. Other emergent wetland species occupy a narrow band of the lacustrine fringe habitat along the reservoir and larger flat regions of the Saluda and Little Saluda Rivers. Approximately 363 acres of emergent wetland exist below the 360-foot contour around the lake, with nearly ninety percent of them occurring in the headwater region of the lake along the Saluda River (Mead and Hunt, 2002a).

Palustrine scrub-shrub wetlands occupy the lacustrine fringe, shallow coves, and the tributary banks. There are approximately 140 acres of this type of wetland below the 360-foot contour around Lake Murray. Pockets of the shrub habitat can be found in coves with the most extensive areas occurring along the Saluda River, just upstream of the Little River confluence. The predominant shrub community consists primarily of buttonbush and black willow, with the occasional presence of persimmon and water willow as well. The palustrine forested wetlands (PFO) occupy approximately 1,618 acres below the 360-foot contour around the lake. It is expected that most of the forested wetlands associated with the lake receive infrequent and irregular flooding, in addition to other inputs such as streamflow and runoff (Mead and Hunt, 2002a). Wetlands are delineated on the USFWS National Wetland Inventory (NWI) database. The USFWS is charged with maintaining the NWI wetland Mapping system. It should be recognized that both jurisdictional and non-jurisdictional wetlands are depicted on NWI maps. The NWI uses an identification and classification system developed specifically for the USFWS (Cowadrin et al. 1979) that is similar to the US Army Corps of Engineers (COE) but it differs in several key aspects. Therefore, it is important to note that jurisdictional wetlands are those wetlands that are subject to regulation under Section 404 of the *Clean Water Act*, and that wetlands not subject to this permitting process are referred to as non-jurisdictional. In terms of resource management, only the COE system determines whether or not a wetland is jurisdictional, while the NWI further classifies wetlands according to hydrology, vegetation and other characteristics.

Water Tupelo stands are located in the upper lake in low wet flats. They consist of a dense, monotypic stand of water tupelo. Since water tupelo stands occur only in areas that are consistently inundated, the shrub layer is absent. Swamp beggar-tick grows on the trunks of the trees at or just above the high water mark (SCE&G, 1994). In areas where the substrate is exposed, false pimpernel is found. These areas are relatively limited and comprise 0.6 acres over 0.1 miles of shoreline habitat (Mead and Hunt, 2002a). These stands are unique because they are the northern most occurrences of water tupelo known to exist in the Saluda River (SCE&G, 1994).

In addition to the forested areas and wetlands, islands, shallow coves, and other ecologically significant botanical resources occur within the *riparian areas* of the Project. These were most recently described and classified by SCE&G (1994) in response to a 1991 FERC *Order to Amend the Land Use and Shoreline Management Plan* (FERC, 1991). Studies undertaken by SCE&G to amend the plan resulted in the classification of 11 habitat types as Environmentally Sensitive Areas (ESAs) below the 360-foot contour, which included nine vegetated habitat types described briefly below, as well as unvegetated shallow shoals and rocky shores having littoral buffer or fishery values. The botanical species found in each of the habitat types are listed in Table E-9. The designation as ESA was not meant to imply an existing threat or need for preservation, but was intended as a reference tool in consideration of management alternatives and establishment of management objectives (SCE&G, 1994).

Shallow Coves are jurisdictional wetlands that include flats and gentle slopes above the 352-foot contour and extend down to about 6 feet below the annual mean high-water mark. They occur immediately below buttonbush and willow flats (described below). Depending on water level, they provide shallow water or exposed shoreline habitat and are usually inundated from late winter through spring. The higher, more exposed portion is more diverse because of its longer exposure and supports distinctly-zoned assemblages of forbs, grasses, sedges, and rushes. The coves cover 32.7 acres of Project lands over a shoreline distance of 2.9 miles (Mead and Hunt, 2002a). These areas provide habitat for several wildlife species and are significant to the recreational fishery, representing most of the suitable spawning and nesting habitat for the resident centrarchids (*i.e.* bass and sunfish).

The draw-down zone is the area between the high water level and the actual water level and is usually inundated from late winter through spring. Graminoid plants (Grasses) dominate the draw down zone and the vegetation usually exhibits a strong pattern of zonation, especially in the lower lake (Mead and Hunt, 2002a). The upper portion of the draw-down zone is typically the most diverse because of the extended periods of exposure (not covered by water), supporting a mixture of forbs (broad leafed herbaceous plants) and graminoid plants. The intermediate and lower portions of the draw down zone are dominated by spikerushes. The draw down zone in the upper portion of Lake Murray consists of extensive flats rather than the sloping, exposed shoreline. The riverine flats are similar to exposed bars and are dominated by graminoid plants.

Shallow shoals areas located on Lake Murray generally consist of submerged ridges and hill tops located above the 352-foot contour. These shallow shoal areas are generally in unprotected areas and are subject to constant wave impact, which makes colonization by vegetation in these areas difficult. However, these areas are important transition zones between the shallow cove, buttonbush, and willow habitats and the deep water.

Buttonbush and willow flats usually occur at or just below the 360-foot elevation and are common along the upper margins of shallow coves and other shoreline areas (SCE&G, 1994). They also occasionally extend up feeder creeks at lower flood plain elevations and are considered jurisdictional wetlands. These flats typically support buttonbush on the lake side with black willow located behind the buttonbushes. Infrequently, only buttonbushes may be found in this zone, either in dense stands or as scattered individuals. This community, when disturbed, is very susceptible to invasion by water primrose. The buttonbush and willow flats cover approximately 352.3 acres of the Project over a shoreline distance of 139.4 miles (Mead and Hunt, 2002a). Other species occurring in these areas are shown in Table E-9. The stability provided by the root systems of the plants growing in this habitat reduces the effects of erosion caused by wave action. Because of this stability, spawning centrarchids use these areas extensively. The structural complexity of these areas also provides a safe haven for larval and juvenile fishes (Mead and Hunt, 2002a).

Bottomland hardwood areas occur in the upper lake as a transition zone between wet flats and upland forest and on the lower lake between shallow coves or buttonbush and willows and upland forest. They are generally found where creeks enter the lake. These areas are important wetlands and help to filter out pollutants and sediments present in runoff. Bottomland hardwood provides important foraging and nesting habitat for several species of wildlife such as the white-tail deer, squirrels, raccoons and a number of neo-tropical bird species (Mead and Hunt, 2002a).

Exposed bar areas of Lake Murray occur in the upper lake and are typically associated with the riverine islands. They are remnants of the old river system and consist primarily of sand and heavier materials deposited during flood events along the river banks before the Saluda River was impounded. Exposed bars are still heavily influenced by river currents and the inflow of nutrients. These areas are inundated during most of the year and are usually exposed only during the winter months, which classify them as wetlands under the NWI mapping system. Graminoid plants typically tend to dominate the plant community structure of the exposed bars. The high velocity and nutrient loading in the upper portion of the reservoir determine habitat suitability of the exposed bars for reservoir fish. Upstream portions of the bars usually have limited fish habitat, while the more protected downstream areas of the bars offer more favorable spawning locations for nest-building bass, crappie, and sunfishes. Exposed bars include 52.2 acres of the Project area over a shoreline distance of 1 mile (Mead and Hunt, 2002a).

Wet flats exist in the upper lake between the bottomland hardwoods and shallow coves and have two distinct forest cover types depending on elevation (low wet flats *vs.* higher flats). Both types are jurisdictional wetlands. The wet flats provide important wildlife habitat for the lake ecosystem and, when submerged, are prime feeding areas for migratory waterfowl. During high-water periods, they are also an important source of course particulate organic matter for the lake, which forms an important supplement to fine and dissolved sources of nutrients supplied by tributary creeks and rivers. The total area of wet flats is 495.4 acres and covers over 15.8 miles of shoreline (Mead and Hunt, 2002a).

11.1.5 Threatened and Endangered Botanical Specis

Seven species are listed as either rare, threatened, or endangered as indicated by federal and state agencies. An assessment of Threatened and Endangered species for the Saluda Dam Remediation Project was conducted in 2001. The following information on threatened and endangered species potentially found in the Project area was taken from the remediation Project environmental report prepared by Mead and Hunt in 2000.

The smooth coneflower (*scientific names for threatened and endangered species are listed in Table E-10*) is an herbaceous perennial that flowers from May to July. They are mainly found in basic soils that undergo periodic mowing, burning, or other disturbances that suppress competition and allow full sunlight to penetrate. These habitats include open woods, cedar barrens, roadsides, clear-cuts, right-of-ways, and dry limestone bluffs. A small population of this coneflower is known from Fort Jackson in Richland County, but there are no known populations in Lexington County. No specimens of smooth coneflower were located during fieldwork conducted in 2000; and with the lack of burning or similar disturbances on downstream Project lands, habitat potential for this species is limited.

Schwienitz's sunflower is a rhizomatous, perennial herb that flowers in late summer in clearings and along the edges of upland woods, roadways, and utility easements. There are no known populations of this species in the Project area and no specimens of this species were located during fieldwork in the late summer of 2000.

Canby's dropwort is a perennial herb of the Coastal Plain wetlands occurs in pond cypress savannas, pond cypress/pond sloughs, and wet pine savannas. It also requires regular burning or mowing. All known populations are in Carolina bays of the Coastal Plain. No habitat exists for this species in the Project area and no specimens were found during field surveys of Project wetlands downstream of the Dam in 2000.

Rough-leaved loosestrife is a perennial herb is found in the Coastal Plain and Sandhill Regions of the Carolinas. It inhabits the grass-shrub transition zone between longleaf pine woods and pond pine pocosins on seasonally-wet sands or shallow organic soils over sand. It also occurs on deep peat soils of the Carolina bays. These habitats are also fire-maintained. The only known South Carolina population of this loosestrife is at Fort Jackson in Richland County. Since there is intensive development and fire suppression in the Project area, there is no habitat potential for this species (Mead and Hunt, 2002a).

In 1991 the USFWS found little amphianthus (pool sprite) in a pool in Saluda County. This plant is restricted to shallow, flat-bottomed depressions, rock-rimmed and normally less than one foot deep, on granitic outcrops, where water collects following a rain event. The depressions may be dry for most of the summer, except for occasional rainy periods (Georgia Natural Heritage Program, Mead and Hunt, 20012).

A harperella population was found by USFWS (1992) in Saluda County. The plants normally occur in rocky or gravel shoals, margins of clear, swift-flowing sections of stream, or at the edges of intermittent pineland ponds in the coastal plain. The status of this species as occurring in the Project boundary is unknown.

A known population of the rocky shoals spider lily exists approximately 10 miles downstream of the Saluda Dam at the confluence of the Saluda and Broad Rivers in Columbia (Clemson University Dept. of News Services, 1997). The plant is found in major streams and rivers among boulders in the rocky shoals, typically with riverweed and water willow. This lily has become rare because of habitat loss caused by the building of dams and canals along river systems, which have altered the flow patterns over the rocky shoals. SCDNR stated that the plant could tolerate high flows, which may reduce the occurrence of competitive plant species.

These species listed require specialized habitats to carry out their life cycles and these habitats are not likely found in the Project area, with the exception of the Rocky Shoals Spider lily (RSSL). ARM Environmental Consultants conducted an assessment of threatened and endangered species for the Saluda Dam remediation project and found that any federally listed species would not occur in the impacted area due primarily to lack of suitable habitat (ARM, 2001). The RSSL has been located in the downstream most reaches of the LSR. For a listing of all botanical Federal and State listed threatened and or endangered species in counties occupied by the Project, please refer to Table E-10.

11.1.6 Invasive Aquatic Plants

Invasive aquatic plants have been problematic in Lake Murray and the LSR for a number of years. In order to keep track of plant abundance and distributions, quantitative data on aquatic plants has been collected through aerial surveys and summarized in distribution maps. In the early 1990's, Brazilian elodea was the primary aquatic plant of concern on Lake Murray (Aulbach-Smith, 1997). Brittle waternymph presented problems as well, however a shift of concern occurred upon the discovery of hydrilla in 1993. Hydrilla is an exotic plant that was introduced into the United States in the 1960's through the aquarium trade. Presently millions of dollars are spent every year in order to control this noxious weed. One key to hydrilla's success is the multiple modes through which it reproduces. Not only does hydrilla spread through seeds, it also reproduces through tubers, plant fragments, and turions (overwintering buds). Boat traffic and waterfowl also contribute to the spread of populations throughout bodies of water (Access Washington, 2004).

Lake Murray

There are several invasive aquatic plant species that are under observation on Lake Murray. These include hydrilla, Eurasian water milfoil, and several species of pondweed (Potamogeton pusillus, P. crispus, and P. illinoensis) (Aulbach-Smith, 1997). Hydrilla populations are beginning to decline in Lake Murray due to the introduction of triploid Chinese grass carp into Lake Murray in 2002. The diet of grass carp is almost exclusively aquatic plants and they can help tremendously in the reduction of invasive plant species. Eurasian milfoil is also a cause for concern on Lake Murray. However, through numerous pesticide applications the spread of Eurasian water milfoil has been confined to one cove of the lake. Several species of pondweed are present and are posing problems as well. The most notable of these is Illinois pondweed. It releases large amounts of seeds that are spread by waterfowl and wave action. Grass carp will readily consume Illinois pondweed, though it seems unaffected by the winter drawdowns that are used in the control of hydrilla (Aulbach, 2001b).

The Lower Saluda River

The majority of aquatic vascular plants on the lower Saluda River are introduced species. Seasonal changes and water fluctuations in the lower Saluda River tend to cause a reduction in the numbers of aquatic plants present in the river channel. However, Brazilian elodea is one *exotic species* that is continuing to expand, and is also becoming more common in the rocky shoals. There is concern that Brazilian elodea may crowd out riverweed, a native plant, that usually resides in the rocky shoals. Parrot's feather grows sporadically amongst Brazilian elodia (Aulbach, 2003). Aquatic plants such as Asian dayflower and water primrose are present in the shallow backwaters downstream from the confluence with the emergency spillway (see Figure E-13) (Aulbach, 2001a).

12.0 WILDLIFE RESOURCES

Although the Lake Murray shoreline continues to undergo development, the project area contains extensive habitats that support diverse and abundant wildlife populations. Shoreline habitats are typical of the Piedmont area of South Carolina and include pine plantations, bottomland and upland hardwood forests, mixed pine/hardwood forests, open fields, and sandhills. The majority of wildlife habitats in shoreline areas are found in the 75 ft. setback, riparian buffer zones, Environmentally Sensitive Areas (ESAs), and undeveloped areas of the project. Details regarding the vegetative resources (*i.e*., wildlife habitats) are presented in Section 9.3.4.

Forested and other terrestrial areas surrounding the project harbor typical woodland species such as wild turkey, white-tailed deer, raccoon, gray squirrel, opossum, and gray fox. Terrestrial areas also support a variety of resident and migratory birdlife including songbirds, woodpeckers, raptors, and upland game birds. Typical species include red-tailed and red-should hawks, bobwhite quail, mourning dove, American robin, eastern bluebird, pileated woodpecker, and meadowlark. The project area also supports an abundance of terrestrial reptiles and amphibians such as eastern box turtle, green anole, broad-headed skink, gray rat snake, southern toad, green tree frog, and marbled salamander.

The abundant open- and shallow-water habitats within the project area support a variety of aquatic and semi-aquatic wildlife such as beaver, river otter, muskrat, and possibly mink. Shallow, often vegetated areas in creekmouths, backwaters, and along reservoir shorelines are used for foraging and cover by migratory and resident waterfowl such as wood ducks, Canada geese, American coots, and black ducks, as well as wading birds such as great blue herons, great egrets, and green herons. In addition to providing important breeding habitat for most amphibian species, these shallow waters also provide year-round habitat for aquatic reptile and amphibian species such as eastern newt, bullfrog, spring peepers, brown and red-bellied water snakes, and mud and musk turtles.

Open water areas are often utilized by such species as bald eagle, kingfisher, osprey, and various gulls for foraging.

Lunch Island on Lake Murray is one of the largest pre-migratory roosting sites for purple martins in the United States (Russell and Gathreaux, 1999). The purple martin is a neotropical migrant, meaning that it migrates annually from its normal range in South America, the West Indies and portions of Central America, northward to breeding grounds across North America (Brown, 1997). This species is unique in that it nests in large colonies and is almost entirely dependant upon man-made structures for nesting (Russell and Gathreaux, 1999). Following the fledging period, purple martins often congregate in large nocturnal roosts of 100,000 or more birds prior to returning southward (Brown, 1997). Beginning in late June and extending through August or early September these congregations engage in two mass movements daily as they exit the roost in the morning to feed and return in the evening (Russell and Gathreaux, 1999). It has been estimated that at least 700,000 birds utilize the Lunch Island roost (Russell and Gauthreaux, 1999), prompting SCE&G, SCDNR, and the Columbia Chapter of the National Audubon Society to designate the eastern end of the island as North America's first purple martin sanctuary.

Typical wildlife species for the project area are listed in Tables E-11 through E-13.

12.1 Threatened and Endangered Wildlife Species

Five species classified as threatened or endangered by state or federal agencies are known to occur within the four counties (Lexington, Richland, Saluda, and Newberry) that the Saluda Project is situated (see Table E-10). However, many of these are coastal plain species and the habitats necessary to support them are not present within the Project boundaries. Currently, only federally threatened bald eagles and federally endangered wood storks are known to occur within the Saluda Project Boundary, and as such, are described in greater detail below (SCDNR, 2002b).

Bald Eagle

The bald eagle was listed as federally-endangered on March 11, 1967, partially due to the significant population declines attributed to the use of DDT. Subsequent to the banning of DDT, populations began to increase and the eagle's status was lowered from endangered to threatened on July 12, 1995 (USFWS, 1995a). Populations continue to recover, with the number of nesting pairs in the lower 48 states increasing from an estimated 417 to 6571 since the 1960's (Bryan et al., 1996). In South Carolina, the number of estimated nesting pairs has increased from 13 in 1977 to 181 in 2003 (Wilde et al., 2003).

Bald eagles may be found throughout North America, typically around water bodies where they feed primarily on fish and scavenge carrion. Studies suggest reservoirs, especially those associated hydroelectric facilities, are particularly attractive to foraging bald eagles (Brown 1996). Eagles nest in large trees near water and typically use the same nest for several years, making repairs to it annually (Degraaf and Rudis, 1986). In South Carolina, the distribution of eagle nesting has shifted, from historically being located primarily along the coast, to encompass more inland areas; this expansion has been attributed to the construction of approximately 491,000 acres of large reservoirs in the state since the early 1900's (Wilde et al., 2003).

Bald eagles have likely used Lake Murray for foraging and nesting since its construction in 1930. Eagles utilizing the lake for foraging are thought to be a mix of native nesting adults and juveniles from South Carolina and adult and juveniles from outside the state (Wilde et al., 2003). Eagles forage on Lake Murray year round, with peak usage likely occurring during the winter months. Nesting of bald eagles on Lake Murray was first documented in 1996, and since that time, the nesting population has increased to six pairs (Wilde et al., 1996). Productivity (young produced) has also increased substantially around the lake from two chicks in 1996 to 10 chicks in the 2002/2003 nesting season (Wilde et al., 2003).

Lake Murray was one of four South Carolina reservoirs affected by an outbreak of Avian Vacuolar Myelinopathy (AVM), which was first documented at DeGray Lake, Arkansas in the winter of 1994-1995 (Jeffers, 2000). AVM has been confirmed in birds from 11 reservoirs in five southern states (SC, NC, GA, AR, TX) and has resulted in the death of at least 93 bald eagles, thousands of American coots, and smaller numbers of waterfowl and other species (Wilde et al., 2003; Birrenkott et al., 2004). AVM is thought to be linked to an unknown neurotoxin that causes lesions in the white matter of the brain and the spinal cord. Affected animals demonstrate difficulty flying, swimming and walking (Jeffers, 2000). Evidence suggests that bald eagles contract AVM by preying on afflicted coots and other waterfowl that are unable to evade predators (Wilde et al., 2003).

Researchers suspect that the neurotoxin thought to cause AVM may be the product of a cyanobacteria (blue-green algae) often found growing in association with aquatic vegetation (i.e., *Hydrilla*) (Wilde et al., 2003). Sampling conducted at AVM-affected reservoirs by SDCNR and the University of South Carolina (USC) during 2001 and 2002 found that one particular species of blue-green algae, which is known to produce toxic compounds, had the greatest incidence of colonization at the location with the highest eagle mortality from AVM (Strom Thurmond Lake on the South Carolina/Georgia border). In addition, a recently-published feeding study involving mallards found a cause-effect relationship between ingestion of *Hydrilla* from these sites and AVM infection (Birrenkott et al., 2004).

Since 2001, SCE&G has funded monthly surveys on Lake Murray to monitor for the presence of AVM-affected birds, as well as periodic collections of American coots to screen for the disease. To date, there have been no know occurrences of AVM in the Lake Murray bald eagle population; however, a low percentage of the coots collected during the winters of 1999 (2 out of 17 collected), 2000 (5 out of 27 collected), and 2003 (1 out of 30 collected) did test positive for the disease, as well as one Canada goose collected during December 2000 (Wilde et al., 2003). Despite the presence of some affected prey species, SCDNR and USC scientists have concluded that, to date, the presence of AVM at

Lake Murray does not appear to have resulted in extensive losses of breeding adult bald eagle as both the number and productivity of eagles nesting on Lake Murray have increased from 1996 level (Wilde et al., 2003). It should be noted that the presence of AVM in the lone coot from the 2003 collection was determined only through clinical testing, with no birds displaying obvious neurological impairment, suggesting that AVM was not severe at Lake Murray during the 2002/2003 season (Wilde et al., 2003).

Wood Stork

The wood stork was federally-listed as endangered on February 28, 1984 (USFWS, 1997). The only stork native to North America, wood storks occurred historically throughout the coastal plain of the southeastern U.S. and Texas. The current U.S. breeding population has declined from an estimated 20,000 pairs in the 1930's to between 5,500 to 9,500 in recent years, with declines attributed primarily to loss of suitable foraging and nesting habitat. Currently, nesting of the species in the U.S. is thought to be limited to the coastal plain of South Carolina, Georgia, and Florida (USFWS, 1997).

Wood storks are highly colonial and typically nest in large rookeries and feed in flocks (USFWS, 1997). Typical foraging habitats include narrow tidal creeks, flooded tidal pools, and freshwater marshes and wetlands. Like most other wading birds, storks feed primarily on small fish. However, because wood storks feed by tactilocation (using the sense of touch), depressions where fish become concentrated during periods of falling water levels are particularly attractive sites (USFWS, 1997). Storks typically use tall cypresses or other trees near water for colonial nest sites. Nests are usually located in the upper branches of large trees and several nests are typically located in each tree. Trees used for nesting and roosting typically provide easy access from the air and an abundance of lateral limbs (USFWS, 1997).

While wood storks are primarily birds of freshwater and brackish wetlands along the coastal plain, wood stork activity has been reported by local residents at several locations within the Lake Murray area since approximately 1999 (Personal Communication, E. Eudaly, USFWS, August 2004). Aerial surveys conducted during the summer of 2004 documented approximately 60 storks feeding at various locations in the middle Saluda River area and the upper portion of Lake Murray (SCE&G and Kleinschmidt, 2004a). SCE&G, in coordination with the USFWS and SCDNR, subsequently developed a long-term study plan to document wood stork usage within the Saluda Project Boundary and in the Project vicinity (SCE&G and Kleinschmidt, 2004a). This study is ongoing and updates of the results will be provided throughout the relicensing process.

Table E-9: Listing of Botanical Species Found Within the Saluda Project Area

Species Common Name	Species Latin Name	Lake Murray	Shallow Coves	Shallow Shoals	Buttonbush and Willow Flats	Bottomland Hardwood	Exposed Bars	Islands	Matured Hardwood Forests	Water Tupelo Stands	Wet Flats	Rocky Shores	Lower Saluda River
American beech	*Fagus grandifolia.*	X							X				X
American elm	*Ulmus americana*	X				X		X			X		
American holly	*Ilex opaca*					X		X	X				
American hornbeam	*Carpinus caroliniana*					X							
Arrowwood	*Viburnum dentatum*												X
Asian dayflower*	*Murdannia keisak*												X
Asters	*Aster sp.*							X					
Barnyard grass	*Echinochloa crusgalli*		X	X			X	X					
Beggar-tick	*Bidens frondosa*		X	X	X								
Bermuda grass	*Cynodon dactylon*							X					
Black cherry	*Prunus serotina*	X						X					
Black highbush blueberry	*Vaccinium atrococcum*							X					
Black oak	*Q. velutina*	X						X					
Black walnut	*Juglans nigra*												X
Black willow	*Salix nigra*				X			X					
Blackberries	*Rubus sp.*							X					
Blueberry	*Vaccinium sp.*								X				
Blue-flowered eryngium	*Eryngium prostratum*			X	X								
Blunt spikerush	*Eleocharis obtusa*			X									
Bosc’s bluet	*Hedyotis boscii*		X	X	X								
Box elder	*Acer negundo*	X											X

Species Common Name	Species Latin Name	Lake Murray	Shallow Coves	Shallow Shoals	Buttonbush and Willow Flats	Bottomland Hardwood	Exposed Bars	Islands	Matured Hardwood Forests	Water Tupelo Stands	Wet Flats	Rocky Shores	Lower Saluda River
Brazilian elodea*	*Egeria densa*	X											X
Brittle waternymph*	*Najas minor*	X											
Butterweed	*Senecio glabellus*										X		
Buttonbush	*Cephalanthus occidentalis*				X			X			X		
Camphor weed	*Heterotheca subaxillaris*							X					
Catbriars	*Smilax bona-nox*							X					
Catbriars	*S. rotundifolia*							X					
Catbriars	*S. glauca*							X					
Cedar	*Juniperus silicicola*												X
Cherry	*Prunus sp.*												X
Cherrybark oak	*Quercus falcata var. pagodaefolia*					X							
Cherrybark oak	*Quercus pagoda*							X					
Chickweed	*Stellaria media*												X
chinkapin oak	*Q. muhlenbergii*	X							X				
Christmas fern	*Polystichum acrostichoides*								X				
Clearweed	*Pilea pumila*												X
Cockle-bur	*Xanthium strumarium*		X	X	X								
Kentucky Bluegrass	*Poa pratensis*												X
Bentgrass	*Gramineae sp.*												X
Fescue	*Festuca sp.*												X
Cottonwood	*Populus deltoides*							X					X

Species Common Name	Species Latin Name	Lake Murray	Shallow Coves	Shallow Shoals	Buttonbush and Willow Flats	Bottomland Hardwood	Exposed Bars	Islands	Matured Hardwood Forests	Water Tupelo Stands	Wet Flats	Rocky Shores	Lower Saluda River
Crab-apple	*Malus Angustifolia*							X					
Creeping burhead	*Echinodorus cordifolius*				X								
Creeping fimbry	*Fimbristylis autumnalis*		X										
Creeping primrose	*Ludwigia palustris*		X	X			X				X		
Creeping rush	*Juncus repens*		X	X									
Daisy	*Erigeron sp.*												X
Dandelion	*Taraxacum offinciniale*												X
Deciduous holly	*Ilex decidua*					X		X			X		
Ditch stonecrop	*Penthorum sedoides*										X		
Dogwood	*Cornus sp.*												X
Dog fennel	*Eupatorium capillifolium*							X					
Dwarf bulrush	*Hemicarpha micrantha*		X				X						
Dwarf crabgrass	*Digitaria serotina*		X	X									
Eastern false-willow	*Baccharis halimifolia*							X					
Ebony spleenwort	*Asplenium platyneuron*								X				
Eclipta	*Eclipta alba*		X	X	X								
Elder	*Sambucus canadensis*												X
Elm	*Ulmus sp.*												X
English ivy	*Hedera helix*							X					
Eryngium	*Eryngium prostratum*		X										
Eurasian Water Milfoil*	*Myriophyllum spicatum*	X											

Species Common Name	Species Latin Name	Lake Murray	Shallow Coves	Shallow Shoals	Buttonbush and Willow Flats	Bottomland Hardwood	Exposed Bars	Islands	Matured Hardwood Forests	Water Tupelo Stands	Wet Flats	Rocky Shores	Lower Saluda River
Fall panic	*Panicum dichotomiflorum*		X	X									
False pimpernel	*Linderina dubia*									X			
Fetterwood	*Leucothoe fontanesiana*								X				
Fireweed	*Erechtites hieracifolia*				X						X		
Flatedge spp.	*Cyperus polystachyos*						X						
Flatedge spp.	*C. strigosus*						X	X					
Flatedge spp.	*C. erythrorhizos*			X			X	X					
Flatedge spp.	*C. flavescens*						X						
Flatsedges	*C. iria*			X									
Flatsedges	*C. compressus*			X									
Flatsedges	*C. haspan*			X									
Flatsedge	*Cyoerus sp.*		X								X		
Fleabane	*Erigeron annuus*												X
Flowering dogwood	*Cornus florida*	X							X				
Goldenrod	*Solidago odora*							X					
Green ash	*Fraxinus pennsylvanica*	X						X			X		
Harbor sweet gum	*Liquidambar sp.*										X		
Honeysuckle	*Gaylussacia sp.*							X					X
Hop hornbeam	*Ostraya virginiana*	X							X				
Horse-nettle	*Solanum carolinense*												X
Japanese honeysuckle	*Lonicera japonica*							X					X
Hydrilla*	*Hydrilla verticillata*	X											

Species Common Name	Species Latin Name	Lake Murray	Shallow Coves	Shallow Shoals	Buttonbush and Willow Flats	Bottomland Hardwood	Exposed Bars	Islands	Matured Hardwood Forests	Water Tupelo Stands	Wet Flats	Rocky Shores	Lower Saluda River
Johnson grass	*Sorghum halepense*							X					
Juniper-leaf	*Polypremum procumbens*		X	X	X								
Laurel oak	*Quercus laurifolia*					X							
Least spikerush	*E. acicularis*			X	X								
Lespedeza	*Lespedeza intermedia*							X					
Loblolly pine	*Pinus taeda*	X						X	X		X		X
Maple	*Acer sp.*												X
Mistletoe	*Phoradendron serotinum*							X					
Mockernut hickory	*C. tomentosa*	X											
Mountain laurel	*Kalmia latifolia*								X				
Muscadine grape	*Vitis rotundifolia*							X					
Mustards	*Brassia sp.*												X
Oak various spp.	*quercus sp.*												X
Overcup oak	*Quercus lyrata*				X			X			X		
Panic grasses	*Panicum dichotomiflorum*				X								
Panic grasses	*P. rigidulum*				X								
Panic grasses	*P. scoparium*				X								
Panic grasses	*Dichanthelium sp.*							X					
Panic grasses	*Panicum sp.*										X		
Parasitic mistletoe	*Phoradendron serotinum*										X		
Parrot's feather*	*Myriophyllum aquaticum*												X
Passion flower	*Passiflora incarnata*							X					

Species Common Name	**Species Latin Name**	**Lake Murray**	**Shallow Coves**	**Shallow Shoals**	**Buttonbush and Willow Flats**	**Bottomland Hardwood**	**Exposed Bars**	**Islands**	**Matured Hardwood Forests**	**Water Tupelo Stands**	**Wet Flats**	**Rocky Shores**	**Lower Saluda River**
Pepper	*Ampelopsis arborea*							X					
Persimmon	*Diospyros virginiana*				X			X					
Pignut hickory	*C. glabra*	X											
Plume grass	*Erianthus sp.*							X					
Poison ivy	*Toxicodendron radicans*												X
Pokeberry	*Phytolacca americana*							X					
Pokeweed	*Phytolacca americana*												X
Pondweed *sp.* *	*Potamogeton crispus*	X											
Pondweed *sp.* *	*Potamogeton illinoensis*	X											
Pondweed *sp.* *	*Potamogeton pusillus*	X											
Post oak	*Quercus stellata*							X					
Purple-top tridens	*Tridens favus*							X					
Rabbit tobacco	*Gnaphalium obtusifolium*							X					
Rattle bush	*Sesbania punicea*							X					
Red cedar	*Juniperus virginiana*							X	X				
Red maple	*Acer rubrum*	X				X		X	X		X		
Red oak	*Q. rubra*	X							X				X
Redbud	*Cercis canadensis*	X											
Red-top panic grass	*Panicum rigidulum*		X	X			X	X					
River birch	*Betula nigra*	X						X					
River seedbox	*Ludwigia leptocarpa*							X					
Rushes	*Juncus sp.*						X						
Sassafrass	*Sassafras albidum*												X

Species Common Name	Species Latin Name	Lake Murray	Shallow Coves	Shallow Shoals	Buttonbush and Willow Flats	Bottomland Hardwood	Exposed Bars	Islands	Matured Hardwood Forests	Water Tupelo Stands	Wet Flats	Rocky Shores	Lower Saluda River
Sedges	*Carex sp.*					X							
Shagbark hickory	*Carya ovata*	X							X				
Shortleaf pine	*P. echinata*	X						X					X
Shortleaf pine	*Pinus taeda*							X					
Shumard oak	*Quercus shumardii*					X							
Slender fimbry	*Fimbristylis autumnalis*			X			X	X					
Slender St. John's-wort	*Hypericum mutilum*							X					
Smart weeds	*Polygonum sp.*										X		
Smartweed	*Polygonum pennsylvanicum*		X	X	X								
Smooth sumac	*Rhus glabra*							X					
Sourwood	*Oxydendron arboreum*	X							X				
Southern red oak	*Quercus falcata*	X						X	X				
Spikerush	*Eleocharis sp.*		X	X									
Spikerush	*E. baldwinii*				X								
Spiny amaranth	*Amaranthus Spinosus*												X
Spotted wintergreen	*Chimaphila maculata*								X				
St. Andrew's-cross	*Ascyrum hypericoides*					X							
Stalkless yellowcress	*Rorippa sessiliflora*			X									
Sugarberry	*Celtis laevigata*							X			X		
Sunflower	*Helianthus annuus*												X
Swamp beggar-tick	*Bidens discoidea*									X			

Species Common Name	Species Latin Name	Lake Murray	Shallow Coves	Shallow Shoals	Buttonbush and Willow Flats	Bottomland Hardwood	Exposed Bars	Islands	Matured Hardwood Forests	Water Tupelo Stands	Wet Flats	Rocky Shores	Lower Saluda River
Swamp chestnut oak	*Quercus michauxii*					X			X				
Swamp dogwood	*Cornus foemina*					X							
Sweet gum	*Liquidambar styraciflua*	X			X	X		X	X		X		
Switch cane	*Arundinaria gigantea*					X		X	X		X		
Sycamore	*Platanus occidentalis*				X			X			X		X
Teal lovegrass	*Eragrostis hypnoides*			X			X	X			X		
Throughworts	*Eupatorium sp.*							X					
Toothcup	*Rotala ramosior*		X	X	X		X	X					
Tridens	*Tridens flavus*							X					
Triple-awn grass	*Aristida sp.*							X					
Trumpet creeper	*Campsis radicans*										X		
Trumpet vine	*Campsis radicans*							X					
Tulip poplar	*Liriodendron tulipifera*	X									X		
Vetch	*Vicia sp*							X					X
Violets	*Viola sp.*												X
Virginia creeper	*Parthenocissus quinquefolia*												X
Walnut	*Juglans sp.*												X
Water hickory	*Carya aquatica*	X						X			X		
Water oak	*Quercus nigra*	X				X		X					
Water primrose*	*Ludwigia hexapetala*				X								X
Water tupelo	*Nyssa aquatica*									X	X		
Water willow	*Justicia americana*				X								
Wax myrtle	*Myrica cerifera*	X											X
White oak	*Quercus alba*	X							X				X

Species Common Name	Species Latin Name	Lake Murray	Shallow Coves	Shallow Shoals	Buttonbush and Willow Flats	Bottomland Hardwood	Exposed Bars	Islands	Matured Hardwood Forests	Water Tupelo Stands	Wet Flats	Rocky Shores	Lower Saluda River
Wild azalea	*Rhododendron canescens*	X							X				
Wild ginger	*Hexastylis arifolia*								X				
Wild oat	*Avena sativa*												X
Willow	*Salix sp.*												X
Willow oak	*Quercus phellos*	X				X		X			X		
Winged sumac	*Rhus copallina*							X					
Wood sage	*Teucrium scorodonia*												X

*Indicates an invasive aquatic plant species

Table E-10: All State and Federally Listed Threatened and Endangered Species for the Counties Surrounding the Saluda Hydroelectric Project

Common Name	Scientific Name	Counties	Federal Status	State Status
		Birds		
bald eagle	*Haliaeetus leucocephalus*	Lexington, Richland, Saluda, Newberry	Threatened	Threatened
red-cockaded woodpecker	*Picoides borealis*	Lexington, Richland, Saluda	Endangered	Endangered
		Mammals		
Rafinesque's big-eared bat	*Corynorhinus rafinesquii*	Richland	None	Endangered
		Herpetofauna		
Webster's salamander	*Plethodon websteri*	Saluda	None	Threatened
pine barrens treefrog	*Hyla andersonii*	Richland	None	Threatened
		Plants		
smooth coneflower	*Echinacea laevigata*	Richland	Endangered	Endangered
shoals spider-lily*	*Hymenocallis coronaria*	Richland, Lexington	Of Concern, Nationally	Of Concern, Nationally
rough-leaved loosestrife	*Lysimachia asperulifolia*	Richland	Endangered	Endangered
canby’s dropwort	*Oxypolis canbyi*	Richland	Endangered	Endangered
pool sprite	*Amphianthus pusillus*	Saluda	Threatened	Threatened
harperella	*Ptilimnium nodosum*	Saluda	Endangered	Endangered

*Even though this species is not threatened or endangered it has been included in this table because it is of concern nationally and is known to occur and is being studied within the project boundary.

Table E-11: Mammals Commonly Found In and Around Lake Murray

COMMON NAME	SCIENTIFIC NAME
	TERRESTRIAL MAMMALS
white-tailed deer	*Odocoileus virginianus*
raccoon	*Procyon lotor*
gray squirrel	*Sciurus carolinensis*
virginia opossum	*Didelphis virginiana*
fox	Family *Canidae*
coyote	*Canis latrans*
skunk	Family *Mustelidae*
bobcat	*Felis rufus*
voles	Family *Cricetidae*
shrews	Family *Soricidae*
	AQUATIC MAMMALS
beaver	*Castor canadensis*
river otter	*Lutra canadensis*
muskrat	*Ondatra zibethicus*
mink	*Mustela vison*

Table E-12: Reptiles (Terrestrial and Aquatic) and Amphibians Commonly Found In and Around Lake Murray

COMMON NAME	SCIENTIFIC NAME
	TERRESTRIAL AND AQUATIC REPTILES
eastern box turtle	*Terrapene carolina*
painted turtle	*Chrysemys sp.*
mud turtle	*Kinosternon sp.*
musk turtle	*Sternotherus sp.*
snapping turtle	*Chelydra serpentina*
green anole	*Anolis carolinus*
northern fence lizard	*Sceloporus undulates hyacinthinus*
broadhead skink	*Eumeces laticeps*
copperhead	*Agkistrodon contortrix*
gray rat snake	*Elaphe obsolete spiloides*
black racer	*Coluber constrictor*
timber rattlesnake	*Crotalus horridus horridus*
cottonmouth	*Agkistrodon piscivorus*
brown water snake	*Nerodia taxispilota*
redbelly water snake	*Nerodia erythrogaster erythrogaster*
	AMPHIBIANS
southern toad	*Bufo terrestris*
bullfrog	*Rana catesbeiana*
green frog	*Rana clamitans*
green treefrog	*Hyla cinerea*
leopard frog	*Rana sp.*
marbled salamander	*Ambystoma opacum*
red salamander	*Pseudotrition ruber*

Table E-13: Bird Species Commonly Found at Lake Murray

COMMON NAME	SCIENTIFIC NAME OR FAMILY
	WATERFOWL
wood duck	*Aix sponsa*
Canada goose	*Branta canadensis*
American coot	*Fulica Americana*
mallard	*Anas platyrhrnchos*
American black duck	*Anas rubripes*
ring-necked duck	*Aythya collaris*
American anhinga	*Anhinga anhinga*
double-crested cormorant	*Phalacrocorax auritus*
herons and egrets	Family *Ardeidae*
	RAPTORS
bald eagle	*Haliaeetus leucocephalus*
osprey	*Pandion haliaetus*
great horned owl	*Bubo virginianus*
red-tailed hawk	*Buteo jamaicensis*
red-shouldered hawk	*Buteo lineatus*
	UPLAND GAME BIRDS
wild turkey	*Meleagris gallopavo*
northern bobwhite	*Colinus virginianus*
mourning dove	*Zenaida macroura*
	SONGBIRDS
warblers	Family *Parulidae*
thrushes	Family *Turdidae*
American robin	*Turdus migratorius*
vireos	Family *Vireonidae*
finches	Family *Fringillidae*
	MISCELLANEOUS BIRDS
woodpeckers	Family *Picidae*
vultures	Family *Cathartidae*
gulls	Family *Laridae*
yellow-bellied sapsuckers	*Sphyrapicus varius*

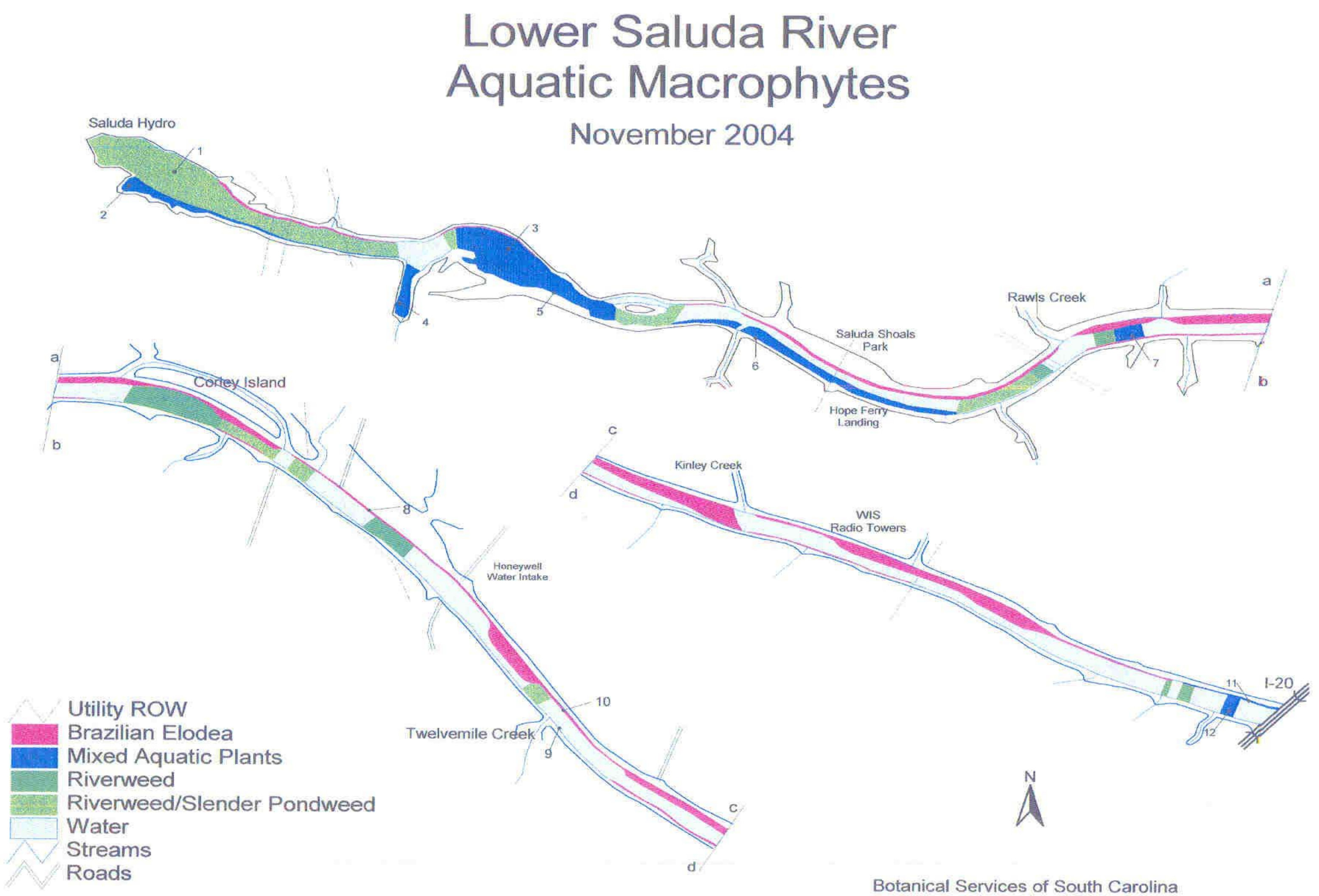


Figure E-13: Aquatic Plants of the Lower Saluda (Aulbach, 2004)

13.0 CULTURAL RESOURCES

13.1 Cultural Resource Studies

Three recent archaeological and historical studies have been conducted within the Project boundary (Trinkley and Southerland, 2001; Hendrix and Bailey, 2003; Lansdell and Bailey, 2003). The purpose of these reports was to identify any historic properties that lie within the Project boundary, to locate any known and potential *cultural resources*, and to make recommendations regarding eligibility for the National Register of Historic Places (NRHP). The studies were carried out in association with SCE&G's proposed construction of a backup dam to the Saluda Dam, a Federal undertaking. These studies present research compiled from the following sources:

- Saluda Dam Office (Irmo, SC)
- South Carolina Department of Archives and History (Columbia)
- South Carolina Historical Society (Charleston)
- South Carolina Institute of Anthropology and Archaeology (Columbia)
- South Carolina Library, University of South Carolina (Columbia)

All three studies relied on both published and unpublished secondary sources including previous archaeological and architectural surveys in the area surrounding the Project and literature on the history of the Columbia area and the midland and upstate regions of South Carolina. In addition, both Bailey and Hendrix (2003) and Bailey and Lansdell (2003) drew extensively upon oral interviews with archaeological collectors to assist in identifying previously unknown archaeological sites.

Trinkley and Southerland (2001)

Trinkley and Southerland conducted a cultural resources survey of four sites within the APE, which was defined as being a one-mile radius from the outer edge of the SCE&G boundary. These sites included the 550-acre Saluda Dam Complex, the 49.1-acre Operators' Village, a 54.9-acre tract adjacent to the spillway, and a 70-acre tract on the Saluda River adjacent to Lot 44. The survey took into consideration both archaeological and above-ground resources. The archaeological survey included shovel testing at 100-foot intervals along transects laid out at 100-foot intervals, with the exception of the Saluda Dam Village (site 38LX411), which was surveyed at 50-foot intervals along transects laid out at 50-foot intervals. The survey also included identifying historic architectural resources and completing architectural survey forms.

Hendrix and Bailey (2003)

Hendrix and Bailey provided an overview of known and potential cultural resources within the APE, which was determined to be those portions of the Lake Murray basin between the maximum pond elevation at 360 feet PD and the minimum pond elevation at 345 feet PD. This study consisted primarily of background research, both in the site files at the South Carolina Institute for Anthropology and Archaeology to develop information about previously recorded cultural resources within the APE, and oral interviews with local informants, primarily amateur archaeological collectors, to locate potential archaeological sites. The information from this research was used to make recommendations regarding areas that have a high potential to contain both known and potential cultural resources. The report did not make any recommendations regarding eligibility for the NRHP.

Lansdell and Bailey (2003)

Lansdell and Bailey conducted an assessment of the known and potential archaeological sites that were identified in Hendrix and Bailey (2003). This survey assessed 31 locales that were either known to contain cultural resources or that research indicated may contain cultural resources; 16 of these locales were previously recorded archaeological sites and 15 were known but not formally recorded archaeological sites. Nine of the 31 sites were found to lie within the APE, which was defined in the same way as in Hendrix and Bailey (2003). The field methods used varied according to the conditions found at each site, but boundaries of the sites were established by excavating a cross pattern of shovel tests at 50-foot intervals. In areas of high artifact concentration, test units measuring 1.5 feet square were excavated. The report included recommendations regarding eligibility for the NRHP.

13.2 Archaeological Overview

The following brief overview is drawn primarily from the outline presented in Lansdell and Bailey (2003).

Paleoindian Period (10000-8000 BC)

There is limited evidence for human occupation in South Carolina during the Paleoindian Period, which is coincident with the terminal Pleistocene age, when the climate was generally colder than it is today and when the sea level was approximately 200 feet lower than at present. The evidence for Paleoindian occupations in South Carolina suggests that cultures were located generally on terraces adjacent to the major river drainages. It is likely that the people who occupied South Carolina during the Paleoindian Period lived as part of mobile hunter and gatherer societies who focused primarily on smaller game and plant foods.

Early Archaic Period (8000-6000 BC)

This period featured the adaptation of local societies to the new climatic conditions of the Holocene, when the climate was still cooler and moister than at present. This is the earliest period for which archaeological evidence is found in the midlands of South Carolina, including along the drainages of the Broad, Saluda, and Congaree Rivers. Early Archaic sites tend to be small; various models of Early Archaic settlement patterns point to a highly mobile group of people who either came together in the winter months along different river drainages or who returned to specific base camps in areas that provide access to diverse natural resources. Exchanges of materials and people might have occurred between these winter settlement groups or base camps once they were settled for the season.

Middle Archaic Period (6000-2000 BC)

Sites that date to this period, when the climate was continuing to warm, tend to be more dense and suggest that groups tended to create long-term residential sites. This is a pattern that relates more closely to those experienced in the Coastal Plain of South Carolina than areas more into the Piedmont. Artifacts from this period tend to be stone projectile points and ground stone tools.

Late Archaic Period (2000-500 BC)

Several developments take place during this period. The earliest ceramic artifacts date to this period, primarily sand tempered with punctuate, incised, finger pinched, stamped, and dentate decorations. Also, this is the earliest period that shows evidence of intensive exploitation of aquatic resources, including anadromous fish. Finally, the evidence for sites in the midlands area of South Carolina also shows two concurrent settlement patterns. Small sites that appear to focus on single activities such as animal processing appear in the upland areas between river drainages and along smaller drainages, while sites within the floodplains of the major drainages tend to be larger and show a more diverse range of activities.

Early Woodland Period (500 BC-AD 200)

Artifacts from this period show an increasing diversity, particularly the ceramics. The range of decorations broadens considerably with an increase in linear and bold Deptford Check Stamped, Deptford Simple Stamped, fabric impressed, paddle stamped, and cord marked examples. Settlement patterns show a dispersal into previously unoccupied areas as groups, and often single families, moved away from the floodplains and into more upland areas above the drainages. Early Woodland sites therefore tend to be smaller with a reduced diversity of artifacts.

Middle and Late Woodland Periods (AD 200-1000)

This is a period of distinctly limited developments from the previous period, and is much less well understood. Most of the ceramic indicators from the Early Woodland period continue throughout the Middle and Late Woodland periods, including check stamped, cord marked, and fabric impressed artifacts. Settlement patterns appear to continue the diffused locales of the earlier period.

Mississippian Period (AD 1000-1543)

This was a period of much more rapid development in the complexities of social organization. Throughout the southeast, this period is marked by greater social stratification, an increasing emphasis on agriculture, public works, and ceremonial centers. While one of the principal centers of Mississippian society in South Carolina lies to the east of Columbia on the Wateree River (Mulberry Mound group), there is little evidence of Mississippian occupation in the immediate Columbia area. This is due to a settlement pattern that focused on distinctive rapids of local rivers in the upland portion of the state and on the major drainages that had extensive flood plains below the Fall Line, and not on the areas such as Columbia that served as transitions between the two areas. The end of this period also marked the beginnings of European explorations into South Carolina, notably DeSoto's visit in 1540. The introduction of European explorers, however, led to a rapid decline in Native American populations as disease, warfare, and slave raids decimated the area.

13.3 Historical Overview

Permanent European settlement in South Carolina began in 1670, when English adventurers from the island of Barbados settled on the west bank of the Ashley River near what is now Charleston; they relocated to the present site of Charleston in 1680. Settlers began moving inland relatively quickly, forming a trading post along the Congaree River as early as 1700. This trading post was located south of what is now Columbia, which was the furthest upriver point where boat traffic was possible.

Speculators began purchasing farm land along the Congaree River south of Columbia, creating plantations dedicated to cash crops that could be sent to Charleston. The pace of settlement increased in the 1740s and 1750s. At this time, new colonial policies encouraged the development of these areas through a township scheme using a headright system which allotted 50 acres to every individual who settled there. At the same time, colonial policies created a system of judicial districts throughout the colony.

In the wake of the Revolutionary War, the most important development in the midlands region was the creation of the new state capitol at Columbia, located on a plain above the Congaree River just below the confluence of the Broad and Saluda Rivers. Improvements in transportation became increasingly important in the early nineteenth century, in the attempt to allow goods from further north and west in the state to pass around the shoals of the Broad and Saluda River to get to the Congaree River, whence they could easily be shipped either to Charleston or Georgetown. This interest resulted in the Columbia Canal, which started at a diversion dam across the Broad River and followed the southern bank of the Broad and Congaree Rivers, and the Saluda Canal, which bypassed shoals in the Saluda River and directed boats to the entrance of the Columbia Canal. The various falls in the Broad and Saluda Rivers above Columbia also provided sources of power for new manufacturing enterprises, most notably the Saluda Factory along the southern bank of the Saluda River, approximately two miles from its confluence with the Broad River; begun in 1834, the plant was destroyed during the Civil War.

In the late nineteenth and early twentieth centuries, despite some promising manufacturing developments, including the Columbia Mills (the first textile plant in the country to be powered by *hydroelectric power*, using waters from the original Columbia Canal), the areas to the west of Columbia remained primarily agricultural. There were, however, a number of small, localized settlements with small houses, churches, and cemeteries. In the 1920s the Lexington Water Power Company (LWPC) began to develop plans for the creation of a dam and hydroelectric facility at Dreher's Shoals on the Saluda River. Agents for the LWPC began acquiring the large tracts of land necessary to develop the massive lake and surrounding lands, totaling approximately

100,000 acres. In the process, the LWPC removed or relocated three churches, six schools, and 193 graveyards.

Development of the hydroelectric facility began in 1927 with land-clearing operations and the beginning work on the Dam. Once completed, the Dam was 1.5 miles long and was the largest earthen Dam that had yet been built. By 1929, construction on the Dam was complete enough so that the lake could be partially filled. Storms in the autumn of that year flooded the Dam and damaged the unfinished powerhouse; by 1930, the repairs had been completed and the Project began generating electricity and the lake was named Lake Murray in honor of William Murray, who first conceived of the plan for the hydroelectric development. The lake was filled to the 360 foot elevation by 1933.

13.4 Historic Resources Within the Project

The cultural resources surveys by Trinkley and Southerland (2001), Hendrix and Bailey (2003), and Lansdell and Bailey (2003) identified 53 archaeological and historic architectural and engineering resources. Twenty-two of these resources have been identified through research but have not yet been assessed for their eligibility for inclusion in the NRHP (Lansdell and Bailey, 2003). Of the remaining thirty-one resources, eight have been determined eligible or potentially eligible for the NRHP. Table E-14 presents the sites that have been identified at the Saluda Project, and the NRHP status of each.

13.5 Protection and Preservation

13.5.1 National Historic Preservation Act Compliance

Section 106 of the National Historic Preservation Act of 1966 (as amended) provides for the review of Federal undertakings that have the potential to affect historic properties. The Section 106 review of these undertakings is described and implemented in 36 CFR 800. As defined by 36 CFR 800.16(I)(I), "historic property" means "any prehistoric or historic district, site, building, structure, or object included in or eligible for inclusion in the National Register of Historic Places (NRHP) maintained by the Secretary of the Interior;" and includes "artifacts, records, and remains that are related to and located within such properties." Moreover, "historic property" includes "properties of traditional religious and cultural importance to an Indian tribe ... and that meet the NRHP criteria." Finally, "eligible for inclusion," as set forth at 36 CFR 800.16(I)(2), means "both properties formally determined as such in accordance with the regulations of the Secretary of the Interior and all other properties that meet the NRHP criteria." For purposes of inclusiveness, this term also applies to those properties that are known to exist but for which NRHP status has not yet been determined.

13.6 Properties Affected by Project Operations or Developments

The Project contains eight archaeological and architectural properties that have been determined eligible or potentially eligible for the NRHP, and an additional 22 sites, the eligibility of which has not yet been determined. The effect of present and future operations of the Saluda Project on all of these properties and potential historic properties must be taken into consideration. None of these properties or potential properties are now being affected by Project operations. Anticipated changes at the Property, including the construction of a new dam for the purposes of seismic stability, will likely adversely affect some of the known historic properties. Any other future activities that may affect these or undiscovered properties will be reviewed for compliance with all pertinent regulations as needed.

13.7 Management Plans

In order to comply with Section 106 in the most efficient and effective way possible, SCE&G will work with all relevant agencies, including at a minimum the State Historic Preservation Office and any federally-recognized Indian tribes that have a traditional connection to the land, to form a Programmatic Agreement (PA). The PA will commit SCE&G, through a Historic Properties Management Plan (HPMP), to specific management strategies designed to provide all appropriate protection to historic properties during the life of the Project License. The HPMP will include provisions for future consultation in the event of discovery of previously unrecorded cultural resources and will outline the necessary steps to allow FERC to remain in compliance with Section 106.

Table E-14: Cultural Resources Identified at the Saluda Project

SITE NUMBER	TYPE	NRHP STATUS
38LX52	Archaeological	Not Assessed
38LX53	Archaeological	Not Assessed
38LX110	Archaeological	Not Assessed
38LX119	Archaeological	Not Assessed
38LX262	Archaeological	Not Assessed
38LX263	Archaeological	Not Assessed
38LX273	Archaeological	Not Assessed
38LX410	Architectural/Archaeological	Eligible
38LX434	Archaeological	Not Eligible
38LX435	Archaeological	Not Eligible
38LX436	Archaeological	Not Eligible
38LX437	Archaeological	Not Eligible
38LX438	Archaeological	Not Eligible
38LX439	Archaeological	Not Eligible
38LX440	Archaeological	Not Eligible
38LX452	Archaeological	Not Eligible
38LX453	Archaeological	Not Eligible
38LX455	Archaeological	Not Eligible
38LX497	Cemetery	Not Eligible
38LX498	Cemetery	Not Eligible
38LX499	Engineering	Not Eligible
38LX617	Cemetery	Not Eligible
38NE1	Archaeological	Not Assessed
38NE29	Archaeological	Not Assessed
38NE34	Archaeological	Not Assessed
38NE43	Archaeological	Not Eligible
38NE194	Archaeological	Not Assessed
38RD134	Archaeological	Potentially Eligible
38SA1	Archaeological	Potentially Eligible

SITE NUMBER	TYPE	NRHP STATUS
38SA13	Archaeological	Not Eligible
38SA104	Archaeological	Not Eligible
24330127.00	Engineering	Eligible
24330127.01	Engineering	Not Eligible
24330127.02	Engineering	Eligible
24330127.03	Engineering	Eligible
24330127.04	Architectural	Eligible
24330127.05	Architectural	Not Eligible
24330127.06	Architectural	Not Eligible
24330127.07	Architectural	Not Eligible
2430128	Bridge	Not Eligible
2430303	Landscape	Not Eligible
2430304	Cemetery	Potentially Eligible
Little Mountain Bridge Abutment	Engineering	Not Assessed
Cooter Scaffold Bridge	Engineering	Not Assessed
Derrick House Foundation	Architectural	Not Assessed
Fairbanks Community & Post Office	Architectural	Not Assessed
Lybrand-Raunch Slave Cemetery	Cemetery	Not Assessed
Jacob Ergle’s Grist Mill	Architectural	Not Assessed
Wingard Cemetery	Cemetery	Not Assessed
Magnolia School	Architectural	Not Assessed
Chapin Road	Transportation/Landscape	Not Assessed
Zion Church	Architecture	Not Assessed
Zion Church Cemetery	Cemetery	Not Assessed

14.0 RECREATION RESOURCES

14.1 Regional Resources

Lake Murray and the four surrounding counties (Richland, Lexington, Saluda, and Newberry) make up one complete tourism region defined as the Capital City/Lake Murray Country region by the South Carolina Department of Parks, Recreation and Tourism (SCPRT) (Figure E-14). The region includes portions of the Sumter National Forest; Billy Dreher Island State Park, which is located on an island in Lake Murray; Sesquicentennial State Park, located in the City of Columbia; Harbison State Forest, located in the City of Columbia; and Congaree Swamp National Park, which is located in Richland County. Numerous trails and state heritage preserves are also located in close proximity to the Project.

Sumter National Forest consists of approximately 360,000 acres, partially located in Newberry and Saluda Counties (SCPRT, 2002). Portions of the forest are designated wildlife management areas where hunting is permitted. The forest also provides campgrounds, hunting camps, picnic areas, boating sites, rifle ranges, swimming areas, and 360 miles of trails. Billy Dreher Island State Park is one of two state parks within the Lake Murray Country region. It is 348 acres in size and is located on Lake Murray in the community of Prosperity. The park provides approximately 100 campsites, cabins, trails, picnic areas, and boat access to Lake Murray. Sesquicentennial State park is 1,419 acres in size and offers approximately 90 campsites, trails, and fishing and picnicking opportunities. Harbison State Forest is a 2,176 acre tract that provides hiking, mountain biking, picnicking, and canoe launching on the Broad River. Special events are also hosted at the forest. At 22,000 acres, Congaree Swamp National Park is reported to be the largest remaining tract of old-growth bottomland hardwood forest remaining in the U.S. It is a congressionally designated wilderness area that provides 18 miles of hiking trails, a 2.3 mile boardwalk, and a canoe trail.

Other popular trails nearby include the 0.5 mile trail in Lexington County at the Riverbanks Zoo; 2.5 mile riverfront trail at Riverfront Park in Columbia; the 11.5 mile

Sesquicentennial trail in Richland County; 7.5 mile Lynches Woods trail in Newberry County; and the 2.3 mile Boardwalk Loop in Richland County at the Congaree Swamp National Park (SCPRT, 2002).

Several state heritage preserves that are open to the public are also located nearby (SCPRT, 2002). Heritage preserves are properties that offer unique cultural or natural resource features. Congaree Creek, 627 acres, is located in Lexington County and offers a 6-mile Guignard Brickworks Loop trail. Shealy's Pond is a 62 acre site also in Lexington County. Both preserves are open year round. A third site, Nipper Creek, is open by appointment only. Nipper Creek is in Richland County and 90 acres in size.

There are no federally designated wild and scenic rivers in the Project study area; however, a portion of the Saluda River below the Saluda Project is designated by the SCDNR as State Scenic Rivers (SCPRT, 2002). Approximately 10 miles of the river hold this special designation, which begins approximately 1 mile downstream of the Dam and extends to the confluence with the Broad River.

14.2 Project Resources

Recreation activities within the Saluda Hydroelectric Project boundary are managed by a combination of state agencies, local governments, and SCE&G. Generally, within each recreation site, the site operator is responsible for management. However, boating, fishing, and hunting regulations and enforcement in South Carolina are the responsibility of the SCDNR.

SCDNR requires that all boat operators under the age of 16 complete a boating course approved by the Department to operate any watercraft with a 15 hp motor or greater unless accompanied by an adult 18 years old or older. SCDNR also regulates watercraft use within 50 feet of docks, piers, moored vessels, or people in the water; wake jumping; registration and titling; required boater equipment; hours of operation; and enforcement.

With respect to fishing, SCDNR regulates fishing methods and devices; creel limits; selling and importing species; licensing; and enforcement. SCDNR also regulates hunting, including waterfowl hunting that may occur within the Project area. SCDNR regulates hunting methods and bag limits; licensing and enforcement; and sets allowable seasons for each species.

14.2.1 Lake Murray

The Project provides both passive and active outdoor recreation opportunities, including scenic viewing, picnicking, boating, bird watching, fishing, golf, hunting, and camping. Other water sports that are available may include wake boarding, knee boarding, waterskiing, hydrofoiling, parasailing, and swimming.

Lake Murray supports an active recreational fishery and is an important boating resource. The lake is host to numerous national and local fishing tournaments annually, and is stocked with striped bass each spring by the SCDNR. Surplus bluegill and largemouth bass reared at the SCDNR hatcheries are occasionally stocked as well. The lake supports substantial boating activity, which includes both power boats, canoes and kayaks, and sail boats. Lake Murray is the site of 6-8 regattas annually (Mead and Hunt, 2002b). In addition, the lake is used as a focal point for holiday and tourist events such as the annual Lake Murray Poker Run and the Independence Day celebrations.

14.2.2 Saluda River

The river section immediately below Saluda Dam is referred to as the LSR. It extends 11 miles from the outflow of the Dam to its confluence with the Broad River to form the Congaree River near downtown Columbia. Similar to the Lake, the LSR also supports an active recreational fishery. The cold waters of the river support a trout and striped bass fishery and offer a range of paddling experiences from flat water to whitewater with class II to V rapids.

Approximately 10 miles of the LSR was designated as a State Scenic River in 1991. It is managed by the SCDNR in compliance with the South Carolina Scenic Rivers Act.

14.2.3 Recreation Sites

Numerous private, commercial, and public recreation sites have been developed to accommodate and provide for recreation. There are a total of 107 recreation sites in the Project boundary that support boat launches, marinas, boat slips, wet and dry storage, campgrounds, picnic areas, beaches, fishing areas and piers, trails, and playgrounds. Additionally, there are 23 impromptu areas that are primarily used for bank fishing. Table E-15 provides a list of formal recreation sites located in the Project area and the facilities present at each site.

For purposes of this ICD, public recreation sites refer to sites that are open to the public without discrimination, and which are operated by federal, state, and local agencies and SCE&G. A commercial site refers to a site operated by a business for profit. A private site refers to a site open only to specific individuals via membership or residency requirements. Of the total, formal recreation sites at the Project, 19 are public sites, 31 are commercial sites, and 57 are private sites.

Public Sites

SCE&G owns 19 public access areas on Lake Murray and the Saluda River, and has set aside 64 SCE&G-owned islands in Lake Murray as undeveloped areas that are available for public recreation. Of the 19 recreation sites, SCE&G operates 16 of them, and leases the remaining sites to others for use as public *recreation areas*.

Table E-15 provides a listing of the public access areas and a summary of the facilities and opportunities available at each. Figure E-14 presents the location of the sites, which are dispersed around the Lake. With the exception of Billy Dreher Island State Park, all sites are operated for day-use.

Collectively, the islands that SCE&G has set aside for recreational use encompasses 220 acres of land. Among them is Lunch Island, also known as Doolittle Island or Bomb Island, where the famous Doolittle Raiders practiced bombing runs prior to their bombing of Tokyo, Japan during World War II. The island is North America's first officially designated purple martin sanctuary where thousands of birds can be observed by visitors.

SCE&G also leases 54.6 acres of land to the Indian Waters Council, Boy Scouts of America, Inc. The property is called Camp Barstow and supports campsites, athletic and activity fields, staff quarters, adult lodge, adult training field, training shelter, swimming area, boat dock, ecology shelter, and dining hall. Other facilities include rifle and archery ranges, a volleyball court, a climbing/rappelling tower, a handicraft shelter, and a barrier-free campsite.

SCE&G's parent company, SCANA, owns and operates an 18 acre site on Pine Island, which is open to SCANA employees and their guests. The island supports a conference center, swimming pool and beach, picnic area with shelters, marina, and tennis courts.

Commercial Sites

Commercial sites in the Project boundary include marinas, campgrounds, restaurants, and hotels and resorts. Commercial operations sites offer significant public access and support services, such as marina services, restaurants, etc. Lake tours are also offered on a double decked, 65 foot tour boat, the Southern Patriot.

In general, marinas are dispersed along the lake and provide access to all portions of the lake. They typically provide boat ramps and launching facilities, fuel services, groceries and food, boat sales, rentals and/or repair, bait and tackle, and boat storage. There are currently 31 public marinas operating on Lake Murray (Table E-16). Most of these sites are commercially operated, with the notable exception of the marina at Billy Dreher Island State Park. Because these are commercial ventures, they are subject to changing hands frequently.

Private Sites

Fifty-seven sites around the lake are operated privately and are available to limited membership (Table E-17). Many of the private marinas and landings exist in conjunction with subdivisions located around the lake, private clubs, or condo associations. These sites are important in that they provide access for specific types of opportunities (*e.g.,* sailing clubs), and to a large number of people at various locations around the lake.

14.3 Existing Use

14.3.1 Market Area

Lake Murray is a destination for nearby residents and tourists alike. The Lake offers boating, fishing, and other water-based activities, as well as golf, hiking, dining and shopping at shore and near-shore parks, marinas, restaurants, and businesses. There are many special events such as fishing tournaments, sailing regattas, the Lake Murray Poker Run, the Lake Murray Dam Run, and the lake-wide Independence Day celebration that draw locals and tourists to the lake community.

SCPRT reports that approximately 90 percent of participation in outdoor recreation occurs in an area close to a resident's home for day to day activities (SCPRT, 2002). Activities that require special environments, such as boating and fishing, generally occur within a region of slightly greater proportions around a resident's home, but still nearby to their residence.

If this trend is also true for the Saluda Project, then a majority of the recreation activity occurring at the Project would be attributed to residents of nearby local communities, and a smaller portion would be attributed to a more regional population from the outskirts of Richland, Lexington, Saluda, and Newberry Counties. Additional activity is attributed to tourists from further away in-state or out-of-state. The latter group would be smaller, but might be prone to stay for longer periods of time. SCE&G recognizes that Lake Murray and the Saluda River are important resources for all user groups, regardless of where they reside.

14.3.2 Existing Use and Activites

SCE&G estimates that approximately 5 million people reside within a 100 mile radius of the Saluda Project (SCE&G, 2002a). Not surprisingly, annual recreational use is estimated to be substantial at approximately 1.5 million people (SCE&G, 2002a). This includes both residents and visitors. Participation in water-based activities such as boating, fishing, and swimming accounts for a majority of this use, though significant activity also occurs onshore, where people picnic, golf, camp, and hunt.

SCPRT estimates that Capital City/Lake Murray Country hosted 2.6 million visitors in 2003 (SCPRT, 2004). Visitors typically stayed an average of 2.8 days. Approximately 9 percent (234,000) of the visitors reported their primary purpose to be for recreation or entertainment. Local use of the lake can be estimated by examining trends in boat registration. Figure E-15 shows the number of registrations from 1993 to 2000 by county. Registration rates in Newberry, Richland, and Saluda Counties all appear to be relatively stable; registrations in Lexington, however, have increased substantially over this time from approximately 18,600 to about 26,700. Obviously not all these boats are used on Lake Murray, but it is likely that many of them are, and further, the volume of registered boats indicates significant interest in the activity within the area.

Not all boats can be expected to be on the lake at all times. A series of aerial photographs were taken of the lake on selected days in 2001 and boat counts were obtained from them (SCE&G. 2002a). Figure E-16 shows the results. Boating use of the lake is moderate during the late spring, builds through early summer, and is heaviest during the Fourth of July week. Use is fairly constant during the summer months, and drops down to low levels in the early fall.

Other items of interest indicating the volume of recreational use of Lake Murray include (Mead & Hunt, 2002b):

- The Lake Murray Tourism and Recreation Association (LMT&RA) estimates that the annual Independence Day celebration is one of the largest celebrations in South Carolina, and that over 135,000 people participated in the event in 1999, with over 10,000 boats and over 40,000 viewers from land.
- LMT&RA estimated 1999 participation in the Lake Murray Poker Run and the Lake Murray Dam Run to be 10,000 and 3,000 people, respectively.
- LMT&RA estimated that 4,000 anglers participated in fishing tournaments in 1999.
- LMT&RA estimates that as many as 150 out-of-state sailboats participate in the 6 to 8 regattas that are held annually.

On the LSR, during the period of July 1, 1999 through June 30, 2000, the SCDNR conducted and angler survey on the river and estimated the angler effort to be 66,639 angler hours, with the majority of this effort (58%) occurring from the bank. The month with the most effort was June and more than 67% of the total effort occurred between April and July. 98% of the anglers interviewed were from South Carolina and the majority (84%) traveled less than 20 miles to fish in the river. An estimate of the total value of the recreational fishery (i.e., trip costs, consumer surplus, and durable goods) was approximately $1.8 million (Beard, 2000).

15.0 LAND USE AND AESTHETICS

The Saluda Project is located in the Santee River Basin in the Piedmont region of South Carolina, near the City of Columbia. The Santee River Basin is comprised of the Santee, Congaree, Catawba-Wateree, Broad and Saluda Rivers.

15.1 Existing Land Use

The Project lies within Richland, Lexington, Newberry and Saluda Counties in South Carolina, with the majority of Project lands falling within Lexington County (Figure A-1). At 756 square miles in size, Richland County is the largest of the four counties, followed by Lexington County (699 square miles), Newberry County (631 square miles) and Saluda County (452 square miles) (South Carolina Association of Governments, 2004). Richland and Lexington Counties are among the most densely populated counties in the sate, ranking 2nd and 5th respectively out of 46 counties total (Ibid).

Richland County supports Fort Jackson, the largest army-training military facility in the U.S., and the University of South Carolina. The county is viewed as being in the head of South Carolina's transportation hub (Richland County, 2003). It is served by three interstate highway systems, eight additional major U.S. highways, five passenger airlines, and bus and passenger rail services (South Carolina Association of counties, 2004). The City of Columbia is the county seat, and also the state capital.

The City of West Columbia is located in Lexington County, where a majority of Project lands and Lake Murray lie. The Lexington County is served by several major transportation routes connected to the capital city (South Carolina Association of Counties, 2004). The City of Lexington is the county seat.

Saluda and Newberry Counties are home to the southwestern and northwestern reaches of Lake Murray, respectively. Large tracts of the Sumter National Forest are located in both counties. The Long Canoe Ranger District occupies the most western reaches of Saluda County and the Enoree Ranger District occupies the northern portion of Newberry County. Transportation infrastructure in the counties is substantial, though only Newberry County has a major highway system running through it. The communities of Saluda and Newberry serve as the county seats for these two counties.

Land use in the vicinity of the Project is influenced by topography, soil characteristics, and current allowable uses of land and water resources. Social and economic factors such as employment, population and development also influence land use patterns.

Richland, Lexington and Newberry Counties all have zoning and / or land use plans in place to guide development in unincorporated areas. Incorporated communities in these counties generally maintain separate zoning requirements. There is no zoning or land use plan in place for Saluda County, though incorporated areas within the county do have zoning.

Land use within the Project boundary is subject to various state, federal, and local regulations in addition to SCE&G's Land Use and Shoreline Management Program (LUSMP). The LUSMP was designed to conserve and maintain the area's natural and man made resources and is used to assist in providing a balance between recreation and environmental controls. SCE&G originally developed a shoreline permitting program in 1975, and added land use component to the program in 1980. The LUSMP is updated every five years in consultation with relevant federal, state and local agencies. The most recent plan was submitted to FERC on February 1, 2000 and was approved by FERC with modifications on June 23, 2004 (107 FERC ¶ 62,273) and further clarified and modified on October 28, 2004 (109 FERC ¶ 61,083). Currently, SCE&G is in the process of revising their land classifications within the project boundary as a part of the relicensing process. Once final, these classifications will be made available.

The LUSMP identifies the major land uses around the lake and the location of a majority of environmentally sensitive areas. Through the LUSMP, SCE&G is responsible for the management of approximately 17,152 acres of land within the Project boundary. Guidelines, including buffer zones and minimum construction setbacks, are in place to define acceptable uses within each classification. The LUSMP is currently published in multiple separate documents; through relicensing, SCE&G will consolidate this into a single document.

SCE&G also has a shoreline permitting program which allows them to monitor construction, water withdrawals, maintenance and placement of docks, boat lifts, boat ramps, dredging and excavation, seawalls, rip rap, vegetation clearing and other shoreline developments (SCE&G, 1995). Permitting fees are assessed for most structures to help defray some of the costs of the program management. The permitting program and associated fees are available on SCE&G's Project website. In conjunction with its relicensing work, SCE&G plans to conduct an evaluation of the sufficiency of its fee schedules, with the objective of adjusting fees and/or implementing a more comprehensive fee schedule to fully support increasingly complex and labor-intensive shoreline management and environmental protection requirements.

Approximately 6,225 acres of watershed land within and adjacent to the Project are leased to the SCDNR as part of the statewide Game Management Program. This land is located adjacent to the western portions of the Lake.

15.2 Aesthetics Resources

FERC (2002) provided an excellent summary of the aesthetic characteristics of the Saluda Project. Except where noted, the information reported in this section is taken directly from that document.

The Saluda Project is located in an area of low, rolling hills between 300 and 1000 feet above sea level and has a local relief of approximately 100 feet. The lake is characterized by multitudes of irregularly shaped peninsulas and numerous inlets and islands, most of which are heavily forested.

At about 48,000 acres, Lake Murray is the fifth largest lake in South Carolina, following Lakes Marion, Thurmond, Hartwell and Moultrie (SCPRT, 2002). It is located in close proximity to South Carolina's capital city and it supports a significant recreation industry. Since its development, the lake has become a natural draw for residents and tourists alike. The early 1970s saw a marked increase in development pressure on the lake, and today, the lake is approximately 60 percent developed, primarily for residential use (FERC, 2003). Parkland, protected lands, and the required 75-foot buffer around the lake provides a natural buffer between Project waters and the homes that were constructed after the buffer zone was implemented in 1991. Shoreline development consists primarily of residences, docks, gazebos and boat lifts, and in some places, particularly prior to the implementation of the SMP, clearing has resulted in some areas having a maintained and manicured appearance.

The eastern half of the lake comprises the main body of the reservoir and has an expansive viewshed over several miles of open water and a few large inlets. The majority of the shoreline in this area is tree covered and interspersed with extensive shoreline development, ranging from individual private docks and large houses to marinas, landings, and park sites. A few large forested islands are located in the main body of the reservoir. The light to moderate tree covered shoreline and the lake's forested islands dominate most distant views across the open water and soften the contrasting shoreline development. The Project's Dam and five large intake towers are clearly visible from the main body of the reservoir. With the extended viewshed of the main body of the reservoir and the tree-covered shoreline, these manmade structures do not detract significantly from the overall visual character of the reservoir.

The western half of the lake is more riverine in nature than the main body of the reservoir and branches out into narrow arms that extend up into many drainage ways and creeks that enter the reservoir. Viewsheds in this area are varied and shortened by the encroaching shoreline and the increased number of small coves, creek beds, and drainage ways. Overall, the shoreline contains less intensive development and more trees and vegetation than the main body of the reservoir. Much of the development in this area includes individual private boat docks and small houses. Typically, the upper ends of the coves in this area are narrow, undeveloped, and heavily vegetated.

The downstream area affected by the Project includes the south side of the river downstream of the existing Dam. The north side of the river is disturbed by existing development, primarily the Project powerhouse, McMeekin Station and various appurtenant facilities. The area downstream of the Dam is primarily visible from Highway 6, a state highway with north and southbound lanes, as it crosses over the Dam and at either end of the Dam from secondary roads. Views of the open water and distant shoreline of the reservoir as well as the Project's intake structures are prominent from the highway and create a generally pleasing viewshed. Motorists have somewhat fleeting views of the areas upstream and downstream of the Dam as they drive on Highway 6. Given the relatively limited, fleeting views of the downstream area and its partially developed nature, the aesthetic quality of the downstream area is considered to be moderate.

During normal water levels, portions of the lake bottom along the periphery of the reservoir shoreline and islands and bars are exposed. At elevation 350, the reservoir has a surface area of about 40,066 feet and about 7,400 acres of lake bottom is exposed. The lake bottom appears as a dark band of substrate around the periphery of the reservoir and around islands and bars. Exposed aquatic vegetation, tree stumps and woody debris are present throughout much of the dewatered area. In general, the shoreline around the main body of the reservoir, including the back ends of small coves, have moderate to highly steep slopes. The shoreline along upper reaches of the lake, including the longer, narrower coves and inlets tend to have gentle gradual slopes. As a result, there is less lake bottom exposed in the main body at elevation 350 than in the upper reaches.

16.0 SOCIOECONOMICS

16.1 Demographics

A summary of the demographic profile of Lexington, Newberry, Richland, and Saluda Counties is provided in Table E-19. Population figures from the U.S. Bureau of the Census (2002) indicate that, in 2000, the combined population of the counties was approximately 592,000. This represents a change of about 89,000 people since 1990, or an increase during the 1990s of 17.7 percent (Table E-18). The rest of South Carolina grew by about 436,000 people or 14.6 percent between 1990 and 2000. In 2002, Lexington, Newberry, Richland and Saluda Counties ranked 5th, 27th, 2nd and 42nd, respectively, in population in the state (out of 46 counties). South Carolina's population is expected to increase to 4,229,990 in 2005, 4,458,930 in 2010, and 4,687,920 in 2015.

Table E-19 shows demographic characteristics of Lexington, Newberry, Richland, and Saluda Counties in 2000. The gender distribution in the four-county area is similar to that of the entire state of South Carolina. Richland County has the highest proportion of people age 18-64 and the lowest proportion of people age 65 or older. The number of high school graduates was similar between Lexington and Newberry Counties and the state as a whole. A lesser percent of the population in Richland County holds high school diplomas while slightly more of the population of Saluda County graduated from high school. The percent of college graduates on the other hand differs from this distribution. There were a high percentage of college graduates in Lexington and Richland Counties, as compared to the state as a whole, and a lesser percentage in Newberry and Saluda Counties.

The number of persons per residence is similar between Lexington and Newberry Counties and the state as a whole. There are slightly fewer people per household in Richland County and slightly more people per household in Saluda County. Richland County is a very urbanized county with the highest percentage of urban residents when compared with Lexington, Newberry and Saluda Counties and statewide. Saluda County, on the other hand, is very rural with over 80 percent of the population comprised of rural residents.

16.2 Economy

A summary of economic information pertaining to the State of South Carolina, Lexington County, Newberry County, Richland County, and Saluda County is provided in Table E-20.

The estimated median household income in 1999 for the Lexington, Newberry, Richland, and Saluda Counties was $44,659, $32,867, $39,961, and $35,774, respectively. Lexington had the highest estimate, 17 percent higher than the state median of $37,082, while Newberry County had the lowest estimate at almost 13 percent lower than the state median. Per capital income (Table E-20) follows the same general distribution with Lexington County having the highest at 118 percent of South Carolina per capita and Newberry having the lowest at 84 percent of the state per capital.

Unemployment follows the inverse distribution with Newberry County having the highest level of unemployed residents over the age of 16 and Lexington County having the lowest. Newberry County also has the greatest percentage of county population living below the poverty level. Lexington County, on the other hand, has the least with 9 percent of county population below poverty level. The other counties were generally equal to or higher than the overall percentage of state residents below poverty level at 14 percent.

The region offers a wide variety of major businesses and industries but also relies heavily on services and government. Employment figures indicate that the civilian labor force in Lexington, Newberry, Richland, and Saluda Counties was approximately 302,000 (Table E-21). Government was the largest employer with services and retail trade being the two largest non-governmental sectors. According to FERC (2002), total payroll in the four-county area was nearly $8 billion, with the highest proportions belonging to government (26.01 percent), services (22.05 percent), manufacturing (13.67 percent), and retail (10.29 percent). The highest earnings per worker were $41,308 for mining, which also has one of the lowest percentages of employees, and $38,490 for wholesale trade (FERC, 2002).

16.3 Social Infrastructure

Lexington, Newberry, Richland, and Saluda Counties provide many services including law enforcement and fire protection, county roads, sanitation, judicial, emergency medical, health care facilities, education, civic organizations and municipal management.

In 1999-2000, Richland County reported 35 private schools with an enrollment of 5,017 students and 68 public schools, with a total of 44,559 students enrolled. By comparison, Saluda County reported only 1 private school having 252 students and 4 public schools with 2,165 students. During the same period, Lexington County reported 13 private schools with an enrollment of 1,136 students and 57 public schools with a total of 46,356 students enrolled. Newberry County had 2 private schools having 260 students and 14 public schools with 5,840 students (SCIway, 2004).

Newberry College and Piedmont Technical College are located in Newberry County. Richland County is home to 8 colleges and universities, as well as, the South Carolina Criminal Justice Academy and the South Carolina Fire Academy. There are no colleges or universities in Saluda or Lexington Counties (SCIway, 2004).

The Project area is served by the Lexington County, Newberry County and Richland County sheriff's offices and several local town police departments. The South Carolina Highway Patrol also has jurisdiction across the state and has its headquarters located in Richland County. The State Fire Marshall's Office is also located in Richland County (South Carolina State Government, 2004). There are a total of 6 hospitals in the quad-county area (SCIway, 2004).

16.4 Access and Transportation

Lexington, Newberry, Richland, and Saluda Counties are served Columbia Metropolitan Airport, Greenville-Spartanburg Airport, and several municipal airports; Amtrak and Greyhound, and a system of highways. Interstate 20 runs from Interstate 95 in the eastern part of South Carolina west to Georgia, intersecting both Richland and Lexington Counties. Interstate 26 runs north from Interstate 20 in Richland County and runs northwest through Newberry County, passing Lake Murray just to the east and continuing to North Carolina. Interstate 77 also runs north from Interstate 20 in Richland County and runs north to North Carolina. There are no major interstates running through Saluda County, which is served primarily by Highways 378 and 178 (SCIway, 2004).

The Saluda Project area is accessible via secondary roads from Interstate 20 to the east, Highway 76 to the north, Highway 378 to the south and State Routes 391 and 194 in Saluda County to the west (SCIway, 2004).

Table E-15: Public Recreation Sites in the Project Area

Site Name (Site Number)	Acres	Fee	Picnicking	Hiking	Camping	Lodging	Swimming	Fishing	Dock Fishing	Multi-Ramp	Ramp	Canoe Access	Docks	Food	Marina	Restrooms	Playground	Store	Owned by SCE&G	Operated by SCE&G	Leased to Other Entity
Lake Murray																					
Billy Dreher State Park (1-11)	348.0	●	●	●	●	●		●		●			●	●	●	●	●	●	●		●
Dam (1-8)	6.8		●						●	●			●						●	●	
Higgins Bridge (1-13)	1.1										●								●	●	
Hilton (1-7)	4.4		●					●	●		●					●			●	●	
Kempson Bridge (1-14)	1.1										●								●	●	
Lake Murray Estates (1-22)											●								●	●	
Macedonia Church (1-12)	5.3		●																●	●	
Murray Shores (1-3)	1.6		●								●		●						●	●	
Parksite (1-1)	17.9		●				●							●					●	●	
River Bend (1-4)	11.6		●					●			●		●						●	●	
Rock Creek (1-6)	1.7		●								●								●	●	
Shull Island (1-2A)																			●	●	
Shull Island (1-2B)											●								●	●	
Shull Island / Larry Koon (1-2)	2.2		●							●			●			●			●	●	●
Sunset 1-(5)	2.3		●								●								●	●	

Site Name (Site Number)	Acres	Fee	Picnicking	Hiking	Camping	Lodging	Swimming	Fishing	Dock Fishing	Multi-Ramp	Ramp	Canoe Access	Docks	Food	Marina	Restrooms	Playground	Store	Owned by SCE&G	Operated by SCE&G	Leased to Other Entity
Lower Saluda River																					
Gardendale												●							●		●
Hope Ferry (1-10)	1.0									●									●	●	
Saluda River Canoe Portage (1-15)	2.0											●							●	●	
Saluda Shoals Park (1-9)	240.0								●	●									●		●
64 Islands	220.0																		●		

Table E-16: Marinas on Lake Murray

Marina Name (Site Number)	Acres	Multi slips	Ramp	Dock	Bait and/or Tackle	Dry Storage	Fuel	Restaurant	Food	Motel	Camping
Acapulco, USA (2-20)			●	●							
Adams Campground (2-24)			●	●							●
Agnew Lake Services (2-2)			●								
Barn (2-15)		●			●				●		●
Billy Dreher Island State Park (2-10)		●	●				●				●
Blacks Bridge Marina (2-14)			●	●	●				●		
Bucks (2-9)			●	●							
Eptings Landing (2-8)											●
Hendrick Landing (2-29)			●	●							
Holiday Shores Point (2-25)			●	●							
Holland Landing (2-12)		●			●				●		●
Hollow Creek Marina (2-22)		●									
Jakes Landing (2-31)		●							●		
Johnny Shealy (2-3)			●	●							●
Lake Murray Marina (2-1)		●						●			
Lighthouse Marina (2-4)		●				●		●			
Little Marina (2-17)			●	●	●				●		
Little River Landing (2-16)			●		●				●		
Lockhart Landing (2-5)			●	●							
Old Palmetto Landing (2-6)			●	●							
P-L Landing (2-11)			●	●					●	●	
Putnams Landing (2-7)		●			●				●		
Robinsons Lakeside Marina (2-26)		●			●				●		
Roys Landing (2-23)			●	●							
Saluda River Resort (2-13)			●		●				●		●
Siesta Cove (2-27)		●			●				●		●

Marina Name (Site Number)	Acres	Multi slips	Ramp	Dock	Bait and/or Tackle	Dry Storage	Fuel	Restaurant	Food	Motel	Camping
Snelgrove Landing (2-30)			●	●							
Spinners Marina (2-19)		●	●	●	●				●		
Swygerts Landing (2-21)			●	●							
Top-of-the-Lake (2-18)			●								
Turners Landing (2-28)			●	●							

Table E-17: Private Marinas and Landings on Lake Murray

Marina Name (Site Number)	Acres	Private Club	Condominium	Subdivision
Ballentive Cove (3-10)				●
Boardwalk Villa (3-56)			●	
Cedar Cove Subdivision (3-15)		●		
Clearwater Cove (3-6)				
Clouds Creek Estates (3-36)				●
Coast Guard Auxiliary (3-13)				
Columbia Farms Employee Club (3-41)		●		
Columbia Sailing Club (3-1)		●		
Crystal Springs Creek (3-37)				●
Edgewater Shores (3-32)				●
Fort Love Point Subdivision (3-16)		●		
Friendly Boating Club (3-57)		●		
Hallmark Shores (3-46)				●
Harbor Place (3-53)				●
Harborside (3-51)			●	
Hilton Place (3-20)				●
Indian Fork (3-17)		●		
J.B. Martin Employee Club (3-40)		●		
Lake Murray Boating/Sporting Club (3-18)		●		
Lake Murray Docks (3-3)		●		
Lake Murray Sailing Club (3-19)				●
Lake View Subdivision (3-35)				●
Lake Wood (3-28)				●
Lands End (3-50)			●	
Leesville Fire Department (3-44)		●		
Lexington County Law		●		

Marina Name (Site Number)	**Acres**	**Private Club**	**Condominium**	**Subdivision**
Enforcement (3-42)				
Mallard Cove (3-54)			●	
Mallard Shores (3-48)			●	
Moss Rock Subdivision (3-45)				●
Nautical Shores Subdivision (3-38)				●
Newberry Exchange Club (3-31)		●		
Newberry Firemen's Association (3-34)				
Newberry Lions Club (3-30)		●		
Night Harbor (3-25)				●
North Lake Development (3-11)				●
Optimist Club (3-21)				
Pine Island Club (3-4)		●		
Plantation Hills (3-23)				●
Plantation Point (3-33)				●
Sandhill Landing Property (3-39)				●
Secret Cove (3-55)				●
Selwood Shores (3-5)				●
Shadowood Subdivision (3-12)				●
Shady Acres (3-24)				●
Ship Yard (3-22)				
Smallwood (3-29)				●
Spences Point (3-49)			●	
Stephenson Lakes (3-27)				●
Tattlers Wharf (3-9)				●
The Landings (3-47)				●
The Village (3-8)				●
Timberlake (3-26)				●
Waxford Subdivision (3-7)				●
Willows End (3-43)				●

Marina Name (Site Number)	**Acres**	**Private Club**	**Condominium**	**Subdivision**
Winward Pointe (3-52)				●
Woodmen of the World (3-14)		●		
Yacht Cove (3-2)			●	

Table E-18: Study Area Population Trends, 1990-2000: Average Annual Percent Change

COUNTY	1990	2000	PERCENT CHANGE
Lexington	167,611	216,014	28.9
Newberry	33,172	36,108	8.85
Richland	285,720	320,677	12.2
Saluda	16,357	19,181	17.3
TOTAL	502,860	591,980	17.7
Rest of South Carolina	2,983,843	3,420,032	14.6

Source: U.S. Bureau of Census, 2002, reported in FERC 2002.

Table E-19: Demographic Characteristics of Residents of Lexington, Newberry Richland and Saluda Counties and South Carolina in 2000.

STATISTIC	SOUTH CAROLINA	LEXINGTON	NEWBERRY	RICHLAND	SALUDA
Percent Male	48.6	48.6	48.2	48.3	49.6
Percent 18 - 64	62.7	63.7	61.2	66.0	60.6
Percent High School Graduates[a]	30.0	29.5	33.5	22.8	38.6
Percent College Graduates[a]	27.1	32.7	21.3	39.2	17.8
Persons per Occupied Housing Unit (1990)	2.53	2.56	2.5	2.44	2.65
Percent Urban	60.5	66.3	33.1	87.2	18.7
Percent Rural	39.5	33.7	66.9	12.8	81.3

Sources: U.S. Bureau of Census, 2002 and South Carolina Office of Research and Statistics, 2004, Reported in FERC, 2002.

[a] This information pertains to persons in 2000 over the age of 25

Table E-20: Economic Characteristics of Residents of Lexington, Newberry Richland and Saluda Counties and South Carolina in 2000

STATISTIC	SOUTH CAROLINA	LEXINGTON	NEWBERRY	RICHLAND	SALUDA
Per Capita Personal Income (1999)	$24,426	$28,906	$20,552	$27,114	$20,992
Civilian Labor Force[a]	1,938,195	114,600	17,203	160,969	9,156
Unemployment Rate (percent)[a]	5.9	3.5	7.8	6.7	5.0
Percent Persons Below Poverty Level (1999)	14.1	9	17	13.7	15.6

Sources: FERC, 2002 and South Carolina Office of Research and Statistics, 2004.

[a] This information pertains to persons in 2000 over the age of 16.

Table E-21: Employment by Sector: Lexington, Newberry, Richland, and Saluda Counties in 2000

SECTOR	JOBS	% OF TOTAL	ANNUAL PAYROLL	% OF TOTAL	ANNUAL EARNINGS / WORKER
Agriculture & Forestry	2,762	0.90	$53,845,243	0.15	$19,495
Mining	3,240	1.00	$13,383,791	0.15	$41,308
Construction	16,162	5.27	$476,359,161	5.42	$29,474
Manufacturing	34,244	11.16	$1,201,624,718	13.67	$35,090
Transport & Utilities	14,694	4.79	$545,664,145	6.21	$37,135
Wholesale Trade	14,422	4.70	$555,106,829	6.32	$38,490
Retail Trade	54,488	17.76	$904,573,419	10.29	$16,601
F.I.R.E.	21,933	7.15	$813,188,054	9.25	$37,076
Services	73,018	23.81	$1,937,779,148	22.05	$26,538
Government	74,675	24.35	$2,286,070,529	26.01	$30,614
TOTAL	306,722		$8,787,595,037		

Source: FERC, 2002.

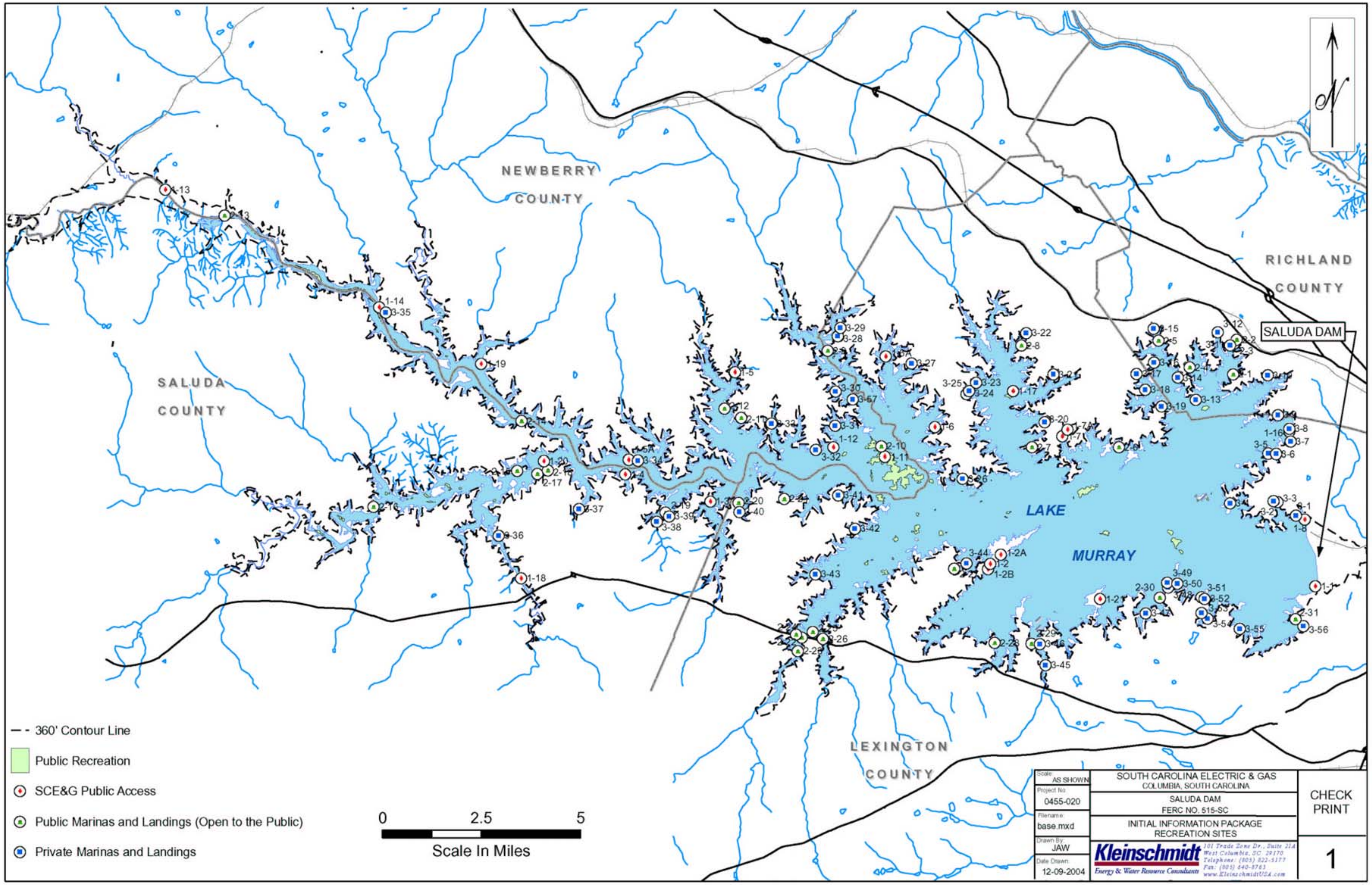


Figure E-14: Public Access and Recreation sites around Lake Murray

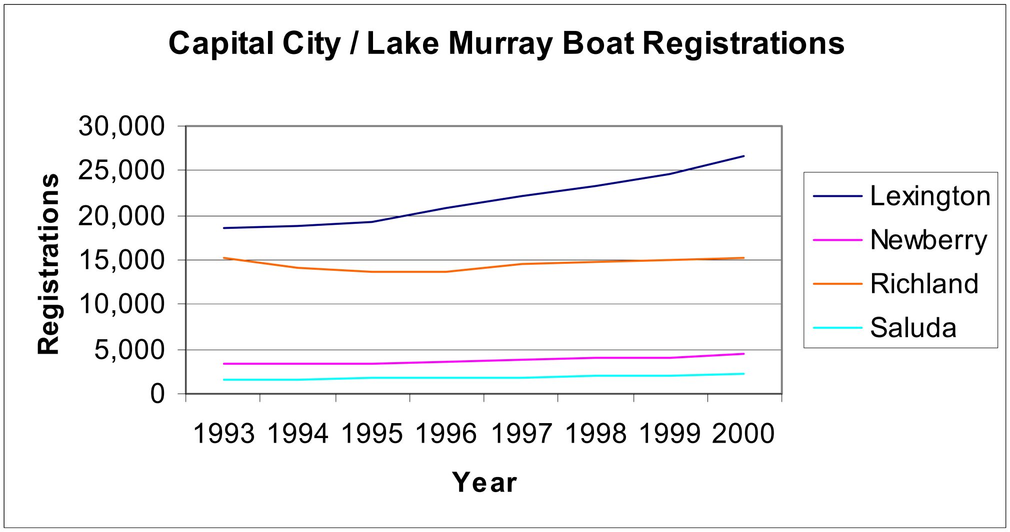


Figure E-15: Capital City Boat Registrations (SCBCB, 2004 and Mead and Hunt, 2002; as modified by Kleinschmidt)

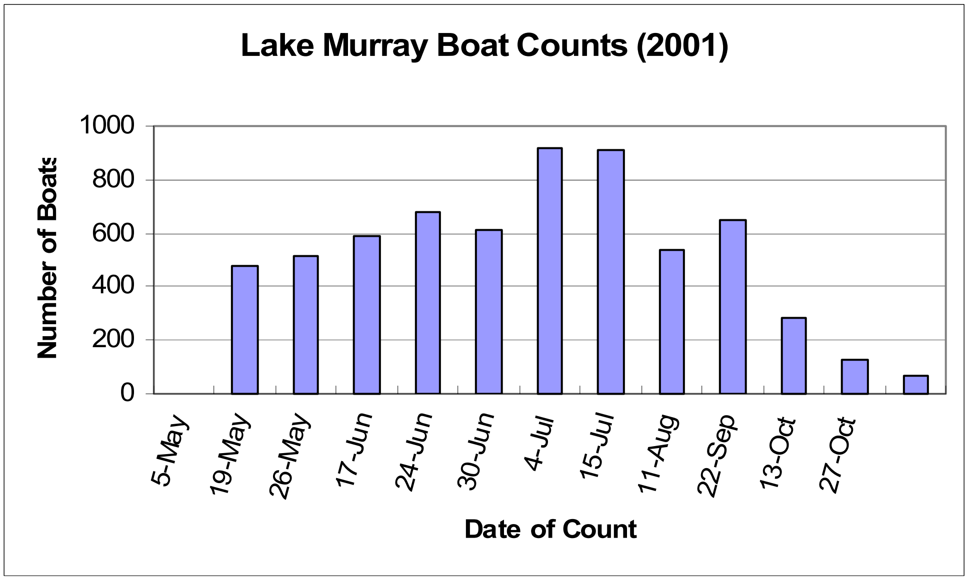
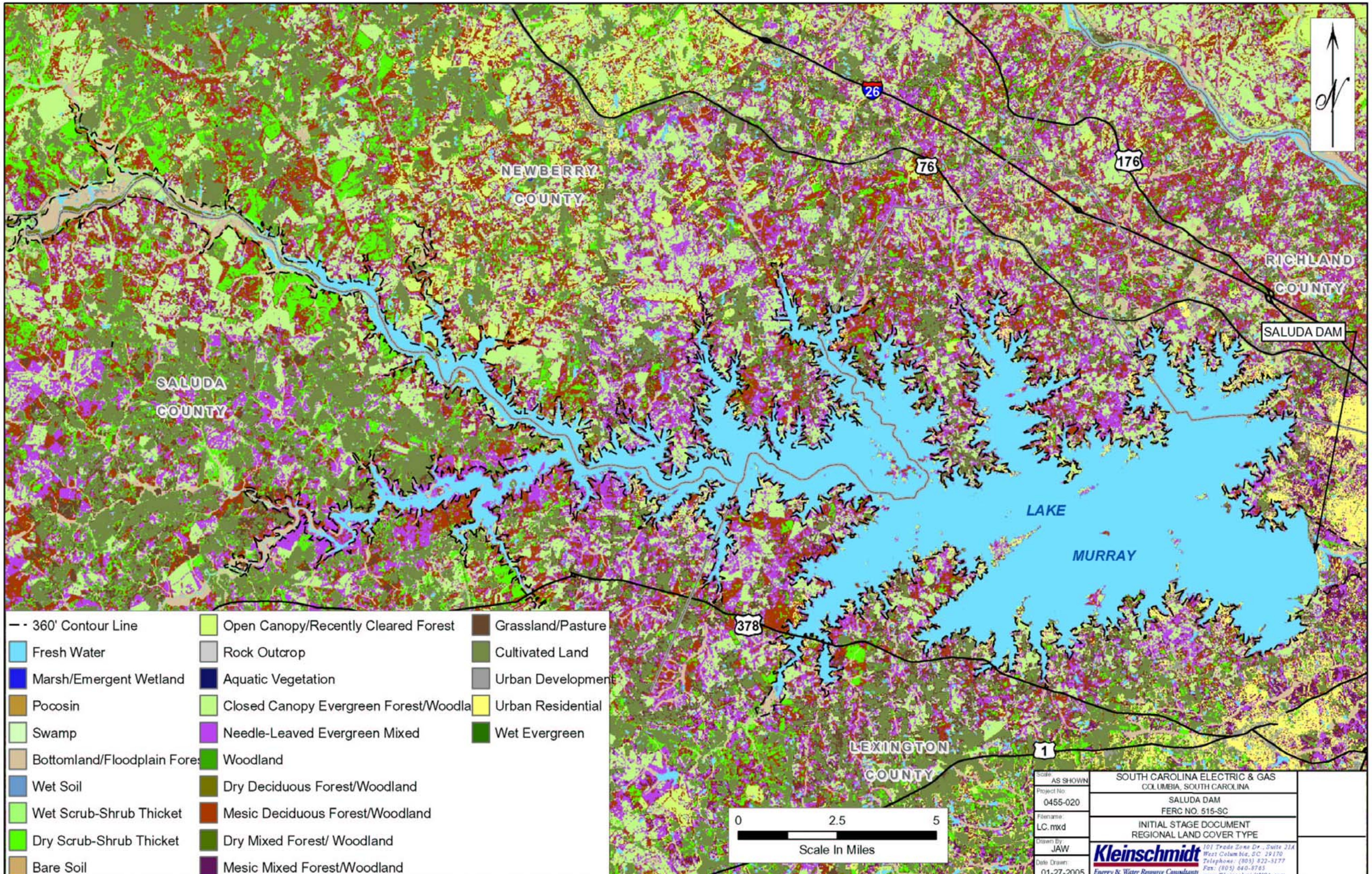


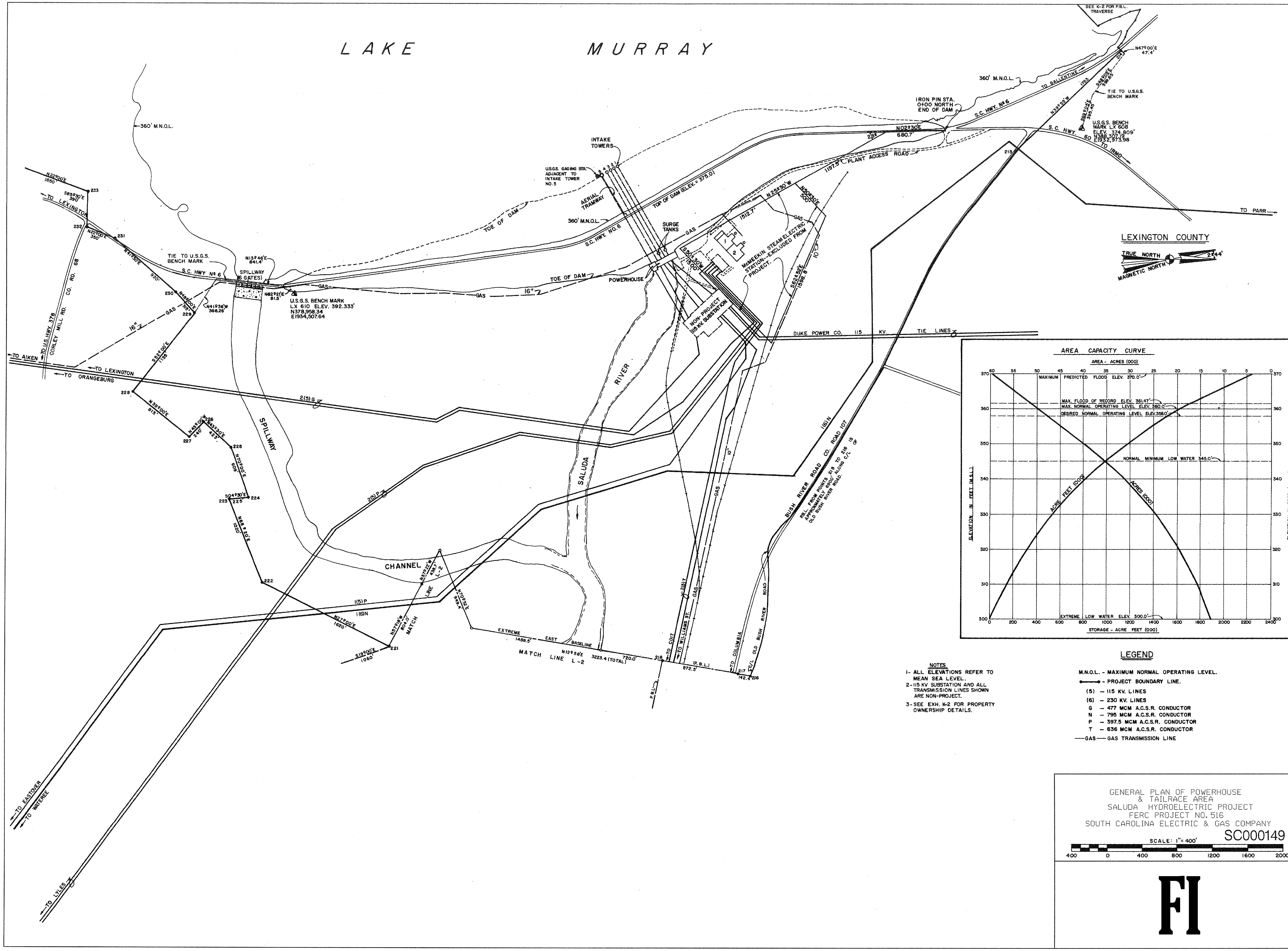
Figure E-16: Lake Murray Boat Counts (Source: The Louis Berger Group, Inc., 2002, cited in Mead & Hunt, 2002b)



South Carolina GAP Analysis data developed by USGS, 2001.

Figure E-17: Land Cover in the Vicinity of Lake Murray

F: GENERAL DESIGN DRAWINGS OF PRIMARY PROJECT WORKS



NOTES

1- ALL ELEVATIONS REFER TO MEAN SEA LEVEL.
2- 115 KV SUBSTATION AND ALL TRANSMISSION LINES SHOWN ARE NON-PROJECT.
3- SEE EXH. K-2 FOR PROPERTY OWNERSHIP DETAILS.

LEGEND

M.N.O.L. - MAXIMUM NORMAL OPERATING LEVEL.
●——● - PROJECT BOUNDARY LINE.
(5) – 115 KV. LINES
(6) – 230 KV. LINES
G – 477 MCM A.C.S.R. CONDUCTOR
N – 795 MCM A.C.S.R. CONDUCTOR
P – 397.5 MCM A.C.S.R. CONDUCTOR
T – 636 MCM A.C.S.R. CONDUCTOR
—GAS— GAS TRANSMISSION LINE

GENERAL PLAN OF POWERHOUSE & TAILRACE AREA
SALUDA HYDROELECTRIC PROJECT
FERC PROJECT NO. 516
SOUTH CAROLINA ELECTRIC & GAS COMPANY

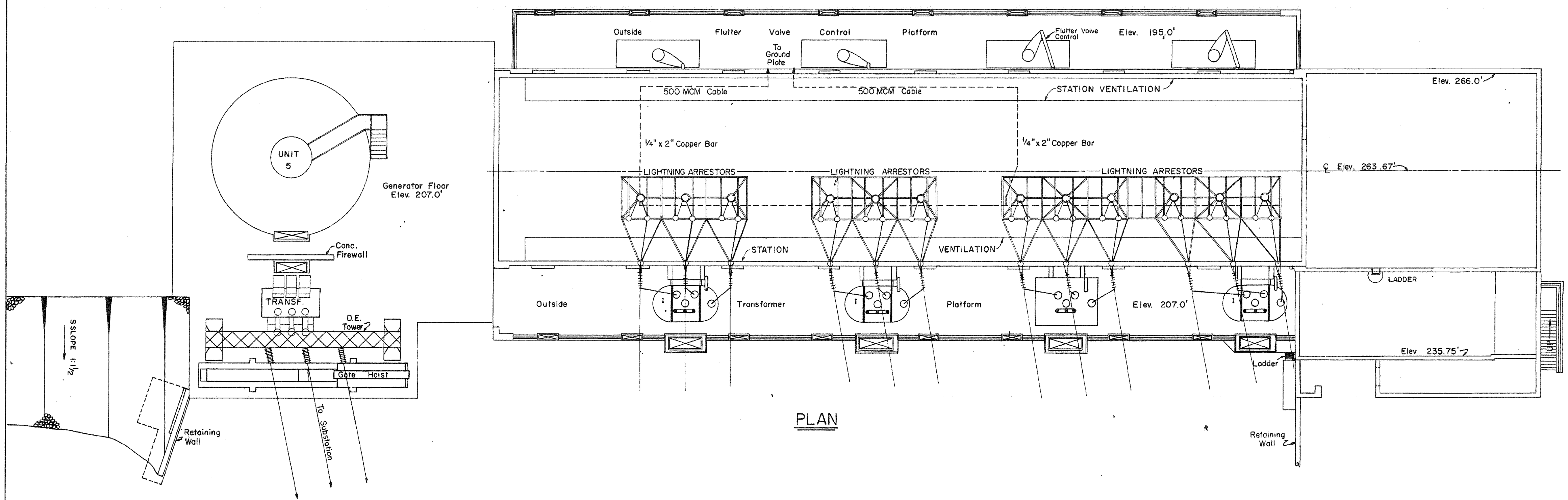
SC000149

SCALE: 1" = 400'

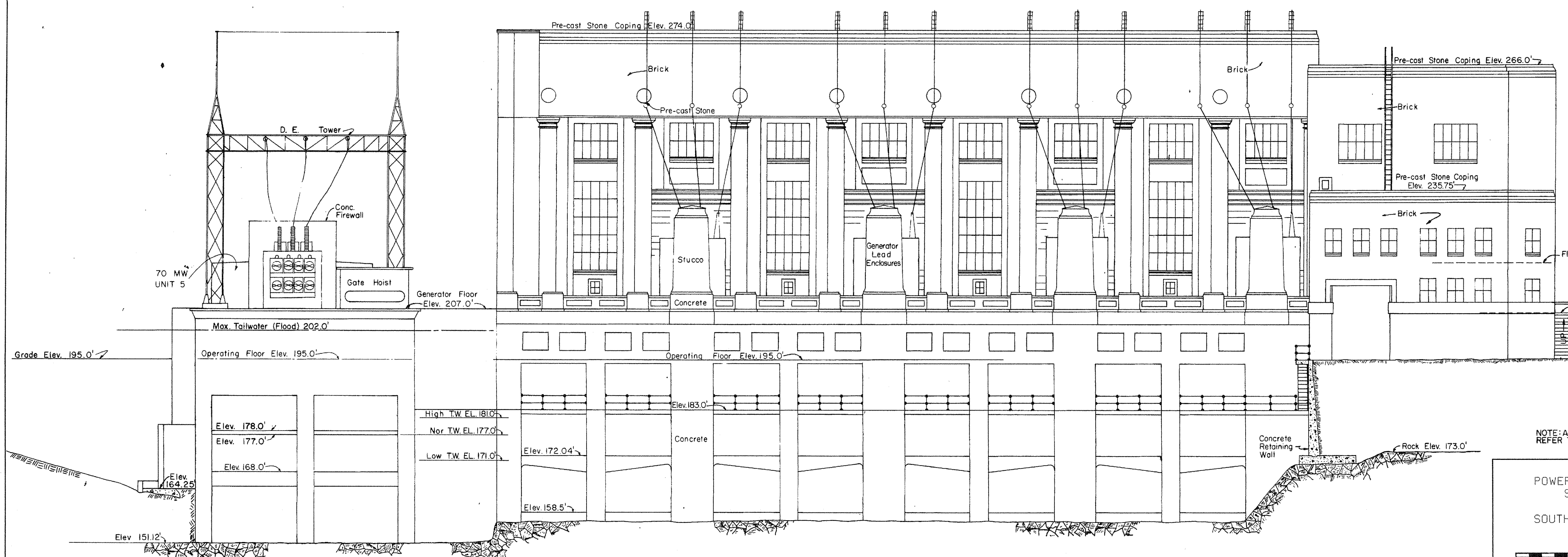
400 0 400 800 1200 1600 2000

FI

F/H CADD DRAWING DO NOT REVISE MANUALLY



PLAN



ELEVATION

NOTE: ALL ELEVATIONS SHOWN REFER TO MEAN SEA LEVEL

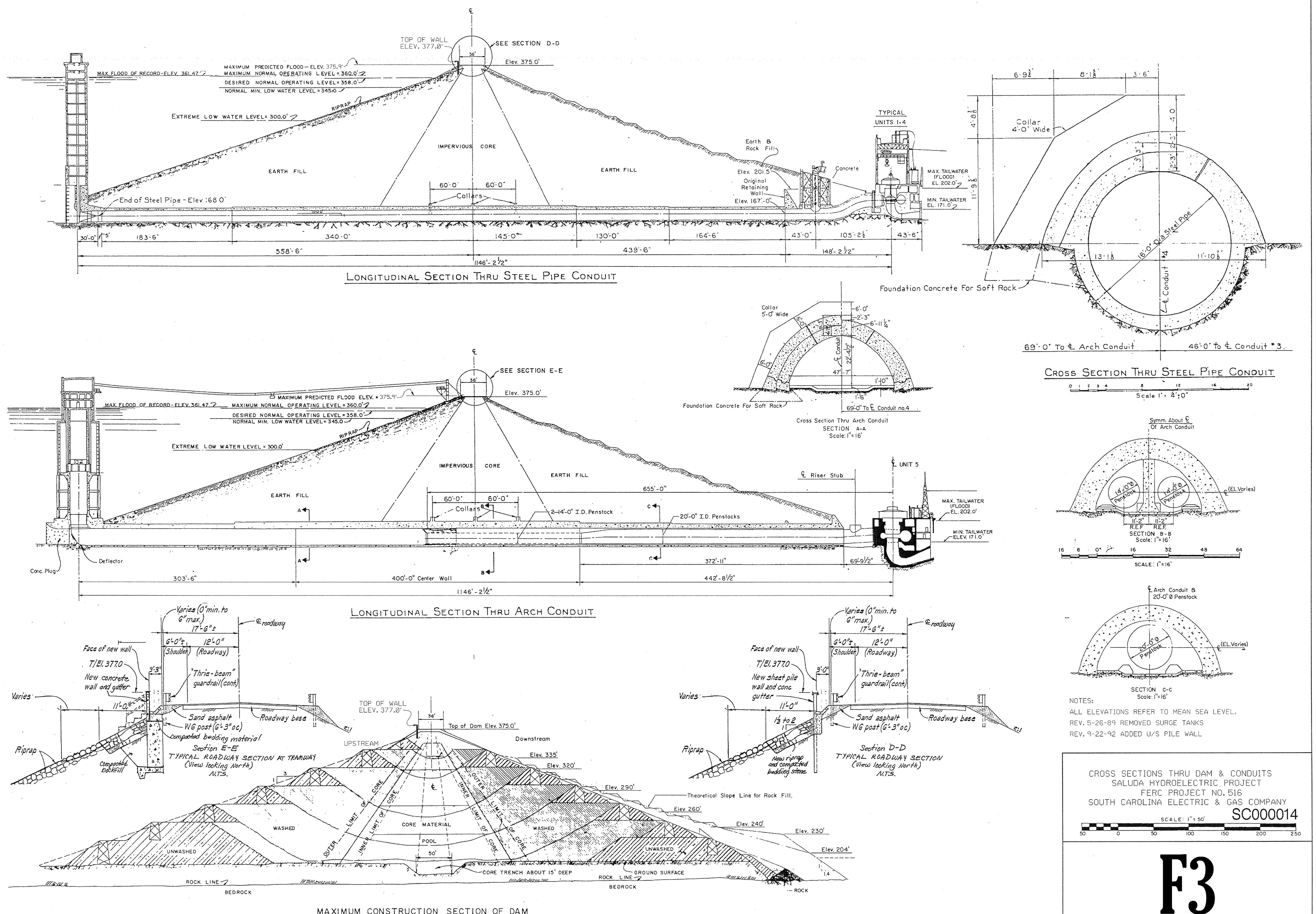
POWERHOUSE - DOWNSTREAM PLAN & ELEV.
SALUDA HYDROELECTRIC PROJECT
FERC PROJECT NO. 516
SOUTH CAROLINA ELECTRIC & GAS COMPANY

SC000013

SCALE: 1" = 12'

12 9 6 3 0 12 24 36 48 60

F2



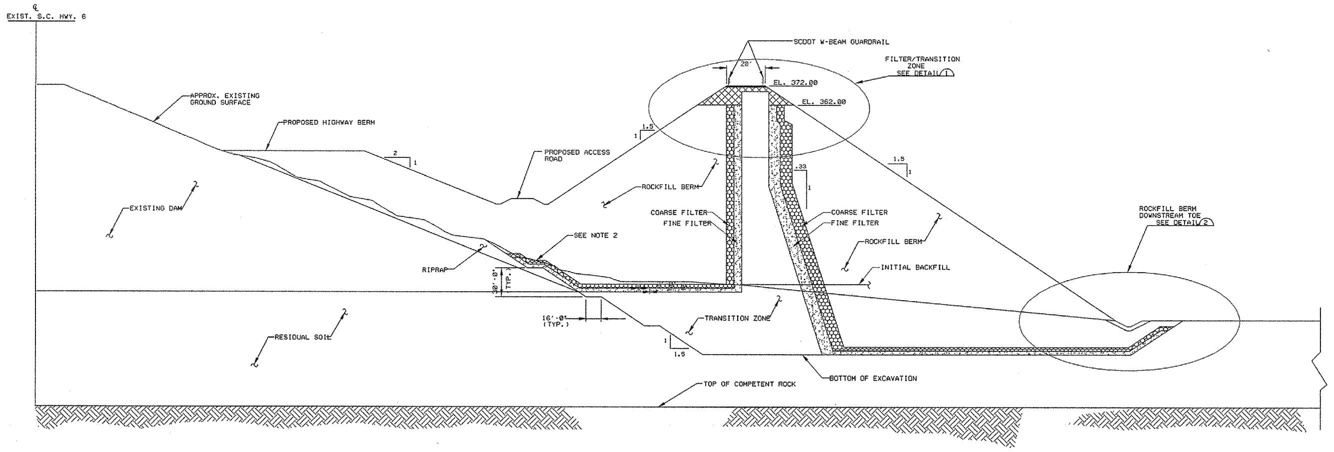
CROSS SECTIONS THRU DAM & CONDUITS
SALUDA HYDROELECTRIC PROJECT
FERC PROJECT NO. 516
SOUTH CAROLINA ELECTRIC & GAS COMPANY

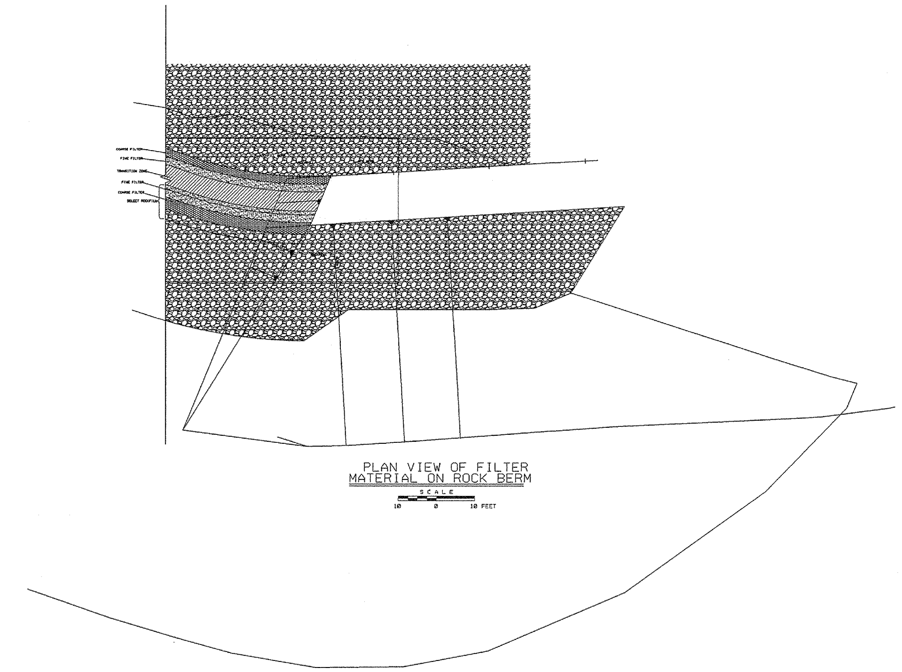
SC000014

SCALE: 1" = 50'

F3

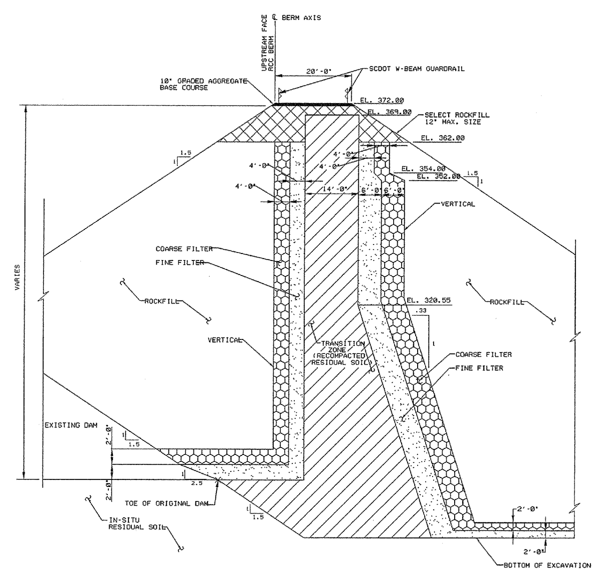
FOSSIL/HYDRO CADD DRAWING DO NOT REVISE MANUALLY





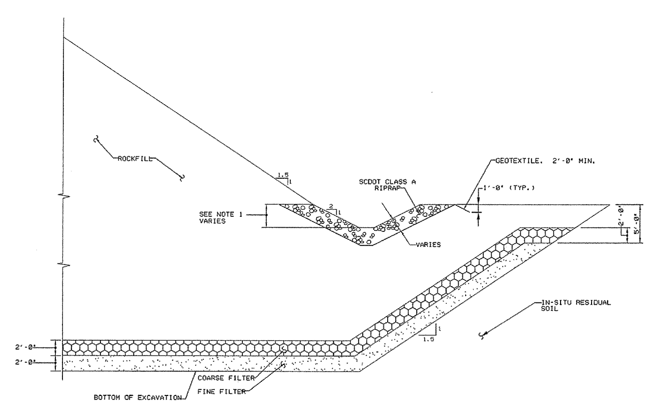
PLAN VIEW OF FILTER MATERIAL ON ROCK BERM

SCALE



DETAIL 1

SCALE



DETAIL 2

SCALE

ROCK BERM TYPICAL SECTIONS AND DETAILS
SALUDA HYDROELECTRIC PROJECT
FERC PROJECT NO. 516
SOUTH CAROLINA ELECTRIC & GAS COMPANY

SCALE AS NOTED

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F4

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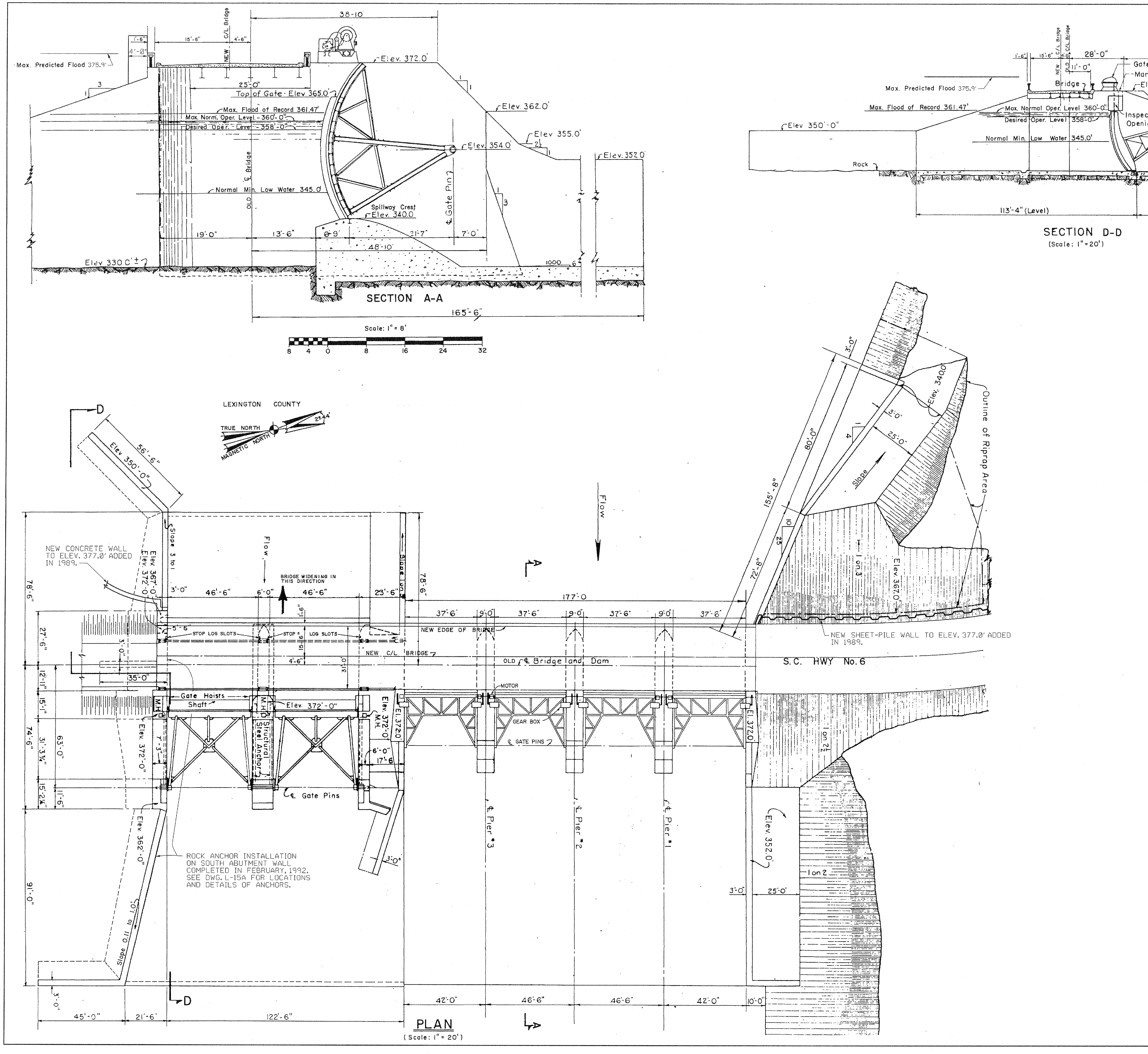


NOTES:
1-ALL ELEVATIONS SHOWN REFER TO MEAN SEA LEVEL.
2-REV. 9-22-92 ADDED SPILLWAY ANCHORS AND U/S WALLS
3-REV. 3-9-93 REVISED SP. RATING CURVE.

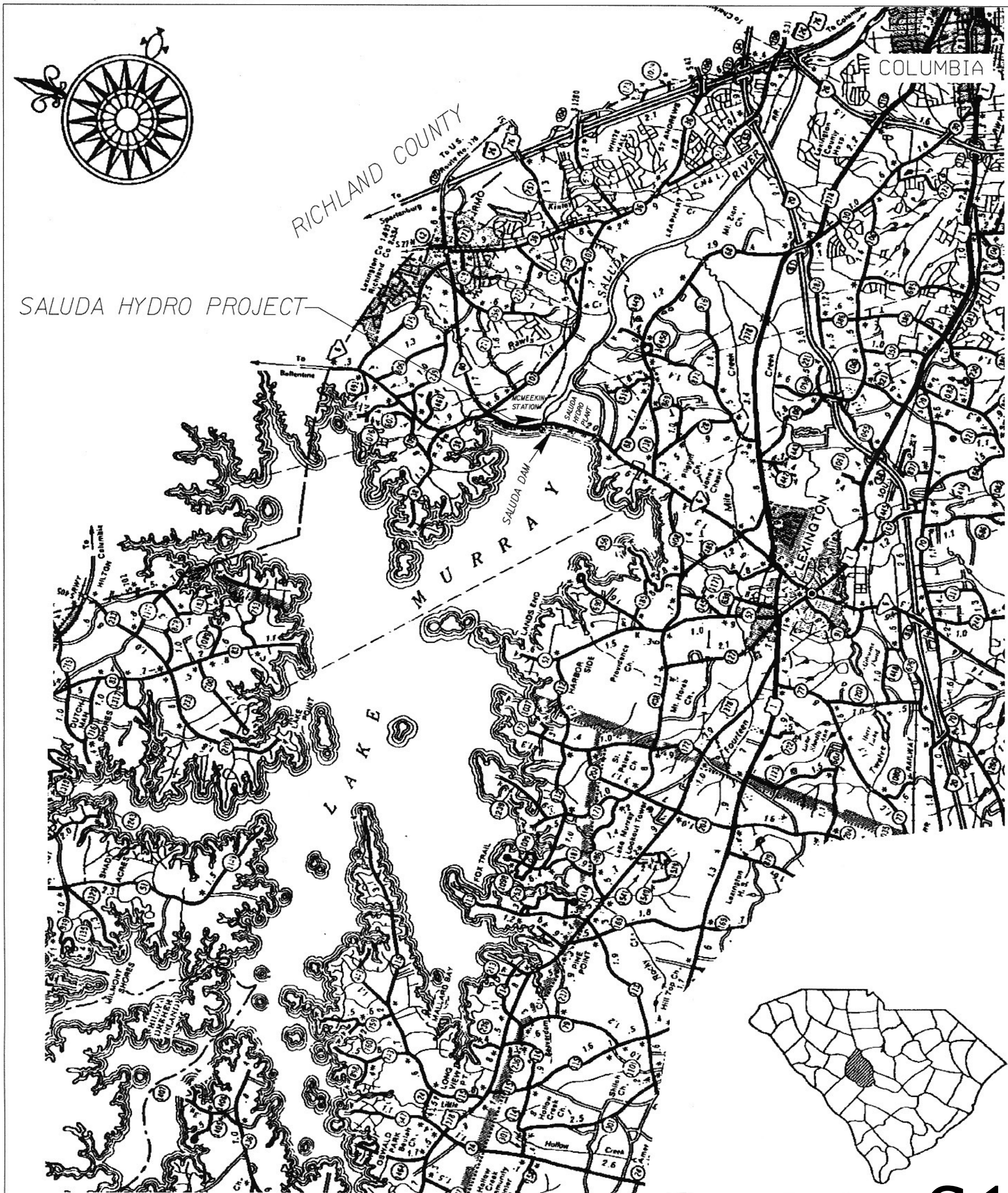
SPILLWAY GATES-PLAN & SECTIONS
SALUDA HYDROELECTRIC PROJECT
FERC PROJECT NO. 516
SOUTH CAROLINA ELECTRIC & GAS COMPANY

SC000015

SCALE: 1" = 20'

F5

G: PROJECT MAPS



G1

GENERAL MAP OF
PROJECT AREA
SALUDA HYDROELECTRIC PROJECT
FERC PROJECT NO. 516
SOUTH CAROLINA ELECTRIC & GAS CO.

SF000023

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PRIVATELY OWNED PUBLIC RECREATIONAL FACILITIES					
1 HOLLOW CREEK MARINA (K-7)	F-5	21 NEWBERRY EXCHANGE CULB (K-25)*	G-3	41 LAKE MURRAY DOCK INC. (K-2)	I-4
2 LITTLE RIVER LANDING (K-14)	D-4	22 NEWBERRY LIONS CLUB (K-25) *	G-3	42 ACAPULCO U.S.A. (K-9) *	F-4
3 BUCK'S MARINA (K-26)	G-3	23 PINE ISLAND CLUB (K-2) *	I-4	43 TATTLER'S WHARF (K-33) *	I-3
4 COLUMBIA SAILING CLUB (K-2) *	J-4	24 PUTNAM LANDING (K-30)	H-3	44 CEDAR COVE (K-31) *	I-3
5 CRAYNE'S LANDING (K-26)	F-2	25 BLACK'S BRIDGE MARINA (K-15)	E-3	45 NIGHT HARBOR (K-28) *	G-3
6 SIESTA COVE CAPMGROUND (K-5)	G-4	26 SALUDA RIVER RESORT (K-20)	C-2	46 SPENCE POINT (K-3) *	H-4
7 EPTING'S CAMP (K-29)	H-3	27 SHEALY LANDING (K-10)	E-3	47 WINDWARD POINT (K-3) *	I-4
8 FRIENDLY BOAT CULB (K-25) *	G-3	28 SNELGROVE'S LANDING (K-4)	I-4	48 MALLARD SHORES (K-3) *	I-4
9 HENDRIX'S LANDING (K-4)	H-5	29 SNUG HARBOR (K-26)	G-3	49 HARBORSIDE CONDOS (K-3) *	I-4
10 HOLLAND'S LANDING (K-24)	F-3	30 BUSH RIVER LANDING (K-21)	D-3	50 LANDING (K-4) *	H-4
11 LAQUANA LANDING (K-7)	G-5	31 SWYGERT'S LANDING (K-8)	F-4	51 MALLARD COVE (K-3) *	H-4
12 JAKE'S LANDING (K-2)	J-5	32 ROY'S LANDING (K-7)	F-5	52 BOARDWALK VILLAS (K-2) *	I-4
13 LIGHT HOUSE MARINA (K-32)	I-3	33 TOM'S LANDING (K-24)	F-3	53 P & L LANDING (K-24)	F-3
14 LAKE MURRAY BOATING & SPORTS CLUB *	I-3	34 TOP OF THE LAKE RESORT (K-10)	E-3		
15 YACH'T COVE (K-2)	I-4	35 TOWN OF PROSPERITY (K-23)	E-3		
16 LAKE MURRAY SAILING CLUB (K-31) *	I-3	36 TURNER'S LANDING (K-5)	H-5		
17 LAKESIDE MARINE (K-7)	F-5	37 ADAM'S CAMPGROUND (K-7) *	F-5		
18 LEXINGTON BOAT CLUB (K-2) *	J-5	38 WEED'S LANDING (K-7)	F-5		
19 SPINNAKER'S MARINA (K-9)	E-4	39 LAKE MURRAY MARINA (K-32)	I-3		
20 MORRIS LANDING (K-22)	E-3	40 THE BARN (K-15) *	D-3		

SOUTH CAROLINA ELECTRIC & GAS CO. PUBLIC RECREATION SITES			
SITE NO. 1 (K-2)	J-4	SITE 2B (K-5)	H-4
SITE NO. 2 (K-5)	H-4	SITE 14 (K-21)	D-2
SITE NO. 2A (K-5)	H-4	SITE 15 (K-1)	K-4
SITE NO. 3 (K-9)	F-4	SITE 16 (K-33)	I-3
SITE NO. 4 (K-10)	E-3	SITE 17 (K-29)	H-3
SITE NO. 4A (K-10)	E-3	SITE 18 (K-11)	E-4
SITE NO. 5 (K-24)	F-3	SITE 19 (K-22)	D-3
SITE NO. 5A (K-23)	E-3	SITE 20 (K-10)	E-3
SITE NO. 6 (K-27)	G-3	SITE 21 (K-4)	H-4
SITE NO. 6A (K-27)	G-3		
SITE NO. 7 (K-30)	H-3		
SITE NO. 7A (K-30)	H-3		
SITE NO. 8 (K-2)	J-4		
SITE NO. 9 (K-1)	J-4		
SITE NO. 10 (K-1)	J-4		
SITE NO. 11 (K-25 & K-27)	G-3		
SITE NO. 12 (K-25)	G-3		
SITE NO. 13 (K-19)	B-2		

PRIVATELY OWNED PUBLIC RECREATION FACILITIES
HAZARD MARKERS BY S.C. WILDLIFE DEPARTMENT
SOUTH CAROLINA ELECTRIC & GAS COMPANY PUBLIC RECREATION AREA (SEE R-2 FOR DETAILS)
DENOTES LANDS LEASED TO S.C. GAME MANAGEMENT DEPT.
H-1 HISTORICAL SITE. (SEE EXHIBITS K & V.)

NOTES:
1. SEE EXHIBIT K FOR LAND WHICH IS CURRENTLY OWNED IN FEE SIMPLE BY S.C.E. & G. CO.
2. LAKE ELEVATION SHOWN IS 354.0' MSL AS TAKEN FROM AERIAL PHOTOGRAPHS.
3. ALL ISLANDS ARE CLASSIFIED AS PROJECT ISLANDS UNLESS OTHERWISE SHOWN.

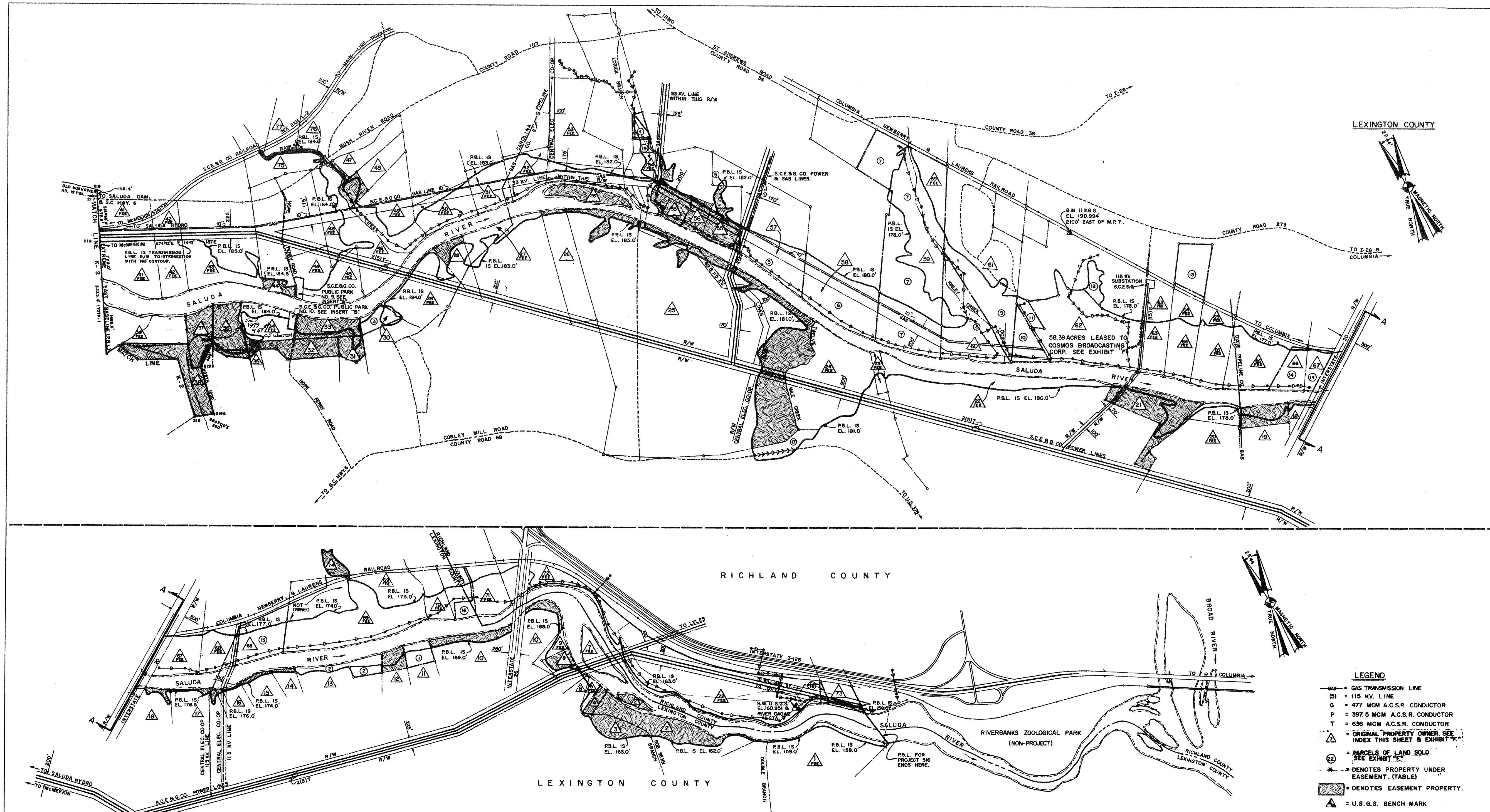
DETAIL MAP OF PROJECT AREA
SALUDA HYDROELECTRIC PROJECT
FERC PROJECT NO. 516
SOUTH CAROLINA ELECTRIC & GAS COMPANY

SC000148

SCALE IN MILES
1 0 1 2 3 4 5 6 7

G2

FOSSIL/HYDRO CADD DRAWING DO NOT REVISE MANUALLY

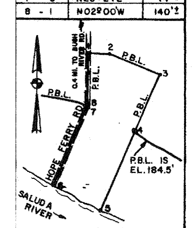


LEGEND

- GAS = GAS TRANSMISSION LINE
- (5) = 115 KV. LINE
- G = 477 MCM A.C.S.R. CONDUCTOR
- P = 397.5 MCM A.C.S.R. CONDUCTOR
- T = 636 MCM A.C.S.R. CONDUCTOR
- (7) = ORIGINAL PROPERTY OWNER. SEE INDEX THIS SHEET & EXHIBIT "F."
- (22) = PARCELS OF LAND SOLD SEE EXHIBIT "F."
- = DENOTES PROPERTY UNDER EASEMENT. (TABLE)
- = DENOTES EASEMENT PROPERTY.
- = U.S.G.S. BENCH MARK
- = DENOTES ROADWAY OR CAUSEWAY INSIDE P.B.L.
- (8 FEE) = DENOTES LAND STILL OWNED IN FEE BY S.C.E.&G.CO. ON THIS SHEET ONLY, FEE SIMPLE PROPERTY ILLUSTRATED AS (9 FEE) INSTEAD OF ■. THIS CHANGE IS TO ASSIST UNDERSTANDING SINCE MAJORITY OF LAND ILLUSTRATED THIS SHEET IS FEE SIMPLE.

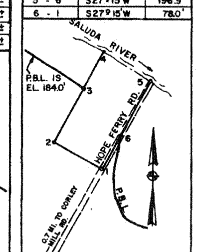
NOTES:
1. ALL ELEVATIONS SHOWN REFER TO MEAN SEA LEVEL.
2. ALL TRANSMISSION LINES SHOWN ARE EXCLUDED FROM THE PROJECT.

SITE 9		
1.50 ACRES±		
FROM - TO	BEARING	DIST.
1 - 2	EAST	61'±
2 - 3	S69°36'E	150.0'
3 - 4	S20°24'W	186'±
4 - 5	S20°24'W	219'±
5 - 6	Along River	150'±
6 - 7	N20°24'E	221'±
7 - 8	N20°24'E	14'±
8 - 1	N02°00'W	140'±

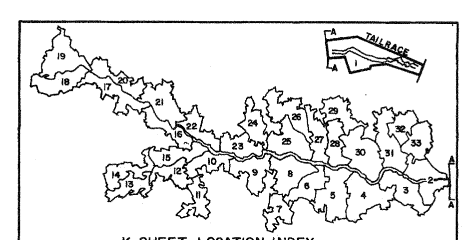


SCALE: 1"=200' (SEE EXH. R-2)
INSERT "A"

SITE 10		
1.00 ACRE±		
FROM - TO	BEARING	DIST.
1 - 2	N62°34'W	150.0'
2 - 3	N27°26'E	173'±
3 - 4	N27°26'E	112.6'±
4 - 5	Along River	150'±
5 - 6	S27°15'W	196.9'
6 - 1	S27°15'W	78.0'



SCALE: 1"=200' (SEE EXH. R-2)
INSERT "B"



K-SHEET LOCATION INDEX

DETAIL MAP OF PROJECT AREA
SALUDA HYDROELECTRIC PROJECT
FERC PROJECT NO. 516
SOUTH CAROLINA ELECTRIC & GAS COMPANY
SCALE: 1"=800'
800 0 800 1600 2400 3200 4000

G3

SF000034

APPENDIX A

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APPENDIX A: LITERATURE CITED

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APPENDIX B

ADDITIONAL INFORMATION FOR THE SALUDA HYDROELECTRIC PROJECT

APPENDIX B: ADDITIONAL AVAILABLE STUDY REFERENCE LIST

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APPENDIX C

GLOSSARY

APPENDIX C: GLOSSARY

acre-foot (feet)	The amount of water it takes to cover one acre to a depth of one foot, 43,560 cubic feet or 1,233.5 cubic meters
active storage	The volume of water in a reservoir between its minimum operating elevation and its maximum normal operating elevation.
anadromous fish	Fish that live in saltwater habitats most of their lives, but periodically migrate into freshwater to spawn and develop to the juvenile stage (e.g., alewife).
anticline	a fold with strata sloping downward on either side
aquatic life	Any plants or animals which live at least part of their life cycle in water.
argillic horizon	the horizon of clay accumulation shows evidence of clay illuvation
baseline	A set of existing environmental conditions upon which comparisons are made during the NEPA process.
benthic	Associated with lake or river bottom or substrate.
benthic macroinvertebrates	Animals without backbones, which are visible to the eye and which live on, under, and around rocks and sediment on the bottoms of lakes, rivers, and streams.
bypass reach	The original water channel of the river that is directly affected by the diversion of water though the penstocks to the generating facilities. This portion of the river, the "bypassed reach" may remain watered or become dewatered.
capacity	The load for which an electric generating unit, other electrical equipment or power line is rated.
Clean Water Act (CWA)	The Federal Water Pollution Control Act of 1972 and subsequent amendments in 1977, 1981, and 1987 (commonly referred to as the Clean Water Act). The Act established a regulatory system for navigable waters in the United States, whether on public or private land. The Act set national policy to eliminate discharge of water pollutants into navigable waters, to regulate discharge of toxic pollutants, and to prohibit discharge of pollutants from point source without permits. Most importantly it authorized EPA to set water quality criteria for states to use to establish water quality standards.
creel census	Counting and interviewing anglers to determine fishing effort and catch. Usually conducted by a census clerk on systematic regularly scheduled visits to significant fishing areas.
cubic feet per second (cfs)	A measurement of water flow representing one cubic foot of water moving past a given point in one second. One cfs is equal to 0.0283 cubic meters per second and 0.646 mgd.
cultural resources	Includes items, structures, etc. of historical, archaeological, or architectural significance.

dam	A structure constructed across a water body typically used to increase the hydraulic head at hydroelectric generating units. A dam typically reduces the velocity of water in a particular river segment and increases the depth of water by forming an impoundment behind the dam. It also generally serves as a water control structure.
demand	The rate at which electric energy is delivered to or by a system at a given instant or averaged over a designated period, usually expressed in kilowatts or megawatts.
diabase	dark, fine-textured, igneous rock
dike	A raised bank, typically earthen, constructed along a waterway to impound the water and to prevent flooding.
dissolved oxygen (DO)	Perhaps the most commonly employed measure of water quality. Low DO levels adversely affect fish and other aquatic life. The total absence of DO leads to the development of an anaerobic condition with the eventual development of odor and aesthetic problems.
distribution lines	Power lines, like those in neighborhoods, used to carry moderate voltage electricity which is "stepped down" to household levels by transformers on power poles.
drawdown	The distance the water surface of a reservoir is lowered from a given elevation as the result of releasing water.
energy	Average power production over a stated interval of time, expressed in kilowatt-hours, megawatt-hours, average kilowatts and average megawatts.
Eutrophic/eutrophication	Waters with a high concentration of nutrients and a high level of primary production.
Exotic species	Those species which are not native to a particular area
fault	A crack or fracture in the earth's surface
Federal Energy Regulatory Commission	The governing federal agency responsible for overseeing the licensing/relicensing and operation of hydroelectric projects in the United States.
Federal Power Commission (FPC)	Predecessor of FERC
flow	The volume of water passing a given point per unit time.
flow duration curve	A graphical representation of the percentage of time in the historical record that a flow of any given magnitude has been equaled or exceeded.
forebay	That portion of a hydroelectric project impoundment immediately upstream of the intake to the turbines (see also headwaters).
generation	The process of producing electricity from other forms of energy, such as steam, heat, or water. Refers to the amount of electric energy produced, expressed in kilowatt hours.

gross storage	The sum of the dead storage and the live storage volumes of a reservoir, the total amount of water contained in a reservoir at its maximum normal operating elevation.
habitat	The locality or external environment in which a plant or animal normally lives and grows.
head	The distance that water falls in passing through a hydraulic structure or device such as a hydroelectric plant. Gross head is the difference between the headwater and tailwater levels; net head is the gross head minus hydraulic losses such as friction incurred as water passes through the structure; and rated head is the head at which the full-gate discharge of a turbine will produce the rated capacity of the connected generator.
headwater	The waters immediately upstream of a dam. For power dams, also referred to as the water in the impoundment which supplies the turbines (see also forebay).
hydraulic	Relating to water in motion.
hydroelectric plant	A facility at which the turbine generators are driven by falling water.
hydroelectric power	Capturing flowing water to produce electrical energy.
hydroelectric project	The complete development of a hydroelectric power site, including dams, reservoirs, transmission lines, and accessories needed for the maintenance and operation of the powerhouse and any other hydroelectric plant support facilities.
hypolimnetic	The deeper cooler portions of a reservoir or lake that result from stratification.
igneous rock	Rock formed from the cooling and solidification of molten mineral matter.
impoundment	The body of water created by a dam.
Initial Consultation Document (ICD)	A document containing detailed information on a hydroelectric project; the document is used to describe the project and its resources and to start the applicant's consultation process with resource agencies and the public.
kilowatt (kW)	A unit of electrical power equal to 1,000 watts.
lacustrine	Related to standing water, (e.g., a lake).
lapilli	Small, round to angular rock fragments which may have been volcanically ejected in a solid or molten state.
license	FERC authorization to construct a new project or continue operating an existing project. The license contains the operating conditions for a term of 30 to 50 years.
littoral	Associated with shallow (shoreline area) water (e.g., the littoral zone of an impoundment).
load	The total customer demand for electric service at any given time.

lotic	Flowing or actively moving water including rivers and streams.
megawatt (MW)	A unit of electrical power equal to one million watts or 1,000 kW.
metamorphic rock	Rock formed by alterations of igneous and sedimentary rocks under intense heat and pressure.
normal operating conditions	The reservoir elevation approximating an average surface elevation at which a reservoir is kept.
outage	The period during which a generating unit, transmission line, or other facility is out of service.
palustrine forested wetland	Dominated by woody vegetation less than 20 ft tall (i.e., willows, dogwood)
palustrine scrub/shrub wetlands	Comprised of woody vegetation that is 20 ft tall or greater (i.e., American elm, swamp white oak).
peaking operations	A powerplant that is scheduled to operate during peak energy demand.
pegmatite	coarse-grained granite
phytoplankton	Algae floating in the water column. These are mostly microscopic single-celled and colonial forms.
piezometer	A device that measures water pressure.
plutonic structures	large igneous intrusions that are formed deep within the earth's crust
Pool	Refers to the reservoir (impounded body of water).
powerhouse	The building that typically houses electric generating equipment.
Probable Maximum Flood (PMF)	A statistical formula used to calculate a hypothetical flood event that could occur on a particular river basin over a particular duration. This is derived from the probable maximum precipitation over time.
project	One or more hydroelectric plants collectively included in a single Federal Energy Regulatory Commission license. Projects typically consist of a dam, reservoir, powerhouse and appurtenant facilities.
Project area	SCE&G lands and waters within the project boundary.
project boundary	A line established by the FERC to enclose the lands, waters and structures needed to operate a licensed hydroelectric project.
Project vicinity	Lands and waters within which studies were conducted for baseline environmental data. These lands and waters include the Project area.
recreation area	A formal or informal area which people use for leisure activities.
relicensing	The administrative proceeding in which FERC, in consultation with other federal and state agencies, decide whether and on what terms to issue a new license for an existing hydroelectric project at the expiration of the original license.

reserve capacity	Extra generating capacity available to meet unanticipated demand for power or to generate power in the event of loss of generation.
reservoir	An artificial lake into which water flows and is stored for future use.
resident fishery	Fish that spend their entire life cycle in freshwater, such as trout and bass.
resource agencies	Federal, state, or interstate agency with responsibilities in the areas of flood control, navigation, irrigation, recreation, fish or wildlife, water resource management, or cultural or other relevant resources of the state in which a project is or will be located.
riparian area	A specialized form of wetland with characteristic vegetation restricted to areas along, adjacent to or contiguous with rivers and streams. Also, periodically flooded lake and reservoir shore areas, as well as lakes with stable water.
seepage	The amount of water that leaks through a structure, such as a dam.
spawn	The act of fish releasing and fertilizing eggs.
spillway	The section of a dam that is designed to pass water over or through it.
stakeholder	any individual or organization (government or non-governmental) with an interest in a hydroelectric project
stock	The existing density of a particular species of fish in an aquatic system.
stratification	A physical and chemical process that results in the formation of distinct layers of water within a lake or reservoir (i.e., epilimnion, metalimnion, and hypolimnion).
streamflow	The rate at which water passes a given point in a stream, usually expressed in cubic feet per second (cfs).
submerged aquatic vegetation	Plants with rigid stems and/or leaves rooted in substrate and generally covered by deep water (greater than 6.6 ft depth), with all of the plant parts covered by water.
synclinal fold axis	a fold in rocks layers, where rock from both sides dips inward towards a center axis
tailrace	The channel located between a hydroelectric powerhouse and the river into which the water is discharged after passing through the turbines.
tailwater	The waters immediately downstream of a dam. For power dams, also referred to as the water discharged from the draft tubes.
tainter gates	A gate with a curved skin or face plate connected with steel arms to an axle. It is usually lifted or lowered by a cable connected to a hook at the top of the gate rotating on the axle as it is moved.
transformer	Equipment vital to the transmission and distribution of electricity designed to increase or decrease voltage.
transmission	The act or process of transporting electric energy in bulk from one point to another in the power system, rather than to individual customers.

transmission lines	Power lines normally used to carry high voltage electricity to substations which then is "stepped down" for distribution to individual customers.
tuff	Rock formed of pyroclastic material.
turbidity	A measure of the extent to which light passing through water is reduced due to suspended materials.
turbine	A machine for generating rotary mechanical power from the energy in a stream of fluid (such as water, steam, or hot gas). Turbines covert the energy of fluids to mechanical energy through the principles of impulse and reaction, or a mixture of the two.
volt	The unit of electromotive force or electric pressure, akin to water pressure in pounds per square inch.
warmwater fish	Species tolerant of warm water (e.g., bass, perch, pickerel, sucker).
watershed	An entire drainage basin including all living and nonliving components of the system.
wetlands	Lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. Wetlands must have the following three attributes: 1) at least periodically, the land supports predominantly hydrophytes; 2) the substrate is predominantly undrained hydric soil; 3) the substrate is on soil and is saturated with water or covered by shallow water at some time during the growing season of each year.

APPENDIX D

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APPENDIX D: SERVICE LIST

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APPENDIX E

LAKE MURRAY WATER QUALITY REPORT

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Columbia, South Carolina

Saluda Project (FERC No. 516)
Lake Murray Water Quality Report

1.0 BACKGROUND

1.1 FERC Relicensing

The Saluda Hydroelectric Project (Saluda Project) is a federally licensed hydroelectric project located on the Saluda River in Lexington County, South Carolina. The Saluda Project is owned and operated by South Carolina Electric & Gas Company (SCE&G) and licensed by the *Federal Energy Regulatory Commission* (FERC) as Project No. 516 and is due to expire in 2010. As part of the relicensing process, SCE&G has contracted with Reservoir Environmental Management, Inc. (REMI) to consolidate current and historical water quality information for the Saluda Project and the Saluda River immediately downstream of the Project. This report presents this consolidated water quality information to be used as part of the relicensing process for the Saluda Project.

1.2 Water Quality Data Available

A considerable amount of water quality information has been collected on Lake Murray over the last six decades. The first data were collected in 1947 and these early efforts continued up to the early 1970's by the South Carolina Pollution Control Authority, the South Carolina Department of Health and Environmental Control (SCDHEC), and the U.S. Geological Survey (USGS). In 1974, the Environmental Protection Agency (EPA) included Lake Murray in its National Eutrophication Survey under which data were collected from significant reservoirs and lakes located all over the United States. As part of the relicensing process for the current FERC license for operating The Saluda Project, SCE&G contracted with ERC, Inc., to conduct a comprehensive assessment of Lake Murray in 1974 and 1975. The SCDHEC has monitored the lake and its inflowing waters monthly since about 1973 and continues to the present time. SCE&G in cooperation with USGS collected data on Lake Murray during the period 1990-1996. SCE&G has continued to monitor water quality on the lake since 1996.

Maps of the study area are presented in Figures 1 through 5. The main body of Lake Murray is presented in Figure 1. The dark blue lines on the map represents the original river channel for the Saluda River as well as the major creeks, and the number of Saluda River miles upstream from the *dam* are indicated on the map. The sampling locations for the SCDHEC and SCE&G are also shown on the maps. Figure 2 shows the upper portion of Lake Murray as well as the inflow region where the Bush and Little Rivers enter the lake and the Saluda River up to Chappells. Figure 3 shows the Little Saluda River watershed and embayment. Figure 4 shows the area above Chappells, and Figure 5 shows the upper portions of the watersheds for the Bush and Little Rivers.

Pertinent characteristics of Lake Murray are presented in Table 1. The reservoir has a maximum depth of 175 feet. The lake is approximately 40 miles long and has a maximum width of 14 miles. The shoreline length is 524 miles, with 330 miles developed for residential use. The shoreline development ratio is 17.7 which means that the lake has 17.7 times the shoreline length that would exist if the lake were circular. Therefore, processes related to the lake margin (e.g., shoreline development, recreational development, and housing development) can be expected to be significant.

Hydrology of the watershed flows is presented in Table 2 and shows the percent distribution of flows from the various sub-basins. It is interesting to note that ERC reported that 56% of inflow enters during the first four months of the year. Annual flows into Lake Murray vary year to year and can affect water quality significantly. Figure 6 presents the annual and summer month flows at Chappells, which is downstream from Greenwood Hydro.

1.3 Important Issues for Lake Murray

The most important water quality parameters are those that might affect the water uses of Lake Murray, i.e., recreation, fishing, drinking water supply, and aesthetics. The following water quality parameters are considered to be the most important. The most important factors that affect these parameters are major sources of wastewater discharges in the watershed and other watershed activities.

- Pathogens are organisms in water that cause diseases in people and are always a concern of those who use water in the natural environment, especially those who are in direct “full-body” contact with the water.

- Temperature and DO are two parameters which are perhaps the most important indicators of the fundamental characteristics of water quality in reservoirs. Temperature affects the physical structure of the reservoir by causing summer thermal stratification which essentially causes the lake to set up in three layers of water: the surface layer, or epilimnion; the bottom layer, or hypolimnion; and the middle layer, or metalimnion. These three layers do not mix with one another, so the surface layer is the only layer that is contact with the atmosphere and sunlight. The surface layer usually has sufficient dissolved oxygen concentration (DO); however, the other two layers usually suffer DO depletion due to inadequate re-aeration. Both temperature and DO significantly affect the fishery that occurs in the reservoir.

- Nutrients also influence the water quality in reservoirs. The primary nutrients required for growth of algae and aquatic plants include carbon, nitrogen, and phosphorus. Phosphorus and nitrogen are usually the most important water quality constituents that control the growth of algae and aquatic plants. The concentrations of phosphorus and nitrogen are most often evaluated for lake eutrophication assessments. Attached aquatic plants are also significantly affected by reservoir pool level operations (i.e., wide variations in pool levels reduce the amount of attached aquatic plants in reservoirs).

- Chlorophyll *a* is a water quality measurement that indicates the amount of lake productivity due to algae that occurs in the water.

- Water Clarity is one of the most important water quality parameters to essentially all users of the lake. The measurement of water clarity is also a key indicator of the levels of algae and suspended solids (usually clay particles) in the water.

2.0 WATER QUALITY DATABASE & ANALYSIS

2.1 Sources of Information

Data from three agencies and SCE&G were consolidated into a database for Lake Murray and its drainage area up to Greenwood Reservoir. The primary source of data used to evaluate trends was from the SCDHEC stations. These data provided monthly, quarterly and yearly measurements of many parameters collected throughout the Lake Murray watershed. The data density in the SCDHEC database is relatively consistent from 1974 to 1998. At the time of this report, SCDHEC data collected after 1998 had not been released, and therefore was not used in this assessment.

The other two agencies that collected water quality data in the Lake Murray watershed were EPA and USGS. EPA collected samples at 7 different locations in March, July and September of 1973. USGS collected data in the 1960s and early 1970 at multiple stations in the watershed.

In 1996 SCE&G took over thirteen USGS water quality sampling stations. Twelve of these stations are located in Lake Murray and one is downstream from the Saluda Dam. SCE&G collects monthly field samples at all the stations, and chemical samples twice a year at seven of the stations.

Table 3 is a general summary of the type and location of the data collected since 1970. The stations in the table are grouped and organized by distance from the Saluda Dam.

2.2 Description of DASLER (Data Management and Analysis System for Lakes, Estuaries, and Rivers)

The DASLER software program was used to build the water quality database. DASLER is a Windows-based program designed to manage and report water quality data. It serves as an interface to database programs such as Microsoft Access and Oracle. DASLER was chosen for building the database because it dictates a strict format for the data, as well as, the metadata. If this format is not followed, DASLER will not accept the data and therefore not include it in the database. This non-imported data can then be corrected and re-entered. This characteristic of DASLER greatly improves the quality of the database and therefore creates a valuable and user-friendly resource.

The Lake Murray database is designed to include all field water quality data, as well as, nutrient, organic, metals and bacteriological data collected in the Lake Murray watershed. Pesticide and other toxic data were not imported into the database, but in many cases were downloaded from STORET and are available in Excel spreadsheets. Table 4 lists and describes the location of all stations that have data in the database. A description of the ID code is at the top of the table. Table 5 provides an overview of data density throughout the Lake Murray watershed. All results in the database were counted without regard for parameter or depth. In other words, lake stations where data was collected at multiple depths will have a larger number than a station where only the surface was sampled even though the stations my have been monitored the same number of times. This table is intended to be used as a quick reference of how much data were collected at each station in each year. Both tables are sorted in the same order and therefore allow easy cross-referencing.

2.3 Types of Analysis Used to Compile the Data

Various types of plots were used to aid in the water quality assessment of Lake Murray. For lake stations with adequate data, contour plots of dissolved oxygen and temperature data were created. These contour plots were prepared for both longitudinal plots across multiple stations as well as across time at the same station and were used to determine water quality patterns over space and time. Time series plots of many different parameters were done for all stations of interest. These plots show all surface samples of a particular parameter for the period of record.

Daily flow data from USGS gages in the watershed including below the Saluda Dam were also analyzed. Daily flow values were averaged for each year, as well as for certain parts of each year such as May through September. Data from the gage at Chappells from 1930 to 1998 were plotted. Since the gage at Chappells represents the primary inflow into Lake Murray, this plot was used to compare hydrology from year to year and allow for categorization of years as low, normal or high flow years. After the years were categorized by flow, water quality patterns for different types of hydrology were determined.

3.0 RESULTS AND DISCUSSION

3.1 Applicable Water Quality Standards

All water in Lake Murray and its inflowing waters are classified as "freshwaters," or FW. The Saluda River below the dam is classified for trout waters, and this reach of river is further classified for "trout put, grow, and take," or TPGT where DO is to maintained at not less than a daily average of 5 mg/l. The FW and TPGT classifications are described in the 1998 report as follows:

- Class FW are freshwaters that are 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.
- Class TPGT are freshwaters suitable for supporting the growth of stocked trout populations and a balanced indigenous aquatic community of fauna and flora.

3.2 Literature Review

We present the following synopsis of several water quality reports available for Lake Murray for the last 25 years. Two major sources are ERC and SCDHEC.

3.2.1 Environmental Research Center, Inc. Report

SCE&G funded a comprehensive water quality and biological assessment of Lake Murray that was conducted over the period September 1974 through August 1975 in conjunction with their previous FERC license application for the Saluda Hydroelectric Project (ERC, Inc., 1976). The ERC report provided a review of the historical database on Lake Murray, for the period 1947 through

1974. The ERC report also provided a comprehensive limnological assessment of Lake Murray. ERC collected and assessed data from 33 stations in and around Lake Murray.

Data were collected for numerous years by federal and state agencies to assess the water quality, flow, and discharge characteristics of Lake Murray and its tributaries. These agencies included the South Carolina Pollution Control Authority, the SCDHEC, and the USGS. The value of these data was limited for several reasons. Generally only single-depth samples easily reached from shore were collected. For the most part data collections were made only in the spring and summer months therefore these data were not representative of open waters and subsurface waters for all months of the year.

Recognizing the limitations of the historical water quality data, seasonal trends were evaluated and changes in selected water quality parameters were evaluated over the length of the lake. In general, noticeable differences occurred between the upper and lower stations in Lake Murray. For example, the concentration of nitrates, phosphates, fecal coliforms and BOD were generally higher at upper lake stations compared to lower lake stations. In part, this was attributed to the change from rapidly flowing waters in the upper part of the lake compared to slow-moving waters in the lower of part of the lake. Historical data from the Bush River suggested an especially high nutrient concentration in this tributary.

ERC estimated that there were 100 houses on Lake Murray shoreline in 1951. Including summer homes, year-round houses, and mobile homes, the number of dwellings had increased to 5000 by 1973. About 40 commercial recreation-oriented establishments, such as gas docks, boat storage, rental and repair, boating and fishing supply sales, and food services had also been established by 1973.

At the time of the ERC study, at least five point source discharges existed on Lake Murray, with two additional discharges proposed. The ERC report also included an assessment of the McMeekin Steam Generating Plant, and ERC concluded that it caused minimal, if any, effects on the ecology of Lake Murray and the Saluda River.

ERC conducted a comprehensive limnological study over the period September 1974 through August, 1975. The stream flows into Lake Murray in the summer of 1975 were the fourth highest over the period of record (see Figure 6).

Sediments

ERC studied the sediments of the lake and found that most of the sedimentation in the lake takes place over a distance from about miles 19 (near Rocky Creek) to 25 (Blacks Bridge) above the dam (see Figures 1 and 2.) They found that these sediments were comprised of a greater percentage of small particles in comparison to other parts of the lake, with the exception of the lower part of the Little Saluda embayment (i.e., near the Hwy. 391 bridge). The lower deepwater stations exhibited very little sediment deposition since the Saluda Dam had been completed.

Water Quality

Twenty-four physical and chemical parameters were sampled at Lake Murray at 33 selected stations over a period of 12 months. Following are some of the ERC results:

- Lake Murray alkalinity values were generally low.
- The pH of Lake Murray seldom deviated outside the limits for Class A waters (6.0 to 8.0) as defined by the South Carolina State Pollution Control Authority. Over the complete 12 months of sampling, the pH of Lake Murray had a range of 5.3 to 9.1 pH units.
- The highest concentrations of chlorophyll *a* were measured at the upper lake tributary stations that included the Saluda River, the Little Saluda River, the Bush River, and Lake Murray near Blacks Bridge and Rocky Creek. The highest

concentration recorded was 64.8 µg/L in the Clouds Creek embayment. The following table summarizes average concentrations of chlorophyll *a* by locations in the lake for the months of May through October.

Location	Chlorophyll *a*, µg/L	
	May-Oct	Annual
Upper lake (down to Rocky Creek)	12.9	10.1
Mid-Lake	6.8	5.9
Lower Lake	4.6	4.0
Mean for all stations	8.1	6.7

- The concentration of dissolved phosphorus varied from 0.42 mg/l in the Bush River to undetectable levels at numerous downstream deepwater stations. The Bush River registered the highest reading in 11 out of 12 monthly sampling periods, with the lower part of the Little Saluda River recording the remaining high value during September, 1974. The lowest readings almost always occurred in the lower part of the lake. They recorded that dissolved phosphorus values for Lake Murray were high in relation to most lakes. As shown in the following table the upper lake area had the highest concentrations, the lower Lake had the lowest concentrations, and the middle lake areas had intermediate values.

Location	Dissolved Phosphorus, mg/l
Upper lake (down to Rocky Creek)	0.10
Mid-Lake	0.09
Lower Lake	0.07
Mean for all stations	0.09

- Total phosphorus concentrations ranged from undetectable to 1.15 mg/l. The Bush River exhibited the highest concentrations in the Lake Murray system in 9 out of 12 monthly sampling periods. The following table summarizes total phosphorus concentrations measured by ERC in Lake Murray.

Location	Total Phosphorus, mg/l
Upper lake (down to Rocky Creek)	0.16
Mid-Lake	0.10
Lower Lake	0.04
Mean for all stations	0.10

- Fecal and total coliforms occasionally reached high levels in Lake Murray, especially after periods of heavy runoff from the watershed. Part of the water quality standards indicated that no more than 10 percent of the total samples shall exceed 400 per 100 ml during any thirty-day period. This part of the standard was exceeded on several occasions at upper lake stations.

- ERC reported that the historical BOD_5 averaged 2.7 mg/l. We assumed that this is the inflow BOD. (page 254, ERC report)

Phytoplankton (Algae)

ERC reported…"The phytoplankton community of most large, freshwater lakes contains the organisms that provide *energy* to the lake ecosystem through photosynthetic conversion of solar energy to stored biochemical energy as food to consuming biological organisms. In some lakes attached algae and aquatic plants also play a substantial role as primary producers, but this is not the case in Lake Murray. The Lake Murray ecosystem appears to be regulated in the upper part of the lake by both autotrophic production and a considerable amount of allochthonous material (i.e., autotrophic production is the production of algae within the lake and allochthonous materials include all organic materials produced in the watershed, both algae and other organic matter.) The mid-region and lower area of the lake and most large lake arms are almost entirely under an autotrophic regime and are not as productive as the upper end of the lake."

"On an annual basis, species composition of the algal community followed a commonly observed pattern, i.e., diatoms made up the greatest percentage of the algal community during colder months while other algal types were more prevalent in the main body of the lake during warmer months. April showed a large increase in green algal species. Shallower upstream and tributary stations, which normally exhibited higher nutrient concentrations than in the main lake, often showed extremely diverse populations and high numbers of individuals."

"As the lake surface and tributaries cleared and warmed in spring, blue-green algae became abundant and dominated the algal populations. Species of

Chroococcus, Anabaena, Oscillatoria, Anabaenopsis, Merismopedia, and Rhaphidiopsis increased to bloom proportions at upper lake stations in summer reaching an average density of 9,050 units/ml in August, 1975. Those lake areas that consistently showed high densities of blue-green algae included the main channel of the lake down to Rocky Creek, the Little Saluda River embayment (including the Cloud Creek arm), and the Bush River. However, the phytoplankton populations in the Saluda River did not increase to densities as high as in the smaller tributaries. Blue-green algae never reached densities that cause floating, odorous masses to develop and were never evident along the shoreline in visible quantities. The mid-region and lower area of the lake had August concentrations of blue-green algae of 2,032 and 2,584 units/ml, respectively."

During the years 1974-1975, Lake Murray was highly productive with regard to phytoplankton densities.

Trophic Status

ERC reported on the results of 24 trophic status determinations for Lake Murray. Twelve of these classifications were determined to be mesotrophic, and 11 of these classifications were reported to be eutrophic. "To classify Lake Murray in any manner other than meso-eutrophic would be erroneous. With further shoreline development and additional nutrient inputs from the watershed and septic tanks, Lake Murray will show symptoms of greater eutrophication. It is unlikely that the lake will ever go back to a total mesotrophic condition but management toward a majority of mesotrophic criteria would be a reasonable objective."

3.2.2 SCDHEC Reports

The SCDHEC has a long history of monitoring, evaluating, and protecting water quality in Lake Murray. The lake has received considerable attention especially over the last 25 years.

The SCDHEC recently published two reports on water quality in the Saluda River basin:

1. Watershed Water Quality Management Strategy—Saluda-Edisto Basin, Technical Report No. 003-95, Bureau of Water Pollution Control
2. Watershed Water Quality Assessment—Saluda River Basin, Technical Report No. 005-98, December, 1998, Bureau of Water

The information in these reports, especially the second report, will be summarized here since they are the most significant assessments of water quality over the last 25 years. SCE&G (in cooperation with USGS) has partnered with SCDHEC over the last 10 years to undertake the water quality assessments on Lake Murray, and the results of all this monitoring are presented in later sections of this report.

SCDHEC Results Reported In the 1995 And 1998 Reports

Table 6 presents the results of the SCDHEC findings for Lake Murray that are described in the above reports. The results of the SCDHEC findings as they apply to water quality and water uses in Lake Murray are summarized as follows:

- The results reported in Table 6 are summarized in Table 7.
- The findings of the 1995 and 1998 reports are generally similar with one big exception: the 1998 report listed a greater number of locations as "not supporting" and "partially supporting." Only 9 locations in Lake Murray and its associated watersheds were found to be fully supporting the *aquatic life* use in 1998 compared to 18 locations in 1995. Locations only on Lake Murray (including embayments) that were fully supporting the aquatic life use were especially reduced: from 11 locations fully supporting in 1995 to only 5 locations fully supporting in 1998. This large decrease is attributable to the effects of metal concentrations exceeding the water quality criteria.
- From a total of 12 stations on Lake Murray (including embayments), 7 stations were listed as non-supporting or only partially supporting water uses. Metal concentrations were listed as the cause for 6 of these stations and nutrients were

listed as the cause for 2 stations (note: the causes for 1 station listed both metals and nutrients.)

- The cause for non-supporting designations at five stations on the lake is copper which exceeds the acute water quality criteria for aquatic life. Two additional stations on the lake were listed as only partially supporting aquatic life due to copper, which exceeds the acute water quality criteria for aquatic life. Copper as well as all other metals were measured as "total" concentrations in the water and sediment samples. Only a part of the total copper would be toxic to aquatic life. The report also states that elevated copper concentrations are reported for many locations all around the State and that these copper concentrations do not appear to cause toxic conditions in waters of the State. The elevated metal concentrations in the lake are consistent with those reported for inflows to the lake; hence, the likely cause for elevated metal concentrations is the natural geology of the watershed.
- <u>Fecal coliforms</u> were identified as the cause for impacting recreation at 6 locations in 1995 and 8 locations in 1998. All of these locations were either in the inflows to Lake Murray or in the tailwater. The elevated fecal coliform designations were all attributable to point or nonpoint sources, or both. All locations in Lake Murray were reported to be fully supporting of the recreational use of the lake; however, increasing trends in fecal coliforms were reported for much of the main channel of the lake, in both 1995 and 1998.
- <u>The eutrophication assessments</u>, which uses a multi-parameter index with a statewide *baseline* from a 1980-81 assessment, indicate that conditions at the upper end of the lake had improved, except at Rocky Creek and in the Bush River arm of Lake Murray. The 1998 report stated that the two upper locations on the Saluda River arm (S-310 and S-223) and the Little Saluda River arm had improved from Category I ratings to Category II ratings, or intermediate trophic status. However, the locations at Rocky Creek and in the Bush River arm of Lake Murray were reported to be among the most eutrophic sites on large lakes in South Carolina. All the locations between Rocky Creek and the dam, including the embayment locations, were reported to be among the least eutrophic in South Carolina. In addition, these same locations were reported to have decreasing

trends in total phosphorus, and a few of the locations were also reported to have decreasing trends in nitrogen and BOD concentrations. The multi-parameter index is based on data for the following parameters: water clarity, total phosphorus, total inorganic nitrogen, chlorophyll *a*, and DO.

- <u>Low DO</u> in the tailwater was the cause for non-supporting and partially supporting ratings in the tailrace and the first station below the dam (S-149). The 1998 report indicated that conditions at this latter location had improved due to a lower percentage of the DO data being less than the water quality criteria. Low pH levels were also given as a reason of non-supporting aquatic life uses in the tailrace.

<u>Miscellaneous Information Provided in the Reports</u>

Except for a very small wastewater discharger (i.e., Dreher Island), there are no direct dischargers to the lake.

SCDHEC is currently considering a “No Discharge” designation for boats on the lake to protect water quality for the water supplies for Columbia and West Columbia as well as for recreation. A final decision was expected in 1999 **[?]**

Watershed management was recommended to reduce phosphorus loading to a number of areas of the lake:

- Rocky Creek area of Lake Murray (S-279)
- Bush River arm of Lake Murray (S-309)

There was a watershed study conducted on the Bush River and Camping Creek to address nonpoint sources. The 1998 reported the following: “This was a comprehensive watershed project in a predominantly agricultural watershed. The project was implemented with several cooperating agencies, with the SCDNR as the lead agency. The project area lies mostly in Newberry County and the watershed drainage is to Lake Murray. The project began in 1990 and was concluded in August of 1998. The project provided funding for technical and financial assistance to farmers in the watershed for Best Management Practices (BMPs) related to rowcropping and confined animal operations. Innovative BMP demonstrations funded by the project included provision of manure nutrient testing by a mobile laboratory, portable animal waste lagoon pumpout and spray irrigation equipment available for rent to farmers in the watershed, and the effective pesticide management."

Growth potential in the area around the lake was discussed for several specific regions, and the following information is taken from selected sections of the 1998 report:

- The area around Lake Murray: "There will be continued growth in areas bordering and surrounding Lake Murray. The widening of US 378 to four lanes has increased the expansion rate on the Lexington side of the lake. US 76 runs along the opposite shoreline of the lake, as does a rail line. The widening of I-26 toward the Chapin\Pomaria Exit is encouraging growth on both sides of the interstate. Residential development continues to grow within the region. The area around the dam is the most developed and has water and sewer. The Richland County portion of the lake is also well developed and has several residential subdivisions where water and sewer are available. A study has been prepared and the findings are currently being reviewed to determine the feasibility of providing sewer service to areas surrounding Lake Murray within the 208 management areas of the Town of Chapin, the City of Columbia, Richland County, the Town of Lexington, and the Lexington County Joint Municipal Water and Sewer Commission (those portions of Lexington and Richland Counties bordering the lake). This will facilitate continued development along the shoreline as well as development along US 378. SC 6 is undergoing a corridor study, and the portion crossing the dam will be widened. The City of Columbia and Lexington County are currently in the discussion phase in working together to solve Lexington County's water and sewer needs. The Bush River continues to be limited in terms of assimilating capacity, and as such there has been discussion among various sewer providers in the county for a larger regional facility that would discharge within this watershed, as well as some discussion for a single entity water and sewer provider for the lower part of Newberry County. Lake

Murray, as the main water-based recreational resource in the region, draws millions of visitors annually to its numerous parks, recreational areas, and waterways. All aspects of growth surrounding Lake Murray (tourist industry, residential development, agricultural activities) are expected to continue."

- The area around the tailwater: "There is high potential for future residential and industrial development in this watershed. The area surrounding the Town of Lexington has grown rapidly during the past several years and the trend should continue. Several important highways run through the area including: SC 6, which runs from the Lake Murray dam south through the Town of Lexington, and US 1 and US 378, which run west from the City of West Columbia and intersects with Highway 6 in Lexington; I–20 also serves the area. The watershed's industrial corridor is one of the most economically attractive in the Midlands Area for future development. Once sewer is readily available, residential development is expected to increase and large industrial prospects can be attracted to the area. The recent construction of a water plant on the shore of Lake Murray north of the Town of Lexington, has made available a water supply sufficient to support development. The City West Columbia and Lexington County have extended major water mains in the area. Non-industrial discharges in the basin are targeted for elimination with effluent transported to the City of Cayce's wastewater treatment plant through a regional system. This will decrease discharge levels into the lower portion of the Saluda River."
- The City of Greenville is located in the Saluda River watershed and has high potential to continue as an urban growth area and source of point and non-point pollution.

Table 8 summarizes the NPDES Permits and lists the major sources and number of minor sources in each sub-basin that drains to Lake Murray (downstream from Greenwood Dam).

Table 9 presents a list of reaches/issues on the SCDHEC 303(d) and Total Maximum Daily Load (TMDL) lists. Fecal coliform is the only issue listed as a cause for TMDLs: two sites on the Bush River and one site on Rawls Creek which discharges to the Saluda River downstream from the dam. Eight sites are designated as being potential TMDL sites, and six of these are caused by fecal coliform. Two of these sites are caused by low DO, which can be attributed to discharges from the Saluda Project.

There are a total of 51 sites listed on the 303(d) list. The most significant cause for listing is fecal coliform, which is shown as the cause at 21 sites. It is important to note that most all of these sites indicate a significant potential concern to recreation where these streams enter Lake Murray or the Saluda River. Although the sampling sites on Lake Murray do not indicate a concern for fecal coliform, it is important to note that inflow regions of Lake Murray and the Saluda River are likely to be contaminated periodically by fecal coliform and unfit for recreation during these times. Recreational uses are likely to be particularly threatened following rainfall/runoff events.

It should be noted that phosphorus is listed as the cause for two sites on the 303(d) list: Bush River arm of Lake Murray (S-309) and Rocky Creek area of Lake Murray (S-279). But these sites are not listed as potential TMDLs even though they are listed at the level of priority 2. The phosphorus concentrations in the inflows to Lake Murray probably contribute to the low DO in the discharges from the Saluda Project.

Table 9 also lists pH as a concern below Saluda Dam. Low pH in reservoir releases is caused by decomposition of organic matter in the lake, and this commonly occurs in lake waters that have low alkalinity like Lake Murray. Organic matter in lakes comes from algal growths (primarily in the lake), wastewater discharges in the watershed, and natural sources in forested watersheds. Such minor low pH excursions (in magnitude as well as frequency) have minor effects on aquatic life (probably immeasurable), and cannot be remedied practically except possibly through watershed reductions of man-made sources of nutrients and organic loads and, possibly, reductions in internal nutrient cycling.

3.3 Analysis of Water Quality Data

3.3.1 Nutrients, Algae, and Water Clarity

Inflow Stations

A considerable amount of data are available for assessing the sources and trends of nutrients that enter Lake Murray, as well as the nutrient concentrations, algal productivity and water clarity in Lake Murray.

The main flow entering Lake Murray comes from the Saluda River. Greenwood Dam can be viewed as the main source of water to the Saluda River that enters Lake Murray. SCDHEC has a sampling station, S-186, a short distance downstream from Greenwood Dam, and water quality data from this location were analyzed to determine the concentrations, patterns, trends, and loads of nutrients and organic matter from this source.

Figure 7 shows the Total Phosphorus (TP) concentrations over the period 1974 to 1998. There was an apparent upward trend in concentrations until 1985 when the concentrations were substantially reduced and an apparent downward trend began. This dramatic change is probably attributable to the implementation of tertiary wastewater treatment for Greenville's wastewater discharges to the Reedy River. The current mean concentration of TP at this station is about 0.02 mg/l. Biological Oxygen Demand (BOD_5) also decreased as shown in Figure 8, dropping from a mean of about 2.5 mg/l during the period 1969 through 1986 to a mean of about 1.3 mg/l for the period 1987 through 1998. The decrease in BOD lagged the decrease in TP perhaps due to the release of methane and other decomposition products from the sediments of Lake Greenwood sometime after the drop of TP in the water column. Total Kjeldahl nitrogen (TKN, a measure of the organic nitrogen and ammonia nitrogen) followed a pattern similar that for TP, probably attributable to the TKN associated with algal growths (see Figure 9.) Nitrate+Nitrite concentrations appeared to decrease over the period 1985 through 1987. However, as shown in Figure 10, there is another interesting observation.

Nitrate+nitrite concentrations drop to near zero every year during the summer and autumn months. This drop in nitrate+nitrite is significant because it indicates that the only algae that may be able to grow during this time in the upper end of Lake Murray are blue-green algae, which are often more troublesome than other algal species such as diatoms and green algae.

There is one additional SCDHEC sampling station on the Saluda River prior to its flowing into Lake Murray: S-295, located at SC 39 near Chappells. Figure 11 presents TP data for the period 1988 through 1998. It is important to note the apparent increase in TP between the Greenwood Dam and station S-295: TP increases from about 0.02 mg/l at S-186 (just below Greenwood Dam) to about 0.06 mg/l at S-295 (approximately 3.5 miles downstream). This 200 % increase in TP is highly significant because TP can result in organic matter (i.e., through algal growths) being generated that is about 100 times the weight of TP available. The water quality in most hydropower reservoirs is very sensitive to the concentration of TP in their inflows. Figure 12 presents the results of a study conducted for EPA to determine the TP concentrations in the inflows to hydropower reservoirs. This figure shows that Lake Murray could be among the cleanest 10-20 % of the reservoirs included in the study if the TP concentration was in the range of 0.02 mg/l like that reported for the station below Greenwood Dam. However, with the TP concentration found at S-295 Lake Murray receives TP concentration that near the 70 percentile ranking for reservoirs that are not considered to be TMDL sites.

An examination of the TP data in Ninety-Six Creek (SCDHEC's station S-093) shows that it has a mean concentration of about 0.7 to 1 mg/l (see figure 13), about 40 times the concentration of TP in the Saluda River below Greenwood Dam. Using the mean concentrations of TP in the Saluda River below Greenwood and in Ninety-Six Creek in combination with their mean annual flows, the respective TP loads exerted on Lake Murray can be estimated. This approximate analysis shows that Ninety-Six Creek has a TP load of 410 lbs/day and the Saluda River has a load of 210 lbs/day. The station at S-295 has a load of about 620 lbs/day, so it's apparent that Ninety-Six Creek accounts for essentially all the increase in TP between Greenwood Dam and Chappells.

The Bush River near its inflow point to Lake Murray also contains a relatively high concentration of TP (see Figure 14): about 0.8 mg/l. Using the same approach for estimating its TP loading to Lake Murray, the Bush River has an estimated load of 280 lbs/day. After the Bush River enters Lake Murray and the Saluda River, the estimated concentration of TP in the Saluda River would be about 0.08 mg/l. This concentration of TP is greater than the mean TP concentration in the Congaree River at the inflow to Lake Marion and ranks at the 80-percentile level when compared to the other reservoirs as discussed above.

The Little Saluda River near the inflow to the Little Saluda River arm of Lake Murray (station S-123) has been monitored by SCDHEC since 1974 (see Figure 15). Their data show a significant decreasing trend over the years, with a significant drop in 1989. The current concentration of TP is about 0.2 mg/l, which leads to an estimated daily load of about 96 lbs/day.

Clouds Creek near the inflow to the Little Saluda River arm of Lake Murray (station S-255) has been monitored by SCDHEC since 1979 (see Figure 16). Their data show a significant increasing trend over the years. The current concentration of TP is about 0.3 mg/l, which leads to an estimated daily load of about 56 lbs/day.

Significant aquatic plant communities at the upper end of Lake Murray (see page 73 in 1998 report) could contribute to high organic and nutrient loads in the upper area of the lake due to their die-off each year and settling in areas of the upper end of the lake. An annual lake draw down would probably help reduce the impacts of these plants on algal production in the upper area of the lake. However, these decomposing plants could then result in higher concentrations of anoxic products in the hypolimnion of the lake and possibly increase the levels of anoxic products that would end up in the discharge through the Saluda Project turbines.

Upper End of Lake Murray, Including Embayments

SCDHEC's station in the Bush River arm of Lake Murray (S-309) was reported in both the 1995 and 1998 reports to be among the most eutrophic sites on large lakes in South Carolina. The TP for this station is plotted in Figure 17, and the mean TP was about 0.1, indicative of eutrophic-hypereutrohic conditions (Heiskary and Walker, 1987).

SCDHEC's and SCE&G's station in the Little Saluda River arm of Lake Murray (S-222 and 8M, respectively) was reported in both SCDHEC reports to be in intermediate trophic condition. However, SCDHEC only had data for 1976-1980, 1992 and 1996-1997. The plot of TP in Figure 18 is based on SCE&G's data that are collected only twice each year. This plot indicates that the mean TP concentration is about 0.04 mg/l.

At Blacks Bridge (S-223, about 25 miles upstream from Saluda Dam), SCDHEC commented in their 1995 report that this was among the most eutrophic sites on large lakes in South Carolina, but in their 1998 report they revised this site to intermediate trophic status. Figure 19 presents the TP data collected at this site since 1974 and shows that the current mean TP concentration is about 0.06 mg/l, about the same as the mean concentration observed at the inflow station at S-295 and about 25 % less than the estimated concentration entering Lake Murray due to the added TP entering from the Bush River. This decrease in TP by the time inflows reach this point can be attributed to precipitation of TP to the sediments, either in the form of inorganic suspended solids or associated with dead algae.

At Lake Murray in the Rocky Creek area (S-279, about 18 miles upstream from the dam), SCDHEC commented in their 1998 report that this was the among the most eutrophic sites on large lakes in South Carolina, but in their 1995 report they reported this site to be intermediate trophic status—in essence the opposite of their 1995 and 1998 ratings for the Blacks Bridge site. Figure 20 presents the TP data collected at this site since 1975 and shows that the current mean TP concentration is about 0.05 mg/l, only a slight decrease from the mean concentration observed at Blacks Bridge. This marginal decrease in TP shows that this station is still strongly influenced by inflow water quality and processes that are characteristic of what limnologists often consider the riverine and transition zones of a reservoir. This observation is consistent with the two SCDHEC reports as well as the ERC report.

The Lower End of Lake Murray, Including the Embayments

For the forebay of Lake Murray (S-204 and 1SP, near the towers upstream from the dam), SCDHEC commented in their 1998 report that this was among the least eutrophic sites in South Carolina. Figure 21 presents the TP data collected at this site since 1976 and shows that the current mean TP concentration is about 0.02 mg/l, and possibly 0.01 mg/l at times as shown for the SCE&G data (these latter data had a lower minimum detectable concentration.) A closer look at the SCDHEC data for this station in comparison with the data collected at Rocky Creek and Blacks Bridge shows that one major difference between the forebay and the upstream stations is that the TP is low essentially all year round in the forebay. The upstream stations occasionally experience TP values as low as 0.02 mg/l (especially in the summer when inflow can be lower and algae consume the TP), but they increase significantly at times.

Comparison of TP, Chlorophyll a, and Secchi Depth at Various Locations

Table 10 summarizes the TP, chlorophyll a, and Secchi *depth* conditions at various locations in the inflows and Lake Murray. Compared to the results reported in the ERC report, the more recent SCDHEC data indicate that TP concentrations are about 50 % less than reported by ERC, but chlorophyll a concentrations are about the same as reported by ERC. This inconsistency (i.e., the lower TP concentration but similar chlorophyll a concentrations) could be caused by a number of factors, but the most likely causes are the higher flows (and associated inorganic suspended solids) during the ERC study and possibly differences in water sample analytical methods.

Nutrient Loads to the Upper End of Lake Murray

Figures 22 and 23 as well as Table 11 show the distribution of flow and TP loadings between the major waterways that enter the upper end of Lake Murray. It is obvious from these charts and table that several smaller waterways contribute much greater TP loads than would be expected for the amount of water that they contribute. Four of the tributaries (i.e., Ninety-Six Creek, Bush River, Little Saluda River, and Clouds Creek) contribute 75 percent of the TP to Lake Murray while their streamflow contributions total 12 percent. As discussed above, the TP concentrations in these smaller waterways are caused by point source discharges and development in the watershed. If these TP loads were reduced, the upper areas of Lake Murray would have less algae and greater water clarity, and the DO in the reservoir and the releases from the Saluda Project likely would be increased (Matthews et al., 2001; Williams, 2001; this report, re: Greenwood).

3.3.2 Dissolved Oxygen and Temperature

Lake Data

SCE&G has collected (or sponsored USGS to collect) water quality profiles throughout Lake Murray during the 1990's. The data collected on DO are the most useful for gleaning understanding of water quality dynamics in the lake. The data collected during the period 1996 through 2000 are plotted in Figures 24 through 28, respectively. A major factor that affects water quality is annual and summer flows through Lake Murray, and these flows are proportional to the flows at Chappells as shown in Figure 6. Figure 6 shows that flows were near normal levels in the years 1996 through 1998 while the flows in 1999 and 2000 were low.

Here are some general patterns of DO that can be gleaned from Figures 24-28:

- DO starts decreasing in the upper part of Lake Murray in May and June each year

- DO is low (< 2 mg/L) in the metalimnion and near the sediments in the upper end of the lake by June each year
- At specific locations within Lake Murray, DO is often lower at some point in the water column than near the sediments, indicating significant DO demands in the water column. This is significant because it suggests that a dominant DO demand can be attributed to inflow water quality parameters like nutrients, algae, and organic matter.
- In July, the DO in the forebay is much greater in low flow years (1999 and 2000) than in normal flow years. In low flow years the DO was generally greater than 5 mg/L at all depths in the forebay, whereas in normal flow years the DO was generally less than 5 mg/L and minimum DO levels varied from < 1 mg/L to < 3 mg/L.
- In August, the DO in the forebay is much greater in low flow years (1999 and 2000) than in normal flow years. In low flow years the DO was generally greater than 3 mg/L at all depths in the forebay, whereas in normal flow years the DO was generally less than 3 mg/L and minimum DO levels were < 0.5 mg/L. Also, the DO in the metalimnion was generally lower than near the sediments in the forebay of Lake Murray. These observations in July and August suggest that water displacement within the reservoir affects the DO distribution within the reservoir, i.e., in normal and wet years, water movement through Lake Murray is greater and moves poor water quality (*e.g.*, low DO) down through the hypolimnion more rapidly.
- In August, the hypolimnion beginning 10 miles above the dam and metalimnion throughout the lake typically experienced DO < 2 mg/L (in all years).
- In September, the DO in the forebay is marginally greater in low flow years (1999 and 2000) than in normal flow years. In low flow years the DO was generally greater than 1.5 mg/L at all depths in the forebay, whereas in normal flow years the DO was generally about 0.5 mg/L and less.
- In September, most of the hypolimnion and metalimnion experienced DO < 0.5 mg/L throughout the lake, except in 1999 and 2000 when the forebay area experienced slightly higher DO concentrations.

- In October, the DO in the hypolimnion was less than 0.5 mg/L at all locations except in 2000 when the DO was about 1 mg/L for about the first eight miles above the dam. It is interesting to note that the elevation of the metalimnion in 1996 was about 10 m lower than in the other years. This was caused by high flows preceding the sampling date that drew the low DO water out of the lake more rapidly than usual.

It is important to note that the low DO values in the upper end of the lake are caused by decomposition of algae and other inflowing organic matter that takes place in the water column as well as in the form of sediment oxygen demand (Ruane and Hauser, 1991). If Lake Murray is like many other hydropower reservoirs, the low DO in the metalimnion all the way to the dam is caused by this decomposition of algae and other organic matter that initiates at the upper end of the lake. Although the DO in the metalimnion appears to be only marginally lower than the DO levels observed near the sediments of the lake, the contour plots do not reveal the difference in the volumes of water with low DO in these two areas of the lake (i.e., the metalimnion volume compared to the volume of water near the sediments.)

The volume of the metalimnion (in July, this layer of the lake occupies an average elevation range from about 94 m to 99.5 m and ranges in temperature from about 17^{o} C to 25^{o} C) is about 350,000 ac-ft whereas the volume of the water with low DO consumed by the sediments is estimated to be about 15,000 ac-ft. There is about 25 times the volume of water with DO depression in the metalimnion as there is in the water with DO depression over the sediments. A rough estimate of the mass of the DO demands in these two areas of the lake is approximately proportional to the volumes of water in these two areas. Hence, it is estimated that the DO demands in the metalimnion (caused primarily by inflow water quality, algae, and sediment oxygen demand in the inflow region of the lake) are about 25 times greater than the DO demand attributed to the sediments in the deeper water of the lake. Following DO depletion in the metalimnion, DO consumption in the hypolimnion speeds up because more organic material (e.g., dead algae) settles through the metalimnion without being decomposed. Hence, even the low DO in the hypolimnion in the late summer can be attributed to DO demands that initiate in the water column (as opposed to the deep reservoir sediments.)

Figure 29 presents contour plots for the temperature dynamics in Lake Murray for the year 1996. It is instructive to track the 16° C contour line over the period of June through October. This shows how a dominant body of water moves through the lake. In June this layer of water is at about elevation 95 m; in July, about elevation 92 m; in August, about elevation 89 m; in September, about elevation 78 m; and in October, all the water having a temperature of 16° C had been drawn out of the lake. This illustrates how water in the metalimnion is drawn down in the lake to where it is eventually all drawn out of the lake through the turbines.

Hypothesis: a major portion of the water with low DO that is passed through the turbines derives from low DO water in the metalimnion and much of the hypolimnion, which is low in DO due to the nutrients and organic matter in the Bush River, Ninety-Six Creek, and Little Saluda River. Sediment oxygen demand in the inflow region of Lake Murray also causes low DO in the metalimnion, but this sediment oxygen demand as well as nutrient releases from these sediments can be attributed to the impacts of these same watershed nutrient and organic sources. As illustrated using the temperature dynamics in the lake, most of the water in the metalimnion and hypolimnion is eventually drawn out through the turbines. The low pH concerns that SCDHEC identified for the turbine discharges can only be addressed by nutrient management in the watershed or, possibly, by reducing internal nutrient cycling.

To prove this hypothesis, a water quality model like CE-QUAL-W2 would be needed to simulate the complex, dynamic water quality linkages and processes as they currently occur as well as how they would occur if nutrients and organic loads from the watershed were reduced. Such a model would allow a quantitative assessment of the effects of the TP loads in the Lake Murray watershed on DO in the releases from Lake Murray. It would also be needed to determine the amount of supplemental aeration that might be needed following implementation of the full turbine venting system and nutrient controls in the watershed. It is important to consider for a situation like Lake Murray how much aeration, if any, is needed following watershed TP reductions. Also, the model would provide an assessment of the benefits of watershed TP controls to the coolwater fish species that inhabit the metalimnion. In addition, the model would allow an assessment of the potential eutrophication improvements in the upper regions of Lake Murray where SCDHEC has designated some of these areas as less than fully supporting.

The turbine discharge from Greenwood Hydro (Buzzards Roost) is now oxygenated (as of 1998), and the DO downstream from this project is plotted in Figure 30. This figure presents the results of SCDHEC grab samples for DO and shows that the DO in the discharge has generally been greater than 5 mg/l, with one exception in 1999 when a DO observation was made at 4.6 mg/L. It is interesting to note that the DO in the Greenwood releases had already improved as a result of the water quality improvements upstream from Greenwood in the 1980's.

The DO in the lower layer of water in the Little Saluda embayment tends to be less than DO in the lower layer of water in the main river channel, sometimes by as much as 5 mg/L (Figure 31.) This could be caused by lower flows in this embayment, higher internal nutrient loads within the embayment (i.e., higher rates of nutrient releases from the sediments within the embayment), and nutrients entering the embayment from the main channel or from the watershed. If these lower DO values are caused by internal nutrient cycling, this factor possibly could be reduced by dropping the pool level of the lake in the winter so as to re-suspend sediments in the embayment and redeposit them the sediments at another location down reservoir where they may not have as much impact on the lake. If these lower DO values are caused by local watershed sources of nutrients, watershed management (point and nonpoint source controls) may be needed to improve DO. If these lower DO values are attributed to nutrients entering from the channel, then nutrient reductions in Ninety-Six Creek and the Bush River may be needed to improve DO.

Tailwater Data

SCE&G started monitoring DO and temperature in the releases from The Saluda Project in 1989, and they are continuing this monitoring. The results of the DO monitoring since 1989 are presented in Figure 32, and the results of the temperature monitoring since 1996 are presented in Figure 33. Presented with the DO and temperature data are the cumulative flows through the Saluda Project starting in January and May for each year.

The most striking pattern shown in these plots is the increased DO starting in 1999 when turbine venting was implemented together with modified operations at the Saluda Project so that aeration could be maximized using the turbine venting capability currently installed. The amount of water flow that passes through the turbines affects the amount of air that can be aspirated through the turbine system—a lower amount of flow, or gate setting, allows more air to be aspirated into the turbine system which in turn allows DO to be increased to a greater extent in the turbine discharges. Figure 34 shows how much DO has increased in the tailwater since this system was implemented in 1999. The median DO has increased from about 2.7 mg/L to about 7.2 mg/L. The percentage of time that the DO is less than 5 mg/L has decreased from 88% to 12%. The percentage of time that the DO is less than 3 mg/L has decreased from about 55% to about 3%.

The current turbine venting system and modified operational scheme was developed using field studies in October 1998 and data analyses using the data obtained during these field studies (Saluda Hydroelectric Project Turbine Venting Study—1998, April 1999.) SCE&G is in the process of implementing other recommendations in the April 1999 report. They have installed hub baffles on Unit 5 and plan to install hub baffles on the other units in the near future.

One significant finding during the 1998 study was that the USGS gage in the tailrace yields lower daily average DO values. Over a period of nine days, the average daily DO as measured by the USGS gage was 0.6 lower than the average of three other DO monitors located across a transect of the river. Instantaneous measures of DO at the USGS monitor were as much as 2.5 mg/l less than monitors located out in the river. The USGS monitor is located in an area of the streambank where it does not measure water that is representative of the river. It was placed there so that it could be maintained on a weekly basis without significantly increasing the cost. A new monitor is available from Stevens® that holds calibration for many months without significant maintenance requirements. SCE&G may want to consider replacing the current monitor with a Stevens® monitor so that it will be more representative of actual conditions.

The plots for 1999-2000 show that daily average DO dropped to less than 4 mg/l periodically. These periods were associated with days when daily turbine flows were higher as evidenced by the cumulative flows during these periods of lower DO. Units 1- 4 currently do not have hub baffles on them, so when these are installed, the daily average DO values will increase. The ultimate capability of turbine venting for adding DO to the discharges at the Saluda Project will not be known until the hub baffles and perhaps other improvements are added to the system and tested.

Part of the success of the turbine venting system can be attributed to the low flows that occurred in 1999-2001, i.e., SCE&G was able to operate the turbine venting without having to operate at higher flows as frequently as they would have to in normal and high flow years. The summertime cumulative flows in 1999-2001 were less than half of the normal cumulative flows observed in most of the other years (see the cumulative flow plots in Figure 32) for which DO data are available.

Following are some additional general observations:

- In normal and wet years, the minimum DO period (i.e., when DO is less than 2 mg/L) tends to start earlier in the year and end sooner.
- In low flow years, maximum temperature in the turbine discharges is lower.

4.0 CONCLUSIONS AND RECOMMENDATIONS

- A considerable amount of water quality data have been collected by SCDHEC and SCE&G over the last 25 years to allow an assessment of conditions on Lake Murray as well as its inflows and the Saluda Project discharges.
- SCDHEC has conducted three assessments of water quality conditions associated with Lake Murray over the last decade.
- The findings of SCDHEC's last two assessments (their 1998 report and their 303(d) list) were similar.
- From a total of twelve stations on Lake Murray (including embayments), seven stations were listed as non-supporting or only partially supporting water uses. Metal concentrations were listed as the cause for six of these stations and nutrients were listed as the cause for two stations (note: the causes for one station listed both metals and nutrients.) The locations impacted by nutrient concentrations were listed as priority 2 on the 303(d) list, but they were not designated as potential TMDL sites. The locations impacted by metals concentrations were given the lowest priority (i.e., priority 3) on the 303(d) list. SCDHEC requires considerable more effort before determining whether the metals concentrations are actually a cause for not fully supporting aquatic life on Lake Murray.
- The stations at Rocky Creek and in the Bush River arm of Lake Murray were reported to be among the most eutrophic sites on large lakes in South Carolina, and both these locations were designated as non-supporting for aquatic life uses. All the locations between Rocky Creek and the dam, including the embayment locations, were reported to be among the least eutrophic in South Carolina.
- Low DO in the tailwater was the cause for non-supporting and partially supporting ratings in the tailrace and the first station below the dam (S-149), respectively. Low pH levels were also given as a reason of non-supporting aquatic life uses in the tailrace. The 303(d) list listed these stations as priority 1, and they may become designated as TMDL sites.
- Fecal coliforms were identified as the cause for impacting recreation at six locations in 1995 and 8 locations in 1998. All of these locations were either in the inflows to Lake Murray or in the tailwater. The elevated fecal coliform designations were all attributable to point or nonpoint sources, or both. All locations in Lake Murray were reported to be fully supporting the recreational use of the lake; however, increasing trends in fecal coliforms were reported for much of the main channel of the lake, in both 1995 and 1998.

- There are a total of 51 sites listed on the 303(d) list. The most significant cause is fecal coliform, which is shown as the cause at 21 sites. Three sites have been designated as TMDLs, and six additional sites may become designated as TMDLs.
- Except for a very small wastewater discharger (i.e., Dreher Island), there are no direct dischargers to the lake.
- SCDHEC is considering a "No Discharge" designation for boats on the lake to protect water quality for the water supplies for Columbia and West Columbia as well as for recreation. A final decision was passed in 1999 approving this designation.
- Watershed management was recommended to reduce phosphorus loading to two areas of the lake: Bush River embayment and the Rocky Creek area of Lake Murray.
- The water quality in the discharges from Greenwood Dam have improved dramatically over the last 15 years. In the late 1980's, nutrients and organic matter was reduced. In 1998, an aeration system was installed and DO in the discharges is now usually greater than 5 mg/l.
- However, the TP load to Lake Murray still remains high due to nutrient loads from Ninety-Six Creek, Bush River, Little Saluda, and Clouds Creek. These tributaries to the upper end of Lake Murray contribute an estimated 75% of the TP load to Lake Murray while their streamflow contributions only total 12%.
- Phosphorus loads have dramatically decreased in the watershed above Greenwood Reservoir and therefore in the discharges from Greenwood Dam. This reduction in pollutant loads has resulted in improved water quality in the upper areas of Lake Murray, especially upstream from Rocky Creek. Similar reductions of P loads in Ninety-Six Creek, Bush River, Little Saluda, and Clouds Creek would probably improve water quality (trophic status, water clarity, reductions in algae, DO) in the upper areas of Lake Murray (Rocky Creek and upstream). If these waterways were reduced to natural levels, the inflows to Lake Murray would be among the cleanest 10-20% of the hydropower reservoirs reported in a recent EPA study (Crossman and Ruane, 2000). DO in the reservoir as well as the releases also would likely improve.
- The concentration of TP in Lake Murray downstream from the Bush River embayment is estimated to be greater than the mean TP concentration in the Congaree River at the inflow to Lake Marion, and ranks at the 80 percentile level when compared to the other reservoirs as discussed above regarding the EPA study.

- Further study (water quality modeling and perhaps additional water quality data collection) would be required to determine how water quality might improve using more point source controls in the watershed as well as a periodic lake drawdown to reduce internal nutrient cycling.
- Considerations for internal nutrient cycling—eutrophication at Rocky Creek and low DO in the metalimnion (and subsequently in the turbine discharges) could be partly attributed to internal nutrient cycling due to it being the first main sampling station in the lake above which a lot of anoxic water forms that may be subject to upwelling due to power pulse inflows being cooler than the surface water. This upwelling could cause additional P and N (i.e., NH_3) into the surface layer. This upwelling of nutrients in combination with low NO_3 in the inflows from Greenwood, especially for the upper lake area, could cause algae to grow. Sediment management should be considered for reducing internal nutrient cycling, if it is occurring. The sediment data collected by ERC showed that the area down to Rocky Creek is depositional. This probably is still the case, but it would be good to get some data to confirm this.
- If the Little Saluda River is experiencing water quality problems (algae, anoxics, low DO), sediment management may be especially important and perhaps the only way to improve conditions due to the small watershed feeding this embayment (i.e., it's a sizeable body of water with relatively low potential for sediments to be flushed out.) Nutrients accumulate in a system like this and just cycle over and over as they are taken up by algae, the algae die and settle, and then the nutrients are cycled up into the water column again.
- The following hypothesis can be formulated based on the available data on Lake Murray, its watershed, and the Saluda Project turbine discharges:

  Hypothesis: a major portion of the water with low DO that is passed through the turbines derives from low DO water in the metalimnion and much of the hypolimnion, which is low in DO due to the nutrients and organic matter in the Bush River, Ninety-Six Creek, and Little Saluda River. Sediment oxygen demand in the inflow region of Lake Murray also causes low DO in the metalimnion, but this sediment oxygen demand as well as nutrient releases from these sediments can be attributed to the impacts of these same watershed nutrient and organic sources. As illustrated using the temperature dynamics in the lake, most of the water in the metalimnion and hypolimnion is eventually drawn out through the turbines. The low pH concerns that SCDHEC identified for the turbine discharges can only be addressed by nutrient management in the watershed or by reducing internal nutrient cycling.

To prove this hypothesis, a water quality model like CE-QUAL-W2 would be needed to simulate the complex, dynamic water quality linkages and processes as they currently occur as well as how they would occur if nutrients and organic loads from the watershed were reduced. Such a model would allow a quantitative assessment of the effects of the TP loads in the Lake Murray watershed on DO in the releases from Lake Murray. It would also be needed to determine the amount of supplemental aeration that might be needed following implementation of the full turbine venting system and nutrient controls in the watershed. It is important to consider for a situation like Lake Murray how much aeration, if any, is needed following watershed TP reductions. Also, the model would provide an assessment of the benefits of watershed TP controls to the coolwater fish species that inhabit the metalimnion. In addition, the model would allow an assessment of the potential eutrophication improvements in the upper regions of Lake Murray where SCDHEC has designated some of these areas as less than fully supporting.

- DO in the turbine discharges probably would improve if TP were reduced using point source controls in the watershed and/or by reducing internal nutrient cycling. Although the DO in the turbine discharges probably would not achieve the South Carolina DO criteria without turbine venting, it would be higher than previous (pre-1999 conditions) concentrations and would exceed previous DO levels with greater frequency of occurrence at selected DO levels, and the metalimnion may not experience DO levels as low as current conditions—this could help lake fish (i.e., DO would be higher in areas of the lake where temperature is more desirable for coolwater species of fish).
- In 1999, a turbine venting system was implemented together with modified operations at the Saluda Project so that aeration could be maximized using the turbine venting capability currently installed. The amount of water flow that passes through the turbines affects the amount of air that can be aspirated through the turbine system—a lower amount of flow, or gate setting, allows more air to be aspirated into the turbine

system which in turn allows DO to be increased to a greater extent in the turbine discharges.

- Since this system was implemented in 1999, the median DO in the Saluda Project discharges has increased from about 2.7 mg/L to about 7.2 mg/L. The percentage of time that the DO is less than 5 mg/L has decreased from 88 percent to 12 percent. The percentage of time that the DO is less than 3 mg/L has decreased from about 55 percent to about 3 percent.
- The current turbine venting system and modified operational scheme was developed using field studies in October 1998 and data analyses using the data obtained during these field studies. SCE&G is in the process of implementing other recommendations from this study. SCE&G has installed hub baffles on Unit 5 and plans to install hub baffles on the other units in the near future.
- One significant finding during the 1998 study was that the USGS gage in the tailrace yields lower daily average DO values. Over a period of nine days, the average daily DO as measured by the USGS gage was 0.6 lower than the average of three other DO monitors located across a transect of the river. Instantaneous measures of DO at the USGS monitor were as much as 2.5 mg/l less than monitors located out in the river. SCE&G may want to consider replacing the current monitor with a Stevens® monitor that can be located in a more representative area of the tailwater.
- Aeration of releases: the current turbine venting system with the addition of hub baffles would increase the achievable minimum DO, especially when turbines are operated at higher gate settings. Additional aeration beyond maximizing the turbine venting system capability might not be needed if nutrient sources in the watershed and possibly the up-reservoir sediments were reduced. Selection of the best approach for the next step of aeration, if it is needed, would depend significantly on the characteristics of the low DO in the reservoir after nutrient loads to the reservoir were reduced. A CE-QUAL-W2 model could be used for estimating the benefits of nutrient controls in the watershed, reduction of internal nutrient cycling, and how DO conditions would change in the reservoir and turbine discharges following nutrient reductions. This model could also be used to determine if and how much supplemental aeration might be needed following reductions of nutrient loads to Lake Murray.

- Fecal coliform levels were reported by SCDHEC to be acceptable in Lake Murray, but fecal coliform in inflowing streams are often above the South Carolina water quality criteria. This is typical of many large reservoirs. Unfortunately, most of the sampling stations within large lakes like Lake Murray are not in sensitive areas where fecal coliform might occasionally exceed the water quality criteria. It is especially important to consider those locations near inflow points where you might expect periodic episodes of high inflows. This concern can be addressed by adding monitoring points closer to the inflow regions (perhaps specifically for fecal coliform) and by educating the public and using warning signs near these inflow points. Special studies can be used to identify these areas and the extent of the concern for each inflow region.

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FIGURES AND TABLES

LIST OF FIGURES

LIST OF TABLES

Table 11: Comparison of the Percent Contributions of Total Phosphorous Loadings to Lake Murray to the Mean Streamflow from each Tributary

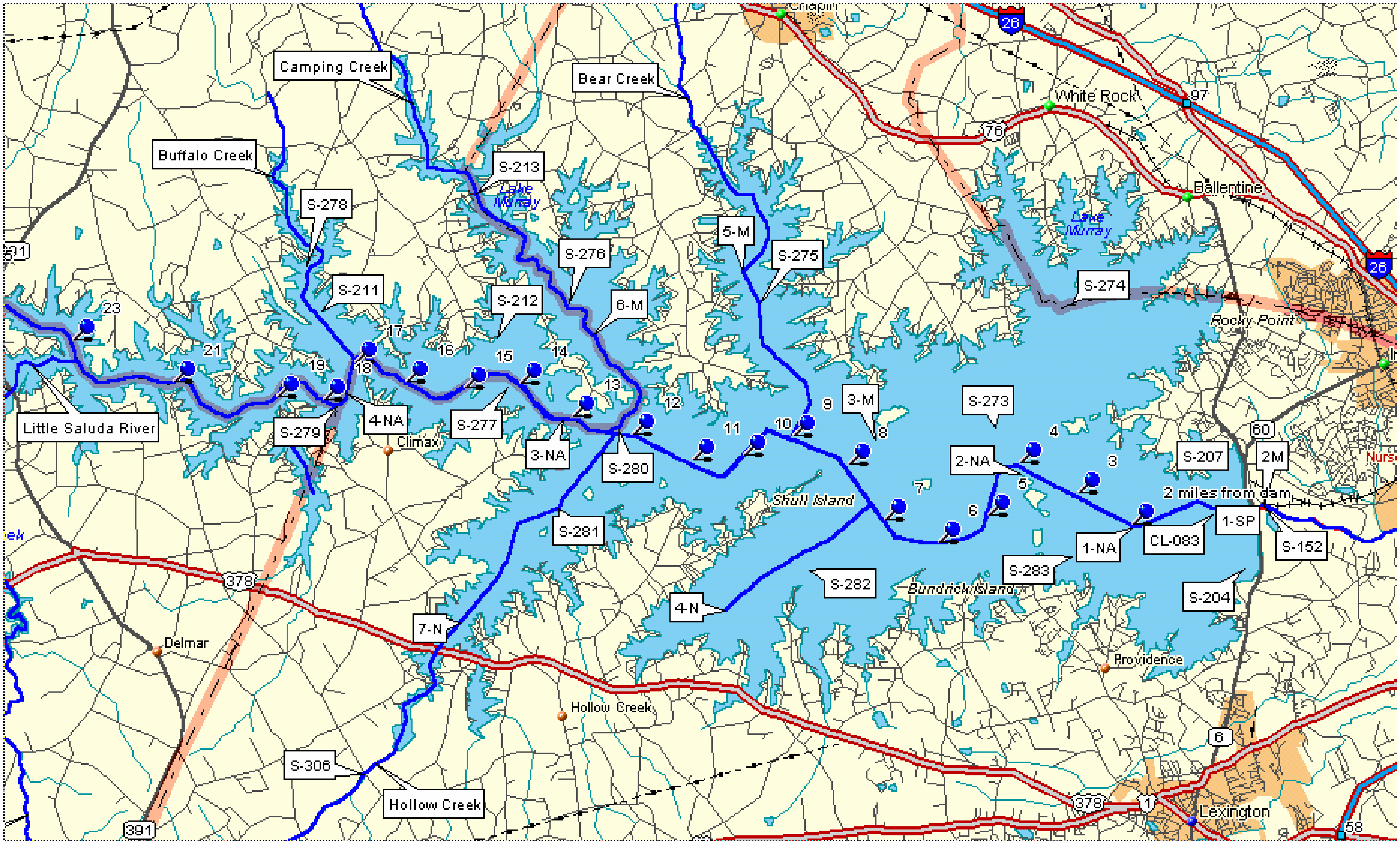


Figure 1: **Saluda River from the Saluda Tailwater to Just Below the Confluence with the Little Saluda River**

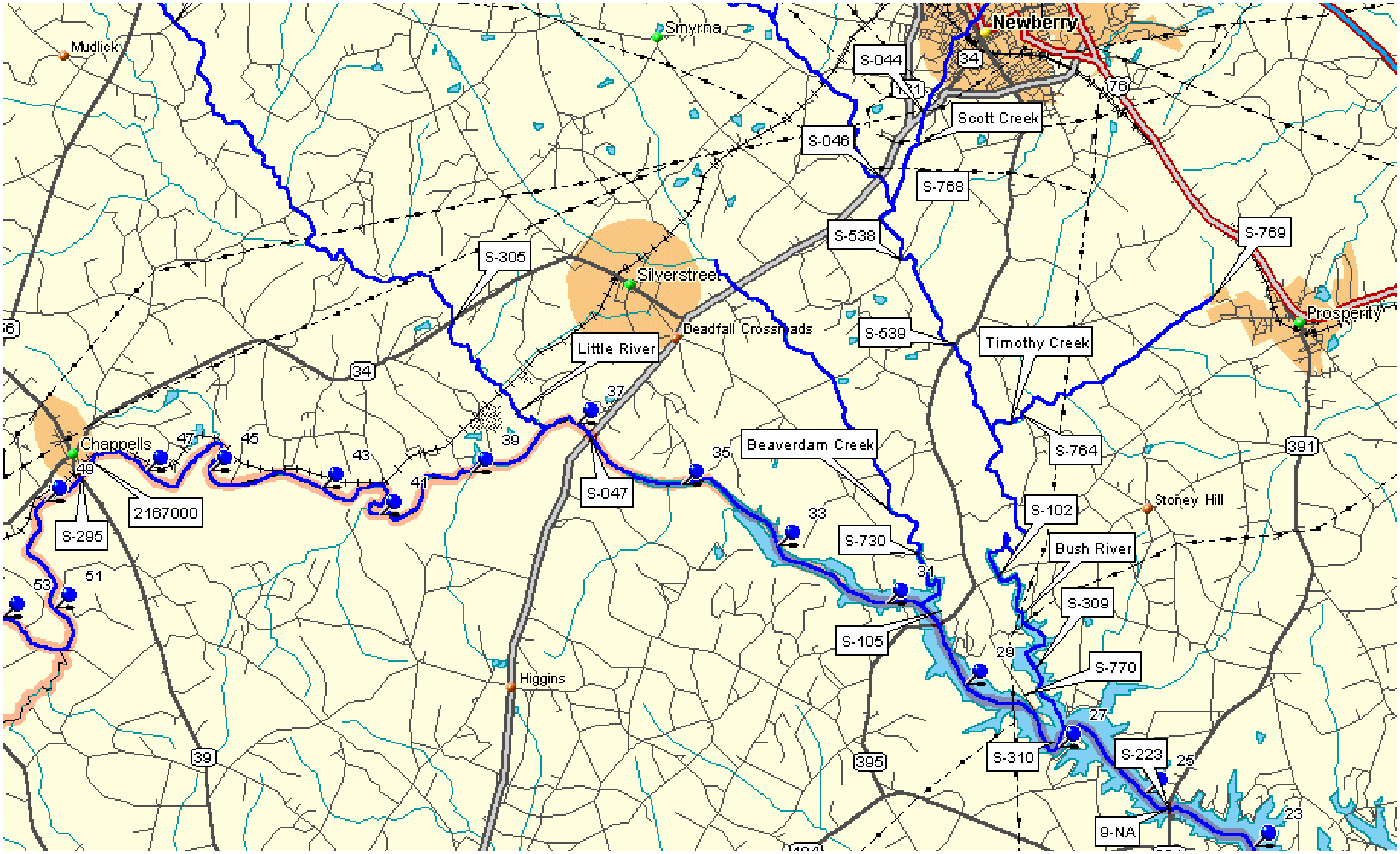


Figure 2: Saluda River from the Confluence with the Little Saluda River to Chappells, Including the Lower Portions of the Bush River and Little River Watersheds

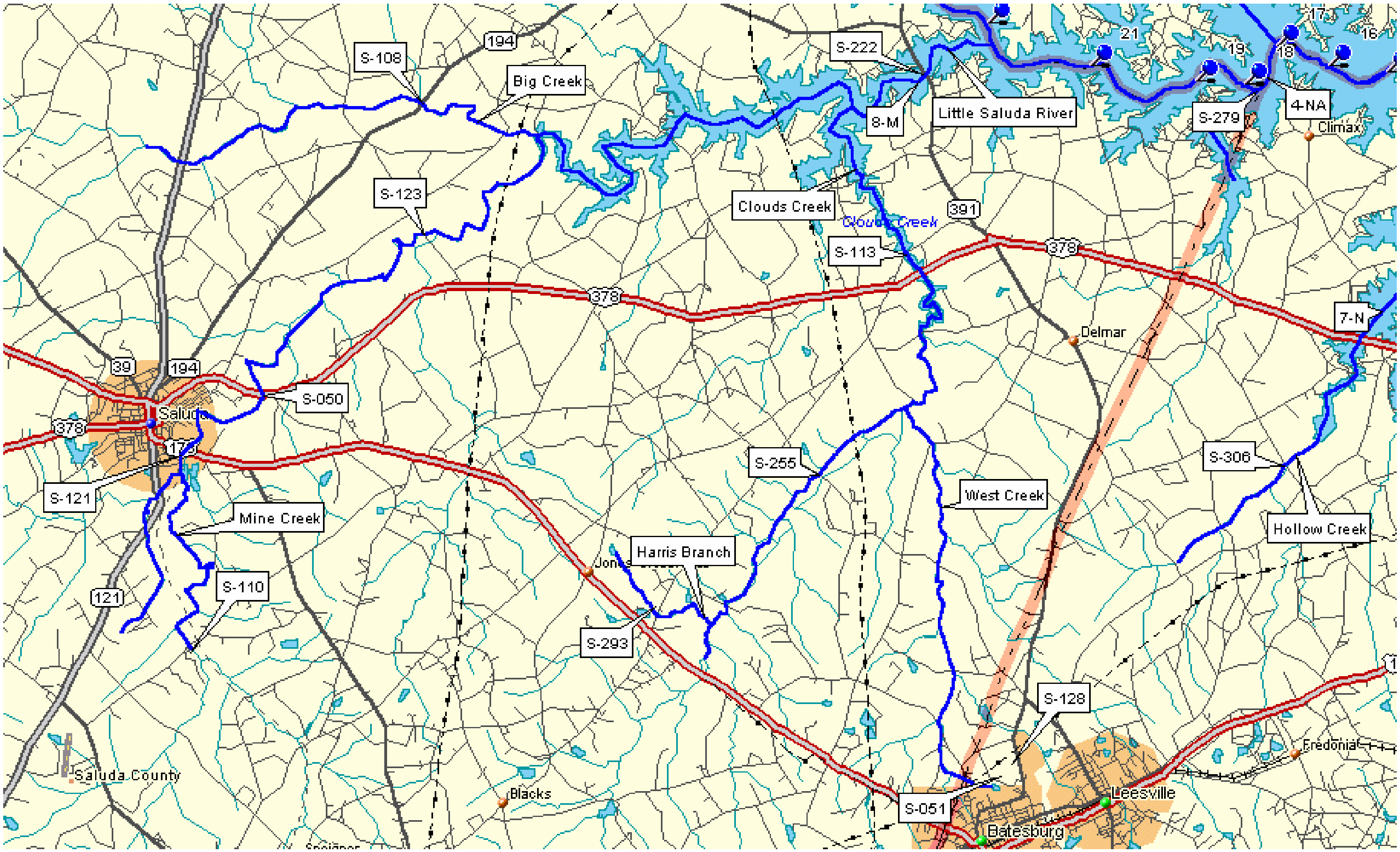


Figure 3: Little Saluda River Watershed

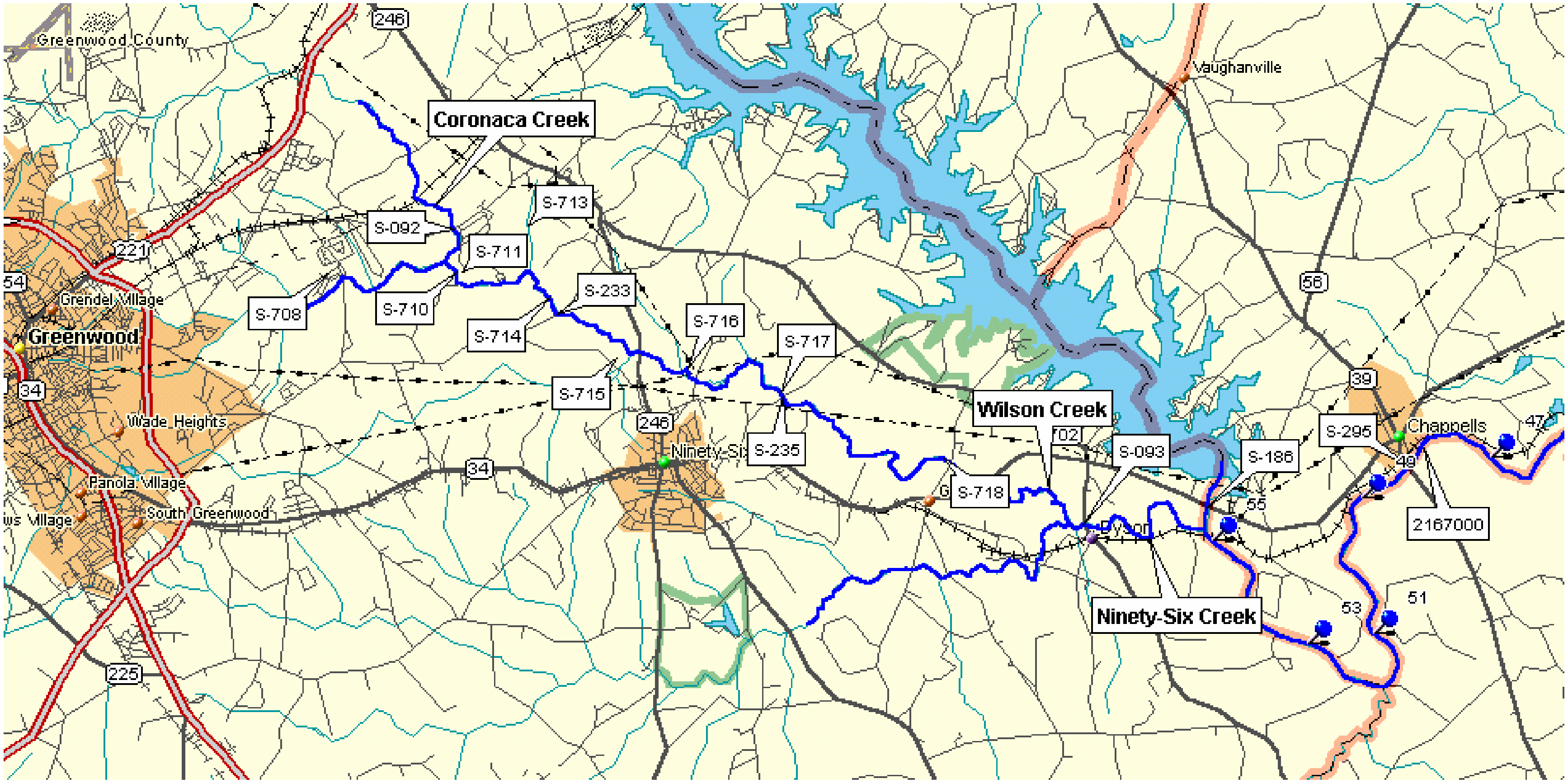


Figure 4: Saluda River from Chappells to Greenwood Dam, Including Ninety-Six Creek Watershed

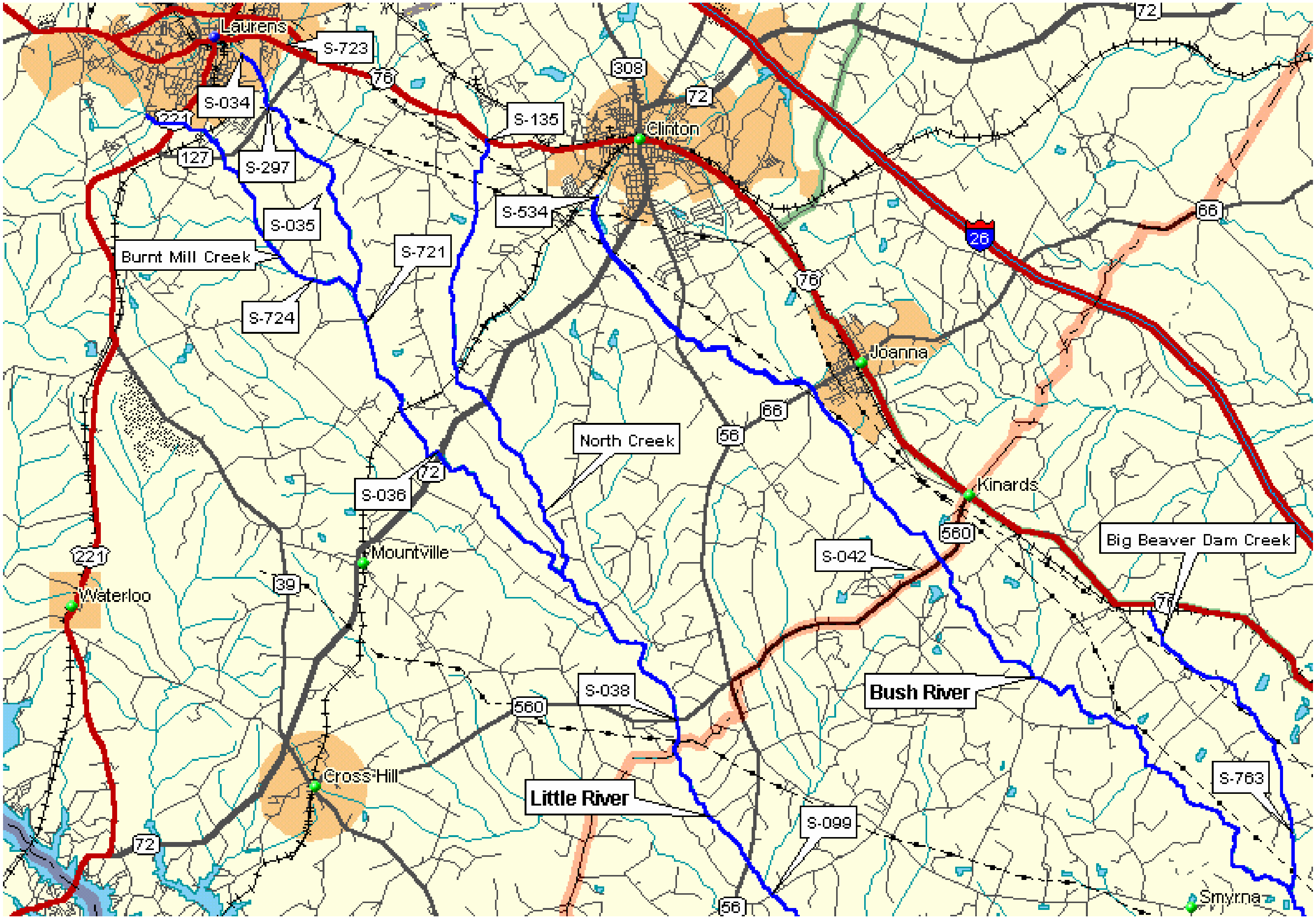


Figure 5: Upper Portions of Bush River and Little River Watersheds

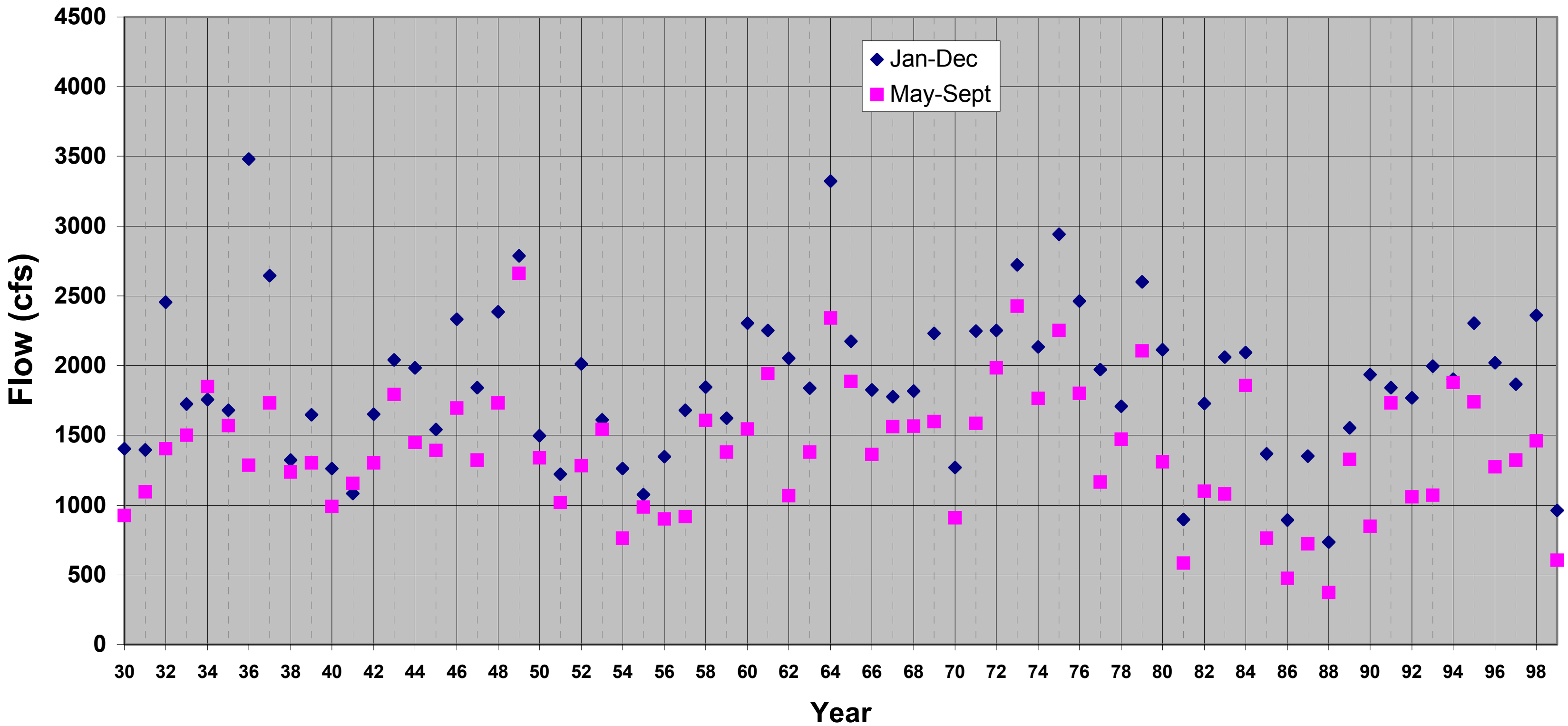


Figure 6: Average Daily Flow at the USGS Gauge at Chappells

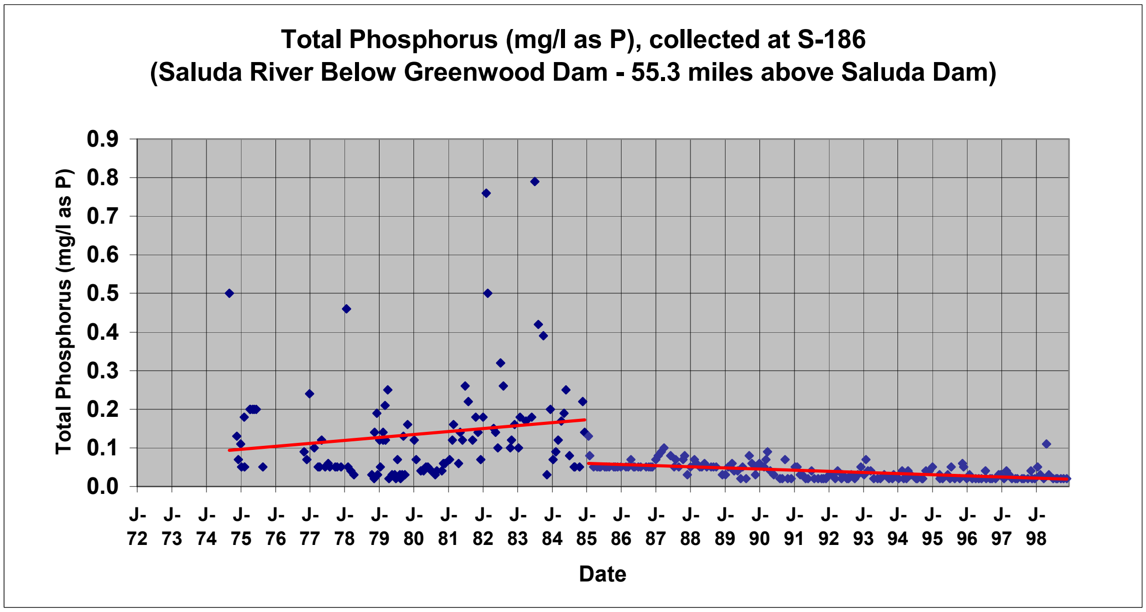


Figure 7: Total Phosphorus (mg/l as P), Collected at S-186

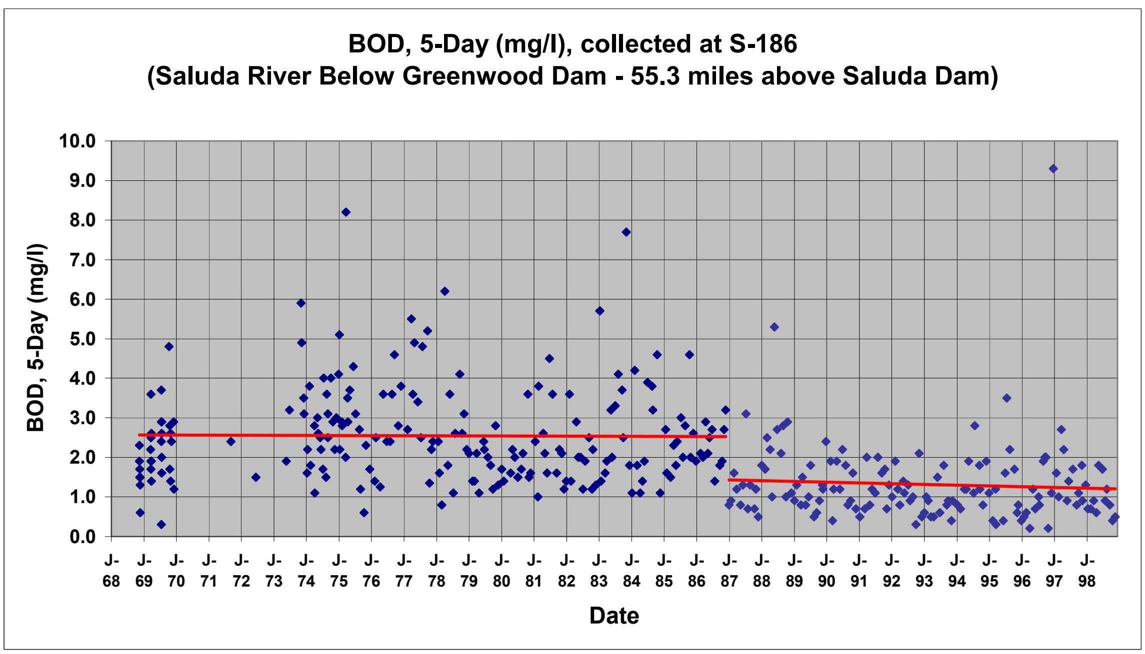


Figure 8: BOD, 5-Day (mg/l), Collected at S-186

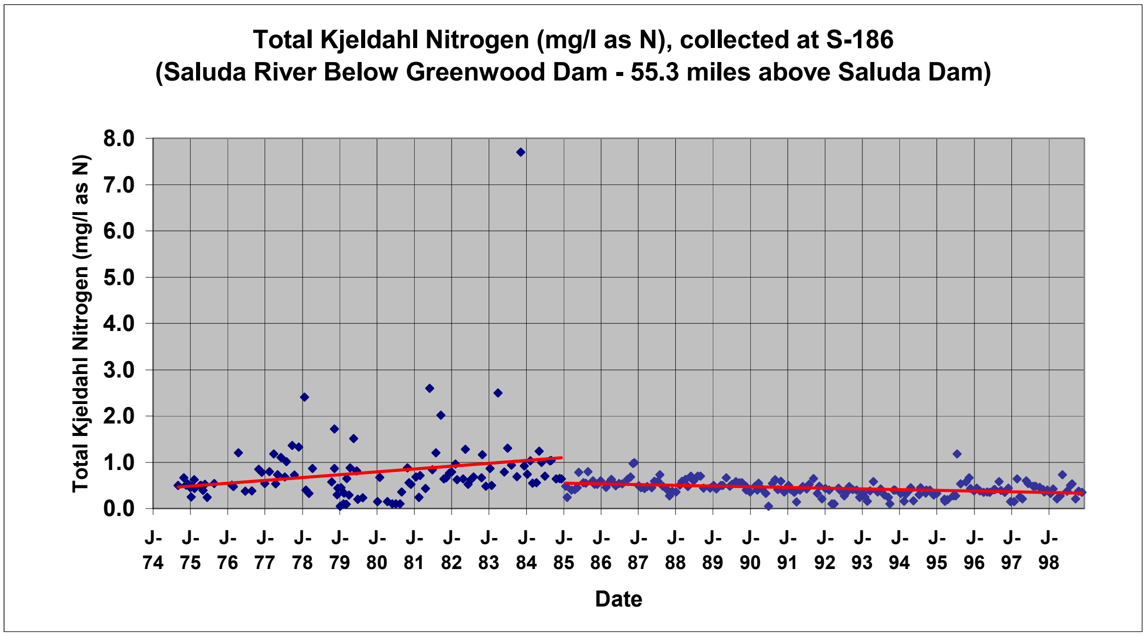


Figure 9: Total Kjeldahl Nitrogen (mg/l as N), Collected at S-186

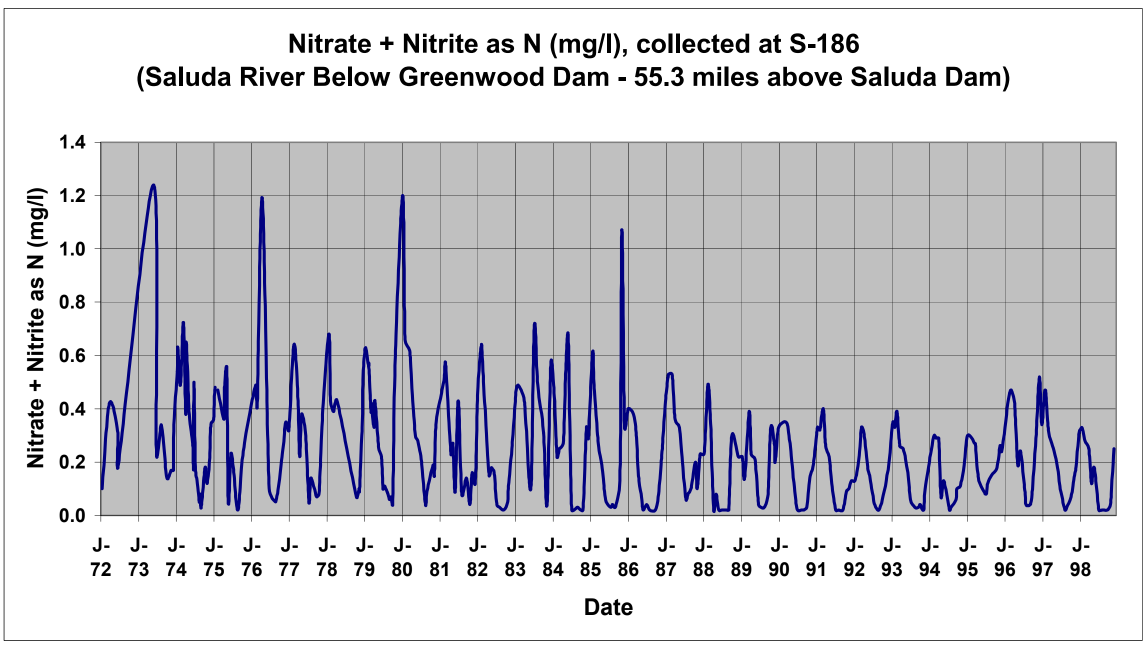


Figure 10: Nitrate + Nitrate as N (mg/l), Collected at S-186

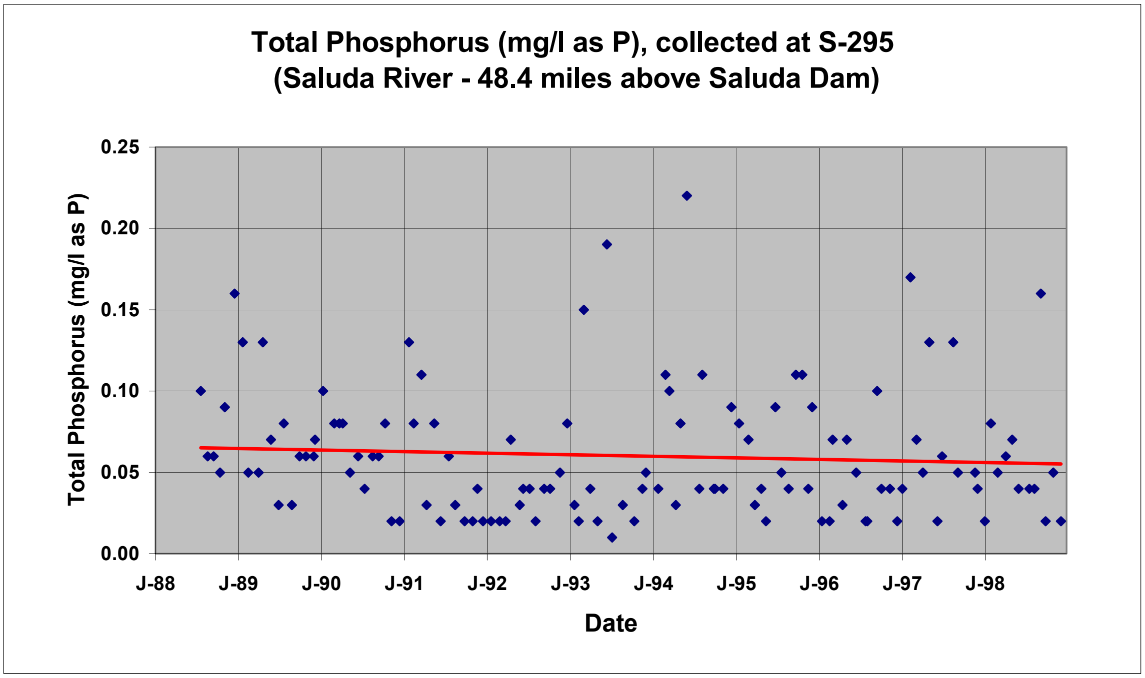


Figure 11: Total Phosphorus (mg/l as P), Collected at S0295

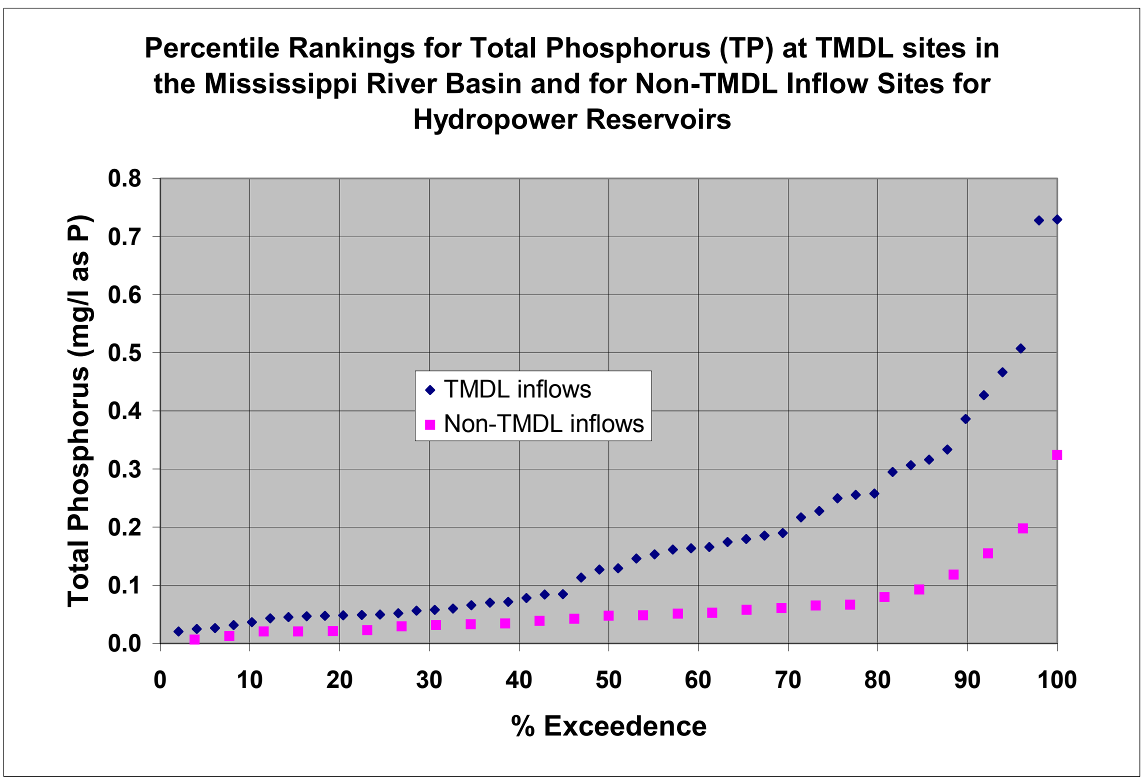


Figure 12: Percentile Rankings for Total Phosphorus (TP) at TMDL Sites in the Mississippi River Basin and for Non-TMDL Inflow Sites for Hydropower Reservoirs

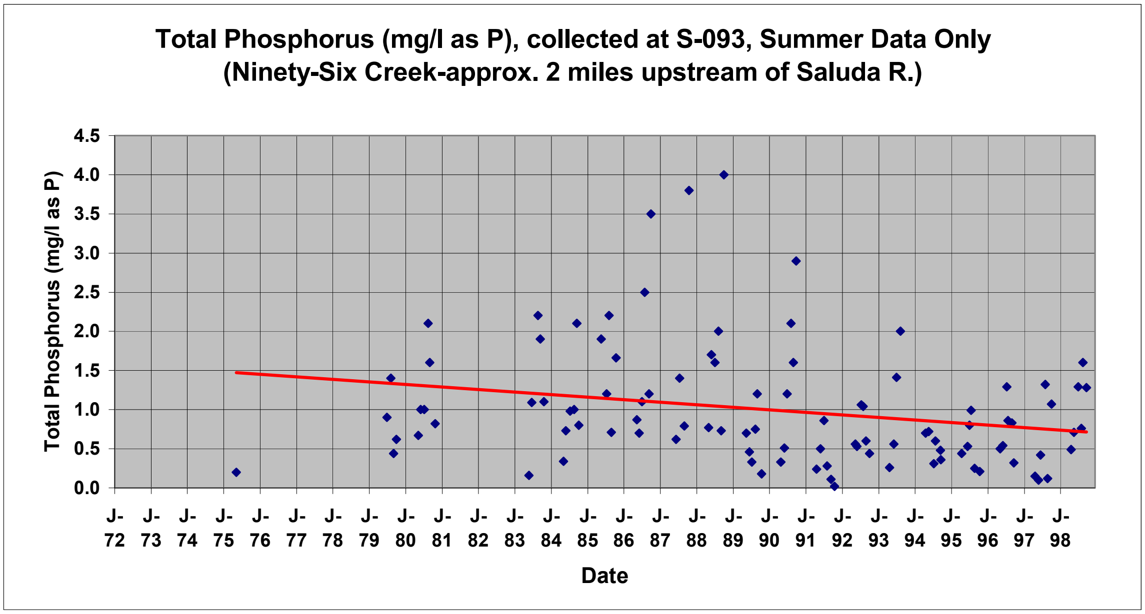


Figure 13: Total Phosphorus (mg/l as P), Collected at S-093, Summer Data Only

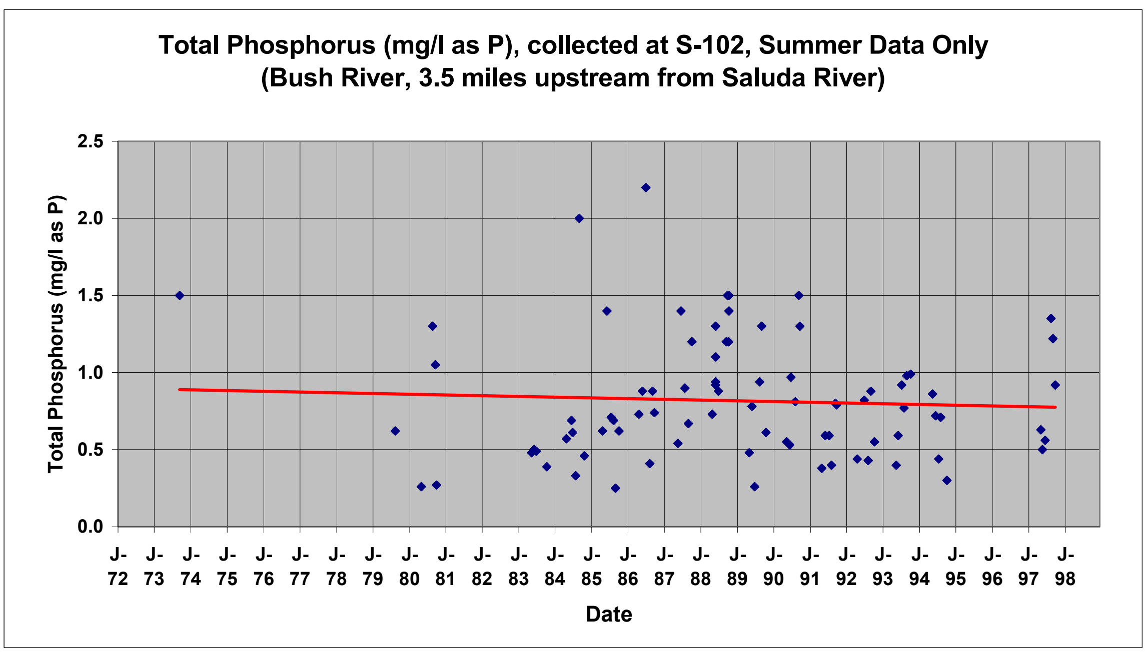


Figure 14: Total Phosphorus (mg/l as P), Collected at S-102, Summer Data Only

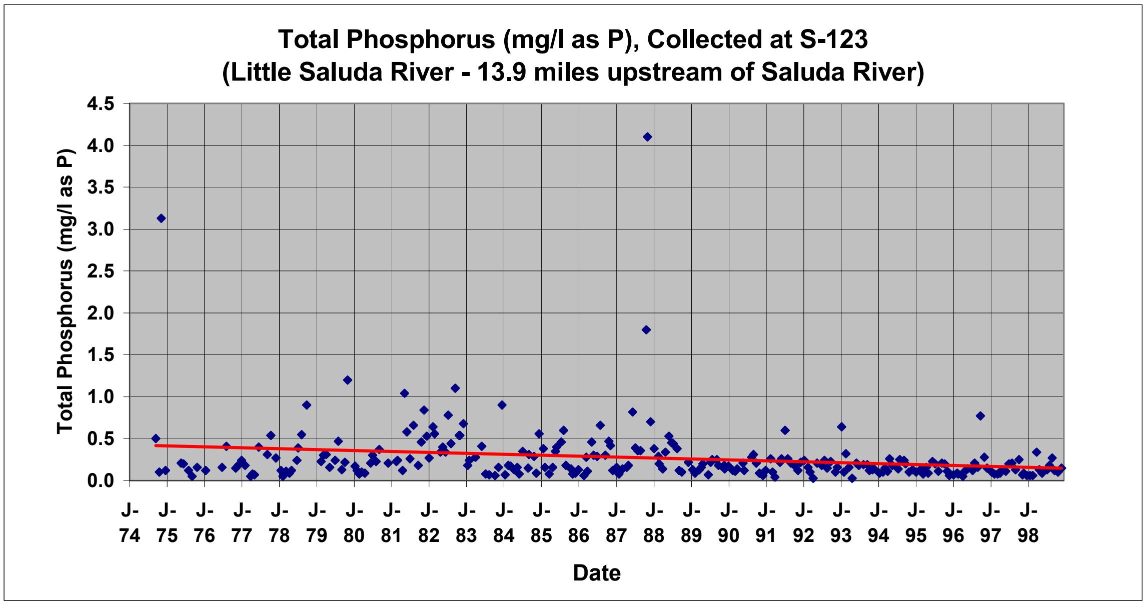


Figure 15: **Total Phosphorus (mg/l as P), Collected at S-123**

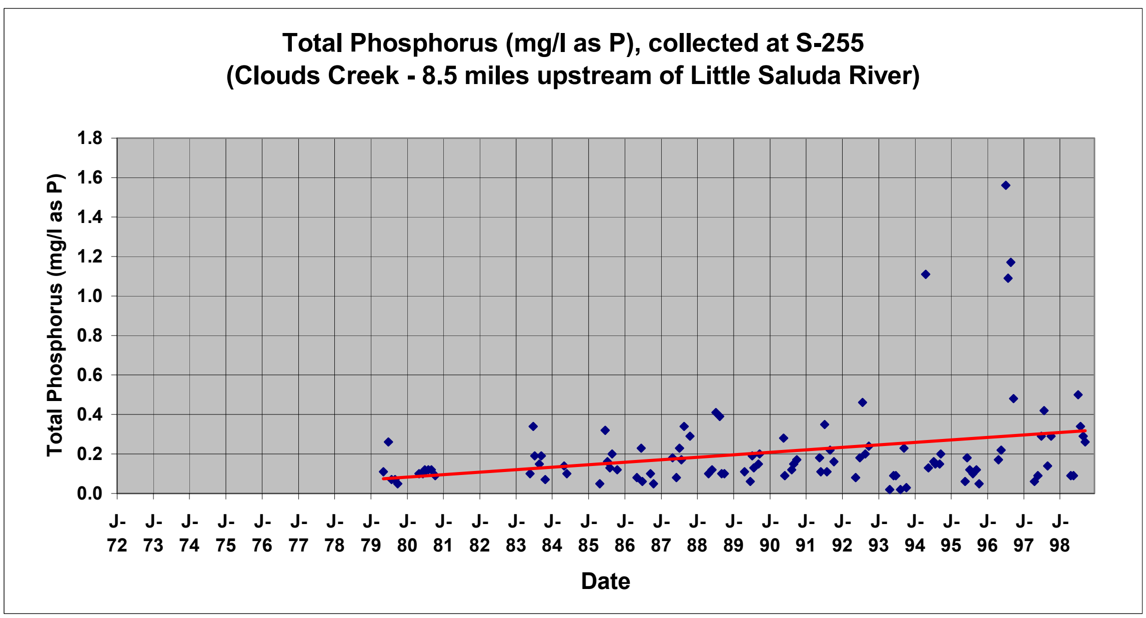


Figure 16: **Total Phosphorus (mg/l as P), Collected at S-255**

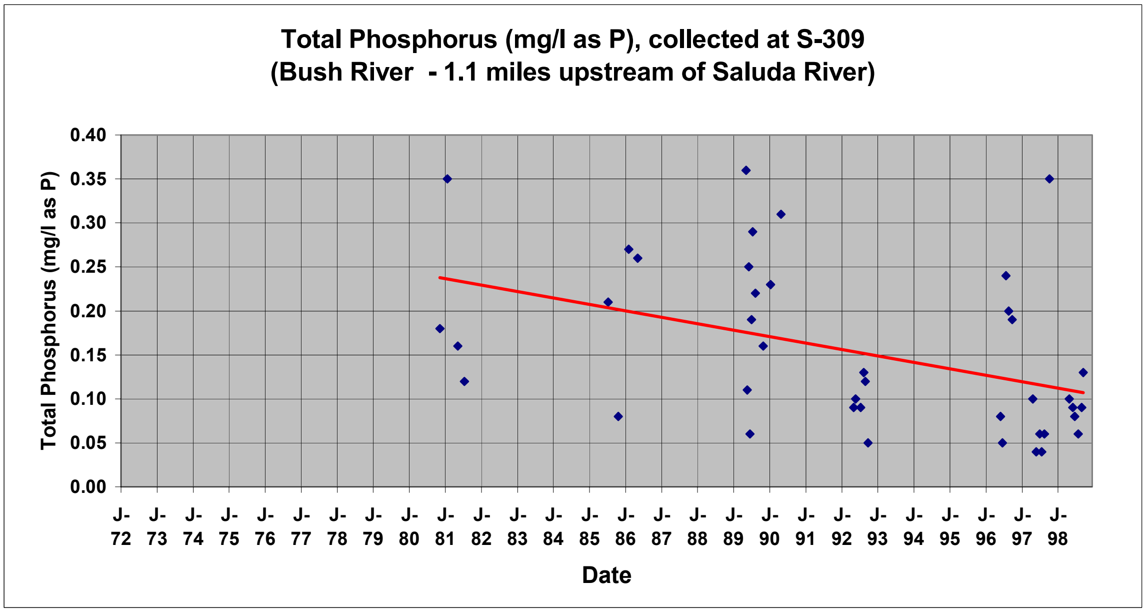


Figure 17: **Total Phosphorus (mg/l as P), Collected at S-309**

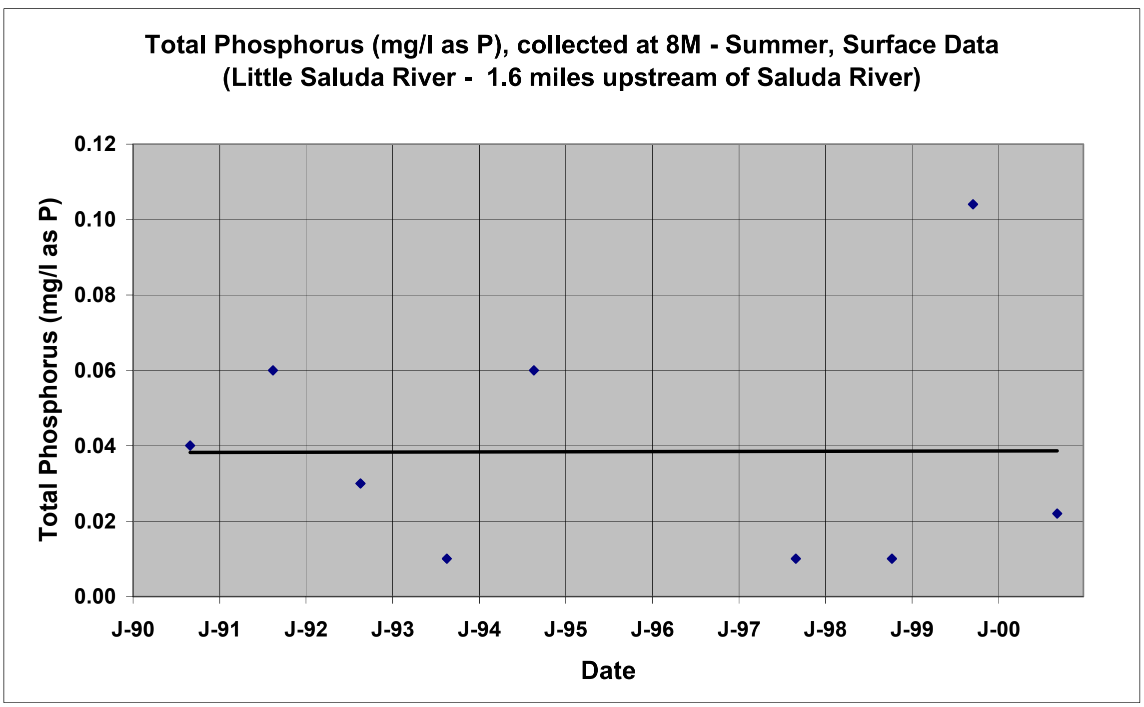


Figure 18: **Total Phosphorus (mg/l as P), Collected at 8M – Summer, Surface Data**

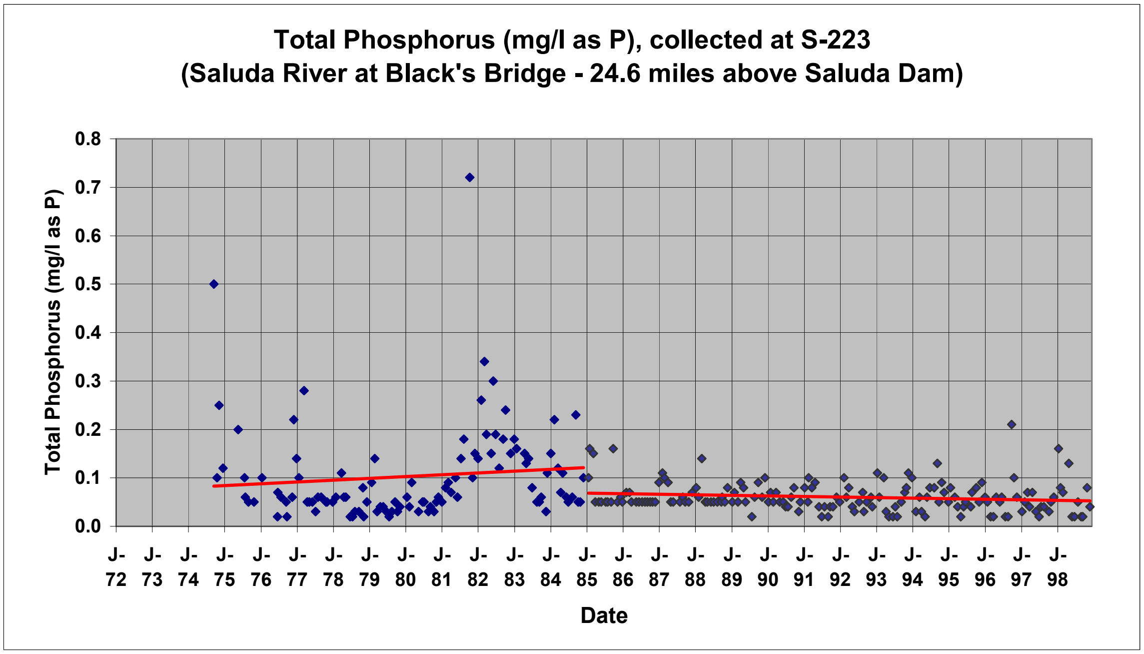


Figure 19: **Total Phosphorus (mg/l as P), Collected at S-223**

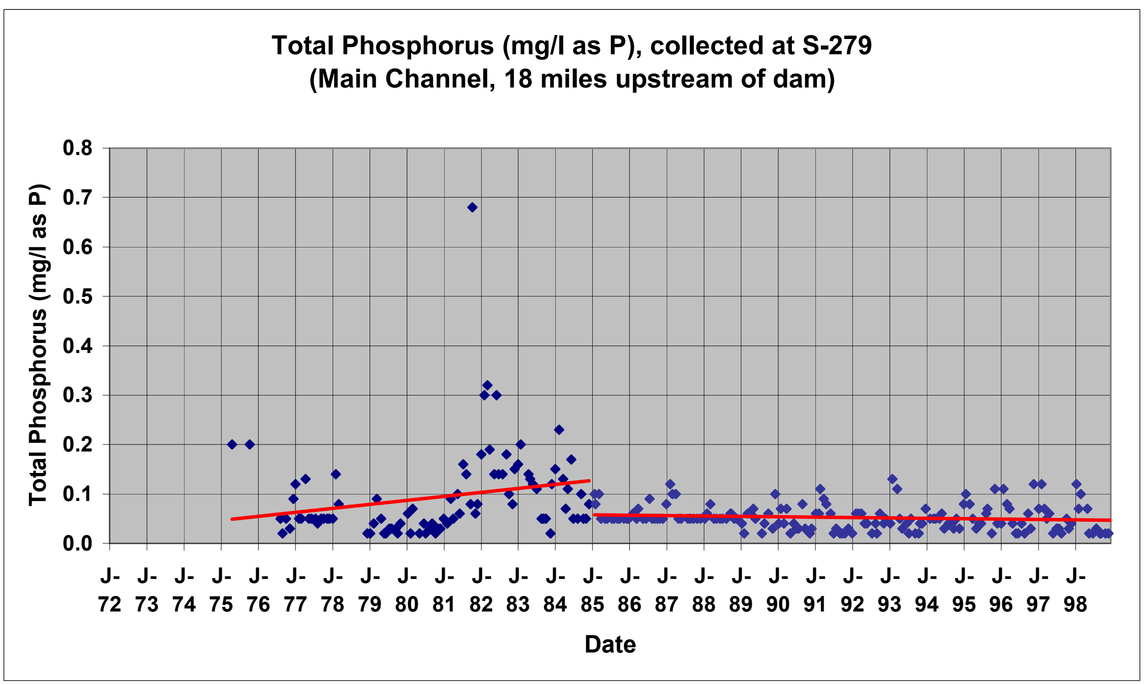


Figure 20: **Total Phosphorus (mg/l as P), Collected at S-279**

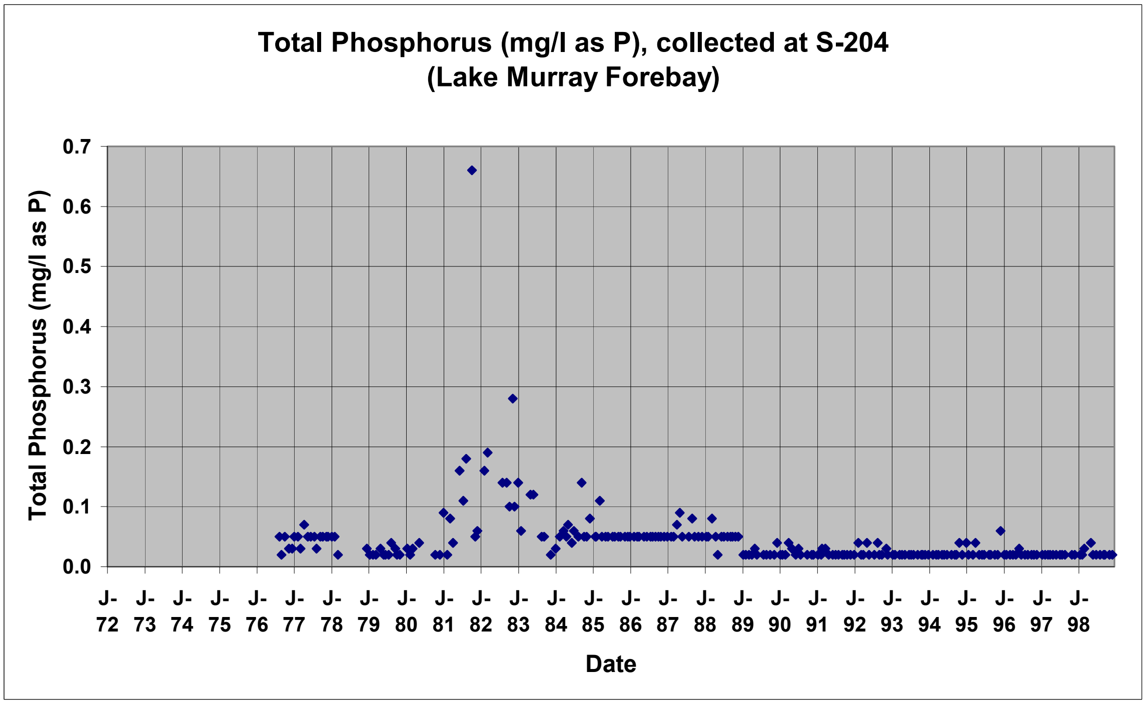
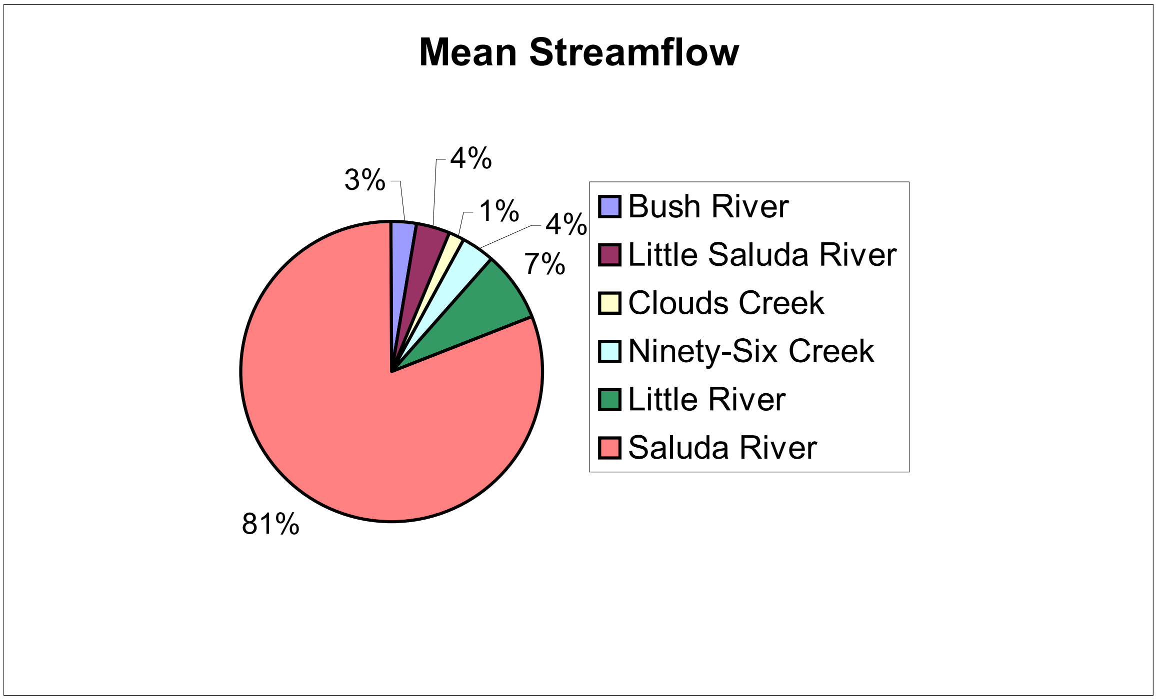


Figure 21: **Total Phosphorus (mg/l as P), Collected at S-204**



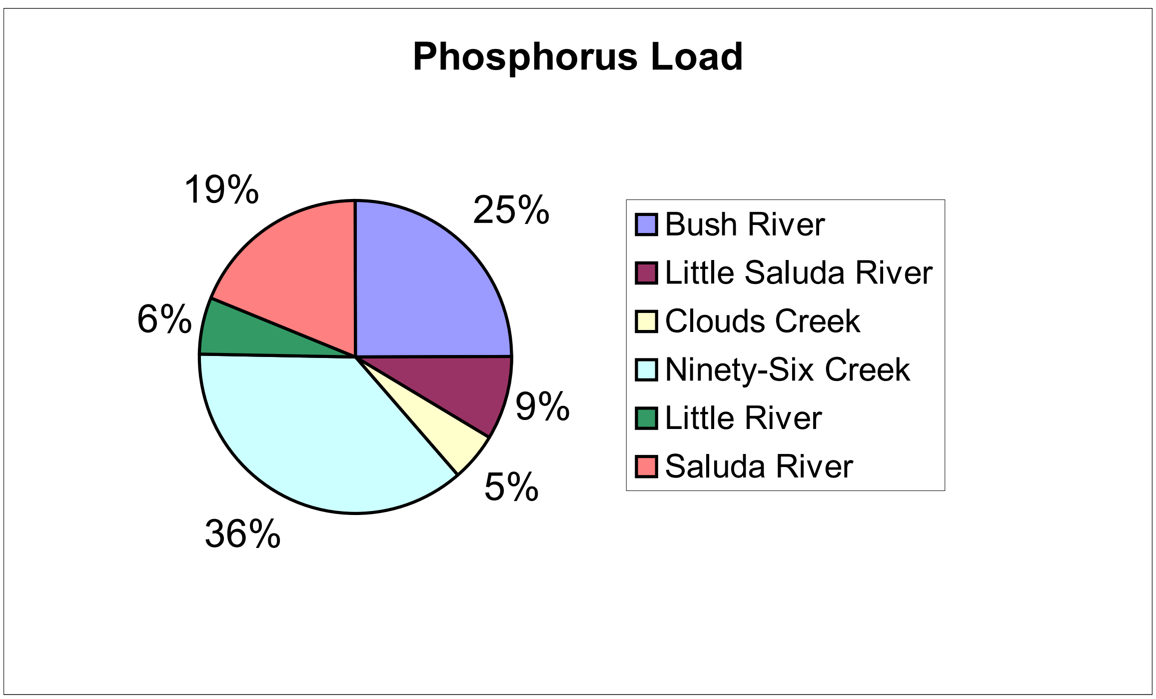
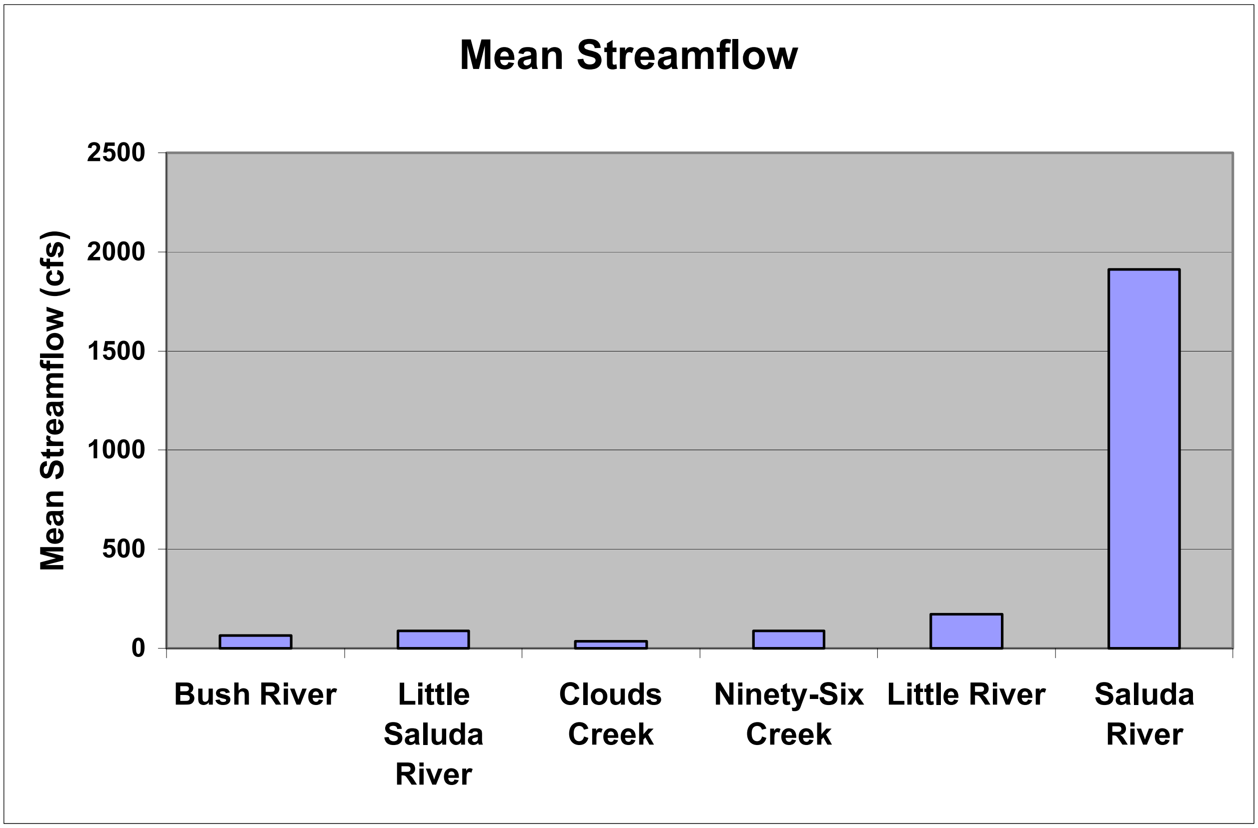


Figure 22: Mean Stream – Phosphorus Load



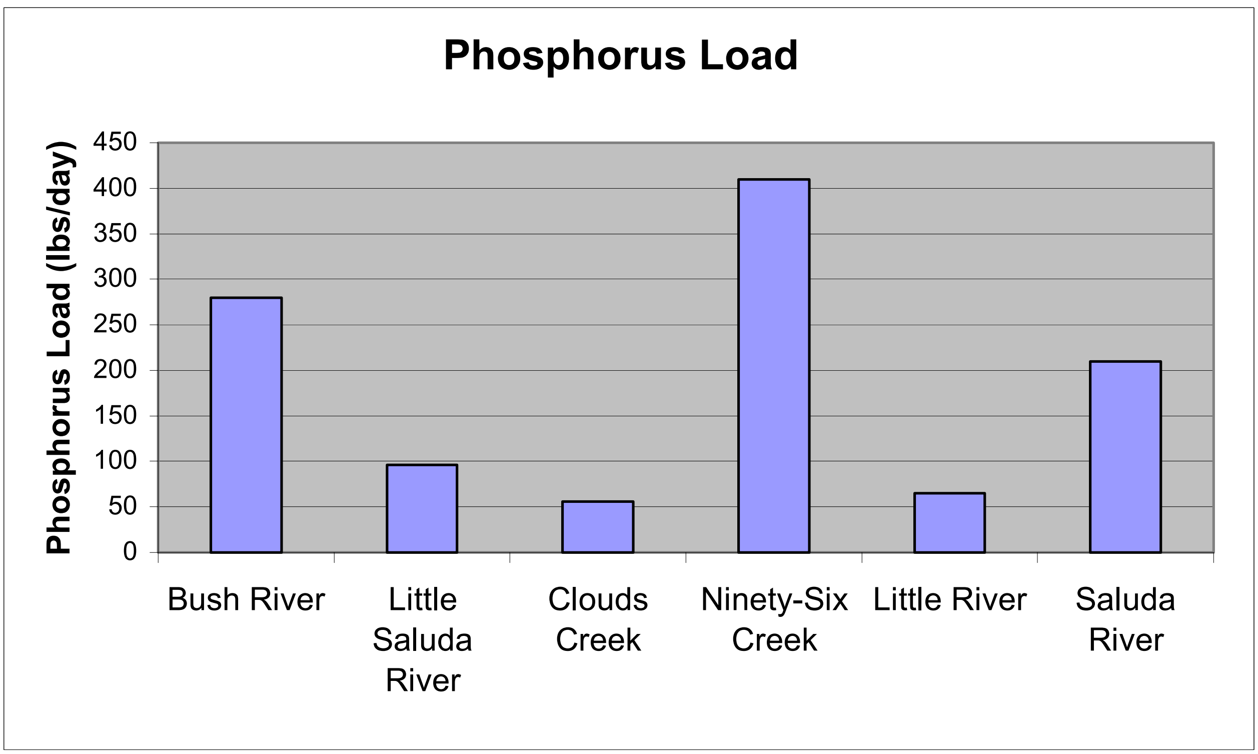
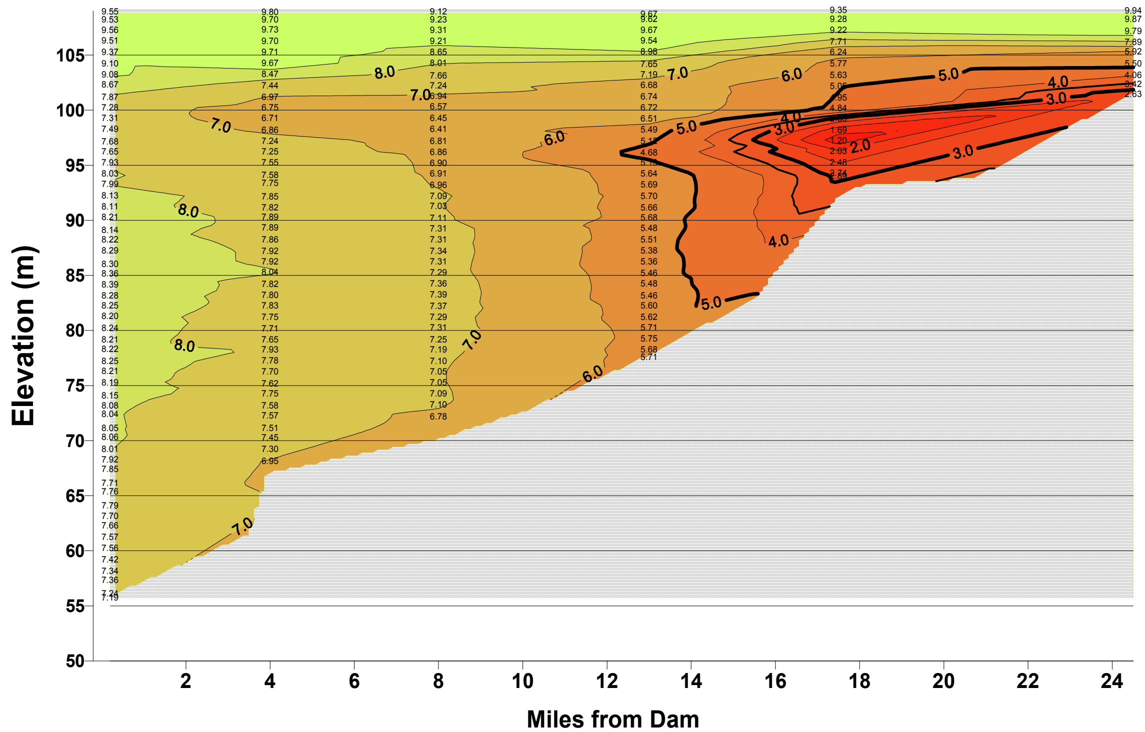


Figure 23: Mean Stream – Phosphorus Load

Lake Murray May 22-23, 1996 - SCE&G stations



Lake Murray June 24-25, 1996 - SCE&G stations

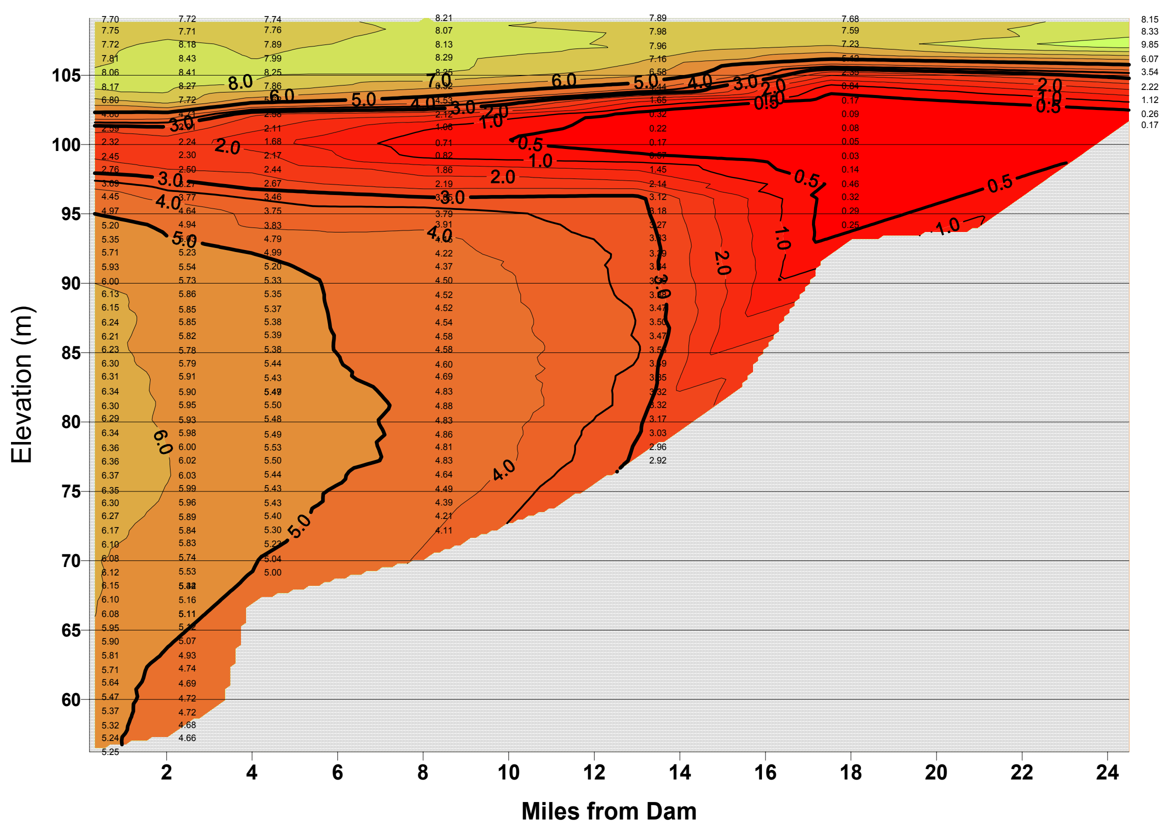
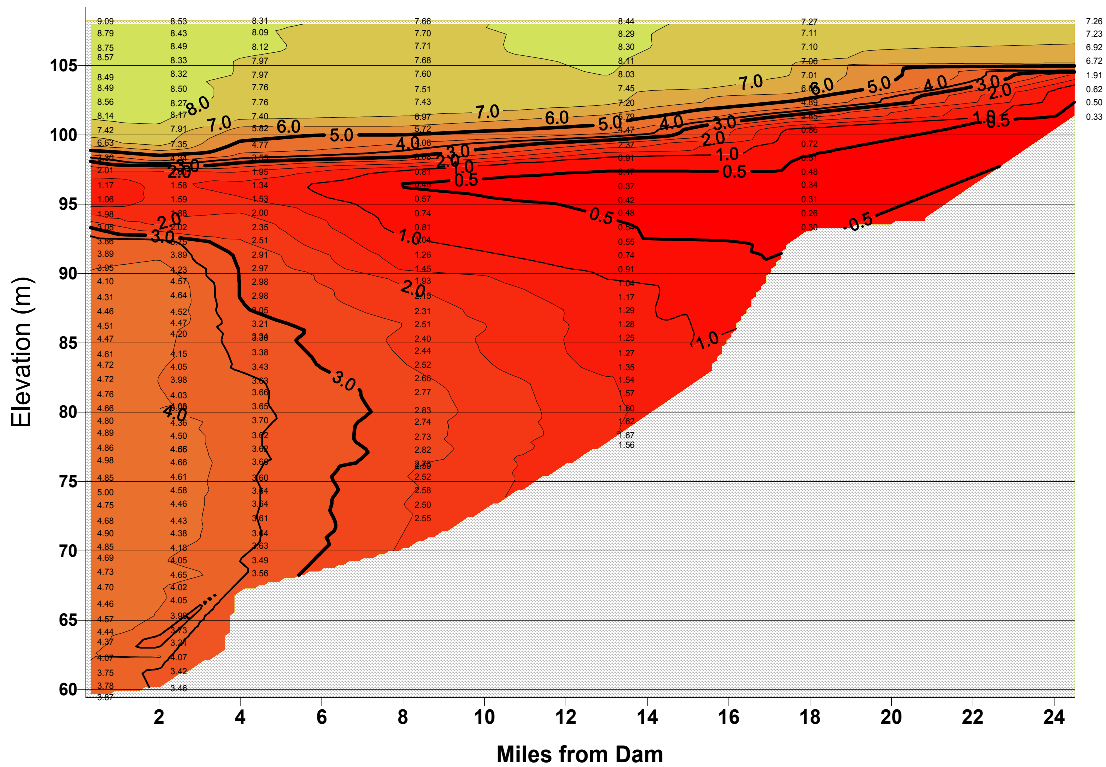


Figure 24: Longitudinal Contour Plot of DO in Lake Murray for 1996

Lake Murray July 25-26, 1996 - SCE&G stations



Lake Murray August 13-14, 1996 - SCE&G stations

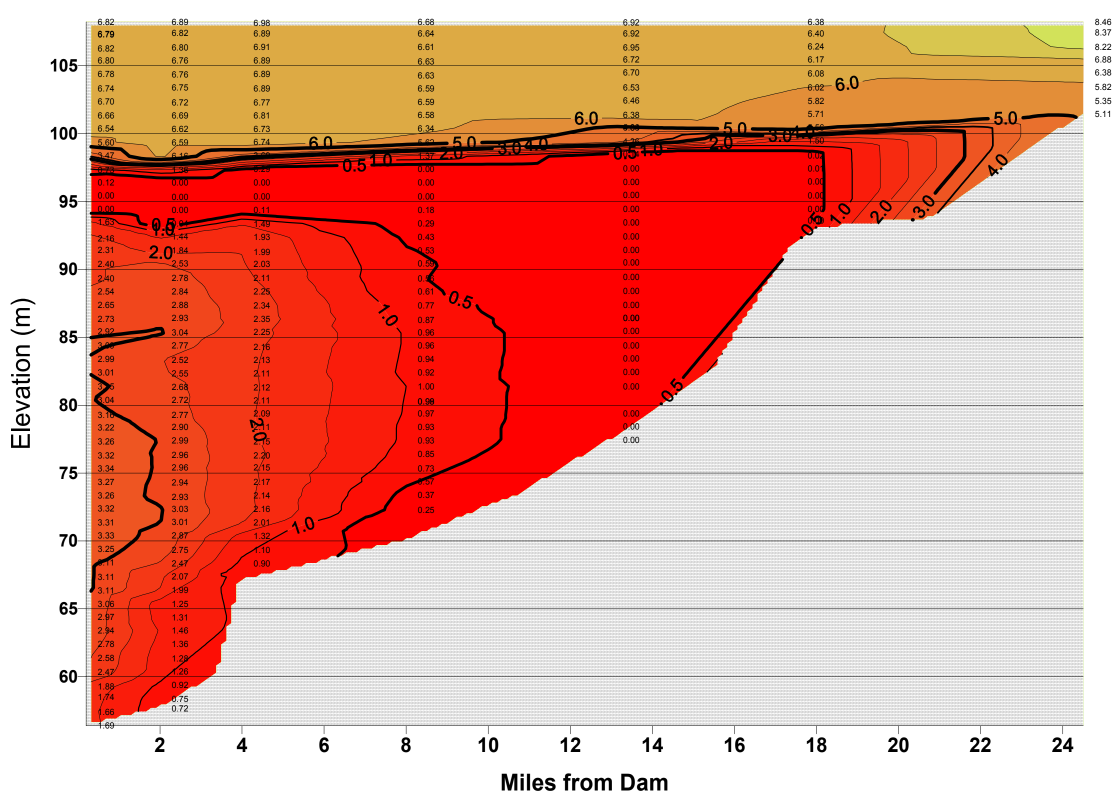
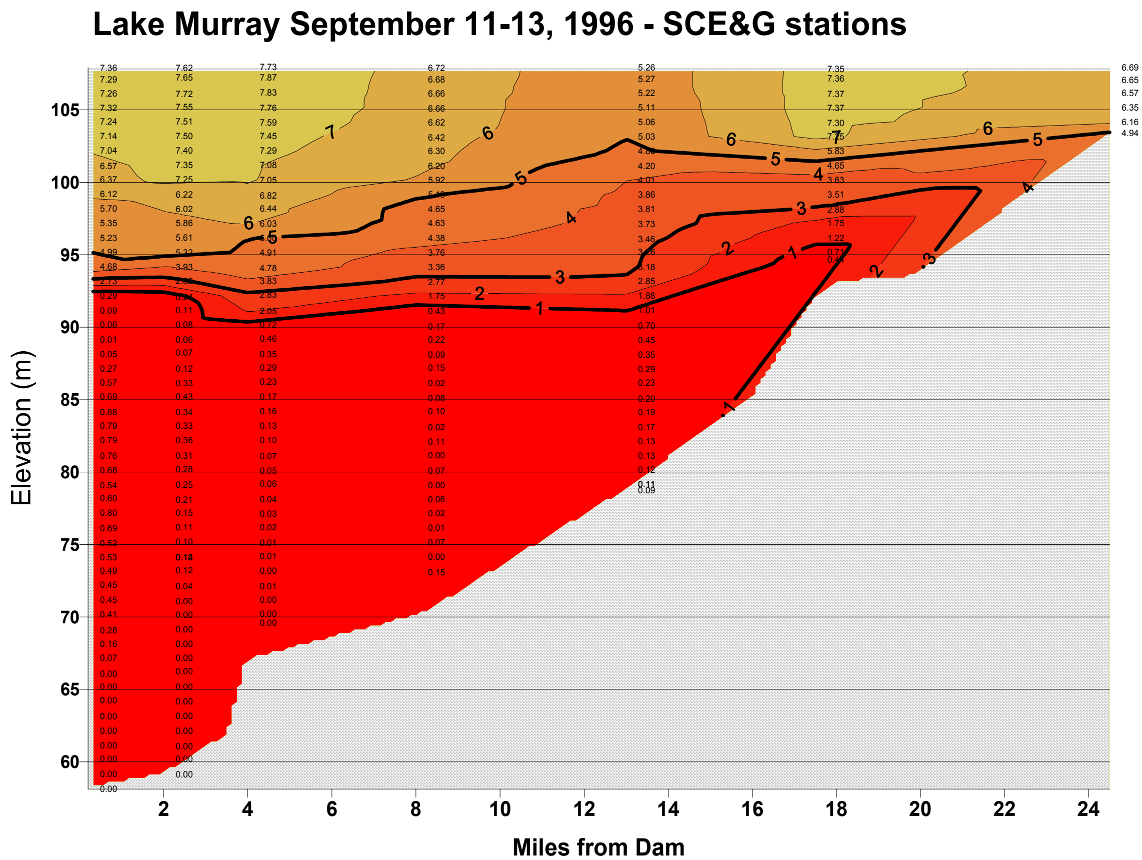


Figure 24: Longitudinal Contour Plot of DO in Lake Murray for 1996 (continued)



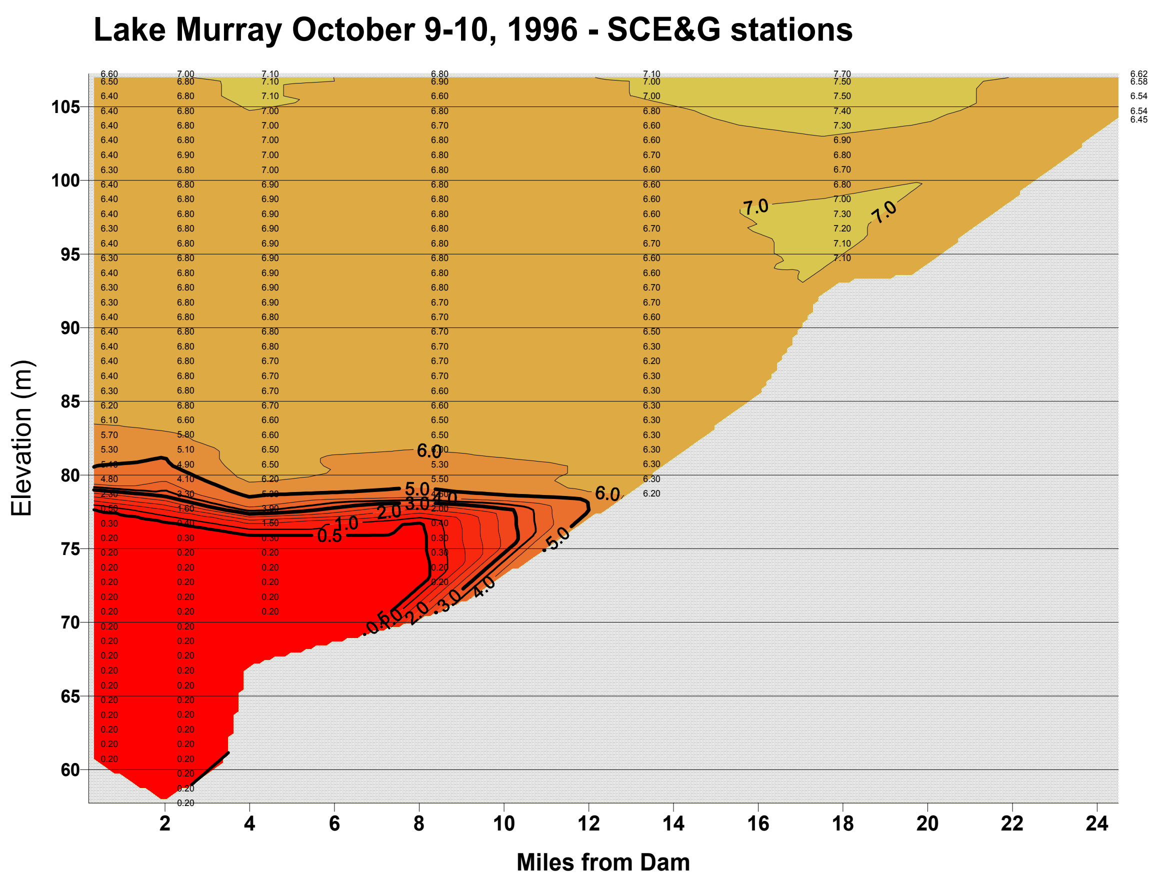


Figure 24: Longitudinal Contour Plot of DO in Lake Murray for 1996 (continued)

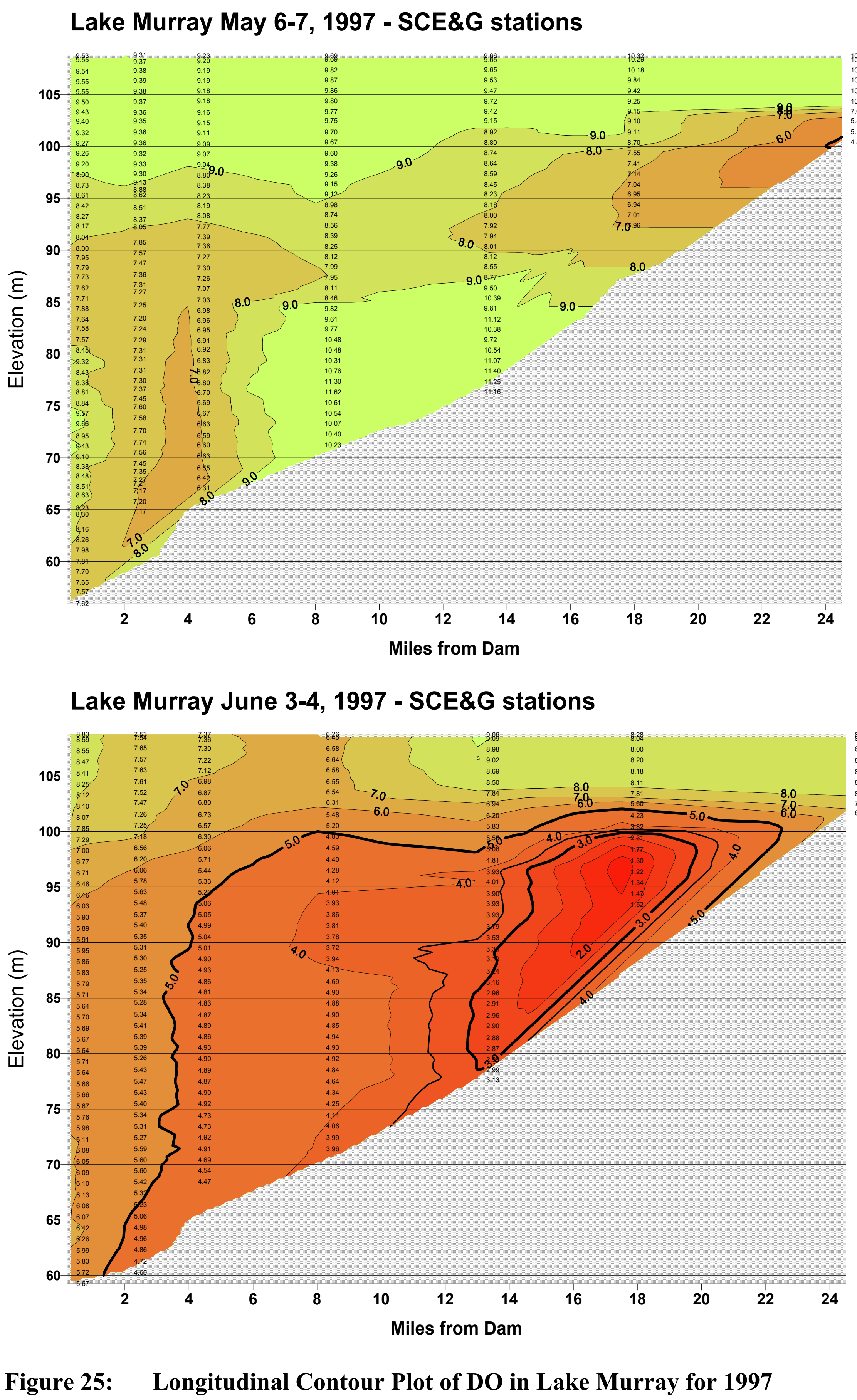
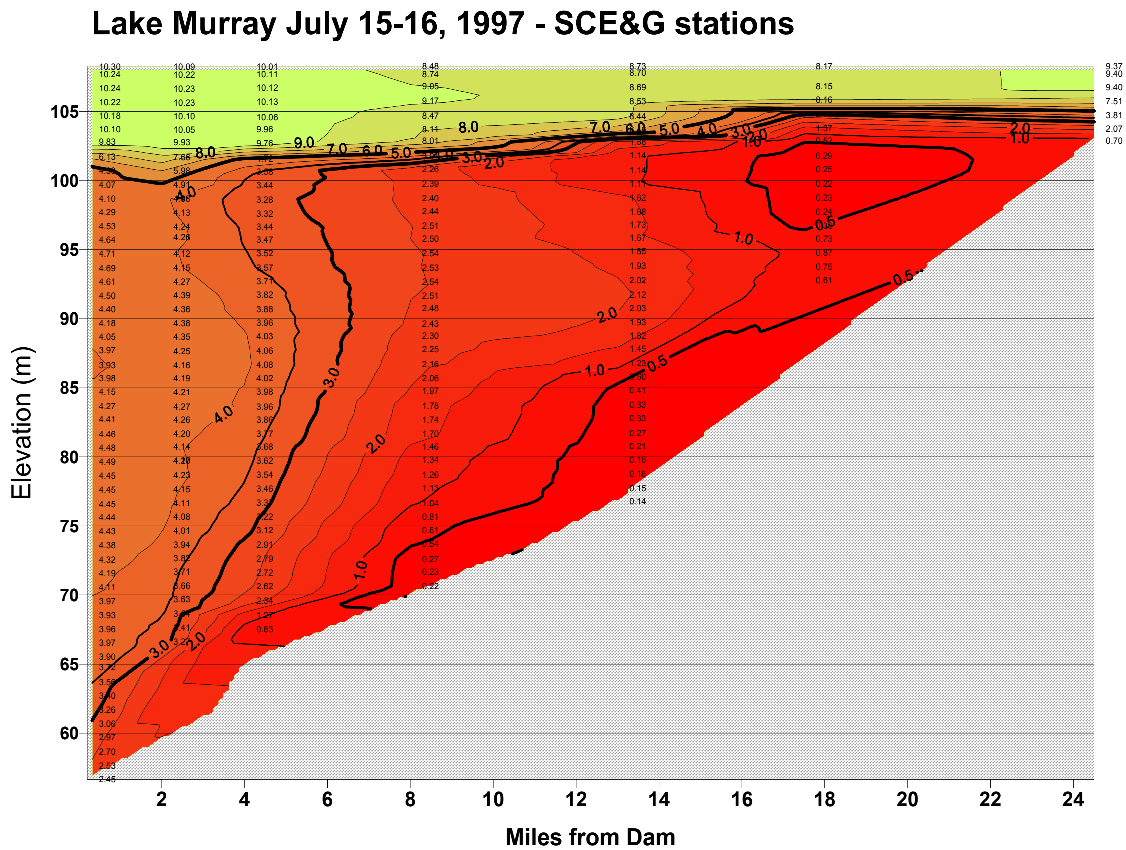


Figure 25: Longitudinal Contour Plot of DO in Lake Murray for 1997



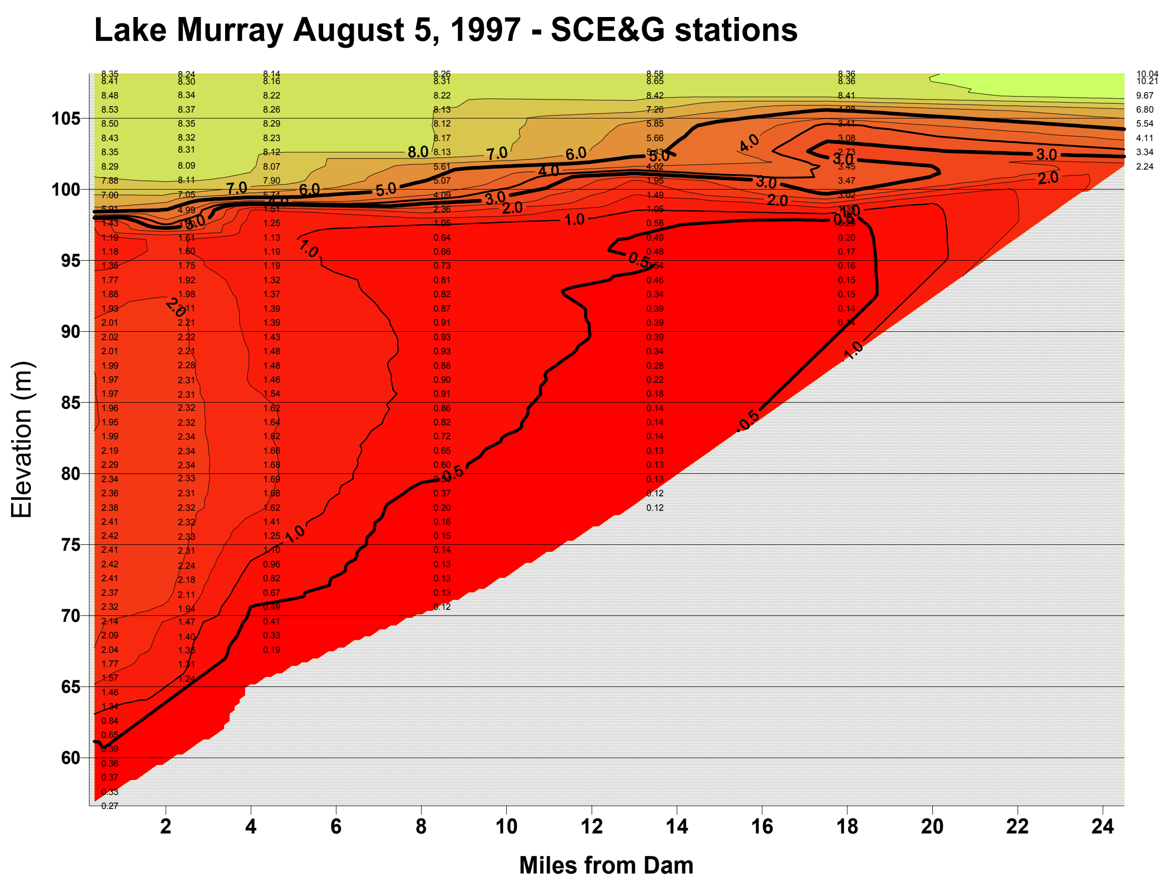


Figure 25: Longitudinal Contour Plot of DO in Lake Murray for 1997 (continued)

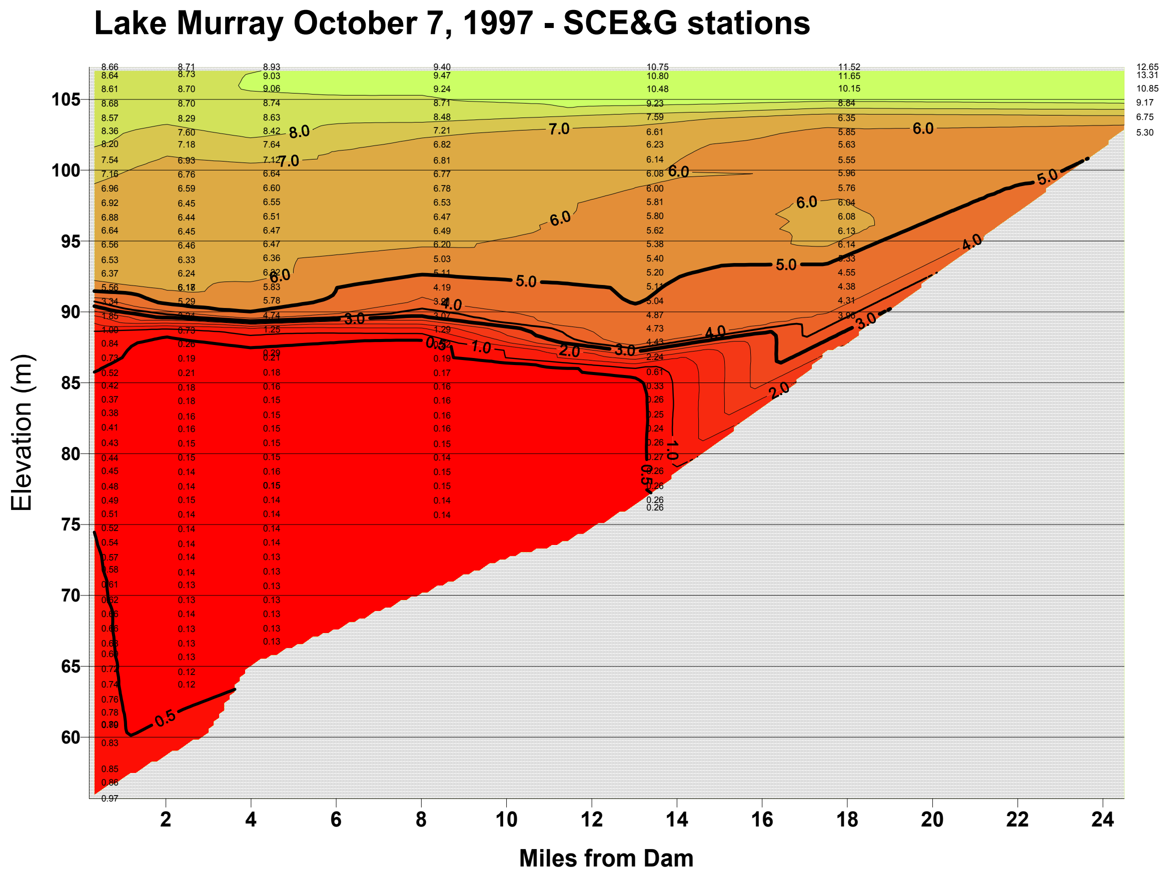
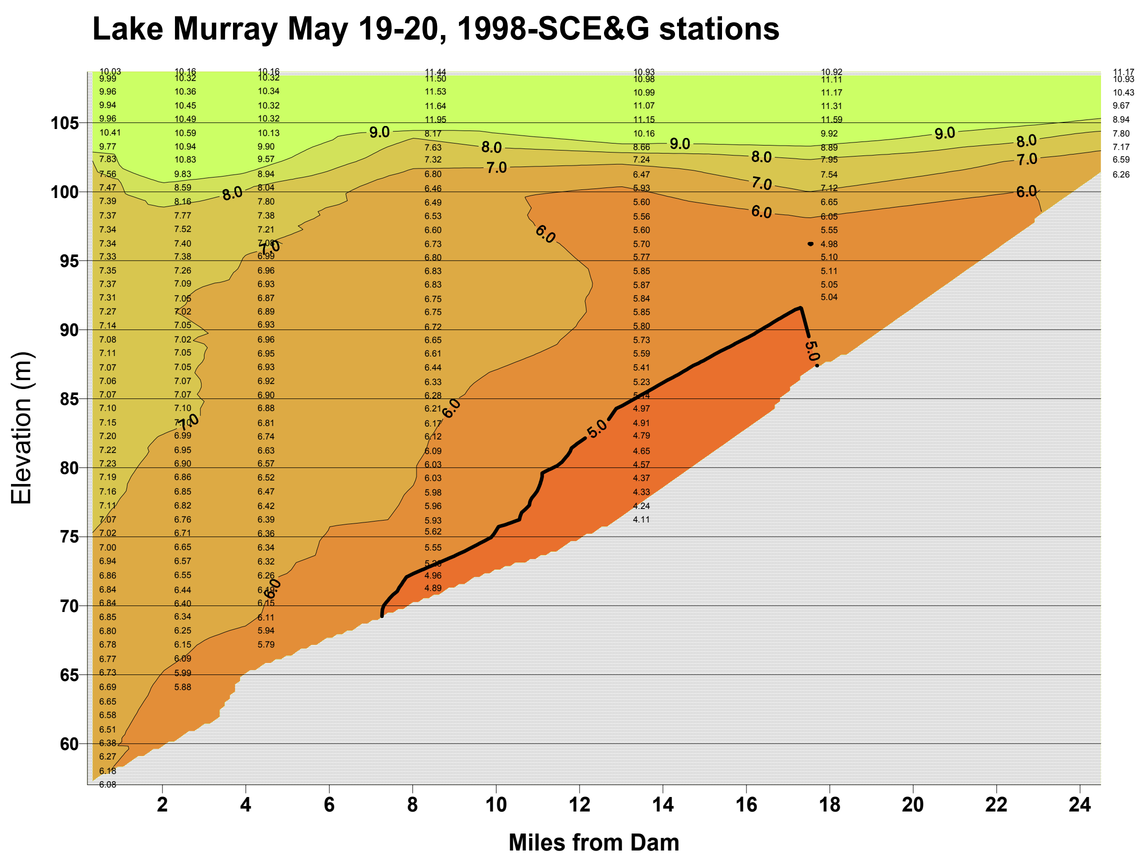


Figure 25: Longitudinal Contour Plot of DO in Lake Murray for 1997 (continued)



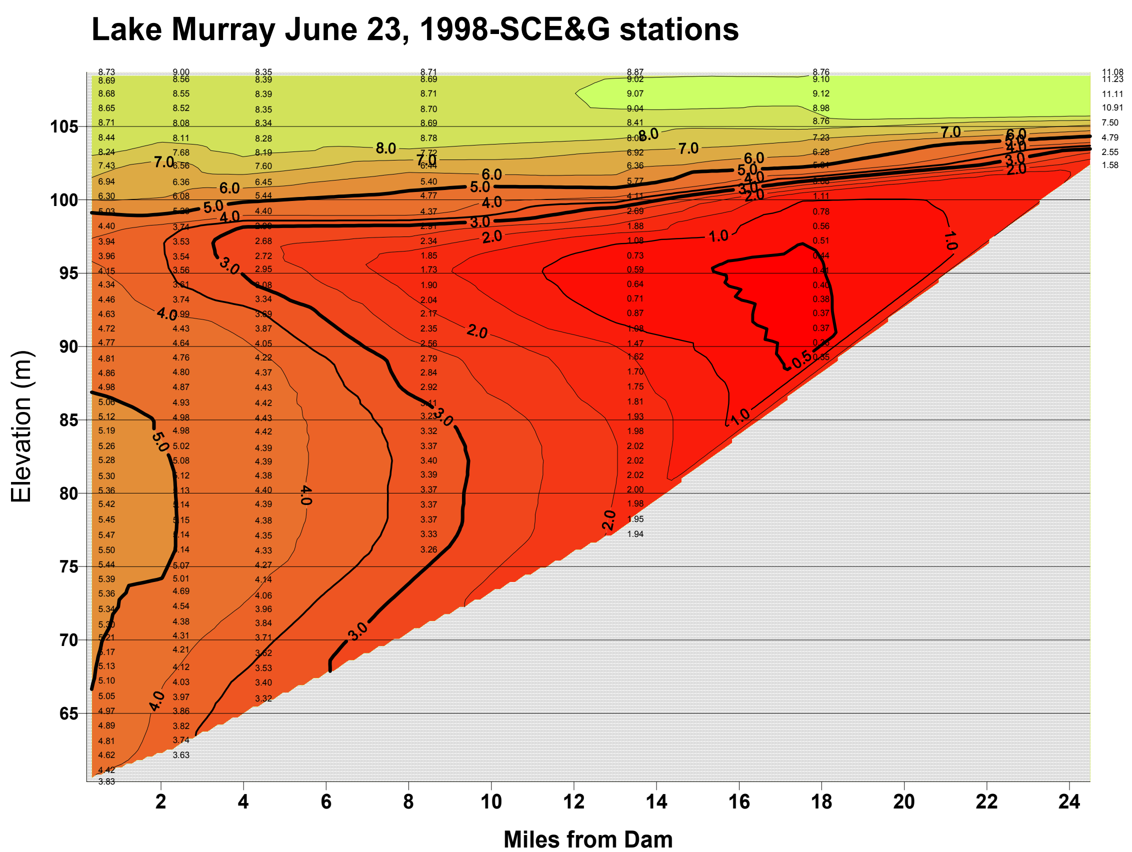
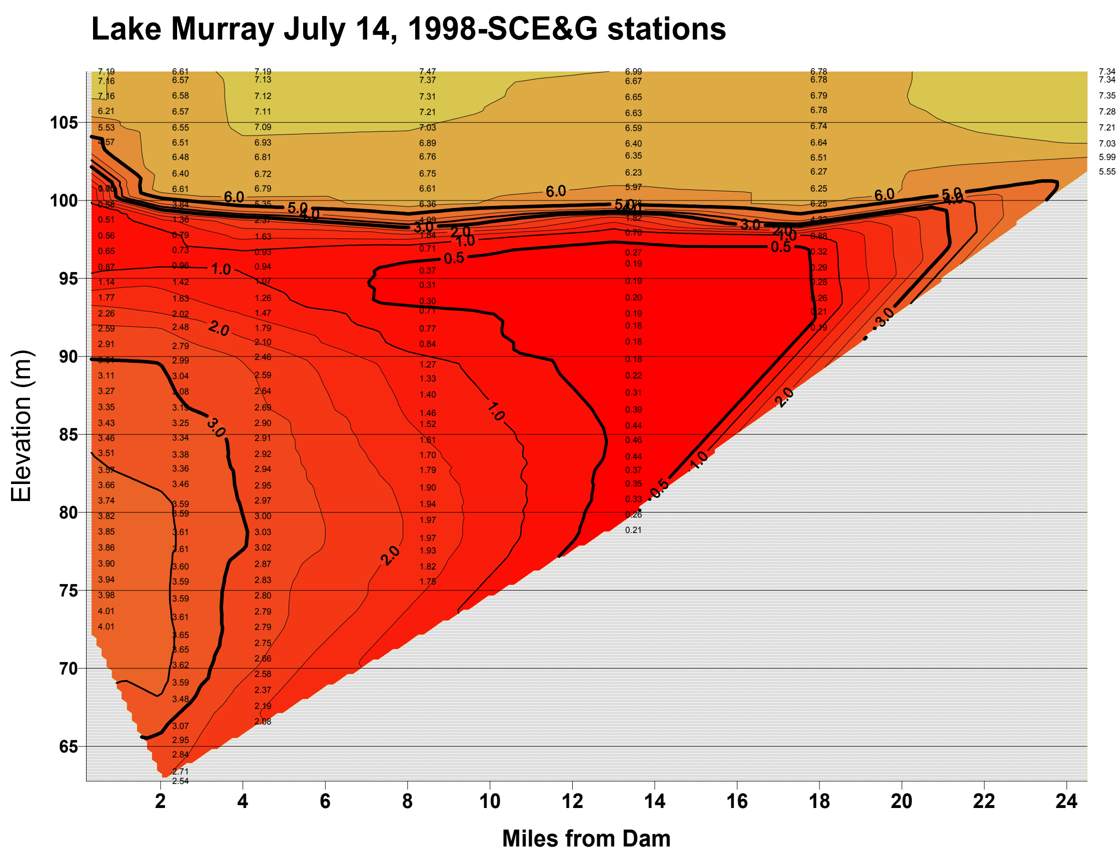


Figure 26: Longitudinal Contour Plot of DO in Lake Murray for 1998



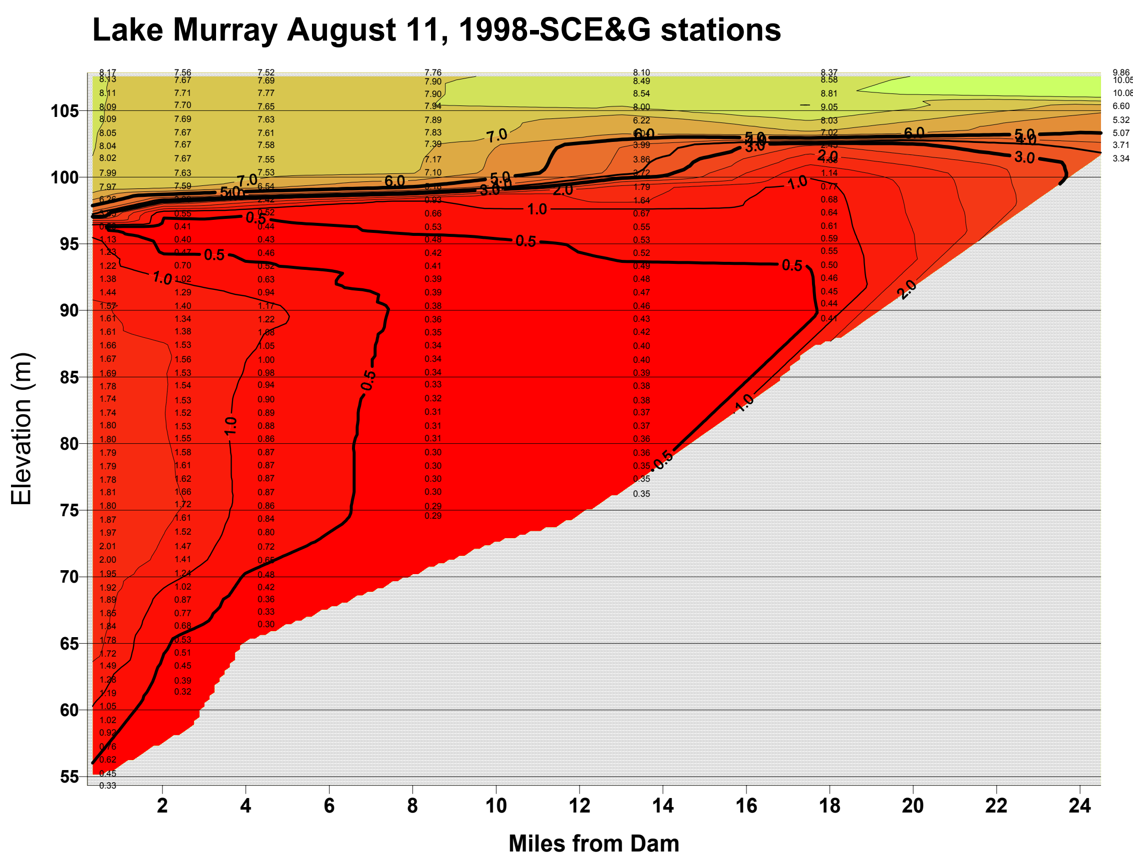
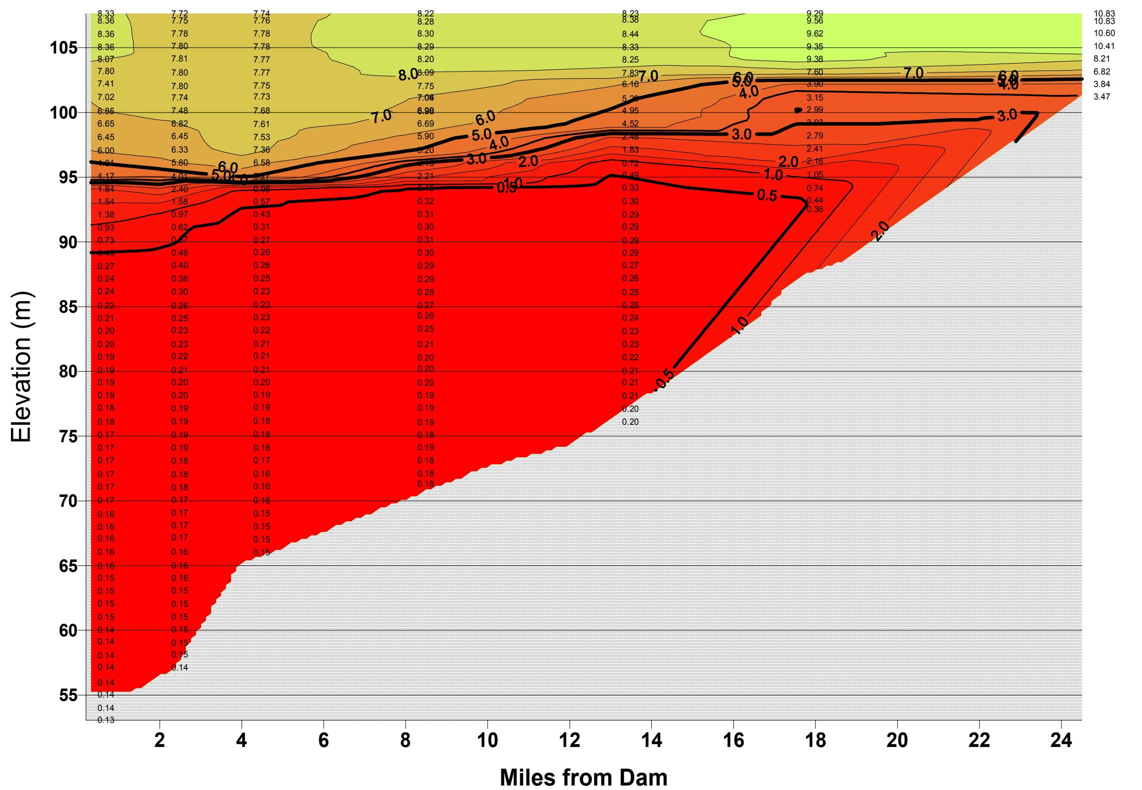


Figure 26: Longitudinal Contour Plot of DO in Lake Murray for 1998 (continued)

Lake Murray September 17, 1998-SCE&G stations



Lake Murray October 14-15, 1998 - SCE&G stations

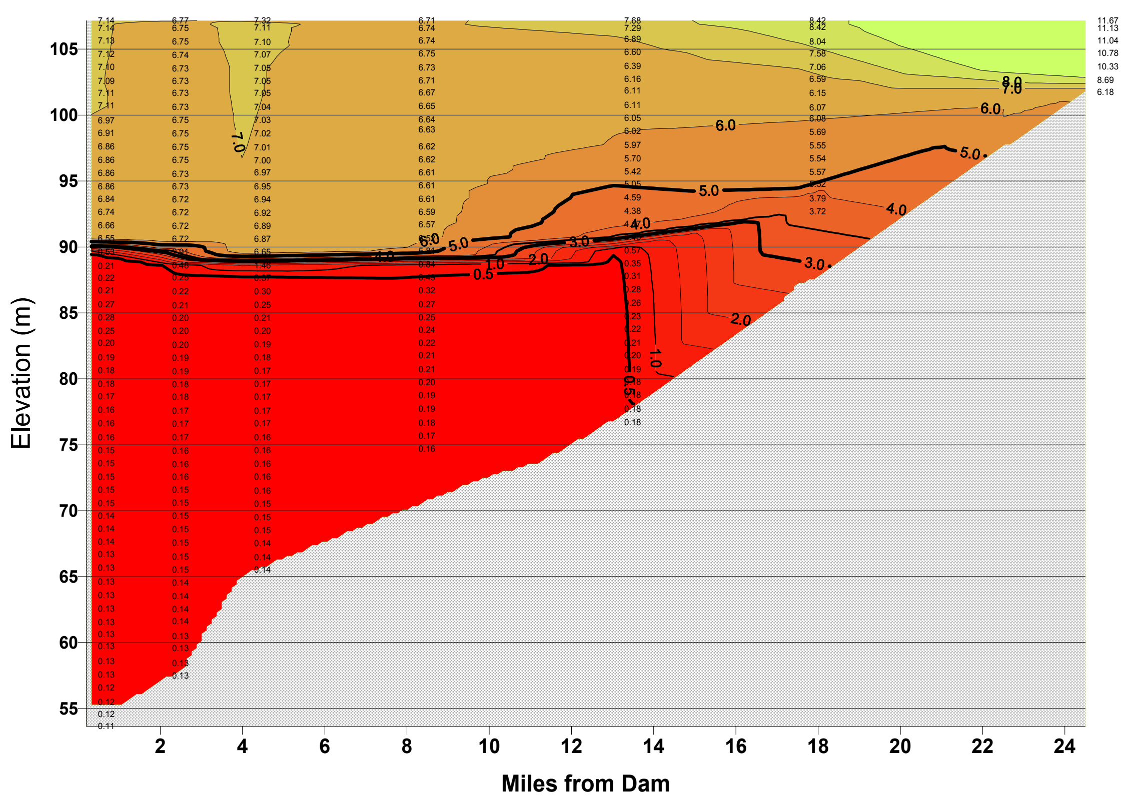
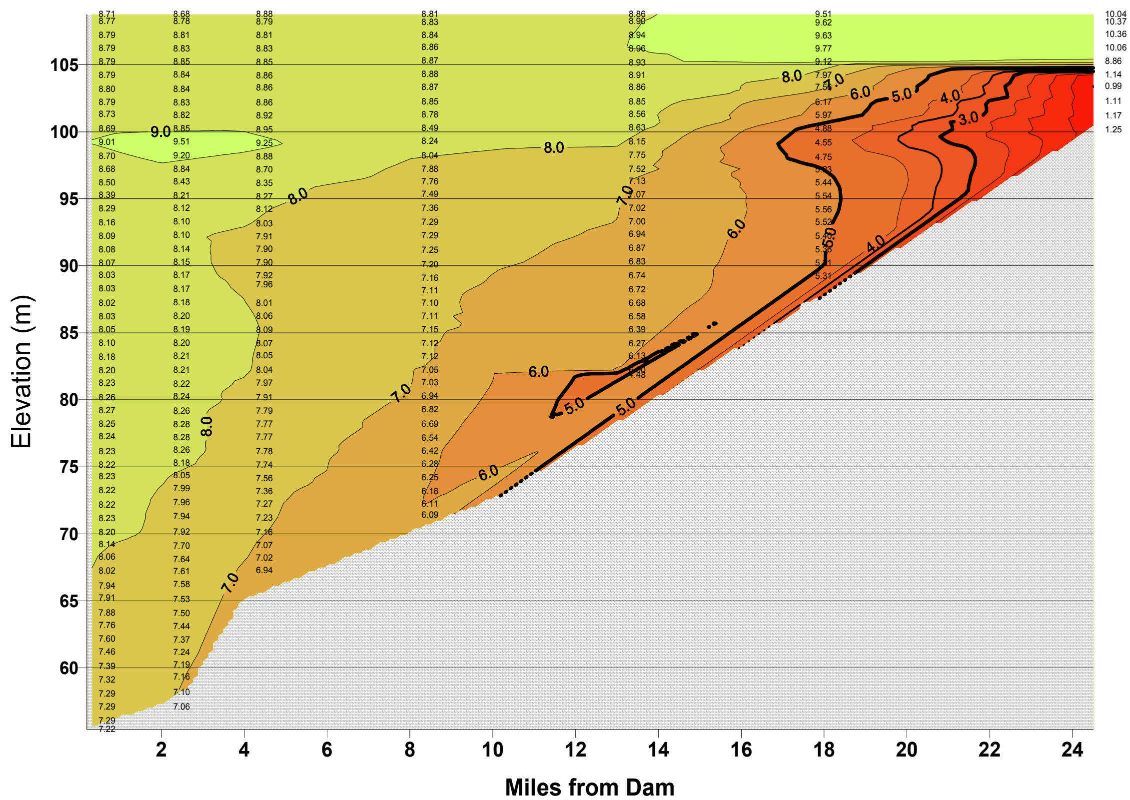


Figure 26: Longitudinal Contour Plot of DO in Lake Murray for 1998 (continued)

Lake Murray May 27, 1999 - SCE&G stations



Lake Murray June 21, 1999 - SCE&G stations

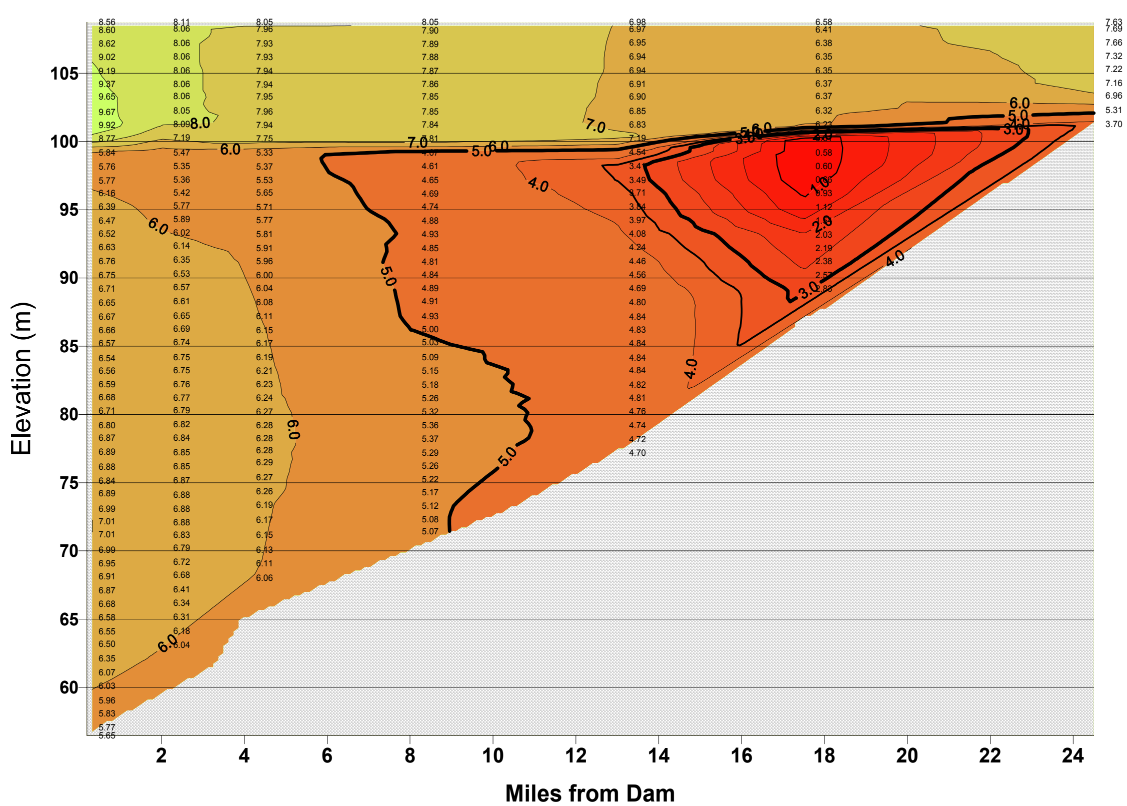
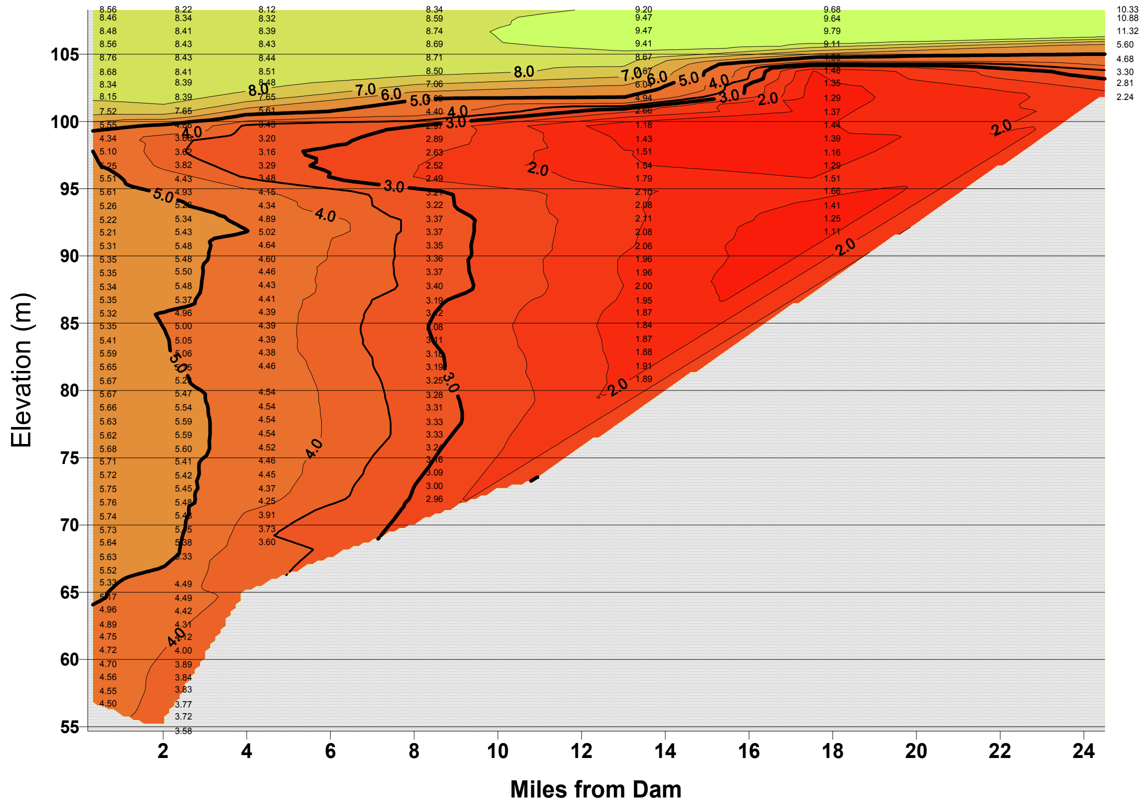


Figure 27: Longitudinal Contour Plot of DO in Lake Murray for 1999

Lake Murray July 21, 1999 - SCE&G stations



Lake Murray August 5, 1999 - SCE&G stations

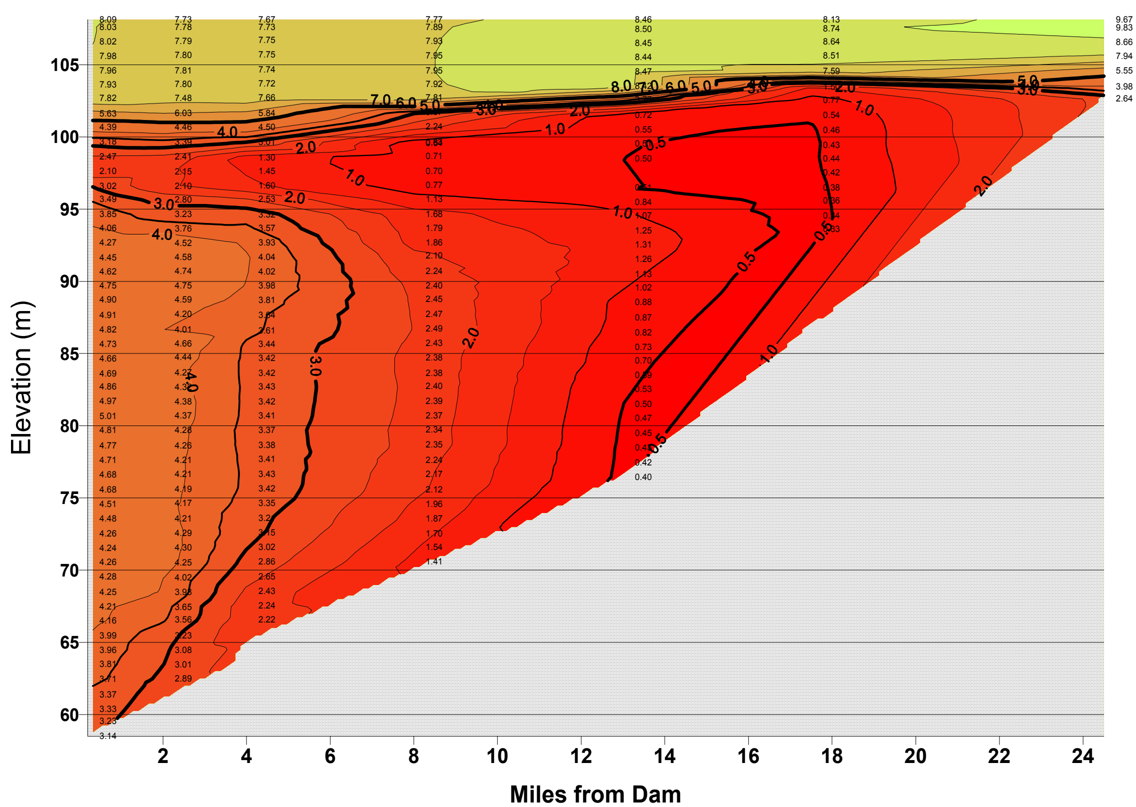
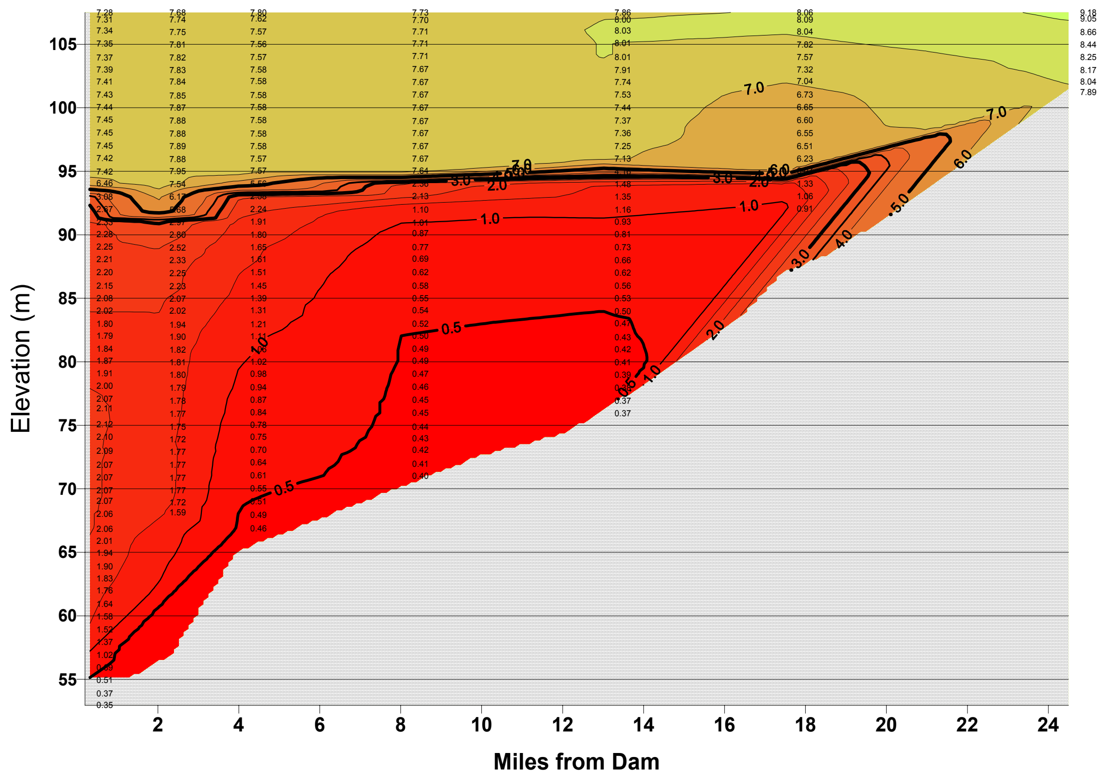


Figure 27: Longitudinal Contour Plot of DO in Lake Murray for 1999 (continued)

Lake Murray September 23, 1999 - SCE&G stations



Lake Murray October 26, 1999 - SCE&G stations

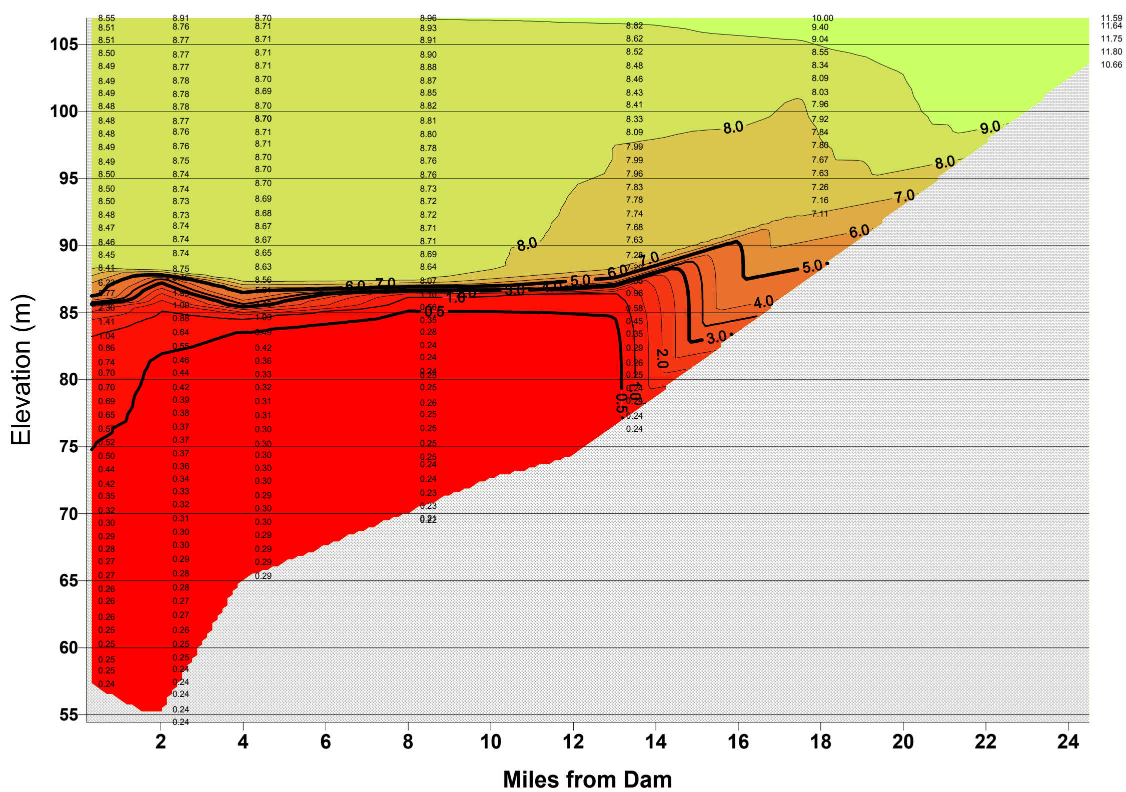
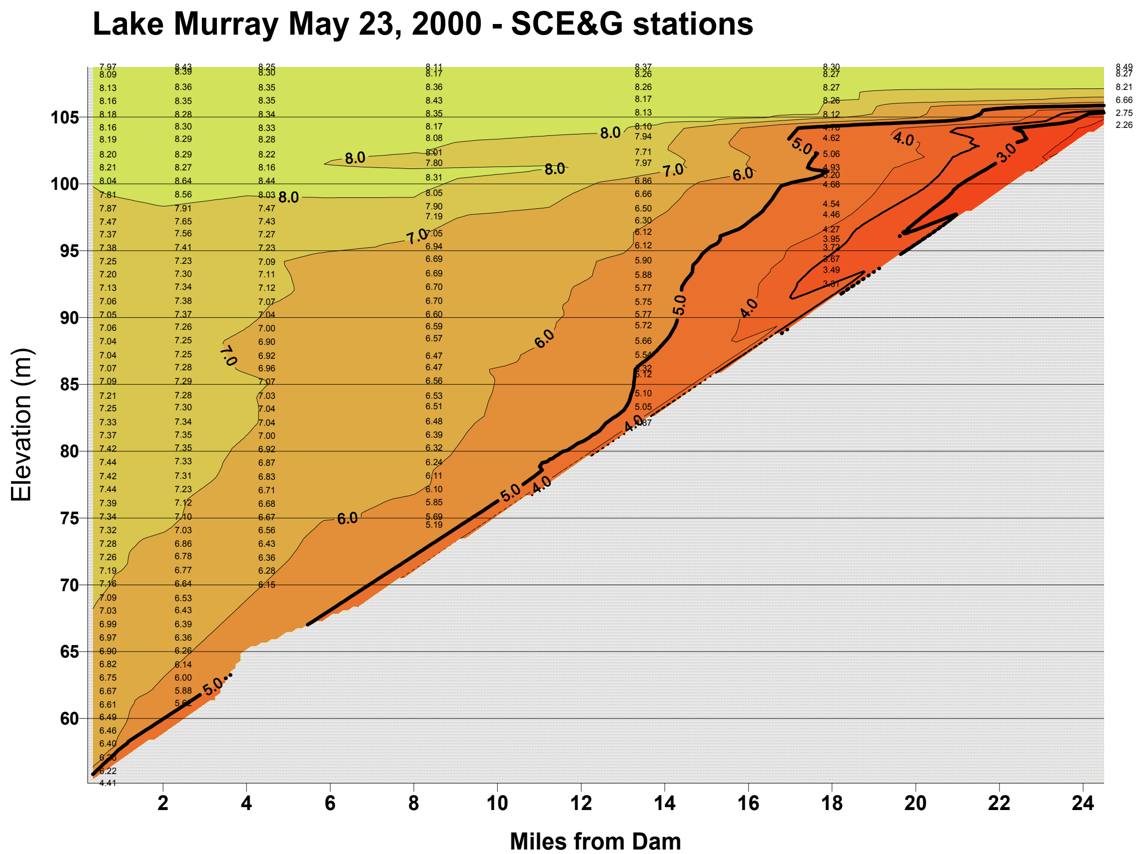


Figure 27: Longitudinal Contour Plot of DO in Lake Murray for 1999 (continued)



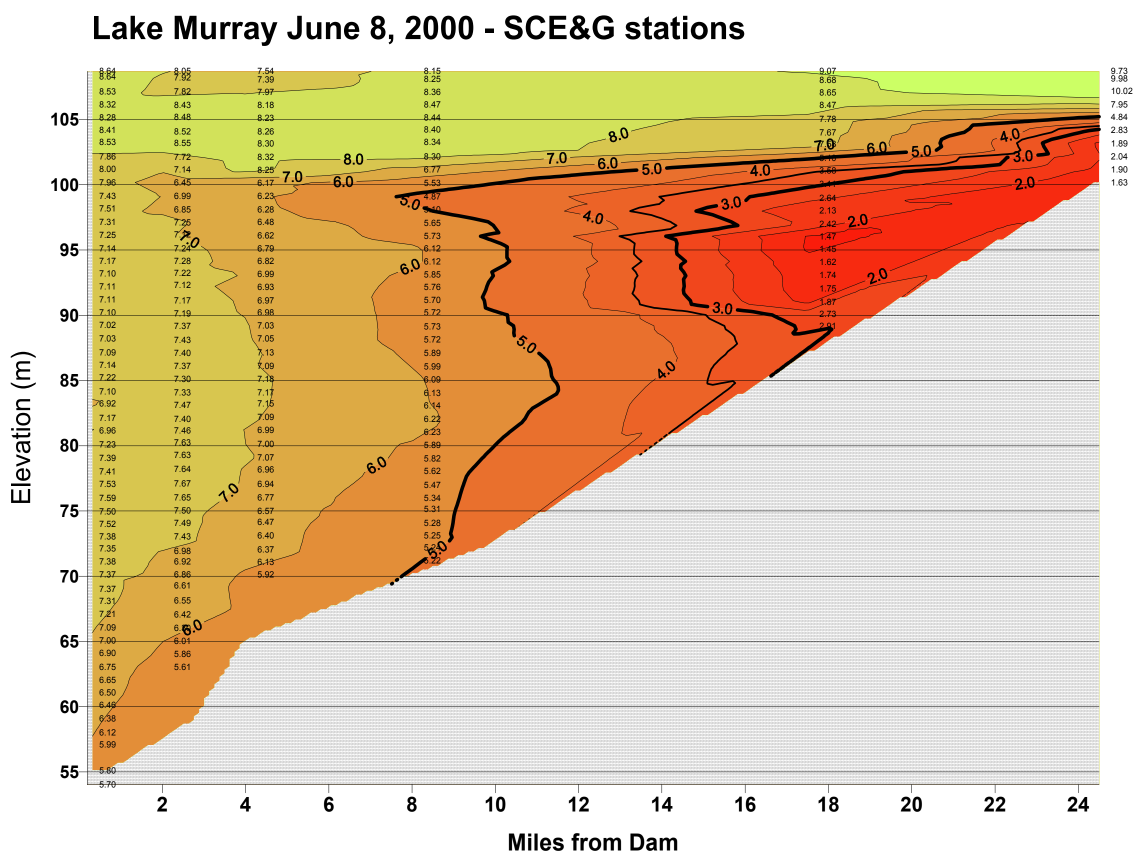
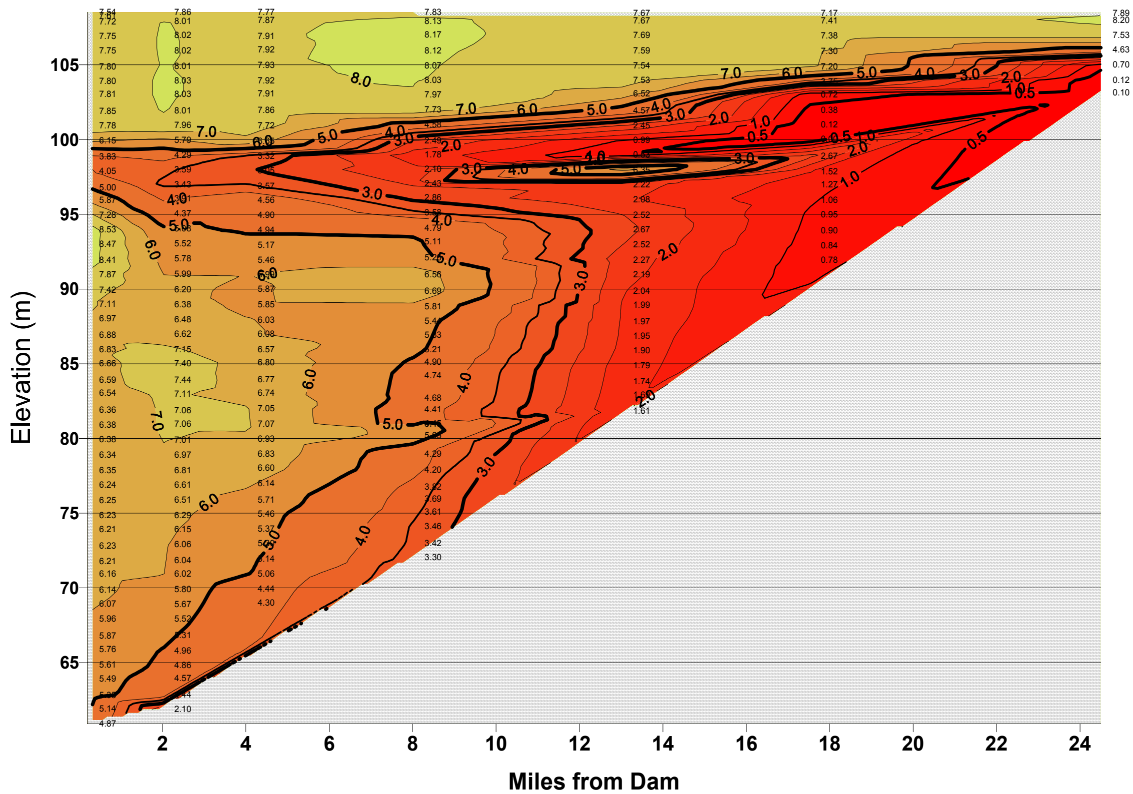


Figure 28: Longitudinal Contour Plot of DO in Lake Murray for 2000

Lake Murray July 10-12, 2000 - SCE&G stations



Lake Murray August 8-9, 2000 - SCE&G stations

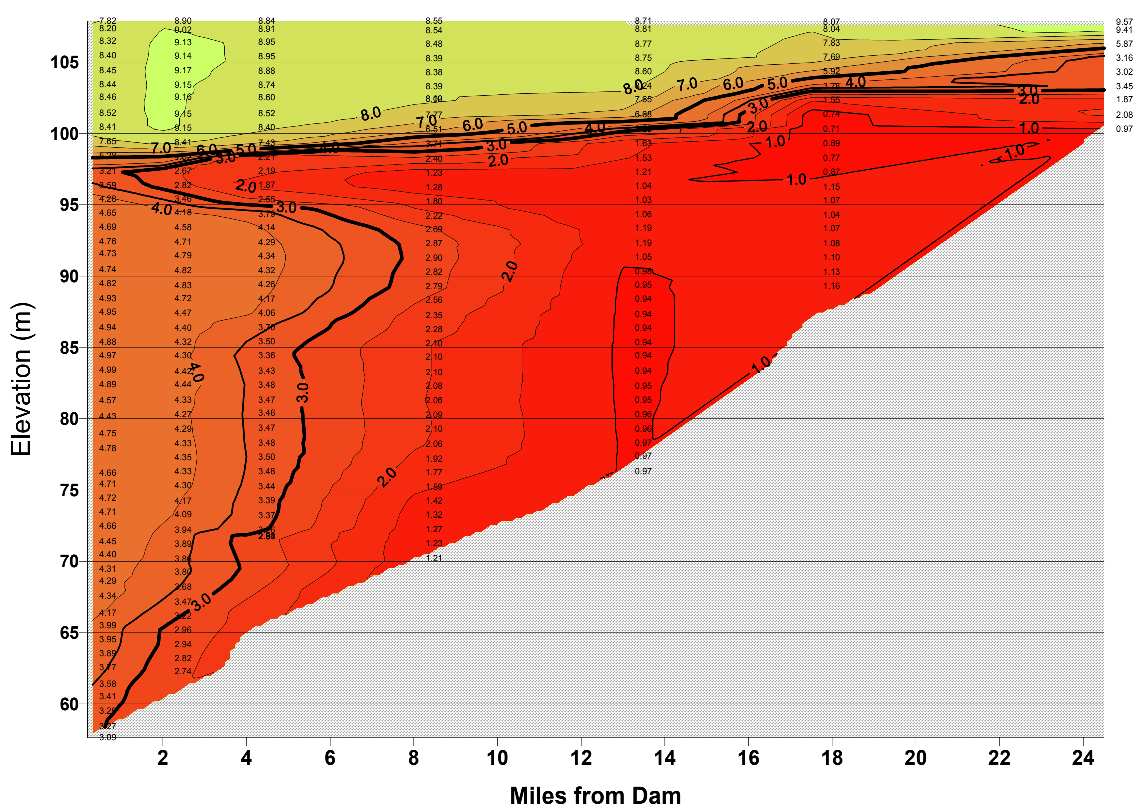
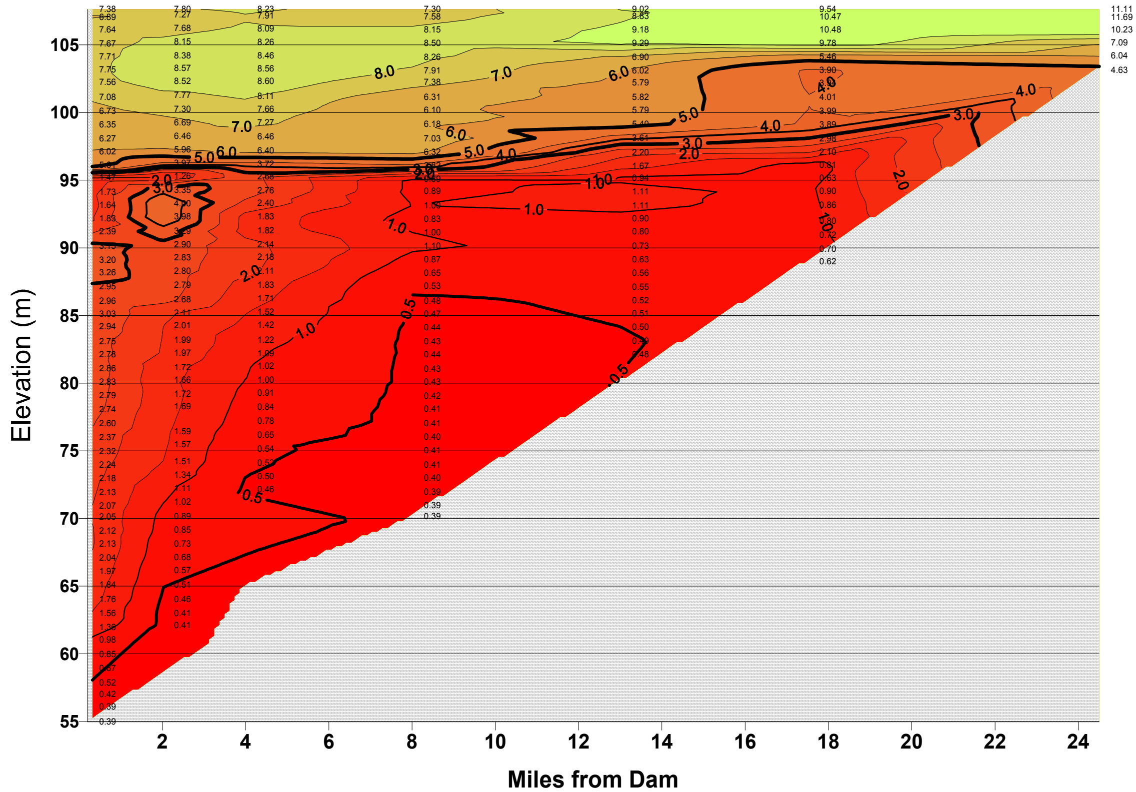


Figure 28: Longitudinal Contour Plot of DO in Lake Murray for 2000 (continued)

Lake Murray September 13-14, 2000 - SCE&G stations



Lake Murray October 12, 2000 - SCE&G stations

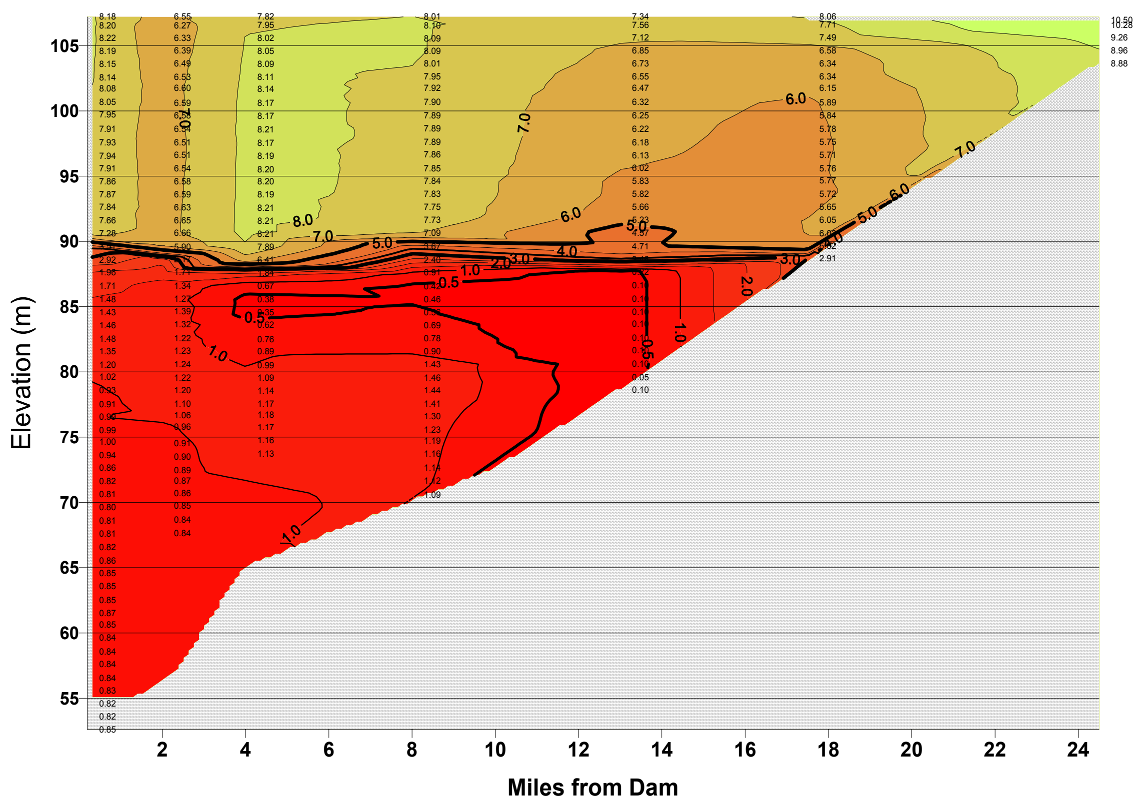
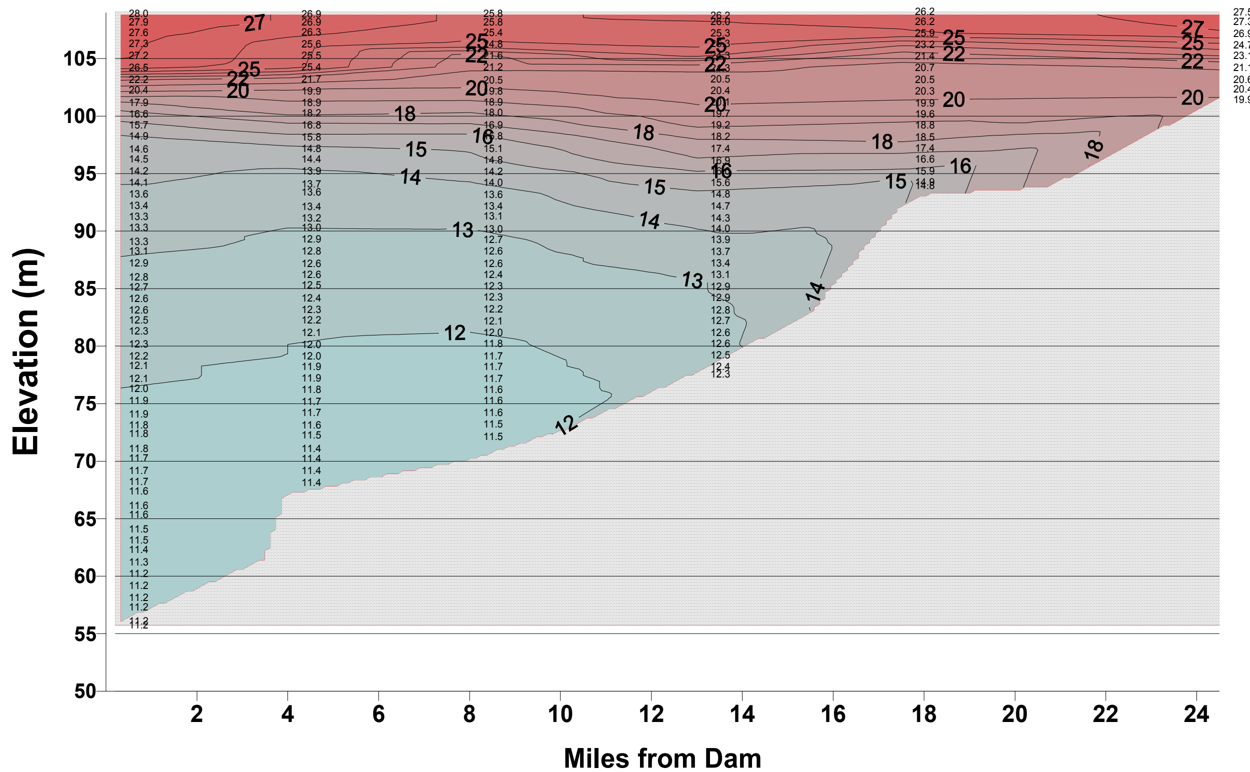


Figure 28: Longitudinal Contour Plot of DO in Lake Murray for 2000 (continued)

Lake Murray Temperature May 22-23, 1996 - SCE&G stations



Lake Murray Temperature June 24-25, 1996 - SCE&G stations

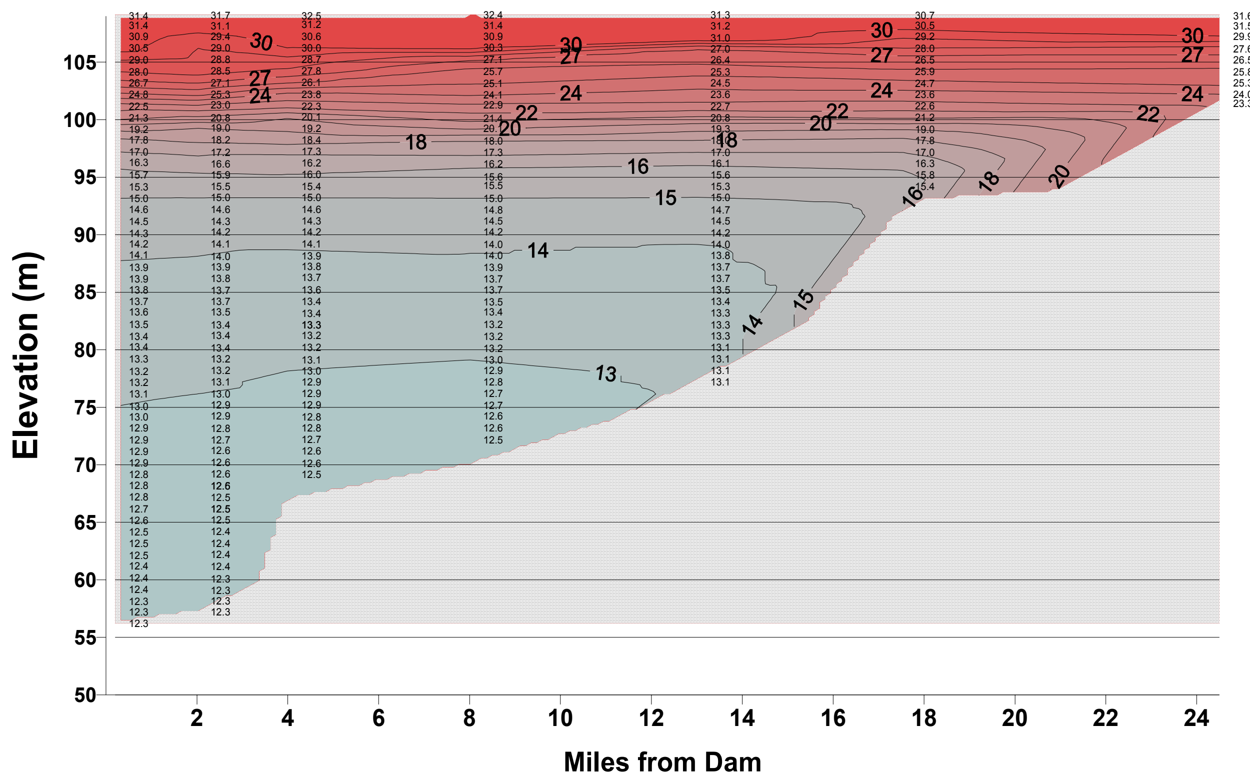
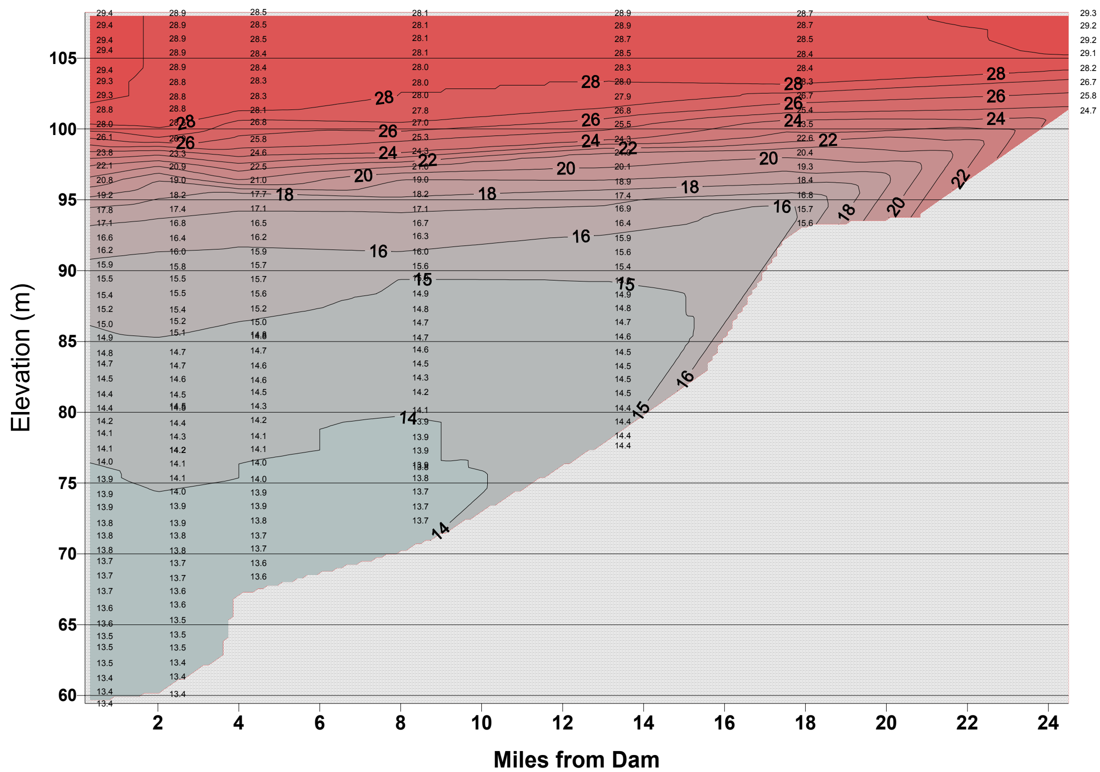


Figure 29: Longitudinal Contour Plots of Temperature for 1996

Lake Murray July 25-26, 1996 - SCE&G stations



Lake Murray August 13-14, 1996 - SCE&G stations

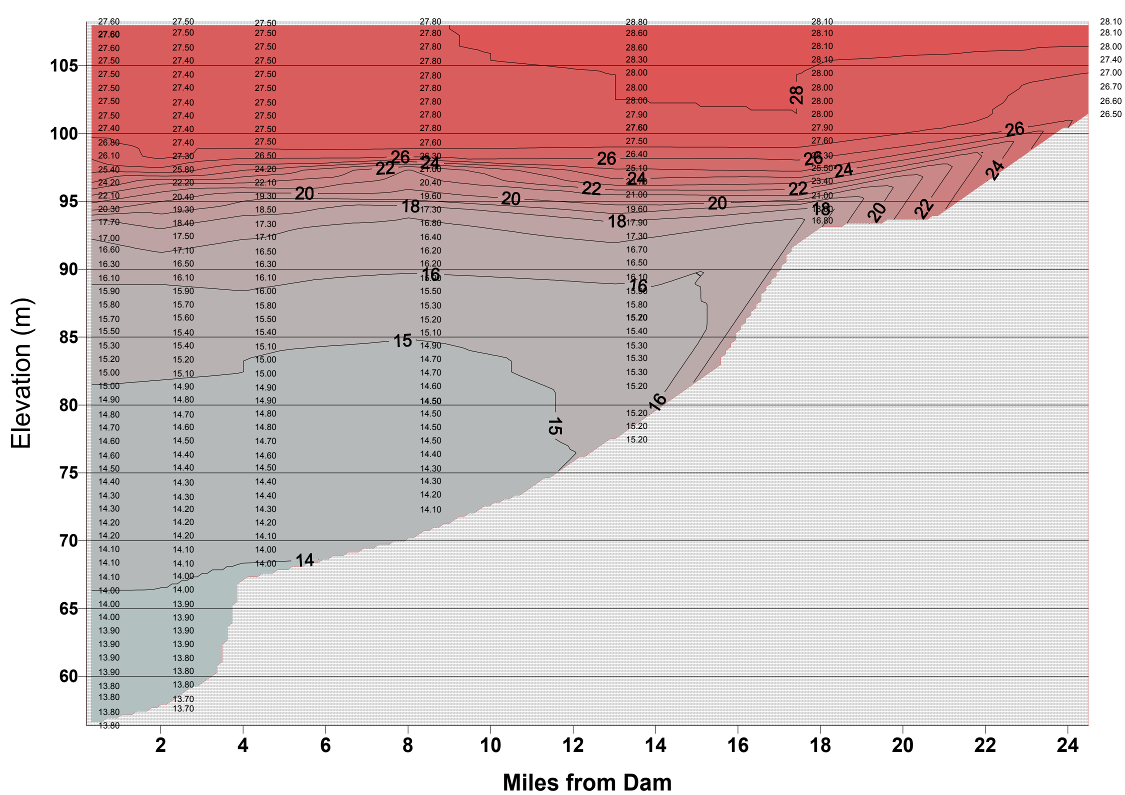
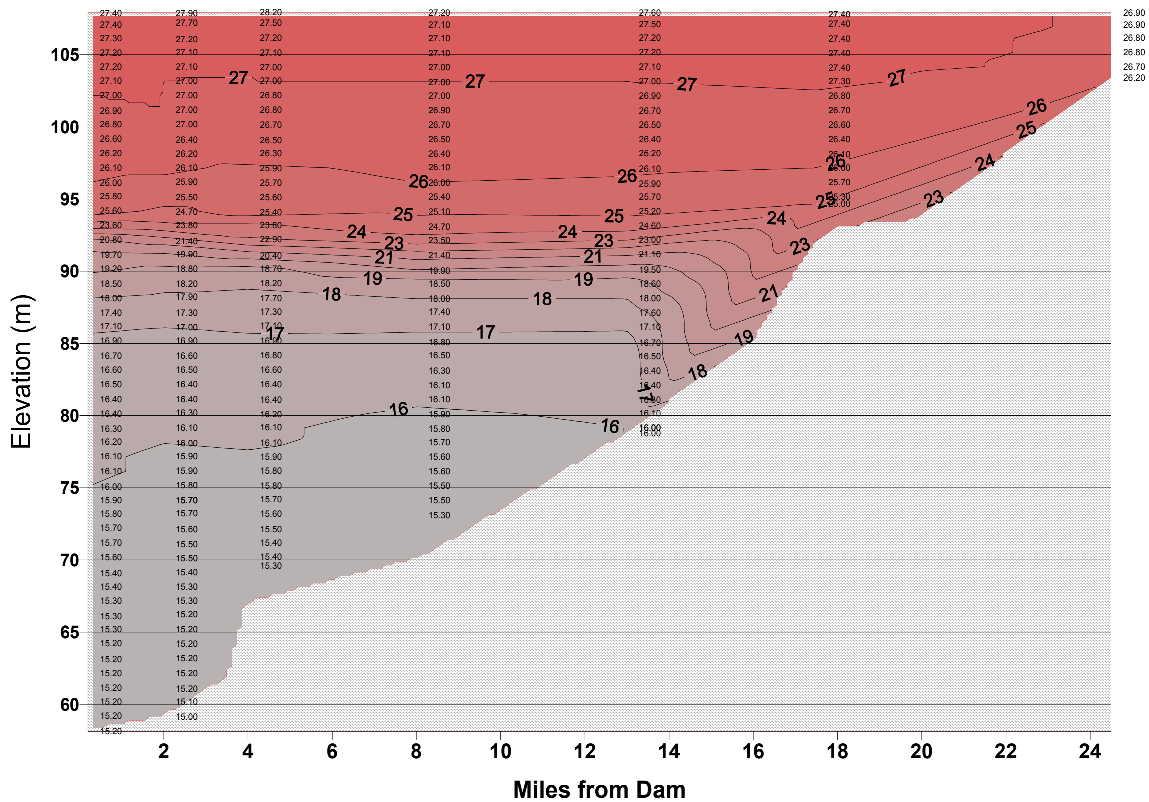


Figure 29: Longitudinal Contour Plots of Temperature for 1996 (continued)

Lake Murray September 11-13, 1996 - SCE&G stations



Lake Murray October 9-10, 1996 - SCE&G stations

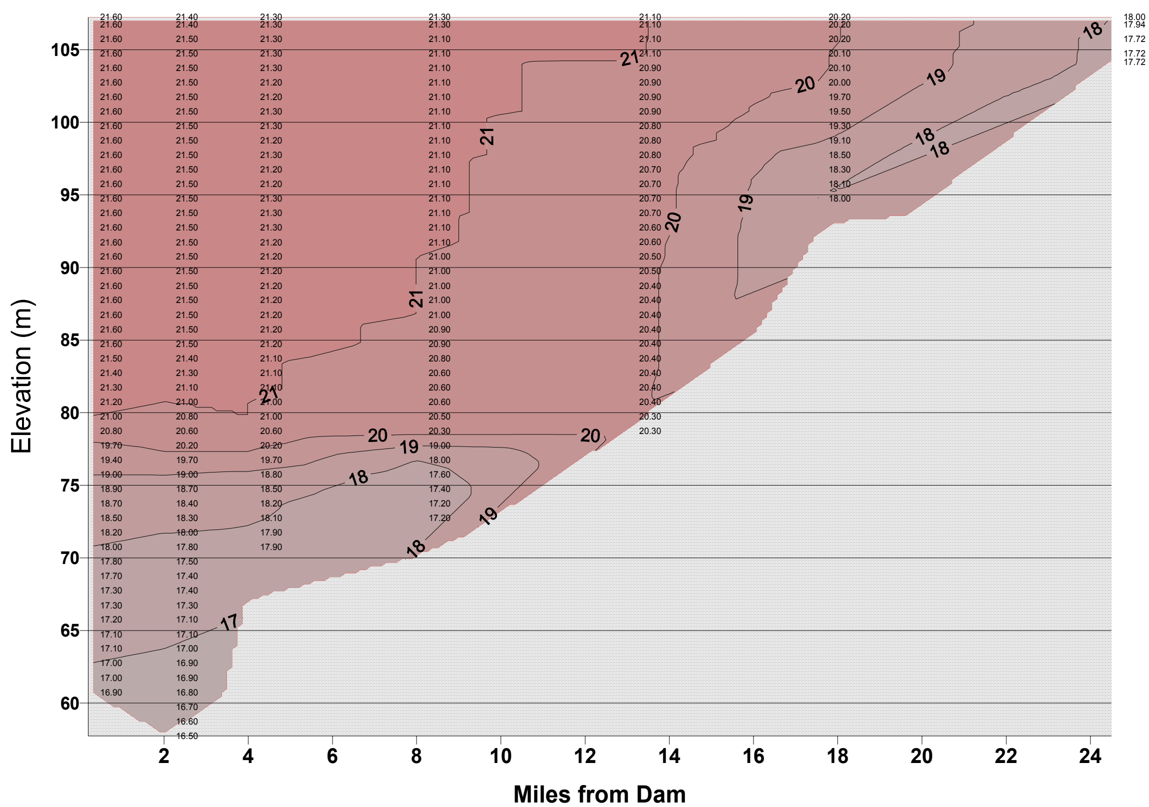


Figure 29: Longitudinal Contour Plots of Temperature for 1996 (continued)

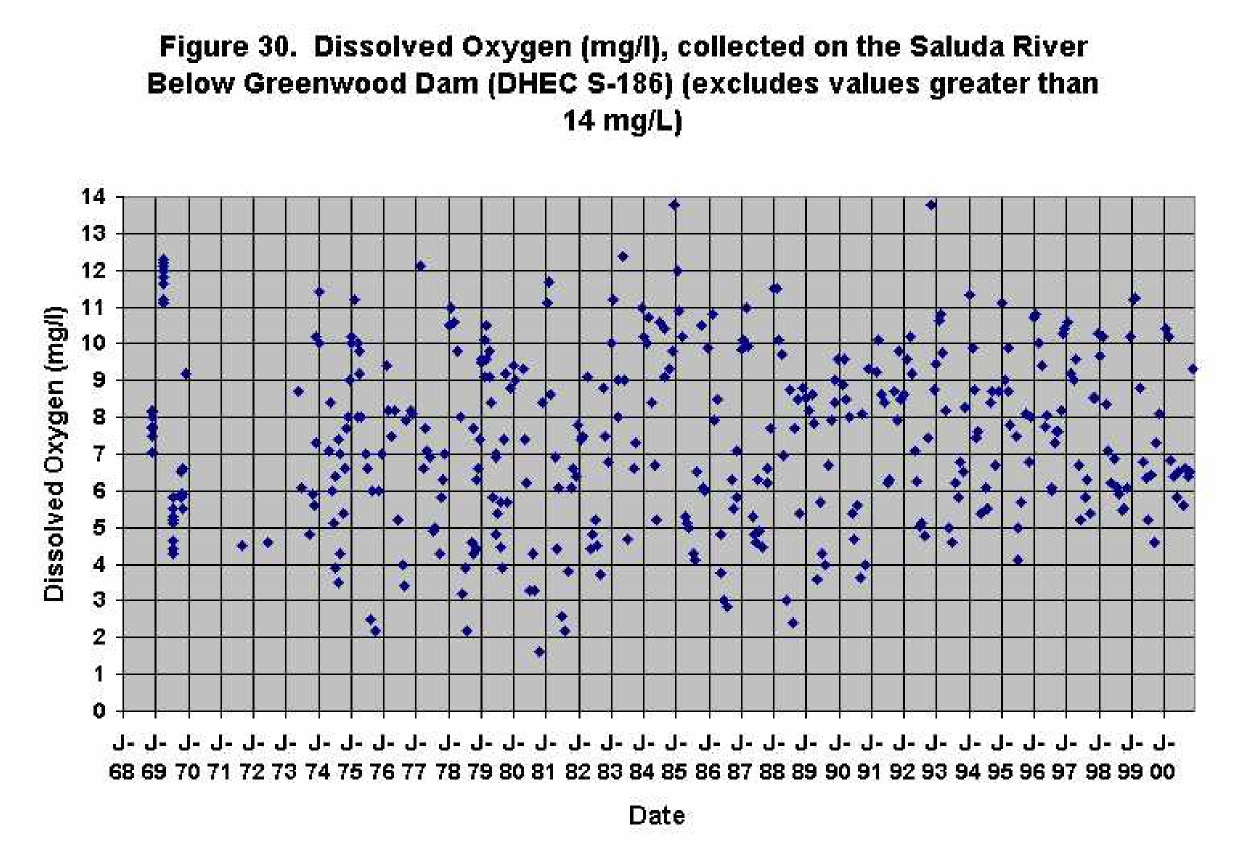


Figure 30. Dissolved Oxygen (mg/l), collected on the Saluda River Below Greenwood Dam (DHEC S-186) (excludes values greater than 14 mg/L)
Dissolved Oxygen (mg/l)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
J-68
J-69
J-70
J-71
J-72
J-73
J-74
J-75
J-76
J-77
J-78
J-79
J-80
J-81
J-82
J-83
J-84
J-85
J-86
J-87
J-88
J-89
J-90
J-91
J-92
J-93
J-94
J-95
J-96
J-97
J-98
J-99
J-00
Date

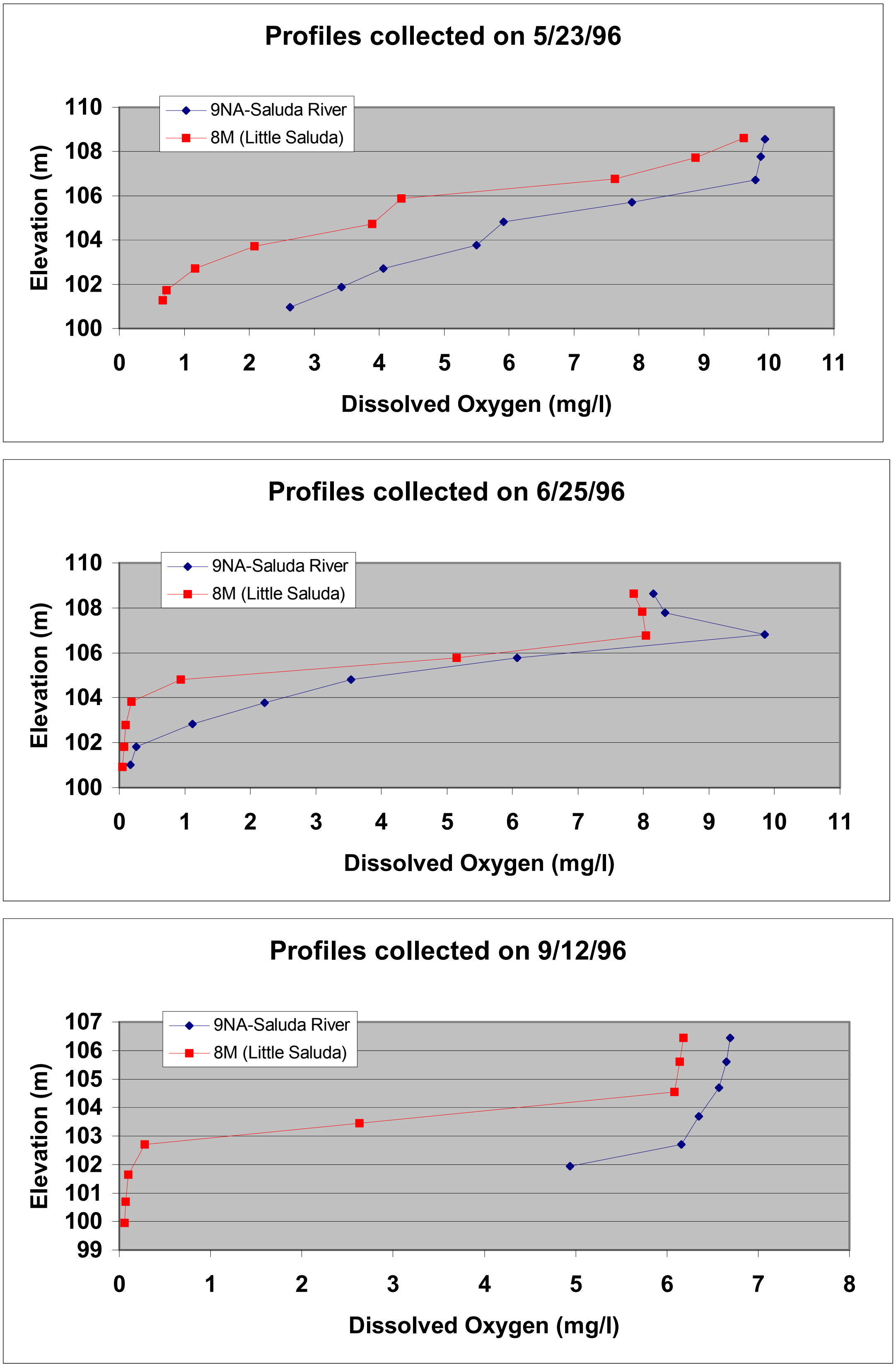
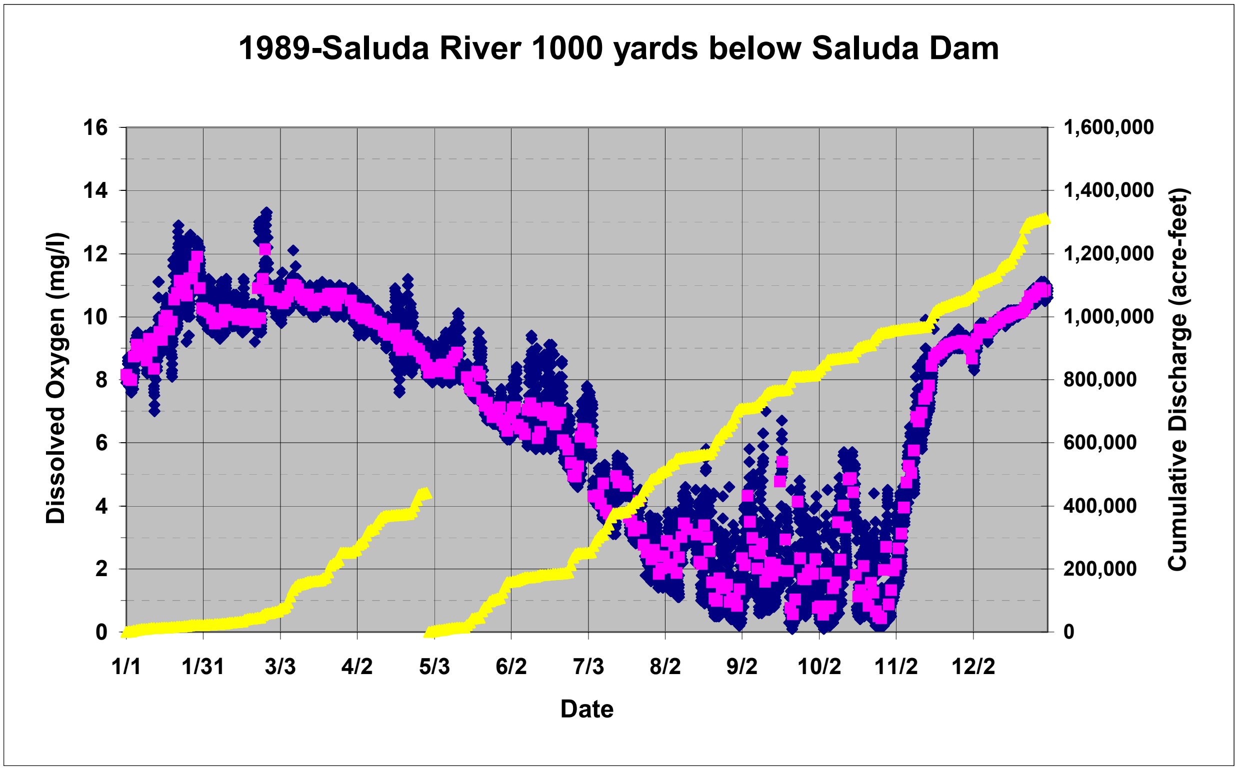


Figure 31: DO Tends to be Lower in the Little Saluda Embayment Than in the Main River



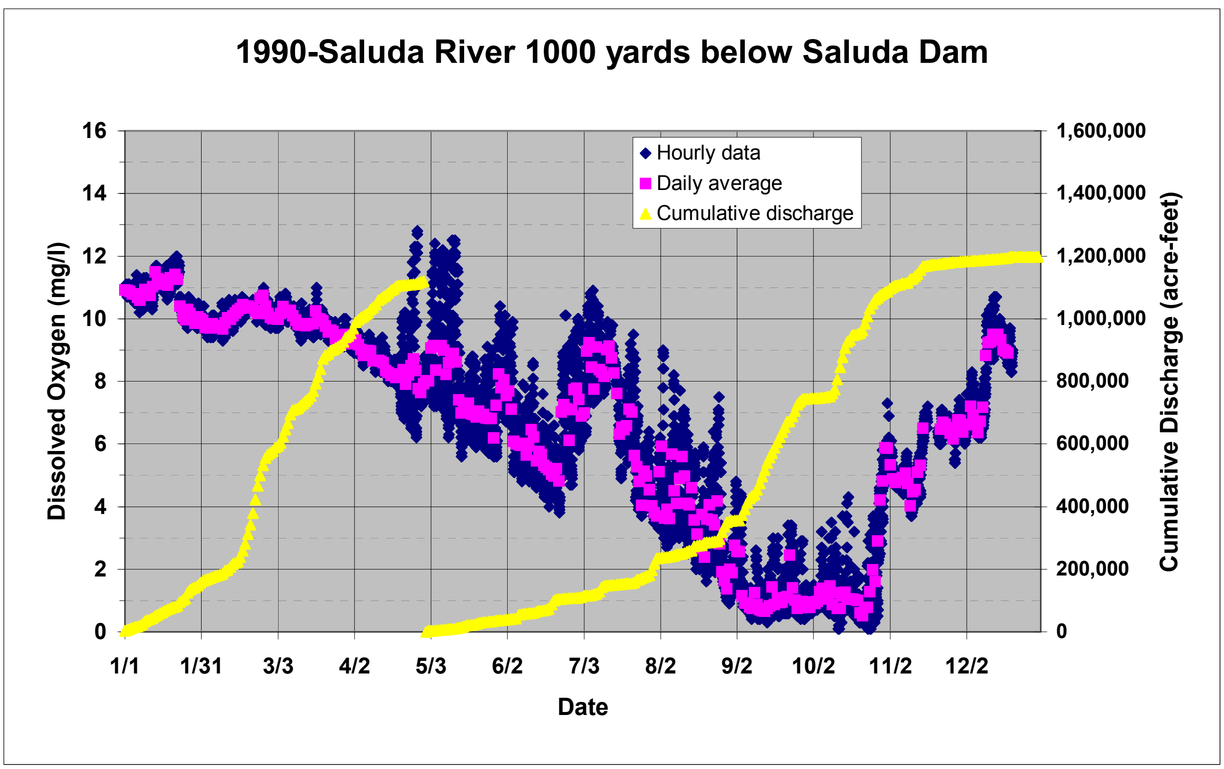
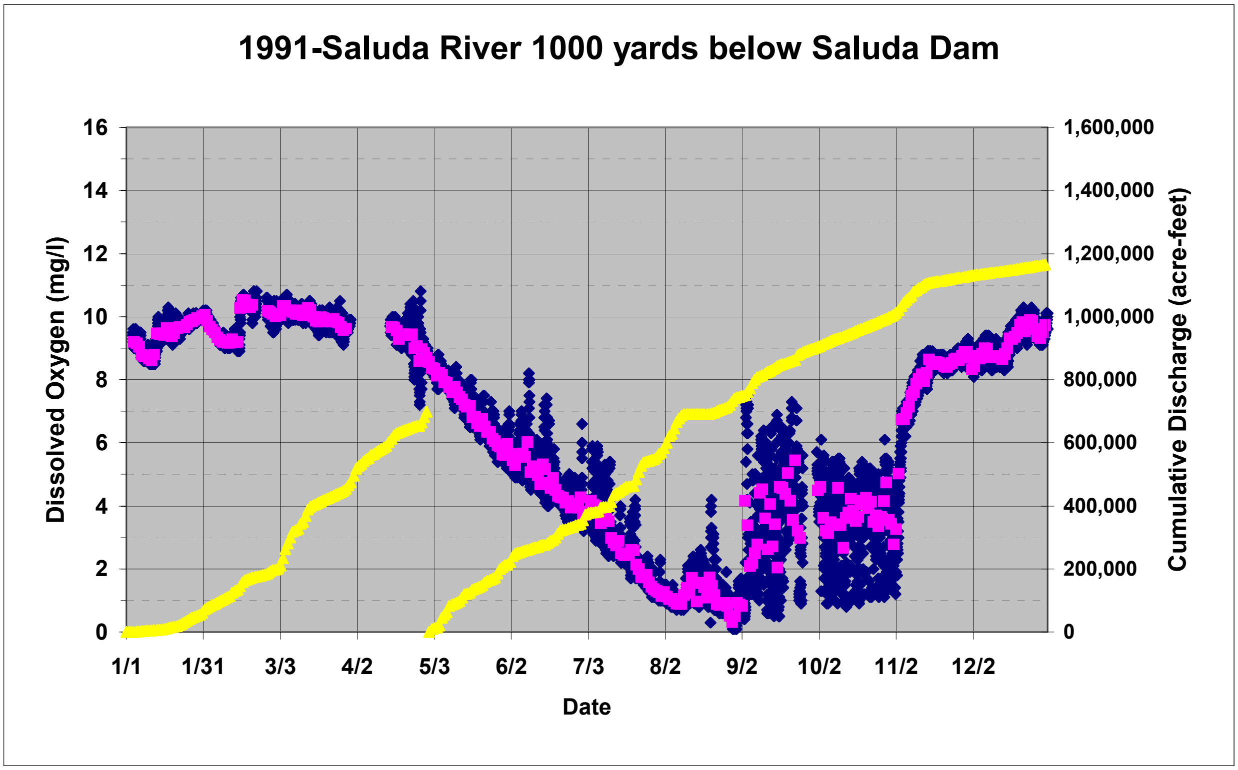


Figure 32: **DO in the Saluda Hydro Turbine Discharges for the Years 1989 Through 2000, Plotted with Cumulative Discharge from January 1 and May 1**



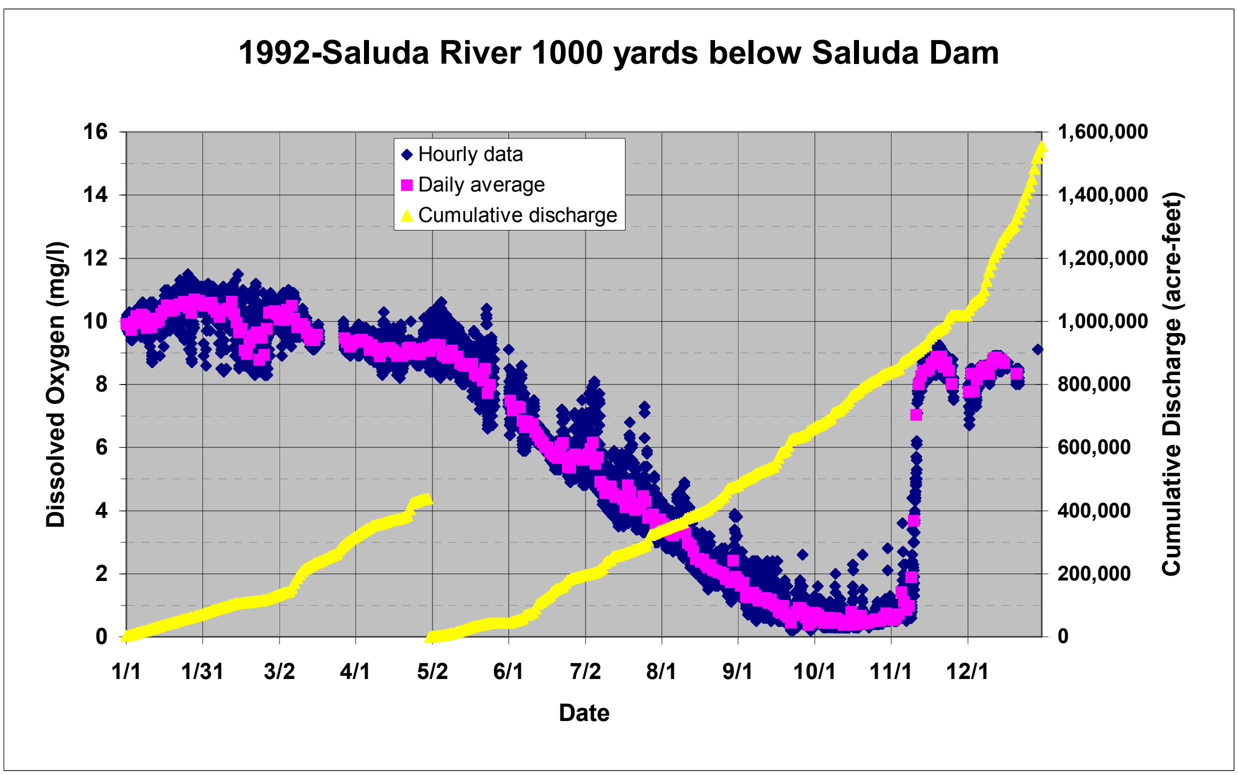
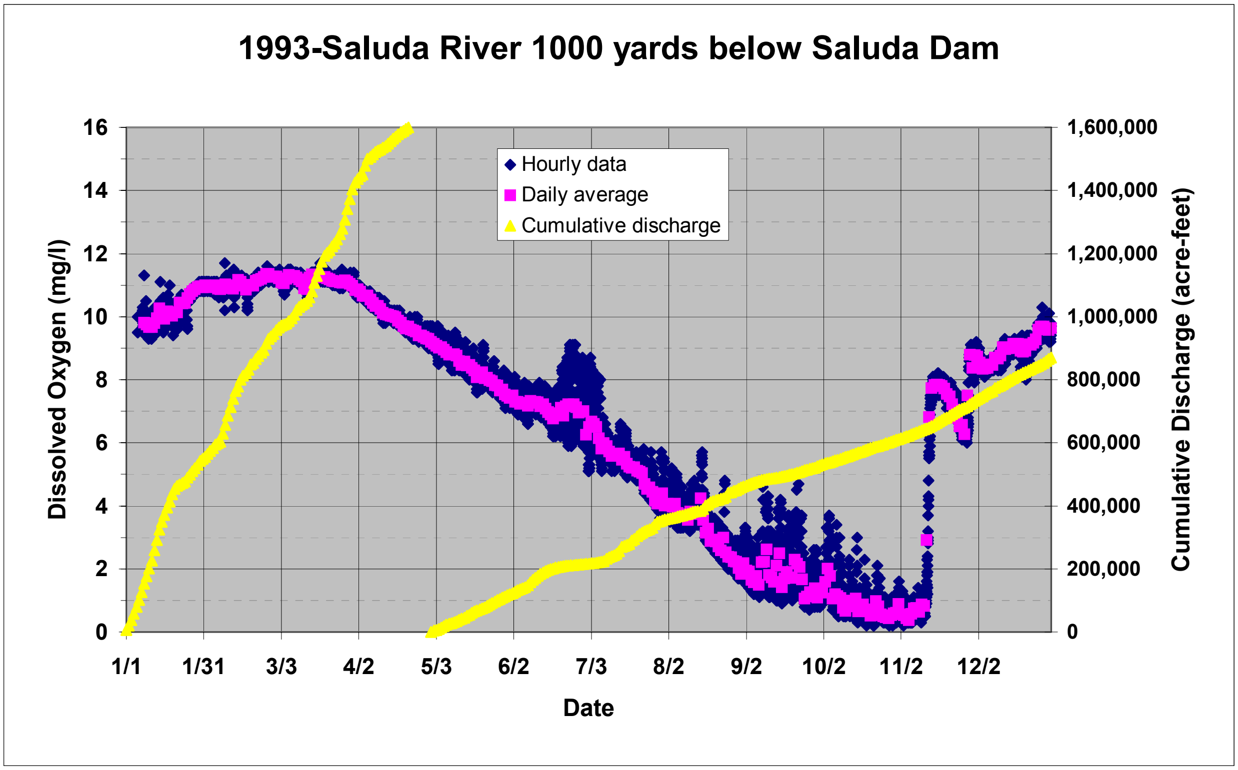


Figure 32: **DO in the Saluda Hydro Turbine Discharges for the Years 1989 Through 2000, Plotted with Cumulative Discharge from January 1 and May 1 (continued)**



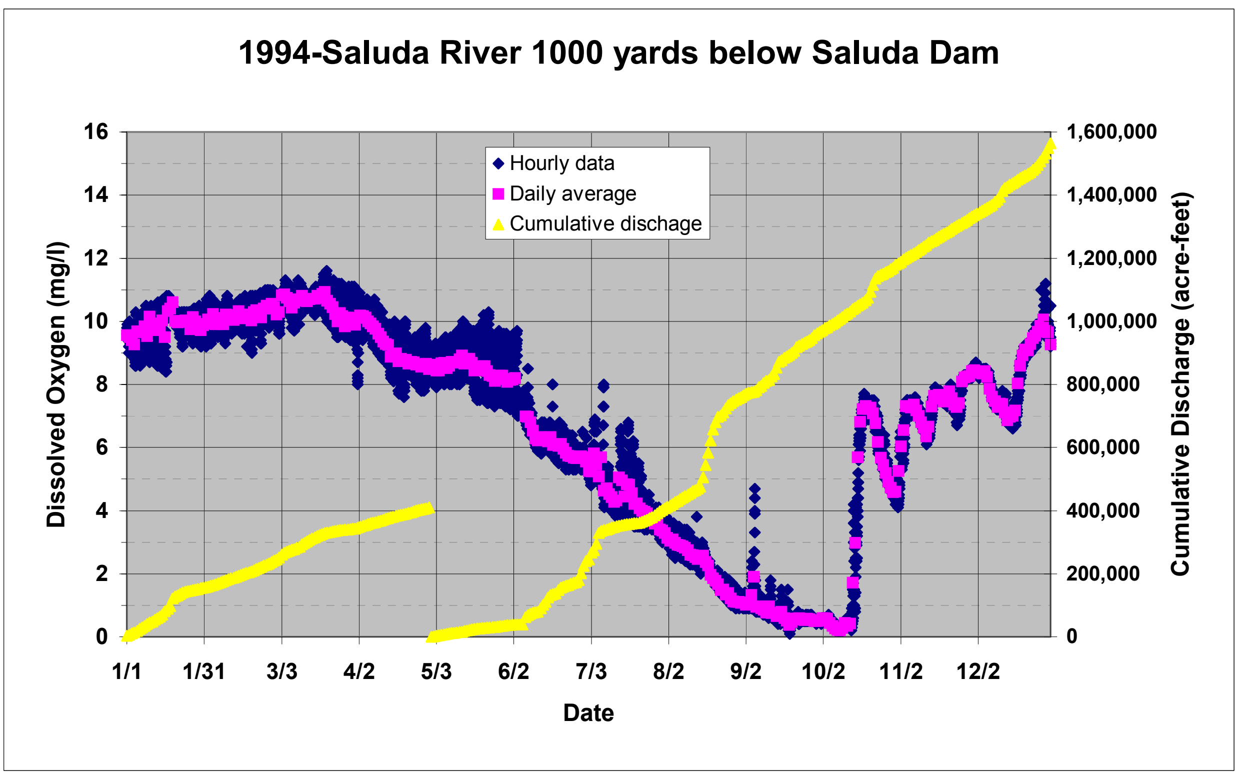
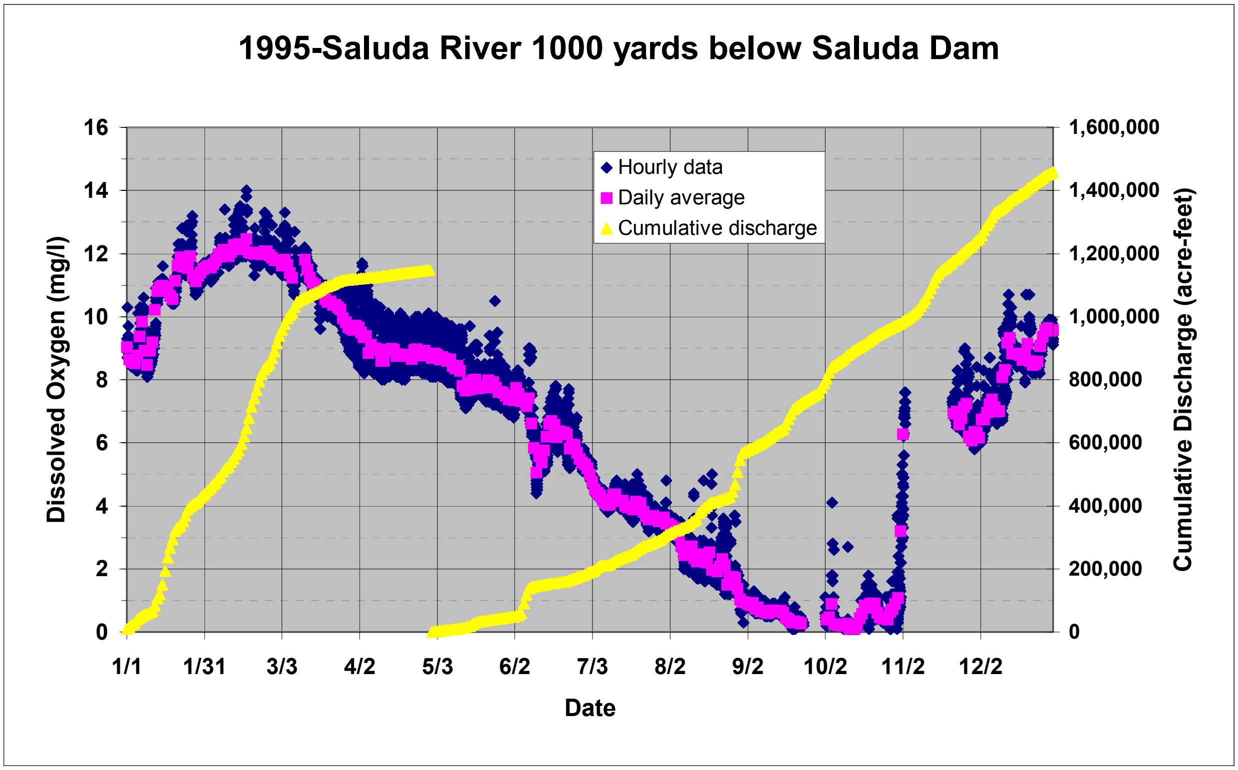


Figure 32: DO in the Saluda Hydro Turbine Discharges for the Years 1989 Through 2000, Plotted with Cumulative Discharge from January 1 and May 1 (continued)



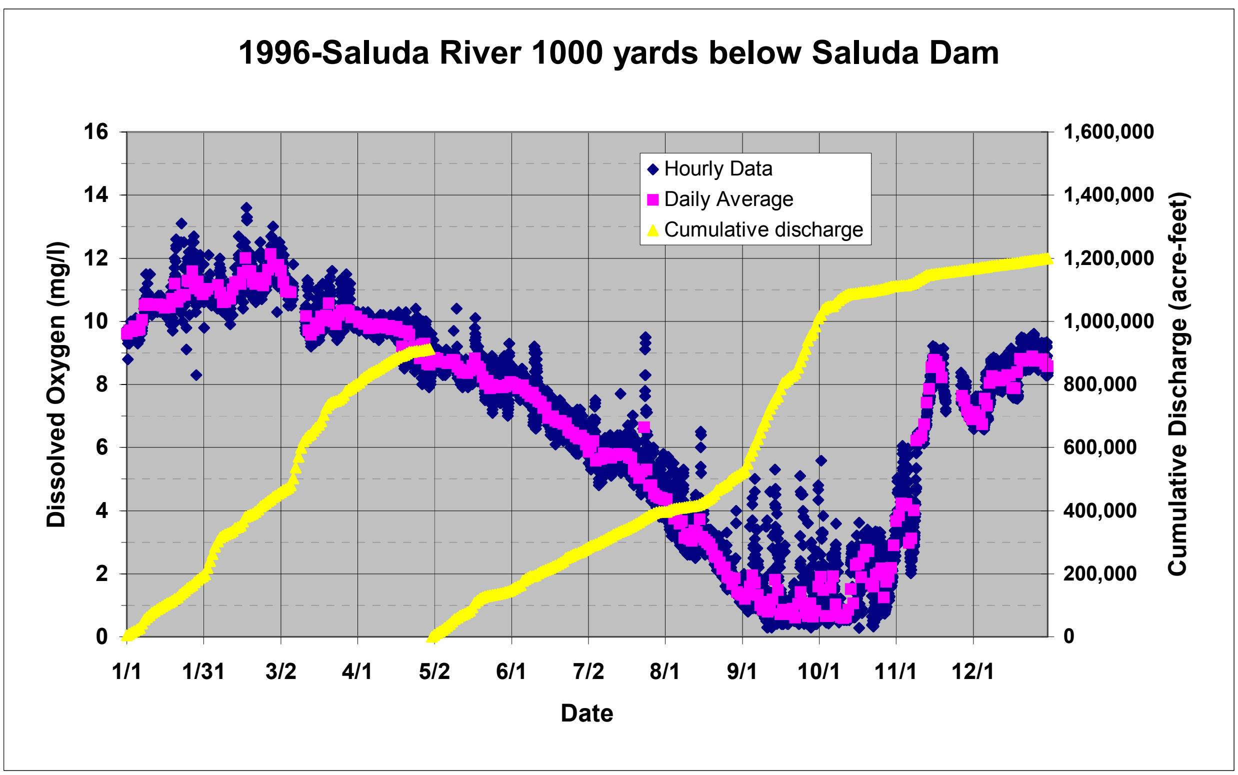
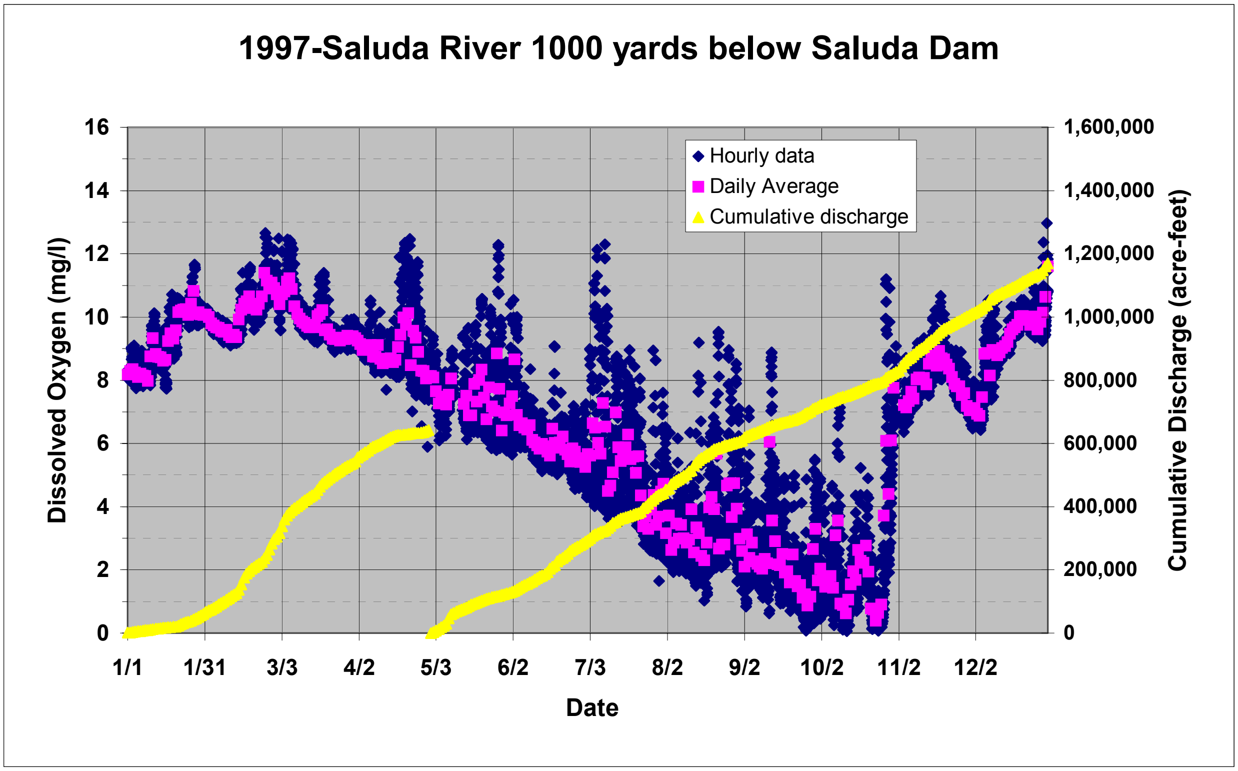


Figure 32: **DO in the Saluda Hydro Turbine Discharges for the Years 1989 Through 2000, Plotted with Cumulative Discharge from January 1 and May 1 (continued)**



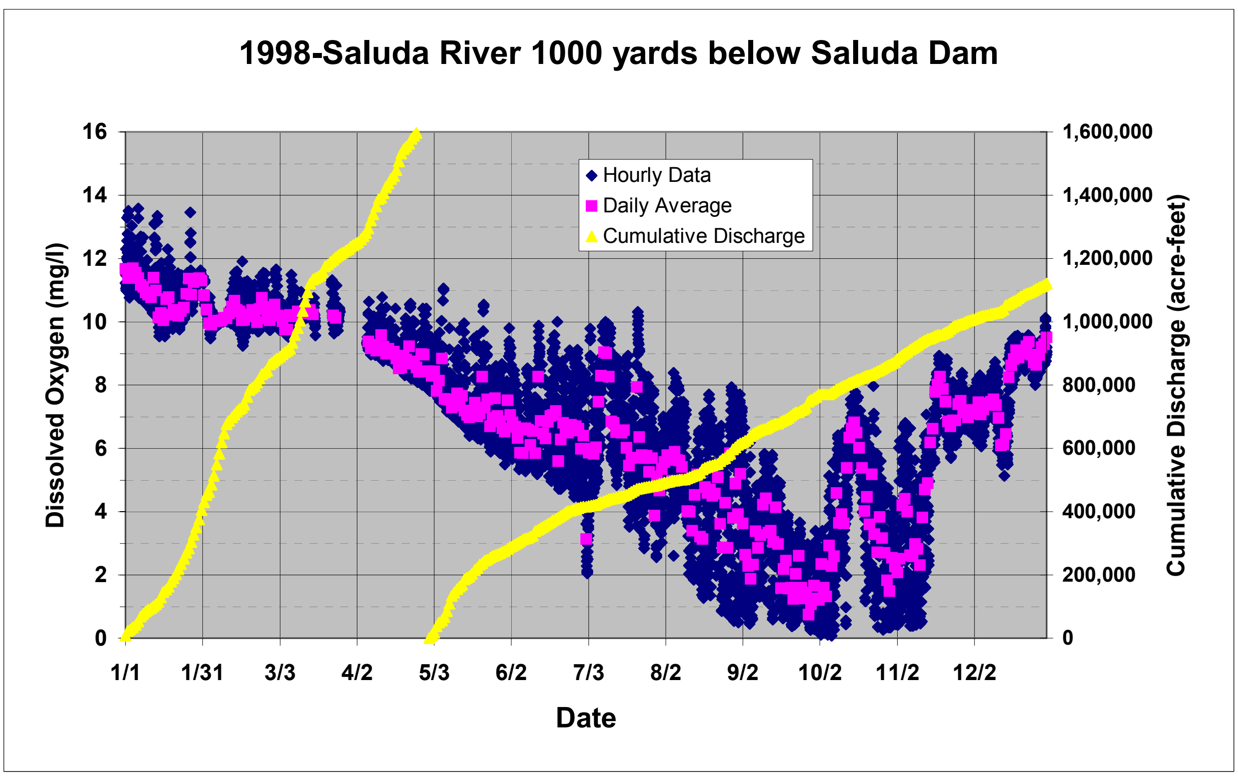
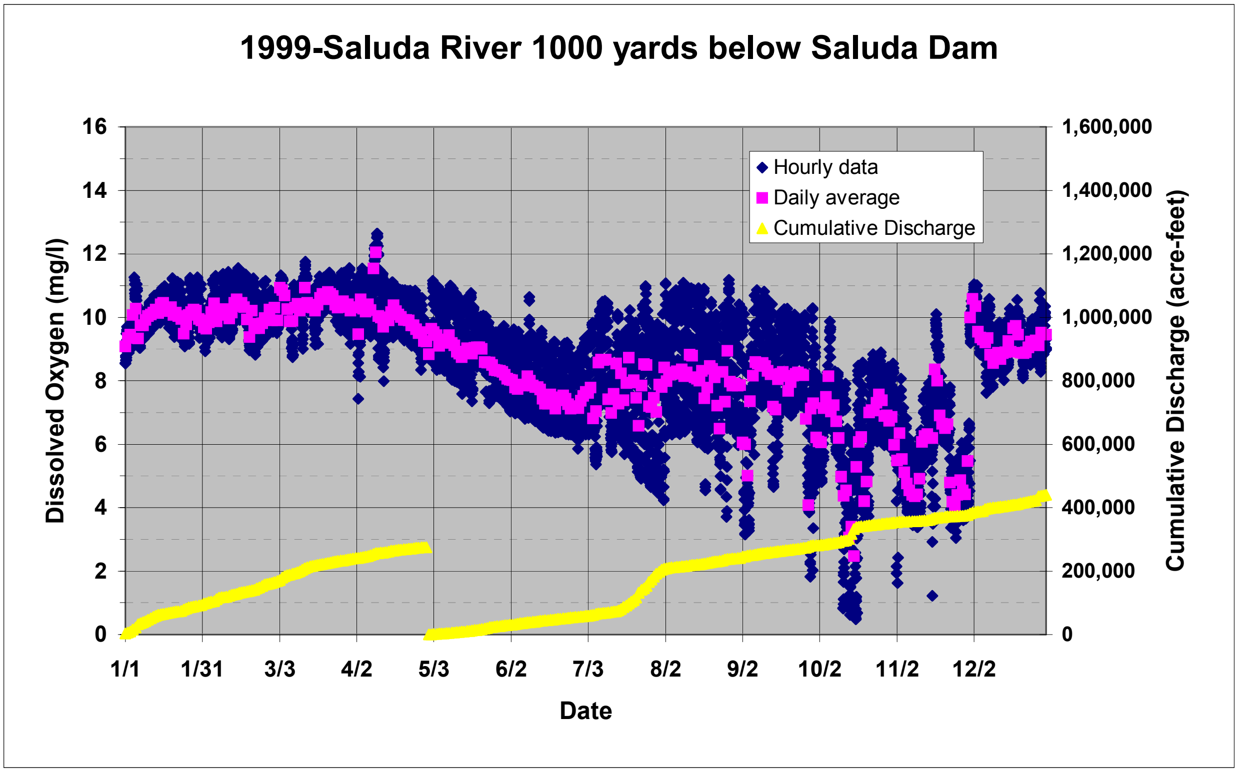


Figure 32: DO in the Saluda Hydro Turbine Discharges for the Years 1989 Through 2000, Plotted with Cumulative Discharge from January 1 and May 1 (continued)



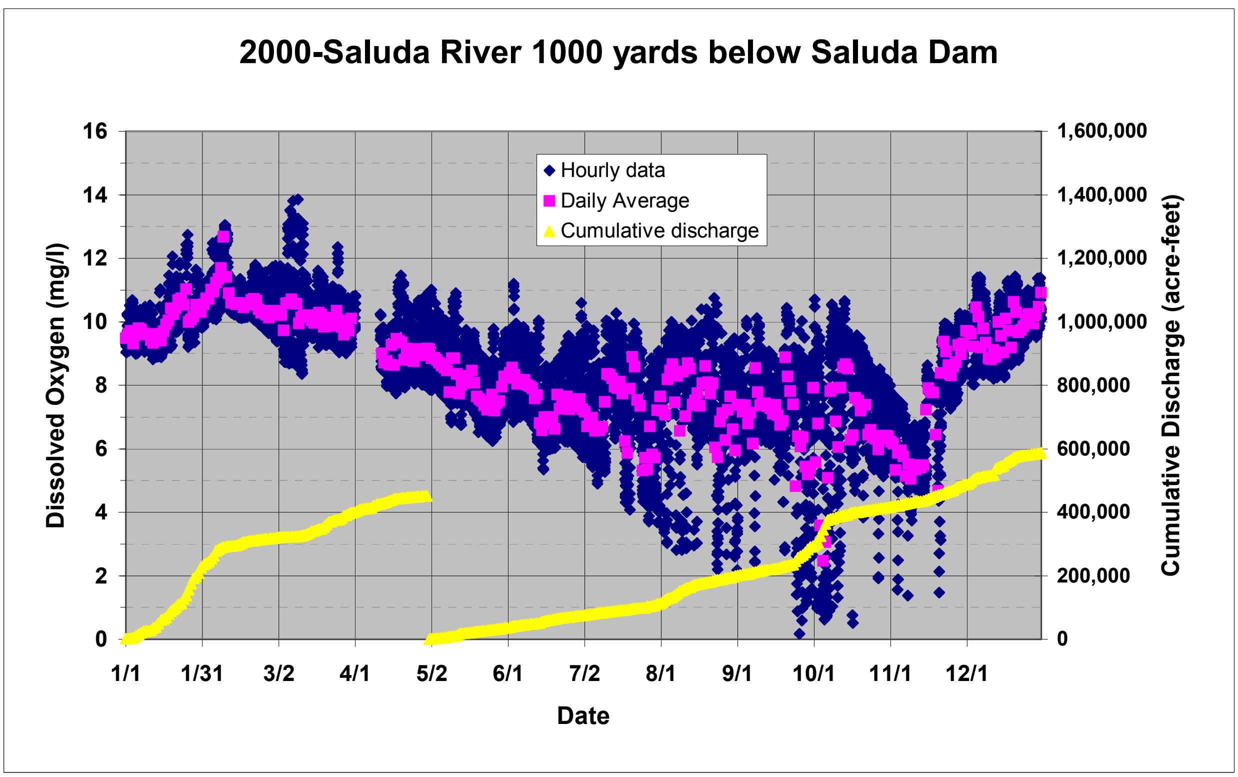
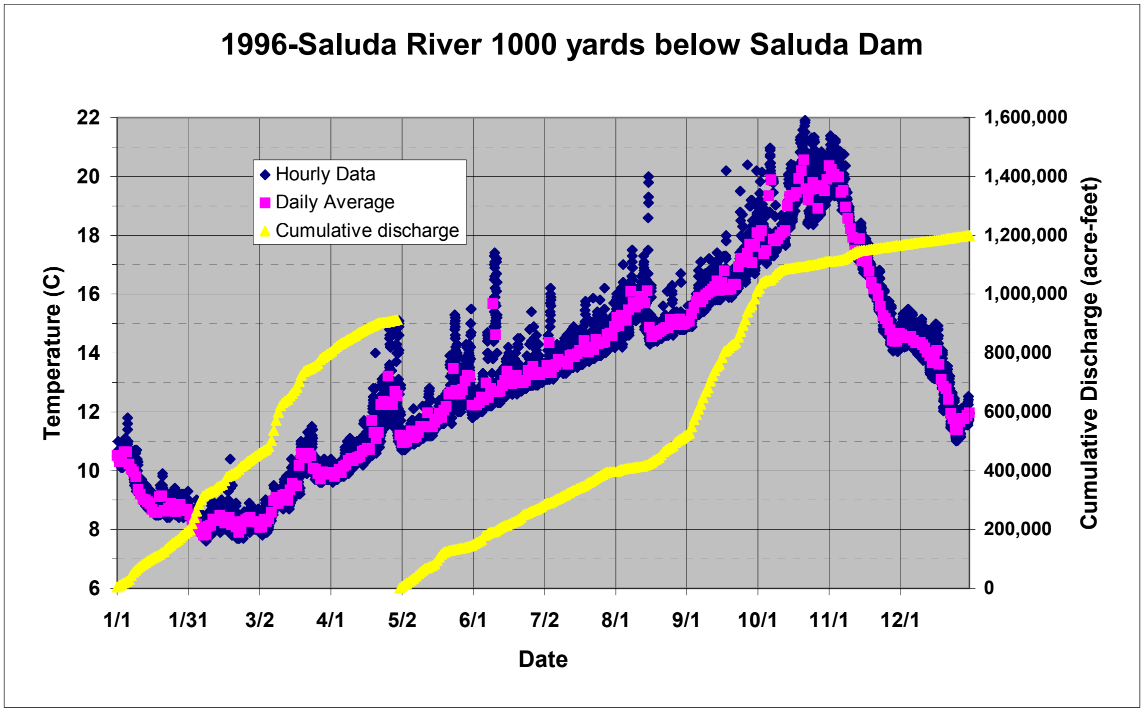


Figure 32: **DO in the Saluda Hydro Turbine Discharges for the Years 1989 Through 2000, Plotted with Cumulative Discharge from January 1 and May 1 (continued)**



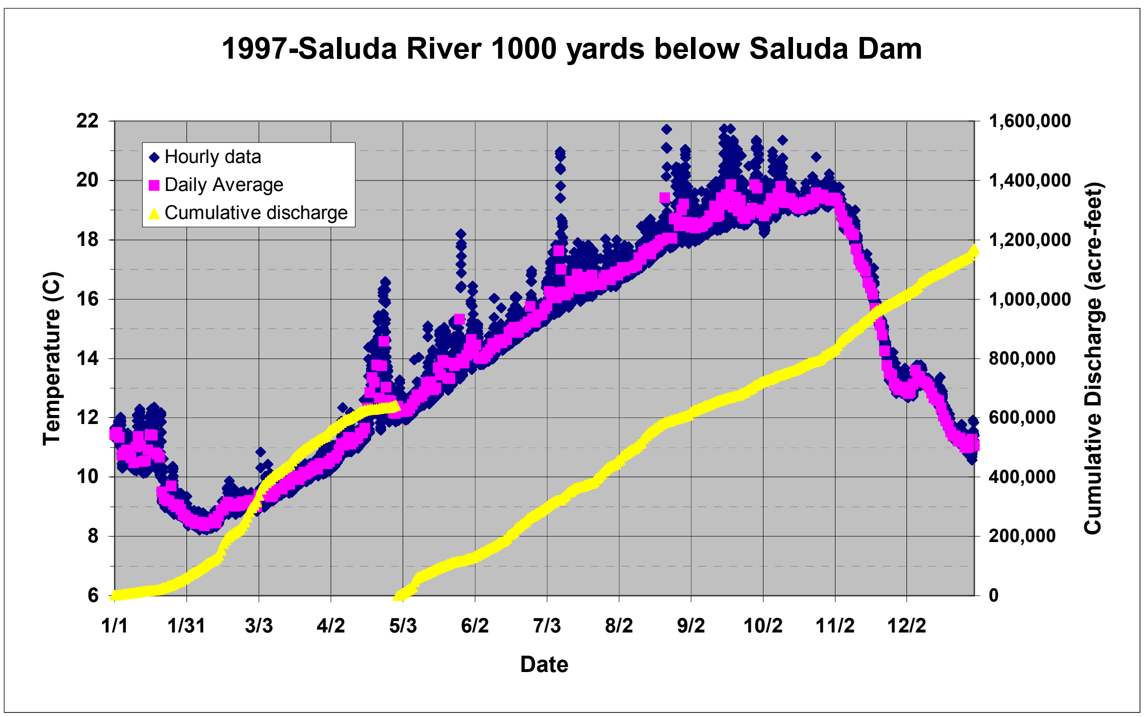
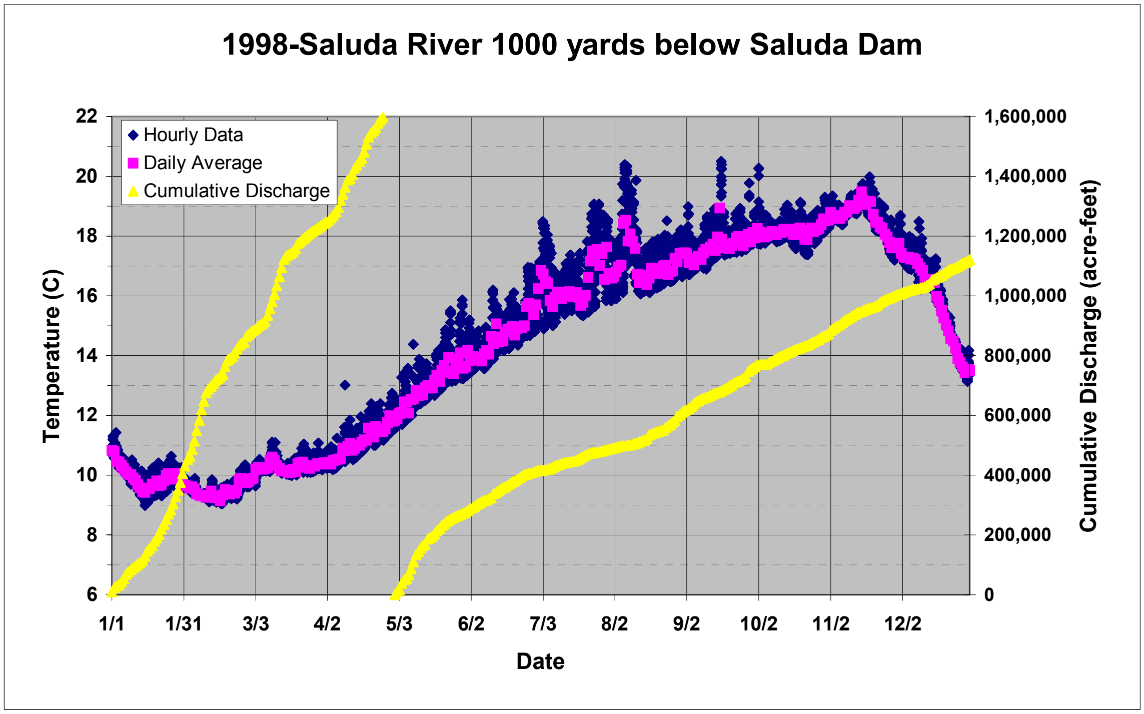


Figure 33: **Temperature in the Saluda Hydro Turbine Discharges for the Years 1996 through 2000, Plotted with Cumulative Discharge from January 1 and May 1**



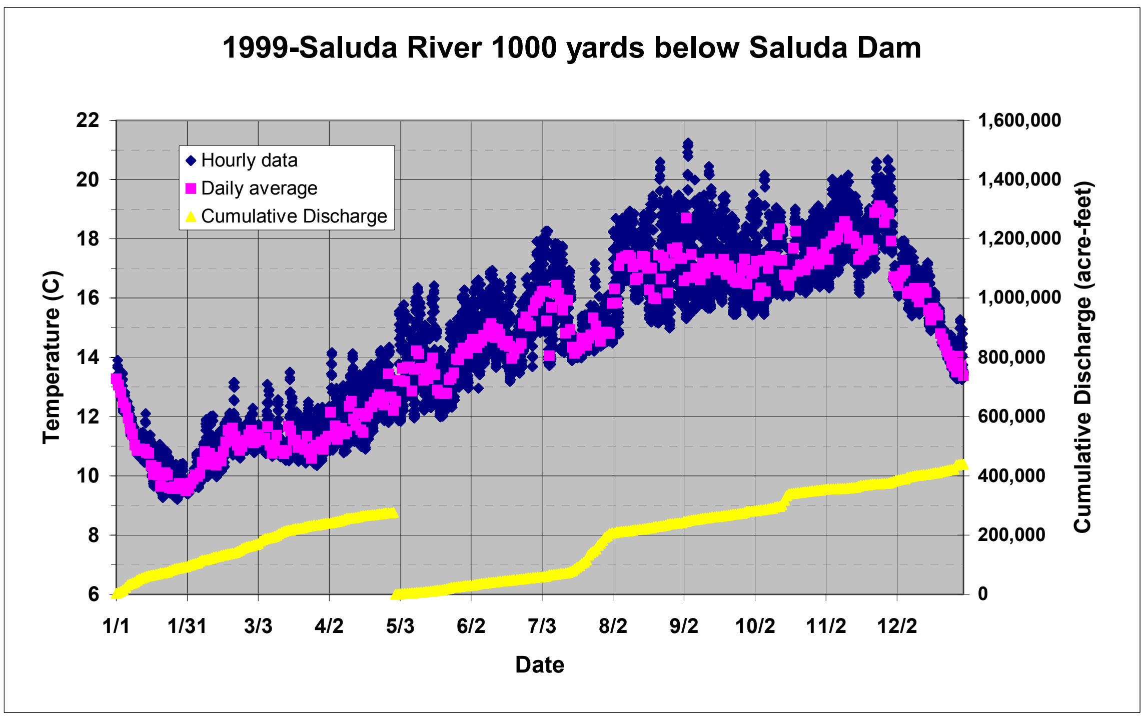


Figure 33: Temperature in the Saluda Hydro Turbine Discharges for the Years 1996 through 2000, Plotted with Cumulative Discharge from January 1 and May 1 (continued)

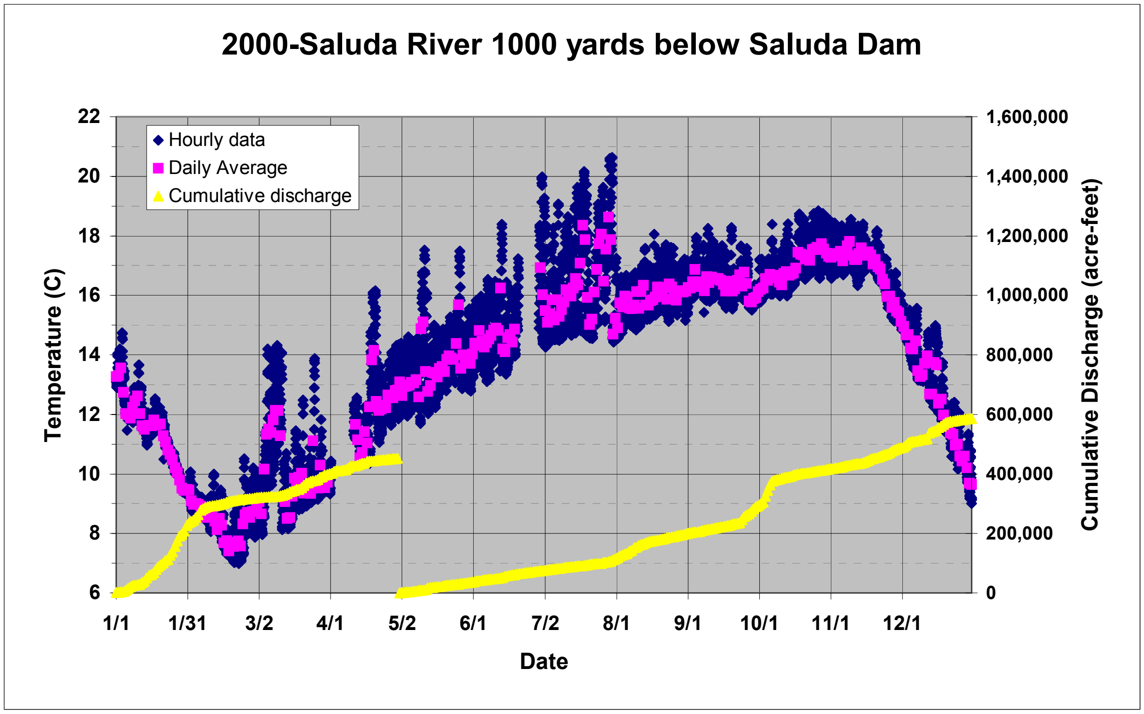


Figure 33: **Temperature in the Saluda Hydro Turbine Discharges for the Years 1996 through 2000, Plotted with Cumulative Discharge from January 1 and May 1 (continued)**

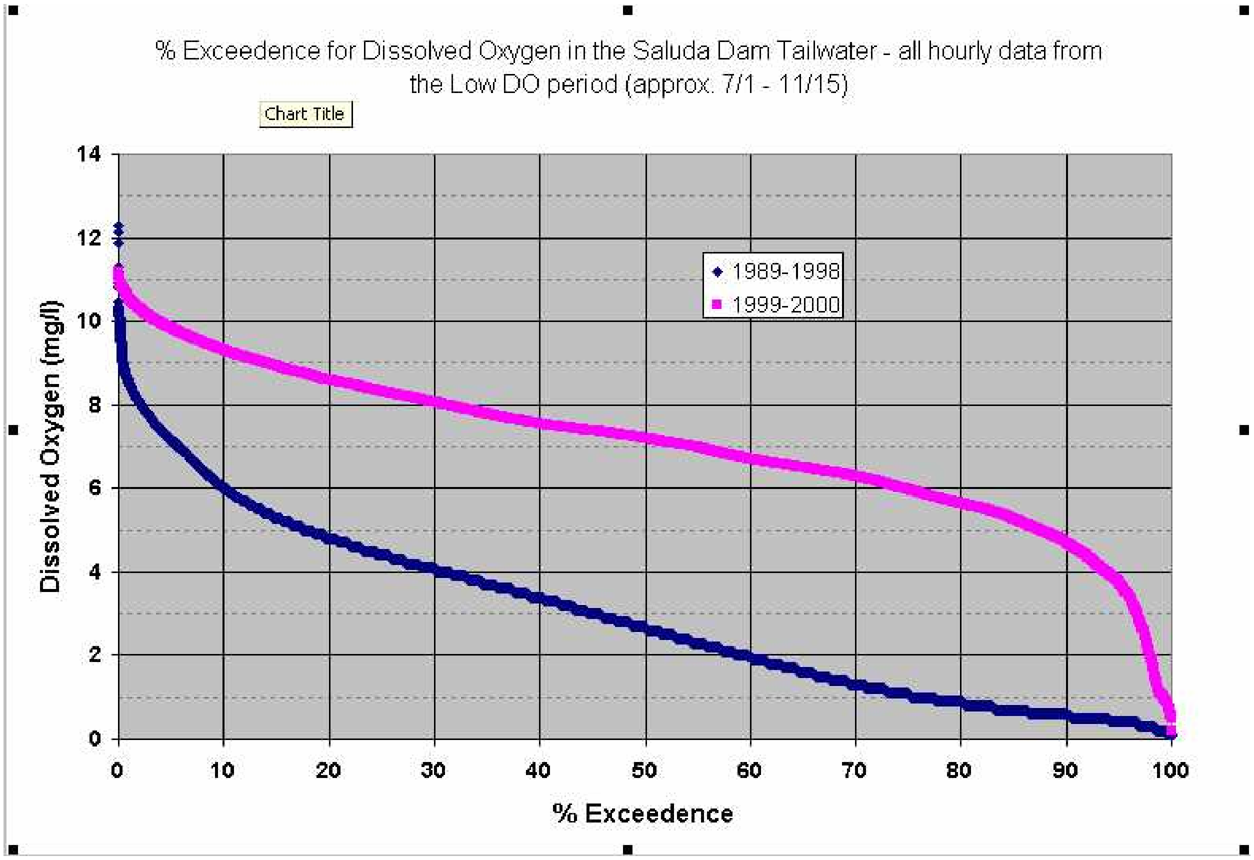

% Exceedence for Dissolved Oxygen in the Saluda Dam Tailwater - all hourly data from the Low DO period (approx. 7/1 - 11/15)
Chart Title
1989-1998
1999-2000
Dissolved Oxygen (mg/l)
14
12
10
8
6
4
2
0
0
10
20
30
40
50
60
70
80
90
100
% Exceedence

Figure 34

Table 1: Physical Characteristics of Lake Murray

	U.S. CUSTOMARY SYSTEM	METRIC SYSTEM
Maximum depth	175 feet	53.3 m
Mean Depth	46 feet	14 m
Drainage area	2260 square miles	5860 km^2
Area of Lake surface	70 square miles	182 km^2
Ratio of DA : lake area	32.2	32.2
Shoreline Length	524 miles	844 km
Shoreline Development Ratio	17.7	17.7
Total lake volume	2,317,000 ac-ft	2,636 hm^3
Useful lake volume	1,654,000 ac-ft	2,041 hm^3
Average Annual Flow	2778 cfs	78.7 cms
Nominal Residence Time	417 days	417 days
Depth of outlets, Units 1-4	175 feet	53 m
Depth of outlets, Unit 5	110 feet	33.5 m
Power Capacity per Unit, Units 1-4	32.5 MW	32.5 MW
Flow Capacity per Unit, Units 1-4	2750 cfs	77.9 cms
Power Capacity, Unit 5	70 MW	70 MW
Flow Capacity, Unit 5	7000 cfs	198 cms

Table 2: Mean Flows at Various Points in the Lake Murray System and Distribution of Inflows to Lake Murray

	MEAN STREAM FLOW, CFS	PERCENT OF TOTAL FLOW
Saluda Hydro	2778	100
Lake Murray Direct Inflows		
Saluda River at inflow	2243	80.74
Bush River	65	2.34
Little Saluda River	89	3.20
Clouds Creek	35	1.26
Big Creek	24	0.86
Beaver Dam Creek	28	1.01
West Creek	21	0.76
Camping Creek	11	0.40
Hollow Creek	15	0.54
Horse Creek	13	0.47
Upstream Inflows		
96 Creek	89	
Little River	172	

Table 3a. Summary of water quality parameter groups at various locations in Lake Murray and its watershed, 1970-85

Miles from Saluda Dam or	Stations	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
0.1 - 0.7 - Forebay	**1SP, S-204, S-207,CL-083, 450701**					F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, C, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, C, S
2.0 - 2.5	**1-NA, S-283**				F, O, N, T, M	F, O, N, T, M, A	F, O, N, T, M, A	F, O, N, T, M, A	F, O, N, T, M, A	F, O, N, T, M, A	F, O, N, T, M, A	F, O, N, T, M, A					
3.8 - 4.3 - Spence Islands	**2-NA, S-273, LMU18, 450702**				F, O, N, T, M	F, O, N, T, M, A	F, O, N, T, M, A	F, O, N, T, M, A	F, O, N, T, M, A	F, O, N, T, M, A	F, O, N, T, M, A	F, O, N, T, M, A	F, O, N, T, M, A	F, O, N, T, M, A	F, O, N, T, M, A	F, O, N, T, M, A	F, O, N, T, M, A
6.7 - 8.3 - Shull Island	**3M, LMU16, 450703**				F, N, T, A, C												
11.2 - 12.2 - Dreher Island	**S-280, 450704**				F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S
13.1	**3NA**																
14.1 - 14.5	**S-277, S-212, LMU10**	F, O, T, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC			F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, FC
17.0 - 17.7 - Rocky Creek	**4NA, S-279, 450705**				F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC
22.2 - 23.7	**450706, LMU3**				F, N, T, A, C												
24.6 - Blacks Bridge	**9NA, S-223**		F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC
27.0 - 30.1 - Bush River	**S-310, S-105, LMU1**	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, N, C				F, N, C
36.7	**S-047**	F, O, T, A, FC	F, O, T, A, FC	F, O, N, T, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC									
47.0 - 48.4 - Chappells	**S-295, 2167000**		F, FC	F, FC	F, FC												
55.5	**S-186**		F, O, T, A, FC	F, O, N, T, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC
Ballentine Embayment	**S-274, 450707, LMU19**				F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S
Turners Cove Embayment	**4N, S-282**				F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC					
Bear Creek Embayment	**5M, S-275. LMU17**				F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC					

Table 3a (cont.) Summary of water quality parameter groups at various locations in Lake Murray and its watershed, 1970-2001

Miles from Saluda Dam or	Stations	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Hollow Creek Embayment	**7N, S-281, LMU11, LMU12**																
Hollow Creek	**S-306, LMU 11-12**																
Camping Creek Embayment	**6M, S-213, S-276, LMU 13-14**	F, O, T, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC			F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, FC
Camping Creek	**S-290**									F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S
Buffalo Creek Embayment	**S-211, S-278, LMU9**			F, O, N, T, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC			F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, FC
Little Saluda River Embayment	**8M, S-222, CL-082, LMU 4-6**		F, O, T, A, FC	F, O, T, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC	F, N, C				F, N, C
Little Saluda River	**S-123, S-050, S-121**	F, O, T, FC	F, O, T, FC	F, O, N, T, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S
Clouds Creek	**S-113, S-255, S-111, LMU5**	F, O, T, A, FC	F, O, T, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, T, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC			F, O, N, T, M, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC
Bush River Embayment	**S-309, LMU2**											F, N, C	F, N, C				F, N, C
Bush River	**S-102, S-046, S-042**	F, O, T, A,	F, O, T, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC
Scott Creek	**S-044**	F, O, A	F, O, A, FC	F, O, N, A, FC	F, O, N, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, T, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC			F, O, N, T, A, FC	F, O, N, T, FC	F, O, N, T, A, FC
Little River	**S-305, S-099, S-038, S-297, S-034**	F, O, T, A	F, O, T, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC
North Creek	**S-135**	F, O, A		F, O, N, A, FC	F, O, N, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC			F, O, N, T, M, A, FC	F, O, N, T, A, FC	F, O, N, T, FC
Ninety Six Creek	**S-093**	F, O, T, A	F, O, T, A, FC	F, O, N, T, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S			F, O, N, T, M, A, FC, S	F, O, N, T, A, FC, S	F, O, N, T, A, FC, S
Coronaca Creek	**S-092, S-184**			F, O, N, M, A, FC	F, O, N, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A			F, O, N, T, M, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC
Wilson Creek	**S-235, S-233**	F, O, T, A	F, O, T, A, FC	F, O, N, T, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S			F, O, N, T, M, A, FC, S	F, O, N, T, A, FC, S	F, O, N, T, A, FC, S

Table 3b. Summary of water quality parameter groups at various locations in Lake Murray and its watershed, 1986-2001

Miles from Saluda Dam or	Stations	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
0.1 - 0.7 - Forebay	1SP, S-204, S-207,CL-083, 450701	F, O, N, T, M, A, FC, C, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, C, S	F, O, N, T, M, A, FC, C, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C
2.0 - 2.5	1-NA, S-283					F	F	F	F	F	F	F	F	F	F	F	F
3.8 - 4.3 - Spence Islands	2-NA, S-273, LMU18, 450702	F, O, N, T, M, A	F, O, N, T, M, A	F, O, N, T, M, A	F, O, N, T, M, A	F, O, N, T, M, A	F, O, N, T, M, A	F, O, N, T, M, A	F, O, N, T, M, A	F, O, N, T, M, A	F, O, N, T, M, A	F, O, N, T, M, A	F, O, N, T, M, A	F, O, N, T, M, A	F	F	F
6.7 - 8.3 - Shull Island	3M, LMU16, 450703		F, N, A, C	F, N, A, C		F, O, N, T, M, A, C	F, O, N, T, M, A, C	F, O, N, T, M, A, C	F, O, N, T, M, A, C	F, O, N, T, M, A, C	F, O, N, T, M, A, C	F, O, N, T, M, A, C	F, O, N, T, M, A, C	F, O, N, T, M, A, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C
11.2 - 12.2 - Dreher Island	S-280, 450704	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S			
13.1	3NA					F	F	F	F	F	F	F	F	F	F	F	F
14.1 - 14.5	S-277, S-212, LMU10	F, O, N, T, FC	F, O, N, T, A, FC, C	F, O, N, T, A, FC, C	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, A, FC	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, FC, E	F, O, N, T, FC, E			
17.0 - 17.7 - Rocky Creek	4NA, S-279, 450705	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F	F	F
22.2 - 23.7	450706, LMU3		F, N, A, C	F, N, A, C													
24.6 - Blacks Bridge	9NA, S-223	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F	F	F
27.0 - 30.1 - Bush River	S-310, S-105, LMU1	F, N, C	F, N, A, C	F, O, N, T, A, C	F, N, C	F, N, C		F, O, N, T, A, FC, C					F, O, N, T, M, A, FC, C				
36.7	S-047		O, N, M					F, O, N, T, M, A, FC				F, O, N, T, M, A, FC	F, O, N, T, M, A, FC, E				
47.0 - 48.4 - Chappells	S-295, 2167000			F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC			
55.5	S-186	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC			
Ballentine Embayment	S-274, 450707, LMU19	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S, C	F, O, N, T, M, A, FC, S, C	F, O, N, T, M, A, FC, S, C, E	F, O, N, T, M, A, FC, S, C, E			
Turners Cove Embayment	4N, S-282					F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C
Bear Creek Embayment	5M, S-275. LMU17		F, N, A, C	F, N, A, C		F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C

Table 3b. (cont.) Summary of water quality parameter groups at various locations in Lake Murray and its watershed, 1986-2001

Miles from Saluda Dam or	Stations	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Hollow Creek Embayment	7N, S-281, LMU11, LMU12		F, N, A, C	F, N, A, C		F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C
Hollow Creek	S-306, LMU 11-12		F, N, A, C	F, N, A, C				F, O, N, T, M, A, FC				F, O, N, T, M, A, FC	F, O, N, T, M, A, FC, C, E				
Camping Creek Embayment	6M, S-213, S-276, LMU 13-14	F, O, N, T, FC	F, O, N, T, A, FC, C	F, O, N, T, A, FC, C	F, O, N, T, FC	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C, E	F, O, N, T, M, A, FC, C, E	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C
Camping Creek	S-290	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S, E	F, O, N, T, M, A, FC, S, E			
Buffalo Creek Embayment	S-211, S-278, LMU9	F, O, N, T, FC	F, O, N, T, A, FC, C	F, O, N, T, A, FC, C	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, A, FC	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, FC, E	F, O, N, T, FC, E			
Little Saluda River Embayment	8M, S-222, CL-082, LMU 4-6	F, N, C	F, N, A, C	F, N, A, C	F, N, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C, E	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C	F, O, N, T, M, A, FC, C
Little Saluda River	S-123, S-050, S-121	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S			
Clouds Creek	S-113, S-255, S-111, LMU5	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, M, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, A, FC			
Bush River Embayment	S-309, LMU2	F, N, C	F, N, A, C	F, N, A, C	F, N, C	F, N, C		F, O, N, T, A, FC, C				F, O, N, T, A, FC, C	F, O, N, T, M, A, FC, C, E	F, O, N, T, A, FC, C, E			
Bush River	S-102, S-046, S-042	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC, E	F, O, N, T, M, A, FC, E			
Scott Creek	S-044	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, A, FC	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, FC			
Little River	S-305, S-099, S-038, S-297, S-034	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC	F, O, N, T, M, A, FC, E	F, O, N, T, M, A, FC, E			
North Creek	S-135	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, A, FC	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, FC			
Ninety Six Creek	S-093	F, O, N, T, A, FC, S	F, O, N, T, A, FC, S	F, O, N, T, FC, S	F, O, N, T, FC, S	F, O, N, T, FC, S	F, O, N, T, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S			
Coronaca Creek	S-092, S-184	F, O, N, T, A, FC	F, O, N, T, A, FC	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, A, FC	F, O, N, T, FC	F, O, N, T, FC	F, O, N, T, A, FC	F, O, N, T, FC	F, O, N, T, A, FC	F, O, N, T, FC	F, O, N, T, A, FC	F, O, N, T, FC			
Wilson Creek	S-235, S-233	F, O, N, T, A, FC, S	F, O, N, T, A, FC, S	F, O, N, T, FC, S	F, O, N, T, FC, S	F, O, N, T, FC, S	F, O, N, T, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S	F, O, N, T, M, A, FC, S			

Table 3 Parameter Group Key

F: Field Parameters (Temp., DO, pH etc.),
O: Organics
N: Nutrients
T: Turbidity
M: Metals
A: Alkalinity
FC: Fecal Coliform
S: Sediment
C: Chlorophyll
E: Ecoli

Table 4: Station Info for DASLER Stations

DASLER ID code
Digit 1 - Agency - 1-SCE&G, 2-DHEC, 3-USGS, 4-EPA
Digits 2-4 - Reservoir - MUR-Murray
Digit 5 - Station Type - F=Free Flowing, L=Lake
Digits 6-9 - Original Station Name
Digit 10 - General Location Type - M=Main Stem, E=Embayment, T=Tributary, TW=Tailwater
Digits 11-12 - Miles from Saluda Dam to the station or the mouth of the tributary where the station is located
*** - Not Determined**

DASLER ID	Location Description	Minor Basin	Stream Code	Water Body	Saluda River Mile	Miles from dam	Miles up Trib.
2MURFS152TW0	Saluda River just below Lake Murray Dam	Murray Tailwater	1	Saluda	8.8	TW	NA
2MURFLM22TW1	Saluda River below Lake Murray Dam	Murray Tailwater	1	Saluda	10.1	TW	NA
1MURL1SP0M00	Lake Murray at penstock 5	MLM 0-10.0	1	Saluda	10.3	0.1	NA
2MURLLM21M00	Intake towers-Lake Murray	MLM 0-10.0	1	Saluda	10.3	0.1	NA
4MURI0701M00	EPA station 450701	MLM 0-10.0	1	Saluda	10.3	0.1	NA
2MURLS204M00	Lake Murray at dam at spillway (marker 1)	MLM 0-10.0	1	Saluda	10.5	0.3	NA
2MURLS207M00	Lake Murray at SCE&G park on SC 6-north side	MLM 0-10.0	1	Saluda	10.5	0.3	NA
2MURLCL83M00	Lake Murray 100 m W dam (public park SC 6 N dam)	MLM 0-10.0	1	Saluda	10.7	0.5	NA
2MURLLM20E01	Sixteen Mile Creek-Lake Murray	MLM 0-10.0	1	Saluda	11.2	1.0	NA
1MURL1NA0M02	Lake Murray 2 miles upstream from dam	MLM 0-10.0	1	Saluda	12.2	2.0	NA
2MURLS283M03	Lake Murray at Marker 7	MLM 0-10.0		Saluda	13.2	3.0	NA
1MURL2NA0M04	Spence Island	MLM 0-10.0	1	Saluda	14	3.8	NA
4MURL0702M04	EPA station 450702	MLM 0-10.0	1	Saluda	14.1	3.9	NA
2MURLLM19E04	Susie Ebert Island-Lake Murray	MLM 0-10.0	1	Saluda	14.2	4.0	NA
2MURLS274E04	Lake Murray at marker 143	MLM 0-10.0	1	Saluda	14.2	4.0	NA
4MURL0707E04	EPA station 450707	MLM 0-10.0	1	Saluda	14.2	4.0	NA
2MURLS273M05	Lake Murray at marker 166	MLM 0-10.0	1	Saluda	14.4	4.2	NA
2MURLLM18M04	Spence Islands-Lake Murray	MLM 0-10.0	1	Saluda	14.5	4.3	NA
4MURL0703M07	EPA station 450703	MLM 0-10.0	1	Saluda	16.9	6.7	NA
2MURLS282E07	Lake Murray at marker 25	MLM 0-10.0	*	*	17.5	7.3	1.3
1MURL4N00E07	Turners Cove	MLM 0-10.0	*	*	17.5	7.3	2.9
1MURL3M00M08	Shull Island	MLM 0-10.0	1	Saluda	18.2	8.0	NA
2MURLLM16M08	Counts Island-Lake Murray	MLM 0-10.0	1	Saluda	18.5	8.3	NA
2MURLS275E09	Lake Murray at marker 128	Bear	2	Bear	19.2	9.0	2.5
1MURL5M00E09	Bear Creek	Bear	2	Bear	19.2	9.0	3.0
2MURLLM17E09	Bear Creek-Lake Murray	Bear	2	Bear	19.2	9.0	3.4
4MURL0704M11	EPA station 450704	MLM 10.1-20.0	1	Saluda	21.4	11.2	NA
2MURLS281E12	Lake Murray at marker 43	Hollow	3	Hollow	22.4	12.2	1.6
2MURLLM11E12	Hollow Creek-Lake Murray	Hollow	3	Hollow	22.4	12.2	2.3
1MURL7N00E12	Hollow Creek	Hollow	3	Hollow	22.4	12.2	4.1
2MURFS306T12	Hollow Creek at S-32-54	Hollow	3	Hollow	22.4	12.2	7.2
2MURLLM12E12	Big Horse Creek-Lake Murray	Hollow	22	Big Horse	22.4	12.2	0.5
2MURLS280M12	Lake Murray at marker 102	MLM 10.1-20.0	1	Saluda	22.4	12.2	NA
1MURL6M00E12	Camping Creek	Camping	4	Camping	22.5	12.3	2.1
2MURLLM13E12	Crystal Lake-Lake Murray	Camping	4	Camping	22.5	12.3	2.7
2MURLS276E12	Lake Murray at marker 93	Camping	4	Camping	22.5	12.3	3.0
2MURLS213E12	Lake Murray at S-36-15	Camping	4	Camping	22.5	12.3	5.6
2MURLLM14E12	Camping Creek-Lake Murray	Camping	4	Camping	22.5	12.3	6.5
2MURFS290T12	Camping at S-36-202	Camping	4	Camping	22.5	12.3	12.5
1MURL3NA0M13	Big Gap	MLM 10.1-20.0	1	Saluda	23.3	13.1	NA
2MURLLM10M14	Billy Dreher Island-Lake Murray	MLM 10.1-20.0	1	Saluda	24.3	14.1	NA
2MURLS277M14	Lake Murray at marker 57	MLM 10.1-20.0	1	Saluda	24.3	14.1	NA

Table 4: (cont.)

2MURLS278E17	Lake Murray at marker 78	Buffalo	14	Buffalo	27.2	17.0	1.8
2MURLLM09E17	Buffalo Creek-Lake Murray	Buffalo	14	Buffalo	27.2	17.0	2.6
1MURL4NA0M18	Rocky Creek	MLM 10.1-20.0	1	Saluda	27.8	17.6	NA
2MURLLM08E18	Rocky Creek-Lake Murray	Rocky Creek	21	Rocky	27.9	17.7	1.8
2MURLS279M18	Lake Murray at Marker 63	MLM 10.1-20.0	1	Saluda	27.9	17.7	NA
2MURLLM07M20	Saluda River after confluence with Little Saluda River	MLM 10.1-20.0	1	Saluda	30	19.8	NA
4MURL0706M22	EPA station 450706	MLM 20.1-33.0	1	Saluda	32.4	22.2	NA
2MURLLM06E23	Little Saluda River before confluence	Little Saluda	5	Little Saluda	32.9	22.7	0.4
2MURLS222E23	Lake Murray Little Saluda River arm at SC 391	Little Saluda	5	Little Saluda	32.9	22.7	1.4
1MURL8M00E23	Little Saluda River at Hwy 391 Bridge	Little Saluda	5	Little Saluda	32.9	22.7	1.6
2MURLCL82E23	Lake Murray Little Saluda River 450m W SC 391 bridge	Little Saluda	5	Little Saluda	32.9	22.7	1.6
2MURLLM04E23	Little Saluda River (above Clouds Creek)	Little Saluda	5	Little Saluda	32.9	22.7	4.4
2MURFS123T23	Little Saluda River at S-41-39 NE Saluda	Little Saluda	5	Little Saluda	32.9	22.7	13.9
2MURFS050T23	Little Saluda River at 378 E Saluda	Little Saluda	5	Little Saluda	32.9	22.7	18.9
2MURFS121T23	Little Saluda River at US 178 SE Saluda	Little Saluda	5	Little Saluda	32.9	22.7	21.0
2MURLLM05E23	Clouds Creek	Little Saluda	6	Clouds	32.9	22.7	1.1
2MURFS113T23	Bridge over Clouds Creek on Rd No 25	Little Saluda	6	Clouds	32.9	22.7	3.1
2MURFS255T23	Clouds Creek at S-41-26 4mi NW of Batesburg	Little Saluda	6	Clouds	32.9	22.7	8.5
2MURFS051T23	West Creek on S-41-150 N of Batesburg	Little Saluda	15	West	32.9	22.7	7.0
2MURFS110T23	Mine Creek at S-41-165 3.4mi S of Saluda	Little Saluda	16	Mine	32.9	22.7	4.0
2MURFS293T23	Harris Branch at S-41-25	Little Saluda	17	Harris	32.9	22.7	1.1
2MURFS108T23	Bridge over Big Creek on SC No 194	Little Saluda	18	Big	32.9	22.7	2.3
2MURFS128T23	Tributary to West Creek on SC-391 1.7mi NW Leesville	Little Saluda	*	*	32.9	22.7	
2MURLLM03M24	Saluda River before confluence	MLM 20.1-33.0	1	Saluda	33.9	23.7	NA
1MURL9NA0M25	Saluda River at Hwy 391	MLM 20.1-33.0	1	Saluda	34.8	24.6	NA
2MURLS223M25	Lake Murray at SC 391 Blacks Bridge	MLM 20.1-33.0	1	Saluda	34.8	24.6	NA
2MURLS309E27	Lake Murray Bush River 4.6km upstream SC 391 bridge	Bush	7	Bush	36.9	26.7	1.1
2MURLLM02E27	Bush River	Bush	7	Bush	36.9	26.7	1.4
2MURFS102T27	Bridge over Bush River on road No 56	Bush	7	Bush	36.9	26.7	3.4
2MURFS539T27	Bush River at SC 395, 5.0 miles S of Newberry	Bush	7	Bush	36.9	26.7	8.4
2MURFS538T27	Bush River at CO rd 66, 2.5 miles S Newberry	Bush	7	Bush	36.9	26.7	10.3
2MURFS046T27	Bush River at bridge on SC 34	Bush	7	Bush	36.9	26.7	12.3
2MURFS042T27	Bush River at SC 560 S Joanna	Bush	7	Bush	36.9	26.7	26.8
2MURFS770E27	Lake Murray in the Bush River cove	Bush	7	Bush	36.9	26.7	*
2MURFS768T27	Newberry Bush River WTP	Bush	7	Bush	36.9	26.7	*
2MURFS044T27	Scott Creek at SC 34 S of Newberry	Bush	13	Scott	36.9	26.7	1.5
2MURFS764T27	Timothy Creek at bridge unnum rd off of SC Hwy 3	Bush	23	Timothy	36.9	26.7	0.7
2MURFS769T27	Newberry County No 1 WTP	Bush	23	Timothy	36.9	26.7	3.8
2MURFS763T30	Big Beaver Dam Creek at bridge on CO rd 56	Bush	24	Big Beaver Dam	36.9	26.7	1.0
2MURLS310M27	Lake Murray Saluda River 3.8km upstream SC 391 bridge	MLM 20.1-33.0	1	Saluda	37.3	27.1	NA
2MURLLM01M28	Saluda River-upstream of Bush River	MLM 20.1-33.0	1	Saluda	38.2	28.0	NA
2MURLS105M30	Saluda River at SC 395 NE Saluda	MLM 20.1-33.0	1	Saluda	40.3	30.1	NA
2MURFS730T30	Beaverdam Creek at unbrd rd prior to Saluda confluence	Beaverdam	19	Beaverdam	40.8	30.6	1.2
2MURLLM15E30	Beaverdam Creek-Lake Murray	*	19	Beaverdam	40.8	30.6	*
2MURFS047M37	Saluda River south of Silver Street	Saluda Free Flowi	1	Saluda	46.9	36.7	NA
2MURFS305T38	Little River at SC 34	Little	8	Little	47.9	37.7	2.7
2MURFS099T38	Little River at S-36-22 8.3mi NW Silverstreet	Little	8	Little	47.9	37.7	10.9
2MURFS038T38	Little River at bridge on SC 560	Little	8	Little	47.9	37.7	14.8
2MURFS036T38	Little River at SC 72	Little	8	Little	47.9	37.7	22.2
2MURFS721T38	Little River at S-30-102	Little	8	Little	47.9	37.7	25.2
2MURFS035T38	Little River at CO rd 37	Little	8	Little	47.9	37.7	27.6
2MURFS297T38	Little River at SC 127	Little	8	Little	47.9	37.7	30.0
2MURFS034T38	Little River above Laurens sewage plt	Little	8	Little	47.9	37.7	31.0
2MURFS135T38	North Creek at US-76, 2.8mi W of Clinton	Little	9	North	47.9	37.7	8.9
2MURFS724T38	Burnt Mill Creek at S-30-4Z	Little	25	Burnt Mill	47.9	37.7	1.0
2MURFS723T38	Unnamed tributary to Little River at US 76 Bus	Little	*	*	47.9	37.7	*
3MURF7000M48	USGS station 2167000	Saluda Free Flowi	1	Saluda	58.2	48.0	NA
2MURFS295M48	Saluda River at SC Route 39	Saluda Free Flowi	1	Saluda	58.6	48.4	NA
2MURFS093T55	Ninety Six Creek SC 702, 5.2mi ESE of Ninety-Six	Ninety-Six	10	Ninety-Six	65.3	55.1	2.3
2MURFS718T55	Wilson Creek	Ninety-Six	11	Wilson	65.3	55.1	2.5
2MURFS235T55	Wilson Creek at S-24-124	Ninety-Six	11	Wilson	65.3	55.1	5.4
2MURFS717T55	Wilson Creek	Ninety-Six	11	Wilson	65.3	55.1	5.4
2MURFS716T55	Wilson Creek	Ninety-Six	11	Wilson	65.3	55.1	7.0
2MURFS715T55	Wilson Creek	Ninety-Six	11	Wilson	65.3	55.1	8.1
2MURFS233T55	Wilson Creek at S-24-101	Ninety-Six	11	Wilson	65.3	55.1	9.0
2MURFS714T55	Wilson Creek	Ninety-Six	11	Wilson	65.3	55.1	9.1
2MURFS710T55	Wilson Creek	Ninety-Six	11	Wilson	65.3	55.1	10.8
2MURFS711T55	Wilson Creek	Ninety-Six	11	Wilson	65.3	55.1	10.8
2MURFS708T55	Wilson Creek	Ninety-Six	11	Wilson	65.3	55.1	13.2
2MURFS709T55	Wilson Creek	Ninety-Six	11	Wilson	65.3	55.1	*
2MURFS719T55	Wilson Creek	Ninety-Six	11	Wilson	65.3	55.1	*
2MURFS092T55	Coronaca Creek at S-24-100, 4mi NW of Ninety-Six	Ninety-Six	12	Coronaca	65.3	55.1	0.3
2MURFS713T55	Unnamed tributary to Wilson Creek	Ninety-Six	*	*	65.3	55.1	*
2MURFS186M55	Saluda River at SC 34 ESE Ninety-Six, Below Lake Greenwood	Saluda Free Flowi	1	Saluda	65.7	55.5	NA

Table 5a. **Total number of water quality observations of all parameters at each station for 1970-1988**

DASLER ID	Minor Basin Name	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88
2MURLLM22TW1	Lake Murray Tailwater																		178	82
2MURFS152TW0	Lake Murray Tailwater			50	69	81	59	69	66	54	66	61			60	63	60	60	64	60
1MURL1SP0M00	Murray Lake Mile 0-10.0																			
2MURLLM21M00	Murray Lake Mile 0-10.0																		179	82
4MURL0701M00	Murray Lake Mile 0-10.0				400															
2MURLS204M00	Murray Lake Mile 0-10.0		17	30	44	111	289	235	226	176	211	437	1112	1188	1272	1274	1208	1100	1209	1188
2MURLS207M00	Murray Lake Mile 0-10.0		17	30	51	127	290	244	238	188	222	157								
2MURLCL83M00	Murray Lake Mile 0-10.0											98	269				199	160		
2MURLLM20E01	Murray Lake Mile 0-10.0																		175	82
1MURL1NA0M02	Murray Lake Mile 0-10.0																			
2MURLS283M03	Murray Lake Mile 0-10.0				9	49	158	206	227	174	211	86								
1MURL2NA0M04	Murray Lake Mile 0-10.0																			
4MURL0702M04	Murray Lake Mile 0-10.0				361															
2MURLLM19E04	Murray Lake Mile 0-10.0																		180	82
2MURLS274E04	Murray Lake Mile 0-10.0				42	125	282	235	227	173	211	411	1028	1039	993	951	997	867	991	850
4MURL0707E04	Murray Lake Mile 0-10.0				249															
2MURLS273M05	Murray Lake Mile 0-10.0				42	126	293	257	247	408	352	510	763	676	1058	864	835	879	1000	829
2MURLLM18M04	Murray Lake Mile 0-10.0																		179	82
4MURL0703M07	Murray Lake Mile 0-10.0				306															
2MURLS282E07	Murray Lake Mile 0-10.0				9	49	160	206	226	209	219	90								

Table 5a. (cont.) Total number of water quality observations of all parameters at each station for 1970-1988

DASLER ID	Minor Basin Name	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88
1MURL4N00E07	Murray Lake Mile 0-10.0																			
1MURL3M00M08	Murray Lake Mile 0-10.0																			
2MURLLM16M08	Murray Lake Mile 0-10.0																		192	82
2MURLS275E09	Bear Creek				9	49	180	205	227	168	211	157								
1MURL5M00E09	Bear Creek																			
2MURLLM17E09	Bear Creek																		195	82
4MURL0704M11	Murray Lake Mile 10.1-20.0				277															
2MURLS281E12	Hollow Creek				18	49	160	205	226	175	209	86								
2MURLLM11E12	Hollow Creek																		194	74
1MURL7N00E12	Hollow Creek																			
2MURFS306T12	Hollow Creek																			
2MURLLM12E12	Hollow Creek																		194	78
2MURLS280M12	Murray Lake Mile 10.1-20.0				42	126	277	236	227	175	212	311	585	548	504	525	586	670	708	666
1MURL6M00E12	Camping Creek																			
2MURLLM13E12	Camping Creek																		194	82
2MURLS276E12	Camping Creek				42	126	212	204	226	175	211	86								
2MURLS213E12	Camping Creek	5	27	33	61	94	50	69	67	55	66	62			60	63	64	59	50	60
2MURLLM14E12	Camping Creek																		196	82
2MURFS290T12	Camping Creek									116	214	207	216	224	215	230	233	229	235	231
1MURL3NA0M13	Murray Lake Mile 10.1-20.0																			

Table 5a. (cont.) Total number of water quality observations of all parameters at each station for 1970-1988

DASLER ID	Minor Basin Name	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88
2MURLLM10M14	Murray Lake Mile 10.1-20.0																		193	82
2MURLS277M14	Murray Lake Mile 10.1-20.0				42	121	277	236	226	230	222	161								
2MURLS212E14	Murray Lake Mile 10.1-20.0	6	29	49	60	86	50	69	67	54	66	61			60	63	64	60	50	60
4MURL0705M17	Murray Lake Mile 10.1-20.0				232															
2MURLS211E17	Buffalo Creek			51	60	94	58	69	67	54	66	62			60	63	64	60	50	60
2MURLS278E17	Buffalo Creek				42	126	274	235	223	175	211	157								
2MURLLM09E17	Buffalo Creek																		192	82
1MURL4NA0M18	Murray Lake Mile 10.1-20.0																			
2MURLLM08E18	Rocky Creek																		179	74
2MURLS279M18	Murray Lake Mile 10.1-20.0				35	120	274	248	238	186	224	356	899	917	939	762	808	805	843	596
2MURLLM07M20	Murray Lake Mile 10.1-20.0																		180	82
4MURL0706M22	Murray Lake Mile 20.1-33.0				177															
2MURLLM06E23	Little Saluda																		176	82
2MURLS222E23	Little Saluda		28	42	79	76	68	282	226	190	224	156								
1MURL8M00E23	Little Saluda																			
2MURLCL82E23	Little Saluda											29	92				55	58		
2MURLLM04E23	Little Saluda																		173	78
2MURFS123T23	Little Saluda	24	14	72	114	150	151	176	154	164	188	172	193	208	192	226	218	217	224	227
2MURFS050T23	Little Saluda	18	8	52	79	37	36	34	62	131	128	98			57	48	53	39	39	37
2MURFS121T23	Little Saluda	33	14	51	135	76	67	144	176	193	242	161	15							

Table 5a. (cont.) Total number of water quality observations of all parameters at each station for 1970-1988

DASLER ID	Minor Basin Name	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88
2MURLLM05E23	Little Saluda																		178	82
2MURFS113T23	Little Saluda	22	25	147	156	106	77	31												
2MURFS255T23	Little Saluda			14	56		30	56	56	27	99	96			98	30	66	52	62	60
2MURFS051T23	Little Saluda	44	17	89	92	60	58	61	61	27	99	69			85	73	66	31	62	20
2MURFS110T23	Little Saluda	22	8	51	129	221	249	178	61	27	99	46			70	74	68	32	52	20
2MURFS293T23	Little Saluda																32	10	51	10
2MURFS108T23	Little Saluda		12	50	105	221	260	151				62								
2MURFS128T23	Little Saluda		7	43	68	84	50	69	96	79	92	79			93	94	134	20		
2MURLLM03M24	Murray Lake Mile 20.1-33.0																		178	82
1MURL9NA0M25	Murray Lake Mile 20.1-33.0																			
2MURLS223M25	Murray Lake Mile 20.1-33.0		16	27	129	223	226	369	246	343	327	409	639	496	580	520	392	396	384	434
2MURLS309E27	Bush River											17	62				46	43		
2MURLLM02E27	Bush River																		178	74
2MURFS102T27	Bush River	14	25	50	76	91	50	69	66	54	67	84			60	63	64	60	58	115
2MURFS539T27	Bush River												135							66
2MURFS538T27	Bush River												135							121
2MURFS046T27	Bush River	16	19	51	82	90	49	24					135							64
2MURFS042T27	Bush River		28	84	222	284	395	325	222	180	213	222	226	231	231	238	218	237	224	344
2MURFS770E27	Bush River																			115
2MURFS768T27	Bush River																			121

Table 5a. (cont.) Total number of water quality observations of all parameters at each station for 1970-1988

DASLER ID	Minor Basin Name	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88
2MURFS044T27	Bush River	12	20	45	61	63	41	60	60	53	60	64			58	59	61	60	58	61
2MURFS764T27	Bush River																			121
2MURFS769T27	Bush River																			121
2MURFS763T30	Bush River																			121
2MURLS310M27	Murray Lake Mile 20.1-33.0											20	68				55	43		
2MURLLM01M28	Murray Lake Mile 20.1-33.0																		173	78
2MURLS105M30	Murray Lake Mile 20.1-33.0	29	17	51	113	123	262	306	213	241	235	149								5
2MURLLM15E30	unnamed																		193	82
2MURFS047M37	Saluda River Free Flowing	30	25	51	56	60	58	23											15	
2MURFS305T38	Little River																			
2MURFS099T38	Little River		28	57	86	59	51	69	66	53	66	64			61	61	60	60	58	61
2MURFS038T38	Little River	24		21	74	49	69	12												
2MURFS036T38	Little River	21		19	60	6									133					
2MURFS721T38	Little River														135					
2MURFS035T38	Little River	28		15	13	50	70	42	66	27	55	19			157	61	59	59	61	60
2MURFS297T38	Little River																			
2MURFS034T38	Little River			19	43	193	307	280	233	192	218	215	231	225	426	239	237	237	235	225
2MURFS135T38	Little River	18		13	33	37	87	38	60	27	50	19			22	61	58	59	60	61
2MURFS723T38	Little River														135					
3MURF7000M48	Saluda River Free Flowing		6	51	42															

Table 5a. (cont.) Total number of water quality observations of all parameters at each station for 1970-1988

DASLER ID	Minor Basin Name	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88
2MURFS295M48	Saluda River Free Flowing																			111
2MURFS093T55	Ninety-Six Creek	12	5	5	18	37	39	35	34	20	48	55			57	48	40	38	32	36
2MURFS718T55	Ninety-Six Creek											124	39						78	
2MURFS235T55	Ninety-Six Creek	12	5	11	19	38	33	38	34	15	48	28			57	48	42	38	33	40
2MURFS717T55	Ninety-Six Creek											124	39						71	
2MURFS716T55	Ninety-Six Creek											124	39						71	
2MURFS715T55	Ninety-Six Creek											86	48						71	
2MURFS233T55	Ninety-Six Creek	12	5	25	31	40	39	35	35	20	46	58			57	50	45	39	35	43
2MURFS714T55	Ninety-Six Creek											128	48						71	
2MURFS710T55	Ninety-Six Creek											122	39						79	
2MURFS711T55	Ninety-Six Creek											79	32						70	
2MURFS708T55	Ninety-Six Creek											85	9							
2MURFS709T55	Ninety-Six Creek											81								
2MURFS719T55	Ninety-Six Creek											123	39						78	
2MURFS092T55	Ninety-Six Creek		12	35	34	82	79	66	61	26	88	106			100	74	66	62	64	60
2MURFS713T55	Ninety-Six Creek											79								
2MURFS186M55	Saluda River Free Flowing		8	11	63	229	200	133	166	218	315	204	207	207	193	227	219	219	232	215

Table 5b. Total number of water quality observations of all parameters at each station for 1989-2001

DASLER ID	Minor Basin Name	89	90	91	92	93	94	95	96	97	98	99	2000	2001
2MURLLM22TW1	Lake Murray Tailwater													
2MURFS152TW0	Lake Murray Tailwater	54	60	59	63	60	62	60	59	59	57			
1MURL1SP0M00	Murray Lake Mile 0-10.0		2285	2262	2665	1923	2077	1924	1830	2510	2584	2647	2612	1117
2MURLLM21M00	Murray Lake Mile 0-10.0													
4MURL0701M00	Murray Lake Mile 0-10.0													
2MURLS204M00	Murray Lake Mile 0-10.0	1100	1238	911	1196	1125	1212	1256	1266	1266	1034			
2MURLS207M00	Murray Lake Mile 0-10.0									1				
2MURLCL83M00	Murray Lake Mile 0-10.0	181	288											
2MURLLM20E01	Murray Lake Mile 0-10.0													
1MURL1NA0M02	Murray Lake Mile 0-10.0				1155	3353	3997	2611	1609	1551	1722	1778	1716	719
2MURLS283M03	Murray Lake Mile 0-10.0													
1MURL2NA0M04	Murray Lake Mile 0-10.0				323	1059	1440	1167	974	1415	1539	1518	1449	587
4MURL0702M04	Murray Lake Mile 0-10.0													
2MURLLM19E04	Murray Lake Mile 0-10.0													
2MURLS274E04	Murray Lake Mile 0-10.0	863	795	905	769	865	895	1015	925	796	663			
4MURL0707E04	Murray Lake Mile 0-10.0													
2MURLS273M05	Murray Lake Mile 0-10.0	839	977	562	741	575	745	991	763	779	854			
2MURLLM18M04	Murray Lake Mile 0-10.0													
4MURL0703M07	Murray Lake Mile 0-10.0													
2MURLS282E07	Murray Lake Mile 0-10.0													
1MURL4N00E07	Murray Lake Mile 0-10.0		588	429	671	589	783	728	562	771	870	824	871	354
1MURL3M00M08	Murray Lake Mile 0-10.0		630	1039	1323	1129	1468	1348	1309	1416	1414	1463	1442	624

Table 5b. (cont.) Total number of water quality observations of all parameters at each station for 1989-2001

DASLER ID	Minor Basin Name	89	90	91	92	93	94	95	96	97	98	99	2000	2001
2MURLLM16M08	Murray Lake Mile 0-10.0													
2MURLS275E09	Bear Creek													
1MURL5M00E09	Bear Creek		601	526	768	627	807	730	668	798	799	749	781	333
2MURLLM17E09	Bear Creek													
4MURL0704M11	Murray Lake Mile 10.1-20.0													
2MURLS281E12	Hollow Creek													
2MURLLM11E12	Hollow Creek													
1MURL7N00E12	Hollow Creek		601	559	517	158	464	418	364	489	484	485	473	201
2MURFS306T12	Hollow Creek				103				38	173				
2MURLLM12E12	Hollow Creek													
2MURLS280M12	Murray Lake Mile 10.1-20.0	694	563	530	545	507	496	491	490	545	562			
1MURL6M00E12	Camping Creek		759	698	844	647	831	768	604	815	847	851	796	402
2MURLLM13E12	Camping Creek													
2MURLS276E12	Camping Creek													
2MURLS213E12	Camping Creek	58	59	60	58	55	50	53	50	54	54			
2MURLLM14E12	Camping Creek													
2MURFS290T12	Camping Creek	223	211	233	214	230	219	195	214	204	227			
1MURL3NA0M13	Murray Lake Mile 10.1-20.0				280	831	1188	1095	1054	1116	1170	1137	992	461
2MURLLM10M14	Murray Lake Mile 10.1-20.0													
2MURLS277M14	Murray Lake Mile 10.1-20.0		18											
2MURLS212E14	Murray Lake Mile 10.1-20.0	59	59	60	58	56	51	54	54	49	53			
4MURL0705M17	Murray Lake Mile 10.1-20.0													

Table 5b. (cont.) Total number of water quality observations of all parameters at each station for 1989-2001

DASLER ID	Minor Basin Name	89	90	91	92	93	94	95	96	97	98	99	2000	2001
2MURLS211E17	Buffalo Creek	60	59	60	58	56	51	54	54	53	54			
2MURLS278E17	Buffalo Creek													
2MURLLM09E17	Buffalo Creek													
1MURL4NA0M18	Murray Lake Mile 10.1-20.0				150	418	588	534	515	615	660	681	678	299
2MURLLM08E18	Rocky Creek													
2MURLS279M18	Murray Lake Mile 10.1-20.0			477	714	694	758	813	646	525	534			
2MURLLM07M20	Murray Lake Mile 10.1-20.0													
4MURL0706M22	Murray Lake Mile 20.1-33.0													
2MURLLM06E23	Little Saluda													
2MURLS222E23	Little Saluda				245				64	423				
1MURL8M00E23	Little Saluda		325	333	404	288	379	325	270	414	414	418	392	183
2MURLCL82E23	Little Saluda	81	60											
2MURLLM04E23	Little Saluda													
2MURFS123T23	Little Saluda	218	204	211	213	219	219	227	207	210	207			
2MURFS050T23	Little Saluda	53	36	56	37	52	45	40	36	42	51			
2MURFS121T23	Little Saluda													
2MURLLM05E23	Little Saluda													
2MURFS113T23	Little Saluda				117				48	213				
2MURFS255T23	Little Saluda	60	50	69	58	65	61	64	61	56	54			
2MURFS051T23	Little Saluda								4					
2MURFS110T23	Little Saluda													
2MURFS293T23	Little Saluda	60	40	10										

Table 5b. (cont.) Total number of water quality observations of all parameters at each station for 1989-2001

DASLER ID	Minor Basin Name	89	90	91	92	93	94	95	96	97	98	99	2000	2001
2MURFS108T23	Little Saluda													
2MURFS128T23	Little Saluda													
2MURLLM03M24	Murray Lake Mile 20.1-33.0													
1MURL9NA0M25	Murray Lake Mile 20.1-33.0				75	187	182	288	250	258	278	266	260	95
2MURLS223M25	Murray Lake Mile 20.1-33.0	417	386	427	453	415	492	468	472	469	456			
2MURLS309E27	Bush River	194	45		127				115	169	157			
2MURLLM02E27	Bush River													
2MURFS102T27	Bush River	60	59	60	61	61	57		40	177				
2MURFS539T27	Bush River													
2MURFS538T27	Bush River													
2MURFS046T27	Bush River		40	59	65	60	60	59	58	62	64			
2MURFS042T27	Bush River	230	233	231	227	226	224	215	221	215	239			
2MURFS770E27	Bush River													
2MURFS768T27	Bush River													
2MURFS044T27	Bush River	61	60	59	59	54	54	55	56	53	54			
2MURFS764T27	Bush River													
2MURFS769T27	Bush River													
2MURFS763T30	Bush River													
2MURLS310M27	Murray Lake Mile 20.1-33.0	48	45		224				34	276				
2MURLLM01M28	Murray Lake Mile 20.1-33.0													
2MURLS105M30	Murray Lake Mile 20.1-33.0													
2MURLLM15E30	unnamed													

Table 5b. (cont.) Total number of water quality observations of all parameters at each station for 1989-2001

DASLER ID	Minor Basin Name	89	90	91	92	93	94	95	96	97	98	99	2000	2001
2MURFS047M37	Saluda River Free Flowing				107				38	165				
2MURFS305T38	Little River				109				38	164				
2MURFS099T38	Little River	60	60	55	58	45	54	54	54	53	59			
2MURFS038T38	Little River				107				15	196	38			
2MURFS036T38	Little River													
2MURFS721T38	Little River													
2MURFS035T38	Little River	59	19								4			
2MURFS297T38	Little River		40	60	56	64	60	60	61	54	45			
2MURFS034T38	Little River	223	230	229	217	231	231	221	221	216	199			
2MURFS135T38	Little River	59	59	60	56	60	60	60	52	58	52			
2MURFS723T38	Little River													
3MURF7000M48	Saluda River Free Flowing													
2MURFS295M48	Saluda River Free Flowing	220	220	220	215	220	220	225	222	205	208			
2MURFS093T55	Ninety-Six Creek	36	36	36	82	119	123	117	127	126	124			
2MURFS718T55	Ninety-Six Creek										1			
2MURFS235T55	Ninety-Six Creek	36	36	36	36	36	36	35	36	37	36			
2MURFS717T55	Ninety-Six Creek													
2MURFS716T55	Ninety-Six Creek													
2MURFS715T55	Ninety-Six Creek													
2MURFS233T55	Ninety-Six Creek	32	36	36	36	36	38	35	36	37	38			
2MURFS714T55	Ninety-Six Creek													
2MURFS710T55	Ninety-Six Creek													

Table 5b. (cont.) Total number of water quality observations of all parameters at each station for 1989-2001

DASLER ID	Minor Basin Name	89	90	91	92	93	94	95	96	97	98	99	2000	2001
2MURFS711T55	Ninety-Six Creek													
2MURFS708T55	Ninety-Six Creek													
2MURFS709T55	Ninety-Six Creek													
2MURFS719T55	Ninety-Six Creek													
2MURFS092T55	Ninety-Six Creek	52	61	60	60	62	64	60	68	55	54			
2MURFS713T55	Ninety-Six Creek													
2MURFS186M55	Saluda River Free Flowing	220	220	208	219	219	220	220	227	213	207			

Table 6: Summary of SC DHEC Reports on the Effects of Water Quality on Lake Uses for Lake Murray Stations

STATIONS AND LOCATIONS	AQUATIC LIFE		RECREATION		DHEC COMMENTS	
	1995 REPORT FOR DATA COLLECTED 1980-1992	1998 REPORT FOR DATA COLLECTED 1993-1997	1995 REPORT FOR DATA COLLECTED 1980-1992	1998 REPORT FOR DATA COLLECTED 1993-1997	1995 REPORT FOR DATA COLLECTED 1980-1992	1998 REPORT FOR DATA COLLECTED 1993-1997
LAKE MURRAY						
S-310, near mouth of Bush River, 27 miles above dam	FS	FS	FS	FS	Among the most eutrophic sites on large lakes in SC; Category I	Intermediate trophic status compared to other SC reservoirs
S-223, Blacks Bridge, 24.7 miles above dam	FS	PS: Cu >acute toxicity	FS	FS	Among the most eutrophic sites on large lakes in SC; Category I	Very high concentration of Zn; sediments, very high Zn, high Ni, Cr, Cu, Pb, and DDT was detected; intermediate trophic status
S-279, Near Rocky Creek, 17.8 miles above dam	FS: high Zn; sediments, DDT detected	NS: Cu >acute toxicity, eutrophication	FS	FS	Increasing trend in BOD_5 and pH; increasing trend in fecal coliform; intermediate trophic condition compared to SC lakes; improved from Category I	Among the most eutrophic sites on large lakes in SC, due to algae; watershed mgt. is recommended to reduce P; very high Cr and Pb, increasing turbidity, increasing trend in fecal coliform; sediments, high Cr, Cu, Pb, Ni, Zn, and DDT, malathion detected

STATIONS AND LOCATIONS	AQUATIC LIFE		RECREATION		DHEC COMMENTS	
	1995 REPORT FOR DATA COLLECTED 1980-1992	1998 REPORT FOR DATA COLLECTED 1993-1997	1995 REPORT FOR DATA COLLECTED 1980-1992	1998 REPORT FOR DATA COLLECTED 1993-1997	1995 REPORT FOR DATA COLLECTED 1980-1992	1998 REPORT FOR DATA COLLECTED 1993-1997
S-280, offshore of Billy Dreher Island, 12.3 miles above dam	FS sediments, very high Cr	NS: Cu >acute toxicity	FS	FS	Increasing trend in pH; increasing trend in fecal coliform	Decreasing trend in P; increasing trend in fecal coliform; sediments, very high Colorado River; among least eutrophic in SC
S-273, 4.8 miles upstream from dam	FS: high Zn in water; sediments, high Cr	NS: Cu >acute toxicity	FS	FS	Increasing trend in pH; increasing trend in fecal coliform	Decreasing trend in P, N, and turbidity; increasing trend in fecal coliform; sediments, very high Cr, Pb, Ni and high Cu, Zn and DDT detected; among least eutrophic in SC
S-204, forebay	PS high Zn in water; sediments, very high Cr and DDT was detected	PS: Cu >acute toxicity	FS	FS	Increasing trend in pH; increasing trend in fecal coliform	Decreasing trend in P and N; increasing trend in fecal coliform; sediments, high Cr, Cu, Pb, and DDT, a-BHC detected; among least eutrophic in SC
EMBAYMENTS OF LAKE MURRAY						
S-309, Bush River Arm	FS	NS: pH and nutrients	FS	FS	Among the most eutrophic sites on large lakes in SC; Category I	Among the most eutrophic embayments in the State due to high algae and P

STATIONS AND LOCATIONS	AQUATIC LIFE		RECREATION		DHEC COMMENTS	
	1995 REPORT FOR DATA COLLECTED 1980-1992	1998 REPORT FOR DATA COLLECTED 1993-1997	1995 REPORT FOR DATA COLLECTED 1980-1992	1998 REPORT FOR DATA COLLECTED 1993-1997	1995 REPORT FOR DATA COLLECTED 1980-1992	1998 REPORT FOR DATA COLLECTED 1993-1997
S-222, Little Saluda Arm	FS	FS	FS	FS	Intermediate trophic condition compared to SC lakes; improved from Class I	Intermediate trophic condition compared to SC lakes
S-211, Buffalo Creek Arm	FS	FS	FS	FS		Decreasing trend in P; among least eutrophic in SC
S-212, cove up from Billy Dreher Island	FS	FS	FS	FS	Increasing trend in pH	Increasing trend in turbidity; decreasing trend in P; among least eutrophic in SC
S-213, Camping Creek Arm	FS	FS	FS	FS	Increasing trend in pH	Decreasing trend in P and BOD_5; among least eutrophic in SC
S-274, the large embayment north of the forebay, in widest part of the lake; near Ballentine and Rocky Point	FS: high Zn in water; sediments, very high Hg and DDT was detected	NS: Cu >acute toxicity	FS	FS	Increasing trend in pH; increasing trend in fecal coliform	Decreasing trend in P, N, and turbidity; increasing trend in fecal coliform; sediments, very high Hg and high Cu and DDT detected; among least eutrophic in SC
SELECTED INFLOWS TO LAKE MURRAY						
S-186, Lake Greenwood discharge, 55.3 miles above dam	PS: low DO	NS: Cu & Zn > acute toxicity	FS	FS		Decreasing trends in pH, BOD_5, TP, TN; increasing trend in DO

STATIONS AND LOCATIONS	AQUATIC LIFE		RECREATION		DHEC COMMENTS	
	1995 REPORT FOR DATA COLLECTED 1980-1992	1998 REPORT FOR DATA COLLECTED 1993-1997	1995 REPORT FOR DATA COLLECTED 1980-1992	1998 REPORT FOR DATA COLLECTED 1993-1997	1995 REPORT FOR DATA COLLECTED 1980-1992	1998 REPORT FOR DATA COLLECTED 1993-1997
S-093, Near mouth of Ninety Six Creek	FS	PS: Cu > acute toxicity	PS: Fecal coliform excursions	PS: Fecal coliform excursions		
S-295, Chappells, 48.3 miles above dam	PS: low DO	NS: Cu > acute toxicity	FS	FS		Decreasing trend in BOD_5; increasing trend in DO
S-305, Little River about 2 miles above mouth	FS	FS	FS	NS: Fecal coliform excursions		Upstream sites were listed as NS for fecal coliform in 1995 report
S-102, Bush River at inflow to Lake Murray	FS	FS	NS: Fecal coliform excursions	NS: Fecal coliform excursions		
S-123, Little Saluda River inflow	PS: DO excursions	PS: DO excursions	NS: Fecal coliform excursions	PS: Fecal coliform excursions		Aquatic life PS designation compounded by decreasing pH, but there is a decreasing trend in BOD_5, TP, TN; increasing trend in fecal coliform
S-255, Clouds Creek inflow	FS	FS	PS: Fecal coliform excursions	FS		
S-290, Camping Creek	FS	NS: Cu & Zn > acute toxicity	NS: Fecal coliform excursions	NS: Fecal coliform excursions		
S-306, Hollow Creek	FS	FS	NS: Fecal coliform excursions	NS: Fecal coliform excursions		

STATIONS AND LOCATIONS	AQUATIC LIFE		RECREATION		DHEC COMMENTS	
	1995 REPORT FOR DATA COLLECTED 1980-1992	1998 REPORT FOR DATA COLLECTED 1993-1997	1995 REPORT FOR DATA COLLECTED 1980-1992	1998 REPORT FOR DATA COLLECTED 1993-1997	1995 REPORT FOR DATA COLLECTED 1980-1992	1998 REPORT FOR DATA COLLECTED 1993-1997
SALUDA RIVER BELOW SALUDA DAM						
S-152, tailrace	NS: low DO	NS: low DO, pH excursions	FS	FS		Significant decreasing trend in DO, increasing trend in suspended solids, decreasing trends in BOD_5, TP, fecal coliform
S-149, Saluda River at the MEPCO Plant water intake	NS: low DO	PS: low DO	FS	PS: fecal coliform excursions		Significant decreasing trend in DO and TP
S-298, USGS gage, miles below the dam	FS	NS: Cu & Zn > acute toxicity	PS: fecal coliform excursions	PS: fecal coliform excursions		Increasing trend in suspended solids, DO

- FS—fully supporting uses.
- NS—not supporting uses.
- PS—partially supporting uses.
- Increasing and decreasing trends identified in the comments columns are statistically valid, but they are not flow adjusted and the 1998 report only covered trends over the 5 year period, 1993 through 1997.
- "high" and "very high" designations for metals have special meaning: they indicate that the metal concentrations are in the top 10 % and 5 % respectively of metals concentrations that exceed the detection limits.
- It is important to note that measurements of metals represent total concentrations of these constituents and are not intended to indicate that the measurements mean that the sediments are toxic. DHEC uses these measurements only to determine if there is a potential for a problem. More detailed assessments would be needed to determine if any actual impacts might occur.
- Cu and Zn are elevated statewide with concentrations frequently measured in excess of acute aquatic life criteria; however, there are no apparent impacts on biota in the state.
- Definitions of FS, NS, and PS: FS represents areas where the water quality measurements indicated less than 10 % excursions from the water quality criteria for DO, pH, and fecal coliform bacteria, as well as free from any biological evidence of effects of metals and organics unless the frequency of occurrence of these constituents was "extreme". NS represents areas where the water quality measurements indicated greater than 25 % excursions from the water quality criteria for DO, pH, and fecal coliform bacteria, and/or there was biological evidence of effects of metals and organics or the frequency of occurrence of these constituents was "extreme".
- An appendix of the reports gives the number of excursions for each station.

Table 7: Number of Locations and How Water Uses Were Supported Based on the 1995 and 1998 Reports – Based on Information in Table 6 (M Indicates Metals are the Cause; N Indicates Nutrients are the Cause; FC Indicates Fecal Coliform are the Cause)

	1995		1998	
	AQUATIC LIFE	RECREATION	AQUATIC LIFE	RECREATION
LAKE MURRAY				
Fully supporting	5	6	1	6
Partially supporting	1, M		2, M	
Not supporting			3, M	
EMBAYMENTS				
Fully supporting	6	6	4	6
Partially supporting				
Not supporting			2, M, N	
SELECTED INFLOWS				
Fully supporting	6	3	4	3
Partially supporting	3, DO	2, FC	2, M, DO	2, FC
Not supporting		4, FC	3, M	4, FC
TAILWATER				
Fully supporting	1	2		1
Partially supporting		1, FC	1, DO	2, FC
Not supporting	2, DO		2, DO, pH, M	
SUMMARY				
Fully supporting	18	17	9	16
Partially supporting	4	3	5	4
Not supporting	2	4	10	4
METALS	**1**		**11**	
Fecal Coliform		7		8
DO	5		3	
NUTRIENTS			**1**	

Table 8: Major Wastewater Dischargers and Number of Minor Dischargers in the Watershed of Lake Murray (Downstream from Greenwood Dam)

		MILLION GALLONS/DAY	NUMBER OF MINOR DISCHARGES
NINETY-SIX CREEK WATERSHED			
	City of Greenwood/Wilson Creek Plant	12.0	
	Number of minor		12
BUSH RIVER WATERSHED			
	City of Newberry/Bush River Plant	3.22	
	Laurens County WRC/Clinton	2.75	
	Number of minor		2
LITTLE RIVER WATERSHED			
	City of Laurens	4.5	
	Number of minor		10
LITTLE SALUDA RIVER WATERSHED			
	Number of minor		3
LAKE MURRAY WATERSHED			
	Number of minor		3

Table 9. Sites listed on the SCDHEC TMDL and 303(d) lists

	IMPAIRED SITE	STATION	COUNTY	IMPAIRED	CAUSE	PRIORITY
	SALUDA RVR AT SC 34 6.5 MI ESE OF 96	S- 186	GREENWOOD	AL	CU	3
	SALUDA RVR AT SC 34 6.5 MI ESE OF 96	S- 186	GREENWOOD	AL	ZN	3
	CORONACA CK AT S- 24- 100 4 MI NW OF 96	S- 092	GREENWOOD	AL	DO	3
	CORONACA CK AT SC HWY 221	S- 184	GREENWOOD	AL	BIO	3
	WILSON CK AT S- 24- 124	S- 235	GREENWOOD	AL	BIO	3
	WILSON CK AT S- 24- 124	S- 235	GREENWOOD	REC	FC	3
	NINETY SIX CK AT SC 702 5.2 MI ESE OF 96	S- 093	GREENWOOD	AL	CU	3
	NINETY SIX CK AT SC 702 5.2 MI ESE OF 96	S- 093	GREENWOOD	REC	FC	3
	SALUDA RIVER AT S. C. ROUTE 39	S- 295	SALUDA	AL	CU	3
	NORTH CK AT JCT WITH US 76 2.8 MI W OF CLINTON	S-135	LAURENS	REC	FC	3
	LITTLE RVR AT SC ROUTE 127	S- 297	LAURENS	REC	FC	3
	LITTLE RVR AT US 76 BUS IN LAURENS ABOVE STP	S- 034	LAURENS	REC	FC	3
	LITTLE RVR AT SC 560	S- 038	LAURENS	REC	FC	3
	LITTLE RVR AT S- 36- 22 8.3 MI NW SILVERSTREET	S- 099	NEWBERRY	REC	FC	3
	LITTLE RVR AT SC 34	S- 305	NEWBERRY	REC	FC	3
	SCOTT CK AT SC 34 SW OF NEWBERRY	S- 044	NEWBERRY	REC	FC	3
	BUSH RIVER AT SC 560 S OF JOANNA	S- 042	NEWBERRY	AL	DO	2
T	BUSH RIVER AT S. C. ROUTE 34	S- 046	NEWBERRY	REC	FC	2
T	BUSH RVR AT S- 36- 41 8.5 MI S OF NEWBERRY	S- 102	NEWBERRY	REC	FC	2
	LAKE MURRAY, BUSH RVR ARM, 4.6 KM US SC 391	S- 309	NEWBERRY	AL	P	2
	LAKE MURRAY, BUSH RVR ARM, 4.6 KM US SC 391	S- 309	NEWBERRY	AL	pH	2
	BLACKS BR, LK MURRAY AT SC 391	S- 223	NEWBERRY	AL	CU	3
	MOORES CK AT HWY 178	S-112	SALUDA	AL	BIO	3
	BIG CK AT SR 122	S-855	SALUDA	AL	BIO	3
	LITTLE SALUDA RVR AT US 378 E SALUDA	S- 050	SALUDA	AL	DO	2
*	LITTLE SALUDA RVR AT US 378 E SALUDA	S- 050	SALUDA	REC	FC	2
	LITTLE SALUDA RVR AT S- 41- 39 5.2 MI NE SALUDA	S- 123	SALUDA	AL	DO	3
*	LITTLE SALUDA RVR AT S- 41- 39 5.2 MI NE SALUDA	S- 123	SALUDA	REC	FC	3
	LK MURRAY AT MARKER 63	S- 279	LEXINGTON	AL	P	2
	LK MURRAY AT MARKER 63	S- 279	LEXINGTON	AL	CU	3
	CAMPING CK S- 36- 202 BLW GA PACIFIC	S- 290	NEWBERRY	REC	FC	2
	HOLLOW CK AT S- 32- 54	S- 306	LEXINGTON	REC	FC	3
	LK MURRAY AT MARKER 166	S- 273	LEXINGTON	AL	CU	3
	LK MURRAY AT MARKER 143	S- 274	LEXINGTON	AL	CU	3
	LK MURRAY AT DAM AT SPILLWAY (MARKER 1)	S- 204	LEXINGTON	AL	CU	3
*	SALUDA RVR JUST BELOW LK MURRAY DAM	S- 152	LEXINGTON	AL	DO	1
	SALUDA RVR JUST BELOW LK MURRAY DAM	S- 152	LEXINGTON	AL	pH	1
	RAWLS CREEK AT S- 32- 107	S- 287	LEXINGTON	AL	BIO	2
T	RAWLS CREEK AT S- 32- 107	S- 287	LEXINGTON	REC	FC	2
	LORICK BR AT PT UPSTRM OF JCT WITH SALUDA RVR	S- 150	LEXINGTON	REC	FC	3
*	SALUDA RVR AT MEPCO ELECT. PLANT WATER INTAKE	S- 149	LEXINGTON	AL	DO	1
*	SALUDA RVR AT MEPCO ELECT. PLANT WATER INTAKE	S- 149	LEXINGTON	REC	FC	2
	FOURTEEN MILE CK AT SR 28	S-848	LEXINGTON	AL	BIO	3
	TWELVE MILE CK AT SR 106	S- 052	LEXINGTON	AL	BIO	3
	TWELVEMILE CREEK AT U. S. ROUTE 378	S- 294	LEXINGTON	AL	CU	3
*	TWELVEMILE CREEK AT U. S. ROUTE 378	S- 294	LEXINGTON	REC	FC	3
	TWELVEMILE CREEK AT U. S. ROUTE 378	S- 294	LEXINGTON	AL	ZN	3
	KINLEY CK AT S- 32- 36 (ST. ANDREWS RD) IN IRMO	S- 260	LEXINGTON	AL	BIO	2
*	KINLEY CK AT S- 32- 36 (ST. ANDREWS RD) IN IRMO	S- 260	LEXINGTON	REC	FC	2
*	SALUDA RVR AT USGS GAUGING STATION, 1/ 2 MI BELOW I- 20	S- 298	LEXINGTON	REC	FC	2
	SALUDA RVR AT USGS GAUGING STATION, 1/ 2 MI BELOW I- 20	S- 298	LEXINGTON	AL	ZN	2

T indicates TMDL designation

***** indicates potential TMDL. Assessment will be done within 2 years

Table 10: Summary of TP, Chlorophyll *a*, and Secchi Depth Conditions at Various Locations in the Inflows and Lake Murray – Includes DHEC Data Only for 1995-98

	TOTAL PHOSPHORUS (MG/L)	CHLOROPHYLL *A* (µG/L)	SECCHI DEPTH (M)
Greenwood Dam (S-186)	0.027	No data	No data
Ninety-Six Creek (S-093)	0.703	No data	No data
Little River (S-099)	0.05	No data	No data
Bush River Embayment (S-309)	0.12	28.6	0.7
Clouds Creek (S-255)	0.34	No data	No data
Blacks Bridge (S-223)	0.05	14.77	1.01
Rocky Creek (S-279)	0.04	11.9	1.4
Dreher Island (S-280)	0.03	6.5	2.0
4.2 Miles from Saluda Dam (S-273)	0.02	5.5	2.8
Ballentine Embayment (S-274)	0.02	5.7	2.4
Forebay (S-204)	0.02	7.3	2.7

Table 11: Comparison of the Percent Contributions of Total Phosphorous Loadings to Lake Murray to the Mean Streamflow from each Tributary

LAKE MURRAY TRIBUTARY	MEAN STREAMFLOW, PERCENT	PHOSPHORUS LOAD, PERCENT
Bush River	3	25
Little Saluda River	4	9
Clouds Creek	1	5
Ninety-Six Creek	4	36
Little River	7	6
Saluda River	81	19