

Prepared in cooperation with Santee Cooper

Bathymetric, Velocity, Streamflow, and Dissolved Oxygen Data on the Pee Dee River near Bostick Boat Landing, Florence County, South Carolina, May–August 2007



Data Series 315

U.S. Department of the Interior
U.S. Geological Survey

Bostick Landing

Cover image. Bostic Landing on the Great Pee Dee River, Florence County, South Carolina, and 2006 USGS Digital Orthoimagery Quarter Quadrangle.

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KEN SALAZAR, Secretary

U.S. Geological Survey

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Conversion Factors

Multiply	By	To obtain
Length		
foot (ft)	0.3048	meter (m)
Flow rate		
foot per second (ft/s)	0.3048	meter per second (m/s)
cubic foot per second (ft ³ /s)	0.02832	cubic meter per second (m ³ /s)

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Concentrations of chemical constituents in water are given in milligrams per liter (mg/L).

Bathymetric, Velocity, Streamflow, and Dissolved Oxygen Data on the Pee Dee River near Bostick Boat Landing, Florence County, South Carolina, May–August 2007

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Introduction

Santee Cooper is planning to construct an electricity generating station in southeastern Florence County near the Kingsburg community. As part of this project, a water-intake structure will be constructed on the Pee Dee River near the Bostick Boat Landing, which is located east of the intersection of State secondary roads S-21-57 and S-21-66 (fig. 1). Velocity, bathymetric, and dissolved oxygen data are needed

to help determine the location for the water-intake structure. The U.S. Geological Survey (USGS), in cooperation with Santee Cooper, collected these data at three different flow regimes during the period of May through August 2007.

Data were collected along 15 transects located at 50-foot intervals starting 400 feet upstream from the boat landing and continuing to 300 feet downstream from the boat landing (fig. 2). All data were geographically referenced using a differentially corrected global positioning system (GPS).

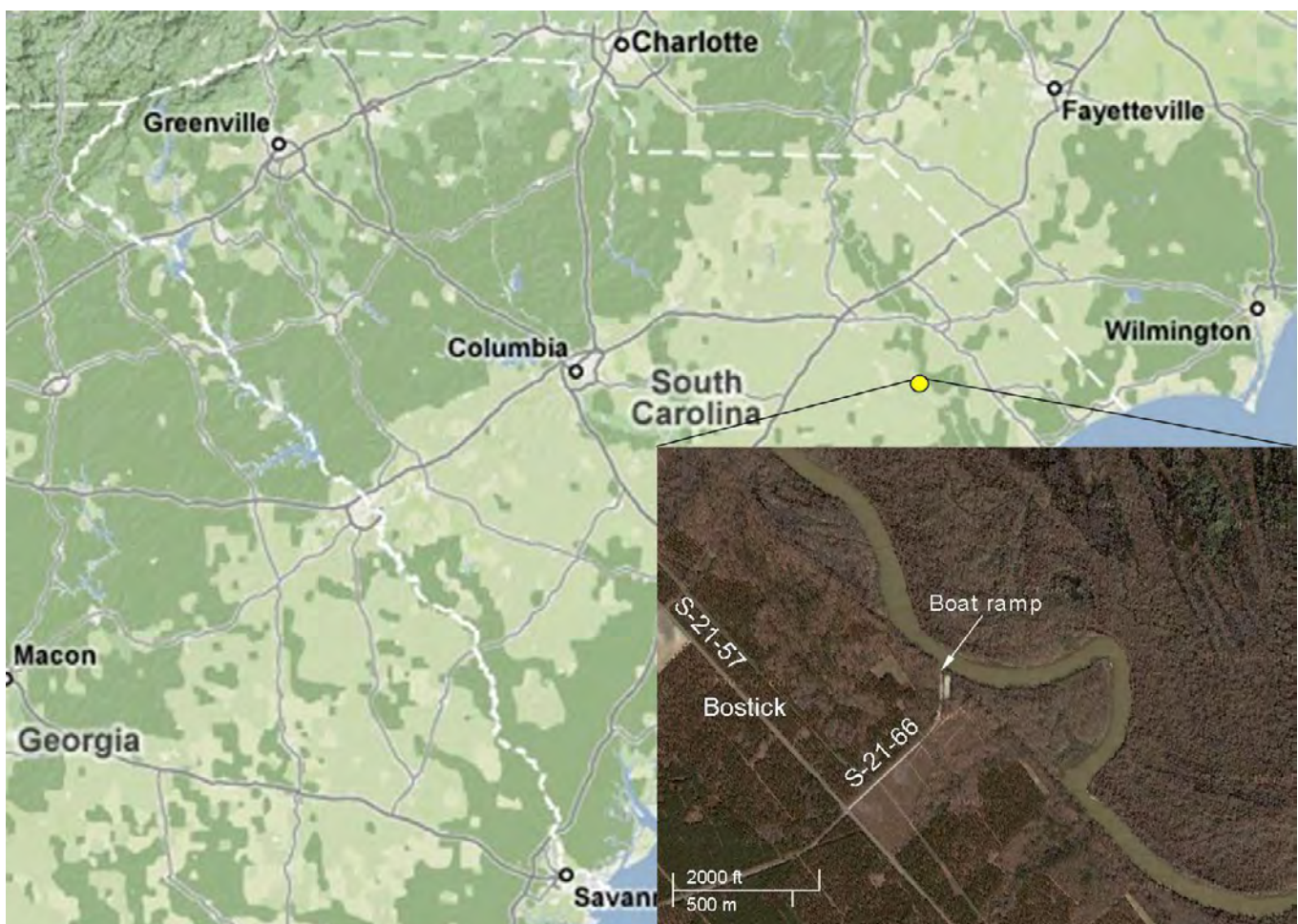


Figure 1. Location of bathymetric, velocity, streamflow, and dissolved oxygen study area on the Pee Dee River near Bostick Boat Landing, Florence County, South Carolina.

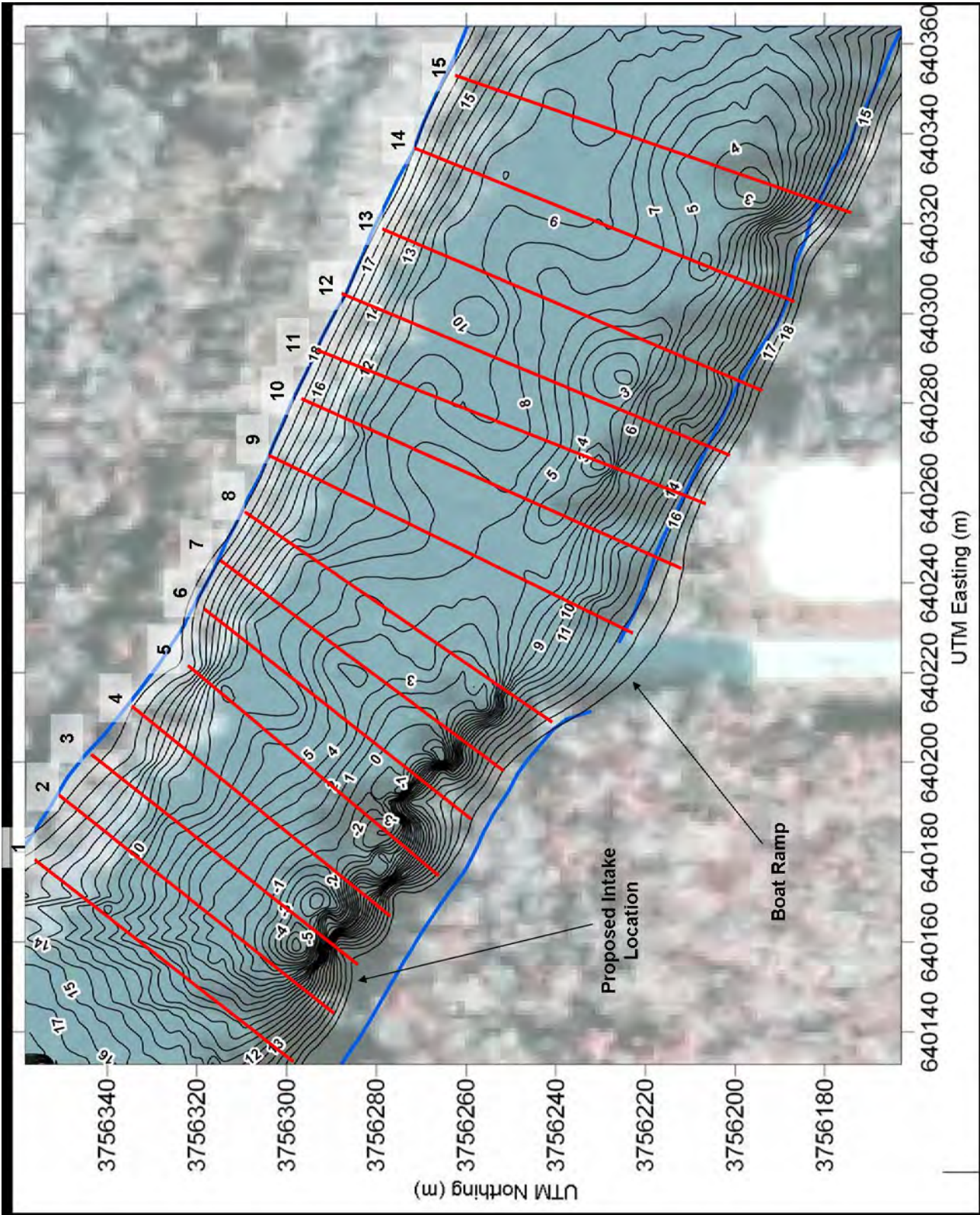


Figure 2. Bathymetry and approximate transect locations on the Pee Dee River near Bostick Boat Landing. Contour lines are in 1-foot intervals and referenced to North American Vertical Datum of 1988. Blue lines indicate approximate "normal" edge of water derived from aerial photography.

Vertical Control

A temporary bench mark was established on April 25, 2007, using differential GPS survey techniques. A reference mark on the concrete curb of the boat landing was established using standard survey leveling techniques (elevation 37.410 ft). A brass tablet reference mark was established by Santee Cooper personnel (elevation 16.377 ft). These reference marks were used to determine water-surface elevations for each of the flow regimes that were measured. Elevations are referenced to the North American Vertical Datum of 1988 (NAVD 88).¹

Bathymetric Data

Bathymetric data were collected on April 25 and May 3, 2007, by interfacing a twelve-channel GPS receiver and data logger to a dual-frequency fathometer. The horizontal coordinates and depth soundings were time tagged and recorded to the data logger. When these data were processed, the depth soundings were assigned a horizontal coordinate by interpolating the time readings from both sets of measurements. The bathymetric map produced from these data depicts 1-ft contour elevations referenced to NAVD 88 (fig. 2). The “0” (zero) contour line represents mean sea level (MSL).

Acoustic Doppler Current Profiler Data

An acoustic Doppler current profiler (ADCP) was used to collect depth, velocity, and streamflow data for the defined study area. Data were collected from a boat using a Teledyne/RD Instruments ADCP. All data were geo-referenced using a differentially corrected GPS in real-time. The ADCP transmits an acoustic pulse through the water column. Each pulse is divided into multiple bins or depth cells. The ADCP continuously transmits these pulses as each transect is navigated. Velocities are computed for each individual depth cell. Because of the frequency of the pulses and the multiple velocity measurements with depth, each transect is composed of hundreds of individual velocity measurements. The velocity data for this study are available upon request from the USGS, but due to the extremely large size of the dataset, are not included in this report.

Data were collected on April 25, May 31, and August 24, 2007. For the purpose of this study, flows on April 25 were classified as “high,” flows on May 31 were classified as “medium,” and flows on August 24 were classified as “low.” Table 1 summarizes the streamflow data collected for the three flow regimes.

The “high” flow streamflow measurements ranged from 11,500 cubic feet per second (ft³/s) to 12,500 ft³/s with a mean of 12,010 ft³/s. The average water-surface elevation for these measurements was 27.04 ft NAVD 88. The water-surface

elevation dropped 0.36 ft during the course of the measurements (4.2 hours). Measured mean velocities ranged from approximately 2 feet per second (ft/s) to 4 ft/s and were generally uniform in direction (fig. 3).

The “medium” flow streamflow measurements ranged from 1,940 ft³/s to 2,250 ft³/s with a mean of 2,080 ft³/s. The average water-surface elevation for these measurements was 13.59 ft NAVD 88. The water-surface elevation rose 0.94 ft during the course of the measurements (4.3 hours). Measured mean velocities ranged from approximately 0.4 ft/s to 2.1 ft/s. Measured velocities were slower with more directional variability in the upper transects (transects 1–8) and then accelerated in the lower transects primarily due to shallower depths (fig. 4).

The “low” flow streamflow measurements ranged from 1,490 ft³/s to 1,620 ft³/s with a mean of 1,560 ft³/s. The average water-surface elevation for these measurements was 12.30 ft NAVD 88. The water-surface elevation dropped 0.04 ft during the course of the measurements (6.5 hours). Measured mean velocities ranged from approximately 0.4 ft/s to 1.7 ft/s. Measured velocities were slower with more directional variability in the upper transects (transects 1–8) and then accelerated in the lower transects primarily due to shallower depths (fig. 5).

Dissolved Oxygen Data

The amount of oxygen that can be dissolved in water is affected by many factors including ambient temperature, atmospheric pressure, and ion activity. Dissolved oxygen (DO) concentrations can be increased in water by atmospheric aeration and photosynthetic activities of aquatic plants; however, DO concentrations also can be decreased by many chemical and biological reactions that depend directly or indirectly on available oxygen.

DO data were collected on April 25–26, May 30, and August 23, 2007. As previously stated, for the purpose of this study, flows on April 25–26 were classified as “high,” flows on May 30 were classified as “medium,” and flows on August 23 were classified as “low.” Table 2 summarizes the DO data collected for the three flow regimes. DO measurements are reported in milligrams per liter (mg/L) and percent saturation. Milligrams per liter is the quantity of oxygen dissolved in 1 liter of water. Percent saturation is the amount of oxygen in a liter of water relative to the total amount of oxygen that the water can hold at that temperature. Occasions of super saturation (greater than 100-percent DO saturation) often are related to excess photosynthetic production of oxygen by aquatic plants as a result of nutrient enrichment, sunlight, and warm water temperatures, which often occur in streams during low-flow conditions.²

¹ NAVD 88 uses one base monument located at Father’s Point, Quebec, Canada, as mean sea level (MSL). All other bench marks in North America are referenced to that one base monument for NAVD 88 elevations.

² Wagner, R.J., Boulger, R.W., Jr., Oblinger, C.J., and Smith, B.A., 2006, Guidelines and standard procedures for continuous water-quality monitors—Station operation, record computation, and data reporting: U.S. Geological Survey Techniques and Methods 1–D3, 51 p. + 8 attachments; accessed November 29, 2007, at <http://pubs.water.usgs.gov/tm1d3>

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Table 1. Streamflow summary of 15 transects for 3 flow regimes.

[ft³/s, cubic feet per second; EST, Eastern Standard Time; NAVD 88, North American Vertical Datum of 1988; ft, feet]

Transect	"High" flow, April 25, 2007		"Medium" flow, May 31, 2007		"Low" flow, August 24, 2007	
	Discharge (ft ³ /s)	Time (EST)	Discharge (ft ³ /s)	Time (EST)	Discharge (ft ³ /s)	Time (EST)
1	11,900	16:07	1,940	10:06	1,550	8:24
2	12,100	15:53	2,100	11:10	1,620	9:44
3	12,000	15:44	2,090	11:23	1,580	10:13
4	11,800	15:33	2,010	11:46	1,580	10:30
5	11,900	15:24	1,960	11:56	1,490	10:45
6	11,900	16:25	1,970	12:06	1,560	11:12
7	11,800	15:10	2,000	12:19	1,570	12:12
8	11,500	14:57	1,970	12:32	1,510	12:25
9	12,100	14:43	2,080	12:58	1,590	13:19
10	12,300	14:30	2,160	13:08	1,600	13:40
11	12,100	14:18	2,160	13:27	1,540	14:29
12	11,800	14:05	2,190	13:40	1,560	14:49
13	12,200	13:37	2,180	13:52	1,550	15:07
14	12,200	13:04	2,150	14:04	1,520	15:22
15	12,500	12:28	2,250	14:15	1,560	15:37
Mean discharge (ft ³ /s)	12,010		2,080		1,560	
Maximum discharge (ft ³ /s)	12,500		2,250		1,620	
Minimum discharge (ft ³ /s)	11,500		1,940		1,490	
Start water-surface elevation (ft) (NAVD 88)	27.22		13.12		12.32	
End water-surface elevation (ft) (NAVD 88)	26.86		14.06		12.28	
Average water-surface elevation (ft) (NAVD 88)	27.04		13.59		12.30	

Table 2. Dissolved oxygen summary of 15 transects for 3 flow regimes.

[mg/L, milligrams per liter]

	"High" flow, April 25–26, 2007		"Medium" flow, May 30, 2007		"Low" flow, August 23, 2007	
	Dissolved oxygen (mg/L)	Dissolved oxygen (percent saturation)	Dissolved oxygen (mg/L)	Dissolved oxygen (percent saturation)	Dissolved oxygen (mg/L)	Dissolved oxygen (percent saturation)
Maximum	6.4	72	8.2	102	10.5	144
Minimum	5.8	63	7.3	89	8.7	117
Mean	6.0	64	7.7	95	9.5	130
Median	6.0	64	7.6	94	9.5	130
Standard deviation	0.08	1.07	0.26	3.73	0.46	6.73

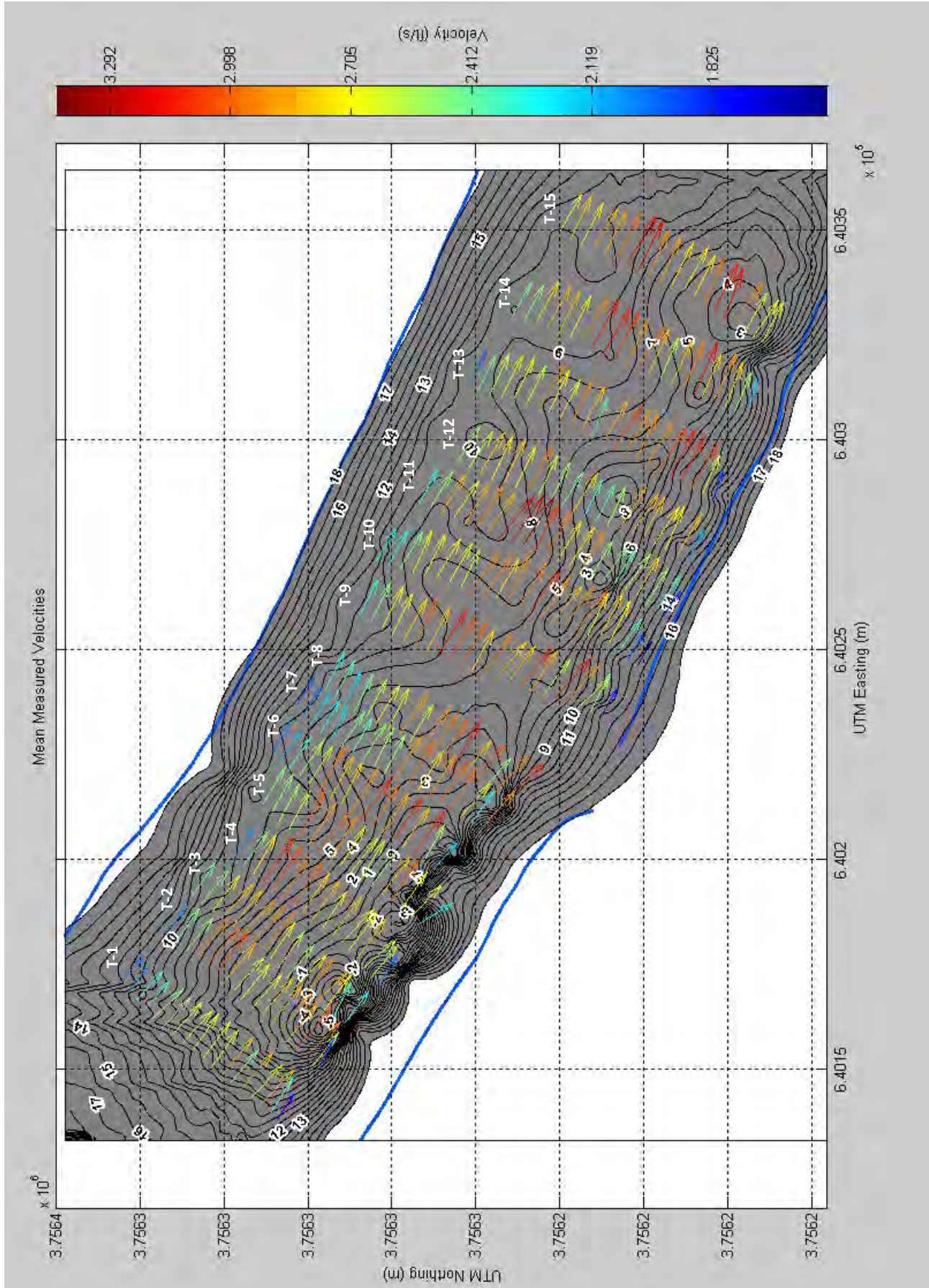


Figure 3. Mean measured velocities for “high” flow, April 25, 2007. Blue lines indicate approximate “normal” edge of water derived from aerial photography.

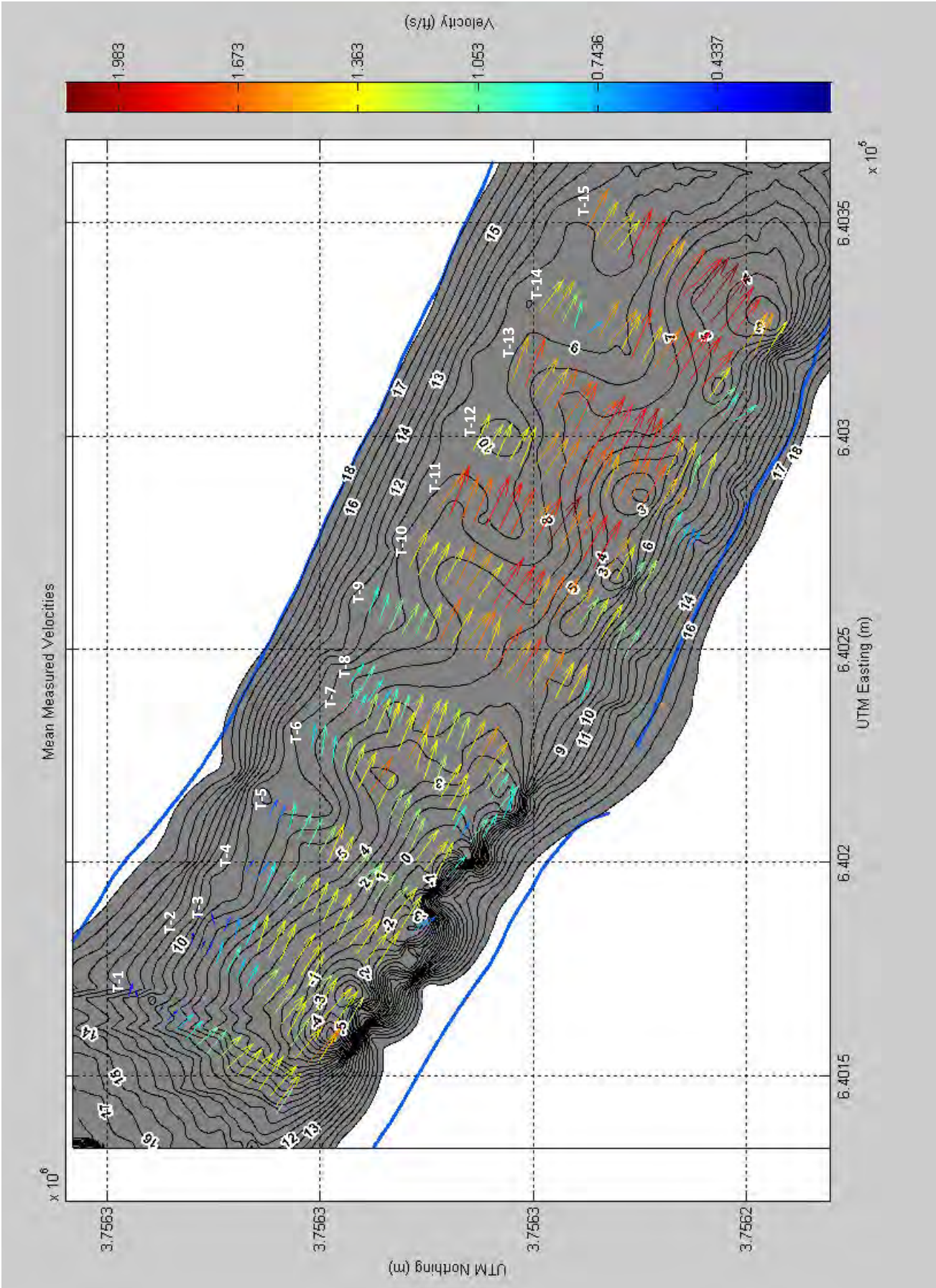


Figure 4. Mean measured velocities for "medium" flow, May 31, 2007. Blue lines indicate approximate "normal" edge of water derived from aerial photography.

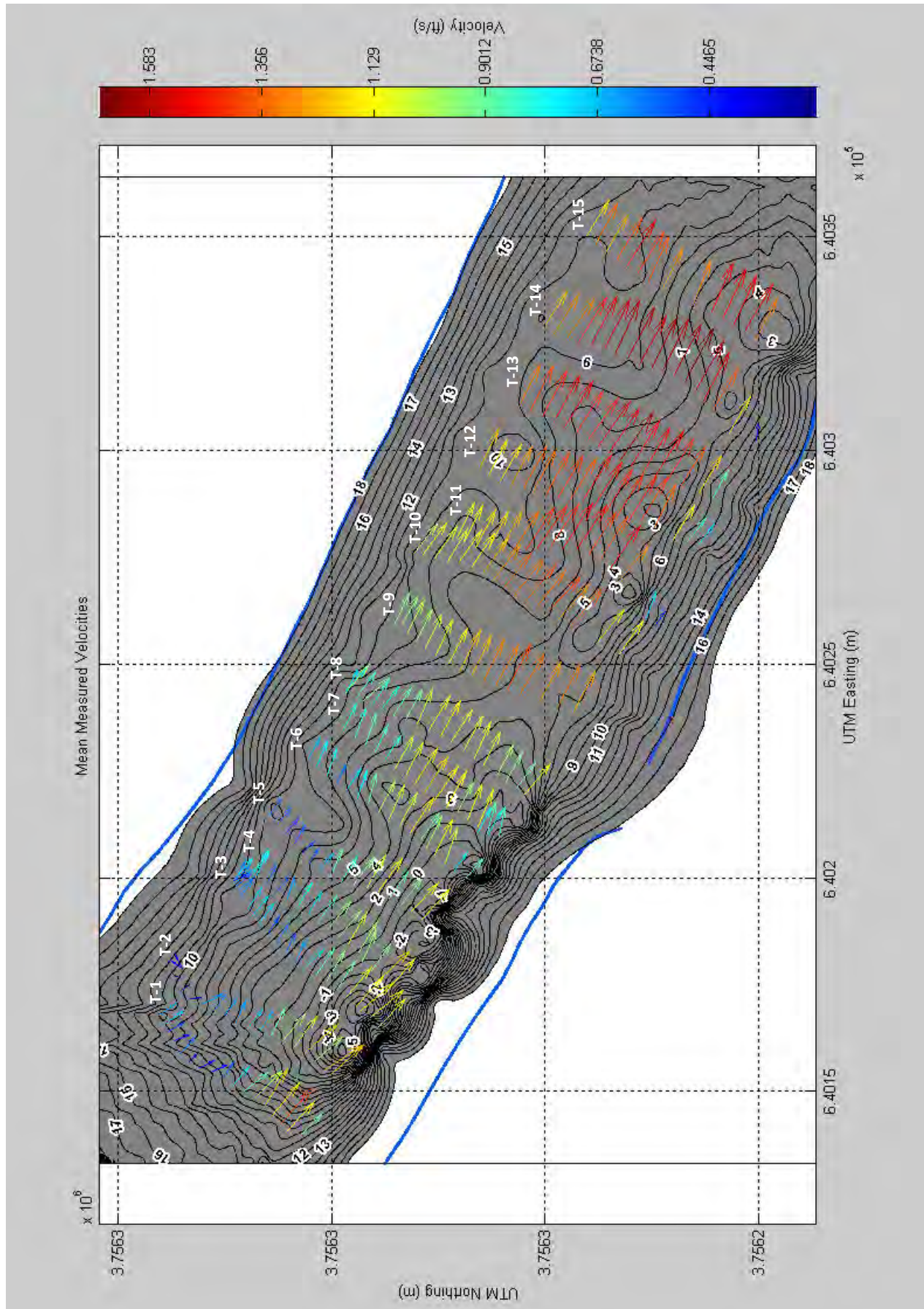


Figure 5. Mean measured velocities for "low" flow, August 24, 2007. Blue lines indicate approximate "normal" edge of water derived from aerial photography.

The “high” flow DO measurements ranged from 5.8 mg/L to 6.4 mg/L with a median of 6.0 mg/L. Due to the length of time involved in making multiple DO measurements in high-flow conditions, the measurements were made over a 2-day period. The average water-surface elevation for these measurements was 26.23 ft NAVD 88. The water-surface elevation dropped 1.98 ft during the course of the measurements (28.0 hours). DO concentrations were consistently stable in both the vertical and lateral of each transect as well as between transects. The spatially consistent DO concentrations indicate a well mixed environment in this flow regime.

The “medium” flow DO measurements ranged from 7.3 mg/L to 8.2 mg/L with a median of 7.6 mg/L. The water-surface elevation for these measurements was approximately 12.96 ft NAVD 88. DO concentrations increased with each transect in the downstream direction. Concentrations on the left side of the river were approximately 2 percent lower than the concentrations mid-channel and near the right bank.³ Increased velocities and increased photosynthetic activities in the shallower depths may account for the higher DO concentrations in the downstream transects.

The “low” flow DO measurements ranged from 8.7 mg/L to 10.5 mg/L with a median of 9.5 mg/L. The average water-surface elevation for these measurements was 11.74 ft NAVD 88. The water-surface elevation dropped 0.09 ft during the course of the measurements (2.25 hours). DO concentrations

increased with each transect in the downstream direction. Increased velocities and increased photosynthetic activities in the shallower depths may account for the higher DO concentrations in the downstream transects.

Summary

Velocity, streamflow, bathymetric, and dissolved oxygen (DO) data were collected along fifteen transects on the Pee Dee River near the Bostick Boat Landing, which is located east of the intersection of State secondary roads S-21-57 and S-21-66 in southeastern Florence County near the Kingsburg community. Velocity, streamflow, and DO data were collected during three flow regimes representing “low,” “medium,” and “high” flow conditions. In “high” flow conditions, measured mean velocities were generally uniform in direction and consistent through all of the transects. In “medium” and “low” flow conditions, velocities were slower with more directional variability in the upper transects and then accelerated in the lower transects primarily due to shallower depths. DO concentrations increased as streamflow decreased in each of the three flow regimes. DO concentrations in the “high” flow regime were spatially consistent. DO concentrations increased with each transect in the downstream direction in the “medium” and “low” flow regimes. The increased concentrations may be the result of increased velocities and increased photosynthetic activities in the shallower depths.

³ Left or right bank is defined relative to the observer facing the downstream direction.

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