WATER QUALITY REPORT

PARR FAIRFIELD HYDROELECTRIC PROJECT
FERC No. 1894

Prepared for:

South Carolina Electric & Gas Company
Cayce, South Carolina

Prepared by:

Kleinschmidt

Lexington, South Carolina
www.KleinschmidtUSA.com

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SOUTH CAROLINA ELECTRIC & GAS COMPANY

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

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1.0 INTRODUCTION

The Parr Fairfield Hydroelectric Project (FERC No. 1894) (“Parr Fairfield Project” or “Project”), owned and operated by the South Carolina Electric & Gas Company (“SCE&G” or “Licensee”), is currently licensed by the Federal Energy Regulatory Commission (“FERC” or “the Commission”) through June 2020. In anticipation of relicensing, this water quality report has been prepared utilizing existing water quality data available for the waters associated with the Parr Fairfield Project including Parr Reservoir, Monticello Reservoir, the downstream reach of the Broad River, located below the Parr Shoals Dam, and a site located upstream of Parr Reservoir, on the Broad River near Carlisle.

The Parr Reservoir, located in Fairfield County, South Carolina, is a 4,400 acre impoundment formed by the Broad River and the Parr Shoals Dam and serves as the lower reservoir for the Fairfield Pumped Storage Development. Monticello Reservoir, a 6,800 acre impoundment is formed by a series of four earthen dams and serves as the upper reservoir for the pumped storage development. While the Broad River upstream and downstream of the Parr Reservoir is not included in the Project Boundary Line (PBL), this report will also examine the water quality at select sites to evaluate potential effects from Project operations.

It should be noted that the V. C. Summer Nuclear Station (VCSNS) is located on the south end of Monticello Reservoir, but is not part of the Parr Fairfield Project. However, the two projects do share Monticello Reservoir, with VCSNS utilizing lake waters as a coolant for its single nuclear unit, Unit #1. Currently the VCSNS is being expanded to include two more nuclear units, 2 and 3, which will utilize the Parr Reservoir as a coolant upon completion of the project.

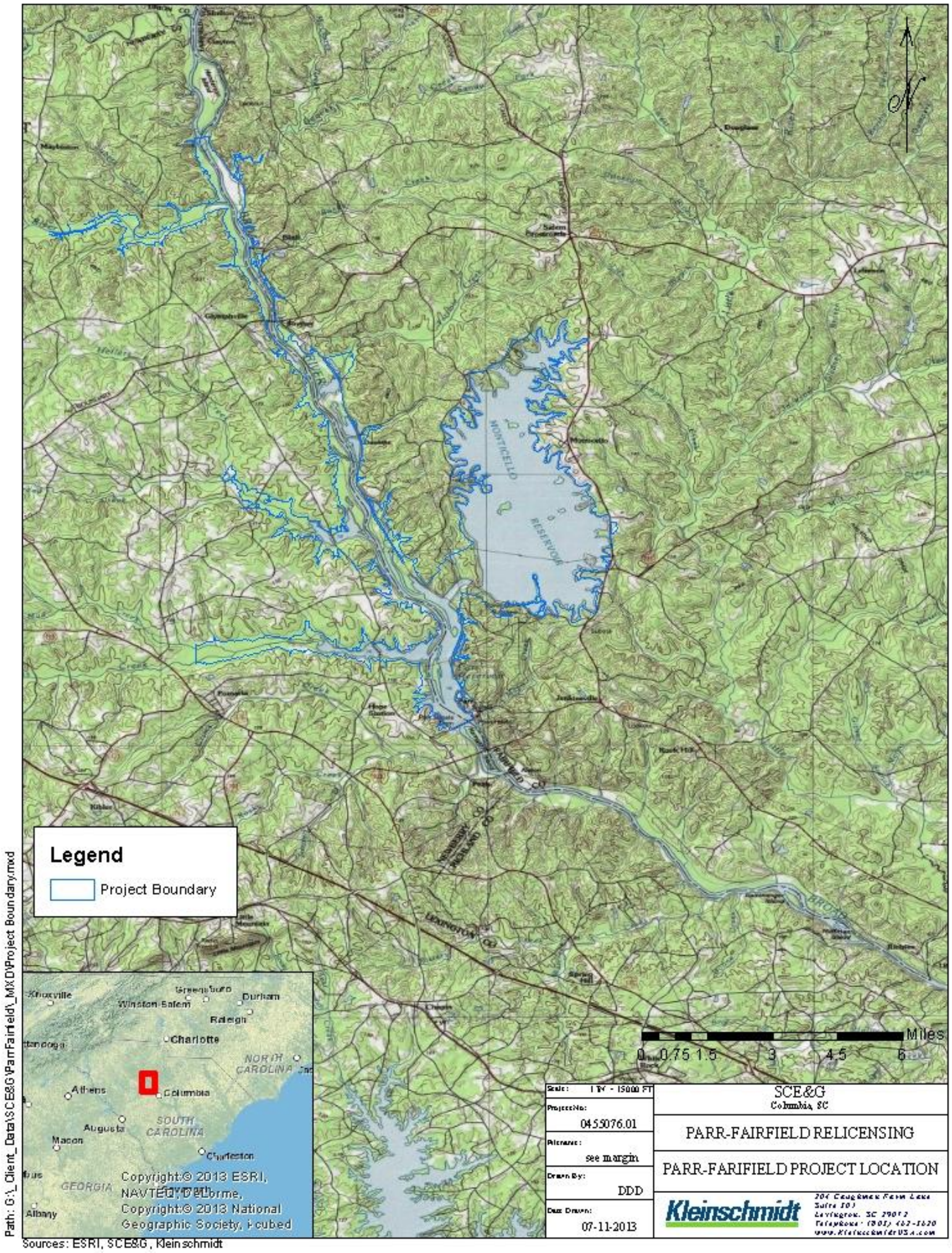


FIGURE 1-1 PARR FAIRFIELD PROJECT BOUNDARY LINE

1.1 Goals and Objectives

The goal of this water quality report is to collect and present existing data for the Parr Reservoir, Monticello Reservoir, and select upstream and downstream sites on the Broad River above Parr Reservoir and below the Parr Shoals Dam to accurately describe the past and current water quality of these areas. In addition, this report serves to establish a water quality baseline for the Project, as well as identify any potential water quality trends which may be associated with effects from Project operations.

1.2 Background Water Quality Information

While there are many ways to evaluate the health of a river or lake, this report focuses on a few common water quality indicators such as water temperature, dissolved oxygen, conductivity and pH, among others, to best describe the health of the Parr Fairfield Project waters. General information on the parameters utilized in this report, along with an explanation of why they are commonly used water quality indicators, is included below.

Dissolved oxygen

Oxygen found in water is measured in its dissolved form as dissolved oxygen, or DO. DO in water is consumed by aquatic animals, decomposition of organic matter and various other chemical reactions, making it an extremely important resource within lakes, streams and rivers. DO levels fluctuate seasonally, as well as diurnally. Aquatic biota can be vulnerable to low DO levels which naturally occur on early mornings of hot summer days, when stream flows are low, water temperatures are high and aquatic plants have not been producing oxygen since sunset the day before (USEPA 1997).

Conductivity

As defined by the United States Environmental Protection Agency (USEPA or EPA), conductivity is a measure of the ability of water to pass an electrical current, and is affected by the presence of inorganic dissolved solids, such as chloride, nitrate, sulfate, and phosphate anions or sodium, magnesium, calcium, iron and aluminum cations. Temperature also has an effect on conductivity, where the warmer the water, the higher the conductivity, which is why conductivity is typically reported at 25^{o}C. The geology of the area through which the river flows will have a large impact on the conductivity of the water. A range of 50 to 1500 µS/cm is typical of rivers throughout the United States. Waters with a conductivity measurement outside of this range may indicate that the river is not suitable for various species of fish and macroinvertebrates (USEPA 1997).

pH

Another indicator of water quality is pH, a term used to indicate the alkalinity or acidity of a substance as ranked on a scale from 1.0 to 14.0. As the acidity in a water sample increases, the pH decreases. The pH for pure water is 7.0. The pH of a river or lake affects many chemical and biological processes occurring in the water, allowing for different organisms to flourish or deteriorate within different pH ranges. Typically, a majority of aquatic animals prefer a pH range of 6.5-8.0. Low pH can allow for toxic elements and compounds to become available for uptake by aquatic plants and animals, producing lethal conditions for many species (USEPA 1997).

Turbidity

The measurement of water clarity is known as turbidity. Materials suspended in water, such as soil particles, algae, plankton and microbes typically ranging in size from 0.004mm to 1.0mm, can decrease the passage of light through water. Since the suspended particles absorb heat, high turbidity can increase water temperatures, and thus decrease DO concentrations. High turbidity will also reduce the amount of light that is able to penetrate the water, which in turn inhibits photosynthesis and the production of DO. Increased tubidity's reduction of light penetration also has a potential affect in mediating algal blooms. Suspended materials that might cause high turbidity can also clog fish gills, reducing a fish's ability to resist disease, as well as lowering fish growth rates and negatively affect egg and larval development (USEPA 1997).

Nitrogen and Phosphorus

Nitrogen is found in several different forms in aquatic ecosystems, including ammonia, nitrates (NO_3) and nitrites (NO_2). Phosphorus usually exists in nature as part of a phosphate molecule (PO_4) and is found in aquatic systems as organic and inorganic phosphate. While nitrogen and phosphorus in their various forms are essential plant nutrients, excessive amounts can cause significant water quality issues. When combined with phosphorus, nitrates in excess amounts can accelerate eutrophication, which causes extreme increases in aquatic plant growth and changes in the types of plants and animals that inhabit a body of water. Dissolved oxygen, temperature and other water quality indicators are also affected (USEPA 1997).

Chlorophyll-a

Chlorophyll-a is the primary photosynthetic pigment in algae and cyanobacteria. Chlorophyll-a is measured to determine the amount of algae present in a water body. High algae concentrations can cause a variety of water quality issues, such as decreased dissolved oxygen and increased nutrient pollution (USEPA 1997).

Metals

While some metals at specific concentrations are essential for good water quality, the presence of other metals is extremely dangerous and toxic to aquatic life. The “heavy metals” such as cadmium, chromium, mercury and lead are the most toxic to aquatic organisms.

2.0 METHODOLOGY

2.1 OVERVIEW

This report covers four separate bodies of water as they relate to the Parr Fairfield Project, including the Parr Reservoir, Monticello Reservoir, the Broad River upstream of Parr Reservoir, and the Broad River downstream of the Parr Shoals Dam. This report also focuses mainly on common water quality indicators such as temperature, dissolved oxygen, pH and conductivity, along with additional data when available, on turbidity, nitrogen, phosphorus, chlorophyll-a and metals. Existing data, extending back to 1999, were assembled for each area from several different sources at several different collection sites. Water quality data were compiled from several sources including the US Geological Service (USGS), the South Carolina Department of Health and Environmental Control (SCDHEC), the South Carolina Department of Natural Resources (SCDNR), and SCANA Corporate Environmental Services (parent company to SCE&G). Figure 2-1 depicts the USGS, SCDHEC, and SCANA water quality monitoring sites utilized in this report.

Sediment from the Parr Reservoir was sampled and analyzed for various metals by SCANA in 2012 and the findings from this study are also included in this report.

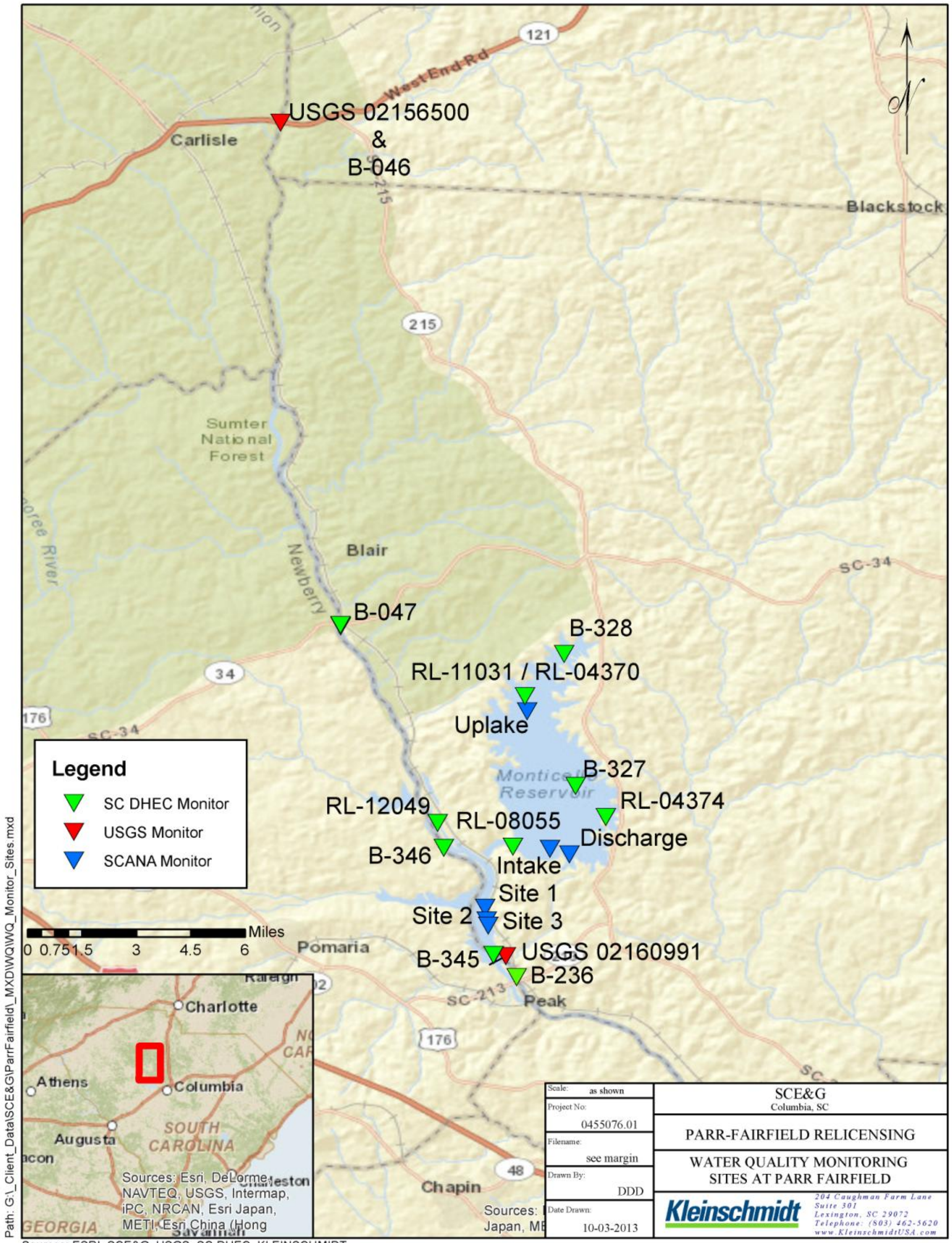


FIGURE 2-1 MAP OF WATER QUALITY MONITORING LOCATIONS FOR THE PARR FAIRFIELD HYDRO PROJECT

2.2 PARR RESERVOIR DATA COLLECTION METHODS

2.2.1 PARR RESERVOIR WATER QUALITY DATA

Data used within this report to describe water quality conditions for the Parr Reservoir were compiled from SCANA and SCDHEC.

SCANA collects vertical profile water quality data at three locations within Parr Reservoir in accordance with the provisions of the Section 401 certification of the Clean Water Act issued to SCE&G by SCDHEC. Sampling locations include the vicinity of the combined discharge of the cooling tower blowdown and other liquid waste streams from the two new nuclear units (2 and 3) that are being constructed adjacent to the Parr Reservoir as part of the V. C. Summer Nuclear Station expansion. The parameters of temperature, dissolved oxygen, specific conductivity, and pH are collected on a monthly basis beginning in 2011 and continuing for five years after the nuclear units 2 and 3 are fully operational. Data included in this report were collected from January 2011 through December 2013. This vertical profile data are currently collected at three locations in the Parr Reservoir, including Site 1, located approximately 500 yards upstream of the proposed discharge site for the new nuclear units 2 and 3; Site 2, located at the proposed discharge site for the new nuclear units 2 and 3; and Site 3, located approximately 300 yards downstream of the proposed discharge site. Figure 2-2 shows the exact monitoring locations in the Parr Reservoir.

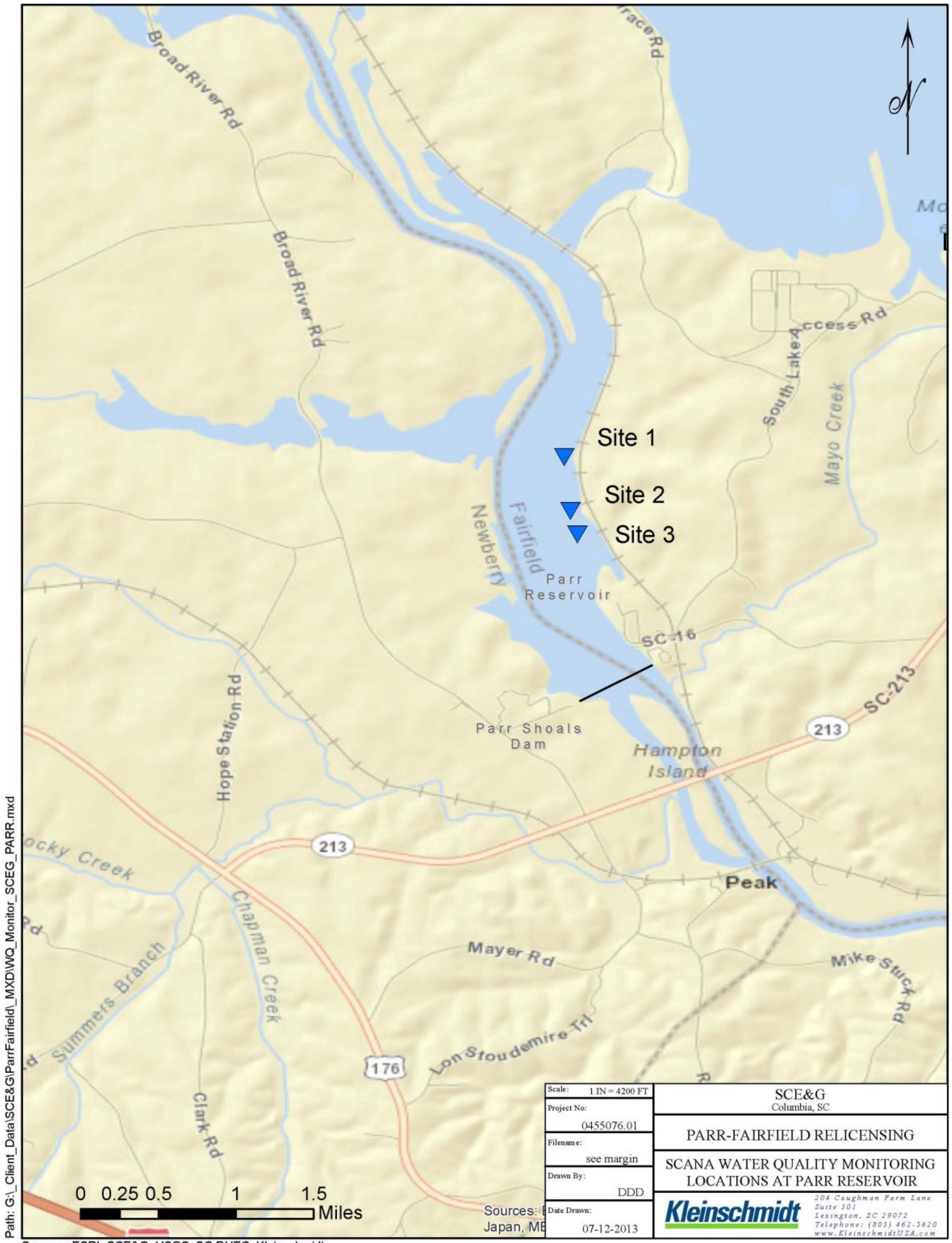


FIGURE 2-2 SCANA MONITORING SITES ON THE PARR RESERVOIR

Data are collected by SCANA employees using a YSI 650 MDS Water Quality Logger that is equipped with a YSI 600XL Sonde or instrumentation of equivalent capabilities and accuracy. The meters used for data collection were calibrated following SCANA SCDHEC approved calibration procedures prior to data collection. To establish a vertical profile of the water quality at each specific site, data were collected at each location beginning at the surface and at one meter intervals to the reservoir bottom. Total depth at each sampling site varies depending on the operation of the Fairfield Pumped Storage and river flow at the time of sampling.

SCANA also collected metals data near Site 2 in the Parr Reservoir (see Figure 2-2). Surface grab samples were collected once a month from June 2007 through April 2008 and sent to an outside lab for analysis.

SCDHEC has several monitoring stations located within the Parr Reservoir. Permanent sites are labeled as B-047, B-346 and B-345. Additionally one randomly selected site was monitored by SCDHEC in 2012 and this site is labeled as RL-12049. The exact locations of these sites are shown in Figure 2-3. Samples are collected at these monitoring sites by way of grab samples on a monthly or bi-monthly basis depending on site and year. Over the years the SCDHEC monitoring schedule has undergone several changes, and therefore monitoring has not occurred continuously at all sites. Also, site B-346 was listed as inactive beginning in 2005. SCDHEC water quality data included in this report were retrieved from the EPA's data warehouse, STORET.

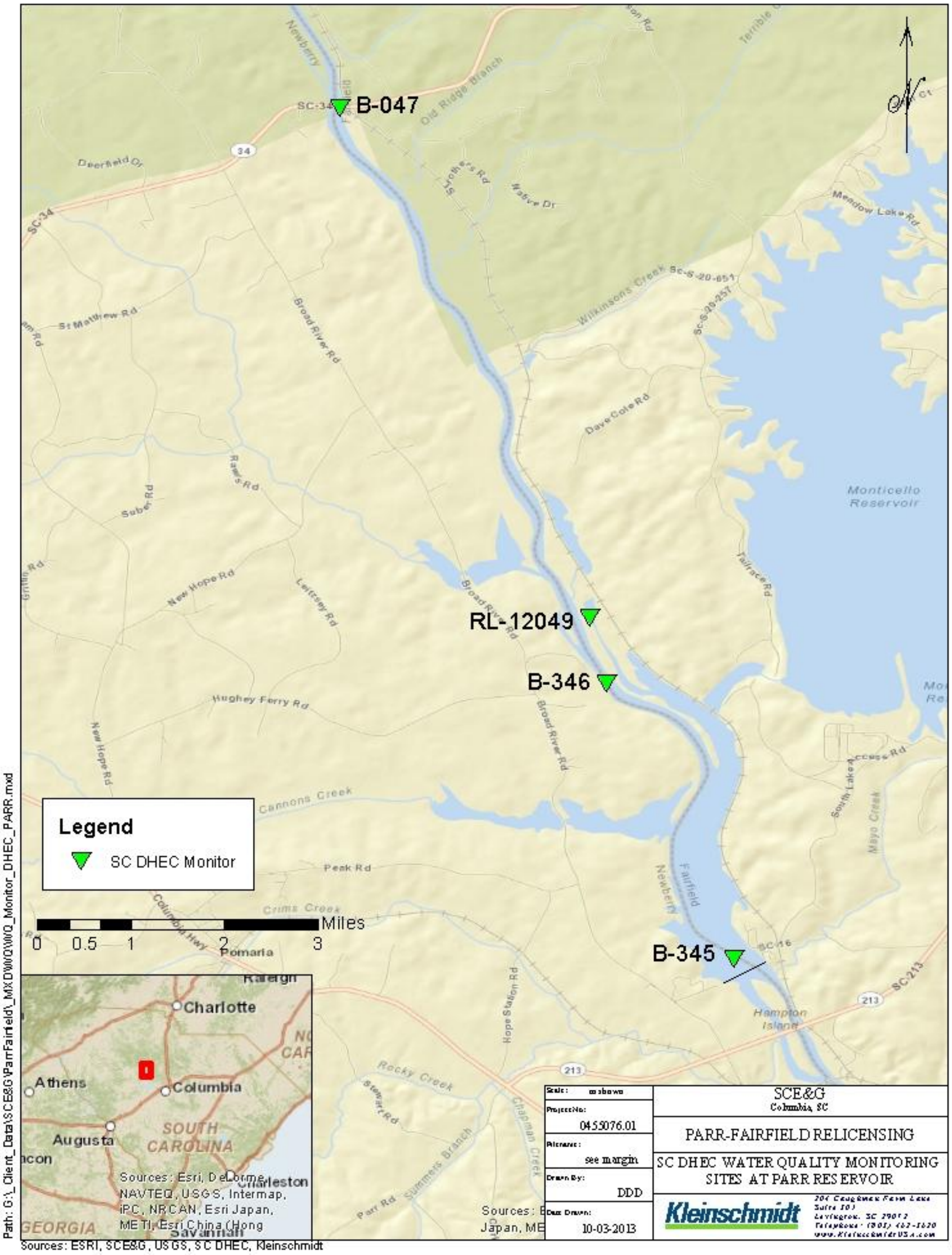


FIGURE 2-3 SCDHEC MONITORING STATIONS ON PARR RESERVOIR

2.2.2 PARR RESERVOIR SEDIMENT DATA

In accordance with provisions of the Clean Water Act Section 401 Water Quality Certification (WQC) issued to SCE&G by SCDHEC, SCANA began annual collections of sediment samples from two locations in the Parr Reservoir for analysis of the following metals (total): aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, silver, strontium, thallium and zinc. Total phosphorus was also measured.

Sediment samples were collected from two transects located within Parr Reservoir. The first transect was located just north of the Heller's Creek confluence approximately 4 miles upstream of the discharge location. The second transect was located approximately 200 yards downstream of the cooling water discharge location. Sampling at each transect consisted of collection of one grab sample from each of five sample points along each transect. One sample was collected from each end of the transect (eastern shore and western shore). The third sample point was located at the mid-point of each transect. The remaining two sample points were located equidistant from the mid-point sample location and each end of each transect. All sample points are constantly inundated at the reservoir's low pool elevation (256ft msl; NGVD 29). The five grab samples were composited and thoroughly homogenized to form one discrete sample from each transect. Basic water quality parameters including temperature, DO, conductivity and temperature were also collected, using a YSI 650 MDS Water Quality Logger equipped with a YSI 600XL Sonde or instrumentation of equivalent capabilities and accuracy at each transect. Figure 2-4 shows the exact location of the two transects.

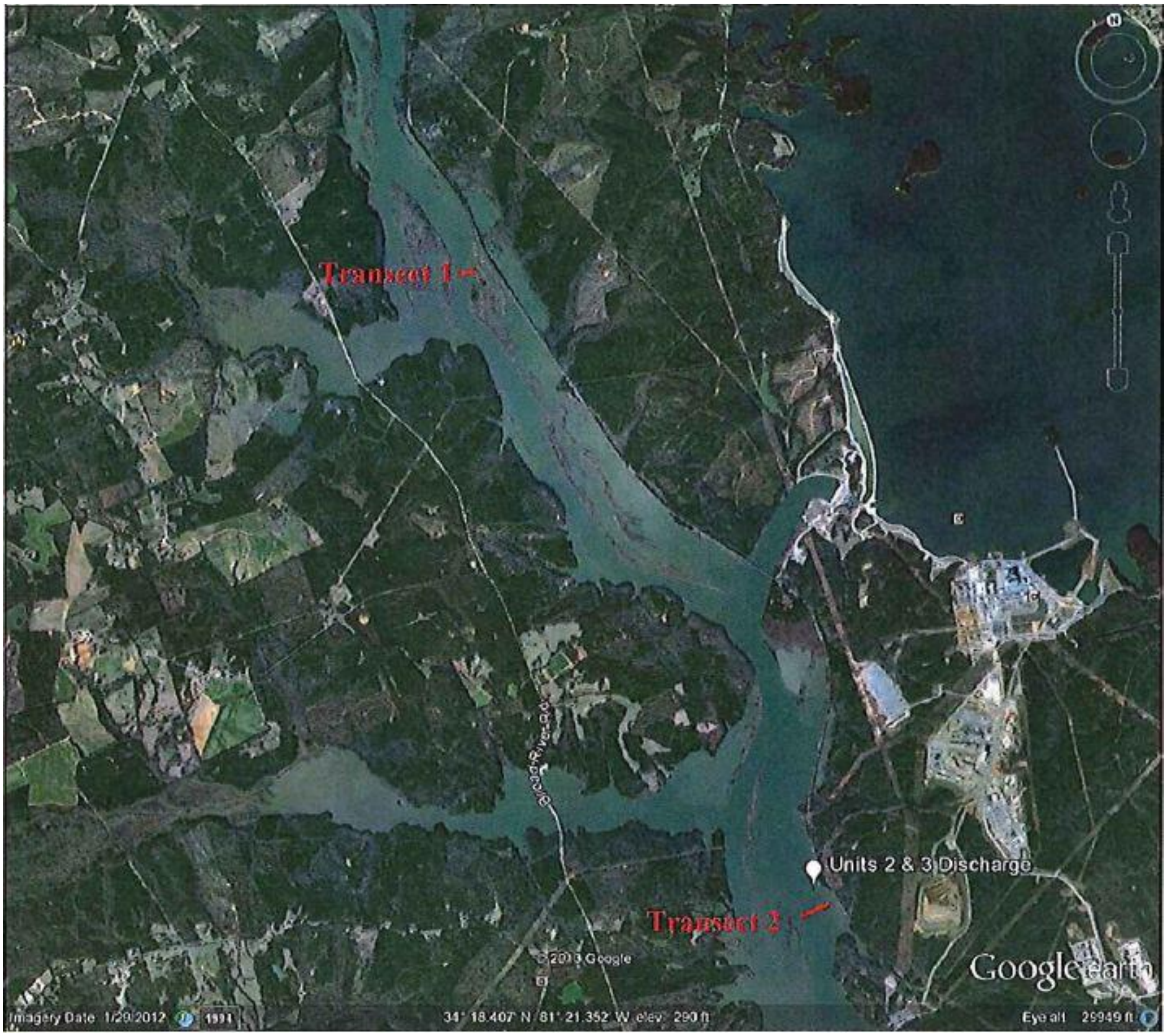
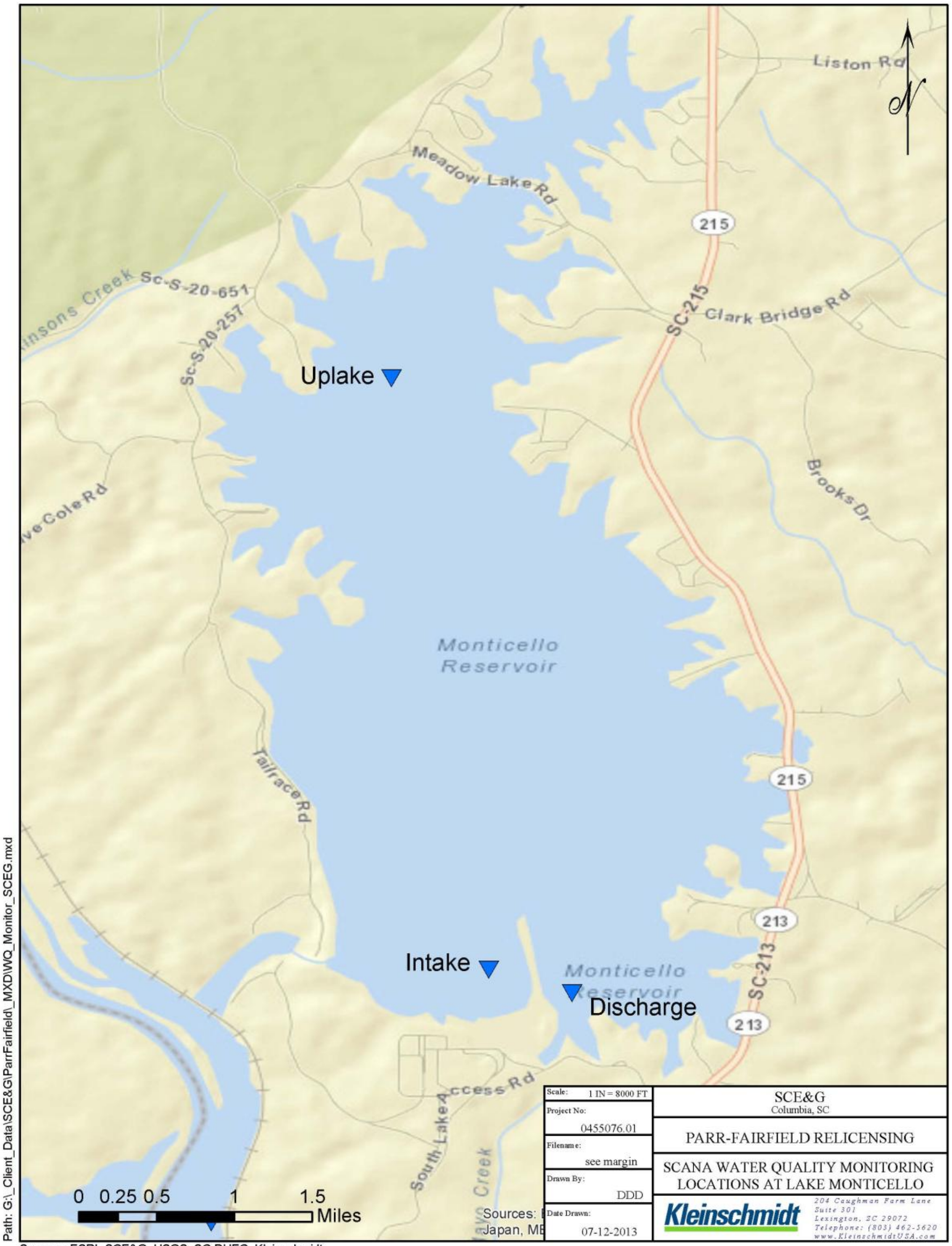


FIGURE 2-4 TRANSECTS FOR PARR RESERVOIR SEDIMENT INVESTIGATION REPORT 2012

2.3 MONTICELLO RESERVOIR DATA COLLECTION METHODS

Data used within this report to describe water quality conditions for Monticello Reservoir were compiled from SCANA and SCDHEC.

SCANA collects vertical profile water quality data in accordance with the provisions of the Section 401 WQC in the vicinity of the intake and discharge of the VCSNS on Monticello Reservoir. The parameters of temperature, dissolved oxygen, specific conductivity, and pH are collected on a monthly basis, with 10 years of data included here, beginning in January 2003 and ending in December 2012. Vertical profile data are currently collected at three locations on Monticello Reservoir, including the site known as “intake,” located in the channel near the circulating water intake for the VCSNS; the site known as "discharge," located just outside the northern end of the circulating water discharge canal for VCSNS; and the site known as "uplake," located near the northern end of the reservoir. Figure 2-5 shows the exact monitoring locations on Monticello Reservoir.



Sources: ESRI, SCE&G, USGS, SC DHEC, Kleinschmidt

FIGURE 2-5 SCANA MONITORING SITES ON MONTICELLO RESERVOIR

Data were collected using a YSI 650 MDS Water Quality Logger that is equipped with a YSI 600XL Sonde or instrumentation of equivalent capabilities and accuracy. The meters used for data collection were calibrated following SCANA procedures prior to data collection. To establish a vertical profile of the water quality at each specific site, field measurements were collected at each location beginning at the surface and at one meter intervals to the reservoir bottom. Total depth at each sampling site varies depending on the operation of the Fairfield Pumped Storage and river flow at the time of sampling.

SCANA also collected metals data near the Intake site on Monticello Reservoir (see Figure 2-5). Surface grab samples were collected once a month from June 2007 through April 2008 and sent to an outside lab for analysis.

SCDHEC has two permanent monitoring stations located on Monticello Reservoir, identified as B-327 and B-328. Additionally four randomly selected sites were monitored by SCDHEC in 2004, 2008, and 2011; these sites are labeled as RL-04370, RL-04374, RL-08055, and RL-11031. The exact location of these sites is shown in Figure 2-6. As previously mentioned, the SCDHEC monitoring schedule has undergone several changes over the last 15 years, and therefore monitoring has not occurred continuously at all sites. Data are collected at these monitoring sites by way of grab samples on a monthly or bi-monthly basis depending on individual site and year. Site B-328 was listed as inactive in 2005. SCDHEC water quality data included in this report was downloaded from the EPA's data warehouse, STORET.

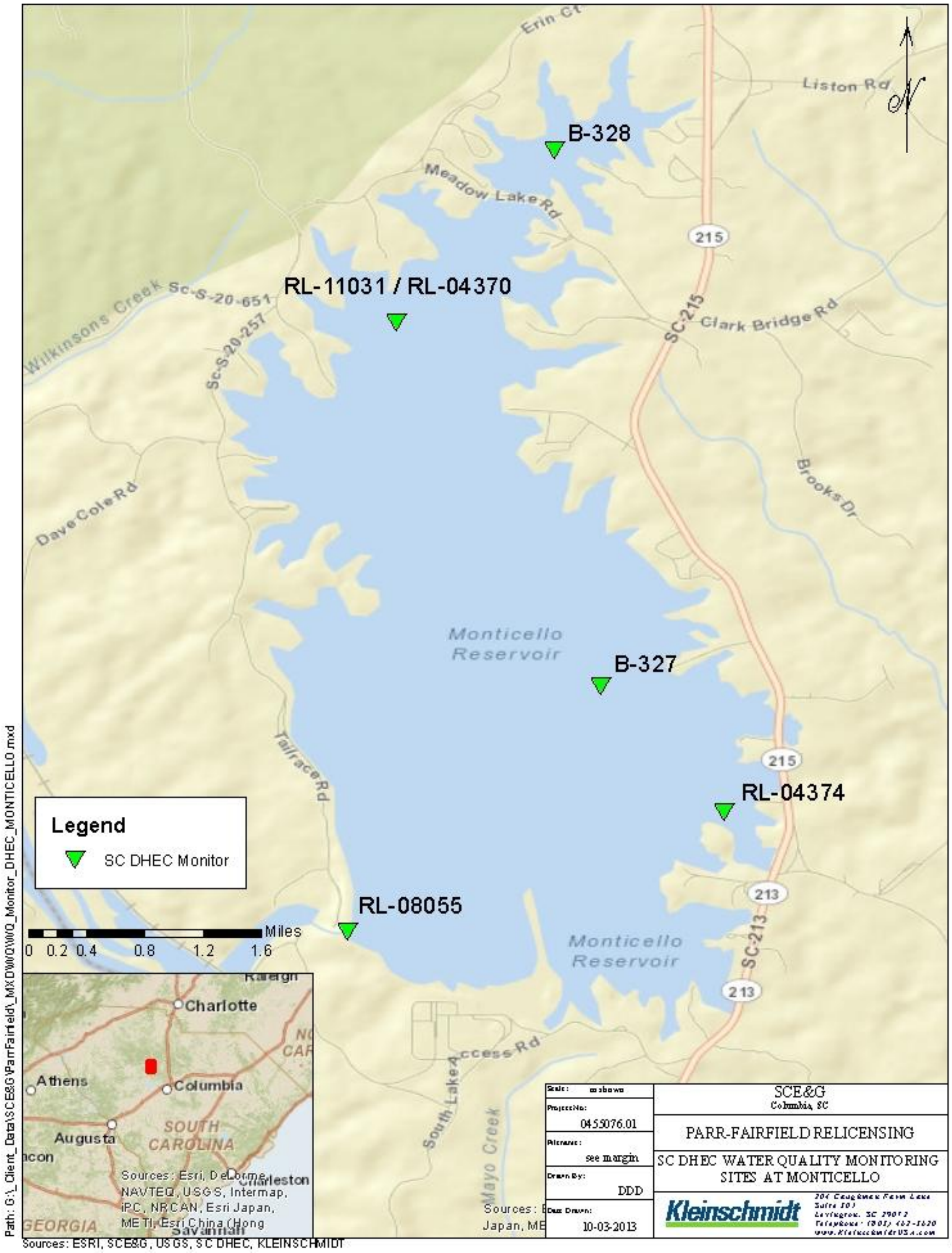


FIGURE 2-6 SCDHEC MONITORING STATIONS ON MONTICELLO RESERVOIR

2.4 BROAD RIVER UPSTREAM OF PARR RESERVOIR DATA COLLECTION METHODS

Data used within this report to describe water quality conditions for the reach of the Broad River upstream of the Parr Reservoir were compiled from USGS, SCDHEC and SCDNR.

The USGS gage 02156500, at the Broad River near Carlisle, SC collects instantaneous data on gage height, specific conductivity, DO, temperature, and pH. For the purposes of this report, only daily averaged data from the last ten years for conductivity, DO, temperature, and pH were used. See Figure 2-7 for a map showing the exact location of the USGS gage.

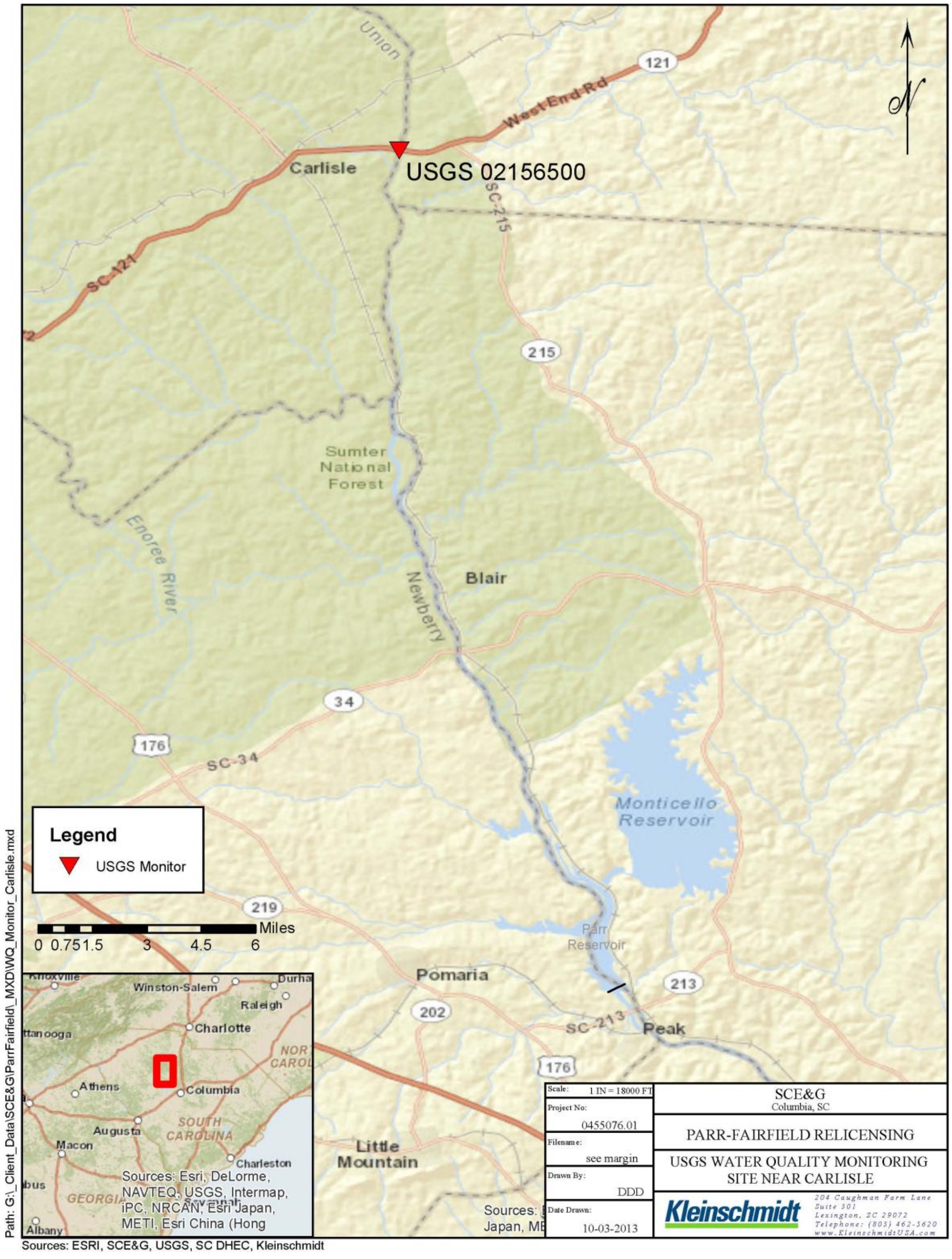


FIGURE 2-7 LOCATION OF USGS GAGE 02156500

SCDHEC has a permanent monitoring site located upstream of the Parr Reservoir near the USGS gage 02156500, labeled as B-046. The exact location of this site is shown in Figure 2-8. Data were collected at this monitoring site by way of grab samples on a monthly basis until late 2009 and bi-monthly thereafter. SCDHEC water quality data for monitoring site B-046 was downloaded from the EPA's data warehouse, STORET.

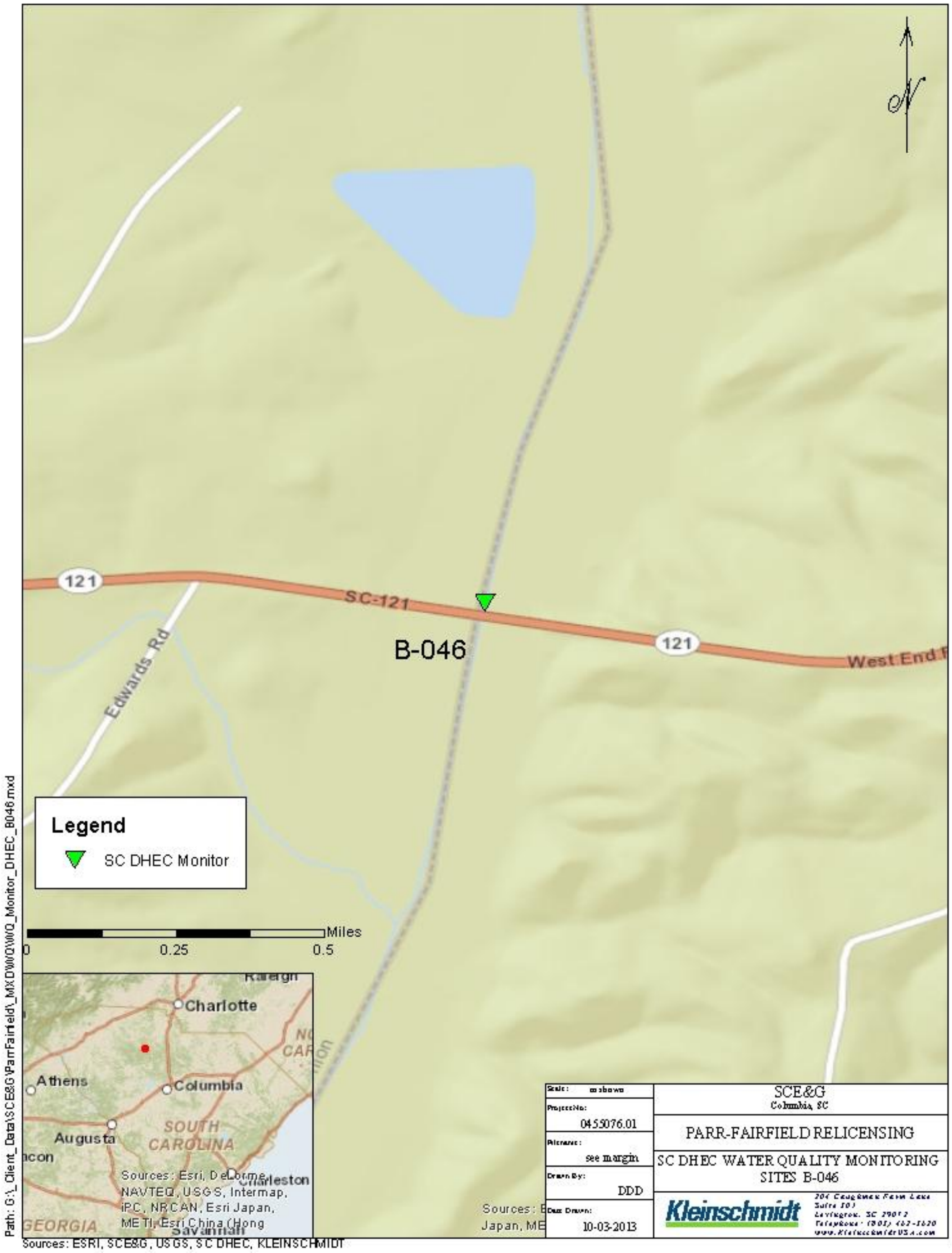


FIGURE 2-8 LOCATION OF SCDHEC MONITORING STATION B-046

Additionally, the South Carolina Geological Survey (SCGS), a division of SCDNR contributed turbidity data that were collected at the USGS gage 02156500 from June of 2012 through August 2013 as part of a four year project funded by the Broad River Mitigation Trust Fund, entitled "Developing sediment management guidelines to enhance habitat and aquatic resources in the Broad River Basin, South Carolina." Water samples were collected with a USGS DH-74 with weight attached to a bridge board, reel and cable. Samples were retrieved using calculated transit rates descending and ascending through the water column to collect depth integrated isokinetic samples. The equal-width-increment (EWI) method was used. Water samples were taken back to the lab and composited. Turbidity was measured with a LaMotte 2020we benchtop turbidity meter. Three individual measurements were taken for each sample and averaged. Water samples were then wet- sieved through a 63um sieve to separate coarse sediment from fine sediment. These two sub-samples were then filtered individually to produce grain size data for in-situ sediment. A third subsample was processed to determine total mass.

2.5 Broad River Downstream of Parr Shoals Dam Data Collection Methods

Data used within this report to describe water quality conditions for the reach of the Broad River immediately downstream of the Parr Shoals Dam were compiled from USGS, SCDHEC and SCDNR.

The USGS gage 02160991, at the Broad River near Jenkinsville, SC collects instantaneous data on gage height, specific conductivity, DO, temperature and pH. For the purposes of this report, only daily averaged data from the last ten years for conductivity, DO, temperature and pH were used. A map showing the exact location of the USGS gage is shown in Figure 2-9.

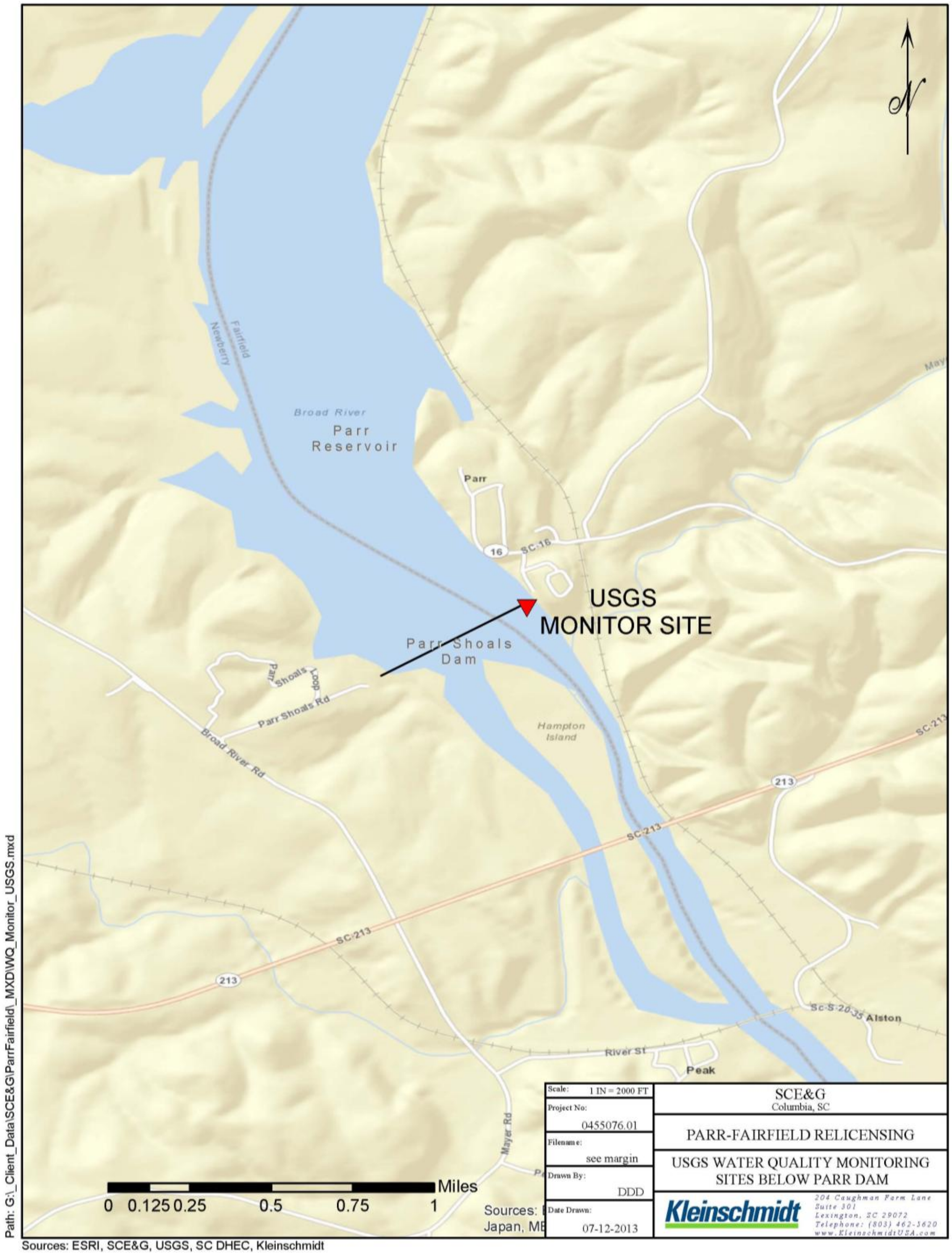


FIGURE 2-9 LOCATION OF USGS GAGE 02160991

SCDHEC has a permanent monitoring site located downstream of the Parr Shoals Dam and the USGS gage 02160991, labeled as B-236. The exact location of this site is shown in Figure 2-10. Data were collected at this monitoring site by way of grab samples on a monthly basis, however data were only available for years 1999 and 2004. This site was listed as inactive in 2005. SCDHEC water quality data for monitoring site B-236 were downloaded from the EPA's data warehouse, STORET.

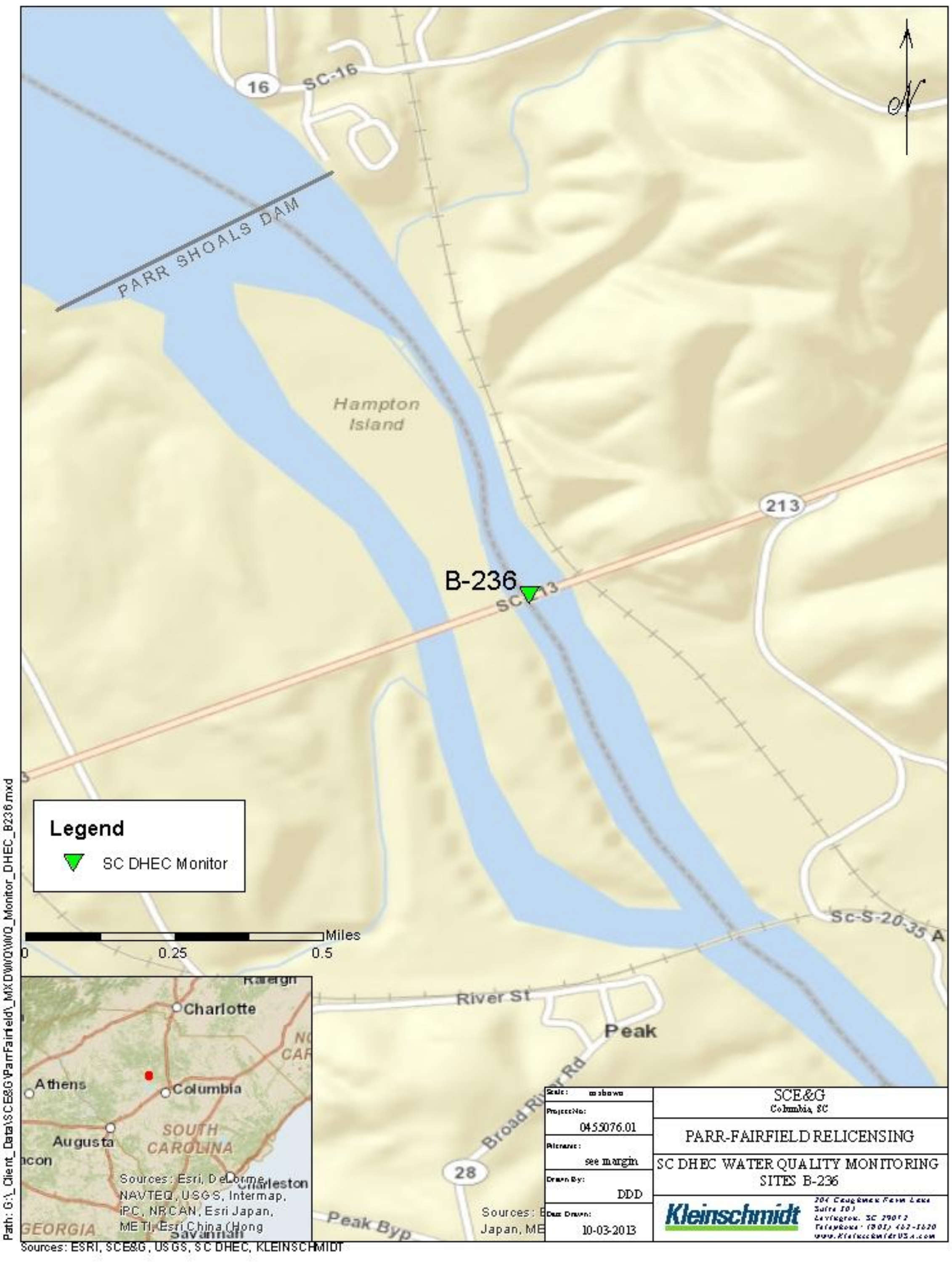


FIGURE 2-10 LOCATION OF SCDHEC MONITORING STATION B-236

SCDNR also contributed water quality data collected over the last few years as part of ongoing fisheries research in the area of the Broad River downstream of the Parr Shoals Dam. It is important to note that these data are currently unpublished and is being collected as part of an ongoing Lower Broad River Fish Community Study being conducted by SCDNR Region 3 Fisheries. Data collections include temperature, DO, conductivity, and salinity measurements using a YSI-85, pH measurements with an Oakton pH11 Series, and turbidity with a La Motte 2020*e*. Data included in this report were collected from three general areas along the Broad River, below the Parr Shoals Dam. Description of these locations are as follows; Reach 1, the first mile below Parr Shoals Dam, from the dam to the railroad crossing; Reach 2A, the pristine middle reach extending from the railroad crossing to the top of Bookman Shoals; and Reach 2B, the pristine middle reach extending from the top of Bookman Shoals to Boatwright Island. Figure 2-11 shows these three reaches of the Broad River.

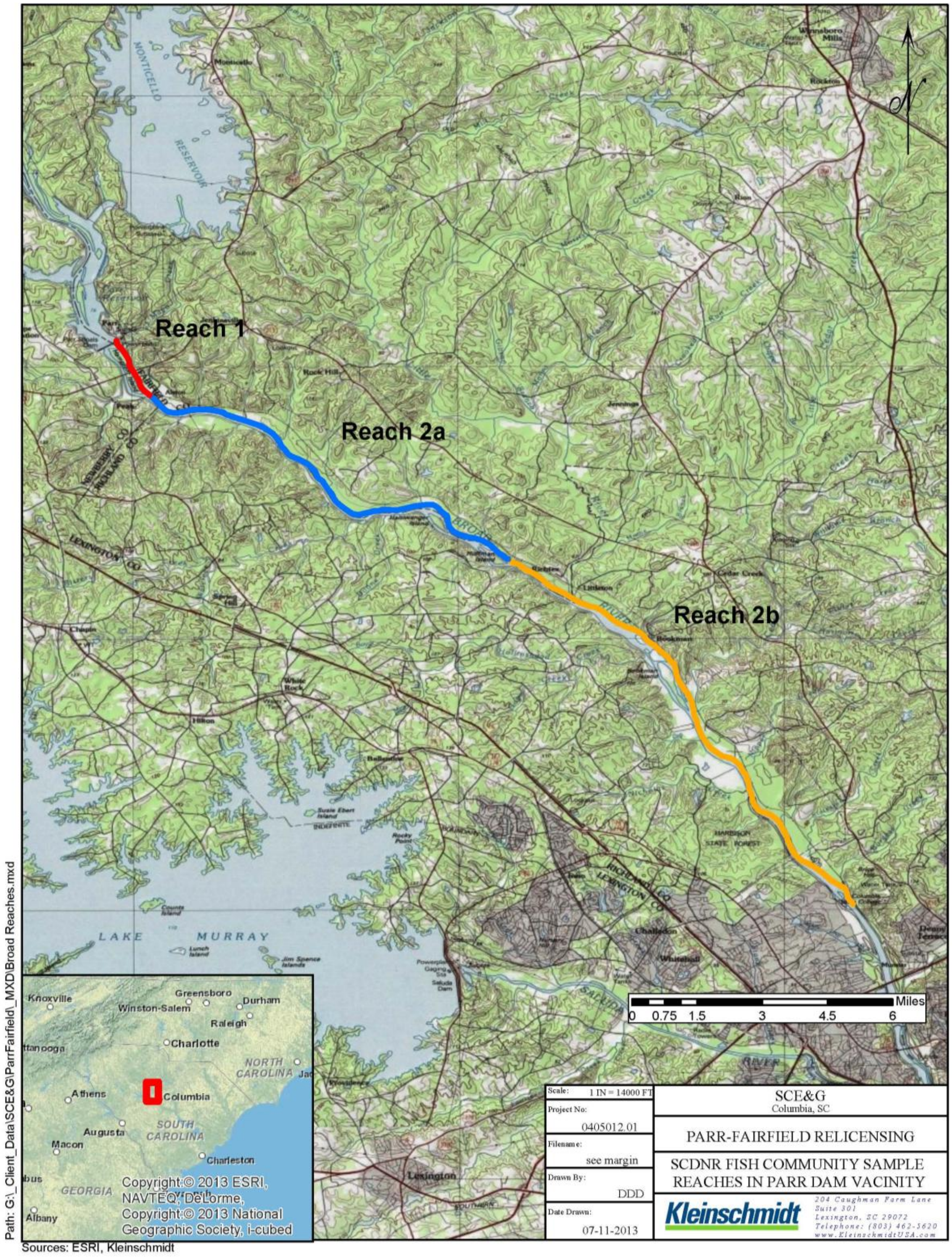


FIGURE 2-11 THREE REACHES OF THE BROAD RIVER DOWNSTREAM OF THE PARR SHOALS DAM

2.6 SCDHEC Water Quality Standards for Freshwaters

SCDHEC identifies freshwaters (FW) as the following; suitable for primary and secondary contact recreation and as a source for drinking water supply after conventional treatment in accordance with SCDHEC requirements; suitable for fishing and the survival and propagation of a balanced indigenous aquatic community of fauna and flora; and suitable for industrial and agricultural uses. All waters associated with the Project are classified as FW by SCDHEC. Listed below in Table 2-1 and Table 2-2 are the SCDHEC water quality standards for FW as they apply to the parameters examined in this report. For SCDHEC standards of metals, see the SCDHEC Regulations 61-68, Water Classifications & Standards.

Table 2-1 SCDHEC Water Quality Standards for Freshwaters

Parameter	Standard
Temperature	The water temperature of all Freshwaters which are free flowing shall not be increased more than 5°F (2.8°C) above natural temperature conditions and shall not exceed a maximum of 90°F (32.2°C) as a result of the discharge of heated liquids unless a different site-specific temperature standard as provided for in C.12. has been established, a mixing zone as provided in C.10. has been established, or a Section 316(a) determination under the Federal Clean Water Act has been completed.
pH	Between 6.0 and 8.5.
Dissolved Oxygen	Daily average not less than 5.0mg/l with a low of 4.0 mg/l.
Turbidity (reservoirs only)	Not to exceed 25 NTUs provided existing uses are maintained
Turbidity (excluding reservoirs)	Not to exceed 50 NTUs provided existing uses are maintained.

Table 2-2 SCDHEC Nutrient Standards for Waters in the Piedmont and Southeastern Plains Ecoregions

Parameter	Standard
Total Nitrogen	≤ 1.50 mg/l
Total Phosphorus	≤ 0.06 mg/l
Chlorophyll a	≤ 40 ug/l

SCDHEC has also identified several metals that they consider to be essential in indicating the ability of a body of water to support aquatic life. These core indicator metals are listed below in Table 2-3.

TABLE 2-3 SCDHEC CORE INDICATOR METALS FOR AQUATIC LIFE SUPPORT USE

CORE INDICATORS METALS
Cadmium
Chromium
Copper
Lead
Mercury
Nickel
Zinc

3.0 RESULTS

3.1 PARR RESERVOIR

3.1.1 SCE&G VERTICAL PROFILE DATA

3.1.1.1 TEMPERATURE

Water temperatures depicted in the graphs below are an average of monthly readings collected by SCE&G personnel, beginning in January of 2011 to December of 2013. Site 1 refers to the monitoring site located approximately 500 yards upstream of the proposed discharge site for the new nuclear units 2 and 3. Site 2 refers to the monitoring site located at the proposed discharge site for the new nuclear units 2 and 3. Site 3 is the monitoring site located approximately 300 yards downstream of the proposed discharge site.

General trends in the water temperature of the Parr Reservoir include increasing temperatures during the summer, peaking at approximately 30^{o}C during the months of July and August, and decreasing temperatures with increasing depth in the reservoir.

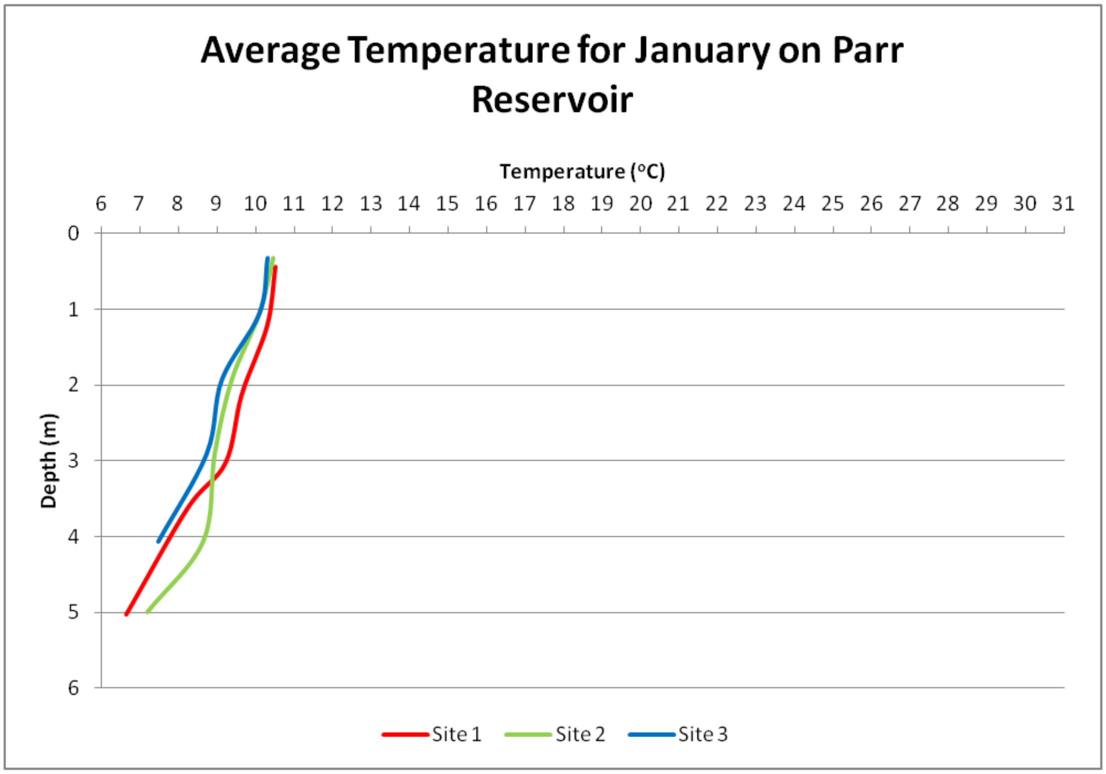


FIGURE 3-1 AVERAGE TEMPERATURE FOR JANUARY ON PARR RESERVOIR

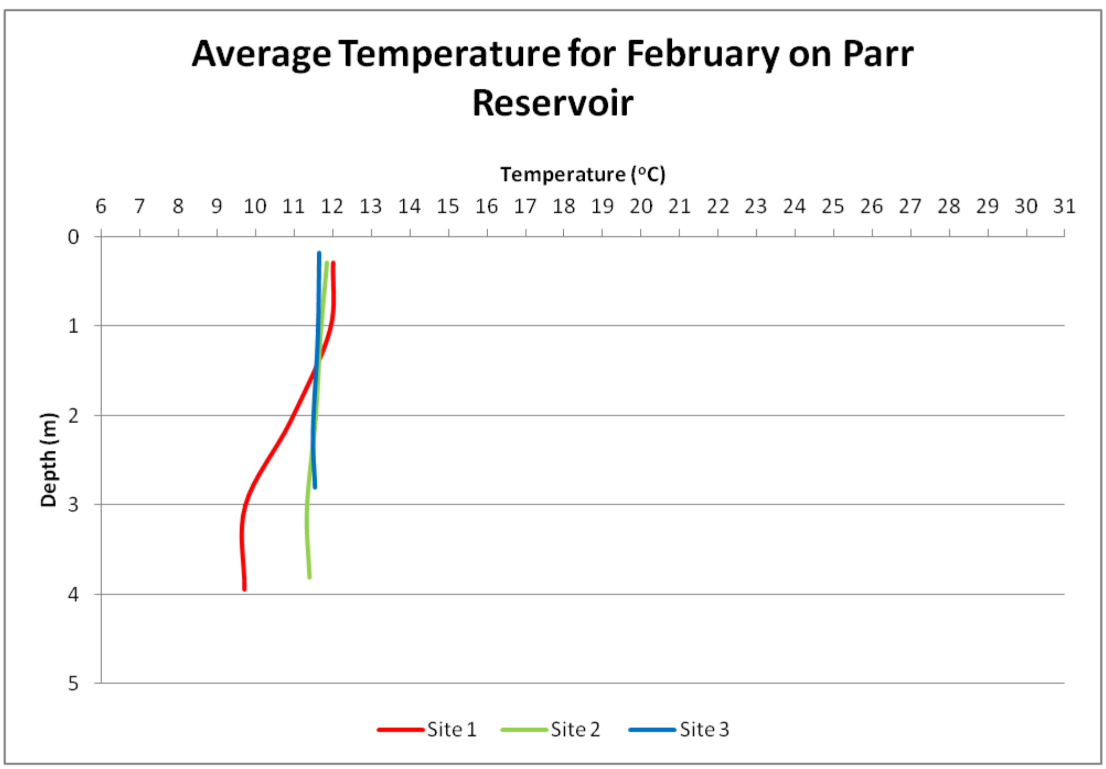


FIGURE 3-2 AVERAGE TEMPERATURE FOR FEBRUARY ON PARR RESERVOIR

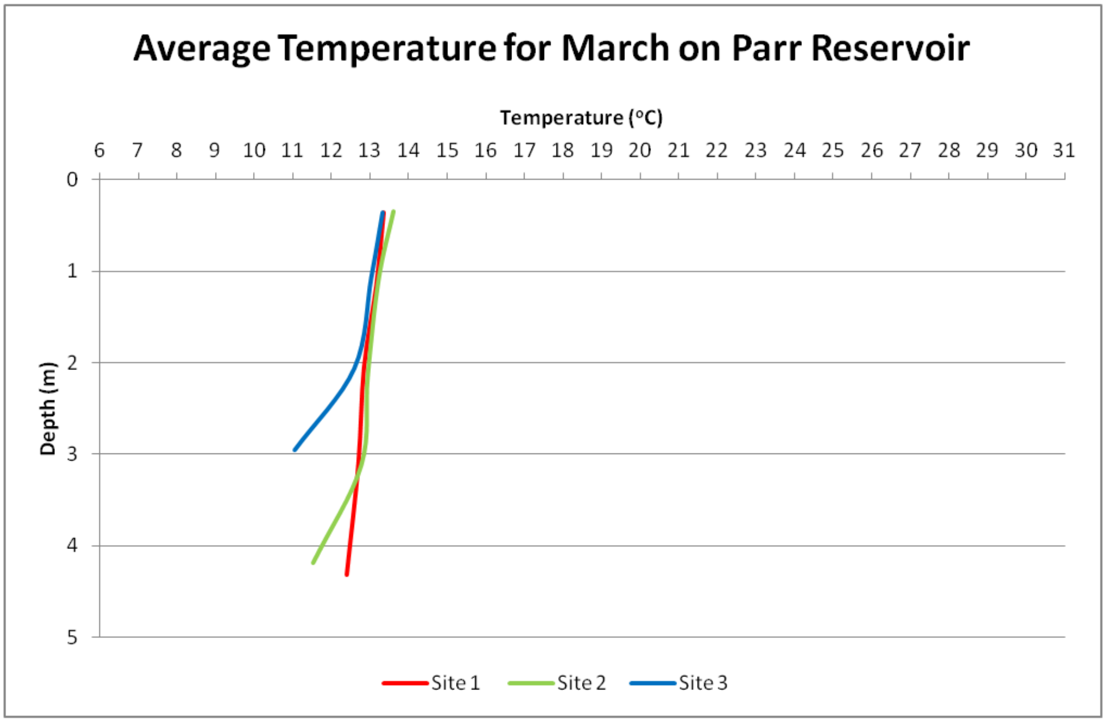


FIGURE 3-3 AVERAGE TEMPERATURE FOR MARCH ON PARR RESERVOIR

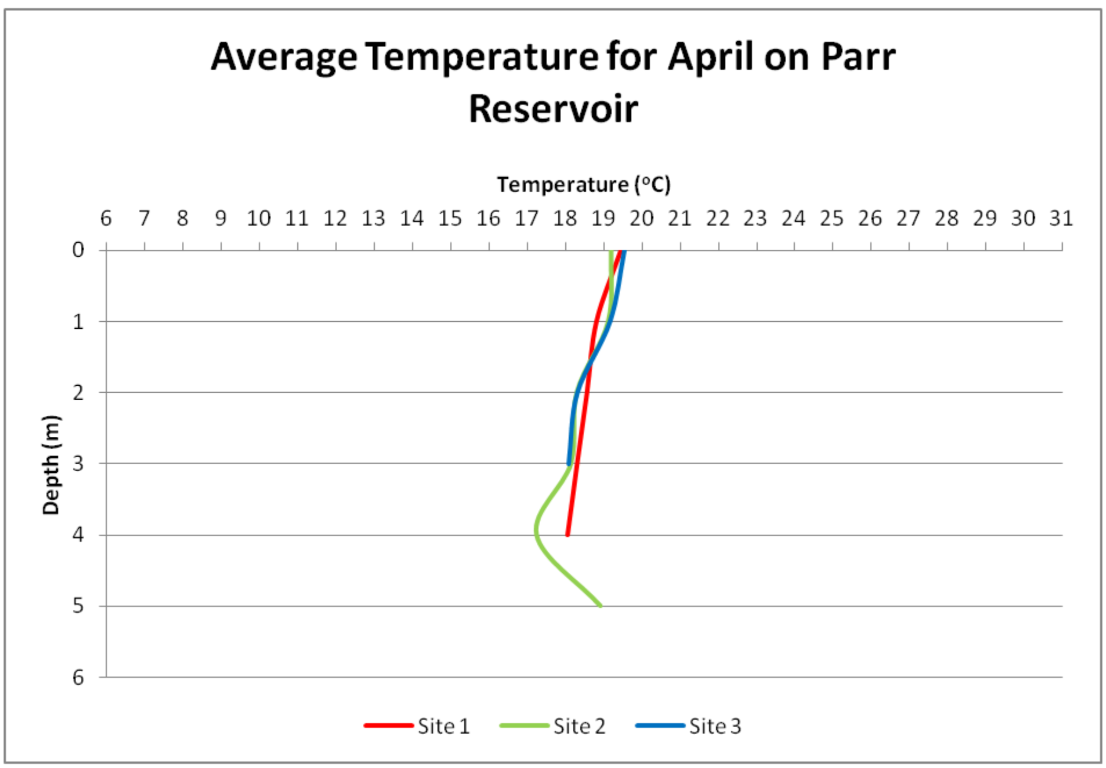


FIGURE 3-4 AVERAGE TEMPERATURE FOR APRIL ON PARR RESERVOIR

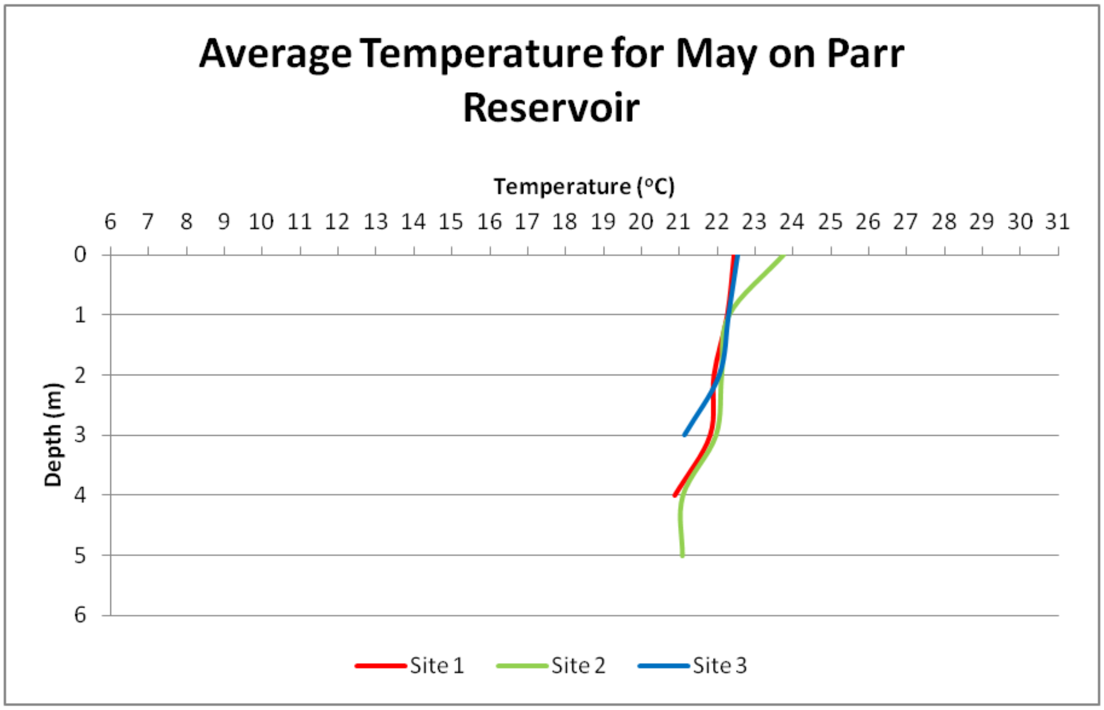


FIGURE 3-5 AVERAGE TEMPERATURE FOR MAY ON PARR RESERVOIR

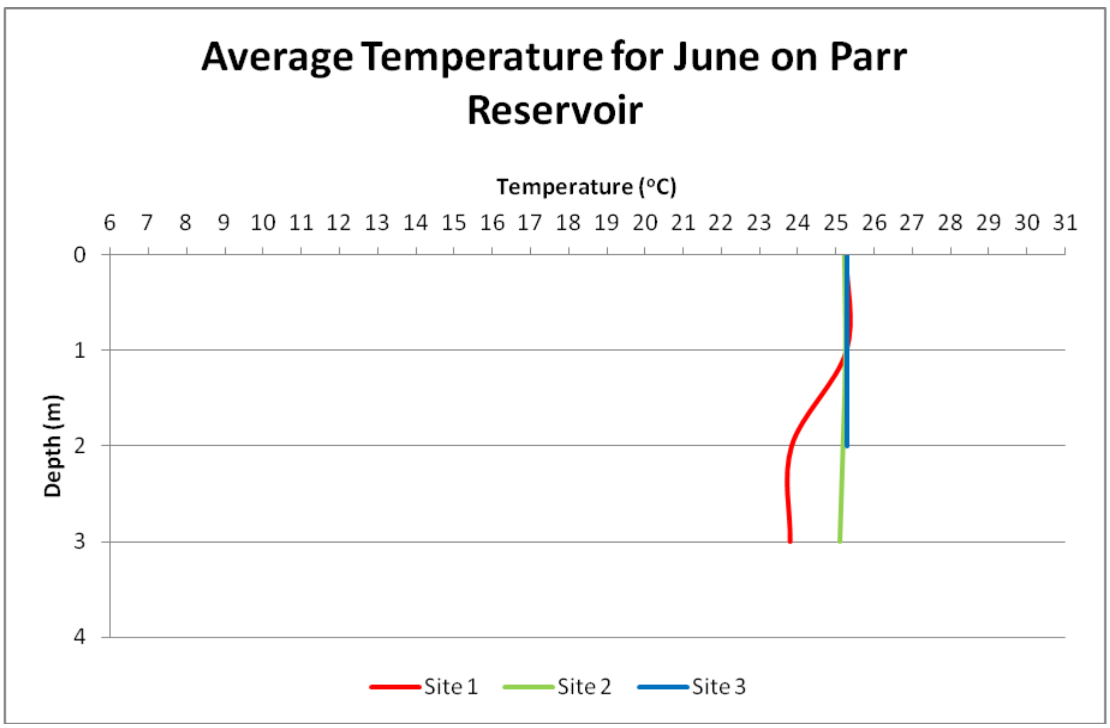


FIGURE 3-6 AVERAGE TEMPERATURE FOR JUNE ON PARR RESERVOIR

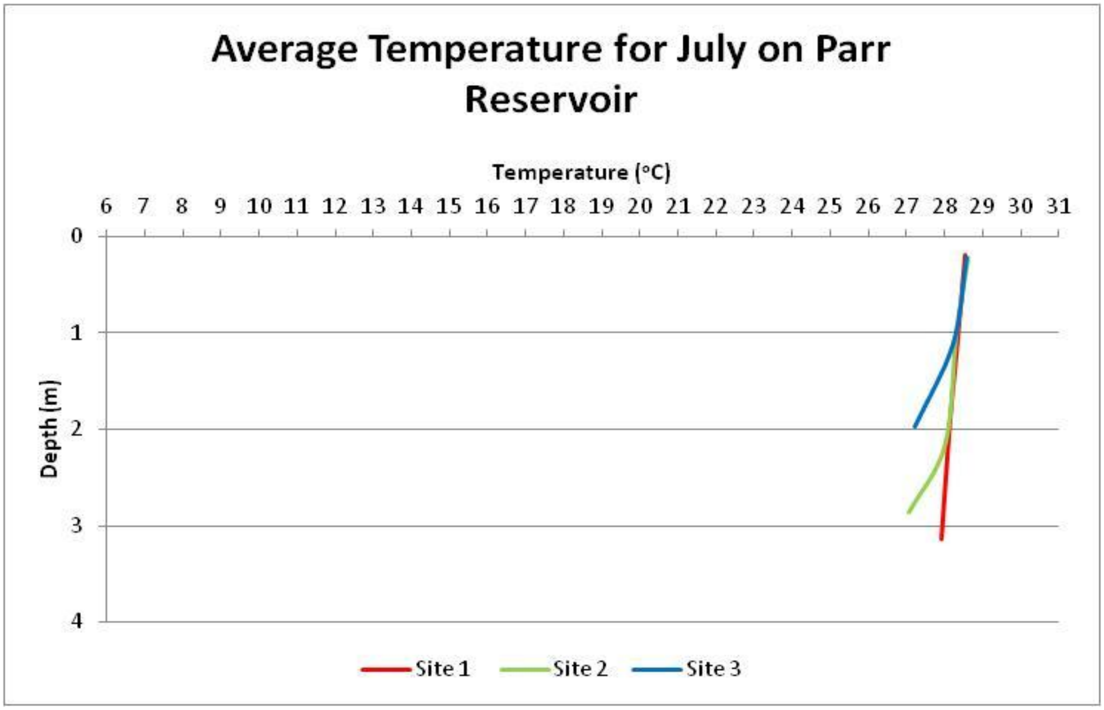


FIGURE 3-7 AVERAGE TEMPERATURE FOR JULY ON PARR RESERVOIR

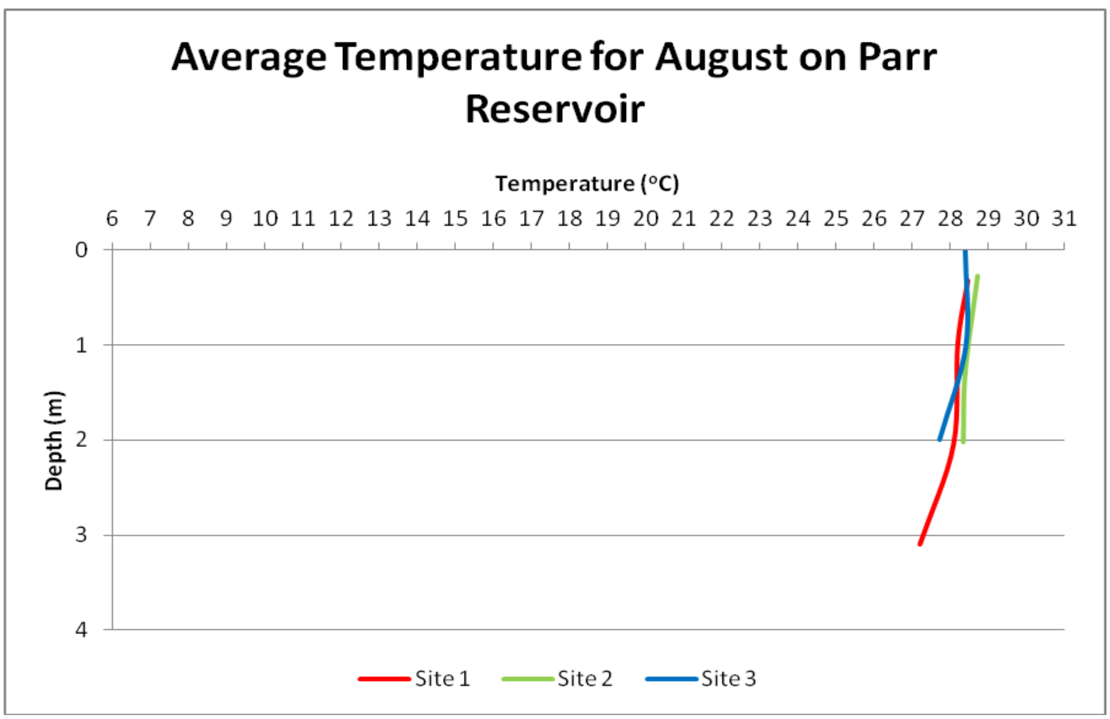


FIGURE 3-8 AVERAGE TEMPERATURE FOR AUGUST ON PARR RESERVOIR

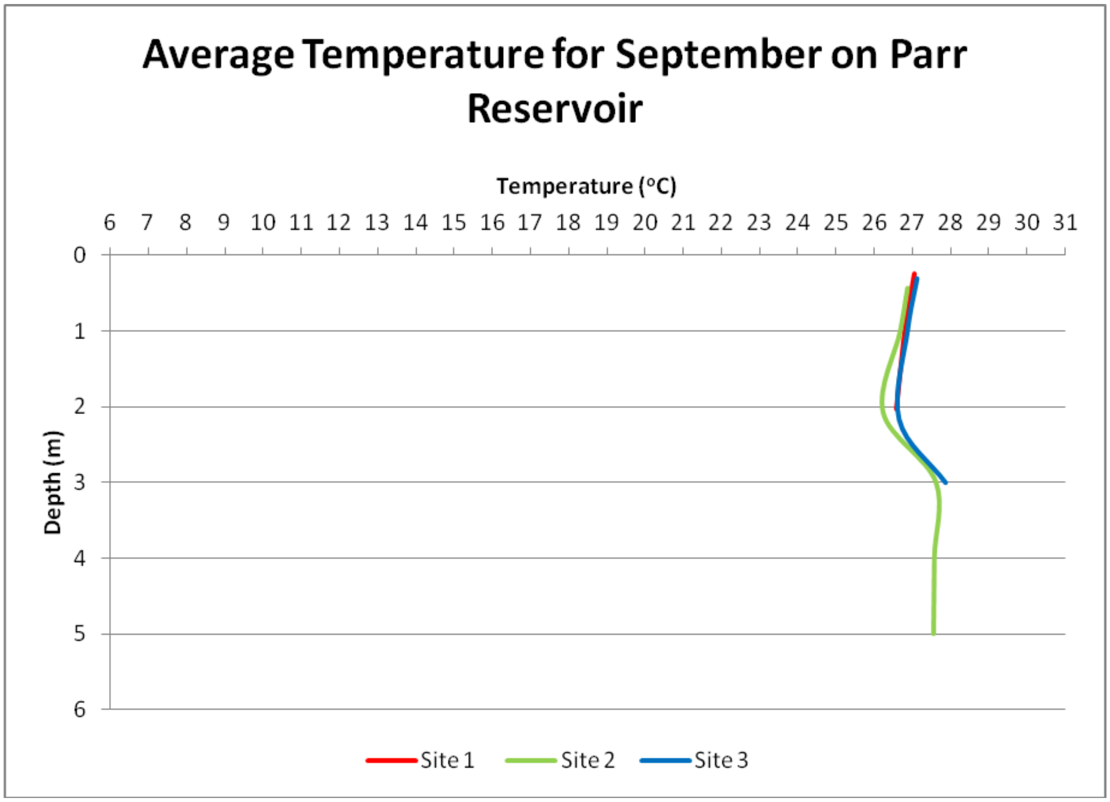


FIGURE 3-9 AVERAGE TEMPERATURE FOR SEPTEMBER ON PARR RESERVOIR

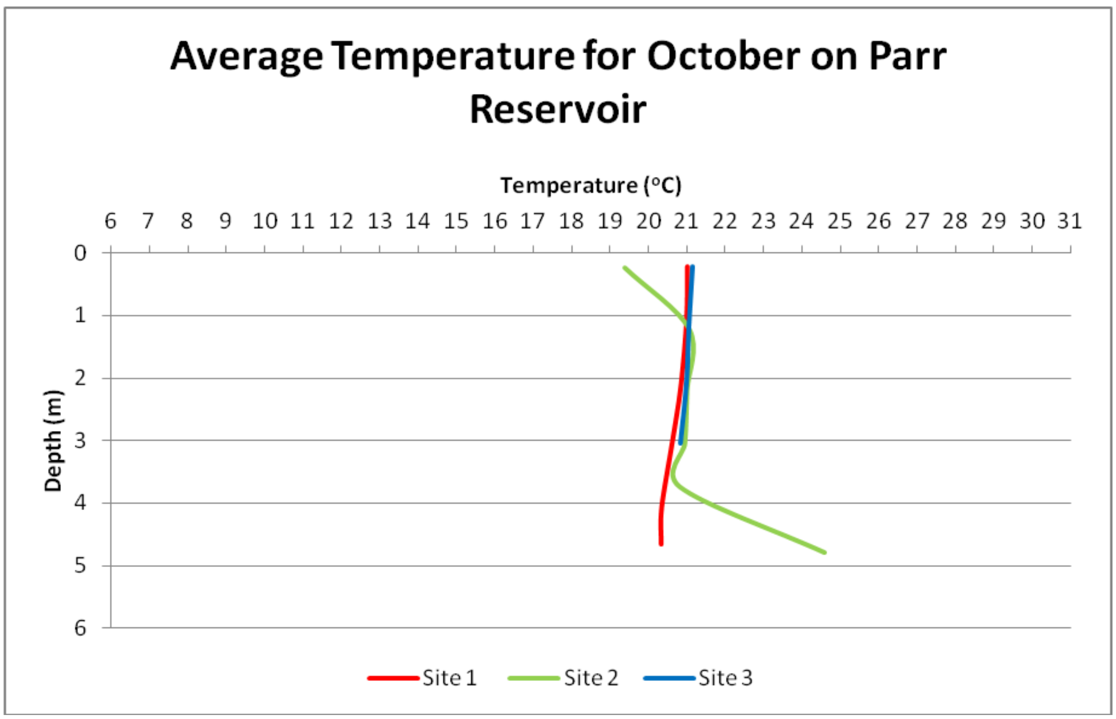


FIGURE 3-10 AVERAGE TEMPERATURE FOR OCTOBER ON PARR RESERVOIR

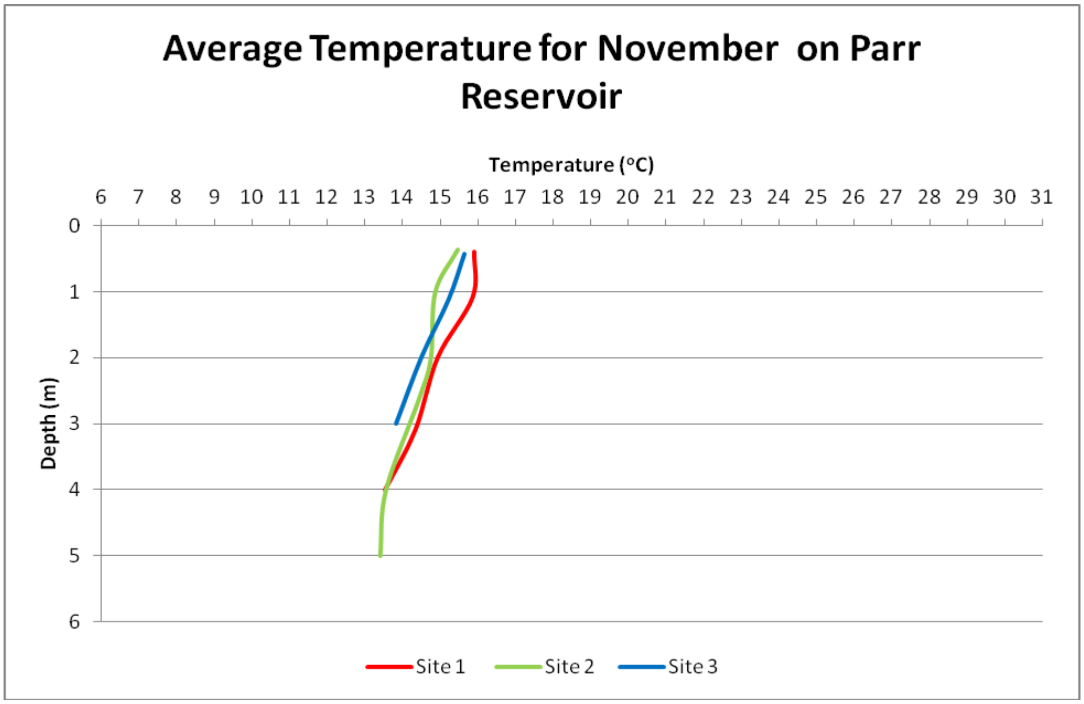


FIGURE 3-11 AVERAGE TEMPERATURE FOR NOVEMBER ON PARR RESERVOIR

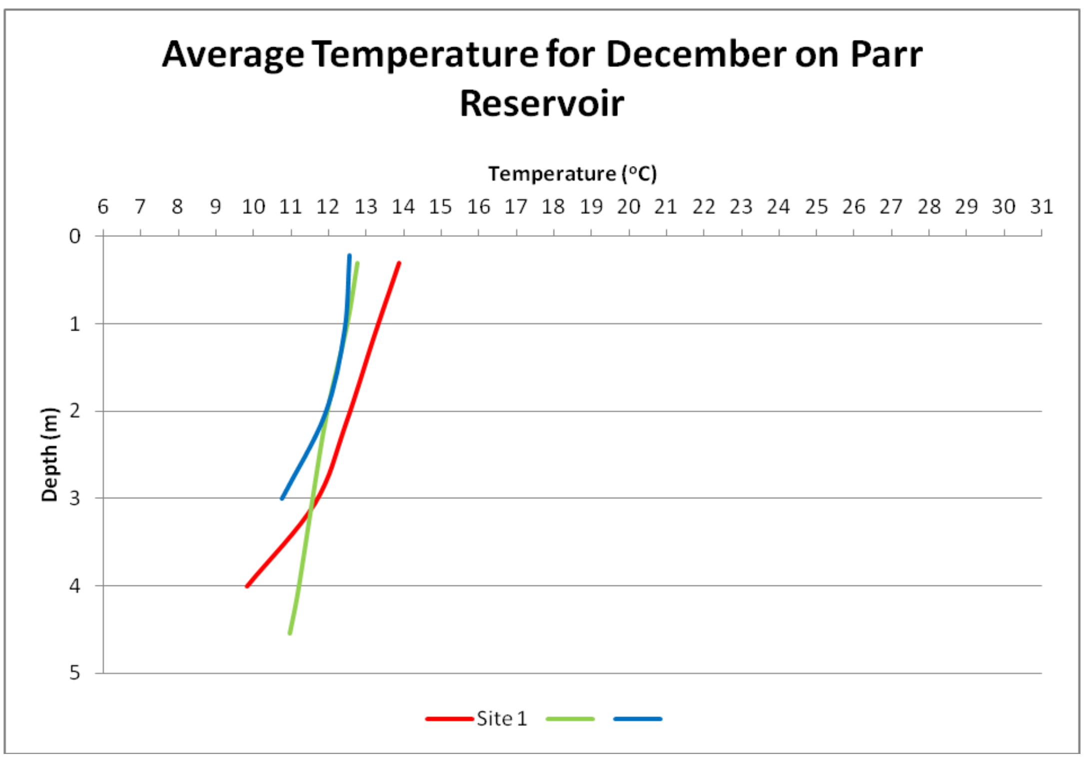


FIGURE 3-12 AVERAGE TEMPERATURE FOR DECEMBER ON PARR RESERVOIR

3.1.1.2 DISSOLVED OXYGEN

Dissolved oxygen values depicted in the graphs below are an average of monthly readings collected by SCE&G personnel, beginning in January of 2011 to December of 2013. Site 1 refers to the monitoring site located approximately 500 yards upstream of the proposed discharge site for the new nuclear units 2 and 3. Site 2 refers to the monitoring site located at the proposed discharge site for the new nuclear units 2 and 3. Site 3 is the monitoring site located approximately 300 yards downstream of the proposed discharge site.

General trends for the Parr Reservoir include a decrease in dissolved oxygen values during the summer months when water temperatures are higher. Dissolved oxygen values also decrease with an increased depth in the reservoir, where there is less possibility of oxygen to be dissolved in the water due to natural occurrences. Since 2011, dissolved oxygen in the Parr Reservoir has rarely dropped below 5.0 mg/L.

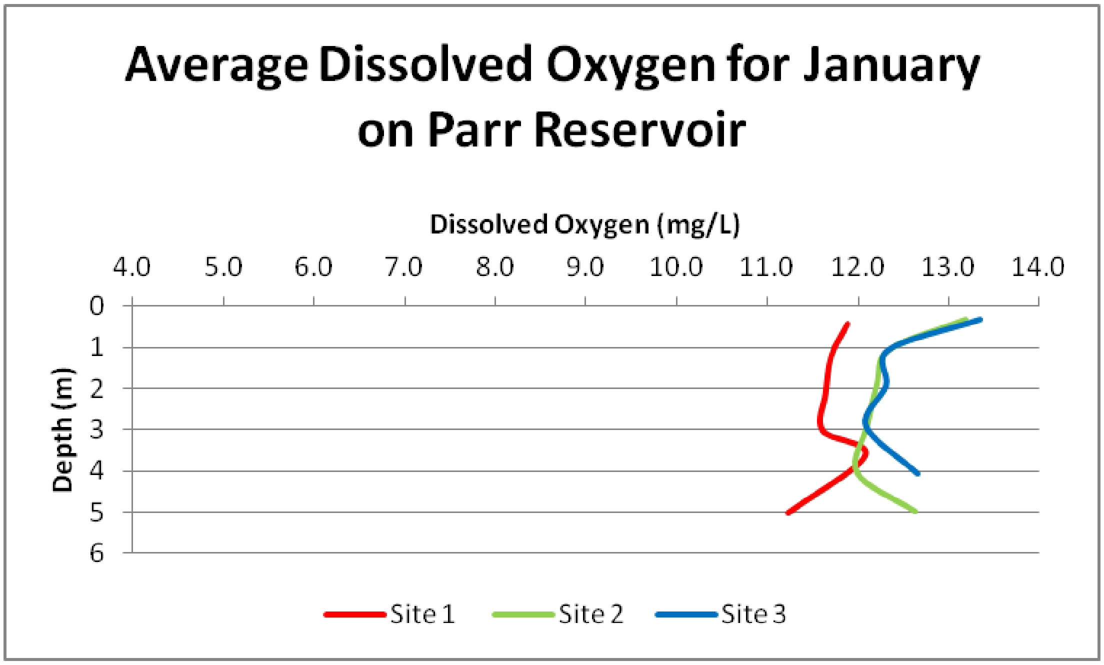


FIGURE 3-13 AVERAGE DISSOLVED OXYGEN FOR JANUARY ON PARR RESERVOIR

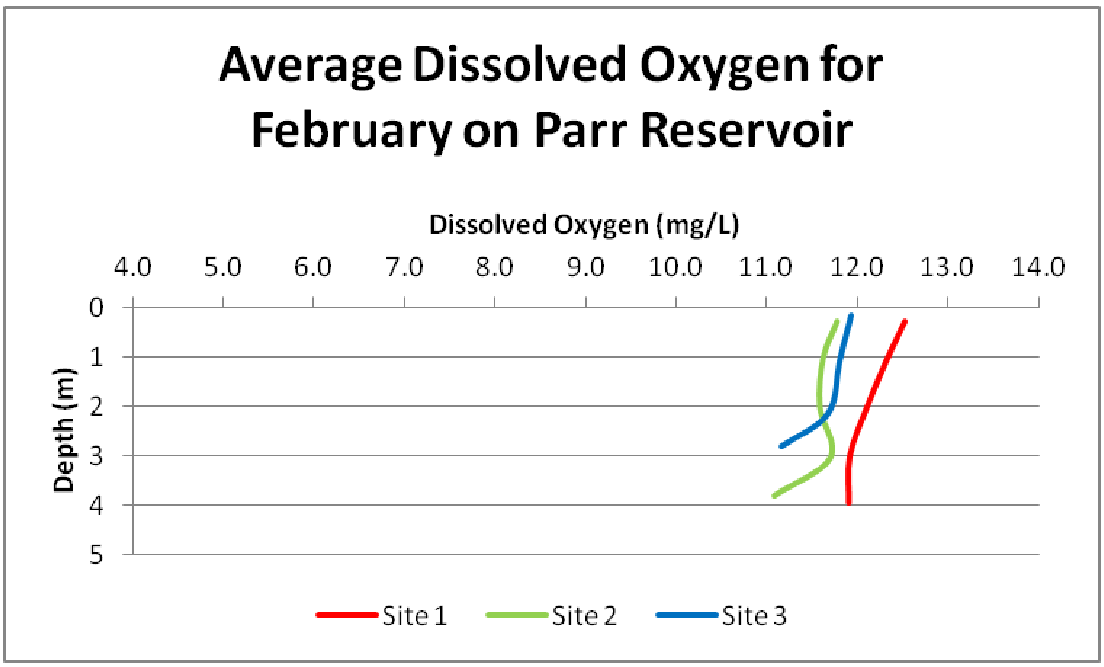


FIGURE 3-14 AVERAGE DISSOLVED OXYGEN FOR FEBRUARY ON PARR RESERVOIR

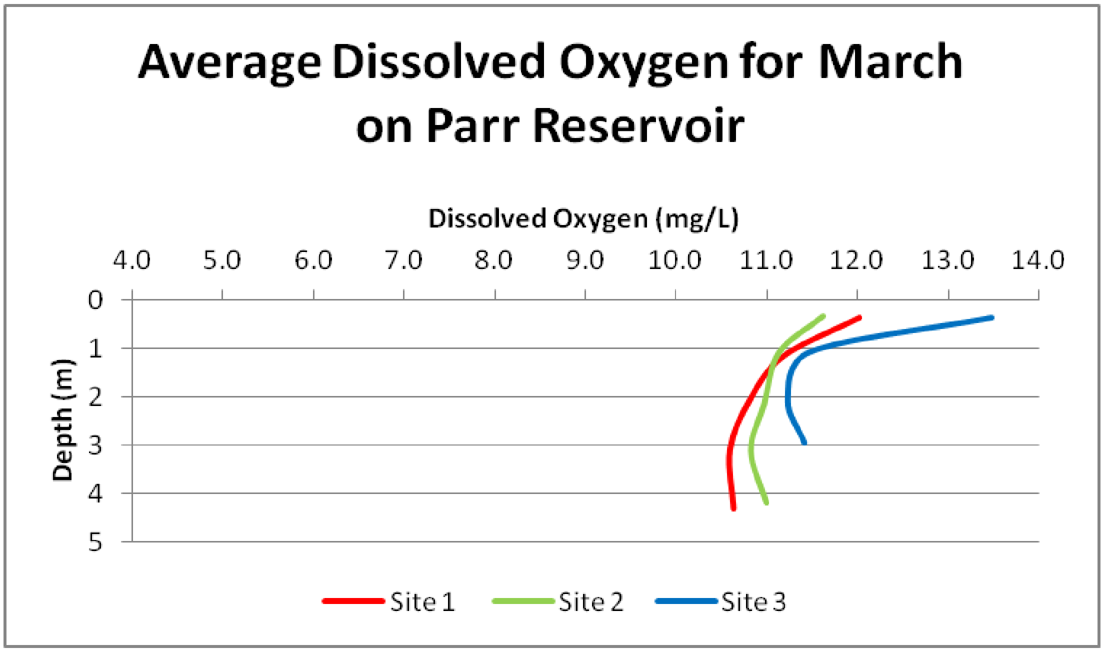


FIGURE 3-15 AVERAGE DISSOLVED OXYGEN FOR MARCH ON PARR RESERVOIR

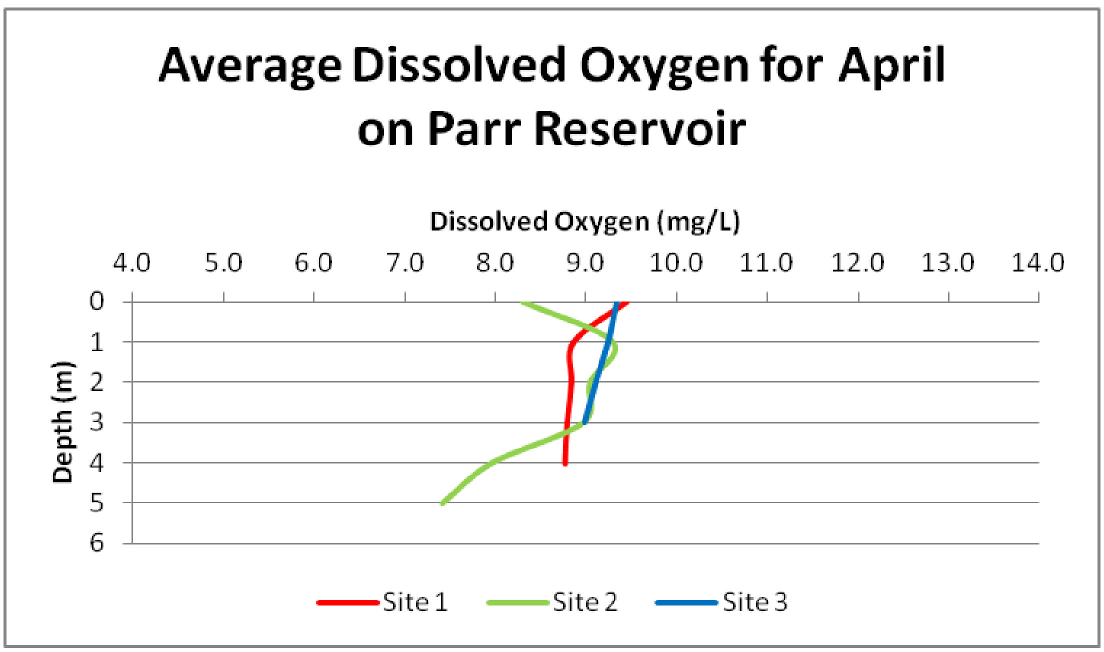


FIGURE 3-16 AVERAGE DISSOLVED OXYGEN FOR APRIL ON PARR RESERVOIR

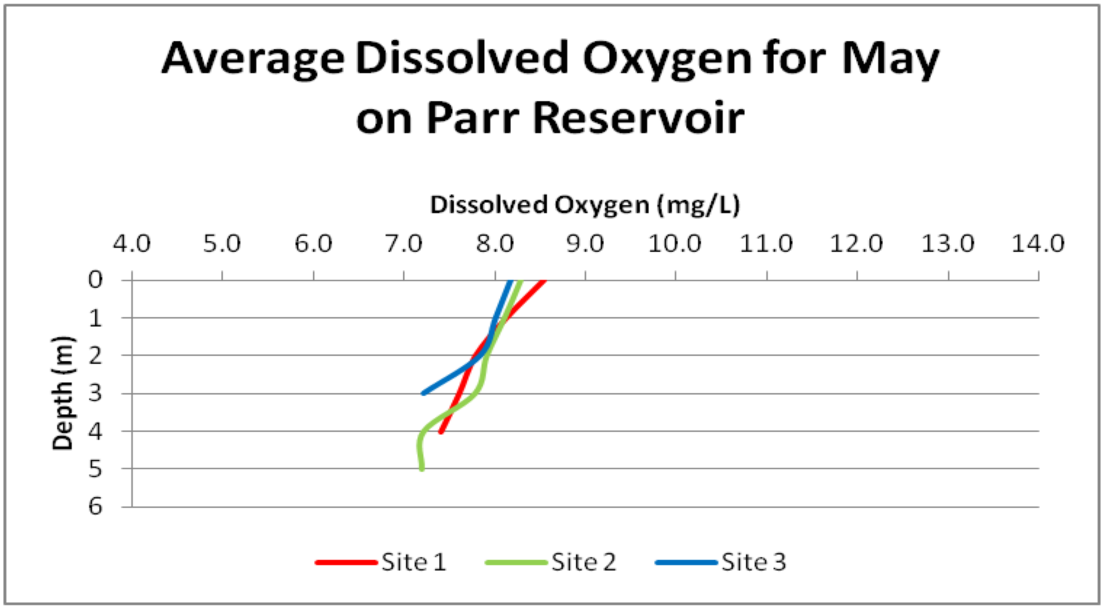


FIGURE 3-17 **AVERAGE DISSOLVED OXYGEN FOR MAY ON PARR RESERVOIR**

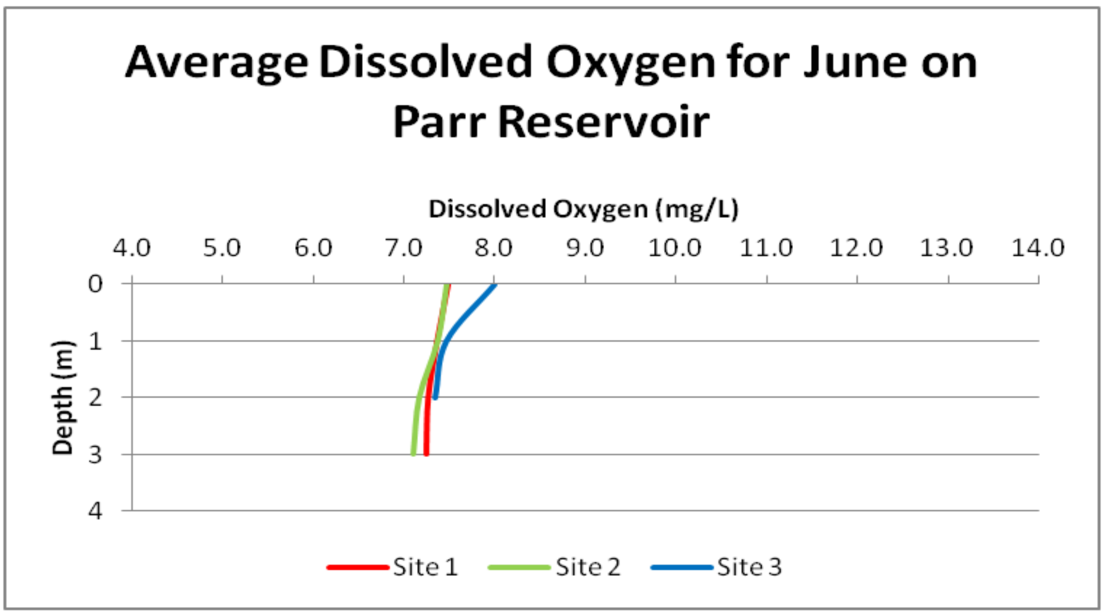


FIGURE 3-18 **AVERAGE DISSOLVED OXYGEN FOR JUNE ON PARR RESERVOIR**

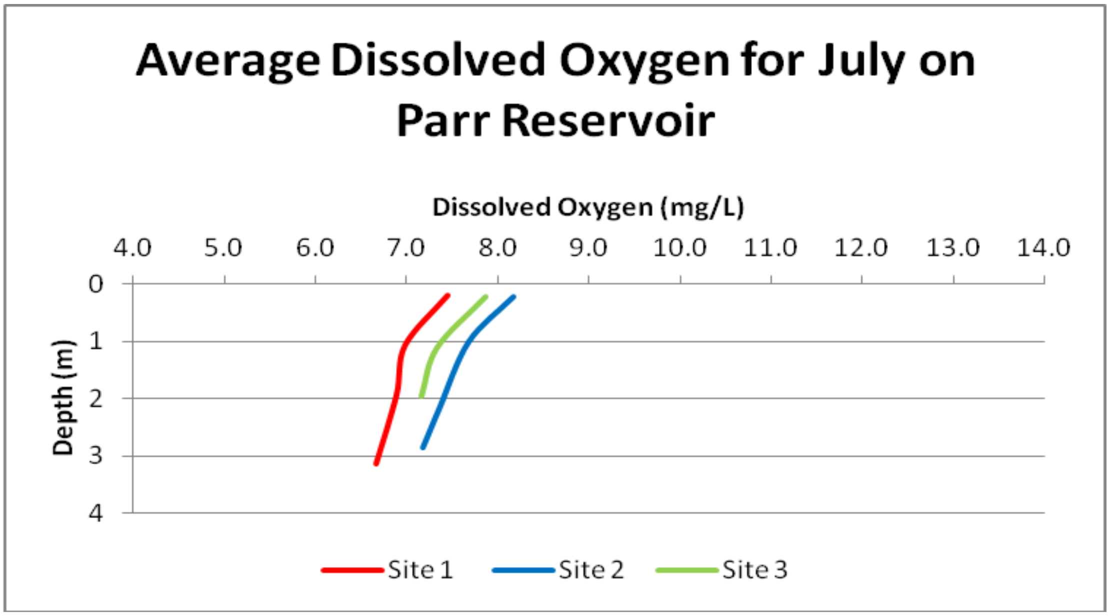


FIGURE 3-19 AVERAGE DISSOLVED OXYGEN FOR JULY ON PARR RESERVOIR

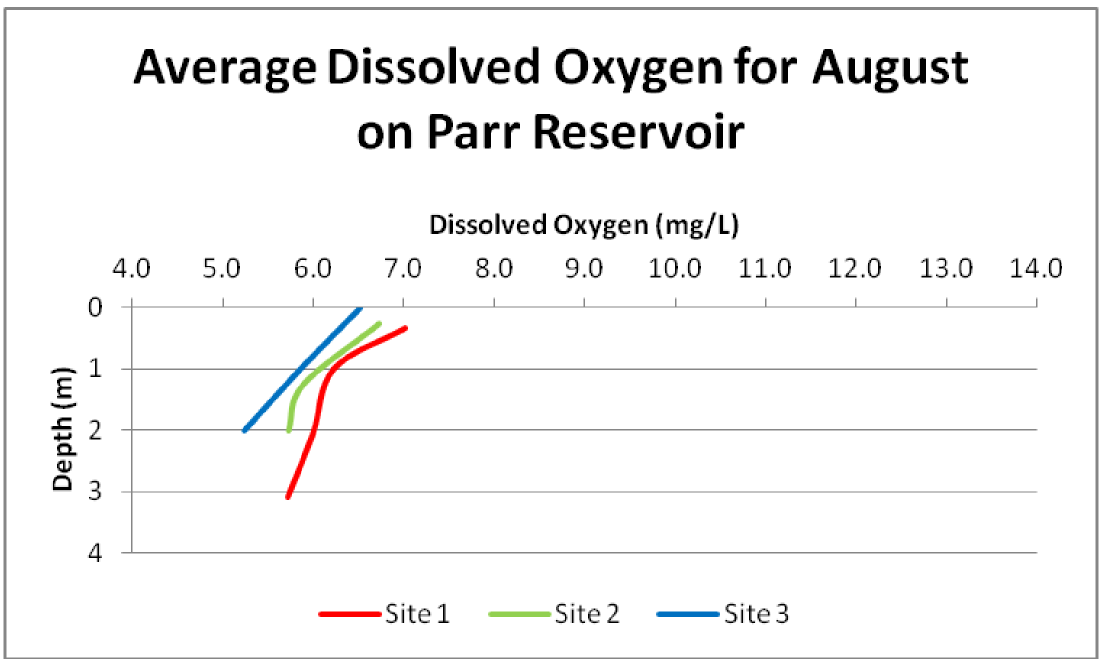


FIGURE 3-20 AVERAGE DISSOLVED OXYGEN FOR AUGUST ON PARR RESERVOIR

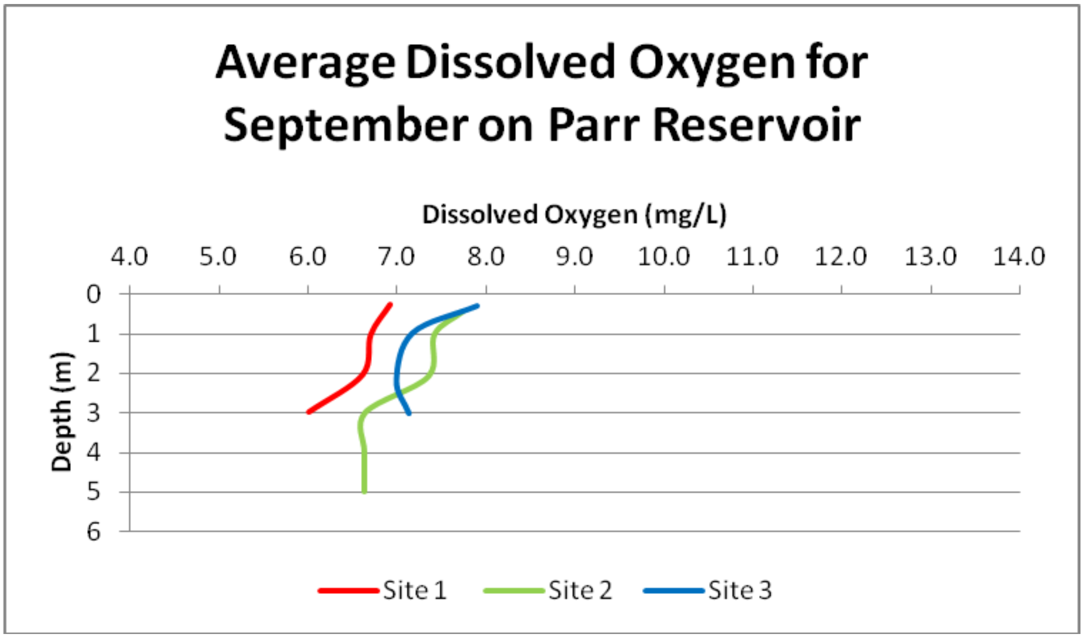


FIGURE 3-21 AVERAGE DISSOLVED OXYGEN FOR SEPTEMBER ON PARR RESERVOIR

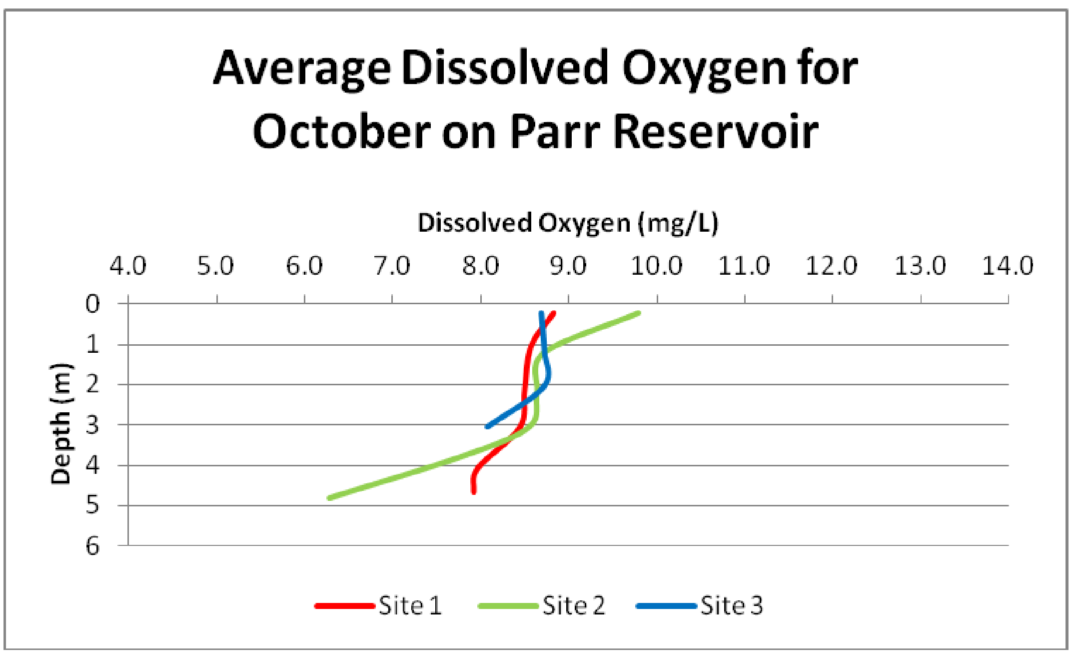


FIGURE 3-22 AVERAGE DISSOLVED OXYGEN FOR OCTOBER ON PARR RESERVOIR

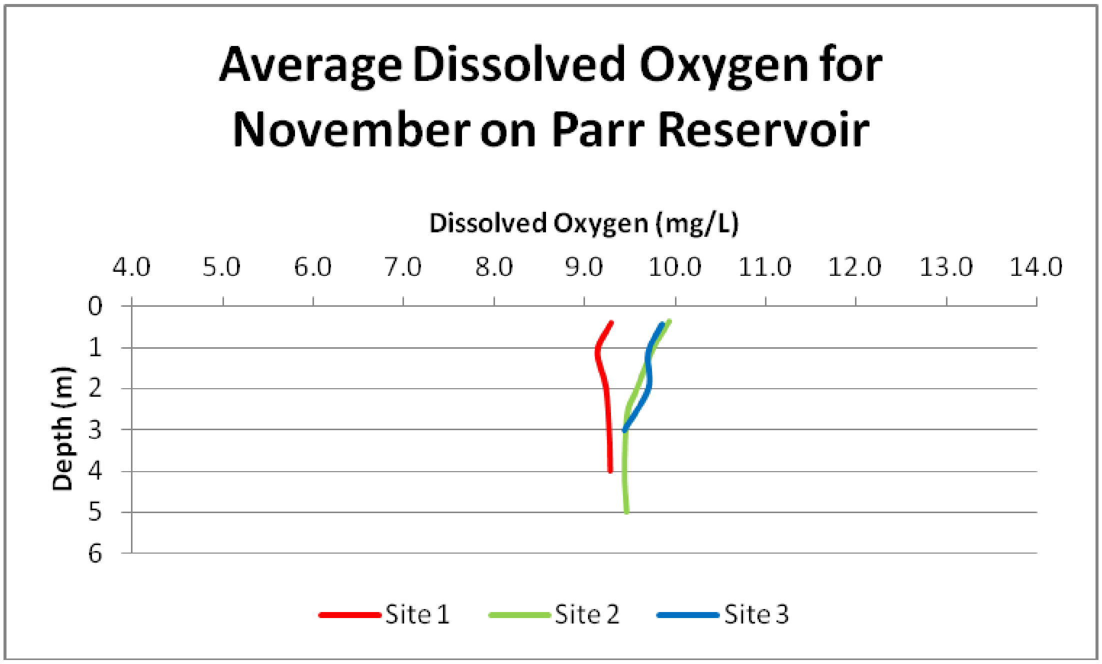


FIGURE 3-23 AVERAGE DISSOLVED OXYGEN FOR NOVEMBER ON PARR RESERVOIR

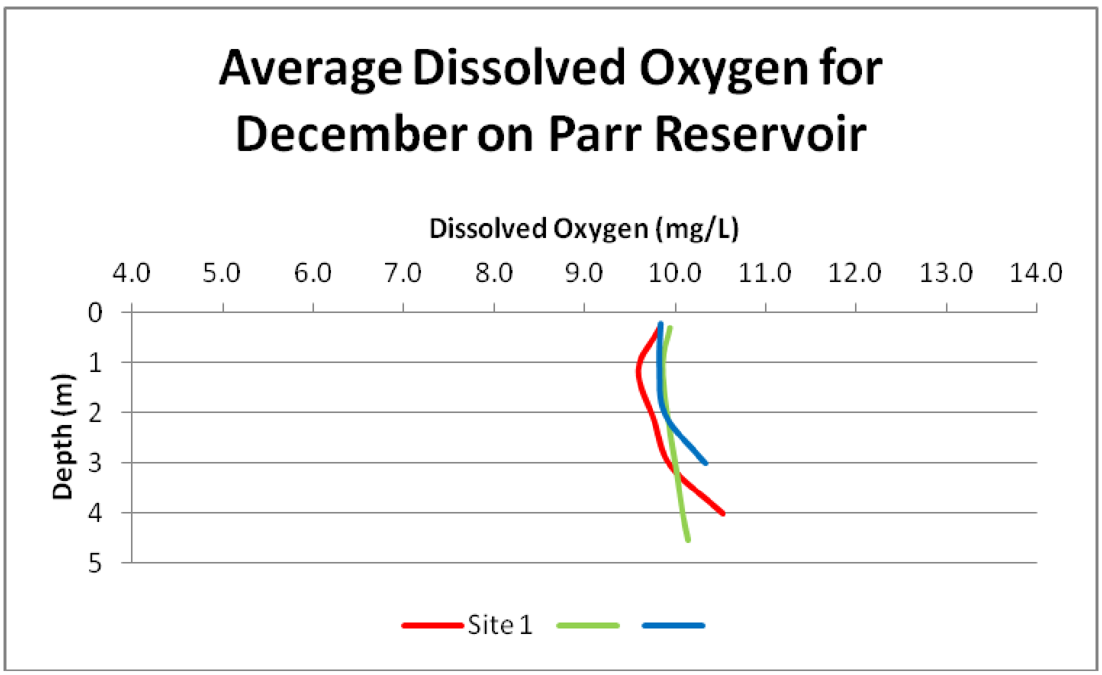


FIGURE 3-24 AVERAGE DISSOLVED OXYGEN FOR DECEMBER ON PARR RESERVOIR

3.1.1.3 SPECIFIC CONDUCTIVITY

Specific conductivity values depicted in the graphs below are an average of monthly readings collected by SCE&G personnel, beginning in January of 2011 to December of 2013. Site 1 refers to the monitoring site located approximately 500 yards upstream of the proposed discharge site for the new nuclear units 2 and 3. Site 2 refers to the monitoring site located at the proposed discharge site for the new nuclear units 2 and 3. Site 3 is the monitoring site located approximately 300 yards downstream of the proposed discharge site.

Conductivity readings for the three monitoring locations in the Parr Reservoir are fairly consistent throughout the year, staying mostly in the 80-90 µS/cm range, with the full range spanning from 65-122 µS/cm.

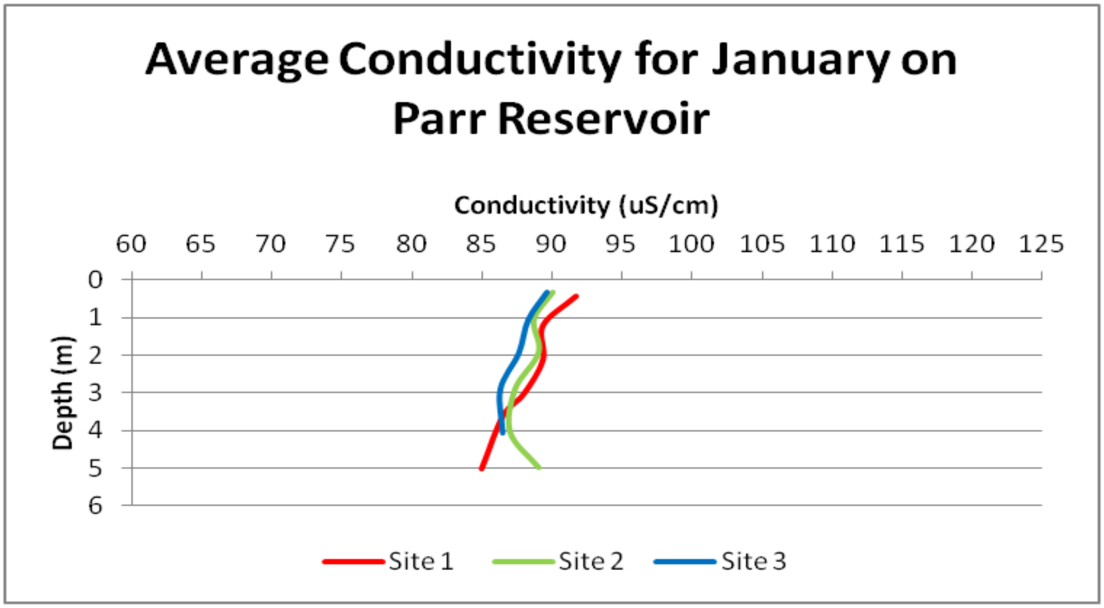


FIGURE 3-25 AVERAGE CONDUCTIVITY FOR JANUARY ON PARR RESERVOIR

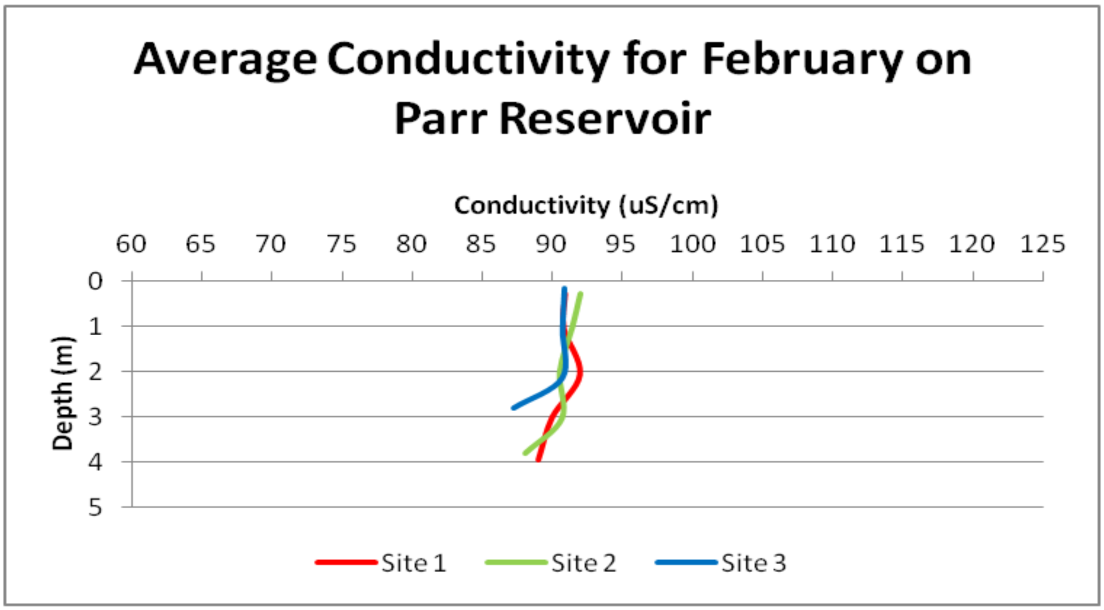


FIGURE 3-26 AVERAGE CONDUCTIVITY FOR FEBRUARY ON PARR RESERVOIR

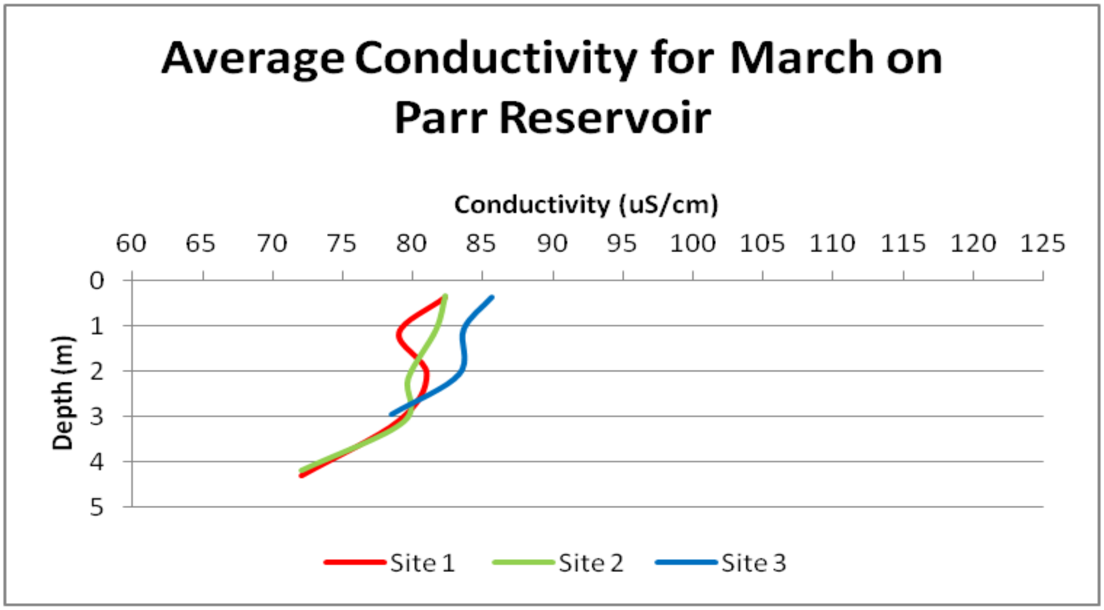


FIGURE 3-27 AVERAGE CONDUCTIVITY FOR MARCH ON PARR RESERVOIR

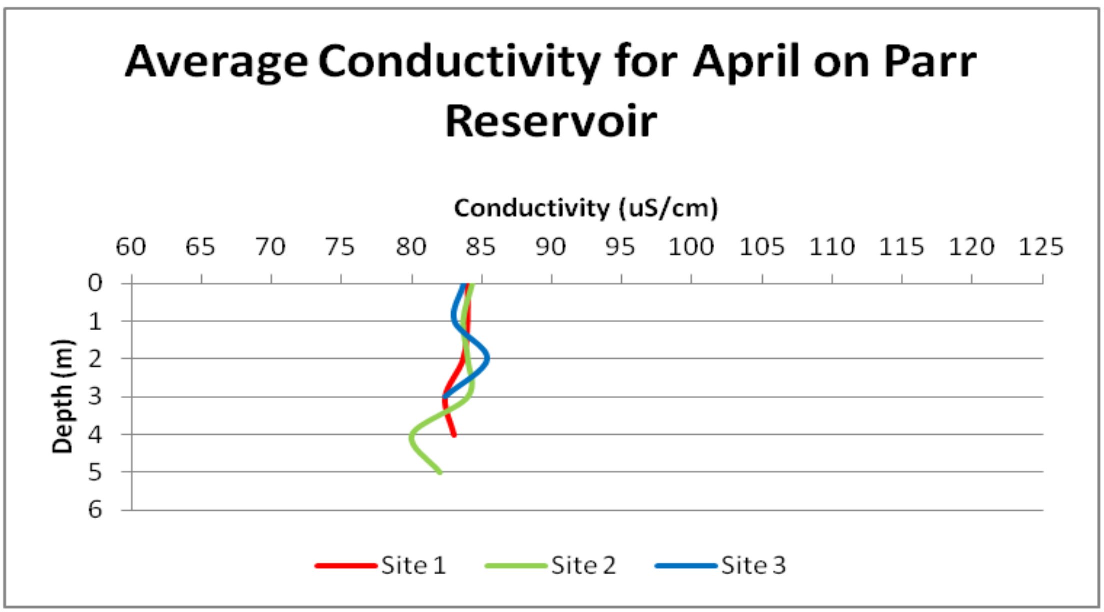


FIGURE 3-28 AVERAGE CONDUCTIVITY FOR APRIL ON PARR RESERVOIR

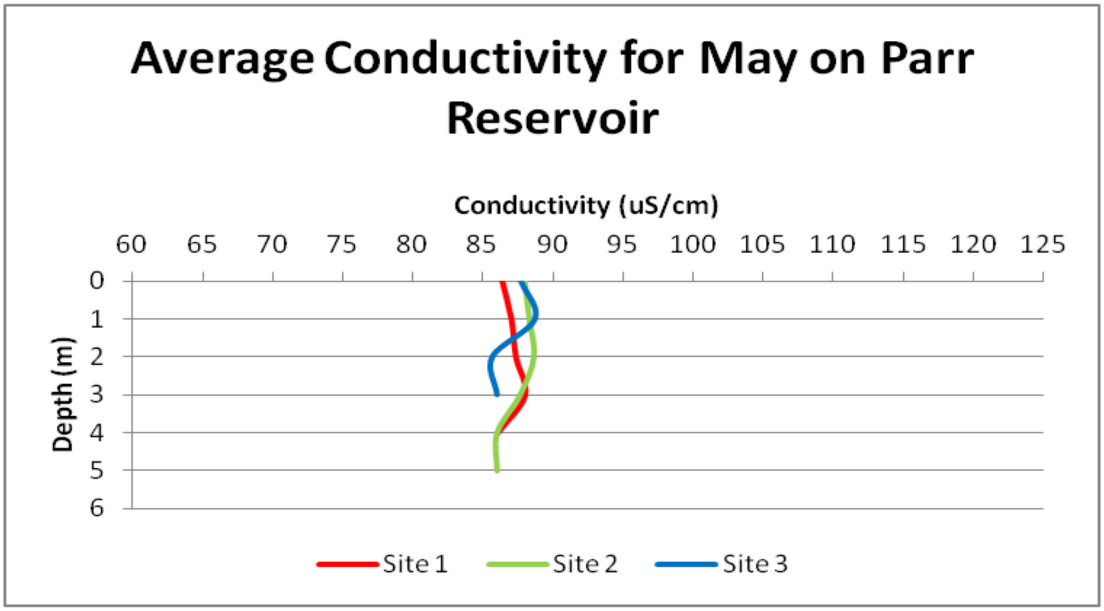


FIGURE 3-29 AVERAGE CONDUCTIVITY FOR MAY ON PARR RESERVOIR

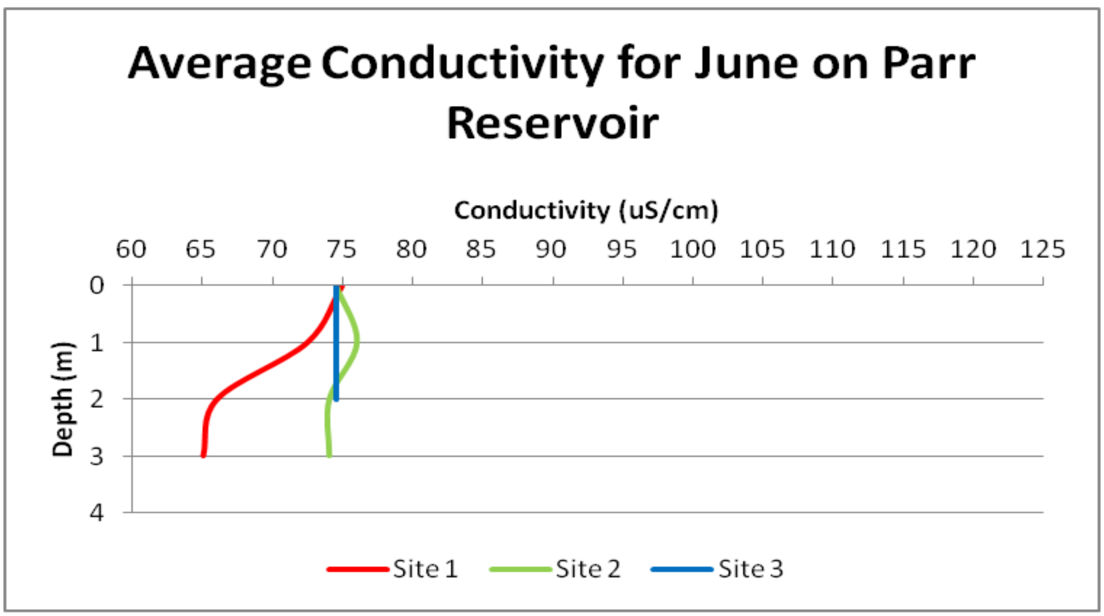


FIGURE 3-30 AVERAGE CONDUCTIVITY FOR JUNE ON PARR RESERVOIR

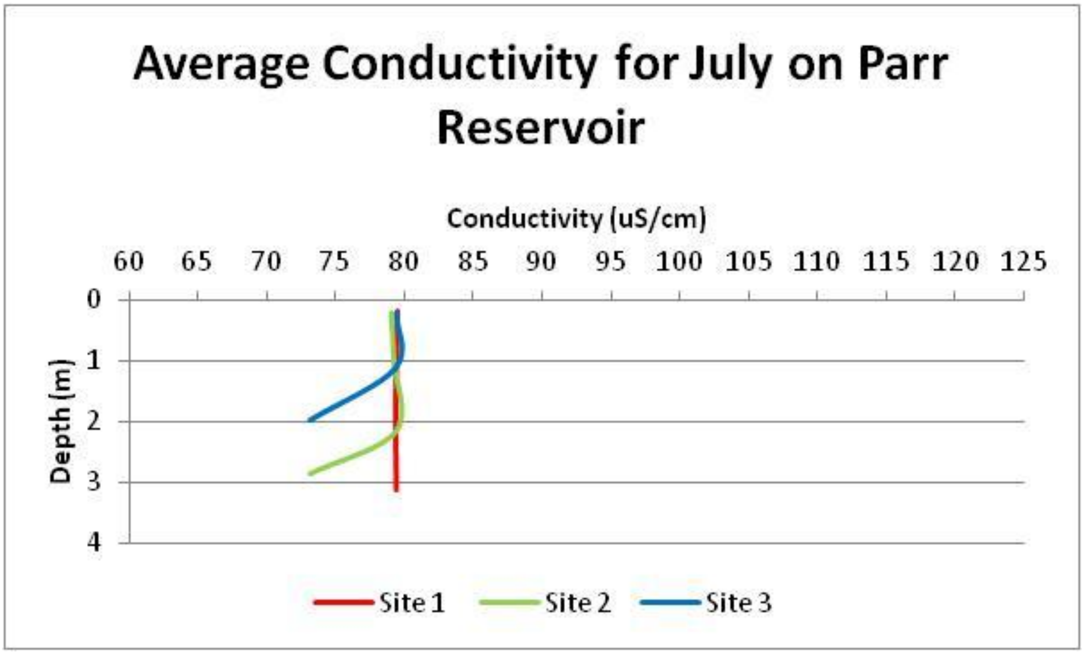


FIGURE 3-31 AVERAGE CONDUCTIVITY FOR JULY ON PARR RESERVOIR

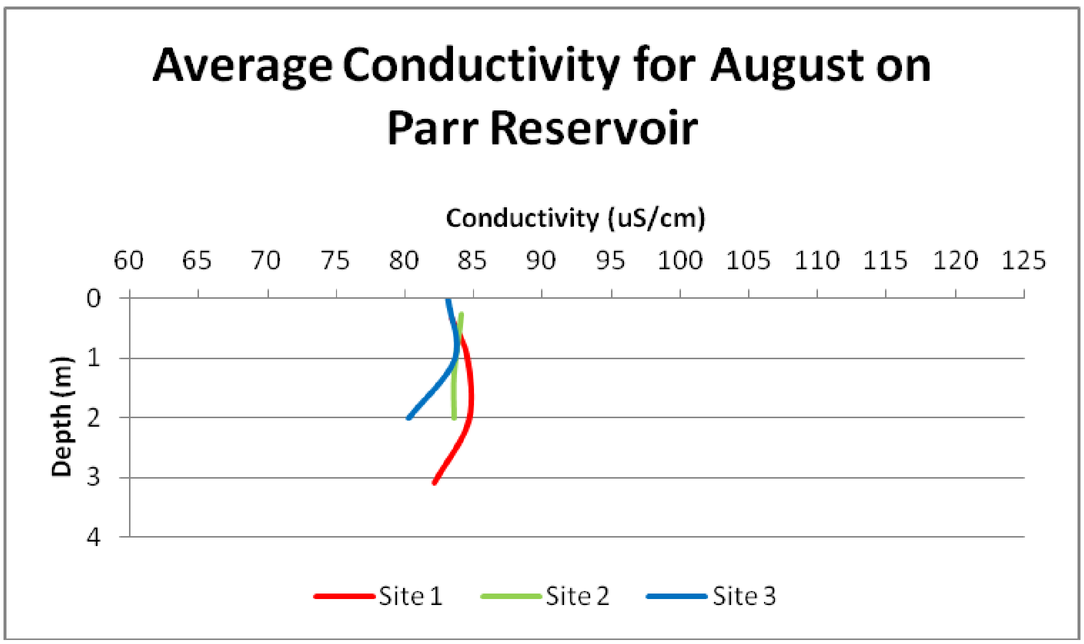


FIGURE 3-32 AVERAGE CONDUCTIVITY FOR AUGUST ON PARR RESERVOIR

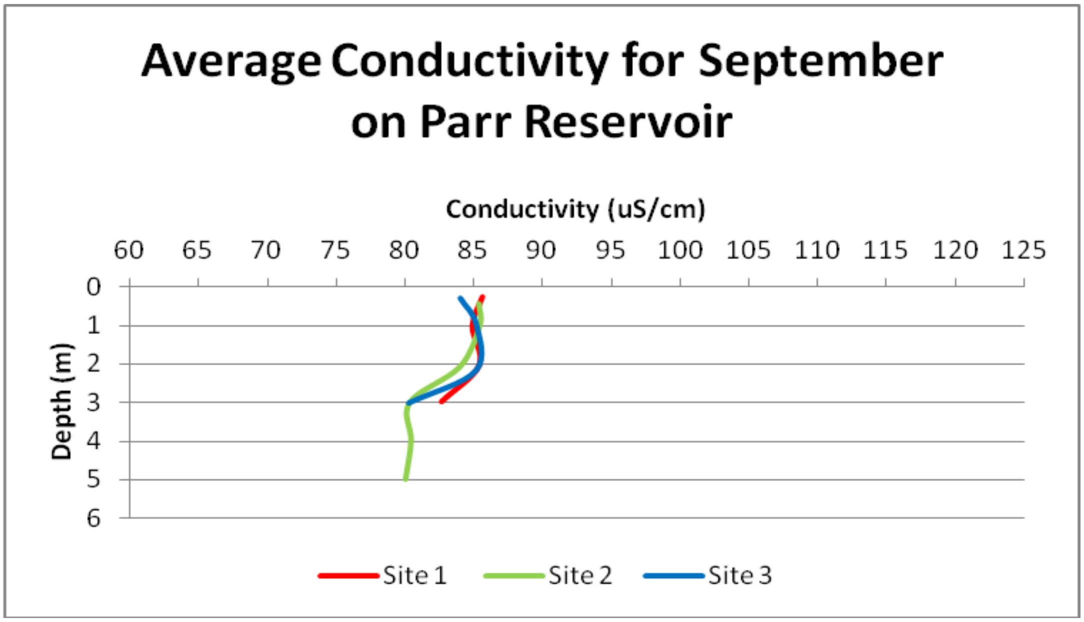


FIGURE 3-33 AVERAGE CONDUCTIVITY FOR SEPTEMBER ON PARR RESERVOIR

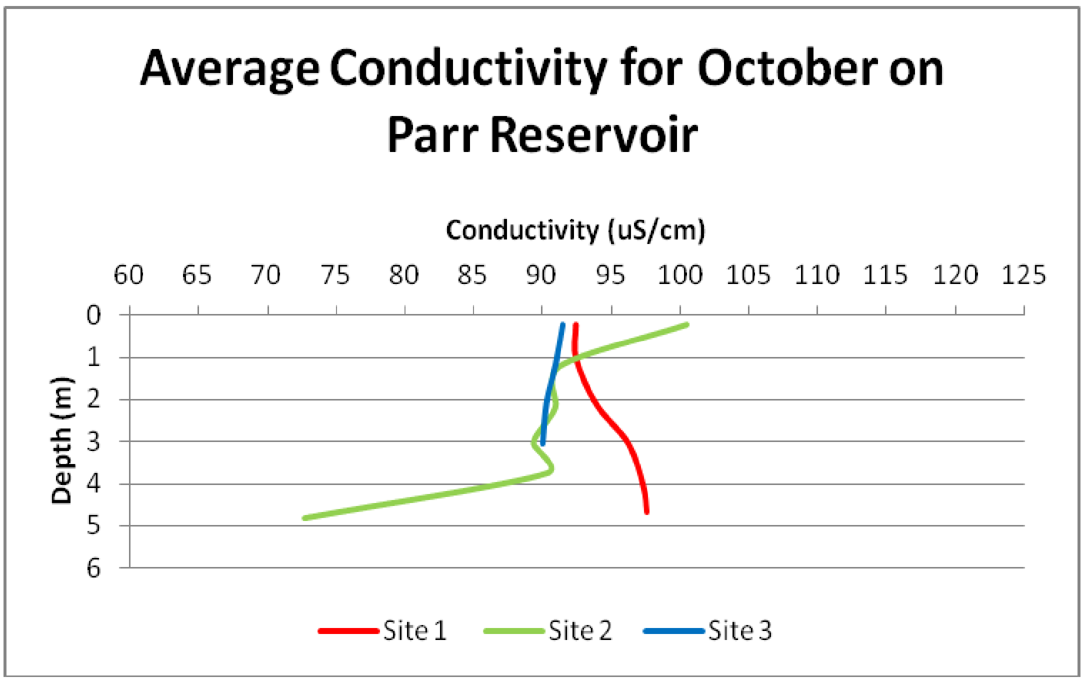


FIGURE 3-34 AVERAGE CONDUCTIVITY FOR OCTOBER ON PARR RESERVOIR

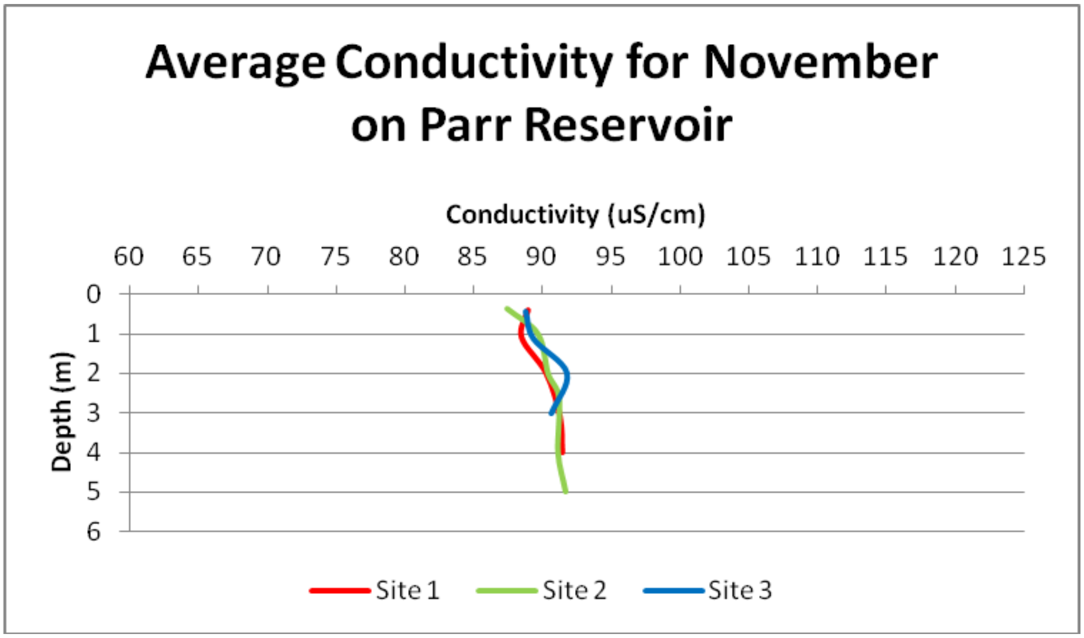


FIGURE 3-35 AVERAGE CONDUCTIVITY FOR NOVEMBER ON PARR RESERVOIR

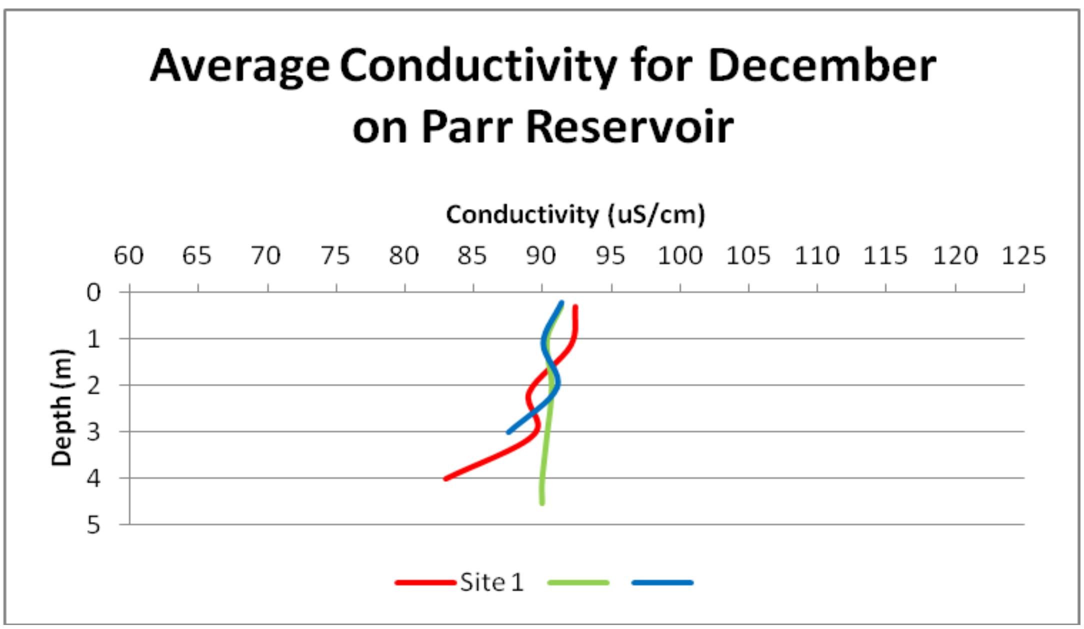


FIGURE 3-36 AVERAGE CONDUCTIVITY FOR DECEMBER ON PARR RESERVOIR

3.1.1.4 pH

pH values depicted in the graphs below are an average of monthly readings collected by SCE&G personnel, beginning in January of 2011 to December of 2013. Site 1 refers to the monitoring site located approximately 500 yards upstream of the proposed discharge site for the new nuclear units 2 and 3. Site 2 refers to the monitoring site located at the proposed discharge site for the new nuclear units 2 and 3. Site 3 is the monitoring site located approximately 300 yards downstream of the proposed discharge site.

Average pH values for the Parr Reservoir hover around 7.0, but range from 6.0 to 8.5 over the course of the year, and at various depths in the reservoir. Generally, pH decreases as the depth of the reservoir increases.

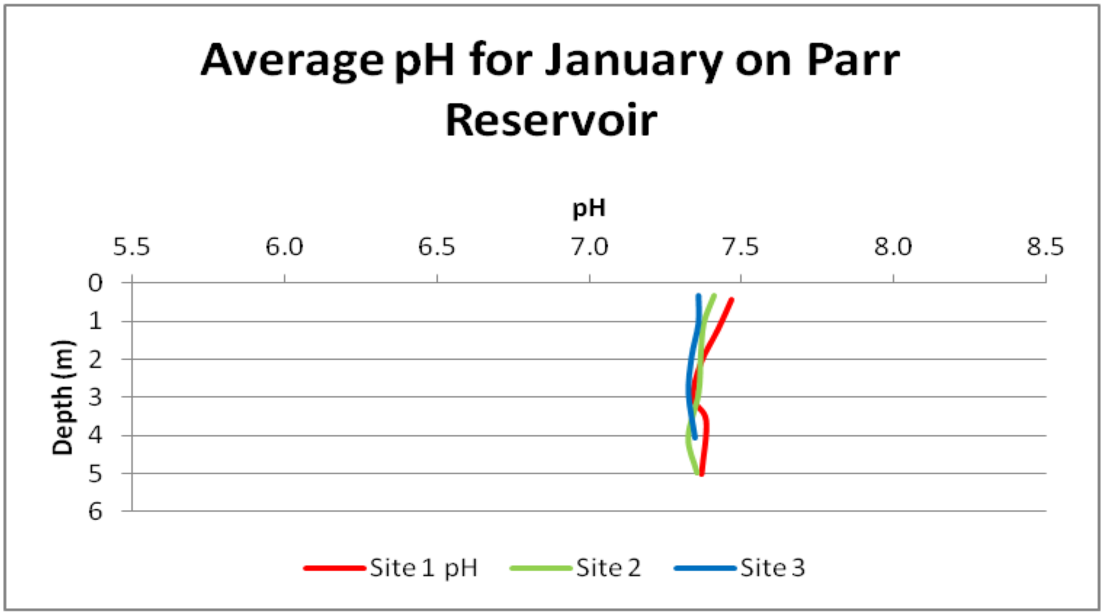


FIGURE 3-37 AVERAGE PH FOR JANUARY ON PARR RESERVOIR

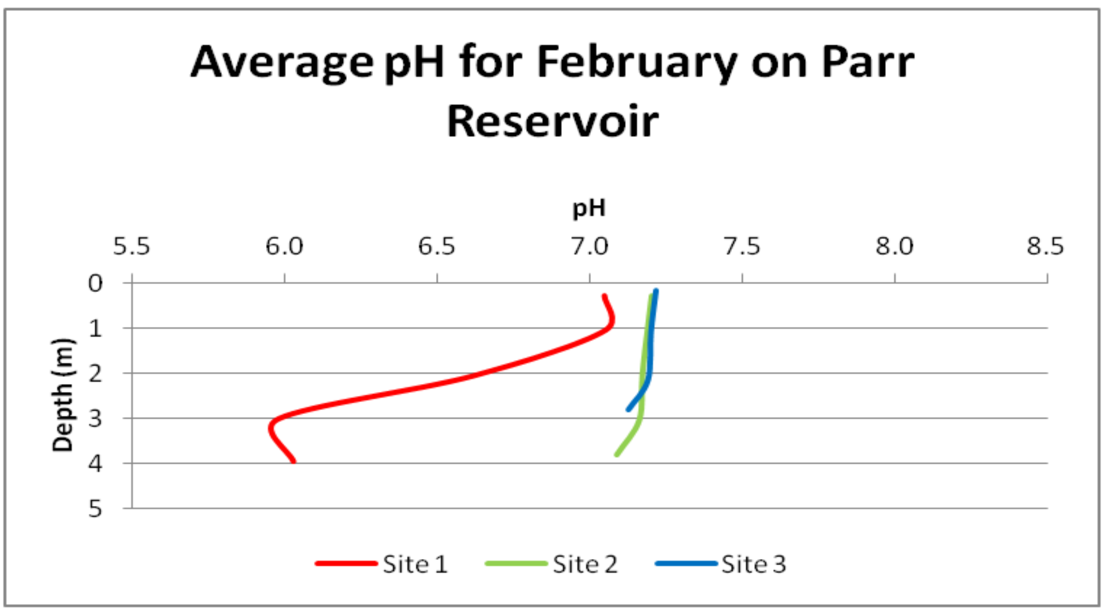


FIGURE 3-38 AVERAGE PH FOR FEBRUARY ON PARR RESERVOIR

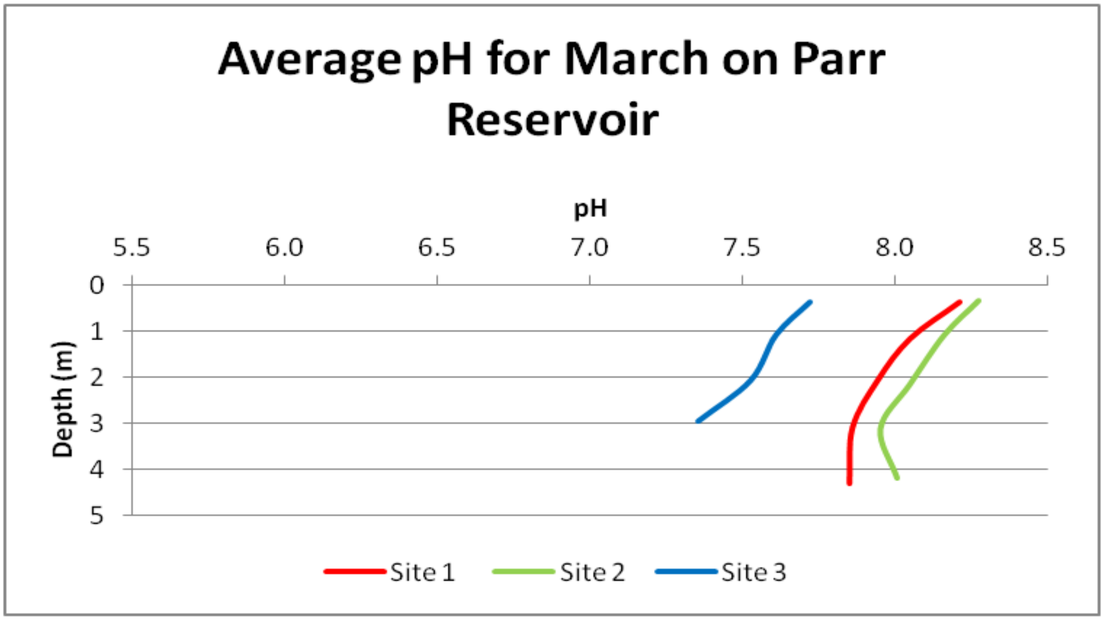


FIGURE 3-39 AVERAGE PH FOR MARCH ON PARR RESERVOIR

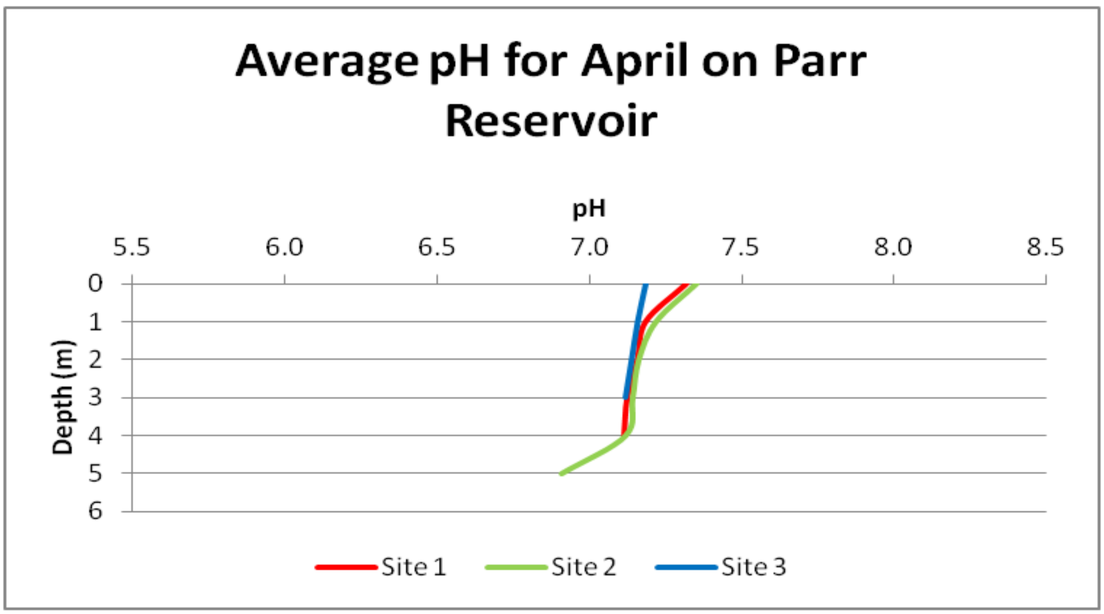


FIGURE 3-40 AVERAGE PH FOR APRIL ON PARR RESERVOIR

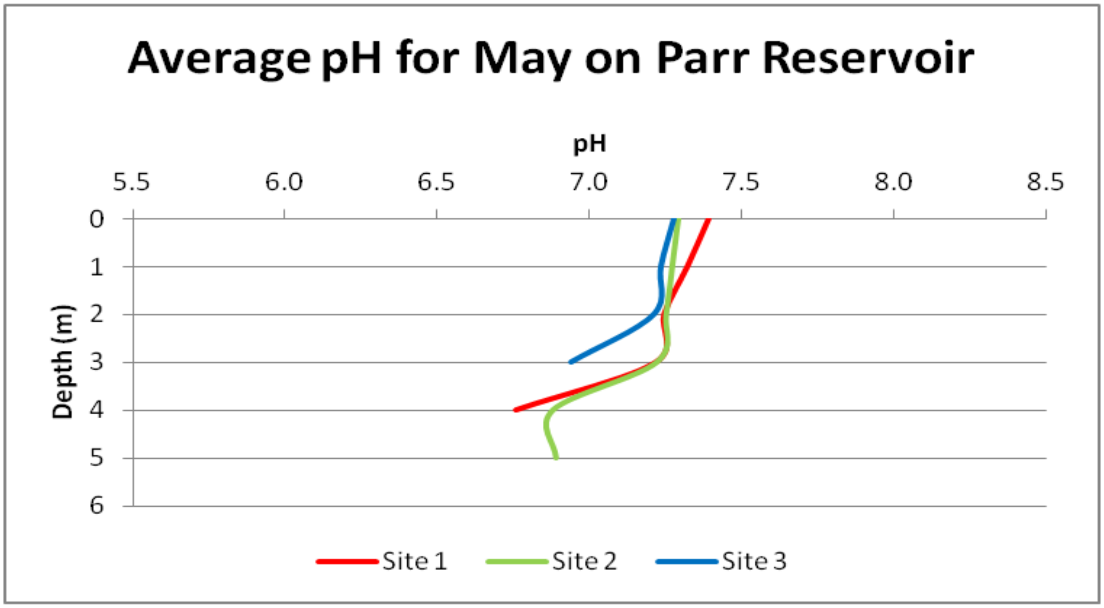


FIGURE 3-41 AVERAGE PH FOR MAY ON PARR RESERVOIR

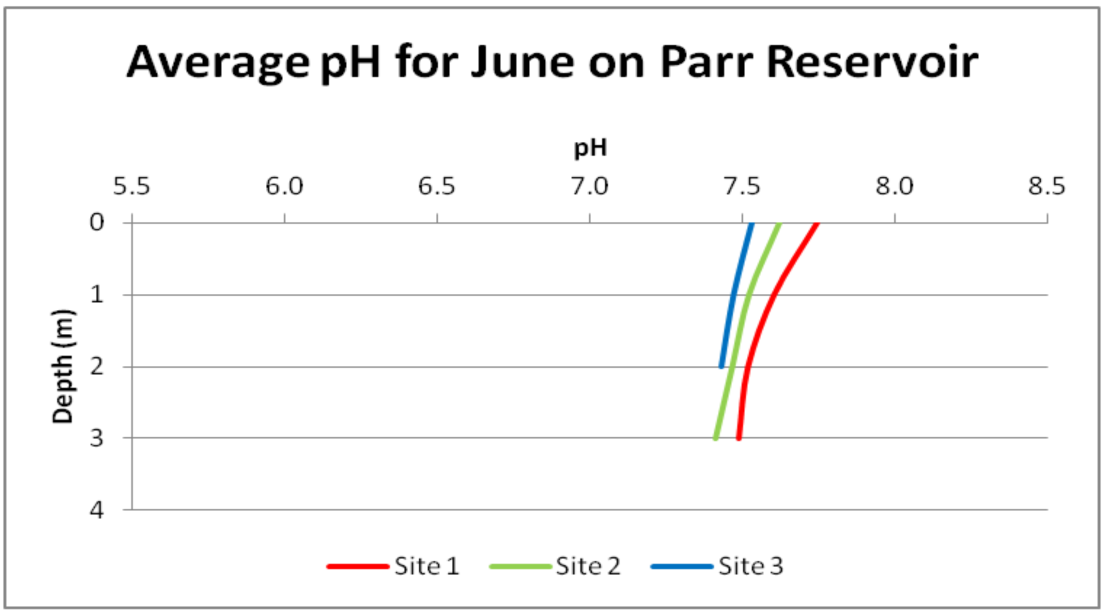


FIGURE 3-42 AVERAGE PH FOR JUNE ON PARR RESERVOIR

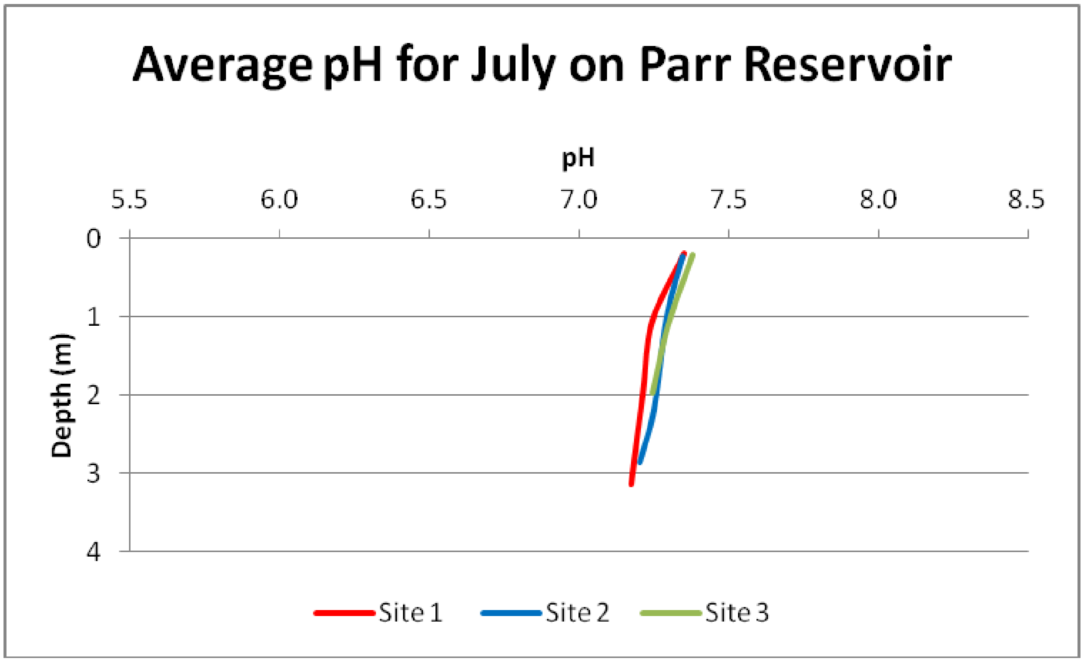


FIGURE 3-43 AVERAGE PH FOR JULY ON PARR RESERVOIR

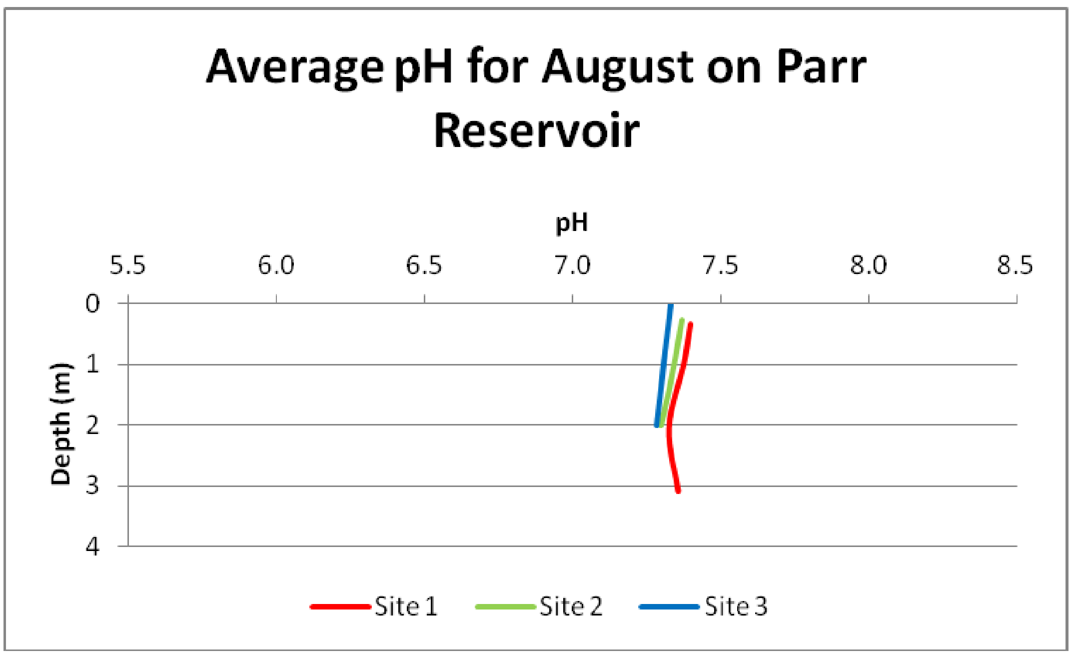


FIGURE 3-44 AVERAGE PH FOR AUGUST ON PARR RESERVOIR

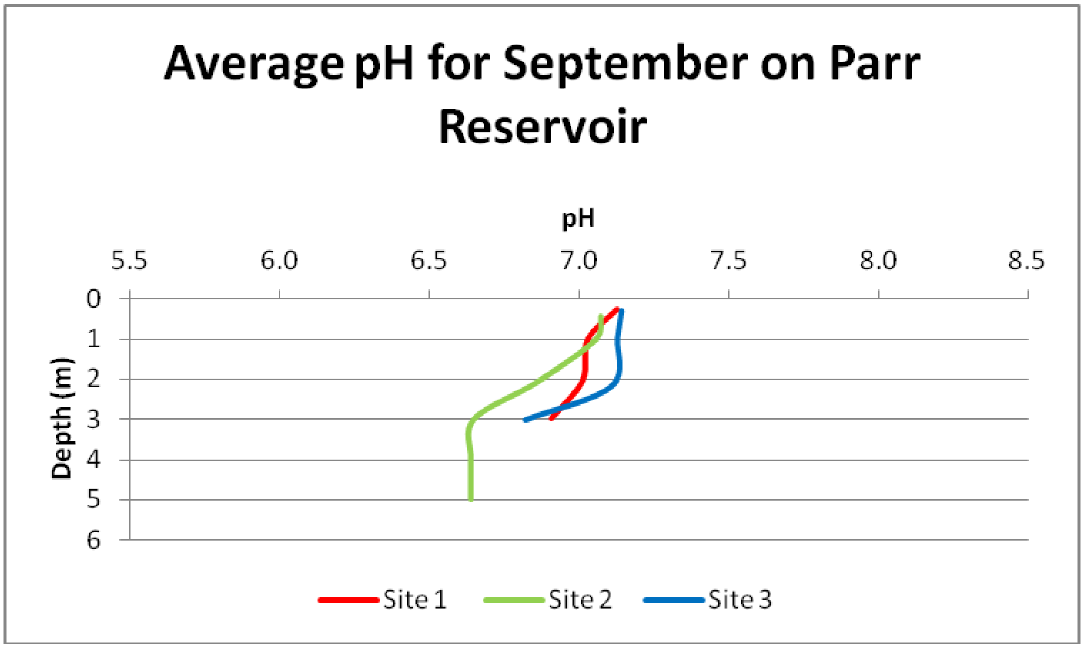


FIGURE 3-45 AVERAGE PH FOR SEPTEMBER ON PARR RESERVOIR

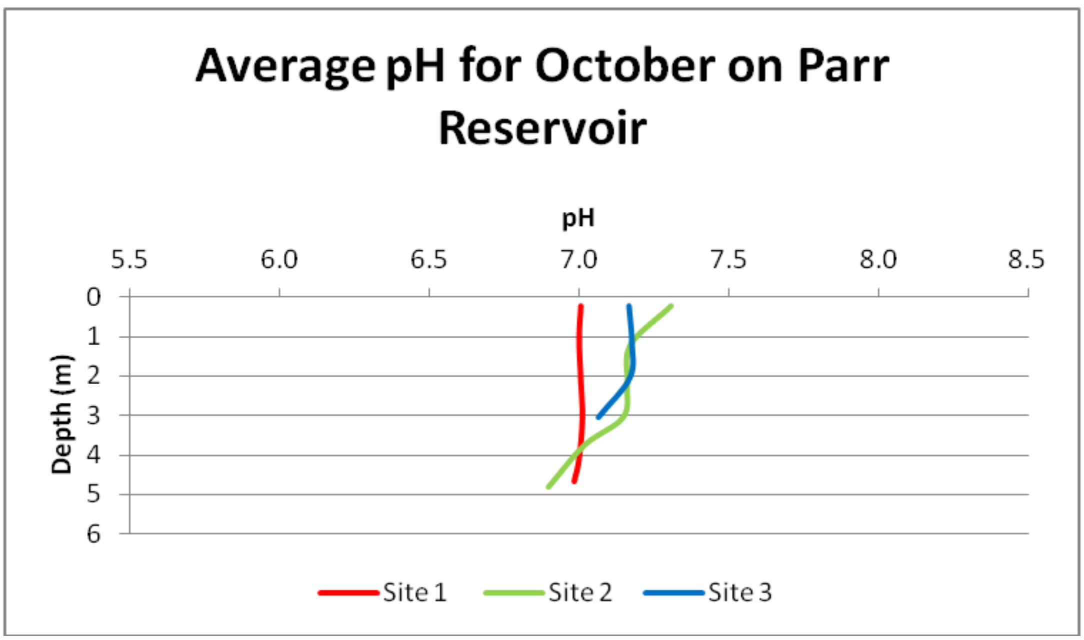


FIGURE 3-46 AVERAGE PH FOR OCTOBER ON PARR RESERVOIR

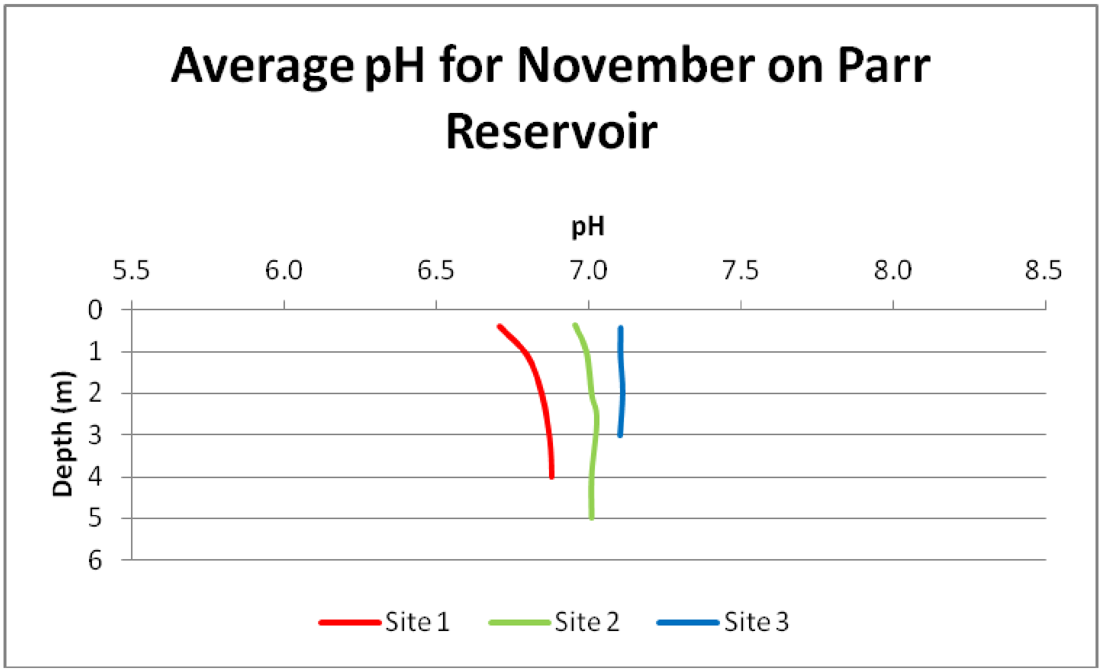


FIGURE 3-47 AVERAGE pH FOR NOVEMBER ON PARR RESERVOIR

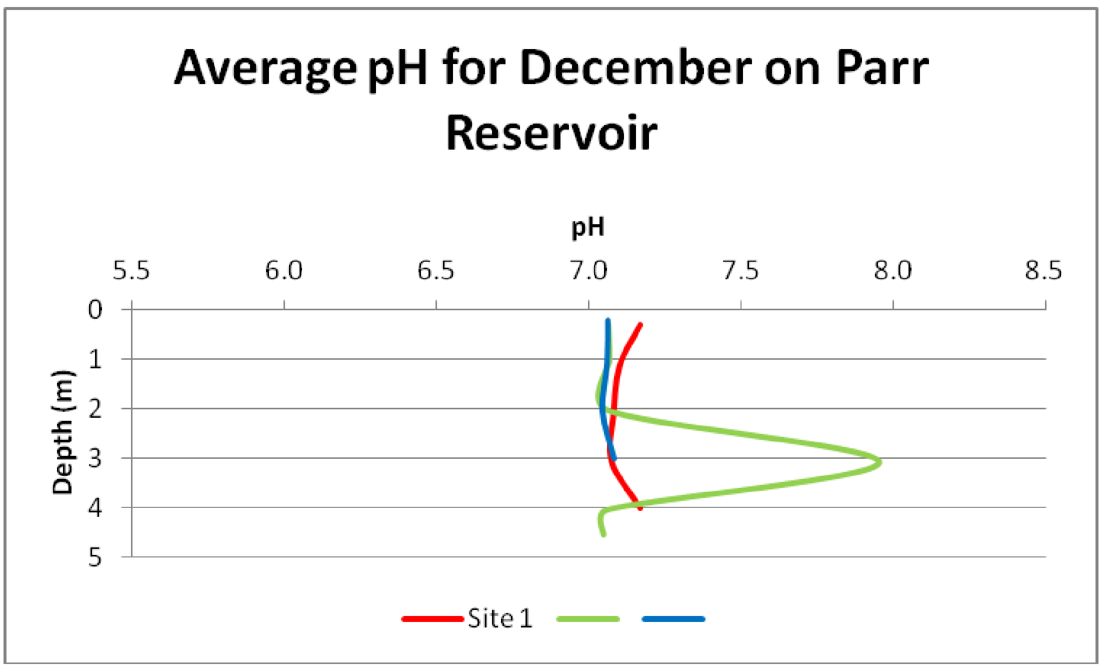


FIGURE 3-48 AVERAGE pH FOR DECEMBER ON PARR RESERVOIR

3.1.1.5 SUMMARY

Vertical profile data was collected on a monthly basis at three sites in Parr Reservoir, beginning in January 2011. Table 3-1 displays the maximum, minimum and mean temperature, DO, conductivity, and pH values on Parr Reservoir for each collection year at each collection location. The data summarized below were collected at a depth of 2 meters.

TABLE 3-1 SUMMARY TABLE FOR PARR RESERVOIR

Parr Reservoir		SITE 1				SITE 2				SITE 3			
		Temp	SpCond	DO Conc	pH	Temp	SpCond	DO Conc	pH	Temp	SpCond	DO Conc	pH
		C	uS/cm	mg/L		C	uS/cm	mg/L		C	uS/cm	mg/L	
2011	MAX	29.94	117	13.46	8.12	29.84	109	14.43	8.46	30.02	107	14.42	8.16
	MIN	8.56	74	5.11	6.85	8.76	73	5.46	7.08	8.58	72	5.30	7.15
	AVG	20.05	90	8.84	7.41	20.03	89	8.84	7.42	20.03	89	8.86	7.40
2012	MAX	28.82	96	12.24	7.75	28.56	97	12.32	7.71	28.66	98	12.63	7.70
	MIN	10.73	81	6.73	6.28	10.72	84	7.98	6.57	10.44	78	7.30	6.78
	AVG	18.38	91	9.30	7.23	18.43	91	9.69	7.23	18.34	90	9.70	7.24
2013	MAX	27.55	90	11.96	8.05	27.60	92	11.90	7.97	27.90	93	11.92	7.41
	MIN	9.62	56	6.23	5.85	8.62	57	5.02	6.59	8.32	57	5.18	6.72
	AVG	18.65	77	8.48	7.04	18.38	78	8.49	7.14	18.27	79	8.67	7.04

3.1.2 SCE&G METALS DATA

Parr Reservoir was analyzed for a variety of parameters, including metals, in 2007 and 2008 as part of the VCSNS expansion. Data were collected in the vicinity of the cooling tower blowdown discharge site on Parr Reservoir. The results of these analyses are shown below (Table 3-2).

TABLE 3-2 WATER QUALITY DATA AT NEW DISCHARGE SITE ON PARR RESERVOIR

		New Discharge Parr	New Discharge Parr	New Discharge Parr	New Discharge Parr	New Discharge Parr	New Discharge Parr	New Discharge Parr	New Discharge Parr	New Discharge Parr	New Discharge Parr	New Discharge Parr
Sample Date		6/26/2007	7/26/2007	8/28/2007	9/13/2007	10/31/2007	11/19/2007	12/11/2007	1/28/2008	2/21/2008	3/6/2008	4/24/2008
Analysis	**MDL /Units**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**
Phosphorus	0.050 mg/l	0.106	0.059	0.062		0.081	0.081			0.07	0.06	0.09
Arsenic	5.0 PPB	0	0	0	0	0	0	0	0	0	0	0
Barium	10.0 PPB	23	21	21	22	16	0	16.5	14	16	26	22
Cadmium	1.0 PPB	0	0	0	0	0	0	0	0	0	0	0
Calcium	100.0 PPB	4798	4089	3286	3564	3728	5059	4503	4478	4557	5575	5621
Chromium	10.0 PPB	0	0	0	0	0	0	0	0	0	0	0
Copper	10.0 PPB	0	0	0	0	0	0	0	0	0	0	0
Iron	10.0 PPB	1017	568	485	669	203	485	357	341	329	2002	922
Lead	5.0 PPB	0	0	0	0	0	0	0	0	0	0	0
Magnesium	100 .0 PPB	1998	2129	2092	2157	2230	466	2180	2139	2014	2138	2255
mercury (liquid)	0.4 PPB	0	0	0	0	0	0	0	0	0	0	0
Potassium	100.0 PPB	2171	2328	2500	2466	2337	2862	2520	2427	2133	2189	2109
Selenium	5.0 PPB	0	0	0	0	0	0	0	0	0	0	0
Silver	10.0 PPB	0	0	0	0	0	0	0	0	0	0	0
Sodium	1000.0 PPB	11780	12820	13600	16600	15620	21870	17090	14610	13170	9713	10900
Total Hardness (calc)	0.0 mg/l	20	19	17	18	19	15	20	20	20	23	23
Chlorides	0.5 mg/l	8.5	8.9	10.7	12.3	11.4	17.2	11.7	10.9	10.4	7.4	8.2
Conductivity	0.05 umhos	100.7	106.6	105.9	116.5	101.3	144.2	135.8	126.2	112.6	126.7	93.1
Nitrate-N	0.11 mg/l as N	0.4	0.24	0.14	0.21	0.28	0.4	0.36	0.43	0.45	0.36	0.32
Othrophosphate	0.010 mg/l	0.69	0.023	0.023	0.038	0.03	0.097	0.027	0.05	0.05	0.098	0.04
pH	0.0 S.U.	6.49		7.23	7.15							
Sulfates	0.5 mg/l	3.69	4.6	7.9	5.9	3.9	8.2	6.1	9	8.9	8.4	6.8
Total Alkalinity	1.0 mg/l	31.5	28.9	36.4	28.33	23.58	41.3	38.03	45.6	31.2	40.1	27.3
Total Dissolved Solid	2.0 mg/l	77	84	70	76	67	99	82	66	79	89	66
Total Suspended Solid	1.0 mg/l	9	8	8	10	3	4	2.5	0	3	12	11
Turbidity	0.05 NTU	22.2	10.5	8.88	13.1	4.02	7.62	5.32	4.02	4.89	35.1	11.7
Fecal Coliform	1.0 #/100ml	37	37	3	16	9	0			2	623	0
Total Coliform	Present/Absent	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present

0 -Represents in results column shows that values are less than the MDL for that particular parameter.

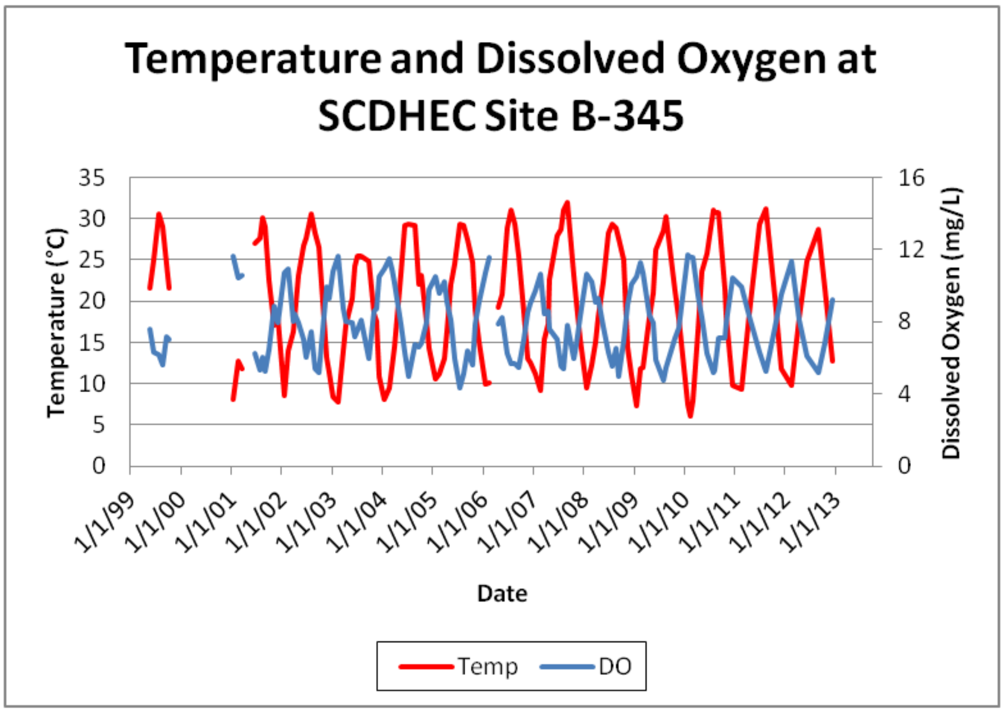
3.1.3 SCDHEC DATA

3.1.3.1 MONITORING STATION B-345

While samples collected from SCDHEC monitoring station B-345, in the forebay behind the dam, have been outside the allowed limits for the parameters discussed below in the past, this site is currently without impairment and is not listed on the South Carolina 303(d) List of Impaired Waters (303(d) list).

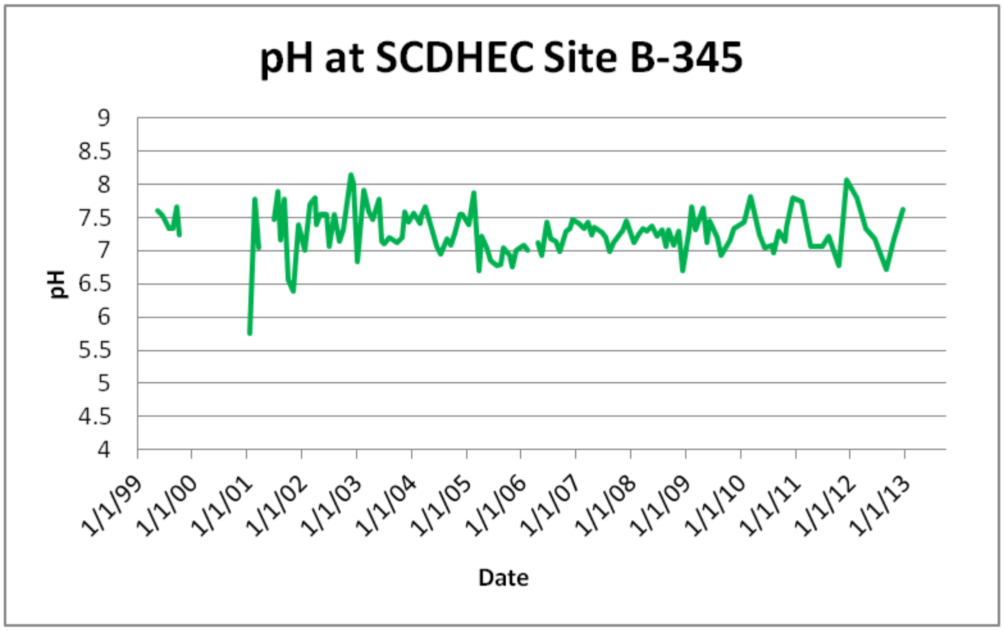
Temperature, DO, pH, and Turbidity

The following data were collected from 1999 through 2013 at the SCDHEC monitoring station B-345, located in the Parr Reservoir. See Table 2-1 for the SCDHEC water quality standards for temperature, DO, pH, and turbidity.



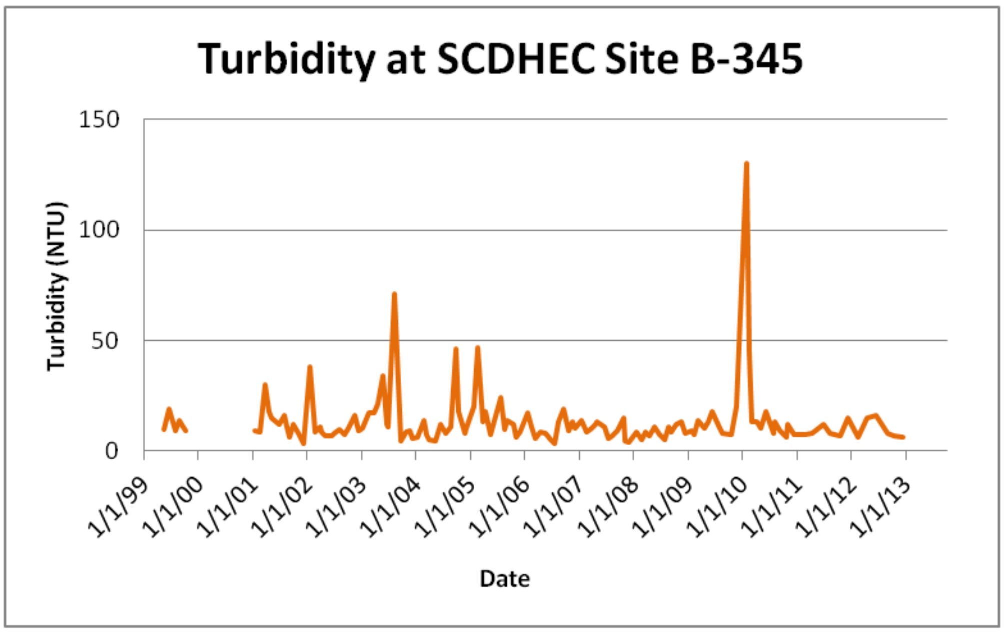
[a] Graph depicts only data that were available on STORET. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-49 WATER TEMPERATURE AND DISSOLVED OXYGEN AT SCDHEC MONITORING STATION B-345[a]



[a] Graph depicts only data that were available on STORET. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-50 PH AT SCDHEC MONITORING STATION B-345[a]



[a] Graph depicts only data that were available on STORET. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-51 TURBIDITY AT SCDHEC MONITORING STATION B-345[a]

Metals

Water samples from monitoring station B-345 were collected on a quarterly basis from 1999 until 2013 and analyzed for metals (Table 3-3). As shown in Table 3-3, the SCDHEC core indicator metals (Table 2-3) have been consistently measured as Present Below Quantification Limit (PBQL) at site B-345, indicating the reservoir supports aquatic life use.

TABLE 3-3 METALS PRESENT AT SCDHEC MONITORING STATION B-345[A]

DATE	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Magnesium (mg/L)	Manganese (mg/L)	Mercury (mg/L)	Nickel (mg/L)	Zinc (mg/L)
8/26/99	PBQL	PBQL	PBQL	0.92	PBQL	-	0.05	PBQL	PBQL	PBQL
2/21/01	PBQL	PBQL	PBQL	0.56	PBQL	-	0.02	PBQL	PBQL	PBQL
5/7/01	PBQL	PBQL	PBQL	0.61	PBQL	-	0.06	PBQL	PBQL	PBQL
8/16/01	PBQL	PBQL	PBQL	0.044	PBQL	-	0.07	PBQL	PBQL	PBQL
11/6/01	PBQL	PBQL	PBQL	0.45	PBQL	-	0.037	PBQL	PBQL	0.041
2/21/02	PBQL	PBQL	0.015	0.4	PBQL	1.9	0.03	PBQL	PBQL	0.048
5/6/02	PBQL	PBQL	PBQL	0.74	PBQL	-	0.053	PBQL	PBQL	PBQL
8/8/02	PBQL	PBQL	PBQL	0.58	PBQL	-	0.07	PBQL	PBQL	0.082
11/21/02	PBQL	PBQL	PBQL	1	PBQL	-	0.034	PBQL	PBQL	0.026
2/19/03	PBQL	PBQL	PBQL	1.4	PBQL	1.8	0.041	PBQL	PBQL	PBQL
5/28/03	PBQL	PBQL	PBQL	2.1	PBQL	-	0.058	PBQL	PBQL	PBQL
8/7/03	PBQL	PBQL	PBQL	2.8	PBQL	-	0.055	PBQL	PBQL	PBQL
11/20/03	PBQL	PBQL	0.035	0.25	PBQL	-	0.018	PBQL	PBQL	0.017
2/25/04	PBQL	PBQL	PBQL	0.88	PBQL	1.6	0.032	PBQL	PBQL	0.048
5/13/04	PBQL	PBQL	PBQL	0.22	PBQL	-	0.027	PBQL	PBQL	0.011
8/26/04	PBQL	PBQL	PBQL	0.4	PBQL	-	0.04	PBQL	PBQL	PBQL
11/22/04	PBQL	PBQL	PBQL	0.47	PBQL	-	0.02	PBQL	PBQL	PBQL
2/23/05	PBQL	PBQL	PBQL	1.8	PBQL	1.5	0.051	PBQL	PBQL	PBQL
5/18/05	PBQL	0.025	PBQL	0.55	PBQL	-	0.046	PBQL	PBQL	PBQL
8/18/05	PBQL	PBQL	PBQL	0.45	PBQL	-	0.046	PBQL	PBQL	PBQL
11/2/05	PBQL	PBQL	PBQL	0.33	PBQL	-	0.026	PBQL	PBQL	PBQL
2/16/06	PBQL	PBQL	PBQL	0.56	PBQL	1.6	0.024	PBQL	PBQL	PBQL
5/18/06	PBQL	PBQL	PBQL	0.44	PBQL	-	0.039	PBQL	PBQL	0.013
8/17/06	PBQL	PBQL	PBQL	0.57	PBQL	-	0.043	PBQL	PBQL	0.016
11/20/06	PBQL	PBQL	PBQL	1	PBQL	-	0.038	PBQL	PBQL	PBQL
2/20/07	PBQL	PBQL	PBQL	0.54	PBQL	1.6	0.019	PBQL	PBQL	0.018
5/2/07	PBQL	PBQL	PBQL	0.3	PBQL	1.6	0.053	PBQL	PBQL	0.031
8/13/07	PBQL	PBQL	PBQL	0.28	PBQL	1.6	0.062	PBQL	PBQL	0.036
11/8/07	PBQL	PBQL	PBQL	0.12	PBQL	1.3	0.02	PBQL	PBQL	PBQL
2/28/08	PBQL	PBQL	PBQL	0.37	PBQL	1.7	0.014	PBQL	PBQL	PBQL
5/22/08	PBQL	PBQL	PBQL	0.66	PBQL	-	0.049	PBQL	PBQL	PBQL
8/19/08	PBQL	PBQL	PBQL	0.4	PBQL	1.8	0.055	PBQL	PBQL	0.017
11/18/08	PBQL	PBQL	PBQL	0.65	PBQL	1.7	0.042	PBQL	PBQL	PBQL
2/12/09	PBQL	PBQL	PBQL	0.46	-	1.8	0.032	PBQL	PBQL	0.018
5/20/09	PBQL	PBQL	PBQL	0.47	-	1.9	0.056	PBQL	PBQL	PBQL
8/20/09	PBQL	PBQL	PBQL	0.27	-	1.9	0.071	PBQL	PBQL	PBQL
11/19/09	0.0002	PBQL	PBQL	0.99	-	1.5	0.033	PBQL	PBQL	PBQL
1/28/10	0.00027	0.0052	PBQL	3.8	-	-	0.12	PBQL	PBQL	PBQL
5/6/10	PBQL	PBQL	PBQL	0.41	-	-	0.055	PBQL	PBQL	PBQL
7/29/10	PBQL	PBQL	PBQL	0.32	-	-	0.043	PBQL	PBQL	PBQL
11/4/10	0.00058	PBQL	PBQL	0.55	-	1.5	0.02	PBQL	PBQL	PBQL
2/16/11	PBQL	PBQL	PBQL	0.31	-	-	0.015	PBQL	PBQL	PBQL
6/29/11	PBQL	PBQL	PBQL	0.32	-	-	0.058	PBQL	PBQL	PBQL
8/11/11	PBQL	PBQL	PBQL	0.27	-	-	0.052	PBQL	PBQL	PBQL
12/5/11	PBQL	PBQL	PBQL	0.73	-	1.5	0.021	PBQL	PBQL	PBQL
2/16/12	PBQL	PBQL	PBQL	0.33	-	-	0.019	PBQL	PBQL	PBQL
6/11/12	PBQL	PBQL	PBQL	0.31	-	-	0.059	PBQL	PBQL	0.01
8/30/12	PBQL	PBQL	PBQL	0.24	-	-	0.048	PBQL	PBQL	PBQL
12/13/12	PBQL	PBQL	PBQL	0.2	-	-	0.022	PBQL	PBQL	PBQL

[A] PBQL is Present Below Quantification Limit.

Nutrients

The nutrients data collected at SCDHEC monitoring station B-345 are presented in the table below. See Table 2-2 for SCDHEC standards for nutrients.

TABLE 3-4 NUTRIENTS AND CHLOROPHYLL A AT SCDHEC MONITORING STATION B-345[A]

Date	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Chlorophyll a (ug/L)	Date	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Chlorophyll a (ug/L)
5/20/99	0.78	0.062	-	1/17/07	0.58	PBQL	-
6/17/99	0.53	0.058	-	2/20/07	0.56	PBQL	-
7/29/99	0.7	0.043	-	5/2/07	-	-	1.42
8/26/99	0.58	0.031	-	6/21/07	0.52	0.045	3.9
9/23/99	0.74	0.039	-	7/19/07	0.65	0.039	3.33
10/5/99	PBQL	0.039	-	8/13/07	PBQL	0.057	4.24
2/21/01	1.15	0.038	-	9/10/07	-	-	4.95
4/17/01	0.66	0.063	-	10/25/07	-	-	2.24
5/7/01	-	-	3.66	11/8/07	0.48	0.049	-
6/26/01	0.41	0.031	-	1/24/08	0.66	0.031	-
7/30/01	-	-	3.05	1/24/08	0.66	0.024	-
8/16/01	0.63	0.046	3.82	2/28/08	0.52	0.039	-
10/4/01	0.42	0.053	1.99	2/28/08	0.52	0.03	-
12/6/01	0.45	0.032	-	3/25/08	0.73	0.028	-
1/24/02	PBQL	0.026	-	3/25/08	0.73	0.028	-
2/21/02	0.45	0.029	-	4/17/08	0.62	PBQL	-
3/27/02	0.51	0.027	-	4/17/08	0.62	0.02	-
5/6/02	0.49	0.031	2.06	5/22/08	PBQL	0.035	-
6/13/02	0.4	0.039	-	5/22/08	PBQL	0.089	-
7/1/02	0.41	0.039	4.45	6/26/08	0.34	0.028	4.72
8/8/02	-	-	8.42	6/26/08	0.34	PBQL	-
9/5/02	0.38	0.036	7.26	7/29/08	0.25	0.06	-
10/2/02	-	-	4.19	7/29/08	0.25	0.046	6.28
11/21/02	0.68	0.032	-	8/19/08	0.202	0.048	6.18
12/12/02	0.64	0.036	-	9/11/08	0.26	0.057	6.5
1/6/03	0.64	0.039	-	9/11/08	0.26	0.032	-
3/27/03	0.54	0.037	-	10/14/08	0.46	0.029	2.51
5/28/03	0.88	0.027	-	10/14/08	0.46	0.04	-
7/2/03	0.49	PBQL	-	11/18/08	PBQL	0.025	-
9/25/03	0.73	0.022	1.74	11/18/08	PBQL	0.047	-
10/30/03	-	-	0.76	12/9/08	1.26	0.071	-
11/20/03	0.98	0.031	-	12/9/08	1.26	0.058	-
1/15/04	0.81	PBQL	-	1/22/09	0.49	0.046	-
3/11/04	0.76	0.031	-	2/12/09	0.55	0.047	-
4/1/04	0.73	PBQL	-	3/5/09	0.69	0.023	-
5/13/04	-	-	2.81	4/23/09	PBQL	PBQL	-
6/17/04	0.82	0.028	2.29	5/20/09	0.86	0.032	2.5
7/15/04	0.62	0.042	2.18	6/11/09	0.44	0.026	1.89
8/26/04	0.49	0.024	4.54	7/30/09	0.3	0.039	5.16
9/22/04	0.6	PBQL	-	8/20/09	0.41	0.041	8.88
10/14/04	0.58	0.023	4.75	10/22/09	0.43	0.037	2.27
11/22/04	0.71	0.022	-	11/19/09	0.48	0.047	-
12/7/04	0.57	0.048	-	1/28/10	0.74	0.12	-
1/20/05	0.98	0.038	-	2/11/10	0.66	0.058	-
2/23/05	0.88	0.03	-	3/4/10	0.61	0.045	-
3/24/05	0.9	0.052	-	4/8/10	PBQL	0.029	-
4/14/05	0.7	0.045	-	5/6/10	0.45	0.051	3.28
5/18/05	0.7	0.031	1.87	6/10/10	2.06	0.042	6.04
6/9/05	0.86	0.046	1.07	7/29/10	0.31	0.038	7.5
7/21/05	0.85	0.047	2.26	8/5/10	0.45	0.055	7.99
8/18/05	0.51	0.083	2.54	9/9/10	0.31	0.036	3.23
9/8/05	0.53	0.047	1.94	10/21/10	0.41	0.03	-
10/20/05	0.69	0.044	-	11/4/10	0.88	0.045	-
11/2/05	0.64	0.033	-	12/14/10	0.82	0.043	-
12/1/05	0.72	0.056	-	2/16/11	0.55	0.052	-
1/17/06	0.73	0.05	-	4/14/11	-	0.054	-
2/16/06	0.77	0.035	-	6/29/11	0.26	0.061	-
3/16/06	0.91	0.043	-	8/11/11	0.29	0.043	15.57
4/20/06	1.04	0.033	-	10/20/11	0.52	0.046	-
5/18/06	PBQL	0.027	2.06	12/5/11	0.69	0.074	-
6/22/06	0.57	0.03	2.5	2/16/12	0.96	0.057	-
7/20/06	0.58	0.037	3.63	4/12/12	0.99	0.083	-
8/17/06	0.95	0.024	3.96	6/11/12	0.48	0.035	5.2
9/14/06	0.53	0.035	3.01	8/30/12	0.55	0.027	8.59
10/26/06	0.56	0.024	1.1	10/17/12	0.63	0.041	3.67
11/20/06	0.54	0.03	-	12/13/12	0.99	0.068	-
12/7/06	0.55	PBQL	-	4/11/13	1.18	0.034	-

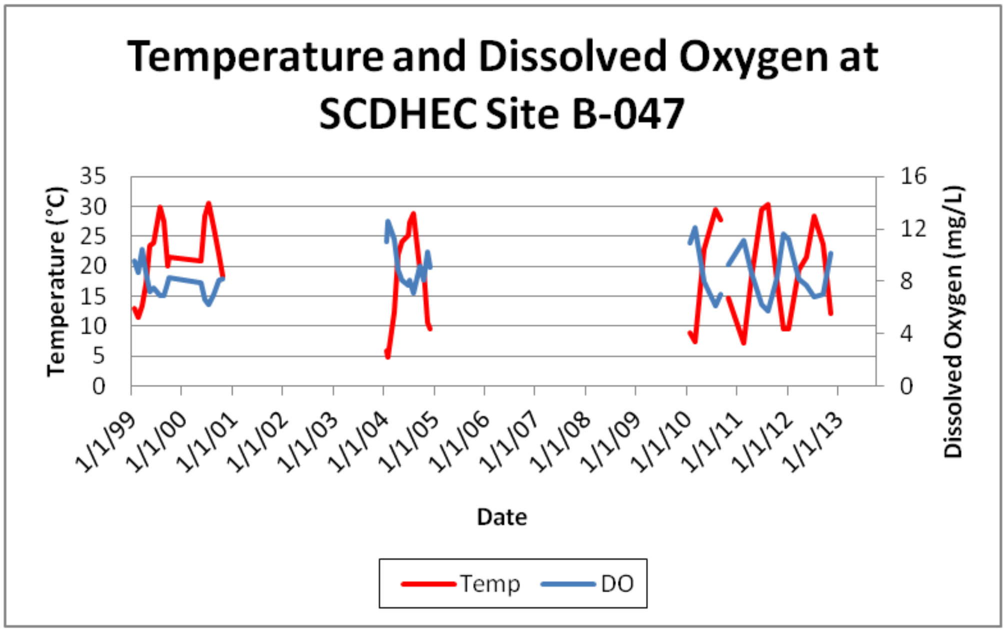
[A] PBQL is Present Below Quantification Limit.

3.1.3.2 MONITORING STATION B-047

Historically, samples collected from SCDHEC monitoring station B-047, Broad River at SC 34, have been outside the allowed limits for some of the parameters discussed below, however this site is currently without impairment and is not listed on the 303(d) list.

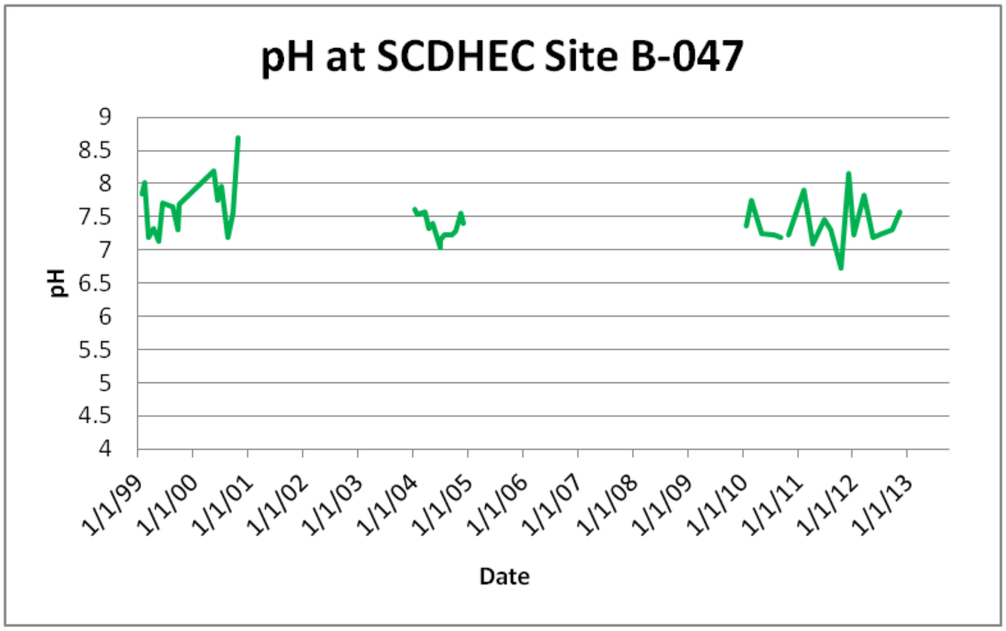
Temperature, DO, pH, and Turbidity

The following data were collected during the years 1999-2000, 2004 and 2010-2012 at the SCDHEC monitoring station B-047, located in the Parr Reservoir. The data collected for temperature, DO, pH, and turbidity reflect expected values, inside normal ranges. See Table 2-1 for the SCDHEC water quality standards for temperature, DO, pH, and turbidity.



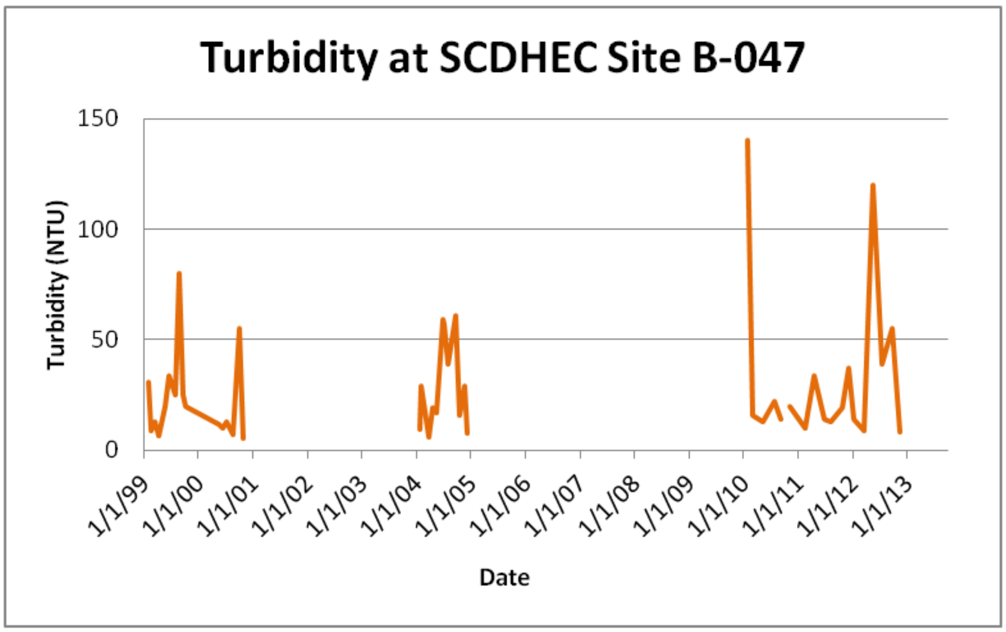
[a] Graph depicts only data that were available on STORET. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-52 WATER TEMPERATURE AND DISSOLVED OXYGEN AT SCDHEC MONITORING STATION B-047 [a]



[a] Graph depicts only data that were available on STORET. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-53 pH AT SCDHEC MONITORING STATION B-047 [a]



[a] Graph depicts only data that were available on STORET. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-54 TURBIDITY AT SCDHEC MONITORING STATION B-047[A]

Metals

Metals data collected by SCDHEC was available on STORET for monitoring station B-047 only for the years 2004, 2010, 2011, and 2012 (Table 3-5). During these years, water samples were tested on a quarterly basis for the presence of metals. In 2012, iron, magnesium, and manganese were all present at various times and levels. However, the aquatic life use core indicator metals (see Table 2-3) are consistently found to be PBQL.

TABLE 3-5 METALS PRESENT AT SCDHEC MONITORING STATION B-047[A]

DATE	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Magnesium (mg/L)	Manganese (mg/L)	Mercury (mg/L)	Nickel (mg/L)	Zinc (mg/L)
2/5/04	PBQL	PBQL	PBQL	1.1	PBQL	1.6	0.041	PBQL	PBQL	PBQL
5/11/04	PBQL	0.01	0.012	1.2	PBQL	-	0.092	PBQL	PBQL	0.025
8/2/04	PBQL	PBQL	PBQL	1.4	PBQL	-	0.042	PBQL	PBQL	PBQL
11/16/04	PBQL	PBQL	PBQL	1.5	PBQL	-	0.03	PBQL	PBQL	PBQL
1/28/10	0.00026	PBQL	PBQL	2.3	-	-	0.089	PBQL	PBQL	0.013
5/6/10	PBQL	PBQL	PBQL	0.5	-	-	0.042	PBQL	PBQL	PBQL
7/29/10	PBQL	PBQL	PBQL	1	-	-	0.065	PBQL	PBQL	PBQL
11/4/10	PBQL	PBQL	PBQL	1.1	-	1.4	0.057	PBQL	PBQL	PBQL
2/16/11	PBQL	PBQL	PBQL	0.53	-		0.029	PBQL	PBQL	PBQL
6/29/11	PBQL	PBQL	PBQL	0.53	-		0.06	PBQL	PBQL	PBQL
8/11/11	PBQL	PBQL	PBQL	0.57	-		0.077	PBQL	PBQL	PBQL
12/5/11	PBQL	PBQL	PBQL	1.2	-	1.5	0.054	PBQL	PBQL	PBQL
1/12/12	PBQL	PBQL	PBQL	0.66	-		0.034	PBQL	PBQL	PBQL
5/15/12	PBQL	PBQL	PBQL	4.4	-		0.34	PBQL	PBQL	PBQL
7/17/12	PBQL	PBQL	PBQL	0.96	-		0.13	PBQL	PBQL	PBQL
11/8/12	PBQL	PBQL	PBQL	0.32	-	1.8	0.027	PBQL	PBQL	PBQL

[A] PBQL is Present Below Quantification Limit.

Nutrients

Nutrients data was collected at SCDHEC monitoring station B-047 during 2004, 2010, 2011, and 2012 and is included in the table below. Site B-047 is considered by SCDHEC to be located in the Broad River; the nutrient and chlorophyll-a standards only apply to reservoirs and therefore do not apply to this site. There are no nutrient and chlorophyll-a standards established for rivers.

TABLE 3-6 NUTRIENTS AT SCDHEC MONITORING STATION B-047

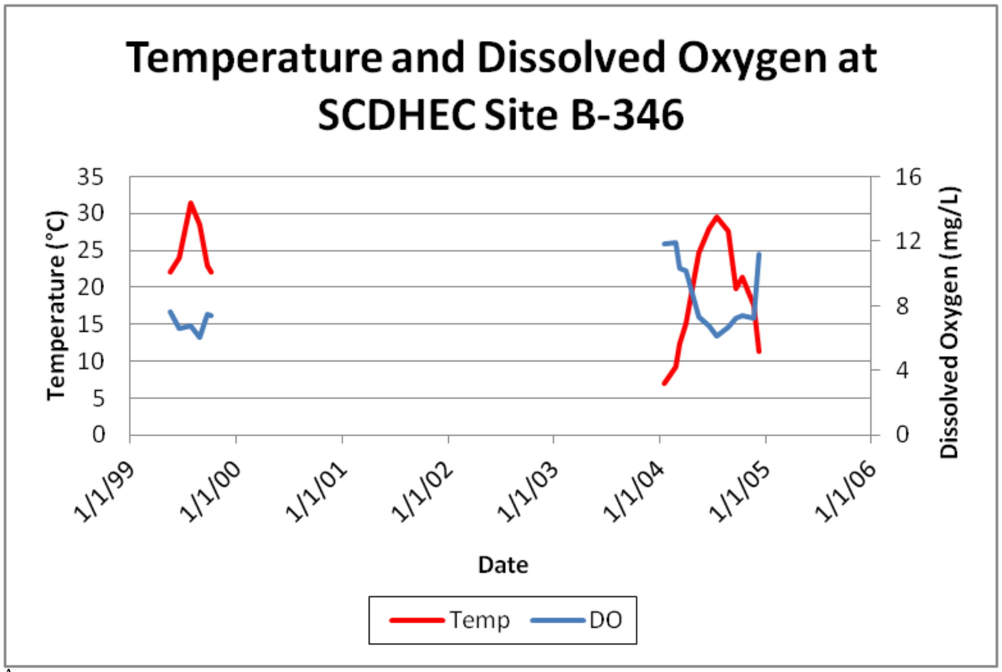
Date	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
1/20/04	-	0.074
2/5/04	0.94	0.052
3/23/04	-	0.047
4/20/04	0.88	0.12
5/11/04	0.78	0.13
6/30/04	0.94	0.11
7/7/04	0.67	0.11
8/2/04	0.86	0.088
9/21/04	0.45	0.057
10/14/04	0.63	0.055
11/16/04	0.66	0.042
12/6/04	0.7	0.13
1/28/10	0.39	0.046
3/4/10	0.51	0.054
5/6/10	0.57	0.13
7/29/10	0.99	0.15
9/9/10	0.87	0.085
11/4/10	0.69	0.092
2/16/11	0.54	0.076
6/29/11	0.6	0.15
8/11/11	0.69	0.15
10/20/11	1.15	0.11
12/5/11	0.84	0.11
1/12/12	0.7	0.13
3/19/12	0.67	0.088
5/15/12	0.53	0.22
7/17/12	0.65	0.12
9/20/12	0.67	0.17
11/8/12	0.94	0.23

3.1.3.3 MONITORING STATION B-346

The SCDHEC monitoring station B-346, Parr Reservoir approximately 3 miles upstream of the dam, is an inactive site where SCDHEC no longer collects water quality data. Currently, this site is listed on the 303(d) list for total phosphorus. See the nutrients section below for more details on the total phosphorus levels at this site.

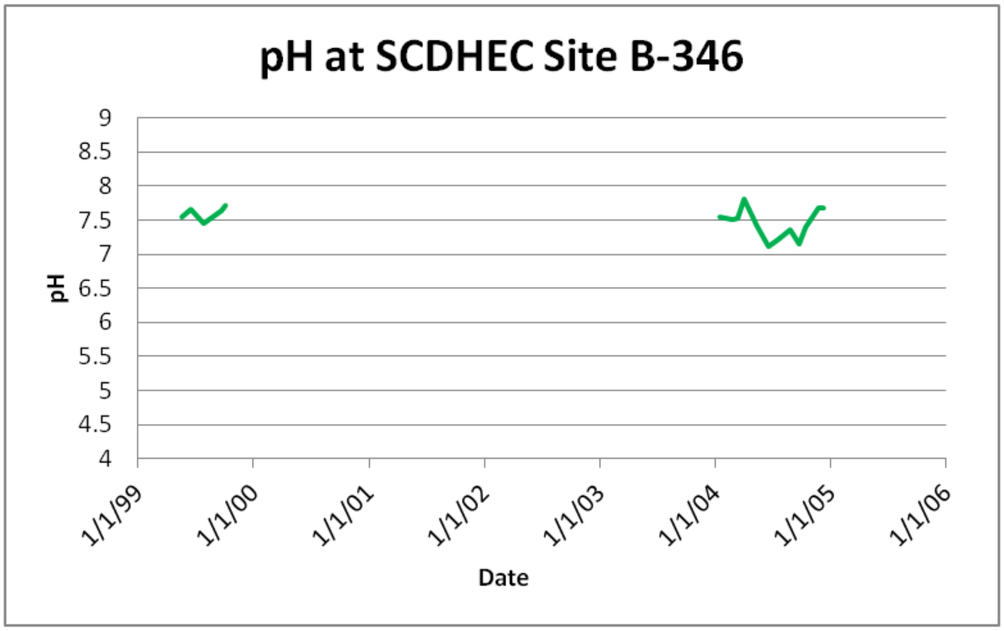
Temperature, DO, pH, and Turbidity

The following data was collected during the years 1999 and 2004 at the SCDHEC monitoring station B-346 located in the Parr Reservoir. See Table 2-1 for the SCDHEC water quality standards for temperature, DO, pH, and turbidity.



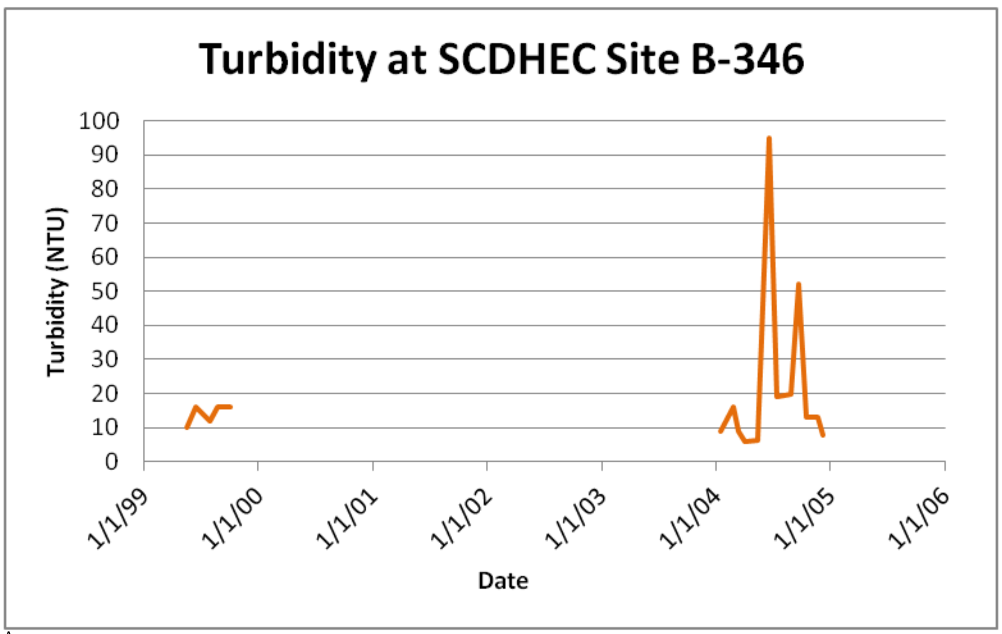
[A] Graph depicts only data that were available on STORET. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-55 WATER TEMPERATURE AND DISSOLVED OXYGEN AT SCDHEC MONITORING STATION B-346[A]



[A] Graph depicts only data that were available on STORET. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-56 PH AT SCDHEC MONITORING STATION B-346[A]



[A] Graph depicts only data that were available on STORET. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-57 TURBIDITY AT SCDHEC MONITORING STATION B-346[A]

Metals

Metals data collected by SCDHEC was available on STORET for monitoring station B-346 only for the year 1999 and 2004. The SCDHEC core indicator metals (Table 2-3) were consistently measured as Present Below Quantification Limit (PBQL) at site B-346, indicating the reservoir supports aquatic life use.

TABLE 3-7 METALS AT SCDHEC MONITORING STATION B-346[A]

DATE	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Magnesium (mg/L)	Manganese (mg/L)	Mercury (mg/L)	Nickel (mg/L)	Zinc (mg/L)
8/26/99	PBQL	PBQL	PBQL	0.84	PBQL	-	0.04	PBQL	PBQL	0.02
2/25/04	PBQL	PBQL	PBQL	1	PBQL	1.7	0.05	PBQL	PBQL	PBQL
5/13/04	PBQL	PBQL	PBQL	0.45	PBQL	-	0.033	PBQL	PBQL	PBQL
8/26/04	PBQL	PBQL	PBQL	1.1	PBQL	-	0.034	PBQL	PBQL	PBQL
11/22/04	PBQL	PBQL	PBQL	0.73	PBQL	-	0.038	PBQL	PBQL	PBQL

[A] PBQL is Present Below Quantification Limit.

Nutrients

Nutrients data was collected at SCDHEC monitoring station B-346 during 1999 and 2004 and is included in the table below. See Table 2-2 for SCDHEC standards for nutrients. This site is currently listed on the 2012 303(d) list for total phosphorus. However, it should be noted that total phosphorus has not been analyzed at this site since 2004.

TABLE 3-8 NUTRIENTS AND CHLOROPHYLL A AT SCDHEC MONITORING STATION B-346[A]

Date	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Chlorophyll a (ug/L)
5/20/99	0.73	-	-
6/17/99	0.7	-	-
7/29/99	1.75	-	-
8/26/99	PBQL	-	-
9/23/99	0.8	-	-
10/5/99	0.74	-	-
1/15/04	0.76	0.051	-
2/25/04	-	0.047	-
3/11/04	0.75	0.036	-
4/1/04	0.54	0.03	-
5/13/04	0.74	0.056	1.47
6/17/04	1.02	0.13	1.54
7/15/04	0.93	0.079	1.41
8/26/04	0.77	0.098	1.24
9/22/04	0.61	0.075	1.01
10/14/04	0.61	0.051	1.29
11/22/04	0.67	0.038	-
12/7/04	0.59	0.037	-

[A] PBQL is Present Below Quantification Limit.

3.1.3.4 MONITORING STATION RL-12049

SCDHEC monitoring station RL-12049, Parr Reservoir approximately 1 mile southeast of the mouth of Hellers Creek, is a randomly selected site that was monitored on a monthly basis during 2012. Data collected at this site is summarized below. These data have not yet been evaluated for potential §303(d) listing.

Temperature, DO, pH, and Turbidity

The following data was collected during 2012 at the SCDHEC monitoring station RL-12049 located in the Parr Reservoir. See Table 2-1 for the SCDHEC water quality standards for temperature, DO, pH, and turbidity.

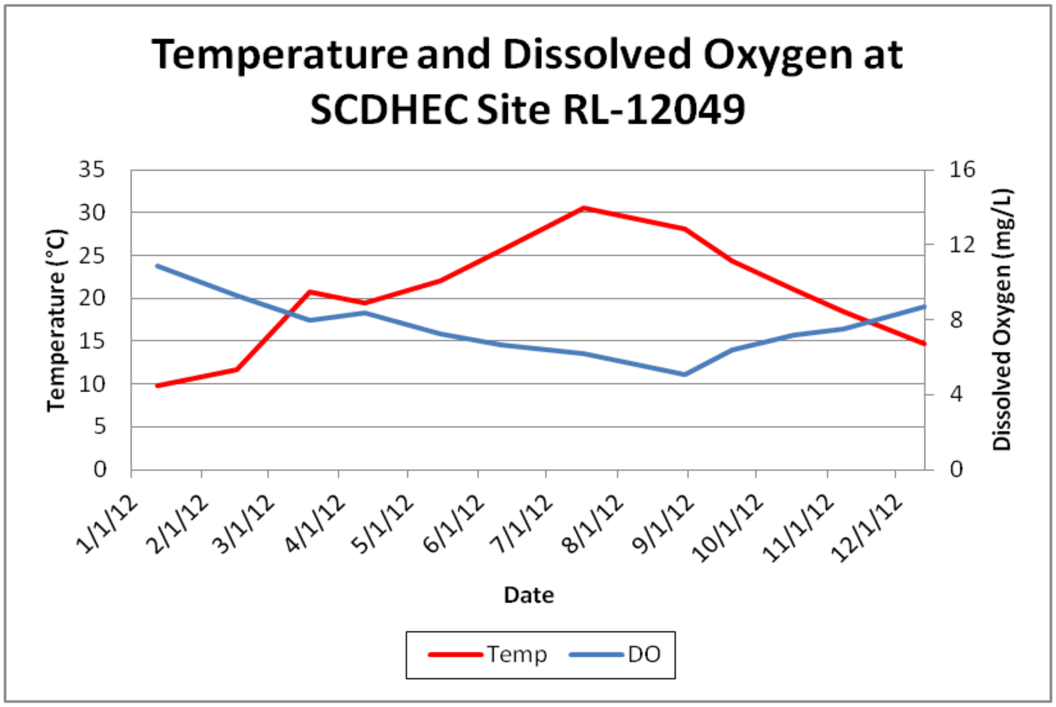
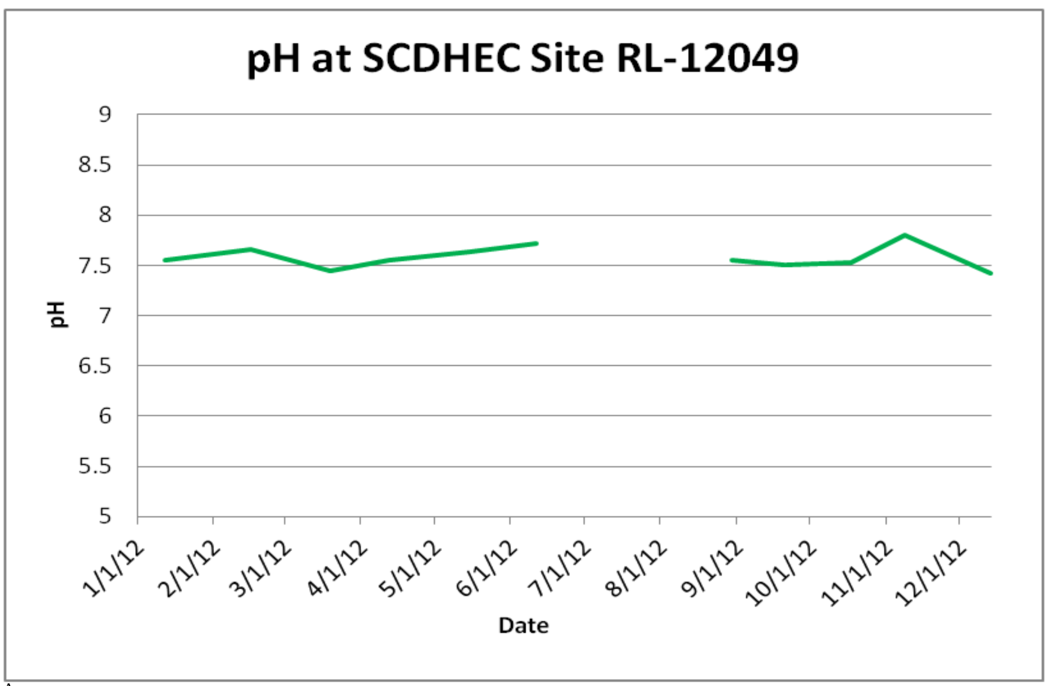


FIGURE 3-58 TEMPERATURE AND DISSOLVED OXYGEN AT SCDHEC MONITORING STATION RL-12049



[A] Graph depicts only data that were available on STORET. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-59 PH AT SCDHEC MONITORING STATION RL-12049[A]

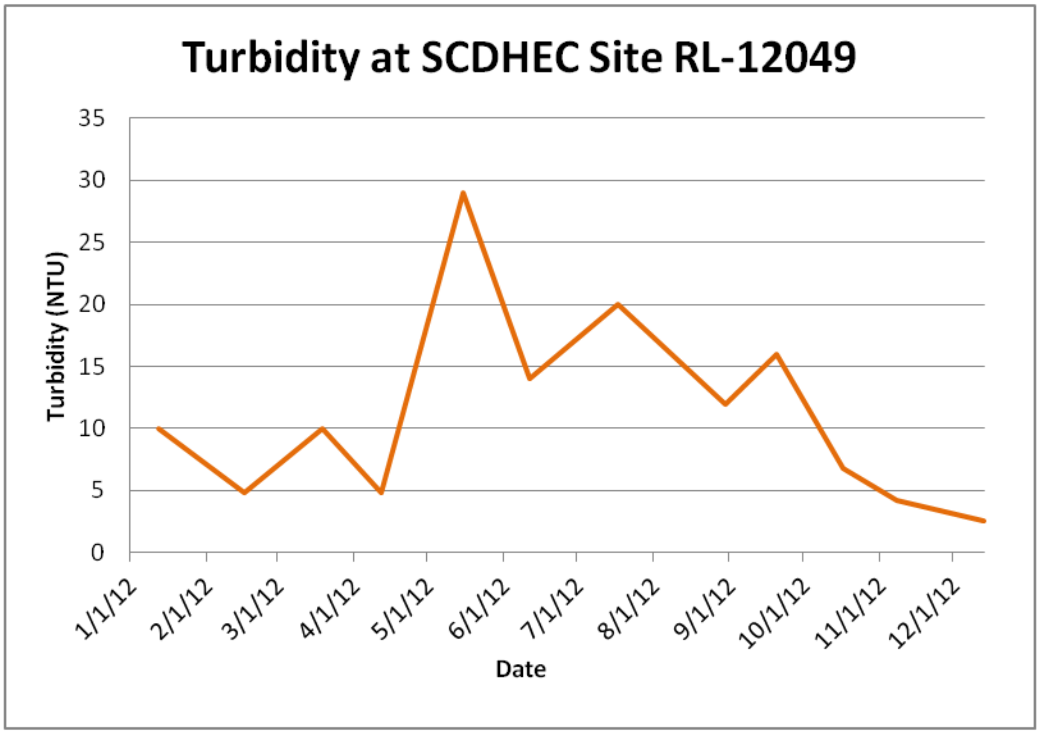


FIGURE 3-60 TURBIDITY AT SCDHEC MONITORING STATION RL-12049

Metals

The metals data collected in 2012 at SCDHEC monitoring site RL-12049 is presented in the table below. The SCDHEC core indicator metals (Table 2-3) were consistently measured as Present Below Quantification Limit (PBQL) at site RL-12049, indicating the reservoir supports aquatic life use.

TABLE 3-9 METALS AT SCDHEC MONITORING STATION RL-12049[A]

DATE	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Magnesium (mg/L)	Manganese (mg/L)	Mercury (mg/L)	Nickel (mg/L)	Zinc (mg/L)
1/12/12	PBQL	PBQL	PBQL	0.69	-	-	0.026	PBQL	PBQL	PBQL
5/15/12	PBQL	PBQL	PBQL	1.8	-	-	0.095	PBQL	PBQL	PBQL
7/17/12	PBQL	PBQL	PBQL	0.48	-	-	0.05	PBQL	PBQL	PBQL
11/8/12	PBQL	PBQL	PBQL	0.089	-	1.6	0.045	PBQL	PBQL	PBQL

[A] PBQL is Present Below Quantification Limit.

Nutrients

Water samples were collected at SCDHEC monitoring site RL-12049 and analyzed for nitrogen, phosphorus and chlorophyll-a. The results of these analyses are included in the table below. See Table 2-2 for SCDHEC standards for nutrients.

TABLE 3-10 NUTRIENTS AND CHLOROPHYLL A AT SCDHEC MONITORING STATION RL-12049[A]

Date	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Chlorophyll a (ug/L)
1/12/12	PBQL	0.1	-
2/16/12	0.76	0.038	-
3/19/12	0.87	0.089	-
4/12/12	0.85	0.036	-
5/15/12	0.62	0.12	1.23
6/11/12	0.7	0.078	4.36
7/17/12	0.72	0.1	-
8/30/12	0.61	0.062	3.55
9/20/12	0.76	0.092	1.62
10/17/12	0.52	0.05	-
11/8/12	0.45	0.032	-
12/13/12	0.86	0.04	-

[A] PBQL is Present Below Quantification Limit.

3.1.4 PARR RESERVOIR SEDIMENT INVESTIGATION 2012

The data collected in 2012 will be used to form a baseline for determining what impact, if any the discharge from the operation of the V.C. Summer Nuclear Station Units 2 and 3 will have on various constituents of the sediment in the vicinity of the discharge. Data will continue to be collected at the two transect sites through the construction and operation of these nuclear units.

3.1.4.1 SEDIMENT INVESTIGATION RESULTS

Four metals, including antimony, arsenic, lead and nickel, were measured at <10 mg/kg. Antimony (1.7 mg/kg) and arsenic (3.8 mg/kg) were detected at Transect 2 compared to non-detect at Transect 1. Lead and nickel concentrations at Transect 2 ranged from 6.0 times to 6.6 times higher than Transect 1. Reference Figure 2-4

Copper, chromium, zinc and barium results at Transect 2 range in values from 15 mg/kg to 97 mg/kg. In comparison Transect 1 values ranged from 2.1 mg/kg to 24 mg/kg. Copper concentrations at Transect 2 (15 mg/kg) were measured 7 times higher than Transect 1 (2.1 mg/kg) results.

The results at Transect 2 for manganese and calcium ranged between 580 mg/kg to 790 mg/kg. Calcium was measured at 790 mg/kg at Transect 2 compared to non-detect at Transect 1 for this sampling event. Manganese concentrations at Transect 2 (580 mg/kg) were two times higher than those at Transect 1 (290 mg/kg).

Potassium, magnesium, aluminum and iron results ranged from 1,600 mg/kg to 21,000 mg/kg at Transect 2, compared to a range of 500 mg/kg to 5,500 mg/kg at Transect 1. Aluminum concentrations at Transects 2 were 6.5 times higher than those at Transect 1. Potassium, magnesium, and iron concentrations at Transect 2 ranged from 3.2 times to 3.8 times higher than Transect 1.

The phosphorus results were higher at Transect 2 with a value of 350 mg/kg compared to a value of 150 mg/kg at Transect 1.

For the complete 2012 Parr Sediment Investigation Report, please see Appendix A.

3.2 MONTICELLO RESERVOIR

3.2.1 SCE&G VERTICAL PROFILE DATA

3.2.1.1 TEMPERATURE

Water temperatures depicted in the graphs below are an average of ten years of monthly readings collected from Monticello Reservoir by SCANA personnel, beginning in January of 2003 to December 2012. The data corresponding to the “intake” refers to that collected at the monitoring site located in the channel near the circulating water intake for the VCSNS. The data corresponding to the “discharge” refers to that collected at the monitoring site located just outside the northern end of the circulating water discharge canal for VCSNS. The data corresponding to the “uplake” refers to that collected at the monitoring site located near the northern end of the reservoir.

Water temperatures in Monticello Reservoir at the monitoring site near the intake of the VCSNS and the monitoring site located at the north end of the reservoir follow a general trend of increasing during the summer months and decreasing with depth of the reservoir. Temperatures at these two locations range from around 9^{o}C during winter months up to 30^{o}C during the summer months. Water temperatures near the discharge area of the VCSNS have a slightly different trend, with surface temperatures being consistently around five to seven degrees warmer than the other two monitoring locations. However, as the depth increases, these temperatures quickly drop back to what is normal for the lake, according to monitoring at the intake and uplake monitoring locations. Please see Appendix B for the Thermal Mixing Zone Evaluation and NPDES permit issued to the VCSNS regarding this water quality trend.

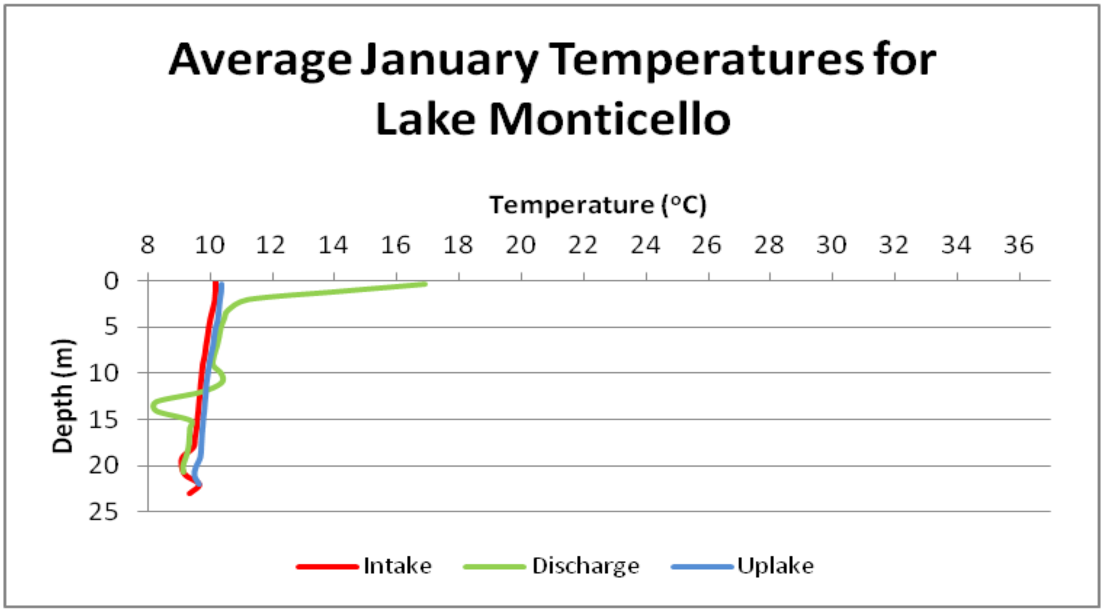


FIGURE 3-61 AVERAGE TEMPERATURE FOR JANUARY ON MONTICELLO RESERVOIR

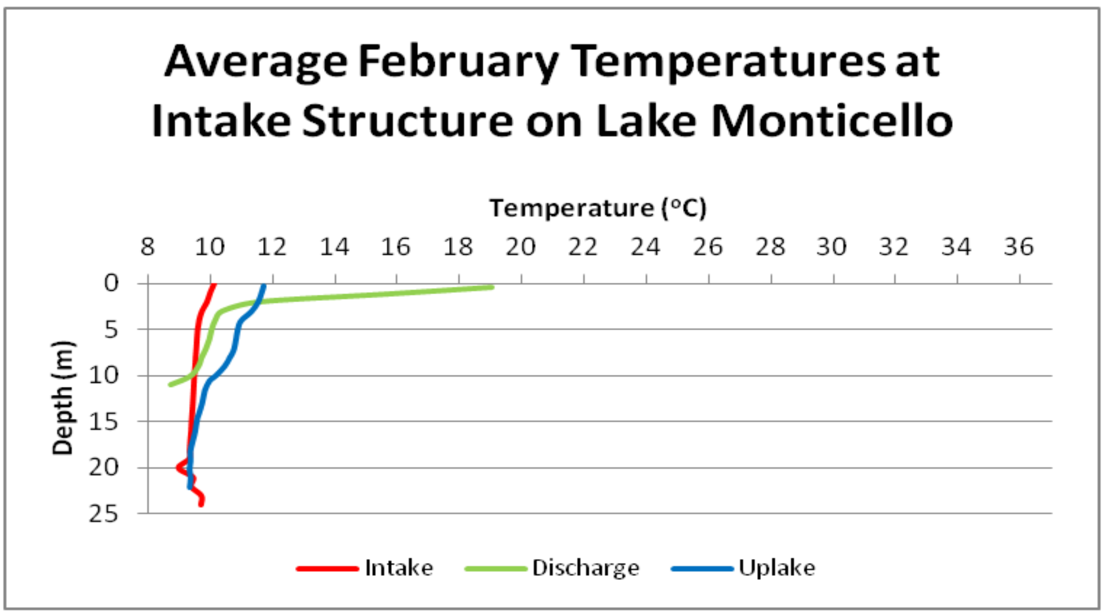


FIGURE 3-62 AVERAGE TEMPERATURE FOR FEBRUARY ON MONTICELLO RESERVOIR

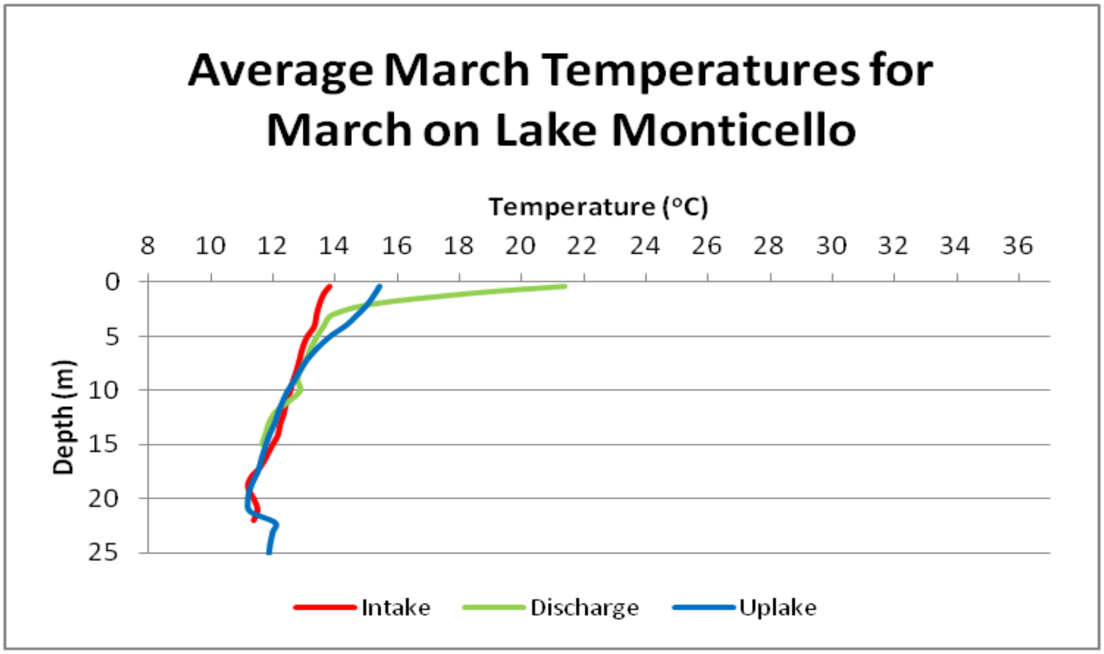


FIGURE 3-63 AVERAGE TEMPERATURE FOR MARCH ON MONTICELLO RESERVOIR

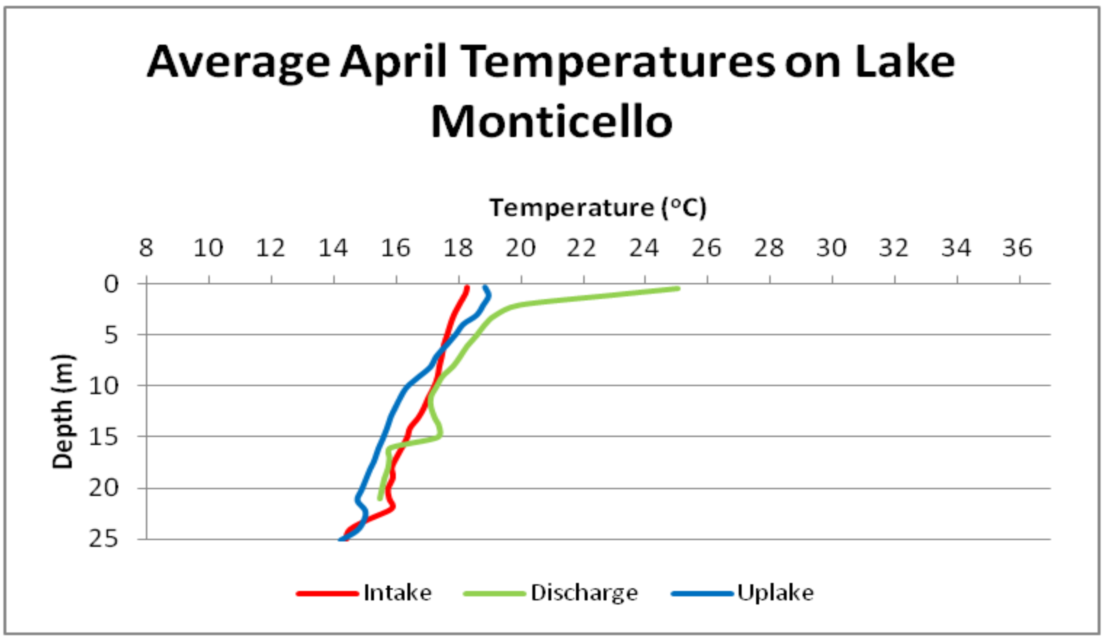


FIGURE 3-64 AVERAGE TEMPERATURE FOR APRIL ON MONTICELLO RESERVOIR

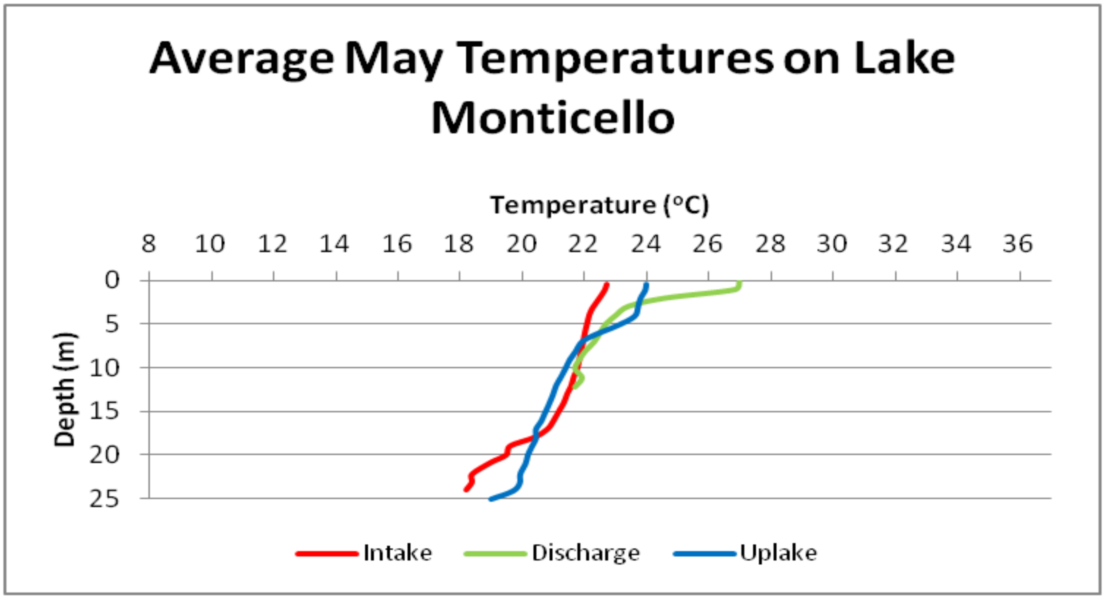


FIGURE 3-65 AVERAGE TEMPERATURE FOR MAY ON MONTICELLO RESERVOIR

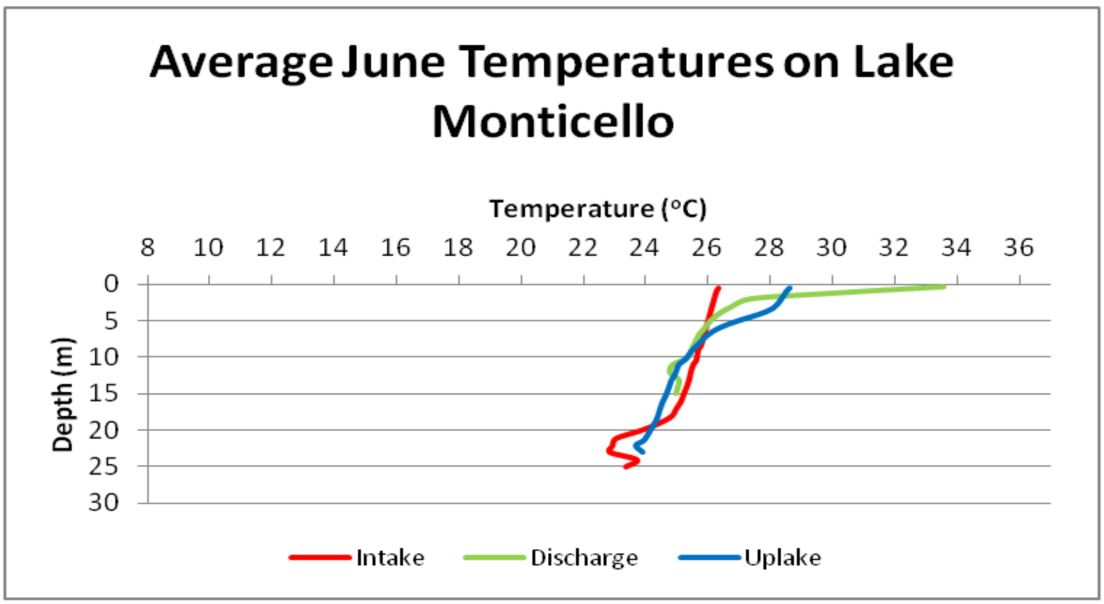


FIGURE 3-66 AVERAGE TEMPERATURE FOR JUNE ON MONTICELLO RESERVOIR

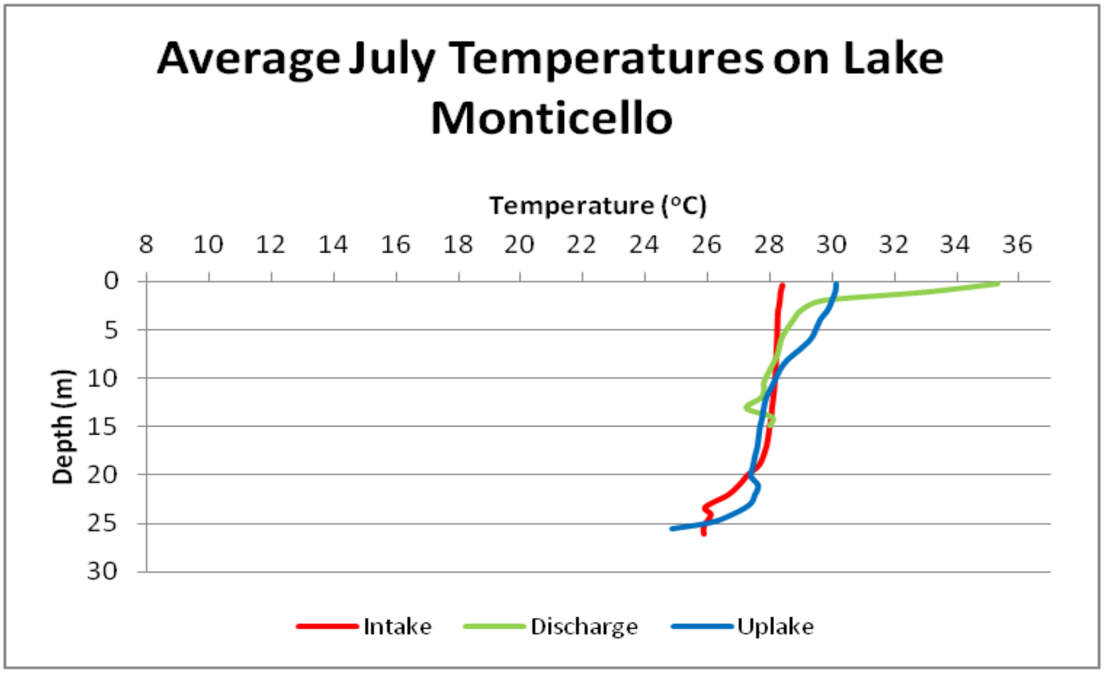


FIGURE 3-67 AVERAGE TEMPERATURE FOR JULY ON MONTICELLO RESERVOIR

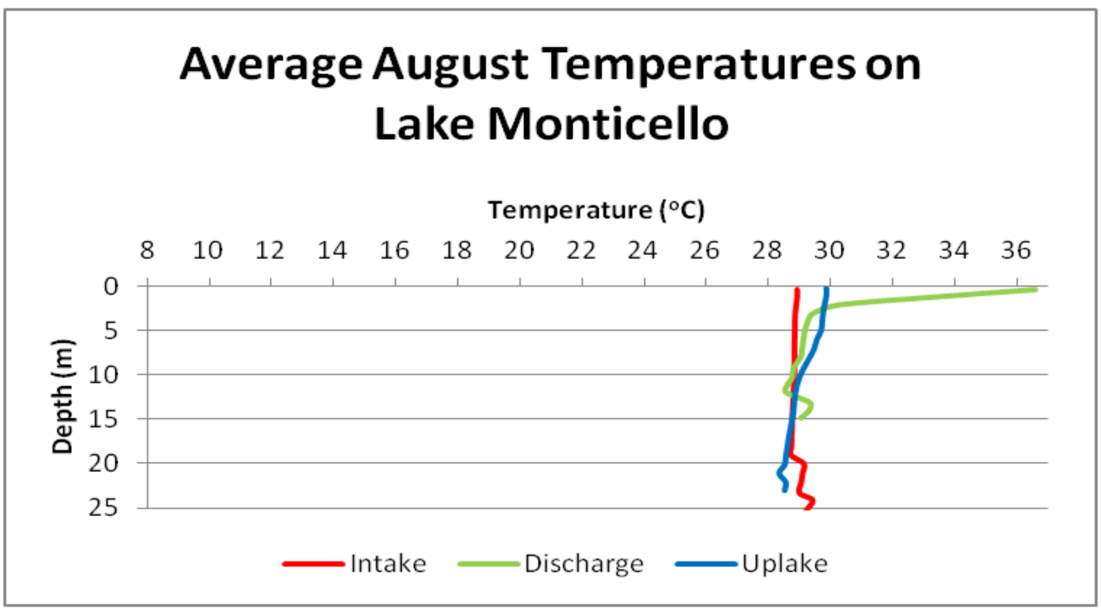


FIGURE 3-68 AVERAGE TEMPERATURE FOR AUGUST ON MONTICELLO RESERVOIR

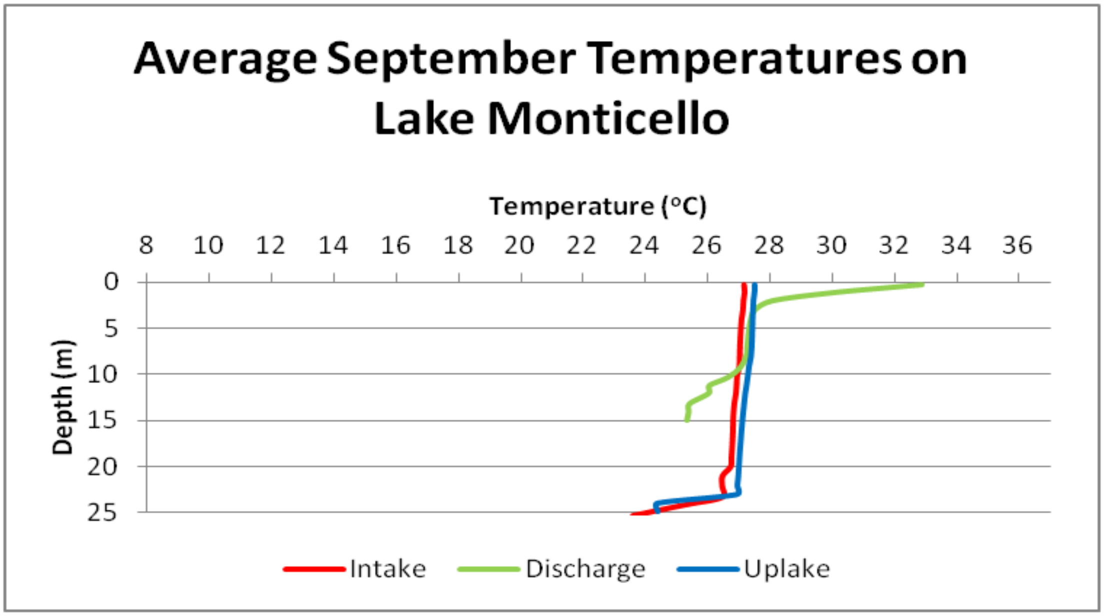


FIGURE 3-69 AVERAGE TEMPERATURE FOR SEPTEMBER ON MONTICELLO RESERVOIR

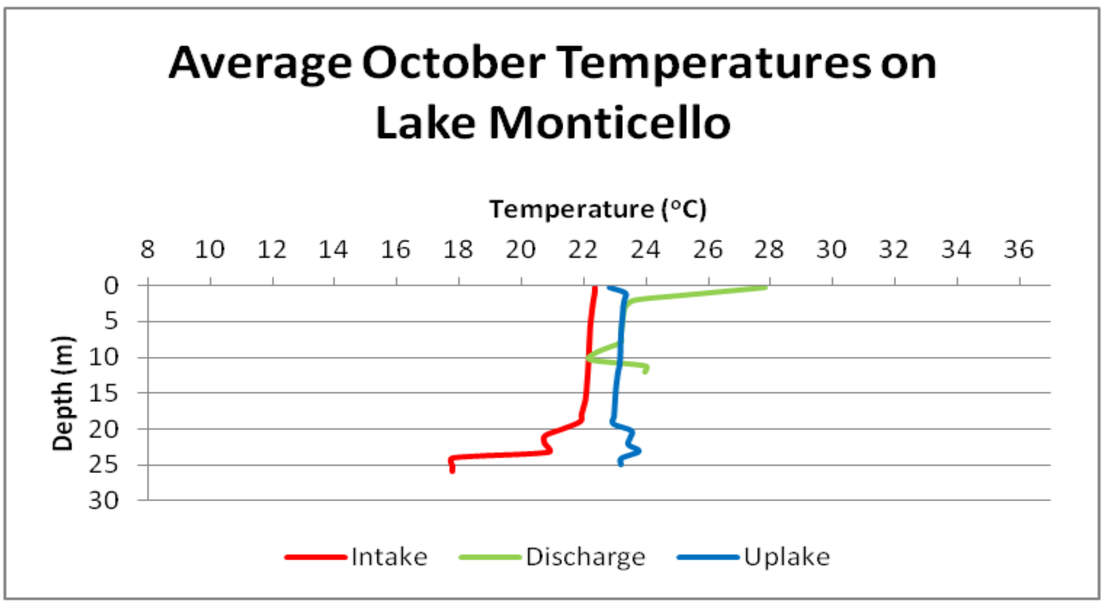


FIGURE 3-70 AVERAGE TEMPERATURE FOR OCTOBER ON MONTICELLO RESERVOIR

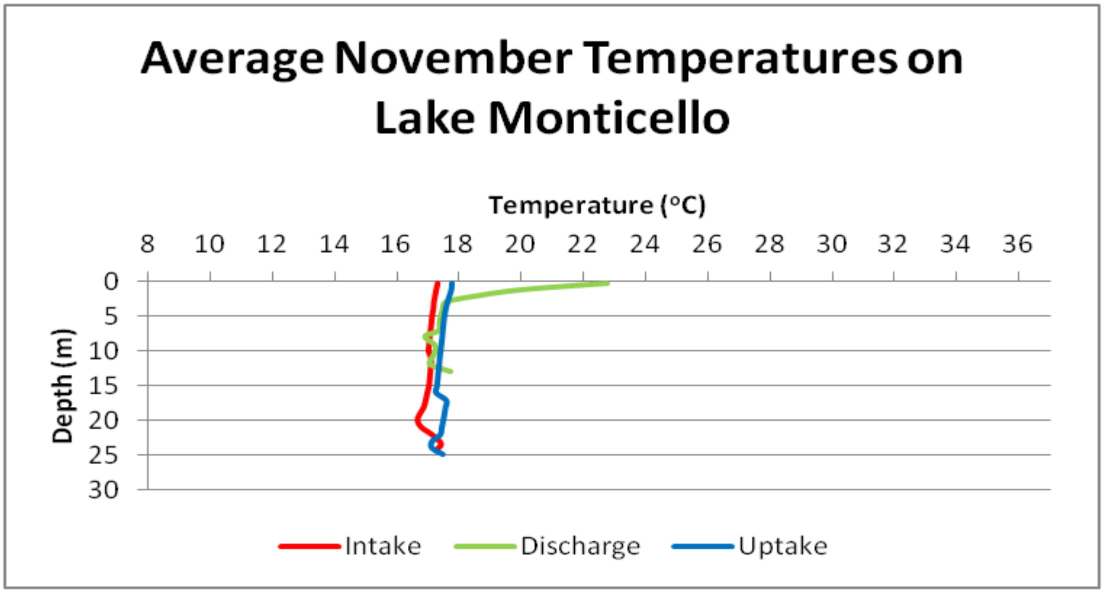


FIGURE 3-71 AVERAGE TEMPERATURE FOR NOVEMBER ON MONTICELLO RESERVOIR

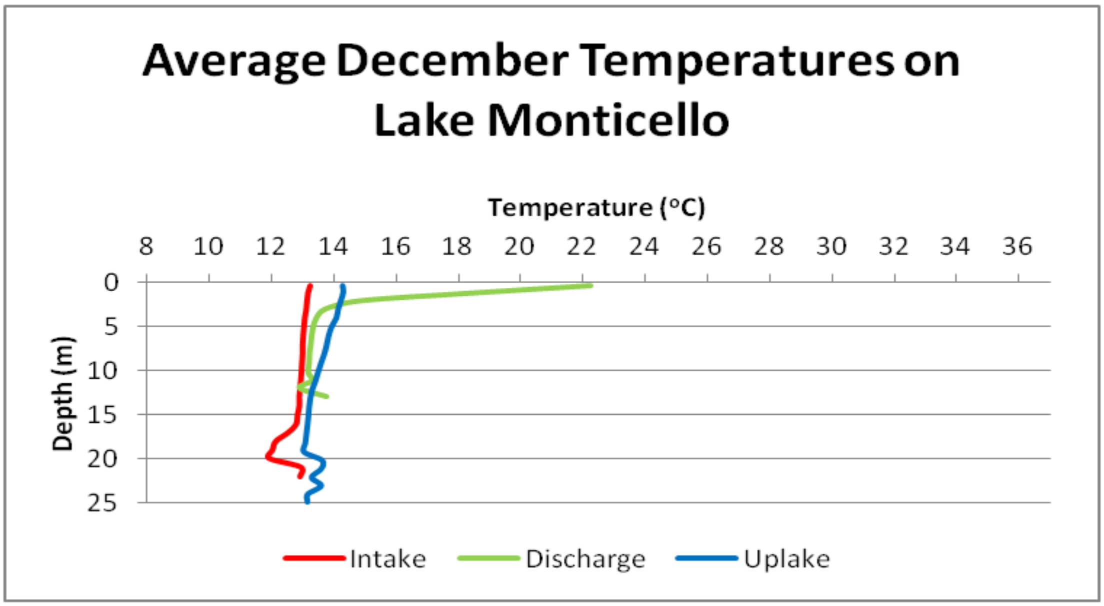


FIGURE 3-72 AVERAGE TEMPERATURE FOR DECEMBER ON MONTICELLO RESERVOIR

3.2.1.2 DISSOLVED OXYGEN

Dissolved oxygen values depicted in the graphs below are an average of ten years of monthly readings collected by SCANA personnel, beginning in January of 2003 to December 2012. The data corresponding to the "intake" refers to that collected at the monitoring site located in the channel near the circulating water intake for the VCSNS. The data corresponding to the "discharge" refers to that collected at the monitoring site located just outside the northern end of the circulating water discharge canal for VCSNS. The data corresponding to the "uplake" refers to that collected at the monitoring site located near the northern end of the reservoir.

The dissolved oxygen values at Monticello Reservoir typically range from 5 mg/L to 8 mg/L in the summer months up to 13 mg/L to 15 mg/L in the winter months, which is to be expected with the fluctuations in water temperatures. Dissolved oxygen levels at the uplake site have dropped to below 5 mg/L at the deepest depths of the reservoir, on several occasions during the summer months. These low DO values can be attributed to the depth of the reservoir, along with the fact that this particular area of the reservoir is far away from any turbulence in the water due to the intake and discharge activities of the VCSNS.

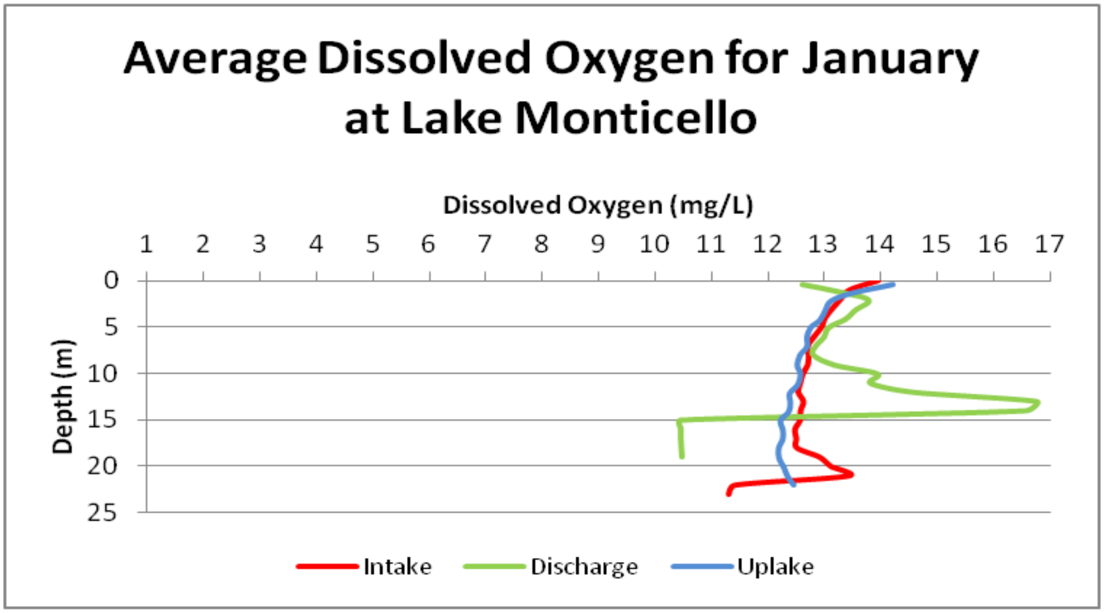


FIGURE 3-73 AVERAGE DISSOLVED OXYGEN FOR JANUARY ON MONTICELLO RESERVOIR

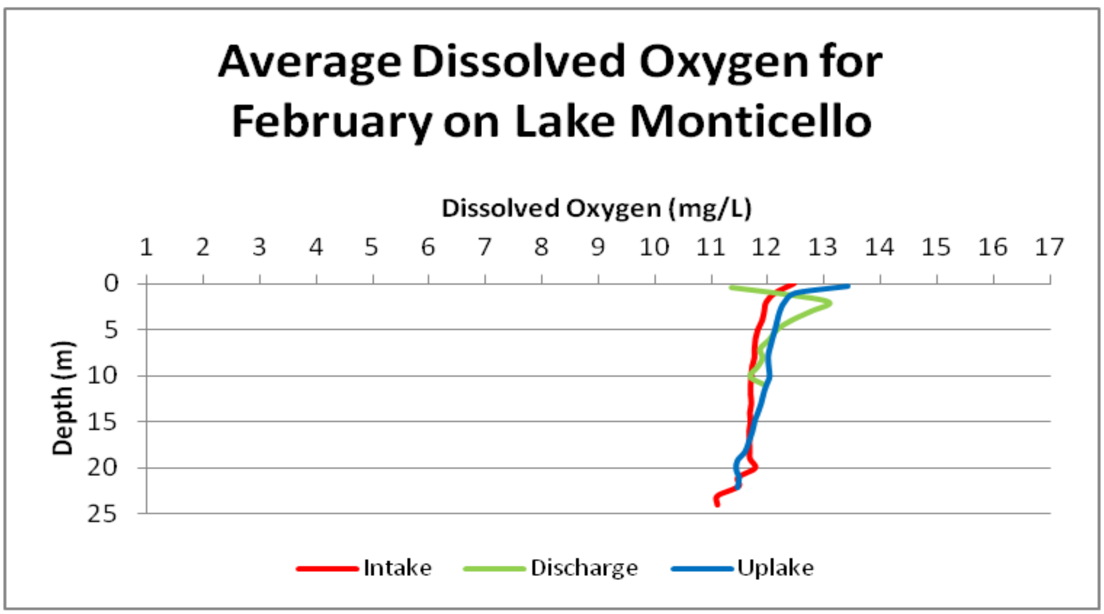


FIGURE 3-74 AVERAGE DISSOLVED OXYGEN FOR FEBRUARY ON MONTICELLO RESERVOIR

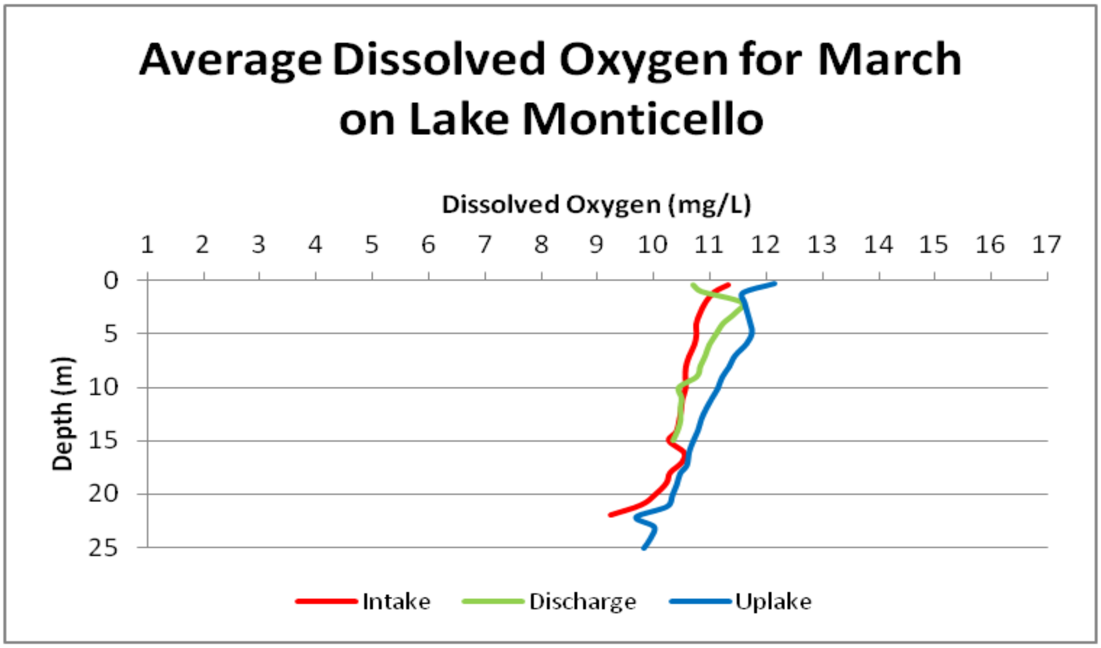


FIGURE 3-75 AVERAGE DISSOLVED OXYGEN FOR MARCH ON MONTICELLO RESERVOIR

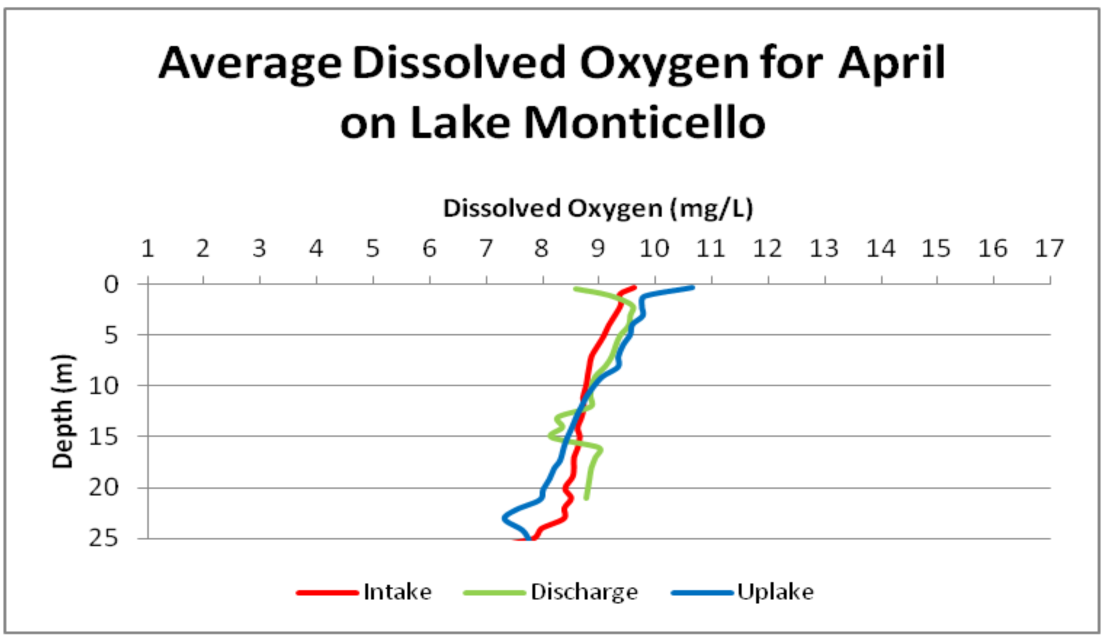


FIGURE 3-76 AVERAGE DISSOLVED OXYGEN FOR APRIL ON MONTICELLO RESERVOIR

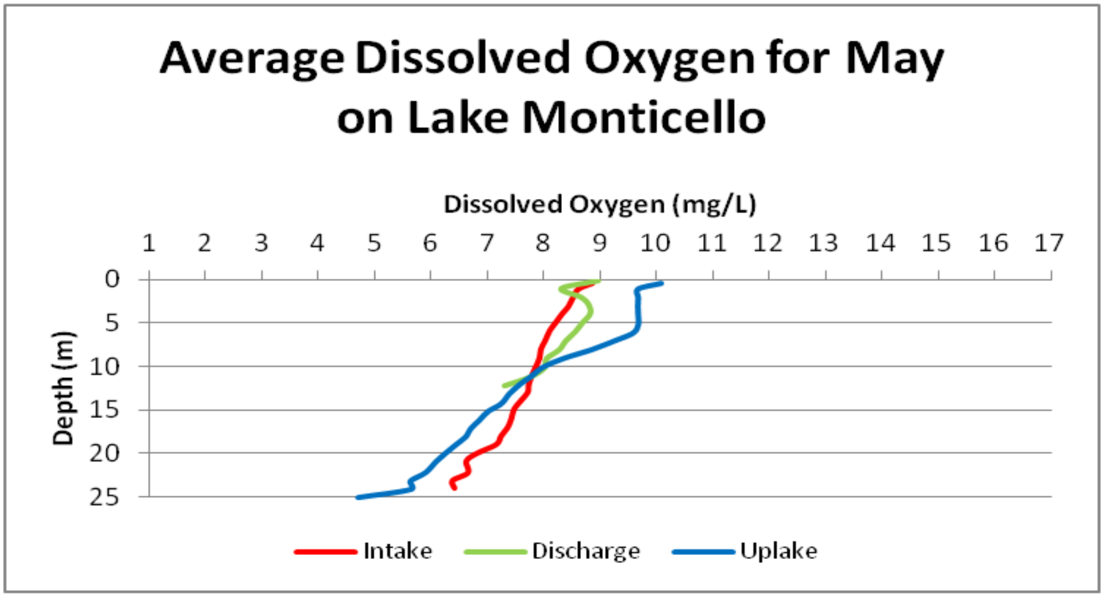


FIGURE 3-77 AVERAGE DISSOLVED OXYGEN FOR MAY ON MONTICELLO RESERVOIR

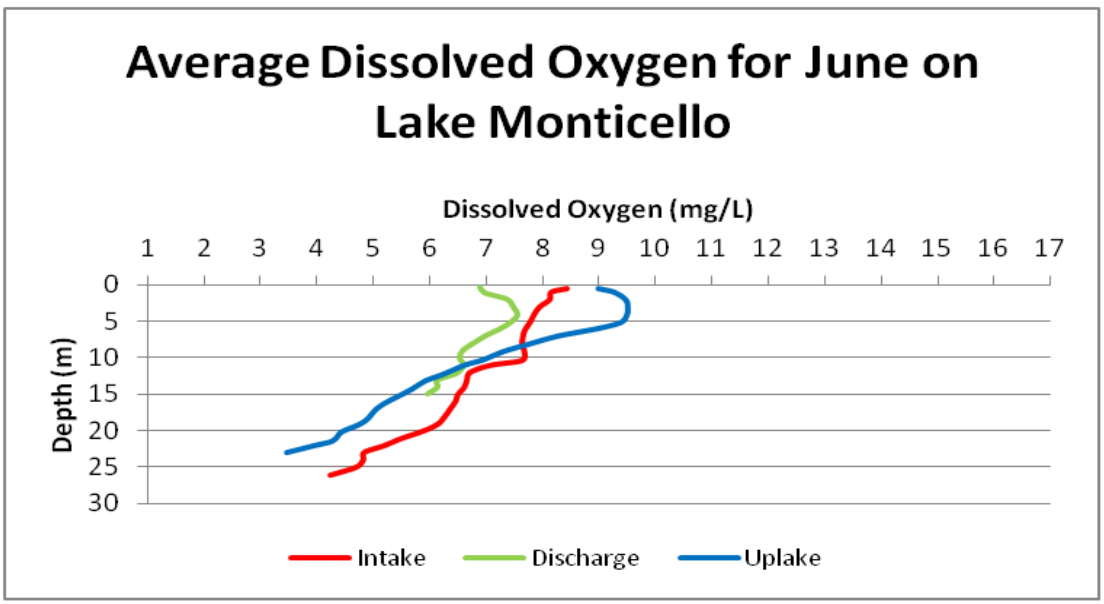


FIGURE 3-78 AVERAGE DISSOLVED OXYGEN FOR JUNE ON MONTICELLO RESERVOIR

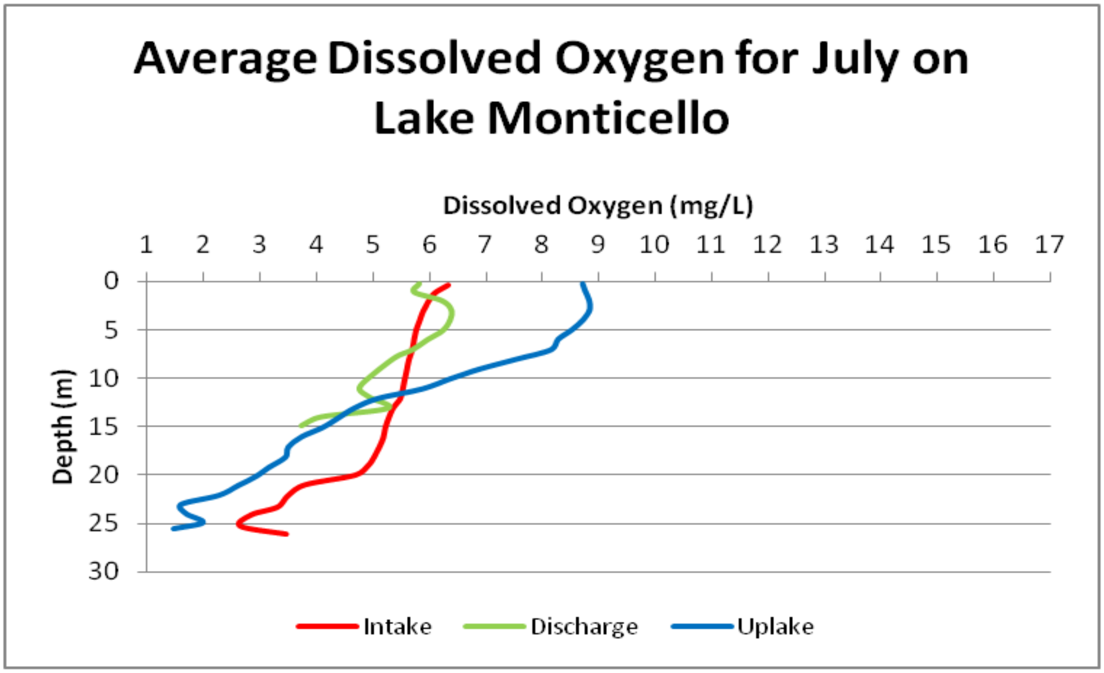


FIGURE 3-79 AVERAGE DISSOLVED OXYGEN FOR JULY ON MONTICELLO RESERVOIR

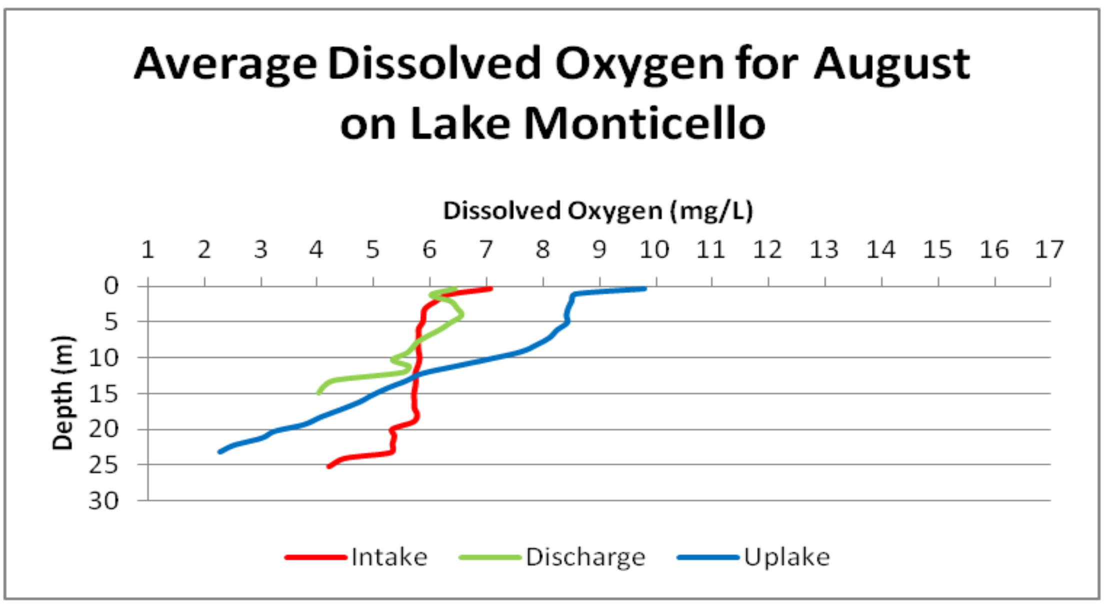


FIGURE 3-80 AVERAGE DISSOLVED OXYGEN FOR AUGUST ON MONTICELLO RESERVOIR

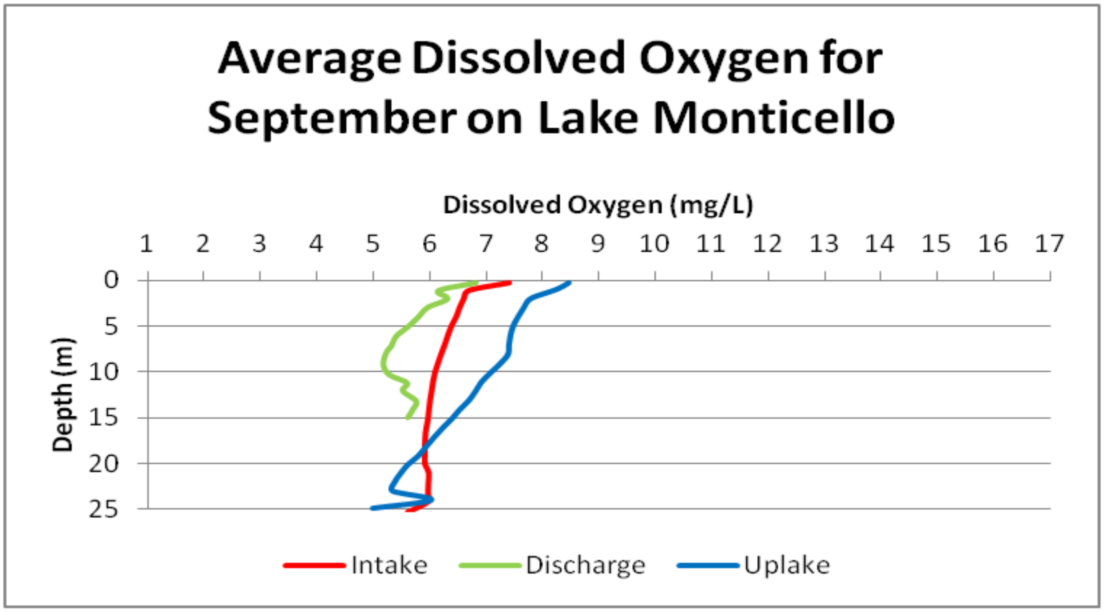


FIGURE 3-81 AVERAGE DISSOLVED OXYGEN FOR SEPTEMBER ON MONTICELLO RESERVOIR

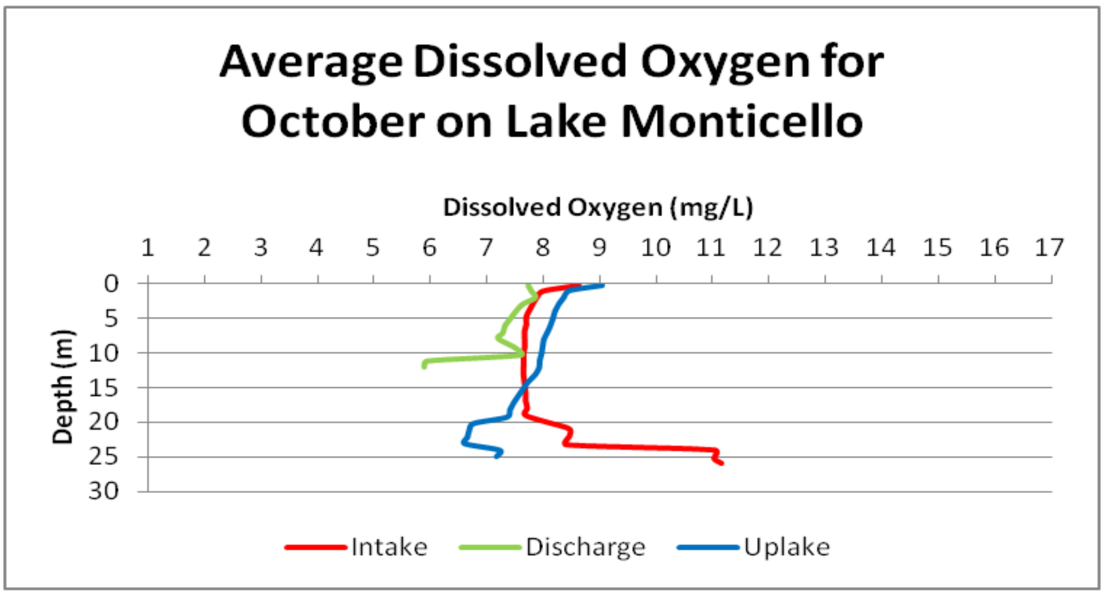


FIGURE 3-82 AVERAGE DISSOLVED OXYGEN FOR OCTOBER ON MONTICELLO RESERVOIR

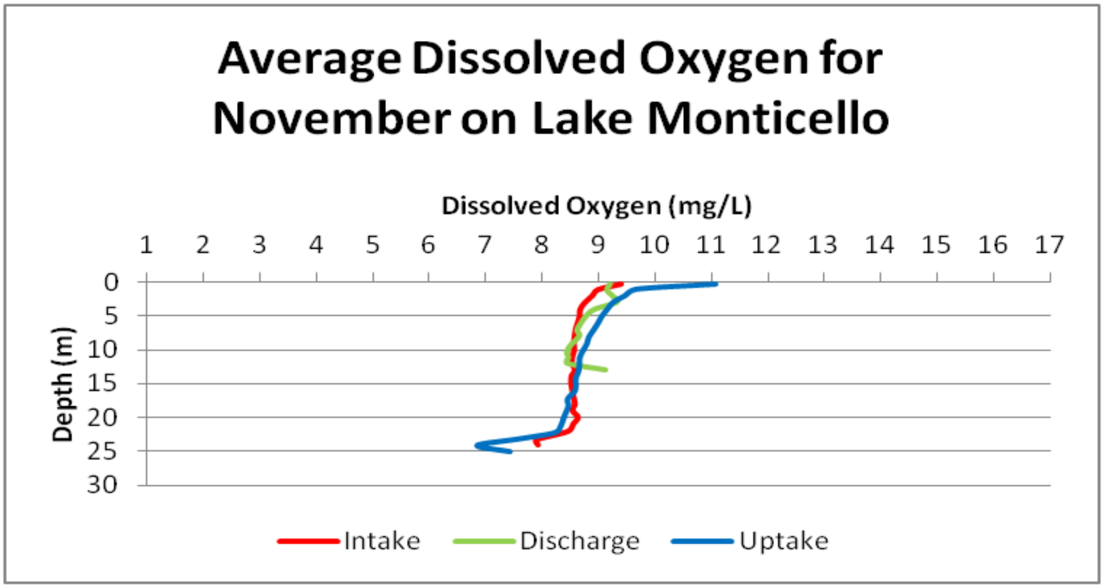


FIGURE 3-83 **AVERAGE DISSOLVED OXYGEN FOR NOVEMBER ON MONTICELLO RESERVOIR**

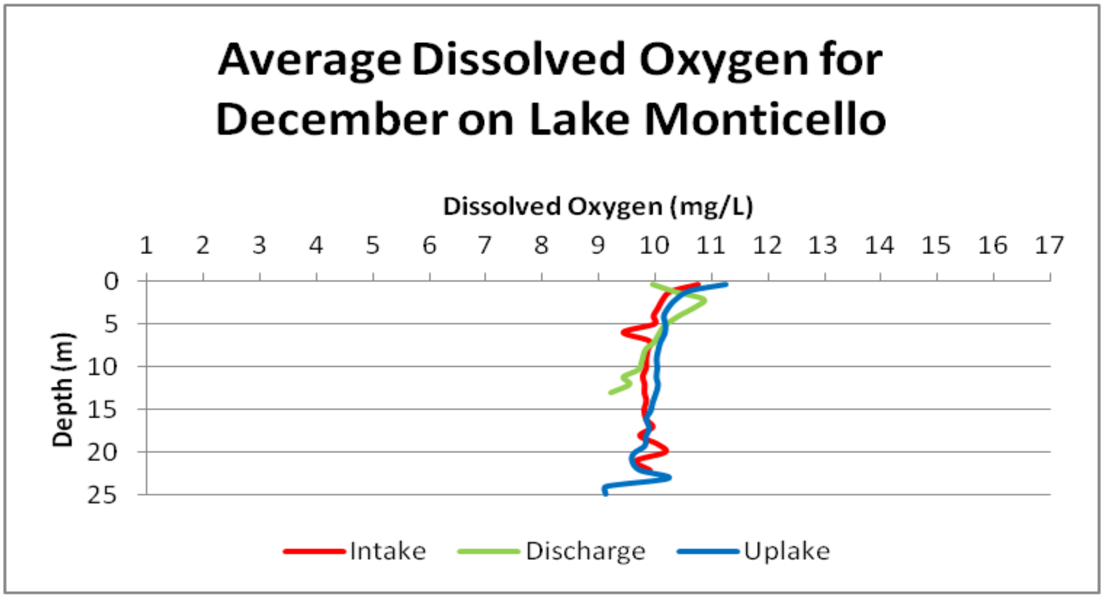


FIGURE 3-84 **AVERAGE DISSOLVED OXYGEN FOR DECEMBER ON MONTICELLO RESERVOIR**

3.2.1.3 SPECIFIC CONDUCTIVITY

Specific conductivity values depicted in the graphs below are an average of ten years of monthly readings collected by SCANA personnel, beginning in January of 2003 to December 2012. The data corresponding to the "intake" refers to that collected at the monitoring site located in the channel near the circulating water intake for the VCSNS. The data corresponding to the "discharge" refers to that collected at the monitoring site located just outside the northern end of the circulating water discharge canal for VCSNS. The data corresponding to the "uplake" refers to that collected at the monitoring site located near the northern end of the reservoir.

Specific conductivity of Monticello Reservoir typically ranges from 80.0 to 120.0 µS/cm at all monitoring sites, at all depths of the reservoir.

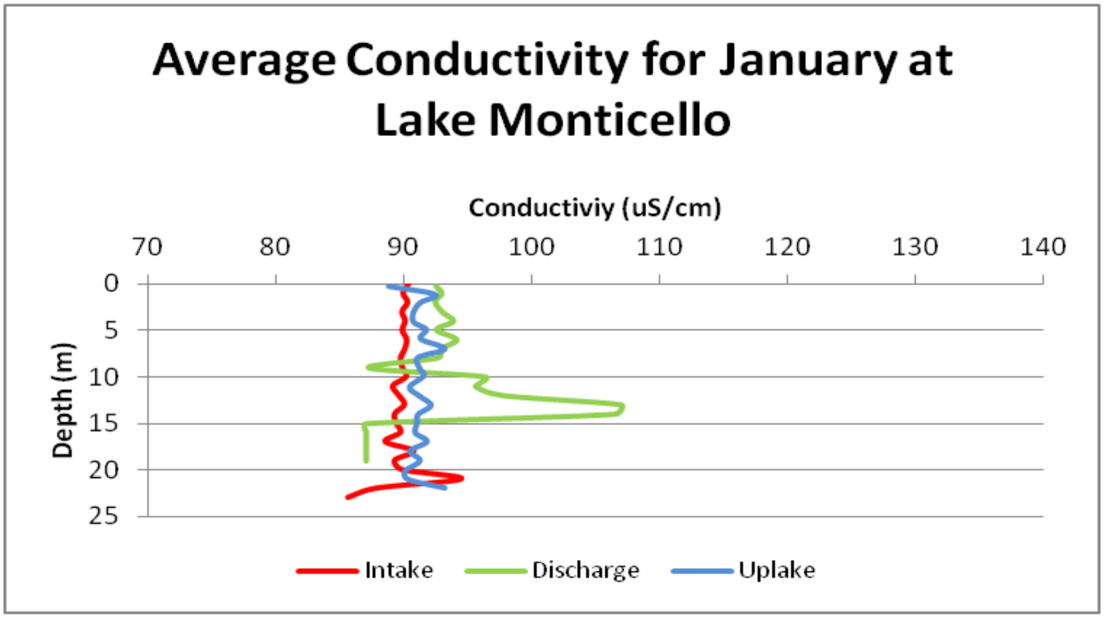


FIGURE 3-85 AVERAGE CONDUCTIVITY FOR JANUARY ON MONTICELLO RESERVOIR

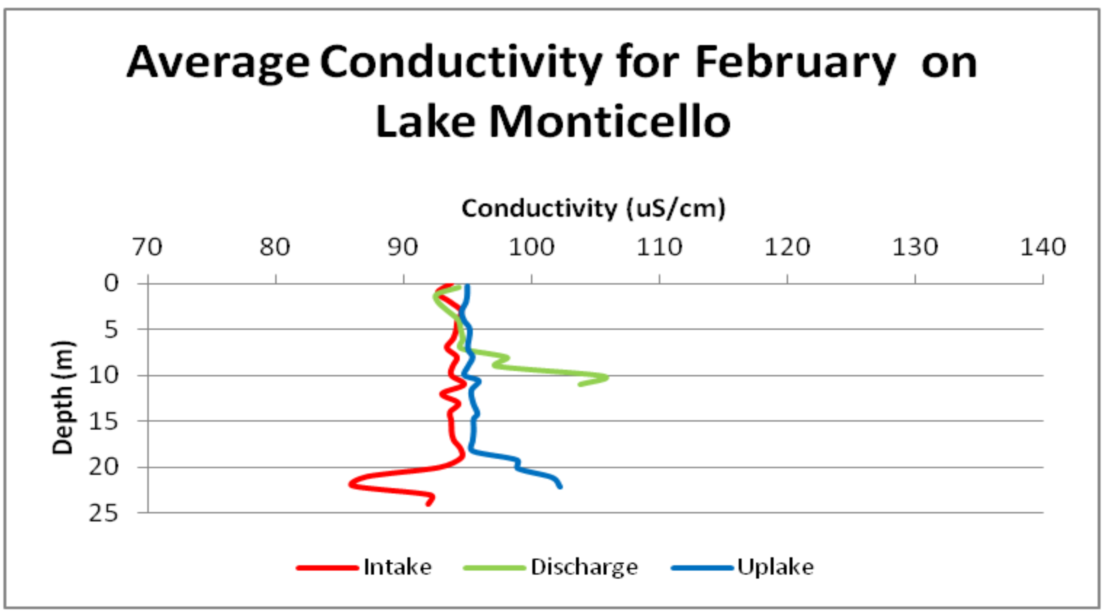


FIGURE 3-86 AVERAGE CONDUCTIVITY FOR FEBRUARY ON MONTICELLO RESERVOIR

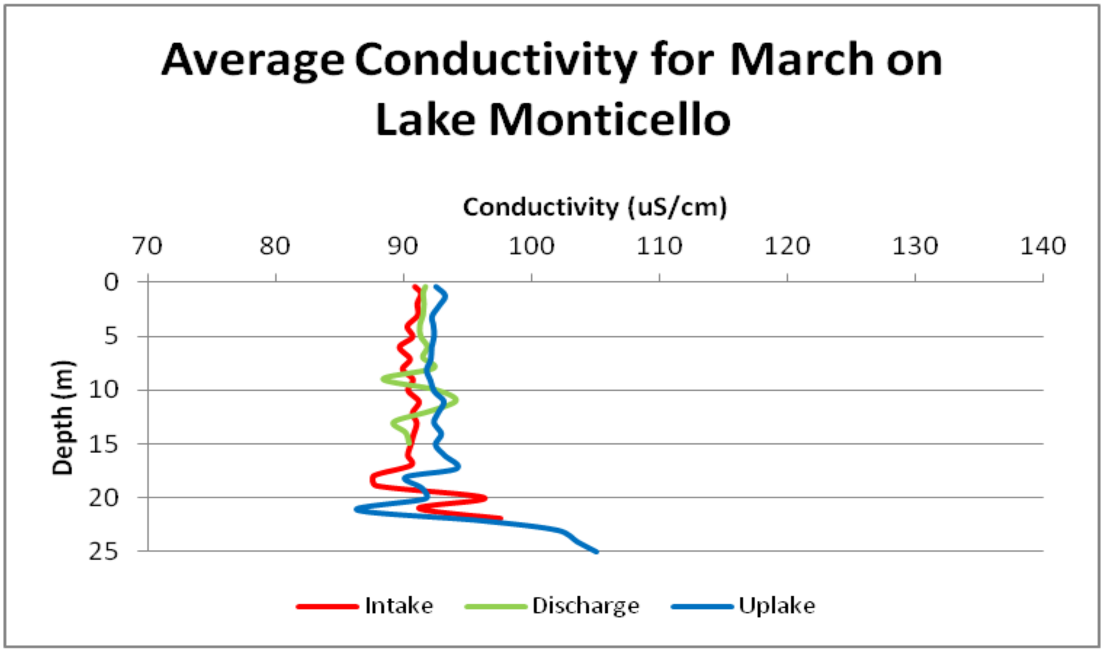


FIGURE 3-87 AVERAGE CONDUCTIVITY FOR MARCH ON MONTICELLO RESERVOIR

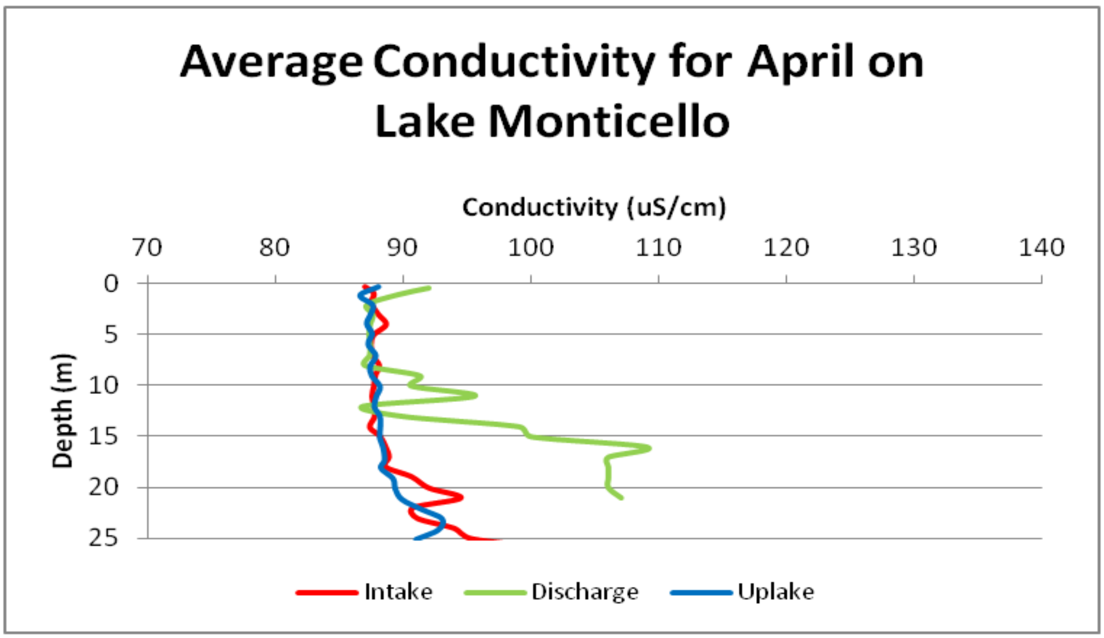


FIGURE 3-88 AVERAGE CONDUCTIVITY FOR APRIL ON MONTICELLO RESERVOIR

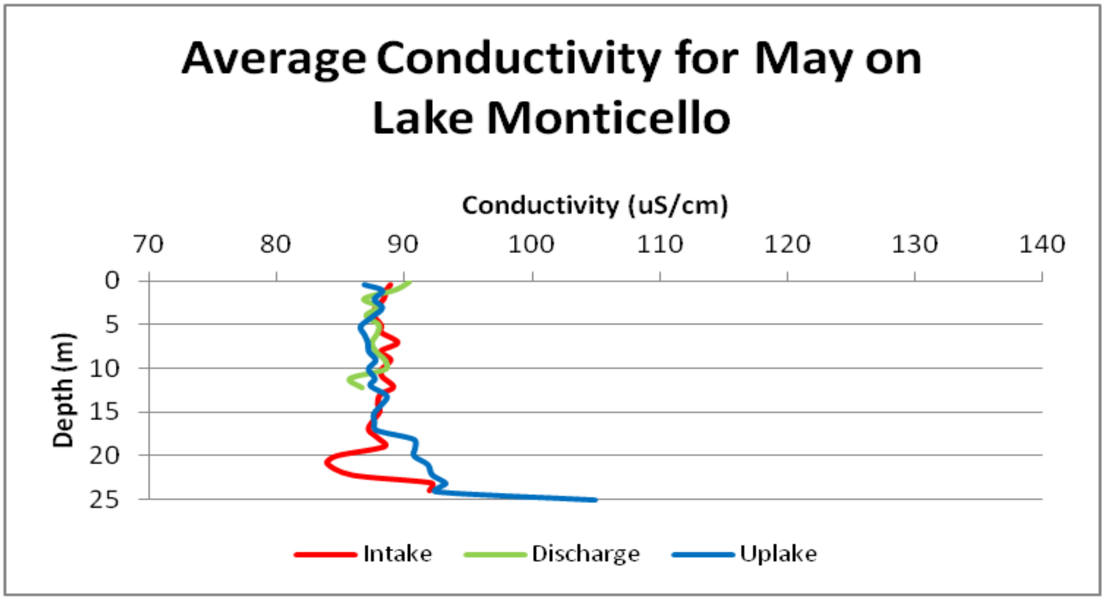


FIGURE 3-89 AVERAGE CONDUCTIVITY FOR MAY ON MONTICELLO RESERVOIR

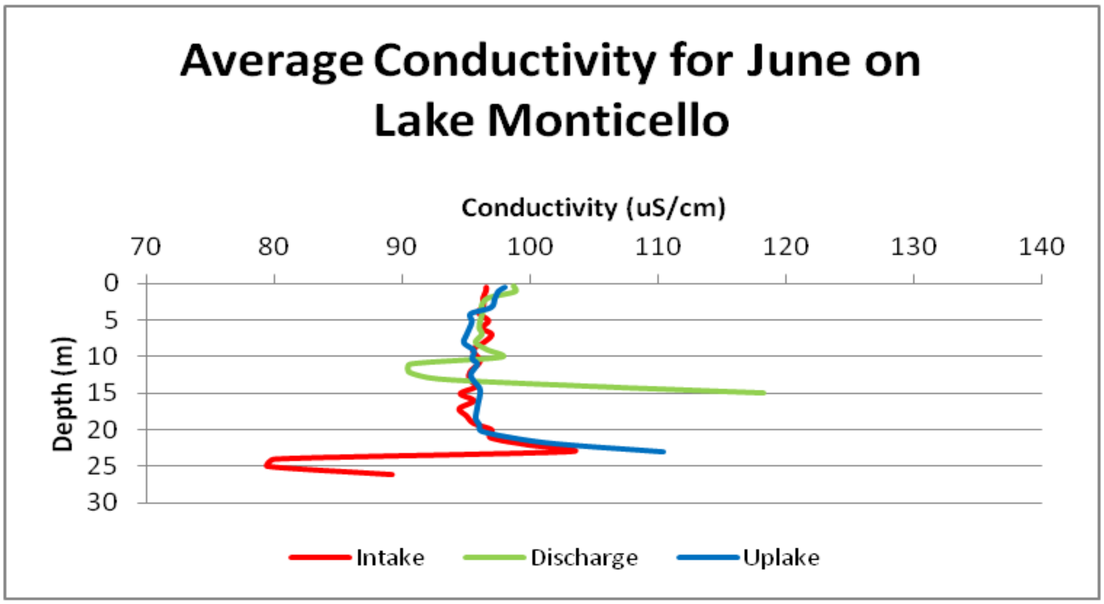


FIGURE 3-90 AVERAGE CONDUCTIVITY FOR JUNE ON MONTICELLO RESERVOIR

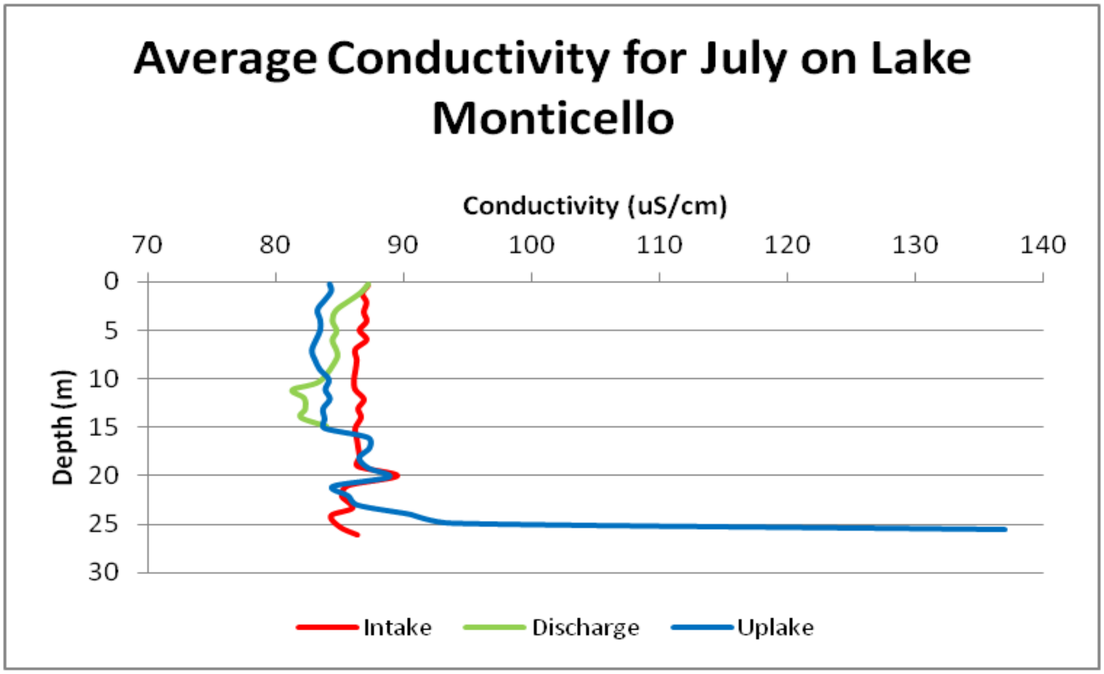


FIGURE 3-91 AVERAGE CONDUCTIVITY FOR JULY ON MONTICELLO RESERVOIR

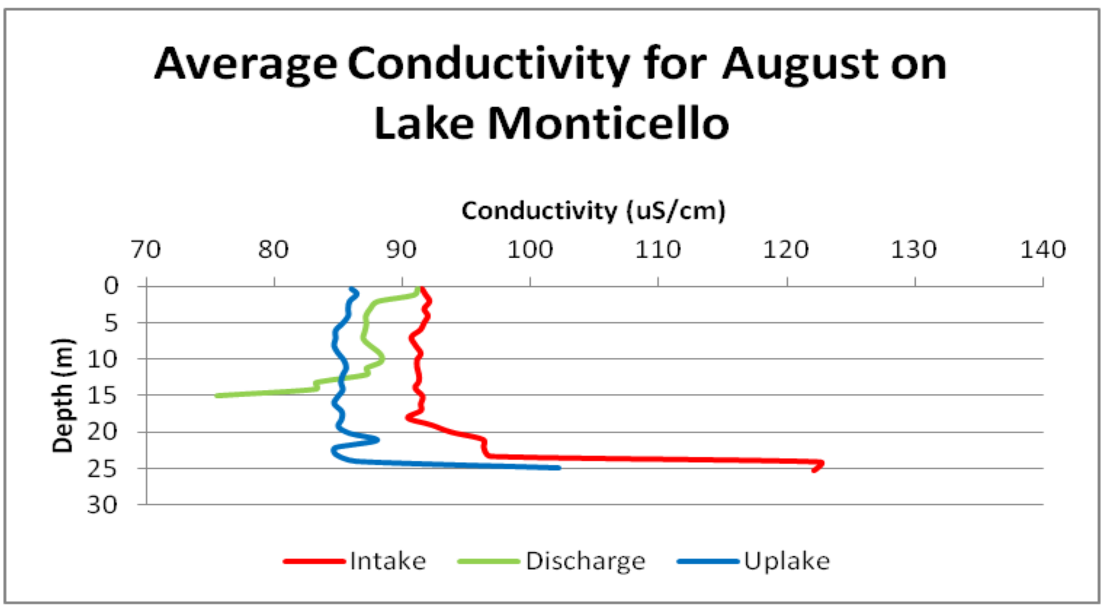


FIGURE 3-92 AVERAGE CONDUCTIVITY FOR AUGUST ON MONTICELLO RESERVOIR

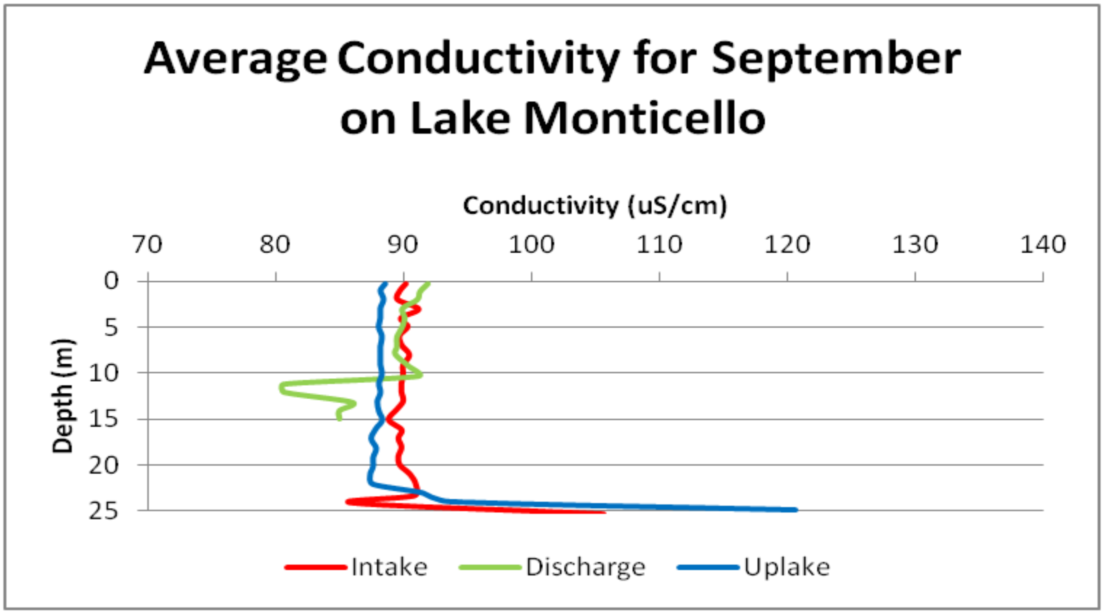


FIGURE 3-93 AVERAGE CONDUCTIVITY FOR SEPTEMBER ON MONTICELLO RESERVOIR

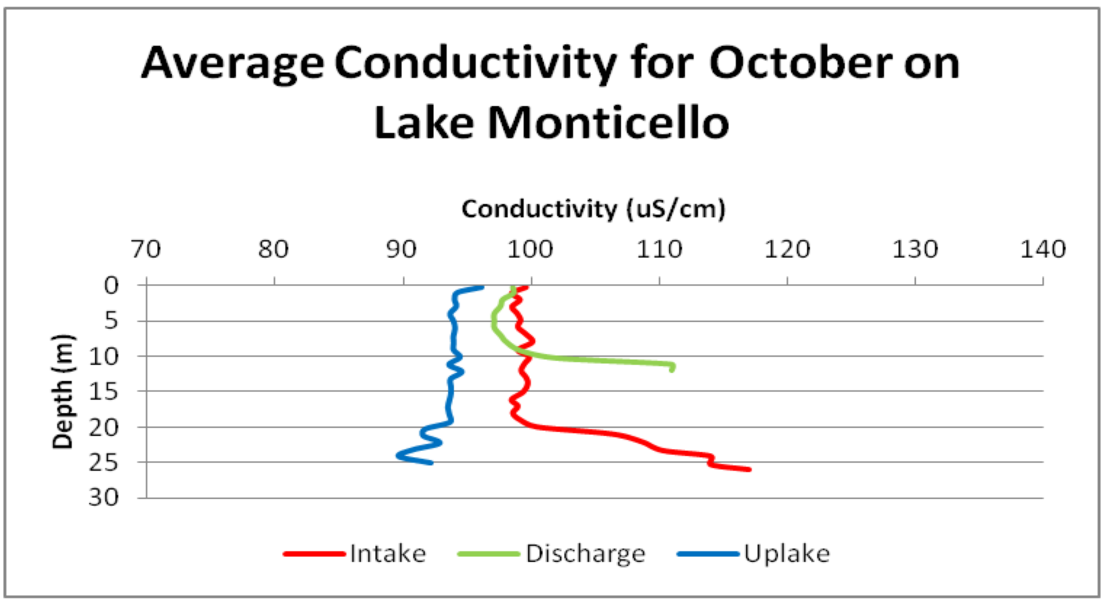


FIGURE 3-94 AVERAGE CONDUCTIVITY FOR OCTOBER ON MONTICELLO RESERVOIR

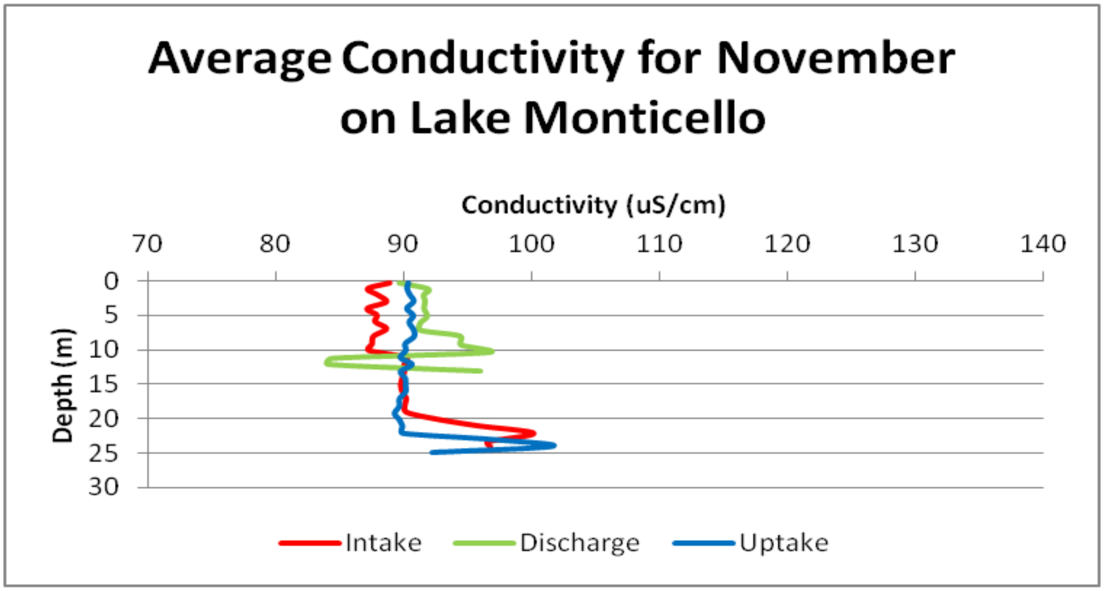


FIGURE 3-95 AVERAGE CONDUCTIVITY FOR NOVEMBER ON MONTICELLO RESERVOIR

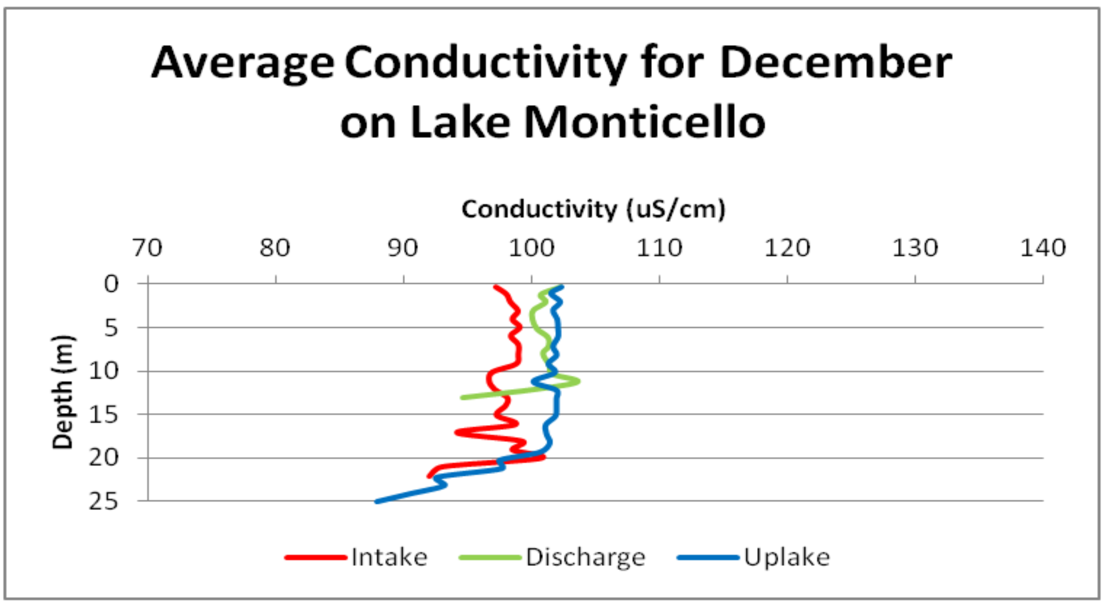


FIGURE 3-96 AVERAGE CONDUCTIVITY FOR DECEMBER ON MONTICELLO RESERVOIR

3.2.1.4 pH

pH values depicted in the graphs below are an average of ten years of monthly readings collected by SCANA personnel, beginning in January of 2003 to December 2012. The data corresponding to the “intake” refers to that collected at the monitoring site located in the channel near the circulating water intake for the VCSNS. The data corresponding to the “discharge” refers to that collected at the monitoring site located just outside the northern end of the circulating water discharge canal for VCSNS. The data corresponding to the “uplake” refers to that collected at the monitoring site located near the northern end of the reservoir.

The pH values at the monitoring sites near the intake and discharge of the VCSNS are consistently around 7.5, with the full range extending from 6.8 to 8.0. The pH at the uplake location is slightly more alkaline, with pH values being just a bit higher than those on the southern end of Monticello Reservoir. Generally, throughout the lake, the pH decreases as the depth of the reservoir increases.

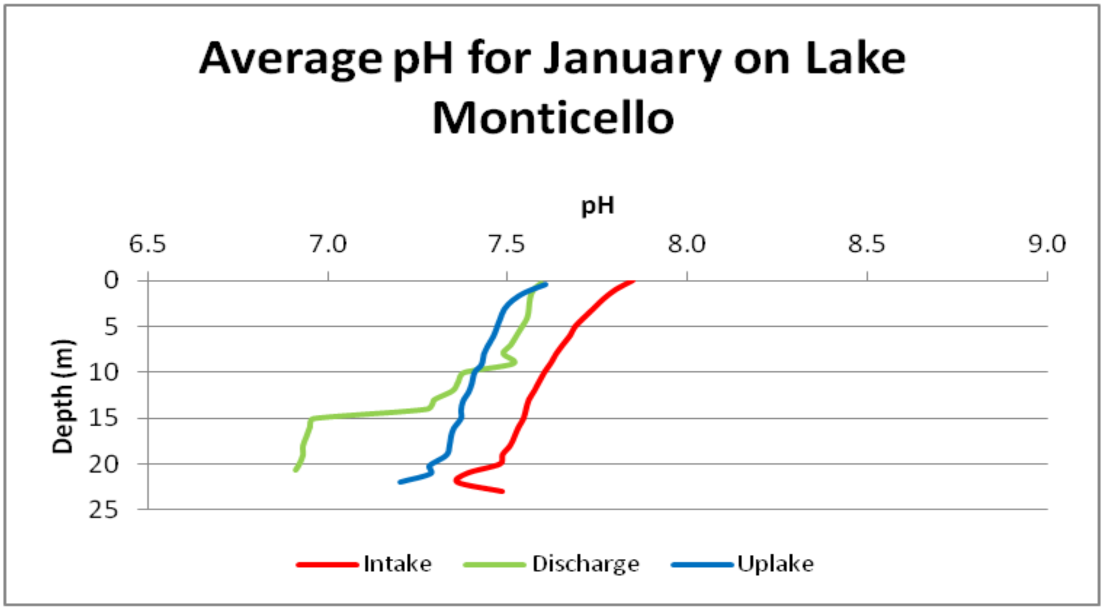


FIGURE 3-97 AVERAGE PH FOR JANUARY ON MONTICELLO RESERVOIR

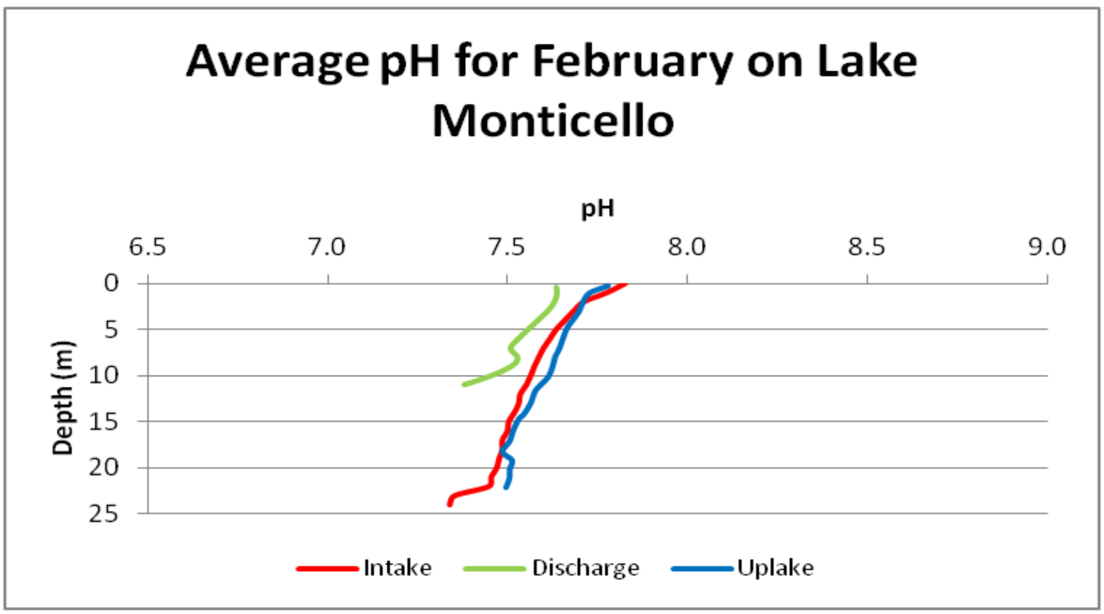


FIGURE 3-98 AVERAGE PH FOR FEBRUARY ON MONTICELLO RESERVOIR

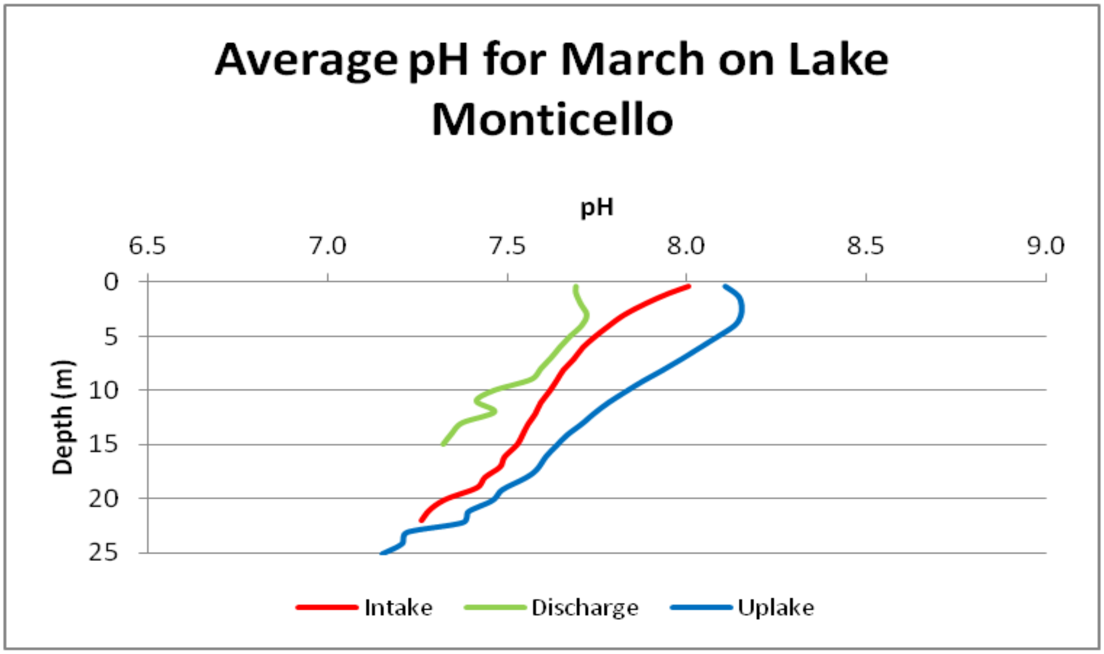


FIGURE 3-99 AVERAGE PH FOR MARCH ON MONTICELLO RESERVOIR

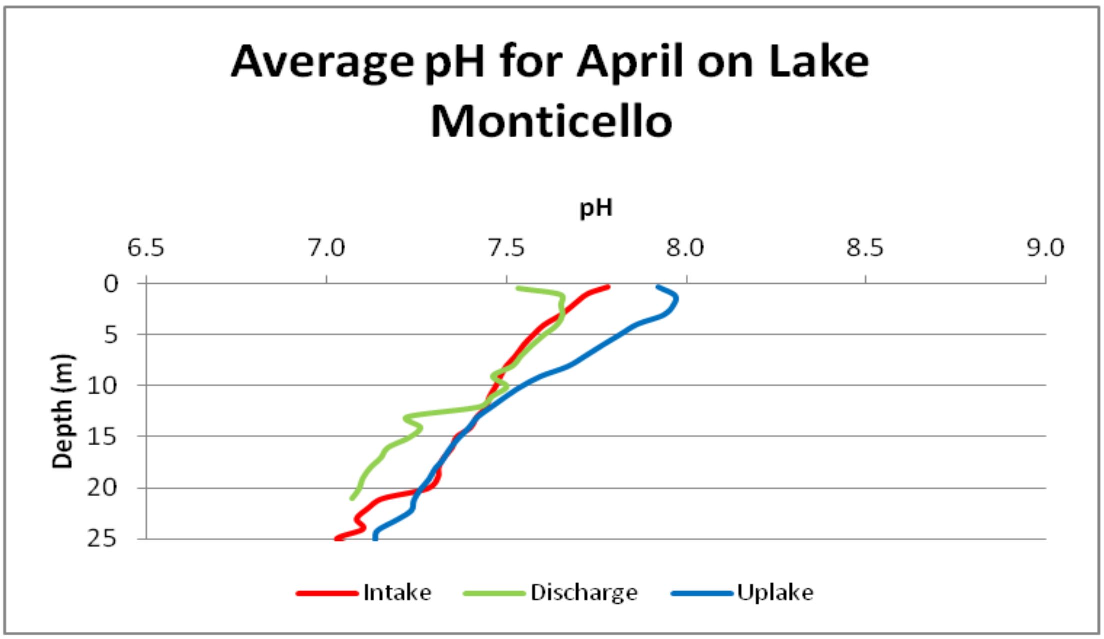


FIGURE 3-100 AVERAGE PH FOR APRIL ON MONTICELLO RESERVOIR

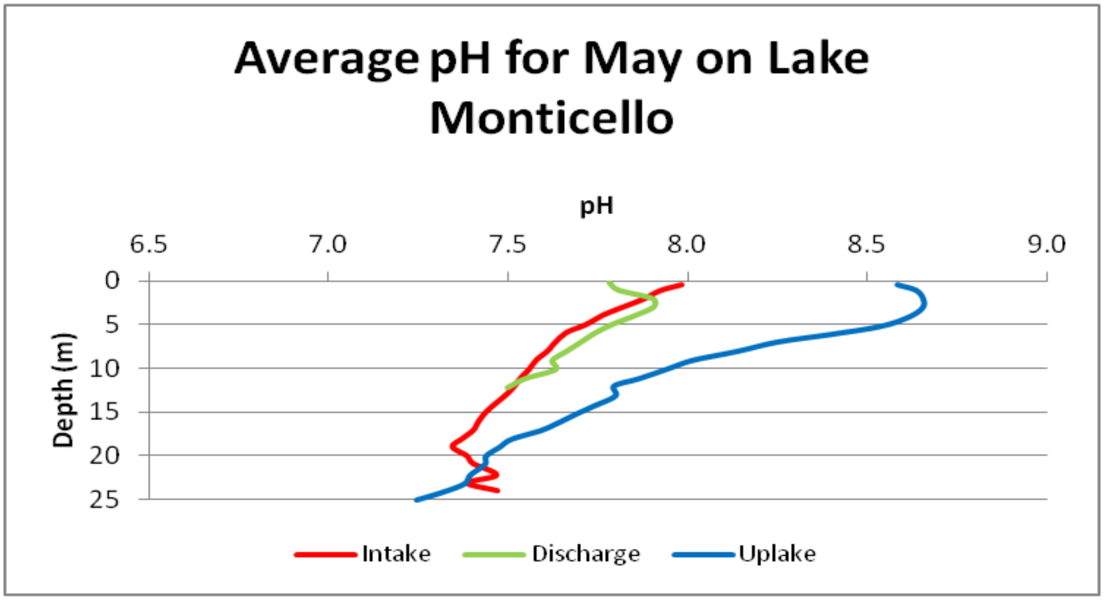


FIGURE 3-101 AVERAGE PH FOR MAY ON MONTICELLO RESERVOIR

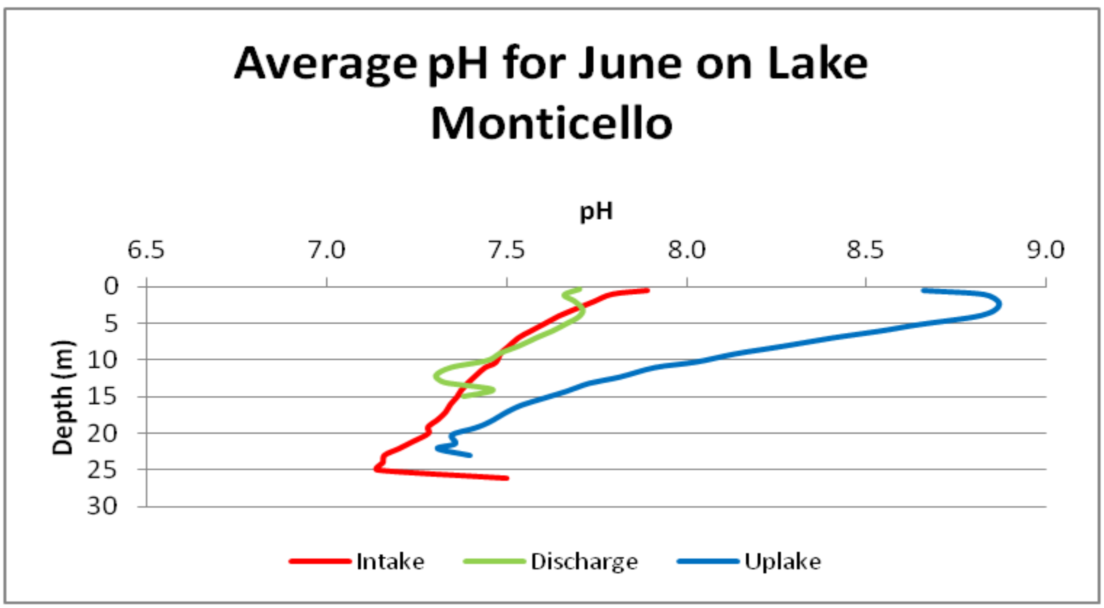


FIGURE 3-102 AVERAGE PH FOR JUNE ON MONTICELLO RESERVOIR

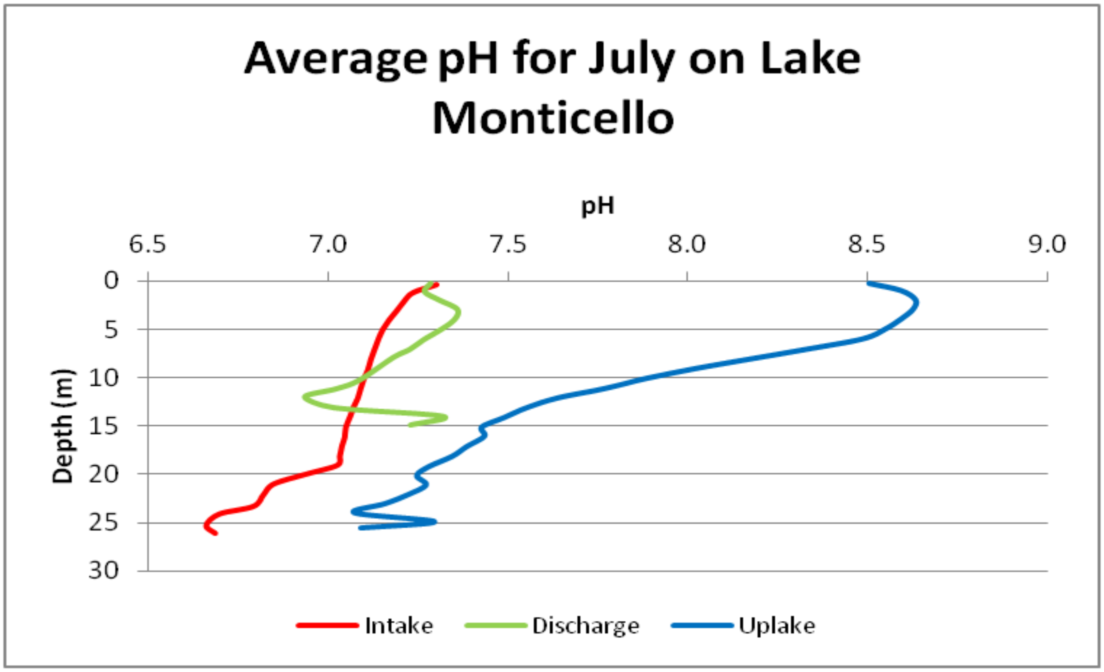


FIGURE 3-103 AVERAGE PH FOR JULY ON MONTICELLO RESERVOIR

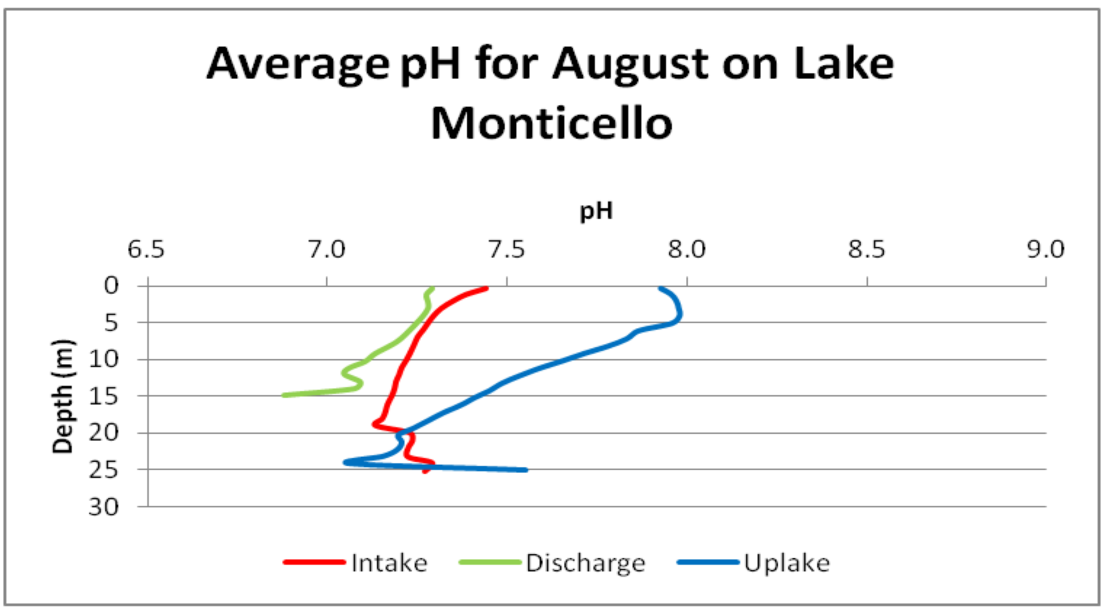


FIGURE 3-104 AVERAGE PH FOR AUGUST ON MONTICELLO RESERVOIR

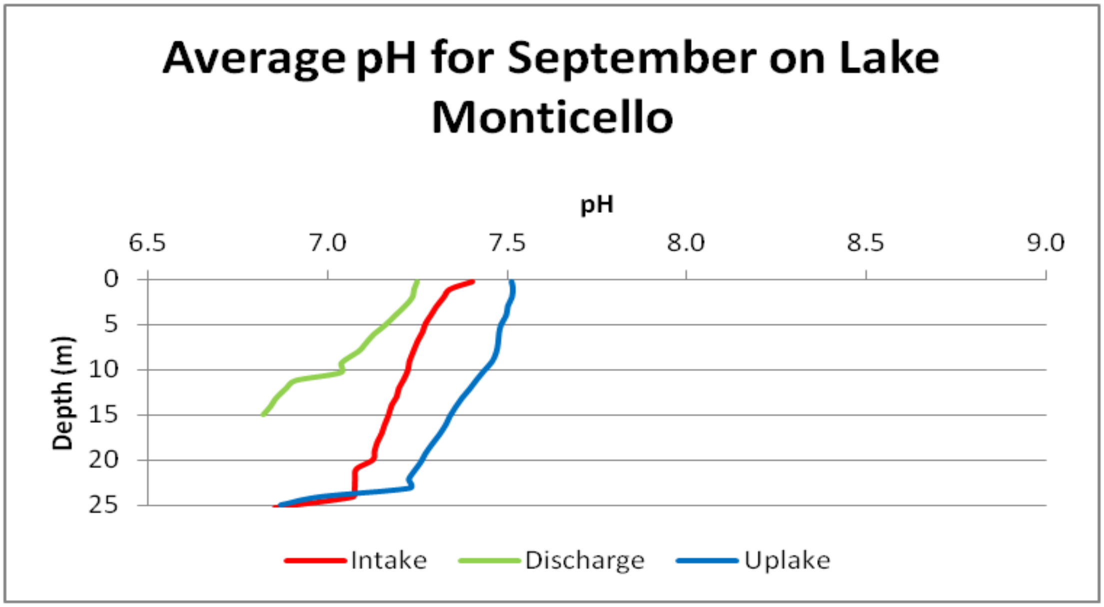


FIGURE 3-105 AVERAGE PH FOR SEPTEMBER ON MONTICELLO RESERVOIR

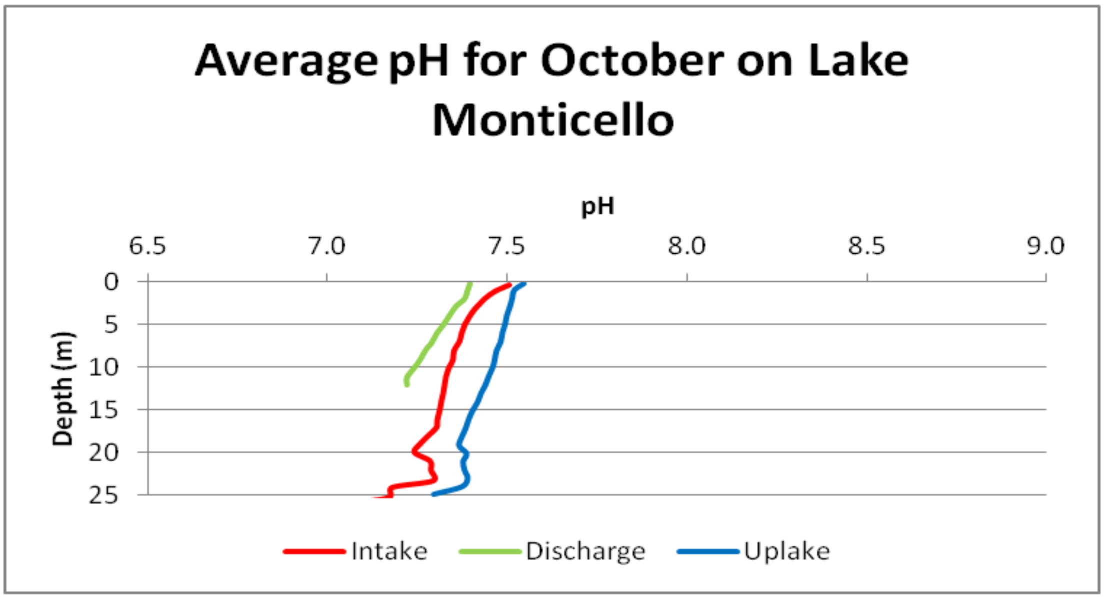


FIGURE 3-106 AVERAGE PH FOR OCTOBER ON MONTICELLO RESERVOIR

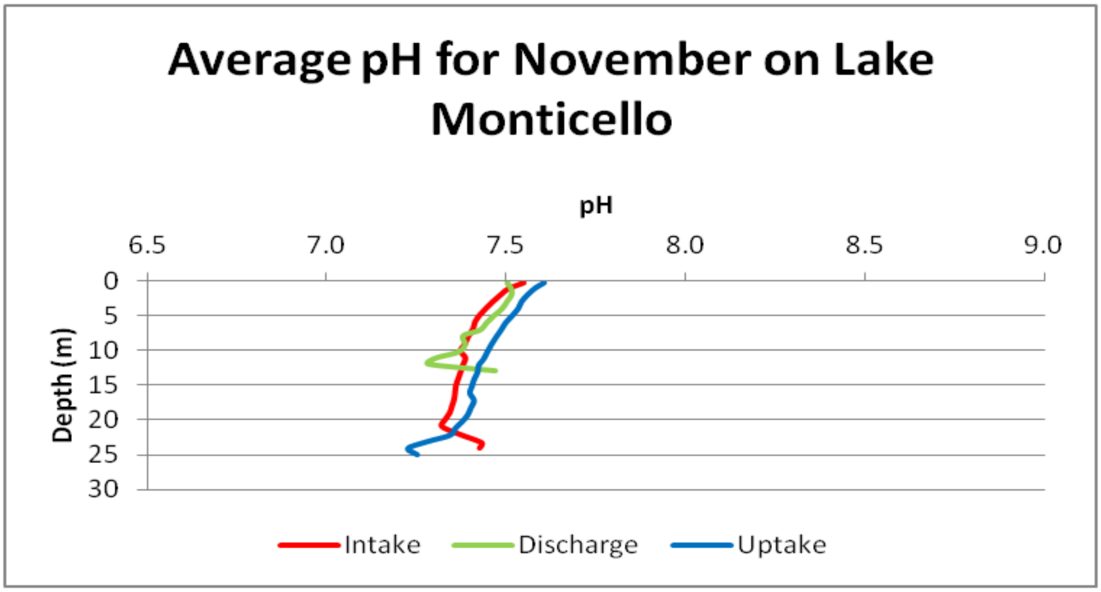


FIGURE 3-107 AVERAGE PH FOR NOVEMBER ON MONTICELLO RESERVOIR

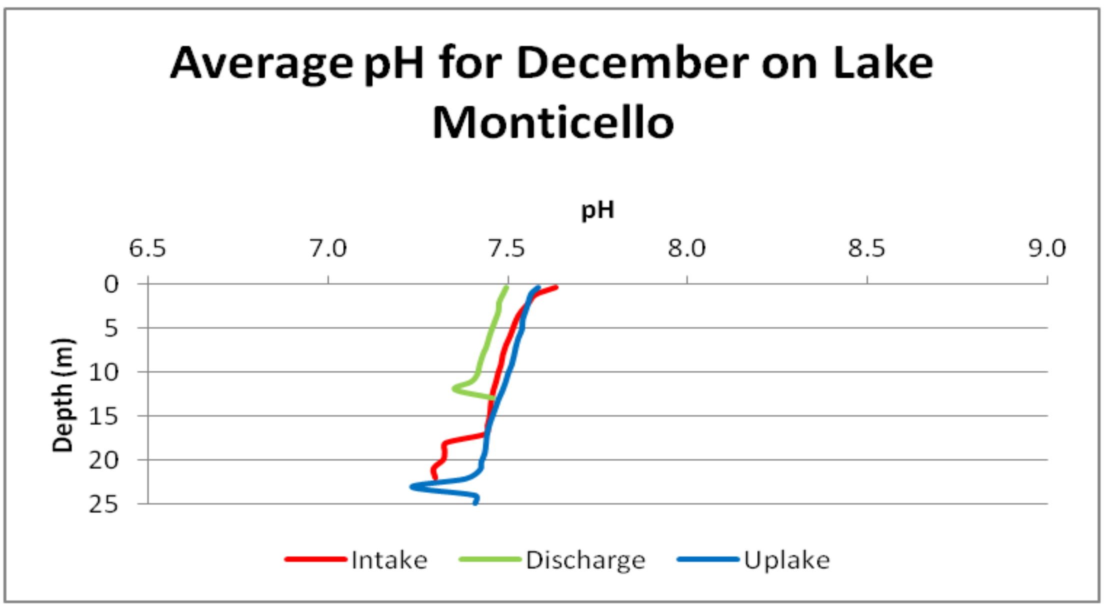


FIGURE 3-108 AVERAGE PH FOR DECEMBER ON MONTICELLO RESERVOIR

3.2.1.5 SUMMARY

Vertical profile data was collected on a monthly basis at three sites in Monticello Reservoir, beginning in 2003. Table 3-11 displays the maximum, minimum and mean temperature, DO, conductivity, and pH values on Monticello Reservoir for each collection year at each collection location. The data presented below was collected at a depth of 2 meters.

TABLE 3-11 SUMMARY TABLE FOR MONTICELLO RESERVOIR

		INTAKE					DISCHARGE					UPLAKE			
		Temp	SpCond	DO Conc	pH		Temp	SpCond	DO Conc	pH		Temp	SpCond	DO Conc	pH
		C	uS/cm	mg/L			C	uS/cm	mg/L			C	uS/cm	mg/L	
2003	MAX	26.73	126	13.39	8.65		28.77	132	12.96	8.22		29.95	140	13.98	9.31
	MIN	8.62	98	7.13	6.97		11.48	102	7.17	6.96		10.38	102	9.60	7.38
	AVG	18.47	110	9.60	7.54		20.52	113	9.92	7.51		20.30	115	11.41	8.31
2004	MAX	29.01	129	14.28	8.09		29.27	120	14.59	7.96		29.89	129	14.07	9.06
	MIN	6.50	68	4.70	7.02		9.46	67	5.13	6.95		6.76	67	7.53	7.19
	AVG	17.12	100	9.06	7.65		18.22	97	11.19	7.57		18.53	99	11.72	8.11
2005	MAX	28.49	78	12.34	7.80		31.29	96	14.01	7.82		31.52	77	12.79	8.80
	MIN	9.64	63	5.30	6.68		10.46	63	5.28	7.02		10.72	60	7.72	6.91
	AVG	19.92	71	8.32	7.33		21.43	73	8.76	7.41		20.79	69	9.83	7.73
2006	MAX	28.98	101	12.09	8.16		29.51	102	13.08	7.93		30.69	101	12.16	8.97
	MIN	10.88	73	4.84	7.08		10.55	73	5.10	7.12		11.61	68	7.45	7.37
	AVG	19.04	85	8.62	7.52		19.60	84	9.36	7.53		20.26	84	9.59	7.98
2007	MAX	29.96	147	11.21	8.28		31.67	129	11.85	8.20		30.41	126	11.82	9.19
	MIN	9.52	78	5.45	7.35		13.29	79	5.32	7.33		10.52	80	6.62	7.39
	AVG	20.61	98	8.06	7.71		23.02	100	8.57	7.60		21.79	95	9.41	8.03
2008	MAX	27.90	166	11.55	8.11		28.44	169	12.49	7.70		28.28	169	12.51	9.28
	MIN	10.44	99	5.96	7.16		11.19	98	5.30	7.11		10.48	98	5.56	7.08
	AVG	19.32	118	8.55	7.54		20.14	119	9.12	7.48		19.66	119	9.75	7.83
2009	MAX	29.33	101	11.68	8.16		29.67	103	13.01	7.86		30.33	105	11.73	8.79
	MIN	10.18	66	5.64	7.31		10.88	66	5.61	7.27		11.57	66	6.85	7.31
	AVG	19.67	86	8.65	7.70		21.31	87	9.07	7.55		20.56	86	9.57	7.86
2010	MAX	30.50	85	16.31	8.32		31.53	85	15.35	7.95		32.13	88	14.27	8.71
	MIN	8.90	58	5.83	7.53		8.53	57	5.81	7.38		8.81	58	7.99	7.66
	AVG	20.52	74	9.93	7.91		21.93	74	9.57	7.67		21.98	75	10.00	8.10
2011	MAX	29.76	101	12.49	8.14		32.61	101	13.56	8.55		30.67	101	12.25	8.90
	MIN	9.00	75	4.98	7.09		9.14	73	5.03	7.03		8.91	75	5.82	7.12
	AVG	20.88	91	8.50	7.46		23.09	89	8.86	7.61		21.44	89	9.06	7.84
2012	MAX	28.74	100	11.73	8.52		30.29	101	12.15	7.81		30.57	98	12.75	9.01
	MIN	11.85	83	4.48	6.58		12.42	80	4.57	6.98		12.23	81	5.31	7.13
	AVG	19.69	92	9.05	7.42		20.72	92	8.95	7.41		20.68	91	9.95	7.94

3.2.1.6

3.2.2 SCE&G METALS DATA

Monticello Reservoir water samples were analyzed for a variety of parameters, including metals, in 2007 and 2008 as part of the VCSNS expansion. Data was collected in the vicinity of the new nuclear intake site on Monticello Reservoir. All parameters analyzed, including metals, are displayed below.

TABLE 3-12 WATER QUALITY DATA AT NEW NUCLEAR INTAKE SITE ON MONTICELLO RESERVOIR

		New Intake Lake Monticello	New Intake Lake Monticello	New Intake Lake Monticello	New Intake Lake Monticello	New Intake Lake Monticello	New Intake Lake Monticello	New Intake Lake Monticello	New Intake Lake Monticello	New Intake Lake Monticello	New Intake Lake Monticello	New Intake Lake Monticello
Sample Date		6/26/2007	7/26/2007	8/28/2007	9/13/2007	10/28/2007	11/19/2007	12/11/2007	1/28/2008	2/21/2008	3/6/2008	4/24/2008
Analysis	**MDL /Units**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**
Phosphorus	0.050 mg/l	0	0	0.06		0	0			0.11	0.14	0.08
Arsenic	5.0 PPB	0	0	0	0	0	0	0	0	0	0	0
Barium	10.0 PPB	17	17	20	18	16	0	15	14	20	14	18
Cadmium	1.0 PPB	0	0	0	0	0	0	0	0	0	0	0
Calcium	100.0 PPB	4035	3799	3609	3552	3536	3732	3887	4496	4751	4725	5218
Chromium	10.0 PPB	0	0	0	0	0	0	0	0	0	0	0
Copper	10.0 PPB	0	0	0	0	0	0	0	0	0	0	0
Iron	10.0 PPB	201	241	473	111	143	126	179	295	1400	208	509
Lead	5.0 PPB	0	0	0	0	0	0	0	0	0	0	0
Magnesium	100 .0 PPB	1898	1925	2071	2107	2185	1940	2174	2141	2079	2004	2137
mercury (liquid)	0.4 PPB	0	0	0	0	0	0	0	0	0	0	0
Potassium	100.0 PPB	1889	2042	2536	2121	2244	2574	2395	2423	2165	2168	2007
Selenium	5.0 PPB	0	0	0	0	0	0	0	0	0	0	0
Silver	10.0 PPB	0	0	0	0	0	0	0	0	0	0	0
Sodium	1000.0 PPB	9713	10510	14600	12750	14450	16120	16600	14750	12380	13410	11140
Total Hardness (calc)	0.0 mg/l	18	18	18	18	18	17	19	20	21	20	22
Chlorides	0.5 mg/l	7.3	8.4	10.7	10.1	10.8	10.9	11.5	10.9	10	10.3	8.3
Conductivity	0.05 umhos	88.9	95.33	105.9	105.2	112.8	108.7	130.9	107.2	104.7	119.9	94.4
Nitrate-N	0.11 mg/l as N	0.22	0.36	0.14	0.14	0.26	0.28	0.32	0.43	0.45	0.38	0.36
Othrophosphate	0.010 mg/l	0	0	0.023	0	0.02	0.026	0.045	0.05	0.07	0.039	0.04
pH	0.0 S.U.	7.35		7.33	7.37							
Sulfates	0.5 mg/l	3.16	4	7.9	4.13	3.5	4.6	5.8	9	8.9	8.5	6.9
Total Alkalinity	1.0 mg/l	34.1	31.5	36.4	33.48	35.37	35.4	43.88	28.5	26	32.1	24.5
Total Dissolved Solid	2.0 mg/l	111	76	70	64	68	85	81	66	74	72	65
Total Suspended Solid	1.0 mg/l	13	4	8	3	2	1	1.4	2	23	2	6
Turbidity	0.05 NTU	5.59	5.42	8.88	2.95	3.43	2.4	2.82	3.75	22.4	3.78	8.24
Fecal Coliform	1.0 #/100ml	14	14	21	5	4	0			7	2	0
Total Coliform	Present/Absent	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present

0 -Represents in results column shows that values are less than the MDL for that particular parameter.

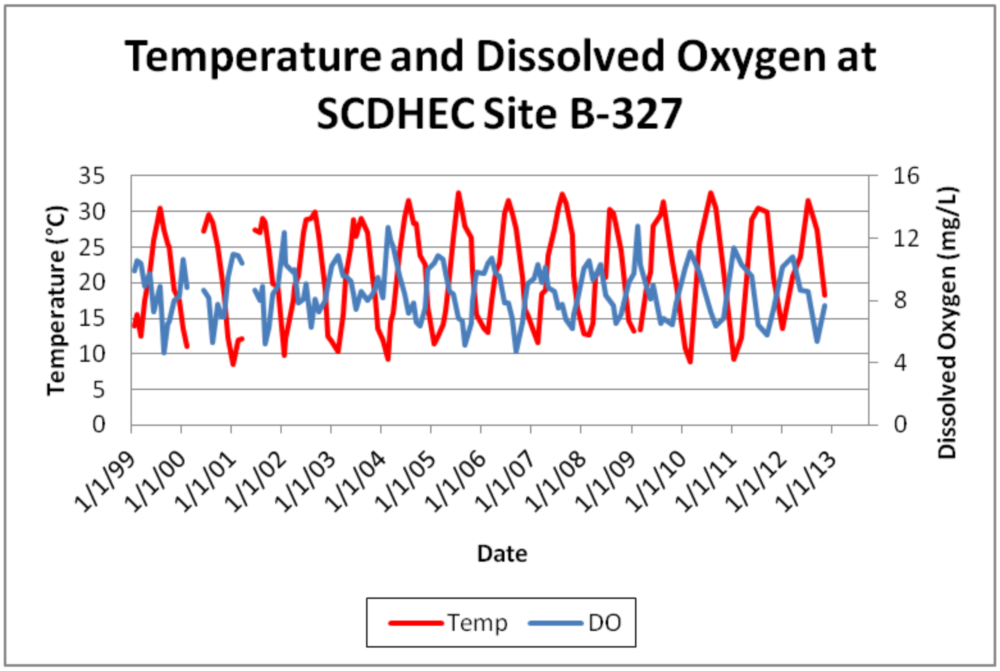
3.2.3 SCDHEC DATA

3.2.3.1 MONITORING STATION B-327

Temperature, DO, pH, and turbidity levels in the Monticello Reservoir are all consistent with state standards. SCDHEC monitoring site B-327, lower impoundment (see Figure 2-6), is not listed on the 2012 303(d) list.

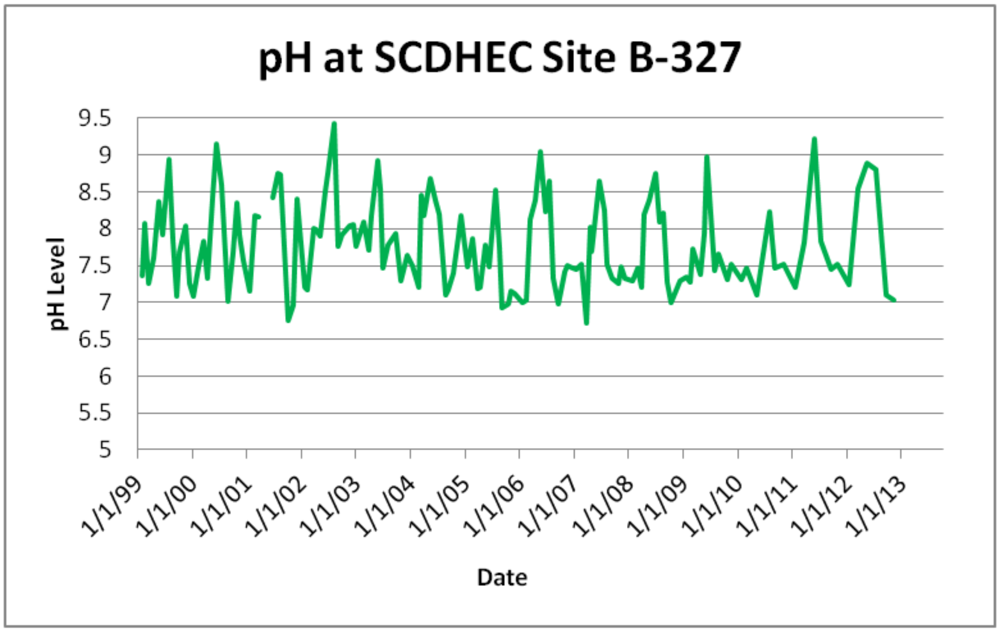
Temperature, DO, pH, and Turbidity

The following data was collected from 1999 through 2012 at the SCDHEC monitoring station B-327 located in the Monticello Reservoir. See Table 2-1 for the SCDHEC water quality standards for temperature, DO, pH, and turbidity.



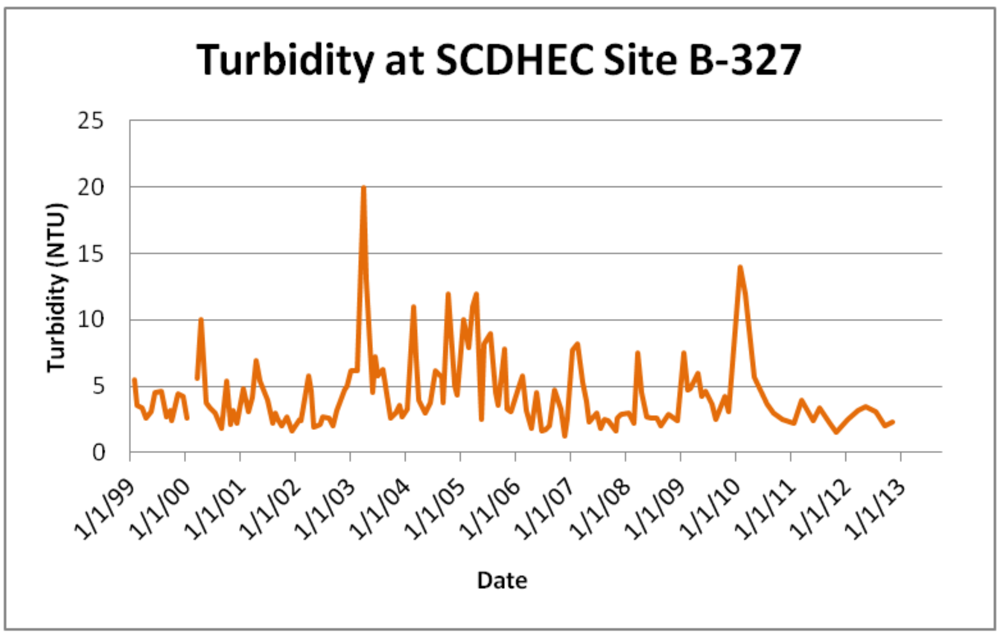
[a] Graph depicts only data that were available on STORET. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-109 WATER TEMPERATURE AND DISSOLVED OXYGEN AT SCDHEC MONITORING STATION B-327 [a]



[a] Graph depicts only data that were available on STORET. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-110 PH AT SCDHEC MONITORING STATION B-327 [a]



[a] Graph depicts only data that were available on STORET. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-111 TURBIDITY AT SCDHEC MONITORING STATION B-327[A]

Metals

Water samples from monitoring station B-327 were collected on a quarterly basis from 1999 through 2012. As shown in Table 3-13, the SCDHEC core indicator metals (Table 2-3) have been consistently measured as Present Below Quantification Limit (PBQL) at site B-327, indicating the reservoir supports aquatic life use.

TABLE 3-13 METALS PRESENT AT SCDHEC MONITORING STATION B-327[A]

DATE	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Magnesium (mg/L)	Manganese (mg/L)	Mercury (mg/L)	Nickel (mg/L)	Zinc (mg/L)
2/18/99	PBQL	PBQL	-	0.5	PBQL	-	PBQL	PBQL	PBQL	0.01
5/20/99	PBQL	PBQL	-	0.23	PBQL	-	PBQL	PBQL	PBQL	PBQL
8/26/99	PBQL	PBQL	-	0.12	PBQL	-	0.01	PBQL	PBQL	PBQL
11/16/99	PBQL	PBQL	-	0.17	PBQL	-	0.01	PBQL	PBQL	PBQL
5/18/00	PBQL	PBQL	-	0.14	PBQL	-	PBQL	PBQL	PBQL	PBQL
8/24/00	PBQL	PBQL	-	0.14	PBQL	-	0.01	PBQL	PBQL	PBQL
11/16/00	PBQL	PBQL	-	0.22	PBQL	-	0.03	PBQL	PBQL	PBQL
2/21/01	PBQL	PBQL	-	0.12	PBQL	-	PBQL	PBQL	PBQL	PBQL
5/7/01	PBQL	PBQL	-	0.25	PBQL	-	PBQL	PBQL	PBQL	PBQL
8/16/01	PBQL	PBQL	-	0.069	PBQL	-	PBQL	PBQL	PBQL	PBQL
11/6/01	PBQL	PBQL	-	0.16	PBQL	-	0.014	PBQL	PBQL	PBQL
2/7/02	PBQL	PBQL	-	0.11	PBQL	1.9	PBQL	PBQL	PBQL	PBQL
5/6/02	PBQL	PBQL	-	0.25	PBQL	-	PBQL	PBQL	PBQL	0.011
8/8/02	PBQL	PBQL	-	0.057	PBQL	-	0.01	PBQL	PBQL	PBQL
11/21/02	PBQL	PBQL	-	0.28	PBQL	-	0.011	PBQL	PBQL	0.016
2/19/03	PBQL	PBQL	-	0.37	PBQL	1.6	0.014	PBQL	PBQL	PBQL
5/28/03	PBQL	PBQL	-	0.82	PBQL	-	0.023	PBQL	PBQL	PBQL
8/7/03	PBQL	PBQL	-	0.2	PBQL	-	PBQL	PBQL	PBQL	PBQL
11/20/03	PBQL	PBQL	-	0.17	PBQL	-	0.015	PBQL	PBQL	PBQL
2/25/04	PBQL	PBQL	-	0.6	PBQL	1.6	0.018	PBQL	PBQL	PBQL
5/13/04	PBQL	PBQL	-	0.16	PBQL	-	PBQL	PBQL	PBQL	PBQL
8/26/04	PBQL	PBQL	-	0.13	PBQL	-	0.011	PBQL	PBQL	PBQL
11/22/04	PBQL	PBQL	-	0.28	PBQL	-	PBQL	PBQL	PBQL	0.021
2/23/05	PBQL	PBQL	-	0.35	PBQL	1.3	PBQL	PBQL	PBQL	PBQL
5/18/05	PBQL	PBQL	-	0.19	PBQL	-	PBQL	PBQL	PBQL	PBQL
8/18/05	PBQL	PBQL	-	0.19	PBQL	-	0.016	PBQL	PBQL	0.01
11/2/05	PBQL	PBQL	-	0.15	PBQL	-	0.015	PBQL	PBQL	PBQL
2/16/06	PBQL	PBQL	-	0.5	PBQL	1.7	0.013	PBQL	PBQL	PBQL
5/18/06	PBQL	PBQL	-	0.2	PBQL	-	0.01	PBQL	PBQL	PBQL
8/17/06	PBQL	PBQL	-	0.095	PBQL	-	0.012	PBQL	PBQL	0.024
11/20/06	PBQL	PBQL	-	0.18	PBQL	-	0.021	PBQL	PBQL	PBQL
2/20/07	PBQL	PBQL	-	0.4	PBQL	1.5	0.015	PBQL	PBQL	PBQL
5/2/07	PBQL	PBQL	-	0.11	PBQL	1.5	PBQL	PBQL	PBQL	0.017
8/13/07	PBQL	PBQL	-	0.063	PBQL	1.7	PBQL	PBQL	PBQL	0.011
11/8/07	PBQL	PBQL	-	0.35	PBQL	1.8	0.042	PBQL	PBQL	PBQL
2/28/08	PBQL	PBQL	-	0.19	PBQL	1.7	PBQL	PBQL	PBQL	PBQL
5/22/08	PBQL	PBQL	-	0.12	PBQL	-	PBQL	PBQL	PBQL	PBQL
8/19/08	PBQL	PBQL	-	0.051	PBQL	1.6	0.013	PBQL	PBQL	PBQL
2/12/09	PBQL	PBQL	-	0.27	PBQL	1.8	PBQL	PBQL	PBQL	0.039
5/20/09	PBQL	PBQL	-	0.17	PBQL	1.8	0.012	PBQL	PBQL	PBQL
8/20/09	0.00013	PBQL	-	0.06	PBQL	1.8	0.014	PBQL	PBQL	PBQL
11/19/09	0.00015	PBQL	-	0.22	PBQL	1.6	0.012	PBQL	PBQL	PBQL
1/28/10	PBQL	PBQL	-	0.55	PBQL	-	0.019	PBQL	PBQL	PBQL
5/6/10	PBQL	PBQL	-	0.2	PBQL	-	PBQL	PBQL	PBQL	PBQL
7/29/10	PBQL	PBQL	-	0.094	PBQL	-	0.012	PBQL	PBQL	PBQL
11/4/10	PBQL	PBQL	-	0.082	PBQL	1.6	0.013	PBQL	PBQL	PBQL
1/19/11	PBQL	PBQL	-	0.14	PBQL	-	0.014	PBQL	PBQL	PBQL
5/31/11	PBQL	PBQL	-	0.044	PBQL	-	PBQL	PBQL	PBQL	PBQL
7/14/11	PBQL	PBQL	-	0.052	PBQL	-	0.013	PBQL	PBQL	PBQL
11/3/11	PBQL	PBQL	-	0.08	PBQL	1.8	0.015	PBQL	PBQL	PBQL
1/12/12	PBQL	PBQL	-	0.1	PBQL	-	0.01	PBQL	PBQL	PBQL
5/15/12	PBQL	PBQL	-	0.11	PBQL	-	PBQL	PBQL	PBQL	PBQL
7/17/12	PBQL	PBQL	-	0.033	PBQL	-	PBQL	PBQL	PBQL	PBQL
11/8/12	PBQL	PBQL	-	0.062	PBQL	1.6	0.036	PBQL	PBQL	PBQL

[A] PBQL is Present Below Quantification Limit.

Nutrients

Nutrients data was collected at SCDHEC monitoring station B-327 from 1999 through 2012 and is included in the table below. See Table 2-2 for SCDHEC standards for nutrients.

TABLE 3-14 NUTRIENTS AND CHLOROPHYLL A AT SCDHEC MONITORING STATION B-327[A]

Date	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Chlorophyll a (ug/L)	Date	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Chlorophyll a (ug/L)
1/28/99	0.55	-	-	5/18/05	0.8	0.031	5.42
2/18/99	0.57	-	-	6/9/05	0.83	0.036	25.73
3/18/99	0.37	-	-	7/21/05	0.64	0.028	14.11
4/15/99	0.61	-	-	8/18/05	0.35	0.032	11.6
5/20/99	0.56	-	-	9/8/05	0.57	PBQL	2.62
6/17/99	0.57	-	-	10/20/05	0.62	0.022	-
7/29/99	0.58	-	-	11/2/05	0.6	PBQL	-
8/26/99	0.41	-	-	12/1/05	0.74	PBQL	-
9/23/99	0.6	-	-	1/17/06	0.68	0.025	-
10/5/99	0.56	-	-	2/16/06	0.81	0.021	-
11/16/99	0.47	-	-	3/16/06	0.7	PBQL	-
12/16/99	0.67	-	-	4/20/06	0.91	PBQL	-
1/13/00	0.34	-	-	5/18/06	0.54	PBQL	25.81
3/16/00	0.68	-	-	6/22/06	0.49	PBQL	2.62
4/13/00	0.6	-	-	7/20/06	PBQL	PBQL	5.26
5/18/00	0.51	-	-	8/17/06	0.83	PBQL	9.55
6/15/00	0.38	-	10.7	9/14/06	0.68	0.02	3.83
7/20/00	PBQL	-	15.1	10/26/06	0.56	0.025	2.59
8/24/00	0.38	-	5.91	11/20/06	0.5	0.029	-
9/28/00	0.43	-	10.5	12/7/06	0.59	0.031	-
10/26/00	0.46	-	4.2	1/17/07	0.59	0.021	-
11/16/00	0.46	-	-	2/20/07	0.66	0.031	-
12/12/00	0.48	-	-	3/22/07	-	0.033	-
2/21/01	0.61	-	-	4/19/07	-	PBQL	-
4/17/01	0.97	-	-	5/2/07	-	PBQL	4.87
5/7/01	-	-	2.66	6/21/07	0.31	PBQL	10.61
6/26/01	0.44	0.036	10.9	7/19/07	0.539	PBQL	9.17
7/30/01	-	0.02	6.94	8/13/07	0.287	PBQL	6.82
8/16/01	0.475	0.024	13.3	9/10/07	0.338	PBQL	6.31
9/5/01	-	PBQL	4.84	10/25/07	-	0.024	3.67
10/4/01	PBQL	0.02	4.88	11/8/07	0.54	0.024	-
11/6/01	-	0.02	-	12/4/07	PBQL	-	-
12/6/01	0.43	PBQL	-	1/24/08	0.58	0.048	-
1/24/02	0.59	0.023	-	2/28/08	0.63	0.036	-
2/7/02	-	0.023	-	3/25/08	0.59	0.044	-
3/27/02	0.72	PBQL	-	3/25/08	0.59	-	-
4/11/02	-	0.022	-	4/17/08	0.51	0.029	-
5/6/02	0.5	PBQL	2.48	4/17/08	0.51	-	-
6/13/02	0.308	PBQL	5.87	5/22/08	0.27	0.032	-
7/1/02	PBQL	PBQL	13.6	6/26/08	-	0.022	6.48
8/8/02	-	PBQL	8.37	7/29/08	-	12.27	
9/5/02	PBQL	PBQL	14.8	8/19/08	0.282	0.03	5.29
10/2/02	-	0.023	12	9/11/08	0.19	PBQL	5.04
11/21/02	0.48	0.024	-	10/14/08	-	0.033	2.81
12/12/02	0.39	0.029	-	12/9/08	1.14	0.039	-
1/6/03	0.53	0.031	-	1/22/09	0.57	0.038	-
2/19/03	-	0.029	-	2/12/09	0.78	0.04	-
3/27/03	0.63	0.037	-	3/5/09	0.69	0.026	-
4/17/03	-	0.034	-	4/23/09	PBQL	0.023	-
5/28/03	0.52	PBQL	-	5/20/09	0.55	0.023	5.86
6/16/03	-	PBQL	-	6/11/09	0.564	PBQL	6.42
7/2/03	0.46	PBQL	-	7/30/09	PBQL	0.026	12.03
8/7/03	-	PBQL	-	8/20/09	PBQL	0.024	12.21
9/25/03	0.85	PBQL	10.77	10/22/09	0.42	0.031	4.22
10/30/03	-	PBQL	1.74	11/19/09	0.46	0.034	-
11/20/03	0.98	PBQL	-	1/28/10	PBQL	0.036	-
12/11/03	-	PBQL	-	3/4/10	PBQL	0.039	-
1/15/04	0.69	PBQL	-	5/6/10	0.32	PBQL	12.67
2/25/04	-	0.023	-	7/29/10	0.247	0.023	10.96
3/11/04	0.91	PBQL	-	9/9/10	0.34	PBQL	10.08
4/1/04	0.76	PBQL	-	11/4/10	0.62	0.024	-
5/13/04	0.42	0.027	12.75	1/19/11	PBQL	0.046	-
6/17/04	0.71	0.034	12	3/17/11	0.68	0.03	-
7/15/04	0.71	0.039	13.28	5/31/11	-	0.023	9.84
8/26/04	0.53	0.029	9.57	7/14/11	0.264	0.03	14.67
9/9/04	0.55	0.024	1.99	9/15/11	0.35	0.022	9.28
10/14/04	0.73	0.027	-	11/3/11	0.81	0.028	-
11/22/04	0.78	0.035	-	1/12/12	PBQL	0.039	-
12/7/04	0.63	0.021	-	3/19/12	0.59	0.03	-
1/20/05	0.96	0.037	-	5/15/12	0.31	0.021	19.76
2/23/05	0.92	0.038	-	7/17/12	0.339	0.023	-
3/24/05	0.81	0.033	-	9/20/12	PBQL	PBQL	6.47
4/14/05	0.74	0.033	-	11/8/12	0.68	0.028	-

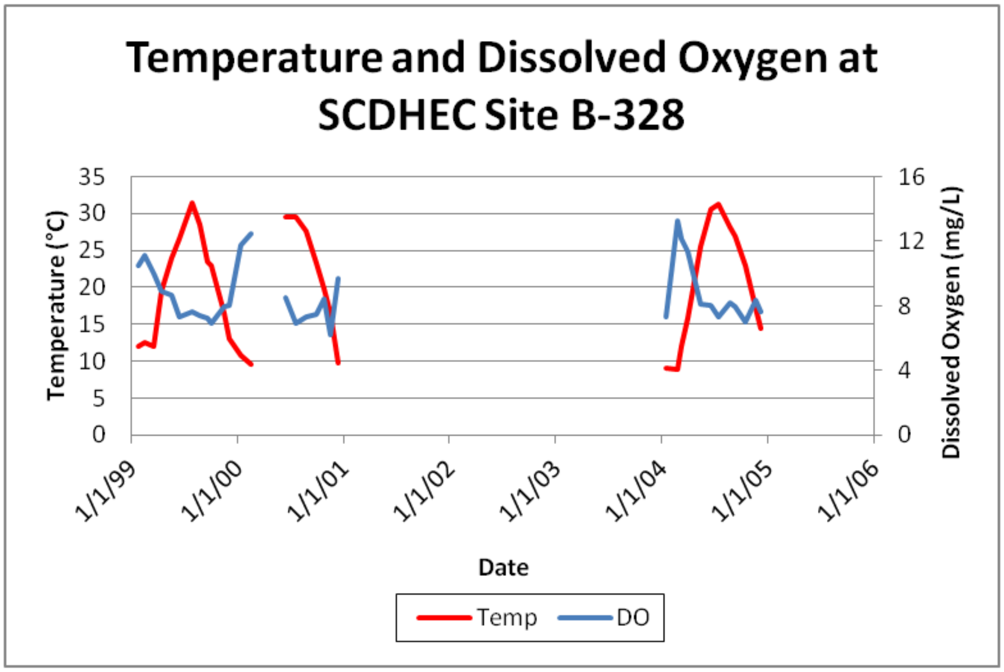
[A] PBQL is Present Below Quantification Limit.

3.2.3.2 MONITORING STATION B-328

The SCDHEC monitoring station B-328, at buoy in the middle of the reservoir, is located in the area of Monticello Reservoir set aside solely for recreation, known as the Recreation Lake. The data presented below shows all parameters reading well within normal and safe limits.

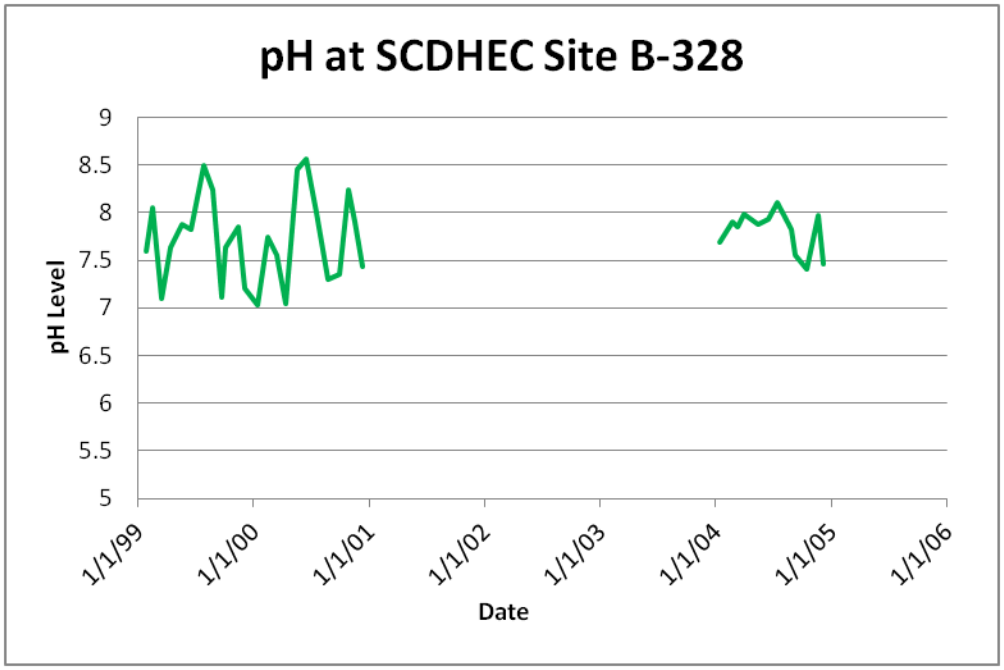
Temperature, DO, pH, and Turbidity

The following data was collected in 1999, 2000 and 2004 at the SCDHEC monitoring station B-328 located in the Monticello Reservoir. See Table 2-1 for the SCDHEC water quality standards for temperature, DO, pH, and turbidity.



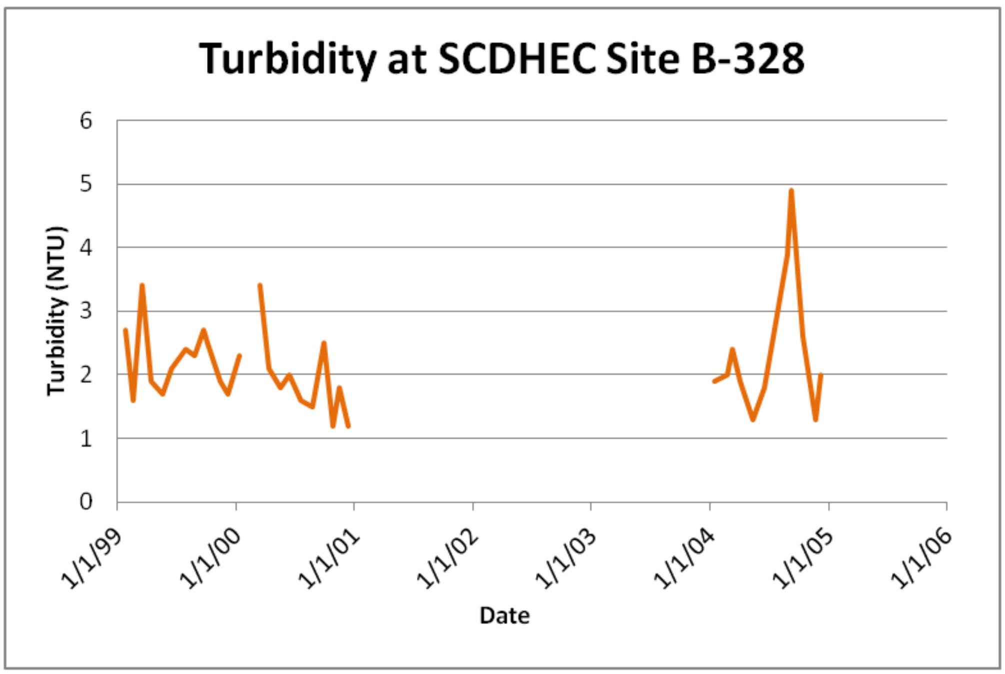
[a] Graph depicts only data that were available on STORET. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-112 WATER TEMPERATURE AND DISSOLVED OXYGEN AT SCDHEC MONITORING STATION B-328 [a]



[a] Graph depicts only data that were available on STORET. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-113 PH AT SCDHEC MONITORING STATION B-328 [a]



[a] Graph depicts only data that were available on STORET. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-114 TURBIDITY AT SCDHEC MONITORING STATION B-328 [a]

Metals

Water samples from monitoring station B-328 were collected on a quarterly basis for the years 1999, 2000 and 2004. As shown in Table 3-15, the SCDHEC core indicator metals (Table 2-3) were consistently measured as Present Below Quantification Limit (PBQL) at site B-328, indicating the reservoir supports aquatic life use.

TABLE 3-15 METALS PRESENT AT SCDHEC MONITORING STATION B-328[A]

DATE	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Magnesium (mg/L)	Manganese (mg/L)	Mercury (mg/L)	Nickel (mg/L)	Zinc (mg/L)
2/18/99	PBQL	PBQL	PBQL	0.15	PBQL	-	0.02	PBQL	PBQL	0.03
5/20/99	PBQL	PBQL	PBQL	0.05	PBQL	-	0.03	PBQL	PBQL	PBQL
8/26/99	PBQL	PBQL	PBQL	0.06	PBQL	-	0.05	PBQL	PBQL	PBQL
11/16/99	PBQL	PBQL	PBQL	0.08	PBQL	-	0.16	PBQL	PBQL	0.01
5/18/00	PBQL	PBQL	PBQL	0.05	PBQL	-	0.03	PBQL	PBQL	PBQL
8/24/00	PBQL	PBQL	PBQL	0.07	PBQL	-	0.05	PBQL	PBQL	PBQL
11/16/00	PBQL	PBQL	PBQL	0.09	PBQL	-	0.32	PBQL	PBQL	PBQL
2/25/04	PBQL	PBQL	PBQL	0.16	PBQL	2	0.019	PBQL	PBQL	PBQL
5/13/04	PBQL	PBQL	PBQL	0.054	PBQL	-	0.043	PBQL	PBQL	PBQL
8/26/04	PBQL	PBQL	PBQL	0.042	PBQL	-	0.03	PBQL	PBQL	PBQL
11/22/04	PBQL	PBQL	PBQL	0.06	PBQL	-	0.044	PBQL	PBQL	PBQL

[A] PBQL is Present Below Quantification Limit.

Nutrients

Water samples collected at SCDHEC monitoring station B-328 in 1999, 2000 and 2004 were analyzed for total nitrogen, total phosphorus and chlorophyll-a. See Table 2-2 for SCDHEC standards for nutrients. As of 2004, these parameters were measured at levels deemed acceptable by SCDHEC.

TABLE 3-16 NUTRIENTS AND CHLOROPHYLL A AT SCDHEC MONITORING STATION B-328[A]

Date	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Chlorophyll a (ug/L)
1/28/99	0.37	-	-
2/18/99	0.27	-	-
3/18/99	0.37	-	-
4/15/99	PBQL	-	-
5/20/99	PBQL	-	-
6/17/99	PBQL	-	-
7/29/99	PBQL	-	-
8/26/99	PBQL	-	-
9/23/99	PBQL	-	-
10/5/99	0.7	-	-
11/16/99	0.39	-	-
12/6/99	0.39	-	-
1/13/00	0.63	-	-
3/16/00	PBQL	-	-
4/13/00	PBQL	-	-
5/18/00	PBQL	-	-
6/15/00	PBQL	-	1.86
7/20/00	PBQL	-	3.03
8/24/00	PBQL	-	6.52
9/28/00	PBQL	-	7.09
10/26/00	PBQL	-	4.42
11/16/00	PBQL	-	-
12/12/00	0.45	-	-
1/15/04	0.602	PBQL	-
2/25/04	-	PBQL	-
3/11/04	0.512	PBQL	-
4/1/04	PBQL	PBQL	-
5/13/04	PBQL	PBQL	1.57
6/17/04	PBQL	PBQL	1.89
7/15/04	PBQL	PBQL	3.09
8/26/04	PBQL	PBQL	3.7
9/9/04	PBQL	0.021	-
10/14/04	PBQL	PBQL	4.67
11/22/04	PBQL	PBQL	-
12/7/04	0.372	PBQL	-

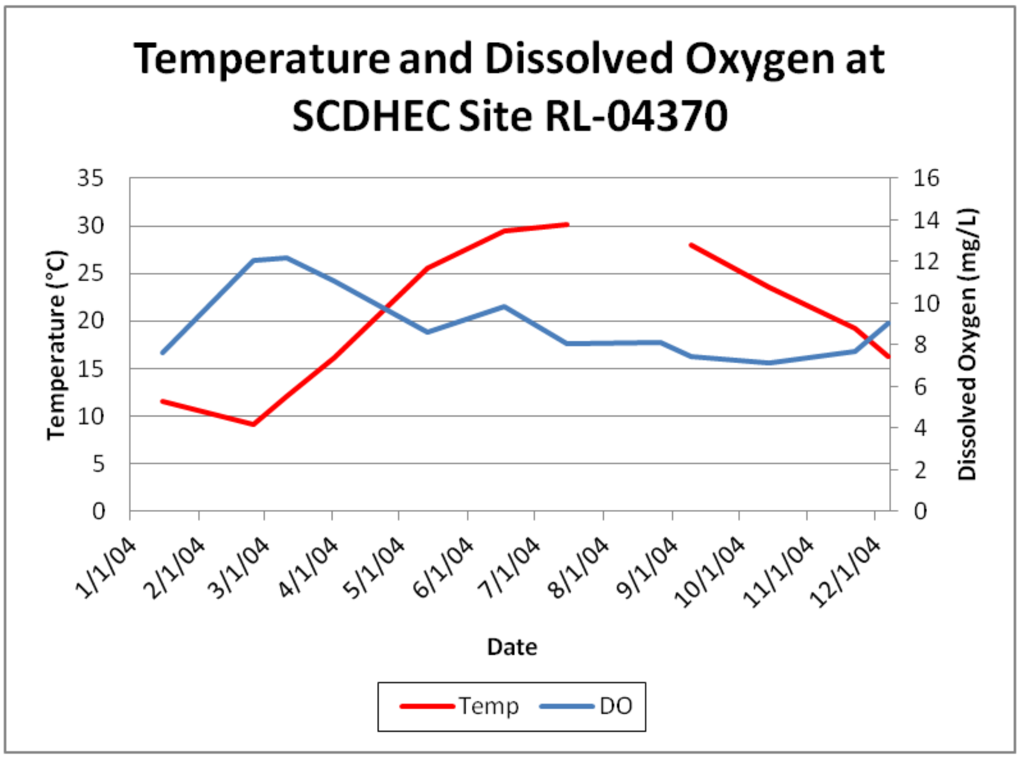
[A] PBQL is Present Below Quantification Limit.

3.2.3.3 Monitoring Station RL-04370

SCDHEC monitoring site RL-04370 was established for water quality monitoring during the year 2004. During this time, this site was included on the state 303(d) list due pH excursions. See information included below for further details.

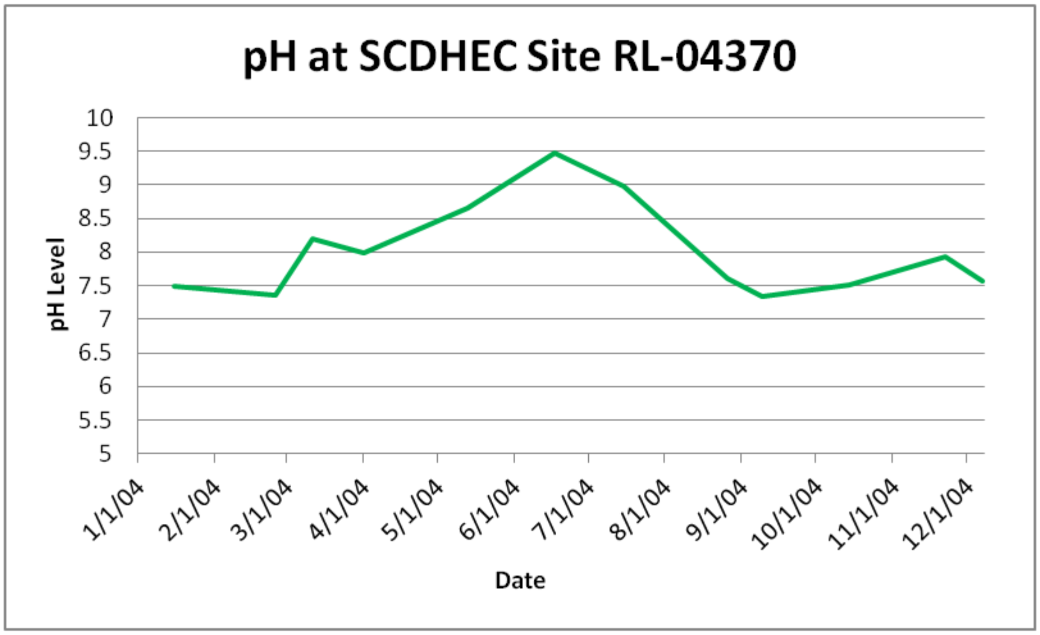
Temperature, DO, pH, and Turbidity

In 2004, the pH levels at SCDHEC monitoring site RL-04370, approximately 1.7 miles NW of the town of Monticello, were measured above the SCDHEC standard. During the summer months, pH values reached nearly 9.5. Due to these excursions, this site was included on the 303(d) list. DO and turbidity values were well within state limits at this site during 2004. See Table 2-1 for the SCDHEC water quality standards for temperature, DO, pH, and turbidity.



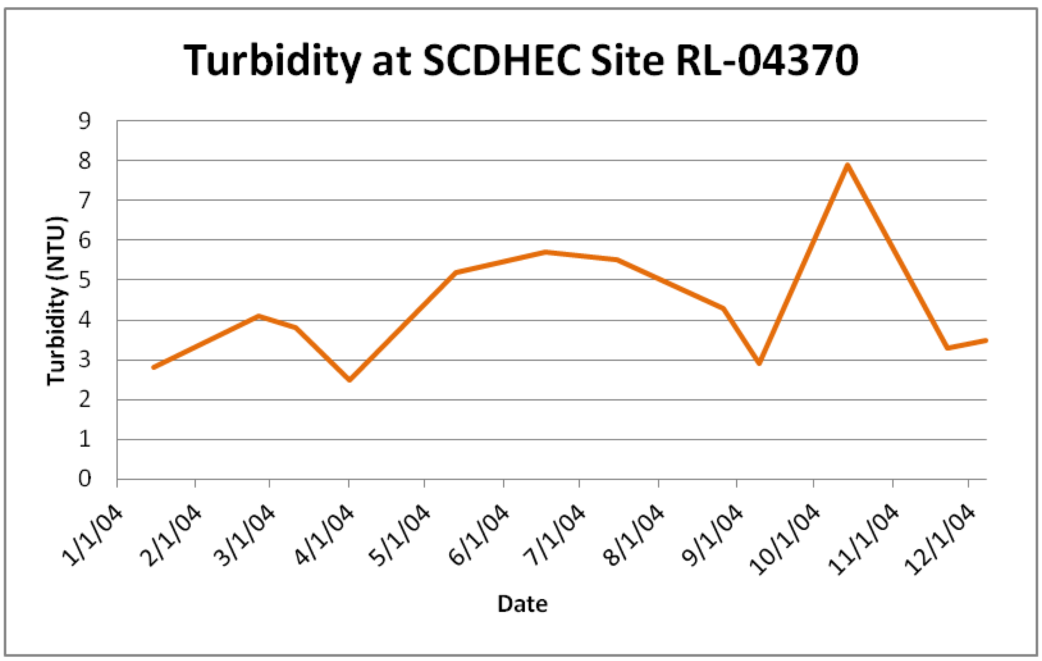
[a] Graph depicts only data that were available on STORET. Any gaps reflect times when data were not collected, or not available.

Figure 3-115 Water Temperature and Dissolved Oxygen at SCDHEC Monitoring Station RL-04370[A]



[a] Graph depicts only data that were available on STORET. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-116 PH AT SCDHEC MONITORING STATION RL-04370[A]



[a] Graph depicts only data that were available on STORET. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-117 TURBIDITY AT SCDHEC MONITORING STATION RL-04370[A]

Metals

Water samples from monitoring station RL-04370 were collected on a quarterly basis during 2004 and analyzed for various metals. Results of these analyses are included below. Analysis of the SCDHEC core indicator metals (Table 2-3) signify the reservoir supports aquatic life use at monitoring site RL-04370.

TABLE 3-17 METALS PRESENT AT SCDHEC MONITORING STATION RL-04370[A]

DATE	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Magnesium (mg/L)	Manganese (mg/L)	Mercury (mg/L)	Nickel (mg/L)	Zinc (mg/L)
2/25/04	PBQL	PBQL	PBQL	0.24	PBQL	1.5	PBQL	PBQL	PBQL	0.028
5/13/04	PBQL	PBQL	PBQL	0.2	PBQL	-	PBQL	PBQL	PBQL	PBQL
8/26/04	PBQL	PBQL	PBQL	0.09	PBQL	-	PBQL	PBQL	PBQL	PBQL
11/22/04	PBQL	PBQL	PBQL	0.22	PBQL	-	PBQL	PBQL	PBQL	PBQL
1/19/11	PBQL	PBQL	PBQL	0.11	-	-	PBQL	PBQL	PBQL	PBQL
5/31/11	PBQL	PBQL	PBQL	0.1	-	-	PBQL	PBQL	PBQL	PBQL
7/14/11	PBQL	PBQL	PBQL	0.04	-	-	PBQL	PBQL	PBQL	PBQL
11/3/11	PBQL	PBQL	PBQL	0.048	-	1.8	0.012	PBQL	PBQL	PBQL

[A] PBQL is Present Below Quantification Limit.

Nutrients

Nutrients data was collected at SCDHEC monitoring station RL-04370 in 2004 and is included in the table below. See Table 2-2 for SCDHEC standards for nutrients.

TABLE 3-18 NUTRIENTS AND CHLOROPHYLL A AT SCDHEC MONITORING STATION RL-04370[A]

Date	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Chlorophyll a (ug/L)
1/15/04	0.62	PBQL	-
2/25/04	-	PBQL	-
3/11/04	0.99	PBQL	-
4/1/04	0.55	PBQL	-
5/13/04	0.39	PBQL	4.47
6/17/04	PBQL	0.044	25.6
7/15/04	0.405	0.027	12.11
8/26/04	0.47	PBQL	11.17
9/9/04	0.6	0.021	-
10/14/04	0.63	0.024	7.13
11/22/04	0.58	0.024	-
12/7/04	0.62	0.02	-
1/19/11	PBQL	0.042	-
2/16/11	0.7	0.046	-
3/17/11	0.66	0.029	-
4/14/11	-	0.027	-
5/31/11	-	0.027	8.77
6/29/11	PBQL	0.041	-
7/14/11	PBQL	0.034	17.95
8/11/11	PBQL	0.025	8.85
9/15/11	PBQL	PBQL	7.62
10/20/11	0.43	PBQL	6.74
11/3/11	0.65	0.027	-
12/5/11	0.84	0.035	-

[A] PBQL is Present Below Quantification Limit.

3.2.3.4 MONITORING STATION RL-04374

SCDHEC monitoring site RL-04374, approximately 3.5 miles N of Jenkinsville, was established for water quality monitoring during the year 2004. This site was added to the state 303(d) list due to pH excursions. See information included below for further details.

Temperature, DO, pH, and Turbidity

In 2004, the pH levels at SCDHEC monitoring site RL-04374 were measured above the SCDHEC standard range (see Table 2-1). During the summer months, pH values were recorded between 8.5 and 9.0. Due to these excursions, this site was included on the 303(d) list. DO and turbidity values were well within state limits at this site during 2004.

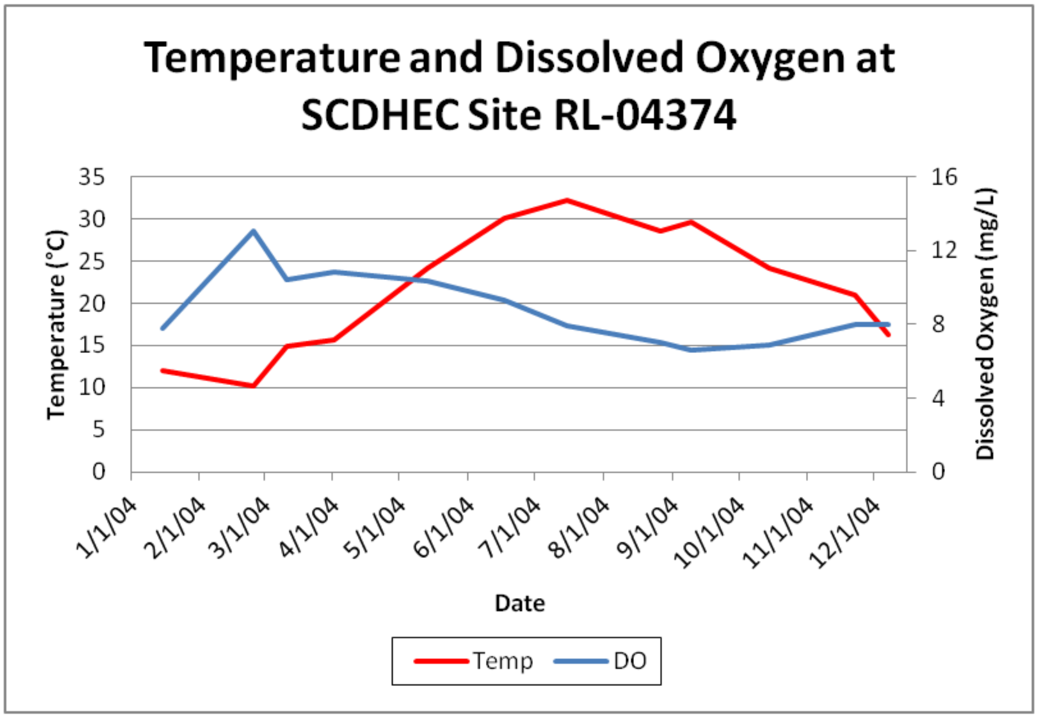


FIGURE 3-118 WATER TEMPERATURE AND DISSOLVED OXYGEN AT SCDHEC MONITORING STATION RL-04374

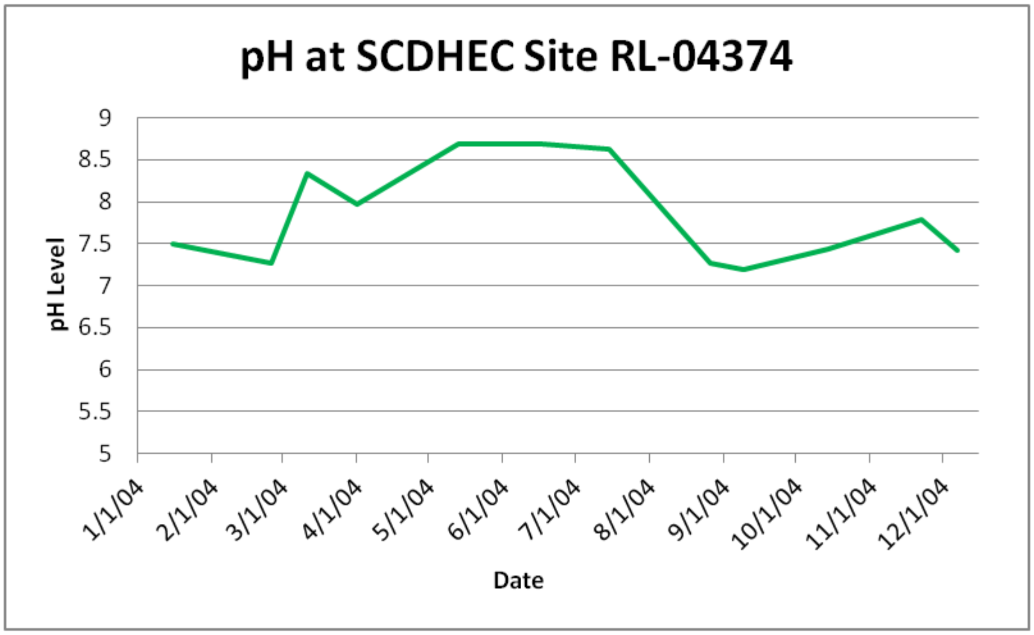


FIGURE 3-119 PH AT SCDHEC MONITORING STATION RL-04374

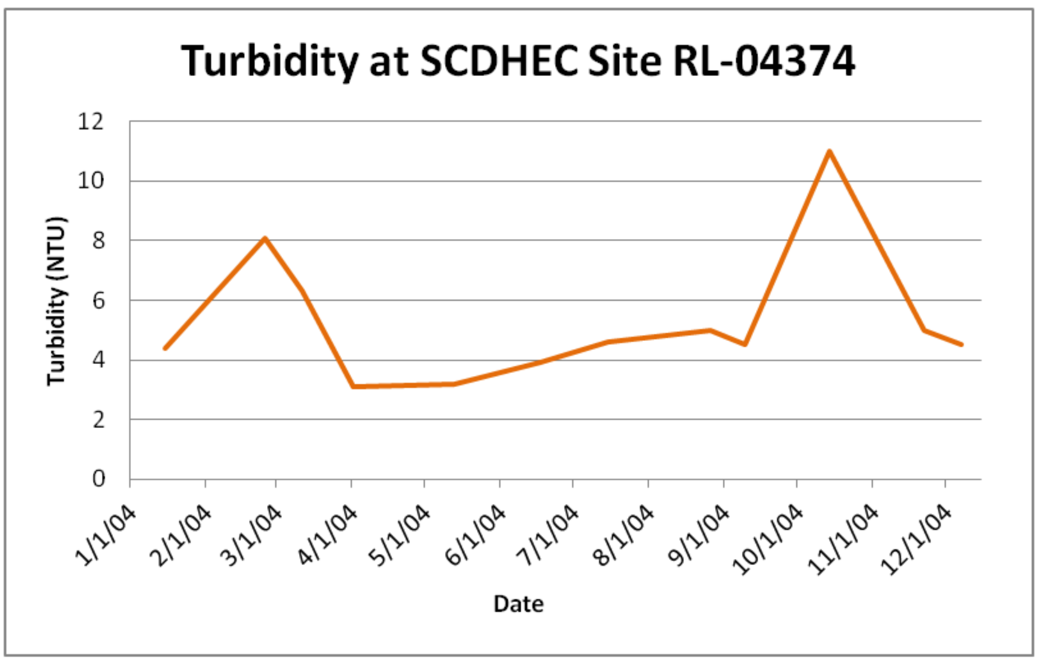


FIGURE 3-120 TURBIDITY AT SCDHEC MONITORING STATION RL-04374

Metals

Water samples from monitoring station RL-04374 were collected on a quarterly basis during 2004 and analyzed for various metals. Results of these analyses are included below. Analysis of the SCDHEC core indicator metals (Table 2-3) signify the reservoir supports aquatic life use at monitoring site RL-04374.

TABLE 3-19 METALS PRESENT AT SCDHEC MONITORING STATION RL-04374[A]

DATE	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Magnesium (mg/L)	Manganese (mg/L)	Mercury (mg/L)	Nickel (mg/L)	Zinc (mg/L)
2/25/04	PBQL	PBQL	PBQL	0.51	PBQL	1.6	0.012	PBQL	PBQL	PBQL
5/13/04	PBQL	PBQL	PBQL	0.11	PBQL	-	PBQL	PBQL	PBQL	PBQL
8/26/04	PBQL	PBQL	PBQL	0.16	PBQL	-	PBQL	PBQL	PBQL	PBQL
11/22/04	PBQL	PBQL	PBQL	0.31	PBQL	-	PBQL	PBQL	PBQL	PBQL

[A] PBQL is Present Below Quantification Limit.

Nutrients

Nutrients data was collected at SCDHEC monitoring station RL-04374 in 2004 and is included in the table below. See Table 2-2 for SCDHEC standards for nutrients.

TABLE 3-20 NUTRIENTS AND CHLOROPHYLL A AT SCDHEC MONITORING STATION RL-04374[A]

Date	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Chlorophyll a (ug/L)
1/15/04	0.73	-	-
2/25/04	-	PBQL	-
3/11/04	0.85	PBQL	-
4/1/04	0.63	PBQL	-
5/13/04	0.61	PBQL	13.36
6/17/04	0.71	0.031	15.31
7/15/04	0.46	0.048	19.41
8/26/04	0.5	0.021	8.72
9/9/04	0.52	0.024	-
10/14/04	0.64	0.029	4.36
11/22/04	0.69	0.056	-
12/7/04	0.64	0.026	-

[A] PBQL is Present Below Quantification Limit.

3.2.3.5 MONITORING STATION RL-08055

SCDHEC monitoring station RL-08055, as close to the outflow at dam as possible, was established for water quality monitoring in Monticello Reservoir during 2008. The data presented below shows all parameters reading well within SCDHEC-established limits.

Temperature, DO, pH, and Turbidity

Data collected in 2008 at the SCDHEC monitoring station RL-08055 located in the Monticello Reservoir is presented in the graphs below. See Table 2-1 for the SCDHEC water quality standards for temperature, DO, pH, and turbidity. It should be noted that this monitoring site is located in close proximity to the Fairfield Pumped Storage Development. Although turbidity may be a concern at this location due to the pumping operations of the facility, it was consistently measured as below the SCDHEC turbidity standard of 25 NTU.

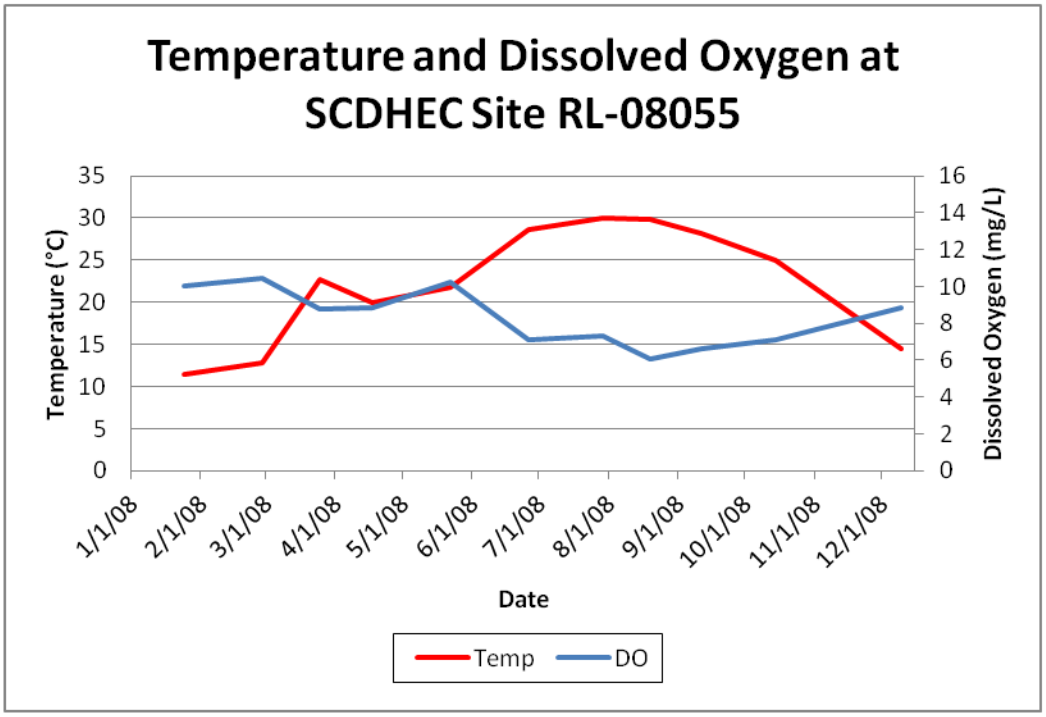


FIGURE 3-121 WATER TEMPERATURE AND DISSOLVED OXYGEN AT SCDHEC MONITORING STATION RL-08055

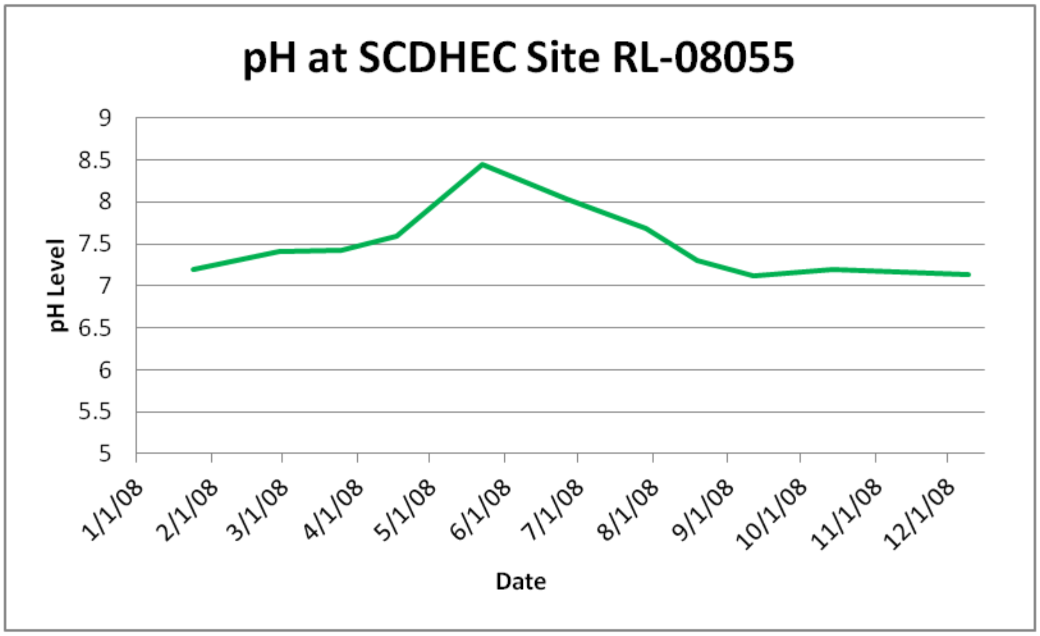


FIGURE 3-122 PH AT SCDHEC MONITORING STATION RL-08055

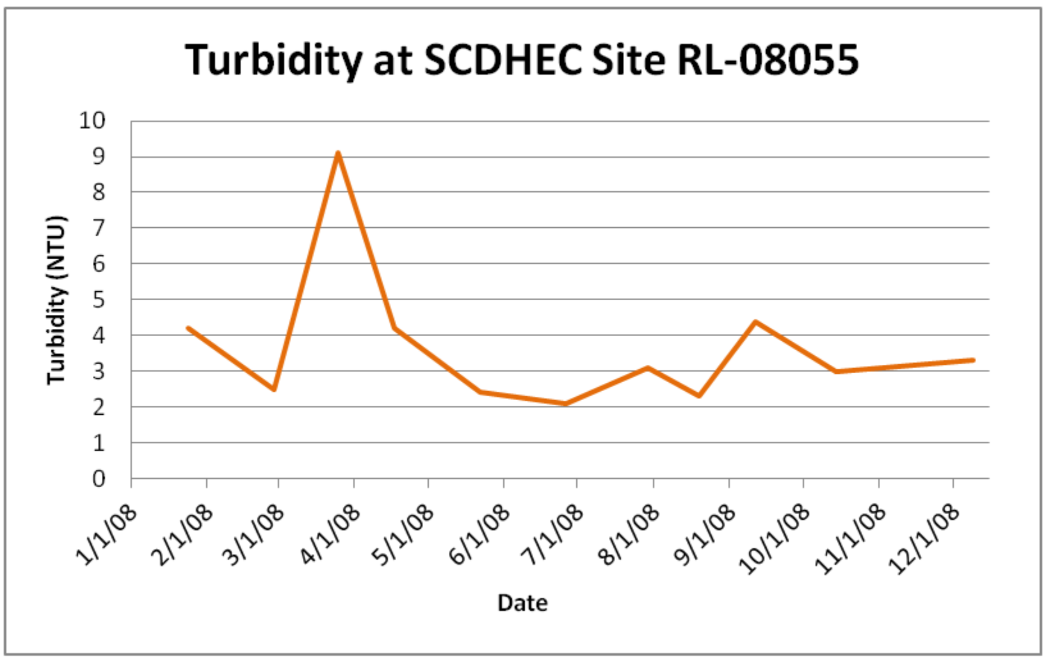


FIGURE 3-123 TURBIDITY AT SCDHEC MONITORING STATION RL-08055

Metals

Water samples from monitoring station RL-08055 were collected on a quarterly basis during 2008 and analyzed for various metals. Results of these analyses are included below. Analysis of the SCDHEC core indicator metals (Table 2-3) signify the reservoir supports aquatic life use at monitoring site RL-08055.

TABLE 3-21 METALS PRESENT AT SCDHEC MONITORING STATION RL-08055[A]

DATE	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Magnesium (mg/L)	Manganese (mg/L)	Mercury (mg/L)	Nickel (mg/L)	Zinc (mg/L)
2/28/2008	PBQL	PBQL	PBQL	0.2	PBQL	1.8	PBQL	PBQL	PBQL	PBQL
4/10/2008	PBQL	PBQL	PBQL	0.14	PBQL	-	0.015	PBQL	PBQL	0.014
5/22/2008	PBQL	PBQL	PBQL	0.12	PBQL	-	PBQL	PBQL	PBQL	PBQL
8/19/2008	PBQL	PBQL	PBQL	0.062	PBQL	0.19	PBQL	PBQL	PBQL	PBQL

[A] PBQL is Present Below Quantification Limit.

Nutrients

Nutrients data was collected at SCDHEC monitoring station RL-08055 in 2008 and is included in the table below. See Table 2-2 for SCDHEC standards for nutrients.

TABLE 3-22 NUTRIENTS AND CHLOROPHYLL A AT SCDHEC MONITORING STATION RL-08055[A]

Date	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Chlorophyll a (ug/L)
1/24/2008	0.61	0.05	-
2/28/2008	0.53	0.038	-
3/18/2008	PBQL	PBQL	-
3/25/2008	1.65	0.059	-
4/10/2008	0.41	PBQL	-
4/17/2008	0.53	0.025	-
5/22/2008	0.39	0.036	-
6/26/2008	-	0.026	7.02
7/29/2008	-	-	12.85
8/19/2008	PBQL	0.026	6.2
9/11/2008	PBQL	PBQL	5.49
10/14/2008	0.41	0.034	3.29
12/9/2008	1.24	0.043	-

[A] PBQL is Present Below Quantification Limit.

3.2.3.6 MONITORING STATION RL-11031

SCDHEC monitoring station RL-11031 was established for water quality monitoring in Monticello Reservoir during 2011. This monitoring station occurs in the same location as site RL-04370, approximately 1.7 miles NW of the town of Monticello. Similar to the pH data collected at site RL-04370 in 2004, pH at site RL-11031 was outside of the SCDHEC established range however these data have not yet been evaluated for potential §303(d) listing.

Temperature, DO, pH, and Turbidity

In 2011, the pH levels at SCDHEC monitoring site RL-11031 were measured above the SCDHEC standard range (see Table 2-1). During the summer months, pH values were recorded between 8.5 and 9.5. DO and turbidity values were well within state limits at this site during 2011.

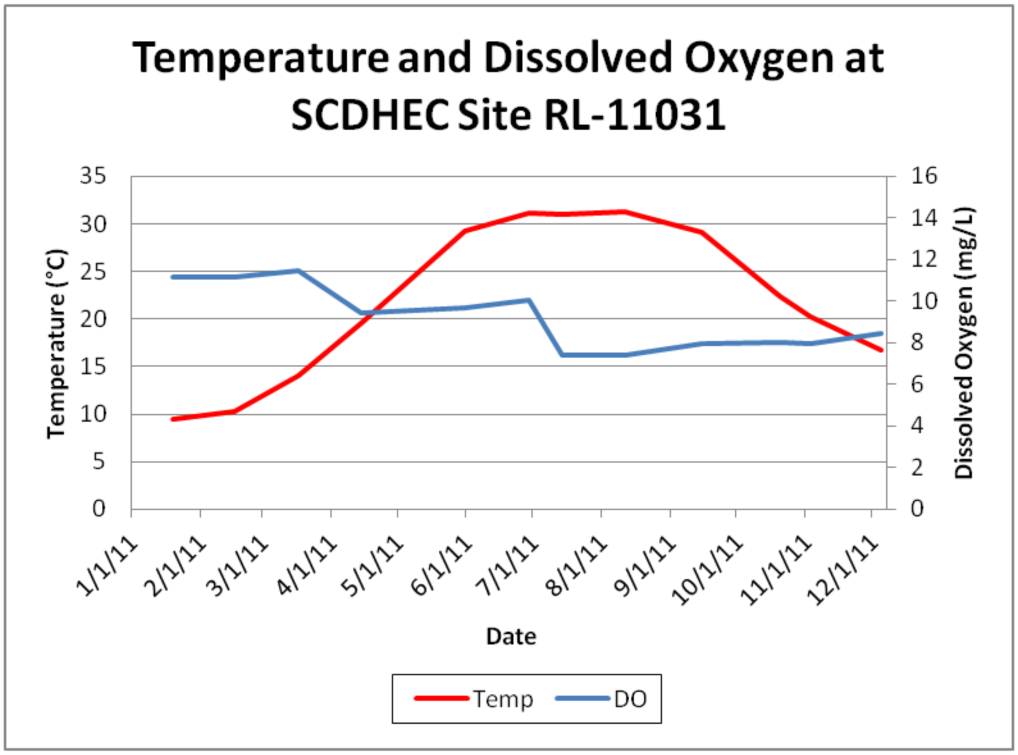


FIGURE 3-124 WATER TEMPERATURE AND DISSOLVED OXYGEN AT SCDHEC MONITORING STATION RL-11031

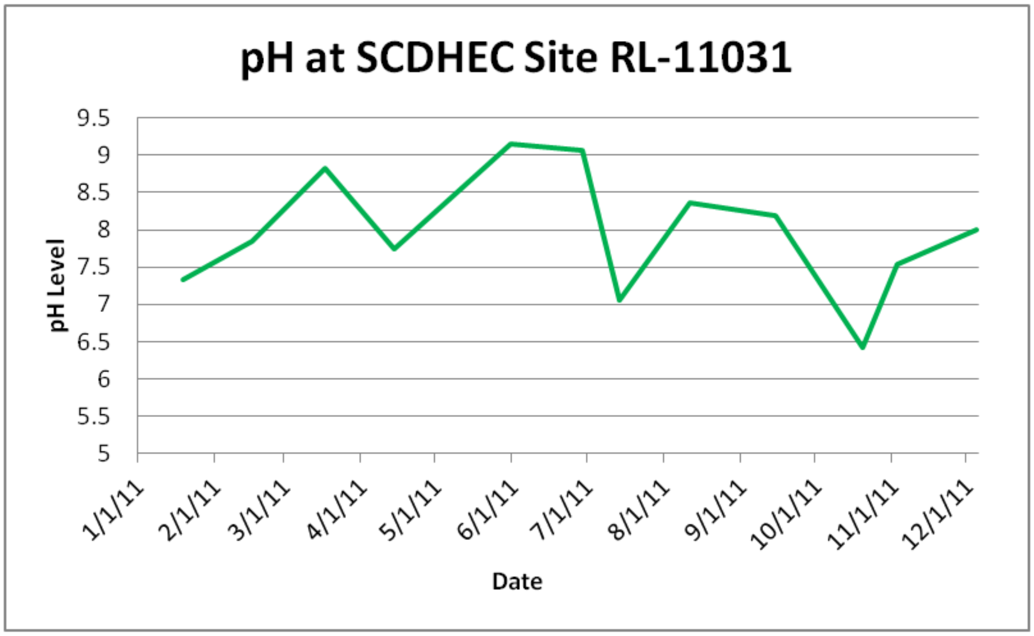


FIGURE 3-125 PH AT SCDHEC MONITORING STATION RL-11031

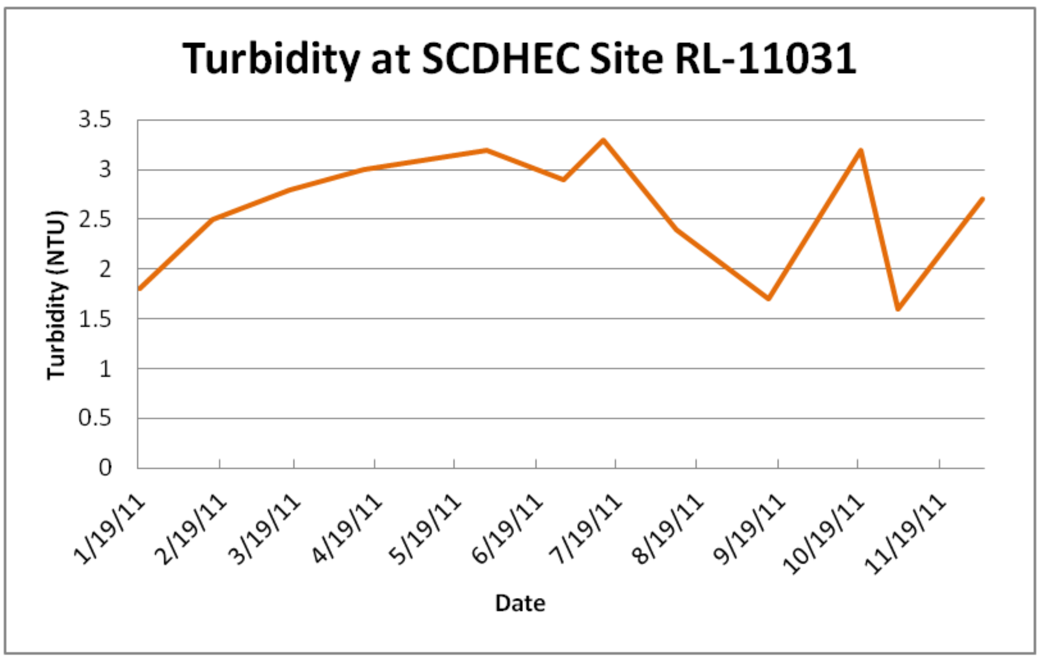


FIGURE 3-126 TURBIDITY AT SCDHEC MONITORING STATION RL-11031

Metals

Water samples from monitoring station RL-11031 were collected on a quarterly basis during 2011 and analyzed for various metals. Results of these analyses are included below. Analysis of the SCDHEC core indicator metals (Table 2-3) signify the reservoir supports aquatic life use at monitoring site RL-11031.

TABLE 3-23 METALS PRESENT AT SCDHEC MONITORING STATION RL-11031[A]

DATE	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Magnesium (mg/L)	Manganese (mg/L)	Mercury (mg/L)	Nickel (mg/L)	Zinc (mg/L)
1/19/11	PBQL	PBQL	PBQL	0.11	-	-	PBQL	PBQL	PBQL	PBQL
5/31/11	PBQL	PBQL	PBQL	0.1	-	-	PBQL	PBQL	PBQL	PBQL
7/14/11	PBQL	PBQL	PBQL	0.04	-	-	PBQL	PBQL	PBQL	PBQL
11/3/11	PBQL	PBQL	PBQL	0.048	-	1.8	0.012	PBQL	PBQL	PBQL

[A] PBQL is Present Below Quantification Limit.

Nutrients

Nutrients data was collected at SCDHEC monitoring station RL-11031 in 2011 and is included in the table below. See Table 2-2 for SCDHEC standards for nutrients.

TABLE 3-24 NUTRIENTS AND CHLOROPHYLL A AT SCDHEC MONITORING STATION RL-11031[A]

Date	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Chlorophyll a (ug/L)
1/19/11	PBQL	0.042	-
2/16/11	0.7	0.046	-
3/17/11	0.66	0.029	-
4/14/11	-	0.027	-
5/31/11	-	0.027	8.77
6/29/11	PBQL	0.041	-
7/14/11	PBQL	0.034	17.95
8/11/11	PBQL	0.025	8.85
9/15/11	PBQL	PBQL	7.62
10/20/11	0.43	PBQL	6.74
11/3/11	0.65	0.027	-
12/5/11	0.84	0.035	-

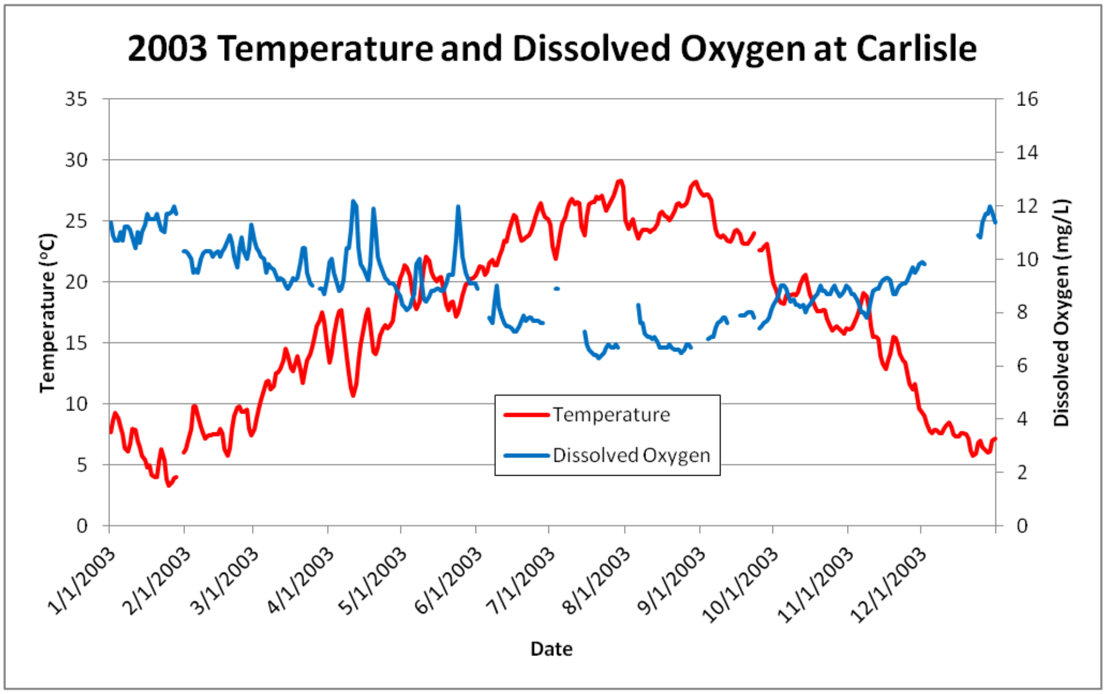
[A] PBQL is Present Below Quantification Limit.

3.3 BROAD RIVER UPSTREAM OF PARR RESERVOIR

3.3.1 USGS SITE 02156500

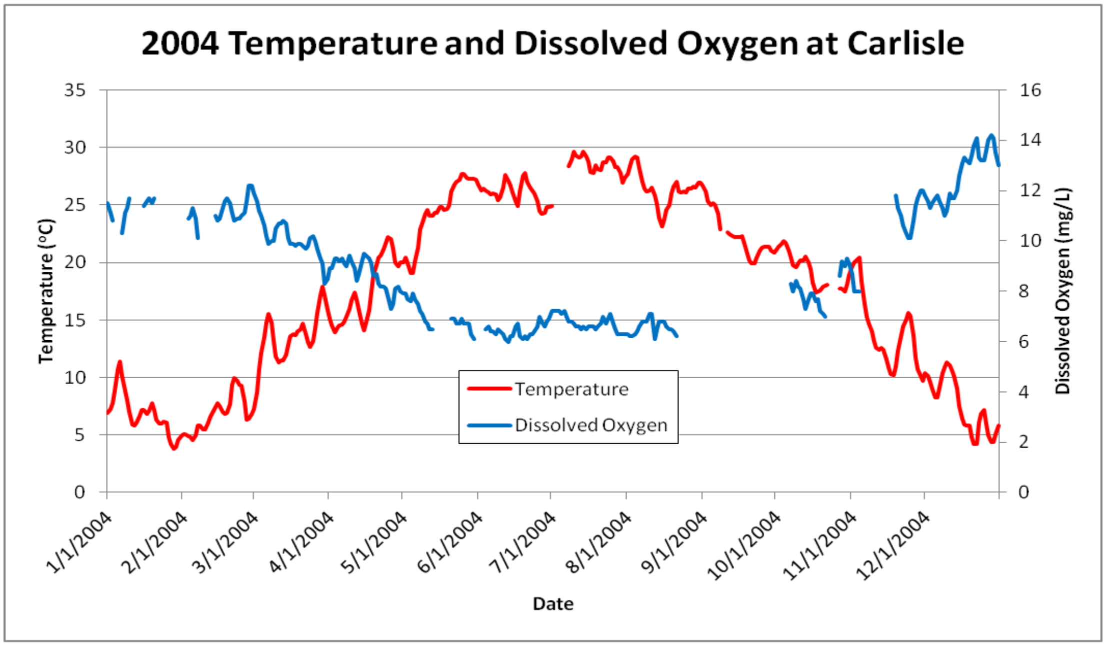
3.3.1.1 TEMPERATURE AND DISSOLVED OXYGEN

Water temperature at the USGS Site 02156500 ranges from approximately 4°C during the winter months to approximately 33°C during the summer. During the summer months, DO levels typically drop to around the 6-7 mg/L range.



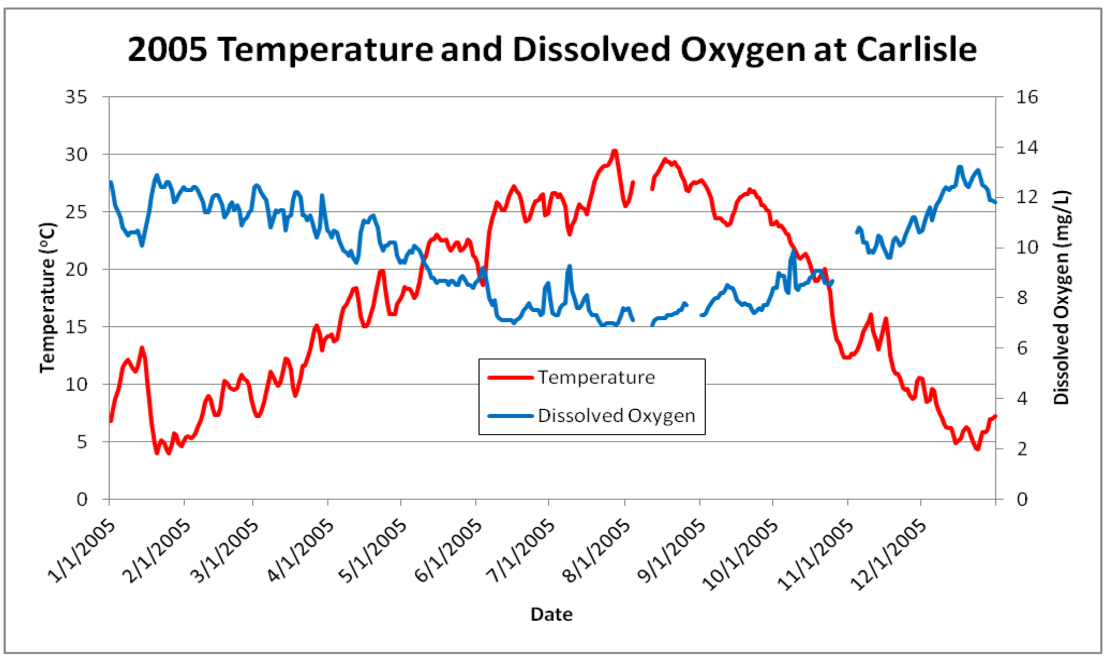
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-127 TEMPERATURE AND DISSOLVED OXYGEN FOR 2003: UPSTREAM OF PARR RESERVOIR[A]



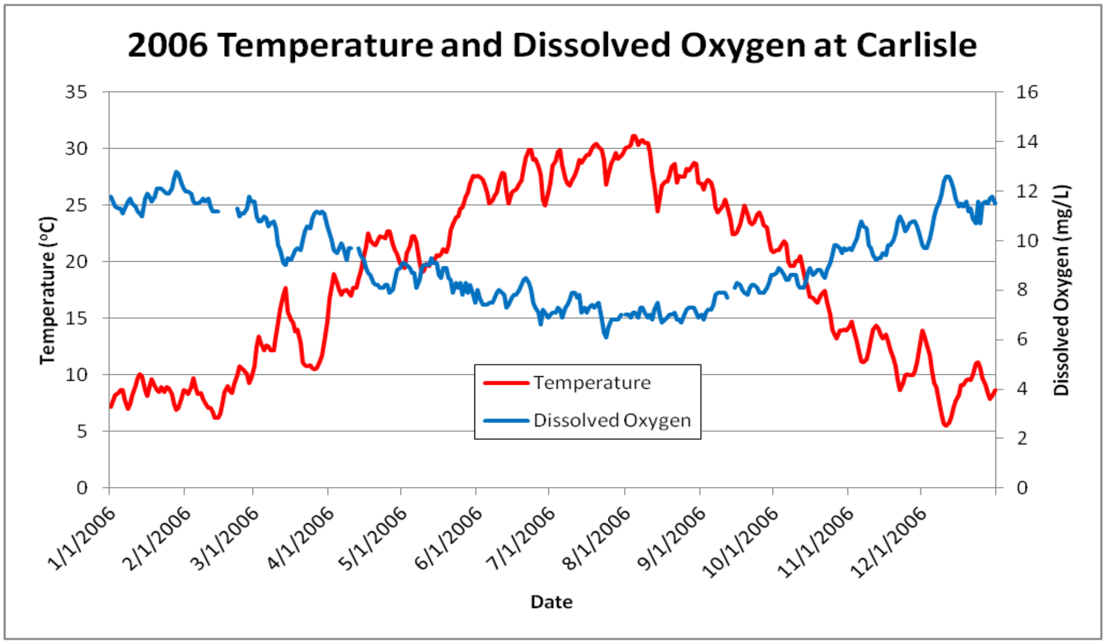
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-128 TEMPERATURE AND DISSOLVED OXYGEN FOR 2004: UPSTREAM OF PARR RESERVOIR[A]



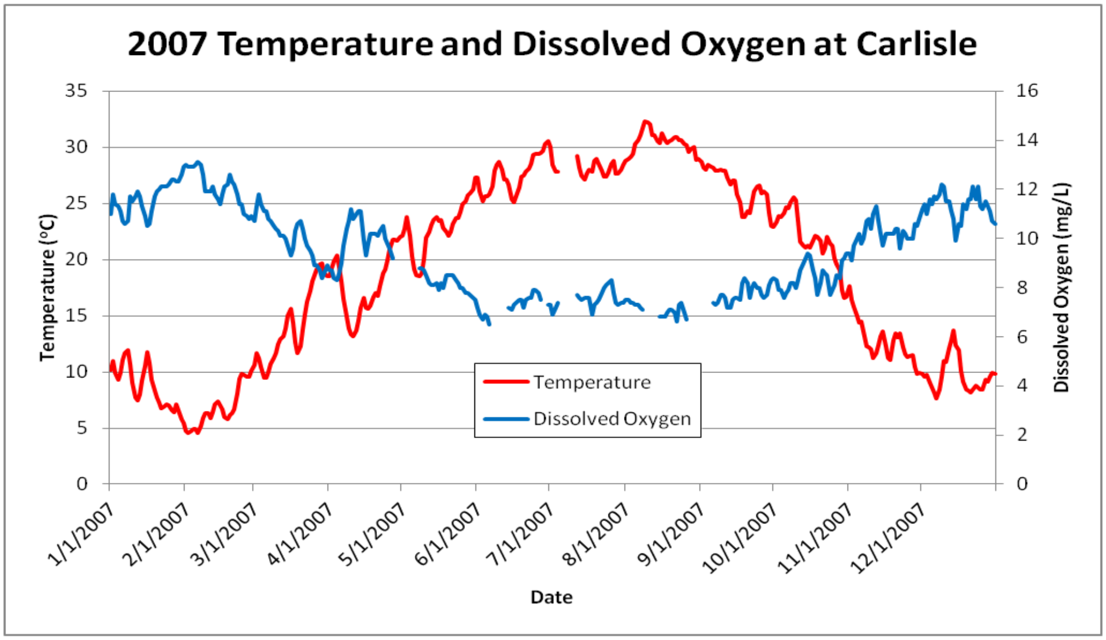
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-129 TEMPERATURE AND DISSOLVED OXYGEN FOR 2005: UPSTREAM OF PARR RESERVOIR[A]



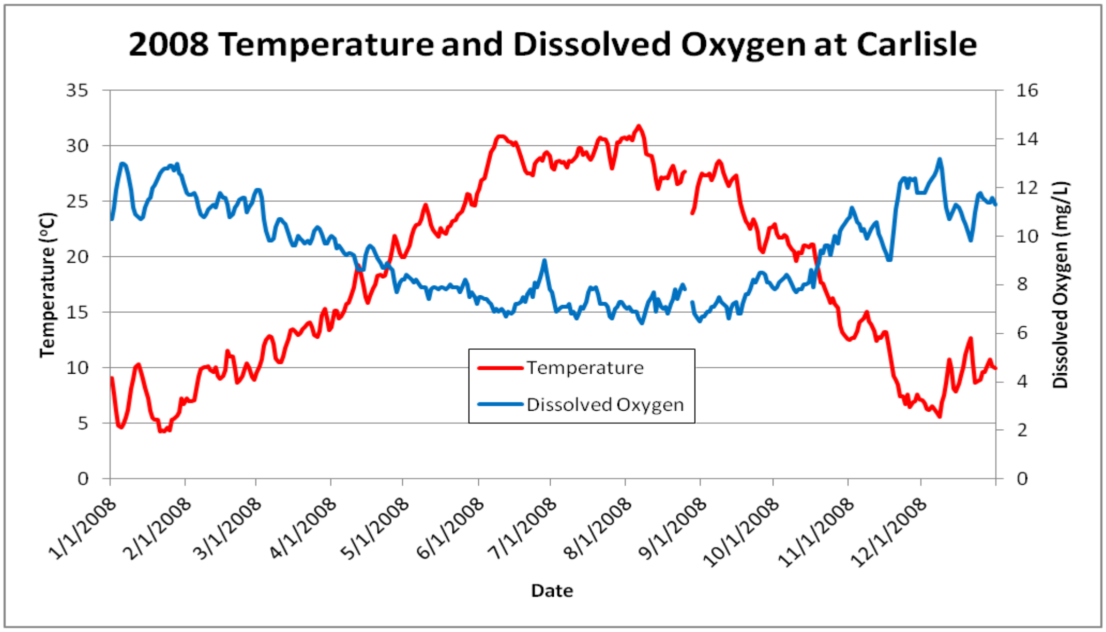
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-130 TEMPERATURE AND DISSOLVED OXYGEN FOR 2006: UPSTREAM OF PARR RESERVOIR[A]



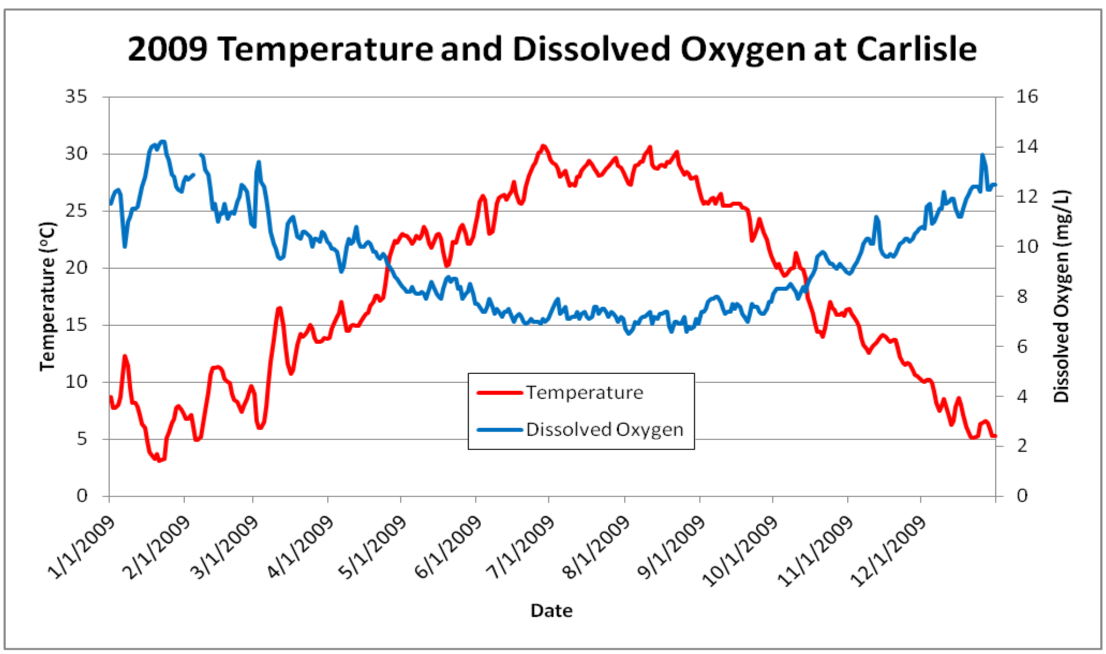
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-131 TEMPERATURE AND DISSOLVED OXYGEN FOR 2007: UPSTREAM OF PARR RESERVOIR[A]



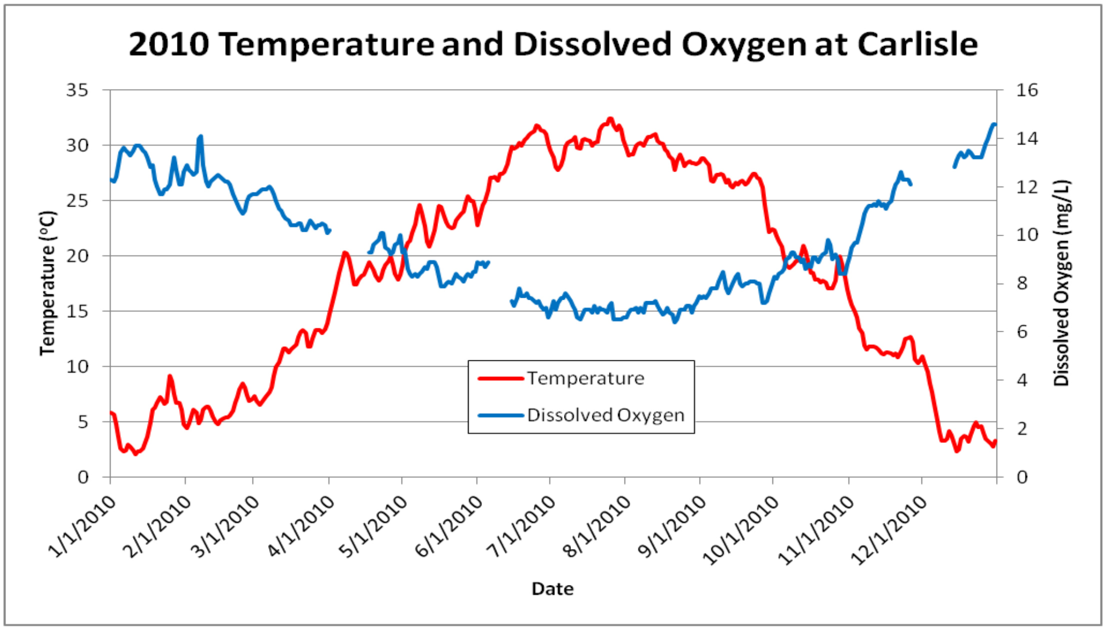
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-132 TEMPERATURE AND DISSOLVED OXYGEN FOR 2008: UPSTREAM OF PARR RESERVOIR[A]



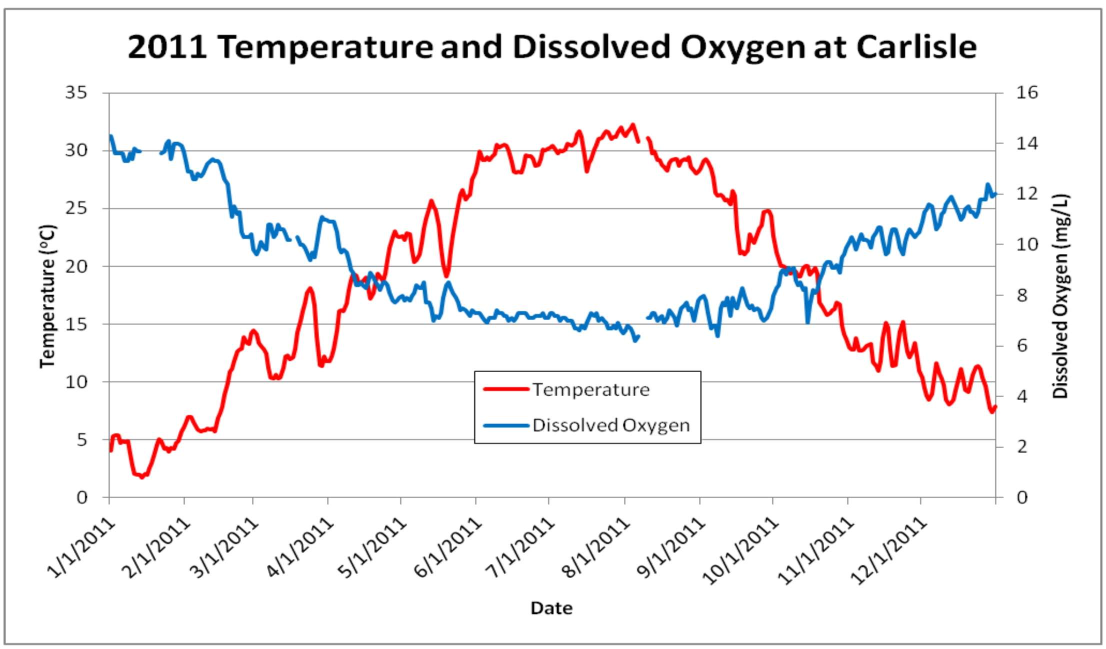
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-133 TEMPERATURE AND DISSOLVED OXYGEN FOR 2009: UPSTREAM OF PARR RESERVOIR[A]



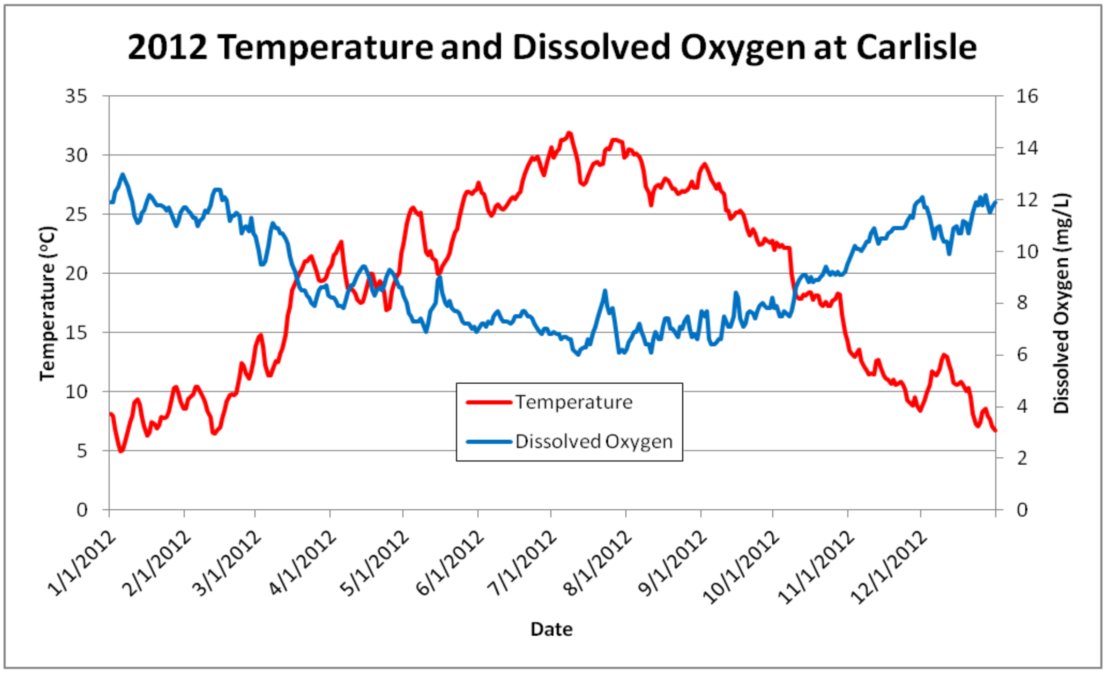
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-134 TEMPERATURE AND DISSOLVED OXYGEN FOR 2010: UPSTREAM OF PARR RESERVOIR[A]



[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-135 TEMPERATURE AND DISSOLVED OXYGEN FOR 2011: UPSTREAM OF PARR RESERVOIR[A]

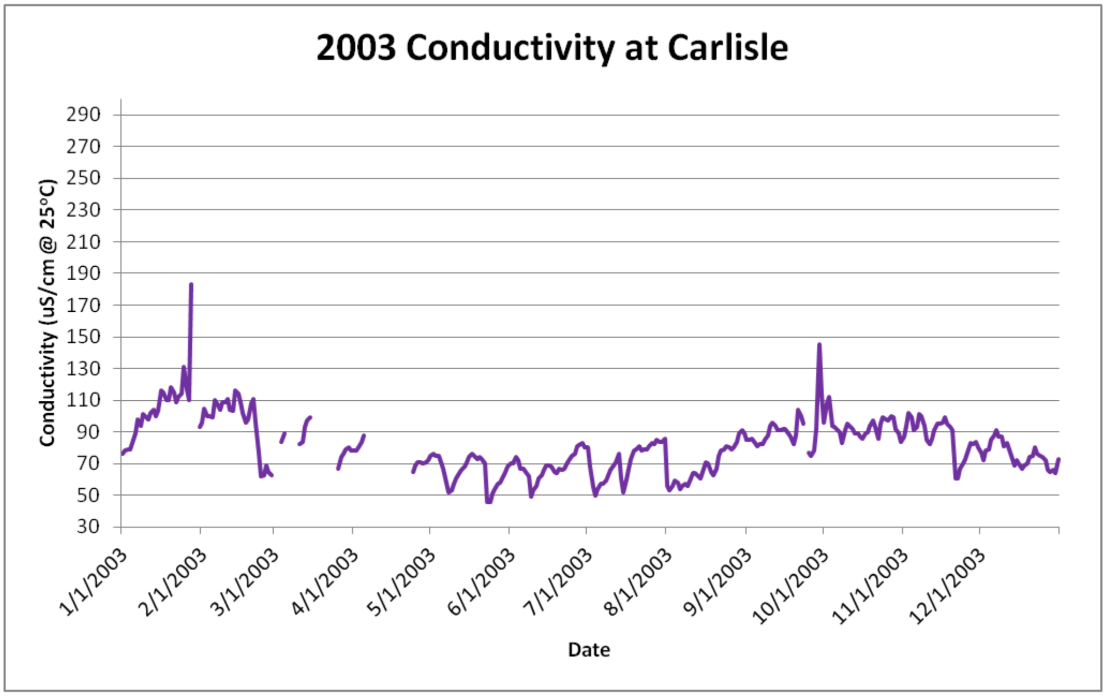


[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-136 TEMPERATURE AND DISSOLVED OXYGEN FOR 2012: UPSTREAM OF PARR RESERVOIR[A]

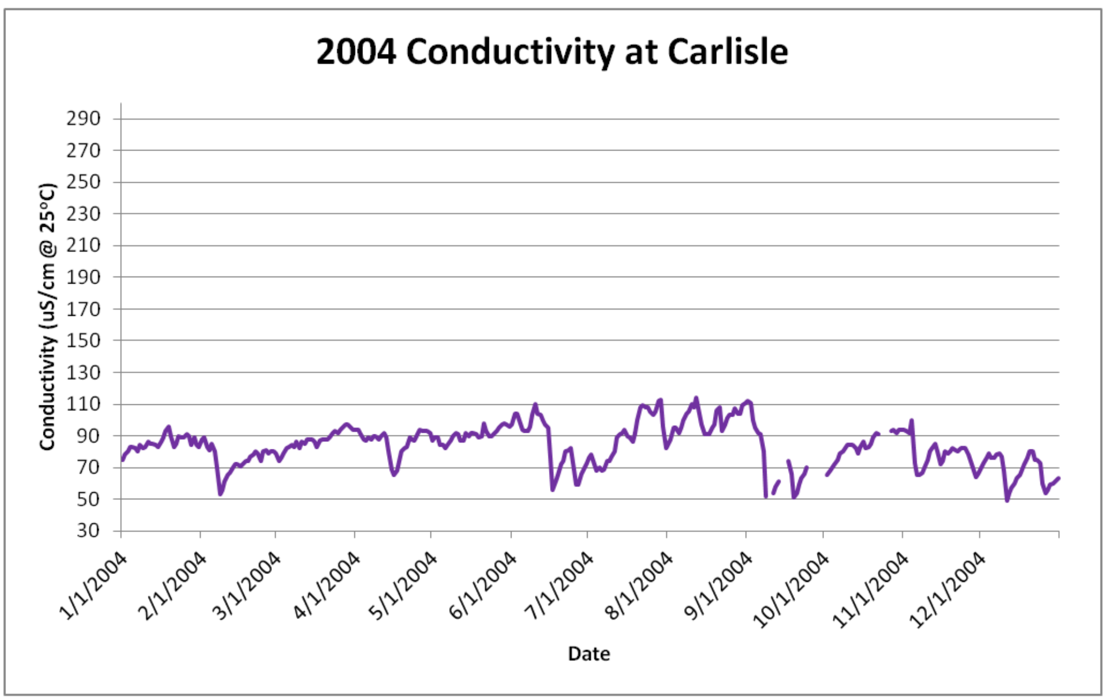
3.3.1.2 CONDUCTIVITY

The conductivity measured at the USGS site 02156500 ranged from approximately 50 µS/cm to 150 µS/cm over the last ten years, except for 2007 and 2008 when the conductivity spiked up to 270 µS/cm. Daily readings for conductivity from January of 2003 through December of 2012 at the USGS site located at Carlisle on the Broad River are shown in the figures below.



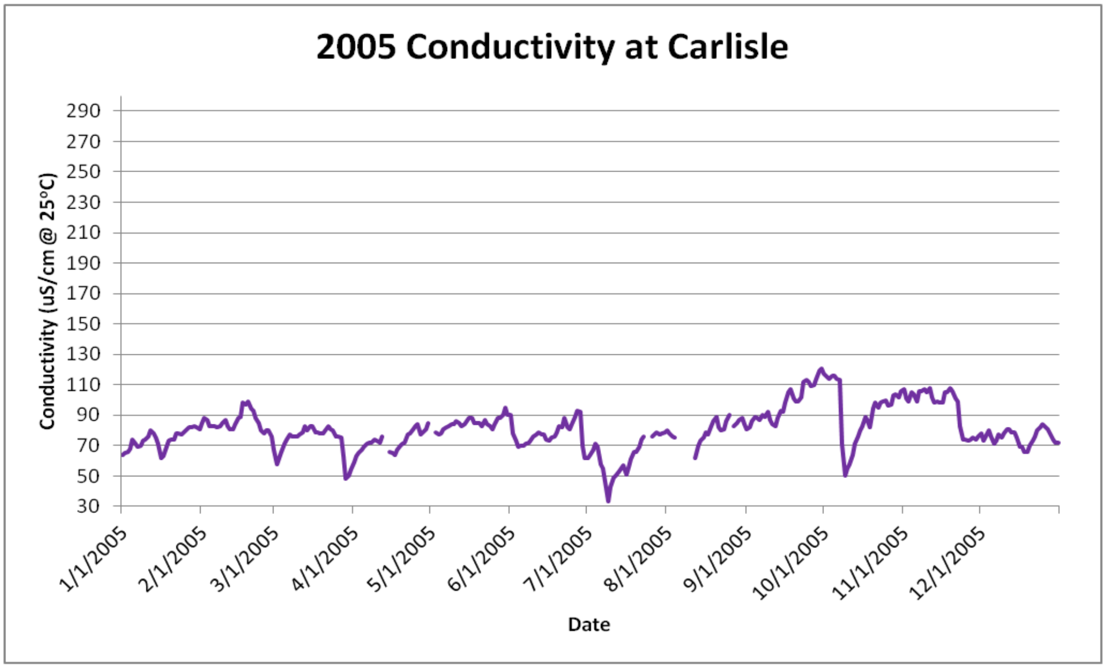
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-137 CONDUCTIVITY FOR 2003: UPSTREAM OF PARR RESERVOIR[A]



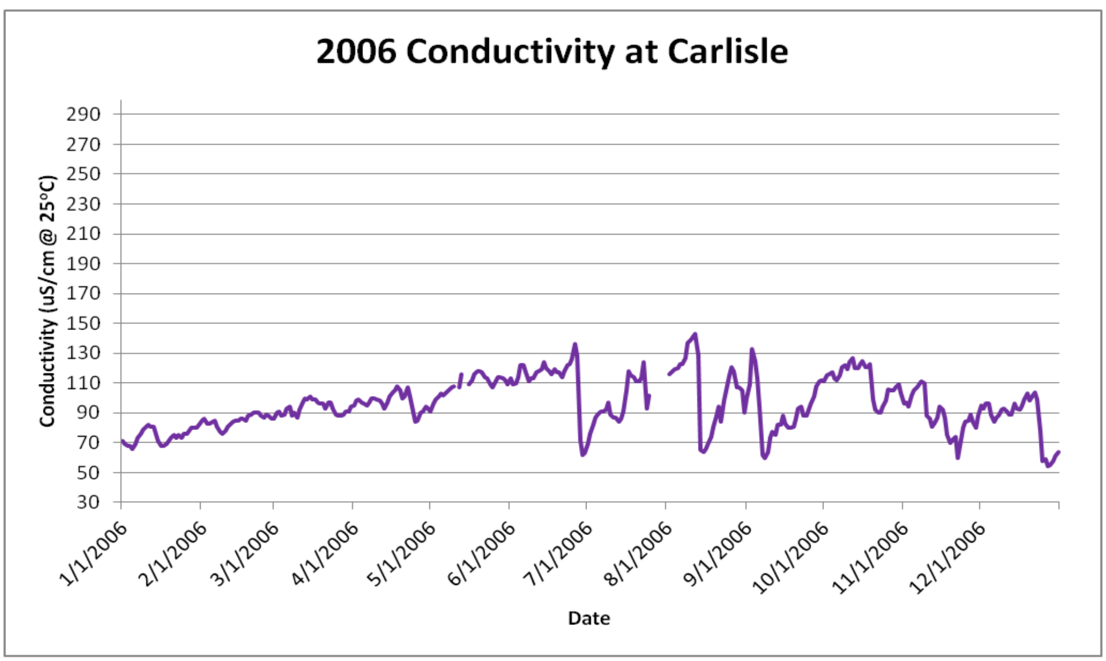
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-138 CONDUCTIVITY FOR 2004: UPSTREAM OF PARR RESERVOIR[A]



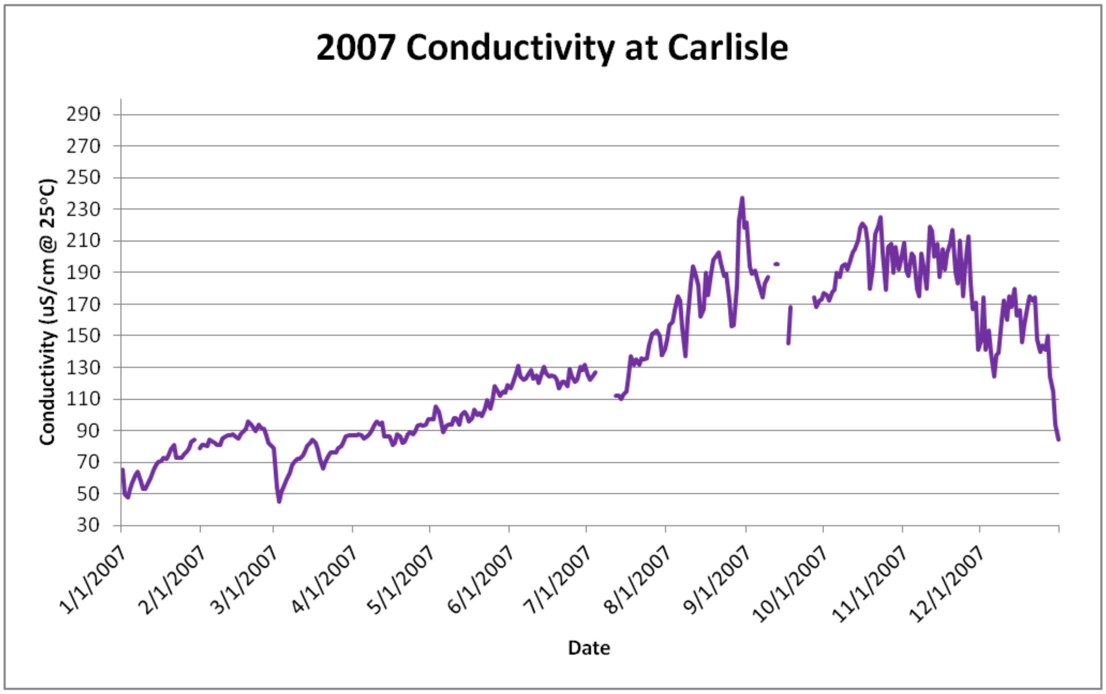
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-139 CONDUCTIVITY FOR 2005: UPSTREAM OF PARR RESERVOIR[A]



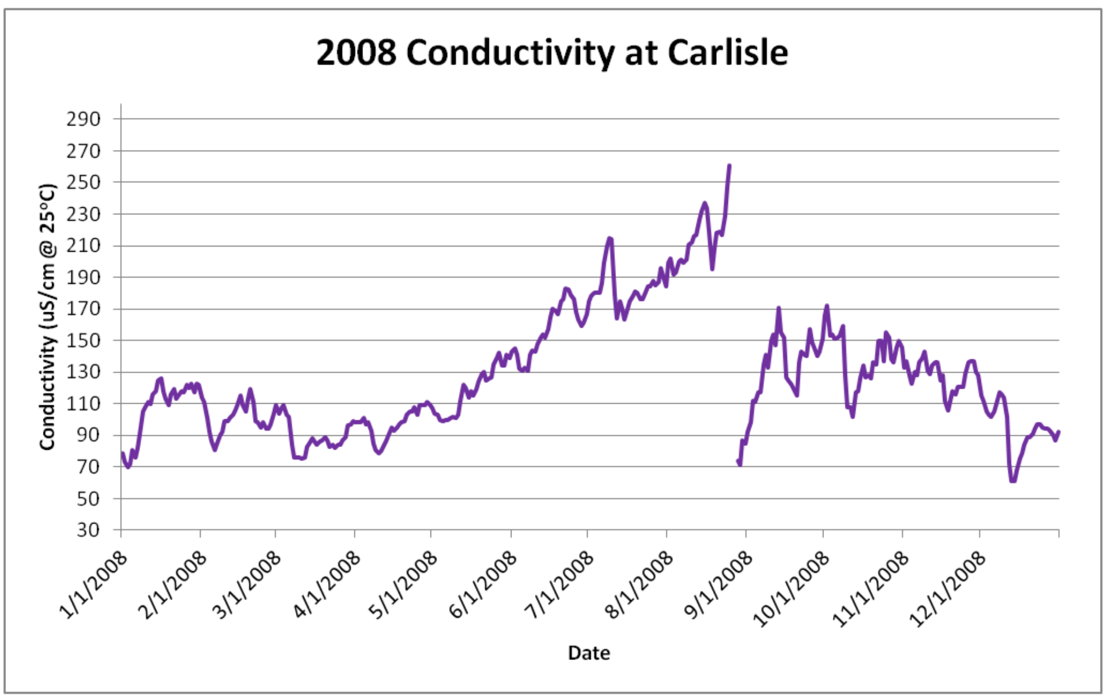
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-140 CONDUCTIVITY FOR 2006: UPSTREAM OF PARR RESERVOIR[A]



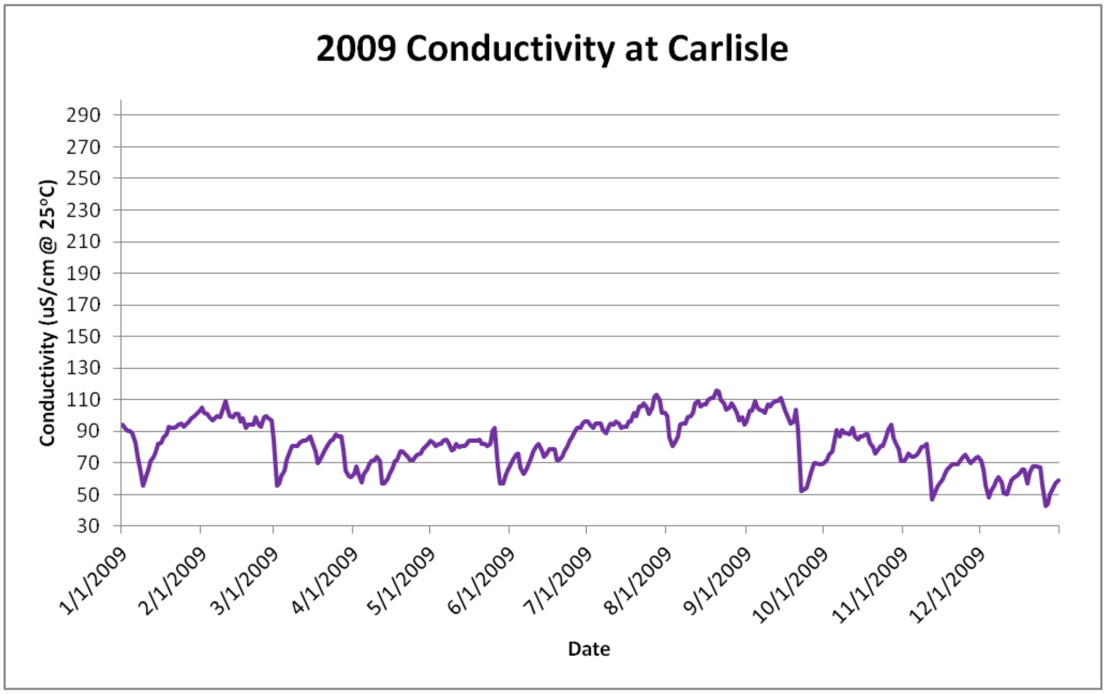
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-141 CONDUCTIVITY FOR 2007: UPSTREAM OF PARR RESERVOIR[A]



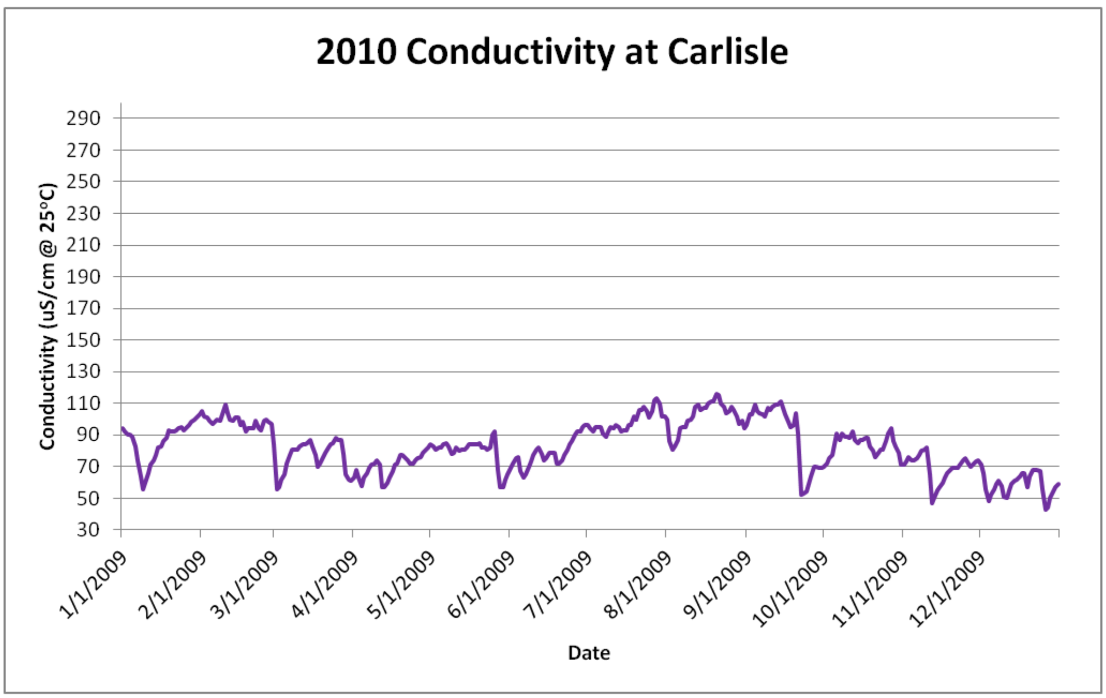
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-142 CONDUCTIVITY FOR 2008: UPSTREAM OF PARR RESERVOIR[A]



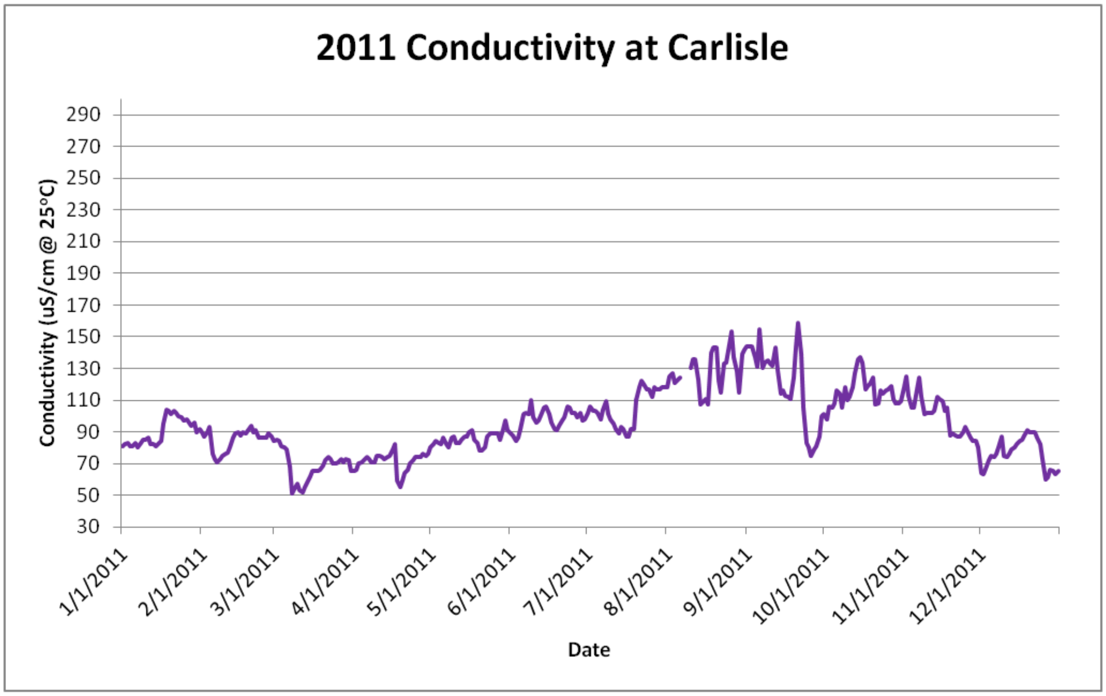
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-143 CONDUCTIVITY FOR 2009: UPSTREAM OF PARR RESERVOIR[A]



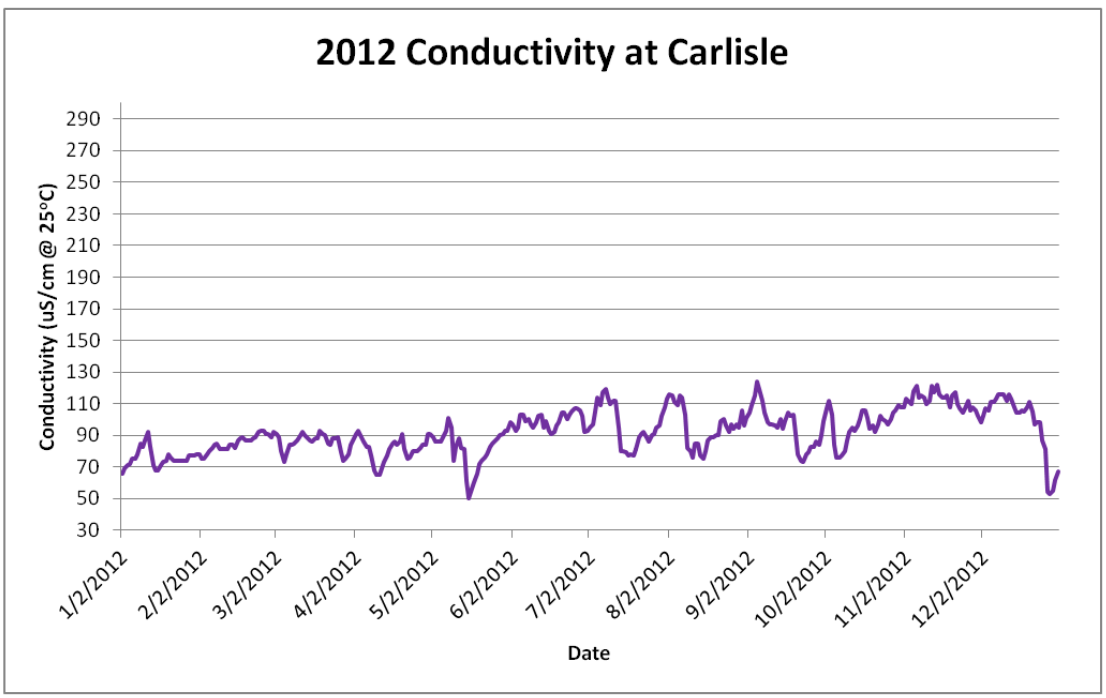
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-144 CONDUCTIVITY FOR 2010: UPSTREAM OF PARR RESERVOIR[A]



[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-145 CONDUCTIVITY FOR 2011: UPSTREAM OF PARR RESERVOIR[A]

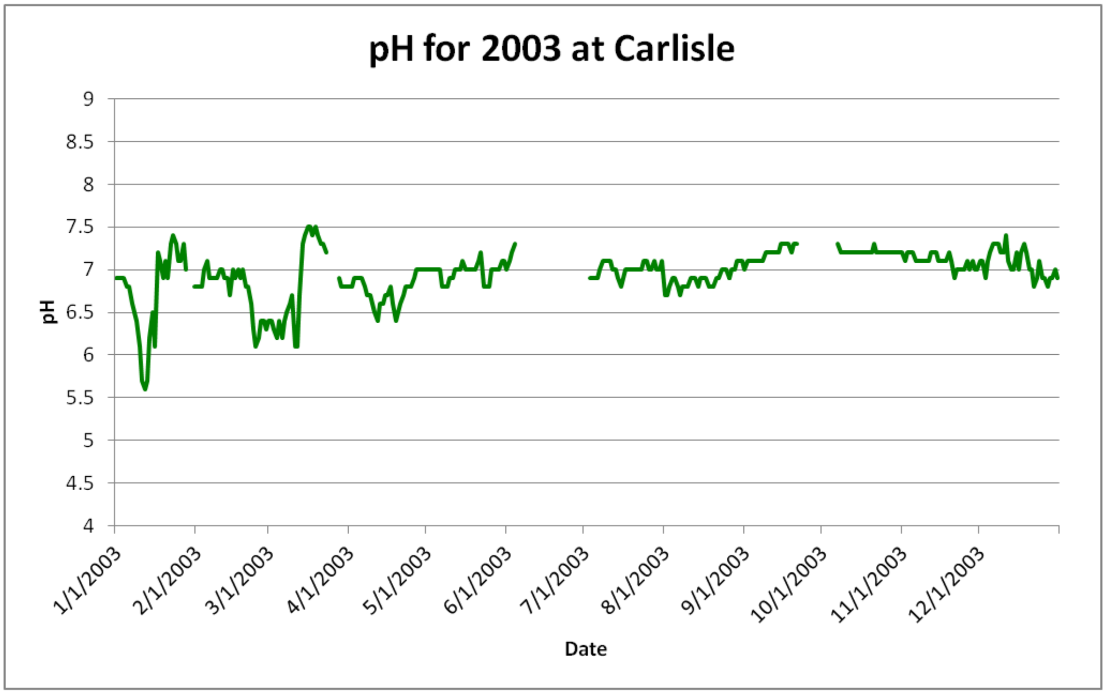


[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-146 CONDUCTIVITY FOR 2012: UPSTREAM OF PARR RESERVOIR[A]

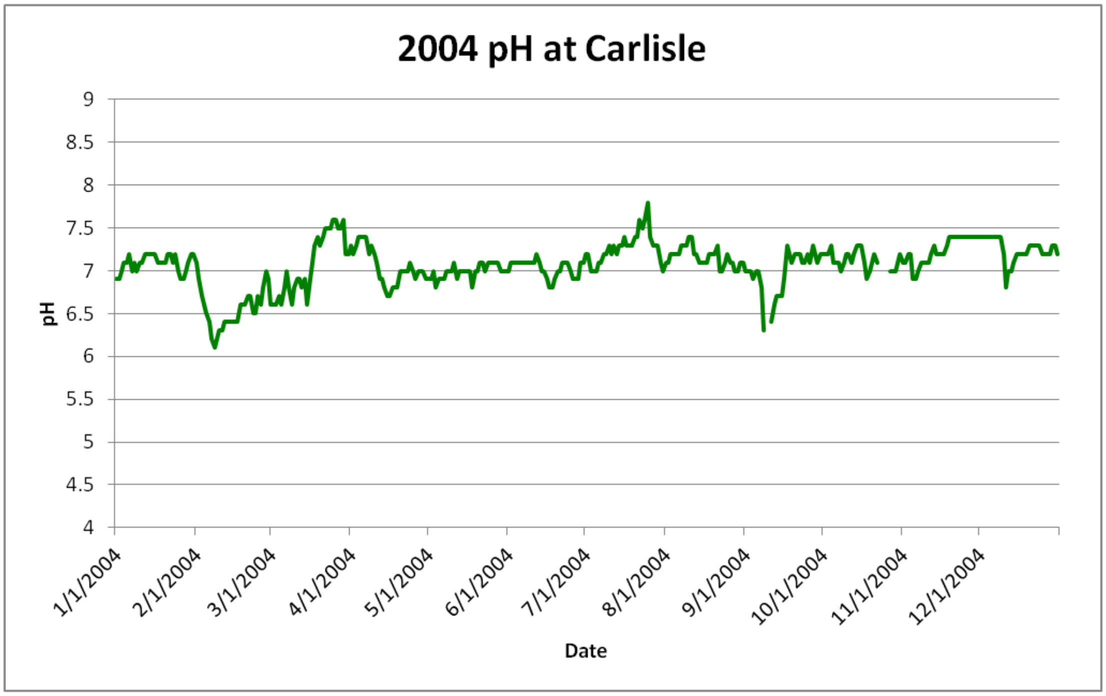
3.3.1.3 PH

Generally, the pH at the USGS monitoring site 02156500 is within the State Standards of 6.5 to 8.0, with few instances of a daily pH reading of below 6.5 in 2003 and 2004.



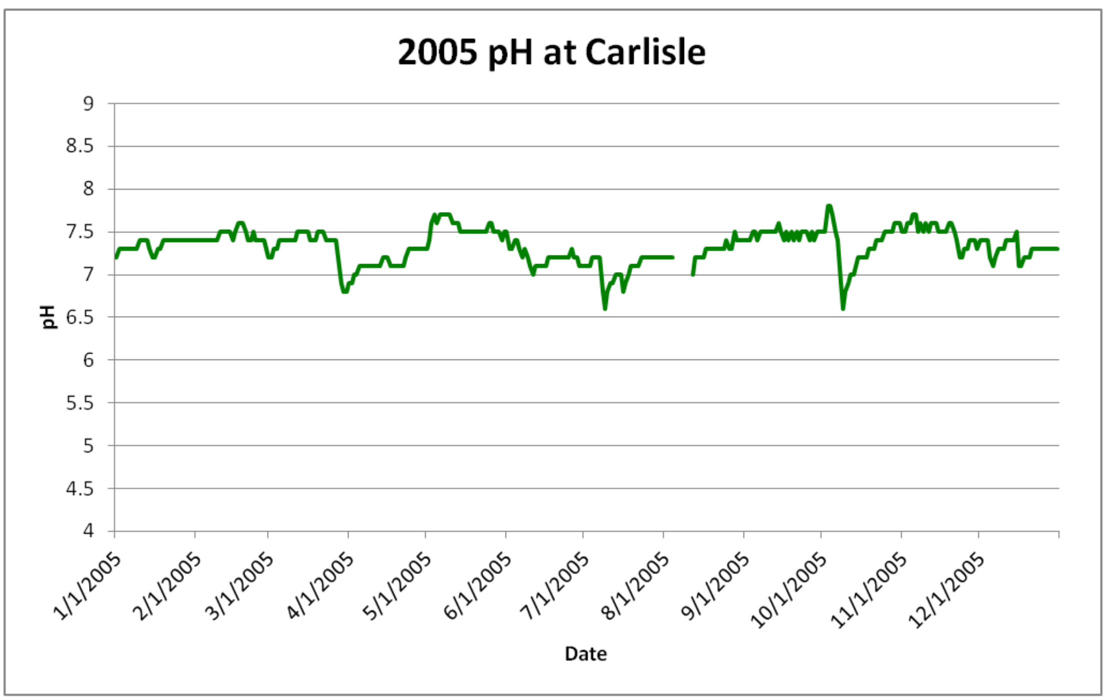
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-147 PH FOR 2003: UPSTREAM OF PARR RESERVOIR[A]



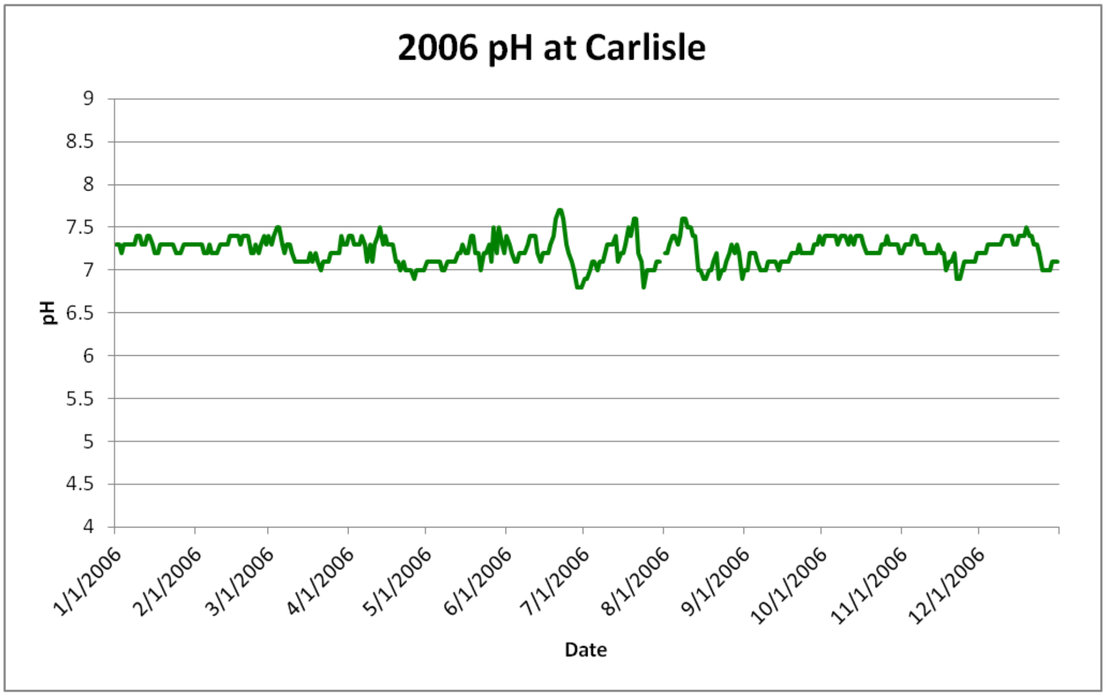
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-148 pH FOR 2004: UPSTREAM OF PARR RESERVOIR[A]



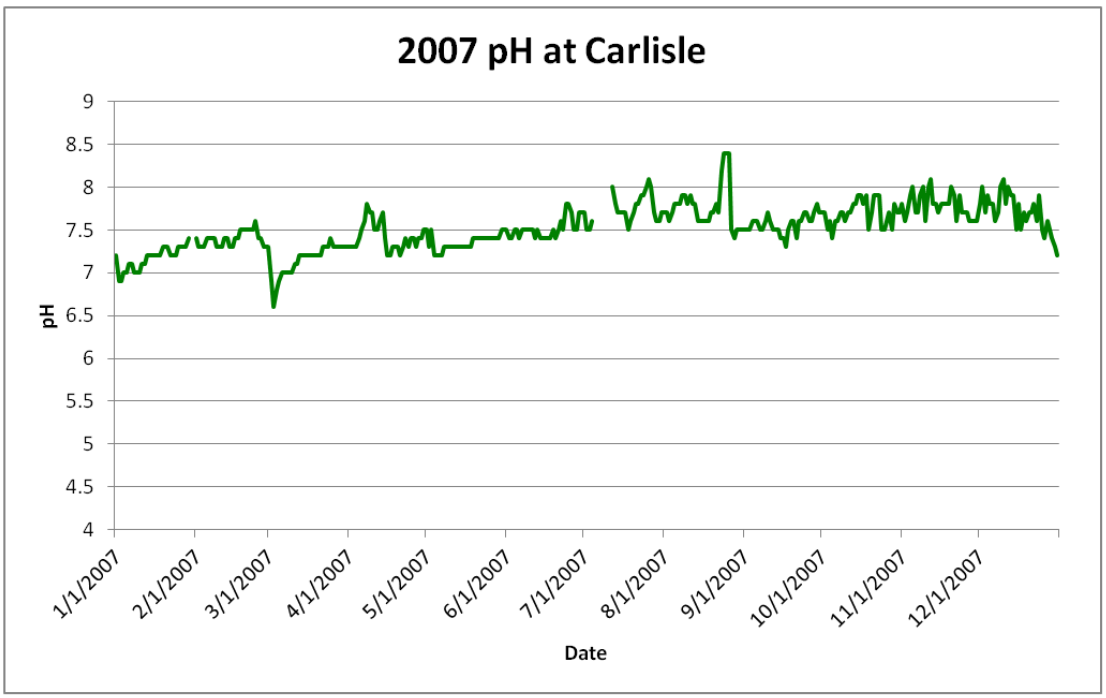
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-149 pH FOR 2005: UPSTREAM OF PARR RESERVOIR[A]



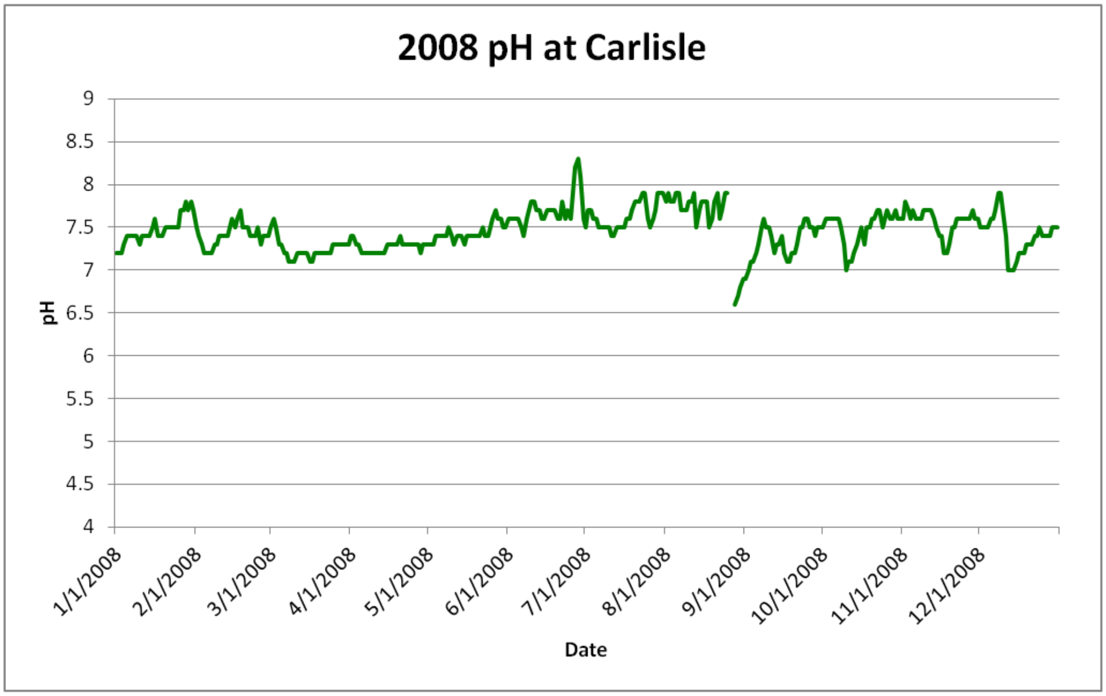
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-150 PH FOR 2006: UPSTREAM OF PARR RESERVOIR[A]



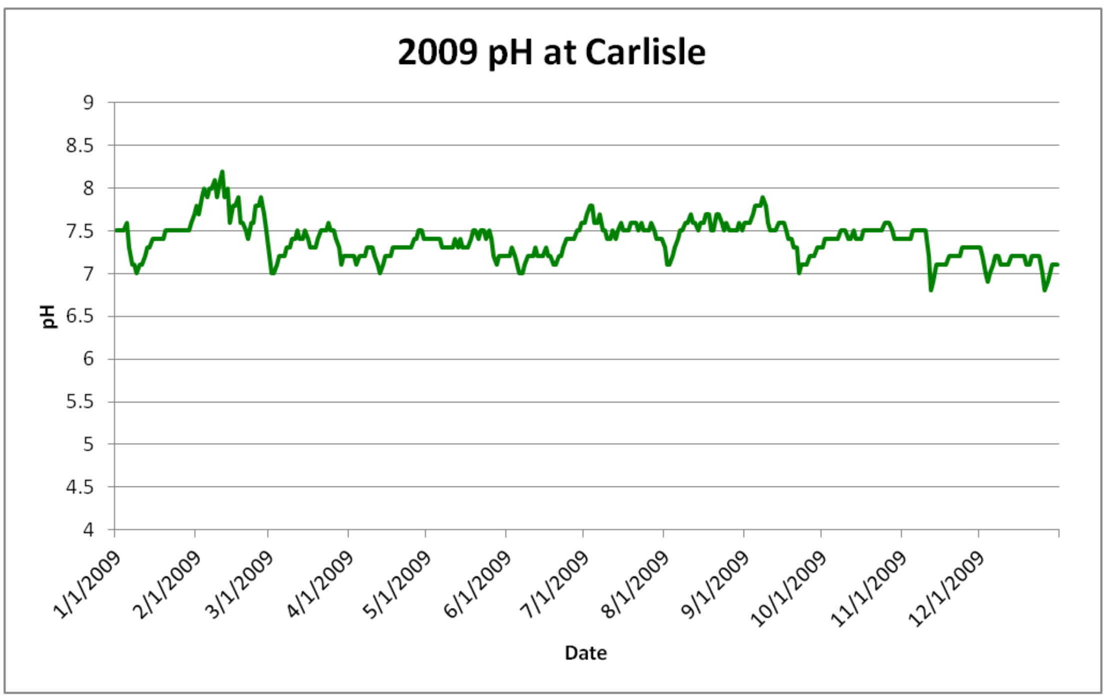
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-151 PH FOR 2007: UPSTREAM OF PARR RESERVOIR[A]



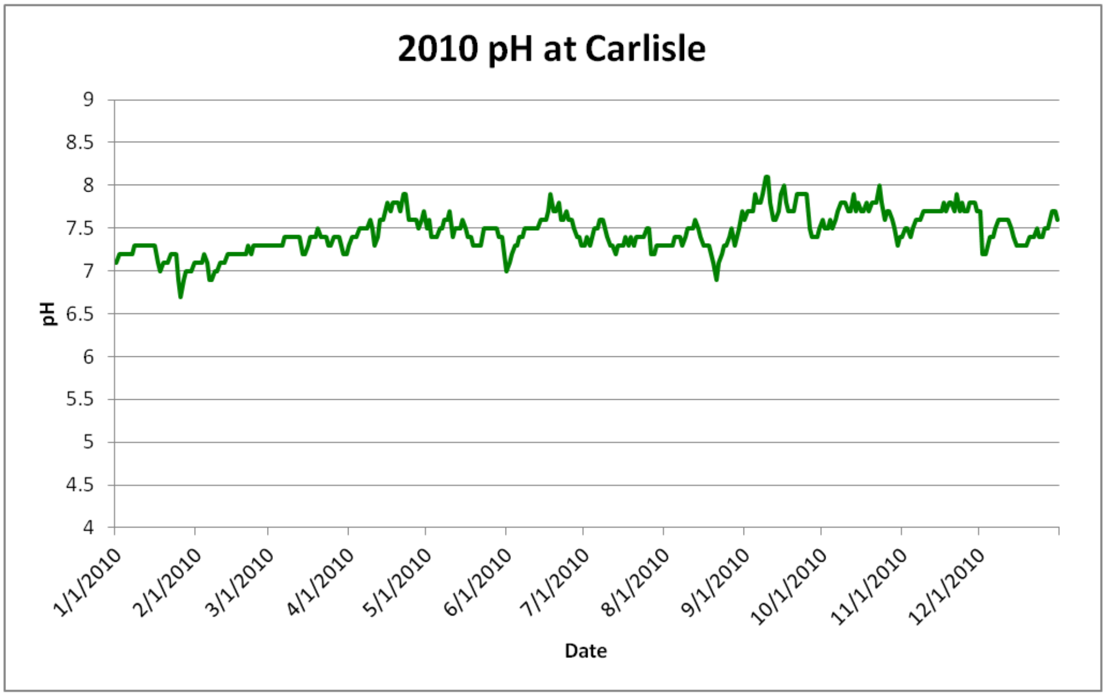
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-152 PH FOR 2008: UPSTREAM OF PARR RESERVOIR[A]



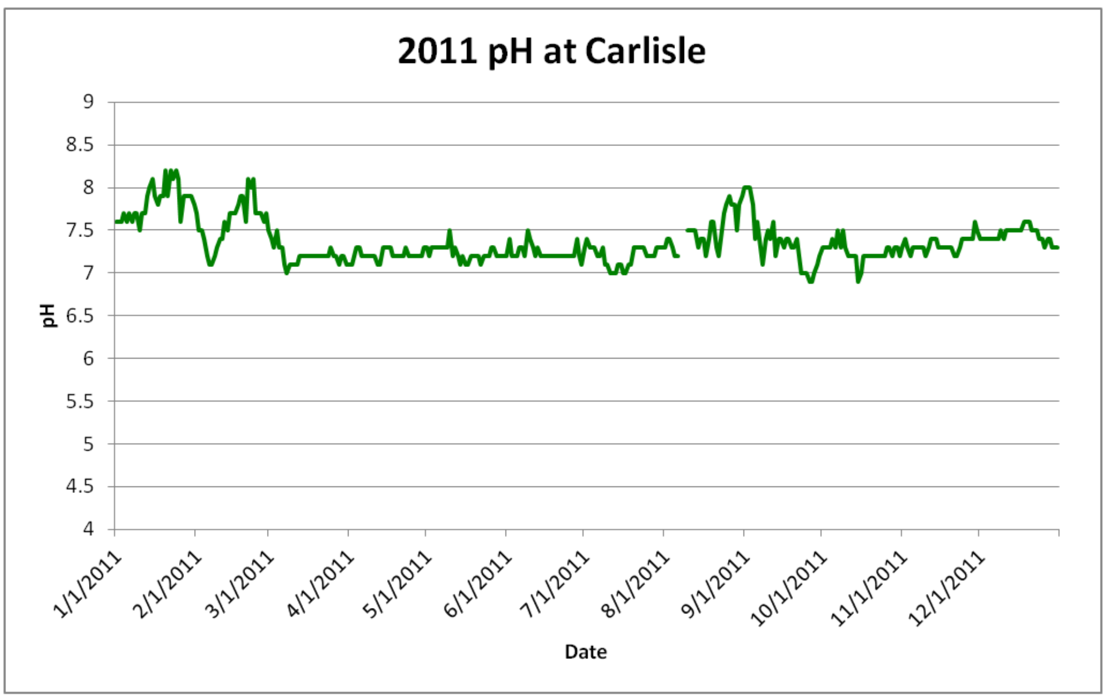
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-153 PH FOR 2009: UPSTREAM OF PARR RESERVOIR[A]



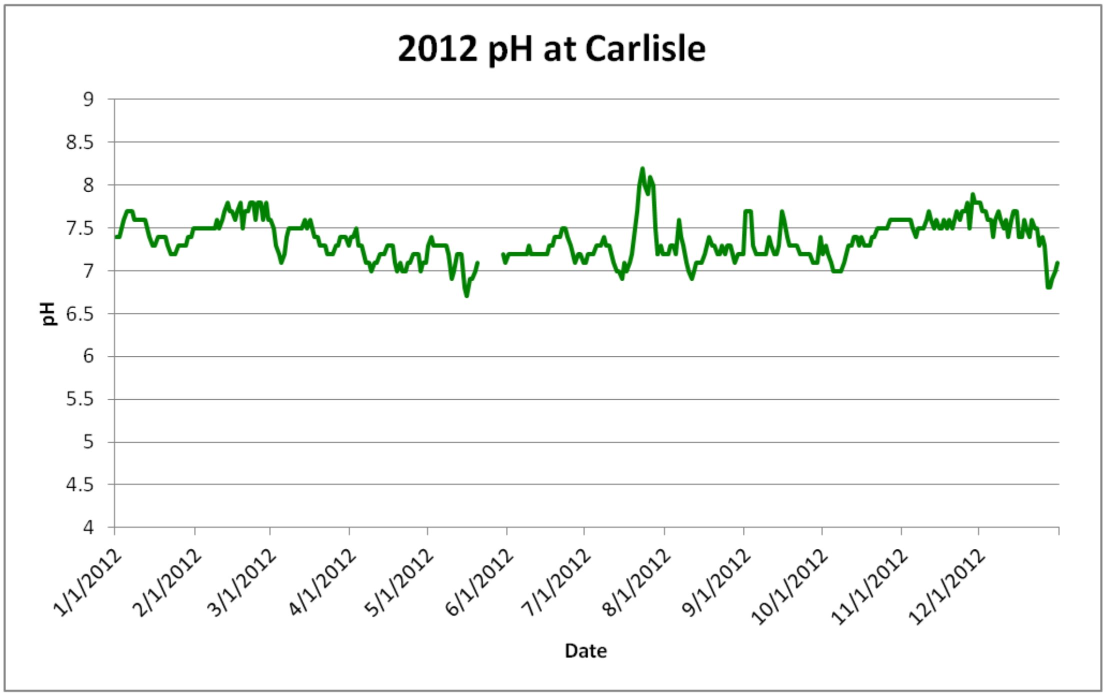
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-154 pH FOR 2010: UPSTREAM OF PARR RESERVOIR[A]



[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-155 pH FOR 2011: UPSTREAM OF PARR RESERVOIR[A]



[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-156 pH FOR 2012: UPSTREAM OF PARR RESERVOIR[A]

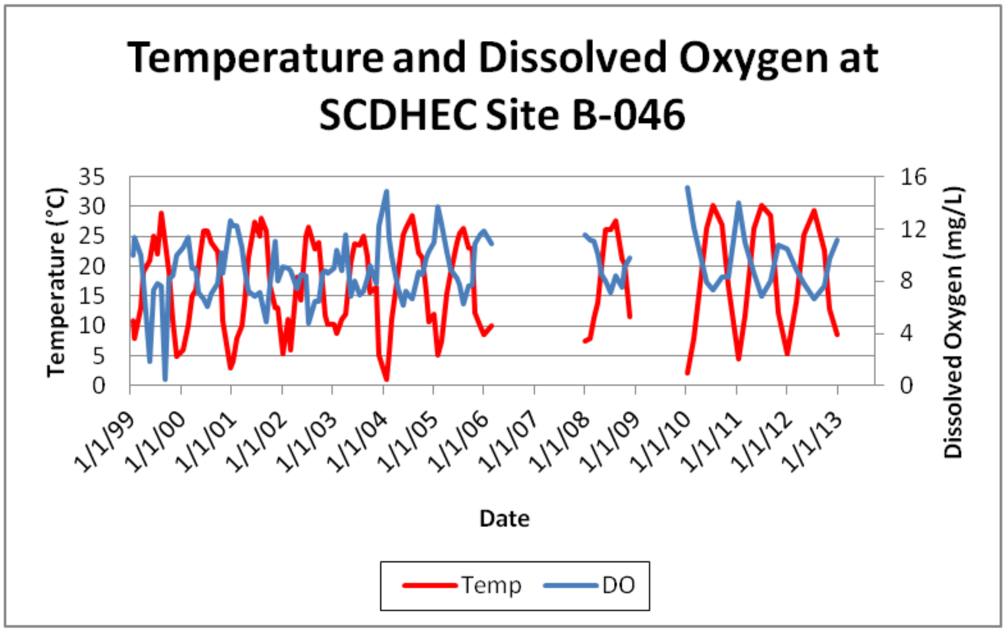
3.3.2 SCDHEC DATA

3.3.2.1 MONITORING STATION B-046

While samples collected from SCDHEC monitoring station B-046, Broad River at SC 72/215/121 bridge 3 miles E of Carlisle, have been above the allowed limits for some of the parameters discussed below in the past, this site is currently without impairment and is not listed on the 2012 303(d) list.

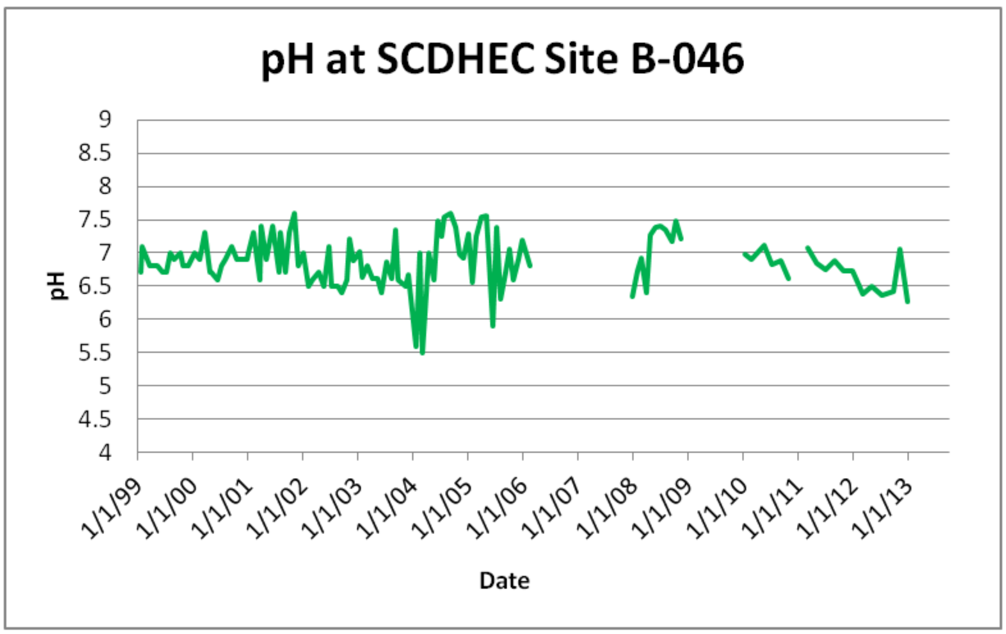
Temperature, DO, pH, and Turbidity

The following data was collected from 1999 through 2013 at the SCDHEC monitoring station B-046, located upstream of the Parr Reservoir. See Table 2-1 for the SCDHEC water quality standards for temperature, DO, pH, and turbidity.



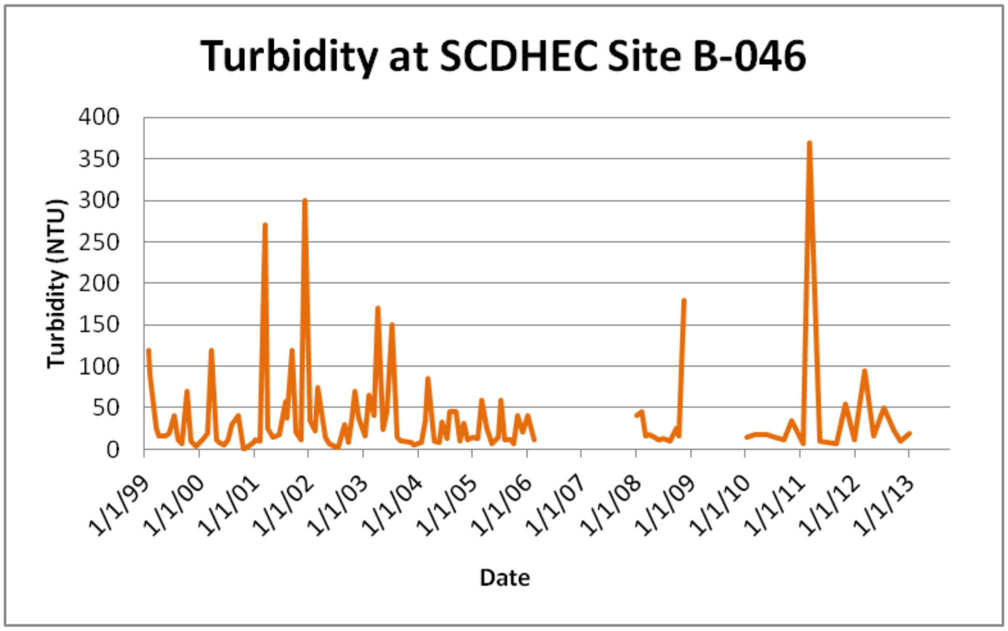
[a] Graph depicts only data that were available on STORET. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-157 WATER TEMPERATURE AND DISSOLVED OXYGEN AT SCDHEC MONITORING STATION B-046[A]



[a] Graph depicts only data that were available on STORET. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-158 PH AT SCDHEC MONITORING STATION B-046[A]



[a] Graph depicts only data that were available on STORET. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-159 TURBIDITY AT SCDHEC MONITORING STATION B-046[A]

Metals

Metals data was collected on a quarterly basis from 1999 through 2012 at SCDHEC monitoring site B-046 and is presented in the table below. As shown in Table 3-25, the SCDHEC core indicator metals (Table 2-3) have been consistently measured as Present Below Quantification Limit (PBQL) at site B-046, indicating the river supports aquatic life use.

TABLE 3-25 METALS PRESENT AT SCDHEC MONITORING STATION B-046[A]

DATE	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Magnesium (mg/L)	Manganese (mg/L)	Mercury (mg/L)	Nickel (mg/L)	Zinc (mg/L)
3/23/99	PBQL	PBQL	PBQL	0.99	PBQL	-	0.04	PBQL	PBQL	PBQL
6/17/99	PBQL	PBQL	PBQL	1.1	PBQL	-	0.07	PBQL	PBQL	0.02
9/7/99	PBQL	PBQL	PBQL	0.4	PBQL	-	0.09	PBQL	PBQL	PBQL
3/23/00	0.01	PBQL	PBQL	9.1	PBQL	-	0.29	PBQL	PBQL	0.03
6/15/00	PBQL	PBQL	PBQL	0.34	PBQL	-	0.1	PBQL	PBQL	PBQL
9/20/00	PBQL	PBQL	PBQL	2.3	PBQL	-	0.12	PBQL	PBQL	0.01
12/28/00	PBQL	PBQL	PBQL	1.4	PBQL	-	0.12	PBQL	PBQL	-
3/21/01	PBQL	PBQL	PBQL	11	PBQL	-	0.55	PBQL	PBQL	0.02
6/19/01	PBQL	PBQL	PBQL	1.8	PBQL	-	0.15	PBQL	PBQL	0.012
9/10/01	PBQL	PBQL	PBQL	7	PBQL	-	0.36	PBQL	PBQL	0.017
12/4/01	PBQL	PBQL	PBQL	5.2	PBQL	-	0.3	PBQL	PBQL	PBQL
3/5/02	PBQL	PBQL	PBQL	1.3	PBQL	3.1	0.13	PBQL	PBQL	PBQL
6/24/02	PBQL	PBQL	PBQL	0.39	PBQL	-	0.17	PBQL	PBQL	PBQL
9/23/02	PBQL	PBQL	0.018	0.58	PBQL	-	0.18	PBQL	PBQL	PBQL
12/3/02	PBQL	PBQL	PBQL	1	PBQL	-	0.048	PBQL	PBQL	0.046
3/11/03	PBQL	PBQL	PBQL	3.1	PBQL	3	0.082	PBQL	PBQL	0.011
6/9/03	PBQL	PBQL	PBQL	3.1	PBQL	-	0.053	PBQL	PBQL	0.011
9/15/03	PBQL	PBQL	PBQL	0.76	PBQL	-	0.14	PBQL	PBQL	0.013
12/2/03	PBQL	PBQL	PBQL	0.68	PBQL	-	0.084	PBQL	PBQL	PBQL
3/10/04	PBQL	PBQL	PBQL	2.4	PBQL	2.4	0.11	PBQL	PBQL	PBQL
6/15/04	PBQL	PBQL	0.03	1.8	PBQL	-	0.066	PBQL	PBQL	0.067
9/15/04	PBQL	PBQL	PBQL	1.6	PBQL	-	0.06	PBQL	PBQL	0.042
12/1/04	PBQL	PBQL	PBQL	0.62	PBQL	-	0.026	PBQL	PBQL	0.022
3/3/05	PBQL	PBQL	PBQL	2.7	PBQL	-	0.047	PBQL	PBQL	0.037
6/20/05	PBQL	PBQL	PBQL	0.6	PBQL	-	0.038	PBQL	PBQL	0.032
9/13/05	PBQL	PBQL	PBQL	0.64	PBQL	-	0.036	PBQL	PBQL	PBQL
12/5/05	PBQL	PBQL	PBQL	2.6	PBQL	-	0.11	PBQL	PBQL	0.018
3/3/08	PBQL	PBQL	PBQL	0.88	PBQL	1.6	0.047	PBQL	PBQL	0.014
6/2/08	PBQL	PBQL	PBQL	0.45	PBQL	1.7	0.049	PBQL	PBQL	0.012
9/24/08	PBQL	PBQL	PBQL	0.6	PBQL	-	0.1	PBQL	PBQL	0.012
3/3/10	0.0013	PBQL	PBQL	0.76	PBQL	-	0.032	PBQL	PBQL	0.032
5/27/10	0.0073	PBQL	PBQL	0.69	PBQL	-	0.037	PBQL	PBQL	PBQL
7/15/10	PBQL	PBQL	PBQL	0.58	PBQL	-	0.055	PBQL	PBQL	0.017
9/16/10	PBQL	PBQL	PBQL	0.56	PBQL	-	0.035	PBQL	PBQL	0.016
11/2/10	0.0001	PBQL	PBQL	1	PBQL	-	0.042	PBQL	PBQL	PBQL
3/7/11	0.00035	0.0099	PBQL	9.4	PBQL	-	0.58	PBQL	PBQL	0.034
5/12/11	PBQL	PBQL	PBQL	0.49	PBQL	-	0.025	PBQL	PBQL	PBQL
9/1/11	PBQL	PBQL	PBQL	0.34	PBQL	-	0.036	PBQL	PBQL	PBQL
11/2/11	PBQL	PBQL	PBQL	2.5	PBQL	-	0.099	PBQL	PBQL	0.015
3/5/12	0.00026	PBQL	PBQL	4.3	PBQL	-	0.061	PBQL	PBQL	0.01
5/7/12	PBQL	PBQL	PBQL	0.7	PBQL	-	0.057	PBQL	PBQL	PBQL
9/25/12	PBQL	PBQL	PBQL	0.48	PBQL	-	0.064	PBQL	PBQL	0.011
11/7/12	PBQL	PBQL	PBQL	0.41	PBQL	-	0.033	PBQL	PBQL	PBQL

[A] PBQL is Present Below Quantification Limit.

Nutrients

Nutrients and chlorophyll-a data was collected at SCDHEC monitoring station B-046 on a monthly basis from 1999 through 2012 and is presented in the table below. Site B-046 is located in the Broad River; the SCDHEC nutrient and chlorophyll-a standards only apply to reservoirs and therefore do not apply to this site. There are no nutrient and chlorophyll-a standards established for rivers.

TABLE 3-26 NUTRIENTS AT SCDHEC MONITORING STATION B-046[A]

Date	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Date	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
1/26/99	0.88	-	1/29/04	-	0.033
2/3/99	0.93	-	2/19/04	0.62	0.052
3/23/99	0.71	-	3/10/04	-	0.042
4/6/99	0.63	-	4/21/04	0.622	0.045
5/19/99	0.59	-	5/25/04	1.03	0.058
6/17/99	0.82	-	6/15/04	1.27	0.13
7/14/99	0.64	-	7/12/04	0.89	0.088
8/10/99	0.62	-	8/2/04	0.76	0.14
9/7/99	2.52	-	9/15/04	1.05	0.099
10/13/99	0.45	-	10/11/04	0.78	0.063
11/3/99	0.34	-	11/8/04	0.63	0.064
1/20/00	PBQL	-	12/1/04	PBQL	-
2/24/00	0.99	-	1/4/05	0.69	0.042
3/23/00	0.88	-	2/3/05	0.88	0.04
4/24/00	0.52	-	3/3/05	0.77	0.063
5/9/00	0.66	-	4/5/05	0.79	0.084
6/15/00	0.67	-	5/9/05	0.57	0.051
7/13/00	0.78	-	6/20/05	0.83	0.037
8/7/00	0.73	-	7/12/05	1.04	0.059
9/20/00	0.87	-	8/8/05	0.57	0.1
10/25/00	PBQL	-	9/13/05	0.64	0.07
11/2/00	PBQL	-	10/6/05	0.92	0.057
12/28/00	0.52	-	11/1/05	0.77	0.25
1/9/01	0.63	-	12/5/05	0.82	0.09
3/21/01	1.18	-	1/4/06	0.88	0.13
5/7/01	0.89	-	1/2/08	0.63	0.089
6/19/01	-	0.18	2/22/06	-	0.045
7/30/01	0.93	0.16	1/2/08	0.63	0.31
8/8/01	-	0.14	2/4/08	0.64	0.14
9/10/01	1.74	0.25	3/3/08	0.56	0.69
10/8/01	-	0.087	4/1/08	1.01	0.11
11/13/01	PBQL	0.11	5/1/08	0.67	0.18
12/4/01	-	0.71	6/2/08	1.2	0.13
1/9/02	0.67	0.12	7/2/08	0.9	0.24
2/13/02	2.384	1.1	8/11/08	-	0.29
3/5/02	-	0.14	9/24/08	0.86	0.09
4/24/02	1.38	0.19	10/16/08	0.75	0.15
5/21/02	-	0.035	11/18/08	0.55	0.18
6/24/02	1.26	0.18	1/13/10	0.67	0.056
7/17/02	-	PBQL	3/3/10	PBQL	0.1
8/28/02	2.36	0.07	5/27/10	0.94	0.16
9/23/02	-	0.043	7/15/10	1.58	0.34
10/21/02	1.25	0.088	9/16/10	1.3	0.46
11/7/02	-	0.12	11/2/10	1.13	0.16
12/3/02	0.78	0.045	1/18/11	PBQL	0.12
1/15/03	-	0.036	3/7/11	0.93	0.5
2/5/03	1.03	0.079	5/12/11	-	0.32
3/11/03	-	0.078	7/6/11	0.54	0.31
4/8/03	1.2	0.2	9/1/11	1.25	0.28
5/12/03	-	0.04	11/2/11	1.17	0.37
6/9/03	0.98	0.068	1/3/12	0.71	0.29
7/14/03	-	0.098	3/5/12	0.99	0.28
8/19/03	0.91	0.041	5/7/12	0.96	0.12
9/15/03	-	0.04	7/17/12	0.79	0.41
10/2/03	0.87	0.044	9/25/12	0.57	0.12
11/19/03	-	0.072	11/7/12	0.8	0.24
12/2/03	1.28	0.037	1/2/13	PBQL	0.092

[A] PBQL is Present Below Quantification Limit.

3.3.3 TURBIDITY DATA CONTRIBUTED BY SCDNR

The turbidity data displayed below was collected by SCDNR near USGS gage 02156500 as part of an ongoing four-year study entitled "Developing sediment management guidelines to enhance habitat and aquatic resources in the Broad River Basin, South Carolina."

TABLE 3-27 TURBIDITY OF BROAD RIVER AT USGS GAGE 02156500

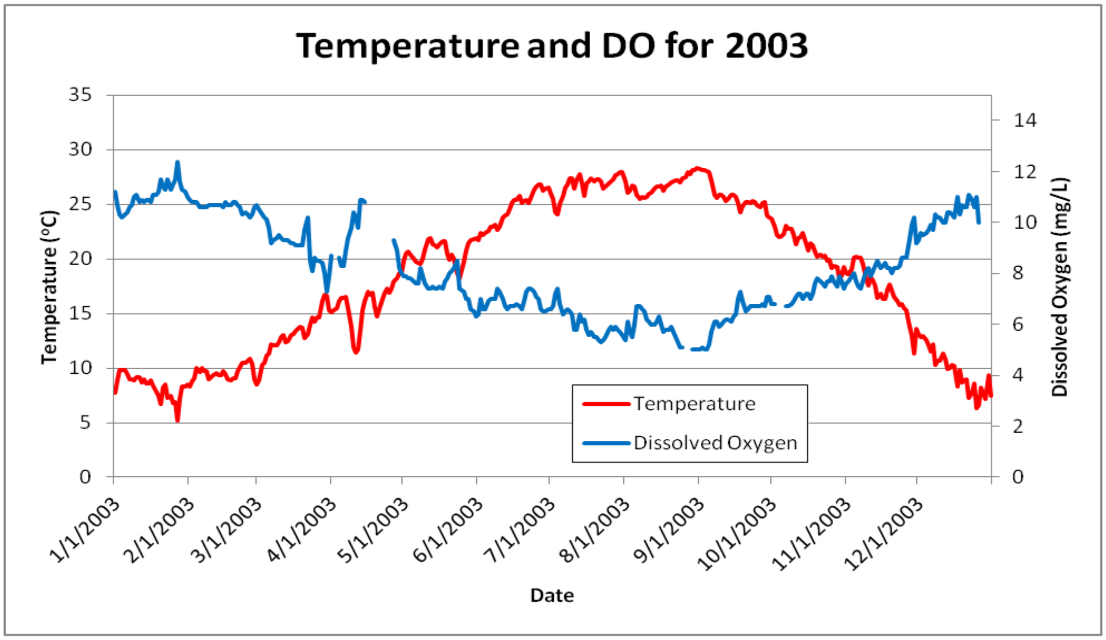
Date	Turbidity (NTU)
6/6/2012	[redacted]
6/20/2012	1.54
7/6/2012	6.93
7/12/2012	21.38
7/27/2012	6.32
8/7/2012	10.34
8/14/2012	26.30
8/20/2012	15.80
8/28/2012	14.80
9/7/2012	16.25
9/21/2012	17.85
10/10/2012	13.58
10/23/2012	7.24
11/14/2012	5.24
12/18/2012	8.17
1/24/2013	[redacted]
2/1/2013	115.00
2/8/2013	12.68
2/19/2013	10.53
2/27/2013	102.70
3/5/2013	10.82
3/13/2013	28.85
3/25/2013	26.31
4/4/2013	7.11
4/19/2013	5.65
4/29/2013	109.30
5/1/2013	58.81
5/6/2013	119.25
5/8/2013	94.13
5/24/2013	46.58
6/4/2013	11.79
6/11/2013	53.34
6/19/2013	20.00
7/5/2013	130.00
7/9/2013	62.03
7/16/2013	83.83
7/24/2013	78.53
8/1/2013	30.11
8/7/2013	49.90
8/8/2013	27.48
8/20/2013	13.88
8/29/2013	9.19

3.4 BROAD RIVER DOWNSTREAM OF PARR SHOALS DAM

3.4.1 USGS SITE 02160991

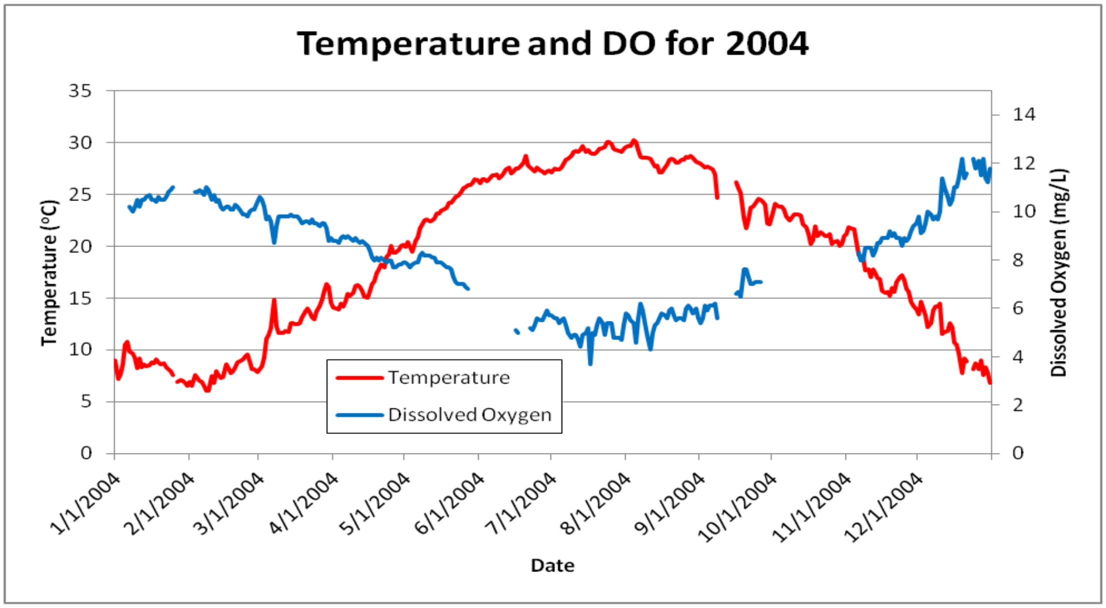
3.4.1.1 TEMPERATURE AND DISSOLVED OXYGEN

Water temperature at the USGS Site 02160991 ranges from approximately 5°C during the winter months to approximately 31°C during the summer. During the summer months, DO levels typically drop between the 5-6 mg/L range with very few instances of a DO level of 4 mg/L.



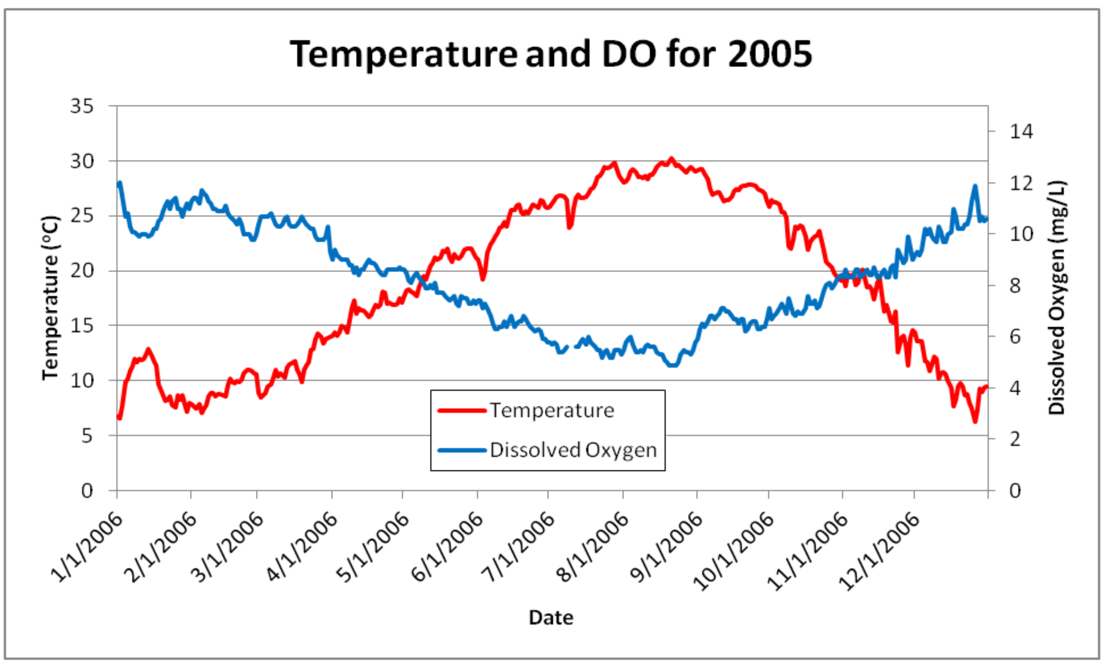
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-160 TEMPERATURE AND DISSOLVED OXYGEN FOR 2003 : DOWNSTREAM OF PARR RESERVOIR[A]



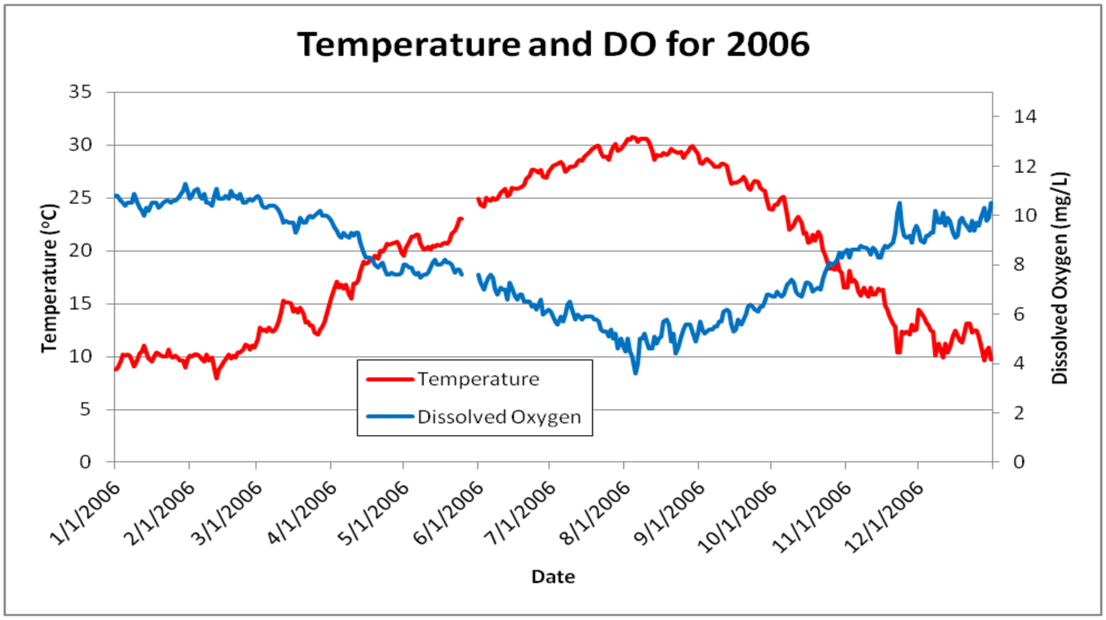
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-161 TEMPERATURE AND DISSOLVED OXYGEN FOR 2004: DOWNSTREAM OF PARR RESERVOIR[A]



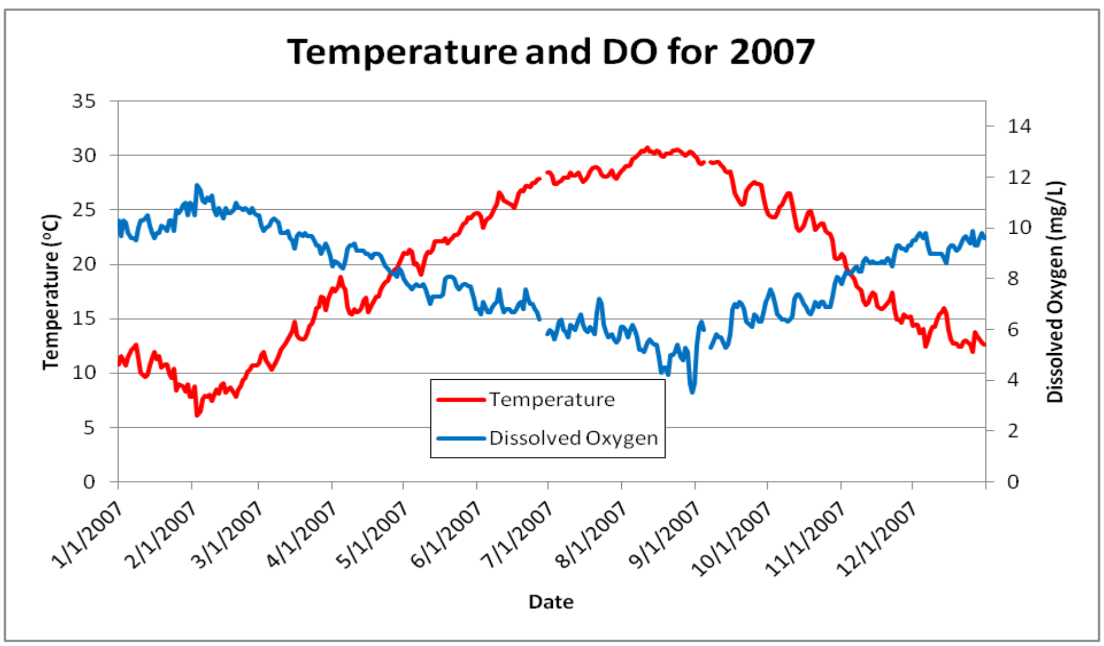
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-162 TEMPERATURE AND DISSOLVED OXYGEN FOR 2005: DOWNSTREAM OF PARR RESERVOIR[A]



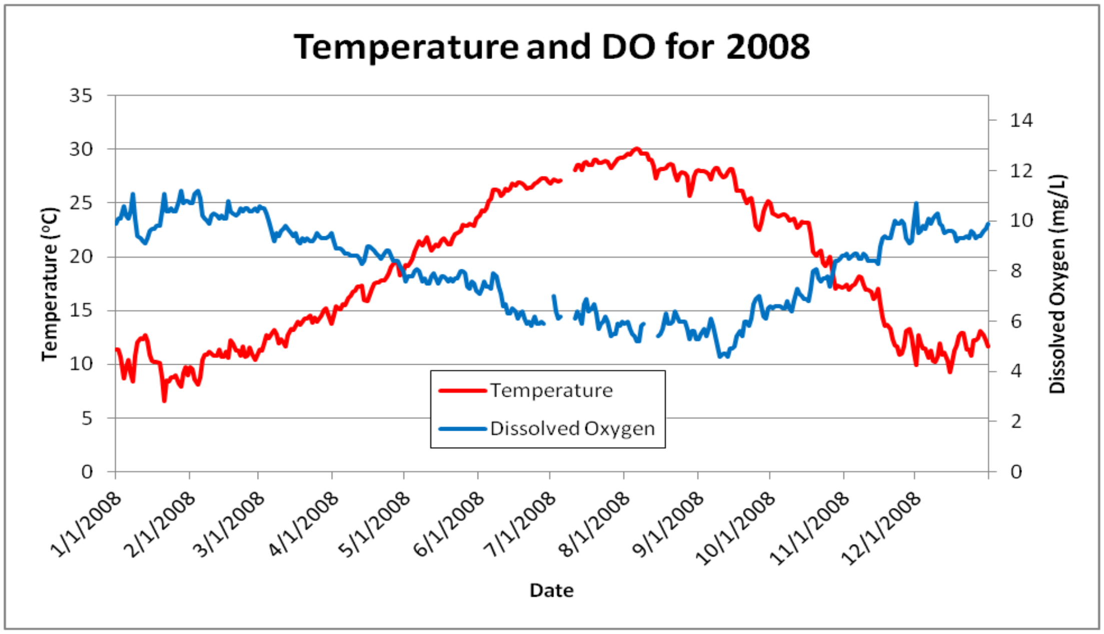
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-163 TEMPERATURE AND DISSOLVED OXYGEN FOR 2006: DOWNSTREAM OF PARR RESERVOIR[A]



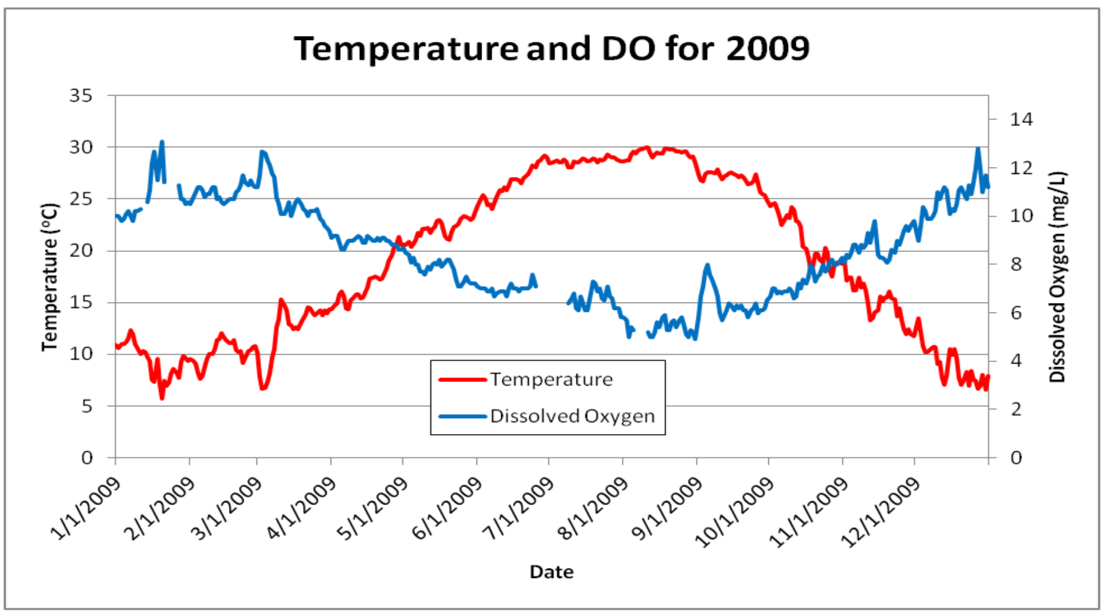
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-164 TEMPERATURE AND DISSOLVED OXYGEN FOR 2007: DOWNSTREAM OF PARR RESERVOIR[A]



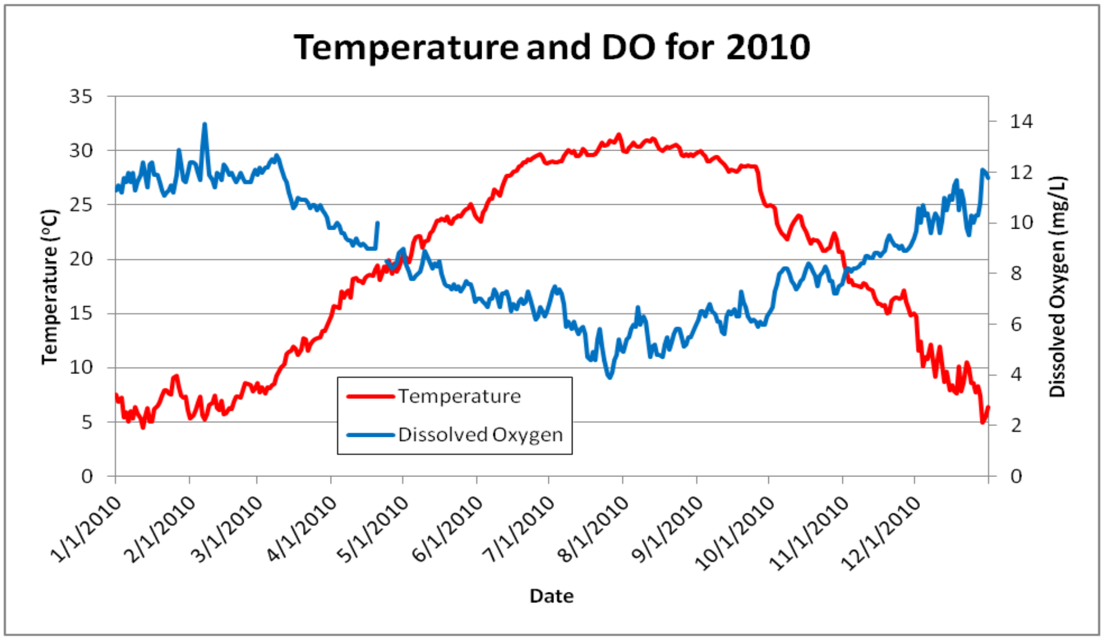
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-165 TEMPERATURE AND DISSOLVED OXYGEN FOR 2008: DOWNSTREAM OF PARR RESERVOIR[A]



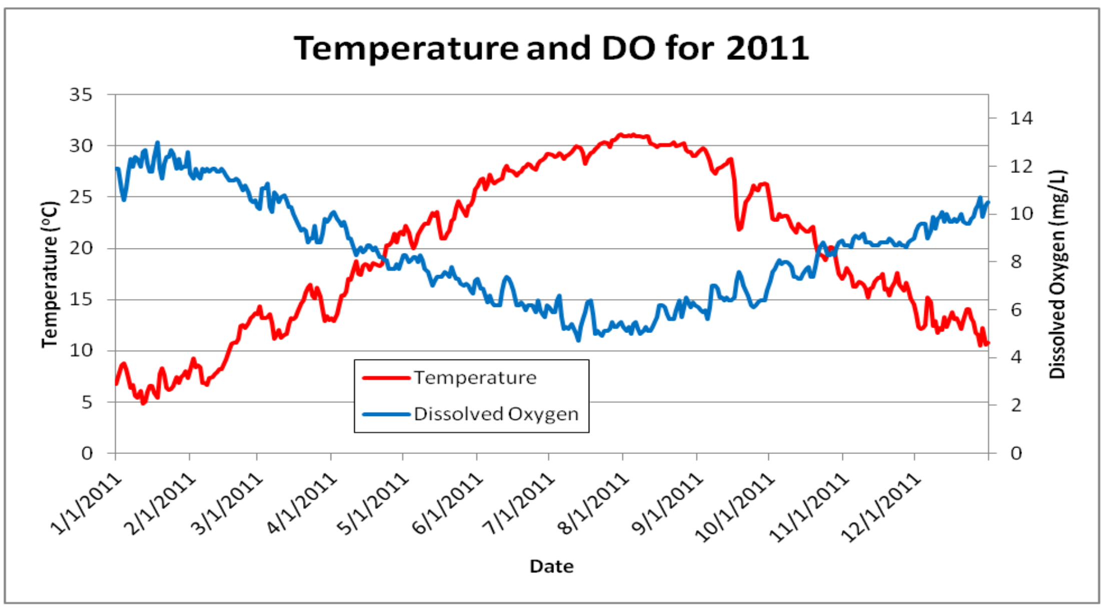
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-166 TEMPERATURE AND DISSOLVED OXYGEN FOR 2009: DOWNSTREAM OF PARR RESERVOIR[A]



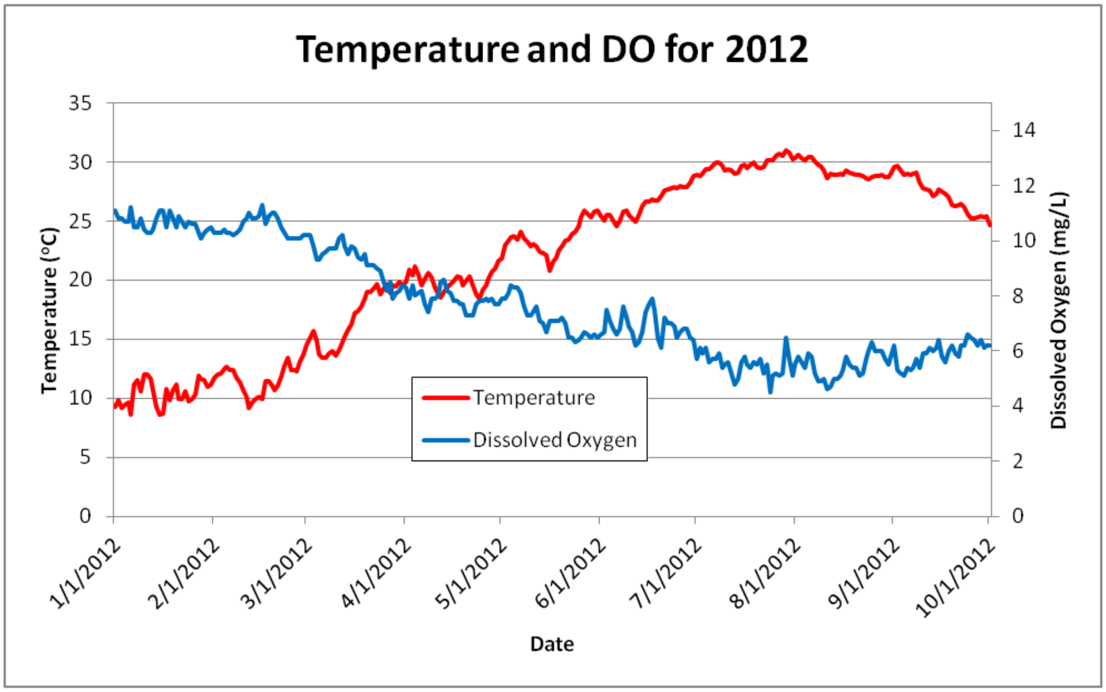
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-167 TEMPERATURE AND DISSOLVED OXYGEN FOR 2010: DOWNSTREAM OF PARR RESERVOIR[A]



[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-168 TEMPERATURE AND DISSOLVED OXYGEN FOR 2011: DOWNSTREAM OF PARR RESERVOIR[A]

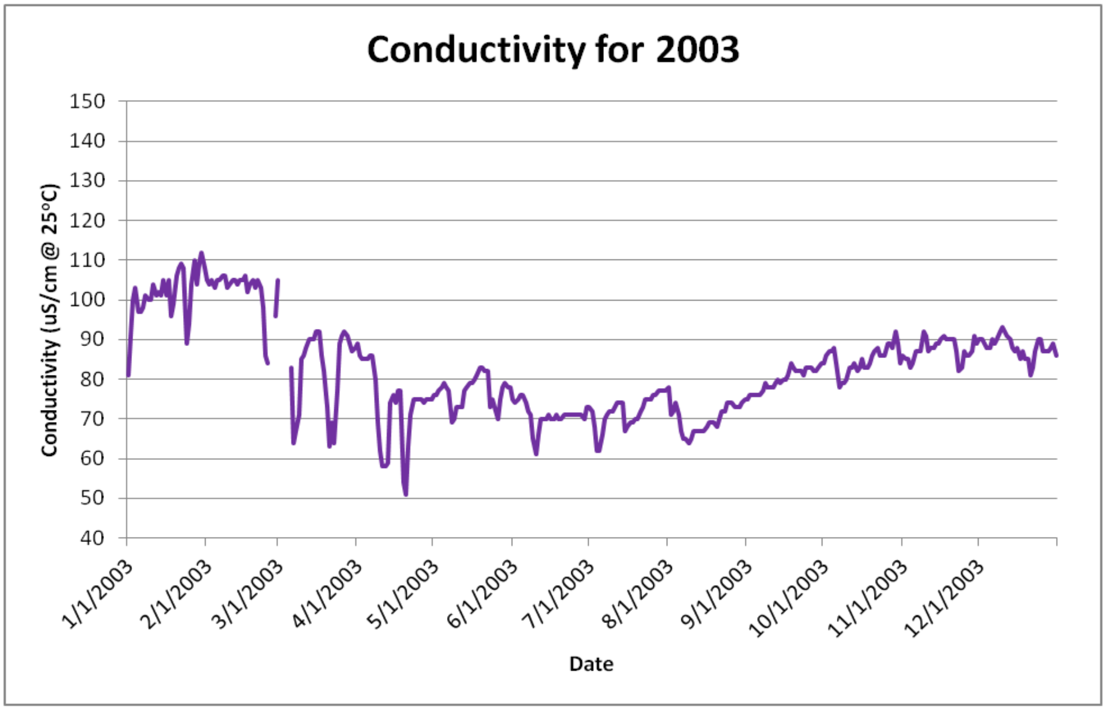


[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-169 TEMPERATURE AND DISSOLVED OXYGEN FOR 2012: DOWNSTREAM OF PARR RESERVOIR[A]

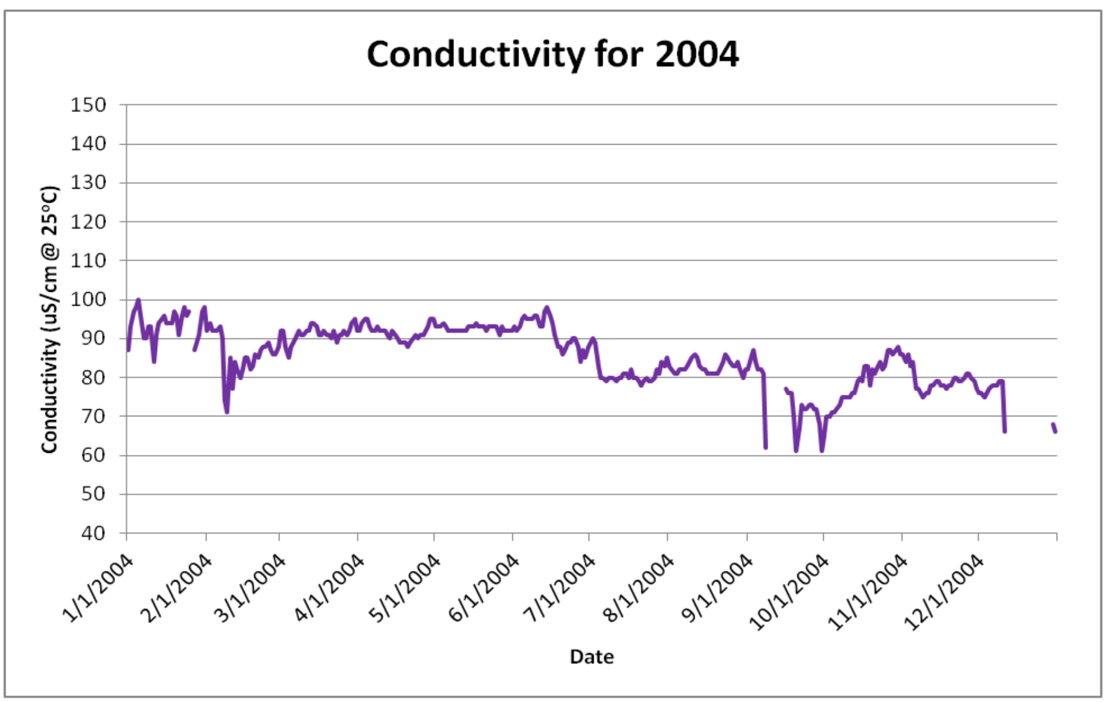
3.4.1.2 CONDUCTIVITY

The conductivity measured at the USGS site 02160991 ranged from approximately 45 µS/cm to 145 µS/cm over the last ten years. Daily readings for conductivity from January of 2003 through September of 2012 at the USGS site located immediately below the Parr Shoals Dam in the Broad River are shown in the figures below.



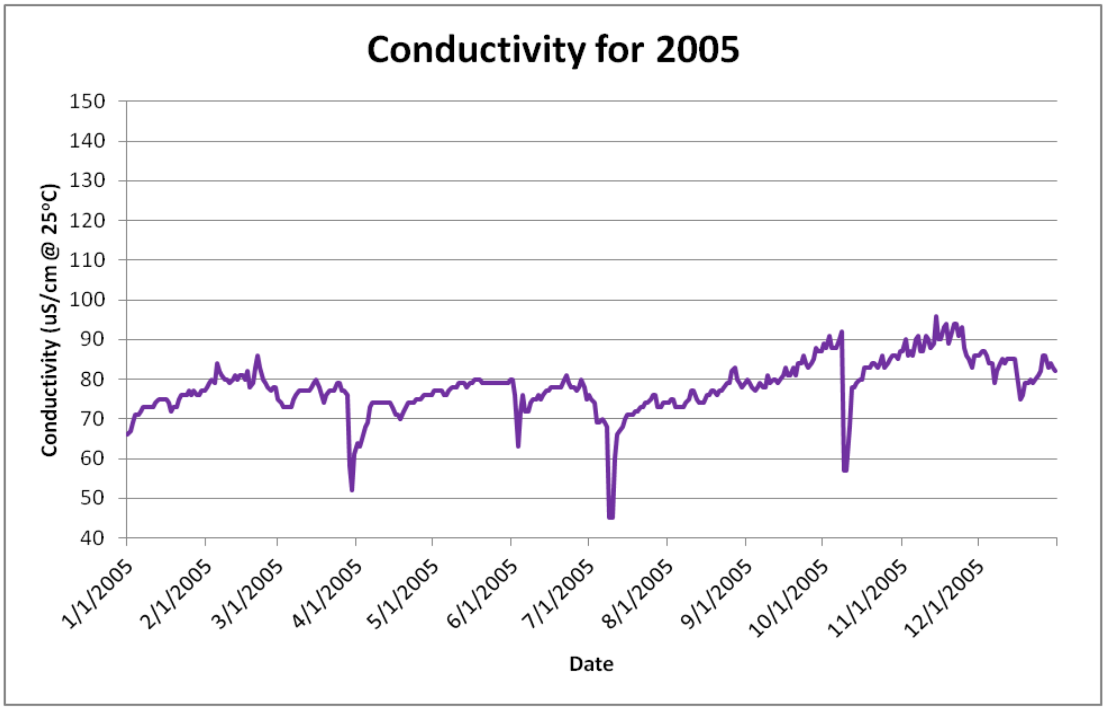
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-170 CONDUCTIVITY FOR 2003: DOWNSTREAM OF PARR RESERVOIR[A]



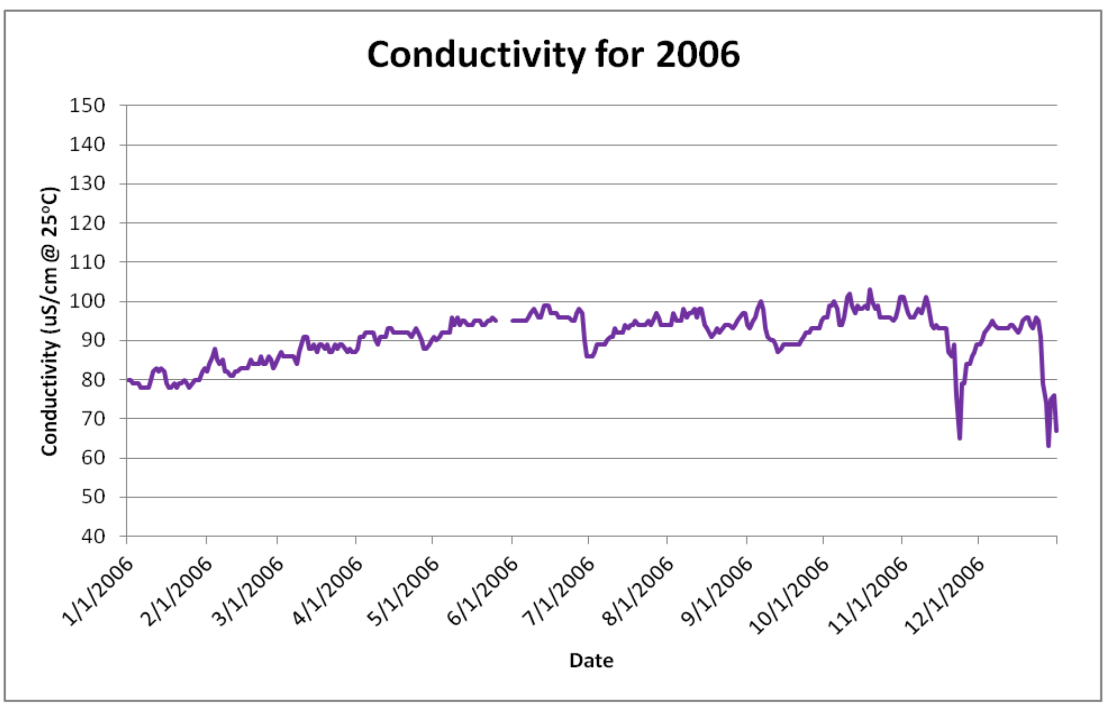
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-171 CONDUCTIVITY FOR 2004: DOWNSTREAM OF PARR RESERVOIR[A]



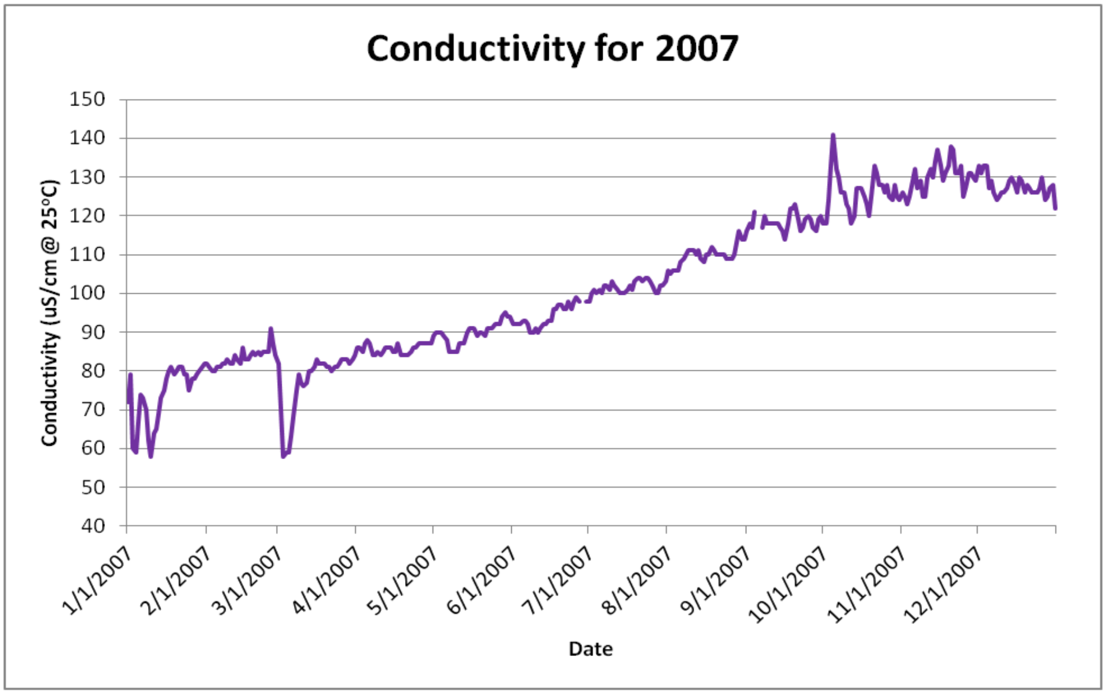
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-172 CONDUCTIVITY FOR 2005: DOWNSTREAM OF PARR RESERVOIR[A]



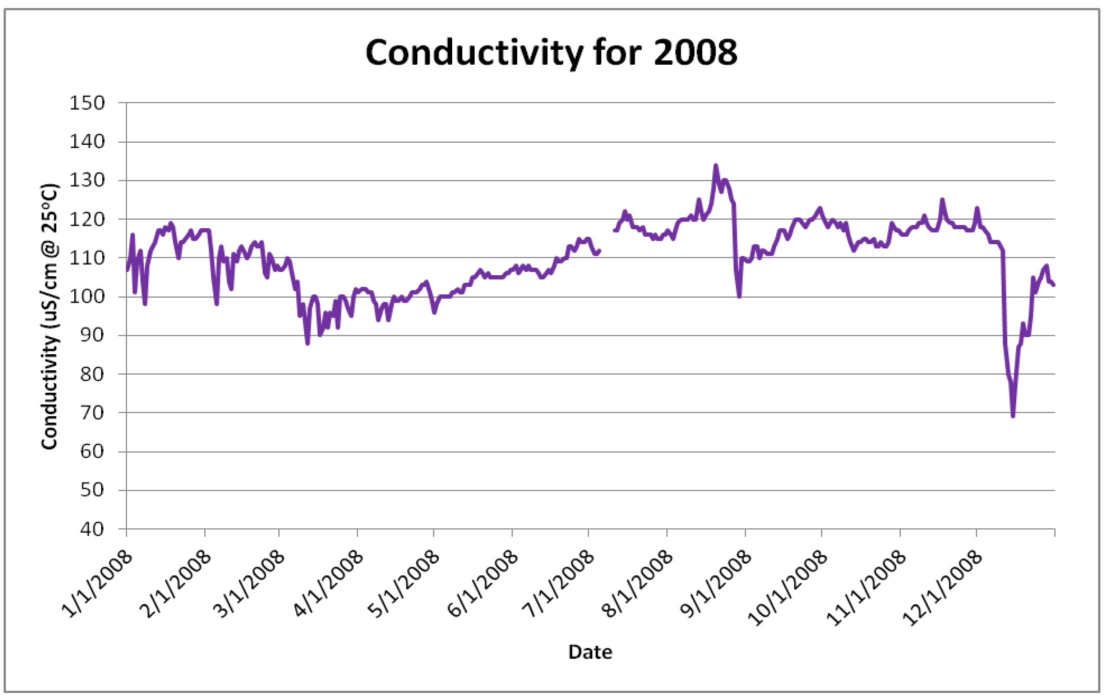
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-173 CONDUCTIVITY FOR 2006: DOWNSTREAM OF PARR RESERVOIR[A]



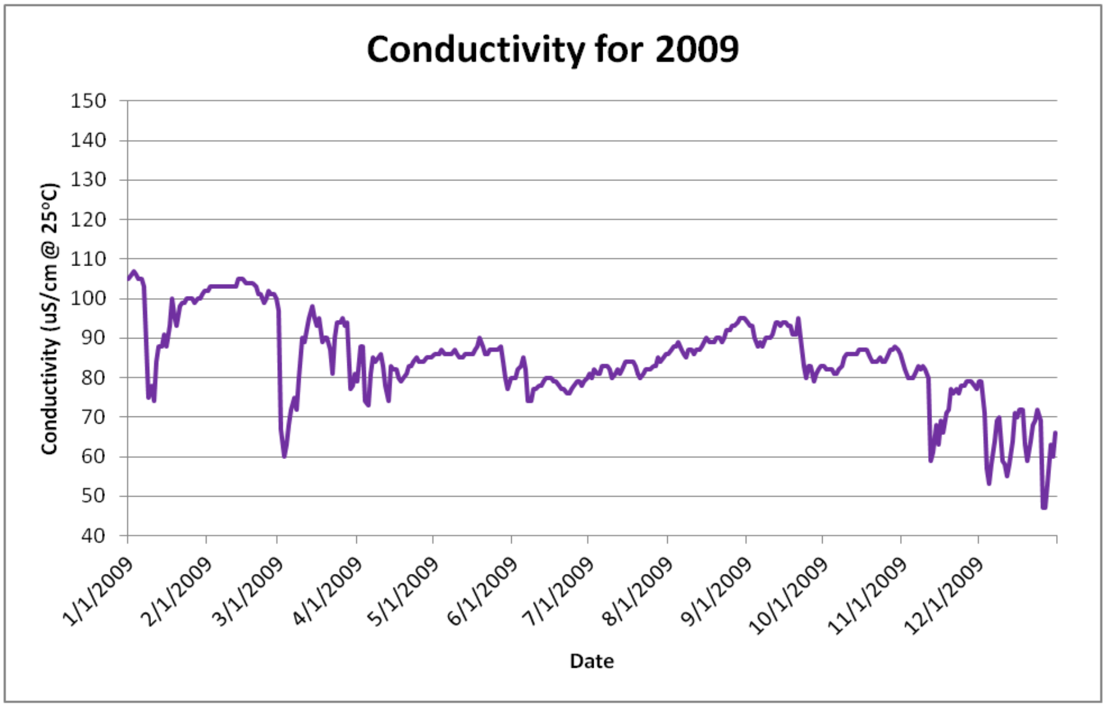
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-174 CONDUCTIVITY FOR 2007: DOWNSTREAM OF PARR RESERVOIR[A]



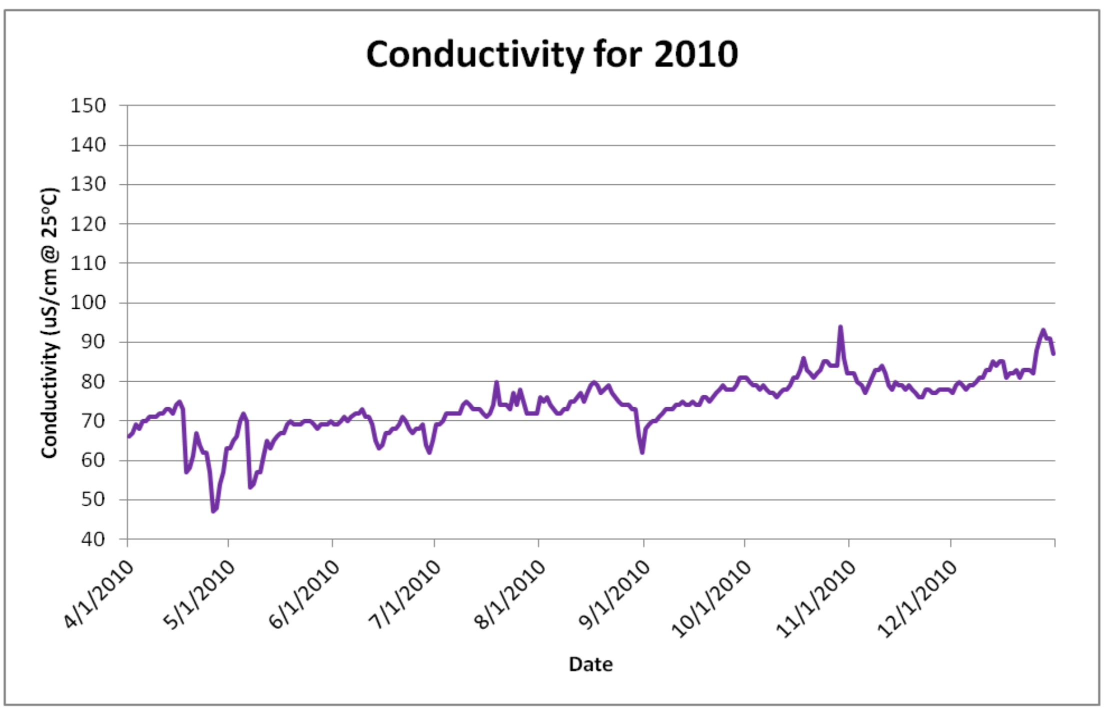
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-175 CONDUCTIVITY FOR 2008: DOWNSTREAM OF PARR RESERVOIR[A]



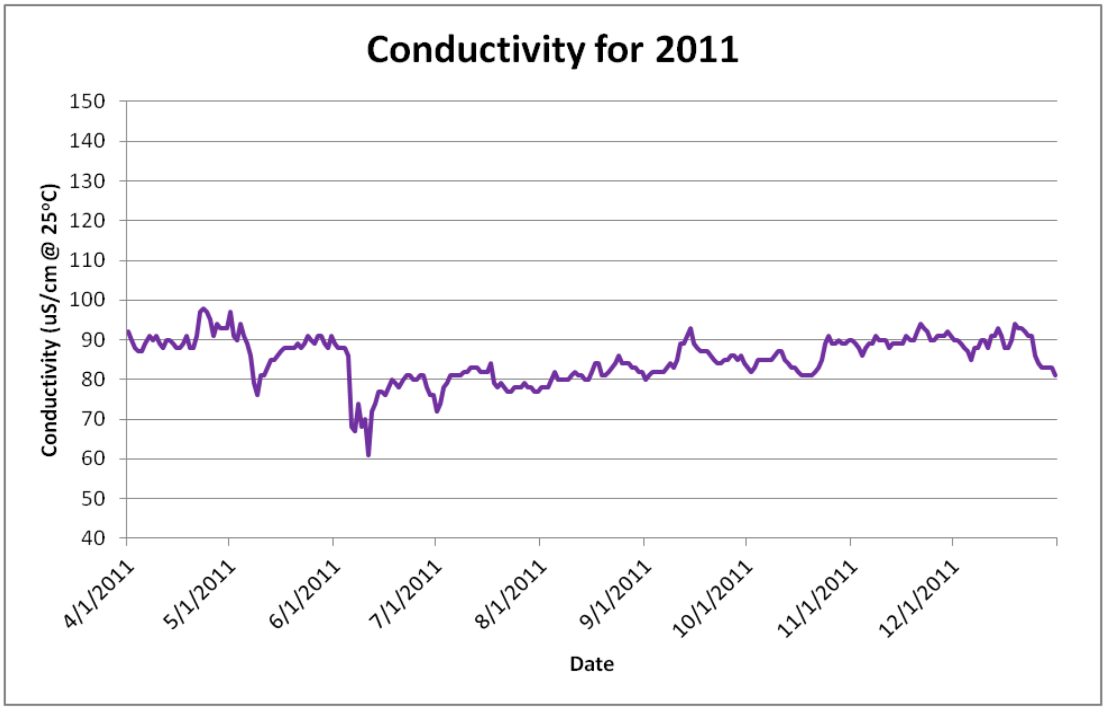
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-176 CONDUCTIVITY FOR 2009: DOWNSTREAM OF PARR RESERVOIR[A]



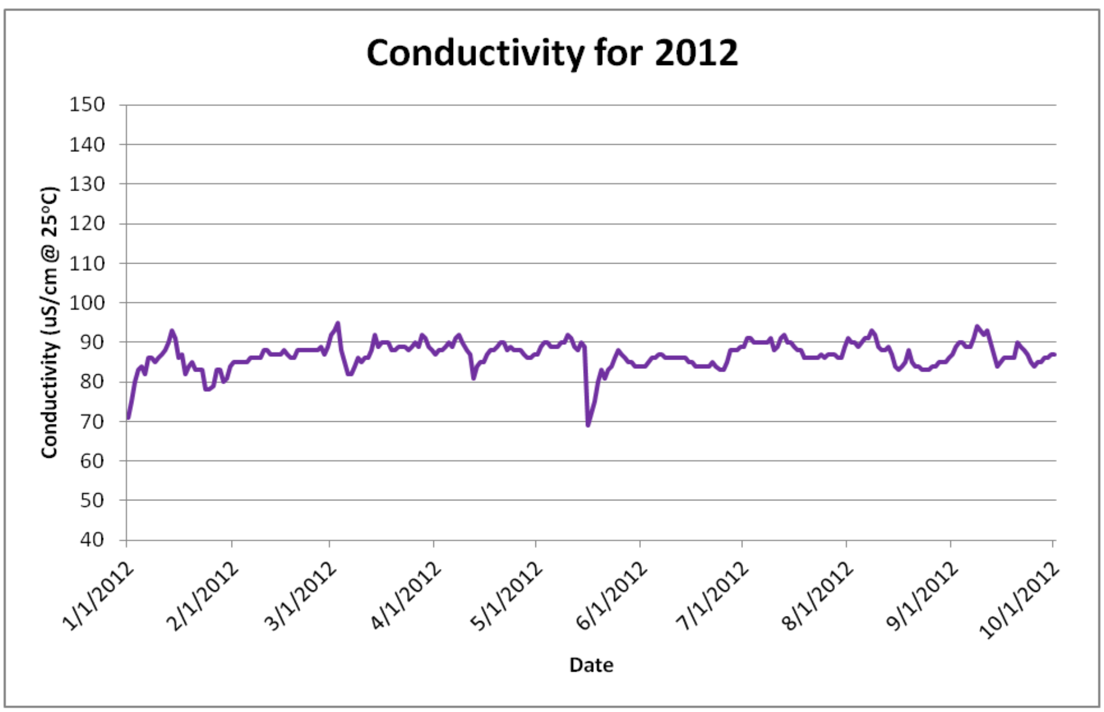
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-177 CONDUCTIVITY FOR 2010: DOWNSTREAM OF PARR RESERVOIR[A]



[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-178 CONDUCTIVITY FOR 2011: DOWNSTREAM OF PARR RESERVOIR[A]

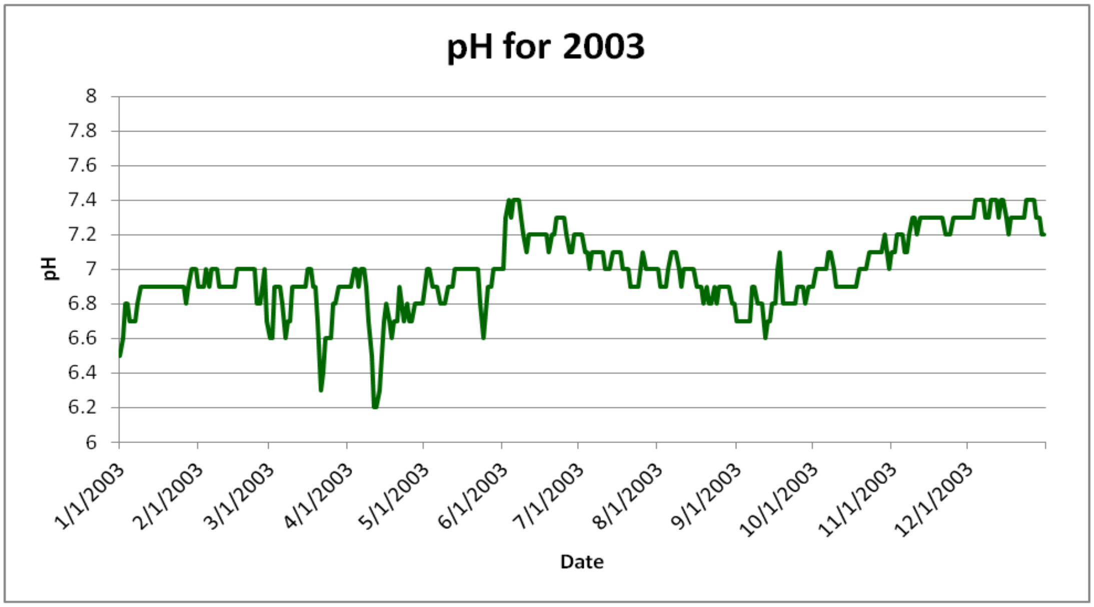


[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-179 CONDUCTIVITY FOR 2012: DOWNSTREAM OF PARR RESERVOIR[A]

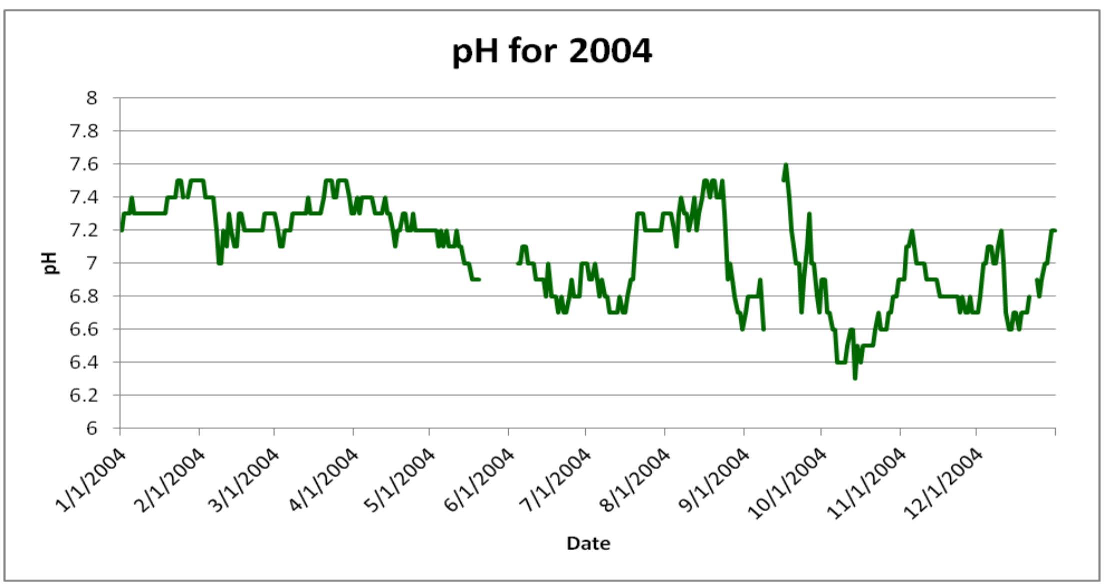
3.4.1.3 PH

Overall, the pH at the USGS monitoring site 02160991 is within the State Standards of 6.5 to 8.0, with few instances of a daily pH reading of below 6.5 in 2003, 2004 and 2007.



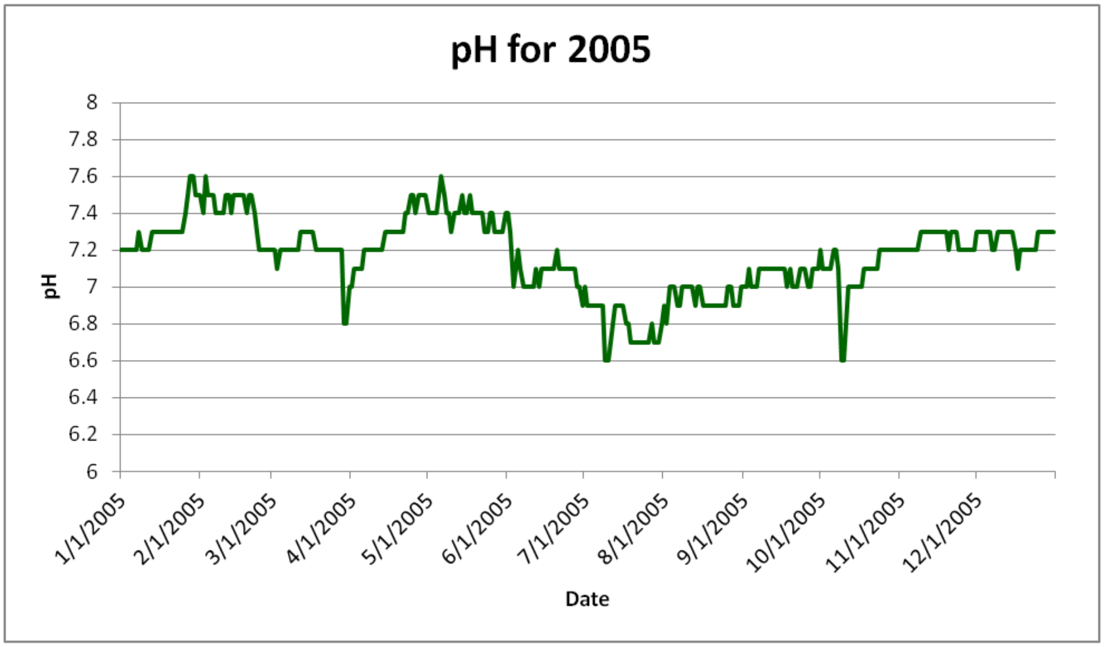
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-180 PH FOR 2003: DOWNSTREAM OF PARR RESERVOIR[A]



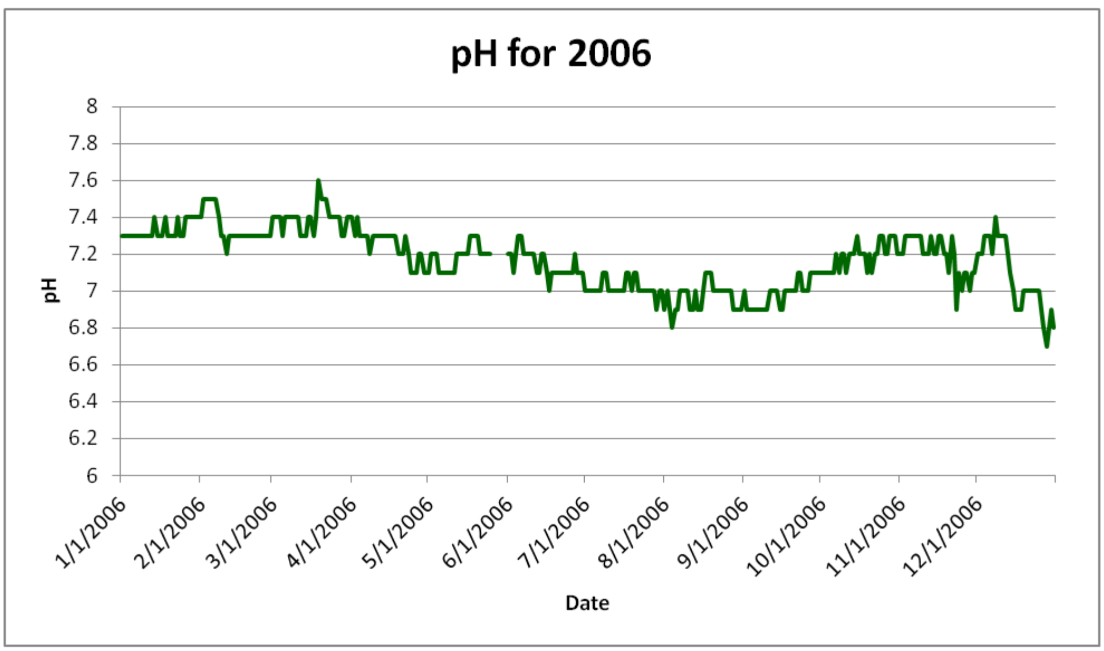
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-181 PH FOR 2004: DOWNSTREAM OF PARR RESERVOIR[A]



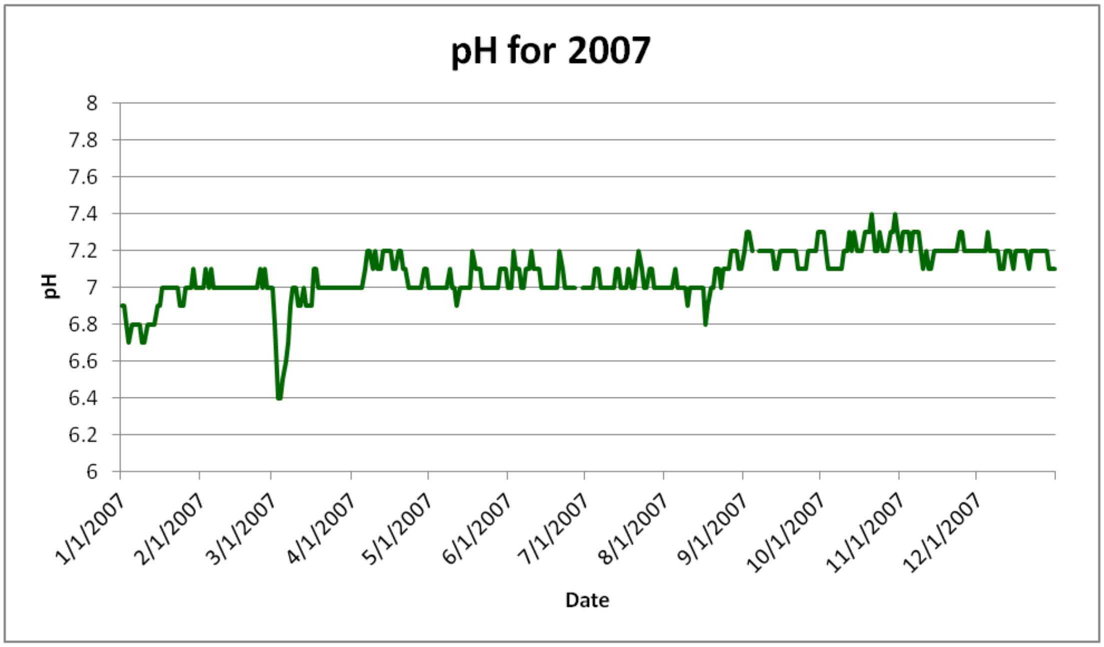
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-182 PH FOR 2005: DOWNSTREAM OF PARR RESERVOIR[A]



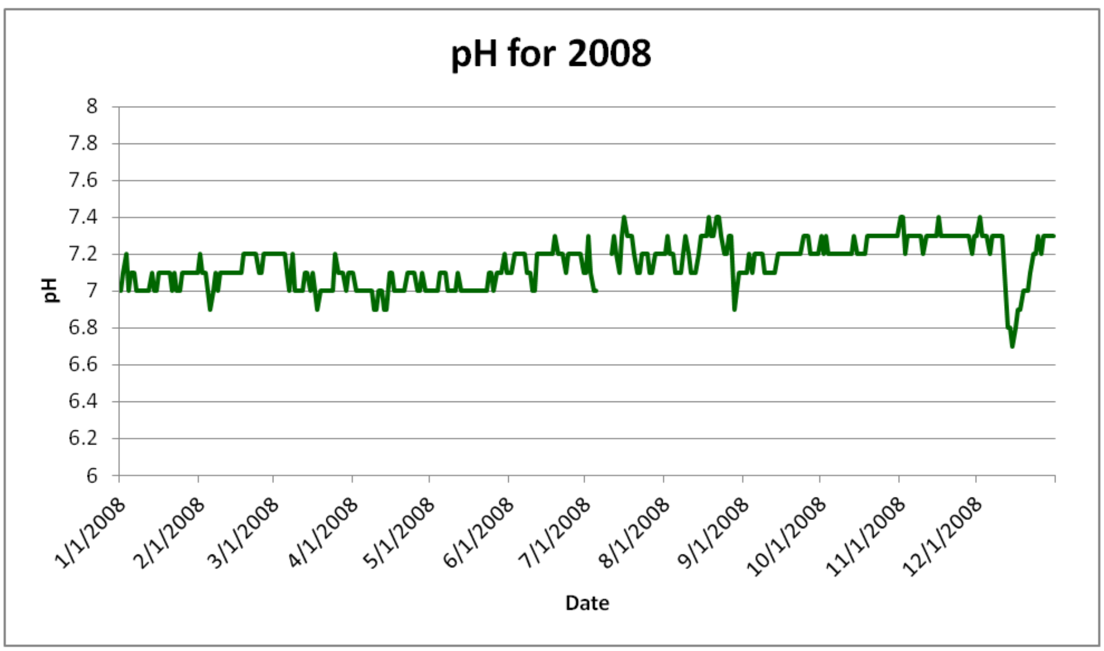
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-183 PH FOR 2006: DOWNSTREAM OF PARR RESERVOIR[A]



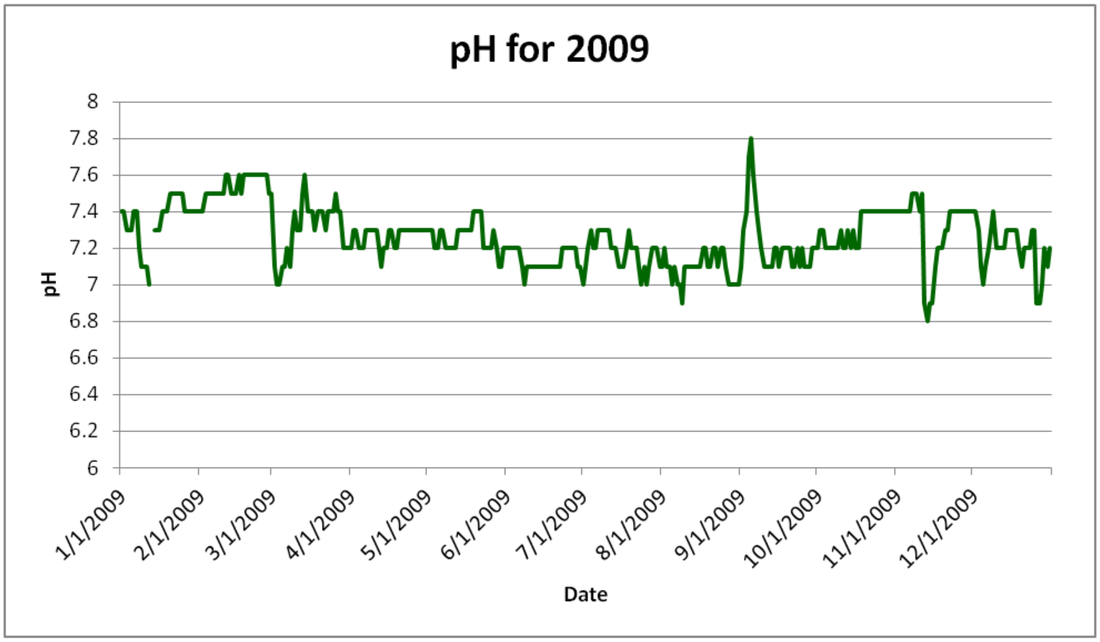
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-184 pH FOR 2007: DOWNSTREAM OF PARR RESERVOIR[A]



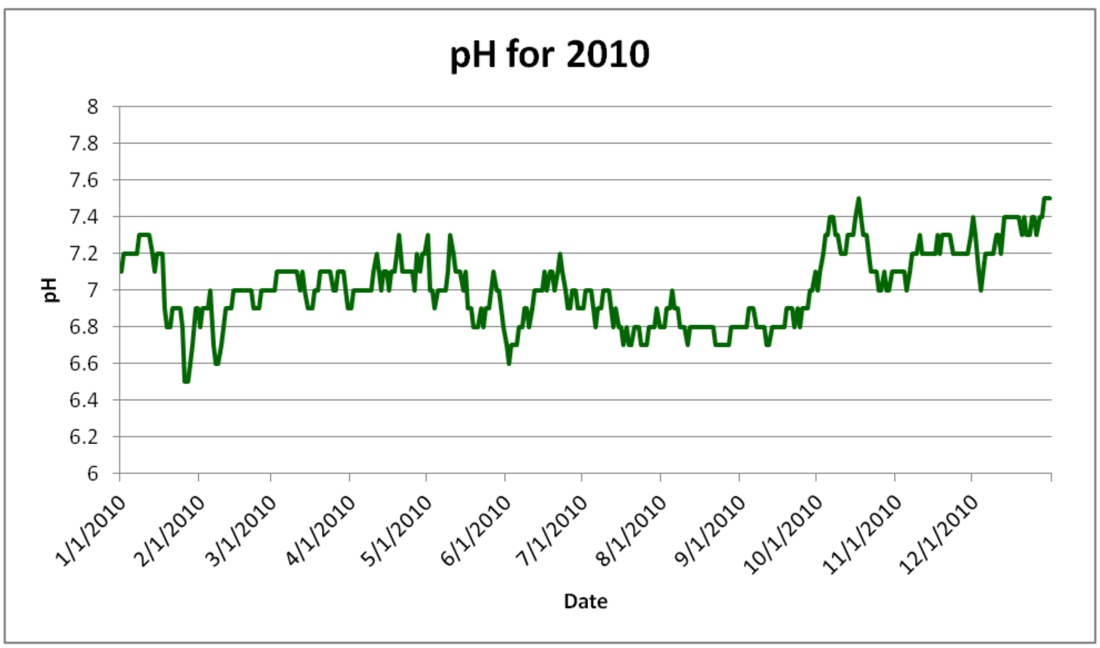
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-185 pH FOR 2008: DOWNSTREAM OF PARR RESERVOIR[A]



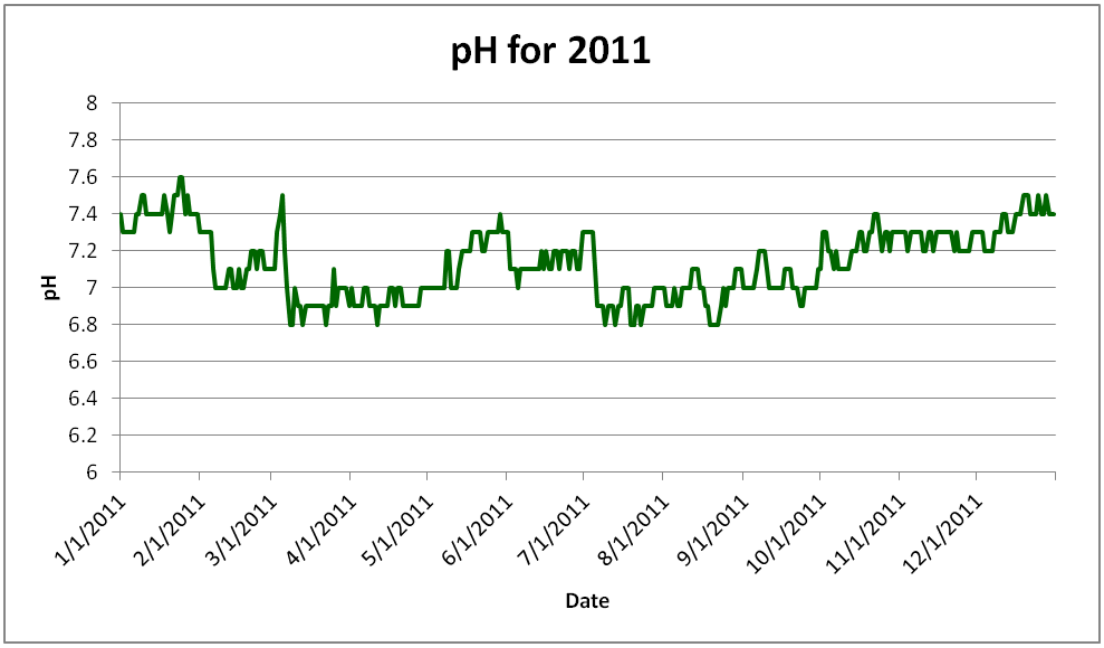
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-186 PH FOR 2009: DOWNSTREAM OF PARR RESERVOIR[A]



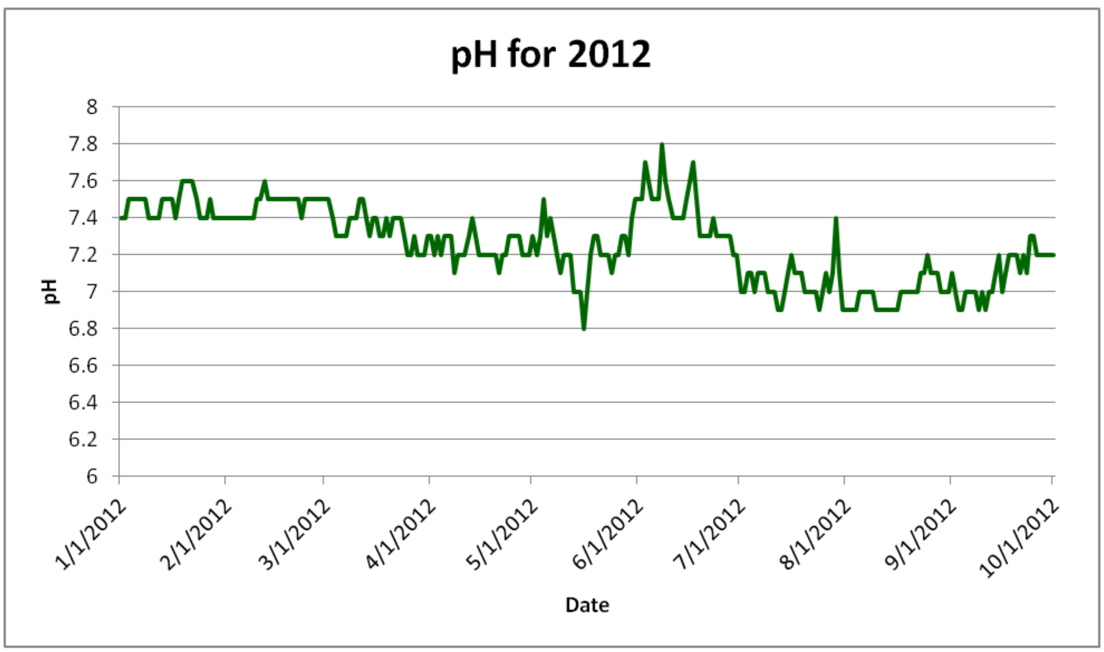
[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-187 PH FOR 2010: DOWNSTREAM OF PARR RESERVOIR[A]



[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-188 PH FOR 2011: DOWNSTREAM OF PARR RESERVOIR[A]



[a] Graph depicts only data that were available on the USGS website. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-189 PH FOR 2012: DOWNSTREAM OF PARR RESERVOIR[A]

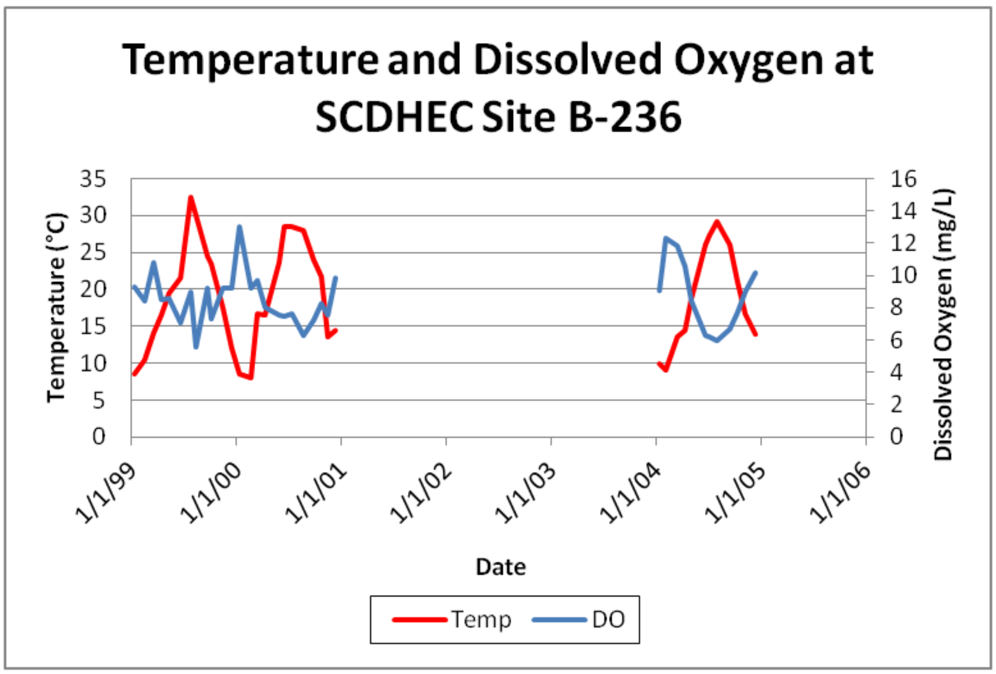
3.4.2 SCDHEC DATA

3.4.2.1 MONITORING STATION B-236

SCDHEC monitoring station B-236, Broad River at the Southern Railroad trestle, approximately 0.5 miles downstream of SC 213, was monitored on a monthly basis during 1999, 2000 and 2004. This site was added to the 303(d) list for a copper excursion in 2004. All other data is within SCDHEC's acceptable limits.

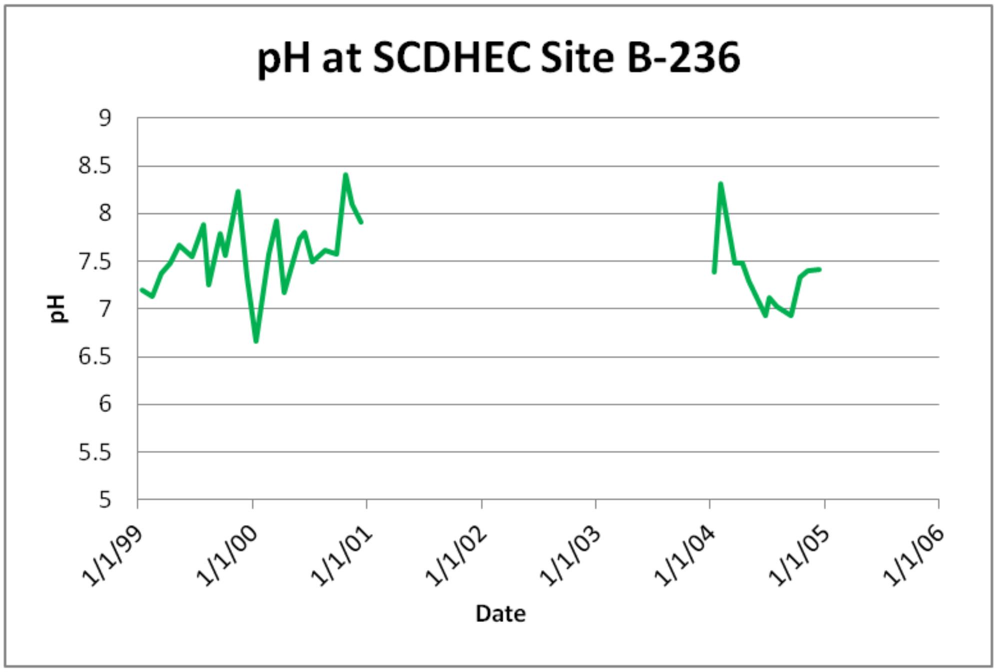
Temperature, DO, pH, and Turbidity

The following data was collected in 1999, 2000 and 2004 at the SCDHEC monitoring station B-236 located below Parr Shoals Dam. See Table 2-1 for the SCDHEC water quality standards for temperature, DO, pH, and turbidity.



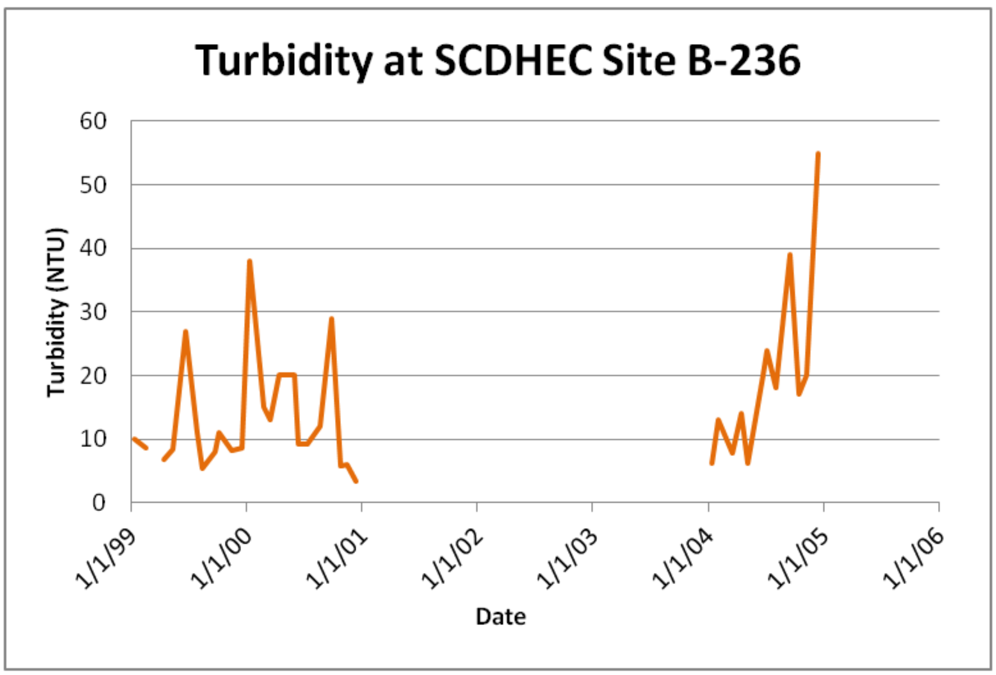
[a] Graph depicts only data that were available on STORET. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-190 WATER TEMPERATURE AND DISSOLVED OXYGEN AT SCDHEC MONITORING STATION B-236[A]



[a] Graph depicts only data that were available on STORET. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-191 PH AT SCDHEC MONITORING STATION B-236[A]



[a] Graph depicts only data that were available on STORET. Any gaps reflect times when data were not collected, or not available.

FIGURE 3-192 TURBIDITY AT SCDHEC MONITORING STATION B-236[A]

Metals

Water samples collected at SCDHEC monitoring station B-236 were analyzed for a variety of metals. In 2004, this site was listed on the 303(d) list for a copper excursion. As shown in Table 3-28, most of the SCDHEC core indicator metals (Table 2-3) were regularly measured as Present Below Quantification Limit (PBQL) at site B-236, indicating the river supports aquatic life use.

TABLE 3-28 METALS PRESENT AT SCDHEC MONITORING STATION B-236[A]

DATE	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Magnesium (mg/L)	Manganese (mg/L)	Mercury (mg/L)	Nickel (mg/L)	Zinc (mg/L)
2/17/99	PBQL	PBQL	PBQL	0.7	PBQL	-	0.036	PBQL	PBQL	PBQL
5/11/99	PBQL	PBQL	PBQL	0.8	PBQL	-	0.04	PBQL	PBQL	0.02
8/16/99	PBQL	PBQL	PBQL	0.27	PBQL	-	0.07	PBQL	PBQL	0.01
11/16/99	PBQL	PBQL	PBQL	0.31	PBQL	-	0.02	PBQL	PBQL	0.04
2/23/00	PBQL	PBQL	PBQL	0.94	PBQL	-	0.04	PBQL	PBQL	0.01
5/31/00	PBQL	PBQL	PBQL	0.8	PBQL	-	0.06	PBQL	PBQL	0.03
8/22/00	PBQL	PBQL	PBQL	0.54	PBQL	-	0.05	PBQL	PBQL	PBQL
11/16/00	PBQL	PBQL	PBQL	0.49	PBQL	-	0.03	PBQL	PBQL	0.04
2/4/04	0.018	0.017	0.018	0.62	PBQL	1.8	0.047	PBQL	PBQL	0.014
5/4/04	PBQL	PBQL	PBQL	0.3	PBQL	-	0.029	PBQL	PBQL	0.031
8/2/04	PBQL	0.33	0.039	1.3	PBQL	-	0.079	PBQL	0.15	0.014
11/9/04	PBQL	PBQL	PBQL	0.91	PBQL	-	0.035	PBQL	PBQL	PBQL

[A] PBQL is Present Below Quantification Limit.

Nutrients

Nutrients data was collected at SCDHEC monitoring station B-236 in 1999, 2000, and 2004 and is included in the table below. Site B-236 is located in the Broad River; the SCDHEC nutrient and chlorophyll-a standards only apply to reservoirs and therefore do not apply to this site. There are no nutrient and chlorophyll-a standards established for rivers.

TABLE 3-29 NUTRIENTS AND CHLOROPHYLL A AT SCDHEC MONITORING STATION B-236[A]

Date	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
1/13/99	1.12	-
2/17/99	PBQL	-
3/18/99	0.7	-
4/15/99	1.25	-
5/11/99	0.68	-
6/22/99	0.96	-
7/29/99	0.71	-
8/16/99	0.64	-
9/22/99	0.38	-
10/5/99	PBQL	-
11/16/99	0.48	-
12/16/99	0.51	-
1/12/00	0.75	-
2/23/00	0.56	-
3/16/00	0.59	-
4/13/00	0.72	-
5/31/00	0.71	-
6/15/00	0.73	-
7/12/00	0.65	-
8/22/00	0.5	-
9/28/00	0.69	-
10/26/00	0.52	-
11/16/00	0.57	-
12/12/00	0.57	0.03
1/13/04	1.31	0.026
3/18/04	0.78	0.022
4/14/04	0.58	0.041
5/4/04	0.88	0.038
6/24/04	1.01	0.069
7/7/04	0.71	0.07
8/2/04	0.7	0.046
9/16/04	0.7	0.055
10/14/04	1.15	0.046
11/9/04	0.82	0.059
12/13/04	0.82	0.08

[A] PBQL is Present Below Quantification Limit.

3.4.3 DATA CONTRIBUTED BY SCDNR

The data included below were collected and submitted by SCDNR. It should be noted that this data is unpublished.

Data collection sites include three different reaches of the Broad River, downstream of the Parr Shoals Dam. The data coincides with that collected at the USGS gage 02160991, and appears to be typical for this area of the Broad River.

TABLE 3-30 WATER QUALITY DATA FROM REACH 1 OF THE BROAD RIVER

Date	Discharge cfs	Temperature (°C)	DO (mg/L)	Conductivity (µS/cm)	pH	Turbidity (NTU)	Salinity (ppt)
8/25/2009	788	27.9	4.47	90.8	7.16	2.57	0
10/22/2009	1812	18.6	6.8	79	7.5	5.77	0
5/12/2010	2535	21.9	8.29	71.6	6.28	8.85	0
8/12/2010	838	32.4	4.64	61.8	7.97	4.44	0
11/2/2010	1507	18.1	5.81	88.3	7.3	18.2	0
4/21/2011	4650	17.9	7.1	78.1	na	8.53	0
8/10/2011	548	29.6	6.33	83	7.44	4.18	0
11/22/2011	2120	17.3	7.02	95.8	na	14.9	0
4/3/2012	2460	20.3	5.3	84.5	6.2	NA	0
8/27/2012	1150	26.5	3.4	89.7	7.38	4.36	0
4/18/2013	3920	20.8	5.04	75.5	-	17.9	0

TABLE 3-31 WATER QUALITY DATA FROM REACH 2A OF THE BROAD RIVER

Date	Discharge cfs	Temperature (°C)	DO (mg/L)	Conductivity (µS/cm)	pH	Turbidity (NTU)	Salinity (ppt)
8/20/2009	807	32	4.89	92.2	7.27	7.87	0
10/23/2009	1510	18.6	6.8	79	7.5	5.77	0
5/13/2010	2992	22.3	6.9	72	6.07	7.89	0
11/3/2010	1610	18	5.95	90.5	7.4	21.3	0
5/9/2011	3520	21.8	7.22	79.7	7.63	-	0
8/4/2011	670	32.3	9.9	80.8	7.86	3.48	0
10/26/2011	850	19.8	7.05	93.7	NA	21.9	0
4/27/2012	1720	20	6.55	79.7	7.37	NA	3
7/5/2012	813	33.5	5.26	83.8	7.8	4.09	0
11/29/2012	1020	12.9	8.02	95.1	6.73	5.97	0
4/23/2013	3430	18.8	6.17	83.1	6.98	7.92	0

TABLE 3-32 WATER QUALITY DATA FROM REACH 2B OF THE BROAD RIVER

Date	Discharge cfs	Temperature (°C)	DO (mg/L)	Conductivity (µS/cm)	pH	Turbidity (NTU)	Salinity (ppt)
8/12/2009	791	29.7	5.91	88.1	7.07	-	0
10/9/2009	1551	23.1	6.25	86.3	7.19	14.8	0
4/26/2010	4605	20.4	10.9	76.2	7.3	5.64	0
8/10/2010	825	30.6	5.9	76	7.26	14.7	0
8/27/2010	860	30.3	6.08	75.2	7.83	10.91	0
11/1/2010	1635	18.8	7.16	91	7.77	4.42	0
5/6/2011	3480	19.3	7.92	78.4	7.13	8.65	0
7/14/2011	788	29.5	6.72	81.3	6.67	3.88	0
10/20/2011	863	18.1	NA	94.1	7.93	7.22	0
4/4/2012	2910	20.9	6.98	96.5	6.62	NA	0
7/30/2012	830	31.1	9.02	85.6	7.01	3.67	0
10/9/2012	1570	20.1	7.88	85.1	6.78	3.37	0
4/25/2013	4440	19.4	5.95	80.7	7.07	10.24	0

3.5 COMPARING UPSTREAM AND DOWNSTREAM OF PARR RESERVOIR

Monthly temperature, DO, and pH data was collected in 2004 by SCDHEC at four monitoring stations located above, within, and below the Project. This data is displayed below. Site B-046 is located upstream of Parr Reservoir, downstream of Neal Shoals Dam. Site B-345 is located in Parr Reservoir, upstream of Parr Shoals Dam. Site B-327 is located within Monticello Reservoir. Site B-236 is located downstream of Parr Shoals Dam. While temperatures at all four sites are very similar, generally temperatures at site B-046 and B-236 are slightly lower during the summer months than at the other sites. This is trend is not unexpected as these sites are located in flowing sections the Broad River versus sites B-235 and B-327, which are located in reservoirs. As with temperature, the DO values at all four sites are very similar. The site located just upstream of the Parr Shoals Dam, B-345, dipped to a low point of approximately 4.5 mg/L in July, but rebounded in August. The pH values at the four sites varies slightly over the course of the year, with site B-327 reaching a high of approximately 8.7 in May. Overall all four sites follow the same general trends for the three parameters examined.

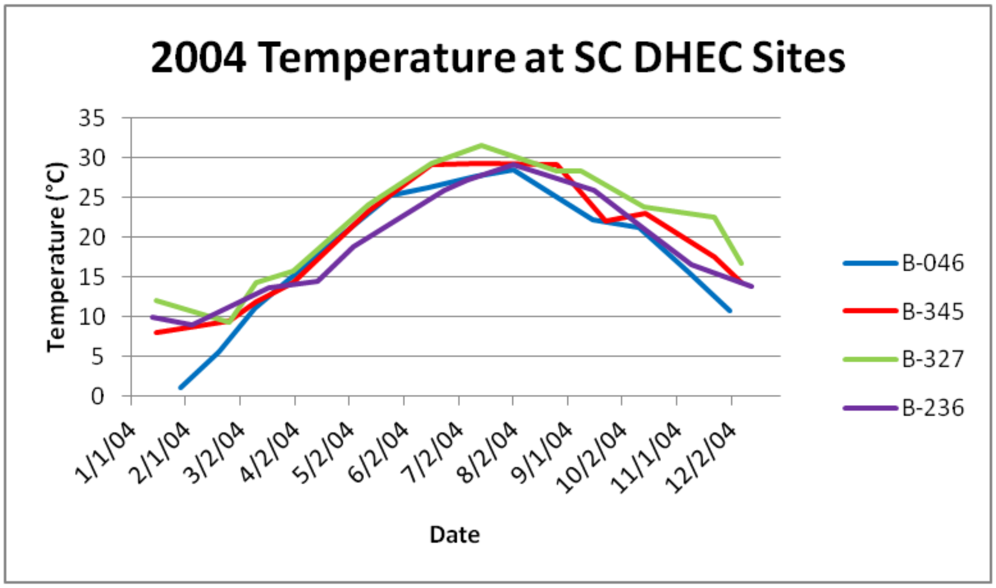


FIGURE 3-193 **2004 WATER TEMPERATURE DATA AT SCDHEC MONITORING STATIONS B-046, B-345, B-327 AND B-236**

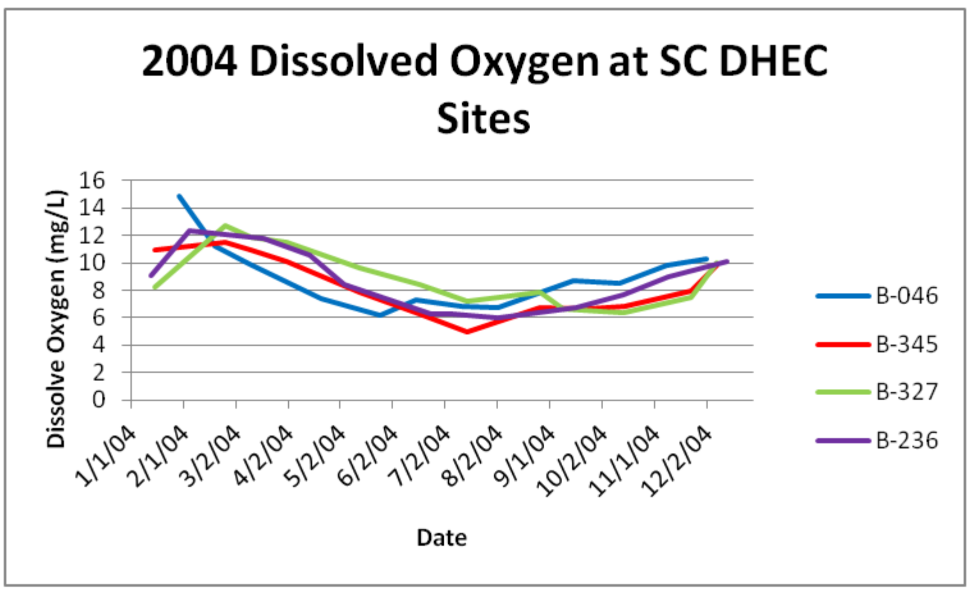


FIGURE 3-194 **2004 DISSOLVED OXYGEN DATA AT SCDHEC MONITORING STATIONS B-046, B-345, B-327 AND B-236**

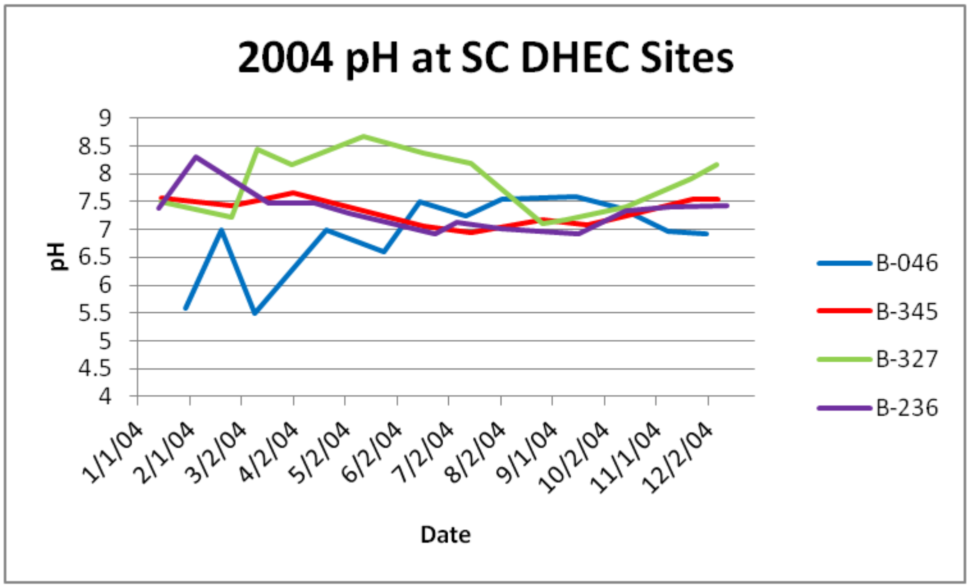


FIGURE 3-195 2004 PH DATA AT SCDHEC MONITORING STATIONS B-046, B-345, B-327, AND B-236

4.0 DISCUSSION AND CONCLUSIONS

Overall, there is a vast amount of data that have been or is currently being collected in the vicinity of the Parr Fairfield Hydroelectric Project. Due to ongoing monitoring efforts by SCANA, SCDHEC, SCDNR and USGS, Parr Reservoir, Monticello Reservoir and the Broad River upstream and downstream of Parr Shoals Dam are constantly being examined for potential water quality issues. Daily, monthly and quarterly readings and analyses provide continual insight into the health of the Project waters. The water quality parameters included in this report are commonly used indicators of the overall health of a body of water.

Data summarized in this report shows that localized water temperature increases do occur in the vicinity of the V.C. Summer Nuclear Station. This phenomenon is explained further in the Thermal Mixing Zone Evaluation at VCSNS, included in Appendix B. Also, SCDHEC monitoring stations B-346, B-236, RL-04370, RL-04374, and RL-11031 are included on the 2012 303(d) list, for excursions in total phosphorus, copper and/or pH.

After examing the results of the water quality analyses summarized in this report, a few general conclusions on the condition of Project waters, as well as upstream and downstream waters associated with the Project, can be made. Water temperature, DO, pH and specific conductivity appear to fluctuate naturally with the time of year and depth of the reservoirs. The Parr Fairfield Project operations contribute a few small, localized effects on water quality, but do not appear to affect the overall quality of the Parr Reservoir, Monticello Reservoir and the Broad River downstream of Parr Shoals Dam.

The data presented here depicts an overall healthy water system, providing suitable habitat for a variety of aquatic species. The clean waters of Monticello Reservoir, Parr Reservoir and the Broad River are also able to provide the public with safe recreation opportunities.

5.0 REFERENCES

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APPENDIX A

2012 PARR SEDIMENT INVESTIGATION REPORT

SCANA Services Inc.

Parr Reservoir Sediment Investigation Report 2012

Milton Quattlebaum

March 2013

Table of Contents

List of Figures

Appendix

Introduction

Parr Reservoir is located in Fairfield County, South Carolina. Parr Reservoir (4,400 acre) is formed by the impounding of the Broad River by the South Carolina Electric and Gas (SCE&G) Parr Shoals Dam (Parr). Daily operation of the SCE&G's Fairfield Pump Storage (FFPS) facility located on Parr Reservoir has two distinct effects on Parr Reservoir. The first being daily fluctuations in water level, and the second being the potential reversal of current flow in Parr Reservoir depending on the Broad River flows.

In accordance with provisions of the Clean Water Act Section 401 Water Quality Certification issued to SCE&G by the South Carolina Department of Health and Environmental Control, SCANA Corporate Environmental Services began annual collections of sediment samples from two locations in Parr Reservoir for analysis of the following metals (total): aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, silver, strontium, thallium, and zinc. Total phosphorus was also measured.

The data from the 2012 collections will begin to provide background information for determining what impact, if any, the discharge from the operation of VCSNS 2 & VCSNS 3 will have on various constituents of the sediment in the vicinity of the discharge

Methods

Sediment samples were collected from two transects located within Parr Reservoir. The first transect (Transect 2) was located approximately 200 yards downstream of the cooling water discharge location. The second transect (Transect 1) was located just north of the Heller's Creek confluence approximately 4 mile upstream of the discharge location. Sampling at each transect consisted of collection of one grab sample from each of five sample points along each transect. One sample was collected from each end of the transect (eastern shore and western shore). The third sample point was located at the mid-point of each transect. The remaining two sample points were located at equal distance from the mid-point sample location and each end of each transect. All sample points are constantly inundated at the reservoir's low pool elevation (256 ft msl; NGVD 29). The five grab samples were composited and thoroughly homogenized to form one discrete sample from each transect. Basic water quality parameters (dissolved oxygen, pH, specific conductivity, and temperature) were collected using a YSI 650 MDS Water Quality Logger equipped with a YSI 600XL Sonde or instrumentation of equivalent capabilities and accuracy at each transect **(Figure 1)**.

Results

Results for the samples collected at the two transects are presented in Appendix 1. A copy of the laboratory report is presented in Appendix 2. For comparing transects, the metals were divided into groups based on detection results for Transect 2. Beryllium, Mercury, Silver, and Thallium were not detected at either transect during this sampling event. Cadmium was the only metal with a higher detection value at Transect 1 (0.4 mg/kg) than transect 2 (0.3 mg/kg).

Four metals (Antimony, Arsenic, Lead and Nickel) were measured at <10 mg/kg. Antimony (1.7 mg/kg) and Arsenic (3.8 mg/kg) were detected at Transect 2 compared to non-detect at Transect 1. Lead and Nickel concentrations at Transect 2 ranged from 6.0X – 6.6X higher than Transect 1.

Copper, Chromium, Zinc, and Barium results at Transect 2 ranged in values from 15 mg/kg – 97 mg/kg. In comparison Transect 1 values ranged from 2.1 mg/kg -24 mg/kg. Copper concentrations at Transect 2 (15 mg/kg) were measured 7X higher than Transect 1 (2.1 mg/kg) results.

The results at Transect 2 for Manganese and Calcium ranged between 580 mg/kg to 790 mg/kg. Calcium was measured at 790 mg/kg at Transect 2 compared to non-detect at Transect 1 for this sampling event. Manganese concentrations at Transect 2 (580 mg/kg) were 2X higher than Transect 1 (290 mg/kg).

Potassium, Magnesium, Aluminum, and Iron results ranged from 1,600 mg/kg, to 21,000 mg/kg at Transect 2, compared to 500 mg/kg to 5,500 mg/kg at Transect 1. Aluminum concentrations at Transects 2 were 6.5X higher than Transect 1. Potassium, Magnesium, and Iron concentrations at Transect 2 ranged from 3.2X to 3.8X higher than Transect 1.

The phosphorous results were higher at Transect 2 with a value of 350 mg/kg compared to a value of 150 mg/kg at Transect 1.

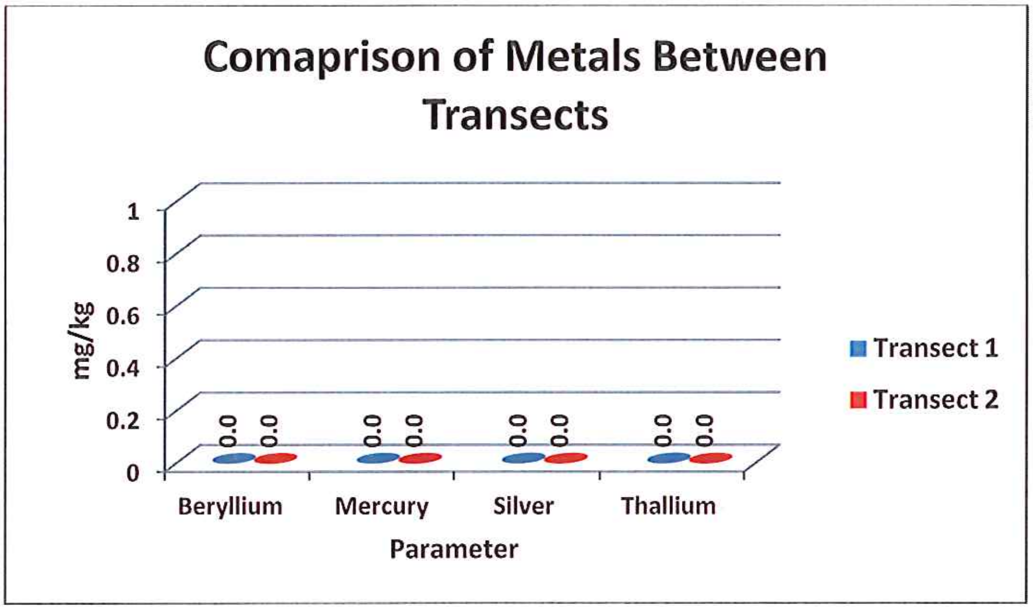
Summary

This data will be used along with subsequent yearly sampling of Transects 1 & 2 to provide background information to help determine what impacts, if any, the discharge from the future operation of VCSNS 2 & VCSNS 3 will have on the aquatic environment of Parr Reservoir as well as the Broad River immediately downstream of Parr Reservoir.

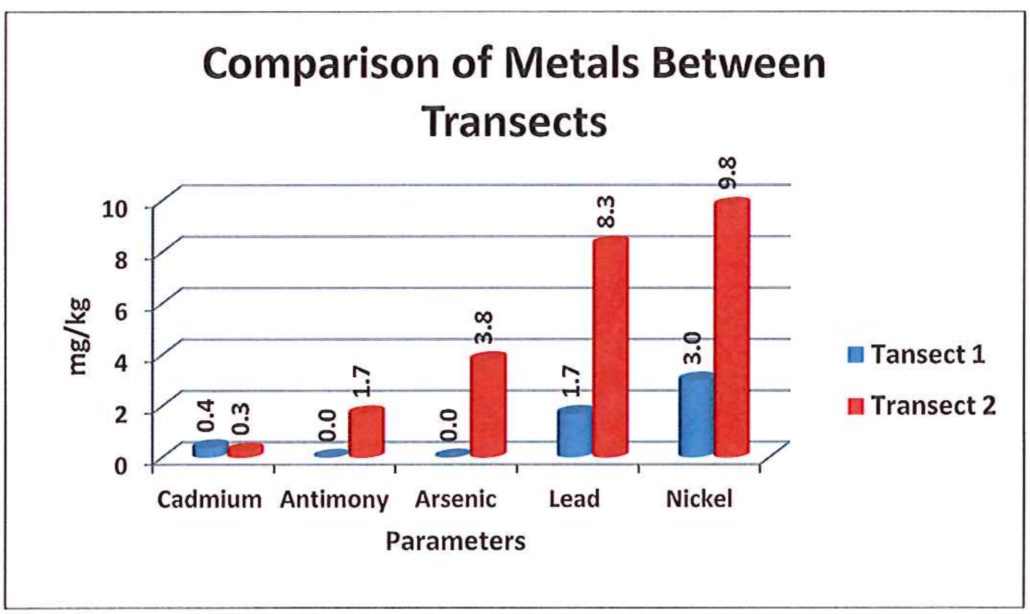
Figure 1. Parr Reservoir Sediment Transect Locations.

Appendix 1

Transect 1 Metals Results versus Transect 2 Metals Results

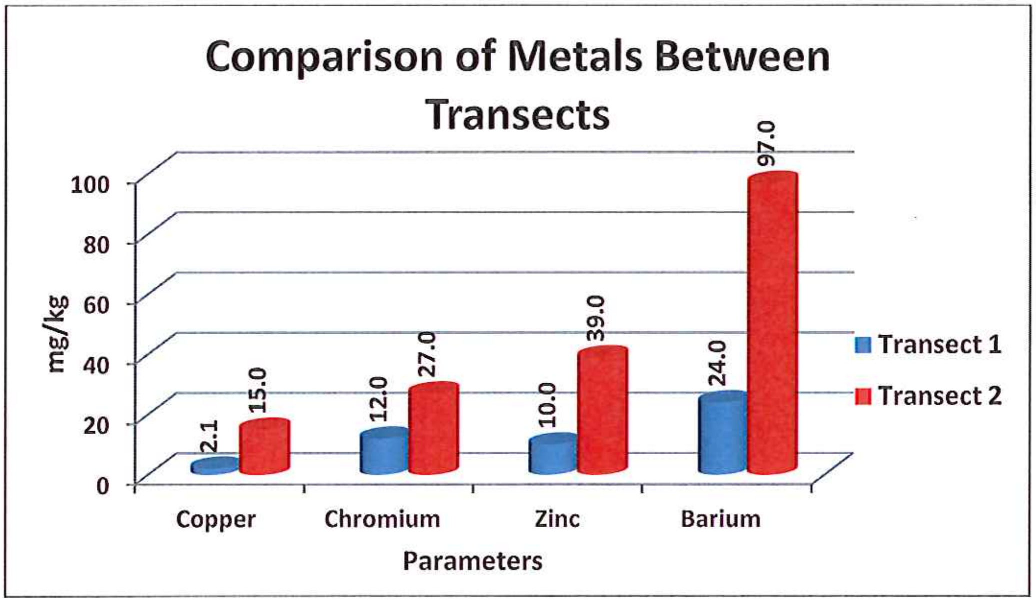


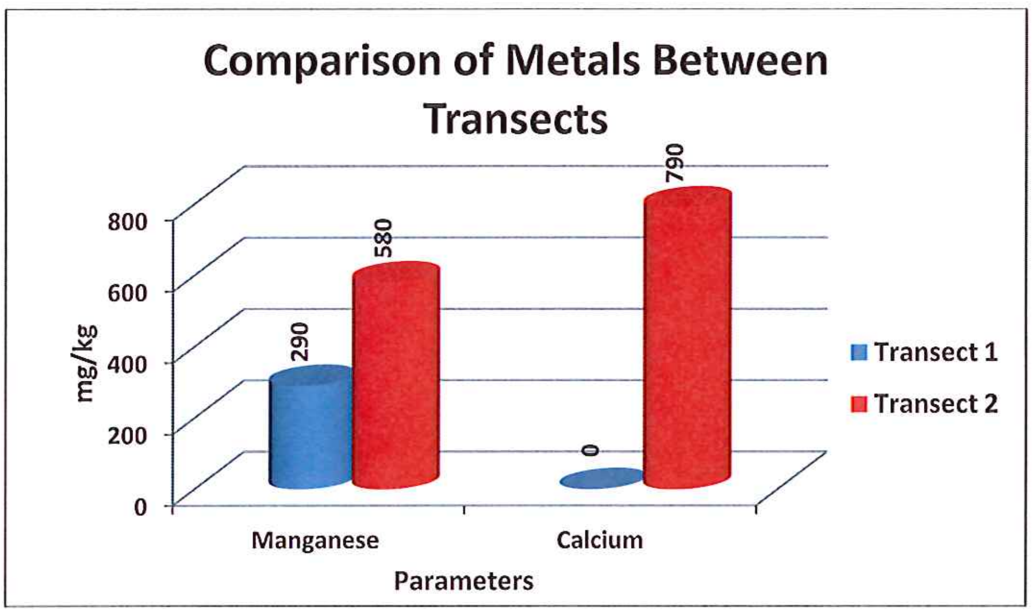
Note: 0.0 = Non- detect



Note: 0.0 = Non- detect

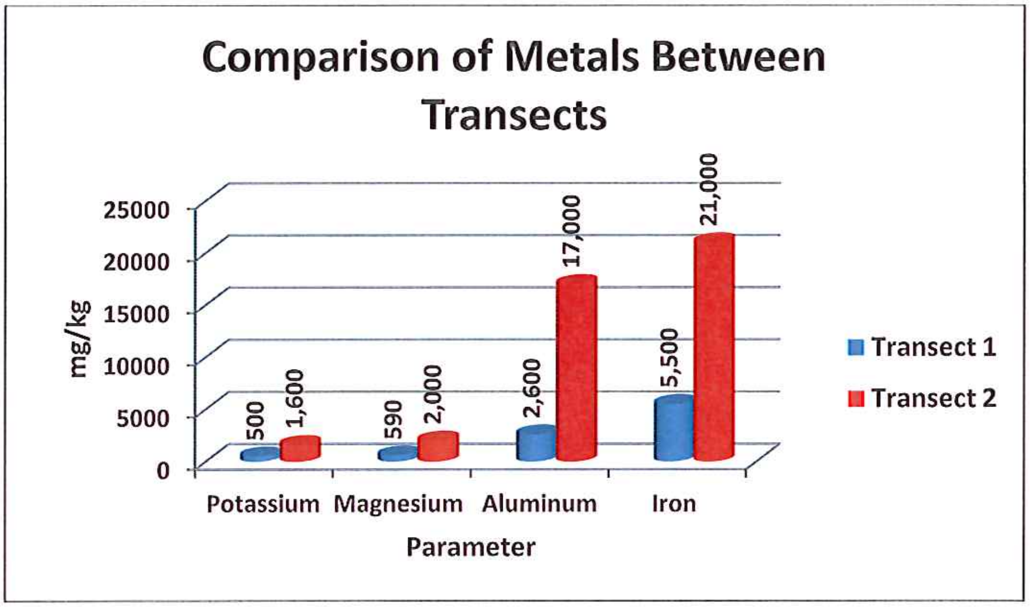
Transect 1 Metals Results versus Transect 2 Metals Results continued:



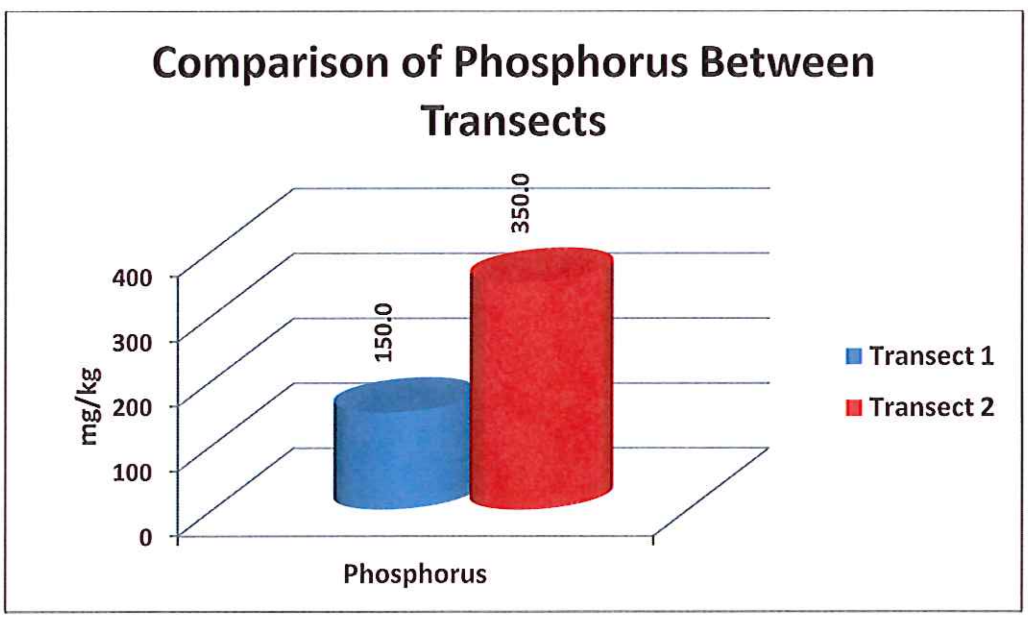


Note: 0.0 = Non- detect

Transect 1 Metals Results versus Transect 2 Metals Results continued:



Transect 1 Total Phosphorus versus Transect 2 Total Phosphorus:



Appendix 2

Laboratory Results.

SHEALY ENVIRONMENTAL SERVICES, INC.

Report of Analysis

SC Electric and Gas Company
220 Operations Way, C221
Cayce, SC 29033--3701
Attention: Milton Quattlebaum

Project Name: **NND**

Lot Number: **NI28059**
Date Completed: **10/08/2012**

Grant Wilton
Project Manager

This report shall not be reproduced, except in its entirety, without the written approval of Shealy Environmental Services, Inc.

The following non-paginated documents are considered part of this report: Chain of Custody Record and Sample Receipt Checklist.

Case Narrative

SC Electric and Gas Company

Lot Number: NI28059

This Report of Analysis contains the analytical result(s) for the sample(s) listed on the Sample Summary following this Case Narrative. The sample receiving date is documented in the header information associated with each sample.

All results listed in this report relate only to the samples that are contained within this report.

Sample receipt, sample analysis, and data review have been performed in accordance with the most current approved NELAC standards, the Shealy Environmental Services, Inc. ("Shealy") Quality Assurance Management Plan (QAMP), standard operating procedures (SOPs), and Shealy policies. Any exceptions to the NELAC standards, the QAMP, SOPs or policies are qualified on the results page or discussed below.

If you have any questions regarding this report please contact the Shealy Project Manager listed on the cover page.

Sample Summary
SC Electric and Gas Company
Lot Number: NI28059

Sample Number	Sample ID	Matrix	Date Sampled	Date Received
001	Sediment Sta Control	Solid	09/27/2012 1129	09/28/2012
002	Sediment Sta 2 Downstream	Solid	09/27/2012 1228	09/28/2012

(2 samples)

SHEALY ENVIRONMENTAL SERVICES, INC.

Executive Summary

SC Electric and Gas Company

Lot Number: NI28059

Sample	Sample ID	Matrix	Parameter	Method	Result	Q	Units	Page
001	Sediment Sta Control	Solid	Phosphorus	365.1	150		mg/kg	5
001	Sediment Sta Control	Solid	Aluminum	6010C	2600		mg/kg	6
001	Sediment Sta Control	Solid	Barium	6010C	24		mg/kg	6
001	Sediment Sta Control	Solid	Cadmium	6010C	0.38		mg/kg	6
001	Sediment Sta Control	Solid	Chromium	6010C	12		mg/kg	6
001	Sediment Sta Control	Solid	Copper	6010C	2.1		mg/kg	6
001	Sediment Sta Control	Solid	Iron	6010C	5500	S	mg/kg	6
001	Sediment Sta Control	Solid	Lead	6010C	1.7		mg/kg	6
001	Sediment Sta Control	Solid	Magnesium	6010C	590		mg/kg	6
001	Sediment Sta Control	Solid	Manganese	6010C	290	S	mg/kg	6
001	Sediment Sta Control	Solid	Nickel	6010C	3.0		mg/kg	6
001	Sediment Sta Control	Solid	Potassium	6010C	500		mg/kg	6
001	Sediment Sta Control	Solid	Zinc	6010C	10		mg/kg	6
002	Sediment Sta 2 Downstream	Solid	Phosphorus	365.1	350		mg/kg	7
002	Sediment Sta 2 Downstream	Solid	Aluminum	6010C	17000	S	mg/kg	8
002	Sediment Sta 2 Downstream	Solid	Antimony	6010C	1.7		mg/kg	8
002	Sediment Sta 2 Downstream	Solid	Arsenic	6010C	3.8		mg/kg	8
002	Sediment Sta 2 Downstream	Solid	Barium	6010C	97		mg/kg	8
002	Sediment Sta 2 Downstream	Solid	Cadmium	6010C	0.26		mg/kg	8
002	Sediment Sta 2 Downstream	Solid	Calcium	6010C	790		mg/kg	8
002	Sediment Sta 2 Downstream	Solid	Chromium	6010C	27		mg/kg	8
002	Sediment Sta 2 Downstream	Solid	Copper	6010C	15		mg/kg	8
002	Sediment Sta 2 Downstream	Solid	Iron	6010C	21000		mg/kg	8
002	Sediment Sta 2 Downstream	Solid	Lead	6010C	8.3		mg/kg	8
002	Sediment Sta 2 Downstream	Solid	Magnesium	6010C	2000		mg/kg	8
002	Sediment Sta 2 Downstream	Solid	Manganese	6010C	580		mg/kg	8
002	Sediment Sta 2 Downstream	Solid	Nickel	6010C	9.8		mg/kg	8
002	Sediment Sta 2 Downstream	Solid	Potassium	6010C	1600		mg/kg	8
002	Sediment Sta 2 Downstream	Solid	Zinc	6010C	39		mg/kg	8

(29 detections)

Inorganic non-metals

Client: **SC Electric and Gas Company**
Description: **Sediment Sta Control**
Date Sampled: **09/27/2012 1129**
Date Received: **09/28/2012**

Laboratory ID: **NI28059-001**
Matrix: **Solid**
% Solids: **77.2** **09/29/2012 0121**

Run	Prep Method	Analytical Method	Dilution	Analysis Date	Analyst	Prep Date	Batch
1		(Phosphorus) 365.1	5	10/05/2012 0843	WKH	10/02/2012 0930	94447

Parameter	CAS Number	Analytical Method	Result	Q	PQL	Units	Run
Phosphorus	**7723-14-0**	**365.1**	**150**		**6.5**	**mg/kg**	**1**

PQL = Practical quantitation limit   B = Detected in the method blank   E = Quantitation of compound exceeded the calibration range   H = Out of holding time   Q = Surrogate failure
ND = Not detected at or above the PQL   J = Estimated result < PQL and ≥ MDL   P = The RPD between two GC columns exceeds 40%   N = Recovery is out of criteria   L = LCS/LCSD failure
Where applicable, all soil sample analysis are reported on a dry weight basis unless flagged with a "W"   * = Reportable result (only when report all runs)   S = MS/MSD failure

TAL Metals

Client: **SC Electric and Gas Company**
Description: **Sediment Sta Control**
Date Sampled: **09/27/2012 1129**
Date Received: **09/28/2012**

Laboratory ID: **NI28059-001**
Matrix: **Solid**
% Solids: **77.2 09/29/2012 0121**

Run	Prep Method	Analytical Method	Dilution	Analysis Date	Analyst	Prep Date	Batch
1	7471B	7471B	1	10/04/2012 1230	COH	10/04/2012 0922	94469
1	3050B	6010C	1	10/03/2012 2319	BNW	10/03/2012 0919	94528
2	3050B	6010C	1	10/05/2012 0216	BNW	10/03/2012 0919	94528

Parameter	CAS Number	Analytical Method	Result	Q	PQL	Units	Run
Aluminum	**7429-90-5**	**6010C**	**2600**		**12**	**mg/kg**	**1**
Antimony	7440-36-0	6010C	ND		0.59	mg/kg	1
Arsenic	7440-38-2	6010C	ND		0.59	mg/kg	2
Barium	**7440-39-3**	**6010C**	**24**		**1.5**	**mg/kg**	**1**
Beryllium	7440-41-7	6010C	ND		0.24	mg/kg	1
Cadmium	**7440-43-9**	**6010C**	**0.38**		**0.12**	**mg/kg**	**1**
Calcium	7440-70-2	6010C	ND		290	mg/kg	2
Chromium	**7440-47-3**	**6010C**	**12**		**0.29**	**mg/kg**	**1**
Copper	**7440-50-8**	**6010C**	**2.1**		**0.29**	**mg/kg**	**1**
Iron	**7439-89-6**	**6010C**	**5500**	**S**	**5.9**	**mg/kg**	**1**
Lead	**7439-92-1**	**6010C**	**1.7**		**0.59**	**mg/kg**	**1**
Magnesium	**7439-95-4**	**6010C**	**590**		**290**	**mg/kg**	**1**
Manganese	**7439-96-5**	**6010C**	**290**	**S**	**0.88**	**mg/kg**	**1**
Mercury	7439-97-6	7471B	ND		0.094	mg/kg	1
Nickel	**7440-02-0**	**6010C**	**3.0**		**2.4**	**mg/kg**	**1**
Potassium	**7440-09-7**	**6010C**	**500**		**290**	**mg/kg**	**1**
Silver	7440-22-4	6010C	ND		0.29	mg/kg	1
Thallium	7440-28-0	6010C	ND		2.9	mg/kg	1
Zinc	**7440-66-6**	**6010C**	**10**		**2.9**	**mg/kg**	**1**

PQL = Practical quantitation limit | B = Detected in the method blank | E = Quantitation of compound exceeded the calibration range | H = Out of holding time | Q = Surrogate failure
ND = Not detected at or above the PQL | J = Estimated result < PQL and ≥ MDL | P = The RPD between two GC columns exceeds 40% | N = Recovery is out of criteria | L = LCS/LCSD failure
Where applicable, all soil sample analysis are reported on a dry weight basis unless flagged with a "W" | * = Reportable result (only when report all runs) | S = MS/MSD failure

Inorganic non-metals

Client: **SC Electric and Gas Company**	Laboratory ID: **NI28059-002**
Description: **Sediment Sta 2 Downstream**	Matrix: **Solid**
Date Sampled: **09/27/2012 1228**	% Solids: **52.5** **09/29/2012 0121**
Date Received: **09/28/2012**	

Run	Prep Method	Analytical Method	Dilution	Analysis Date	Analyst	Prep Date	Batch
1		(Phosphorus) 365.1	10	10/05/2012 0927	WKH	10/02/2012 0930	94447

Parameter	CAS Number	Analytical Method	Result	Q	PQL	Units	Run
Phosphorus	**7723-14-0**	**365.1**	**350**		**19**	**mg/kg**	**1**

PQL = Practical quantitation limit
B = Detected in the method blank
E = Quantitation of compound exceeded the calibration range
H = Out of holding time
Q = Surrogate failure
ND = Not detected at or above the PQL
J = Estimated result < PQL and ≥ MDL
P = The RPD between two GC columns exceeds 40%
N = Recovery is out of criteria
L = LCS/LCSD failure
Where applicable, all soil sample analysis are reported on a dry weight basis unless flagged with a "W"
* = Reportable result (only when report all runs)
S = MS/MSD failure

TAL Metals

Client: **SC Electric and Gas Company**
Description: **Sediment Sta 2 Downstream**
Date Sampled: **09/27/2012 1228**
Date Received: **09/28/2012**

Laboratory ID: **NI28059-002**
Matrix: **Solid**
% Solids: **52.5 09/29/2012 0121**

Run	Prep Method	Analytical Method	Dilution	Analysis Date	Analyst	Prep Date	Batch
1	7471B	7471B	1	10/04/2012 1232	COH	10/04/2012 0922	94469
1	3050B	6010C	1	10/03/2012 2334	BNW	10/03/2012 0919	94528
2	3050B	6010C	1	10/05/2012 0231	BNW	10/03/2012 0919	94528

Parameter	CAS Number	Analytical Method	Result	Q	PQL	Units	Run
Aluminum	**7429-90-5**	**6010C**	**17000**	**S**	**18**	**mg/kg**	**1**
Antimony	**7440-36-0**	**6010C**	**1.7**		**0.90**	**mg/kg**	**1**
Arsenic	**7440-38-2**	**6010C**	**3.8**		**0.90**	**mg/kg**	**1**
Barium	**7440-39-3**	**6010C**	**97**		**2.3**	**mg/kg**	**1**
Beryllium	7440-41-7	6010C	ND		0.36	mg/kg	1
Cadmium	**7440-43-9**	**6010C**	**0.26**		**0.18**	**mg/kg**	**1**
Calcium	**7440-70-2**	**6010C**	**790**		**450**	**mg/kg**	**2**
Chromium	**7440-47-3**	**6010C**	**27**		**0.45**	**mg/kg**	**1**
Copper	**7440-50-8**	**6010C**	**15**		**0.45**	**mg/kg**	**1**
Iron	**7439-89-6**	**6010C**	**21000**		**9.0**	**mg/kg**	**1**
Lead	**7439-92-1**	**6010C**	**8.3**		**0.90**	**mg/kg**	**1**
Magnesium	**7439-95-4**	**6010C**	**2000**		**450**	**mg/kg**	**1**
Manganese	**7439-96-5**	**6010C**	**580**		**1.4**	**mg/kg**	**1**
Mercury	7439-97-6	7471B	ND		0.16	mg/kg	1
Nickel	**7440-02-0**	**6010C**	**9.8**		**3.6**	**mg/kg**	**1**
Potassium	**7440-09-7**	**6010C**	**1600**		**450**	**mg/kg**	**1**
Silver	7440-22-4	6010C	ND		0.45	mg/kg	1
Thallium	7440-28-0	6010C	ND		4.5	mg/kg	1
Zinc	**7440-66-6**	**6010C**	**39**		**4.5**	**mg/kg**	**1**

PQL = Practical quantitation limit | B = Detected in the method blank | E = Quantitation of compound exceeded the calibration range | H = Out of holding time | Q = Surrogate failure
ND = Not detected at or above the PQL | J = Estimated result < PQL and ≥ MDL | P = The RPD between two GC columns exceeds 40% | N = Recovery is out of criteria | L = LCS/LCSD failure
Where applicable, all soil sample analysis are reported on a dry weight basis unless flagged with a "W" | * = Reportable result (only when report all runs) | S = MS/MSD failure

SHEALY ENVIRONMENTAL SERVICES, INC.

SHEALY **Chain of Custody Record**

Shealy Environmental Services, Inc.
106 Vantage Point Drive
West Columbia, South Carolina 29172
Telephone No. (803) 791-9700 Fax No. (803) 791-9111
www.shealylab.com

Number 30300

Client	Report to Contact	Sampler (Printed Name)	Quote No.
SCE&G	Milton Quattlebaum	Milton Quattlebaum	
Address: 2112 North Lake Dr.	Telephone No. / Fax No. / Email: (803)217-8162 mquattlebaum@scana.com	Waybill No.	Page 1 of 1
City: Columbia; State: SC; Zip Code: 29212	Preservative: 1. Unpres. 2. NaOH/ZnA 3. H2SO4 4. HNO3 5. HCL 6. Na Thio. 7. NaOH		
Project Name: NND			Lot No. NI2859
Project Number	P.O Number		

	Number of Containers	Bottle (See Instructions on back)	Preservative
Metals	1	L	1
Total Phosphorus	1	L	1

Sample ID / Description (Containers for each sample may be combined on one line)	Date 2012	Time	G=Grab C=Composite	Matrix: GW	DW	WW	S	Other	Metals	Total Phosphorus	Remarks / Cooler ID
Sediment Steel Control	27Sept	1129	G				K		1	1	Metals: Arsenic,
Sediment Sta 2 Downstrm	27Sept	1228	G				K		1	1	Barium, Beryllium,
											Cadmium, Calcium
											Chromium, Copper Iron, Lead,
											Magnesium, Manganese,
											Mercury, Nickel,
											Potassium, Silver,
											Strontium, Thallium & Zinc
											Aluminum, Antimony

MNQ 28 Sept 2012

Turn Around Time Required (Prior lab approval required for expedited TAT): ☐ Standard ☐ Rush (Please Specify)

Sample Disposal: ☐ Return to Client ☐ Disposal by Lab

QC Requirements (Specify)

Possible Hazard Identification: ☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison ☐ Unknown

Relinquished by	Date	Time	Received by	Date	Time
1. Relinquished by / Sampler: [signature]	28Sept2012	0905	1. Received by		
2. Relinquished by			2. Received by		
3. Relinquished by			3. Received by		
4. Relinquished by			4. Laboratory Received by: [signature]	9-28-12	0905

Note: All samples are retained for six weeks from receipt unless other arrangements are made.

LAB USE ONLY — Received on Ice (Check): ☑ Yes ☐ No ☐ Ice Pack; Receipt Temp. 5.5 °C; Temp. Blank ☐ Y ☑ N

SHEALY ENVIRONMENTAL SERVICES, INC.

Sample Receipt Checklist (SRC)

Client: SCE+G Cooler Inspected by/date: EV 9/28/12 Lot #: NL28059

Means of receipt: ☐ SESI ☑ Client ☐ UPS ☐ FedEx ☐ Airborne Exp ☐ Other

Yes ☐	No ☑		1. Were custody seals present on the cooler?
Yes ☐	No ☐		2. If custody seals were present, were they intact and unbroken?

Cooler ID/temperature upon receipt 5.5 °C / °C / °C / °C
Method: ☐ Temperature Blank ☑ Against Bottles
Method of coolant: ☑ Wet Ice ☐ Blue ice ☐ Dry Ice ☐ None

If response is No (or Yes for 14, 15, 16), an explanation/resolution must be provided.

Yes ☐	No ☐	NA ☑	3. If temperature of any cooler exceeded 6.0°C, was Project Manager notified? PM notified by SRC, phone, note (circle one), other: ________. (For coolers received via commercial courier, PMs are to be notified immediately.
Yes ☐	No ☐	NA ☑	4. Is the commercial courier's packing slip attached to this form?
Yes ☑	No ☐		5. Were proper custody procedures (relinquished/received) followed?
Yes ☐	No ☐	NA ☑	5a Were samples relinquished by client to commercial courier?
Yes ☑	No ☐		6. Were sample IDs listed?
Yes ☑	No ☐		7. Was collection date & time listed?
Yes ☑	No ☐		8. Were tests to be performed listed on the COC?
Yes ☑	No ☐		9. Did all samples arrive in the proper containers for each test?
Yes ☑	No ☐		10. Did all container label information (ID, date, time) agree with COC?
Yes ☑	No ☐		11. Did all containers arrive in good condition (unbroken, lids on, etc.)?
Yes ☑	No ☐		12. Was adequate sample volume available?
Yes ☑	No ☐		13. Were all samples received within ½ the holding time or 48 hours, whichever comes first?
Yes ☐	No ☑		14. Were any samples containers missing?
Yes ☐	No ☑		15. Were there any excess samples not listed on COC?
Yes ☐	No ☐	NA ☑	16. Were bubbles present >"pea size" (¼"or 6mm in diameter) in any VOA vials?
Yes ☐	No ☐	NA ☑	17. Were all metals/O&G/HEM/nutrient samples received at a pH of <2?
Yes ☐	No ☐	NA ☑	18. Were all cyanide and/or sulfide samples received at a pH >12?
Yes ☐	No ☐	NA ☑	19. Were all applicable NH3/TKN/cyanide/phenol/BNA/pest/PCB/herb (<0.2mg/L) samples free of residual chlorine?
Yes ☐	No ☐	NA ☑	20. Were collection temperatures documented on the COC for NC samples?
Yes ☐	No ☐	NA ☑	21. Were client remarks/requests (i.e. requested dilutions, MS/MSD designations, etc...) correctly transcribed from the COC into the comment section in LIMS?

Sample Preservation (Must be completed for any sample(s) incorrectly preserved or with headspace.)

Sample(s) ________ were received incorrectly preserved and were adjusted accordingly in sample receiving with ________ (H_2SO_4,HNO_3,HCl,NaOH) with the SR # (number) ________

Sample(s) ________ were received with bubbles >6 mm in diameter.

Sample(s) ________ were received with TRC >0.2 mg/L for NH3/TKN/cyanide/BNA/pest/PCB/herb.

Corrective Action taken, if necessary:

Was client notified: Yes ☐ No ☐ Did client respond: Yes ☐ No ☐

SESI employee: ________ Date of response: ________

Comments: ________

APPENDIX B

THERMAL MIXING ZONE EVALUATION

VIRGIL C. SUMMER NUCLEAR STATION

NPDES PERMIT

Prepared for

SCANA – South Carolina Electric and Gas
100 SCANA Parkway
Cayce, SC 29033

THERMAL MIXING ZONE EVALUATION VIRGIL C. SUMMER NUCLEAR STATION NPDES PERMIT FAIRFIELD COUNTY, SOUTH CAROLINA

Prepared by

Geosyntec consultants

engineers | scientists | innovators

&

MMI

engineers • scientists • innovators

Project Number GR4796

January 9, 2012

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

TABLE OF CONTENTS (Continued)

1. INTRODUCTION

South Carolina Electric and Gas (SCE&G, a subsidiary of SCANA Corporation) is making an application to the South Carolina Department of Health and Environmental Control (DHEC) for a renewal of its National Pollutant Discharge Elimination System (NPDES) permit for Unit 1 of the Virgil C. Summer Nuclear Generating Station (V. C. Summer Station) located in Fairfield County near Jenkinsville, South Carolina.

This document presents background and technical information supporting formal requests to DHEC for the thermal mixing zone for the V. C. Summer Station cooling water effluent discharge to the Monticello Reservoir pursuant to Rule 61-68 (Water Classifications and Standards) Section C.10.

Facility Description

Summer Station is a single-unit, 974-megawatt (MW) nuclear-fueled electric power generating facility that operates as a base-load facility. It uses a once-through cooling water system that withdraws cooling water from Monticello Reservoir via a single shoreline-positioned cooling water intake structure (CWIS) located at the south end of the reservoir. After the cooling water leaves the condensers, the heated water is conveyed to a "discharge bay" and then through a 1,000 foot (ft) discharge canal leading into Monticello Reservoir.

Monticello Reservoir is a 6,800-acre (ac) freshwater impoundment that was built in the Frees Creek valley in 1978 to serve both as the cooling water source for Summer Station and the upper pool for the Fairfield Pumped Storage Facility (FPSF). The Federal Energy Regulatory Commission (FERC) regulates water levels in Monticello Reservoir through the hydropower license for SCE&G's Parr Shoals (Broad River) Hydroelectric Project (FERC License No. 1894), of which FPSF is a part. The FERC license for Parr Shoals establishes water surface elevation guidelines for Monticello Reservoir between 425.0 feet (ft) above mean sea level (msl) (high water level) and 420.5 ft msl (low water level). Reservoir levels may fluctuate daily within this 4.5-ft operating band as a result of FPSF operation.

The operation of the FPSF will vary depending on the season and system power needs. In summer, the facility generally pumps water from Parr Reservoir to Monticello Reservoir between the hours of 11:00 pm and 8:00 am and generates power by releasing water between the hours of 10:00 am and 11:00 pm. In winter, FPSF generally pumps water daily from Parr Reservoir to Monticello Reservoir between 11:00 pm and 6:00 am and generates between the hours of 6:00 am and 1:00 pm. Pumping to Monticello Reservoir is normally done at maximum capacity during off-peak periods. The power output for FPSF varies from one generator up to the maximum output from eight generators, depending on demand. Consistent with its operation as a peaking facility, maximum output of FPSF may not be necessary on all days.

Permitting History

The NPDES permitting history for the Summer Station discharge extends from the mid-1970s when the facility was first permitted. Operating as a once-through cooling water system, thermal addition to Monticello Reservoir is substantial with discharge flow rates up to 532,000 gallons per minute (768 million gallons per day). To comply with South Carolina Department of Health and Environmental Control (DHEC) water quality standards for temperature in lakes, SCE&G conducted studies to successfully support alternate thermal effluent limitations under Clean Water Act Section 316(a) per South Carolina Regulation 61-68 – Water Classifications and Standards: Section E.12.c.)[1]. The following numeric effluent limitations for temperature were established for Summer Station Outfall 001 in the initial permit:

- a daily maximum temperature of 113°F to be measured "in pipe" prior to discharge;
- a monthly average temperature of 90°F measured at the FPSF intake structure (considered the mixing zone boundary);
- a maximum thermal plume size of 6,700 acres; and

[1] The weekly average water temperature of all Freshwaters which are **lakes** shall not be increased more than 5°F (2.8°C) above natural conditions and shall not exceed 90°F (32.2°C) as a result of the discharge of heated liquids unless a different site-specific temperature standard as provided for in C.12. has been established, a mixing zone as provided in C.10. has been established, or a Section 316(a) determination under the Federal Clean Water Act has been completed (South Carolina Regulation 61-68 – Water Classifications and Standards: Section E.12.c.).

- a monthly average temperature rise (ΔT) within the plume of 3°F measured between the FPSF intake structure and a point at the northern end of the reservoir.

Based on several years of monitoring, DHEC ultimately eliminated the plume size and ΔT limitations leaving in place the 113°F daily maximum limit and 90°F monthly average limit in subsequent permits.

Thermal discharges and repeated continuation of alternate thermal limits (variances) in NPDES permits that are based on historical 316(a) demonstration study data have come under increased scrutiny by the U.S. Environmental Protection Agency (USEPA) who oversees the DHEC NPDES program. Recently, DHEC and SCE&G have had discussions relative to renewal of the current NPDES permit for V. C. Summer Station concerning the level of information needed to support the continued discharge temperature limits for the facility. There have been no substantive changes[2] to V. C. Summer Station operations since issuance of the initial NPDES permit in the mid-1970s. As such, SCE&G believes that reevaluation of the thermal mixing zone characteristics and boundaries via updated hydrodynamic modeling (in complement to the earlier 316(a) demonstration study data) will provide the quantitative information needed by DHEC to support a decision maintaining the current temperature limits for Summer Station that is consistent with South Carolina Regulation 61-68, Section E.12.

Related Modeling Work

The primary modeling study related to the thermal plume characteristics of the cooling water discharge for the V. C. Summer Station was carried out by NUS Corporation in 1985 [1] and updated in 1989 [2]. A mathematical model of the lake was created which accounted for discharge and atmospheric parameters and calculated the thermal plume based on assumed vertical temperature profiles. The conclusions of the study showed that the VC Summer Station would not violate any of the three quantitative temperature limits in the NPDES permit at the time, even under extreme meteorological conditions.

[2] Licensed power output of the V.C. Summer Station Unit 1 has been increased, but due to some cooling loads being handled by a small cooling tower, the heat loading to the reservoir has not changed significantly. Additionally, the discharge canal was dredged (canal is now deeper than it was originally) to alleviate fish kills in the discharge bay area.

While certainly an advanced and comprehensive analysis at the time, the NUS study did not consider several important features of the thermal discharge. In particular, the Unit 1 cooling water discharges into a small basin (approximately 600 ft x 600 ft surface dimension), which is connected to the reservoir through a channel approximately 900 ft in length and 200 ft wide. The dynamics in the basin and channel are complex; recirculating flows in the basin, and an unusual return flow of cold water flowing along the bottom of the channel from the reservoir to the basin. These features could not have been reasonably accounted for and calculated by the NUS study, and neither can they be calculated with more modern tools such as CORMIX [3], since in both these cases underlying assumptions are made regarding the temperature profiles.

In order to more definitively characterize the V. C. Summer Station Unit 1 thermal discharge into the hydrodynamically and spatially complex mixing environment in the basin, channel and reservoir, a more robust modeling approach was needed. As such, three-dimensional Computational Fluid Dynamics (CFD) modeling effort was conducted.

CFD modeling is based on the Navier-Stokes equations for fluid motion, which are simply an expression of Newton's laws of motion with additional viscous stress terms required to calculate fluid flow [4]. The equations express the laws of conservation of mass, momentum and energy and are hence a "fundamental" set of equations (i.e., no assumptions are made in forming the basic equation set).

CFD modeling has been used successfully for over 40 years in a variety of industrial and environmental applications. The Tennessee Valley Authority (TVA) used CFD modeling to evaluate the thermal discharge from its Browns Ferry Nuclear Power Plant to Wheeler Reservoir in north Alabama [5]. The CFD model allowed TVA to determine thermal plume mixing and temperature rise patterns as well as other hydrodynamic features of the discharge. Notably, TVA found close agreement between CFD model predicted water temperatures and direct temperature measurements at the operating diffusers.

More recently, Geosyntec Consultants and MMI Engineering employed CFD to model the complex thermal plume characteristics of the proposed William States Lee III Nuclear Generating Station, as part of the NPDES permit application for the site submitted by Duke Energy to DHEC. Similar to the current study, the thermal plume was affected by operations in the receiving water body that significantly affected the surface elevation.

Other examples of CFD environmental applications include the U.S. Department of Energy's Pacific Northwest National Laboratory use of CFD in the hydrodynamic evaluation of the North Fork Dam forebay on the Clackamas River in Oregon and to model the three-dimensional velocity field below Bonneville Dam to enhance fish passage [6]. CFD has also been used to investigate the increased discharge associated with the re-powering of an existing power plant [7].

2. GENERATION OF THE COMPUTATIONAL MODEL

Geosyntec/MMI Engineering uses a variety of classical and computational analysis techniques to assess the performance of fluid systems and processes. For detailed CFD analysis, calculations are made with the general purpose, commercial CFD code ANSYS-CFX Version 12 [8]. This is the CFD model code selected for the current analysis. Full details of the computational model are given in Appendix A.

The extent (geometry) of the Monticello Reservoir and discharge bay and canal environment in the CFD models included:

- the Unit 1 discharge bay and canal;
- the Fairfield Pumped Storage Facility intakes;
- the backwater areas in the locality of the canal; and,
- a section of the Monticello Reservoir extended approximately 1.6 miles north of the discharge structure.

Total surface area of the modeled domain was approximately 1800 acres, or approximately 25% of the total surface area of the reservoir.

Bathymetry data in the discharge bay and canal, and in part of the Monticello Reservoir, was collected by Geosyntec in the form of point-depth measurements in a series of transects. These point data were interpolated to form part of the reservoir bed in the CFD models. For the areas of the model that were not covered by the bathymetry data, a contour map was provided to MMI/Geosyntec (a section of this map in shown in

Figure 3) and was digitized by MMI/Geosyntec to create approximately 10,000 additional data points (Figure 4) that were combined with the collected bathymetry data to form the entire model (see Figure 5 and Figure 6). A more detailed view of the model in the vicinity of the discharge, showing the bay and canal, is shown on Figure 7 and Figure 8.

Detailed drawings of the discharge structure were not available; however the shape of the structure and its dimensions and exact location can be calculated from aerial photographs. The discharge pipe diameter is 144" [9], and in the model this was represented as a square cross-section (rather than circular) of the same area as the circular pipe. This ensures the correct mass, energy and momentum input into the model and the highly turbulent flows near the discharge would quickly smooth out small differences in the shape of the discharge pipe.

Views of the computational mesh, which contained approximately 500,000 cells with 20 cells in the depth direction, are shown on Figure 9 and Figure 10.

3. SCENARIOS

The following modeling scenarios were run to capture the expected worst case results (thermally and spatially) for the Summer Station thermal discharge:

- **Scenario 1** – Thermal discharge under peak load and discharge flow with Monticello Reservoir elevation under high water-slack conditions (no flow through FPSF).
- **Scenario 2** – Thermal discharge under peak load and discharge flow with Monticello Reservoir elevation under low water-slack conditions (no flow through FPSF).
- **Scenario 3** – Thermal discharge under peak load and discharge flow with Monticello Reservoir elevation under low water-rising conditions (FPSF pump-back); and
- **Scenario 4** – Thermal discharge under peak load and discharge flow with Monticello Reservoir elevation under high water-falling conditions (FPSF generation).

Each scenario was modeled under critical conditions of summer when ambient reservoir and discharge temperatures are expected to be greatest and have the most potential for acute effects to aquatic life. This will allow evaluation of thermal plume mixing characteristics and spatial dimensions in the context of the DHEC 90°F temperature criterion. Based on data transmitted to MMI/Geosyntec [10], the ambient reservoir temperature was set to 86.4°F as this was the highest monthly-average temperature recorded at the Unit 1 intakes in 2010. The discharge temperature was set to 113.0°F which was measured during August 2011, and is approximately 1°F higher than the recorded highest monthly-average discharge temperature in 2010.

Additionally, each scenario was also modeled under winter conditions when differential between the plume temperature and ambient temperature (i.e., ΔT) are expected to be greatest. This will allow evaluation of thermal plume mixing characteristics and spatial dimensions in the context of the DHEC 5°F ΔT temperature criterion. Based on data transmitted to MMI/Geosyntec [10], the highest monthly-averaged ΔT for 2010 occurred in November, where the monthly-average reservoir temperature was recorded at 66.6°F and the monthly-average discharge temperature was 98.7°F, resulting in a ΔT of 32.1°F. These temperature values were used to represent winter conditions.

In all cases, the discharge flow rate was set to 532,000 gpm which is the flow rate through the Unit 1 intake with all three intake pumps fully operational. Based on data transmitted to MMI/Geosyntec [11], the flow rate for FPSF pump-back was set to 41,800 cfs and the flow rate for FPSF generation was set to 50,400 cfs.

4. VALIDATION OF THE COMPUTATIONAL MODEL

Geosyntec collected temperature and velocity profiles during a data survey conducted on the Monticello Reservoir in August 2011. The most useful "snapshot" of the temperature of the thermal plume was taken at around 2pm on August 3rd 2011in the form of five temperature profiles extending to a maximum depth of 25ft. These profiles are shown on Figure 11 (note that the temperature scale is in degrees Celsius). At the time of the measurements, the discharge temperature was 44.1°C (111.4 °F) and this is shown for reference on Figure 11 by the broken purple line on the right. The most striking feature of the measurements is the difference between the discharge temperature and the measured temperature in the discharge bay (i.e. almost immediately downstream of the discharge). This profile is shown in blue in the figure. If the water in the discharge bay were from the discharge alone, then a temperature near to 44.1°C would be expected as the only losses would be minor. However, the measurements show temperatures around 40°C in the discharge bay. An indication of the explanation for this can be deduced from the temperature profile taken at the confluence of the discharge bay and canal (shown in red). For depths below 15 ft, the temperature reduces rapidly to less than 34°C. The profile taken at the mouth of the discharge canal (green) has a similar dramatic reduction in temperature below 10 ft depth, to just above 30°C near the bottom, which is approximately the same as the recorded background temperature (light blue). It appears from the data that it is likely that these temperature profiles comprise discharge (hot) water in the upper layer and ambient (cold) water in the lower layer, which, since this pattern is repeated at in the discharge bay (red line) suggests that cold water is flowing from the reservoir into the bay along the bottom of the discharge canal, and hot water is flowing in the opposite direction near the surface. Indeed, this phenomenon of warm water flowing over cool water in the discharge canal was explained to MMI/Geosyntec staff by SCE&G staff prior to the measurements being taken. The field measurements confirmed this.

A somewhat less expected feature of the temperature profiles is the apparent inversion in the upper 5ft of the profiles, where the temperature reduces significantly, suggesting a cooler, more dense layer near the surface on top of a warmer and less dense layer below (in opposition to the natural tendency of buoyancy). The only physical explanation for this reduction in temperature is a very high rate of heat loss at the surface, much higher than one would expect by classical heat loss calculations alone. This may be linked to waves generated by the discharge or the wind, or churning aeration of the very upper layer.

To investigate the accuracy of the computational model, a simulation was run to approximate the thermal plume as closely as possible at the time the measurements were taken. The discharge temperature was set to 44.1°C (111.4 °F) and the flow rate was set to 532,000 gpm. The surface elevation of the reservoir was set to 423.5 ft msl which was calculated from level-loggers installed by Geosyntec. In addition, a surface shear stress was applied that was equivalent to a 10 ft/s north-easterly wind which was recorded on the day.

Figure 12 shows a contour plot of temperature on the surface of the reservoir resulting from the simulation. The blue coloration indicates the ambient temperature of the reservoir (set as 32.0°C) while the red coloration indicates a temperature equal to the discharge temperature. The plume can be seen to gradually reduce in temperature away from the discharge bay and canal. Interestingly, the oranges and yellows in the discharge bay as predicted in the CFD model indicate much lower temperatures than in the discharge pipe. To investigate this further, two contour plots were produced of temperature on the surface and at 18 ft depth – these are shown on Figure 13 (a) and (b) respectively. Figure 13 (a) shows a close view of the contour plot in Figure 12, and surface temperatures of approximately 41.0°C can be observed. However, Figure 13 (b) which is the temperature at 18 ft depth, shows much cooler (blue) temperatures near the bottom of the discharge canal, as was observed in the field measurements. A clear visualization of this phenomenon can be seen on Figure 14, where velocity vectors are shown on a vertical cut-plane in the center of the canal, and are colored by temperature rather than velocity. There is a clear flow of cold water from the reservoir to the discharge bay in the lower layers, and a flow of hot water in the reverse direction in the upper layers.

Qualitatively the model thus agrees with the anticipated flows, despite these flows being unusual. A quantitative comparison is shown on Figure 15 where the lines indicate results from the CFD model and the circles indicate measured data. The colors of the lines and circles match where the profiles were taken at the same locations. The CFD results in the discharge bay (blue line) shows that the temperature has decreased in the discharge bay by approximately the correct amount. This is due to the counter-flow of cold water into the bay from the reservoir, which is shown by the CFD model results at the confluence of the discharge bay and canal (red line). The sharp decrease in temperature mirrors the measured temperature gradient well. The major differences between the model and measured temperature profiles exist within the upper layer, where the inversion is not predicted by the CFD model. This is not unexpected since it is difficult to account for the inversion recorded by the data. However, it is important to note that the differences between the model and the data result in a higher surface temperature being predicted by the CFD model, showing that the model results will in general be conservative. At the mouth of the discharge canal (green line) the surface temperature is again over-predicted, but the sharp temperature gradient seen below 5 ft depth is captured, albeit at a slightly shallower depth in the model than was measured. Importantly, the model and data match well in the region halfway between the canal and exclusion buoys (orange), as the edges of the thermal plume are expected near this region. The last profile comparison (light blue line) is simply the background profile, which was set as constant in the CFD model but showed slight variation with depth in the measured data, probably due to naturally formed thermoclines rather than the thermal plume itself given the distance between the measurement and the discharge (approximately 2 miles).

The validation effort therefore shows that the CFD model qualitatively predicts the correct behavior, particularly with respect to the known unusual flows in the discharge canal. The agreement between the model and measured data is generally good, with the greatest discrepancies near the surface of the reservoir. Where these discrepancies occur, the CFD model over-predicts the measured data, so the model results are conservative with respect to surface temperature and therefore the size and magnitude of the thermal plumes.

5. MODEL RESULTS – T = 90°F PLUME

The four scenarios listed in §3 were run under summer conditions to evaluate the size of the 90°F thermal plume, as these conditions represent the worst-case scenarios for this plume. In all scenarios the discharge temperature was set to 113.0°F and the ambient reservoir temperature was 86.4°F. The scenarios for summer conditions are referred to as 1S, 2S, 3S and 4S in the text and figure captions, and the input parameters and results are summarized in §7 for reference.

The surface temperature for scenario 1S is shown on Figure 16. In this scenario, the reservoir surface elevation is high (425.0 ft msl) and the FPSF flow rate is zero (slack conditions). This figure provides a full view of the thermal plume in plan view, although it must be remembered that the analysis is three-dimensional so variations in temperature in the depth direction are captured. As anticipated, the hot plume spreads and cools as it mixes with the ambient water downstream of the discharge canal (the red areas in the figure represent temperatures about 112.0°F and the blue indicates less than 87.0°F). The 90°F plume is difficult to distinguish from the contour plot, so it is shown more clearly on Figure 17 where the purple area shows the 90.0°F. Note that the area shown on this figure does not necessarily extend vertically down to the bottom of the reservoir, as the temperature gradients highlighted in the validation study will also exist here. The dimensions of the thermal plume account for these variations as the computational model is three-dimensional. The volume of the 90.0°F plume for scenario 1S is 1,418 acre-ft and the surface area is 128 acres. The maximum length of the plume, which is taken from the end of the discharge pipe to the point in the plume furthest away from the pipe, is 4,332 ft, while the width of the plume (the maximum width in approximately an east-west direction) is 3,312 ft. Note that although the maximum depth of the plume is 40 ft, the average depth of the plume is only 6.4 ft, indicating that the majority of the plume is relatively shallow.

Scenario 2S is the same simulation as scenario 1S but at a low surface elevation (420.5 ft). As the volume of the ambient water is reduced in the reservoir, but the flow rate from the discharge remains the same, it might be expected that the plume would be slightly larger in volume than the previous scenario. This is indeed the case – the volume of the 90°F plume is 1,627 acre-ft and the surface area is 150 acres. The temperature contours and 90°F plume for this case are shown on Figure 19.

When the FPSF is pumping under low surface elevation, approximately 41,800 cfs is injected into the reservoir at the ambient reservoir temperature. This is the situation modeled in scenario 3S. The velocity vectors on the surface of the reservoir are shown on Figure 20 where the scale is from zero velocity (blue) to 3 ft/s (red). Although the jet from the FPSF is set almost directly from west to east in the model, the proximity and angle of the coast just to the south of the FPSF causes the jet to turn south, resulting in a large recirculation region bounded by the jetty and the island. Although the change to the flows in the western region of the lake are significantly changed, the raised jetty effectively shields the thermal plume, so that neither the temperature contours (Figure 21) or the 90°F plume (Figure 22) are changed from slack conditions (compare to scenario 2S). Indeed, the 90°F plume are very similar to those in scenario 2S: the plume volume is 1,626 acre-feet, the surface area is 150 acres and the maximum length and width are 4,699 ft and 3,830 ft respectively.

The final scenario under summer conditions is 4S, where the FPSF is generating, removing 50,400 cfs of flow from the reservoir. This generates a velocity field pointing towards the FPSF intakes, as shown by the velocity vectors on Figure 23 (the scale in this figure is from zero (blue) to 1 ft/s (red). Note that the influence of the FPSF is lesser when the flow is being withdrawn from the reservoir rather than injected, since the flow is withdrawn from all angles rather than the highly directional jet seen in Figure 20. The withdrawal of fluid from the reservoir does have the effect of "pulling" the plume and results in a stretched but shallower thermal plume – the maximum length and width of the plume are 4,775 ft and 3,705 ft respectively, but the average depth has reduced to 6.1 ft. Overall the 90°F plume is largest in this flow regime, with a volume of 1,790 acre-ft and a surface area of 163 acres. The reason why the generating rather than pumping regime increases the plume size is twofold: first, the "pulling" of the fluid is less turbulent and does not cause additional mixing; second, the flow does not sharply turn, as was shown by the vectors near the island for the previous scenario. The surface temperature contours and 90°F plume for this case are shown on Figure 24 and Figure 25 respectively.

A summary of these results is given by the table in §7.

6. MODEL RESULTS – ΔT = 5°F PLUME

The worst case for the ΔT = 5°F thermal plume is under winter conditions where the temperature difference between the background and discharge is greatest. As explained in §3, this occurs in November where the monthly-average ambient reservoir temperature is 66.6°F and the discharge temperature is 98.7°F, a ΔT of 32.1°F. These temperatures were set for all four winter scenarios, and are referred to as 1W, 2W, 3W and 4W in the text and figure captions, and the input parameters and results are summarized in §8 for reference.

The surface temperature for scenario 1W (high surface elevation, slack conditions) is shown on Figure 26. Similar to the figures for the summer conditions, the blue coloration indicates ambient temperatures and red indicates temperatures similar to the plume; however in winter the ambient temperature is now 66.6°F and the plume temperatures is 98.7°F. In this color scale the thermal plume appears to be similar in shape and size to the summer plumes, but it is the ΔT = 5°F rather than the 90°F plume that is of interest here. This is shown for scenario 1W by the green area in Figure 27. This plume is visibly smaller than the 90°F plumes in the previous section. The volume of the ΔT = 5°F for this scenario is 799 acre-feet and the surface area is 77 acres. The maximum length and width are 3,391 ft and 2,763 ft respectively, while the average depth is 6.5 ft.

The same simulation but for low surface elevation of 420.5 ft msl was run as scenario 2W. For the summer simulations, the reduced surface elevation resulted in a larger thermal plume, and this is also the case for the winter conditions, as the volume has increased to 1,005 acre-ft and the surface area has increased to 107 acres. Similarly, the maximum length and width have increased to 4,129 ft and 3,190 ft respectively, but the plume on average is shallower with an average depth of 5.5 ft. The temperature contours and plume can be seen on Figure 28 and Figure 29.

A large recirculation zone was observed in the summer simulation with the FPSF pumping, and this is also seen under winter conditions in Figure 30, which shows velocity vectors (blue is zero, red is 3 ft/s) for scenario 3W. The vectors are very similar to those for scenario 3S, which is expected as the FPSF pumping flow rate is the same in both cases. However, unlike the summer scenario where an almost identical plume resulted with the FPSF pumping, in this case the plume is slightly bigger. This is not noticeable on the temperature contours (Figure 31) or the plume visualization (Figure 32) but the statistics show a marginal increase in plume size, to 1,148 acre-ft volume and 120 acres surface area. The maximum length and width has also increased to 4,219 ft and 3,325 ft respectively, but the average depth remains the same as scenario 2W at 5.5 ft.

Scenario 4W is the final scenario under winter conditions, simulating FPSF generating flow (50,400 cfs removed from the reservoir). The velocity vectors for this scenario are shown on Figure 33, which show the effect of the flow being removed from the reservoir. Similar to the results for summer conditions, the generating condition for the FPSF results in an extended but shallower plume; the surface area is 110 acres and the average depth is 5.8 ft. The plume dimensions are 3,183 ft for maximum width and 3,901 ft for maximum length, and result in an increase in volume over scenario 1W to 1,043 acre-feet.

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7. RESULTS SUMMARY – T = 90°F PLUME

	Scenario 1S	Scenario 2S	Scenario 3S	Scenario 4S
Description	*Summer, high water, slack*	*Summer, low water, slack*	*Summer, low water, pumping*	*Summer, high water, generating*
Reservoir Surface Elevation	425.0 ft msl	420.5 ft msl	420.5 ft msl	425.0 ft msl
Reservoir Temperature	86.4°F	86.4°F	86.4°F	86.4°F
Discharge Flow	532,000 gpm	532,000 gpm	532,000 gpm	532,000 gpm
Discharge Temperature	113.0°F	113.0°F	113.0°F	113.0°F
FPSF Operation	0 cfs	0 cfs	+ 41,800 cfs	- 50,400 cfs
Dimensions of the T = 90°F Thermal Plume				
- **Volume**	1,418 acre-ft	1,627 acre-ft	1,626 acre-ft	1,790 acre-ft
- **Surface area**	128 acre	150 acre	150 acre	163 acre
- **Average Depth/Thickness**	6.4 ft	6.0 ft	5.9 ft	6.1 ft
- **Maximum Depth/Thickness**	40 ft	36 ft	36 ft	40 ft
- **Maximum Width**	3,312 ft	3,840 ft	3,830 ft	3,705 ft
- **Maximum Length**[3]	4,332 ft	4,699 ft	4,699 ft	4,775 ft

[3] Calculated from the end of the discharge pipe.

8. RESULTS SUMMARY – ΔT = 5°F PLUME

	Scenario 1W	Scenario 2W	Scenario 3W	Scenario 4W
Description	*Winter, high water, slack*	*Winter, low water, slack*	*Winter, low water, pumping*	*Winter, high water, generating*
Reservoir Surface Elevation	425.0 ft msl	420.5 ft msl	420.5 ft msl	425.0 ft msl
Reservoir Temperature	66.6°F	66.6°F	66.6°F	66.6°F
Discharge Flow	532,000 gpm	532,000 gpm	532,000 gpm	532,000 gpm
Discharge Temperature	98.7°F	98.7°F	98.7°F	98.7°F
FPSF Operation	0 cfs	0 cfs	+ 41,800 cfs	- 50,400 cfs
Dimensions of the ΔT = 5°F Thermal Plume				
- **Volume**	799 acre-ft	1,005 acre-ft	1,148 acre-ft	1,043 acre-ft
- **Surface area**	77 acre	107 acre	120 acre	110 acre
- **Average Depth/Thickness**	6.5 ft	5.5 ft	5.5 ft	5.8 ft
- **Maximum Depth/Thickness**	40 ft	36 ft	36 ft	40 ft
- **Maximum Width**	2,763 ft	3,190 ft	3,325 ft	3,183 ft
- **Maximum Length**[4]	3,391 ft	4,129 ft	4,219 ft	3,901 ft

[4] Calculated from the end of the discharge pipe.

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9. RELEVANCE TO THE THEMRAL MIXING ZONE RENEWAL

The results of the thermal modeling relative to the thermal mixing zone are as follows.

For the T = 90°F plume:

- The maximum plume dimensions occur in summer, when the reservoir is at high surface elevation (425.0 ft msl) and the FPSF is generating.
- The maximum volume is 1,790 acre-ft.
- The maximum surface area is 163 acres.
- The maximum length is 4,775 ft.
- The maximum width is 3,705 ft.

For the ΔT = 5°F plume:

- The maximum plume dimensions occur in winter, when the reservoir is at low surface elevation (420.5 ft msl) and the FPSF is pumping.
- The maximum volume is 1,148 acre-ft.
- The maximum surface area is 120 acres.
- The maximum length is 4,219 ft.
- The maximum width is 3,325 ft.

The above results indicate that the **T = 90°F plume has a larger impact** than the ΔT = 5°F plume.

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[10] *Email correspondence*, from Summer, S. (SCE&G) to Heynes, O. (MMI) on 11/28/11 at 12:15 PM.

[11] *Email correspondence*, from Summer, S. (SCE&G) to Heynes, O. (MMI) on 11/28/11 at 12:07 PM.

11. FIGURES

N

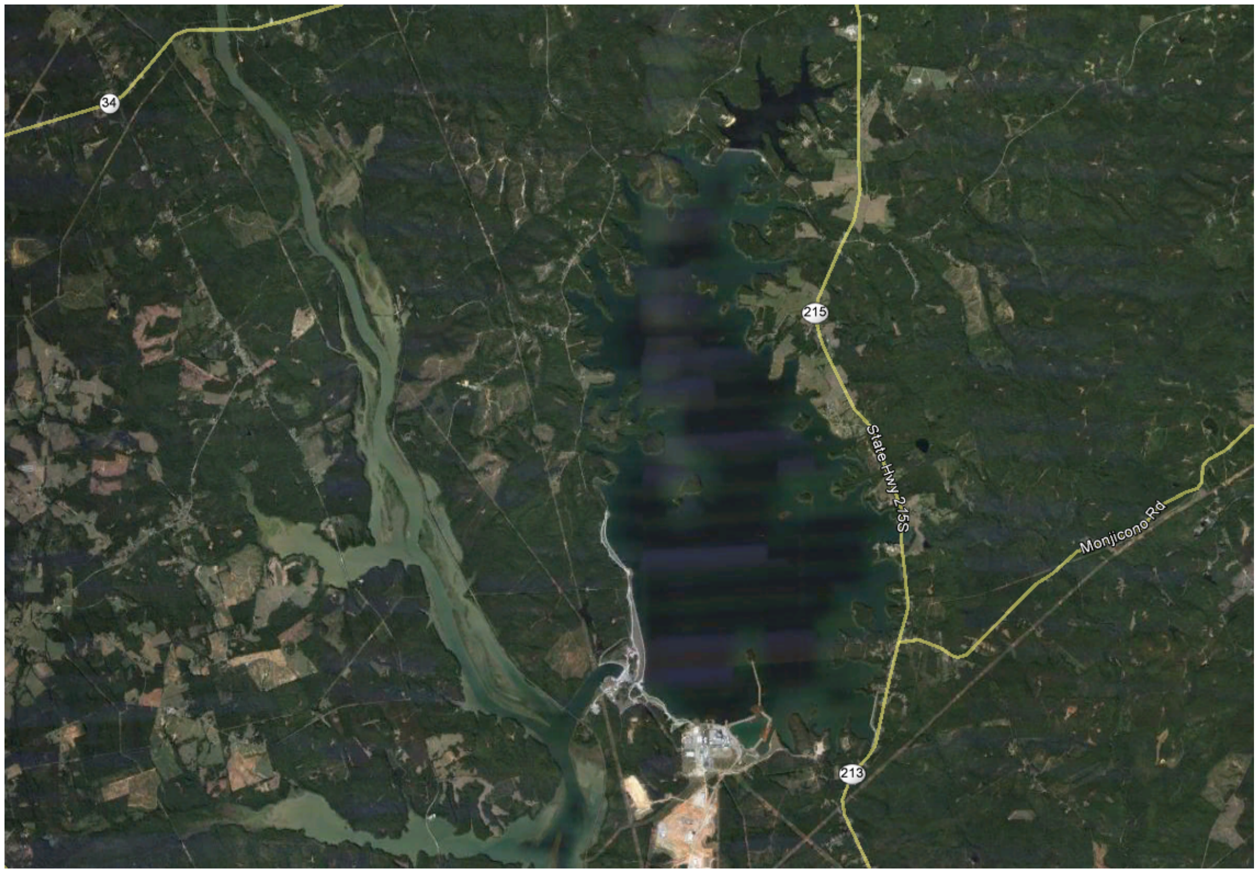

Figure 1 – Aerial photograph of the Monticello Reservoir and V. C. Summer Station

Figure 2 – Close aerial photograph of the Monticello Reservoir and V. C. Summer Station

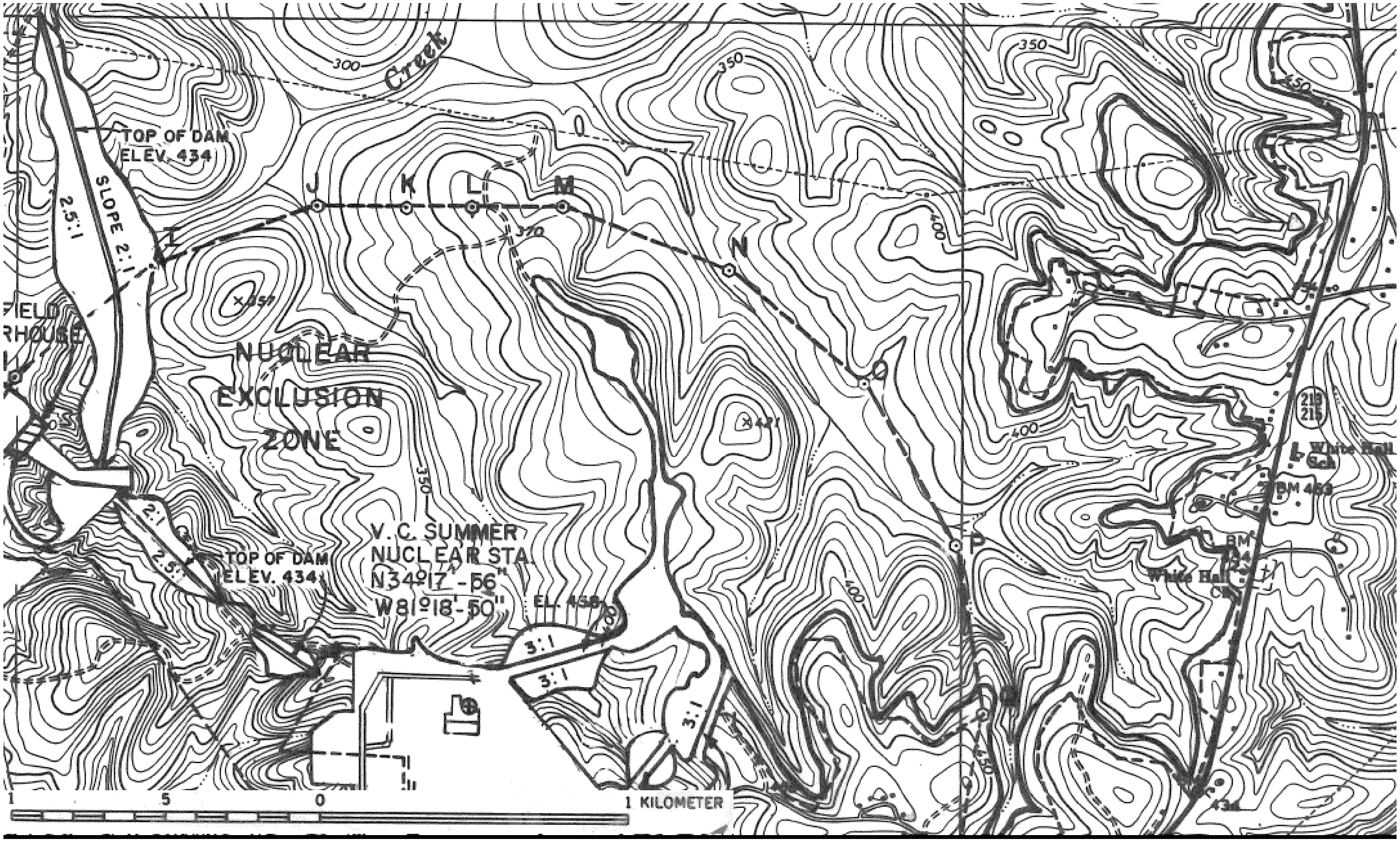

Figure 3 – Contour map of the Monticello Reservoir in the vicinity of the Unit 1 thermal discharge.

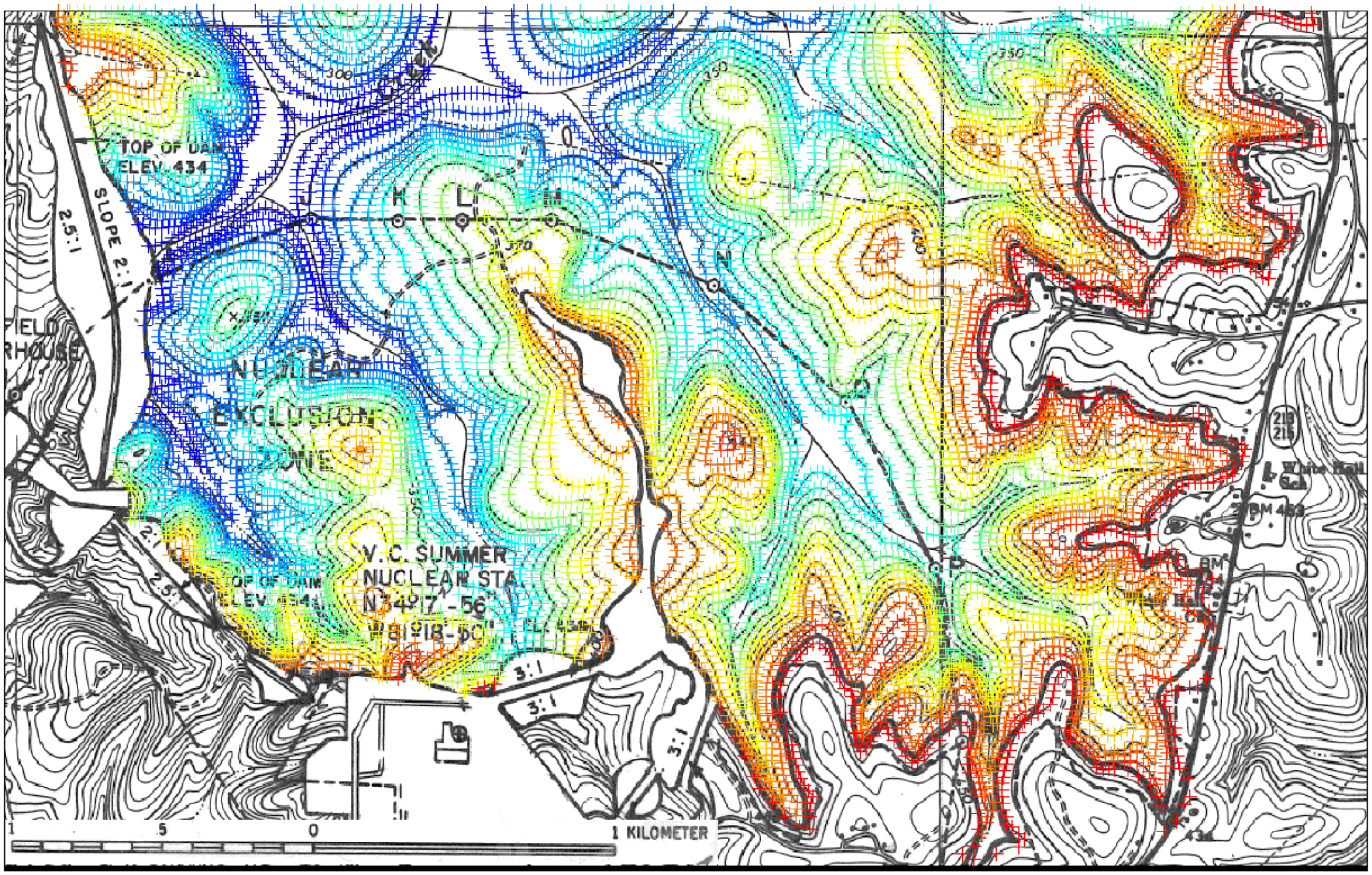

Figure 4 – Digitized points from the contour map, colored by elevation (red is 430 ft msl, blue is 270 ft msl).

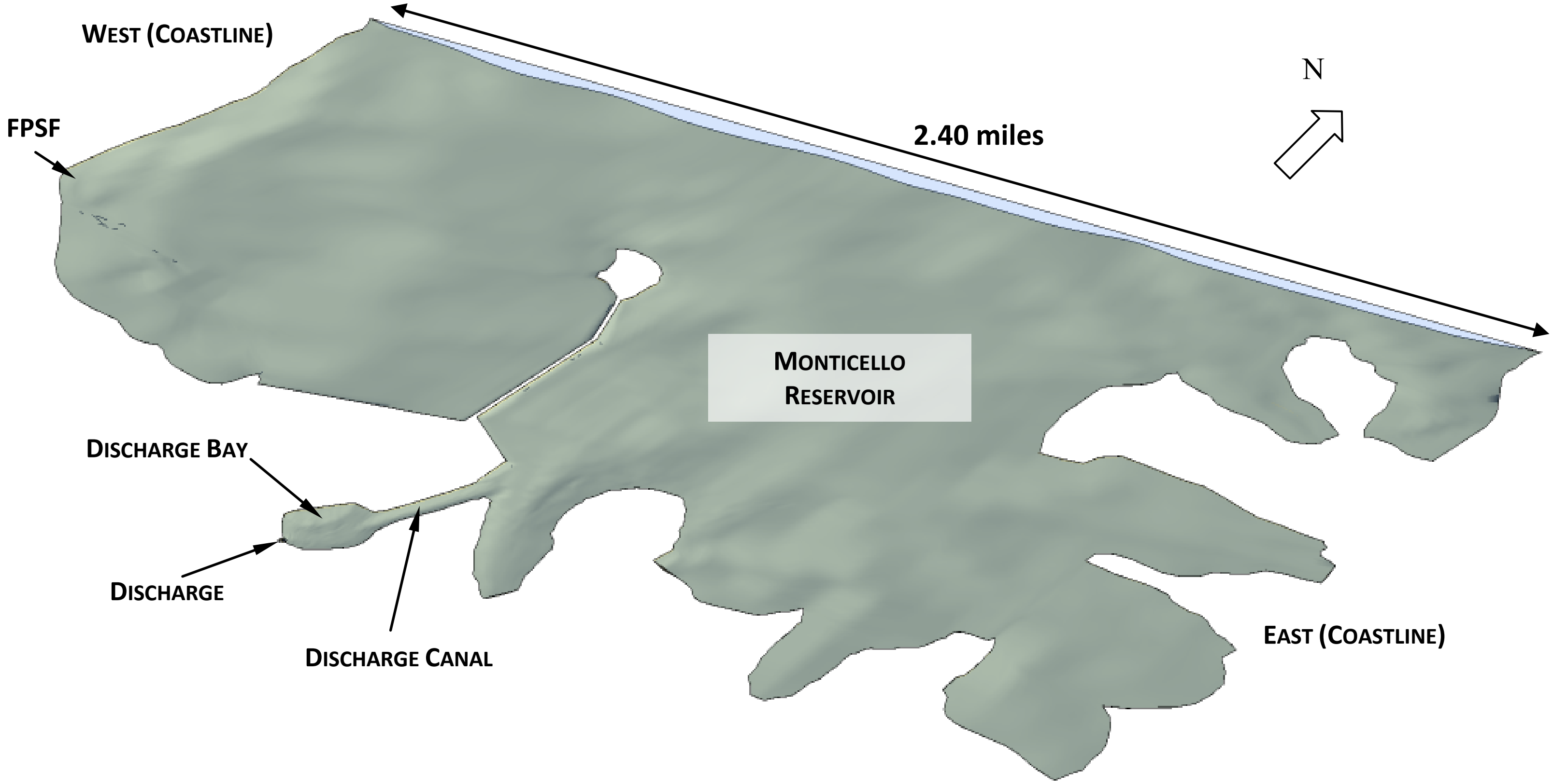

Figure 5 – Perspective view of the computational model.

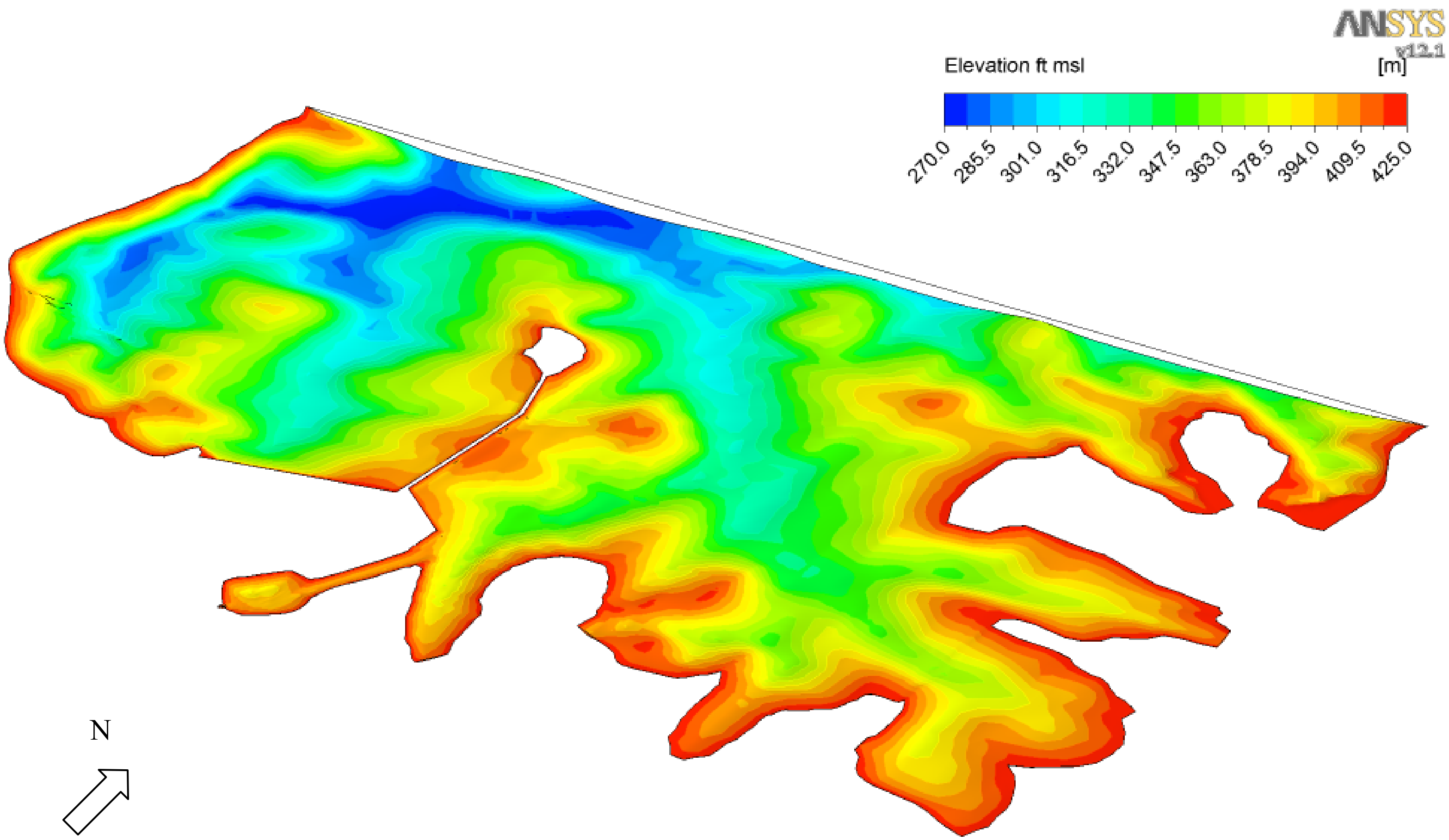

Figure 6 – Contour map showing surface elevation in the computational model.

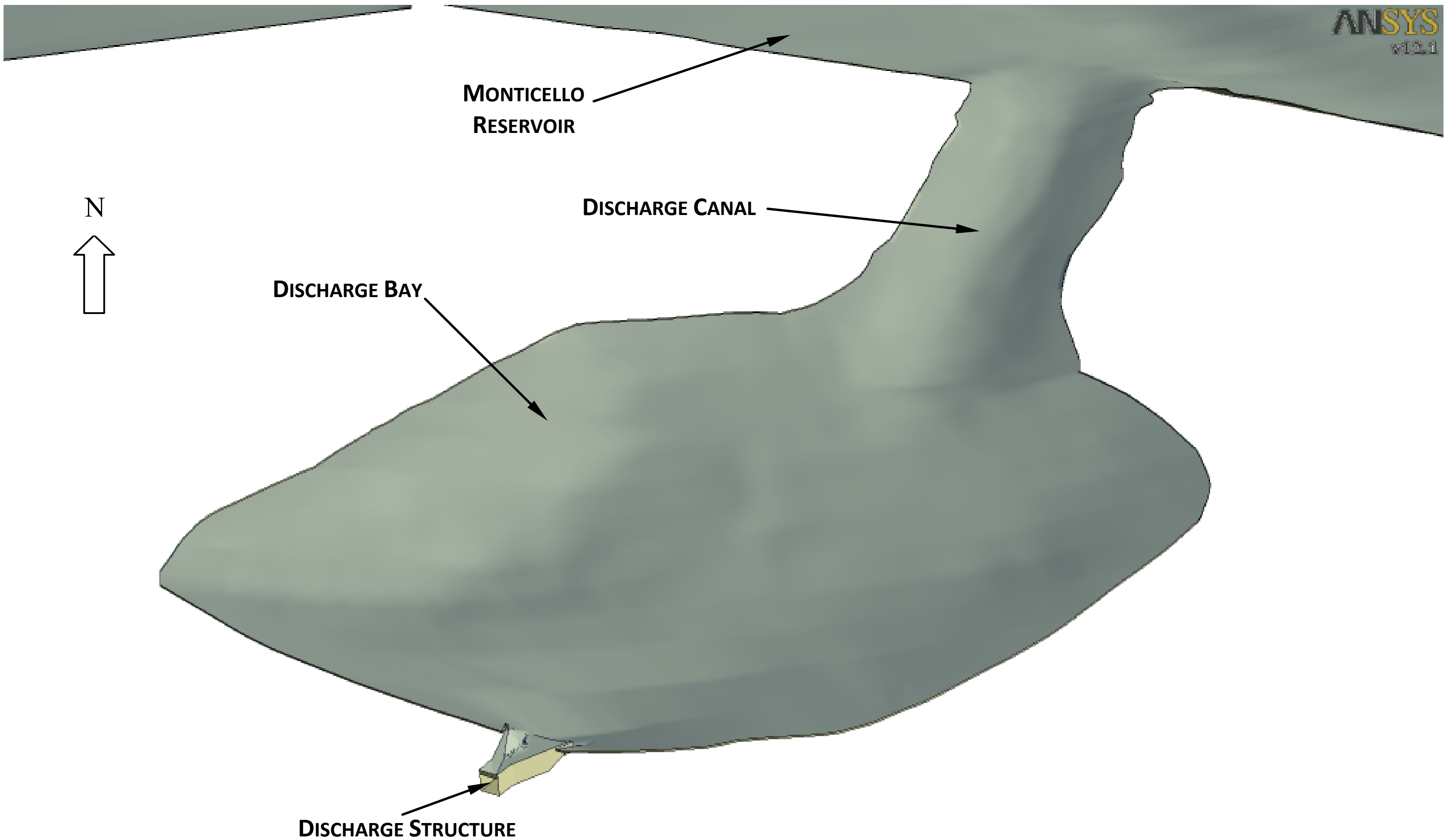

Figure 7 – View of the model near the discharge structure, bay and canal.

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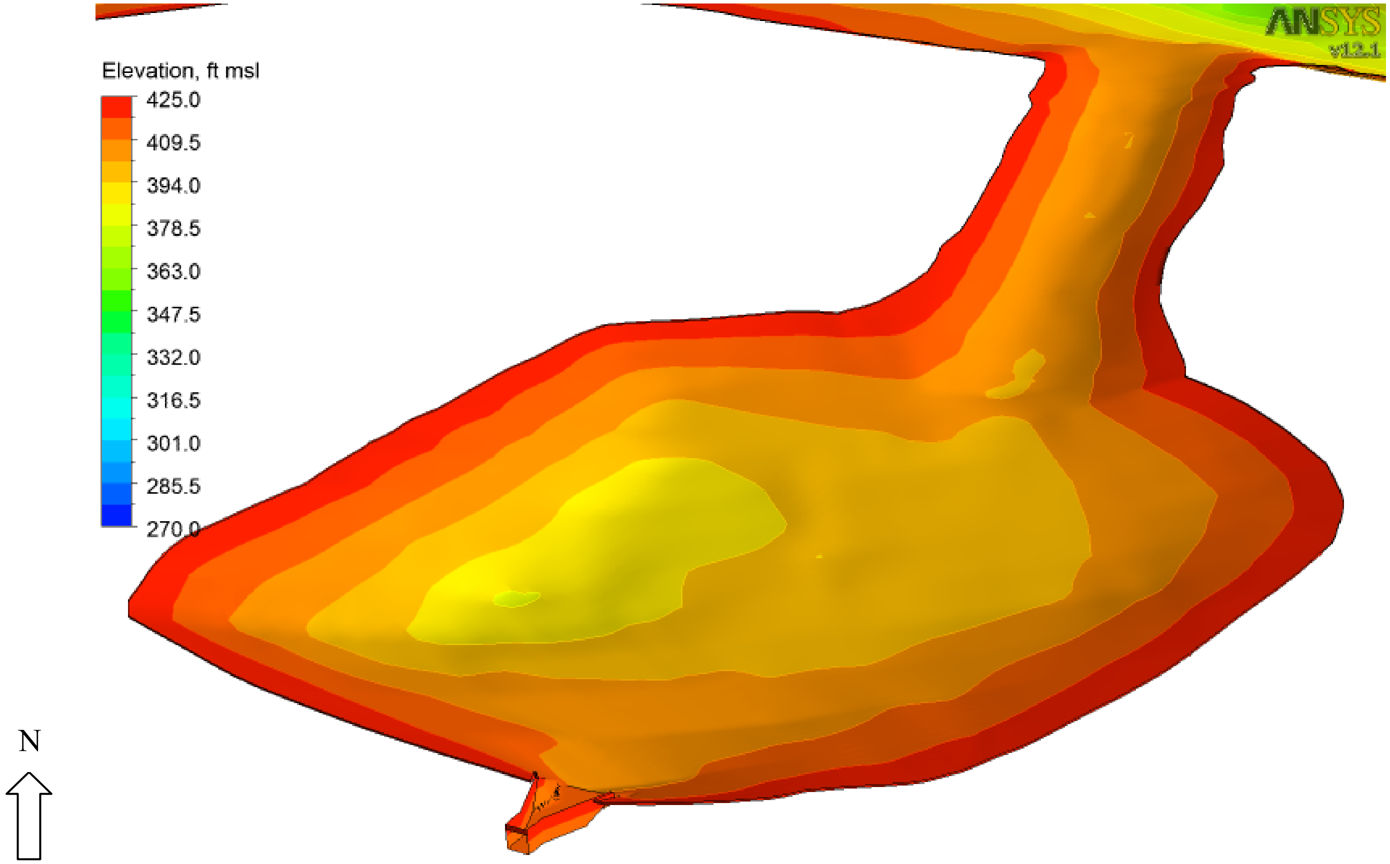

Figure 8 – Elevation contour plot near the discharge structure, bay and canal.

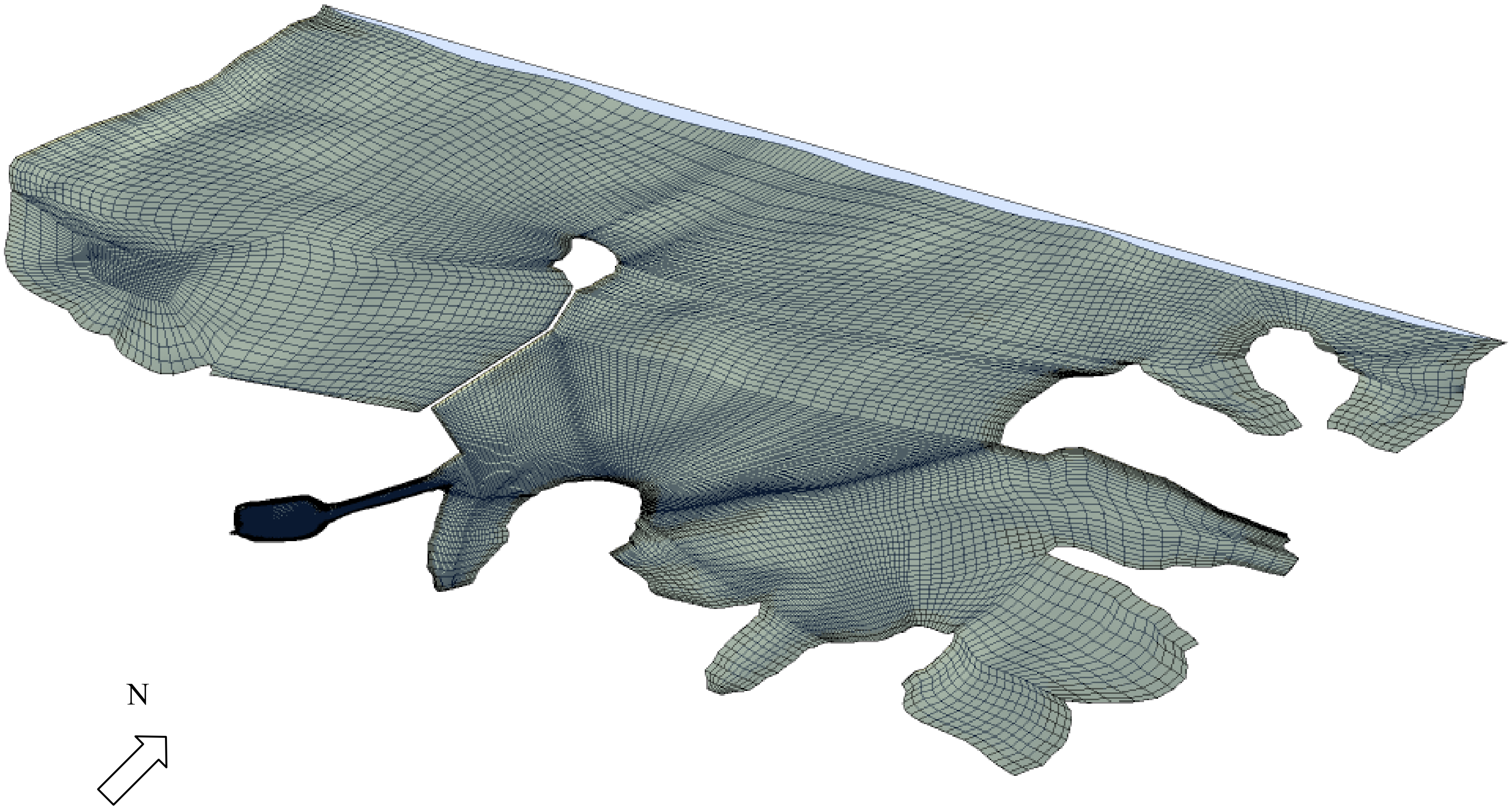

Figure 9 – Computational mesh.

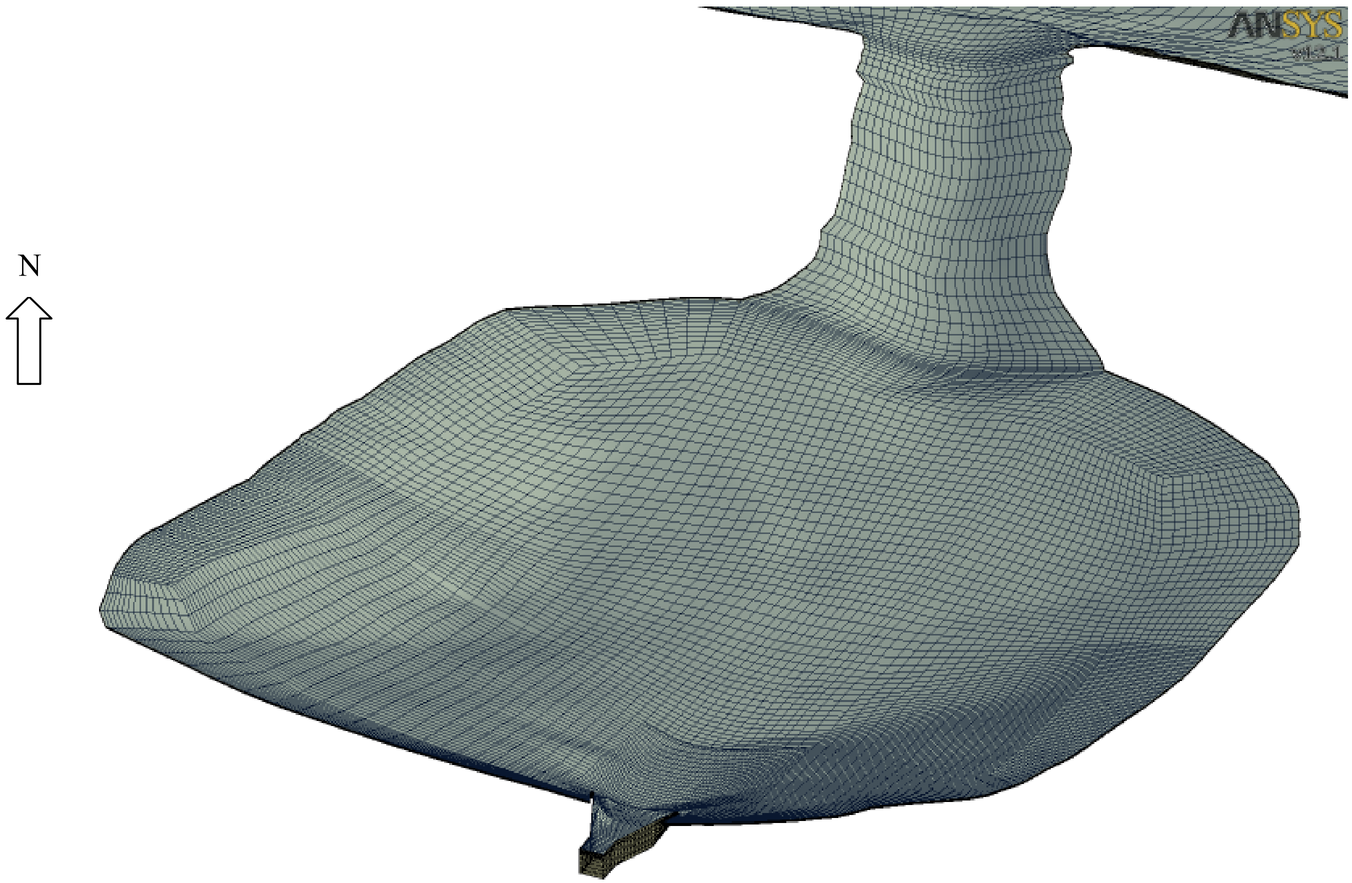

Figure 10 – View of the computational mesh near the discharge structure.

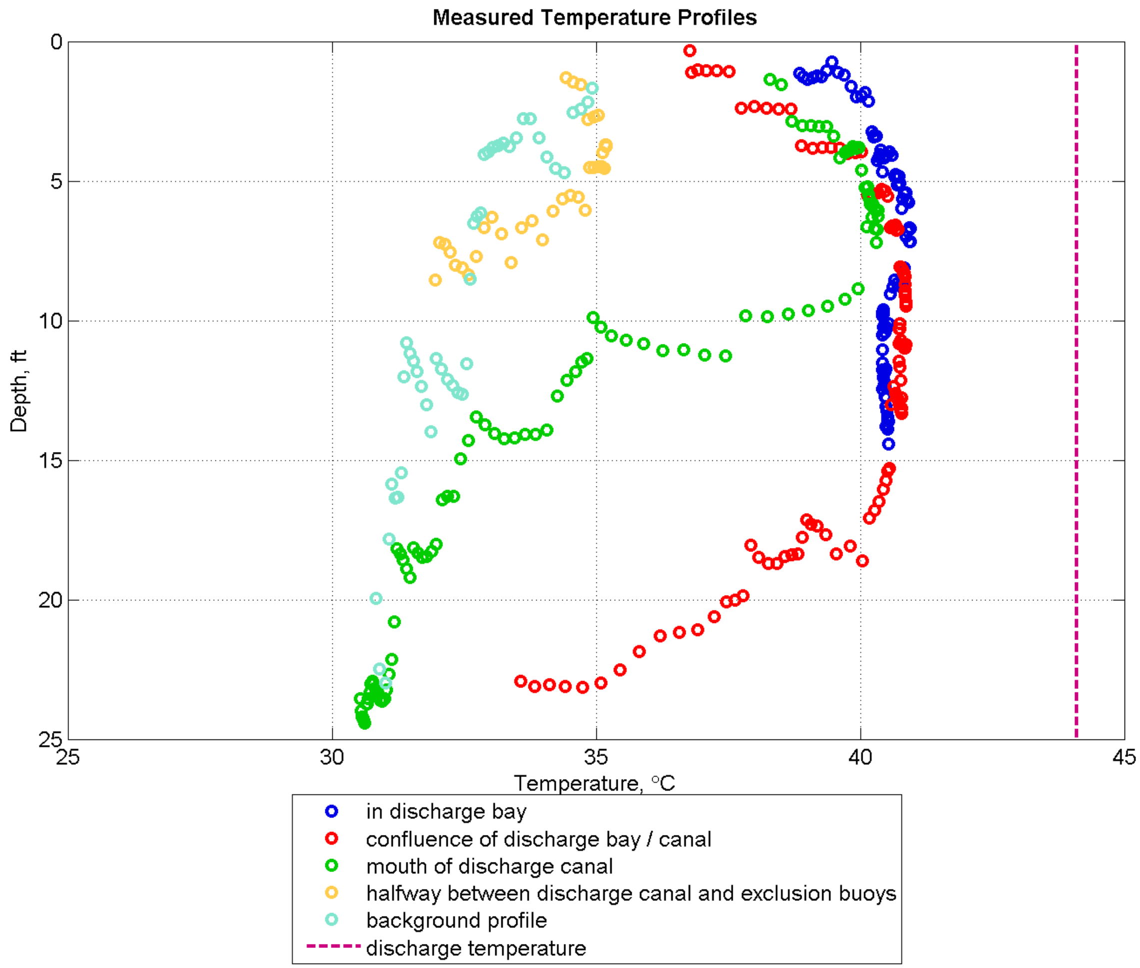

Figure 11 – Temperature profiles collected for validation.

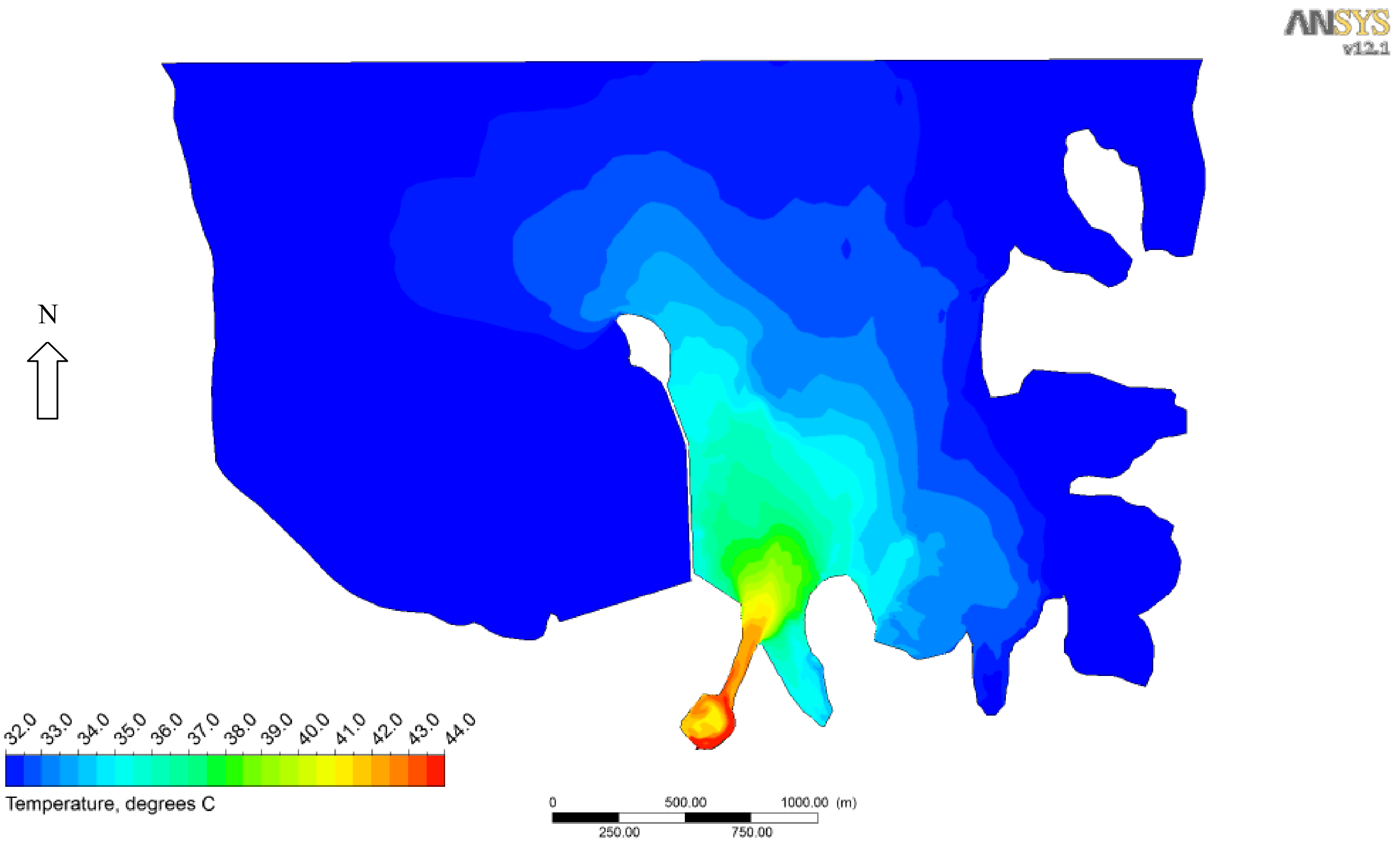

Figure 12 – Contour plot of surface temperature in the numerical model for validation.

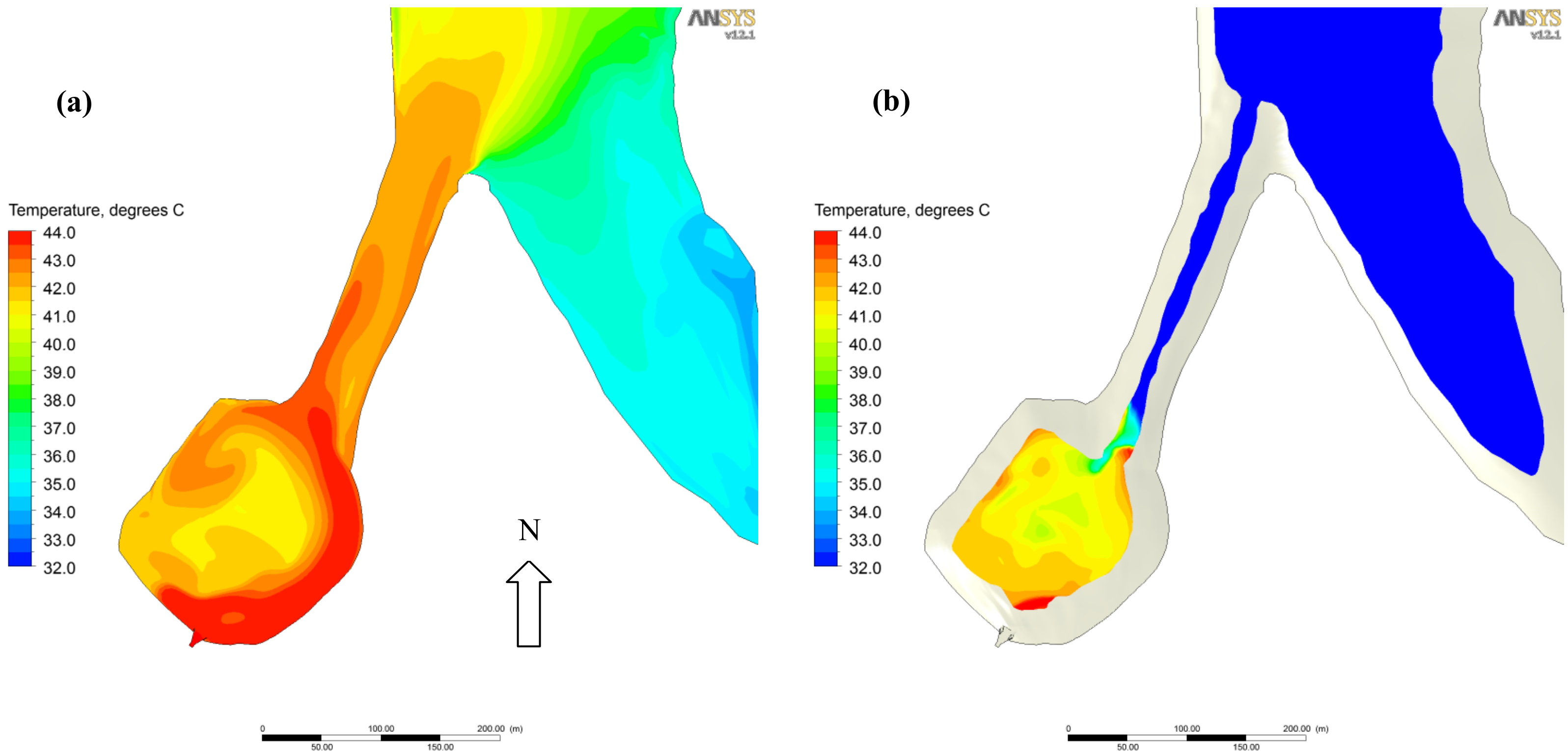

Figure 13 – Contour plot of temperature near the discharge bay at (a) the surface, and (b) 18 ft depth.

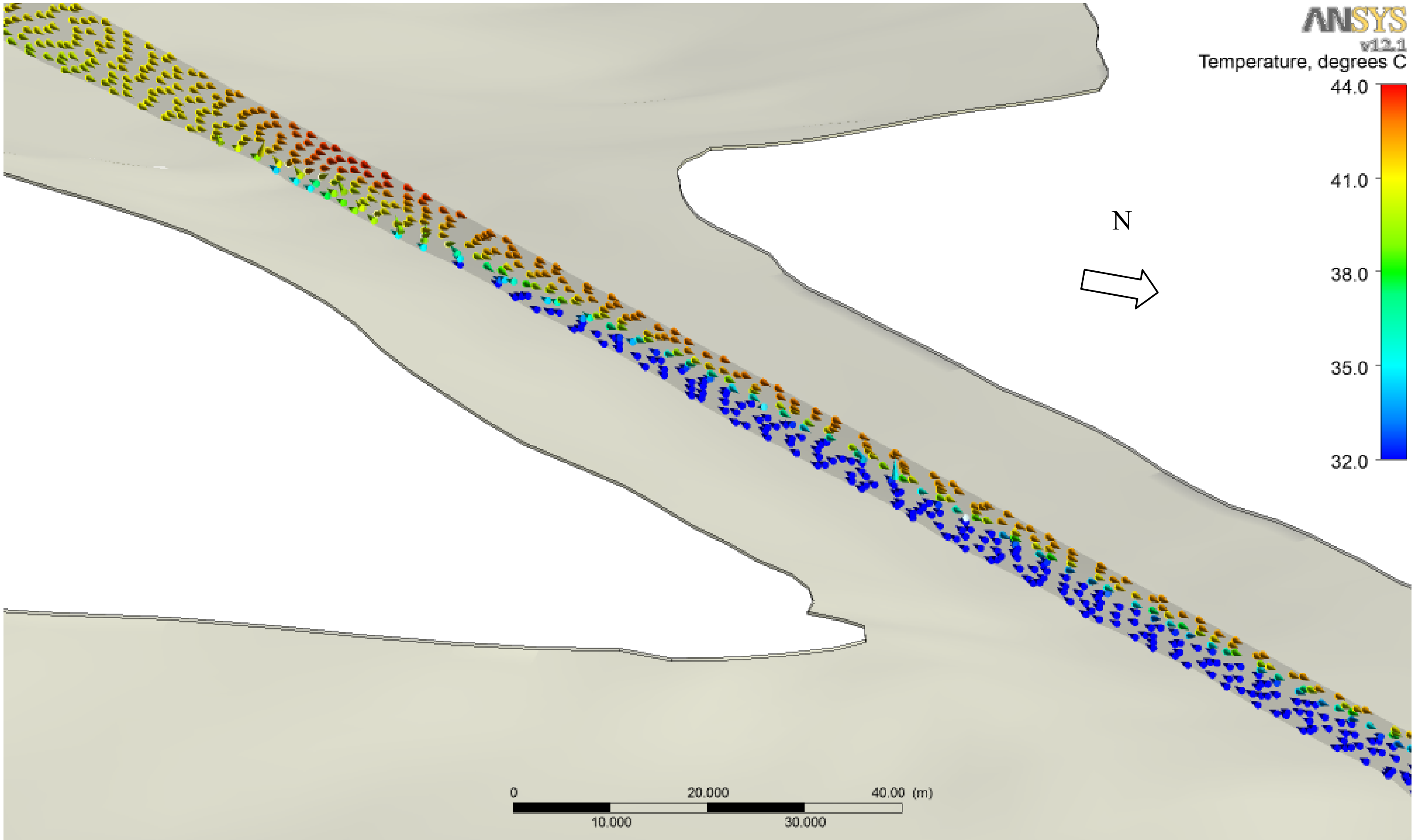

Figure 14 – Velocity vectors in the discharge canal colored by temperature.

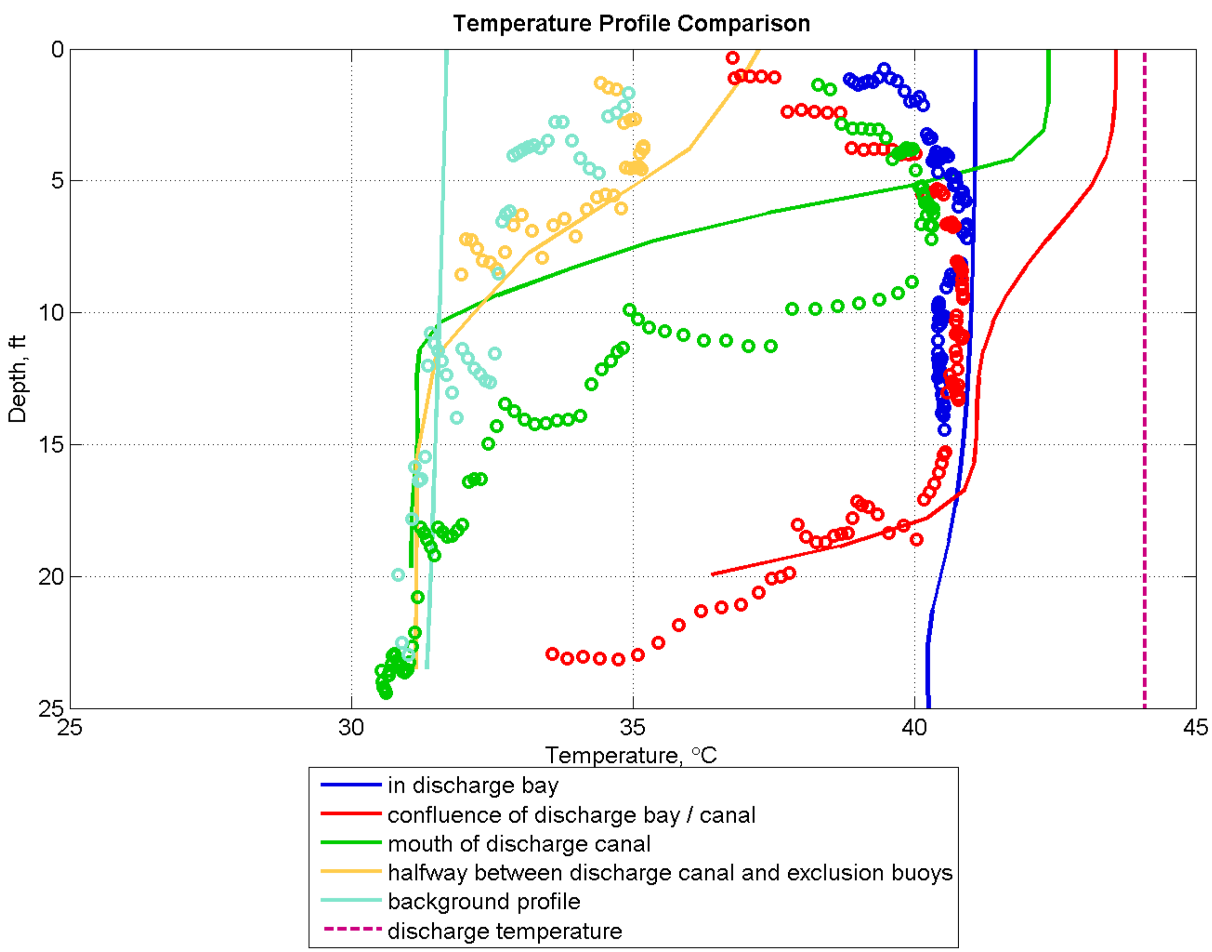

Figure 15 – Comparison between the CFD and collected temperature data.

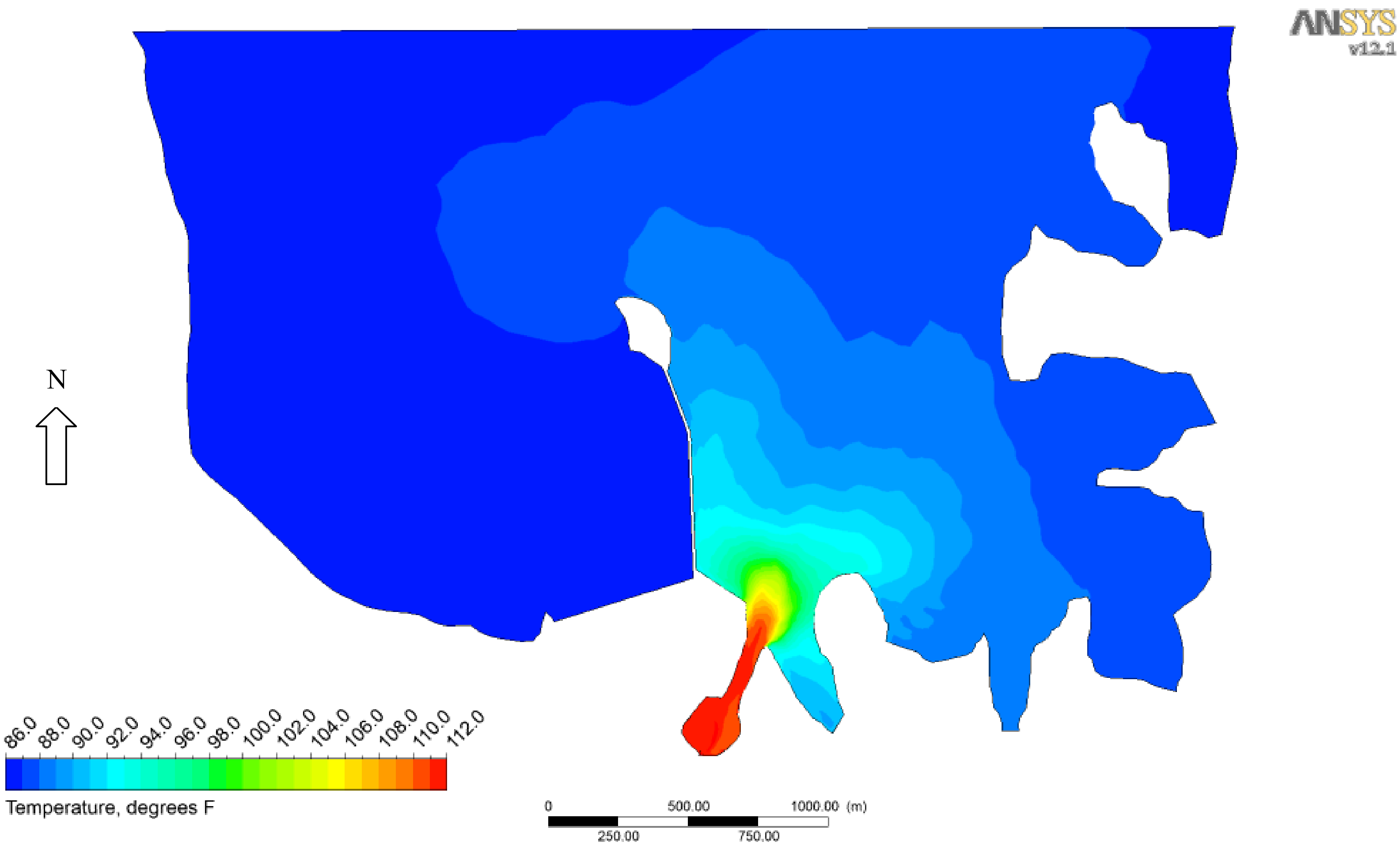

Figure 16 – Scenario 1S, surface temperature.

Figure 17 – Scenario 1S, 90°F thermal plume (purple).

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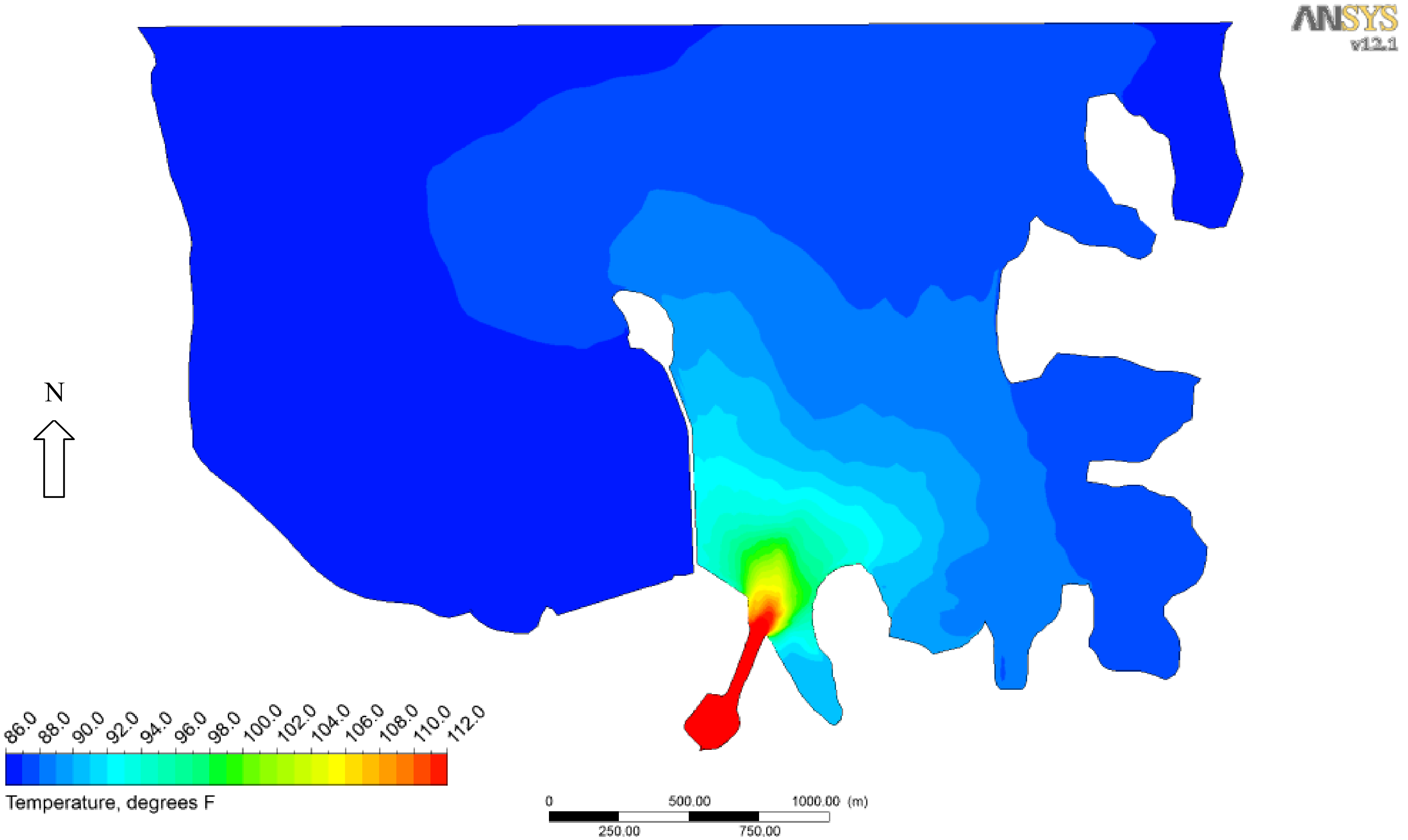

Figure 18 – Scenario 2S, surface temperature.

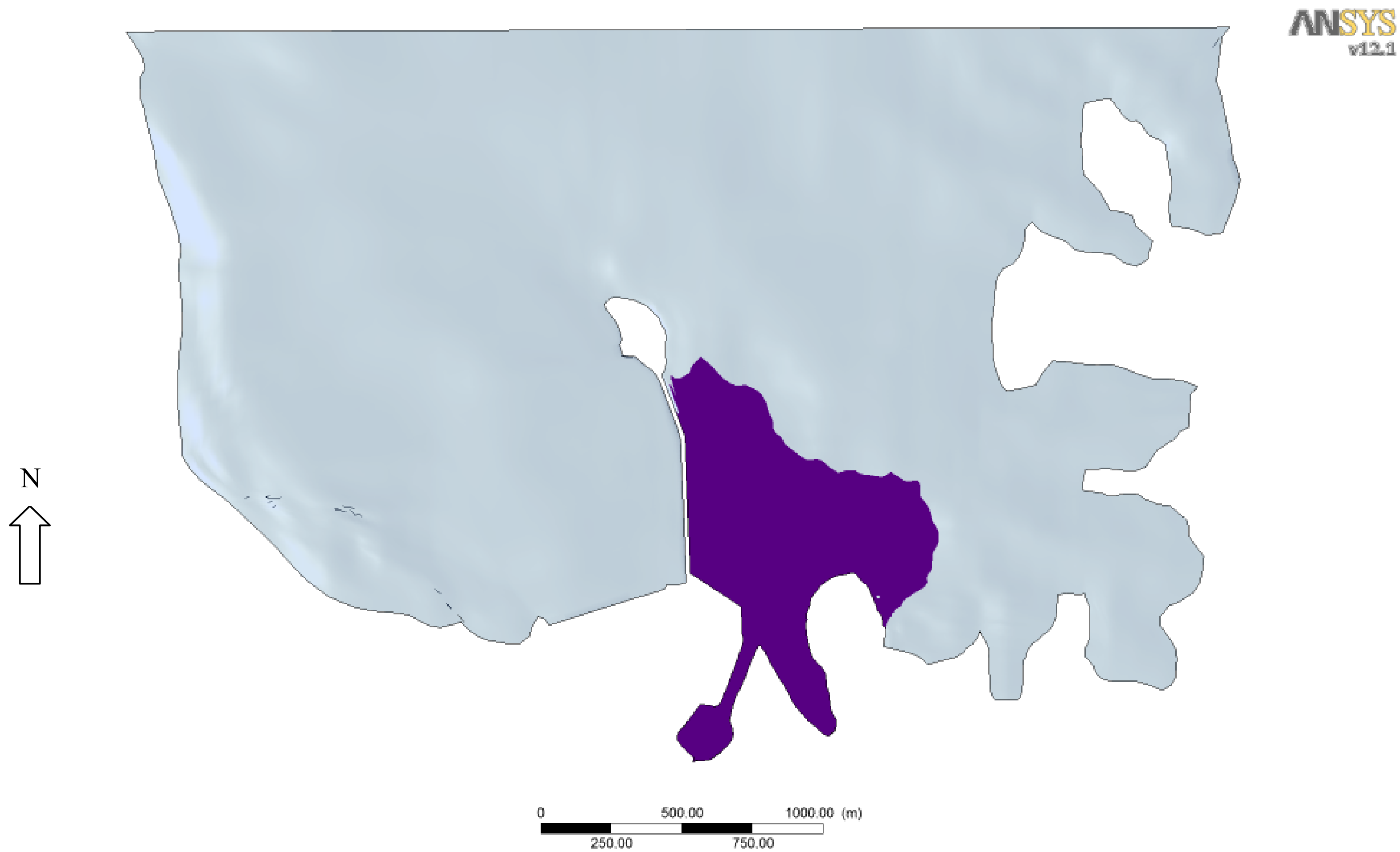

Figure 19 – Scenario 2S, 90°F thermal plume (purple).

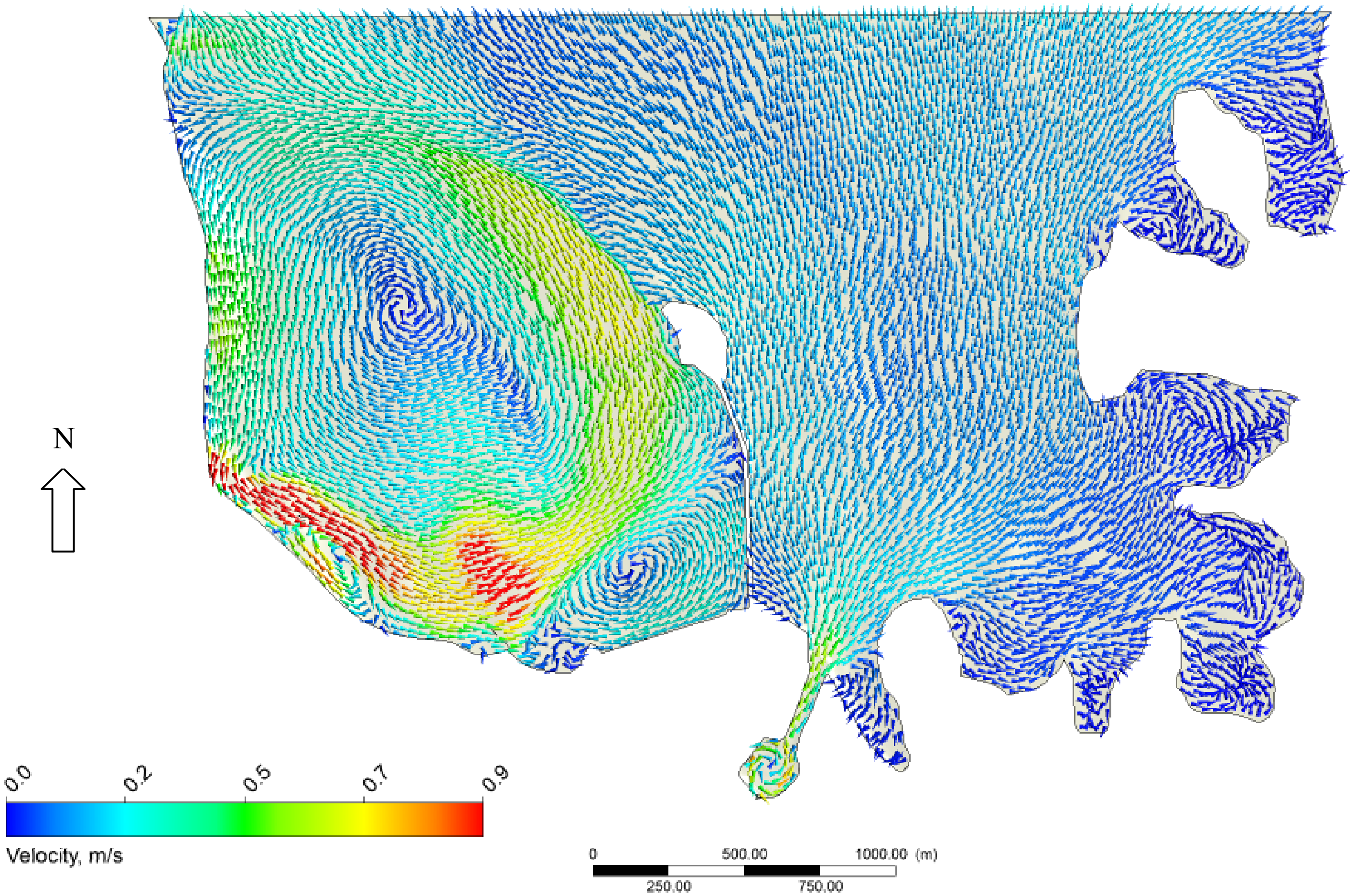

Figure 20 – Scenario 3S, surface velocity vectors.

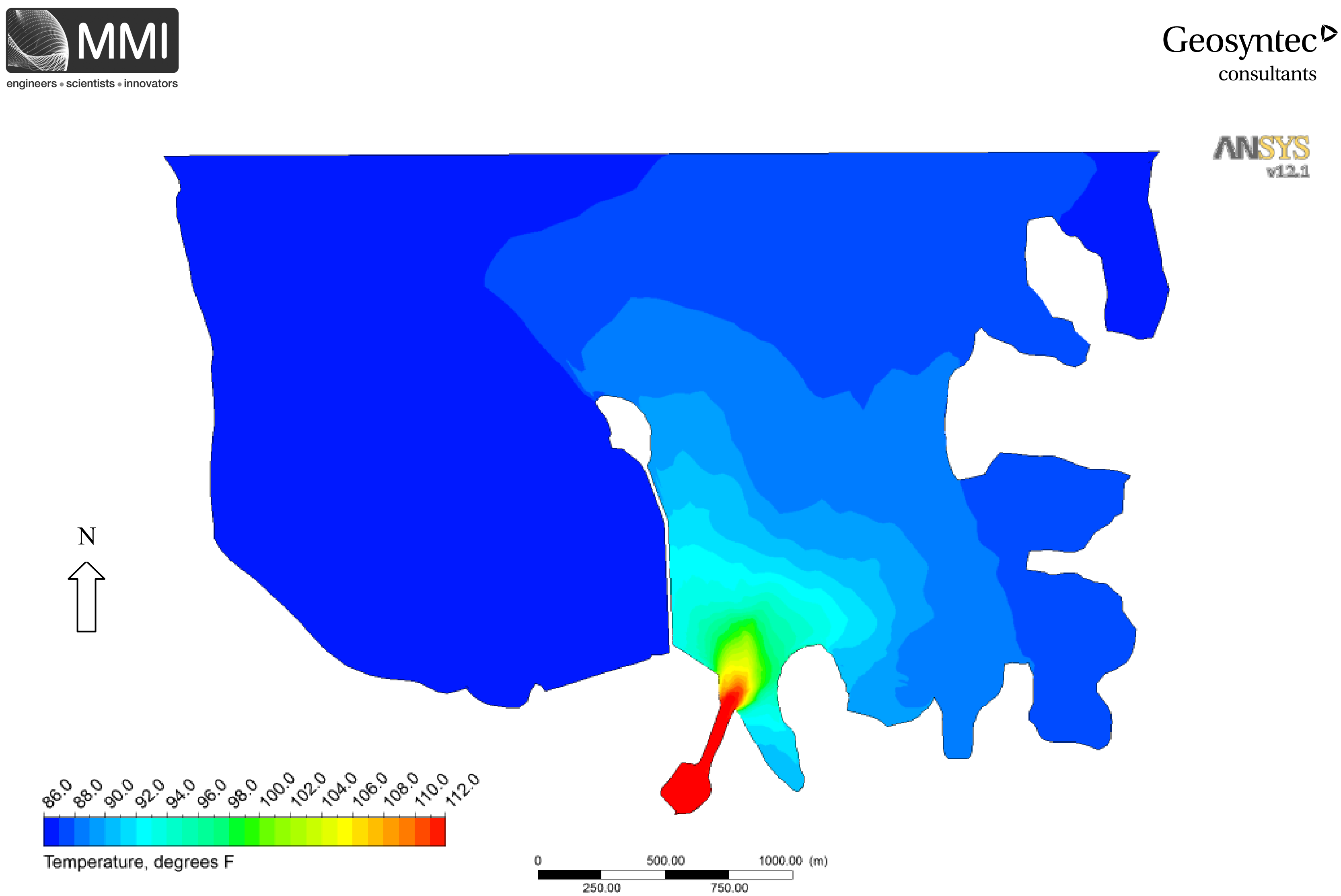

Figure 21 – Scenario 3S, surface temperature.

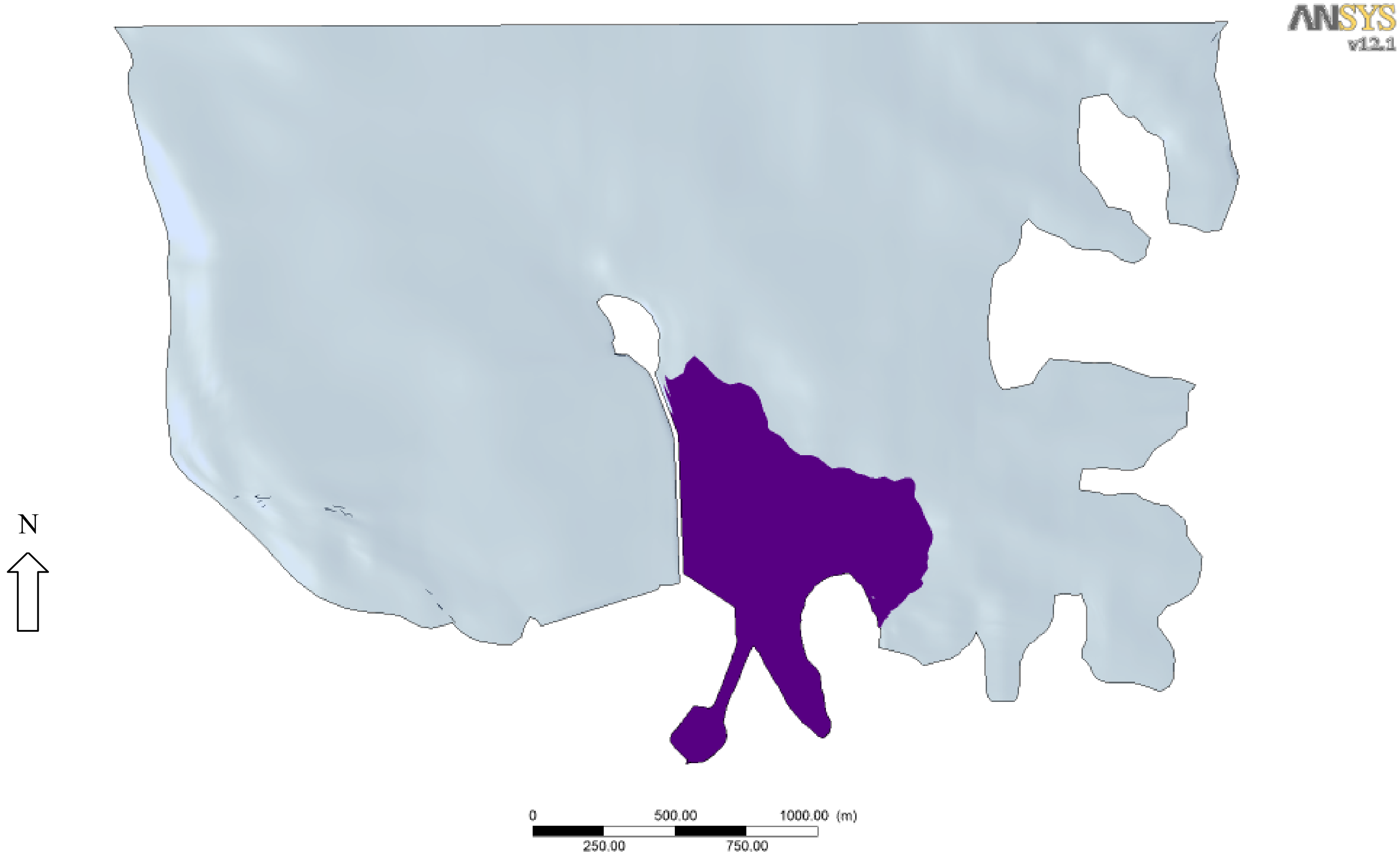

Figure 22 – Scenario 3S, 90°F thermal plume (purple).

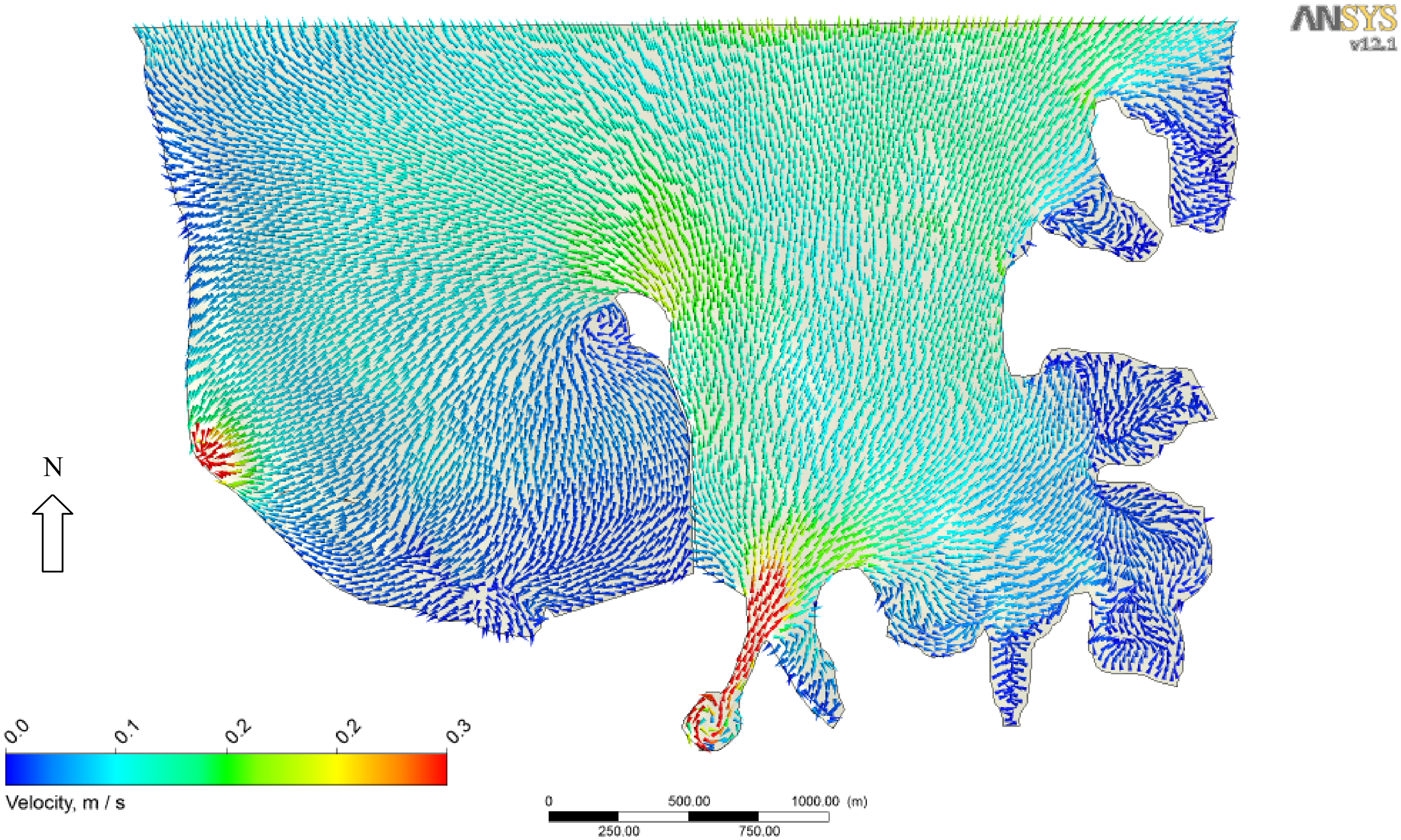

Figure 23 – Scenario 4S, surface velocity vectors.

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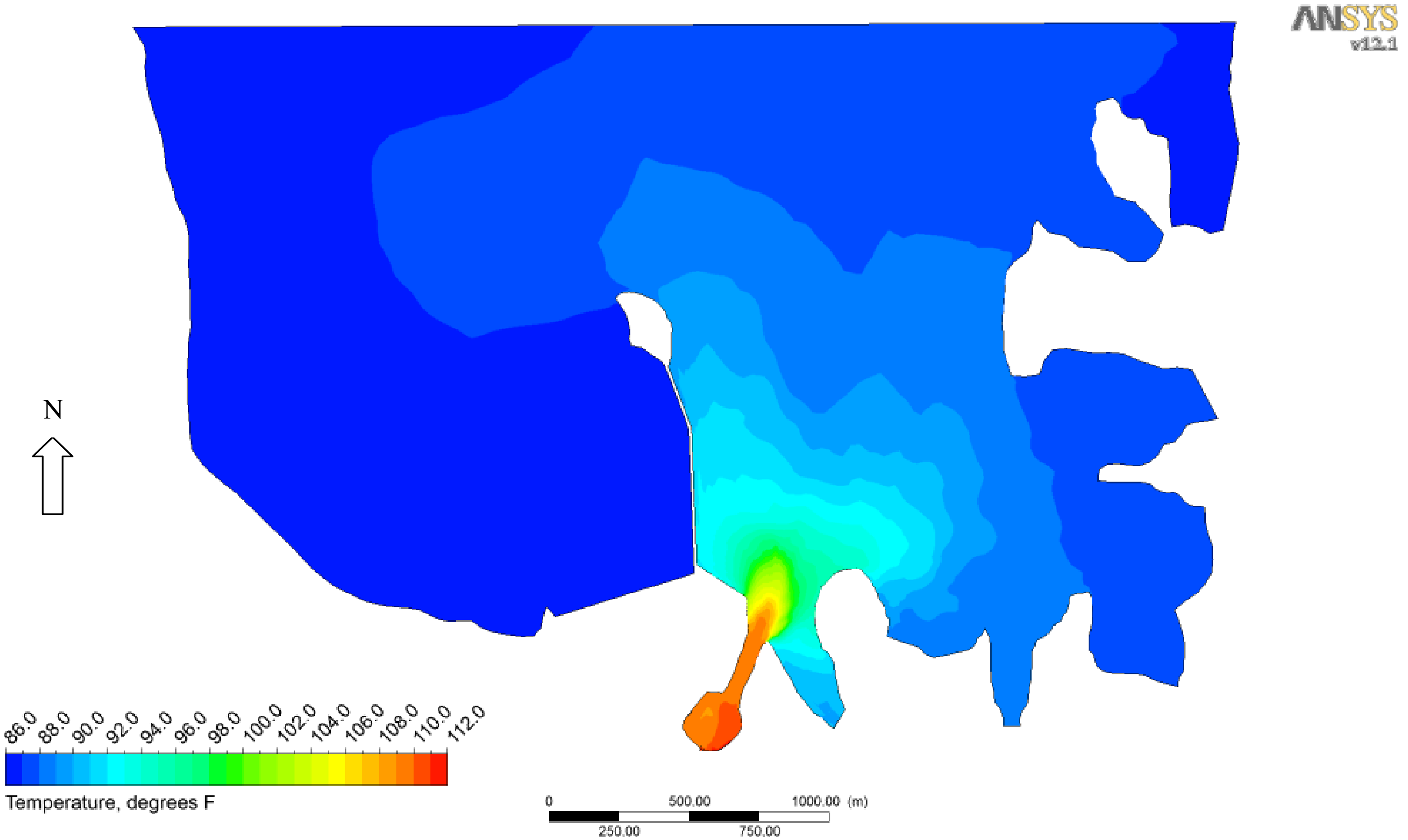

Figure 24 – Scenario 4S, surface temperature.

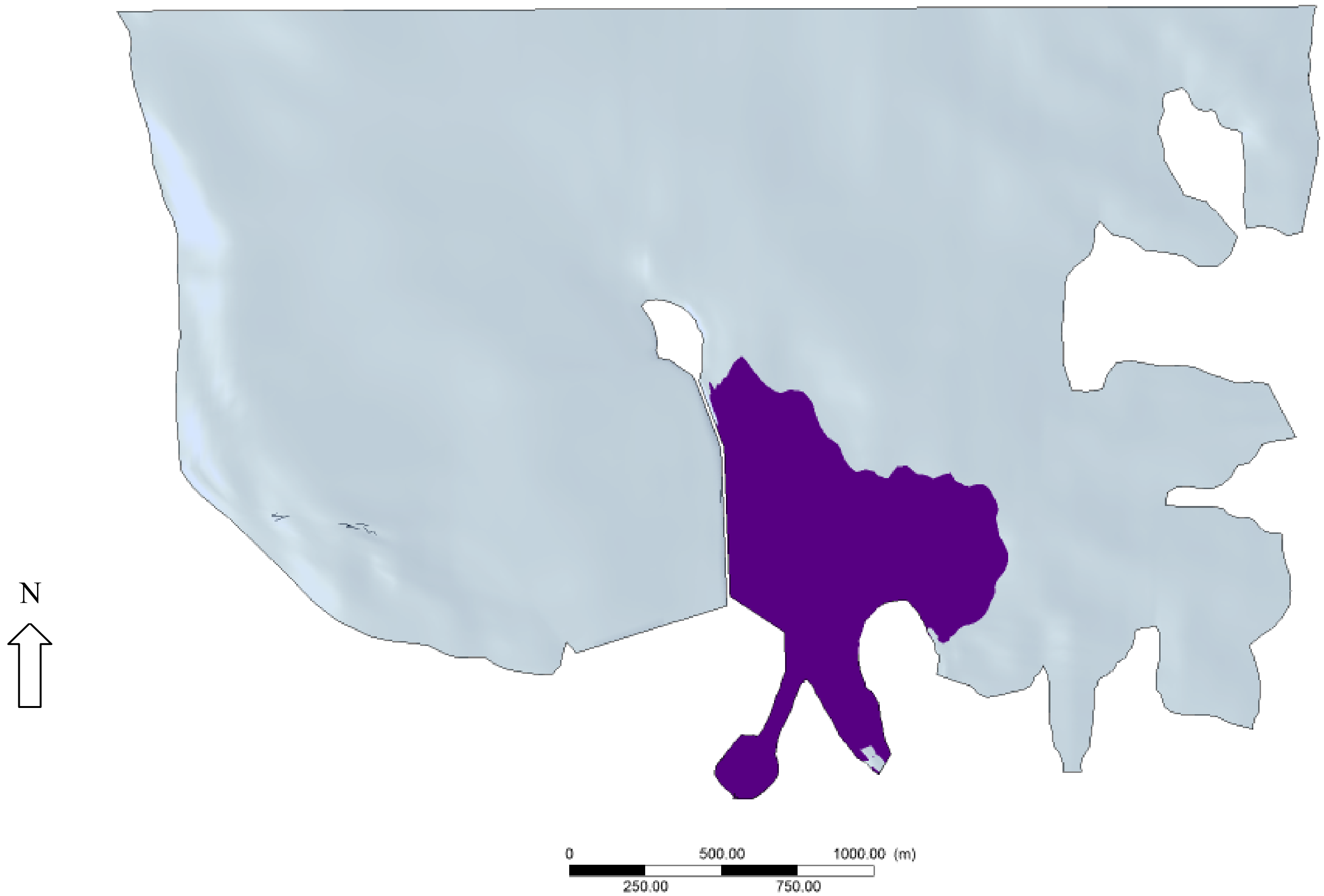

Figure 25 – Scenario 4S, 90°F thermal plume (purple).

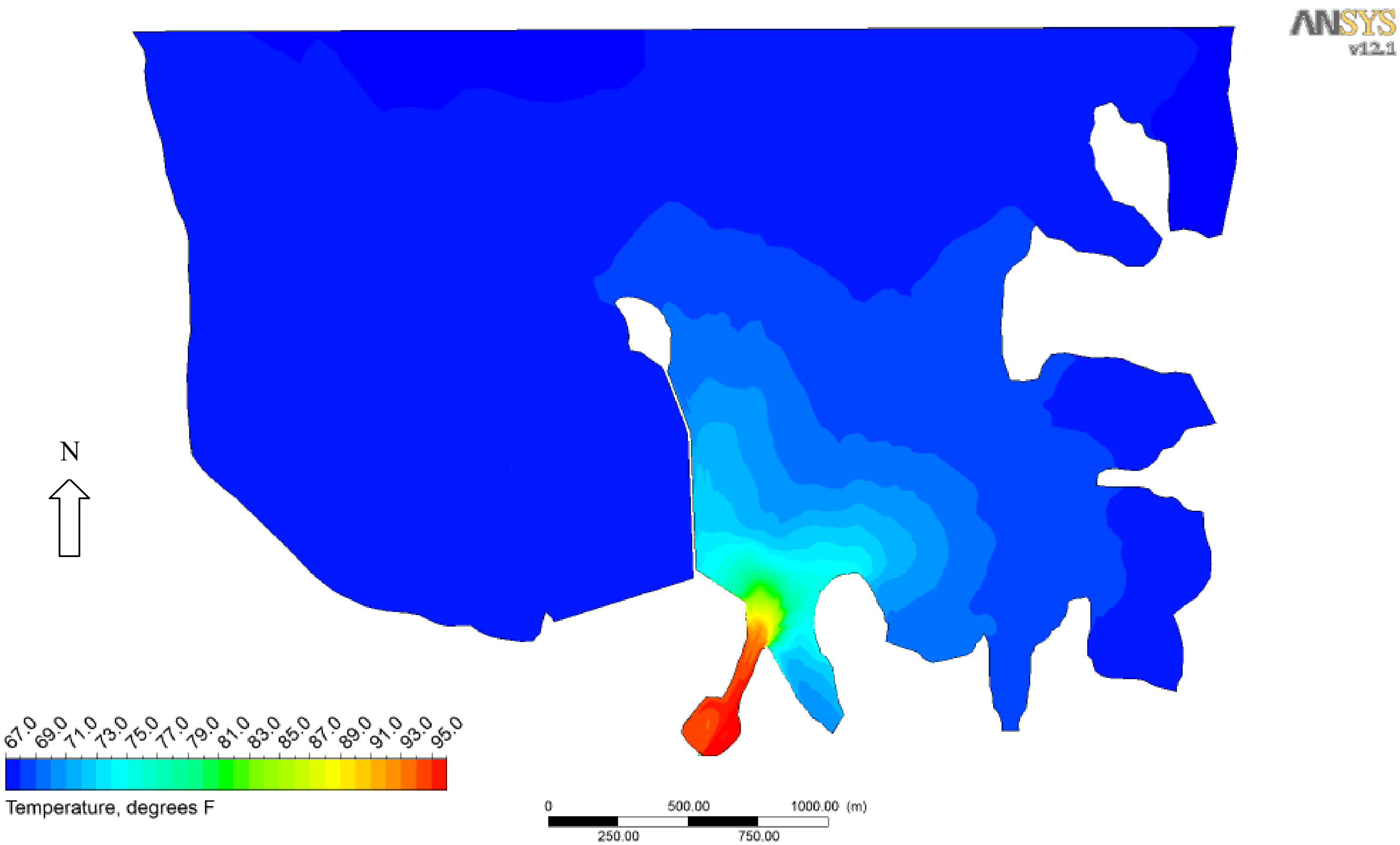

Figure 26 – Scenario 1W, surface temperature.

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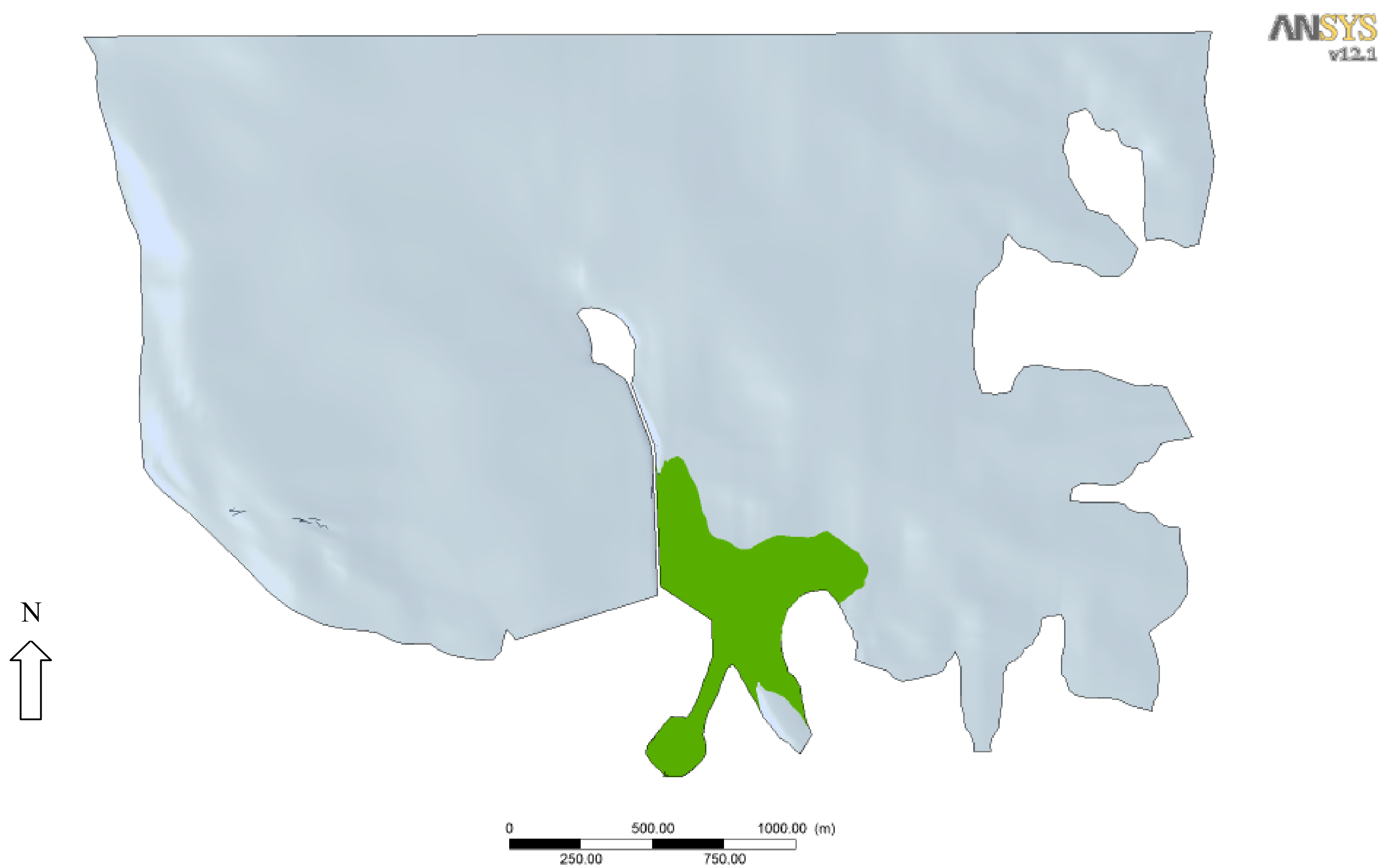

Figure 27 – Scenario 1W, ΔT = 5°F thermal plume (green).

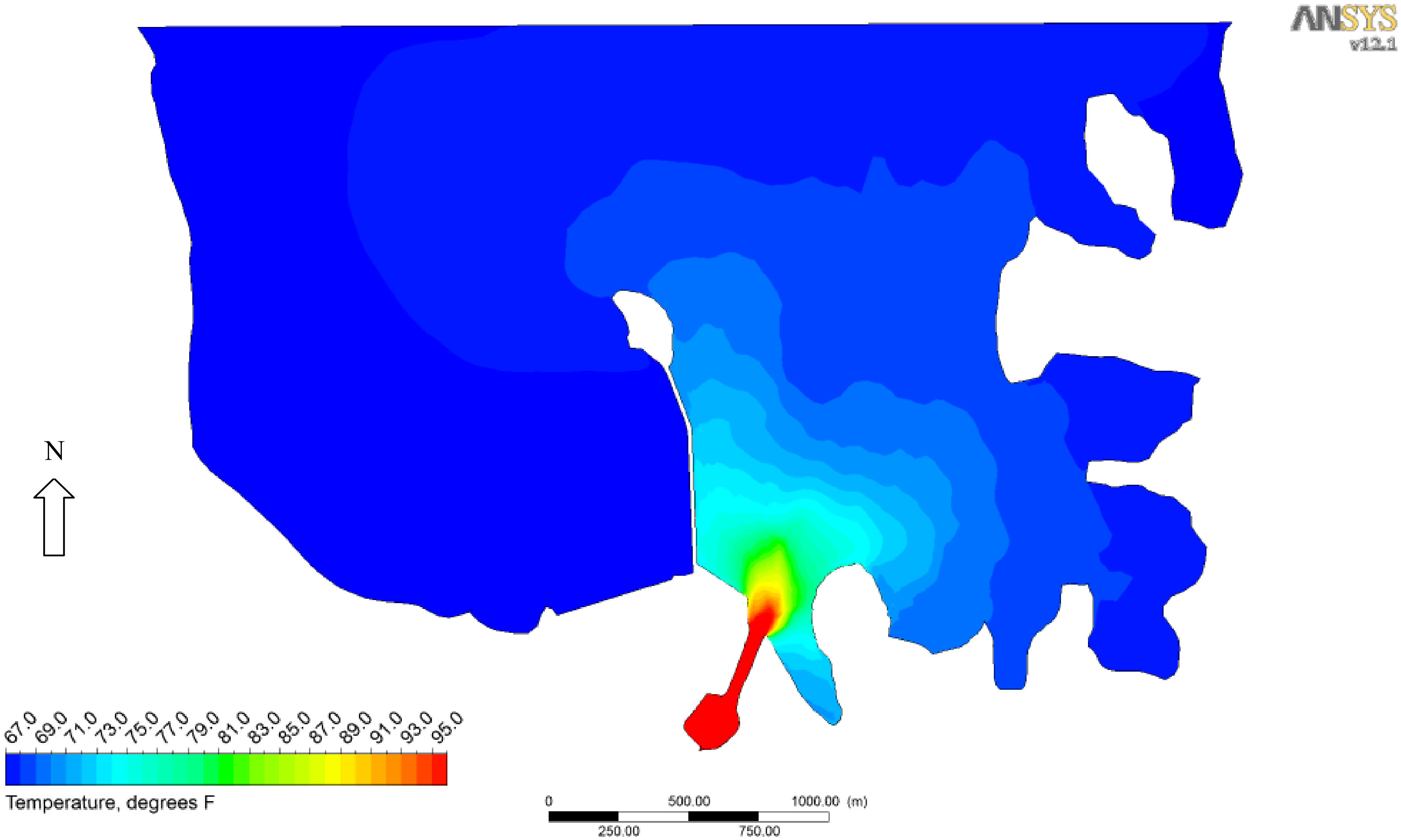

Figure 28 – Scenario 2W, surface temperature.

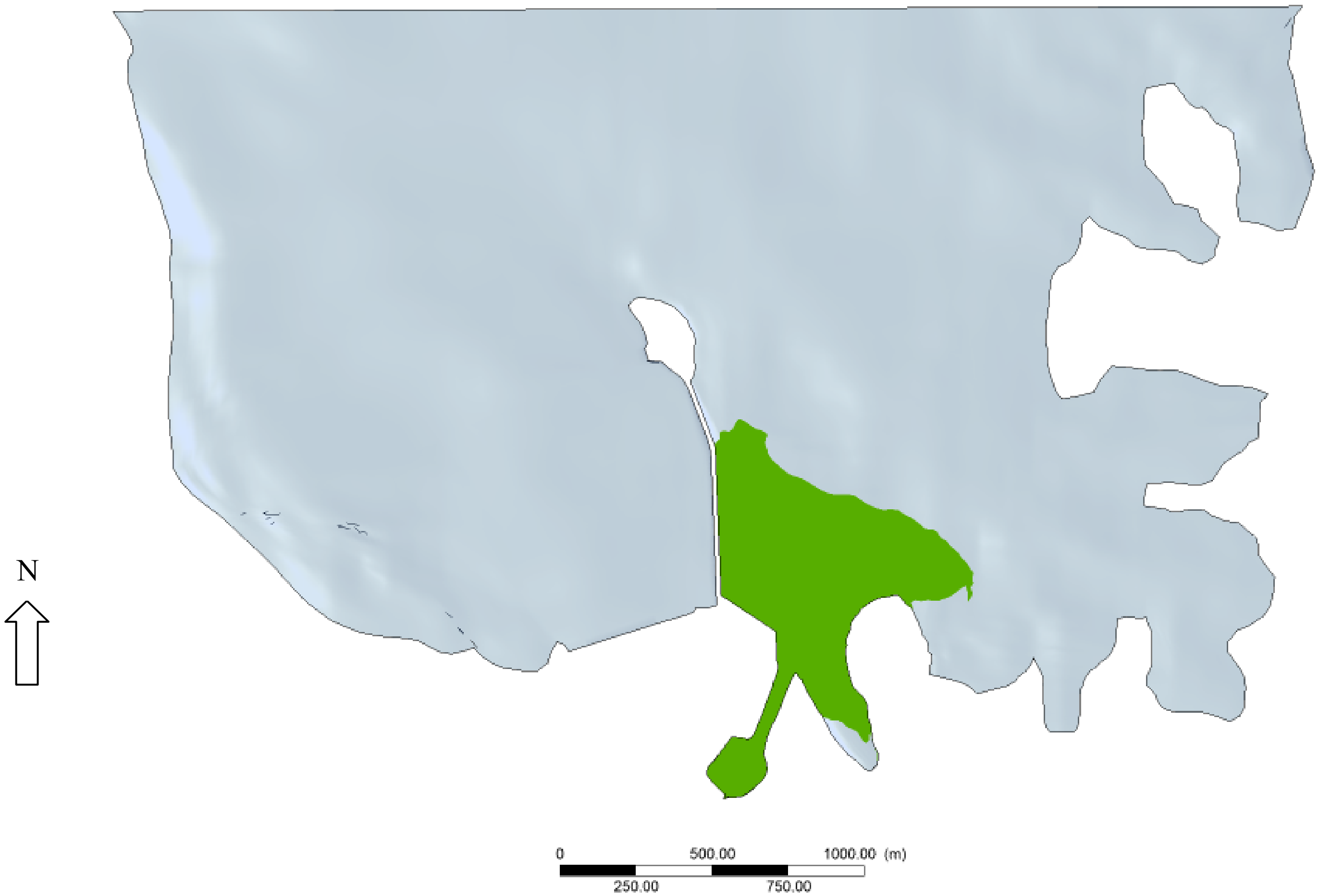

Figure 29 – Scenario 2W, ΔT = 5°F thermal plume (green).

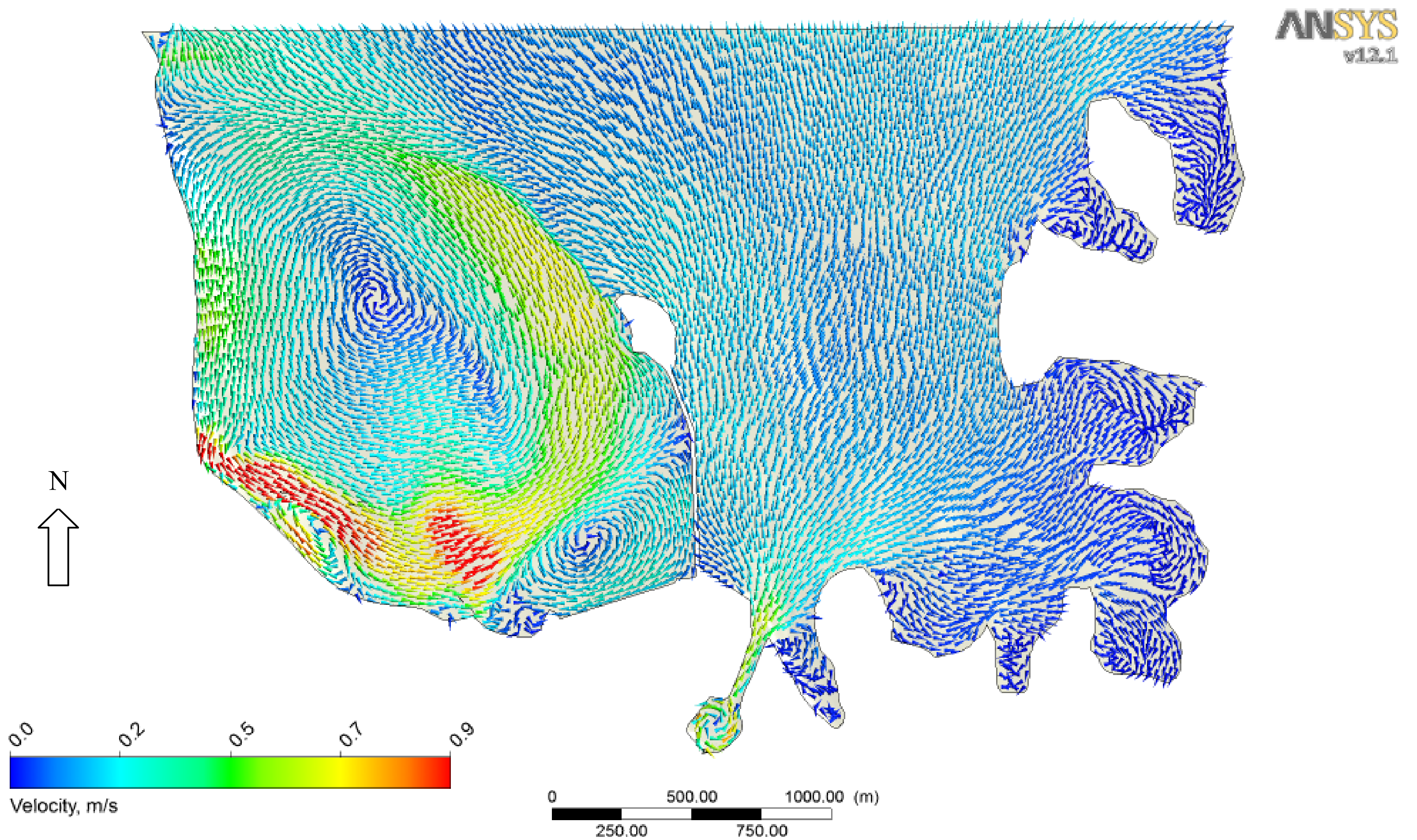

Figure 30 – Scenario 3W, surface velocity vectors

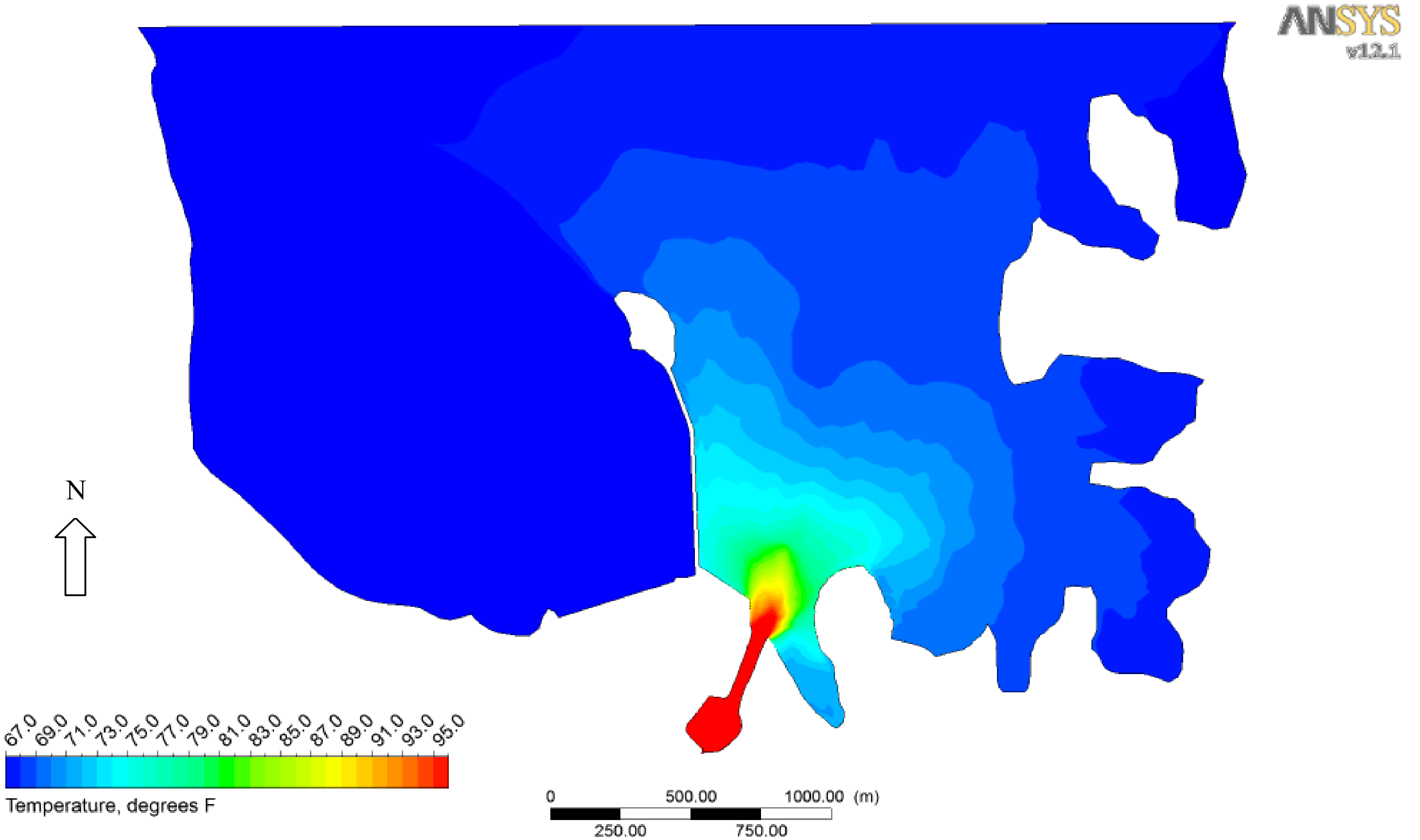

Figure 31 – Scenario 3W, surface temperature.

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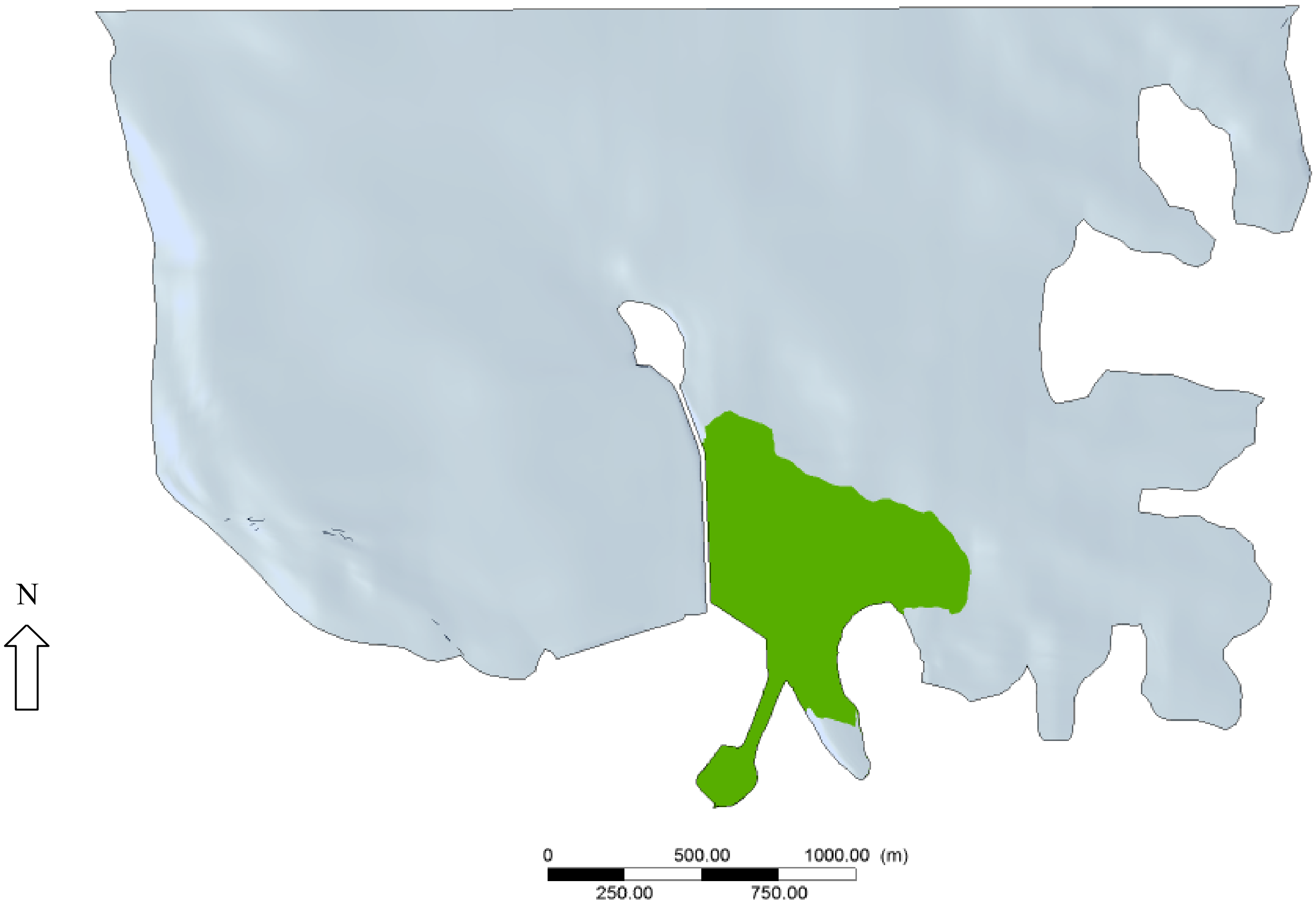

Figure 32 – Scenario 3W, ΔT = 5°F thermal plume (green).

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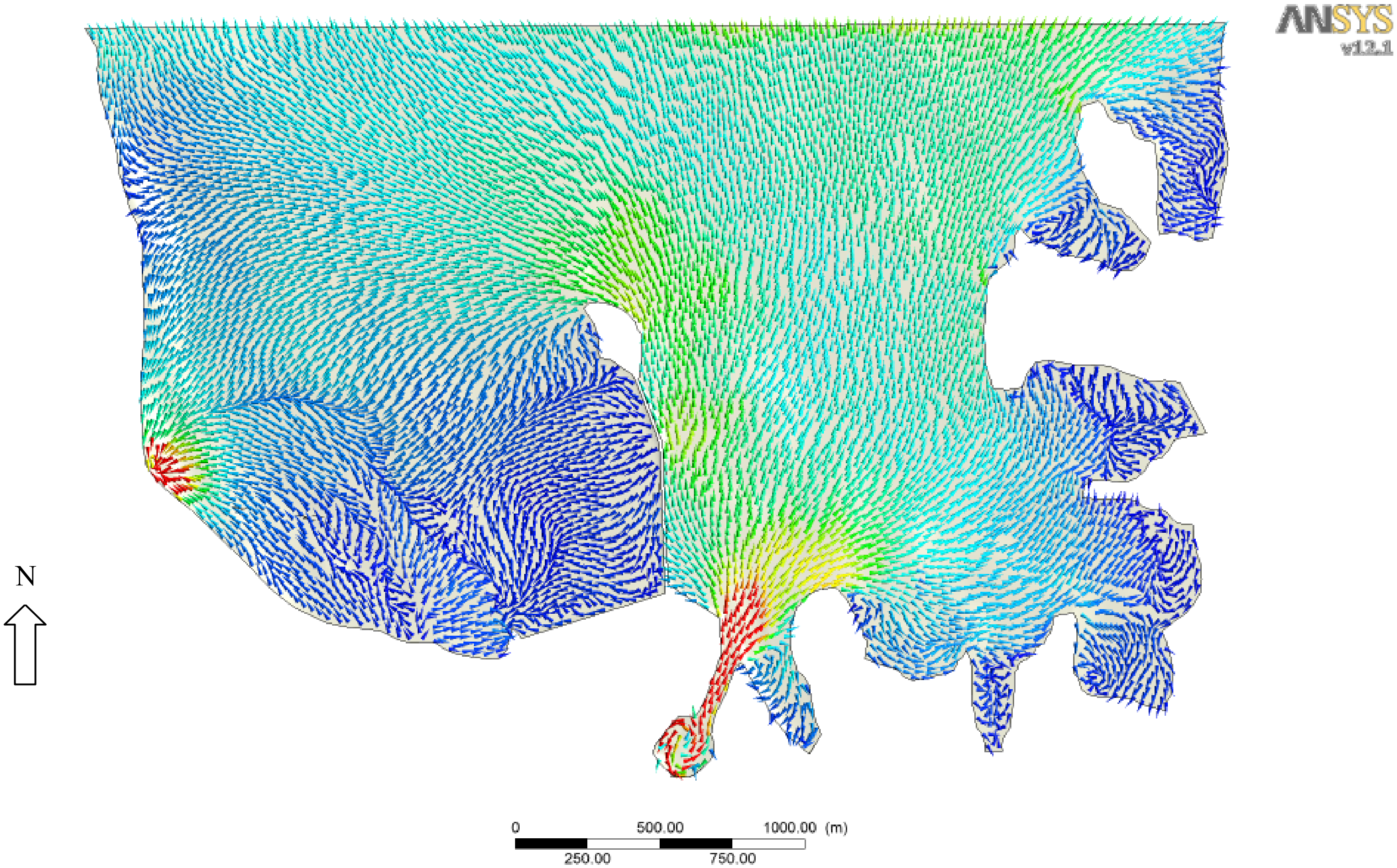

Figure 33 – Scenario 4W, surface velocity vectors

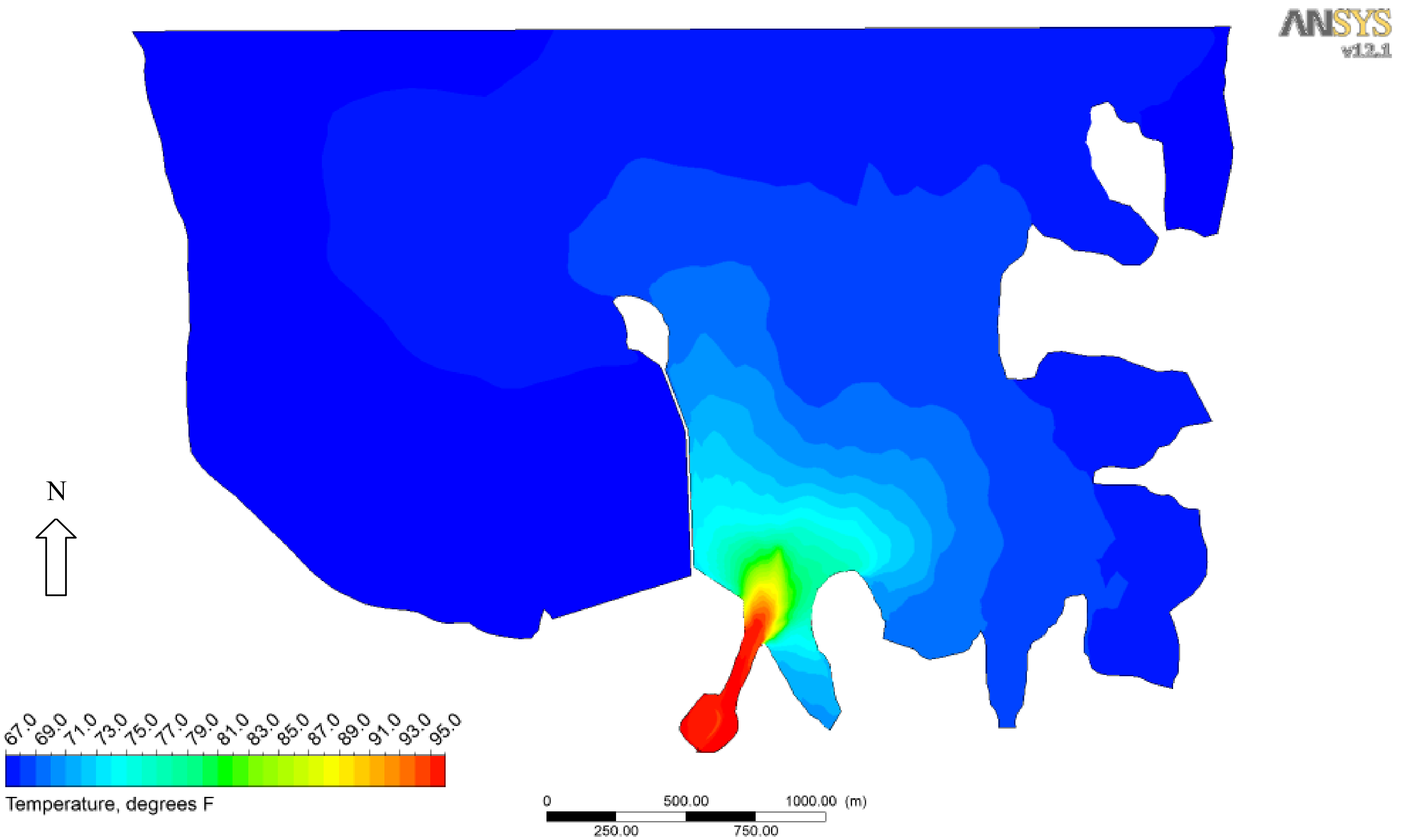

Figure 34 – Scenario 4W, surface temperature.

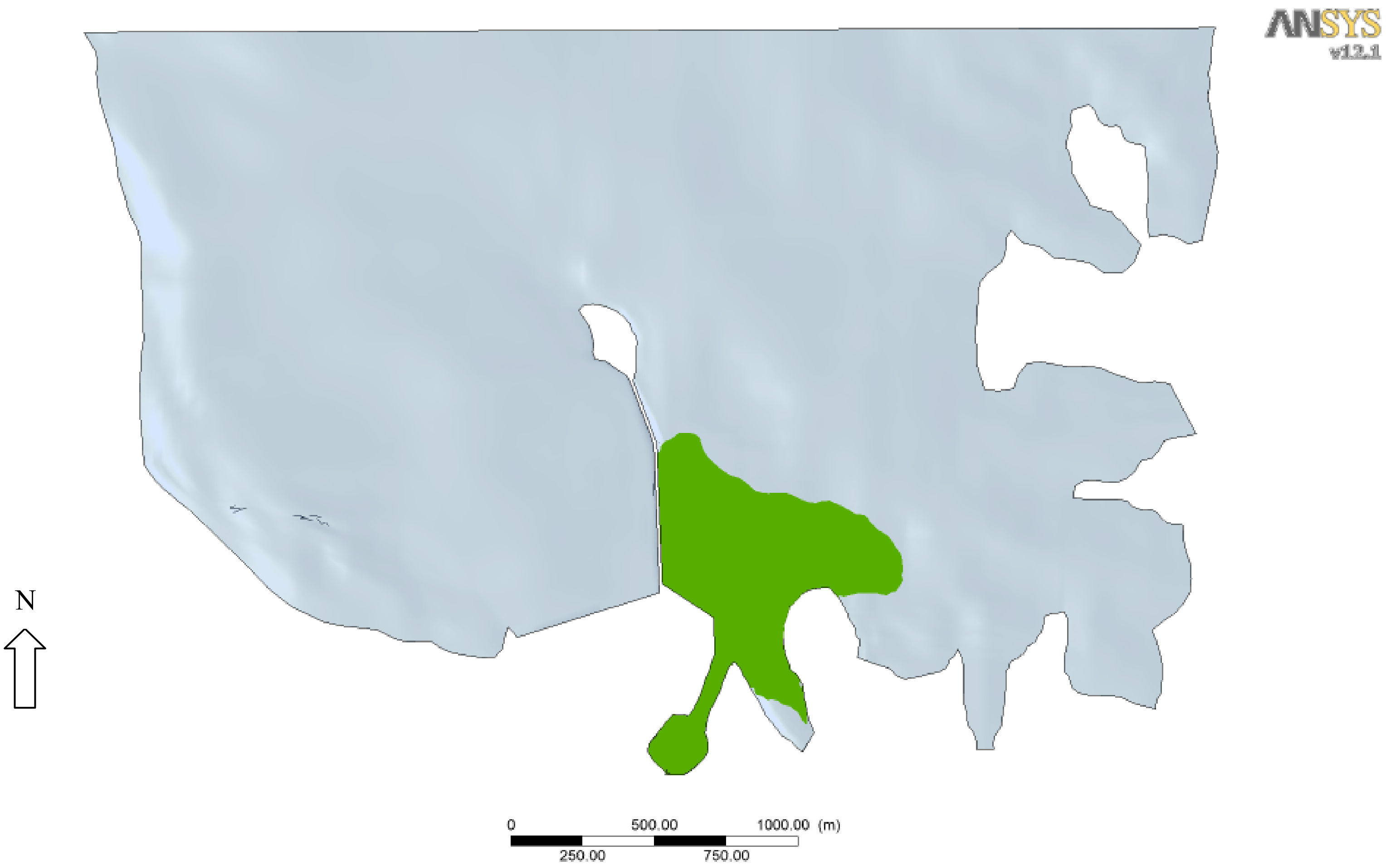

Figure 35 – Scenario 4W, ΔT = 5°F thermal plume (green).

12. APPENDIX A – DETAILS OF THE NUMERICAL MODEL

Geometry and Mesh

The geometry and mesh generation were described in §2 of this report. A custom-built digitizer in Matlab was used to digitized the contour map, and produce a surface. This surface was read into the ICEM mesh generator to create the meshes.

Boundary Conditions

The primary boundary condition in the CFD model was the flow rate and temperature applied discharge. In all simulations, a point source (or sink) was used to represent the flow being withdrawn through the cooling water intakes. Similarly, where the FPSF was operating, a mass and directional momentum point source was employed. The north surface of the domain was a zero-pressure "opening". This allows fluid to flow into the domain through the north boundary without exerting unphysical influence on the flow. The bottom surface of the domain was set to a "wall" and the top surface, representing the water surface, was set to a "smooth wall" (i.e. no shear stress).

Computational Models

Thermodynamic

The density of water in the domain depended on temperature only, using a tested polynomial relationship between density and temperature.

Turbulence

The shear-stress transport model (SST) was used for all simulations, which is a blend of the well-recognized k-ε and k-ω turbulence models.

Numerics

Model

All simulations were performed using Ansys-CFX 12.0, a widely recognized industrial CFD software package. The model was run in steady-state mode as transient instabilities were not observed.

Discretization

For the simulation, a specified blend factor of 0.5 was used, which is a blend between first- and second-order schemes. This scheme was used to provide a balance between numerical accuracy and stability.

The temporal term in the transient simulations was discretized using a second-order implicit Euler scheme.

Convergence

The root-mean-square residuals were less than 1e-04 for all transport equations solved. This level of convergence is acceptable for a transient simulation, especially as the volume of the thermal plumes was not observed to change. Imbalances for all conserved variables were less than 1%.

Prepared for

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THERMAL MIXING ZONE EVALUATION
VIRGIL C. SUMMER NUCLEAR STATION
NPDES PERMIT
FAIRFIELD COUNTY, SOUTH CAROLINA

ADDENDUM:
ADDITIONAL MODELING CASES FOR REVISED RESERVOIR AMBIENT AND DISCHARGE TEMPERATURES

Prepared by

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1255 Roberts Boulevard, Suite 200
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Project Number GK5460

February 2014

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

South Carolina Electric and Gas Company (SCE&G, a subsidiary of SCANA Corporation) is making an application to the South Carolina Department of Health and Environmental Control (SCDHEC) for a renewal of its National Pollutant Discharge Elimination System (NPDES) permit for Unit 1 of the Virgil C. Summer Nuclear Station (VCSNS). VCSNS is located in Fairfield County near Jenkinsville, South Carolina.

Geosyntec Consultants (Geosyntec), and its wholly-owned subsidiary MMI Engineering (MMI), have supported SCE&G in the permit application process by providing modeling studies to determine the size of thermal mixing zones in Monticello Reservoir due to cooling water discharges from VCSNS Unit 1. This was reported in Geosyntec report *Thermal Mixing Zone Evaluation Virgil C. Summer Nuclear Station NPDES Permit* (Geosyntec Project reference GR4796; date January 9, 2012).

SCDHEC has since reviewed the report on the thermal plume sizes and has requested further information from SCE&G. This has included a request for additional modeling to determine the thermal plume sizes under the discharge conditions stated on the NPDES permit application and with revised ambient temperatures representing the highest and lowest ambient temperatures recorded over a longer period than used in the earlier modeling work.

This report is an addendum to the earlier thermal mixing zone report to provide the results of the additional models. As far as possible, the same model set ups have been used as in the original reported work with changes made only to the boundary and initial conditions in Monticello Reservoir to meet SCDHEC's request. This report is focused to provide principally the results of the additional modeling scenarios and does not include the full background to the work and computational model detail. As such, it should be read in conjunction with the original report.

2. MODELED TEMPERATURES

2.1 Reservoir Ambient Temperature

The preceding work used ambient temperatures in Monticello Reservoir which were based on Discharge Monitoring Report (DMR) temperature data for VCSNS Unit 1 for 2010, the most recent complete year of temperature monitoring data at the time. These ambient reservoir temperatures were:

- Summer Condition: 86.4°F – this was the highest monthly-averaged temperature measured at the Unit 1 intakes in 2010.

- Winter Condition: 66.6°F – this was the reservoir temperature when the highest monthly-averaged change in temperature (ΔT) was recorded in 2010 between the reservoir ambient conditions and the Unit 1 cooling water discharge.

To address SCDHEC questions about the original model runs, SCE&G compiled DMR temperature data for VCSNS Unit 1 for a 10-year period from 2003 through 2012. Inspection of the 10-year data set revealed that the monthly average intake temperature of 86.4°F recorded in August 2010, which was used in the modeling of summer critical conditions, was the highest monthly average intake temperature in the 10-year data set.

Based on review of the longer-term data and SCE&G's proposal to maintain 113°F as a daily maximum discharge limit year-round, SCDHEC requested additional modeling runs using the highest and lowest ambient temperatures from the 10-year temperature data set. Specifically, SCDHEC requested that the additional model scenarios use the highest possible discharge temperature of 113°F for summer and winter model runs and these ambient reservoir temperatures:

- Summer Condition: 87.9^{o}F – this was the highest daily maximum Unit 1 intake temperature recorded from 2003 through 2012 (July 2010).

- Winter Condition: 46.4^{o}F – this was a low monthly-averaged Unit 1 intake temperature recorded from 2003 through 2012 (January 2010).

2.2 Nuclear Station Cooling Water Discharge Temperature

In the preceding work, the VCSNS Unit 1 cooling water discharge temperatures were set to 113°F (summer) and 98.7°F (winter).

For the current calculations, the cooling water discharge temperature has been set to 113°F for both summer and winter conditions to match the NPDES permit application and as requested by SCDHEC.

3. MODELED SCENARIOS

There are four principal scenarios for Monticello Reservoir which were tested in the preceding work for both summer and winter temperature conditions:

1. **Scenario 1 –** Thermal discharge under peak load and discharge flow with Monticello Reservoir elevation under high water-slack conditions (no flow through Fairfield Pumped Storage Facility [FPSF]).

2. **Scenario 2 –** Thermal discharge under peak load and discharge flow with Monticello Reservoir elevation under low water-slack conditions (no flow through FPSF).

3. **Scenario 3 –** Thermal discharge under peak load and discharge flow with Monticello Reservoir elevation under low water-rising conditions (FPSF pump-back); and

4. **Scenario 4 –** Thermal discharge under peak load and discharge flow with Monticello Reservoir elevation under high water-falling conditions (FPSF generation).

All four scenarios were calculated in the preceding work, as it was not possible to determine *a priori* which scenario would provide the worst case in terms of the 90°F plume size (summer) and $\Delta T > 5$°F plume size (winter).

For the current work under summer conditions, it has been judged that there is only a small change in temperatures compared with the preceding work – the discharge temperature remains the same (113°F) and the ambient temperature has increased by only 1.5°F. It can be reasonably assumed that the worst scenario previously calculated would also be the worst case for the new temperature conditions. This was Scenario 4 (High water Level; FPSF generating), which is the only summer condition case to have been recalculated in the current work.

Under winter conditions, the current requirement for discharge and ambient temperatures has changed more considerably compared with the preceding calculations (discharge temperature has increased from 98.7°F to 113°F; ambient temperature has decreased from 66.6°F to 46.4°F). Given these large variations, it has not been possible reasonably to assume that the worst case will remain the same as previously calculated. Hence, all four winter scenarios have been re-calculated in the current work.

The cases which have been calculated in the current work are summarized in Table 1. Scenarios denoted with a "W" are the winter runs and the scenario denoted with an "S" is the summer run.

Table 1. Scenarios Calculated in the Current Work

Case	***Scenario***	***Water Level (feet)***	***FPSF (cfs)***	***Discharge Temp (° F)***	***Ambient Temp (° F)***	***Cooling Water Flow (gpm)***
1	1W	425.0	0	113	46.4	532,000
2	2W	420.5	0	113	46.4	532,000
3	3W	420.5	41800	113	46.4	532,000
4	4W	425.0	-50400	113	46.4	532,000
5	4S	425.0	-50400	113	87.9	532,000

4. COMPUTATIONAL MODEL

As far as was possible, the same modeling conditions were applied to the computational model in the current work as were used in the preceding work. This has been considered essential for direct comparison of cases. The changes that have been made and their potential effect on the results are noted in the following sub-sections.

4.1 Geometry and Mesh

The exact same geometry and mesh that were used in the preceding work have been used in the current work.

4.2 Boundary and Initial Conditions

All boundary and initial conditions have been applied in the same manner, with the only changes being to the specified values of ambient and cooling water discharge temperatures.

4.3 Computational Models

The thermodynamic model has retained the same dependence of water density on temperature only using the same tested polynomial relationship.

The same Shear Stress Transport (SST) turbulence model has been used for all calculations.

4.4 Numerical Models

The preceding work used the ANSYS-CFX v12.0 software to perform the calculations; this is a commercially available, general purpose Computational Fluid Dynamics (CFD) software package which is widely applied throughout a range of industries. The current work has used a later release of the same software ANSYS-CFX v14.0[1]. There are no changes to the solution method between these releases.

---

[1] ANSYS releases a new version of the code generally every 12 months; the new versions typically have new models for more esoteric calculations (combustion; 2-phase flow; reaction kinetics, etc.) and some bug fixes. However the underlying engine of the software has not changed since they released v5 in the mid 1990's. There have been no changes between v12 and v14 to the sub-set of models we are using in this analysis.

The preceding work used time-dependent ("transient") calculations to determine the plume sizes. Although there was no variation of the flow conditions with time, a time-dependent solution method is required to resolve the thermal buoyancy forces which are significant in large parts of the reservoir. The same approach has been used in the current work.

For spatial discretization[2], the preceding work used a specified blend factor between first and second order schemes for all transported variables, with a blend factor of 0.5. In the current work a hybrid differencing scheme has been used, which applies second-order differencing as widely as possible in the domain, only reverting to first-order differencing in regions of high gradients in the transported variables. This was largely a change in style, rather than substance. The hybrid scheme has the potential to be marginally more accurate, but with perhaps slightly less stability.

For temporal discretization[3], the preceding work used a second-order implicit Euler scheme. In the current work, a first-order implicit Euler scheme was used as the second-order scheme is only considered essential where there are true transient conditions, rather than using a transient scheme to reach a steady solution.

Convergence in the preceding work was judged to be achieved by three metrics: (i) when the Root-Mean-Square (RMS) residuals were reduced below 1.0e-4 for all transport equations solved at each time step in the time-dependent solution; (ii) when the variable imbalances for all conserved variables were less than 1 percent; (iii) when the thermal plume sizes were observed not to vary in time. The same approach has been used in the current work with the exception that RMS residuals were reduced to 1.0e-5. This was largely a change in style, rather than substance.

[2] *Discretization* describes a numerical technique which is used in computational models. The flow domain – in this case the reservoir – is split into a very large number of grid cells, typically 10^5 – 10^6 and the flow details (velocity, pressure, temperature, turbulence) are calculated in each grid cell. The numerical method must have some means of passing information between neighbouring cells and other near-neighbours – this is the spatial discretization scheme.

[3] Similarly the flow data must be passed between time steps – this requires the temporal discretization scheme

5. RESULTS

5.1 Preceding Work

The principal results for plume sizes which were calculated in the preceding work are repeated here for comparison. Only the results for the cases which have been re-run in the current work are shown in Table 2. The average depths have been updated to be somewhat greater, as they were not presented correctly in the preceding report[4]; the plume volume, area, and average depth are the same.

The following thermal conditions were used in the preceding work:

- Winter: ambient temperature: 66.6°F; discharge temperature: 98.7°F.
- Summer: ambient temperature: 86.4°F; discharge temperature: 113°F.

Table 2. Calculated Plume Sizes Repeated from the Preceding Work

Case	*Scenario*	*Volume (acre-ft)*	*Surface Area (acre)*	*Average Depth (ft)*	*Maximum Depth (ft)*
		Winter Conditions ΔT = 5°F			
1	1W	799	77	10.4	40
2	2W	1,005	107	9.4	36
3	3W	1,148	120	9.6	36
4	4W	1,043	110	9.5	40
		Summer Conditions T = 90°F			
5	4S	1,790	163	6.1	40

[4] The results from the preceding analysis were originally provided in the tables in Section 7 "Results Summary – T = 90°F Plume" and Section 8 "Results Summary – ΔT = 5°F Plume" of report: *Thermal Mixing Zone Evaluation Virgil C. Summer Nuclear Station NPDES Permit* (Geosyntec Project reference GR4796; date January 9, 2012).

5.2 Current Work

The equivalent results for the plume sizes calculated in the current work are shown in Table 3.

The following thermal conditions were used in the current work:

- Winter: ambient temperature: 46.4°F; discharge temperature: 113°F.
- Summer: ambient temperature: 87.9°F; discharge temperature: 113°F.

Table 3. Calculated Plume Sizes from the Current Work

Case	*Scenario*	*Volume (acre-ft)*	*Surface Area (acre)*	*Average Depth (ft)*	*Maximum Depth (ft)*
		Winter Conditions ΔT = 5°F			
1	1W	1,031	125	8.2	40
2	2W	1,109	388	2.9	36
3	3W	1,246	130	9.6	36
4	4W	1,503	218	6.9	40
		Summer Conditions T = 90°F			
5	4S	4,841	378	12.8	40

Contour plots showing the extent of the thermal plumes at the surface of the reservoir for each case are presented in Figures 1 through 5.

5.3 Results Discussion – Winter Condition

The preceding work showed that the worst case in winter was Scenario 3 (low water; pump-back operation at FPSF). This was the worst case for both the ΔT = 5°F plume volume and area on the reservoir surface.

In the current work, the worst case for ΔT > 5°F plume volume is Scenario 4 (high water; generation at FPSF) and the worst case for area on the surface of the reservoir is Scenario 2 (low water; no flow through FPSF) (Table 3). The ΔT > 5°F plume remains to the east of the island at the end of the jetty (Figures 1, 3, and 4) for all cases except Scenario 2, where it just passes around the northernmost extent of the island (Figure 2).

In general, the plumes calculated with the ambient temperature 46.4°F and discharge temperature 113°F (Table 3) have greater volume and greater extent on the surface of the reservoir than the equivalent plumes in the preceding work with ambient temperature 66.6°F and discharge temperature 98.7°F (Table 2). There are a number of effects which influence this. Firstly, the higher discharge temperature results in a greater body of water with ΔT > 5°F; the lower ambient temperature also acts to increase this plume size. However, counter to that, the lower ambient temperature also provides a greater cooling effect and has the potential to reduce the thermal plume size. Overall, it appears that the increased discharge temperature and lower ambient temperature act to increase the size of the winter thermal plume, as defined by ΔT > 5°F, to a greater extent than the lower ambient temperature provides cooling.

Scenario 2 is also slightly unusual in that the average plume depth (or thickness) is shallow; this increases its area on the surface of the reservoir relative to the other scenarios. This is most likely due to the low water level used in Scenario 2, which is set at 420.5 ft mean sea level (msl), compared with the high water level cases using 425 ft msl. Scenario 3 also has the low water level, but there is increased mixing in the reservoir due to pump-back operations at FPSF.

5.4 Results Discussion – Summer Condition

The T = 90°F thermal plume for Scenario 4 (high water; generation at FPSF) is considerably larger for the current conditions than in the preceding work. The increase is evident in the volume, extent on the surface area, and depth of the thermal plume (Tables 2 and 3).

The only change in the conditions for this scenario was the increase in the ambient temperature from 86.4°F to 87.9°F. Although this is a small increase, it is significantly closer to the T = 90°F limit that defines the thermal plume, and thus less able to cool the discharged water.

As shown in Figure 5, the thermal plume remains to the east of the island and does not extend towards the FPSF or the VCSNS Unit 1 cooling water intake structure.

6. CONCLUSIONS

Additional calculations have been carried out for cooling water discharges from VCSNS Unit 1 into Monticello Reservoir. The additional calculations have been made at the request of SCDHEC to investigate a number of effects: lower ambient temperature in the winter; higher ambient temperature in the summer; and cooling water discharge of 113°F in the winter.

In winter, reducing the ambient temperature in the reservoir and increasing the cooling water discharge temperature has the effect of increasing slightly the $\Delta T > 5°F$ thermal plume size. The worst case for plume volume is Scenario 4 (high water; FPSF pumping back to Monticello Reservoir) and worst case for plume area on the reservoir surface is Scenario 2 (low water; no flow through FPSF). The $\Delta T > 5°F$ plume remains to the east of the island at the end of the jetty (located between the VCSNS cooling water intake structure and the discharge point) for all cases except Scenario 2, where it just passes around the northernmost extent of the island.

In summer, increasing the ambient temperature in the reservoir to 87.9°F has a large effect on the $T = 90°F$ thermal plume. This is because there is little cooling potential in the reservoir when the ambient temperature is already close to the thermal plume limit. However, the thermal plume remains to the east of the island.

Both winter and summer cases show larger thermal plumes than were calculated in the preceding work, due to the revised ambient and discharge temperatures specified by SCDHEC. However, it is significant that in all cases calculated, the thermal plumes due to the cooling water discharge remain entirely or predominantly to the east of the island that separates the VCSNS cooling water intake structure and discharge. The thermal plumes do not approach the FPSF intake, the VCSNS Unit 1 cooling water intake structure, or the northern reach of Monticello Reservoir.

FIGURES

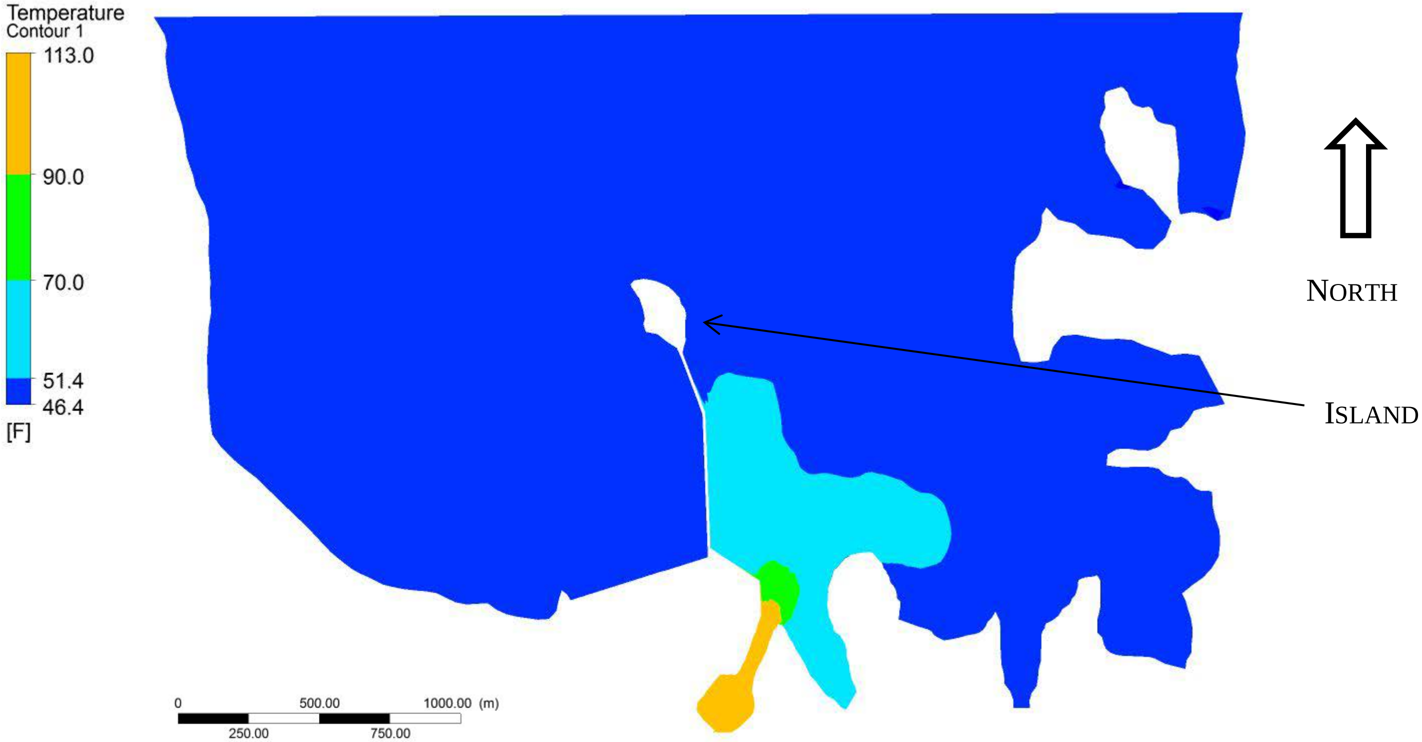


Figure 1. Scenario 1: Winter - High Water; No Flow through FPSF.

Contour plot showing the extent of the $\Delta T > 5°F$ plume which for $T_{ambient} = 46.4°F$ has the value $T_{plume} = 51.4°F$

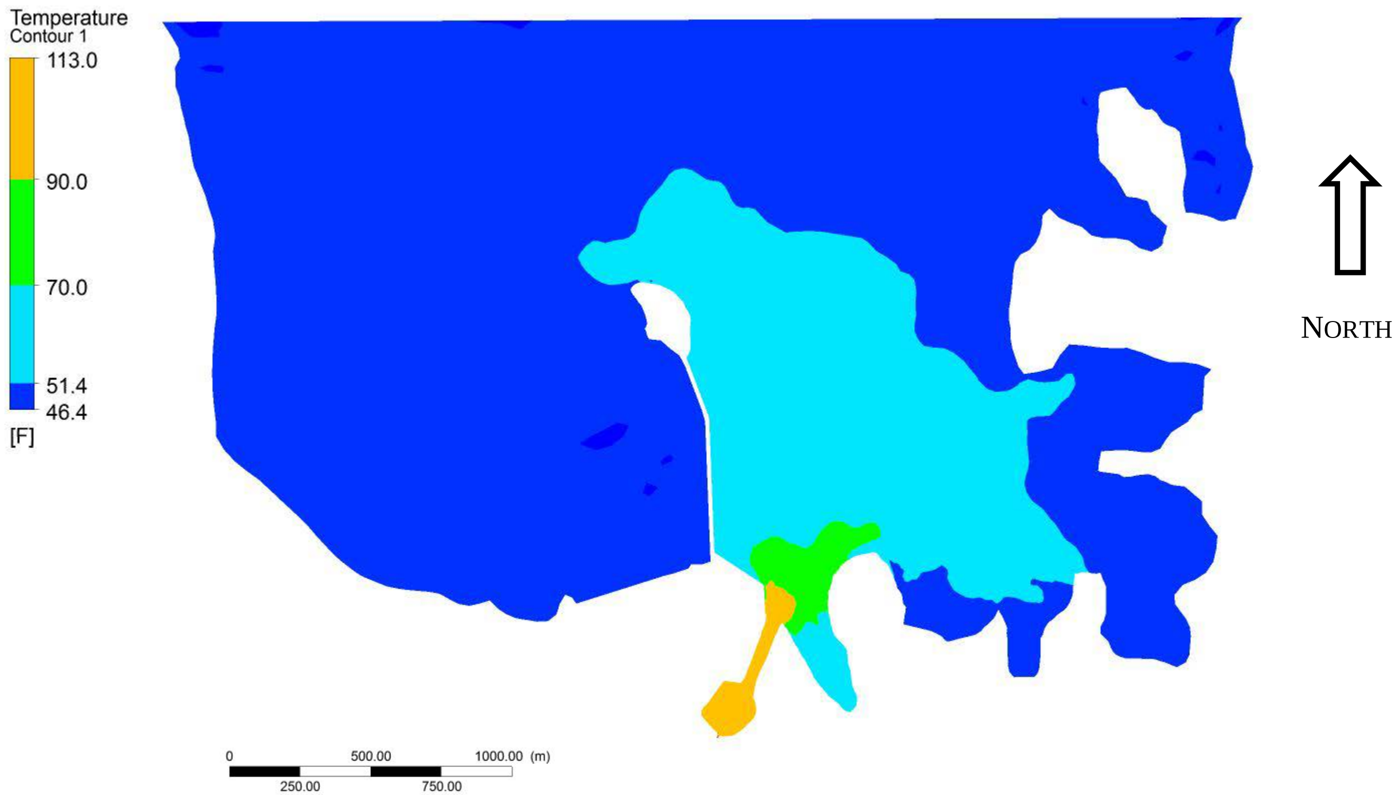


Figure 2. Scenario 2: Winter - Low Water; No Flow through FPSF.

Contour plot showing the extent of the $\Delta T > 5°F$ plume which for $T_{ambient} = 46.4°F$ has the value $T_{plume} = 51.4°F$

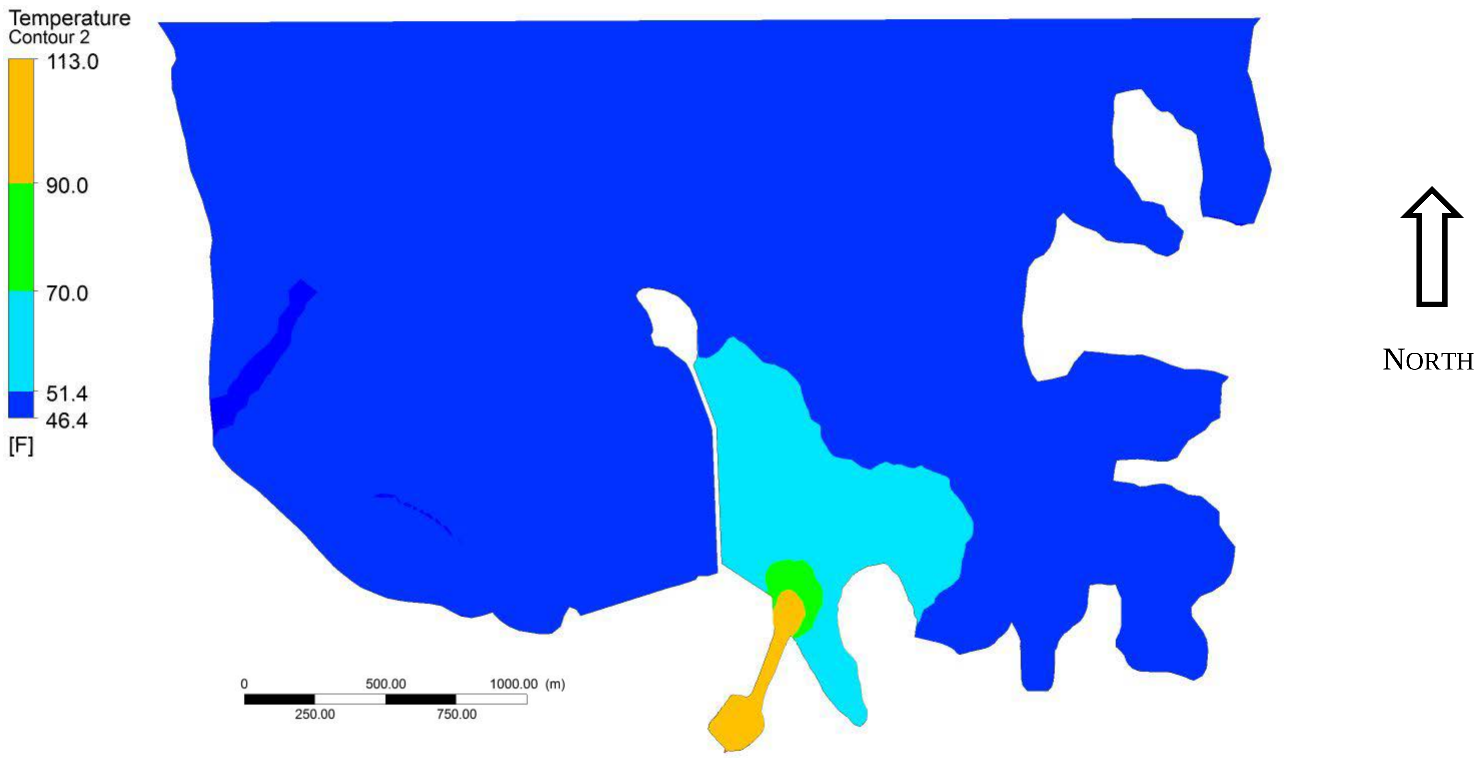


Figure 3. Scenario 3: Winter - Low Water; FPSF Pumping Back to Reservoir.

Contour plot showing the extent of the $\Delta T > 5°F$ plume which for $T_{ambient} = 46.4°F$ has the value $T_{plume} = 51.4°F$

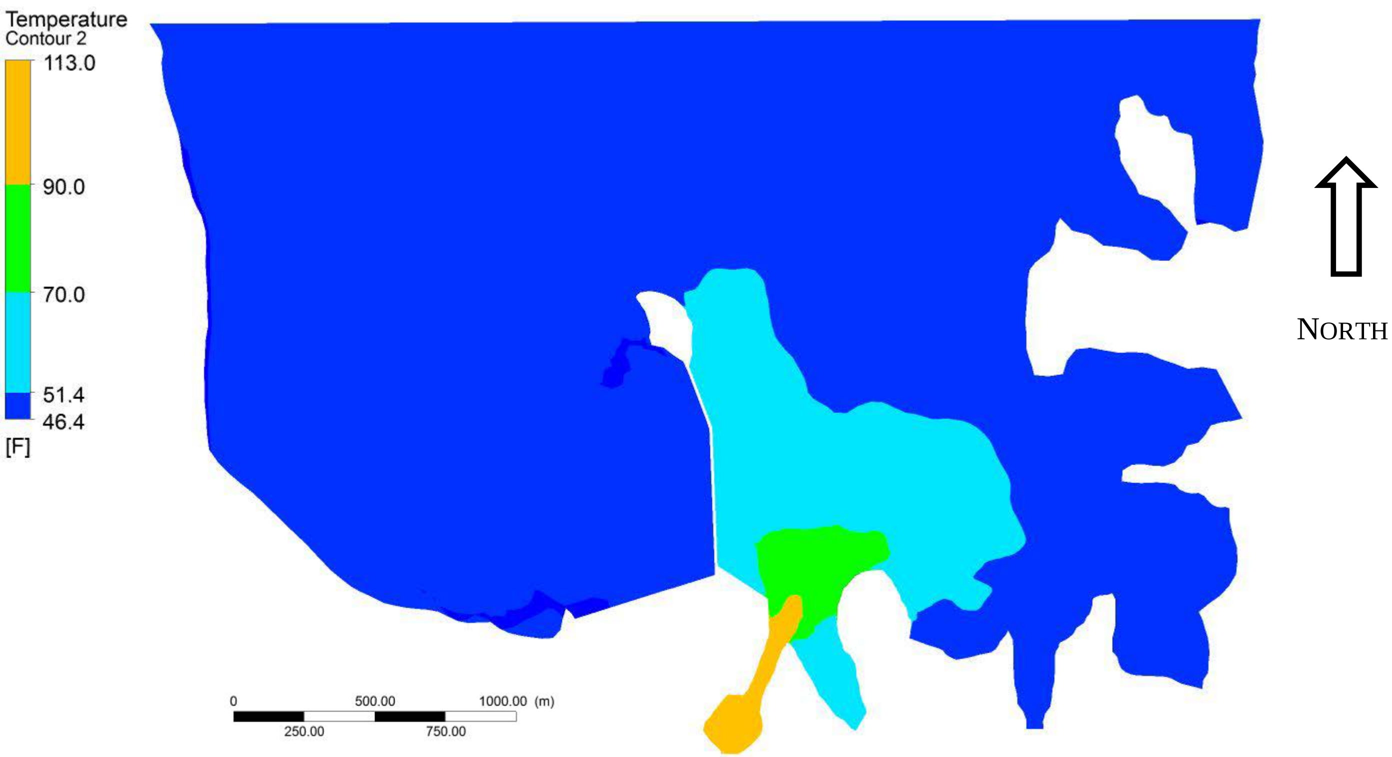


Figure 4. Scenario 4: Winter - High Water; FPSF Generating (Discharging from Reservoir).

Contour plot showing the extent of the $\Delta T > 5°F$ plume which for $T_{ambient} = 46.4°F$ has the value $T_{plume} = 51.4°F$

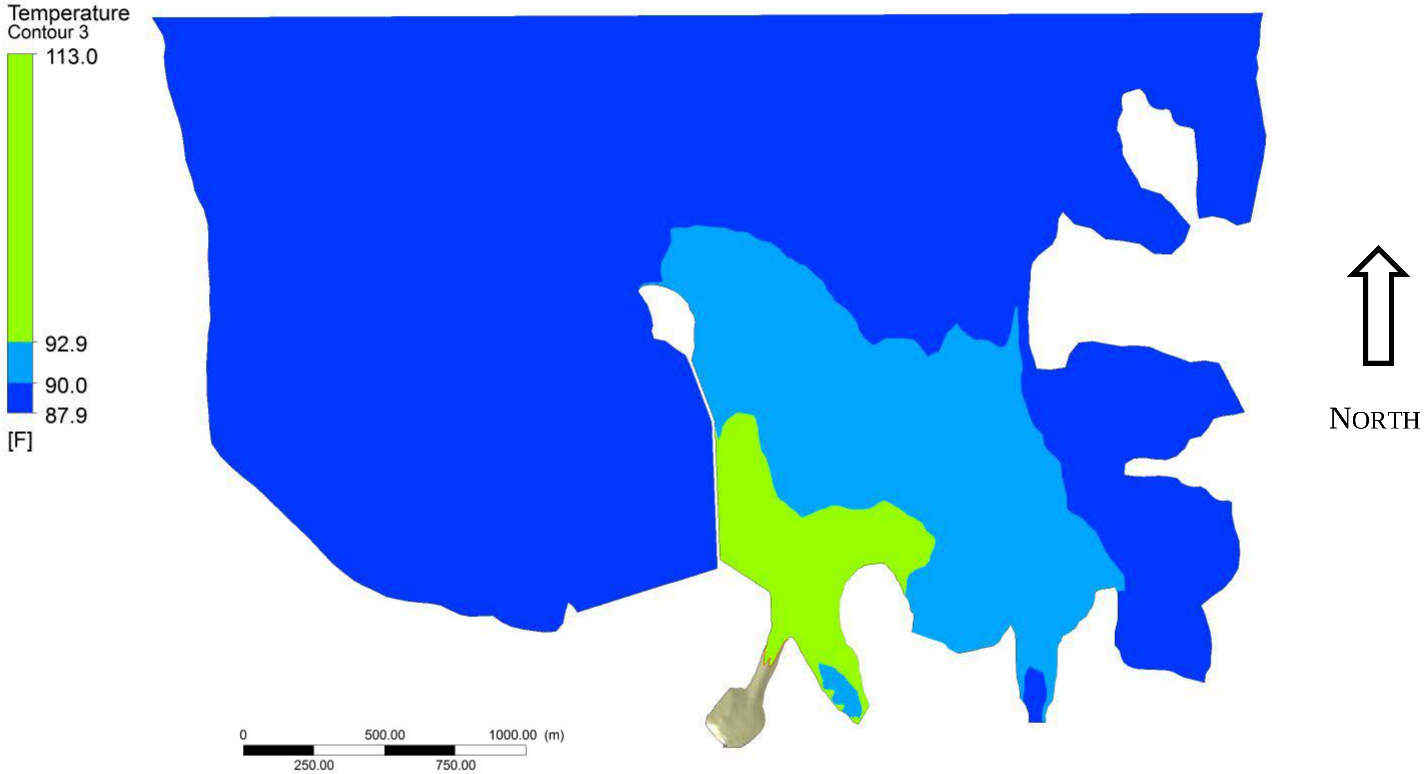


Figure 5. Scenario 4: Summer - High Water; FPSF Generating (Discharging from Reservoir).

Contour plot showing the extent of the T = 90°F plume;
also shown is ΔT > 5°F plume which for $T_{ambient}$ = 87.9°F has the value T_{plume} = 92.9°F

APPENDIX C

PARR HYDROELECTRIC PROJECT – WATER QUALITY ADDENDUM – JUNE 2014

At the Water Quality TWC meeting on February 4, 2014, the TWC noted that the Parr Water Quality Report identified multiple dissolved oxygen (DO) levels below 4.0 mg/l in the Parr Shoals Dam tailrace. The TWC agreed that SCE&G would consolidate historic USGS data to examine those excursions and to provide any operations that might be associated with the data. SCE&G requested hourly DO, temperature and river flow data from 2004 through 2013 for the following USGS stations:

1. USGS 02160991 Broad River near Jenkinsville, SC
2. USGS 02156500 Broad River near Carlisle, SC
3. USGS 02160700 Enoree River at Whitmire, SC
4. USGS 02160105 Tyger River near Delta, SC

Our analysis of the data focused on the period from July through September of each year from 2004 through 2013. For this analysis, we plotted hourly readings of flow, temperature, and DO levels at each of the gage stations. Those plots and the raw data will be available to the TWC upon request. Included below are data from the Jenkinsville gage, located immediately downstream of the Parr Shoals Dam along the east bank of the tailrace (FIGURE 1 through FIGURE 10). Since flow data is not collected at the Jenkinsville gage, flow data from the Alston gage, USGS 02161000, was used.

FIGURE 1 2004 TEMPERATURE AND DISSOLVED OXYGEN AT USGS 02160991; AND FLOW AT USGS 02161000

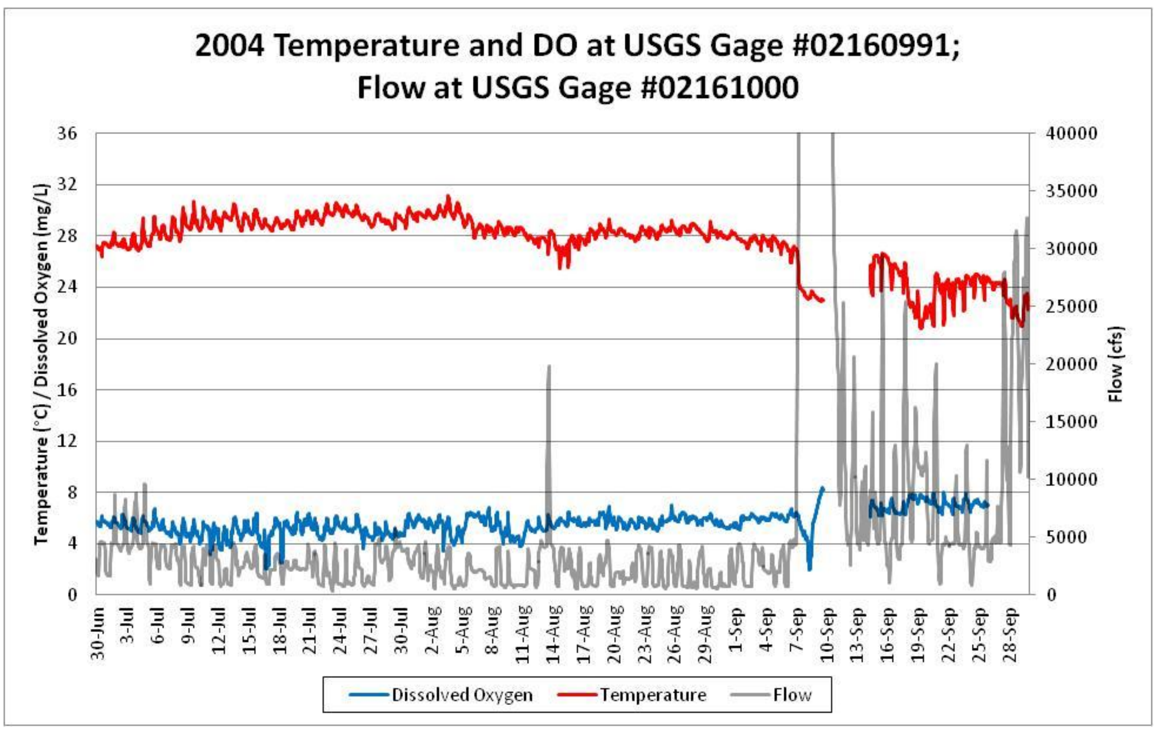


FIGURE 2 2005 TEMPERATURE AND DISSOLVED OXYGEN AT USGS 02160991; AND FLOW AT USGS 02161000

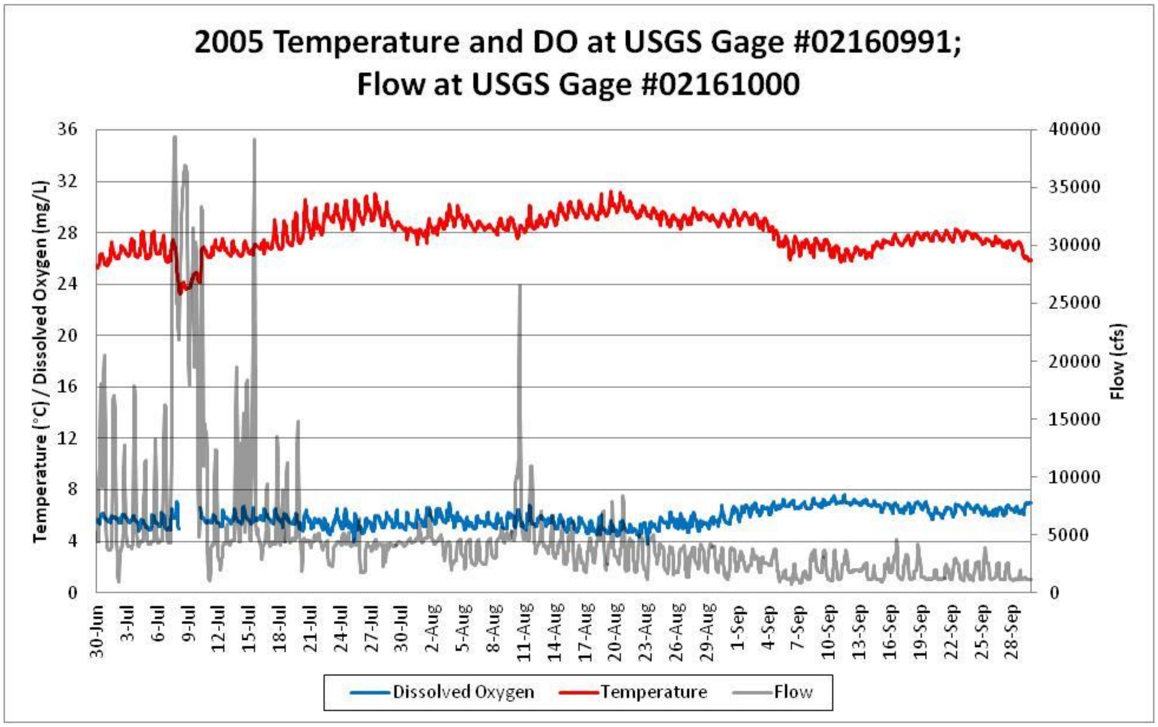


FIGURE 3 2006 TEMPERATURE AND DISSOLVED OXYGEN AT USGS 02160991; AND FLOW AT USGS 02161000

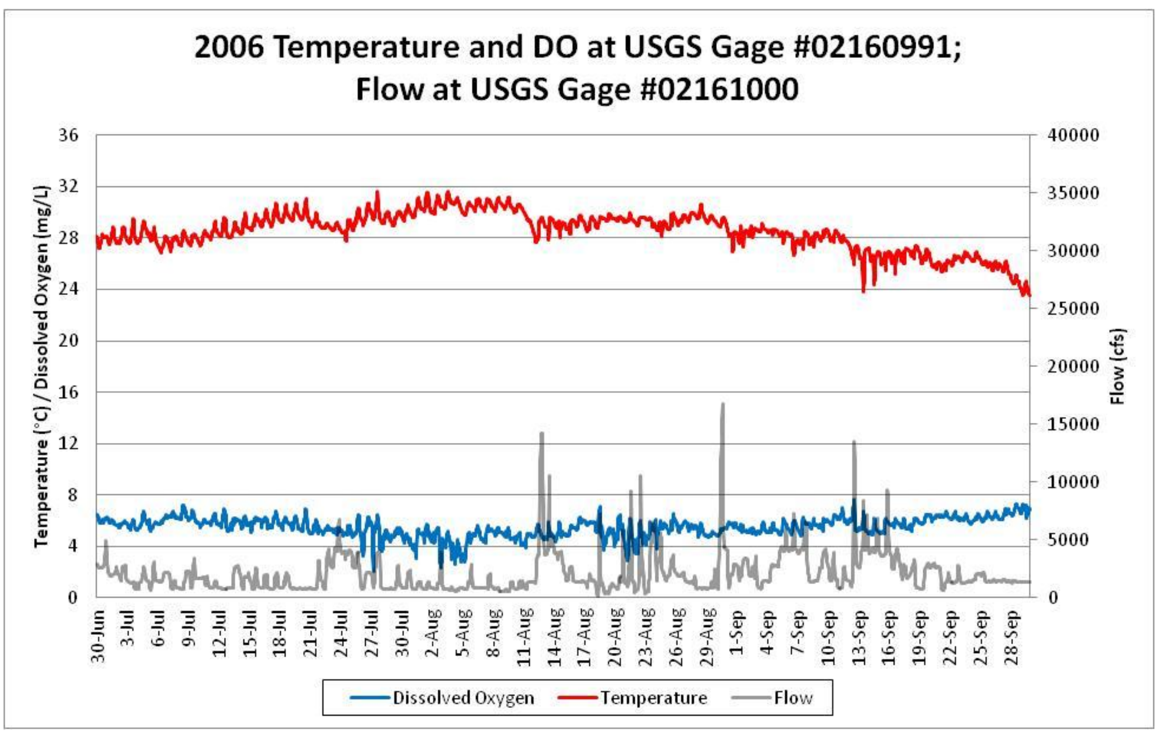


FIGURE 4 2007 TEMPERATURE AND DISSOLVED OXYGEN AT USGS 02160991; AND FLOW AT USGS 02161000

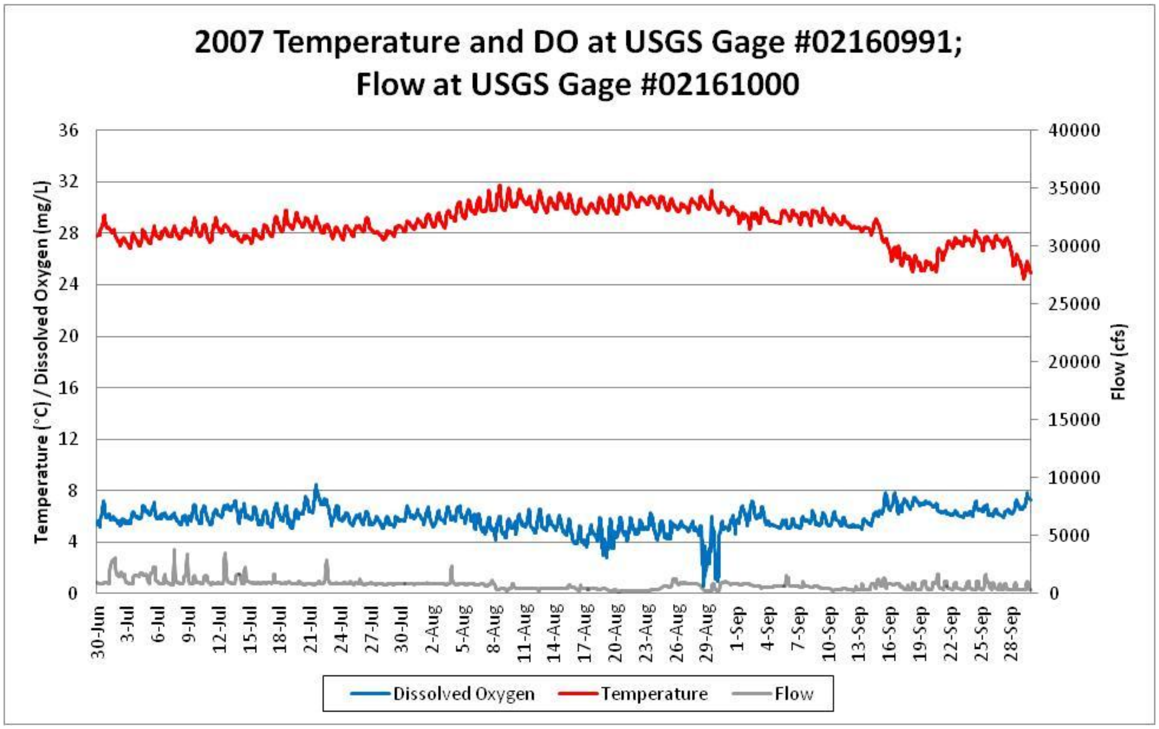


FIGURE 5 2008 TEMPERATURE AND DISSOLVED OXYGEN AT USGS 02160991; AND FLOW AT USGS 02161000

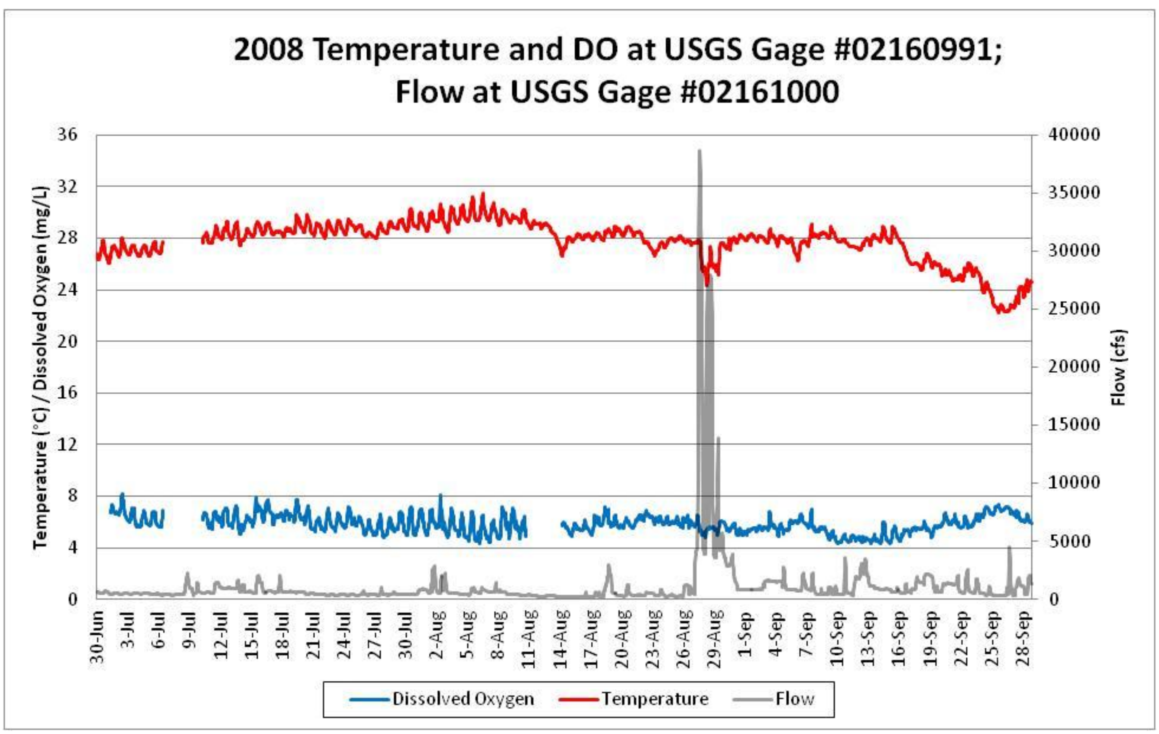


FIGURE 6 **2009 TEMPERATURE AND DISSOLVED OXYGEN AT USGS 02160991; AND FLOW AT USGS 02161000**

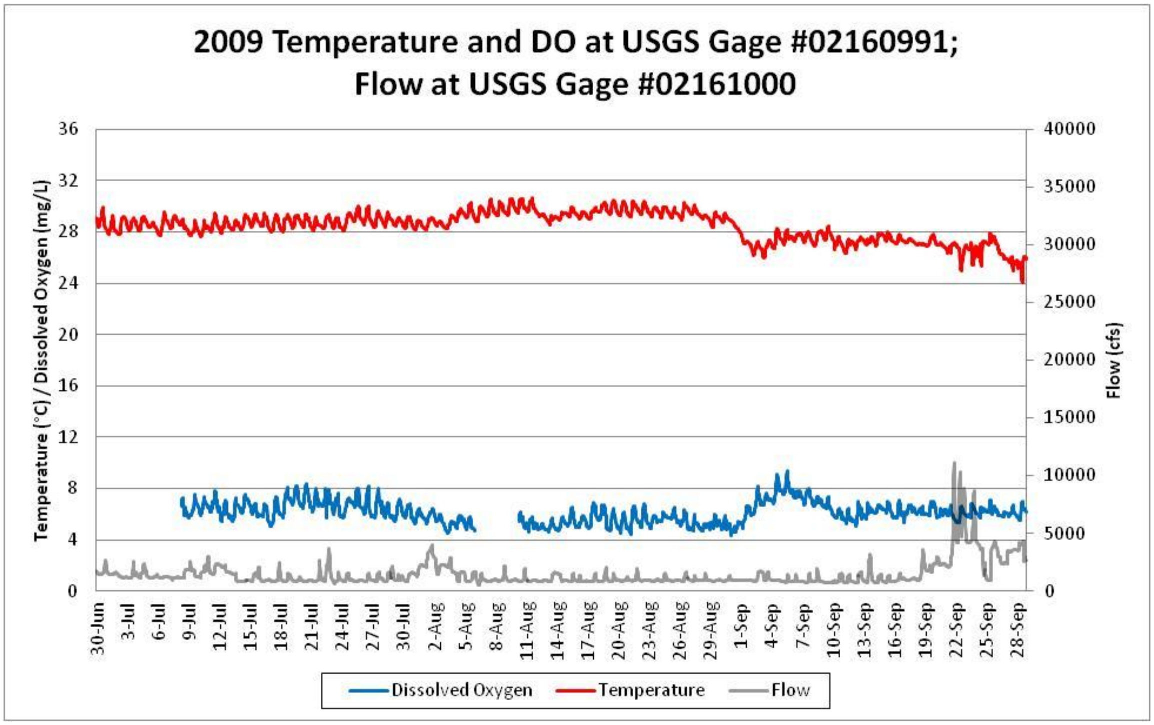


FIGURE 7 **2010 TEMPERATURE AND DISSOLVED OXYGEN AT USGS 02160991; AND FLOW AT USGS 02161000**

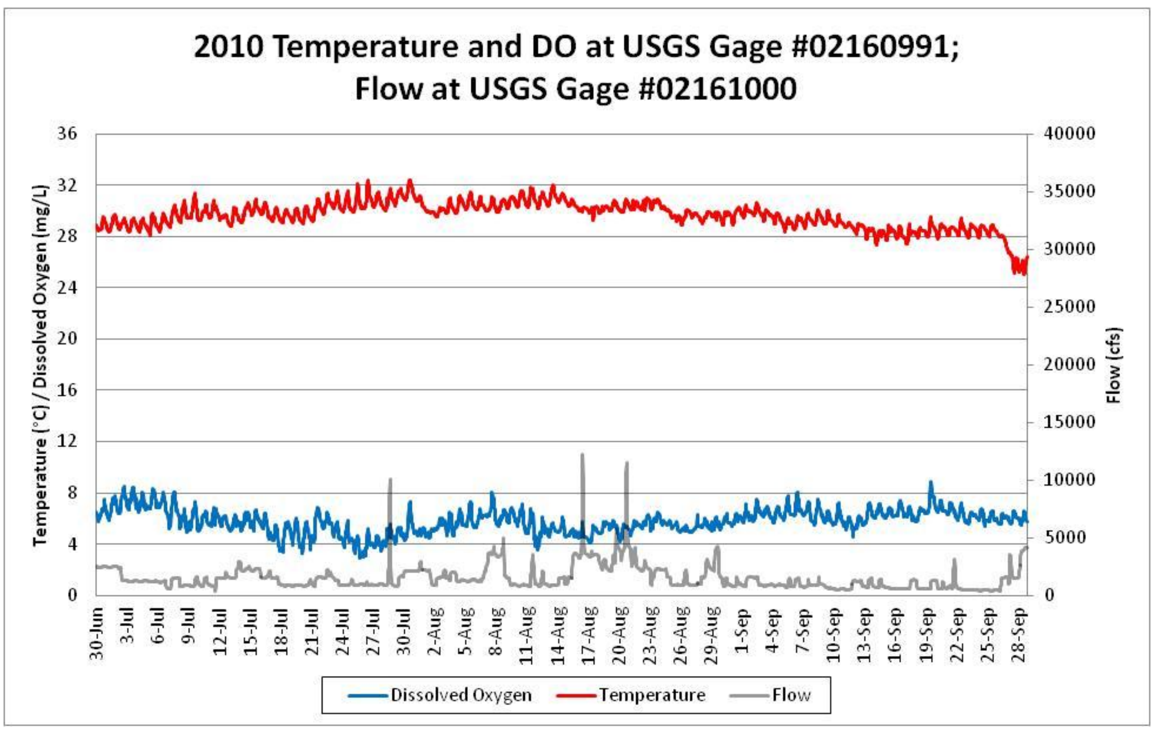


FIGURE 8 2011 TEMPERATURE AND DISSOLVED OXYGEN AT USGS 02160991; AND FLOW AT USGS 02161000

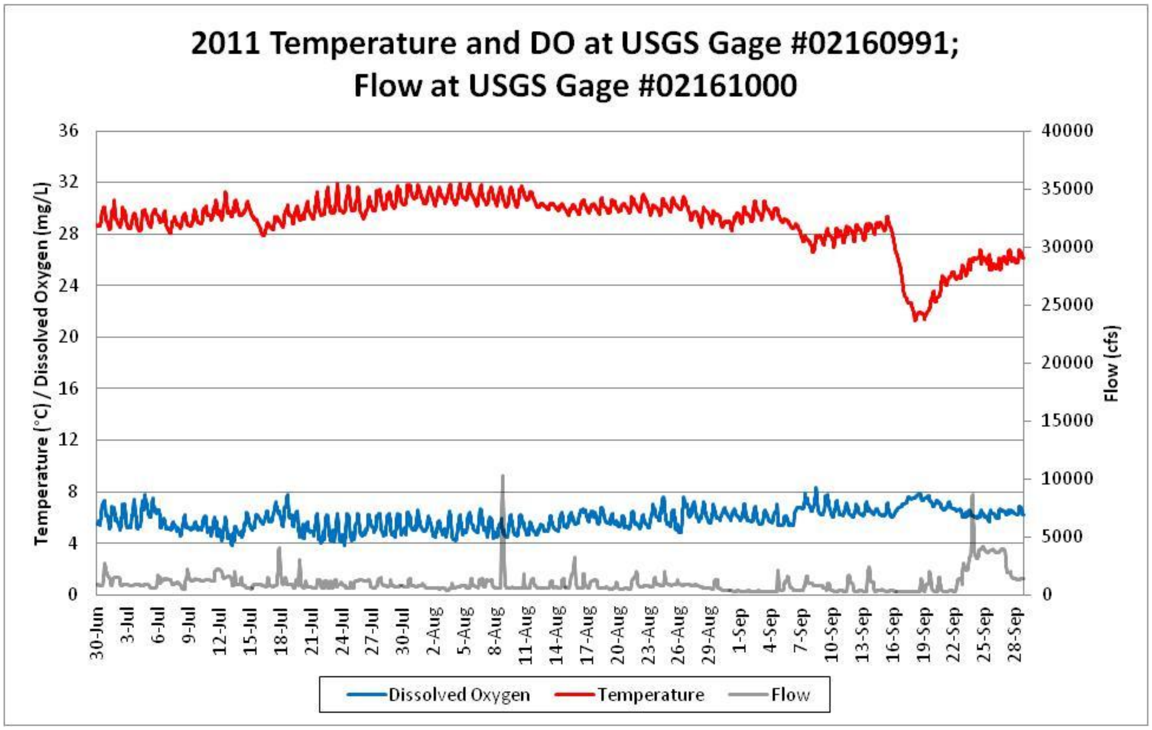


FIGURE 9 2012 TEMPERATURE AND DISSOLVED OXYGEN AT USGS 02160991; AND FLOW AT USGS 02161000

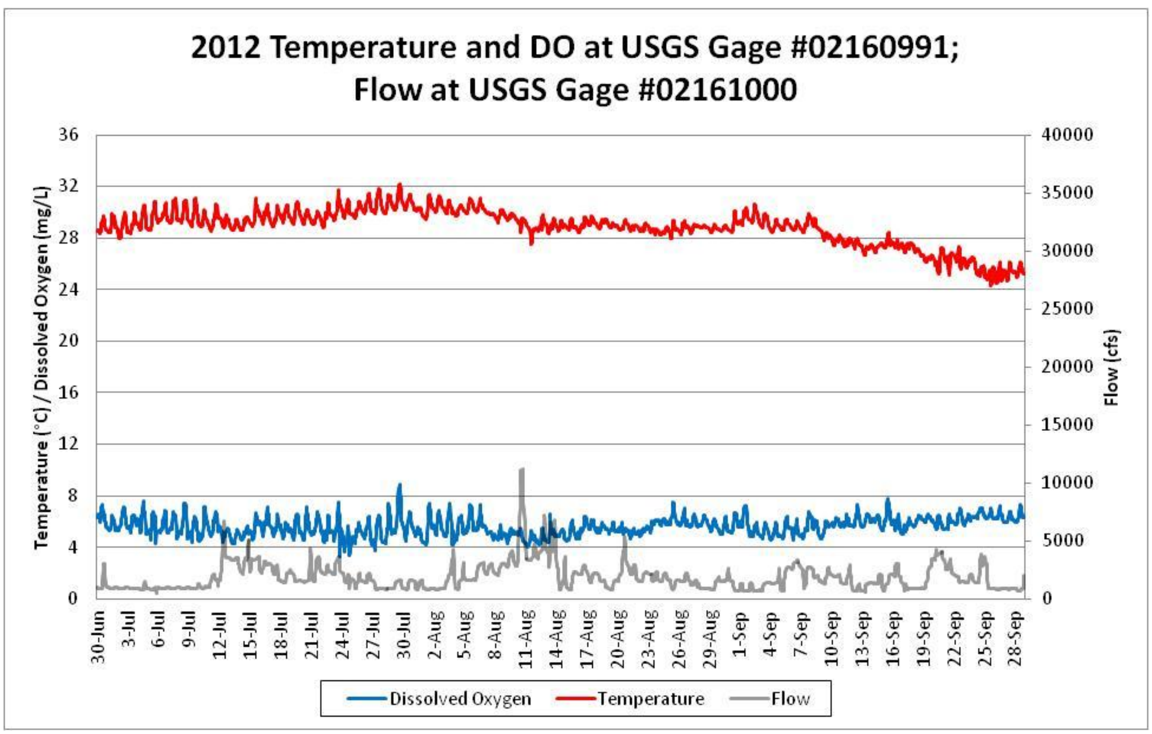
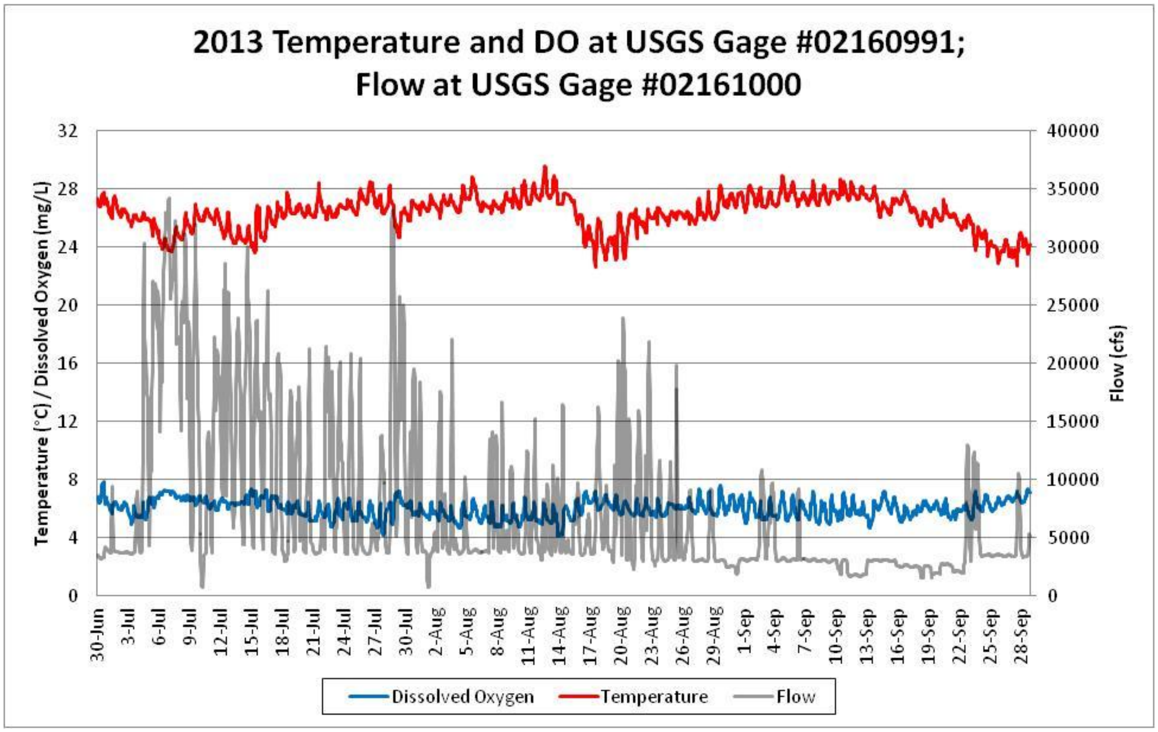


FIGURE 10 2013 TEMPERATURE AND DISSOLVED OXYGEN AT USGS 02160991; AND FLOW AT USGS 02161000



Review of the data verified that there are periodic excursions of DO levels less than 4.0 mg/l. These events are not consistent from year to year and do not typically have a long duration. We have presented representative excerpts of the raw data in TABLE 1 through TABLE 4 to demonstrate the month, flow, temperature, time of day, and DO level experienced.

TABLE 1 JULY 19-20, 2010: DO EXCURSION

Date	Time	DO (mg/L)	Temperature (°C)	Flow (cfs)
7/19/2010	9:00 pm	4.3	29.5	900.7
7/19/2010	10:00 pm	4.0	29.4	900.7
7/19/2010	11:00 pm	3.7	29.4	900.7
7/20/2010	12:00 am	3.9	29.3	900.7
7/20/2010	1:00 am	3.8	29.3	900.7
7/20/2010	2:00 am	3.8	29.2	888.0
7/20/2010	3:00 am	3.7	29.2	875.3
7/20/2010	4:00 am	3.6	29.1	862.7
7/20/2010	5:00 am	3.3	29.1	862.7
7/20/2010	6:00 am	3.7	29.0	837.7
7/20/2010	7:00 am	4.0	29.1	837.7
7/20/2010	8:00 am	4.5	29.2	825.3

TABLE 2 JULY 13, 2011: DO EXCURSION

Date	Time	DO (mg/L)	Temperature (°C)	Flow (cfs)
7/13/2011	5:00 am	4.6	29.7	1474.9
7/13/2011	6:00 am	3.9	29.3	1369.9
7/13/2011	7:00 am	3.8	29.3	939.3
7/13/2011	8:00 am	4.1	29.5	812.9

TABLE 3 JULY 24, 2012: DO EXCURSION

Date	Time	DO (mg/L)	Temperature (°C)	Flow (cfs)
7/24/2012	6:00 am	4.2	29.6	2107.6
7/24/2012	7:00 am	3.9	29.6	1789.4
7/24/2012	8:00 am	3.6	29.5	1536.0
7/24/2012	9:00 am	3.9	29.7	1459.7
7/24/2012	10:00 am	4.3	30.1	1429.5
7/24/2012	11:00 am	4.3	30.1	1429.5
7/24/2012	12:00 pm	4.4	30.2	1444.6
7/24/2012	1:00 pm	4.4	30.3	1444.6
7/24/2012	2:00 pm	4.7	30.6	1399.6
7/24/2012	3:00 pm	5.6	30.9	1444.6
7/24/2012	4:00 pm	5.7	31.0	1954.6
7/24/2012	5:00 pm	5.5	30.9	2124.8
7/24/2012	6:00 pm	4.8	30.8	1971.4
7/24/2012	7:00 pm	3.5	30.1	1154.4
7/24/2012	8:00 pm	3.4	29.9	875.3
7/24/2012	9:00 pm	3.6	29.9	1520.7
7/24/2012	10:00 pm	3.6	29.9	1676.9
7/24/2012	11:00 pm	4.1	29.9	1724.8

TABLE 4 JULY 27, 2012: DO EXCURSION

Date	Time	DO (mg/L)	Temperature (°C)	Flow (cfs)
7/27/2012	6:00 am	4.2	30.0	1490.1
7/27/2012	7:00 am	3.7	29.9	1196.5
7/27/2012	8:00 am	3.8	30.0	900.7
7/27/2012	9:00 am	4.3	30.0	837.7

Our review of this data lead us to the conclusion that the low DO levels frequently occur during the early morning hours when DO levels often begin to decline (diel fluctuation) and flows begin to decline. Based on this observation we reviewed the location of the USGS monitor which is located along the bank in a back eddy just downstream of the Parr Shoals Dam. We also asked the USGS to provide any information they had on the type of monitoring equipment used and how it had changed over time. The following is a consolidation of email excerpts that we received from Michael Hall of the USGS:

> The current DO probe that the USGS uses at the Parr Dam monitoring site is a YSI 6150 ROX, which is an optical DO probe with a self cleaning wiper system. Looking back over the last year and a half, there have been no corrections needed to the sensor data for fouling or calibration drift. The sensors and sonde are cleaned at least monthly, but sometimes more often in the summer months if needed. The DO membrane itself rarely has any visible fouling because of the wiper system. Calibration is checked monthly and readings are also verified at each visit with a separate calibrated field meter. YSI states that the accuracy of the ROX DO is +/- 0.1 mg/L or 1% of reading, whichever is greater. The USGS applies corrections to the data if the combined fouling and drift differences exceed +/- 0.3 mg/L.
>
> [USGS hasn't] noticed any issues with the quality of the readings and can't ever recall the water being stagnant where the sonde housing is placed. The flow at the sonde is mostly negative due to a swirling motion, but any debris or other trash that is floating in the pool gets "flushed" fairly quickly, so I would assume the water is constantly being refreshed. If you would like, we can arrange to be on site during different unit releases to better determine if there is a stagnant issue.
>
> Prior to the ROX sensor [installation – June 2011], [USGS] used a YSI 5739 and YSI Rapid Pulse DO Probes. All three sensors have the same accuracy according to YSI. [USGS doesn't] have the exact dates that the ROX was installed, but [they] believe it was in the 2011 water year. The frequency of cleaning for the older probes was 2 to 4 weeks depending on season and flow events. Those probes didn't self clean, so during the summer months they usually needed more attention"

It is our suspicion that some, if not all, of these low DO events are related to low flows in the tailrace and backflow or stagnant flows at the USGS monitor. To test this theory, we have planned to collect additional data in the tailrace during July and August of 2014 and compare it with USGS data collected at the same time. We will focus on these warmer summer months when flows are lower and more likely for us to observe any deviations.

DO readings will be collected along a transect starting at the furthest turbine discharge on the west end of the Parr Shoals powerhouse and proceed to the east towards the USGS monitor using a Hydrolab Surveyor 4a with a Hydrolab MS 5 sonde or similar equipment. DO readings will be collected at the mid-depth of the water column from a maximum of 10 sample locations along the transect. Collections will be performed at one hour before sunrise, at sunrise, and one hour after sunrise. Collections will also be coordinated with lower flow events – possibly scheduled for each sampling. We will perform up to eight collections during July and August of 2014 to detect any differences in the transect DO measurements and the USGS data measurements.

The transect data will be compared to the USGS data. We will use figures and tables to display the collected data and patterns in the DO level will be described based on time, flow, and distance from the USGS monitor. We will consolidate this information into a letter report to share with the TWC for review and discussion.