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ENTRAINMENT ASSESSMENT AT THE PLANT VOGTLE ELECTRIC GENERATING PLANT

WAYNESBORO, GEORGIA

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A SOUTHERN COMPANY

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1. INTRODUCTION

In February of 2008, Georgia Power Company's (GPC) Environmental Services staff based in Smyrna, Georgia responded to Southern Nuclear's request to conduct an aquatic impingement and entrainment assessment of Plant Vogtle's make-up water intake structure. Following a site reconnaissance in early March 2008, GPC submitted a plan of study The sampling approach included four primary components including:

1) source water ichthyoplankton sampling in the Savannah River,

2) source water/intake canal ichthyoplankton (entrainment) sampling,

3) impingement sampling via the traveling screen screen-wash system, and

4) performance of work under a quality assurance/quality control plan to ensure that work was performed in high quality manner consistent with standard scientific practices, and as it pertains to sampling methodology, perform a comparison between collection gear types and data between two sampling locations upstream of the intake structure.

Following a brief period of internal review by Southern Nuclear, a sampling plan was established with authorization to proceed including implementations by Plant Vogtle to install temporary procedure modifications in order to provide GPC staff site access to aquatic impingement and entrainment sampling. Plant Vogtle Operations personnel have provided and continue to provide communications and staff resources to operate the traveling screen system for the ongoing impingement study component.

Field components of the study were initiated on 10 March 2008. Study components 1, 2, and 4 described above have been completed for the entrainment portion of the study. The methods and results of those study components are described in the following section of this report. Study component 3, the impingement study, was designed as a 12-month study encompassing twice per month sampling currently scheduled to conclude in February 2009. Interim impingement data have reported in a separate report (GPC 2008).

Under direction and support provided by Southern Nuclear, the study approach, field sampling components, and data analysis of this study have been conducted and managed by Georgia Power Company's Environmental Services Group based at 5131 Maner Road in Smyrna, GA

Field methods used in this study are based on widely accepted, standard scientific practices and stem from Georgia Power Company staffs' previous experience in performing entrainment and impingement assessment studies following applicable EPA guidance.

Planning elements for this study include:

- review of historical and recent studies characterizing the fish community in the vicinity of the site and potential fish community impacts via Plant Vogtle Operations
- a sampling approach to support development of a scientifically valid estimate of entrainment rate at Plant Vogtle
- an assessment of a fish communities susceptible to entrainment in the vicinity of the make-up water intake structure to include:
- taxonomic identification of entrained fish species and their life stages to the lowest practical taxon
- description of abundance and temporal/spatial characteristics
- characterization of annual, seasonal, and diel variations in entrainment rate
- documentation of current entrainment rates of all life stages of fish and shellfish at the facility
- identification of any Federal and/or State protected species

The following sections provide a description of the Plant Vogtle Study Area and the make-up water intake structure (Section 2), methods (Section 3), description of available environmental parameters that may aid data interpretation (Section 4), and discussion of the study results including calculation of entrainment rate at Plant Vogtle (Section 5).

1.1 Study Objective

The objective of this study was to characterize the current entrainment rate at Plant Vogtle Unit 1 & 2 make-up water intake structure and use that information to infer

entrainment rate for the similarly designed intake structure for the proposed Vogtle Units 3 & 4.

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2. STUDY AREA DESCRIPTION

2.1 Environment

The Plant Vogtle Site is located at Savannah River Mile (RM) 150.9. The plant is located approximately 26 miles south-southeast of Augusta, in Burke County, Georgia (Figure 2-1) directly across the river from the Department of Energy's Savannah River Site (SRS) property. The Savannah River, which provides the make-up-cooling water source for Plant Vogtle's cooling tower system, is a primary river that drains the eastern and western boundaries of Georgia and South Carolina, respectively. The Savannah River originates in the mountains of North Carolina, South Carolina, and Georgia and flows approximately 505 kilometers (km) to the Atlantic Ocean. The Savannah River in the vicinity of Plant Vogtle lies in the Coastal Plain physiographic province which is characterized by sandy or sandy loam soils with rolling hills and a mixed pine-hardwood vegetative association. The Savannah River upstream from the Plant Vogtle intake structure receives wastewater discharges from municipalities and industries. The river at the site is typical of large southeastern Coastal Plain rivers except that the channel was historically dredged and maintained by the Corps of Engineers (COE) so that it is highly channelized. Studies on the Savannah River have been conducted since 1951 (GPC. 1984b). In a recent publication by Marcy et al. 2005, *Fishes of the Middle Savannah River Basin*, the Savannah River was characterized as being high in fish diversity and home to at least 118 native fish species. The middle Savannah River in the vicinity of Plant Vogtle is home to at least 98 species of fish - fifteen of which are species introduced mostly for fisheries management purposes. Potential aquatic community entrainment at Plant Vogtle was initially characterized in early siting studies of the mid-1970s and reported later in GPC's 1984 Operations Environmental Report for licensing of Plant Vogtle (GPC 1984).

The 1984 report of site studies performed during January through August of 1974 suggested that prevailing biological and physical factors combined with the low intake canal velocities, would result in minimal entrainment of eggs and larvae and not have a significant effect on the fish population of the Savannah River.

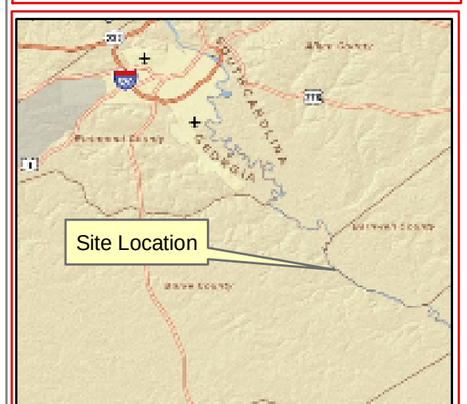
Vogtle Entrainment and Impingement Sampling

Burke County

Figure 2-1 Sample Location Map

Legend

GA Counties



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2.2 Intake Canal and Structure

Among its major components, the Plant Vogtle river water intake system consists of the intake canal structure and make-up pumps. The intake canal is 356 feet (ft) long, 140 ft wide with an earthen bottom at 67 ft above mean sea level (msl), at the time it was constructed, and vertical steel sheet pile sides (canal walls) extending to 98 ft msl. The intake canal has a surface skimmer weir at about 78 ft msl with guide vanes at the river entrance. The skimmer weir consists of fixed and removable sections with the fixed sections having elevations less than 78 ft msl. A bottom canal weir is located approximately 100 ft from the mouth of the canal. Silting protection is provided by a sedimentation basin formed by the skimming weir and the canal weir. A floating trash boom is located in front of the skimmer weir to divert large floating debris (GPC 1984).

The component of river velocity parallel to the canal opening is small thus minimizing the potential for fish entering the canal. In addition, a lateral passageway is provided at the canal entrance which permits fish to escape (GPC 1984).

Flow through the intake canal is determined by plant operating conditions. Water velocities in the canal are also dependent on the river water level. Average velocity at the river intake canal ranges from 0.01 ft/second (s) at minimum plant withdrawal rate of 13,000 gallons per minute (gpm) and a river water level of 98 msl (top of the canal sheet pilings) to a 1.05 ft/s at a maximum plant withdrawal rate (72,000 gpm) based on all four make-up water pumps running and a minimum river water level of 78.4 ft msl (allowing for a 2 ft degradation of river bed elevation) at a flow of 5,800 cubic ft/s (ft^3/s). At average plant operating conditions (42,000 gpm with two intake makeup water pumps operating) and annual water level (84 ft msl based on average river flow of 10,300 ft^3/s, the canal entrance velocity is 0.11 ft/s (GPC 1984).

The intake structure is a 147 ft long, 72 ft wide concrete structure with four chambers, each housing one pump, a traveling water screen, a trash rack, stop logs, and screen wash discharge to a common pit with course-grated steel insert basket. The traveling screens are FMC type-45A (3/8 –inch size steel mesh of ASTM A36 structural steel shape) that currently are set to rotate one cycle every eight hours (hrs) or on a high screen differential of six inches of water at the low-setting rotation speed of five ft per minute (min). The velocities of water through the traveling screens at average annual water level (84.0 ft msl) is 0.69 ft/s and 0.82 ft/s with river level at minimum stage (78.4 ft msl) (GPC 1984).

2.3 Make-up Water Pumps

Four vertical pumps, each name-plate-rated at 22,000 gpm (or a maximum pump flow of 15.84 million gallons per day [MGD]) are located in the river intake structure. The typical operating scenario utilizes two pumps. Total pumping rates can vary day to day based on operational needs. Pumping rates vary periodically due to make-up water needs based on cooling basin water levels. Also, periodically, cooling tower blow-down requires added dilution which requires increased pumping volumes for discharge compliance.

3. METHODS

Copies of template field data sheets used for sampling source water and entrainment are included in Appendix A.

3.1 Source Water Early Life Stage Fish Community Assessment

Ichthyoplankton (fish eggs and larva) samples were collected from the Savannah River near the Plant Vogtle make-up water intake structure as a means to characterize the component of the fish community most subject to entrainment. Field sampling began during the late winter/early spring of 2008 in order to capture a representative sample of early season migratory fish spawning. Source water community samples were collected twice per month (approximately at two-week intervals) during 10 March 2008 through 29 July 2008. The sampled period is typically representative of maximum spring and summer fish egg and larval drift – the most biologically productive season of the year for spawning resident and migratory fishes.

Each sample event consisted of an ichthyoplankton collection at approximately 6-hour (hr) intervals. Samples from each discrete station along across-sectional transect were composited - ultimately resulting in collection of samples representative of 12-hour diurnal (daytime) and 12-hr nocturnal (nighttime) periods to facilitate assessment of diel behavior in the drift community potentially subject to entrainment into the Plant Vogtle make-up water intake structure.

Ichthyoplankton samples were collected from one primary location, a cross-sectional transect, positioned approximately at RM 151.0 (at inland waterway marker No. 72) or about 300 ft upstream from the mouth of the intake canal. Additionally, samples were periodically collected from a second transect located about 0.3 miles farther upstream in a reach of the river in the vicinity of the area proposed as the new make-up water intake for Units 3&4 (Figure 2-1). Three discrete ichthyoplankton stations were positioned along transects approximately 30-ft from the left bank, at mid-channel, and approximately 30 ft from the right bank. Ichthyoplankton samples were collected at the upstream location in the same left-, mid-, and right-bank positioning manner for an examination of between-gear and between-location analysis.

Samples collected from the second location (near the proposed Unit 3&4 intake) were used for analysis and comparison between gear types and efficiencies (e.g.,

plankton net vs. submersible pump) and locations (Savannah River main stem vs. inside the intake canal) in the source water and entrainment sampling locations.

Ichthyoplankton samples were collected at each station with a standard double plankton net rig comprised of a towing bridle, two 500-micron sized Nitex mesh 3:1 ratio (length to diameter) nets mounted in a side by side 0.5 meter round net ring bracket. Each net captures samples with a plastic "sieve bucket" mounted at the cod end. A portion of the bucket has an opening screened with 500-micron stainless steel mesh wire to retain planktonic organisms.

The double net rig yielded a field sample and a replicate sample set aside for archival as a 1:1 fallback quality assurance measure. Field samples were submitted for laboratory taxonomic processing and the archived samples stored at Georgia Power Company's biology lab in Smyrna, GA. The net hoop/bracket was equipped with an 11 lb. wire depressor weight (Wildco Model 90-G10) to minimize tangential drag behind the boat as a result of river current/water column velocity. An additional 16 lbs of weight in the form of down-rigger "cannonball" weights" were also used to further increase slope and reduce the length of cable required to sample at desired depth intervals. A calibrated, propeller driven General Oceanics current meter (Model No. 2030R) was mounted in the mouth of one of the two nets to provide for calculation of sampled water volumes and velocity for each discrete sample.

Before deploying the plankton nets, the sample boat was positioned at a given sampling station by setting an anchor. Once anchored, the net rig was deployed into the river by means of a hoist, winch, and depth-marked-cable. Prior to deployment, the current meter start count was recorded on a field data sheet. Actual sampling depth during each event was determined prior to deployment based on maximum water depth. The sampling method was based on adequately sampling the entire water column to yield a representative community sample by capturing both floating and demersal early life stages of fish in the drift community. Based on depth sounder readings on the boat depth finder (Garmin MapSounder 168), the net rig was initially deployed to the deepest optimal sampling depth (as a means to limit substrate materials from entering the sample) then retrieved by 1-meter sampling intervals following five to ten-minute sampling effort at each depth interval. For example, if depths could be effectively sampled down to four meters based on river stage, the total sample time would be 20 minutes based on 5-minute sampling effort at all depth intervals. As river stage declined from spring into summer, sampling times were increased with each event to offset the reduced number of depth intervals and otherwise reduced sampling effort/volume. In

that the goal of the study was to provide representative drift community samples by sampling at least between 100 to 150 cubic meters (m^3) of river water per net per station.

Following the sampling effort at each station, the net rig was retrieved via hoist and winch. As the nets breeched the water surface upon retrieval, the current meter end-number was read from the current meter and recorded on the station data sheet. The plankton nets, partially suspended at the water surface were manually washed down from the outside with river water to rinse down and capture any sample debris and/or organisms clinging to the upper walls of the nets. Once rinsed, the nets were brought onboard and the sample buckets removed from each net by loosening stainless steel attachment bands. Bucket screens were back-washed with river water with a hand held squirt bottle. Once rinsed, the nets were brought onboard and the sample buckets removed from each net by loosening stainless steel attachment bands. Bucket screens were back-washed with river water with a hand held squirt bottle.

Sample materials were then dispensed from each net bucket into separately labeled 1-liter wide mouth plastic jars. Contents of each jar were fixed and preserved with 5-percent formalin. Label information was placed inside the jar with the sample and included the site name, station location, date and time of collection, indication of field sample vs archive sample, and collectors' initials. The jars were temporarily stored in coolers or an open organizer tray for transport under chain of custody to Georgia Power Company's biology lab located at 5131 Maner Road in Smyrna, GA. Once retrieved and signed for acceptance at the lab, sample jars destined for the processing lab (Normandeau Associates Laboratory, 25 Nashua Road, Bedford, New Hampshire) were assigned outer stick-on labels to match an inner jar label. Jar lids were taped, and the jars each double bagged in zip-lock bags before being packed into a cooler with a completed chain-of-custody form taped into the lid of each cooler. The back page carbon copy of each completed chain of custody form was retained by the task manager before sealing the shipping containers. Additional packing material was added before each cooler was securely taped and shut and labeled for overnight shipment (FEDEX) to the processing lab.

In addition to the sampling station identifiers, sample collectors, sample depths, sample times, and current meter readings, other supporting field data collection information was recorded on field data sheets. These data included measures of physicochemical water quality including pH (standard units), surface water temperature (°C), turbidity (NTU), conductivity (microSiemens/cm), and dissolved oxygen

concentration (mg/L). Additionally, any observations regarding current weather, recent precipitation, equipment malfunction, or deviations from the intended sampling method were noted on field data sheets.

Following each sample event, provisional river discharge data corresponding to the days and nights of sampling dates was electronically retrieved from the USGS real-time data website for the Waynesboro, GA gage Station No. 021973269 (located at Plant Vogtle) and stored on Georgia Power Company's network computer system.

Samples received by the taxonomic processing laboratory were rinsed and sorted to remove any preserved fish eggs and larvae from detritus or other sample debris. Each egg and larva were identified to the lowest practical taxon and enumerated before a final quality assurance check and data entry. Lab results were submitted to Georgia Power in electronic form once the samples were fully processed. The lab data were further managed at Georgia Power in electronic spreadsheets for synthesis into this report.

3.1.1 Calculation of Source Water Sample Egg and Larval Densities

Densities were calculated by dividing the total number of eggs and larvae for a given sample period by the total volume of river water filtered through the plankton net. The densities were further examined by performing the same calculation separately for eggs and larvae.

3.2 Entrainment Assessment

The first of nine of entrainment sampling events was conducted 26 March 2008. This sample was collected in the mouth of the intake canal by means of a boat-mounted 425 gallons per minute (gpm) centrifugal pump. This event provided an opportunity to evaluate and validate pumping as a collection method for entrainment sampling. The boat-mounted pump collected entrainment samples by moving water through the pump through a 500 *u* mesh ichthyoplankton net mounted at the boat railing. During the same sampling event, source water samples were collected with the same net gear in the stationary, boat drift net sampling method described above. Both pumped- and netted samples yielded at least two life stages of fish larvae from multiple species in densities per species ranging from 0.004 to 0.03 fish per m^3 for pumped samples and 0.001 to 0.05 fish per m^3 for net samples thus validating the use of pumping as a method for collection of entrainment/canal samples. Samples were confirmed by the taxonomic

laboratory as being captured and preserved in good condition. This evaluation, and ultimately, change in sampling gear was made after the first event following investigator observations that sampling from the inner canal location and in the relatively uniform and quiescent hydraulic characteristics inside the canal would yield a more representative sample of the entrained community. Also, due to the canal configuration with two tiers of sheet piling, it was not feasible to sample further inside the canal with the boat mounted pump. Instead, the more portable dual submersible pump system was chosen for use at a deployment/sampling point located inside the canal closer to the intake screens. The submersible pump system was shore-based, powered by a portable electric generator, and positioned on the top of the south canal bulkhead about 150 ft upstream from the intake screens (Figure 2-1). The following eight entrainment sampling events were conducted using the submersible pump system.

Entrainment samples were collected twice per month (approximately at the same two-week intervals as riverine source water community samples) beginning on 26 March 2008 and ending on 29 July 2008. Each sample event consisted of approximately 6-hr sample collection time intervals which were ultimately composited to be representative of 12-hr diurnal and 12-hr nocturnal periods. This sample schedule provided a means to perform a direct comparison to the riverine drift community beyond the mouth of the canal.

The entrainment pump system consisted of two Tsurumi Model LB3-750 submersible pumps each with name plate capacity at level head of 73 gpm. This type of pump is capable of pushing water vertically through a two-inch hose as high a 37 ft. The height of the canal wall from water surface to top of the wire rope hand railing during the survey ranged from approximately 23 to 24 ft. The distance from the water to the head of each net mouth was monitored during the study in order to calculate entrainment sample volume based on manufacturer curve rated head loss from maximum rated pump capacity at height. Canal water (entrainment samples) delivered by pump ultimately emptied through horizontal sections of hose into the same type of standard double plankton net rig mounted inside two side by side 55-gallon (gal) plastic drums located at the top of the canal wall. Each drum discharged sieved sample water through a two-inch diameter PVC drain fittings (45 degree elbows) which in turn emptied into a four-inch corrugated plastic storm drain hose ultimate carrying sieved water back into the canal at a location positioned about 20 ft downstream of the submersible pumps. The sampling goal was to collect between 50 to 100 m^3 of sample per net. Sample volume was calculated by multiplying head-rated pump capacity times the time (minutes) pumped then converted from units of gpm to m^3. Just as with the

source water sampling, the double net rig was used to yield simultaneous field and replicate samples for archival during each event as a fallback quality assurance measure, if needed. Entrainment samples were collected from sieve buckets then handled and shipped in the same manner as the riverine source sampling. Any observations regarding equipment malfunction or deviations from the intended sampling method were noted on field data sheets.

3.2.1 Calculation of Entrainment Sample Densities

Community (fish eggs and larvae) densities were calculated by dividing the total number of eggs and larvae for a given sample period by the total volume of river water filtered through the plankton net and the result reported in number of organisms per 1000-m^3 (1000 cubic meters)

3.2.2 Calculation of Entrainment Rate

The entrainment rate was developed based on actual daily make-up water intake pumping. In that diminished occurrence of source water fish eggs and larvae at the end of July clearly bracketed the end of the drift season, the five-month entrainment study result represents the annual entrainment estimate. To calculate the annual estimate, daily entrainment rate (number of organisms/1000-m3) was established based on the result of each half-monthly entrainment sampling event result. Daily entrainment rates based on entrainment sample volumes were scaled-up by the appropriate multiplier to reflect actual daily make up water intake volumes. These adjusted daily entrainment rates were then summed to yield half-monthly entrainment rates. Half-monthly entrainment rates were summed to yield an unadjusted annual rate.

Additionally, for perspective and to account for expected natural and operational variability, a half monthly mean entrainment rate was calculated for all sampling events and statistically treated with the 95-percent confident interval. The upper limit was applied to the half-monthly mean entrainment rate which was in turn multiplied out by a factor of five in order to yield an upper estimate of “annual” entrainment for Plant Vogtle based on the upper 95% confidence limit.

3.3 Quality Assurance and Quality Control

Project quality assurance/quality control (QA/QC) procedures for this study followed established procedures for general field and laboratory studies conducted by Georgia Power’s Environmental Laboratory (GPC, 2002). Each sampling event

included senior technical involvement and preparation of trip reports summarizing field observations on the performance of the collection system including the sample collection, handling, processing, record keeping, any health and safety issues on site and communication with plant personnel.

3.4 Plant Operations and Environmental Parameters

Plant operational parameters were recorded at Plant Vogtle throughout the course of the study including intake make-up water flow rates and ambient and/or inlet water temperature. Environmental parameters such as river stage data and precipitation data were obtained from electronic sources. Appendix B contains tabular and/or graphical summaries of these supporting data.

3.4.1 Plant Operations

The frequency of power generation, thus make-up cooling water, pump flows, at Plant Vogtle is very stable. Although, each of the four make-up water intake pumps at Plant Vogtle are design-rated to pump 22,000 gpm (63.36 mgd or 240,000 m^3/day), actual pump flows through a given period of time can be affected by daily operational needs, periodic maintenance (outage), and to a minor degree, changes inflow head pressure due to fluctuations in river stage elevation. A summary of mean pumping rate per half monthly sampling period is as recorded during the study period is shown in Table B-1, Appendix B.

3.4.2 Environmental Parameters

Table B-2 in Appendix B provides a summary of water quality parameters recorded during the source water study component. Water temperature data were collected through a variety of means during the study including manually recorded ambient river surface water temperatures via a multi-array Hydrolab water quality meter, and for the purpose of trend analysis electronic USGS daily water quality data records as available and applicable for the study area.

The river stage at Plant Vogtle change constantly in response to regulated flow conditions from Corps of Engineers operations upstream and influenced by local precipitation and/or riparian vegetation evapo-transpiration rates. Regional ambient air temperatures, river stage and discharge, and precipitation records were electronically obtained from the USGS Waynesboro gage (Station No. 021973269) and the University of Georgia weather monitoring net work (Figures B-1 through B-3; Appendix B).

4. RESULTS

4.1 Source Water (Savannah River) Early Life Stage Fish Community

A total of 67 source water ichthyoplankton samples were collected from the Savannah River during the study period. Sixty (89.5 percent) of those samples were collected from the three sampling stations positioned along the primary sampling transect located upstream from the intake structure at its confluence with the Savannah River. The seven (11.7 percent) remaining samples, used as a measure of between-gear and between-location analyses, were collected along the second transect located near the proposed location of the Units 3&4 intake structure (Figure 2-1).

4.1.1 Species Composition and Relative Abundance

Table 4-1 provides a list of taxa and taxa groups (fish eggs and larvae identifiable in the lab to the lowest practical taxon) collected from the source water community. Sixteen species were identified among 23 taxa groups representing 13 taxonomic families (Table 4-1). Among the seven remaining taxa groups, four were identifiable to Family-level, two groups to Genus-level, and one to Class-level. No protected species were collected from source water. All species or taxa groups except for yellow perch (*Perca flavescens*), an introduced species, and carp (*Cyprinus carpio*), an exotic species, are considered native to the drainage.

A total of 910 fish eggs and larvae were collected from source water samples (Table C-1; Appendix C). The single numerically most dominant taxa group was Unidentified Cyprinidae (minnows) with 184 specimens accounting for 20.2 percent of the total sample followed in decreasing order by American shad (*Alosa sapidisimma*) with 166 individual specimens (18.2 percent) and Unidentified Clupeidae (herrings) (165 specimens or 18.1 percent).

Among the total source water sample, at least nine species represented by 18 specimens in three life stages (eggs, yolk-sac and post-yolk-sac larvae) were collected in a total of four daytime samples (~1.9 percent of the total source water sample) collected near the proposed location for Units 3&4. Species or taxa groups represented there included brook silverside, carp, northern hogsucker, spotted sucker, yellow perch, and unidentified members of Clupeidae, Cyprinidae, Unidentified darters, and the Class Osteichthyes. Unidentified darter was the most abundant taxon (Table C-2, Appendix C).

TABLE 4-1. CHECKLIST OF SPECIES COLLECTED IN THE PLANT VOGTLE SOURCE WATER AND ENTRAINMENT SAMPLING, MARCH - JULY 2008

Families	Common Name*	Species	Common Name	Status	SW[1]	ENT[2]
Aphredoderidae	Pirate Perch					
		Aphredodearous sayanus	pirate perch	Native	√	√
Atherinidae	Silversides					
		Labidesthes sicculus	brook silverside	Native	√	
Catostomidae	Suckers					
		Hypentilium nigricans	northern hogsucker	Native	√	
		Minytrema melanops	spotted sucker	Native	√	
		unidentidified Catostomidae	--	--	√	√
Centrarchidae	Sun fishes					
		Lepomis macrochirus	bluegill	Native	√	
		unidentified Lepomis	--	--	√	√
Clupeidae	Herrings					
		Alosa sapidissima	American shad	Native	√	
		Dorosoma cepedianum	gizzard shad	Native	√	
		Unidentified clupeidae	--	--	√	
Cyprinidae	Minnows					
		Cyprinus carpio	carp	Exotic	√	
		Unidentified cyprinidae	--	--	√	√
Cyprinodontidae	Pupfishes					
		Unidentified cyprinodontidae	--	--	√	
Engraulidae	Anchovies					
		Anchoa mitchilli	bay anchovy	Native	√	
Ictaluridae	Catfishes					
		Ameiurus natalis	yellow bullhead	Native	√	√
		Ictalurus punctatus	channel catfish	Native	√	
Lepisosteidae	Gars					
		Lepisoteus osseus	longnose gar	Native	√	
Moronidae	Temperate Basses					
		Morone saxatilis	striped bass	Native	√	
		Morone americana	white perch	Native	√	
Osteichthyes	Bony Fishes					
		Unidentified Osteichthyes	--	--	√	√
Percidae	Perches and Darters					
		Perca flavescens	yellow perch	Introduced	√	√
		Unidentified darter	--	--	√	
Soleidae	Soles					
		Trinectes maculatus	hogchoker	Native	√	

Notes:
* = Nomenclature by Page and Burr, 1991.
1 = SW - species/taxa groups collected via source water sampling
2 = ENT - species/taxa groups collected via entrainment sampling

4.1.2 Temporal and Diel Distribution

The relative variation in egg and larval sample abundance during the five months of survey varied from about two percent (early March and both July sample events) to almost 19 percent (late April into early May)(Table C-1, Appendix C). Peak organism abundance was observed from 23 April to 8 May 2008. Peak fish egg and larval abundance in riverine drift was marked primarily by relatively high numbers of egg, yolk-sac and post-yolk-sac life stages of Unidentified Cyprinidae, American shad, and Unidentified Clupeidae. The number of individual specimens per sampling event ranged from 0 to 170 with an average of 46 organisms per sampling event.

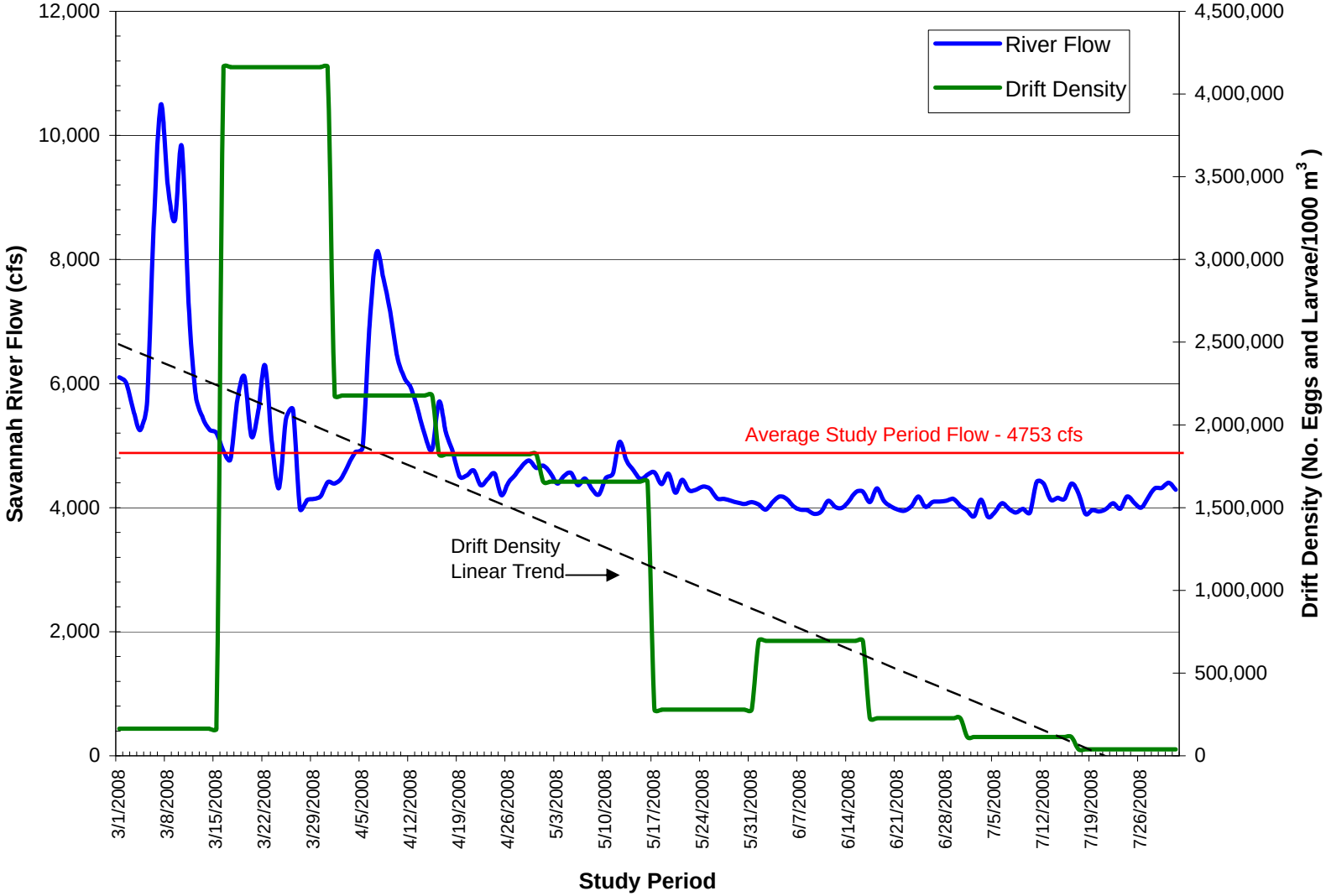
As shown in Figure 4-1, egg and larval drift abundance during the study period declined with elevated springtime river flows ranging upward near 13,000 cfs to a late-through summer low-flow average near 4,100 cfs. A sharp decline in egg and larval density was observed in mid-May which continued to an end-of-season bracket by mid July. Thus the opportunity for intake entrainment at Plant Vogtle is reduced with declining seasonal river flows. This trend is typical of southeastern, seasonal drift patterns in Piedmont and upper Coastal Plain systems.

As for diel effect, approximately 61.6 percent of all organisms collected were found in nighttime samples. The number of organisms was higher in night samples in 9 of 10 sample events. Night samples averaged 56.1 organisms per sample event whereas day samples averaged 34.9 organisms per sample event.

4.1.3 Life Stages

As shown in Table C-3, Appendix C, peak drift in the Savannah River occurred in early May and with this peak node of egg and larval abundance bracketed between early April and mid-May. The most abundant life stage collected in source water samples was fish eggs which comprised 562 (61.8 percent) of the total 910 specimens collected. Peak drift for eggs occurred during late April through early May 2008. Yolk-sac larvae and post-yolk-sac larvae comprised 16.4 and 16.2 percent of the source water community sample, respectively. Peak drift of yolk-sac larvae and post-yolk-sac larvae occurred during late April and early may, respectively. Yearling or older life stages in the samples were few in number comprising 4.4 percent of the sample (Table C-3, Appendix C). Peak abundance for yearling or older life stages occurred during early June through mid-July.

Figure 4-1
Savannah River/Source Water Flow vs. Egg and Larval Drift Density



Note: Savannah River egg and larval densities are presented as half-monthly steps as calculated from actual sampling events during the study period.

The most abundant taxa group, Unidentified Cyprinidae (minnows), exhibited four life stages in source water samples with the most abundant life stage occurring as yolk-sac larvae observable in peak proportions during late April and again in the month of June (Table C-5, Appendix C). This peak of yolk-sac larvae were followed by an earlier pulse of eggs in the drift in late April.

American shad, a migratory (anadromous) species, was the second most abundant drift organism collected from the Savannah River. American shad was encountered in two life stage forms including egg (165 specimens) and yolk-sac larvae (one specimen). The bulk of egg and larval drift for American shad occurred primarily during mid-April through May with peak abundance noted in early May (Table C-5, Appendix D).

Unidentified Clupeidae, the third most abundant taxa group collected from source water was observed in three life stages including egg, yolk-sac larvae, and post-yolk-sac larvae. Egg life stage was the most abundant with peak occurrence in the drift between early April and mid-May (Table C-5, Appendix C).

4.1.4 Source Water Community Density

Table C-4, Appendix C shows a summary of egg and larval density as collected in the riverine source ichthyoplankton samples. The summary provides density as number of specimens per 1000 m^3.by sampling date and by day and night sampling periods. Average daytime egg and larval density per sampling event varied from 7.8 organisms/1000 m^3 (late July) to approximately 659.1 organisms/1000 m^3 (late April) with an overall daytime mean of 19.2 organisms/1000 $m^{3.}$ Nighttime densities varied from 21 organisms/1000 m^3 (early March) to approximately 1999.7 organisms/1000 m^3 (early May) with an overall mean per sampling event mean of 33.5 organisms/1000 m^3. For the entire study period, mean, per-event egg and larval density was 403.6 organisms/1000 m^3.

The Unidentified Cyprinidae yielded the highest day-time density for a single taxa group at 289.4 organisms/1000 $m^{3.}$ American shad were observed in the highest density for nighttime samples as well as overall for any single species or event throughout the study period.

For the sake of comparison, source water samples were collected during the daytime near the proposed location of Units 3&4 during the two sampling dates of late May and early June resulting in a mean fish egg and larva density of 52.9 organisms/1000 m^3. Unidentified darters yielded the highest density (17.7

organisms/1000 m^3) among samples collected at the upstream location. During the same time as those sampling events, daytime egg and larval densities sampled at the primary transect were very comparable ranging from 29.5 to 52.8 organisms per 1000-m^3 (Table C-4, Appendix C). No one species was unique to the proposed intake location of Units 3&4.

Based on the USGS gage data, mean daily river flow during the five-month study period (156 bracketed days), was 11,403,000 m^3 (~11.4 million cubic meters) Source water organism density was 403.6 organisms per 1000-m^3 (Table C-4, Appendix C).

4.2 Entrainment

A total of 36 ichthyoplankton samples collected inside the intake canal (Figure 2-1) during the study period. Due to the apparent uniform and quiescent hydraulic conditions inside the intake canal, it was assumed that single point mid-depth location provided representative samples of the entrained community. Once composited into 12-hr day and 12-hr night samples, following 6-hour sample collection intervals during each period, the 18 samples were processed for taxa identification and enumeration.

4.2.1 Species Composition and Relative Abundance

As shown in Table 4-1 and Table D-1, Appendix D, a total of 25 individual specimens comprised of three fish species and four taxonomic families/groups were collected via pumped entrainment samples during March through July 2008. No protected species were collected.

Among the three species, yellow perch (*Perca flavescens*) was the most abundant (40 percent) followed in decreasing order of ranked abundance by yellow bullhead (*Ameiurus natalis*) and pirate perch (*Aphredoderus sayanus*), each accounting for four percent of the sample catch. As for the unidentified taxa, members of the Catostomidae (suckers) were thee most dominant (20 percent) followed by the Centrarchidae (sunfishes) with 16 percent of the sample (Table D-1, Appendix D).

4.2.2 Temporal and Diel Distribution

As shown in Table D-1, Appendix D, relative change in sample abundance was quite variable (0 to 52 percent) during the 5-month study. Fifty-two percent of the entrainment sample organisms were collected in the month of March, 20 percent in April and 16 percent in the month of July.

The majority of entrainment sample organisms were collected at night (72 percent) vs. day (28 percent) (Table D-1, Appendix D).

4.2.3 Life Stages

Table D-2, Appendix D provides a breakdown of life stage occurrence by sample dates for taxa collected in entrainment samples. The few egg and larval specimens collected in entrainment samples occurred between mid-March and late-July with peak abundance (52 percent of samples) observed in mid-March. The most relatively abundant life stage component of entrainment samples was post-yolk-sac larvae representing 68 percent of the samples. Yolk-sac larvae was the second most abundant life stage group represented in entrainment samples accounting for 24 percent of the total. No eggs were encountered in entrainment samples indicating their potential absence in entrained water due to early settling out of the water column between the mouth of the canal and the head of the intake structure.

The most abundant entrainment sample species was yellow perch which was encountered as being equally represented in two life stages (yolk-sac and post-yolk-sac larvae)(Table D-3; Appendix D). Yellow perch were collected from mid-march to late April in entrainment samples.

Five unidentified, individual specimens of Catostomidae (suckers) were the second most abundant group represented in entrainment samples. Catostomids were encountered only in post-yolk-sac larval form and from mid-March to late April

Unidentified Lepomids (sunfishes), the third most abundant taxa group collected in entrainment samples, were represented by four specimens distributed in two life stages including yolk-sac and post-yolk-sac larvae. Unidentified Lepomids were collected from mid-June through late-July (Table D-3, Appendix D).

4.2.4 Entrainment Rate

Table D-4, Appendix D shows a tabular summary of egg and larval density as collected in the entrainment sampling program. The summary provides density as number of specimens by 1000 m^3.by sampling date and by day and night sampling periods. Per sampling-event daytime egg and larval density varied from 0 (zero) organisms/1000 m^3 to approximately 18.1 organisms/1000 m^3 (late March). Nighttime

density varied from 0.01 to 29 organisms/1000 $m^{3.}$ For the entire study period, mean per-event density was approximately 11.3 organisms/1000 m^3.

Table D-5, Appendix D, provides a summary of actual sample entrainment compared to the annual estimate and the annual estimate derived by applying the 95% upper confidence limit (UCL) to the half-monthly mean. The actual number of organisms enumerated in entrainment samples is 25. The annual estimate based on the sum of half monthly totals is 448,803. No organisms were collected in two of nine entrainment sampling events resulting a half-monthly mean entrainment rate of 49,867. Source water samples did not reveal a correlating trend at the time (May samples). When applying the 95% UCL, the statistical effect on the mean half monthly entrainment value results in a lower annual entrainment rate (568,154 organisms including the calculated confidence level of 13,261 organisms).

Plant Vogtle's mean daily make-up water intake pumping flow (241,000 m^3) represents approximately 2.1 percent of the mean daily flow (11,402,000 m^3) in the Savannah River (at Plant Vogtle based on study period flow records). Estimated daily entrainment rate is 1,230 organisms [eggs and larvae]) whereas the estimated daily source water drift abundance is 312,039 organisms (Table D-5, Appendix D).

4.3 Operational and Environmental Parameters

4.4.1 Operational Parameters

Plant Vogtle conducted make-up water pumping through its intake structure throughout the entire study period. Copies of operational reports showing daily recorded make-up water pumping are included in Appendix B. Mean daily make-up water pumping rate for the entire 156-day study period was 64.3 mgd (or 243.400 m^3). Compared to the mean daily discharge for the Savannah River of 11,402,000 $m^{3,}$ make-up water up pumping at Plant Vogtle represents approximately 2.1 percent of the available Savannah River flow based on measurements recorded during March 2008 – August 2008.

4.4.2 Environmental Parameters

Water quality data were recorded by the field crew during each field sampling events (March 2009 – August 2008)(Table B-2, Appendix B). Surface water temperature ranged from 12.3 to 28.6°C). The pH (standard units) varied from 6.7 to

8.4. Specific conductance ranged from 103.4 to 140.1 *u*S/cm with the highest measurements recorded at the end of the sampling period. Dissolved oxygen ranged from 6.7 to 9.0 mg/L consistent with inverse response to increasing water temperature. Turbidity ranged from 0 to 6.4 NTUs varying with precipitation.

Regional air temperature ranged from 1.0 to 38.1 °C based on the Midville, Georgia weather monitoring station (Figure B-1, Appendix B). River stage ranged from 5.9 to 11.7 ft (USGS Waynesboro Gage Station) with a daily mean stage of 6.8 ft. River flow ranged from 3,760 to 10,500 cfs with a daily mean flow of 4,646 cfs (or 11,367,000 m3). River stage exhibited decline consistent with seasonal trend from early spring to late summer (Figure B-2, Appendix B). Daily precipitation throughout the study period ranged from 0 to 2.0 inches with mean daily rainfall of 0.09 inches (Figure B-3, Appendix B) which is characteristic of severe drought conditions for the second consecutive year in the region.

Daily entrainment rates were statistically compared through regression analysis with daily data for these environmental variables. No significant correlation relationship was found between air temperature, water temperature, precipitation, or river stage for entrainment rate.

5. SUMMARY AND DISCUSSION

An entrainment study of Plant Vogtle's make-up water intake structure was conducted by GPC environmental field services staff during March through July of 2008. The study included two primary tasks including:

- source water (riverine) sampling for fish eggs and larvae from the Savannah River upstream of the Plant Vogtle intake canal, and
- entrainment sampling for fish eggs and larvae from the Plant Vogtle intake canal for fish eggs and larvae.

Results of the source water and entrained community descriptions are based on five months of "half-monthly" sampling during March through July 2008.

Entrainment sampling yielded seven species or taxa groups (29.2 percent) out of the 24 taxa groups represented in source water samples. Entrained taxa were also represented in the list of source water taxa. No protected fish species were encountered in source water or entrainment samples.

Peak organism abundance in the Savannah River occurred from 23 April to 8 May 2008 and was marked by relatively high numbers of egg, yolk-sac and post-yolk-sac life stages of Unidentified Cyprinidae and American shad. Source water samples yielded at least 23 species representing 13 taxonomic families. Most (~61.6 percent) of the eggs and larvae were present in nighttime samples. Eggs were the most abundant life stage collected overall accounting for 61.8 percent of the total sample. The density of source water organisms was calculated at 403.6 organisms per 1000 m^3. Extrapolation of sample data results in a calculated source water drift rate of approximately 312,039 organisms per day.

Total entrainment sampling effort yielded 25 individual specimens representing at least seven species indicating a paucity of organisms present in canal intake waters. Most (72 percent) life stage forms in entrainment samples were post-yolk-sac larvae. No eggs were encountered in entrainment samples an indication that eggs may have settled out of the water column as water velocities substantially diminish at the mouth of the canal. Most organisms were collected at night. The density of entrained organisms was calculated as 11.3 organisms per 1000 m^3 based on sample results. Annualized extrapolation of sample data resulted in an entrainment rate of 1,230 organisms (eggs and larvae)/day.

Plant Vogtle's mean daily make-up water intake pumping flow of 241,000 m^3 represents approximately 2.1 percent of the mean daily flow 11,402,000 m^3 in the Savannah River based on study period flow records. No statistically significant relationship was found between entrainment rate and trends of air temperature, water temperature, or river discharge. Empirical observations of river flow and riverine egg and larval drift during the study period (Figure 4-1) clearly demonstrated abrupt decline in drift abundance following the end of elevated springtime flows and the beginning of early summer flow norm.

Fish eggs and larvae source water samples were approximately 36.4 times more numerous than entrainment samples collected during the same period. The three most abundant source water taxa were not ranked the same as found in entrainment samples. The numerically most dominant source water taxa were Unidentified Cyprinidae (20.2 percent), American shad (18.2 percent), and Unidentified Clupeidae (18.1 percent); whereas, the most abundant entrainment sample taxa were yellow perch (40 percent), Unidentified Catostomidae (20 percent), and Unidentified Lepomis (16 percent). By comparison, yellow perch accounted for 1.8 percent of source water samples,

Unidentified Catostomidae (8.2 percent), and Unidentified Lepomis (2.3 percent) of the source water sample.

Pirate perch was the only species common to source water and entrainment samples. Although not the most common species among either source water or entrainment samples, pirate perch is known to be common in the study area and is well suited for habitation and spawning in a variety of habitat types including the intake canal. Pirate perch is known both as an egg broadcaster over a variety of substrates as well as being a cavity nester (Marcy et al. 2005).

Six other species or taxa groups were represented both in source water and canal entrainment samples (Table 4-1) in at least one life stage. They included yellow bullhead, yellow perch, Unidentified Catostomids, Unidentified Lepomids, and unidentifiable fish eggs (Class Osteichthyes). Although a common species in the region and in entrainment samples, yellow perch is not native to the middle Savannah River. Its historical occurrence is more northern in range and it has been widely introduced elsewhere including the Savannah Basin (Marcy et al. 2005).

Table 5-1 provides a numerical comparison between species common to both source and entrainment sampling by sample type and life stage. No eggs were encountered in entrainment samples for any of the seven common species nor for any other species encountered during the source water study. Yolk-sac larvae were observed in both entrainment and source water samples for only one taxa group (Unidentified Lepomis). Post-yolk-sac larvae were encountered in both entrainment and source water samples in five of the seven common taxa/groups. The only species common to both source water and entrainment samples as a young-of-the-year life stage was yellow bullhead. Post-yolk-sac larvae represented 68 percent of the entrainment samples; whereas, eggs were the most abundant life stage collected from source water.

Although few samples were collected there, no single species was unique to the proposed intake location of Units 3&4 as compared to the primary transect sampling location. Source water samples were collected near the proposed location of Units 3&4 intake on two dates including late-May and early-June resulting in a mean fish egg and larva density of 52.9 organisms/1000 m^3. During the same time as those sampling events, daytime egg and larval densities sampled from the primary transect were very comparable ranging from 29.5 to 52.8 organisms per 1000-m^3.

The siting study entrainment assessment performed in GPC's 1974 studies of Plant Vogtle Units 1&2 relied on then-recent studies at the adjacent Savannah River Site

TABLE 5-1. SUMMARY OF LIFE STAGES FOR SPECIES OR TAXA GROUPS COMMON TO SOURCE WATER AND ENTRAINMENT SAMPLES, PLANT VOGTLE, MARCH 2008 THROUGH JULY 2008

	Number of Specimens by Life Stage and Sample Type							
Common Name	**Egg**		**Yolk-Sac Larvae**		**Post-Yolk-Sac Larvae**		**Young-of-the-Year**	
	SW	**EN**	**SW**	**EN**	**SW**	**EN**	**SW**	**EN**
pirate perch	--	--	--	--	2	1	--	--
unidentified Catostomidae	--	--	13	--	62	5	--	--
unidentified Cyprinidae	51	--	82	--	41	3	1	--
unidentified Lepomis	2	--	2	1	17	3	--	--
unidentified Osteichthyes	28	--	--	--	--	--	--	--
yellow bullhead	--	--	--	--	--	--	20	1
yellow perch	--	--	10	5	6	5	--	--

Note:
SW = source water sample; EN = canal entrainment sample
Table does not include ten specimens unidentifiable to life stage.

(SRS) where intensive field studies demonstrated that fish eggs were rarely found in canal plankton samples. It was concluded then that eggs and larvae settled to the bottom of the intake canal before becoming entrained owing to substantially decreased water column velocities inside the canal as compared to the Savannah River (source water) where swifter current keep eggs and larvae in suspension in the drift. The indication was that eggs and larvae which entered the intake canal were not necessarily entrained further validated by the fact that sunfish, minnows, and silversides persisted in the SRS intake canal. Per the SRS studies, sunfish in particular were known to spawn in the intake canals and were the dominant species there year round. The early Plant Vogtle studies concluded that the Vogtle intake structure would be constructed in a similar manner as SRS intake structures and minimal entrainment would likewise result.

For perspective in evaluating the 2008 study results, findings from GPC's 1974 source water study and entrainment assessment were reviewed for comparison. The 1974 source-water study at Plant Vogtle utilized six sampling stations on the Savannah River (two net collection stations along three transects) and used 1-meter nets constructed of 760 *u* mesh. Egg and larval samples were collected during January through May and July through August with and average sample time per station of 15 minutes. A total of 89 day samples and 88 night samples were collected. The sampling resulted in collected of 1,423 eggs and 2,177 larvae with at least 34 species of fish represented. Overall, a greater number of eggs and larvae were collected at night. Peak drift abundance occurred during April and May with a sharp increase detected in July. Crappie larvae were the largest contributor to the drift community accounting for 29.3 percent of the sample by American shad eggs (23.6 percent) and spotted sucker larvae (15.7 percent). The highest densities, per 1000 m^3, were reported for Clupeidae, Catostomidae, and Centrarchidae.

For comparison, entrainment at the Savannah River Plant pump-house intakes, located a short distance upstream for Pant Vogtle, was estimated in 1982, 1983, 1984, and 1985. Several taxa especially gizzard shad in 1982 and 1983, crappie in 1983 and 1984, and spotted sucker in 1985 occurred in unusually high densities suggesting they were spawned in the canals. Species that spawned in the canals tended to exhibit increased entrainment. Entrainment losses averaged 10×10^6 eggs and 18.8×10^6 larvae annually (vs ~3.1×10^5 total eggs and larvae at Plant Vogtle). Entrainment loses were primarily American shad and other herring species (clupeids). Entrainment was greatest during periods of high intake water usage which coincided with low river flow during the spawning season (*in* Kilgo et al. 2005).

Many aspects of the 2008 source water study at Plant Vogtle were comparable to the 1974 study. The 2008 study used a total of three sampling stations aligned along one of the same upstream river cross-sections used in the 1974 study. Additionally, three stations were sampled along a single cross-section near the proposed location of Units 3&4 on one occasion and again at one of those three stations on one other occasion. Samples were collected during longer periods (average time per station of 18.6 minutes) with nets using a smaller net opening and mesh size as compared to the 1974 study (15 minutes). Samples in 2008 were collected during March through July whish directly overlapped the 1974 sampling period. . Sixty-four day samples and 60 night samples were collected in 208 vs. 89 and 88 day and night samples in the 1974 study. More organisms were collected at night in 2008 just as observed in the 1974 study. Peak drift abundance in 1974 and 2008 occurred in April, May, with a sharp increase in July in 1974 and a pronounced peak in May in the 2008 study (without consideration for long- or short-term environmental, climatologic, or hydrological trends that may have influenced results during either study). Cyprinidae, in contrast to crappies (29.3 percent were the single largest contributor to the drift population in 2008 accounting for 20.0 percent of the total. In 1974, American shad eggs accounted for 23.6 percent of the source water sample compared to 18.2 percent of the sample in 2008. In 2008, members of the Cyprinidae and Clupeidae were the largest contributors of yolk-sac and post-yolk-sac larvae in source water samples. The highest organism density recorded during the day in the 2008 study was exhibited by Unidentified Cyprinidae at 289.4 organisms/1000 $m^{3.}$ American shad exhibited the highest density for nighttime samples as well throughout the study for a single species or event. Highest organism densities in the 1974 study were observed in families of Clupeidae, Catostomidae, and Centrarchidae.

The 2008 source water study conducted at Plant Vogtle revealed the presence of egg and early larval forms through yearling life stage for a diversity (23) of fish species representative of recently documented fish fauna of the region. The observed trend in timing of recruitment and peak drift abundance were consistent with those documented in previous studies of the area. The 2008 entrainment study result was consistent with conclusions drawn from the 1974 siting studies in demonstrating that entrainment impact at Plant Vogtle is likely minimal owing to the relative absence of organisms in entrainment samples collected from the intake canal during period of peak riverine drift. The low numbers of entrained organisms collected samples appear to likewise be related to the substantial differential decrease in water column velocity as source water is drawn from the river, partially deflected through the stop log gate and sediment catchment sheet pilings located in the mouth of the intake canal. Many semi-buoyant or

demersal eggs and larvae that enter the canal, otherwise suspended in passing riverine currents, likely quickly settle into sedimentary substrates in the proximal end of the canal. Thus, most early life stage fishes entering the canal never reach the intake screens. The most abundant species entrained included only larval stages of yellow perch, unidentified suckers, and unidentified sunfishes. Owing to the type of habitat present in the canal, particularly sunfishes may even reside and spawn in the intake canal where suitable habitats and quiescent hydraulic conditions prevail. Localized and source water occurrence larval sunfishes in addition to abundance pulses of suckers and yellow perch from source water apparently contribute to the majority of entrainment based on sample results. The early GPC studies referred to SRP studies where it was stated that fish eggs carried by riverine flows were generally closer to the bottom and upon entering the intake canal encountered a sharp decrease in velocity and has a tendency to settle to the bottom resulting in low entrainment rates. The abundance of American shad eggs in particular in source water was not detected in entrainment samples indicating further that little entrainment occurs through the Plant Vogtle intake structure.

Overall, the 2008 entrainment assessment result combined with earlier GPC and SRP findings (and the fact that less than 2.2 percent of the Savannah River flow is withdrawn by the intake) indicate that entrainment effect at Plant Vogtle is minimal resulting in an insignificant effect on the fish population of the Savannah River.

6. REFERENCES

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APPENDIX A

Field Data Sheet Templates

FIGURE A-1. Vogtle I & E Study - Source Water Community Sampling Data Sheet*

Collected by:_____
Date:_____
Gear: dual 1:3 ratio 0.5 m Nitex 500 micron mesh plankton nets

Sampling Period Circle One:	DAY 1	DAY 2	NIGHT 1	NIGHT 2	Depth (m)	Time at Depth (mins)
Location: Left Bank (facing upstream)						
Time start			HRS		1	
Current meter start count					2	
Current meter stop count					3	
Time stop			HRS		4	
Total time for retrieval			MINS		5	
Calculated sample flow volume (m^3/s)					6	
Location: Mid-Channel						
Time start (HRS)			HRS		1	
Current meter start count					2	
Current meter stop count					3	
Time stop (HRS)			HRS		4	
Total time for retrieval (mins)			MINS		5	
Calculated sample flow volume (m^3/s)					6	
Location: Right Bank (facing upstream)						
Time start (HRS)			HRS		1	
Current meter start count					2	
Current meter stop count					3	
Time stop (HRS)			HRS		4	
Total time for retrieval (mins)			MINS		5	
Calculated sample flow volume (m^3/s)					6	

Comments/Observations:
* 6 hour samples are archived (type A samples)
* day and night sample components are composited for laboratory analysis (type C samples)

FIGURE A-2. Vogtle I & E Study - Canal Entrainment Sampling Data Sheet*

Collected by:_____

Date:_____

Canal Water Stage to top rail_____**ft**

Depth of Pump Deployment _____**ft**

Pumps: 2 electric Tsurumi LB3-750 type with 73 gpm capacity at level head

	DAY 1	DAY 2	NIGHT 1	NIGHT 2
Time start (HRS)				
Time stop (HRS)				
Total pumping time (mins)				
Calculated sample flow volume (m^3)				

Notes:

Flow volume flow based on depth and river stage and performance curve:_____ gals/min

* 6 hour samples are archived (type A samples)

* day and night sample components are composited for laboratory analysis (type C samples)

FIGURE A-3. Vogtle I & E Study Sample Chain Of Custody

Collected by:_____

Sample No.	Integrated Sample ID and Collection Date	Approximate Time of Collection	Preservative	Shipped to taxonomy lab	Archived at GPC Smyrna
		~0000 HRs	5% formalin or 10% formalin Wet Ice	√	√
1	ENLD1A				
2	ENLD2A				
3	ENLDCOMP				
4	ENLN1A				
5	ENLN2A				
6	ENLNCOMP				
7	IMDA				
8	IMNA				
9	SWLD1A				
10	SWLD2A				
11	SWLDCOMP				
12	SWMD1A				
13	SWMD2A				
14	SWMDCOMP				
15	SWRD1A				
16	SWRD2A				
17	SWRDCOMP				
18	SWLN1A				
19	SWLN2A				
20	SWLNCOMP				
21	SWMN1A				
22	SWMN2A				
23	SWMNCOMP				
24	SWRN1A				
25	SWRN2A				
26	SWRNCOMP				
27					
28					
29					
30					

EN = entrainment sample D1 = first day sample C = composited 1st and 2nd day or night samples
IM = impingement sample N2 = second night sample
SW = source water sample A = archived 6-hour sample

Relinquished by:_____ Date:_____ Time:_____

Received by:_____ Date: _____ Time:_____

APPENDIX B

Summaries of Operational and Environmental Parameters

TABLE B-1. SUMMARY OF HALF-MONTHLY MAKE-UP WATER INTAKE PUMPING VOLUMES AT PLANT VOGTLE, MARCH 2008 THROUGH JULY 2008

Sample Period	Pump Volume (MGD)[1]
early March 2008	61.1
late March 2008	61.4
early April 2008	63.4
late April 2008	63.4
early May 2008	61.9
late May 2008	62.2
early June 2008	64.3
late June 2008	63.4
early July 2008	62.8
late July 2008	70.7

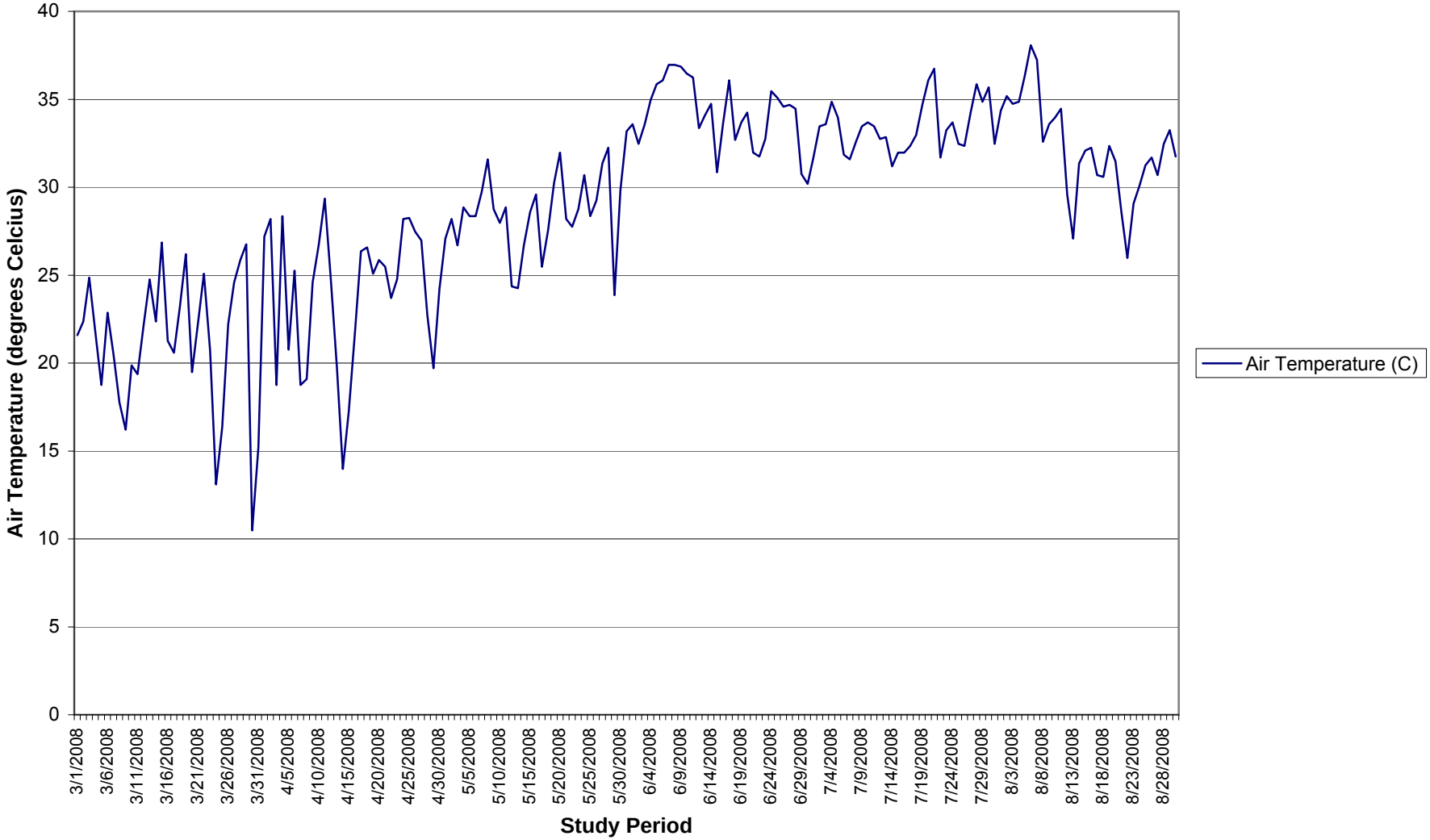
Notes:

1 =MGD - million gallons per day

TABLE B-2. SUMMARY OF PHYSICOCHEMICAL WATER QUALITY MEASUREMENTS COLLECTED DURING THE SOURCE WATER COMMUNITY STUDY AT PLANT VOGTLE, MARCH 2008 THROUGH JULY 2008

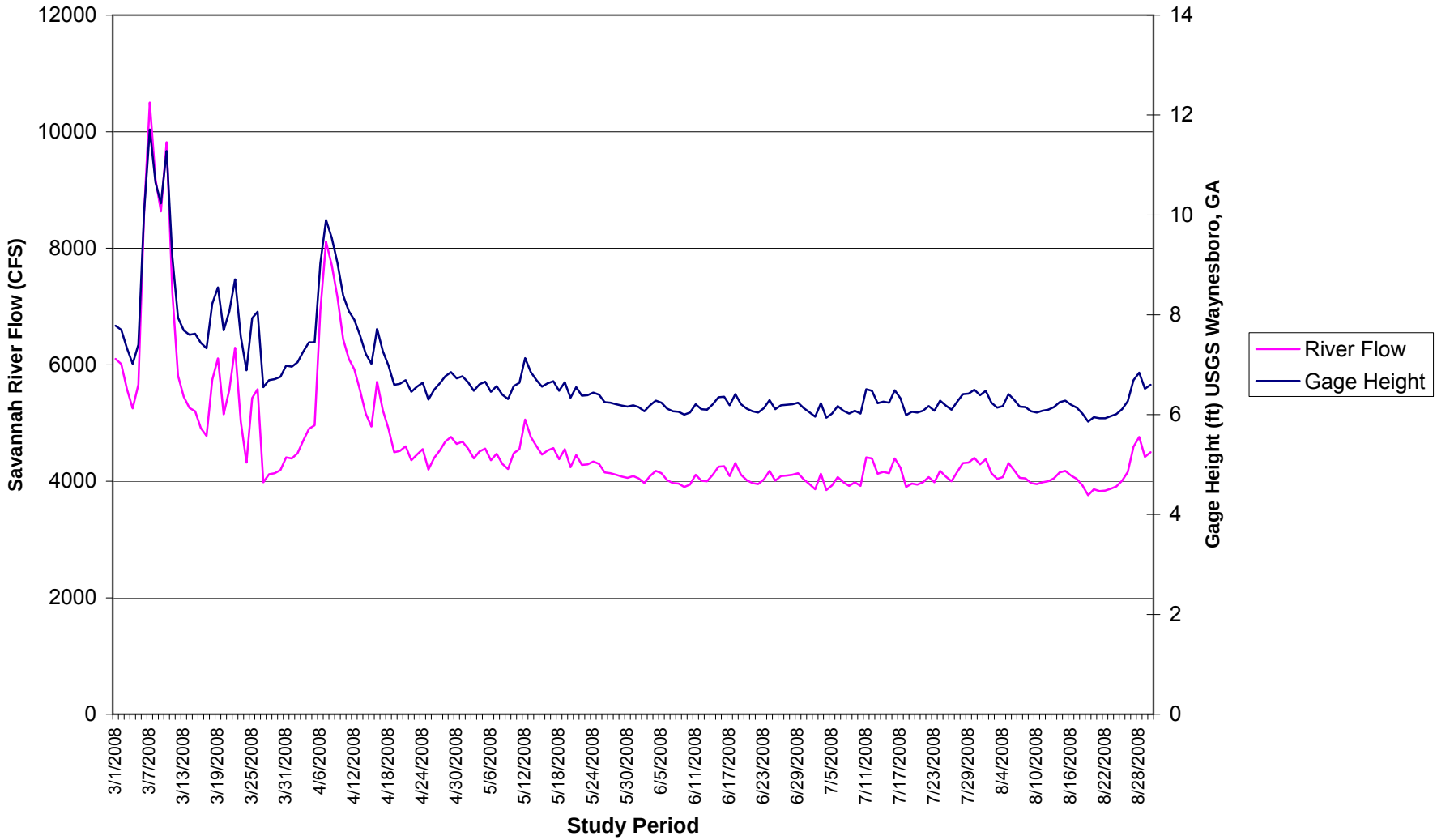
Event	Mean Water Temperature (°C)	pH (SU)	Conductivity (uS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)
10-12 March 2008	12.5	7.4	123.0	8.5	--
17-19 March 2008	15.5	7.0	103.4	8.8	0.8
8-10 April 2008	17.0	6.7	118.0	8.2	0.8
22-24 April 2008	18.4	7.1	113.4	9.0	0.0
6-8 May 2008	22.4	7.2	121.1	7.7	0.0
20-22 May 2008	22.7	7.1	106.2	7.2	6.4
10-12 June 2008	28.6	8.0	128.5	7.2	0.0
24-25 June 2008	27.0	8.2	127.5	7.4	0.0
15-16 July 2008	26.5	7.2	130.5	6.7	0.3
29-30 July 2008	27.6	8.4	140.1	6.9	0.0

Figure B-1
Air Temperature Recorded at the Midville, GA, Burke County, Weather Station



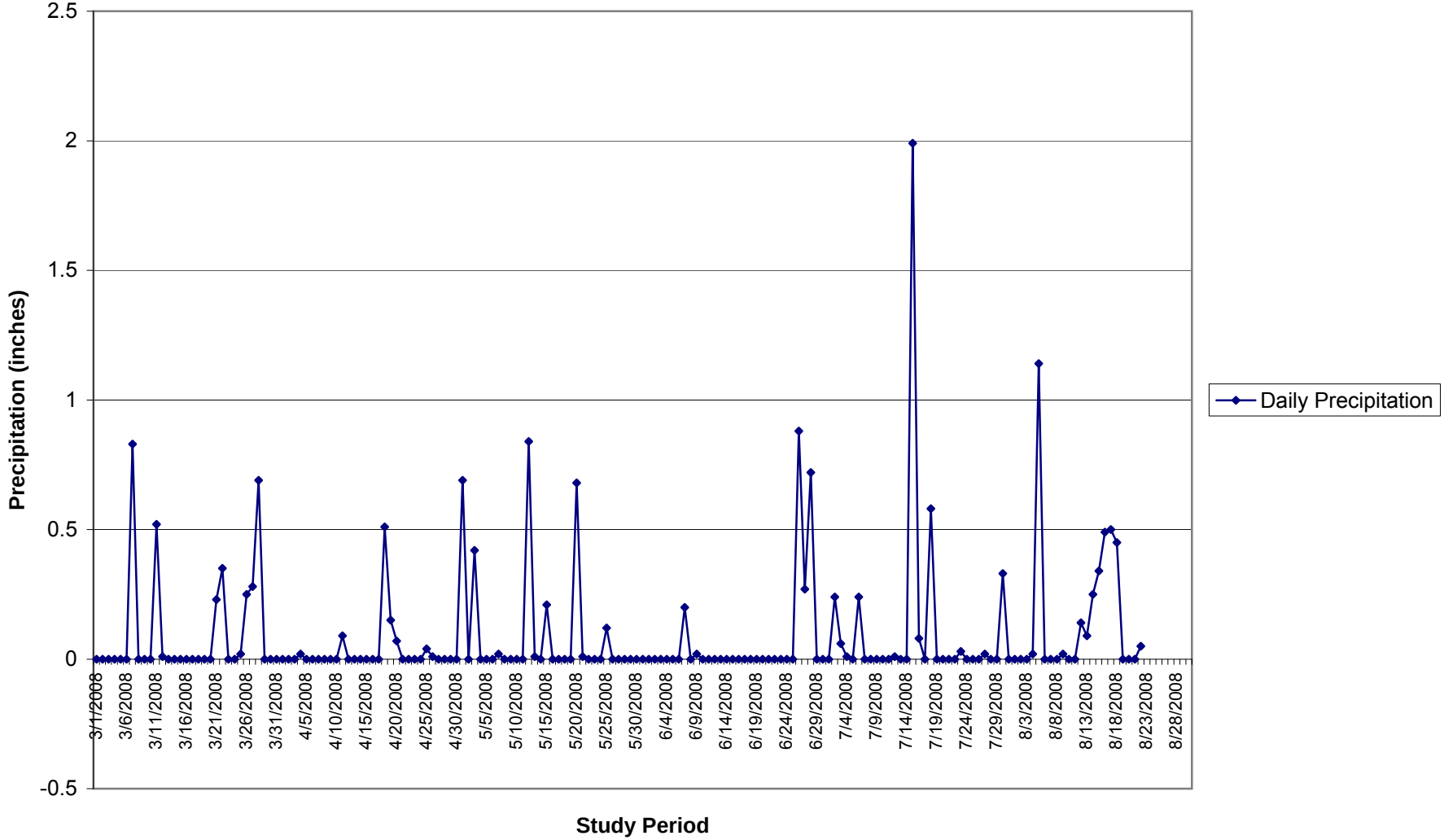
LAB7600

Figure B-2
Savannah River Flow (cfs) vs Gage Height (ft) msl



LAB7600

Figure B-3
Daily Precipitation, USGS Waynesboro,GA



LAB7600

Monthly Surface Water Withdrawal Report (Raw Water Intake Data)

Report all Values in Millions of Gallons (Gallons/1,000,000)	Surface Water	Surface Water	Surface Water	Surface Water	Surface Water
	Withdrawal Permit #:	Withdrawal Permit #:	Withdrawal Permit #:	Withdrawal Permit #:	Withdrawal Permit #:
	017-0191-05				
	Water Source:	Water Source:	Water Source:	Water Source:	Water Source:
	Savannah River				
Day of Month	Withdrawn (MG)*	Withdrawn (MG)*	Withdrawn (MG)*	Withdrawn (MG)*	Withdrawn (MG)*
1	63.36				
2	63.36				
3	63.36				
4	63.36				
5	63.36				
6	63.36				
7	63.36				
8	63.36				
9	63.36				
10	63.36				
11	63.36				
12	63.36				
13	58.83				
14	63.07				
15	63.36				
16	63.36				
17	63.36				
18	63.36				
19	63.36				
20	63.36				
21	63.36				
22	63.36				
23	63.36				
24	63.36				
25	63.36				
26	63.36				
27	63.36				
28	63.36				
29	63.36				
30	63.36				
31	63.36				
Total (MG)*	1959.34				
Average (MGD)**	63.20				
Max Day (MG)*	63.36				

Submit data for each Surface Water Withdrawal Permit. Permits that were not used must still be reported by inputting zero's for each day.

System Name: Southern Nuclear Operating Company-Plant Vogtle

WSID # or SIC #: SIC 4911

Month: **March**

Year: **2008**

Send to: Georgia Environmental Protection Division
Watershed Protection Branch, SW M&I Unit
4220 International Parkway
Suite 101
Atlanta, GA 30354-3902
Phone: (404) 675-1646
Fax: (404) 675-6244
E-mail: surface_water@mail.dnr.state.ga.us

I certify that all information contained on this form is correct and true to the best of my knowledge.

Signature 4-2-9 Date

Clif Buck
Print Name

Chemistry Manager
Title

contact information for SNC Env. Affairs

(205) 992 - 6387
Phone Number

(205) 992 - 6108
Fax Number

*: MG represents millions of gallons.
(MG = Gallons / 1,000,000)

**: MGD represents million gallons per day.
Average is calculated by dividing total quantity of water withdrawn by the number of days in the calendar month.
Average = (Total in MG / Days in month)

Monthly Surface Water Withdrawal Report (Raw Water Intake Data)

Report all Values in Millions of Gallons (Gallons/1,000,000)	Surface Water	Surface Water	Surface Water	Surface Water	Surface Water
	Withdrawal Permit #:	Withdrawal Permit #:	Withdrawal Permit #:	Withdrawal Permit #:	Withdrawal Permit #:
	017-0191-05				
	Water Source:	Water Source:	Water Source:	Water Source:	Water Source:
	Savannah River				
Day of Month	Withdrawn (MG)*	Withdrawn (MG)*	Withdrawn (MG)*	Withdrawn (MG)*	Withdrawn (MG)*
1	63.36				
2	63.36				
3	63.36				
4	63.36				
5	63.36				
6	63.36				
7	63.36				
8	63.36				
9	63.36				
10	63.36				
11	63.36				
12	63.36				
13	63.36				
14	63.36				
15	63.36				
16	63.36				
17	63.36				
18	63.36				
19	63.36				
20	63.36				
21	63.36				
22	63.36				
23	63.36				
24	63.36				
25	63.36				
26	63.36				
27	63.36				
28	63.36				
29	63.36				
30	63.36				
Total (MG)*	1900.8				
Average (MGD)**	63.36				
Max Day (MG)*	63.36				

Submit data for each Surface Water Withdrawal Permit. Permits that were not used must still be reported by inputting zero's for each day.

System Name: Southern Nuclear Operating Company-Plant Vogtle

WSID # or SIC #: SIC 4911

Month: **April**

Year: **2008**

Send to: Georgia Environmental Protection Division
Watershed Protection Branch, SW M&I Unit
4220 International Parkway
Suite 101
Atlanta, GA 30354-3902
Phone: (404) 675-1646
Fax: (404) 675-6244
E-mail: surface_water@mail.dnr.state.ga.us

I certify that all information contained on this form is correct and true to the best of my knowledge.

5-2-08
Signature Date

for ~~[illegible]~~ Clif Buck

Clif Buck
Print Name

Chemistry Manager
Title

contact information for SNC Env. Affairs

(205) 992 - 6387
Phone Number

(205) 992 - 6108
Fax Number

*: MG represents millions of gallons.
(MG = Gallons / 1,000,000)

**: MGD represents million gallons per day.
Average is calculated by dividing total quantity of water withdrawn by the number of days in the calendar month.
Average = (Total in MG / Days in month)

Monthly Surface Water Withdrawal Report (Raw Water Intake Data)

Report all Values In Millions of Gallons (Gallons/1,000,000)	Surface Water Withdrawal Permit #: 017-0191-05	Surface Water Withdrawal Permit #:	Surface Water Withdrawal Permit #:	Surface Water Withdrawal Permit #:	Surface Water Withdrawal Permit #:
	Water Source: Savannah River	Water Source:	Water Source:	Water Source:	Water Source:
Day of Month	Withdrawn (MG)*	Withdrawn (MG)*	Withdrawn (MG)*	Withdrawn (MG)*	Withdrawn (MG)*
1	63.36				
2	63.36				
3	63.36				
4	63.36				
5	63.36				
6	63.36				
7	71.24				
8	63.36				
9	63.36				
10	63.36				
11	63.36				
12	63.36				
13	63.36				
14	63.36				
15	63.36				
16	63.36				
17	63.36				
18	63.36				
19	63.36				
20	63.36				
21	63.36				
22	63.36				
23	63.36				
24	76.89				
25	63.36				
26	63.36				
27	63.36				
28	63.36				
29	63.36				
30	63.36				
31	63.36				
Total (MG)*	1985.57				
Average (MGD)**	64.05				
Max Day (MG)*	76.89				

Submit data for each Surface Water Withdrawal Permit. Permits that were not used must still be reported by inputting zero's for each day.

System Name: Southern Nuclear Operating Company-Plant Vogtle

WSID # or SIC #: SIC 4911

Month: **May**

Year: **2008**

Send to: Georgia Environmental Protection Division
Watershed Protection Branch, SW M&I Unit
4220 International Parkway
Suite 101
Atlanta, GA 30354-3902
Phone: (404) 675-1646
Fax: (404) 675-6244
E-mail: surface_water@mail.dnr.state.ga.us

I certify that all information contained on this form is correct and true to the best of my knowledge.

Signature 6-6-08 Date

Clif Buck
Print Name

Chemistry Manager
Title

contact information for SNC Env. Affairs

(205) 992 - 6387
Phone Number

(205) 992 - 6108
Fax Number

*: MG represents millions of gallons.
(MG = Gallons / 1,000,000)

**: MGD represents million gallons per day.
Average is calculated by dividing total quantity of water withdrawn by the number of days in the calendar month.
Average = (Total in MG / Days in month)

Monthly Surface Water Withdrawal Report (Raw Water Intake Data)

Report all Values in Millions of Gallons (Gallons/1,000,000)	Surface Water	Surface Water	Surface Water	Surface Water	Surface Water
	Withdrawal Permit #:	Withdrawal Permit #:	Withdrawal Permit #:	Withdrawal Permit #:	Withdrawal Permit #:
	017-0191-05				
	Water Source:	Water Source:	Water Source:	Water Source:	Water Source:
	Savannah River				
Day of Month	Withdrawn (MG)*	Withdrawn (MG)*	Withdrawn (MG)*	Withdrawn (MG)*	Withdrawn (MG)*
1	63.36				
2	63.36				
3	63.36				
4	66.40				
5	73.30				
6	64.06				
7	63.36				
8	63.36				
9	63.36				
10	63.36				
11	63.36				
12	63.36				
13	63.36				
14	63.36				
15	63.36				
16	63.36				
17	63.36				
18	63.36				
19	63.36				
20	63.36				
21	63.36				
22	63.36				
23	63.36				
24	63.36				
25	63.36				
26	63.36				
27	63.36				
28	63.36				
29	63.36				
30	63.36				
Total (MG)*	1914.48				
Average (MGD)**	63.82				
Max Day (MG)*	73.30				

Submit data for each Surface Water Withdrawal Permit. Permits that were not used must still be reported by inputting zero's for each day.

System Name: Southern Nuclear Operating Company-Plant Vogtle

WSID # or SIC #: SIC 4911

Month: **June**

Year: **2008**

Send to: Georgia Environmental Protection Division
Watershed Protection Branch, SW M&I Unit
4220 International Parkway
Suite 101
Atlanta, GA 30354-3902
Phone: (404) 675-1646
Fax: (404) 675-6244
E-mail: surface_water@mail.dnr.state.ga.us

I certify that all information contained on this form is correct and true to the best of my knowledge.

Stan Varnum 7-10-08
Signature Date

Stan Varnum for Clif Buck

Clif Buck
Print Name

Chemistry Manager
Title

contact information for SNC Env. Affairs

(205) 992 - 6387
Phone Number

(205) 992 - 6108
Fax Number

*: MG represents millions of gallons.
(MG = Gallons / 1,000,000)

**: MGD represents million gallons per day.
Average is calculated by dividing total quantity of water withdrawn by the number of days in the calendar month.
Average = (Total in MG / Days in month)

Monthly Surface Water Withdrawal Report (Raw Water Intake Data)

Report all Values in Millions of Gallons (Gallons/1,000,000)	Surface Water	Surface Water	Surface Water	Surface Water	Surface Water
	Withdrawal Permit #:	Withdrawal Permit #:	Withdrawal Permit #:	Withdrawal Permit #:	Withdrawal Permit #:
	017-0191-05				
	Water Source:	Water Source:	Water Source:	Water Source:	Water Source:
	Savannah River				
Day of Month	Withdrawn (MG)*	Withdrawn (MG)*	Withdrawn (MG)*	Withdrawn (MG)*	Withdrawn (MG)*
1	63.36				
2	63.36				
3	63.36				
4	63.36				
5	63.36				
6	63.36				
7	63.36				
8	63.36				
9	63.36				
10	63.36				
11	73.15				
12	63.36				
13	63.36				
14	75.61				
15	63.36				
16	63.36				
17	63.36				
18	63.36				
19	75.35				
20	74.76				
21	70.62				
22	75.94				
23	75.31				
24	75.39				
25	71.04				
26	71.70				
27	76.47				
28	72.20				
29	76.27				
30	63.36				
31	63.36				
Total (MG)*	2104.29				
Average (MGD)**	67.88				
Max Day (MG)*	76.47				

Submit data for each Surface Water Withdrawal Permit. Permits that were not used must still be reported by inputting zero's for each day.

System Name: Southern Nuclear Operating Company-Plant Vogtle

WSID # or SIC #: SIC 4911

Month: **July**

Year: **2008**

Send to: Georgia Environmental Protection Division
Watershed Protection Branch, SW M&I Unit
4220 International Parkway
Suite 101
Atlanta, GA 30354-3902
Phone: (404) 675-1646
Fax: (404) 675-6244
E-mail: surface_water@mail.dnr.state.ga.us

I certify that all information contained on this form is correct and true to the best of my knowledge.

Signature 8/5/08 Date

Clif Buck
Print Name

Chemistry Manager
Title

contact information for SNC Env. Affairs

(205) 992 - 6387
Phone Number

(205) 992 - 6108
Fax Number

*: MG represents millions of gallons.
(MG = Gallons / 1,000,000)

**: MGD represents million gallons per day.
Average is calculated by dividing total quantity of water withdrawn by the number of days in the calendar month.
Average = (Total in MG / Days in month)

APPENDIX C

Source Water Community Sampling Results

TABLE C-1. SPECIES SUMMARY BY SAMPLE DATE OF ORGANISMS COLLECTED FROM THE SOURCE WATER COMMUNITY AT PLANT VOGTLE, MARCH 2008 - JULY 2008

Species Name	3/11/2008 -Day	3/12/2008 - Night	3/26/2008 - Day	3/27/2008 - Night	4/9/2008 - Day	4/10/2008 - Night	4/23/2008 - Day	4/24/2008 - Night	5/7/2008 - Day	5/8/2008 - Night	5/21/2008 - Day	5/22/2008 - Night	6/11/2008 - Day	6/12/2008 - Night	6/25/2005 -Day	6/26/2005 - Night	7/15/2008 - Day	7/16/2008 - Night	7/29/2008 - Day	7/30/2008 - Night	**Number**	*% of Total*
American Shad		5		11	1	49		2	2	72	3	20		1							**166**	*18.2%*
bay anchovy							3					3									**6**	*0.7%*
bluegill																1					**1**	*0.1%*
brook silverside										1			1								**2**	*0.2%*
carp									15	16	2	2	6	5	1	4					**51**	*5.6%*
channel catfish														1		1		10		5	**17**	*1.9%*
gizzard shad	1																				**1**	*0.1%*
hogchoker						1															**1**	*0.1%*
longnose gar														1							**1**	*0.1%*
northern hogsucker											4										**4**	*0.4%*
pirate perch						2															**2**	*0.2%*
spotted sucker											1										**1**	*0.1%*
striped bass							22	5		34											**61**	*6.7%*
Unidentified Catostomidae					6	8	16	11	14	17	2			1							**75**	*8.2%*
Unidentified Clupeidae		2		4	34	24	13	38	15	15	14	3	1		1					1	**165**	*18.1%*
Unidentified Cyprinidae	1		3	10	14	8	54	11	6	4	1	7	8	26	4	17		7		3	**184**	*20.2%*
Unidentified Cyprinodontidae																			1		**1**	*0.1%*
Unidentified darter	2	1	3	8	6	5	7	9	2	9	4	4	5	4	2	1					**72**	*7.9%*
Unidentified Lepomis						1			1		1	2	2	5		1		4		4	**21**	*2.3%*
Unidentified Osteichthyes			3	1	3	1	6	3	3		6	1	2	2							**31**	*3.4%*
white perch									6	1	2		2								**11**	*1.2%*
yellow bullhead														16		4					**20**	*2.2%*
yellow yerch			1		6	1	2	2		1	1		1	1							**16**	*1.8%*
TOTALS	**4**	**8**	**10**	**34**	**70**	**100**	**123**	**81**	**64**	**170**	**41**	**42**	**28**	**63**	**8**	**29**	**0**	**21**	**1**	**13**	**910**	***100%***
Day TOTALS	**4**		**10**		**70**		**123**		**64**		**41**		**28**		**8**		**0**		**1**		**349**	***38.4%***
Night TOTALS		**8**		**34**		**100**		**81**		**170**		**42**		**63**		**29**		**21**		**13**	**561**	***61.6%***

TABLE C-2. SUMMARY OF TAXA ABUNDANCE AND LIFE STAGES COLLECTED* FROM SOURCE WATER AT THE PROPOSED LOCATION OF UNITS 3&4 INTAKE, MARCH 2008 - JULY 2008

	Number of Specimens by Life Stage				
Common Name	**Egg**	**Yolk-sac larvae**	**Post yolk-sac larvae**	**Unidentified**	**Totals**
Brook Silverside	1	--	--	--	**1**
Carp	1	--	--	--	**1**
Northern Hogsucker	--	--	1	--	**1**
Spotted Sucker	--	--	1	--	**1**
Unidentified clupeidae	--	--	--	1	**1**
Unidentified cyprinidae	--	3	--	--	**3**
Unidentified darter	2	3	--	--	**5**
Unidentified osteichthyes	4	--	--	--	**4**
Yellow Perch	--	1	--	--	**1**
Totals	**8**	**7**	**2**	**1**	**18**

Note:

* = based on a total sample effor of four (4) individual samples collected during daytime only.

- - none collected

TABLE C-3. RELATIVE ABUNDANCE AND LIFE STAGE OCCURRENCE IN RIVERINE SOURCE WATER, MARCH 2008 - JULY 2008

		Total Number of Organisms Collected at Plant Vogtle during March 2008 - 30 July 2008					
		Source Water Sampling					
		Eggs	Yolk-Sac Larvae	Post Yolk-Sac Larvae	Yearling or Older	Unidentified	Totals
Event 1	10-12 March 2008	11	0	1	0	0	12
Event 2	17-19 March 2008	41	2	1	0	0	44
Event 3	8-10 April 2008	122	23	22	1	2	170
Event 4	22-24 April 2008	131	41	26	0	6	204
Event 5	6-8 May 2008	179	15	40	0	0	234
Event 6	20-22 May 2008	41	22	17	1	2	83
Event 7	10-12 June 2008	30	25	18	17	1	91
Event 8	24-25 June 2008	7	18	5	6	1	37
Event 9	15-16 July 2008	0	0	11	10	0	21
Event 10	29-30 July 2008	0	3	6	5	0	14
	Totals	**562**	**149**	**147**	**40**	**12**	**910**

TABLE C-4. DENSITIES OF EGGS AND LARVAE COMBINED FOR EACH TAXA PER 1000 CUBIC METERS OF WATER SAMPLED DURING DAY AND NIGHT PERIODS OF SOURCE WATER SAMPLNG NEAR PLANT VOGTLE, MARCH 2008 - JULY 2008

Sample Event	Species	Day	Night	USWD*	Mean Egg and Larval Density/ 1000 M3
10-12 March 2008	American Shad	0.0	13.1	(--)	
	Gizzard Shad	2.6	0.0	(--)	
	Unidentified Clupeidae	0.0	5.3	(--)	
	Unidentified Cyprinidae	2.6	0.0	(--)	
	Unidentified darter	5.3	2.6	(--)	
	Totals	**10.5**	**21.0**	(--)	**31.5**
17-19 March 2008	American Shad	0.0	36.9	(--)	
	Unidentified Clupeidae	0.0	13.4	(--)	
	Unidentified Cyprinidae	10.1	33.6	(--)	
	Unidentified darter	10.1	26.9	(--)	
	Unidentified Osteichthyes	10.1	3.4	(--)	
	Yellow Perch	3.4	0.0	(--)	
	Totals	**33.6**	**114.1**	(--)	**147.7**
8-10 April 2008	American Shad	3.1	153.3	(--)	
	Hogchoker	0.0	3.1	(--)	
	Pirate Perch	0.0	6.3	(--)	
	Unidentified Catostomidae	18.8	25.0	(--)	
	Unidentified Clupeidae	106.4	75.1	(--)	
	Unidentified Cyprinidae	43.8	25.0	(--)	
	Unidentified darter	18.8	15.6	(--)	
	Unidentified Lepomis	0.0	3.1	(--)	
	Unidentified Osteichthyes	9.4	3.1	(--)	
	Yellow Perch	18.8	3.1	(--)	
	Totals	**219.0**	**312.8**	(--)	**531.8**
22-24 April 2008	American Shad	0.0	10.7	(--)	
	Bay Anchovy	16.1	0.0	(--)	
	Striped Bass	117.9	26.8	(--)	
	Unidentified Catostomidae	85.7	58.9	(--)	
	Unidentified Clupeidae	69.7	203.6	(--)	
	Unidentified Cyprinidae	289.4	58.9	(--)	
	Unidentified darter	37.5	48.2	(--)	
	Unidentified Osteichthyes	32.2	16.1	(--)	
	Yellow Perch	10.7	10.7	(--)	
	Totals	**659.1**	**434.1**	(--)	**1093.2**

TABLE C-4 (CONT.)

Sample Event	Species	Day	Night	(--)	Mean
6-8 May 2008	American Shad	11.8	423.4	(--)	
	Brook Silverside	0.0	5.9	(--)	
	Carp	88.2	94.1	(--)	
	Striped Bass	0.0	199.9	(--)	
	Unidentified Catostomidae	82.3	100.0	(--)	
	Unidentified Clupeidae	88.2	88.2	(--)	
	Unidentified Cyprinidae	35.3	23.5	(--)	
	Unidentified darter	11.8	52.9	(--)	
	Unidentified Lepomis	5.9	0.0	(--)	
	Unidentified Osteichthyes	17.6	0.0	(--)	
	White Perch	35.3	5.9	(--)	
	Yellow Perch	0.0	5.9	(--)	
	Totals	**376.4**	**999.7**	(--)	**1376.1**
20-22 May 2008	American Shad	17.6	117.4	0.0	
	Bay Anchovy	0.0	17.6	0.0	
	Carp	11.7	11.7	0.0	
	Northern Hogsucker	17.6	0.0	5.9	
	Spotted Sucker	0.0	0.0	5.9	
	Unidentified Catostomidae	11.7	0.0	0.0	
	Unidentified Clupeidae	82.2	17.6	0.0	
	Unidentified Cyprinidae	5.9	41.1	0.0	
	Unidentified darter	11.7	23.5	11.7	
	Unidentified Lepomis	5.9	11.7	0.0	
	Unidentified Osteichthyes	23.5	5.9	11.7	
	White Perch	11.7	0.0	0.0	
	Yellow Perch	0.0	0.0	5.9	
	Totals	**52.8**	**41.1**	**41.1**	**93.9**
10-12 June 2008	American Shad	0.0	5.9	0.0	
	Brook Silverside	0.0	0.0	5.9	
	Carp	29.5	29.5	5.9	
	Channel Catfish	0.0	5.9	0.0	
	Longnose Gar	0.0	5.9	0.0	
	Unidentified Catostomidae	0.0	5.9	0.0	
	Unidentified Clupeidae	0.0	0.0	5.9	
	Unidentified Cyprinidae	29.5	153.2	17.7	
	Unidentified darter	11.8	23.6	17.7	
	Unidentified Lepomis	11.8	29.5	0.0	
	Unidentified Osteichthyes	0.0	11.8	11.8	
	White Perch	11.8	0.0	0.0	
	Yellow Bullhead	0.0	94.3	0.0	
	Yellow Perch	5.9	5.9	0.0	
	Totals	**29.5**	**141.4**	**64.8**	**170.8**

TABLE C-4 (CONT.)

Sample Event	Species	Day	Night	USWD*	Mean
24-25 June 2008	Bluegill	0.0	5.7	(--)	
	Carp	5.7	22.8	(--)	
	Channel Catfish	0.0	5.7	(--)	
	Unidentified Clupeidae	5.7	0.0	(--)	
	Unidentified Cyprinidae	22.8	97.1	(--)	
	Unidentified darter	11.4	5.7	(--)	
	Unidentified Lepomis	0.0	5.7	(--)	
	Yellow Bullhead	0.0	22.8	(--)	
	Totals	**40.0**	**131.3**	(--)	**171.3**
15-16 July 2008	Channel Catfish	0.0	55.7	(--)	
	Unidentified Cyprinidae	0.0	39.0	(--)	
	Unidentified Lepomis	0.0	22.3	(--)	
	Totals	**40.0**	**271.2**	(--)	**311.2**
29-30 July 2008	Channel Catfish	0.0	38.9	(--)	
	Unidentified Clupeidae	0.0	7.8	(--)	
	Unidentified Cyprinidae	0.0	23.3	(--)	
	Unidentified Cyprinodontidae	7.8	0.0	(--)	
	Unidentified Lepomis	0.0	31.1	(--)	
	Totals	**7.8**	**101.1**	(--)	**108.9**
Primary Transect, Mean Daytime Densities		**19.4**	**33.9**		**403.6**
	Proposed Units 3&4 Location[1]			**52.9**	

Note:

* (--) = no sample collected.

USWD includes samples collected from the Savannah River near the proposed location of the Units 3&4 intake.

a = based on mean of all individual taxa.

TABLE C-5. SUMMARY OF LIFE STAGES REPRESENTED FOR THE THREE MOST ABUNDANT TAXA COLLECTED IN SOURCE WATER SAMPLES FROM THE SAVANNAH RIVER AT PLANT VOGTLE, MARCH 2008 - JULY 2008

Dominant Species	Sample Date	Egg	Yolk-Sac Larvae	Post-Yolk-Sac-Larvae	Young-of-the-Year	Yearling+	Subtotals
Unidentified Cyprindidae							
	10-12 March 2008	1					**1**
	17-19 March 2008	13					**13**
	8-10 April 2008	1	16	5			**22**
	22-24 April 2008	27	26	7			**60**
	6-8 May 2008	1	5	4			**10**
	20-22 May 2008	1	3	2	1		**7**
	10-12 June 2008	7	16	11			**34**
	24-25 June 2008	2	14	4			**20**
	15-16 July 2008			7			**7**
	29-30 July 2008		2	1			**3**
	Subtotals	**53**	**82**	**41**	**1**	**0**	**177**
							+7 unidentified
American shad							
	10-12 March 2008	5	0	0	0	0	**5**
	17-19 March 2008	11	0	0	0	0	**11**
	8-10 April 2008	50	0	0	0	0	**50**
	22-24 April 2008	2	0	0	0	0	**2**
	6-8 May 2008	74	0	0	0	0	**74**
	20-22 May 2008	22	1	0	0	0	**23**
	10-12 June 2008	1	0	0	0	0	**1**
	24-25 June 2008	0	0	0	0	0	**0**
	15-16 July 2008	0	0	0	0	0	**0**
	29-30 July 2008	0	0	0	0	0	**0**
	Subtotals	**165**	**1**	**0**	**0**	**0**	**166**
Unidentified Clupeidae							
	10-12 March 2008	2	0	0	0	0	**2**
	17-19 March 2008	4	0	0	0	0	**4**
	8-10 April 2008	58	0	0	0	0	**58**
	22-24 April 2008	50	0	2	0	0	**52**
	6-8 May 2008	28	0	2	0	0	**30**
	20-22 May 2008	3	8	5	0	0	**16**
	10-12 June 2008	0	0	0	0	0	**0**
	24-25 June 2008	1	0	0	0	0	**1**
	15-16 July 2008	0	0	0	0	0	**0**
	29-30 July 2008	0	0	1	0	0	**1**
	Subtotals	**146**	**8**	**10**	**0**	**0**	**164**
							+1 unidentified

APPENDIX D

Entrainment Sampling Results

TABLE D-1. SPECIES SUMMARY BY SAMPLE DATE OF ORGANISMS COLLECTED VIA ENTRAINMENT SAMPLING IN THE PLANT VOGTLE INAKE CANAL, MARCH 2008 - JULY 2008

Species Name	3/26/2008 - Day	3/27/2008 - Night	4/9/2008 - Day	4/10/2008 - Night	4/23/2008 - Day	4/24/2008 - Night	5/7/2008 - Day	5/8/2008 - Night	5/21/2008 - Day	5/22/2008 - Night	6/11/2008 - Day	6/12/2008 - Night	6/25/2005 -Day	6/26/2005 - Night	7/15/2008 - Day	7/16/2008 - Night	7/29/2008 - Day	7/30/2008 - Night	**Number**	*% of Total*
pirate perch		1																	**1**	*4.0%*
Unidentified Catostomidae	2	2				1													**5**	*20.0%*
Unidentified Cyprinidae				1												2			**3**	*12.0%*
Unidentified Lepomis													1	1	1			1	**4**	*16.0%*
Unidentified Osteichthyes						1													**1**	*4.0%*
yellow bullhead												1							**1**	*4.0%*
yellow perch	3	5				2													**10**	*40.0%*
TOTALS	**5**	**8**	**0**	**1**	**0**	**4**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**2**	**0**	**1**	**25**	***100%***
Day TOTALS	**5**		**0**		**0**		**0**		**0**		**0**		**1**		**1**		**0**		**7**	***28.0%***
Night TOTALS		**8**		**1**		**4**		**0**		**0**		**1**		**1**		**2**		**1**	**18**	***72.0%***

TABLE D-2. RELATIVE ABUNDANCE AND LIFE STAGE OCCURRENCE IN CANAL ENTRAINMENT SAMPLES, MARCH 2008 - JULY 2008

		Entrainment Sampling						
		Eggs	Yolk-Sac Larvae	Post Yolk-Sac Larvae	Yearling or Older	Unidentified	Totals	%
Event 1	10-12 March 2008	0	0	0	0	0	0	0%
Event 2	17-19 March 2008	0	5	8	0	0	13	52%
Event 3	8-10 April 2008	0	0	1	0	0	1	4%
Event 4	22-24 April 2008	0	0	3	0	1	4	16%
Event 5	6-8 May 2008	0	0	0	0	0	0	0%
Event 6	20-22 May 2008	0	0	0	0	0	0	0%
Event 7	10-12 June 2008	0	0	0	1	0	1	4%
Event 8	24-25 June 2008	0	1	1	0	0	2	8%
Event 9	15-16 July 2008	0	0	3	0	0	3	12%
Event 10	29-30 July 2008	0	0	1	0	0	1	4%
	Totals	**0**	**6**	**17**	**1**	**1**	**25**	100%

TABLE D-3. SUMMARY OF LIFE STAGES REPRESENTED FOR THE THREE MOST ABUNDANT ENTRAINED TAXA, PLANT VOGTLE INTAKE CANAL, MARCH 2008 - JULY 2008

Dominant Species	Sample Date	Egg	Yolk-Sac Larvae	Post-Yolk-Sac Larvae	Young-of-the-Year	Yearling+	Subtotals
yellow perch							
	10-12 March 2008	0	0	0	0	0	**0**
	17-19 March 2008	0	5	3	0	0	**8**
	8-10 April 2008	0	0	0	0	0	**0**
	22-24 April 2008	0	0	2	0	0	**2**
	6-8 May 2008	0	0	0	0	0	**0**
	20-22 May 2008	0	0	0	0	0	**0**
	10-12 June 2008	0	0	0	0	0	**0**
	24-25 June 2008	0	0	0	0	0	**0**
	29-30 July 2008	0	0	0	0	0	**0**
	15-16 July 2008	0	0	0	0	0	**0**
	Subtotals	**0**	**5**	**5**	**0**	**0**	**10**
Unidentified Catostomidae							
							0
	10-12 March 2008	0	0	0	0	0	**0**
	17-19 March 2008	0	0	4	0	0	**4**
	8-10 April 2008	0	0	0	0	0	**0**
	22-24 April 2008	0	0	1	0	0	**1**
	6-8 May 2008	0	0	0	0	0	**0**
	20-22 May 2008	0	0	0	0	0	**0**
	10-12 June 2008	0	0	0	0	0	**0**
	24-25 June 2008	0	0	0	0	0	**0**
	15-16 July 2008	0	0	0	0	0	**0**
	29-30 July 2008	0	0	0	0	0	**0**
	Subtotals	**0**	**0**	**5**	**0**	**0**	**5**
Unidentified Lepomis							
	10-12 March 2008	0	0	0	0	0	**0**
	17-19 March 2008	0	0	0	0	0	**0**
	8-10 April 2008	0	0	0	0	0	**0**
	22-24 April 2008	0	0	0	0	0	**0**
	6-8 May 2008	0	0	0	0	0	**0**
	20-22 May 2008	0	0	0	0	0	**0**
	10-12 June 2008	0	0	0	0	0	**0**
	24-25 June 2008	0	1	1	0	0	**2**
	15-16 July 2008	0	0	1	0	0	**1**
	29-30 July 2008	0	0	1	0	0	**1**
	Subtotals	**0**	**1**	**3**	**0**	**0**	**4**

TABLE D-4. DENSITIES OF EGGS AND LARVAE COMBINED FOR EACH TAXA PER 1000 CUBIC METERS (No./1000 M3) OF WATER SAMPLED DURING DAY AND NIGHT PERIODS COLLECTED VIA SUBMERSIBLE PUMP FROM THE PLANT VOGTLE INTAKE CANAL DURING MARCH 2008 - JULY 2008

Sample Event	Species	Day	Night	Mean Egg and Larval Density/ 1000 M3
10-12 March 2008	None	0.0	0.0	
	Totals	**0.0**	**0.0**	**0.0**
17-19 March 2008	Pirate Perch	0.0	3.6	
	Unidentified Catostomidae	7.3	7.3	
	Yellow Perch	10.9	18.1	
	Totals	**18.1**	**29.0**	**47.2**
8-10 April 2008	Unidentified Cyprinidae	0.0	9.4	
	Totals	**0.0**	**9.4**	**9.4**
22-24 April 2008	Unidentified Catostomidae	0.0	6.8	
	Unidentified Osteichthyes	0.0	6.8	
	Yellow Perch	0.0	13.6	
	Totals	**0.0**	**27.1**	**27.1**
6-8 May 2008	None	0.0	0.0	
	Totals	**0.0**	**0.0**	**0.0**
20-22 May 2008	None	0.0	0.0	
	Totals	**0.0**	**0.0**	**0.0**
10-12 June 2008	Yellow Bullhead	0.0	5.7	
	Totals	**0.0**	**5.7**	**5.7**
24-25 June 2008	Unidentified Lepomis	0.01	0.01	
	Totals	**0.01**	**0.01**	**0.0**
15-16 July 2008	Unidentified Cyprinidae	0.0	11.6	
	Unidentified Lepomis	0.0	5.8	
	Totals	**0.0**	**17.4**	**17.4**
29-30 July 2008	Unidentified Lepomis	0.0	5.9	
	Totals	**0.0**	**5.9**	**5.9**
_____	**Mean Density**	**1.8**	**9.4**	**11.3** [a]

Notes:
a = based on per-sample event means..

TABLE D-5. ANNUAL ENTRAINMENT AT PLANT VOGTLE BASED ON DATA COLLECTED DURING MARCH 2008 - JULY 2008

Common Name	Annual Entrainment		Number of Entrained Organisms during the Five Month Study	Relative Abundance of Entrained Organisms
	Entrainment Estimate (No. Organisms)	Upper Confidence Limit (1) Based on Mean Half-Monthly Rate		
pirate perch	17,952	22,726	1	4%
unidentified Catastomidae	89,761	113,631	5	20%
unidentified Cyprinidae	53,856	68,178	3	12%
unidenified Lepomis	71,808	90,905	4	16%
unidentified Osteichthyes	17,952	22,726	1	4%
yellow bullhead	17,952	22,726	1	4%
yellow perch	179,521	227,262	10	40%
TOTAL	**448,803**	**568,154**	**25**	

Note:

(1) Confidence limit for each species is estimated using relative abundance percentages applied to the actual 95% UCL; difference between 95% UCL and annual estimate due to two events in which no organisms were entrained based actual sample data.
(2) Standard deviation of the mean half-monthly rate is 58,983 (organisms).

TABLE D-6. COMPARISON BETWEEN DAILY ENTRAINMENT RATE VS SOURCE WATER COMMUNITY DRIFT RATE DURING MARCH 2008 - JULY 2008

Location	Mean Daily Make-up Water Flow (m3) [1]	Mean Daily River Flow (m3) [1]	Estimated Number of Entrained Organisms/Day [1*]	Estimated Number of Non-Entrained Source Water Organisms/Day [2]
Plant Vogtle Intake	241,000		1,230	
Savannah River at Plant Vogtle		11,402,000		312,039

Note:

1 = Based on actual daily intake pump volumes or river discharge.

* = Daily entrainment based on the 95% UCL.