QUALITY ASSURANCE PLAN AND STANDARD OPERATING PROCEDURES FOR ENTRAINMENT SAMPLING AT VIRGIL C. SUMMER NUCLEAR STATION, JENKINSVILLE, SOUTH CAROLINA

REV 3

Prepared for

SCANA Services, Inc.
220 Operation Way, MC C221
Cayce, South Carolina 29033-3701

Prepared by

NORMANDEAU ASSOCIATES, INC.
8261 Highway 73, Suite C
Stanley, NC 28164

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Revision Log

Revision No.	Date	Changes
1	April 12, 2016	Original Issued Field and Lab SOP
2	July 22, 2016	Clarify water quality sampling procedures, added Fig. 2-2
3	November 3, 2016	Standardize preservative to 5% formalin

TABLE OF CONTENTS

1.0 INTRODUCTION

South Carolina Electric & Gas (SCE&G) owns and operates Virgil C. Summer Nuclear Station Unit 1 (VCSNS) located in Jenkinsville, North Carolina on Monticello Reservoir (Figure 1-1). This Quality Assurance Plan (QA Plan) describes the sample collection and data analysis methods to be used for sampling fish and shellfish entrainment at the cooling water intake structure (CWIS) for VCSNS. This QA Plan is based on the procedures outlined in Entrainment Sampling Plan for VCSNS developed by Geosyntec (2015). VCSNS Unit 1 operates using a single CWIS located along the shoreline of Monticello Reservoir as part of a once-through cooling water system regulated by the South Carolina Department of Health and Environmental Control (SCDHEC) under National Pollutant Discharge Elimination System Permit No. SC0030856 (see facility description in section 2.1 of this study plan). Since Monticello Reservoir has been determined by SCDHEC to be part of a "closed-cycle recirculating system," the facility meets the impingement mortality standard. The entrainment sampling proposed in this plan will assist SCDHEC in determining whether VCSNS Unit 1 meets the entrainment standard and whether the facility will be required to submit further information as outlined in 40 CFR § 122.21(r)(9) through (r)(12).

Ichthyoplankton sampling in the hydraulic area of influence (HAI) of the VCSNS intake structure is proposed from March through August of 2016 to estimate entrainment at VCSNS. This document is a project-specific Quality Assurance Plan (QAP) consistent with USEPA protocols (USEPA 2001) that describes the Standard Operating Procedures (SOPs) to be used for the field, laboratory, and data file preparation, review, and retention activities.

1.1 ORGANIZATION OF THIS DOCUMENT

Following a facility description of VCSNS (Section 2.0) and description of program organization (Section 3.0), are site-specific SOPs for field sampling (Section 4.0) and laboratory activities (Section 5.0). The following topics are addressed by the two SOPs:

- sampling schedule and location,
- equipment,
- procedures,
- sample handling,
- data handling,
- quality control,
- reference collection, and
- instrument calibration and maintenance.

Procedures for data processing, from receipt of completed data sheets to reviewing and approving the final data files, are described in Section 6.0.

A system for providing the appropriate training for project personnel is described in Section 7.0.

Quality Assurance procedures are described in Section 8.0.

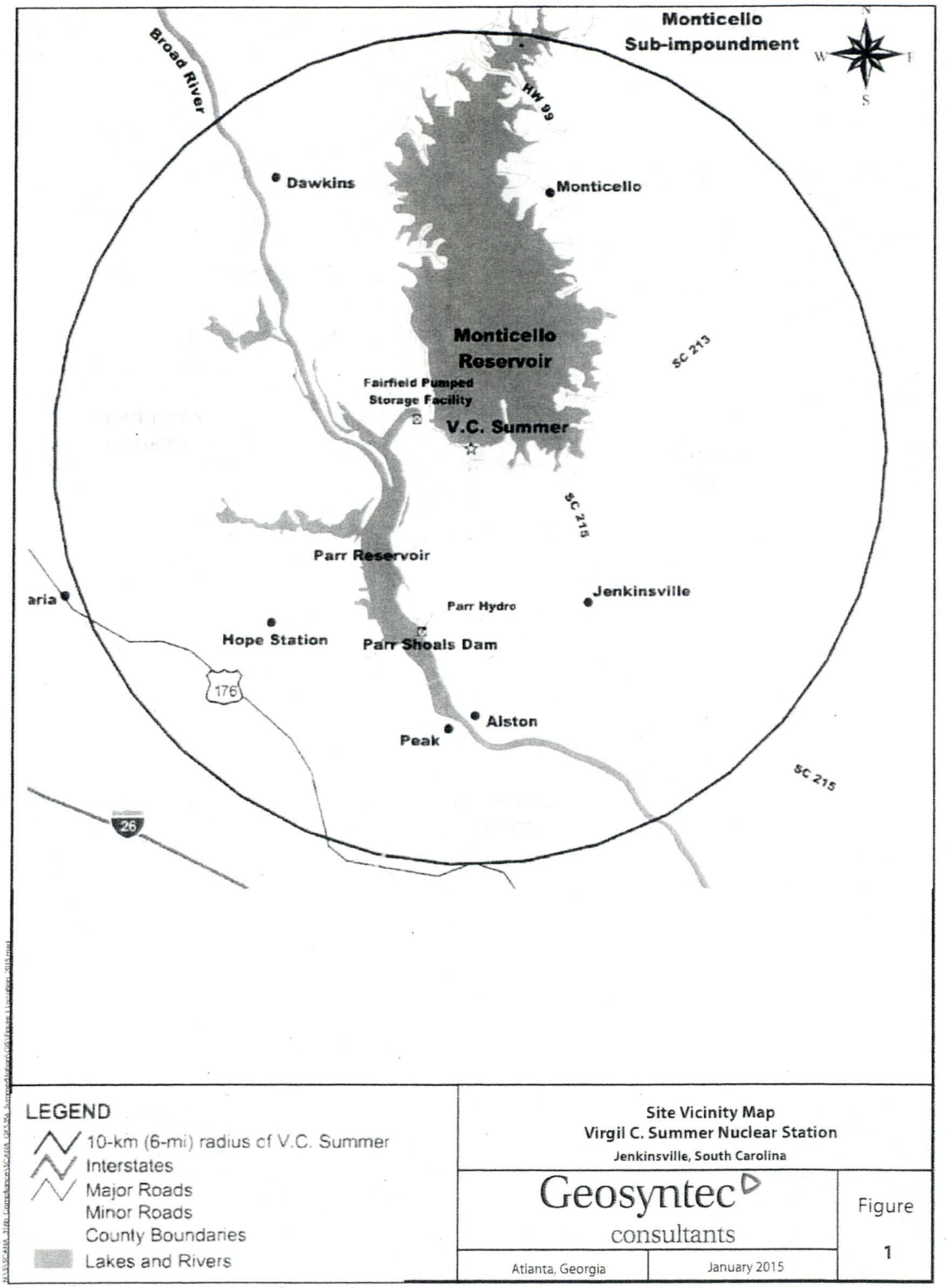

Figure 1-1. Site vicinity map for Virgil C. Summer Nuclear Station (from Geosyntec 2015).

2.0 FACILITY DESCRIPTION

Geosyntec (2015) provides a description of VCSNS Unit 1 and is repeated here. VCSNS is a 972.7-megawatt, nuclear-fueled, base-load generating facility. Unit 1 uses a cooling water system with a design intake capacity of approximately 533,122 gallons per minute or 768 MGD. It withdraws cooling water from Monticello Reservoir via a single shoreline CWIS located at the south end of the reservoir (Figure 2-1). Although the cooling system operates in a "once-through" mode, Monticello Reservoir was constructed for the purpose of serving as part of the cooling water system (NRC, 2004). The use of Monticello Reservoir as a cooling impoundment for VCSNS Unit 1 has been determined to be a "closed-cycle recirculating system" under 40 CFR, Part 125, Subpart J, § 125.92(c)(2).

The VCSNS Unit 1 CWIS consists of an inlet bay about 550 ft wide east to west and about 200 ft in length north to south. The water depth in the bay ranges from 30 to 40 ft. Bathymetry of the intake bay measured using acoustic Doppler current profiling (ADCP) techniques is presented in Figure 2-2.

The circulating water intake structure is 93 ft wide with six intake bays each approximately 13-ft wide. Parallel concrete retainer walls extend out into the intake bay of the reservoir a distance of approximately 30 ft. Trash racks comprised of steel bars with 10-inch (in) spacing are located along the upstream face of the intake structure to prevent large debris from entering the intake bays. The trash racks are mounted to the bottom of a skimmer wall that extends from the water surface to a depth of 9.5 ft (415.5 ft mean sea level [MSL NGVD29]) at normal high water (425 ft MSL). The skimmer wall is designed to exclude floating debris from entering the cooling water system and, combined with the intake retainer walls, to optimize withdrawal of the coolest water from the water column at the pump house. Vertical traveling water screens are located 25 ft behind the trash racks to strain out smaller debris. A bar grid structure is located between the traveling screens and the circulating pumps. Three circulating water pumps convey screened flow to the condensers. At normal high water, the CWIS is designed to withdraw water from the water column between the 415.5 ft and 390 ft MSL; or from a depth of 9.5 ft to 35 ft.

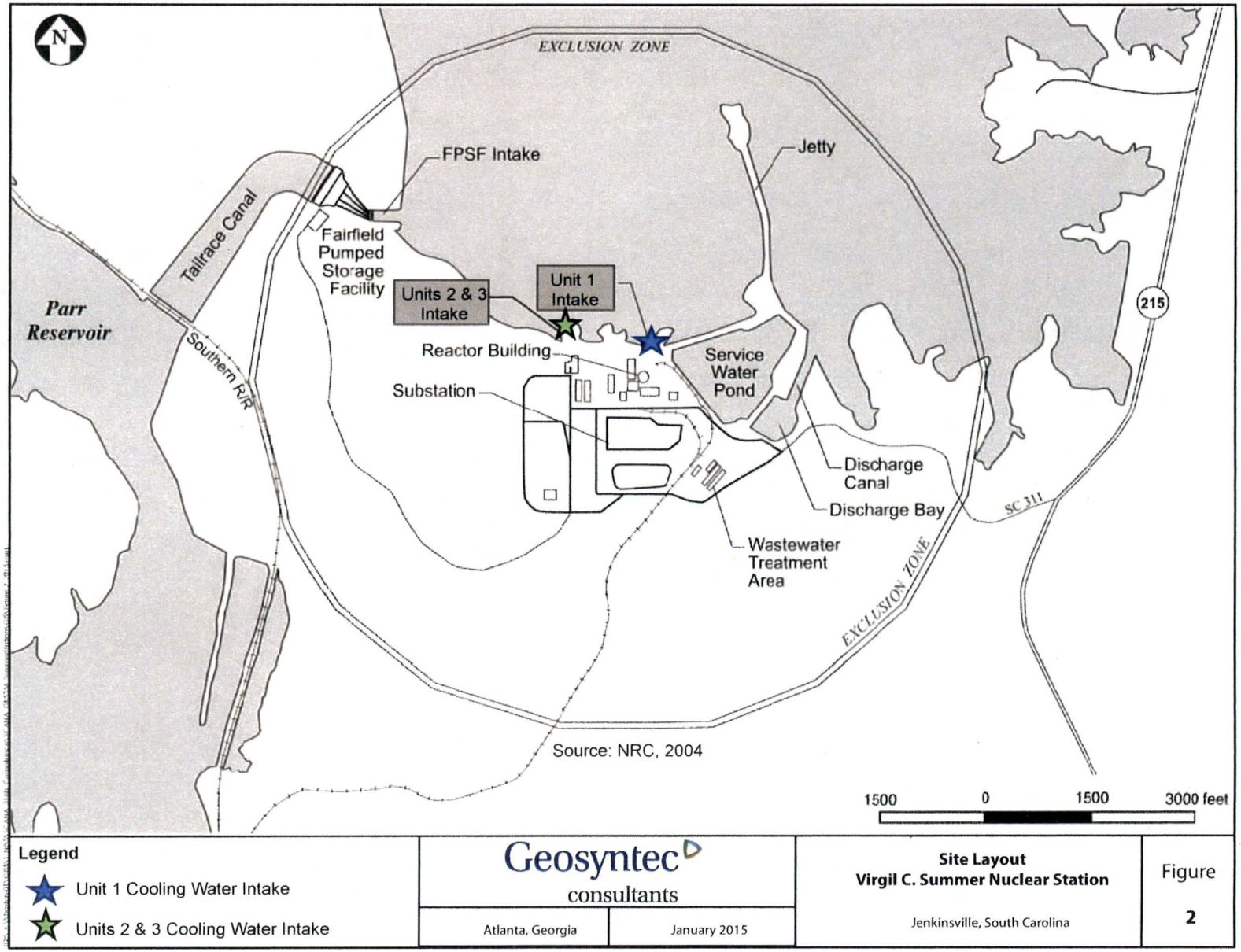

Figure 2-1. Site layout for Virgil C. Summer Nuclear Station (from Geosyntec 2015).

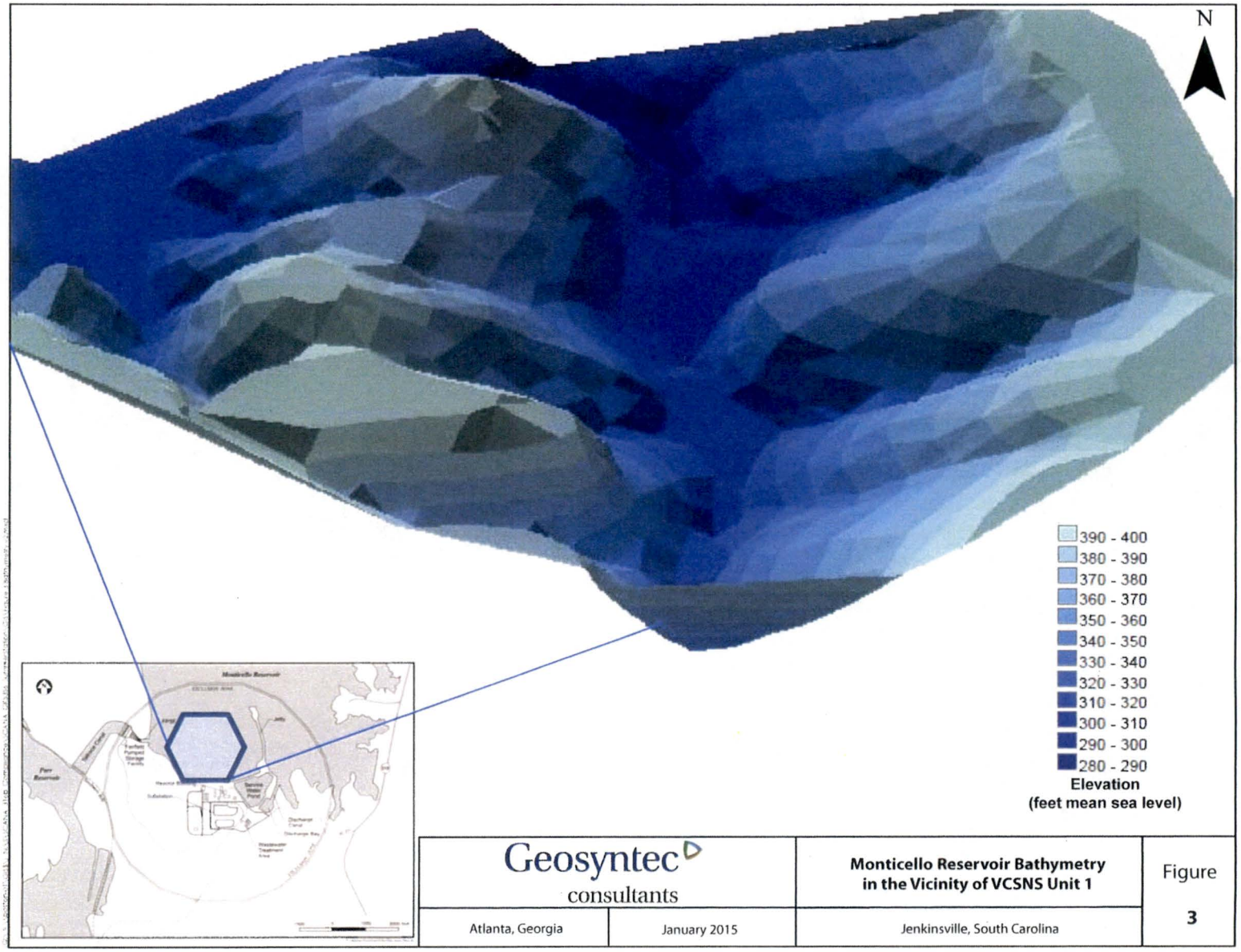

Figure 2-2. Monticello Reservoir bathymetry in the vicinity of the VCSNS Unit 1 CWIS (from Geosyntec 2015).

3.0 PROGRAM ORGANIZATION AND COMMUNICATION

Figure 3-1 presents the program organization for the VCSNS entrainment studies. Normandeau's Program Manager, David Coughlan is the primary point of contact for communications between SCE&G and Normandeau. Mr. Coughlan will be responsible for the overall management of the project including field, laboratory and data processing functions. He will be assisted by Mr. Paul Geoghegan, Technical Director who will also be responsible for the data management. Mobilization and field sampling will be the responsibility of Mr. Jeff Wollis. Ms. Hannah Proctor will be responsible for analysis of entrainment samples in the Normandeau biological laboratory Bedford, NH. She will be responsible for the training and supervision of technicians and the quality control of laboratory tasks. Mr. Coughlan and Mr. Geoghegan will also be responsible for data analysis.

No Normandeau staff is authorized to communicate with outside entities such as state or federal agencies, intervener groups, media, or the public with regard to any activities related to VCSNS. Any inquiries by outside entities to Normandeau staff will be reported to the Normandeau Program Manager.

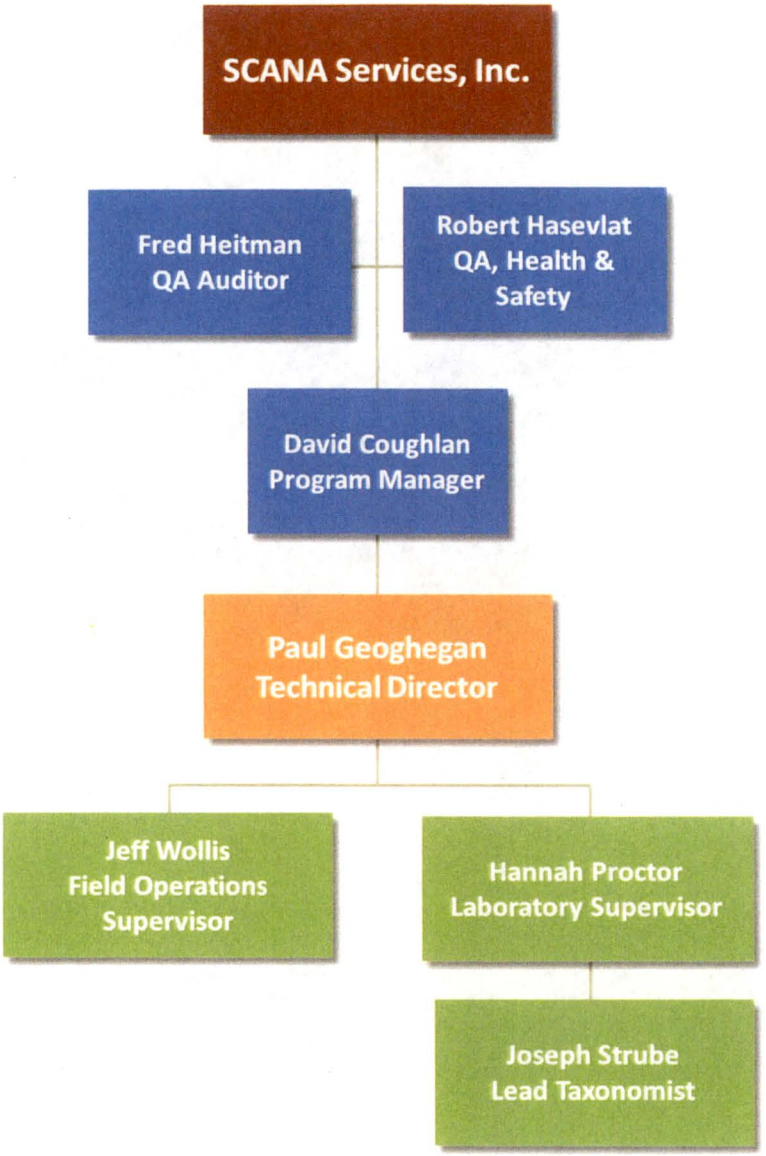

Figure 3-1. Program Organization for the Virgil C. Summer Nuclear Station Unit 1 Entrainment Studies.

4.0 ENTRAINMENT FIELD STANDARD OPERATING PROCEDURE (SOP)

4.1 SAMPLING SCHEDULE AND LOCATION

The abundance of entrained fish eggs and larvae will be determined by sampling the hydraulic area of influence of Unit 1 of VCSNS at the surface and mid-depth (Figure 4-1). Sampling is scheduled twice per month between 1 March and 31 August during 2016 for a total of 12 sampling events. Each sampling event will consist of the collection of day and night samples in each of the surface (1 m) and mid-depth strata (5 m), resulting in the collection of 48 samples (6 months x 2 samples/month x 2 diel periods x 2 depth strata). The sampling events will be separated by a minimum of seven days. Day sampling will be conducted at last two hours after sunrise and two hours before sunset. Night sampling will be conducted at least two hours after sunset and two hours before sunrise.

Sampling will be conducted with a 0.5 m bongo net equipped with a flowmeter and a 0.300 mm mesh net. Each side of the bongo net will be composited into one sample to reach the target volume of 50-100 m^3. Samples from each sampling depth and from each day and night sampling effort will be kept separate. Samples will be preserved in the field with 5% formalin and labeled both internally and externally. Samples will be shipped to the Normandeau biological laboratory in Bedford, NH, after each sampling event.

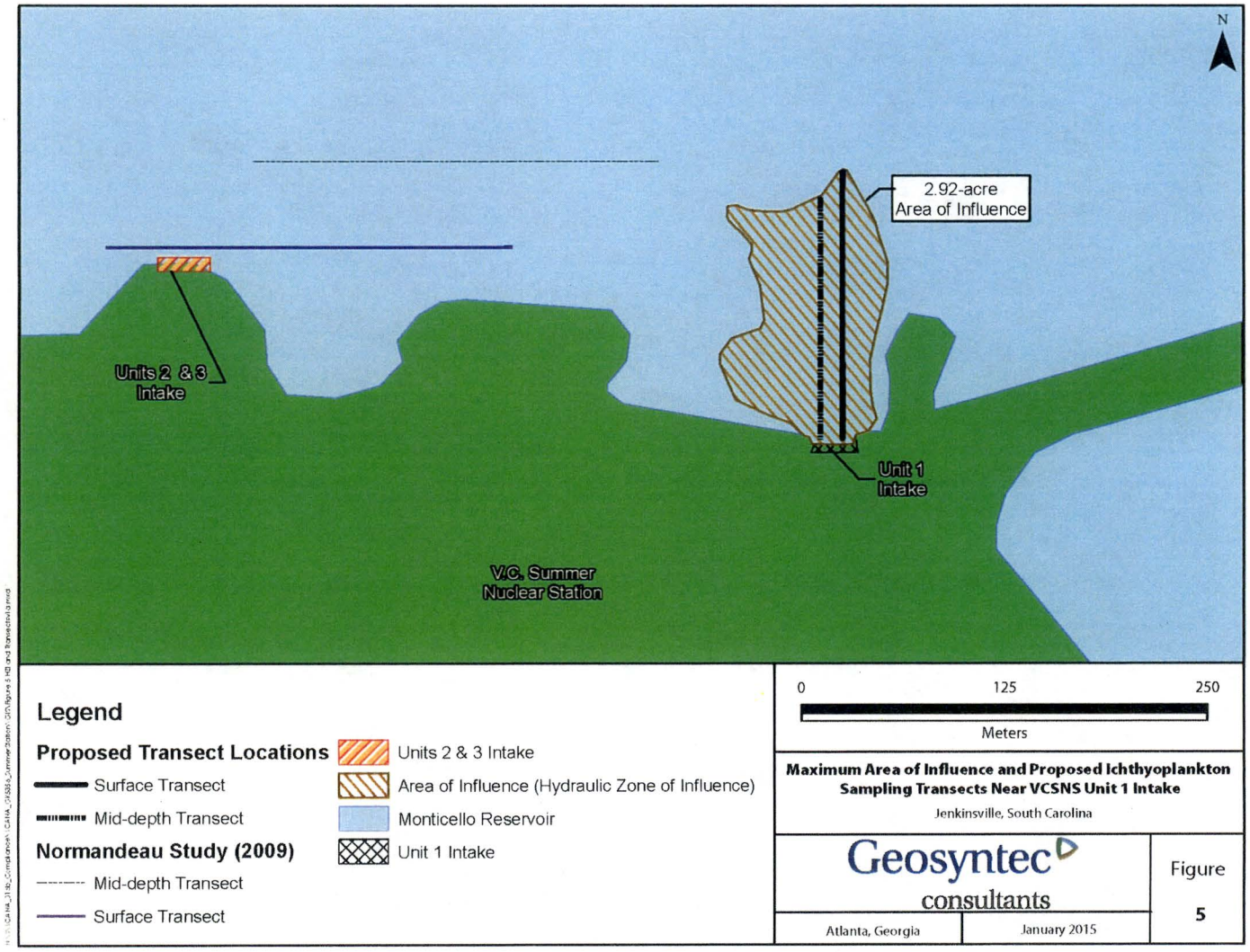

Figure 4-1. Maximum Area of Influence and Ichthyoplankton Sampling Transects near the Virgil C. Summer Station Unit 1 Intake (from Geosyntec 21015).

4.2 EQUIPMENT

Collection gear for the VCSNS entrainment sampling consists of a boat; a bongo net frame equipped with two 0.300 mm mesh Bongo nets, two General Oceanics flowmeters (and 1backup) and the following equipment:

- Copy of QA/QC Plan
- Data sheets
- Appropriate spill kit with absorbent material
- Flowmeter repair kit
- 0.300 mm mesh cod end bucket
- 1-L wide mouth sample jars with associated internal and external labels
- Depressor weights including backup
- 0.300 mm mesh sieves and squirt bottles
- Plastic basin for transferring sample material
- Sample jars (10)
- 5% formalin solution and MSDS
- Appropriate personal protection equipment
- First aid kit and Flashlights
- Disposable nitrile gloves
- Assorted plastic buckets
- Rope, bow, stern, long safety rope (100 ft.)
- Sample collection and calibration data sheets (Rite in the Rain paper)
- Chain of custody forms
- Assorted binders with pens, pencils, SOP, labels, logbooks, cameras
- Clipboards
- YSI Professional Plus water quality meters for measuring temperature to the nearest 0.1°C , dissolved oxygen concentration to the nearest 0.1 mg/l, conductivity to the nearest scale division, and pH to the nearest pH unit, and back up meters
- Calibration solutions as specified by water quality meter manufacturer
- Running lights for boat with Q beams (2) and work lights (2)
- Tool box
- GPS
- Deep cycle battery
- Generator
- Rain gear

4.3 PROCEDURES

Project personnel will check in with plant personnel and security prior to the initiation of sampling and will check out when sampling is complete. Prior to any sampling activities a "tailgate" safety meeting will be held to identify any possible safety hazards, discuss lessons learned in previous sampling trips, and evaluate any new conditions on site for possible safety concerns.

4.3.2 Sample Collection

Attach the nets, cod end buckets, flowmeter, and depressors to the bongo frames. Check all sampling gear for secure connections. Check GPS to ensure sampling is within the hydraulic area of influence. Fill out the sample identification information at the top of the Entrainment Field Data Sheet (Section 4.5.1).

Lower sampling gear to appropriate depth and start tow. Monitor position with GPS and terminate sample at the far end of the hydraulic area of influence. Check flowmeter reading to ensure target sample volume of 50-100 m^3 is reached. The flowmeter counts on each side should be about 10,000-15,000 to reach the target volume. Make additional collections if necessary and composite to reach target sample volume. More than one subsample may be preserved in the same jar, but if multiple jars are used, label each one with the same sample number and indicate that multiple jars were used (e.g. "1 of __").

When the sample is completed wash the sample (or subsample) from the outside of the net into the cod end bucket. The concentrated sample material from the cod end bucket is then washed from the outside into a 0.300 mm mesh (or finer) sieve placed in a larger plastic basin to remove excess water. Take care that none of the sample is spilled, and that the contents of the net and cod end bucket are completely rinsed into the sieve. Wash the contents of the sieve from the bottom of the sieve into the sample jar over a plastic basin. Any material spilled into the basin during the transfer from the cod end to the sieve, or from the sieve to the sample jar, is washed through the 0.300 sieve and placed in the sample jar.

Sample containers and cod end buckets that are open should be set down only in a container or bucket, just in case the sample is spilled. Preserve the sample by adding sufficient formalin to make the final concentration 5% (50 mm of full-strength formalin per liter of sample).

Sample jars should be no more than 25% full of organisms and debris for adequate preservation. Label the jars externally with the sample number and the number of jars (e.g., 1 of 4, 2 of 4, etc.). Place an internal label in each jar giving the sample number.

Repeat the above procedures for additional diel and depth samples within the 24-hr collection period.

4.3.3 Water Quality

Temperature (to 0.1 °C) and dissolved oxygen (nearest 0.1 mg/l) will be recorded at three depths with each day and night period of a sampling event. Water quality probes will sample the water surface, a mid-depth location, and a bottom location and correspond to depths of 1', 20 – 25', and 40 – 50', respectively, for this VCSNS entrainment sampling study. Water quality sampling will occur within

the area of the sampling event and at a location that provides sufficient depth for all three water quality sampling depths.

4.3.3.1 Equipment

Water quality measurements will be made with a Yellow Springs Instruments (YSI) model 6920 multiparameter sonde. The YSI meter will be operated using the manufacturer's procedures (Appendix A) and calibrated prior to and following each sampling event.

4.4 SAMPLE HANDLING

The lids to the samples jars will be sealed with electrical tape to prevent spillage. Samples will be packaged in a manner to avoid movement and leakage, and shipped over night to the Normandeau Biological Laboratory in Bedford, NH.

4.5 DATA HANDLING

4.5.1 Data Sheets and Coding Instructions

A unique sample number will be assigned to each VCSNS entrainment collection. The sample number will be a three-digit unique consecutive number. Record the sample identification and status (described below), collection times, and flowmeter readings on the Entrainment Field Data Sheet (Appendix B) according to the instructions below. Use the space for comments at the bottom of the data sheet to explain any problems or unusual circumstances.

VARIABLE	INSTRUCTIONS
Survey	Consecutive numbers for each day or night sampling event
Sample Number	Consecutive unique numbers
Date	Enter the date in mm/dd/yy format
Time	Enter the time in hh/mm format
Employee number	Enter the employee number of the field crew leader
Lake level	Enter the lake level in decimal feet
Use Code	Enter code for status of sample: 0 = void (no sample) 1 = valid sample 2 = sample is provisional due to flowmeter problem
Total Depth	Enter the water depth in decimal feet
Near Surface Sampling Depth	Enter the depth of sampling for the near surface sample
Top Sampling Depth	Enter the depth of sampling for the mid-depth sample

VARIABLE	INSTRUCTIONS
Comments	Enter appropriate comments that pertain to sampling effort
Serial Number	Record the serial number of the flowmeter
End	Record the flowmeter reading at the end of the sample
Start	Record the flowmeter reading at the start of the sample
Diff	Enter the difference between the end and start flowmeter readings.
Depth WQ	Record in decimal feet the depth of the water quality measurements
H2O Temp	Record the water temperature to the nearest tenth in degrees C
DO	Record the dissolved oxygen concentration to the nearest tenth of a mg/l
Air temp	Record the air temperature in degrees F
Cloud Cover	Enter the percentage cloud cover using the codes on the data sheet
Precipitation	Enter the precipitation type using the codes on the data sheet
Wind Direction	Enter the wind direction using the codes on the data sheet
Wave Height	Enter the wave height using the codes on the data sheet
Wind Speed	Enter the wind speed using the codes on the data sheet

4.5.2 Storage and Chain of Custody of Data Sheets

Check over all data sheets to make sure they are completely and correctly filled out, and to be alert to any unusual or unexpected data values. Initial the bottom of the data sheet. Transport the original data sheets to the field office, file a photocopy of each data sheet there for safe keeping and QA/QC verification, and dispatch the originals to data center in Bedford, NH.

5.0 ENTRAINMENT LABORATORY STANDARD OPERATING PROCEDURES

5.1 SAMPLES TO BE ANALYZED

Entrainment sampling at VCSNS during 2016 is scheduled twice per month during March through August for a total of 12 sampling events. Each sampling event consists of samples collected during two diel periods from two depths. The total number of entrainment samples delivered to the laboratory for the 2016 program will be up to 48 (6 months x 2 sampling events/month x 2 diel periods/sampling event).

5.2 EQUIPMENT

The following items are required for laboratory analysis of ichthyoplankton in entrainment samples:

- Sorting pans
- Lights
- Magnifiers
- 0.300 mm mesh sieve
- Dissecting microscopes
- Motoda plankton splitter
- Sieves
- Rose bengal stain
- Gridded Petri dishes
- Divided Petri dishes
- Jars, with lids
- Forceps
- Pipettes
- Multitally counters
- Squirt bottles
- Lab data sheets
- Pencils
- Vials, with caps
- Vial labels
- Taxonomic literature
- Copy of SOP
- Ocular micrometers
- Millimeter rulers
- Masking tape
- Rubber bands
- Random number table

5.3 PROCEDURES

5.3.1 Sample Preparation

Once the entrainment samples have been received by the laboratory, each sample will be analyzed as representative of the entrainment collection for the corresponding diel period. Samples will be logged into the laboratory and the Chain-of-Custody forms verified. Samples will be washed with fresh water through a 0.300 mm mesh sieve to remove formalin and fine debris. Monticello Reservoir is an inland, pumped-storage reservoir which does not support commercially or recreationally important shellfish species. It, and the adjacent Parr Reservoir and Broad River, do support populations of freshwater mussels (no listed species have been identified) and populations of the Asiatic clam. It is unlikely that larval stages of freshwater mussels would be found in the water column in Monticello Reservoir due to their reproductive strategy. Larvae of the Asiatic clam might be found in the water column, but this species is an introduced, nuisance species. Since Monticello is subject to daily variation in water level, it has little submerged vegetation and does not provide good habitat for crayfish. Larval crayfish are unlikely to be found in the water column in Monticello Reservoir. For these reasons, no procedures for identifying shellfish larvae are included in this document.

5.3.1.1 Subsampling Restrictions and Quotas

Samples estimated to contain more than 400 fish eggs and larvae combined may be subsampled in the laboratory, with a minimum of 200 eggs and larvae combined to be analyzed. This quota applies to the total count of all species combined, not to individual species.

For each sample with a low ichthyoplankton concentration and a high total volume of detritus and other plankton (more than 400 ml settled volume), sort a maximum of one-half of the sample for eggs and larvae.

5.3.1.2 Sample Splitting Sequence

Use the following sequence of procedures in processing a sample that is subsampled by splitting. To eliminate any chance of bias, some steps in the procedure are to be performed by an assistant, as indicated below, so that the sorter has no prior knowledge of which samples are to be subjected to quality control inspection.

This procedure also applies when a previously split sample is further subsampled because the fraction sorted was larger than necessary to meet the quota. In this situation the term "sample" in the following procedure refers to the part of the original sample that is to be further subsampled, and the selected fraction(s) are "analyzed" rather than "sorted."

1. Examine the sample to estimate the smallest size fraction that is likely to contain at least 200 eggs and larvae combined.
2. Divide the sample material into two equal parts using the techniques in Section 5.3.1.3.
3. Randomly select one of the two divisions for processing (or for further subsampling, if a smaller fraction is needed). Selection should be done using a random number table or a coin toss, so that each of the two divisions has an equal chance of being selected. The person

performing the division must not know which of the two divisions will be analyzed before the division is completed (it is not acceptable to always select the division from the same chamber of the splitter).

4. Set aside the fraction not selected for further processing and label it to identify the sample number and fractional size.

5. If the fraction that was selected for further processing needs to be subsampled further, repeat steps 2-4 as many times as necessary to produce the desired fraction for analysis. When the desired fraction is obtained, label it to show the sample number and fractional size.

6. Sort the subsample by the procedures in Section 4.3.2. Organisms must be sorted from the entire subsample even if the quota is reached before finishing the subsample.

5.3.1.3 Sample Splitting Technique

Perform all sample splitting using a Motoda splitter. The presence of filamentous algae or large items (including large juvenile fish, or older age classes) can interfere with the even distribution of material and organisms between the two chambers of the splitter. Therefore, to insure successful results, observe the following techniques: (1) Adjust sample dilution to be great enough to allow free mixing of the sample but not so great as to promote clumping due to over dilution. (2) Remove large fish and excessive amounts of filamentous algae before splitting, returning any adhering ichthyoplankton to the sample. (3) Pull apart remaining clumps of algae before splitting. (4) Scrutinize detritus and organisms during the splitting process to see that they appear equally distributed before making the final division. (5) Remix and split again if the two resulting portions of a division do not appear equal. If a sample has too much algae to be split satisfactorily, sort the entire sample, and if numbers of ichthyoplankton are high splitting may be performed after sorting. Large juveniles that are removed from the whole sample before splitting must be kept separate from ichthyoplankton sorted from the sample after splitting, and they must be labeled to show they represent the whole sample.

5.3.2 Sorting

Remove fish eggs, larvae, and juveniles from the samples according to the following procedures:

- Samples may be stained with rose bengal to facilitate sorting.
- Pour the sample contents into a sieve with a mesh equivalent to, or finer than, 0.300 mm and rinse with water to remove the preservative.
- If the sample contains large numbers of eggs and larvae, prepare a subsample following the procedures in Section 5.3.1.
- Carefully wash the sample contents into a container making certain that nothing remains in the sieve. Pour portions of the sample from the container into a pan and examine them under a magnifying lens.
- Remove fish eggs, larvae, and juveniles from the sample using forceps, pipettes, and probes. Remove only those fragments that include the head.

- Maintain a count for eggs and larvae (all species and lifestages combined) that are removed from the sample.
- When sorting is completed, recheck the sample for organisms. After the sample has been rechecked, label vials containing the sorted organisms and place them in a box designated for sorted samples. Record the sorting results and date completed in a log.
- Carefully wash back the remaining sample contents into the original sample container, appropriately preserved, and return it to the storage area.
- If a sample is not completed by the end of the work day, it may be left unpreserved overnight if adequate precautions are taken to prevent it from drying out. No sample or part of a sample, however, should remain unpreserved for more than 24 hours.

5.3.3 Identification

Identify, stage, count, and measure the sorted ichthyoplankton according to the following procedures:

- Obtain the sample vials containing the sorted organisms from the storage area and sign them out by initialing a status log.
- Rinse specimens free of preservative and submerge them in water in a Petri dish. Use a binocular microscope with an ocular micrometer to examine the specimens, and identify them to the lowest practical taxon (usually species) by referring to the literature, the reference collections, and by consulting with fellow taxonomists.
- Determine the life stage of each specimen. Pertinent life stages are defined and identified as follows:

  Egg: the embryonic developmental stage, from spawning until hatching. Eggs frequently become damaged during collection and sample processing. Damaged eggs are counted as the number of embryos (without regard to how many egg capsules are present). Do not count non-fertilized eggs if they are present.

  Yolk-sac larva: the transition stage from hatching through the development of a complete, functional digestive system (regardless of the degree of yolk and/or oil globule retention).

  Post yolk-sac larva: the transition stage from development of a complete, functional digestive system to transformation to juvenile form (regardless of the degree of yolk and/or oil globule retention), including the leptocephalus stage of eels.

  Young-of-the year: the stage from completed transformation to Age 1 (i.e., 12 months after hatching). A young-of-the-year has a full complement of fin rays identical to that of an adult. Eels are classified in this stage until Age 2.

  Yearling or older: a fish at least one year old.

- Count the specimens of each life stage. Record the counts by species and stage on the lab data sheet (refer to Section 4.5.1 for coding instructions).
- From each sample, measure a maximum of 25 representative individuals (eggs and larvae) from each taxon for total length to the nearest 0.1 mm. If more than 25 individuals are present, randomize the selection of specimens for measuring by the following procedure. Spread them uniformly in a gridded container, select a starting point in the grid by means of a random number table, and then measure the first 25 measurable specimens encountered in a predetermined pattern commencing at the starting point. Every grid space must have an equal probability of being selected as the starting point, so that every specimen will have an equal probability of being included in the subsample.
- Place identified organisms in vials with an adequate amount of preservative for storage. Specimens may be removed for inclusion in the reference collection. For those removed, list the species, life stage, and numbers on the comments section of the form and note their removal on a tag retained inside the appropriate vial. Label all vials for a single sample, initial them and band them together. Record the number of vials for the sample on the data form. For reference collection procedures refer to Section 5.7.

5.4 SAMPLE HANDLING

5.4.1 Sample Control

Each sample will be given a unique sample number at the time of collection. Track each sample by that sample number throughout the laboratory and data processing functions.

5.4.2 Chain of Custody Records

The chain of custody documentation begins with the field office providing a list with the following information for each sample in a shipment delivered to the laboratory facility: sample collection date, sample collection time, sample identification number, and number of jars. Upon receipt of the samples, a laboratory representative verifies that all jars of all samples on the list are present, then signs and dates the chain of custody document.

After samples have been received in the laboratory, track their location and status during all phases of storage and laboratory analysis by means of sample control logs. The function of this system is to provide a paper trail of who performed each step in the analysis of a sample from collection to storage, when each step occurred, what condition the samples were in and where each step took place.

5.4.3 Preservation and Storage

Retain the original preservative (formalin solution) for reuse in preserving the residue of sorted samples, adding 5% formalin as needed to fill the sample jars. Store processed samples (i.e., detritus and organisms not removed from split samples) for one year. Keep sorted ichthyoplankton in vials in a heated storage area for a minimum of one year after the end of the project or until SCE&G authorizes their disposal. Tape the tops of jars and vials to prevent loss of preservative by evaporation.

5.4.4 Disposal

Disposal of sample residue remaining after sorting (detritus and organisms not removed from split samples) and vials of organisms from processed samples may proceed after storage for one year and after receiving authorization from SCE&G. Follow all applicable state and federal regulations for hazardous waste disposal.

5.5 DATA HANDLING

5.5.1 Data Sheets and Coding Instructions

Record ichthyoplankton counts and measurements on Entrainment Lab Count Data Sheets and Entrainment Lab Length Data Sheets (Appendix B). The Entrainment Lab Count Data Sheet is for count data and the Entrainment Lab Length Data Sheet is for measurements. Indicate in the upper right-hand corner of each data sheet how many pages there are for the sample (use "1 of 1" for a one-page sample, "1 of 2" and "2 of 2" for a two-page sample, etc.). Record also in the upper right-hand section of the first page the identifier's initials, the date the sample was identified, and the number of vials.

5.5.1.1 Count Data

Record count data in the top ("Card Type L1") section of the data sheet according to the following instructions.

VARIABLE	INSTRUCTIONS
SAMPLE	Record the unique sample number.
CARD TYPE	Preprinted: L1
CATCH_CD	Enter 1 for valid non-empty sample or 2 for valid empty sample (data sheets are not required for void samples)
SPL_FACT	Enter 1.00 if the whole sample is analyzed; if the sample is subsampled record the ratio of the whole sample to the subsample (e.g., 8.00 for a 1/8 split)
TAXON	Enter the TAXON code from the Taxon Code List (Appendix C). Taxa not on the list will be added with a new sequential taxon code.
STAGE	Enter one of the following life stage codes: 0 = unknown larval stage 1 = eggs 2 = yolk-sac larvae 3 = post yolk-sac larvae 4 = young-of-the-year 5 = yearling or older
COUNT	Record the number of organisms of the indicated taxon and life stage in the sample (or subsample)
SPECIES NAME	Record the common name for the taxon

5.5.1.2 Measurement Data

Record measurement data for ichthyoplankton on Entrainment Count Data Sheet (Card Type L2) according to the following instructions.

VARIABLE	INSTRUCTIONS
SAMPLE	Record the sample number
Card Type	Preprinted: L2
TAXON	Enter the taxon codes for other species measured on Entrainment Lab Length Data Sheets.
STAGE	Enter the life stage code for each larva measured (2, 3, 4, or 5 for fish species). Refer to the life stage code definitions used for count data (Section 4.3.3).
FISH ID	Preprinted 1-25
SCALE MEASURE-MENT	Record the total length of larvae to the nearest 0.1 optical micrometer unit or to the nearest 0.1 mm.

5.5.2 Storage and Chain of Custody of Data Sheets

Maintain all completed data sheets in duplicate. Keep photocopies at the site of origin and transfer the originals as needed from the laboratory to the data center, quality control, and a master project file. Track the custody of data sheets by means of data control logs. Data sheets will be maintained for three years.

5.6 QUALITY CONTROL

5.6.1 Tasks Subject to Quality Control

The following tasks are subjected to quality control checks consisting of reanalysis of randomly selected samples or measurements:

- sorting
- identification, life stage determination, and enumeration

5.6.2 Inspection Plans start

Items are inspected using a quality control (QC) procedure to achieve a 10 percent or better AOQL (Average Outgoing Quality Limit). For precision checks a minimum of 10% of a technician's samples are selected for resorting or re-identification; with the survey size being a batch of ten samples.

Select items for reanalysis according to the plan using a random number table. The original analyzer should not know whether a sample is to be checked before the analysis of that sample has been com-

pleted. Perform all quality control checks "blindly" (i.e., the individual performing the QC inspection should have no knowledge of the original analyst's results).

Apply the QC plan on an individual processor basis, so that each person's work is subjected to the QC plan independently of others, starting at 100% inspection.

A resolution (third person) value may be determined for any sample found defective. All errors found during the QC check, whether the sample is found to be defective or not, are to be corrected on the data sheets. (A difference between original and QC counts that is within acceptable limits is not considered to be an error). Results of the quality control program are to be presented to all sorters and identifiers and help is to be made available to anyone failing a QC check.

In some cases a QC inspection may be able to determine the taxon or life stage of damaged specimens when the original identifier has recorded them as unknown life stage, unidentified taxon, or a higher level taxon (genus or family). If a more general taxon or life stage used by the original identifier includes the more specific category used by the QC inspector, and that is the only reason for a count discrepancy, then that sample does not fail the QC inspection on the basis of that taxon. For example, damaged specimens recorded as *Morone* sp. by the original identifier and as striped bass by the QC inspector are to be considered in agreement because the category *Morone* sp. includes striped bass. In contrast, an original determination of unidentified gobiid would not be acceptable if the QC determination was striped bass, because striped bass is not included in the family Gobiidae. If substantial differences occur between the original and QC counts as a result of identifying or staging to different levels, then the identifier should be provided with additional guidance or training to minimize such differences in future samples.

5.6.3 Acceptance/Rejection Criteria

5.6.3.1 Sorting

A sample is considered defective if the sorter failed to remove 10 percent of the total organisms in the sample (or subsample). Percent error is calculated as follows (where "QC count" denotes the number missed by the sorter):

$$\% \text{ error} = 100\% \times \text{QC count}/(\text{sorter's count} + \text{QC count})$$

When the total count (sorter's plus QC) is ≤20, then the sample is considered defective only if the sorter missed more than two organisms.

5.6.3.2 Identification

A sample is considered defective if an error of 10 percent or more is made in identifying, assigning a life stage, or counting any species. In determining whether a sample is defective, analyzer and QC results are compared within each taxon/life stage combination.

For each taxon (or for a life stage within a taxon) the percent error is calculated as follows (except where the QC count is ≤20, the percent error is considered to be zero if analyzer and QC counts differ by no more than two organisms):

$$\% \text{ error} = 100\% \times |(\text{analyzer count} - \text{QC count})| / \text{QC count}$$

A sample with a percent error of greater than or equal to 10% for any life stage for any taxon is considered defective.

For each defective sample, a resolution may be determined in which a third person reanalyzes the sample (resolution value). The error for each species and life stage will then be calculated using the resolution counts as the divisor. This will be done for both identification and QC counts:

$$\% \text{ error} = 100\% \times |(\text{identifier count} - \text{resolution count})| / \text{resolution count}$$

$$\% \text{ error} = 100\% \times |(\text{QC count} - \text{resolution count})| / \text{resolution count}$$

If the resolution vs. identifier error is <10 percent, the sample passes. If they are not, the sample fails and identifier counts are replaced by QC counts for all cases, provided the QC vs. resolution error is <10 percent. If the resolution vs. identifier and the resolution vs. QC errors are both 10 percent or more, the sample will be thoroughly reviewed by all three people and the identifier's sample processing will not continue until agreement can be reached on the identification of the sample. Subsequent samples will be reanalyzed by the QC person until eight consecutive samples pass. Notify the Laboratory Manager of any identifier exceeding two failed samples.

5.6.4 Quality Control Records

Maintain quality control logs, documenting the samples analyzed, the samples selected for reanalysis according to the QC plan, the results of the QC analysis, and any corrective action performed. All QC logs will be 100% inspected monthly by the Laboratory Supervisors. A summary report of quality control results and follow-up corrective action will be submitted to the client upon request.

5.6.5 Quality Control Personnel

The QC of the sorting process is to be conducted under the direct supervision of the Sorting Supervisor. Only the Sorting Supervisor or individuals with a documented sorting QC record of superior performance may provide sort QC.

Regarding identification QC, only the Identification Supervisors will be performing the QC on ichthyoplankton identification.

5.7 REFERENCE COLLECTION

Make sure that each taxon and life stage identified in the VCSNS entrainment program is represented in a project-specific ichthyoplankton reference collection at the biology laboratory. One reference collection will be maintained for SCE&G. Develop this reference collection by removing specimens from VCSNS entrainment samples and storing them in vials in a designated area. If available, include several (e.g., 10) specimens per taxon per stage, displaying a variety of sizes. Label the vials with the scientific name, date of capture, capture location, and a reference collection catalog number. The catalog number identifies a card containing more detailed sampling information, identifier, com-

ments, etc. File the cards alphabetically by family, genus, and species. Photographs will be taken of key species and lifestages to be determined based on abundance and consultation with client.

5.8 INSTRUMENT CALIBRATION

Calibrate each ocular micrometer periodically (at least weekly) using a stage micrometer. After calibration of ocular micrometers on zoom microscopes, place a calibration mark on the microscope so that measurement accuracy is maintained. Ocular micrometers on microscopes that have been adjusted or moved must be recalibrated before use. Document the calibrations in a log showing the dates and results of the calibrations.

6.0 DATA PROCESSING

6.1 DATA ENTRY VERIFICATION AND DATA SHEET CHAIN OF CUSTODY

Provide a submittal form with each batch of data sheets submitted to the Technical Data Processing (TDP) department for data entry. Information on the submittal form should include names of sender and recipient, date sent, and dates of entrainment collections included in the batch.

Key all data twice, resolving discrepancies between the two versions as they are flagged by the data verification program.

After data entry and verification are complete, transfer custody of the data sheets from TDP to the originators, where they are used in the error checking and quality control tasks, and finally stored in a project file for five years. Document the transfer from TDP back to the originator by one or more submittal sheets containing the same information as those used to transfer custody to TDP.

6.2 SYSTEMATIC ERROR CHECKS

Keyed data are subjected to a series of systematic error checking programs developed specifically for this project. These consist of univariate, bivariate, and multivariate checks specified by project personnel. Univariate range checks identify records for which one or more variables have values outside their valid or expected ranges. Bivariate and multivariate checks compare values of related variables. Additional checks scan the data for duplicate or missing observations. All records flagged by these programs are resolved, and corrections to both the data files and the data sheets are made as necessary. After error checking is complete, data files are subjected to quality control inspection (refer to Section 5.4).

6.3 DATA FILE FORMAT

Error checked data files are assembled into a SAS, Excel, or Microsoft Access database. Three analytic files will be prepared:

- Entrainment Field Data containing data originating from the Entrainment Field Data Sheet
- Entrainment Count Data containing data originating from the L1 lab data sheet
- Entrainment Measurement Data contain data originating from the L2 lab data sheet

Each of these data files will contain the variable "Sample" that will allow data files to be merged.

6.4 QUALITY CONTROL OF DATA FILES

Data files that have completed the systematic error checking process undergo a QC inspection to assure a 1% AOQL (Average Outgoing Quality Limit) according to a lot sampling plan (American Society for Quality Control. 1993. Sampling procedures and tables for inspection by attributes.

ANSI/ASQC Z1.4-1993). This procedure insures that ≥99% of the observations in a data file agree with the original data sheets. The number of observations to be checked, and the number of those that must be within tolerance are shown below. If more than the acceptable number of failures are found, then the data set must be inspected 100%.

Lot Sampling Plan for QC Inspection at Less Than 1% AOQL.

		Number of Failures	
Lot Size	**Sample Size**	**Accept If ≤**	**Reject If ≥**
1-32	ALL	0	1
33-500	32	0	1
501-3,200	125	1	2
3,201-10,000	200	2	3
10,001-35,000	315	3	4
35,001-150,000	500	5	6
150,001-500,000	800	7	8
500,001 and over	1,250	10	11

7.0 TRAINING

In order to assure the standardization of field, laboratory, and data processing procedures, a two level system for training technicians is followed: the first level being documented standard operating procedures; the second level being a training program for all new project personnel. At a minimum, this training program consists of the following steps:

- Prior to any on-site sampling, Normandeau staff will participate in any SCE&G or site-specific health and safety training as required by VCSNS.
- A complete reading and explanation of the project Quality Assurance Plan and Standard Operating Procedures (this document) including the Health and Safety Plan (Appendix D). A sign-off sheet filed in the program file will document reading of the SOP by project personnel.
- Observation by the Normandeau Field Site Supervisor or Laboratory Manager of the first two or more times a new procedure is performed. This is documented with a signed checklist.
- Direct supervision by an experienced technician of personnel assigned to unfamiliar tasks for their first two or more attempts.
- 100% quality control checks for at least the first three samples analyzed.
- On tasks requiring identification of fish and ichthyoplankton, the Program Manager will have final approval as to who is qualified to make these identifications. In some cases special training will be required to participate in tasks, as set forth by the Program Manager.

8.0 QUALITY ASSURANCE

8.1 NONCONFORMANCE REPORTS AND CORRECTIVE ACTION

Documentation of problems or unusual events occurring during a program will be accomplished using Extraordinary Event/Nonconformity (EENC) forms. The EENC form (Appendix A) is designed to dispense information to the Program Manager and Quality Assurance department and to obtain necessary action on items that are critical to technical operations and management of programs. The report results from observations such as these:

- deviations from standard operating procedures
- losing a sample
- finding an endangered species in a sample
- noting samples that are grossly different from expected (content, preservation, labels)
- noting a phenomenon that may deserve continued monitoring in the interest of the client and therefore may require a change in the scope of work
- quality control samples that exceed acceptable limits
- unusually high entrainment counts.

Items, samples, data, or information not in conformity with specifications or which do not meet preconditions for the next step in processing or use, are set aside until the problem is resolved and documented via the EENC report procedure.

The EENC report is designed for use by any person who identifies a problem or discovers information that is germane to a program scope of work or the improvement or change of contract performance. The originator describes the problem and may make recommendations for its resolution. Two temporary copies are made, and the original is sent to the Program Manager. One of the copies is kept by the originator in a file for "open" EENC reports (corrective action in progress), and the other is sent to the Quality Assurance Supervisor, who periodically checks on the progress of corrective action.

The Program Manager confers with appropriate parties and decides what corrective action will be required. Instructions to the Action Addressee (the person responsible for carrying out the corrective action) are written on the original EENC report. The Program Manger retains the original and sends a copy to the Action Addressee.

The Action Addressee resolves the problem as directed and then signs the EENC copy and returns it to the Program Manager to signify that the corrective action has been completed.

The Program Manager files the signed copy from each Action Addressee (there may be more than one), and when all corrective action is complete signs the original EENC report, keeps a temporary copy, and forwards the original to the QA Supervisor.

The QA Supervisor reviews the EENC report, and signifies acceptance of the resolution by signing and dating the report to "close" it. A copy of the closed EENC report is retained in QA files, the temporary copy received earlier from the originator is discarded, and the original is returned to the Program Manager.

The Program Manager discards the temporary copy and keeps the original on file. A copy of the closed EENC report is sent to the originator, and additional copies are sent to any other affected parties. The originator discards the temporary copy in the file of open EENC reports and files the copy of the closed EENC report.

8.2 QA AUDITS

It is the responsibility of the Quality Assurance organization to verify the achievement of quality through all phases of the project. Once the proposal, program design, and work development phases are complete, these responsibilities will be accomplished primarily by audits, tests, and surveys which will provide objective evidence that the quality control program and technical requirements, methods, and procedures as outlined in the study QA manual are being implemented. These audits will be conducted by an audit team of technically qualified personnel familiar with, but independent of and not responsible for, the work or activities under evaluation. Field sampling procedures will be audited by an outside organization (Mr. Fred Heitman, Enercon Services) that has access to this QA Plan and will report his findings to Mr. Dave Coughlan, ~~reports directly to~~ Normandeau's Program Manager, and SCE&G. ~~QA, Health and Safety Vice President.~~ Those field sampling procedure audits will occur twice during the field sampling season and be used to report and correct and procedural deficiencies. The audit team will review the operations, specifications, QC systems, plans, and project objectives and examine the acquisition and transfer of data from field to report.

Observations of nonconformities and program deficiencies will be classified into three categories:

A. Deficiencies that affect the data adversely;

B. Deficiencies that might affect the data adversely; and

C. Deficiencies or procedural changes that cannot affect the data adversely.

Class A deficiencies will be resolved before that portion of the program can proceed. Class B deficiencies must have a determination as to whether they should be changed to Class A or C deficiencies and whether or not corrective action is necessary. If corrective action is necessary, it will be performed within a reasonable time frame agreed to by the program management, the Quality Assurance Department, and SCE&G. Operations with Class A or B deficiencies will be subject to reaudit to determine the effectiveness of corrective action. Class C deficiencies must have corrective action accomplished before the next scheduled audit or end of the project, whichever comes first.

Audit results will be presented orally to the appropriate project or facility management by the audit team after the audit has been completed. At this time, specific findings will be presented and recommended courses of corrective action developed. Subsequently, the audit results will be documented in a written audit report and reviewed by management having responsibility in the areas audited. These

reports will include a summary of audit results, observations made with a listing of non-conformities, recommendations and corrective action taken.

The quality assurance director will maintain a file of all project and facility audits. This file will include copies of the audit checklists, audit reports, written replies, the record of completion of corrective action and follow-up action. A summary report of audit results, and follow-up corrective action will also be made available for SCE&G's review.

REFERENCES

Geosyntec Consultants. 2015. Entrainment Sampling Plan Virgil C. Summer Nuclear Station Unit 1. Prepared by Geosyntec Consultants for SCANA Services Inc.

USEPA 2001. Guidance for Preparing Standard Operating Procedures (SOPs). EPA/240/B-01/004 March 2001

Appendix A

YSI 6-series Multiparameter Water Quality Sondes User Manual

Available upon request (379 pages)

APPENDIX B

Forms

EXTRAORDINARY EVENT/NONCONFORMITY REPORT

EE/NC Report Number: Date:_____ From:_____

Respond by (date):_____ Project No.:_____ Title:_____

Date closed:_____

ADDRESSEES:

QA: __✓__ Project Mgr.:_____ Field Mgr.:_____ Lab Mgr.:_____ Technical Mgr.:_____ Others:_____

PROBLEM DEFINITION (e.g.. Sample ID, Activity, Data, Standard, etc. Not in Conformity) :

RECOMMENDATIONS FOR or CORRECTIVE ACTION TAKEN:

Signed:

ACTION ADDRESSEE RESPONSE:

CORRECTIVE ACTION COMPLETED: Date:_____ Signed:_____

Distribution: ORIGINAL:QA, COPIES OF ORIGINAL: Originator, Addressees
RESPONSES: QA (responses are to be made on copies)

VC Summer Station, 23681.000
2016 Entrainment Field Data Sheet

CT=S1

NEAR SURFACE SAMPLING

TYPE [1] SURVEY [ ][ ][ ]

SAMPLE	DATE (mmddyy)	TIME (hh:mm)	EMPLOYEE #	LAKE LEVEL	USE_CODE	SAMPLE ID #
[ ][ ][ ]	[ ][ ][ ][ ][ ][ ]	[ ][ ][ ][ ]	[ ][ ][ ][ ][ ][ ]	[ ][ ][.][ ]	[ ]	

TOTAL DEPTH [ ][ ].

blank = no sampling problems
2 = sampling problem
5 = void sample

NEAR SURFACE SAMPLING DEPTH [ ][ ].

	BONGO NET A FLOWMETER	BONGO NET B FLOWMETER
SERIAL NUMBER	[ ][ ][ ][ ][ ]	[ ][ ][ ][ ][ ]
END	[ ][ ][ ][ ][ ][ ]	[ ][ ][ ][ ][ ][ ]
START	[ ][ ][ ][ ][ ][ ]	[ ][ ][ ][ ][ ][ ]
DIFF	[ ][ ][ ][ ][ ][ ]	[ ][ ][ ][ ][ ][ ]

COMMENTS:

CT=S1

MID DEPTH SAMPLING

TYPE [2] SURVEY [ ][ ][ ]

SAMPLE	DATE (mmddyy)	TIME (hh:mm)	EMPLOYEE #	LAKE LEVEL	USE_CODE	SAMPLE ID #
[ ][ ][ ]	[ ][ ][ ][ ][ ][ ]	[ ][ ][ ][ ]	[ ][ ][ ][ ][ ][ ]	[ ][ ][.][ ]	[ ]	

TOTAL DEPTH [ ][ ].

blank = no sampling problems
2 = sampling problem
5 = void sample

TOP SAMPLING DEPTH [ ][ ].

	BONGO NET A FLOWMETER	BONGO NET B FLOWMETER
SERIAL NUMBER	[ ][ ][ ][ ][ ]	[ ][ ][ ][ ][ ]
END	[ ][ ][ ][ ][ ][ ]	[ ][ ][ ][ ][ ][ ]
START	[ ][ ][ ][ ][ ][ ]	[ ][ ][ ][ ][ ][ ]
DIFF	[ ][ ][ ][ ][ ][ ]	[ ][ ][ ][ ][ ][ ]

COMMENTS:

\WC_summer\Vc_Field_side1.AI 04/2016

VC Summer Station, 23681.000
2016 Entrainment Field Data Sheet

Survey ☐☐☐.

DATE (mmddyy) ☐☐☐☐☐☐

TIME (hh:mm) ☐☐☐☐

CT=WQ

DEPTH_WQ feet	H2O_TEMP	DO

CT=E1

Air temp (ºC) ☐☐☐☐

Cloud cover (%) ☐

Precipitation ☐

Wind direction ☐

Wave Height ☐

Cloud cover
0 = 1-9%
1 = 10-19%
2 = 20-29%
3 = 30-39%
4 = 40-49%
5 = 50-59%
6 = 60-69%
7 = 70-79%
8 = 80-89%
9 = 90 - 100%

Precipitation
0 = None
1 = Light rain
2 = Heavy rain
3 = Snow

Wind direction
0 = No wind
1 = North
2 = South
3 = East
4 = West

Wave Height
1 - calm to 1/2 ft
2 - light chop (>1/2 ft to 1 ft)
3 - heavy chop (>1 ft to 2 ft)
4 - large waves (>2 ft)

Wind Speed ☐

Wind speed (MPH)	Water surface	Land
1 = 0-7	Smooth/small wavelets	Leaves rustle, wind on face
2 = 8-11	Lg. wavelets,scattered whitecaps	Leaves & twigs in constant motion, flag waving
3 = 12-16	Small waves, frequent whitecaps	Raises dust & loose paper, sm. branches moving
4 = 17-24	Medium crested waves, many whitecaps	Small trees begin to sway
5 = 25-35	Large waves,foam,blown spray	Whole trees in motion

Vc_Field_side2.a1 04/2016

VC Summer Station, 23681.000
2016 Entrainment Lab Data Sheet

PAGE 1 OF ___

Project Name:_____ **Project No:** _____ **Plant:** _____

SAMPLE | CARD TYPE | CATCH_CD

[ ] | [L 1] | [ ] ANALYZED BY: _____ DATE: _____ NO. VIALS: ____

SPL_FACT	TAXON	STAGE	COUNT	SPECIES NAME

STAGE CODES

0 = unknown

1.= egg

2 = yolk-sac larva

3 = post yolk-sac larva

4 = young-of-the-year

5 = yearling or older

SAMPLE [ ] CARD TYPE [L 2] CONVERSION FACTOR [.]

TAXON	STAGE	TAXON	STAGE	TAXON	STAGE
SCALE MEASUREMENT	SCALE MEASUREMENT	SCALE MEASUREMENT	SCALE MEASUREMENT	SCALE MEASUREMENT	SCALE MEASUREMENT
1	14	1	14	1	14
2	15	2	15	2	15
3	16	3	16	3	16
4	17	4	17	4	17
5	18	5	18	5	18
6	19	6	19	6	19
7	20	7	20	7	20
8	21	8	21	8	21
9	22	9	22	9	22
10	23	10	23	10	23
11	24	11	24	11	24
12	25	12	25	12	25
13		13		13	

VC_Summer\VC_LabL1.ai 4/16

VC Summer Station, 23681.000
2016 Entrainment Lab Data Sheet

PAGE ___ OF ___

Project Name: ____________ **Project No:** ____________ **Plant:** ____________

SAMPLE [ ] CARD TYPE [L 2]

STAGE CODES
0 = unknown
2 = yolk-sac larva
3 = post yolk-sac larva
4 = young-of-the-year
5 = yearling or older

TAXON [ ] STAGE [ ]

	SCALE	MEASUREMENT		SCALE	MEASUREMENT
1			14		
2			15		
3			16		
4			17		
5			18		
6			19		
7			20		
8			21		
9			22		
10			23		
11			24		
12			25		
13					

TAXON [ ] STAGE [ ]

	SCALE	MEASUREMENT		SCALE	MEASUREMENT
1			14		
2			15		
3			16		
4			17		
5			18		
6			19		
7			20		
8			21		
9			22		
10			23		
11			24		
12			25		
13					

TAXON [ ] STAGE [ ]

	SCALE	MEASUREMENT		SCALE	MEASUREMENT
1			14		
2			15		
3			16		
4			17		
5			18		
6			19		
7			20		
8			21		
9			22		
10			23		
11			24		
12			25		
13					

TAXON [ ] STAGE [ ]

	SCALE	MEASUREMENT		SCALE	MEASUREMENT
1			14		
2			15		
3			16		
4			17		
5			18		
6			19		
7			20		
8			21		
9			22		
10			23		
11			24		
12			25		
13					

TAXON [ ] STAGE [ ]

	SCALE	MEASUREMENT		SCALE	MEASUREMENT
1			14		
2			15		
3			16		
4			17		
5			18		
6			19		
7			20		
8			21		
9			22		
10			23		
11			24		
12			25		
13					

TAXON [ ] STAGE [ ]

	SCALE	MEASUREMENT		SCALE	MEASUREMENT
1			14		
2			15		
3			16		
4			17		
5			18		
6			19		
7			20		
8			21		
9			22		
10			23		
11			24		
12			25		
13					

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APPENDIX C

Fish Taxon Codes

Appendix Table C-1. Taxon codes for fish species.

Tax-on	SCIENTIFC NAME	COMMON NAME
1	*Acipenser oxyrinchus*	Atlantic Sturgeon
2	*Acipenser brevirostrum*	Shortnose Sturgeon
3	*Chologaster cornuta*	Swampfish
4	*Amia calva*	Bowfin
5	*Anguilla rostrata*	American Eel
6	*Aphredoderus sayanus*	Pirate Perch
7	*Labidesthes sicculus*	Brook Silverside
8	*Menidia beryllina*	Inland Silverside
9	*Strongylura marina*	Atlantic Needlefish
10	*Paralichthys dentatus*	Summer Flounder
11	*Paralichthys lethostigma*	Southern Flounder
12	*Carpiodes carpio*	River Carpsucker
13	*Carpriodes cyprinus*	Quillback
14	*Carpriodes velifer*	Highfin Carpsucker
15	*Catostomus commersoni*	White Sucker
16	*Erimyzon oblongus*	Creek Chubsucker
17	*Erimyzon succeta*	Lake Chubsucker
18	*Hypentelium nigricans*	Northern Hogsucker
19	*Ictiobus bubalus*	Smallmouth Buffalo
20	*Ictiobus cyprinellus*	Bigmouth Buffalo
21	*Minytrema melanops*	Spotted Sucker
22	*Moxostoma carinatum*	River Redhorse
23	*Moxostoma collapsum*	Notchlip Redhorse
24	*Moxostoma duquesnei*	Black Redhorse
25	*Moxostoma erythrurum*	Golden Redhorse
26	*Moxostoma macrolepidotum*	Shorthead Redhorse
27	*Moxostoma pappillosum*	V-Lip Redhorse
28	*Moxostoma robustum*	Robust Redhorse
29	*Moxostoma sp.*	Carolina Redhorse
30	*Acantharchus pomotis*	Mud Sunfish
31	*Ambloplites cavifrons*	Roanoke Bass

Tax-on	SCIENTIFC NAME	COMMON NAME
32	*Ambloplites rupestris*	Rock Bass
33	*Centrarchus macropterus*	Flier
34	*Enneacanthus chaetodon*	Blackbanded Sunfish
35	*Enneacanthus gloriosus*	Bluespotted Sunfish
36	*Enneacanthus obesus*	Banded Sunfish
37	*Lepomis auritus*	Redbreast
38	*Lepomis cyanellus*	Green Sunfish
39	*Lepomis gibbosus*	Pumpkinseed
40	*Lepomis gulosis*	Warmouth
41	*Lepomis macrochirus*	Bluegill
42	*Lepomis marginatus*	Dollar Sunfish
43	*Lepomis megalotis*	Longear Sunfish
44	*Lepomis microlophus*	Redear
45	*Lepomis punctatus*	Spotted Sunfish
46	*Micropterus coosae*	Redeye Bass
47	*Micropterus dolomieu*	Smallmouth Bass
48	*Micropterus punctulatus*	Spotted Bass
49	*Micropterus salmoides*	Largemouth Bass
50	*Morone americana*	White Perch
51	*Morone chrysops*	White Bass
52	*Morone saxatilis*	Striped Bass
53	*Morone saxatilis x chrysops*	Hybrid Bass (Striped x White)
54	*Pomoxis annularis*	White Crappie
55	*Pomoxis nigromaculatus*	Black Crappie
56	*Alosa aestivalis*	Blueback Herring
57	*Alosa mediocris*	Hickory Shad
58	*Alosa pseudoharengus*	Alewife
59	*Alosa sapidissima*	American Shad
60	*Brevoortia tyrannus*	Atlantic Menhaden
61	*Dorosoma cepedianum*	Gizzard Shad
62	*Dorosoma petenense*	Threadfin Shad
63	*Cottus bairdi*	Mottled Sculpin
64	*Cottus carolinae*	Banded Sculpin

Tax-on	SCIENTIFC NAME	COMMON NAME
65	*Fundulus confluentus*	Marsh Killifish
66	*Fundulus diaphanus*	Banded Killifish
67	*Fundulus heteroclitus*	Mummichog
68	*Fundulus lineolatus*	Lined Topminnow
69	*Fundulus luciae*	Spotfin Killifish
70	*Fundulus majalis*	Striped Killifish
71	*Fundulus rathbuni*	Speckled Killifish
72	*Fundulus waccamensis*	Waccamaw Killifish
73	*Lucania goodei*	Bluefin Killifish
74	*Lucania parva*	Rainwater Killifish
75	*Campostoma anomalum*	Central Stoneroller
76	*Carassius auratus*	Goldfish
77	*Ctenopharyngodon idella*	Grass Carp
78	*Cyprinella analostana*	Satinfin Shiner
79	*Cyprinella nivea*	Whitefin Shiner
80	*Cyprinus carpio*	Carp
81	*Exoglossum laurae*	Tonguetied Minnow
82	*Exoglossum maxillingua*	Cutlips Minnow
83	*Hybognathus regius*	Eastern Silvery Minnow
84	*Hybopsis aestivalis*	Speckled Chub
85	*Hybopsis amblops*	Bigeye Chub
86	*Hybopsis hypsinotus*	Highback Chub
87	*Hybopsis insignis*	Blotched Chub
88	*Cyprinella labrosa*	Thicklip Chub
89	*Hybopsis monacha*	Spotfin Chub
90	*Hybopsis rubrifrons*	Rosyface Chub
91	*Cyprinella zanema*	Santee Chub
92	*Nocomis leptocephalus*	Bluehead Chub
93	*Nocomis micropogon*	River Chub
94	*Nocomis platyrhynchus*	Bigmouth Chub
95	*Nocomis raneyi*	Bull Chub
96	*Notemigonus chrysoleucas*	Golden Shiner
97	*Luxilus albeolus*	White Shiner

Tax-on	SCIENTIFC NAME	COMMON NAME
98	*Notropis alborus*	Whitemouth Shiner
99	*Notropis altipinnis*	Highfin Shiner
100	*Notropis amoenus*	Comely Shiner
101	*Lythrurus ardens*	Rosefin Shiner
102	*Notropis atherinoides*	Emerald Shiner
103	*Notropis bifrenatus*	Bridle Shiner
104	*Luxilus cerasinus*	Crescent Shiner
105	*Notropis chalybaeus*	Ironcolor Shiner
106	*Notropis chiliticus*	Redlip Shiner
107	*Notropis chlorocephalus*	Greenhead Shiner
108	*Notropis chloristius*	Greenfin Shiner
109	*Luxilus chrysocephalus*	Striped Shiner
110	*Luxilus coccogenis*	Warpaint Shiner
111	*Notropis cummingsae*	Dusky Shiner
112	*Notropis emiliae*	Pugnose Minnow
113	*Notropis hudsonius*	Spottail Shiner
114	*Notropis hypselopterus*	Sailfin Shiner
115	*Notropis leedsi*	Bannerfin Shiner
116	*Notropis leuciodus*	Tennessee Shiner
117	*Notropis lutipinnis*	Yellowfin Shiner
118	*Notropis maculatus*	Taillight Shiner
119	*Notropis mekistocholas*	Cape Fear Shiner
120	*Notropis petersoni*	Coastal Shiner
121	*Notropis photogenis*	Silver Shiner
122	*Notropis procne*	Swallowtail Shiner
123	*Cyprinella pyrrhomelas*	Fieryblack Shiner
124	*Notropis rubellus*	Rosyface Shiner
125	*Notropis rubricroceus*	Saffron Shiner
126	*Notropis scabriceps*	New River Shiner
127	*Notropis scepticus*	Sandbar Shiner
128	*Notropis spectrunculus*	Mirror Shiner
129	*Notropis spilopterus*	Spotfin Shiner
130	*Notropis telescopus*	Telescope Shiner

Tax-on	SCIENTIFC NAME	COMMON NAME
131	*Notropis volucellus*	Mimic Shiner
132	*Phenacobius crassilabrum*	Fatlips Minnow
133	*Phenacobius teretulus*	Kanawha Minnow
134	*Phenacobius uranops*	Stargazing Minnow
135	*Phoxinus oreas*	Mountain Redbelly Dace
136	*Phoxinus tennesseensis*	Tennessee Dace
137	*Pimephales notatus*	Bluntnose Minnow
138	*Pimephales promelas*	Fathead Minnow
139	*Pimephales vigilax*	Bullhead Minnow
140	*Rhinichthys atratulyus*	Blacknose Dace
141	*Rhinichthys cataractae*	Longnose Dace
142	*Semotilus atromaculatus*	Creek Chub
143	*Semotilus lumbee*	Sandhills Chub
144	*Elassoma boelki*	Carolina Pygmy Sunfish
145	*Elassoma evergladei*	Everglades Pygmy Sunfish
146	*Elassoma zonatum*	Banded Pygmy Sunfish
147	*Esox americanus*	Redfin Pickerel
148	*Esox lucius*	Northern Pike
149	*Esox masquinongy*	Muskellunge
150	*Esox niger*	Chain Pickerel
151	*Ameiurus brunneus*	Snail Bullhead
152	*Ameiurus catus*	White Catfish
153	*Ameiurus melas*	Black Bullhead
154	*Ameiurus natalis*	Yellow Bullhead
155	*Ameiurus nebulosus*	Brown Bullhead
156	*Ameiurus platycephalus*	Flat Bullhead
157	*Ictalurus furcatus*	Blue Catfish
158	*Ictalurus punctatus*	Channel Catfish
159	*Noturus eleutherus*	Mountain Madtom
160	*Noturus flavus*	Stonecat
161	*Noturus furiosus*	Carolina Madtom
162	*Noturus gilberti*	Orangefin Madtom
163	*Noturus gyrinus*	Tadpole Madtom

Tax-on	SCIENTIFC NAME	COMMON NAME
164	*Noturus insignis*	Margined Madtom
165	*Noturus leptacanthus*	Broadtail Madtom
166	*Pylodictus olivaris*	Flathead Catfish
167	*Lepisosteus osseus*	Longnose Gar
168	*Lepisosteus platyrhincus*	Florida Gar
169	*Agonostomus monticola*	Mountain Mullet
170	*Mugil cephalus*	Striped Mullet
171	*Mugil curema*	White Mullet
172	*Etheostoma acuticeps*	Sharphead Darter
173	*Etheostoma blenniodes*	Greenside Darter
174	*Etheostoma chlorobranchium*	Greenfin Darter
175	*Etheostoma collis*	Carolina Darter
176	*Etheostoma flabellare*	Fantail Darter
177	*Etheostoma fricksium*	Savannah Darter
178	*Etheostoma fusiforme*	Swamp Darter
179	*Etheostoma hopkinsi*	Christmas Darter
180	*Etheostoma inscriptum*	Turquoise Darter
181	*Etheostoma jessiae*	Blueside Darter
182	*Etheostoma kanawhae*	Kanawha Darter
183	*Etheostoma mariae*	Pinewoods Darter
184	*Etheostoma nigrum*	Johnny Darter
185	*Etheostoma olmstedi*	Tessellated Darter
186	*Etheostoma perlongum*	Waccamaw Darter
187	*Etheostoma podostemone*	Riverweed Darter
188	*Etheostoma rufilineatum*	Redline Darter
189	*Etheostoma serriferum*	Sawcheek Darter
190	*Etheostoma simoterum*	Tennessee Snubnose Darter
191	*Etheostoma swannanoa*	Swannanoa Darter
192	*Etheostoma thalassinum*	Seagreen Darter
193	*Etheostoma vitreum*	Glassy Darter
194	*Etheostoma vulneratum*	Wounded Darter
195	*Etheostoma zonale*	Banded Darter
196	*Perca flavescens*	Yellow Perch

Tax-on	SCIENTIFC NAME	COMMON NAME
197	*Percina aurantiaca*	Tangerine Darter
198	*Percina burtoni*	Blotchside Logperch
199	*Percina caprodes*	Logperch
200	*Percina crassa*	Piedmont Darter
201	*Percina evides*	Gilt Darter
202	*Percina gymnocephala*	Appalachia Darter
203	*Percina macrocephala*	Longhead Darter
204	*Percina nigrofasciata*	Blackbanded Darter
205	*Percina oxyrhyncha*	Sharpnose Darter
206	*Percina peltata*	Shield Darter
207	*Percina rex*	Roanoke Logperch
208	*Percina roanoka*	Roanoke Darter
209	*Percina sciera*	Dusky Darter
210	*Percina squamata*	Olive Darter
211	*Stizostedion canadense*	Sauger
212	*Stizostedion vitreum*	Walleye
213	*Stizostedion canadense x vitreum*	Saugeye
214	*Gambusia holbrooki*	Eastern Mosquitofish
215	*Heterandria formosa*	Least Killifish
216	*Poecilia latipinna*	Sailfin Molly
217	*Oncorhynchus mykiss*	Rainbow Trout
218	*Salmo Trutta*	Brown Trout
219	*Salvelinus fontinalis*	Brook Trout
220	*Trinectes maculatus*	Hogchoker
221	*Umbra pygmae*	Eastern Mudminnow
222	*Gobionellus shufeldti*	Freshwater Goby
223		Unidentified darter
224		Unidentified osteichthyes
225		Unidentified lepomis
226		Unidentified madtom
227	*Enchelyopus cimbrius*	Fourbeard rockling
228		Unidentified cyprinidae
229		Unidentified clupeidae

Tax-on	SCIENTIFC NAME	COMMON NAME
230		Bay Anchovy
231		Unidentified Catastomidae
232		Unidentified cyprinodontidae
233	*Notropis cornutus*	Common shiner
234	*Ichthyomyzon bdellium*	Ohio lamprey
235	*Etheostoma stigmaeum*	Speckled darter
236	*Lythrurus lirus*	Mountain shiner
237	*Moxostoma anisurum*	Silver redhorse
238	*Ictiobus niger*	Black buffalo
239	*Morone mississippiensis*	Yellow bass
240	*Hiodon tergisus*	Mooneye
241	*Alosa chrysochloris*	Skipjack herring
242	*Aplodinotus grunniens*	Freshwater drum
243	*Cyprinella galactura*	Whitetail shiner
244	*Cyprinodon variegatus*	Sheepshead minnow
245	*Elops saurus*	Ladyfish
246	*Syngnathus scovelli*	Gulf pipefish
247	*Pogonias cromis*	Black drum
248	*Bairdella chrysoura*	Silver Perch
249	*Cynoscion nebulosus*	Spotted seatrout
999	*no fish caught*	no fish caught
250	*Fundulus catenatus*	Northern studfish

Appendix 4. Field sampling audit report of Mr. Bob Hasevlat resulting from his June 22, 2016, observations at Monticello Reservoir.

To: David Coughlan (Project Manager/Stanley Charlotte NC Office)
Paul Geoghegan (Senior Project Manager/Bedford NH Office)

cc: Hannah Proctor (Laboratory Manager/Bedford NH)

From: Bob Hasevlat

Date: October 24, 2016

Re: VC Summer Field and Laboratory Audit

Audit: SCANA - 001

Audit Reference: Draft QAP and SOP for Virgil C Summer Nuclear Station, Jenkinsville,SC :Revision 1. April 2016

Audit Dates: June 22, 2016(Field); Laboratory (October 21, 2016)

Audited Personnel: Field Team Lead: Jeff Wollis; Field Technician: Dean Hughes
Laboratory Manager: Hannah Proctor

SUMMARY: Field tasks were audited at the Monticello Reservoir on June 22, 2016. Sampling gear including Bongo nets and flowmeters were checked for fitness for use prior to deployment and found adequate. Collection of samples 41 and 42 (day samples) and samples 43 and 44 (night samples) were observed. Nets were towed for a sufficient time to record a flowmeter difference between 10000 -15000 counts (revolutions) to achieve a target volume of 50-100 cubic meters (Section 4.3.2). Upon retrieval, samples were washed down into appropriately externally and internally labelled sample containers and preserved with formalin as instructed. Samples were secured for return to shore and later shipment to the Bedford laboratory for processing. Sample data sheets were completed fully and accurately following the coding instructions in Section 4.5.1 of the SOP.

Water quality data was collected at each sample location. This data was collected as described in the SOP (Section 4.3.3.). The Yellow Springs Instrument Model 6920 Multiparameter Sonde was calibrated prior to sampling (Section 4.3.3.1). A review of the calibration log indicated the sonde met calibration tolerances for use.

Laboratory sample processing was not observed. Instead, a review of chain of custody forms, sample logs, laboratory data sheets and quality records was performed for the samples that were observed during the field audit. The chain of custody log for the samples collected during the field audit was inspected and was found complete and with appropriate signatures for sample transfer. Also, the laboratory sample log sheet (records sample entry by sample number into the laboratory and stage of processing until complete) was reviewed and found to be complete with appropriate notations for sample processing.

Identification data sheets were reviewed for the June 22 samples. For all samples, taxa were identified and entered as the appropriate fish species life stage. In addition, an appropriate number of specimens from

each sample were selected and measured (Section 5.3.3) using an ocular micrometer. A calibration log for the micrometer found the equipment in compliance.

Quality control for the project for sorting and identification tasks was performed as described in Section 5.6. The quality control log for the samples collected on June 22 was inspected; it was complete and followed the laboratory's inspection plan to select sorted and identified samples for quality inspection.

Also, the ocular micrometer used to measure specimen lengths was calibrated weekly and documented in a log indicating dates and calibration results (Section 5.8).

A project-specific reference collection of ichthyoplankton was maintained of various life stages of each taxon and life stage if possible (Section 5.7). The collection was observed and included properly labeled vials of the fish taxon and life stages as described.

Appendix 5. Field sampling audit report of Mr. Fred Heitman resulting from his July 27, 2016, observations at Monticello Reservoir.

Mr. Fred Heitman, Enercon Services, Inc., provide the following summary of his 2016 activities for this report: "On July 27, 2016 I rode with the Normandeau field sampling crew that was performing ichthyoplankton sampling on Monticello Reservoir for the Sumner NPP (Nuclear Power Plant). The crew was headed by Mr. Jeff Wollis. The first sample was collected during daylight hours in the prescribed locations. During this sampling event I carefully monitored the actions of the crew as they collected samples to ensure that they were following the prescribed protocols. I concluded that all procedures were followed for the collection of this sample. After dark the crew re-assembled and began preparing for a second sampling episode. I carefully monitored the activities of the crew. The samples were collected in accordance with their prescribed procedures in the proper locations. My overall assessment is that this is a highly qualified crew that is experienced in the collection of ichthyoplankton samples. They performed their roles efficiently and in a safe and highly skilled manner."

Appendix 6. Detailed Comments on report of V. C. Summer entrainment study, 2016 by Charles C. Coutant.

Detailed Comments on report of V. C. Summer entrainment study, 2016
Charles C. Coutant

Although not required by EPA 316(b) requirements the entrainment study "V.C. Summer Nuclear Station Entrainment Study - 2016. Prepared for: SCANA RFP WK9622-(2015)" was peer reviewed by Dr. Charles C. Coutant, Aquatic Ecologist. Dr. Coutant provided a detailed review of the report and provided many excellent comments. We have provided a copy of Dr. Coutant's comments (black font) and the applicable SCE&G responses (blue font). Dr. Coutant was not privy to any previous discussions between SCDHEC and VC Summer regarding the purpose of the study or how it is to be used to demonstrate compliance with the EPA 316(b) requirements. He was under the impression the study would be used to provide input to additional studies and evaluations (i.e. r(10), r(11) and r(12)). Some of the recommendations made by Dr. Coutant in relation to the development of additional studies and evaluations will be deferred at this time. The new report is titled "V.C. Summer Nuclear Station Entrainment Study – 2016 and revised 2017. Prepared for: SCANA RFP WK9622-(2015)".

1.0 Introduction

It would be helpful in this introduction to make a distinction between determining the concentrations (density) of entrainable fish eggs and larvae in the reservoir water and estimating the numbers entrained by the plant's actual cooling water withdrawals (Actual Intake Flow, AIF). The next-to-last sentence could be interpreted as indicating the report covers both steps or just the initial one. *We will provide clarity to indicate that both ichthyoplankton density and ichthyoplankton entrainment estimates are covered.*
Surprisingly, the introduction makes no mention of the EPA Rule or its requirements for an entrainment study. *This material was part of the GeoSyntec Study Plan and not repeated for that reason. We will include mention of the EPA Rule and also attach the GeoSyntec Study Plan as an Appendix.*

2.0 Facility Description

First paragraph: The first sentence starts out suggesting that someone who wants to know the facility needs to read elsewhere, which is not a good topic sentence for the paragraph or section. *For clarity, we will provide information on FPSS and also reference the GeoSyntec Study Plan.* This report needs to stand alone, although the reference can be cited later in the paragraph for additional detail. I suggest starting with the second sentence with a relevant addition such as: ...that uses once-through condenser cooling. *This change was made.* It's not clear what agency made the determination that the system is a CCRS under the CFR; was it NRC, which was cited, or EPA, which administers the implementation of 316(b) and is not cited? *We will indicate that SCDHEC made the determination per material in the GeoSyntec Study Plan.*

Figure 2-1: Although this figure is good for the near layout, it would be helpful to also have a figure with broader scale that would show where in SC the plant is located and more of the reservoirs to get the context of ichthyoplankton in a pumped storage arrangement (that

may be peculiar to it). Also, the figure shows intakes for Units 2 & 3 as well as Unit 1, which is the focus of this report. Some explanation seems needed, especially if the study for these units is planned for use as the second study year for meeting the EPA Rule. *A broader scale map was inserted as a new Figure 2-1 and more information on the CWIS for VC Summer units 2 & 3 will be added to re-numbered Figure 2-2.*

Second paragraph: It is customary to include a figure or two of the actual CWIS in order to provide visual perspective for the description in the text. The location and purpose of the retainer walls, for example, are not clear from the text. The mesh size of the traveling water screens is usually given, as it pertains to the organism sizes that are entrainable. It would seem important to describe the jetty arrangement that separates the intake flow from the thermal discharge flow, as seen in Figure 2-1, for this affects the intake's zone of influence. Likewise for the detail of the skimmer wall in the intake. *More information on the CWIS (including traveling screen mesh = 3/8" square mesh) was provided and two new figures inserted. Figures 2-3 and 2-4 (thanks to diagrams provided by SCANA) provide plan and cross-section views of the CWIS. A third paragraph describing the 'area of hydraulic influence' and its derivation was added to Section 2.0. Figure 3-1 was re-numbered to Figure 2-5.*

Figure 2-2: This figure could use some labels to clarify what is shown. For example, an indication of the Unit 1 intake (although from the inset one can guess where it is). The key is in feet of elevation, but that takes some figuring from data in the text to tell what the depths are, which isn't very helpful to the reader. Distances would help, or at least a note that the dimensions of the hexagon on the inset are to scale. *We have removed this figure entirely. If Monticello Reservoir elevations are typically in the 420-425 ft msl range and the elevations on the Geosyntec bathymetric map begin at 390-400 ft msl (and proceed to deeper depths) then most of the surface depths affected by the CWIS are not displayed on this image. See above for the new discussion of the 'area of hydraulic influence' with the re-numbering of Figure 3-1 to Figure 2-5.*

3.0 Methods and Materials

Sampling Site and Larval Fish Collections

First paragraph: It seems important to say something about how this area of influence was determined and what the figure represents. Was it determined by measured flow velocities? Is there a citation for that work? *An entirely new third paragraph was added to Section 2.0 on 'area of hydraulic influence' and the Geosyntec (2005) reference was added to Section 6.0, Literature Cited.* The text now switches to metric measure; since the previous description is in feet this suggests a need to use either one or the other or both units throughout. *Engineers prefer the English system and scientists prefer the metric system, once the engineering discussion concludes all measures will be in metric units. Dr. Coutant is familiar with this dilemma and we suggest no changes to the units.*

Figure 3-1: Showing the area of influence is good, because it presumably denotes organisms that would be committed to the intake. As noted above, it would be useful to know how it

was determined. The rough outline suggests it somehow conforms to the bathymetry, but this isn't stated. *The third paragraph in Section 2 provides more detail on the derivation of the hydraulic zone of influence and has been previously discussed.* Since the scales of figures 2-1 and 2-2 are in feet, and 3-1 is in meters (although the area is in acres), laying the two together isn't simple. This figure also is confused by including sampling transects from another Normandeau study (Units 2&3). This inclusion suggests that the report may compare studies, which wasn't stated in the introduction. At least have the legend and text indicate that the 2009 transect locations are provided for reference in the discussion. *We have updated the caption of Figure 3-1 (Now re-numbered to Figure 2-5) to provide more information on the 2009 study.*

Second paragraph: Introduction of the previous study here seems odd. This might better have been mentioned in the introduction, where understanding of the two studies could have been put in perspective. *We have included more details of the 2008-2009 study in the Introduction.* Knowing that there are apparently two years of study (2008-2009, 2016) would help the case that the ichthyoplankton concentrations in the general intake area are well understood. It would be clearer that the QA plan and SOP were for this study if the earlier study were mentioned in the introduction rather than here. *We have made clear that the SOP and QA Plan (attached as Appendix 3) pertain to the 2016 data collection and not the 2008-2009 results.*

Water Quality and Environmental Data Collection

Second paragraph: This paragraph suggests that the study is of both concentrations (density) of organisms in the reservoir water and the numbers entrained (see note above). It's useful to make the distinction because one can always take the concentration data for taxa and extrapolate to different withdrawal rates, not just the actual withdrawal rates at the time of the study. The entrainment data may need to be used in this way for the subsequent sections of the EPA Rule. The way the time was divided up sounds fine. The validity of using total semi-monthly intake flows depends on the stability of the pumping. Since this is a base-load plant (stated in Section 2), this is reasonable but may need explanation (a peaking plant would need to have the withdrawals different for day and night that wouldn't be captured by a total period flow). *Information about the base-load nature of VC Summer were originally included in Section 2 (Facility Description) and 5 (Discussion), we have added additional mention of base-load operation in Section 1 (Introduction). Most of the provided comment about non-base load plants does not apply to VC Summer.*

Table 3-1: This table's legend indicates that the data were depth-averaged, which was not mentioned in the text to this point. It would be helpful if the reasoning were explained, since the facility purposely withdraws water in summer from the deeper, cooler layers and avoids the warm, shallow layers. Depth averaging in late June through end of August seems inconsistent with the reservoir stratification and the intended withdrawal location. However, with the skimmer wall extending down 9.5 ft below normal pool elevation (Section 2) the mid-depth samples at 5 m (about 15 ft) could make the depth averaging ok.

This goes back to defining the area of influence: was it determined as a surface phenomenon or was it tailored to the depths of water withdrawal under the skimmer wall? Also, the table legend might clarify that the proportions of day and night are the relative proportions due to the calendar, not proportional withdrawals (see above). *Depth-averaging is considered appropriate for several reasons. 1) Nighttime mixing during FPSS pumpback will mix the surface layer of the reservoir near the Summer Station CWIS and provide a more even distribution of ichthyoplankton. This mixing* ***may*** *minimize ichthyoplankton density differences between surface and mid-depth tows. 2) Temperature measurements show the water column to be almost isothermal in mid-April and then to come isothermal again from mid-July to study conclusion. 3) Dissolved oxygen (DO) data is somewhat harder to interpret as DO concentrations are similar in March and April, diverge as the reservoir warms (with concomitant DO declines) and surface aeration affects the surface DO measurements, and then become variable as FPSS pumpback raises mid-depth DO concentration at night compared to values measured during daylight. 4) A t-test of the ichthyoplankton densities in surface vs mid-depth tows showed no statistical difference between the two strata (despite the obvious difference observed for one life stage of one species) and supported the notion that strata should be combined. The combined effect of FPSS mixing, statistical analysis, and similar water quality measures at various times during the study period would seem to make a unique analysis of surface vs. mid-depth ichthyoplankton densities (and thus entrainment estimates) impractical. It is possibly for this reason that the Geosyntec Study Pan (Appendix 1), pgs 11-12, under Data Analysis, stated "Extrapolation of entrainment rates to an annual total will be calculated using an average measured ichthyoplankton density (organisms per m^3) and plant withdrawal rates (m^3 of water per month). The entrainment rate will be the number of organisms per month (or other unit of time)." Original study plan guidance indicates that the ichthyoplankton densities should be derived from averages.*

The legend to Table 3-1 was revised.

Field sampling Quality Assurance

I assume the SOP will be available for the reader if/when this report goes to the regulators. The EPA Rule states explicitly that the methods must be presented in the Entrainment Characterization Study. The summary here may be ok, but some regulators want more details (e.g., how the nets raised and lowered, how they are washed down). *The Field Sampling SOP (Normandeau 2016) has been included as Appendix 3.*

Sample Processing and Taxonomy

Second paragraph: Some regulators want to know the taxonomic sources or technical experts that were used in the identifications. Consider providing this information. *Taxonomic references and the qualifications of our taxonomic experts have been included.*

Larval Density and Entrainment Estimates

As noted above, it is usually fruitful to separate the methods and results into density data for taxa and estimated entrainment using known water or projected withdrawals. This

section blends the two. This becomes important when the EPA Rule's sections on alternative technologies and benefits analyses come into play. They will have to get the information from this study.

First paragraph: Could be clarified by separating methods for determining density and entrainment. The first eight lines refer to density whereas the rest beginning with "In recognition..." refer to calculating what was entrained. Provision of good topic sentences for the parts of this paragraph would make the distinction clear. The first paragraph could begin with something like: Ichthyoplankton densities were calculated with flowmeter data (providing the actual volumes sampled) and the numbers counted in the samples, which were then standardized to number per 100m3. The second part could start with something like: The numbers entrained under plant operations were estimated by densities and the volumes of water withdrawals. In recognition... *Per Dr. Coutant's suggestions, the discussion of methods relative to Larval Density and Entrainment Estimates have been placed into two separate paragraphs and his use of topic sentences followed.*

Second paragraph: I am not the best person to evaluate the details of the statistics. However, the emphasis seems to be on calculating the facility's annual entrainment, which does need to be done. However, use of these data for r(10), r(11), and r(12) of the Rule will need taxon-specific and life-stage-specific densities and entrainment numbers that can be used for evaluating alternative technologies, equivalent adults for entrainment losses (and fishery losses from the lost adults, etc.) and societal benefits of these alternatives compared to the present condition. Does this methodology provide that? Might need some further explanation. *Larval fish density data have been provided by taxon, life stage, sampling depth, diel period, and month in Tables 4-3 and 4-4; estimated entrainment numbers have been provided by taxon, life stage, diel period, and month in Tables 4-5 and 4-6.*

4.0 Results

Sampling Site and Larval Fish collections

First paragraph: Although not essential, it might be useful to reiterate that the sampling was in the zone of influence near the Summer Plant intake where organisms are likely committed to be entrained into the intake. Clearly indicating this will be helpful for justifying the study for application to the other r's of the Rule. *Mention of the 'area of hydraulic influence' occurs in Sections 1 (Introduction) and 3 (Materials and Methods) and a paragraph on the subject has been added in Sections 2 (Facility Description). This term will also be included in the opening line of Section 4 (Results).*

Figure 4-1: I suggest the legend be more specific about location, such as above. Also, it would be most clear if it said total ichthyoplankton. *These excellent suggestions have been incorporated.*

Table 4-1: This is a good table, but it would be helpful if the names were the same as in Figure 4-2 and other pie charts, perhaps in parentheses. *The Pie Charts aggregate fish by taxonomic families to show general trends, any finer division by genus or species would make them more burdensome and harder to interpret. Table 4-1 generally provides a finer*

level of data as it includes ichthyoplankton counts to the species, genus, or family levels. Based on these considerations, we did not make the suggested changes.

Figure 4-2: Good figure. Again, it would be good to be specific about location. *These excellent suggestions have been incorporated*

Water Quality and Environmental Data
First and second paragraphs: For easy reading, I suggest each paragraph start with the topic word, Temperature or Dissolved Oxygen, and emphasize the results (not reiteration of methods). Something like: Water temperatures measured at surface, mid-depth and deep varied greatly with depth but little between day and night (...). ... *As several of these comments have asked us to reiterate previous language, we will keep these sentences in place.*

Second paragraph: This paragraph refers to the Fairfield Pumped Storage Station, which wasn't described in the introduction or facility description. See comments on the facility section. The fact that the Summer Station is on a pumped-storage system is relevant both for water quality and for considerations in the Rule. *Discussion of FPSS was provided in Section 2 (Facility Description).*

Fourth paragraph (top of page 6) and Appendices 2 & 3: Mixing units makes for confusion and poor communication. The text and appendices use Million Gallons per Day (Appendix 2), gallons per minute (text), million gallons per minute (Appendix 3), million gallons per month with equivalent cubic meters per month (text). *For clarity, we have maintained the units as provided to us by SCE&G.* Although it is informative to give the service-water flows and cooling-water flows separately (Appendices 2 and 3, respectively), entrainment will be the total flow, which is given just as a range in the text. *Appendices 2 and 3 were left intact (but re-labeled to Figure 4-4 and Figure 4-5, respectively) to provide all possible data for reviewers.* It should be easy to make a small appendix table to show the total volume per month or per half-month used in the calculations. Those would be the actual numbers used, which would facilitate someone checking your figures.

Field Sampling and Quality Assurance
Good documentation.

Sample Processing and Taxonomy
Except for the reference to the Broad River Basin, this short section seems to be a statement or restatement of methods and results presented earlier. I suggest moving some of this to methods or the earlier results presentation and deleting it here. *We have left this short section intact as past comments to reiterate data have been instructive and, also, removal of the short section might create an awkward one-sentence paragraph.*

Larval Density

In line 2, then should be than. See below notes on the table vs. text. *This editorial change was made.*

Table 4-3: The legend could indicate that the list is in order of abundance overall in samples. *Table 4-3 was re-numbered to Table 4-6 and the legend was modified per this comment.* There seems to be considerable difference between surface and midwater, especially for the most abundant taxa/life stages. This observation doesn't correlate well with the text that stated (page 3 and this section) that there were no significant differences between surface and midwater thus allowing depth averaging. Also, the generalization that there were more in surface waters than midwater isn't true for Dorosoma PYSL that was twice as abundant in midwater. Some explanation seems needed. *The paired t-tests of log10(x+1) transformed densities identified a significant difference between Day and Night ichthyoplankton densities but NOT between Surface vs Mid-depth ichthyoplankton densities during a sampling event. While Dr. Coutant correctly recognize some discrepancies for the Dorosoma, their contribution to a significant t-test statistic for the Surface vs Mid-depth comparison were evidently masked by variability emanating from all the other taxa and life stages collected. Thus, we have not pursued any segregation of Surface vs Mid-depth ichthyoplankton density data and have averaged these densities for entrainment calculations. However, we have computationally pursued and elaborated upon the Day vs. Night differences in ichthyoplankton densities as they impact entrainment calculations.*

Table 4-4: Legend might say that the samples are depth averaged. *Table 4-4 was re-numbered to Table 4-7 and this editorial change was made.*

Entrainment Estimates

First paragraph: This paragraph seems to just repeat or expand on the data on density, even referring to the same tables and figures. The term "entrainment density" is confusing, for density is in the water and entrainment is what goes in the plant. It is really important to distinguish between the ichthyoplankton density in the waterbody and their entrainment in the withdrawn water (which depends on the amount of water withdrawn). The statistics would have been better presented in the section on larval density, not here. *Agreed – we have moved the density discussion to the Larval Density portion of Section 4.0.*

Second paragraph: Now we have entrainment. But I would avoid the confusing term entrainment abundance by saying estimated number of ichthyoplankton entrained considering the density of ichthyoplankton near the intake and the amount of water withdrawn by the station (Actual Intake Flow or AIF, per Rule). *Agreed – we have made this change.*

Figure 4-8: To help avoid confusion between density and entrainment, which would arise from saying in the reservoir, it would be good to add to the legend something like: ...C) estimated total ichthyoplankton withdrawn by the Summer Nuclear Station considering the ichthyplankton density in Monticello Reservoir near the intake and the amount of water

withdrawn by the station, March through August 2016. *Agreed – we have made this change.*

Table 4-5: Would be clearer to say: Estimated numbers of ichthyoplankton entrained in the Summer Nuclear Station (millions)...Station summed for all dates from 1 March through 31 August 2016, considering ichthyoplankton densities near the station and amount of water withdrawn. Also, diel looks odd here, and might better be said as diel period. *These changes have been made.*

Table 4-6: Similar comment as for Table 4-6, but in this case you want to say for each month rather than summed for all months. *These changes have been made.*

Figure 4-9. This figure may make sense to a cowboy with his boots strapped on, but it needs a better legend for readers like me. I suggest something like (if I understand it correctly): Estimates of the median and upper and lower 95% confidence limits for the numbers of ichthyoplankton of all taxa and life stages entrained by the Summer Nuclear Station annually based on the displayed probability distribution of a bootstrap analysis of 10,000 runs. *Agreed – we have made this change.*

5.0 Discussion

General: Good use of the literature and good logic. This analysis will be important for the benefits analysis for meeting the EPA Rule.

Second paragraph: It might be useful to expand a bit on the 2009 study by indicating it was nearby as shown in Figure 3-1. *We have provided more language relative to the Normandeau (2009) study per the comments.* With that discussion it would be clear why the figure includes the areas sampled in 2008-2009, something not initially clear (see comment above on Figure 3-1).

Third full paragraph on Page 10: It might take some explanation here. If DO levels in deeper water are below that needed by ichthyoplankton in summer (precluding larval fish occurrence) and the skimmer wall at the intake withdraws deeper and cooler water, why aren't the entrainment numbers based on densities in surface and middepths overestimating the actual entrainment? Here is where a section diagram of the intake and near field intake area would be helpful (see earlier comment). *More elaboration was provided on this paragraph, though we surmise the discussion about the withdrawal of deeper and cooler water does not apply to the VC Summer surface-oriented CWIS (maximum depth of 30' below the normal pool elevation of 420 msl). While Dr. Coutant's grasp of reservoir limnology is unparalleled, the description of the Summer CWIS indicates it is only capable of withdrawing the coolest water* ***available*** *to it at the CWIS and not necessarily the coolest water that might be available in the entire reservoir. WQ measurements taken at the time of entrainment sampling within the zone of entrainable cooling water show generally isothermal conditions in summer with marginal DO at deeper depths during daylight that trends towards more acceptable levels at night (probably owing to FPSS*

pumpback-related mixing). This variability may mask depth-related differences. Additionally, as stated in the Discussion about Table 3-1 (on pg 4 of this document), depth-averaging of ichthyoplankton densities has considerable support.

Last paragraph of the discussion: This discussion will be important for the benefits analysis of alternatives under the EPA Rule. The difficulty will be quantifying the points in this paragraph, as the benefits analysis will have to do. Can this report or further references help supply that quantitative information? *This paragraph was modified slightly. The benefits analysis will probably not be necessary if this second year of entrainment data satisfies SCDHEC's needs.*

Nowhere in the introduction or discussion is the use of this information for complying with the EPA Rule mentioned. I can only assume that the Rule was one (probably the main) reason for doing the study. Will this study be submitted as the official Entrainment Characterization Study for Section 122.21(r)(9) of the Rule? Is this year's study to be grouped with the 2008-2009 study to complete the mandated 2-year study? It looks like it could be.

The Rule is quite specific about what is required of the Entrainment Characterization Study. Here are the relevant parts of the Rule (I'm sure you know this, but it is handy to see it together with my evaluation questions, which follow):

(9) Entrainment Characterization Study. The owner or operator of an existing facility that withdraws greater than 125 mgd AIF, where the withdrawal of the cooling water is measured at a location within the cooling water intake structure that the Director deems appropriate, must develop for submission to the Director an Entrainment Characterization Study that includes a minimum of two years of entrainment data collection. The entrainment characterization study must include the following components:

(i) Entrainment data collection method. The study should identify and document the data collection period and frequency. The study should document and identify organisms to the lowest taxon possible of all life stages of fish and shellfish that are in the vicinity of the cooling water intake structure(s) and are susceptible to entrainment, including any organisms identified by the Director and any species protected under Federal, State or Tribal Law, including any threatened or endangered species within a habitat range that includes waters within the vicinity of the cooling water intake structure. Biological data collection must be representative of the entrainment at the intakes subject to this provision. The owner or operator of the facility must identify and document how the location of the cooling water intake structure in the waterbody and water column are accounted for by the data collection locations; We have made a greater effort to specify the lack of threatened or endangered species in Monticello Reservoir.

The Summer Station CWIS withdraws surface waters down to a depth of 35 ft and the Surface and Mid-depth ichthyoplankton tows collect organisms from within this same water volume.

(ii) Biological Entrainment Characterization. Characterization of all life stages of fish and shellfish and any species protected under Federal, State, or Tribal Law, (including threatened or endangered species), including a description of their abundance and their temporal and spatial characteristics in the vicinity of the cooling water intake structure(s), based on sufficient data to characterize annual, seasonal and diel variations in entrainment, including but not limited to variations related to climate and weather differences, spawning, feeding, and water column migration. This characterization may include historical data that are representative of current operational practices of the facility and of biological conditions at the site. Identification of all life stages of fish and shellfish must include identification of any surrogate species used, and identification of data representing both motile and non-motile life-stages and organisms;

(iii) Analysis and Supporting Documentation. Documentation of the current entrainment of all life stages of fish, shellfish, and any species protected under Federal, State, or Tribal law (including threatened or endangered species). The documentation may include historical data that are representative of the current operation of the facility and of biological conditions at the site. Entrainment data to support the facility's calculations must be collected during periods of representative operational flows for the cooling water intake structure, and the flows associated with the data collection must be documented. The method used to determine latent mortality along with data for specific organism mortality or survival that is applied to other lifestages or species must be identified. The owner or operator of the facility must identify and document all assumptions and calculations used to determine the total entrainment for that facility together with all methods and quality assurance/quality control procedures for data collection and data analysis. The proposed data collection and data analysis methods must be appropriate for a quantitative survey.

The Rule does not require a formal peer review of the Entrainment Characterization Study. However, this study provides the baseline information used for the evaluation of alternative technologies and a benefits valuation study to estimate the benefits of evaluated fish protection technologies. Therefore, it is important that the study be technically sound and applicable to the needs of the other r's.

In evaluating an Entrainment Characterization Study for r(9), either study plans or reports, I have found certain questions to be useful that have been developed through experience in applying the work to the other r's. They are (my comments on this study report are in brackets after the question):

1. Is the facility described, mapped, and diagrammed sufficiently well for a novice reader such as the regulator in the state or EPA region to see the facility's regional context, the waterbody from which water is withdrawn and details of the CWIS that are important to entrainment characterization. [as noted in comments above, some aspects of this could

be better, particularly the broader context of the pump-storage reservoirs and the finer context of physical structure of the intake.] *Discussion of the FPSS has been added, as has been a diagram of the Summer CWIS. A cross-sectional view of the CWIS was provided by SCE&G.*

2. Were two years of study conducted (or planned)? [This report is only a one-year study for 2016. From what is shown, it looks like the 2008-2009 study (Normandeau 2009) could be considered the second year. But that would have to be explicit. There is no indication that this study would be repeated another year.] *We have indicated that Normandeau (2009) is the first year of the entrainment characterization and that this 2016 study is being submitted for consideration as the second year.*
3. Were the study protocols and sampling methods adequately described? [For most, yes, but there may be details in the SOP that would help clarify what was done.] *SOP added as Appendix 3.*
4. Was the frequency and duration of sampling adequate to characterize the entrainable species and life stages? [Seems ok.] *No further action taken.*
5. Was the sampling and handling gear appropriate for the study and location and adequately described? [Yes] *No further action taken.*
6. Were samples taken during representative intake flows? [Yes] *No further action taken.*
7. Were the Rule's mandate for annual, seasonal and diel differences obtained? [Yes] *No further action taken.*
8. Were environmental factors considered, especially as they may become drivers of variability in entrainment rates? [Yes, but no particular analysis other than seasonal differences. Some mention of depth differences in discussion, but these seem contradictory to depth averaging.] *We have presented evidence for depth averaging.*
9. Were the methods for processing samples appropriate? [Yes; might want to pull some info from the SOP] *Lab QA procedures have been described in the SOP (Appendix 3).*
10. Were data entry, verification and backup reasonable and appropriate? [seems so] *Based on the Lab QA Audit of Mr. Hasevlat – yes.*
11. Were the analytical methods for determining density in the entrained water and entrainment considering the water withdrawn (AIF) reasonable and adequate? [Yes, but a clearer distinction could be made between the steps of getting densities, determining numbers entrained on sampling periods, and determining annual entrainment. But there are questions about depth averaging that need work] *These points have been enhanced in the report and we have addressed depth averaging.*
12. Were federally protected species and critical habitats considered? [Not explicitly discussed. May need some evidence that there are none in the area.] *We have made a greater effort to specify the lack of threatened or endangered species in Monticello Reservoir.*
13. Was the study adequate for estimating entrainment impacts on fish and shellfish species in the source water body? [Information and literature citations were presented on the rationale for saying the entrained species are fast reproducers and bounce back quickly.]
14. Was a QA/QC Plan provided? [No, other than audits, but there must have been one. Could be appended, like the SOP also might.] *SOP and QA/QC Plan have been provided in Appendix 3.*

15. Was the QA/QC Plan adequate for ensuring the integrity of the results? [Probably, but not fully demonstrated.] *QA/QC Plan has been provided as Appendix 3.*
16. Was the study conducted by qualified staff? [Yes, although some studies cite their authorities for larval identifications, such as published ichthyoplankton keys. Not critical, but might intercept any questions.] *We have provided more adult and larval fish references and highlight the qualifications of our taxonomists.*
17. Were assumptions and uncertainties presented and discussed? [Not explicitly]
18. If historical data were used was their use adequately justified? [There was some citation of the Normandeau 2008-2009 study in discussion, but it was not explicitly analyzed for the present study or for consideration as a second year for the Rule] *Normandeau (2009) added an Appendix 2.*
19. Is the technical information adequate as input to the (r)(10) and (r)(11) evaluations that must conduct analyses of Equivalent Adult, Production Foregone, and Lost Fisheries Yield? [There was no attempt to put the study report in the context of the EPA Rule, so it is difficult to tell. Nonetheless, I believe the necessary information is there, especially the basic numbers entrained by species and stage. These data would be enhanced if the Normandeau 2009 report is considered part of a "2-year" study of ichthyoplankton density in the vicinity. The discussion states that the ichthyoplankton were essentially the same, so it should qualify but may still need better justification to satisfy the regulators. Since the species most encountered are forage species, Threadfin Shad and Gizzard Shad, the Lost Fisheries Yield will be the indirect route of lost food for predator (game) fish. Life history parameters will need to be supplied to or by the contractor doing the modeling, so won't be needed in this report.] *We have provided more information on this study relative to the EPA Rule and included the Normandeau (2009) study as an appendix.*