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WATER RESOURCES COMMISSION

Report No. 2

A Reconnaissance of the Santee River Estuary, South Carolina

By

T. Ray Cummings

Prepared by
U. S. Geological Survey, Water Resources Division
in cooperation with
South Carolina Water Resources Commission
Columbia, South Carolina
1970

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ABSTRACT

The chemical and physical characteristics of water of the Santee River estuary have been related to tidal conditions and fresh-water inflow, and the suitability of water for use at different locations has been considered. Data obtained during the investigation provide a basis for evaluating some of the effects of a proposed diversion of water from Lake Moultrie to the Santee River.

Under normal conditions, releases of water from Lake Marion to the Santee River estuary are 500 to 600 cfs (cubic feet per second). On several days during April and May 1969, however, flood releases exceeded 40,000 cfs. An estimated 85 percent of the fresh-water inflow moves to the Atlantic Ocean through the North Santee River, because of a channel constriction in the upper reaches of the South Santee River.

A tidal discharge measurement made at mile 5.9 on the North Santee River showed a maximum flow of 18,500 cfs on the ebb tide, and a maximum flow of 18,500 cfs on the flood tide. Maximum average velocity of the water mass was 1.8 fps (feet per second) on the ebb tide, and 1.5 fps on the flood tide. At mile 7.0 on the South Santee River, a tidal discharge measurement showed a maximum flow of 14,500 cfs on the flood tide; on the ebb tide the maximum flow was estimated to be 15,800 cfs. Maximum average velocities of the water mass of the South Santee River were slightly less than on the North Santee River.

Below mile 15, the North Santee River has an estimated volume of 7.8×10^8 cu ft (cubic feet) at mean high tide, and an estimated volume of 5.3×10^8 cu ft at mean low tide. Below mile 15 on the South Santee River, the etimated volumes of water are 6.7×10^8 cu ft at mean high tide and 3.9×10^8 cubic feet at mean low tide.

At high tide, the maximum specific conductance of water at mile 5.0 on both the North and South Santee Rivers was 40,000 to 50,000 micromhos. At low tide at the same locations, the maximum specific conductance was 20,000 to 30,000 micromhos. At mile 12 on both the North and South Santee Rivers, maximum specific conductance values were 10,000 to 20,000 micromhos at high tide and 100 to 200 micromhos at low tide. Although the maximum specific conductance values of the North and South Santee Rivers are within the same range at a given mile point, under average inflow and tidal conditions water of the South Santee River has a slightly greater salinity than water at the same location on the North Santee River.

Under flood conditions in April and May 1969, the Santee River estuary changed from a partially mixed to a highly stratified estuary. As flood waters flushed salt water seaward, fresh-water was observed below mile 5.0 on both the North and South Santee Rivers.

Dissolved oxygen measurements, temperature measurements, and chemical analyses of water indicate that the quality of the water and the variations in quality are due to natural processes; only the occurrence of detergents and pesticides indicate cultural activity.

Water of the North and South Santee Rivers at mile 14 and above is of excellent quality for most domestic, industrial, and agricultural uses, and for the propagation of aquatic life. Below mile 14, water is suitable for many uses, but the suitability of the water must be evaluated with knowledge of the intended use.

INTRODUCTION

Purpose and Scope of the Investigation

This report summarizes the results of a reconnaissance of the Santee River estuary during the period July 1968 to August 1969. The principal purpose of the investigation was to determine the chemical and physical characteristics of the water, to relate if possible these characteristics to tidal conditions and fresh-water inflow, and to evaluate the suitability of the water for use. Data obtained during the investigation provide a basis for evaluating some of the changes that will occur if water from Lake Moultrie, which was formed in 1941 by diverting water from the Santee River, is rediverted to the Santee River in accordance with present plans.

Cooperation

The investigation was part of a cooperative program between the U. S. Geological Survey and the South Carolina Water Resources Commission, Mr. Clair P. Guess, Executive Director. This cooperative program calls for a reconnaissance investigation of one estuary each year until all of South Carolina's major estuaries have been studied. The investigation was under the supervision of John S. Stallings, district chief, U. S. Geological Survey, Columbia, South Carolina.

CHARACTERISTICS OF ESTUARINE WATERS

An estuary has been defined by Pritchard (1967) as a semi-enclosed coastal body of water which has a free connection with the open sea and within which sea water is measurably diluted with fresh water derived from land drainage. In this report, an estuary is considered to extend from the river mouth upstream to that point at which tidal fluctuations no longer affect the water surface elevation of the river.

When sea water and river water mix in an estuary, the body of salt water that results has a composition that reflects the quantity and quality of the waters that mix and the manner in which they mix. Because salt water has a greater density than fresh water, salt water frequently moves inland as a density current along the bottom of a channel, while a less dense fresh water is moving seaward at the surface. At a given location in an estuary, the boundary between salt water in the bottom of a channel and fresh water at the surface may be sharp and well defined, or the boundary may be replaced by a gradual transition from fresh to salt water. Under other conditions, mixing of salt and fresh water may be complete, or nearly so, and the composition of the water may be homogeneous. Because a given circulation pattern tends to predominate in an estuary, estuaries are frequently classed as highly stratified, moderately stratified, or vertically homogeneous.

Many factors determine the nature of an estuary. Tides, currents, fresh-water discharge, sea level, winds, depth and configuration of an estuary, the rotation of the earth, temperature of both sea and river water, evaporation, and amount of rainfall are important. Because of the large number of factors, highly variable conditions occur throughout an estuary. Aquatic life that develops is adaptable to these conditions, and exists in delicate ecological balance.

DESCRIPTION OF THE SANTEE RIVER ESTUARY

Location

Plate 1 is a map of the Santee River estuary showing its location in South Carolina. The Santee River leaves Lake Marion at mile 87.4[1/], flows generally northeast for a few miles, then turns southeast. At about mile 19, the Santee River divides

1/ Santee River mileages are a continuation of the North Santee River mileages.

into the North and South Santee Rivers, which enter the Atlantic Ocean approximately 45 miles northeast of Charleston, S. C., and approximately 17 miles south of Georgetown, S. C. On the south, the Santee and South Santee Rivers are bordered by Berkeley and Charleston Counties; on the north they are bordered by Georgetown, Williamsburg, and Clarendon Counties. The North Santee River lies entirely within Georgetown County. The Intracoastal Waterway, which runs northeast-southwest along the South Carolina coast, crosses the North and South Santee Rivers between miles 5.0 and 6.0.

The Santee River estuary extends inland to a point about half the distance to Lake Marion. Field observations on July 15, 1969, indicated that for conditions prevalent on that day, the farthest upstream point at which there was a tidal effect was about mile 44. The maximum upstream point at which there is a tidal effect has been estimated to be mile 48 (Col. Robert E. Rich, Corps of Engineers, U. S. Army, Charleston, S. C., written commun., 1966).

Swamps border much of the Santee River estuary. Numerous tributaries enter the estuary and many of them are connected with the estuary at more than one location. These tributaries have small drainage areas, and yield only local runoff to the estuary.

Geometry

On May 22 and 23, 1969, bottom profiles of the main channels of the Santee River estuary were made using a recording fathometer, beginning at mile 0.0 on the North Santee River and at mile 1.0 on South Santee River. No profile could be obtained at mile 0.0 on the South Santee River because shallowness at some points made boat passage impossible. Profiles were made at each mile point through mile 19 on the North Santee River, and through mile 15 on the South Santee River. Above mile 15 on the South Santee River, the channel is too narrow, shallow, and filled with heavy vegetation to permit boat passage. Above the junction of the North and South Santee River, profiles were made at two mile intervals, beginning at mile 21 and continuing through mile 29. Above mile 29, the shallow channel prevented use of the fathometer.

Plates 2 and 3 show these profiles as viewed if looking upstream; the water surface elevations are those existing at mean high tide at each location. The profile shown on Plate 3 for mile 0.0 on the South Santee River has been estimated from U. S. Coast and Geodetic Survey charts.

The average depth of the North Santee River is greater than the average depth of the South Santee River; its average width, however, is slightly less. The estimated volume of the North Santee River from mile 0.0 to mile 15 is 7.8×10^8 cubic feet at mean high tide; at mean low tide the estimated volume is 5.3×10^8 cubic feet. The estimated volume of the South Santee River from mile 0.0 to mile 15 is 6.7×10^8 cubic feet at mean high tide; at mean low tide the estimated volume is 3.9×10^8 cubic feet.

North Santee Bay, although several miles long and about 4,000 feet wide at some locations, is very shallow. At high tide, its total volume probably does not exceed one-fourth of that of the North Santee River below mile 15.

TIDAL CONDITIONS

Tidal gages were established at two locations in the Santee River estuary in November and December 1968. One gage was installed at mile 6.6 on the South Santee River, on the left bank, approximately 2,100 feet east of the mouth of Pleasant Creek at latitude 33°09'25", longitude 79°20'05". This station has been assigned the following U. S. Geological Survey number and name: 02-1719.00 South Santee River below Pleasant Creek near McClellanville, S. C. A second gage was installed on the Santee River at mile 37, 200 feet west of U. S. Highway 17A, on the right bank, at latitude 33°18'15", longitude 79°40'45". This station has been assigned the following number and name: 02-1717.00 Santee River near Jamestown, S. C.

South Santee River below Pleasant Creek near McClellanville

The gage established on the South Santee River below Pleasant Creek is located approximately 1,400 feet east of Old Santee Club Wharf, and approximately 900 feet north of Brown Island. At Old Santee Club Wharf, the U. S. Coast and Geodetic Survey measured high and low waters in 1935 (written communication, J. M. Symons, 1968) and established tide planes based on a Charleston, S. C., reference datum. These planes are as follows: mean high water, 4.10 feet; mean tide level, 2.05 feet; and mean low water, 0.00 feet. Brown Island is currently a "subordinate station" of the U. S. Coast and Geodetic Survey. A subordinate station is one at which tide predictions can be obtained by applying established differences to the time and height predictions (or measurements) at a reference station. Tide heights and tide times at the Charleston reference station may be converted to Brown Island heights and times by subtracting 1.1 feet from the Charleston high tide height, subtracting 0.0 feet from the low tide height, adding 20 minutes to the Charleston high tide time, and adding one hour and 27 minutes to the low tide time (U. S. Coast and Geodetic Survey, 1969).

The proximity of Old Santee Club Wharf, Brown Island, and the gage established 2,100 feet east of Pleasant Creek, made it possible to regard time and height of tides to be essentially the same at all three locations, and further, to regard the established relations of height and time between the Brown Island and the Charleston stations as applicable to Old Santee Club Wharf and the gage east of Pleasant Creek. Thus, mean high water and mean low water tide planes, and time and height corrections based on Charleston, are applicable to the gage established east of Pleasant Creek. These relations, however, are appropriate under average conditions, and may not hold on a day to day basis as local climatic effects cause deviations from average conditions.

Height of Tide

The tide gage at South Santee River below Pleasant Creek was operated from November 14, 1968 to August 5, 1969 (Plate 1). Figure 1 shows the percentage of time that a given low or high tide was equaled or exceeded. Tide heights shown are based on the datum of the Charleston tide gage of U. S. Coast and Geodetic Survey.

The highest tide measured at the South Santee gage was 5.7 feet; the lowest tide measured was -1.15 feet. Mean high water at the gage was 4.04 feet; mean low water 0.00 feet. The tide planes agree closely with those found by the U. S. Coast and Geodetic Survey in 1935.

Time of Tide

Data obtained from the gage at South Santee River below Pleasant Creek indicate that on a day-to-day basis, the actual time of occurrence of a high or low tide may be as much as an hour earlier or later than predicted by tide tables of the U. S. Coast and Geodetic Survey. The average high tide at the South Santee gage occurs about 3 minutes later than predicted from data published for the Charleston reference station; the average low tide occurs about 1 minute later than predicted.

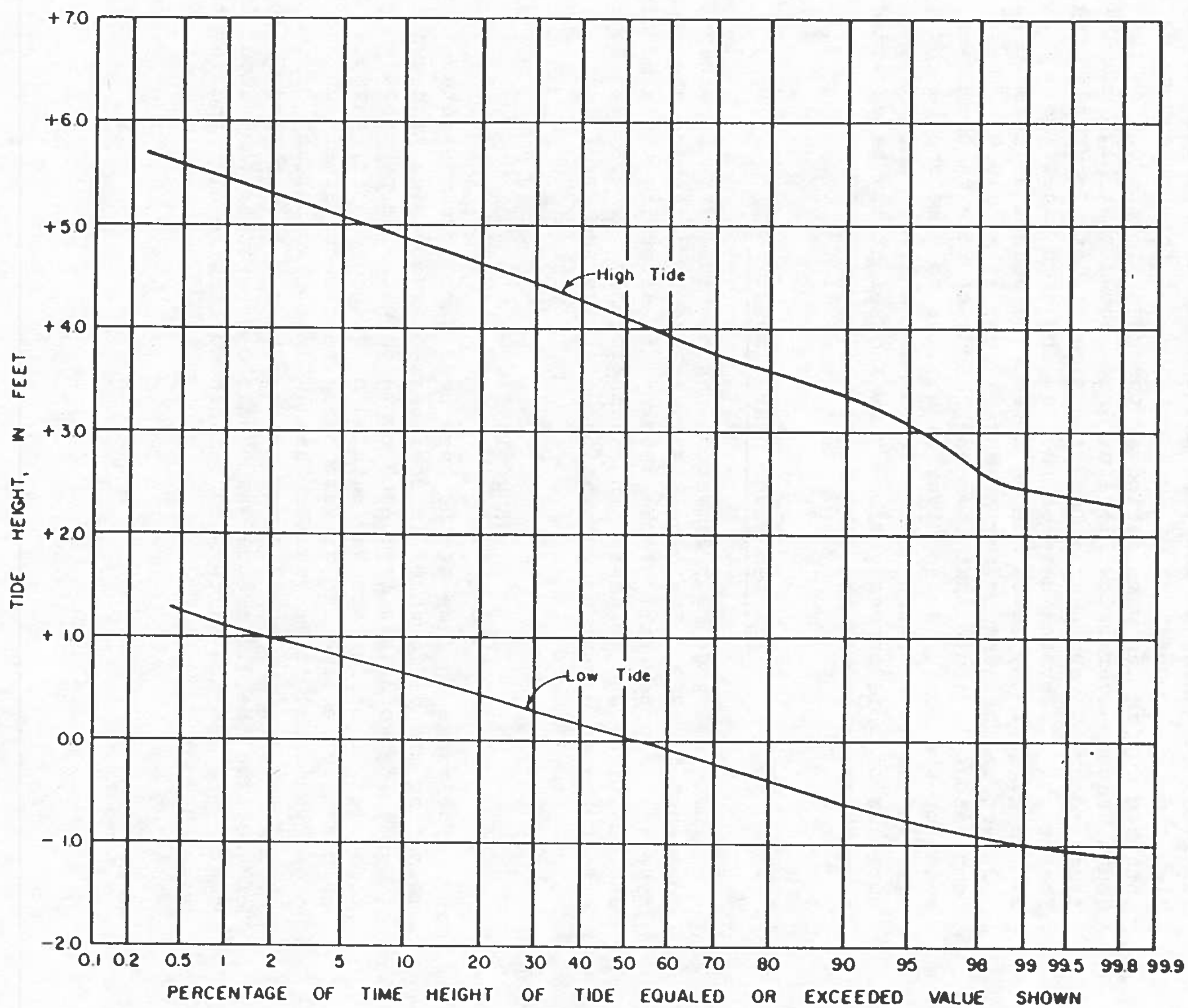


Figure 1.--Frequency curves of height of high and low tides, South Santee River below Pleasant Creek near McClellanville, November 1968 to August 1969.

North Santee River at mile 6.0

On August 3, 1969, a staff gage was installed at mile 6.0 on the North Santee River. The staff gage was read at frequent intervals beginning at low tide and continuing over the subsequent high tide. A comparison of data obtained at this gage with data obtained during the same period at the gage at mile 6.6 on the South Santee River below Pleasant Creek shows that high and low tides occur at very nearly the same time at both locations (fig. 2). The height difference between the low and high tides was 4.5 feet at the gage on the South Santee River; the height difference was 4.3 feet at the gage on North Santee River at mile 6.0. These comparisons indicate that time and height of tide in the lower reach of the North Santee River is similar to time and height of tide in the lower reach of the South Santee River, and for the purposes of this investigation, time and height may be regarded as concurrent and of the same magnitude.

Santee River near Jamestown

The tidal gage near Jamestown was operated from December 5, 1968 to August 5, 1969. The gage was installed to determine the range in tide in the upper part of the estuary, to determine times of high and low tide, and to assist in estimating how far upstream tides effect the water-surface elevation under average conditions.

Range in Tide

The range in tide at the gage near Jamestown was determined by measuring the differences in feet between successive high and low tides. Figure 3 is a frequency curve showing the percentage of time a given difference was equaled or exceeded. For example, 50 percent of the time the difference between successive high and low tides was equal to or greater than 1.1 feet; 10 percent of the time the difference was equal to or greater than 1.5 feet; and 90 percent of the time the difference was equal to or greater than about 0.6 feet. The average difference between successive high and low tides was 1.0 foot.

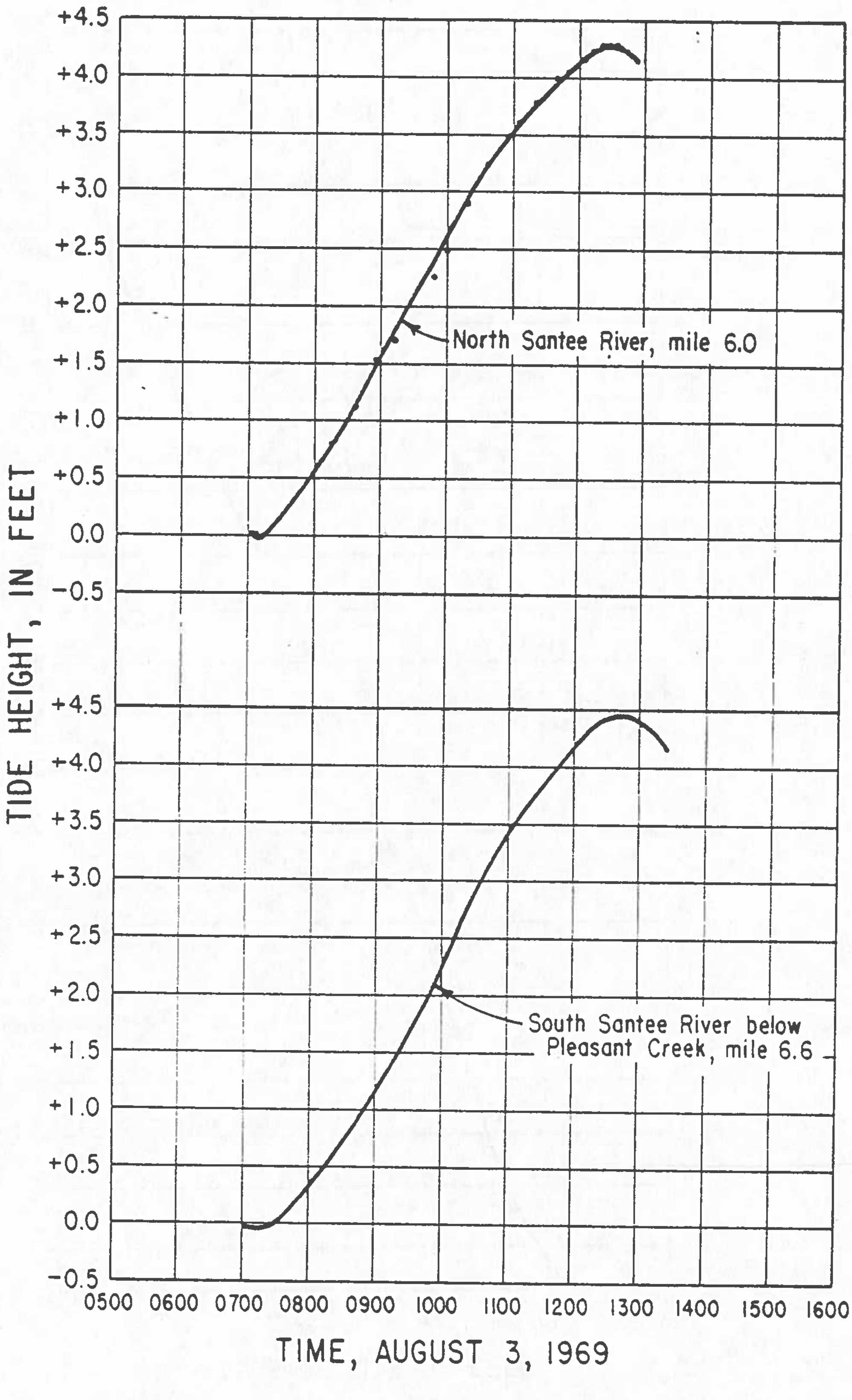


Figure 2.--Relation of high and low tides, North and South Santee Rivers, August 3, 1969.

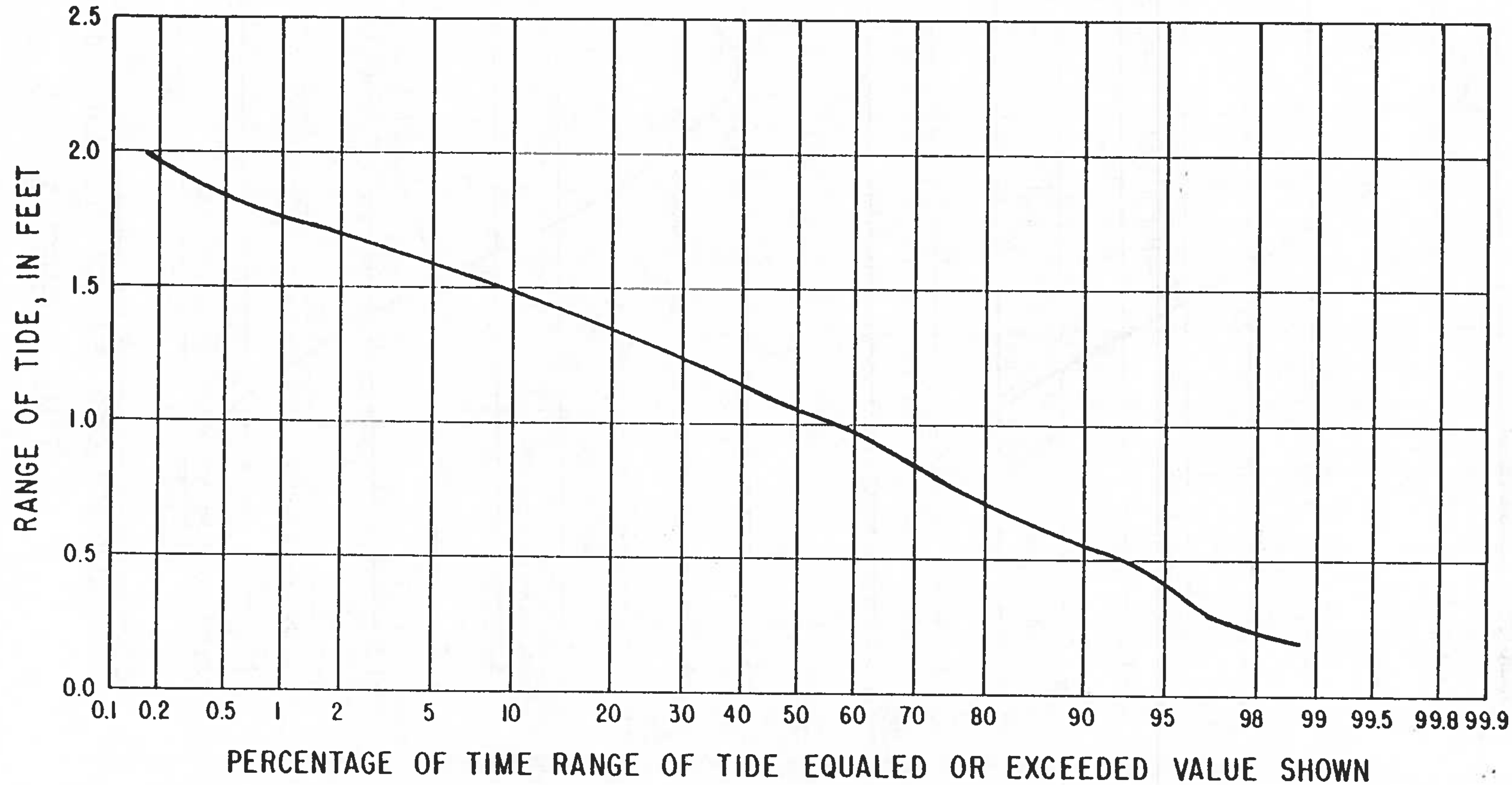


Figure 3.--Frequency curve of range of tide, Santee River near Jamestown, December 1968 to August 1969.

Time of tide relation to

North and South Santee Rivers

The time of tide at the gage at Santee River near Jamestown lags the time of tide in the lower reaches of the estuary by several hours. Based on 24 representative high tides, the time lag between the gage near Jamestown and the gage at South Santee River below Pleasant Creek[1/] (at mile 6.6) ranged from 2 hours 42 minutes to 4 hours 30 minutes. The average time difference was 3 hours 40 minutes. Based on 24 representative low tides, the time ranged from 4 hours 10 minutes to 7 hours 20 minutes. The average time lag for low tide was 5 hours 32 minutes. Because high and low tides on the North Santee River were found to be concurrent with those on the South Santee River at the same mile point, the time comparison is generally applicable to the North Santee River.

Although it is impossible from these data to determine the time of high or low tide at locations between the two gages (because of differences in channel geometry and other factors), high tide seems to occur on an average of about 7 minutes later each successive mile upstream, and low tide an average of about 11 minutes later each successive mile upstream.

North Santee River at Mile 13

On July 29, 1969, time and height of high and low tides were measured at North Santee River at mile 13, and compared to those occurring at the tide gage on the South Santee River. The results were as follows:

Location	Time[2/]		Range of Tide[3/]
	Low Tide	High Tide	(in feet)
South Santee River, mile 6.6	0335	0825	4.1
North Santee River, mile 13	0430	0908	3.9

These data indicate that the time lags cited above (7 minutes per mile at high tide and 11 minutes per mile at low tide) provide a reasonable estimate of times of tides at least as far upstream as mile 13.

1/ The distance between the two gages is 28.8 miles. The distance between the gage near Jamestown and mile 6.6 on the North Santee River is 30.4 miles.

2/ Time cited in this report is Eastern Daylight Time.

3/ Difference between successive high and low tides.

QUANTITY OF FRESH-WATER INFLOW

The quantity of fresh-water inflow to the Santee River estuary is controlled by releases from Lake Marion, which is owned by the State of South Carolina and operated by the South Carolina Public Service Authority. Under the license granted by the Federal Power Commission, a minimum flow of 500 cfs (cubic feet per second) must be released from Lake Marion to the Santee River. Except during periods of floods, discharge to the Santee River usually is between 500 and 600 cfs[1/]. The water is released through a small hydro-electric plant at the south end of the dam. During times of flood, water is spilled to the Santee River through the tainter gates of the dam.

Except during 1959 and 1962, releases from Lake Marion exceeded 40,000 cfs on at least one occasion each year during the 1958 to 1969 period. The maximum release measured at the U. S. Geological Survey's gaging station near Pineville[2/] at mile 85 (2.4 miles downstream from the dam) was 81,800 cfs on October 21, 1965.

Figure 4 shows daily mean discharge of Santee River near Pineville during the period of this investigation. Discharge was less than 600 cfs 85 percent of the time. In April, heavy rains upstream from Lake Marion made it necessary to release flood water on April 16. Releases were increased until on April 20, 21, 22, and 23, daily mean discharges were 40,000 cfs or greater. Thereafter, releases were decreased until April 30, when a normal release schedule was resumed.

1/ After a five year study to find a solution to shoaling in Charleston Harbor, the U. S. Army Corps of Engineers recommended that water be diverted from Lake Moultrie (on the Cooper River) through a canal to the Santee River. Currently, releases from Lake Moultrie to the Cooper River average about 15,000 cfs. After canal construction, flow to the Cooper River would be reduced to an average of about 3,000 cfs; about 12,000 cfs would be diverted to the Santee River at a point near St. Stephen. An increase of 12,000 cfs in fresh-water inflow to the Santee River estuary will probably result in major changes in salinity conditions, and in the ecological balances now existing.

2/ Records from the station, which began operation in April 1942, are published in the U. S. Geological Survey's annual series of basic data reports as 2-1715. Santee River near Pineville. (See selected references.)

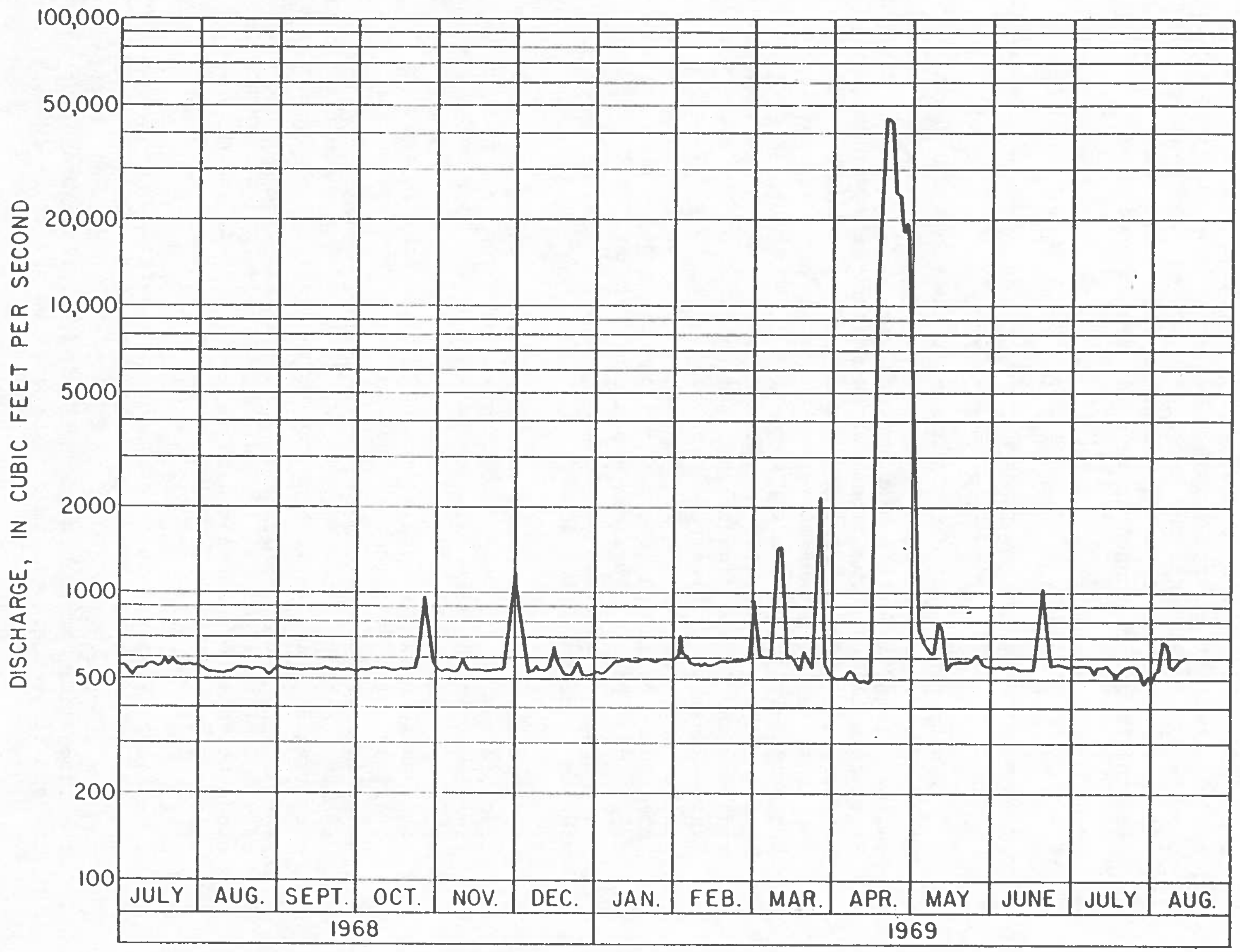


Figure 4.--Daily mean discharge at Santee River near Pineville, July 1968 to August 1969.

Figure 5 shows flood data obtained during April and May at Lake Marion Dam, at the gaging station near Pineville, and at the gaging station near Jamestown. (See table 1.) Several days are required for a large volume of water to move into the estuary, because of the distance the water must travel, and because large releases spread out into the swamps as flow increases, then drain back to the river channel as releases are stopped.

TIDAL DISCHARGE AND VELOCITY

North Santee River

Measurements of tidal discharge of the North and South Santee Rivers were made on five different days during the investigation. (See table 2.) Measurements were made on the North Santee River at mile 5.9. The first series measurements were made on February 12, 1969, approximately one hour prior to low tide. A second series of measurements were made on April 22, 1969, approximately one hour after high tide. The third series was made on June 4, 1969 over a complete tidal cycle. Measurements made on June 4, and tide height data obtained at the gage on South Santee River below Pleasant Creek, are shown in figure 6. A maximum discharge of 18,500 cfs was measured on the flood tide, three hours following low tide and one and a half hours prior to high tide. On the ebb tide, a maximum discharge of 18,500 cfs was measured four hours after high tide and two hours forty-five minutes preceding low tide.

Discharge measurements made on February 12 and April 22 are also plotted on figure 6. Each measurement has been plotted on the figure in the same relation to high or low tide on June 4 as it was related to high or low tide on the day it was made. Although there is no single tide height - discharge relation in an estuary, the fact that the February and April measurements do not differ greatly from those made in June, suggest that the discharge data obtained is representative of discharge conditions occurring at this location on the North Santee River. Discharge data of June 4 were obtained over a tidal cycle having a difference of 4.0 feet between low tide and high tide. This difference is close to that between mean high water (4.1 feet) and mean low water (0.0 feet) at this location in the estuary.

Figure 7 shows the relation of tide height on June 4 to the average velocity of the water mass over the tidal cycle. A maximum average velocity of 1.5 fps (feet per second) occurred on the flood tide; a maximum average velocity of 1.8 fps occurred on the ebb tide. Several times, at points in the cross section,

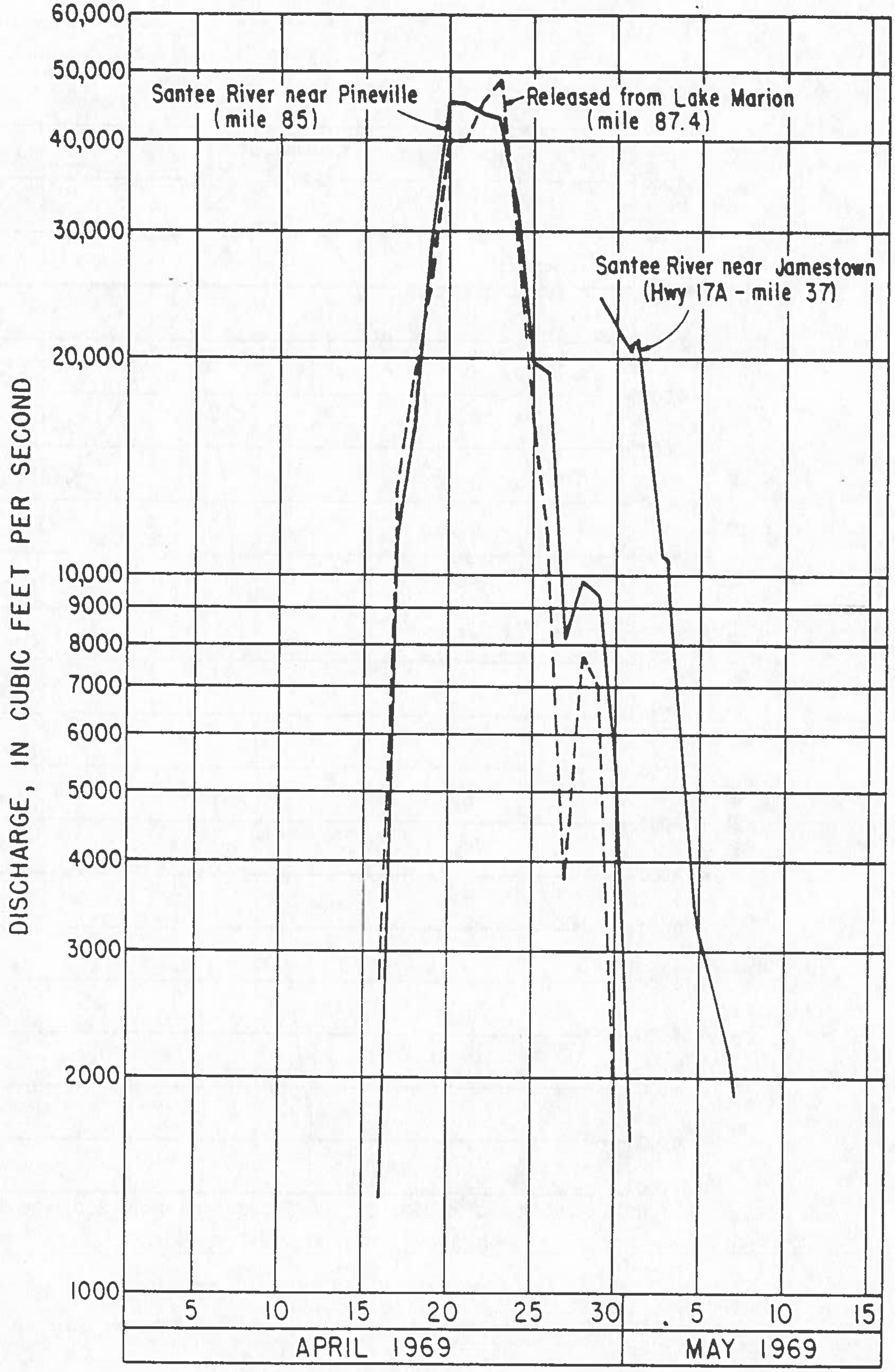


Figure 5.--Flood discharges of Santee River, April and May, 1969.

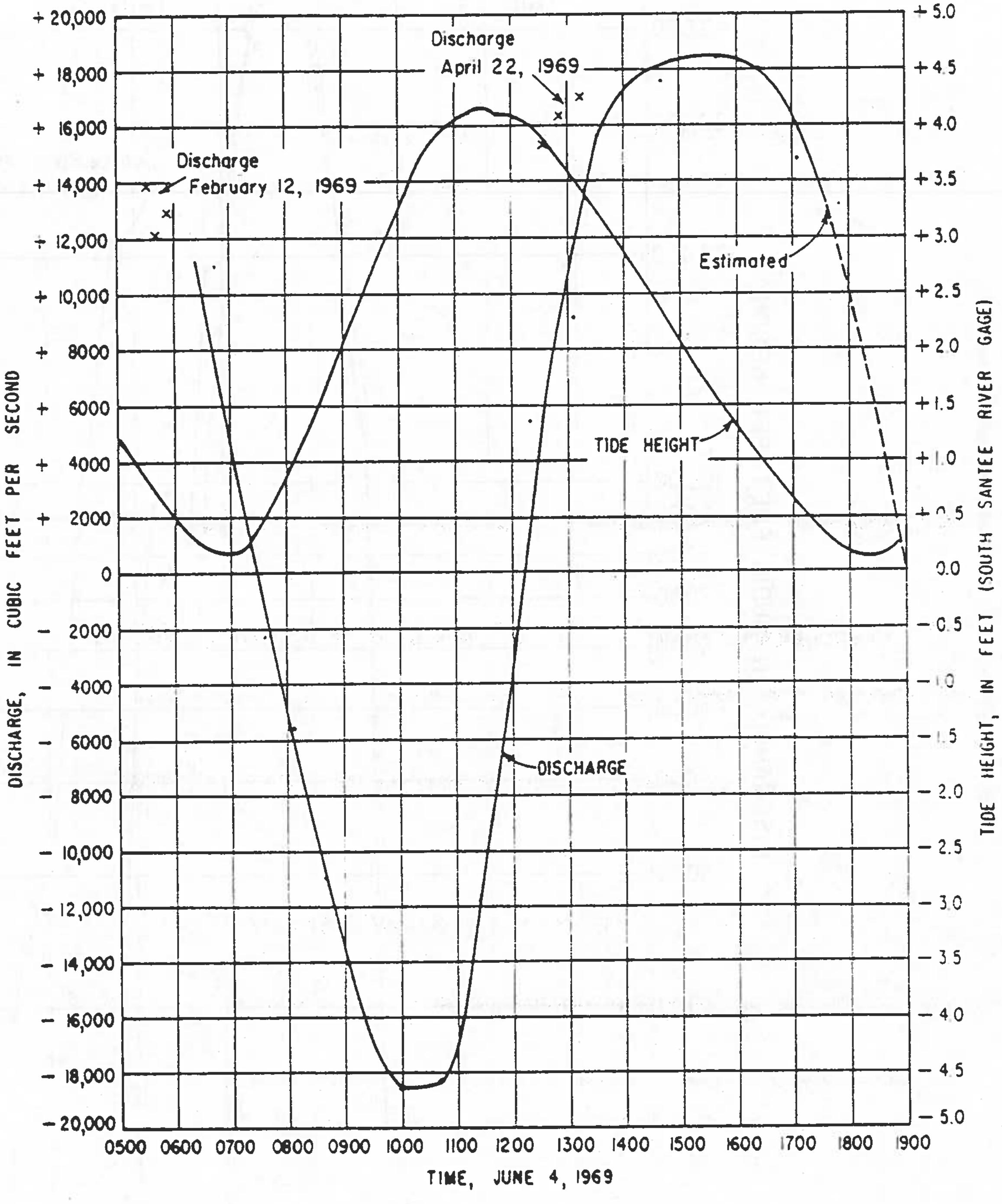


Figure 6.--Discharge during a tidal cycle, North Santee River at mile 5.9, June 4, 1969.

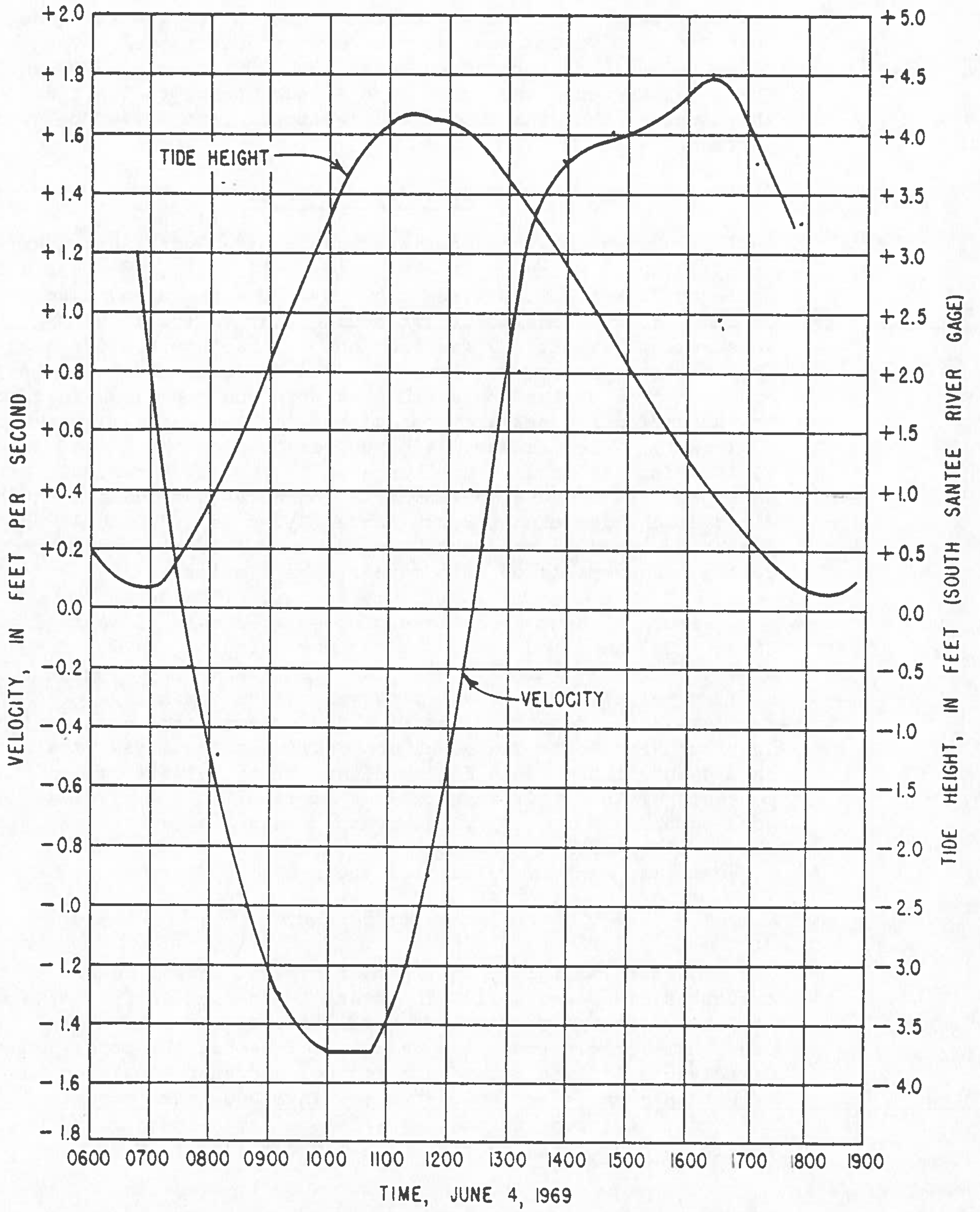


Figure 7.--Average velocity of water mass, North Santee River at mile 5.9, June 4, 1969.

velocity exceeded 2.5 fps. On one occasion, on the ebb tide, a velocity of 3.72 fps was measured near the left bank. Table 3 gives velocity data obtained March 19, 1969 at miles 8.0 and 13. These measurements were made 3 to 4 hours prior to low tide; they suggest that maximum velocities occur 1 to 5 feet below the surface.

South Santee River

Discharge measurements were made on the South Santee River at mile 7.0 on February 13, 1969, April 22, 1969, and over a tidal cycle on June 5, 1969. (See table 2.) The measurement on February 13 was made about two hours prior to low tide; the measurement on April 22 was made about three hours after high tide. These data are shown in figure 8. The difference between low tide and high tide during the measurement of June 5 was 4.0 feet, close to the difference between mean high water and mean low water (4.1 feet). The maximum discharge measured on the flood tide was 14,500 cfs; the maximum discharge on the ebb tide has been estimated as 15,800 cfs. These measurements indicate that maximum ebb and flood discharges of the South Santee River is 2,700 to 4,000 cfs less than those of the North Santee River. Tidal conditions during measurements on both rivers were similar.

Figure 9 shows velocities of the water mass of South Santee River. On the flood tide, the maximum velocity was 1.2 fps; however, a point velocity near the right bank was 2.78 fps. The maximum velocity on the ebb tide was not determined but the data indicate that it was at least 1.4 fps. Comparison of data for the North and South Santee Rivers indicates that less water moves in and out of the South Santee River during a tidal cycle, and movement of the water mass is less rapid. Table 3 gives velocity data obtained March 19, 1969, on the South Santee River at mile 7.0. These data obtained about two and a half hours prior to low tide suggest that maximum velocities occur 1 to 3 feet below the surface.

SALINITY CONDITIONS

The term salinity, in its most general sense, refers to the amount of dissolved solids in water. Most frequently the term is used in reference to highly mineralized salt or sea waters. When used in a formal sense, the term is defined as the total amount of dissolved solids in water in parts per thousand (‰), or the weight in grams of dissolved solids in 1,000 grams of water. In this investigation, salinity was determined by measuring the specific conductance in micromhos per centimeter at 25°C.

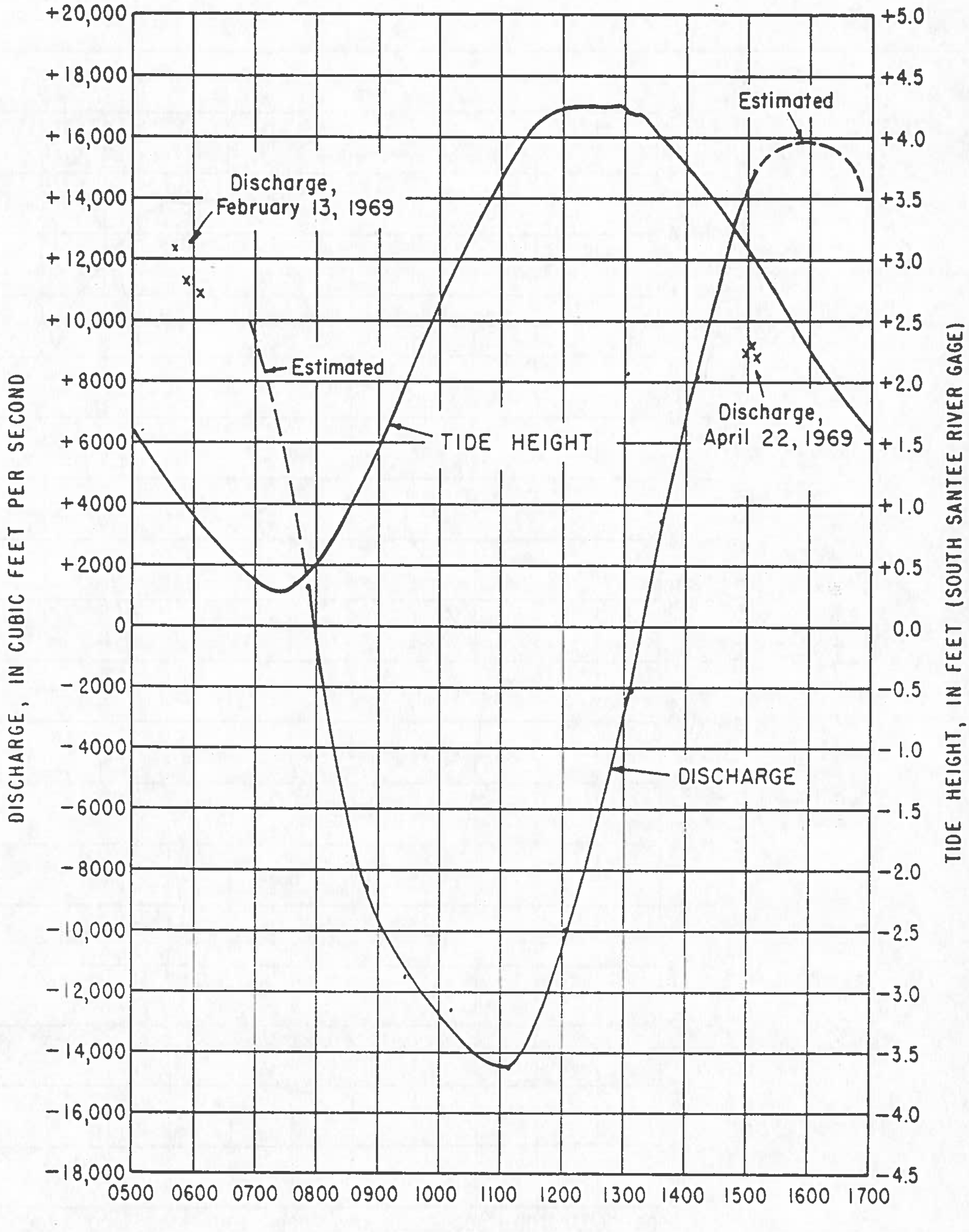


Figure 8.--Discharge during a tidal cycle, South Santee River at mile 7.0, June 5, 1969.

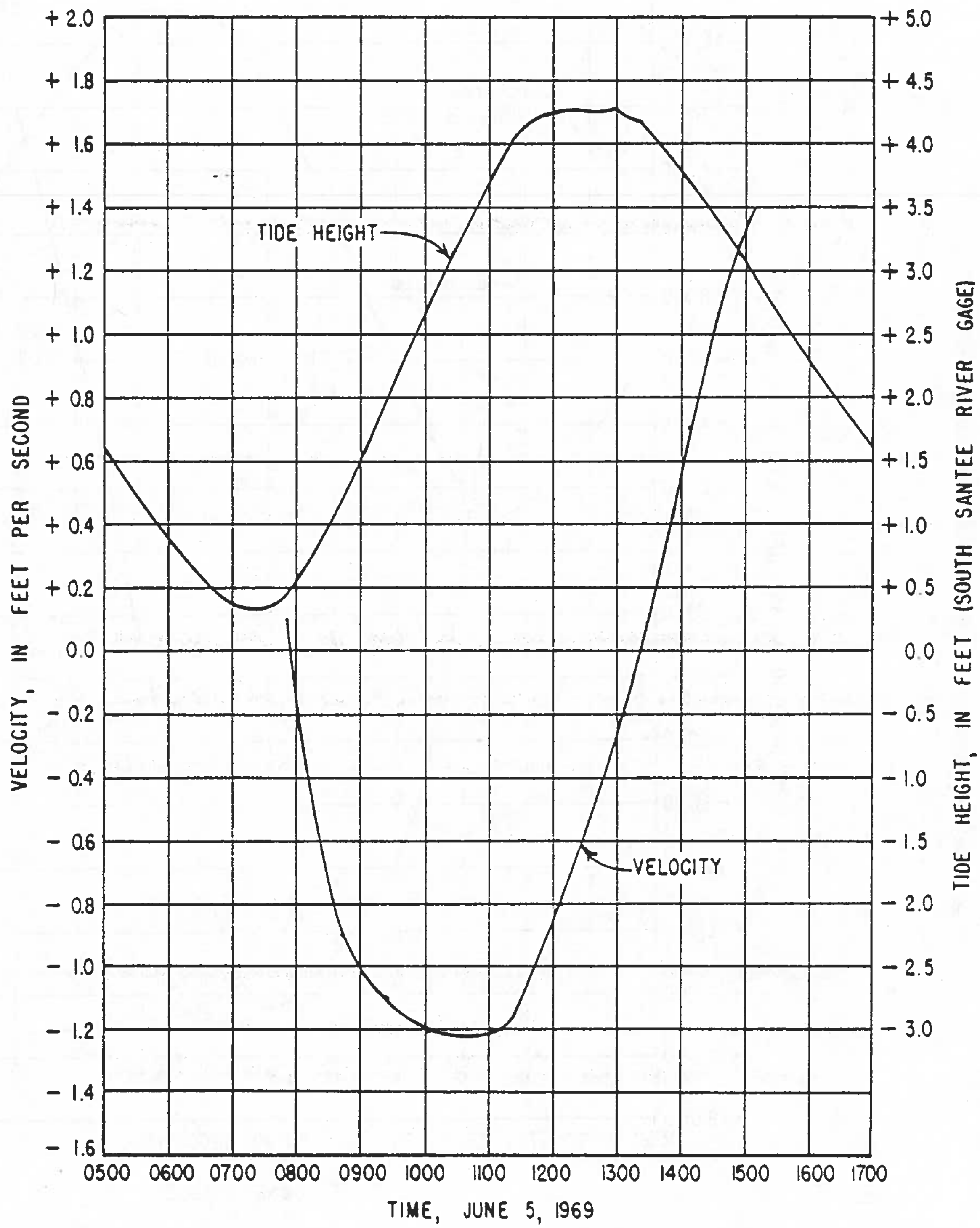


Figure 9.--Average velocity of water mass, South Santee River at mile 7.0, June 5, 1969.

Specific conductance is a measure of the ability of water to conduct an electric current and is related to the amount and type of dissolved solids in solution. Figure 10 shows the relation of salinity in parts per thousand to specific conductance in micromhos at 25°C. Data used in preparing figure 10 are those of Cox (1965).

The U. S. Coast and Geodetic Survey measures salinity and temperature at many locations along the Atlantic Coast. According to the Coast and Geodetic Survey (1965), during the period 1951-62 mean monthly salinity at Myrtle Beach, S. C., ranged from 32.5 ‰ in April to 35.5 ‰ in August. Myrtle Beach is approximately 45 miles northeast of the mouth of the Santee River estuary; salinity values measured at Myrtle Beach probably do not differ appreciably from those just off the coast from the Santee River estuary. Based on the relation given in figure 10, sea water near the mouth of the Santee River estuary probably has a specific conductance that ranges from about 50,000 to about 54,000 micromhos.

During this investigation periodic measurements of salinity, temperature, and dissolved oxygen were made usually at one mile intervals on both the North and South Santee Rivers, and on the Santee River. The reach in which most of the measurements were made extended from salt water to fresh water. Most measurements were made at either high or low tide. At each mile point where a measurement was made, salinity was determined from surface to bottom, usually at two-foot intervals. Data obtained are given in tables 4 and 5.

Relation of Specific Conductance to Height of Tide

During normal flow conditions, the specific conductance of water in the lower reach of an estuary generally is related to the height of tide. Figure 11 shows the relation of specific conductance to tide height at miles 6.0, 8.0, and 9.0 and 13 on the North Santee River. All of the specific conductance measurements used in preparing figure 11 were obtained when flow at the gage at Santee River near Pineville was in the range 520 to 624 cfs. No exact relation is evident from the data obtained; it is evident, however, that the higher the high or low tide, the greater specific conductance tends to be at a mile point.

Figure 12 shows the relation between specific conductance and height of tide for the South Santee River at miles 6.0, 8.0, 9.0 and 13. Flow at Santee River near Pineville ranged from 530 to 1060 cfs at the times the specific conductance measurements were made. Higher tides probably would cause higher specific conductance values at each of these mile points.

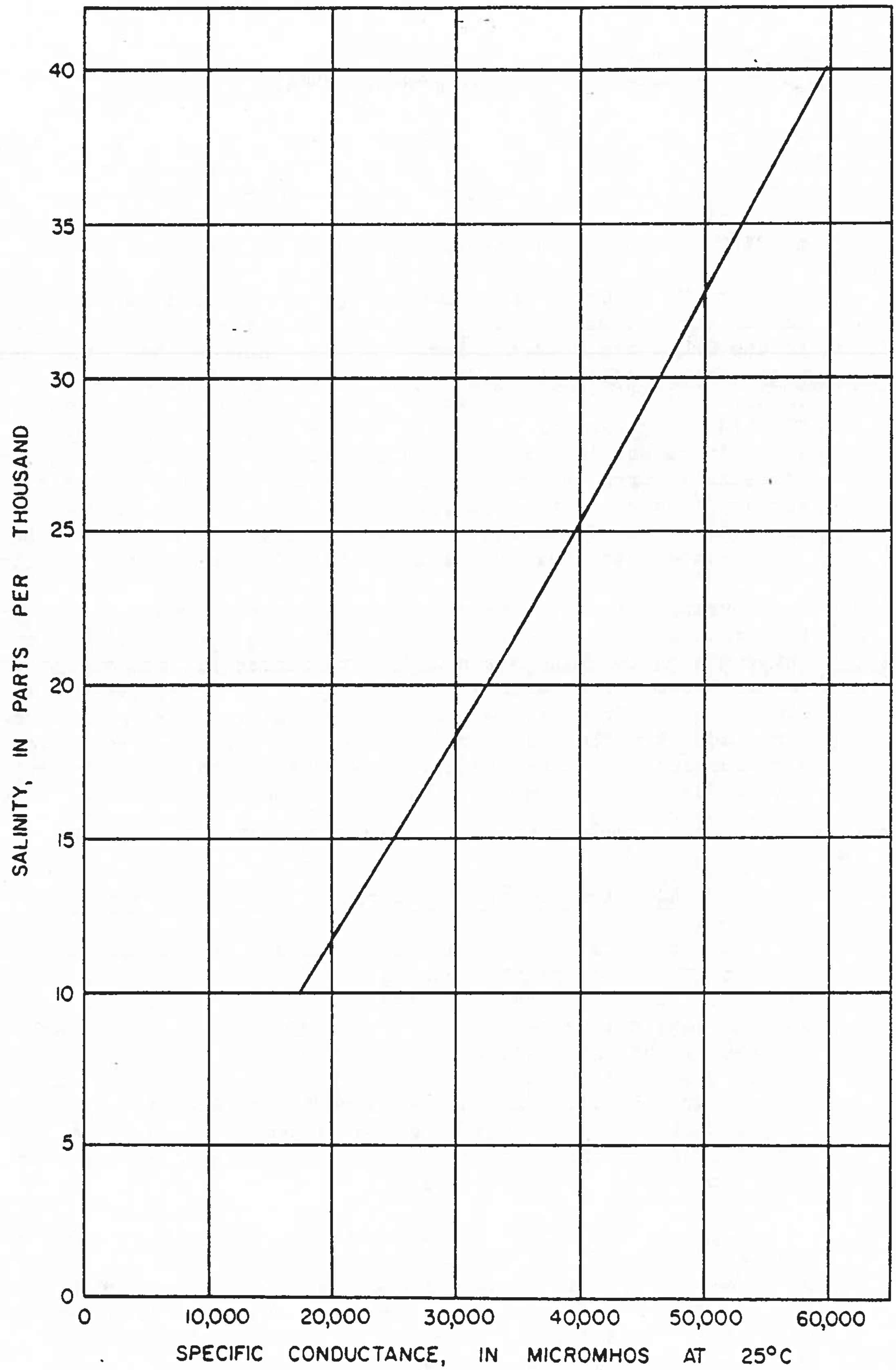


Figure 10.--Relation between salinity and specific conductance at 25°C (Data from Cox, 1965).

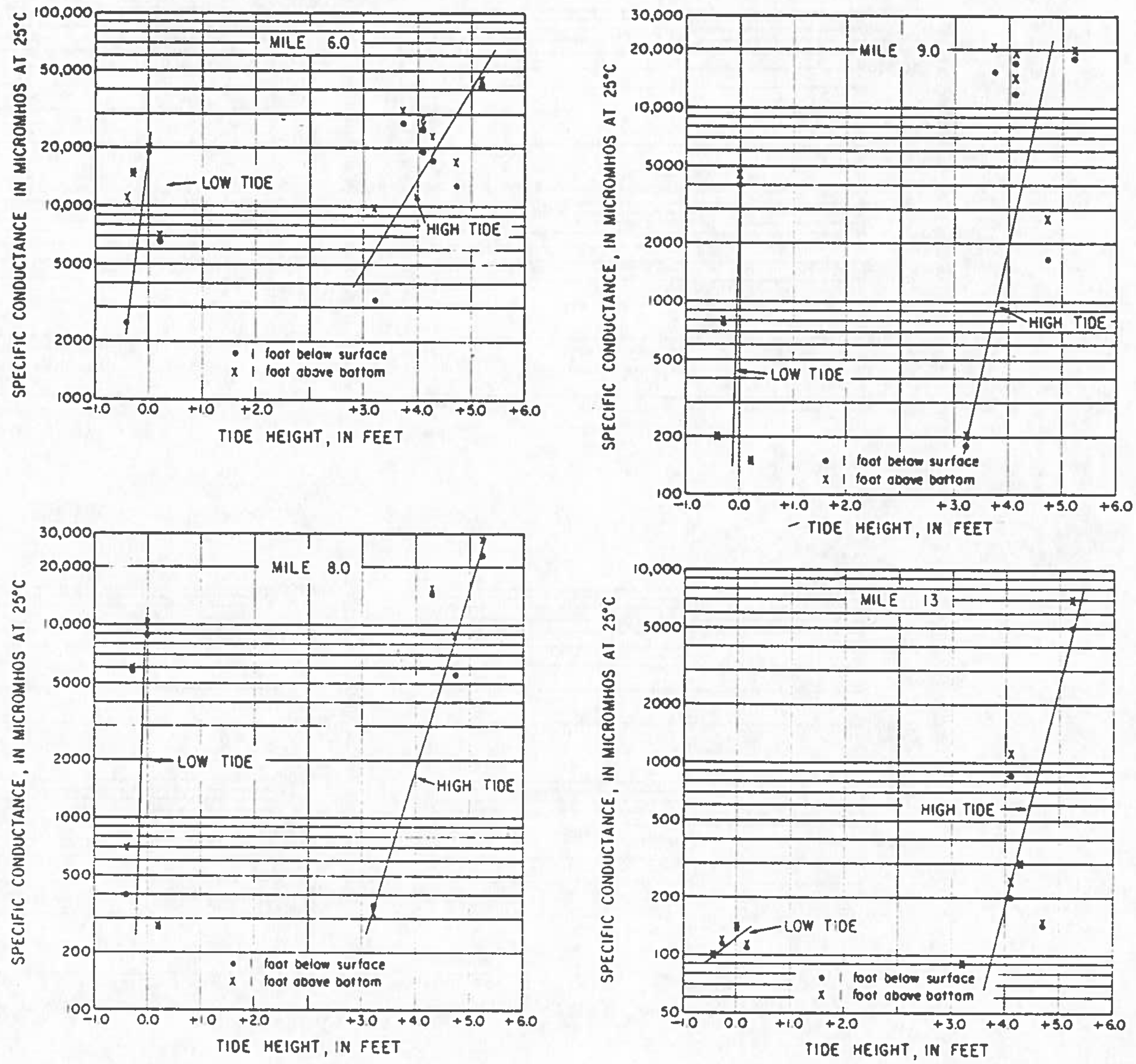


Figure 11.--Relation of specific conductance to tide height, North Santee River at miles 6.0, 8.0, 9.0, and 13.

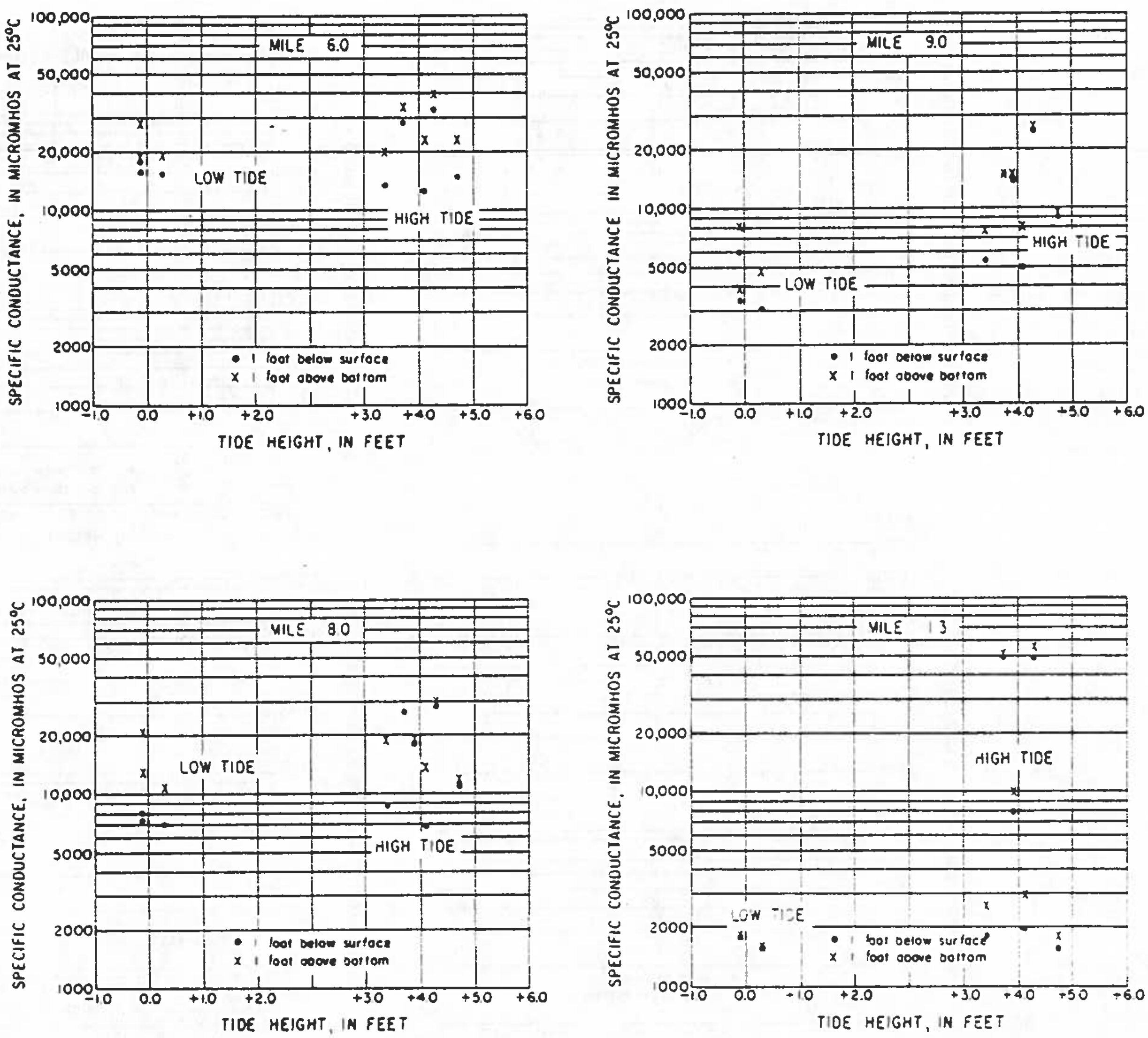


Figure 12.--Relation of specific conductance to tide height, South Santee River, at miles 6.0, 8.0, 9.0, and 13.

To better define relations that exist, much additional information would be required, particularly that which can be obtained only during unpredictable tidal conditions.[1/]

Range in Specific Conductance at Mile Points

Figures 13 and 14 show the range in specific conductance values at mile points 5.0 through 14 at high and low tides on both the North and South Santee Rivers. All specific conductance data obtained during the investigation were used in preparing the figures, with the exception of data obtained during the flood of April and May. If measurements of specific conductance were not obtained at a mile point, data for the point were estimated and used in preparation of the figure.

1/ On October 15, 1969, after this investigation had been completed, a storm off the South Carolina coast resulted in a tide 1.8 feet above mean high water at Charleston. At the gage on the South Santee River, assuming standard corrections apply, the tide was 5.9 feet, approximately 0.2 feet higher than any tide measured at the gage during the investigation, and 0.7 feet higher than any tidal condition at which salinity measurements were made. Fortunately, U. S. Geological Survey personnel were in the area and were able to make salinity measurements at high tide from U. S. Highway 17A bridge on both the North and South Santee Rivers. On the South Santee River the bridge crosses the river at mile 11.3, and on the North Santee River at mile 13.3. At the bridge on the South Santee River specific conductance was 19,000 micromhos seven feet below the surface, about two and a half times as great as was measured at mile 11 during the investigation. At the bridge on the North Santee River, specific conductance was 7,000 micromhos one foot below the surface, about 1,000 micromhos greater than was measured at this depth at mile 13 during the investigation. It was impossible to measure specific conductance throughout the vertical because of the height of the bridge. Thus, water near the bottom may have had a much higher specific conductance.

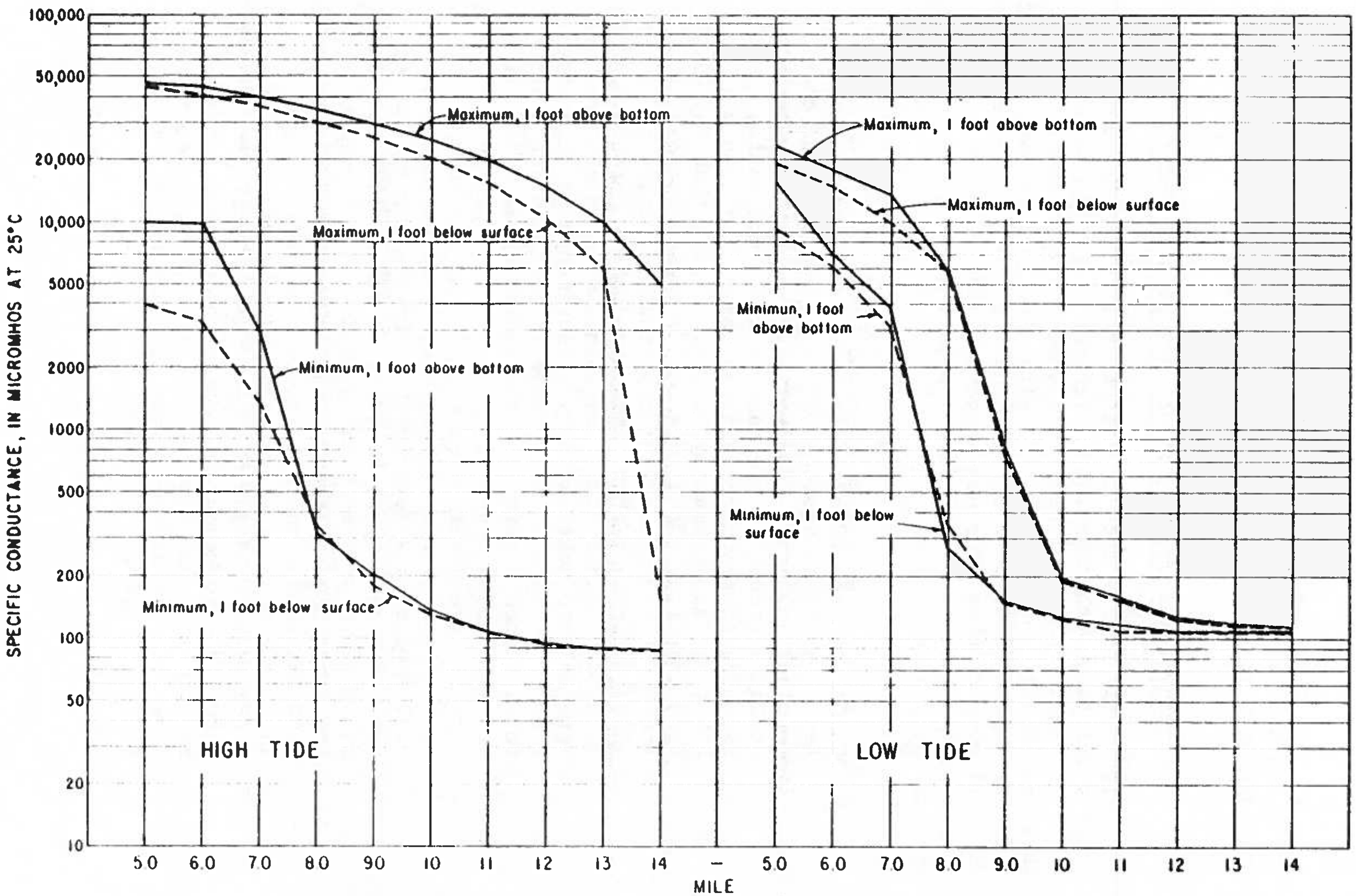


Figure 13.--Maximum and minimum specific conductance values at high and low tide, North Santee River.

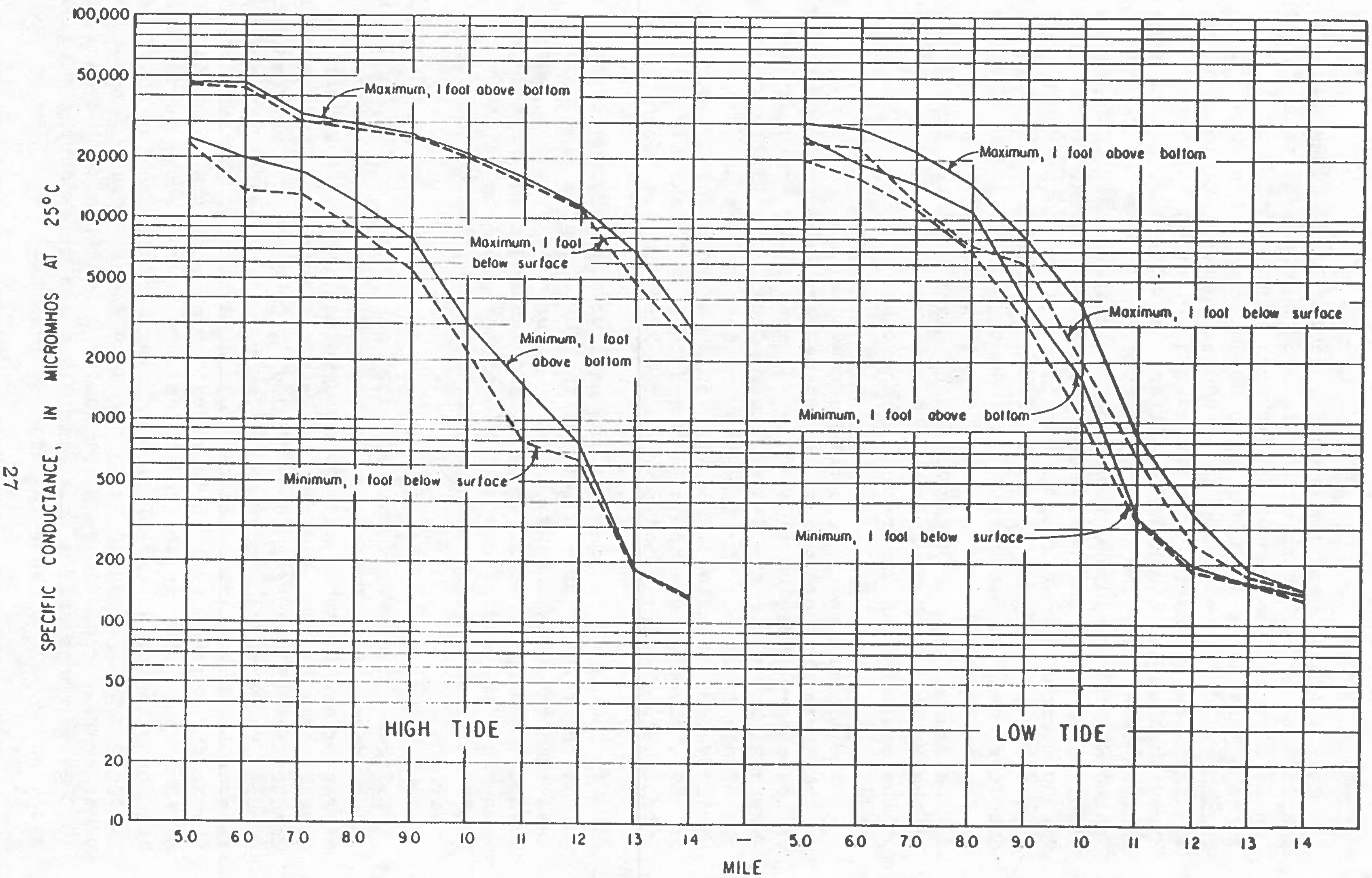


Figure 14.--Maximum and minimum specific conductance values at high and low tide, South Santee River.

At high tide, maximum specific conductance values were similar at corresponding mile points on both the North and South Santee Rivers. Maximum values at high tide at mile 5.0 on both streams were between 40,000 to 50,000 micromhos. At mile 12, maximum values were 10,000 to 15,000 micromhos. Minimum values at high tide, however, were considerably less on the North Santee River than on the South Santee River. At mile 5.0 on both streams, minimum observed values one foot above the bottom on the North Santee River were 10,000 micromhos or less; on the South Santee River the minimum observed value one foot above the bottom were 25,000 micromhos. At mile 12, minimum values on the South Santee River at high tide were between 600 and 800 micromhos, but less than 100 micromhos on the North Santee River. Because an estimated 85 percent of the flow of the Santee River flows to the ocean through the North Santee River channel, the salinity of the North Santee River would be expected to be less than that of the South Santee River much of the time.

The minimum specific conductance values observed at mile 5.0 on the North Santee River at high tide were less than the minimum values observed at low tide. The Waccamaw River which enters Winyah Bay north of the Santee River estuary was in flood during the middle of June - the time when minimum values at high tide were observed at mile 5.0 on the North Santee River. A portion of these flood waters may have moved through Winyah Bay into the Intracoastal Waterway and reached the North Santee River.

At low tide both maximum and minimum specific conductance values observed at mile points on the North Santee River are less than those on the South Santee River. At mile 5.0, for example, maximum specific conductance values ranged from 30,200 micromhos (one foot above bottom) on the South Santee River to 23,600 micromhos (one foot above bottom) on the North Santee River.

Figure 15 shows average salinity conditions at high and low tides under normal inflow conditions. Figure 15 was prepared by averaging measurements made at mile points in both the North and South Santee Rivers, and then estimating the points where specific conductance values of 20,000, 10,000, 1,000, and 200 micromhos occur. The data show that the salinity of the South Santee River is greater between mile points 5.0 and 14 than in the same reach on the North Santee River, which probably reflects the fact that less of the fresh water inflow to the estuary moves to the ocean through the South Santee River. This also results in a greater shift of a water mass of a given salinity during a tidal cycle. For example, under average conditions, water having a specific conductance of 10,000 micromhos shifts approximately three miles during a tidal cycle on the North Santee River, but less than two miles on the South Santee River.

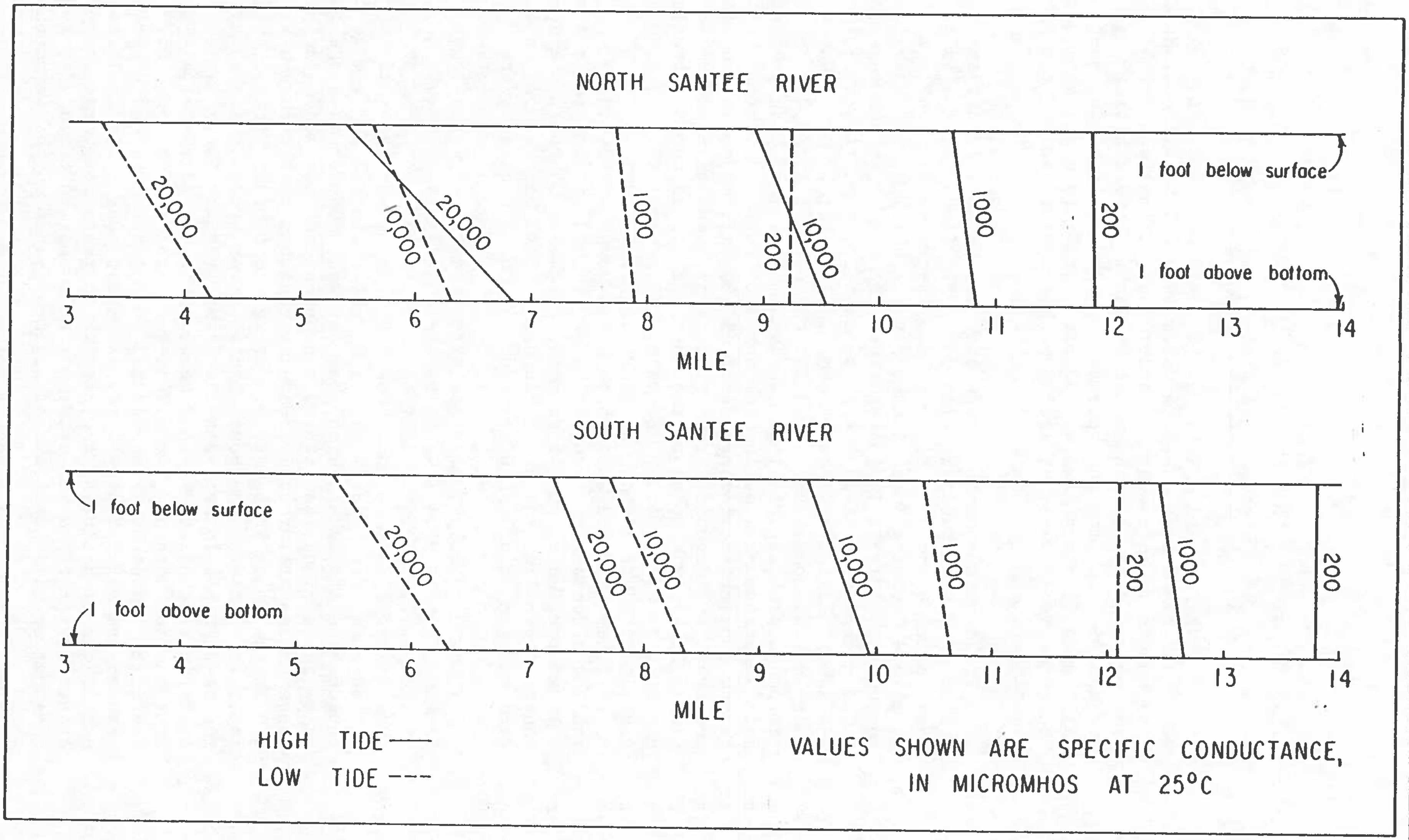


Figure 15.--Average salinity conditions at high and low tide, North and South Santee Rivers.

Flood of April and May, 1969

During the period April 16 to April 30, 1969, approximately 272 x 10^8 cubic feet of flood water were released from Lake Marion. This amount is equivalent to about twenty times the estimated high-tide volume of the North and South Santee Rivers between miles 0.0 and 15. The maximum release occurred on April 23, when the daily mean discharge was 48,600 cfs. After releases were terminated, about two weeks were required for the major effect of the flood to diminish.

Field measurements of specific conductance to determine the effect of flood releases began on April 23 and terminated on May 8. (See tables 6 and 7). Figures 16 illustrates changes in salinity at mile 4.0 on the North Santee River. Until May 4, specific conductance at mile 4.0 on the North Santee River was less than 1,000 micromhos at high tide; at low tide, specific conductance at the same location did not exceed 1,000 micromhos until May 8. Under normal conditions, specific conductance is 20,000 to 40,000 micromhos at this location. The maximum seaward displacement of salt water occurred during the April 25 to May 2 period. Water having a specific conductance of 100-200 micromhos, which under average low tide conditions is found at about mile 12 on the North Santee River, was moved to the mouth of the estuary. At mile 0.0 on April 30 at low tide, the water had a vertically uniform specific conductance of 125 micromhos. Although the relative proportions of flood water that moved down each of the North Santee and South Santee River cannot be determined, it is probable that a large portion of the water moved to the sea through the North Santee River (and through North Santee Bay) because of the channel constriction at miles 16 to 17 on the South Santee River.

Figure 17 illustrates salinity conditions on the South Santee River at mile 4.0 during the flood. At mile 4.0, a minimum specific conductance of 132 micromhos occurred at low tide on April 30. Although no high tide measurements of specific conductance were made at mile 4.0 prior to April 30, specific conductance at high tide on that day was 280 micromhos one foot below the surface, and 12,200 micromhos one foot above the bottom. These values are probably near the minimums that occurred at mile 4.0 on the South Santee River during the flood. Much of the fresh water that entered the South Santee River probably did so by moving down the Intracoastal Waterway from the North Santee River. Specific conductance was not measured in the Intracoastal Waterway between the North and South Santee Rivers, but on April 25, specific conductance was measured in the reach of the waterway between the North Santee River and Winyah Bay. Figure 18 is a map of the area showing the results of these measurements. The effect of the flood was evident throughout the reach. Approximately one-quarter mile northeast of Kinlock Island on the Intracoastal

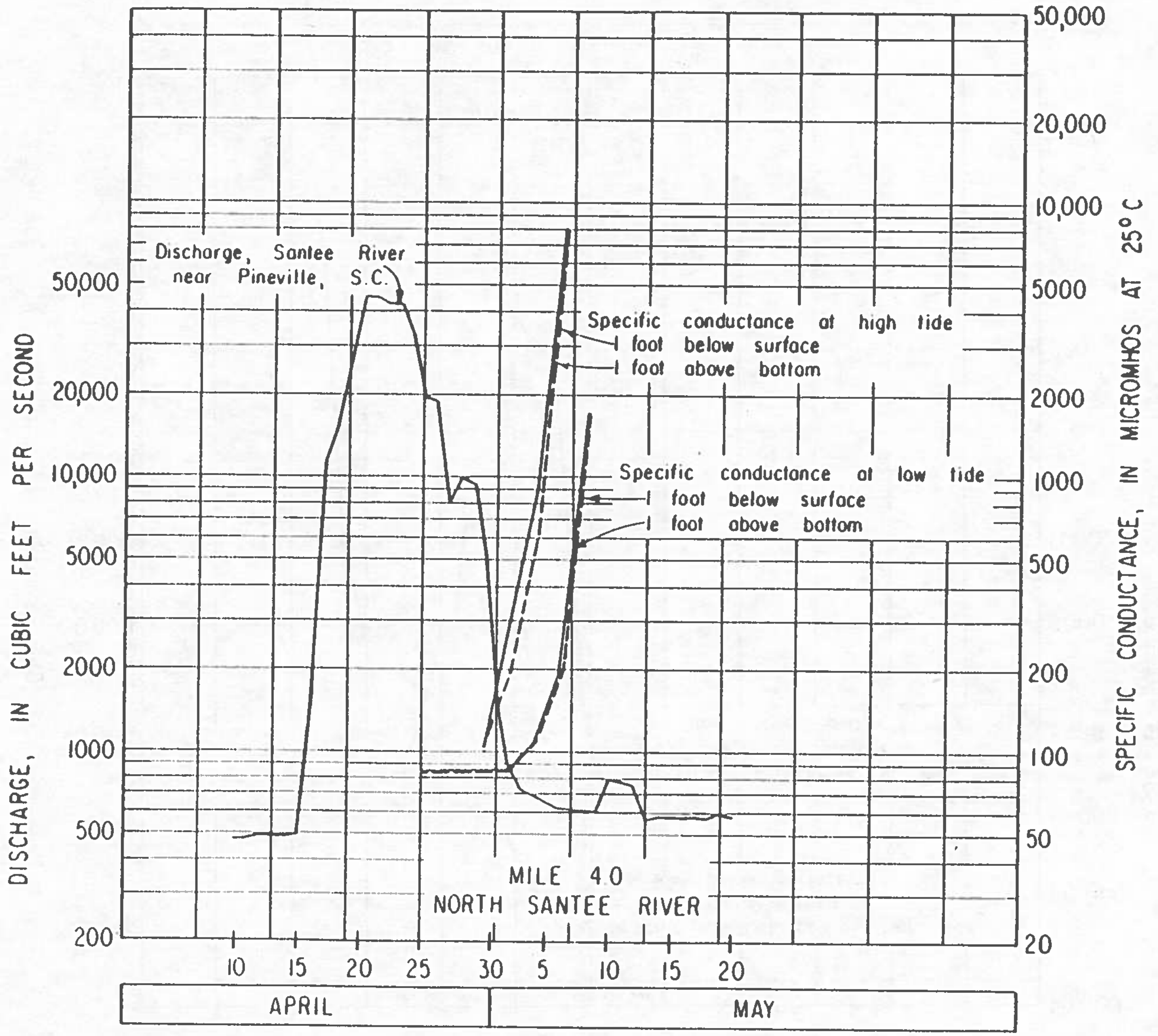


Figure 16.--Relation of specific conductance to fresh-water inflow, North Santee River, at mile 4.0, April and May 1969.

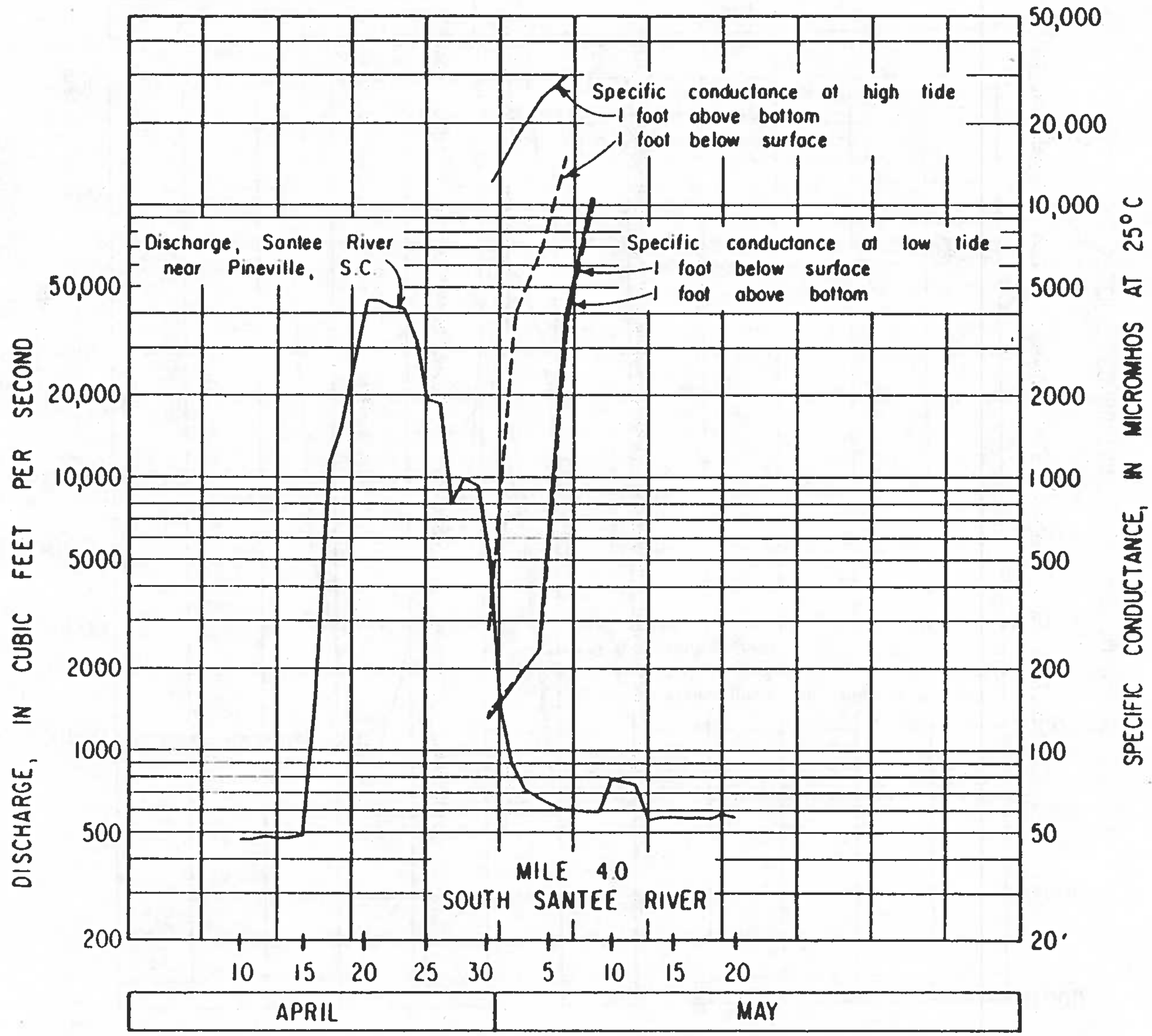


Figure 17.--Relation of specific conductance to fresh-water inflow, South Santee River at mile 4.0, April and May 1969.

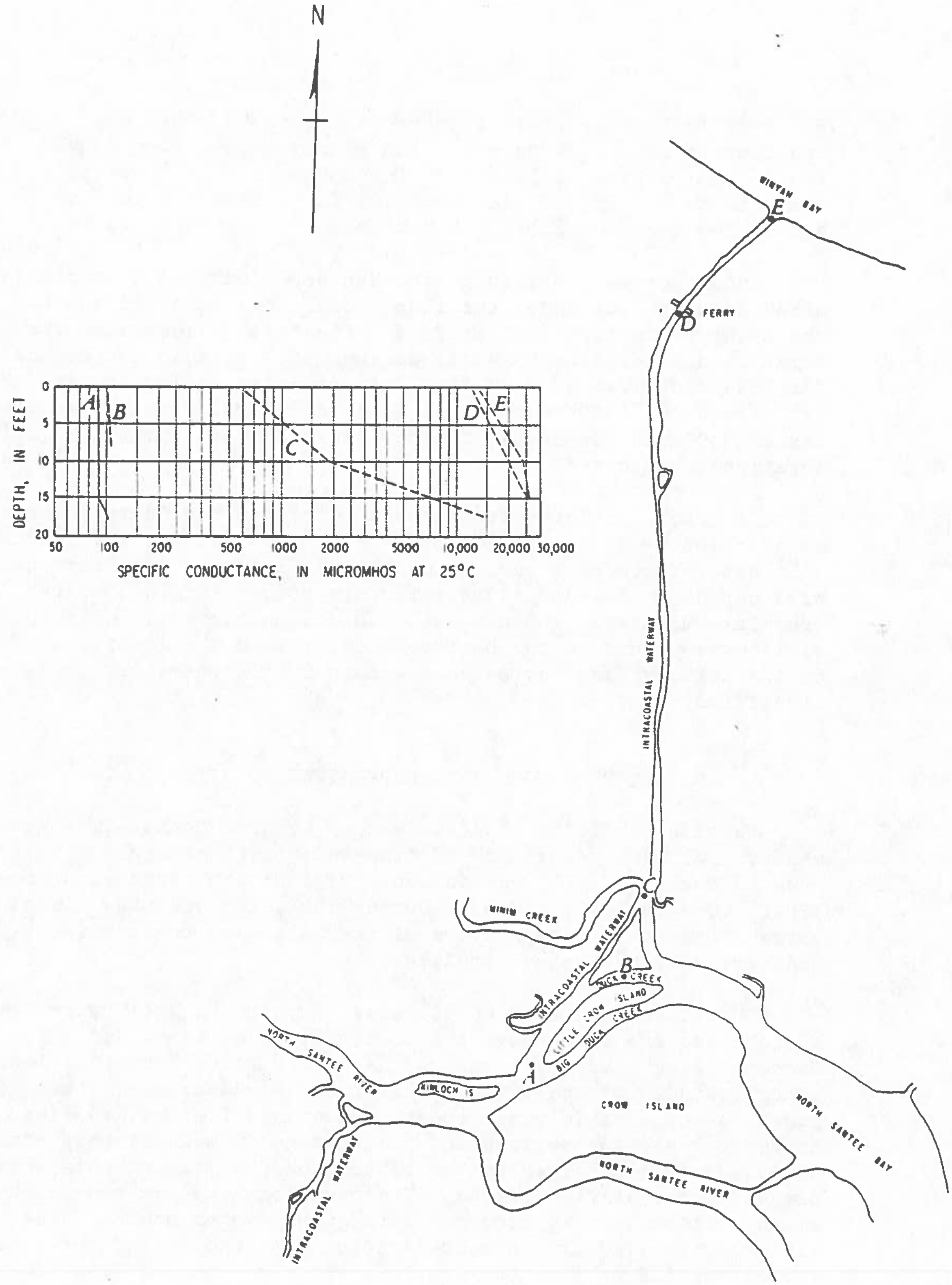


Figure 18.--Effect of flood on salinity of Intracoastal Waterway, April 25, 1969.

Waterway (Site A), specific conductance was 90 micromhos one foot below the surface and 110 micromhos one foot above the bottom; at the entrance to Winyah Bay (Site E), specific conductance was 13,500 micromhos one foot below the surface and 25,500 one foot above the bottom.

Under normal conditions, the Santee Estuary is a partially mixed estuary, but under the flood conditions in April and May, the estuary was highly stratified. Figure 19 illustrates the stratified conditions on April 30 and May 4 at mile 2.0 on the North Santee River at high tide. Fresh water inflow to the estuary on April 30 measured at U. S. Highway 17A near Jamestown, was 22,000 cfs. On May 4, fresh water measured at the same location was about 5,400 cfs.

Diversion of water from Lake Moultrie to the Santee River, as proposed by U. S. Army Corps of Engineers, will likely force salt water farther seaward than it is at present; the distance will depend on the amount of water diverted. Inflow of water from Lake Moultrie probably will cause a much greater differential between surface and bottom salinities in the lower reaches of the estuary, and may cause the estuary to become highly stratified.

DISSOLVED OXYGEN AND TEMPERATURE AT MILE POINTS

Vertical profiles of dissolved oxygen and temperature were measured at mile points at the time salinity measurements were made in December 1968, and in January, February, March and June 1969. (See tables 4 and 5.) During these periods, the dissolved-oxygen content and temperature of the water was comparatively uniform in each vertical profile.

The difference between dissolved oxygen one foot below the surface and one foot above the bottom at mile points did not exceed 1.5 mg/l at any location. A difference 0.7 mg/l or less occurred in 95 of the 107 vertical profile measurements that were made. A total of 96 measurements showed a difference in dissolved oxygen between the surface and the bottom; 20 measurements showed dissolved oxygen higher at the bottom; and 76 measurements showed oxygen higher at the surface. The occasions when oxygen was higher at the bottom usually occurred during the winter months. The minimum dissolved oxygen concentration measured during the investigation was 5.9 mg/l on the South Santee River during June; the maximum concentration was 16.0 mg/l on the South Santee River in January. Dissolved oxygen concentrations average about 0.8 mg/l higher at mile 14 than at mile 5.0 on both the North and South Santee Rivers. Because the solubility of dissolved oxygen decreases with increasing salinity, the difference of 0.8 mg/l is very close to that expected if the salinity at the two locations is considered.

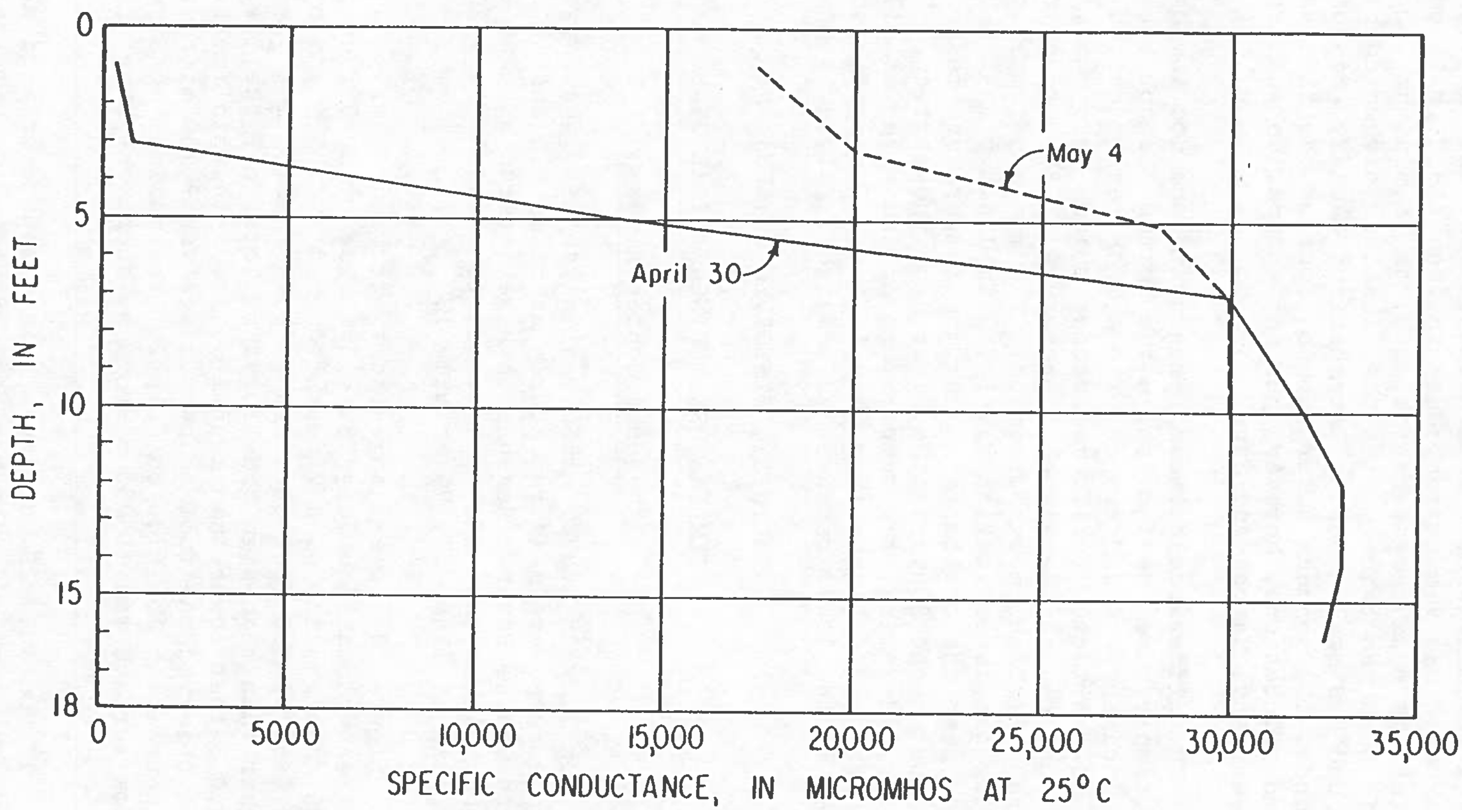


Figure 19.--Stratification of North Santee River at mile 2.0 during flood, Spril 30 and May 4, 1969.

A maximum percent saturation of 130 occurred when the maximum observed dissolved oxygen concentration (16.0 mg/l) occurred. During the measurements at mile points, a minimum percent saturation of 75 occurred twice[1/] when the dissolved oxygen concentration was 8.2 and 8.3 mg/l. During December and January, dissolved oxygen exceeded 100 percent saturation on four of the five salinity runs. At most locations, however, percent saturation was less than 100 in February, March, and June.

The difference between temperature one foot below the surface and temperature one foot above the bottom did not exceed 1.0°C at any location. A difference of 0.4°C or less occurred in 86 of the 107 vertical profile measurements that were made. Water at the surface had the higher temperature in 88 percent of the cases where a difference was observed. The minimum temperature measured during the investigation was 5.0°C in January on the South Santee River near the bottom. The maximum temperature measured was 28.5°C in June on the South Santee River near the surface. During the winter and spring, the temperature of the water at mile 14 was as much as 1°C higher than at mile 5.0. During the summer, however, water in the lower reaches had a slightly higher temperature.

SALINITY, DISSOLVED OXYGEN, AND TEMPERATURE DURING A TIDAL CYCLE

North Santee River

On July 28 and 29, 1969, salinity dissolved oxygen, and temperature were measured hourly at miles 6.0 and 13 on the North Santee River. Measurements were begun at 1500 EST July 28 at both locations, and were terminated at 0500 July 29 at mile 6.0, and at 1300 July 29 at mile 13.

Figure 20 shows changes that occurred at mile 6.0. During the measurements on July 28, a low tide of -0.3 feet occurred at 1425, a high tide of 5.2 feet occurred at 1950, and on July 29, a low tide of 0.0 feet occurred at 0340. High tide was 1.1 foot higher than mean high tide for this location; the low tide at 1425 was 0.3 feet lower than mean low tide. The minimum specific conductance observed one foot below surface was 9,750 micromhos, about half an hour after low tide on July 28; the maximum observed one foot below surface was 41,000 micromhos, about one hour after high tide.

1/ On July 29, during a measurement over a tidal cycle at mile 6.0 on the North Santee River, percent saturation of dissolved oxygen was 61.

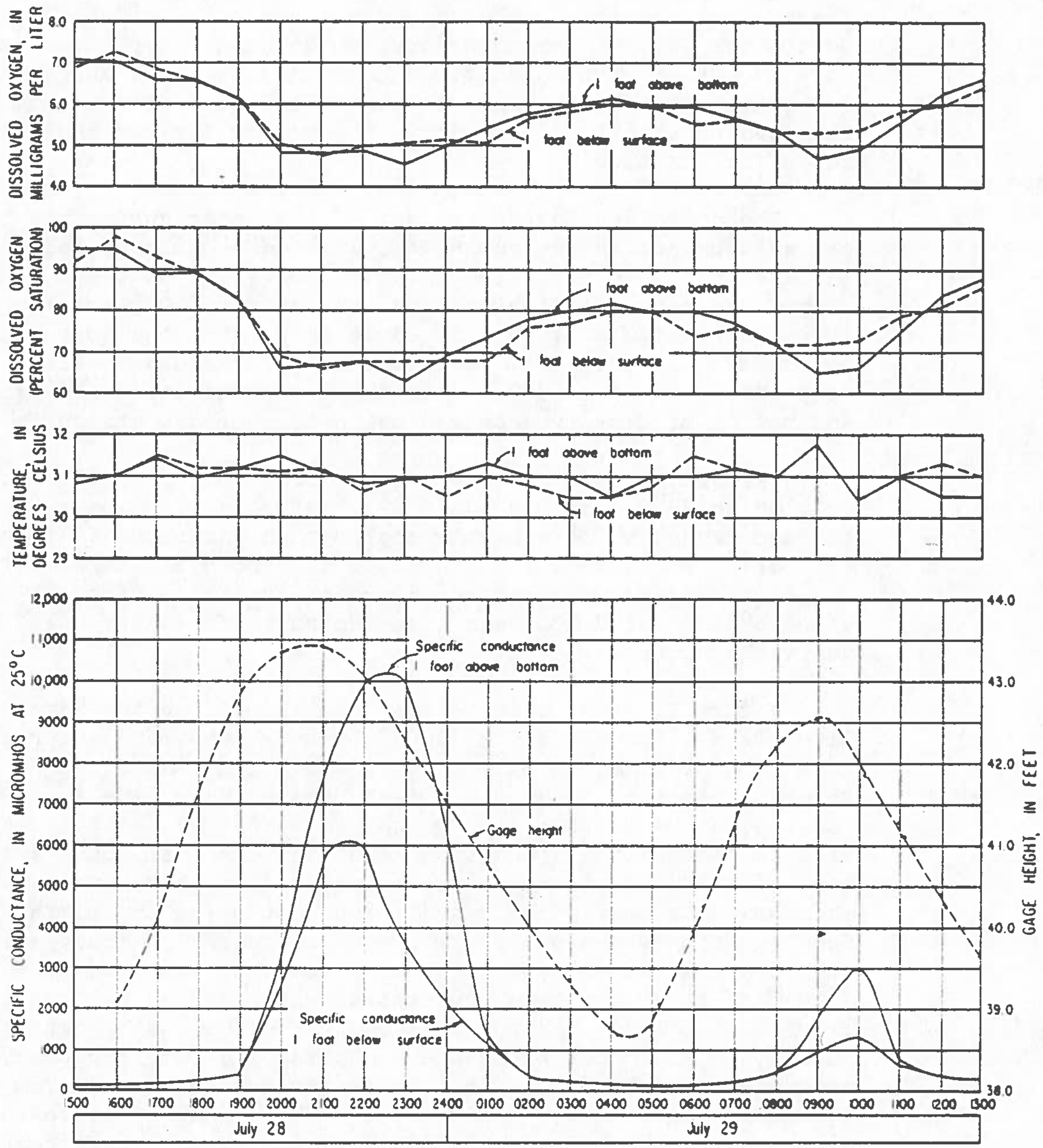


Figure 20.--Changes in specific conductance, dissolved oxygen, and temperature of North Santee River at mile 6.0, July 28-29, 1969.

The minimum specific conductance observed one foot above the bottom was 15,300 micromhos about 20 minutes after low tide on July 29; the maximum specific conductance one foot above the bottom was 45,000 micromhos at high tide. Specific conductance remained constant one foot above the bottom for two hours following low tide.

The dissolved oxygen content of the water during the period of measurement ranged from 6.4 mg/l at 1600 one foot below the surface to 4.3 mg/l at 0500 one foot above the bottom. Dissolved oxygen, as percent of saturation, ranged from 90 percent one foot above the bottom at 2000 July 28 to 61 percent one foot above the bottom at 0500 July 29. The cessation of photosynthetic activity is evident at about 2000, as both the concentration and percent saturation of dissolved oxygen begin to decrease gradually.

Temperature of the water ranged from 30.5°C at 1500 on July 28 to 29.2°C at 0500 July 29. Water one foot below surface tended to be slightly cooler than water one foot above the bottom through much of the late afternoon and night. The range in temperature one foot above the bottom during the period was 0.8°C, about 0.5°C less than the range for water one foot below the surface.

Figure 21 shows data obtained at mile 13 on the North Santee River from 1500 July 28 to 1300 July 29 -- the period during which data were obtained at mile 6.0. A staff gage installed at mile 13 showed a range in tide of 4.7 feet between high tide at 2100 and low tide at 0412 (at mile 6.0 the range in tide was 5.2 feet). At mile 13 the maximum specific conductance one foot above the bottom was about 10,000 micromhos approximately two hours after high tide. The maximum specific conductance one foot below the surface was 6,000 micromhos approximately one hour after high tide, which suggests that water near the bottom continued to move upstream for some time after upstream movement of water at the surface had ceased. From 2200 to 2300, the specific conductance of water near the bottom was 10,000 micromhos or greater. During the same period the specific conductance of water one foot below surface decreased from about 6,000 micromhos to 3,600 micromhos. These data indicate that, although the channel is only 12 to 14 feet deep, water near the surface moved seaward more rapidly than did water near the bottom. The minimum specific conductance during the 22 hour period was 119 micromhos at both the surface and the bottom.

Dissolved oxygen ranged from 7.2 mg/l one foot below the surface at 1600 July 28 to 4.6 mg/l at one foot above the bottom at 2300 July 28. Maximum and minimum percent saturation values

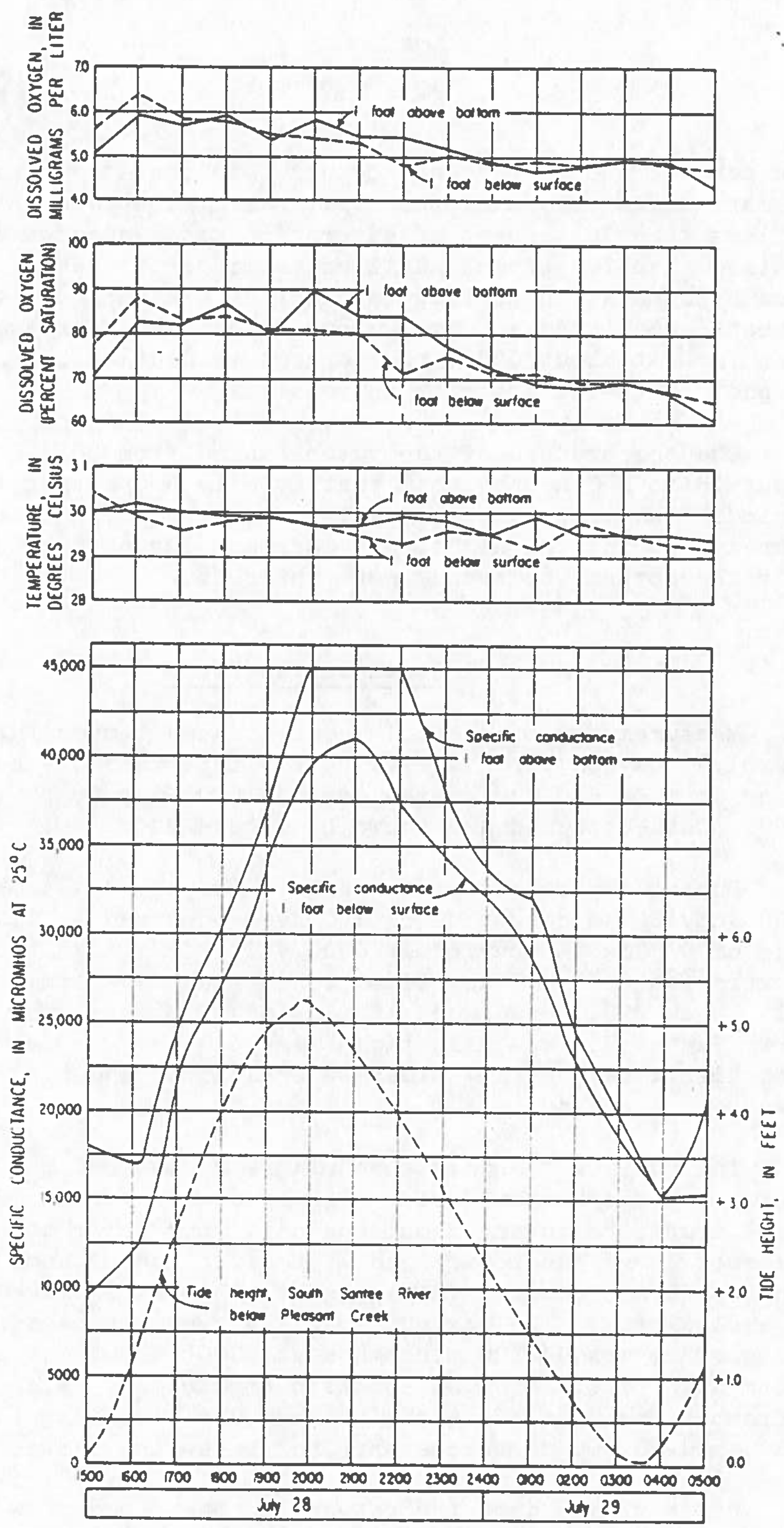


Figure 21.--Changes in specific conductance, dissolved oxygen, and temperature of North Santee River at mile 13, July 28-29, 1969.

(98 percent and 63 percent) occurred at the same times and depths as maximum and minimum concentrations. Dissolved oxygen decreased to less than 70 percent of saturation after sundown and continued at less than 70 percent until after midnight. When the water became fresh at about 0200, percent saturation rose to about 80 percent, continued so until about 0600, then decreased to less than 70. At about 0900, the percent saturation began to increase as photosynthetic activity increased.

The temperature of the water ranged from 30.5°C to 31.8°, or about 1° to 2°C higher than that at mile 6.0 during the same period. The temperature of water near the surface tended to decrease during the night, and increase during the early morning. Near the bottom, no trends were apparent.

South Santee River

Measurements of specific conductance, temperature, and dissolved oxygen were made at hourly intervals on the South Santee River at mile 6.0 during the period 1500 July 30 to 1200 July 31, 1969. Data obtained are shown on figure 22.

During the measurements, a low tide of -0.4 feet occurred at 1630 July 30; a high tide of 5.0 feet occurred at 2130. A low tide of 0.0 feet occurred at 0450 July 31; a high tide of 4.5 feet occurred at 0950. Thus, tidal conditions were similar to those on July 28 and 29, 1969, when similar measurements were made on the North Santee River. High tides were 0.4 and 0.9 feet higher than mean high tide, and low tides were equal to and 0.4 foot lower than mean low tide.

The maximum specific conductance was 47,000 micromhos one foot above the bottom during high tide on July 30. For about three hours, beginning about one-half hour prior to high tide, water one foot above the bottom had a specific conductance between 46,000 and 47,000 micromhos. This suggests that water moved up the estuary at a slow rate. The maximum specific conductance one foot below the surface was 44,500 micromhos at 2300, about one and a half hours after high tide. Minimum specific conductance values were 25,400 micromhos one foot above the bottom just preceding low tide at 1630, and 23,000 micromhos one foot below the surface at 1700.

Water moving into the estuary on the flood tide at mile 6.0 had a vertical difference in specific conductance from surface to bottom of about 4,000 to 6,000 micromhos. Water moving out of the estuary on the ebb tide had an almost uniform specific conductance from surface to bottom. This suggests that considerable mixing occurred. Although such mixing may be a normal occurrence, heavy rains and high winds during the time these measurements were made probably contributed to more rapid mixing of surface and bottom layers. Weather conditions may have caused the unusual surface and bottom salinity patterns measured after low tide on July 31 (fig. 22).

The maximum dissolved oxygen concentration during the period was 8.1 mg/l at 1700 July 30 one foot below the surface. The minimum concentration was 4.8 mg/l at 0400 and at 0700 on July 31 one foot above the bottom. Near the surface, during the late afternoon, the water was supersaturated (115 percent at 1700) with respect to dissolved oxygen. A minimum of 69 percent of saturation occurred at 0400. Although dissolved oxygen decreased sharply between 1700 and 1800, it remained between 90 and 100 percent until 2400, then decreased to 70 to 75 percent until about 0800 July 31 when it began to increase. No sharp decrease in dissolved oxygen was noted at sundown. It is likely that several hours were required for biological utilization of surplus dissolved oxygen, and thus the oxygen sag normally associated with cessation of photosynthetic activity was not evident until about midnight.

Water temperatures during the period of measurement ranged from 28.2°C to 30.0°C. These values are about 1°C lower than those observed on the North Santee River, possibly because of the heavy rains that occurred during the night of July 29.

CHEMICAL AND PHYSICAL CHARACTERISTICS OF WATER

Santee River near Pineville

The chemical characteristics of fresh-water inflow to the Santee River estuary have been measured periodically at the U. S. Geological Survey's gaging station near Pineville (mile 85) since 1951. Samples were collected and analyzed on 55 occasions; table 8 gives the observed maximum and minimum values for dissolved substances and physical properties. The data indicate fresh-water inflow to the estuary has a low dissolved-solids content (maximum, 73 mg/l), low concentrations of individual dissolved substances, and is comparatively uniform in quality.

Santee River estuary

On July 15 and 16, 1969, samples of water for laboratory analysis were collected at several locations in the Santee River estuary. (See table 9.) On July 15, the water at mile 37 had a

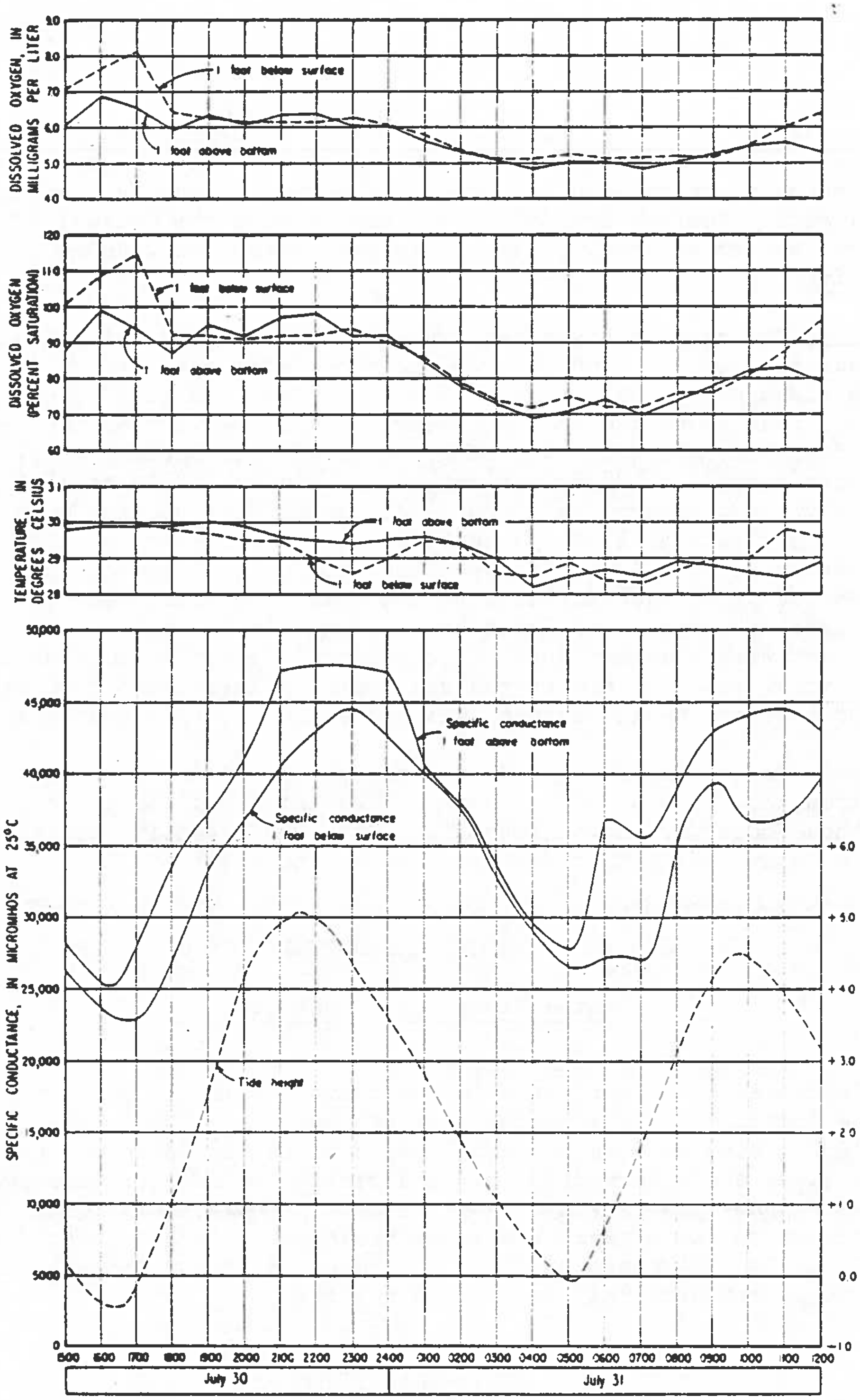


Figure 22.--Changes in specific conductance, dissolved oxygen, and temperature of South Santee River at mile 6.0, July 30, 31, 1969.

dissolved-solids content of 62 mg/l; individual dissolved substances were also low. The concentrations of all substances except calcium and barcarbonate fell within the maximum-minimum range observed at Santee River near Pineville (table 8). The analyses of the samples obtained at mile 37 and at the gage near Pineville indicate that neither natural or cultural factors significantly affect water quality between Lake Marion Dam and mile 37. The only indication of wastes at this location is the presence of MBAS[1/] (synthetic detergents). No source for the detergent can be positively cited.

The farthest downstream point at which samples were obtained was at mile 4.0 on the North Santee River. More highly mineralized water, however, occurred at miles 5.0 and 6.0 on the South Santee River. At mile 5.0 on the South Santee River, the water had a dissolved-solids content of 27,500 mg/l. Based on the concentrations of individual dissolved substances, water at mile 5.0 was 70-80 percent sea water[2/]. MBAS concentrations in the lower reaches of the estuary were high. At mile 4.0 on the South Santee River MBAS was 3.4 mg/l. MBAS concentrations in water of both the North and South Santee Rivers became progressively higher downstream from mile 14. This suggests that the MBAS may have originated outside the estuary, and, by the movement of off-shore currents, was brought to a location where tidal action would transport it into the estuary.

It does not seem likely, however, that this would account for the presence of MBAS at mile 37. On the two days the samples were obtained, a detailed survey of all tributaries and small inlets to the estuary from mile 4.0 to mile 44 was conducted. Specific conductance and temperature were measured at numerous locations; no evidence was found that indicated wastes were entering the Santee River during the period of survey.

1/ MBAS - methylene blue active substance.

2/ The composition of sea water varies from place to place over the world, but for a given salinity its composition is relatively constant. For a sea water having a salinity of 35 parts per thousand, Riley and Skirrow (1965, p. 647) tabulated the concentrations of major ions of sea water in grams per kilogram. These concentrations, recomputed in terms of milligrams per liter, are as follows: calcium, 423; magnesium, 1,326; sodium, 11,010; potassium, 396; bicarbonate, 145; sulfate, 2,775; chloride, 19,806; fluoride, 1.3; and bromide, 68.

Figure 23 (in pocket) shows the relation between specific conductance and individual dissolved substances and properties based on the samples collected on July 15 and 16, 1969. At specific conductance values greater than about 1,000 micromhos, the relation of each of the substances and properties to specific conductance tends to become uniform and predictable. Figure 23, in conjunction with figure 15, may be used to determine the location in the estuary at which a given concentration of an individual dissolved substance is likely to occur. For example, the South Carolina Pollution Control Authority defines a tidal salt water in its classification standards system as one having a chloride content greater than 250 mg/l. Figure 23 indicates that such a water will have a specific conductance of about 900 micromhos. Figure 15 indicates that on the North Santee River a chloride content of 250 mg/l is likely to occur between miles 8.0 and 11, and that on the South Santee River a chloride content of 250 mg/l is likely to occur between miles 9.0 and 13.

Color, Turbidity, and Secchi Disc Transparency

On August 4 and 5, 1969, measurements of color, turbidity, and Secchi disc transparency were made on the North and South Santee Rivers, and on the Santee River. These data are given in table 10. The color of water is due to both organic and inorganic ions in solution and its measure is based on the platinum-cobalt scale of Hazen (1892). Turbidity is caused by insoluble suspended material in water, and is determined by measuring the scattering and absorption of light by small suspended particles. The U. S. Geological Survey measures turbidity by comparisons to standard reference suspensions of SiO_2. Secchi disc transparency is measured by lowering a white or white and black disc into water and noting the depth at which the white can no longer be distinguished; thus, it provides a rough indication of the transmission of light through the water.

Figure 24 shows the relation of color and Secchi disc transparency to location on the North Santee River and on the Santee River. On August 4, color of water one foot below the surface ranged from 10 units at mile 5.0 to 65 units at mile 12; the color decreased to 15 units at mile 25, then increased to 30 units at mile 33. The change in Secchi disc transparency was inverse to that of color, the minimum Secchi disc value occurring at the location where the maximum color was observed, and the maximum Secchi disc value occurring at the location where minimum color was observed.

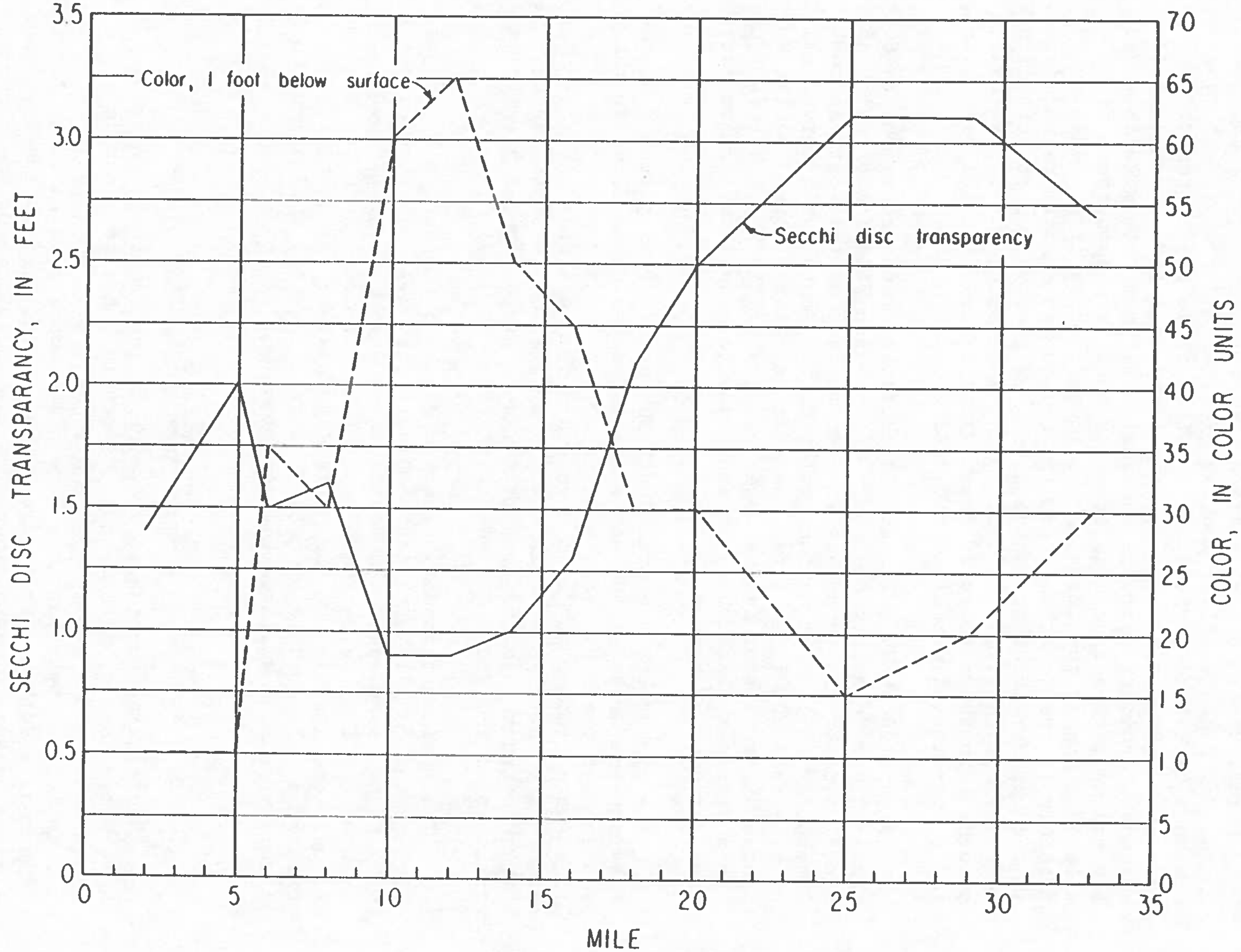


Figure 24.--Relation of color and Secchi Disc transparency to location,

North Santee and Santee Rivers, August 4, 1969.

Figure 25 shows the relation of turbidity to depth and location on the North Santee River and Santee River. Turbidity was measured one foot below the surface and one foot above the bottom at 13 locations. Except at mile 10, turbidity near the bottom equaled or exceeded turbidity near the surface. Upstream from mile 18, turbidity was half to a fourth as great as turbidity downstream from mile 18. Higher turbidity in the lower reaches of the estuary probably is due to strong tide induced currents that are not found in the upper reaches of Santee River. Higher values of turbidity near the bottom likely reflect both the settling out of material brought into the estuary by fresh-water inflow, and the resuspension and dispersion of deposited material by currents.

Figure 26 shows color and Secchi disc transparency on the South Santee River on August 5, 1969. The inverse relation of color and Secchi disc transparency was similar to that of the North Santee River (fig. 24). The maximum color on the South Santee River - 180 units - is about three times the maximum color observed on the North Santee River. Water in the upper reaches of the South Santee River has a distinct blackish appearance, due to dissolved organic matter from surrounding swamps.

The higher color of the South Santee River is probably due to the fact that most of the water of the Santee River flows to the sea through the North Santee River. The flushing action of the fresh-water inflow tends to move swamp drainage from the North Santee River more rapidly; whereas swamp drainage in the South Santee River tends to accumulate and constitute, at a given time, a greater fraction of the South Santee River volume.

The maximum turbidity observed on the South Santee River was higher than on the North Santee River (fig. 27). At five of seven mile points sampled on the South Santee River, turbidity was greater one foot below the surface than one foot above the bottom. At only one location on the North Santee River was turbidity greater at the surface. On both rivers, however, the maximum turbidity at the surface occurred at mile 10.

Radiochemicals

Radioactive substances in water of the Santee River estuary were determined by measuring alpha particle and beta particle radiation. Alpha particles are high velocity, positively charged helium nuclei; beta particles are high velocity, negatively charged electrons. Both particles are common products of radioactive decay. A gross measure of each, therefore, is indicative of the amount of radioactive substances present.

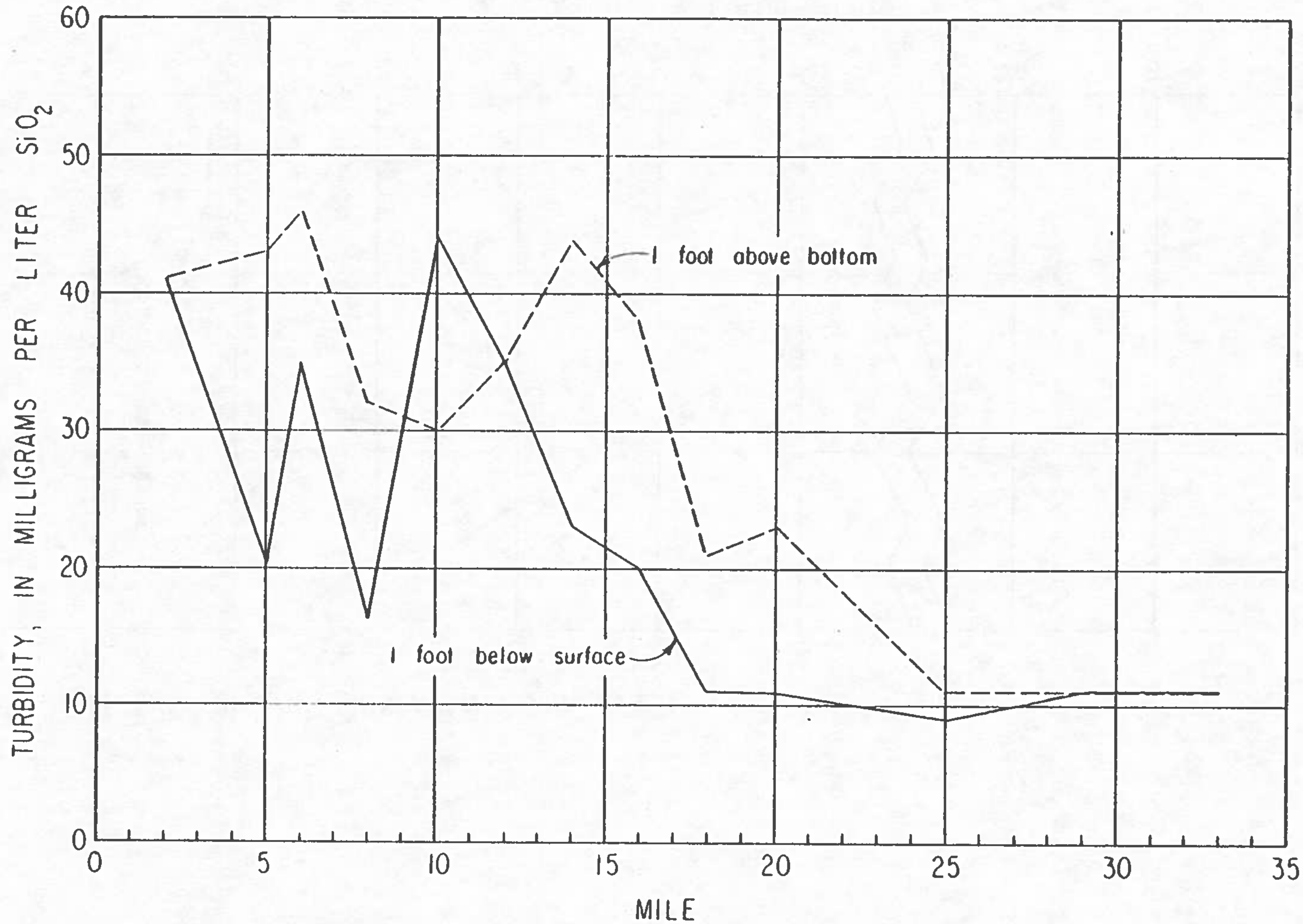


Figure 25.--Relation of turbidity to location, North Santee and Santee Rivers, August 4, 1969.

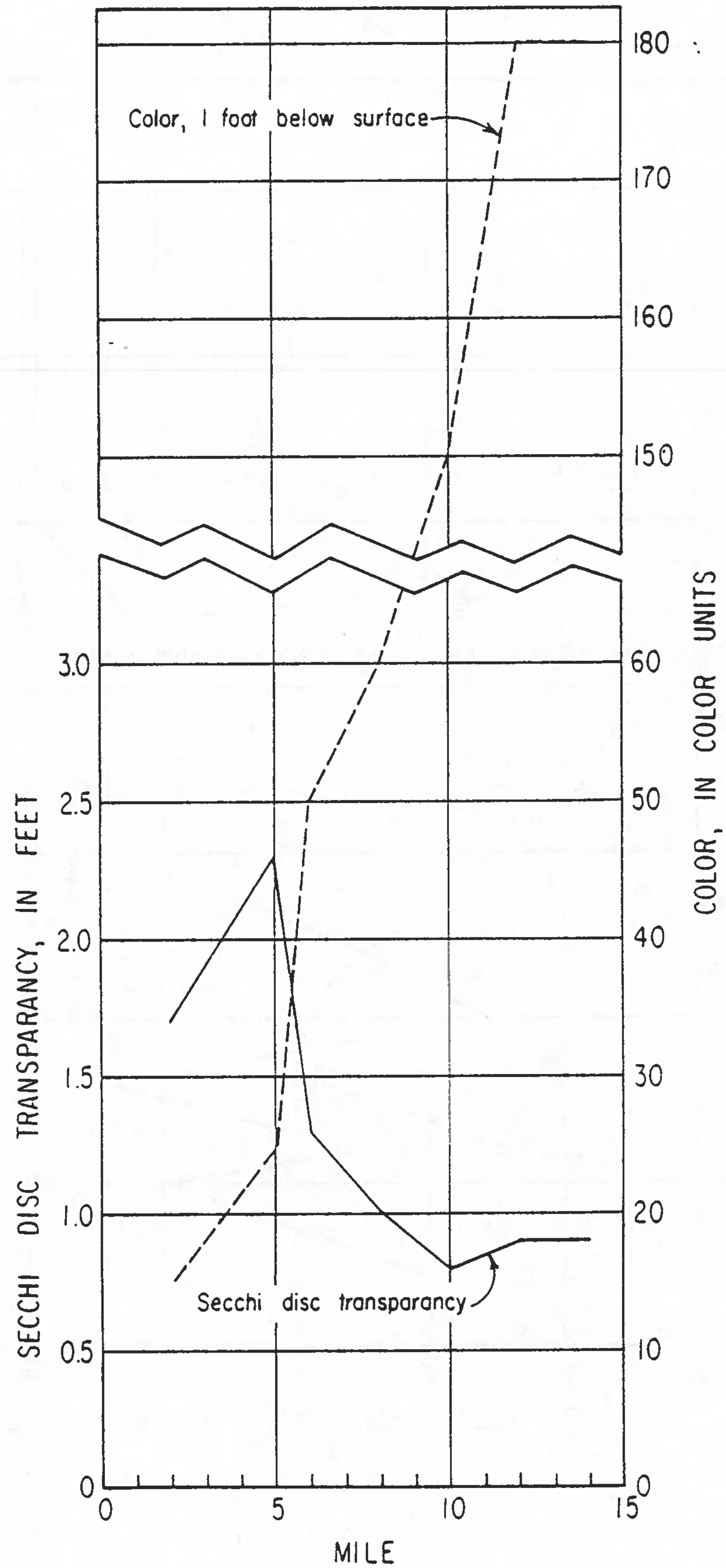


Figure 26.--Relation of color and Secchi Disc transparency to location, South Santee River, August 5, 1969

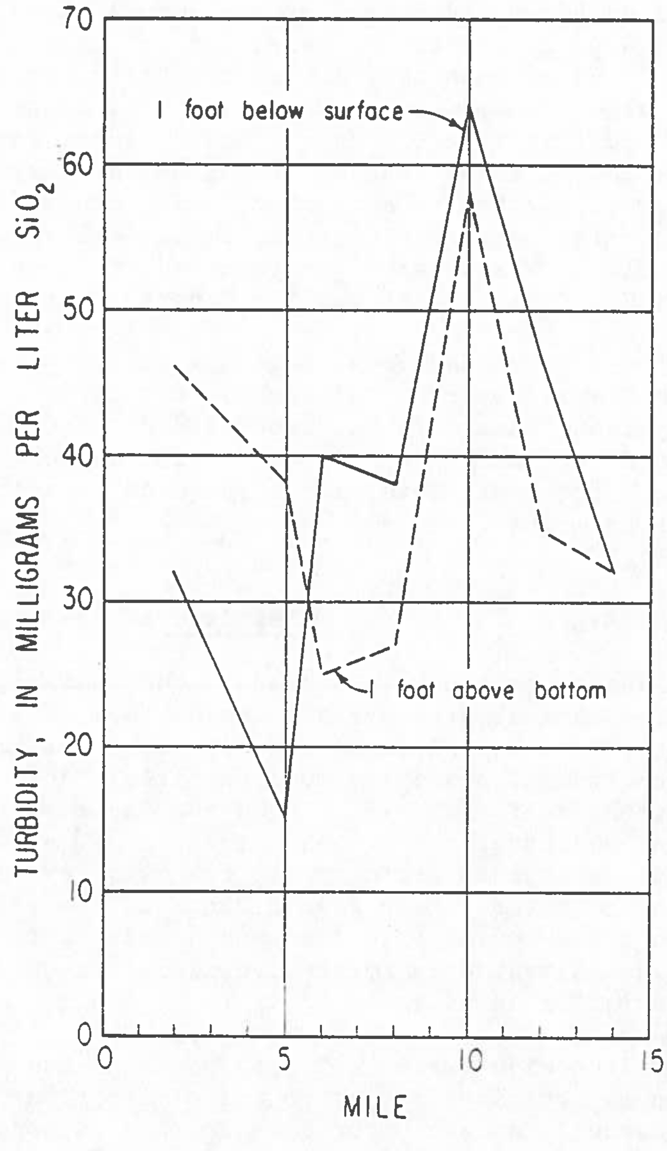


Figure 27.--Relation of turbidity to location, South Santee River, August 5, 1969.

Table 11 gives gross alpha and gross beta analyses made on samples collected in July 1969 from the North and South Santee Rivers and from the Santee River. Gross alpha values ranged from 0.3 pc/l (picocuries per liter) at mile 37 on the Santee River to 60 pc/l at mile 4.0 on the North Santee River. Gross beta values ranged from 2.9 pc/l at mile 37 on the Santee River to 830 pc/l at mile 6.0 on the South Santee River. The higher values in the lower reaches of the estuary may be due to the greater proportion of sea water, which contains greater amounts of naturally occurring radionuclides. All values obtained, however, are well below suggested limits cited in a review of the literature by the California Water Quality Control Board (1963).

Gross alpha and gross beta are low in water discharged to the Santee River estuary. Ten samples obtained by the U. S. Geological Survey from January to September 1968 at the gaging station at Santee River near Pineville (mile 85), showed a range of 2.6 to 3.8 pc/l for gross beta, and a range of less than 0.4 to 1.9 pc/l for gross alpha.

Pesticides

Pesticides occur in surface waters usually as a result of run-off from agricultural areas to which they have been applied, or directly from aerial spraying. In water, pesticides tend to be absorbed on suspended sediment particles, some of which settle to form the bed of a stream. Thus, the bed material usually contains higher concentrations of pesticides than the overlying water. Because pesticides are normally found in very low concentrations in surface water, their significance at the present time is largely due to their toxicity to fish and aquatic life and to their tendency to be concentrated in successive stages in the food chain of organisms existing in water.

Of the wide variety of pesticides in use, the chlorinated hydrocarbon insecticides are of principal importance because of their resistance to natural processes of chemical and biological degradation. Table 12 gives the results of analyses of eight common chlorinated hydrocarbon insecticides. Samples of bed material and overlying water were obtained in June 1969 at four locations in Santee River estuary. Five of the insecticides- aldrin, dieldrin, endrin, heptachlor, and lindane- were not detected at any location. DDT, DDD, and DDE were found at three of the four locations. Concentrations were higher in the lower reaches of the estuary than in the upper reaches. Bed material contained more of the insecticides than did overlying water. None of the concentrations, however, exceeded those considered permissible in public water supplies. (See section on suitability of water for use)

Coliform Bacteria

The coliform group of bacteria includes types that inhabit human and animal intestines, and other types that are found on vegetation and soils. Evaluations of the sanitary quality of water are frequently based on measurements of the density of coliform bacteria. Table 13 gives the results of measurements made at several locations in the Santee River estuary. During July 1969, coliform density ranged from 4 to 80 colonies per 100 milliliters. These densities are typical of many unpolluted surface waters which, with proper treatment, are suitable as public supplies. (See section on suitability of water for use.)

Biochemical Oxygen Demand (BOD)

Biochemical oxygen demand is a measure of the oxygen required to remove organic matter from water in the process of decomposition by aerobic bacteria; the demand is normally measured by determining the oxygen utilized during a 5-day incubation period at 20°C. On July 17, 1969, samples were obtained on the South Santee River at miles 6.0 and 14, and on the Santee River at miles 27 and 29. Analyses were made using a manometric BOD apparatus which, although probably less accurate than standard laboratory techniques, is suitable for a general appraisal of the magnitude of the demand. BOD was not detected when the samples were analyzed, indicating that no significant amounts of oxygen consuming wastes were present.

Suspended sediment

The suspended sediment characteristics of fresh-water inflow to the Santee River estuary at the gaging station near Pineville were measured periodically from July 1966 to June 1968. During the same period samples were also obtained at Lake Marion Dam on 26 days when flood waters were spilled. Sediment concentrations ranged from 6 to 38 mg/l at the gage, and from 4 to 31 mg/l at Lake Marion Dam (U. S. Geological Survey, 1967, 1968). The average suspended sediment concentration at the gaging station was 13 mg/l. The average concentration in flood waters released from the lake did not differ appreciably. During the two year period, an estimated 27,000 tons of sediment were discharged to the estuary. Because of the large volumes of water released from the lake during floods, approximately half of this amount (13,600 tons) entered the estuary during flood periods.

Samples of suspended sediment in the Santee River estuary were obtained in February, April, and May 1969 on the ebb tide. Most of the samples were depth integrated, i.e., a sample was collected so as to obtain water throughout a vertical, thus representing the average sediment concentration at a sampling site. Other samples were obtained at specific depths. Analyses of the samples are shown in table 14. Figure 28 shows the concentrations of suspended sediment during the flood of April 1969, and during a period of normal inflow to the estuary in May.

The highest suspended sediment concentration (71 mg/l) of a depth integrated sample obtained on the North Santee River occurred during the flood period at miles 7.0 and 10. Although sediment concentrations were less during the period of normal flow in May, the pattern of change was similar to that in April. Concentrations increased from mile 5.0 through mile 10, then progressively decreased upstream.

Only one sample of suspended sediment was collected on the South Santee River during the flood of April 1969; samples were obtained through mile 10 in May, however. The concentration at mile 5.0 on the South Santee River during the flood on April 24 was 47 mg/l, identical to that found at mile 5.0 on the North Santee River on the preceding day. In May, under normal flow conditions, sediment concentrations at miles 5.0, 7.0, and 10 on the South Santee River were a few milligrams per liter less than those at the same locations on the North Santee River, but similar changes with location occurred as on the preceding day on the North Santee River.

On February 14, 1969, samples were collected about three hours after high tide. At mile 5.9 on the North Santee River sediment concentrations increased from 56 mg/l one foot below the surface to 94 mg/l one foot above the bottom. At mile 7.0 on the South Santee River, sediment concentrations increased from 119 mg/l one foot below the surface to 178 mg/l one foot above the bottom.

Bed Material

Bed material samples were obtained on April 23 and 24 and on June 18, 1969, at several locations in the estuary. The samples were analyzed for percent of sand, and percent of silt plus clay. The results of the analyses are given in table 15. In general, there was a progressive increase in the percent of sand in the bed material upstream from mile 5.0 on both the North and South Santee Rivers. Percent sand ranged from 5.1 percent at mile 6.0 on the South Santee River to 100 percent at mile 24 on the Santee River. At most locations, sand constituted more than 90 percent of the bed material. Between mile 5.0 and 7.0 on both the North and South Santee Rivers, the fraction of silt and clay is greater than 10 percent. The low sand content at mile 6.0 on the South Santee River is likely the result of a local condition that cannot be explained without additional information.

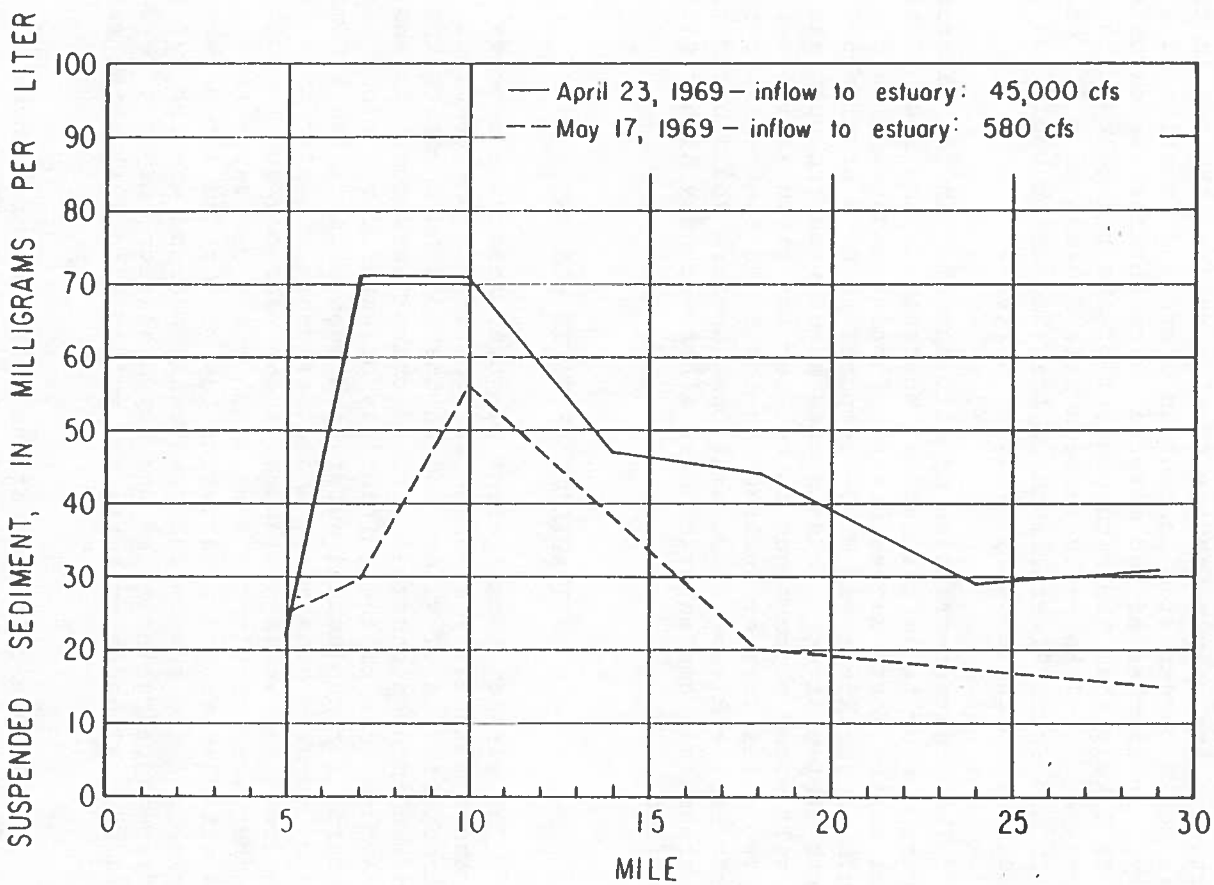


Figure 28.--Relation of suspended sediment concentration to location, North Santee and Santee Rivers.

Most of the sand fraction of suspended sediment settles to the bed before reaching the lower part of the estuary. Much of the finer silt and clay fraction probably is transported farther downstream until, after mixing with water of sufficient salt content, it tends to flocculate and settle to the bottom. Although particles are resuspended by tidal currents, the bed in the mixing area would be expected to contain a greater fraction of silt and clay. No samples of bed material were obtained below mile 5.0, but it is likely that the sand content of the bed below mile 5.0 increases. In the reach between mile 0.0 and mile 5.0 on both the North and South Rivers, much of the sand is probably sea sand brought into the estuary by tidal currents.

The greatest fraction of silt and clay in bed material probably occurs one or two miles farther upstream on the South Santee River than on the North Santee River. Percent sand at mile 5.0 on the South Santee River was 97.0[1/] compared to 81.6 at mile 5.0 on the North Santee River. This is consistent with the upstream movement of salt water which tends to be, for any given salinity front, one to two miles farther upstream on the South Santee River than on the North Santee River. Flocculation therefore would occur farther upstream, and bed material have a correspondly higher silt and clay fraction.

SUITABILITY OF WATER FOR USE

The effective management of water resources depends largely on the availability of basic information on the chemical and physical characteristics of water, and on the continued monitoring of natural and man induced changes in these characteristics. Extensive studies have been made of the suitability of water for various uses, and criteria for evaluating water have been established. Domestic, agricultural, industrial, and other users of water have varying requirements; water suitable for one user may not be suitable for another even within the same broad water use category. Also, a raw water whose characteristics may rate it as a poor supply, may be amenable to economical treatment, whereas another water, having different characteristics and rated as poor, may not be so easily treated. Although criteria are valuable in evaluating water,

1/ Sample collected at the left side of channel; repeated attempts to obtain a bed material sample at the right side of channel yielded only oyster shells.

the ultimate suitability of water can depend on the treatment process. In the following sections of this report, some of the criteria used in evaluating waters are discussed, and water of the Santee River estuary is considered within the framework of those criteria.

Domestic Use

The U. S. Public Health Service (1962) has established standards for water used on interstate common carriers. These standards have been endorsed by the American Water Works Association and are generally used to evaluate domestic water supplies. Some of the limits on chemical constituents in drinking water are as follows:

Constituent	Maximum recommended Concentration (mg/l)
Iron (Fe)	0.3
Manganese (Mn)	.05
Sulfate (SO_4)	250
Chloride (Cl)	250
Fluoride (F)	.8-1.7[1/]
Nitrate (NO_3)	45
Dissolved solids	500

In addition, the U. S. Public Health Service recommended that the color of drinking water be limited to 15 units, and that turbidity be limited to 5 units.[2/] Limiting values of coliform organisms in raw water depend largely on the type of treatment used and on the proportion of fecal organisms present. Raw waters having a coliform density as great as 20,000 per 100 ml have been used after extensive treatment. For finished water supplies, however, the U. S. Public Health Service requires that the average coliform density of all samples examined (by the membrane filter technique) during a month not exceed 1 per 100 ml.

1/ Recommended limits for fluoride content are based on the annual average of maximum daily air temperatures. For example, when the average is 10.0°C to 12.0°C, the recommended upper limit is 1.7 mg/l; when the average is between 26.3°C and 32.5°C, the upper limit is 0.8 mg/l.

2/ Jackson turbidity units.

For public water supplies, the National Technical Advisory Committee (1968) recommended both "permissible" and "desirable" criteria for some of the substances found in water. For chlorinated hydrocarbon insecticides, they suggest permissible criteria as follows:

Substance	Maximum concentration (in $\mu g/l$)
Aldrin	17
DDT	42
Dieldrin	17
Endrin	1
Heptachlor	18
Lindane	56

Although the above values are cited as maximum permissible criteria, the Advisory Committee suggested that all of the substances should be absent to meet a desirable criteria standard. Other permissible criteria recommended by the Advisory Committee include a pH range of 6.0 to 8.5, and a MBAS permissible criteria limit of 0.5 mg/l. As a desirable criteria, however, it is recommended that MBAS be "virtually absent".

Hardness, a property of water that affects its use, is caused principally by calcium and magnesium. Arbitrarily, the U. S. Geological Survey classifies water in the following manner with regard to hardness (as $CaCO_3$): 60 mg/l or less, soft; 61 to 120 mg/l, moderately hard; 121 to 180 mg/l, hard; and 181 mg/l or more, very hard. Generally water that is hard or very hard results in excessive soap consumption.

In evaluating the suitability of water of the Santee River estuary for domestic use, criteria for dissolved-solids content must be considered of primary importance because of the wide changes in salinity that occur at a given location. Based on figure 23, water in the Santee River estuary having a dissolved-solids content of 500 mg/l typically has a hardness of 160 mg/l, a sulfate content of 23 mg/l, and a chloride content of 250 mg/l. Data of table 9 indicates that water having a dissolved-solids content of about 500 mg/l will have a fluoride content of about 0.2 mg/l, a nitrate content of about 0.5 mg/l, a color of about 15 units, and a pH of 7.0. Thus water having a dissolved-solids content of about 500 mg/l in the Santee River estuary is hard, but generally suitable for domestic use.

Figure 23 indicates that water having a dissolved-solids content of 500 mg/l will have a specific conductance of about 900 micromhos. Figure 15 indicates that under average salinity conditions such a water is likely to occur on the North Santee River upstream from mile 11 at high tide, and upstream from mile 8.0 at low tide. On the South Santee River, such a water is likely to occur upstream from about mile 13 at high tide, and upstream from about mile 11 at low tide. Specific conductance values of 1,000 micromhos at the surface and about 2,500 at the bottom, however, were observed on one occasion as far upstream as mile 14 at high tide on the North Santee River. On the South Santee River, specific conductance values of 2,600 micromhos at the surface and 3,000 micromhos at the bottom were observed on one occasion as far upstream as mile 14 at high tide.

Although water unsuitable for domestic use occurs at times at mile 14, the above suggests that it is possible to obtain domestic water supplies below mile 14 on both the North and South Santee Rivers, providing withdrawal can be temporarily stopped during high tide on occasional days. Should flow to the Santee River estuary be increased by diverting water from Lake Moultrie, water having a dissolved-solids content of less than 500 mg/l will likely be available at all times at mile 14, and perhaps considerably farther downstream. (See section on flood of April and May 1969.)

With respect to other substances or properties--color, turbidity, MBAS, pesticides, radiochemicals, and coliform--water of the estuary that is a potential domestic supply meets the criteria for domestic use.

Industrial Use

Water quality requirements of industrial users vary widely. Some industries may require water virtually free of dissolved material, whereas other industries may satisfactorily use water having a dissolved-solids content approaching that of sea water. For many industries, however, water that meets public supply criteria is suitable under most conditions. Of principal importance to many industries is that the raw water supply used have a relatively constant quality and temperature. Variations in either may require frequent changes in a treatment process that hamper efficient and economical operation.

Water quality criteria for various industrial uses have been reviewed in publications of the California Water Quality Control Board (1963) and the National Technical Advisory Committee (1968). The report of the National Technical Advisory Committee considered industrial water at the point of use and at the point of supply in six groups as follows: (1) steam generation and cooling; (2) textile, lumber, paper, and allied products; (3) chemicals and allied products; (4) petroleum and coal products; (5) primary metal industries; and (6) food and kindred products, and leather tanning and finishing.

Table 16 gives characteristics of raw waters that have been used as industrial supplies. Data contained in table 16 have been extracted from the National Technical Advisory Committee (1968, p.189). Treatment of water having these characteristics is necessary in the majority of cases. Thus, the quality characteristics given in the table represent waters that experience has indicated can be treated successfully to meet the more demanding requirements at the point of use.

For food and kindred products, and for the leather industry, criteria equivalent to those for public supplies are usually required. More stringent requirements are necessary in the food industry because water may be incorporated in a product, and because of the fact that substances in water may cause undesirable chemical reactions. In tanning operations, iron and manganese in the water may cause staining; other substances interfere by chemical reaction during some steps in the processing.

Based on the criteria given in table 16, water for industrial use can be obtained throughout most of the Santee River estuary. The less stringent the requirements of an industry, the farther downstream can be the point of withdrawal. Water for cooling and boiler makeup usually can be obtained upstream from mile 7.0 on the North Santee River and upstream from mile 8.0 on the South Santee River. For industries requiring water with criteria equivalent to those of public water supply, suitable water may be obtained at those locations and under the conditions described under "Domestic use".

Water for industries such as the textile, which may require water having a dissolved-solids content not exceeding 150 mg/l, must be withdrawn farther upstream than those meeting public supply criteria. Figure 23 indicates that water having a dissolved-solids content of 150 mg/l has a specific conductance of 250 micromhos. Such water can likely be obtained under most conditions upstream from mile 18. If fresh water inflow to the estuary is increased by diversion of water from the Cooper River basin, water of acceptable quality to many industries will be available at points farther downstream.

Agricultural use

Irrigation

Studies of the quality of water for irrigation in the western part of the United States have been more extensive than in other parts of the country. In recent years increasing attention has been given to the quality of water for supplementary irrigation in the more humid eastern part of the country. Criteria for judging the suitability of water in arid areas differ from those necessary in humid areas, principally because of the more acidic soils, more frequent rainfall and better leaching of soil that occurs, and the fact that irrigation water is applied only when rainfall is deficient. In all irrigation water, however, important considerations are (1) the sodium content, (2) the relation of sodium to bicarbonate and to calcium and magnesium in the water, (3) trace elements such as boron, and (4) total mineralization. In humid regions, the relative importance of one factor may be different from that in an arid region. In general, more highly mineralized waters may be used for irrigation in the eastern part of the country than in the western part.

Lunin and others (1960) found that in humid areas there is a relation between the number of times supplementary irrigation water may be applied and the specific conductance of water, provided there has been no salt accumulation in soils prior to the start of irrigation, and there is no intervening rainfall sufficient to leach the soils. Their suggested guidelines, for crops of different salt tolerance1/ are as follows:

1/ Some of the crops having good salt tolerance include barley, beets, cotton, saltgrass, bermudagrass, barley hay, kale, asparagus, and spinach. Some of the crops having moderate salt tolerance include rye, wheat, oats, corn, sweetclover, Dallisgrass, alfalfa, vetch, tomatoes, broccoli, cabbage, potatoes, lettuce, pepper, squash, carrots, onions, peas, cucumbers, grapes, and cantaloupes. Crops having a poor salt tolerance include field beans, white clover, radishes, celery, green beans, pears, apples, plums, apricots, and peaches.

Specific conductance (micromhos at 25°C)	Number of irrigations: Good salt tolerance	Moderate salt tolerance	Poor salt tolerance
1,000	--	15	7
2,000	11	7	4
3,000	7	5	2
4,000	5	3	2
5,000	4	2-3	1
6,000	3	2	1
7,000	2-3	1-2	--
8,000	2	1	--

Based on figure 15, which shows average salinity conditions in the Santee River estuary, water having a specific conductance of 1,000 micromhos or less can be obtained from the North Santee River upstream from about mile 11 at high tide, and upstream from mile 8.0 at low tide. Water having a specific conductance of 8,000 micromhos or less usually can be obtained about one mile farther downstream in each case. On the South Santee River, water having a specific conductance of 1,000 micromhos usually can be obtained upstream from mile 13 at high tide, and upstream from about mile 11 at low tide. Water having a specific conductance of 8,000 micromhos or less on the South Santee River can be obtained one to two miles farther downstream. Figures 13 and 14 indicate, however, that under occasional high tide conditions, water of 1,000 micromhos or less can be obtained only above mile 14 on both the North and South Santee River, and water of no greater than 8,000 micromhos about one to two miles farther downstream.

Stock and Wildlife Watering

Studies relating water quality to the health of stock and wildlife have not been numerous, and therefore rigid criteria for evaluating the usefulness of a supply are difficult to establish. Stock are capable of good health even when they drink water unfit for human consumption. Nevertheless, a high dissolved-solids content can cause poor growth, sickness, and even death. Beath and others (1953) suggested the following classification as a guide for evaluating stock water:

Dissolved-solids content (mg/l)	Classification
Less than 1,000	Good
1,000 to 3,000	Fair (usable)
3,000 to 5,000	Poor (usable)
5,000 to 7,000	Very poor (questionable)
more than 7,000	Not advisable

Other studies have indicated that sulfate, sodium, fluoride, chloride, and some trace substance may be objectionable if present in high concentrations. Usually, however, if the total dissolved-solids content is not excessive, individual dissolved substances do not occur in harmful amounts. Livestock vary in their tolerance to highly mineralized water; the National Technical Advisory Committee (1968) has listed stock in an order of increasing tolerance as follows: poultry, swine, horses, dairy cattle, beef cattle, and sheep.

Using guidelines cited above, and figures 13, 14, and 15, the suitability of water for stock watering at various locations in the Santee River estuary can be determined.

Aquatic Life

Aquatic life in streams and estuaries are, in a sense, the products of the existing environment. Under natural conditions, there exists a delicate balance between the various forms of life that have developed. Water quality criteria become important mainly when man's activity alters or threatens to alter the environment by the disposal of wastes, by causing a major change in streamflow, or by modifying the physical condition of the basin. The National Technical Advisory Committee (1968) states that in order to protect estuarine organisms, no changes in channels, basin geometry, or freshwater inflow should be made that will permanently change existing salt water patterns by more than ten percent.

Criteria suggested for aquatic life are usually applied to unpolluted environments from the standpoint of whether or not a given change in water quality will permit the water to continue to be suitable for existing organisms rather than whether existing water quality is suitable. Detailed examinations of criteria can be found in publications of the California Water Quality Control Board (1963) and the National Technical Advisory Committee (1968).

At the present time only two chemical parameters are potentially hazardous to aquatic life in the Santee River estuary. Synthetic detergents (MBAS) were found at all locations at which samples were obtained for chemical analysis. The maximum concentration found was 3.4 mg/l. (See table 9 and section on chemical characteristics of water.) The National Technical Advisory Committee has suggested that MBAS not exceed 1 mg/l for a period exceeding 24 hours. If data obtained are typical of usual conditions, recommended criteria for MBAS are exceeded in the lower reaches of the Santee River estuary.

Because of their acute toxicity, pesticides are extremely harmful to aquatic life. For some of the chlorinated hydrocarbon insecticides, the National Technical Advisory Committee has listed 48-hour TL_m 1/ values for shrimp as follows:

Insecticide	48-hour TL_m (in µg/l)
Aldrin	0.04
Endrin	.2
Heptachlor	.2
Lindane	.2
DDT	.6
DDD	3.0
Dieldrin	.3

The Advisory Committee recommends that environmental levels of the above substances not be permitted to exceed 0.05 µg/l.

Concentrations of insecticides found in water of the Santee River estuary do not exceed the recommended maximum environmental value. Although the concentrations found in bed material are not directly comparable to the recommended criteria because they are reported in micrograms per kilogram of material, the higher concentrations of DDE (0.83 and 0.32 µg/l) and DDD (1.7 and 0.92 µg/l) found in the lower reaches of the Santee River estuary represent a potential hazard to organisms that exist on the bottom, and ultimately to other forms of aquatic life in the food chain.

STREAM CLASSIFICATION AND WATER QUALITY STANDARDS OF SOUTH CAROLINA

The South Carolina Pollution Control Authority has classified streams and set water quality standards for the purpose of protecting and improving the quality of waters of the State. The North and South Santee Rivers from the Atlantic Ocean to a point 1,000 feet upstream from the Intracoastal Waterway are classified as Class SA. From a point 1,000 feet upstream from the Intracoastal Waterway to U. S. Highway 17, the North and South Santee Rivers are classified as Class SB. Upstream from U. S. Highway 17, the North and South Santee Rivers and the Santee River are classified as Class C.

1/ Median tolerance limit - the amount required to kill 50 percent of test organisms within an exposure period of 48 hours.

Class SA waters are those defined as being suitable for shell fishing for market purposes and any other usages, and as being suitable for uses requiring water of lesser quality. Waters in this class shall be free of garbage, cinders, ashes, oils, sludge or other refuse, and sewage or waste effluents must be effectively disinfected. Dissolved oxygen must not be less than 5.0 mg/l; coliform group organisms must meet U. S. Public Health Service standards. Toxic wastes, deleterious substances, colored or other wastes may not be added to the water in sufficient amounts to be injurious to edible fish or shellfish or their culture and propagation. Wastes must not change the pH more than 0.3 units above or below waste free water in the same area; in fall, winter and spring, wastes must not raise the temperature of the water by more than 4°F (2.2°C), and in the summer by more than 1.5°F (0.8°C).

Class SB water is defined as that suitable for bathing and any other usages except shellfishing for market purposes, and as being also suitable for uses requiring water of less quality. Standards for Class SB are similar to those for Class SA water, with the exception that limits on fecal coliform have been included and the variation in pH may be 0.5 unit.

Class C water is defined as that suitable for propagation of fish, industrial and agricultural uses, and other uses requiring water of lesser quality. The pH of these waters must range between 6.0 and 8.5, except swamp waters, which may range between 5.0 and 8.5. Dissolved oxygen must not be less than 4 mg/l, except for swamp waters which may be as low as 2.5 mg/l. Temperature shall not exceed 93.2°F (34°C) at any time after mixing of heated and normal water.

With respect to the substances and properties measured in this investigation, waters of the North Santee, South Santee, and Santee Rivers meet standards of the South Carolina Pollution Control Authority.

SUMMARY

High and low tides on the South Santee River may occur as much as an hour earlier or later than predicted from tide tables. Over a number of tidal cycles, however, actual times of high or low tide tend to agree closely with predicted times. In the lower reaches of the estuary, the times and height of high and low tide may be considered concurrent and of the same magnitude on both the North and South Santee Rivers at the same distance upstream from the mouth. At a tidal gage at mile 37 near Jamestown, high tide occurs an average of 3 hours and 40 minutes later than at the gage on the South Santee River below Pleasant Creek at mile 6.6. Low tide occurs on the average 5 hours and 32 minutes later. Data suggest that through mile 13 at least, high tide occurs about 7 minutes later each successive mile upstream; low tide occurs about 11 minutes later each successive mile upstream.

Fresh-water inflow to the Santee River estuary is usually 500 to 600 cfs, although as much as 81,800 cfs has been released from Lake Marion for a short period during the past ten years. During 1969, releases from Lake Marion were 40,000 cfs or greater on four consecutive days.

Under normal flow conditions, an estimated 85 percent of the fresh-water inflow to the estuary moves to the sea through the North Santee River channel. Below mile 15, the North Santee River has estimated volumes of 7.8×10^8 cubic feet at mean high tide, and 5.3×10^8 cubic feet at mean low tide. Below mile 15, the South Santee River has estimated volumes of 6.7×10^8 cubic feet at mean high tide, and 3.9×10^8 cubic feet at mean low tide.

In the lower reach of the North Santee River, measurements of tidal discharge showed a maximum of 18,500 cfs on the flood tide, and 18,500 cfs on the ebb tide. In the lower reach of the South Santee River, comparable discharges were 14,500 cfs on the flood tide, and an estimated 15,800 cfs on the ebb tide. Depending upon depth and location, the velocity of the water in the lower reaches of the Santee River estuary ranges from less than 1 fps to about 4 fps.

No exact relation between specific conductance and tide height could be deduced from the data obtained. However, the higher the height of a tide the greater is specific conductance at a given location on both the North and South Santee Rivers. At high tide, maximum specific conductance values measured at mile 5.0 on both the North and South Santee Rivers were between 40,000 and 50,000 micromhos; maximum values measured at mile 12 on both rivers were between 10,000 and 15,000 micromhos. Minimum values at high tide were considerably less on the North Santee River than on the South Santee River. On the North Santee River at mile 5.0, minimum values were 4,000 micromhos or more; on the South Santee River at mile 5.0, minimum values were 23,000 micromhos or more. The lower values for the North Santee River reflect the fact that much of the fresh-water inflow to the estuary passes to the ocean through the North Santee River channel.

The upstream boundary of tidal salt waters, defined by the South Carolina Pollution Control Authority as having a chloride content of 250 mg/l or greater, occurs between miles 8.0 and 11 on the North Santee River, and between miles 9.0 and 13 on the South Santee River.

Flood releases from Lake Marion, beginning April 16 and ending April 30, were equivalent to an estimated twenty times the high tide volume of both the North and South Santee River below mile 15. The effect of these waters was to reduce the specific conductance at mile 4.0 on the North Santee River at high tide to less than 1,000 micromhos until May 4. Measurements at high tide were not made on the South Santee River until April 30, but at low tide specific conductance was less than 1,000 micromhos until May 5. This suggests that specific conductance at high tide on the South Santee River did not drop so low as on the North Santee River. Under normal conditions, the Santee River estuary may be classed as partially-mixed; during the flood its salinity characteristics were those of a highly stratified estuary. If the proposed diversion of water from Lake Moultrie occurs, the Santee River estuary, particularly the North Santee River, may tend to become highly stratified.

Temperature of water in the Santee River estuary ranged from 5.0°C in January to 28.5°C in June. The difference between temperature one foot below the surface and temperature one foot above the bottom did not exceed 1°C at any location. At the time of most measurements, temperature near the surface was slightly higher. Dissolved oxygen ranged from 5.9 mg/l to 16.0 mg/l. Percent saturation ranged from 61 to 130. The difference between dissolved oxygen one foot below the surface and one foot above the bottom did not exceed 1.5 mg/l at any location.

The chemical characteristics of water of the Santee River estuary typify predictable compositions that result from the mixing of fresh-water inflow (maximum dissolved-solids content, 73 mg/l) with sea water. Of substances found upon analysis, only MBAS and chlorinated hydrocarbon insecticides could be identified as of other than natural origin. DDD, DDE, and DDT were detected in the water; bed material, however, contained significantly more than the overlying water. Radiochemicals are low in the Santee River estuary as are coliform bacteria. On the North Santee River, a maximum Secchi disc transparency of 3.2 feet occurs between miles 25 and 30, a maximum color of 65 units occurs at about mile 12, and maximum turbidities of 40 to 50 mg/l SiO_2 occur below mile 15. On the South Santee River, similar conditions exist, with the major exception that color was as great as 180 units.

Suspended sediment concentrations are higher below mile 10 on both the North and South Santee Rivers than above mile 10. At most locations sand constitutes more than 90 percent of the bed material. Size analyses indicate, however, that between mile 5.0 and 7.0 on both the North and South Santee Rivers, the fraction of silt and clay is greater than 10 percent.

Water of the Santee River estuary at mile 14 and above is of excellent quality for most domestic, industrial, agricultural uses, and the propagation of aquatic life. Below mile 14, consideration must be given to the effect of salt water, and to the conditions under which withdrawals are to be made. The suitability of water for industrial use depends primarily upon the intended use, and sites selected for withdrawal must be made on that basis.

Similarly, below mile 14, withdrawal water for irrigation must be based on the salt tolerance of crops and the amount of water required. The presence of pesticides and MBAS in water of the Santee River estuary represent a potential hazard to aquatic life and to the suitability of the water for domestic use should the concentrations of either increase significantly.

SELECTED REFERENCES

Beath, O. A., and others, 1953, Poisonous plants and livestock poisoning: Wyoming Agr. Expt. Sta., Bull. 324, 94 p.

California State Water Quality Control Board, 1963, Water quality criteria: California State Water Quality Control Board, pub. 3-A, 548 p.

Cox, R. A., 1965, The physical properties of sea water, in Riley, J. P., and Skirrow, Geoffrey, Chemical oceanography: New York, Academic Press, v. 1, p. 105.

Hazen, Allen, 1892, A new color standard for natural waters: Am. Chem. Soc. Jour., v. 12, p. 427-428.

Lunin, Jesse, and others, 1960, Use of brackish water for irrigation in humid regions, U. S. Department of Agriculture, Agriculture Information Bull. 213, 5 p.

National Technical Advisory Committee, 1968, Water quality criteria: Federal Water Pollution Control Administration, 234 p.

Pritchard, D. W., 1967, Observations of circulation in coastal plain estuaries, in Lauff, G. H., Estuaries: Washington, D. C., American Association for the Advancement of Science, pub. 83, p. 37.

Riley, J. P., and Skirrow, Geoffrey, 1965, Chemical oceanography: New York, Academic Press, v. 1, p. 647.

South Carolina Pollution Control Authority, 1967, Water classification-standards system for the State of South Carolina: South Carolina Pollution Control Authority, Columbia, South Carolina, 8 p.

U. S. Coast and Geodetic Survey, 1965, Surface water temperature and salinity, Atlantic coast of North and South America: U. S. Coast and Geodetic Survey pub. 31-1.

____________________, 1969, High and low water predictions, east coast of North and South America, including Greenland: U. S. Coast and Geodetic Survey Tide Tables.

U. S. Geological Survey, Quality of surface waters of the United States, pts. 1 and 2, North Atlantic Slope Basins and South Atlantic Slope and Eastern Gulf of Mexico Basins: U. S. Geol. Survey Water-Supply Papers (published annually through 1963).

________________________, Water Resources data for South Carolina, pt. 2, Water quality records (published annually since 1964).

________________________, Surface water supply of the United States, pt. 2-A, South Atlantic Slope basins, James River to Savannah River: U. S. Geol. Survey Water-Supply Papers (published annually through 1960).

________________________, Water Resources data for South Carolina, pt. 1, Surface water records (published annually since 1961).

U. S. Public Health Service, 1962, Drinking water standards: U. S. Public Health Service Pub. 956, 61 p.

Table 1.--Discharge measurements of Santee River near Jamestown, April and May 1969.

/Measurements by U. S. Geological Survey/

Date	Time	Discharge (cfs)
April 29, 1969	1320	24,400
May 1, 1969	0750	20,500
Do--------	1155	21,000
Do--------	1615	21,400
May 3, 1969	0825	10,600
Do--------	1145	10,100
Do--------	1535	9,340
May 5, 1969	0830	3,230
Do--------	1220	3,140
Do--------	1555	3,100
May 7, 1969	0830	2,140
Do--------	1230	1,880

Table 2.--Tidal discharge and velocity measurements, North and South Santee Rivers, February, April, and June 1969.

/Measurements by U. S. Geological Survey/

Location	Date	Time	Discharge (cfs)[1/]	Average velocity (fps)[1/]
North Santee River, mile 5.9	Feb. 12, 1969	0944	+ 13,900	+ 1.3
	-----do-----	0953	+ 12,100	+ 1.2
	-----do-----	1004	+ 12,900	+ 1.3
	April 22, 1969	1339	+ 15,300	+ 1.2
	------do------	1359	+ 16,300	+ 1.4
	------do------	1419	+ 17,000	+ 1.4
	June 4, 1969	0645	+ 11,000	+ 1.2
	-----do------	0735	- 2,270	- .2
	-----do------	0807	- 5,600	- .5
	-----do------	0840	- 11,000	- 1.0
	-----do------	0906	- 14,400	- 1.3
	-----do------	0957	- 18,500	- 1.5
	-----do------	1040	- 18,400	- 1.5
	-----do------	1138	- 10,900	- .9
	-----do------	1220	+ 5,460	+ .4
	-----do------	1308	+ 9,180	+ .8
	-----do------	1354	+ 18,000	+ 1.5
	-----do------	1442	+ 17,600	+ 1.6
	-----do------	1538	+ 18,500	+ 1.6
	-----do------	1624	+ 18,000	+ 1.8
	-----do------	1707	+ 14,800	+ 1.5
	-----do------	1750	+ 13,200	+ 1.3
South Santee River, mile 7.0	Feb. 13, 1969	1022	+ 12,300	+ 1.3
	-----do------	1033	+ 11,300	+ 1.2
	-----do------	1044	+ 10,900	+ 1.2
	April 22, 1969	1511	+ 8,950	+ 0.9
	------do------	1525	+ 9,170	+ .9
	------do------	1540	+ 8,820	+ .9
	June 5, 1969	0752	+ 1,210	+ 0.1
	-----do-----	0846	- 8,620	- .9
	-----do-----	0927	- 11,500	- 1.1
	-----do-----	1010	- 12,600	- 1.2
	-----do-----	1109	- 14,500	- 1.2
	-----do-----	1204	- 9,960	- .8
	-----do-----	1306	- 2,030	- .2
	-----do-----	1410	+ 8,150	+ .7
	-----do-----	1508	+ 14,900	+ 1.4

1/ Positive values signify ebb tide; negative values signify flood tide.

Table 3.--Velocity of tidal outflow, Santee River estuary, March 19, 1969

/Measurements by U. S. Geological Survey/

Depth (in feet)	Velocity (in feet per second)					
	North Santee River, Mile 8.0			North Santee River, Mile 13		South Santee River, Mile 7.0
	Left quarter-point	Midstream	Right quarter-point	Left quarter-point	Midstream	Midstream
1	1.66	1.80	1.84	0.80	2.20	1.62
2	--	--	--	1.62	2.20	--
3	2.24	2.10	1.84	1.76	1.84	1.44
4	--	--	--	1.76	1.96	--
5	1.92	1.84	1.76	1.70	1.96	.95
6	--	--	--	1.54	1.88	--
7	1.84	1.96	1.76	1.47	1.47	.89
8	--	--	--	1.58	1.66	--
9	1.38	1.73	1.76	1.23	1.51	.55
10	--	--	--	1.16	1.47	--
11	--	1.84	1.84	.70	1.29	.25
12	--	--	--	--	--	--
13	--	1.96	1.92	--	--	--
15	--	1.47	1.38	--	--	--
17	--	1.32	1.33	--	--	--
18	--	1.11	--	--	--	--
19	--	--	1.33	--	--	--

Table 4.--Field measurements of specific conductance, temperature, and dissolved oxygen of the North Santee River.

[Measurements by U. S. Geological Survey]

Date	Tide	Depth (in Feet)	Mile 6.0				Mile 7.0				Mile 9.0				Mile 10.5			
			Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)
December 10, 1968	High	1	19,000	8.1	14.8	126	16,000	8.1	13.4	121	12,000	8.6	13.3	120	7,300	8.0	14.0	122
		3	21,000	8.1	13.4	123	16,000	8.2	14.0	126	12,000	8.6	13.3	120	7,300	7.9	14.7	128
		5	23,000	8.0	13.7	125	16,000	8.2	14.0	126	12,800	8.6	13.7	124	7,300	7.9	14.7	128
		7	25,000	8.0	13.4	123	16,500	8.3	13.8	125	13,000	8.6	13.7	124	7,500	7.9	14.7	128
		10	25,000	8.0	13.4	123	16,500	8.3	14.0	126	13,000	8.6	13.7	124	8,000	7.9	14.3	128
		12	25,000	8.0	13.4	123	16,500	8.1	14.0	126	13,100	8.6	13.7	124	8,000	7.9	14.3	126
		14	25,000	8.0	13.4	123	16,500	8.1	14.0	126	13,100	8.6	13.7	124	8,000	7.9	14.3	128
		16	26,000	8.0	13.4	124	16,500	8.1	14.0	126	13,100	8.6	13.7	124	8,000	7.9	14.5	128
		18	26,000	8.0	13.4	124	16,500	8.1	14.0	126	13,200	8.6	13.7	124	--	--	--	--
		20	--	--	--	--	--	--	--	--	13,800	--	13.7	124	--	--	--	--
		22	--	--	--	--	--	--	--	--	13,800	8.6	13.7	124	--	--	--	--
		24	--	--	--	--	--	--	--	--	14,000	8.6	13.7	124	--	--	--	--
		26	--	--	--	--	--	--	--	--	14,000	8.6	13.7	124	--	--	--	--
		28	--	--	--	--	--	--	--	--	14,000	8.6	13.7	124	--	--	--	--
		29	--	--	--	--	--	--	--	--	14,000	8.6	13.7	124	--	--	--	--

Date	Tide	Depth (in Feet)	Mile 12				Mile 12.5				Mile 13				Mile 15			
			Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)
December 10, 1968	High	1	1,760	9.2	13.1	116	410	9.2	13.6	119	200	9.1	13.7	121	128	9.1	13.7	121
		3	2,000	9.2	13.8	122	445	9.1	13.7	121	210	9.2	13.9	122	--	--	--	--
		5	2,350	9.2	13.9	124	445	9.0	14.1	123	222	9.1	14.0	124	--	--	--	--
		7	2,680	9.3	13.9	123	450	9.1	14.0	124	238	9.2	13.9	122	--	--	--	--
		10	2,710	9.2	13.9	124	400	9.2	13.9	122	240	9.2	13.9	122	130	9.1	13.7	121
		12	2,800	9.2	13.9	124	550	9.2	13.9	122	240	9.2	13.9	122	--	--	--	--
		14	2,820	9.2	13.9	124	555	9.2	13.9	122	240	9.2	13.9	122	--	--	--	--
		16	2,820 1/	9.2	13.9	124	565	9.2	13.9	122	240 1/	9.2	13.9	122	--	--	--	--
		18	--	--	--	--	570	9.2	13.9	122	--	--	--	--	--	--	--	--
		20	--	--	--	--	570	9.2	13.9	122	--	--	--	--	130	9.1	13.7	121
		22	--	--	--	--	550	9.2	13.9	122	--	--	--	--	--	--	--	--
		24	--	--	--	--	--	--	--	--	--	--	--	--	130	9.1	13.7	121
		26	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		28	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		29	--	--	--	--	--	--	--	--	--	--	--	--	130	9.0	13.8	120

Date	Tide	Depth (in Feet)	Mile 18.9				Mile				Mile				Mile			
			Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)
December 10, 1968	High	1	105	8.9	13.8	120												
		3	105	8.9	13.8	120												
		5	105	8.9	13.8	120												
		7	105	8.9	13.8	120												
		10	105	8.9	14.0	122												

Table 4.--Field measurements of specific conductance, temperature, and dissolved oxygen of the North Santee River--continued.

[Measurements by U. S. Geological Survey]

Date	Tide	Depth (In Feet	Mile 5.0				Mile 6.0				Mile 7.0				Mile 8.0			
			Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)
January 16, 1969	Low	1	13,600	5.6	13.8	115	15,000	6.1	13.3	115	9,200	6.1	13.1	111	5,800	6.0	13.3	110
		3	13,800	5.6	14.0	119	15,200	6.0	13.7	117	9,600	6.1	13.1	111	6,800	--	13.1	109
		5	13,900	--	14.0	119	15,100	6.0	13.7	117	9,800	6.0	13.4	112	6,800	6.0	13.1	109
		7	14,000	5.6	14.0	119	15,200	6.0	13.7	117	10,900	5.9	13.1	110	6,800	--	13.1	109
		10	13,500	--	14.0	119	15,300	6.0	13.7	117	12,200	5.7	13.0	110	6,800	6.0	13.1	109
		12	13,500	5.6	13.8	117	15,400	--	13.7	117	13,800	5.7	13.0	110	5,800	--	13.1	109
		14	13,700	--	13.8	117	15,400	5.9	13.4	115	--	--	--	--	6,800	6.0	13.1	109
		16	18,000	5.7	13.5	115	15,400	5.9	13.4	115	--	--	--	--	5,800	6.0	13.3	110
		18	--	--	--	--	15,500	5.9	13.4	115	--	--	--	--	6,900	6.0	13.3	110
		20	--	--	--	--	15,030	5.9	13.4	115	--	--	--	--	5,800	6.0	13.3	110
		22	--	--	--	--	--	--	--	--	--	--	--	--	5,900	6.0	13.2	110
		24	--	--	--	--	--	--	--	--	--	--	--	--	5,900	6.1	13.3	110
		25	--	--	--	--	--	--	--	--	--	--	---	--	5,900	6.0	13.3	110

Date	Tide	Depth (In Feet	Mile 9.0				Mile 10				Mile 11				Mile 12			
			Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)
January 16, 1969	Low	1	770	6.1	13.4	110	190	6.0	13.6	111	154	6.0	13.4	109	125	6.0	13.6	111
		3	770	--	13.4	110	190	--	13.6	111	155	--	13.4	109	125	--	13.6	111
		5	780	6.1	13.6	112	191	6.0	13.6	111	155	6.0	13.9	113	126	6.0	14.3	116
		7	800	--	13.6	112	195	--	13.6	111	157	--	13.9	113	126	--	14.3	116
		10	800	6.0	13.6	111	195 [2]	6.0	13.4	109	157	--	13.9	113	127 [2]	6.0	14.0	114
		12	790	--	13.6	111	--	--	--	--	--	--	--	--	--	--	--	--
		14	780	6.0	13.6	111	--	--	--	--	--	--	--	--	--	--	--	--
		16	780	--	13.6	111	--	--	--	--	160	6.0	13.9	113	--	--	--	--
		18	740	6.0	13.6	111	--	--	--	--	--	--	--	--	--	--	--	--
		20	780	--	13.6	111	--	--	--	--	--	--	--	--	--	--	--	--
		22	780	6.0	13.6	111	--	--	--	--	--	--	--	--	--	--	--	--

Date	Tide	Depth (In Feet	Mile 13				Mile 14				Mile				Mile			
			Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)
January 16, 1969	Low	1	116	6.0	14.1	114	115	6.1	13.8	113								
		3	116	--	14.1	114	--	--	--	--								
		5	117	6.0	14.5	117	--	--	--	--								
		7	119	--	14.5	117	--	--	--	--								
		10	119	--	14.1	114	--	--	--	--								
		12	119 [3]	6.0	14.1	114	--	--	--	--								
		14	--	--	--	--	--	--	--	--								
		16	--	--	--	--	117 [4]	--	13.8	113								
		18	--	--	--	--	--	--	--	--								
		20	--	--	--	--	117 [5]	6.1	13.8	113								

Table 4.--Field measurements of specific conductance, temperature, and dissolved oxygen of the North Santee River--continued.

[Measurements by U. S. Geological Survey]

Date	Tide	Depth (In Feet	Mile 5.0				Mile 6.0				Mile 7.0				Mile 8.0			
			Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)
February 13, 1969	Low	1	9,800	10.1	9.6	91	6,600	10.4	9.7	91	1,400	10.6	9.8	92	275	10.5	9.7	90
		3	10,300	10.1	9.4	90	6,700	10.4	9.4	88	1,610	10.4	9.7	90	275	10.4	9.8	90
		5	10,700	10.0	9.4	88	7,100	10.1	9.5	90	2,200	10.3	9.6	89	275	10.4	9.8	90
		7	11,700	10.0	9.3	88	7,200	10.1	9.4	88	2,800	10.3	9.6	89	275	--	--	--
		10	13,200	9.8	9.2	87	7,200	10.1	9.4	88	3,900	10.2	9.3	87	275	10.4	9.6	89
		12	15,000	9.8	9.0	86	7,200	10.1	9.4	88	4,000 7/	10.2	9.1	85	275	10.4	9.6	89
		14	16,000	9.7	9.0	87	7,100	10.1	9.4	88	--	--	--	--	275	--	--	--
		16	--	--	--	--	7,100	10.2	9.3	88	--	--	--	--	275	10.4	9.7	90
		18	--	--	--	--	7,100	10.2	9.4	89	--	--	--	--	275	10.3	9.6	89
		20	--	--	--	--	7,100 8/	10.3	9.5	90	--	--	--	--	--	--	--	--
		21	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Date	Tide	Depth (In Feet	Mile 9.0				Mile 10				Mile 11				Mile 12			
			Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)
February 12, 1969	Low	1	149	10.4	10.4	96	125	10.6	10.3	96	110	10.5	10.4	96	111	10.5	10.6	98
		3	--	--	--	--	125	10.6	10.3	96	110	--	--	--	111	--	--	--
		5	--	10.6	--	--	125	--	--	--	117	10.5	10.4	96	111	10.5	10.4	96
		7	--	--	10.0	93	125	10.5	10.0	92	117	--	--	--	111	--	--	--
		10	149	--	--	--	125 8/	10.5	10.2	94	118	10.5	10.2	94	111	10.4	10.5	97
		12	--	--	--	--	--	--	--	--	118	--	--	--	112	10.4	10.4	96
		14	--	--	--	--	--	--	--	--	118	10.4	10.0	93	--	--	--	--
		16	150	10.5	9.8	91	--	--	--	--	118	10.4	10.2	94	--	--	--	--
		18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		20	151	10.5	9.8	91	--	--	--	--	--	--	--	--	--	--	--	--
		21	150	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Date	Tide	Depth (In Feet	Mile 13				Mile 14				Mile				Mile			
			Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)
February 12, 1969	Low	1	110	10.6	10.4	97	110	10.6	11.0	102								
		3	110	--	--	--	110	--	--	--								
		5	110	10.5	10.5	97	110	10.6	10.9	102								
		7	110	--	--	--	110	--	--	--								
		10	110	10.5	10.5	97	110	10.5	10.7	99								
		12	110 9/	10.5	10.5	97	110	--	--	--								
		14	--	--	--	--	110	10.5	10.7	99								
		16	--	--	--	--	110	--	--	--								
		18	--	--	--	--	110	10.5	10.6	99								
		20	--	--	--	--	112	10.4	10.6	98								
		21	--	--	--	--	--	--	--	--								

Table 4.--Field measurements of specific conductance, temperature, and dissolved oxygen of the North Santee River--continued.

/Measurements by U. S. Geological Survey/

Date	Tide	Depth (In Feet	Mile 5.0				Mile 6.0				Mile 7.0				Mile 8.0			
			Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)
March 19, 1969	High	1	18,000	11.8	8.8	89	12,800	11.8	8.9	88	10,200	11.5	9.1	89	6,600	11.8	9.6	94
		3	18,000	11.8	8.9	90	12,800	11.7	9.0	89	10,200	11.5	9.1	89	6,800	11.8	9.3	92
		5	18,000	11.8	9.1	92	12,800	11.8	8.9	88	10,600	11.5	9.1	89	6,900	11.7	9.3	92
		7	18,600	11.8	8.7	88	14,000	11.8	8.9	89	11,800	11.5	9.1	89	7,100	11.6	9.4	91
		10	19,400	11.8	8.6	88	15,700	11.5	8.9	88	12,800	11.5	8.8	87	7,700	11.5	9.3	91
		12	19,400	11.7	8.7	88	16,200	11.5	8.7	86	12,800	11.5	8.8	87	7,700	11.6	9.3	91
		14	19,400	11.7	8.7	88	16,900	11.6	8.6	87	12,800	11.5	8.8	87	8,200	11.6	9.2	90
		16	20,100	11.7	8.6	88	16,900	11.5	8.8	87	--	--	--	--	8,800 10/	11.6	9.2	90
		18	20,100	11.8	8.0	82	16,900	11.5	8.8	87	--	--	--	--	--	--	--	--
		20	--	--	--	--	16,900	11.5	8.8	87	--	--	--	--	--	--	--	--
		22	--	--	--	--	16,900	11.5	8.8	87	--	--	--	--	--	--	--	--

Date	Tide	Depth (In Feet	Mile 9.0				Mile 10				Mile 10.5				Mile 12			
			Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)
March 19, 1969	High	1	1,650	10.8	10.2	98	850	11.8	10.1	99	490	11.9	10.1	97	140	12.0	10.6	100
		3	1,650	10.8	10.2	98	875	11.8	10.0	98	490	11.8	10.1	96	146	12.0	10.4	99
		5	1,750	11.7	9.6	95	850	11.8	9.9	97	480	11.8	10.1	97	146	11.9	10.6	100
		7	1,800	11.6	9.7	95	850	11.7	10.0	98	480	11.8	9.9	95	146	11.9	10.2	97
		10	2,300	11.6	9.6	94	860	11.6	10.0	98	480	11.7	10.2	97	146	11.8	10.3	96
		12	2,300	11.5	9.6	94	--	--	--	--	482	11.6	10.0	96	142	11.8	10.3	98
		14	2,500	11.5	9.6	04	--	--	--	--	--	--	--	--	142	11.8	10.3	98
		16	2,600	11.5	9.6	94	--	--	--	--	--	--	--	--	146 11/	11.8	9.9	94
		18	2,600	11.5	9.6	94	--	--	--	--	--	--	--	--	--	--	--	--
		20	2,600	11.5	9.6	94	--	--	--	--	--	--	--	--	--	--	--	--
		22	2,650	11.5	9.6	94	--	--	--	--	--	--	--	--	--	--	--	--

Date	Tide	Depth (In Feet	Mile 13				Mile 14				Mile				Mile			
			Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)
March 19, 1969	High	1	142	12.0	10.5	100	95	11.9	10.6	100								
		3	142	11.9	10.5	100	96	11.9	10.6	100								
		5	146	11.8	10.5	100	98	11.9	10.4	99								
		7	146	11.8	10.5	100	96	11.9	10.4	99								
		10	146	11.7	10.5	100	96	11.8	10.4	99								
		12	146	11.6	10.4	100	98	11.8	10.4	99								
		14	146	11.5	10.5	99	95	11.9	10.3	98								
		16	--	--	--	--	96	11.9	10.3	98								
		18	--	--	--	--	--	--	--	--								
		)	--	--	--	--	--	--	--	--								
		22	--	--	--	--	--	--	--	--								

[Measurements by U. S. Geological Survey]

Date	Tide	Depth (In Feet)	Mile 5.0 Specific Conductance (in micromhos at 25°C)	Mile 5.0 Temperature (°C)	Mile 5.0 Dissolved Oxygen (mg/l)	Mile 5.0 Dissolved Oxygen (percent saturation)	Mile 6.0 Specific Conductance (in micromhos at 25°C)	Mile 6.0 Temperature (°C)	Mile 6.0 Dissolved Oxygen (mg/l)	Mile 6.0 Dissolved Oxygen (percent saturation)	Mile 7.0 Specific Conductance (in micromhos at 25°C)	Mile 7.0 Temperature (°C)	Mile 7.0 Dissolved Oxygen (mg/l)	Mile 7.0 Dissolved Oxygen (percent saturation)	Mile 8.0 Specific Conductance (in micromhos at 25°C	Mile 8.0 Temperature (°C)	Mile 8.0 Dissolved Oxygen (mg/l)	Mile 8.0 Dissolved Oxygen (percent saturation)
June 19, 1969	High	1	4,000	28.0	6.9	90	3,300	28.2	7.1	93	1,350	28.0	6.9	89	350	28.0	7.0	90
		3	7,000	27.8	6.8	89	3,400	28.2	6.9	91	1,600	28.0	6.9	89	340	28.0	7.0	90
		5	8,500	27.8	6.5	88	5,500	28.2	6.2	82	1,850	28.0	6.9	89	330	27.8	7.2	93
		7	9,500	27.5	6.6	87	6,200	27.5	6.3	82	2,000	27.5	6.7	86	320	27.8	7.0	90
		10	10,000	27.5	6.6	87	8,100	27.5	6.1	80	3,000	27.5	6.4	82	320	27.5	6.8	87
		12	10,000	27.4	6.5	86	8,800	27.4	6.1	80	3,000	27.5	6.4	82	310	27.5	6.8	87
		14	10,000	27.4	6.5	86	9,200	27.5	6.1	80	3,000	27.5	6.4	82	310	27.5	6.5	83
		16	--	--	--	--	9,400	27.5	6.1	80	--	--	--	--	310	27.5	6.5	83
		18	--	--	--	--	9,800	27.5	6.1	80	--	--	--	--	320	27.5	6.2	79
		20	--	--	--	--	9,900	27.5	6.1	80	--	--	--	--	320	27.5	6.3	81
		22	--	--	--	--	--	--	--	--	--	--	--	--	320	27.5	6.2	79

Date	Tide	Depth (In Feet)	Mile 8.6 Specific Conductance (in micromhos at 25°C)	Mile 8.6 Temperature (°C)	Mile 8.6 Dissolved Oxygen (mg/l)	Mile 8.6 Dissolved Oxygen (percent saturation)	Mile 9.0 Specific Conductance (in micromhos at 25°C)	Mile 9.0 Temperature (°C)	Mile 9.0 Dissolved Oxygen (mg/l)	Mile 9.0 Dissolved Oxygen (percent saturation)	Mile 10 Specific Conductance (in micromhos at 25°C)	Mile 10 Temperature (°C)	Mile 10 Dissolved Oxygen (mg/l)	Mile 10 Dissolved Oxygen (percent saturation)	Mile 11 Specific Conductance (in micromhos at 25°C)	Mile 11 Temperature (°C)	Mile 11 Dissolved Oxygen (mg/l)	Mile 11 Dissolved Oxygen (percent saturation)
June 19, 1969	High	1	220	27.5	7.2	92	180	27.5	7.2	92	130	27.5	7.1	91	107	27.8	7.0	90
		3	220	27.5	7.2	92	180	27.5	7.2	92	130	27.5	6.9	88	105	27.8	6.6	85
		5	225	27.5	7.1	91	180	27.5	7.2	92	137	27.5	6.8	87	104	27.6	6.5	84
		7	225	27.5	7.0	90	190	27.5	7.1	91	137	27.5	6.7	86	106	27.1	6.5	83
		10	225	27.5	6.8	87	195	27.2	7.1	91	135	27.5	6.6	84	108	27.0	6.6	84
		12	230	27.5	6.8	87	198	27.2	7.2	92	135 12/	27.4	6.7	86	108	27.0	6.5	82
		14	230	27.5	6.7	86	200	27.2	7.1	91	--	--	--	--	108	27.0	6.5	82
		16	230	27.5	6.6	84	202	27.2	6.8	87	--	--	--	--	108	27.0	6.5	82
		18	230	27.5	6.6	84	202	27.2	6.7	86	--	--	--	--	108	27.0	6.5	82
		20	--	--	--	--	205	27.0	6.7	85	--	--	--	--	108	27.0	6.5	82
		22	--	--	--	--	205	27.0	6.7	85	--	--	--	--	--	--	--	--

Date	Tide	Depth (In Feet)	Mile 12 Specific Conductance (in micromhos at 25°C)	Mile 12 Temperature (°C)	Mile 12 Dissolved Oxygen (mg/l)	Mile 12 Dissolved Oxygen (percent saturation)	Mile 13 Specific Conductance (in micromhos at 25°C)	Mile 13 Temperature (°C)	Mile 13 Dissolved Oxygen (mg/l)	Mile 13 Dissolved Oxygen (percent saturation)	Mile 14 Specific Conductance (in micromhos at 25°C)	Mile 14 Temperature (°C)	Mile 14 Dissolved Oxygen (mg/l)	Mile 14 Dissolved Oxygen (percent saturation)	Mile Specific Conductance (in micromhos at 25°C	Mile Temperature (°C)	Mile Dissolved Oxygen (mg/l)	Mile Dissolved Oxygen (percent saturation)
June 19, 1969	High	1	95	27.5	7.2	92	90	27.8	7.1	91	88	27.8	7.7	99				
		3	95	27.5	7.2	92	90	27.5	7.0	90	89	27.5	7.6	97				
		5	95	27.5	6.6	84	90	27.5	6.8	87	90	27.5	7.6	97				
		7	95	27.1	6.6	84	90	27.0	6.7	85	90	27.5	7.6	97				
		10	94	27.0	6.7	85	90	27.0	6.6	84	86	27.2	7.4	95				
		12	95	27.1	6.5	83	90	27.0	6.5	82	86	27.1	7.2	92				
		14	95	27.0	6.6	84	90 14/	27.0	6.4	81	87	27.0	6.7	85				
		16	95 13/	27.0	6.6	84	--	--	--	--	88	27.0	6.7	85				
		18	--	--	--	--	--	--	--	--	88	26.9	6.6	84				
		20	--	--	--	--	--	--	--	--	87	26.9	6.6	84				
		22	--	--	--	--	--	--	--	--	89	26.8	6.6	84				
		24	--	--	--	--	--	--	--	--	80	26.8	6.5	82				

Date	Tide	Depth (In Feet)	Mile 5.0 Specific Conductance (in micromhos at 25°C)	Mile 5.0 Temperature (°C)	Mile 5.0 Dissolved Oxygen (mg/l)	Mile 5.0 Dissolved Oxygen (percent saturation)	Mile 6.0 Specific Conductance (in micromhos at 25°C)	Mile 6.0 Temperature (°C)	Mile 6.0 Dissolved Oxygen (mg/l)	Mile 6.0 Dissolved Oxygen (percent saturation)	Mile 7.0 Specific Conductance (in micromhos at 25°C)	Mile 7.0 Temperature (°C)	Mile 7.0 Dissolved Oxygen (mg/l)	Mile 7.0 Dissolved Oxygen (percent saturation)	Mile 9.0 Specific Conductance (in micromhos at 25°C	Mile 9.0 Temperature (°C)	Mile 9.0 Dissolved Oxygen (mg/l)	Mile 9.0 Dissolved Oxygen (percent saturation)
July 16, 1969	High	1	26,500	85	--	--	27,000	85	--	--	22,000	85	--	--	15,500	88	--	--
		19	33,000	84	--	--	31,000	85	--	--	27,000	85	--	--	20,800	87	--	--

1/ Measurements of specific conductance, temperature, and dissolved oxygen at mile 12 made at a depth of 15 feet rather than 16 feet as indicated. The following footnotes also indicate the depths of measurement if different from that indicated in the table: 2/ 9 feet; 3/ 11 feet; 4/ 15 feet; 5/ 19 feet; 6/ 19 feet; 7/ 11 feet; 8/ 9 feet; 9/ 11 feet; 10/ 15 feet; 11/ 15 feet; 12/ 11 feet; 13/ 15 feet; and 14/ 13 feet.

Table 5.--Field measurements of specific conductance, temperature, and dissolved oxygen of the South Santee River.

[Measurements by U. S. Geological Survey]

Date	Tide	Depth (In Feet)	Mile 6.9				Mile 8.0				Mile 9.5				Mile 10.4			
			Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)
December 12, 1968	High	1	23,500	6.6	10.8	97	18,100	7.0	11.6	102	12,500	7.0	11.4	98	8,250	6.8	10.9	93
		3	24,000	6.5	10.9	96	18,100	7.0	11.1	98	12,600	7.1	11.0	97	8,400	6.6	10.9	93
		5	24,400	6.5	10.8	96	18,100	7.0	11.0	97	12,600	7.1	11.1	97	8,650	6.5	10.7	90
		7	23,800	6.5	10.9	96	18,500	6.8	11.0	97	13,000	6.8	11.0	95	8,650	6.6	10.7	92
		10	24,000	6.5	10.9	96	18,700	6.7	11.0	97	13,100	6.8	10.9	94	8,800	6.8	10.5	90
		12	24,200	6.5	10.9	97	19,000	6.7	10.6	94	13,500	6.8	10.9	94	--	--	--	--
		14	24,200	6.5	10.9	97	19,000	6.7	10.8	95	13,500	6.9	10.8	93	--	--	--	--
		16	24,200	6.5	10.9	97	19,200	6.7	10.8	95	13,500	6.8	10.8	93	--	--	--	--
		18	--	--	--	--	19,200	6.7	10.8	95	--	--	--	--	--	--	--	--
		20	--	--	--	--	19,200	6.7	10.8	95	--	--	--	--	--	--	--	--

Date	Tide	Depth (In Feet)	Mile 11				Mile 12				Mile 12.5				Mile 13.5			
			Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)
December 12, 1968	High	1	5,600	6.9	11.0	93	1,500	6.6	11.2	93	1,000	6.3	11.4	94	510	6.3	11.1	91
		3	6,050	6.6	11.0	93	2,000	6.4	11.0	91	1,180	6.3	11.1	92	510	6.1	10.8	88
		5	6,100	6.6	11.0	93	2,150	6.4	11.0	91	1,220	6.3	11.1	92	565	6.1	10.8	89
		7	6,350	6.7	11.0	93	2,200	6.3	11.0	91	1,230	6.2	10.8	89	646	6.1	10.8	89
		10	6,760	6.7	11.0	93	2,280	6.2	11.0	91	--	--	--	--	710	6.1	10.8	89
		12	--	--	--	--	2,280	6.2	11.0	91	--	--	--	--	725	6.1	10.7	87
		14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		20	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Date	Tide	Depth (In Feet)	Mile 14				Mile 16.7				Mile				Mile			
			Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)
December 12, 1968	High	1	210	6.0	11.4	92	127	6.9	11.7	97								
		3	220	6.0	11.4	92	127	6.9	11.7	97								
		5	220	6.0	11.4	92	--	--	--	--								
		7	236	6.0	11.4	92	--	--	--	--								
		10	236	6.2	11.4	93	--	--	--	--								
		12	--	--	--	--	--	--	--	--								
		14	--	--	--	--	--	--	--	--								
		16	--	--	--	--	--	--	--	--								
		18	--	--	--	--	--	--	--	--								
		20	--	--	--	--	--	--	--	--								

Table 5.--Field measurements of specific conductance, temperature, and dissolved oxygen of the South Santee River--continued.

[Measurements by U. S. Geological Survey]

Date	Tide	Depth (In Feet)	Mile 6.7 Specific Conductance (in micromhos at 25°C)	Mile 6.7 Temperature (°C)	Mile 6.7 Dissolved Oxygen (mg/l)	Mile 6.7 Dissolved Oxygen (percent saturation)	Mile 9.0 Specific Conductance (in micromhos at 25°C)	Mile 9.0 Temperature (°C)	Mile 9.0 Dissolved Oxygen (mg/l)	Mile 9.0 Dissolved Oxygen (percent saturation)	Mile 10.4 Specific Conductance (in micromhos at 25°C)	Mile 10.4 Temperature (°C)	Mile 10.4 Dissolved Oxygen (mg/l)	Mile 10.4 Dissolved Oxygen (percent saturation)	Mile 11 Specific Conductance (in micromhos at 25°C)	Mile 11 Temperature (°C)	Mile 11 Dissolved Oxygen (mg/l)	Mile 11 Dissolved Oxygen (percent saturation)
January 14, 1969	Low	1	14,000	5.3	15.1	127	3,600	5.4	14.7	118	1,580	5.4	13.1	106	380	5.5	15.4	123
		3	14,400	5.3	15.1	127	3,700	5.4	14.7	118	1,580	5.4	13.1	106	395	5.4	15.4	124
		5	14,800	5.2	14.9	125	4,100	5.4	14.7	118	1,720	5.4	13.1	106	395	--	15.4	124
		7	15,000	5.1	14.5	125	5,000	5.4	14.6	117	2,000	5.4	13.1	106	395	5.4	15.4	124
		10	16,800	5.0	14.5	121	--	--	--	--	2,000 1/	5.4	12.9	104	410 1/	5.3	15.6	125
		12	17,000	5.0	14.5	121	--	--	--	--	--	--	--	--	--	--	--	--
		13	17,000	5.0	14.5	121	--	--	--	--	--	--	--	--	--	--	--	--

Date	Tide	Depth (In Feet)	Mile 12 Specific Conductance (in micromhos at 25°C)	Mile 12 Temperature (°C)	Mile 12 Dissolved Oxygen (mg/l)	Mile 12 Dissolved Oxygen (percent saturation)	Mile 12.5 Specific Conductance (in micromhos at 25°C)	Mile 12.5 Temperature (°C)	Mile 12.5 Dissolved Oxygen (mg/l)	Mile 12.5 Dissolved Oxygen (percent saturation)	Mile 14 Specific Conductance (in micromhos at 25°C)	Mile 14 Temperature (°C)	Mile 14 Dissolved Oxygen (mg/l)	Mile 14 Dissolved Oxygen (percent saturation)	Mile Specific Conductance (in micromhos at 25°C)	Mile Temperature (°C)	Mile Dissolved Oxygen (mg/l)	Mile Dissolved Oxygen (percent saturation)
January 14, 1969	Low	1	200	5.6	15.7	128	180	5.8	15.8	128	145	6.0	16.0	130				
		3	200	5.6	15.7	128	--	--	--	--	--	--	--	--				
		5	200	--	15.7	128	100	5.8	15.8	128	145	6.0	16.0	130				
		7	200	5.6	15.7	128	--	--	--	--	--	--	--	--				
		10	200 1/	5.6	15.7	128	--	--	--	--	--	--	--	--				
		12	--	--	--	--	--	--	--	--	--	--	--	--				
		13	--	--	--	--	--	--	--	--	--	--	--	--				

Date	Tide	Depth (In Feet)	Mile 5.0 Specific Conductance (in micromhos at 25°C)	Mile 5.0 Temperature (°C)	Mile 5.0 Dissolved Oxygen (mg/l)	Mile 5.0 Dissolved Oxygen (percent saturation)	Mile 6.0 Specific Conductance (in micromhos at 25°C)	Mile 6.0 Temperature (°C)	Mile 6.0 Dissolved Oxygen (mg/l)	Mile 6.0 Dissolved Oxygen (percent saturation)	Mile 7.0 Specific Conductance (in micromhos at 25°C)	Mile 7.0 Temperature (°C)	Mile 7.0 Dissolved Oxygen (mg/l)	Mile 7.0 Dissolved Oxygen (percent saturation)	Mile 8.0 Specific Conductance (in micromhos at 25°C)	Mile 8.0 Temperature (°C)	Mile 8.0 Dissolved Oxygen (mg/l)	Mile 8.0 Dissolved Oxygen (percent saturation)
January 15, 1969	Low	1	19,800	5.1	12.9	110	16,000	5.1	12.7	107	11,400	5.4	12.8	106	7,500	5.4	12.6	104
		3	20,000	5.2	12.8	109	16,600	5.1	12.8	108	12,100	5.1	12.6	105	7,900	--	12.6	104
		5	24,700	5.3	12.4	115	17,000	5.2	12.7	107	13,400	5.1	12.6	106	10,800	5.3	12.4	103
		7	26,600	5.3	12.3	108	17,500	5.3	12.8	109	14,500	--	--	106	11,400	--	12.4	104
		10	29,500	5.4	12.2	108	18,700	5.5	12.6	107	15,000	5.1	12.5	105	12,400	5.1	12.2	102
		12	30,000	5.4	12.2	108	--	--	--	--	16,400	5.1	12.4	105	12,600	--	12.2	102
		14	30,000 2/	5.4	12.2	108	--	--	--	--	--	--	--	--	12,700	5.0	12.3	101
		16	--	--	--	--	--	--	--	--	--	--	--	--	13,000	--	12.3	101
		18	--	--	--	--	--	--	--	--	--	--	--	--	13,100	5.0	12.3	102
		19	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 5.--Field measurements of specific conductance, temperature, and dissolved oxygen of the South Santee River--continued.

[Measurements by U. S. Geological Survey]

Date	Tide	Depth (In Feet)	Mile 9.0				Mile 10				Mile 11				Mile 12			
			Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)
January 15, 1969	Low	1	6,000	5.6	12.6	104	2,030	5.6	13.0	107	680	5.6	12.9	105	254	6.0	13.4	108
		3	7,100	5.3	12.7	104	2,110	--	--	--	720	--	--	--	258	--	--	--
		5	8,000	5.2	12.6	103	2,340	5.3	13.3	107	760	5.4	13.4	107	280	6.0	13.4	109
		7	8,100 3/	5.0	12.3	100	2,470	--	13.3	107	780	5.4	13.4	107	320	--	13.4	109
		10	--	--	--	--	3,410	5.2	12.8	104	830 5/	5.4	13.4	107	334	6.0	13.2	108
		12	--	--	--	--	3,740 4/	--	12.8	104	--	--	--	--	355	6.0	13.2	108

Date	Tide	Depth (In Feet)	Mile 13				Mile 14				Mile				Mile			
			Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)
January 16, 1969	Low	1	173	6.2	13.3	109	149	6.2	13.4	111								
		3	179	--	13.3	109	149	6.2	13.6	112								
		5	180	6.2	13.6	112	149	6.2	13.8	114								
		7	182	--	13.6	112	150 6/	6.2	13.8	114								
		10	184	6.2	13.6	112	--	--	--	--								
		12	184	--	13.6	112	--	--	--	--								
		14	184	6.2	13.6	112	--	--	--	--								
		16	184	--	13.6	112	--	--	--	--								
		18	184	--	13.6	112	--	--	--	--								
		19	184	6.1	13.4	110	--	--	--	--								

Date	Tide	Depth (In Feet)	Mile 5.0				Mile 6.0				Mile 7.0				Mile 8.0			
			Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)
February 11, 1969	Low	1	20,800	9.2	8.5	81	15,600	9.1	8.4	79	12,000	9.2	8.4	78	7,000	9.3	8.5	78
		3	21,000	9.2	8.5	81	15,800	9.1	8.4	79	12,300	9.2	8.4	78	7,250	9.3	8.5	78
		5	22,300	9.2	8.3	80	16,000	9.0	8.4	78	13,000	9.1	8.4	78	7,250	9.2	8.6	78
		7	28,400	9.1	8.2	80	17,500	9.0	8.1	76	13,700	9.1	8.3	77	8,200	9.2	8.4	77
		10	30,200	9.0	8.0	79	18,500	9.0	8.0	75	14,700	9.1	8.2	77	9,000	9.1	8.2	76
		12	30,200	9.0	8.0	79	19,300	9.1	8.2	78	16,000 7/	9.1	8.2	77	9,500	9.0	8.2	76
		14	--	--	--	--	19,500	9.1	8.2	78	--	--	--	--	9,800	9.0	8.3	76
		16	--	--	--	--	--	--	--	--	--	--	--	--	11,000	9.0	8.2	75

Date	Tide	Depth (In Feet)	Mile 9.0				Mile 10				Mile 11				Mile 12			
			Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)
February 11, 1969	Low	1	3,100	9.2	8.4	76	1,070	9.5	8.8	79	340	9.5	8.8	79	185	9.7	8.8	80
		3	3,100	9.2	8.4	76	1,100	9.4	--	--	350	9.4	8.9	80	185	--	--	--
		5	3,550	9.1	8.4	76	1,150	9.4	8.7	79	410	9.4	8.8	79	190	9.6	9.0	82
		7	4,800 8/	9.0	8.3	75	1,350	9.3	8.6	77	430	9.4	8.8	79	185	9.5	8.8	76
		10	--	--	--	--	1,650 9/	9.2	8.6	76	--	--	--	--	--	--	--	--

Date	Tide	Depth (In Feet)	Mile 13				Mile 14				Mile				Mile			
			Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)
February 11, 1969	Low	1	158	10.1	9.1	84	131	10.4	9.4	87								
		3	158	10.0	9.0	82	135	10.3	9.0	83								
		5	160	10.0	8.9	81	140	10.0	9.0	82								
		7	160	9.9	9.0	82	140	9.9	9.0	82								

Table 5.--Field measurements of specific conductance, temperature, and dissolved oxygen of the South Santee River--continued.

[Measurements by U. S. Geological Survey]

Date	Tide	Depth (In Feet)	Mile 5.0 Specific Conductance (in micromhos at 25°C)	Mile 5.0 Temperature (°C)	Mile 5.0 Dissolved Oxygen (mg/l)	Mile 5.0 Dissolved Oxygen (percent saturation)	Mile 6.0 Specific Conductance (in micromhos at 25°C)	Mile 6.0 Temperature (°C)	Mile 6.0 Dissolved Oxygen (mg/l)	Mile 6.0 Dissolved Oxygen (percent saturation)	Mile 7.0 Specific Conductance (in micromhos at 25°C)	Mile 7.0 Temperature (°C)	Mile 7.0 Dissolved Oxygen (mg/l)	Mile 7.0 Dissolved Oxygen (percent saturation)	Mile 8.0 Specific Conductance (in micromhos at 25°C)	Mile 8.0 Temperature (°C)	Mile 8.0 Dissolved Oxygen (mg/l)	Mile 8.0 Dissolved Oxygen (percent saturation)
March 30, 1966	High	1	24,000	12.8	8.4	87	18,000	12.8	8.7	88	14,000	13.0	8.5	86	11,000	12.9	8.5	85
		3	26,000	12.6	8.7	90	19,000	12.8	8.5	87	15,000	13.0	8.5	86	11,000	12.5	8.7	86
		5	28,000	12.5	8.7	90	20,000	12.6	8.6	89	16,000	12.9	8.5	86	12,000	12.4	8.5	85
		7	28,000	12.5	8.6	90	20,400	12.6	8.6	89	16,000	12.9	8.4	85	12,000	12.4	8.5	86
		10	30,000	12.5	8.5	90	23,000	12.5	8.6	89	17,000	12.7	8.4	86	12,000	12.4	8.4	83
		12	30,000	12.3	8.7	91	23,000	12.6	8.6	89	17,000 10/	12.6	8.4	86	--	--	--	--
		14	--	--	--	--	23,000	12.6	8.7	90	--	--	--	--	--	--	--	--
		16	--	--	--	--	23,000	12.6	8.7	91	--	--	--	--	--	--	--	--
		17	--	--	--	--	23,000	12.6	8.7	90	--	--	--	--	--	--	--	--

Date	Tide	Depth (In Feet)	Mile 9.0 Specific Conductance (in micromhos at 25°C)	Mile 9.0 Temperature (°C)	Mile 9.0 Dissolved Oxygen (mg/l)	Mile 9.0 Dissolved Oxygen (percent saturation)	Mile 10 Specific Conductance (in micromhos at 25°C)	Mile 10 Temperature (°C)	Mile 10 Dissolved Oxygen (mg/l)	Mile 10 Dissolved Oxygen (percent saturation)	Mile 11 Specific Conductance (in micromhos at 25°C)	Mile 11 Temperature (°C)	Mile 11 Dissolved Oxygen (mg/l)	Mile 11 Dissolved Oxygen (percent saturation)	Mile 12 Specific Conductance (in micromhos at 25°C)	Mile 12 Temperature (°C)	Mile 12 Dissolved Oxygen (mg/l)	Mile 12 Dissolved Oxygen (percent saturation)
March 30, 1966	High	1	9,000	12.8	8.8	81	3,200	13.1	9.0	89	1,250	13.2	8.9	88	760	13.1	9.2	90
		3	9,000	12.2	8.6	81	3,200	13.0	8.8	86	1,400	13.0	9.0	87	820	12.9	9.0	87
		5	9,500	12.2	8.5	80	3,200	12.8	8.8	86	1,450	13.0	8.9	86	850	12.9	8.9	87
		7	9,500	12.2	8.5	80	3,500	12.6	8.7	85	1,480	13.0	8.8	86	880	12.7	9.0	87
		10	9,500	12.2	8.5	80	3,500	12.6	8.7	85	1,500	13.0	8.8	86	900	12.6	9.0	88
		12	--	--	--	--	3,500	12.6	8.7	85	1,500	13.0	8.8	86	900	12.6	9.0	88
		14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		17	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Date	Tide	Depth (In Feet)	Mile 13 Specific Conductance (in micromhos at 25°C)	Mile 13 Temperature (°C)	Mile 13 Dissolved Oxygen (mg/l)	Mile 13 Dissolved Oxygen (percent saturation)	Mile 14 Specific Conductance (in micromhos at 25°C)	Mile 14 Temperature (°C)	Mile 14 Dissolved Oxygen (mg/l)	Mile 14 Dissolved Oxygen (percent saturation)	Mile Specific Conductance (in micromhos at 25°C)	Mile Temperature (°C)	Mile Dissolved Oxygen (mg/l)	Mile Dissolved Oxygen (percent saturation)	Mile Specific Conductance (in micromhos at 25°C)	Mile Temperature (°C)	Mile Dissolved Oxygen (mg/l)	Mile Dissolved Oxygen (percent saturation)
March 30, 1966	High	1	160	13.2	9.2	90	130	13.0	9.1	88								
		3	170	12.8	9.2	89	135	13.0	9.1	88								
		5	180	12.8	9.1	88	135	12.9	8.7	85								
		7	180	12.6	9.0	88	--	--	--	--								
		10	185	12.5	9.1	87	--	--	--	--								
		12	--	--	--	--	--	--	--	--								
		14	--	--	--	--	--	--	--	--								
		16	--	--	--	--	--	--	--	--								
		17	--	--	--	--	--	--	--	--								

Table 5.--Field measurements of specific conductance, temperature, and dissolved oxygen of the South Santee River--continued.

/Measurements by U. S. Geological Survey/

Date	Tide	Depth (In Feet	Mile 5.0				Mile 6.0				Mile 7.0				Mile 8.0			
			Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)
June 20, 1969	High	1	23,000	28.2	6.1	85	13,500	27.9	6.9	93	13,000	27.8	6.8	91	8,800	27.6	7.4	101
		3	23,000	28.2	6.1	85	15,000	28.2	6.6	90	14,000	28.0	6.3	85	9,500	27.8	7.2	95
		5	24,000	28.2	6.0	83	20,000	28.1	6.5	89	16,000	27.9	6.1	83	11,000	27.7	6.8	90
		7	25,000	28.2	6.0	84	20,000	28.2	6.4	88	17,000	28.0	6.1	83	11,500	27.8	6.6	87
		10	25,000	28.2	6.1	85	20,000	28.2	6.2	85	18,000	28.0	6.2	84	12,000	27.8	6.5	86
		12	25,000	28.2	6.1	85	--	--	--	--	18,000	28.0	6.2	84	13,700	27.8	6.3	86
		14	25,000	28.2	6.0	84	--	--	--	--	18,000	28.0	6.1	82	13,900	27.8	6.2	83
		16	--	--	--	--	--	--	--	--	--	--	--	--	14,000	27.8	5.9	80

Date	Tide	Depth (In Feet	Mile 9.0				Mile 10				Mile 11				Mile 12			
			Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)
June 20, 1969	High	1	5,500	28.1	7.1	94	2,200	28.3	6.7	88	780	28.5	7.2	93	640	28.5	7.3	93
		3	6,000	28.1	7.1	94	2,500	28.2	6.4	83	900	28.2	6.9	89	640	28.3	6.8	88
		5	6,300	28.0	7.2	94	2,500	27.8	6.5	84	1,500	28.0	6.6	86	690	28.3	6.6	88
		7	6,600	28.0	7.1	93	2,800	27.8	6.5	84	1,620	28.0	6.3	82	710	28.0	6.8	88
		10	7,800 11/	28.0	6.5	86	3,000	27.8	6.4	82	1,700 13/	27.9	6.3	81	770 14/	28.0	6.6	88
		12	--	--	--	--	3,000 12/	27.8	6.2	80	--	--	--	--	--	--	--	--
		14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Date	Tide	Depth (In Feet	Mile 13				Mile 14				Mile				Mile			
			Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C)	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)	Specific Conductance (in micromhos at 25°C	Temperature (°C)	Dissolved Oxygen (mg/l)	Dissolved Oxygen (percent saturation)
June 20, 1969	High	1	183	28.2	7.4	95	143	28.2	7.5	96								
		3	195	28.2	7.2	93	144	28.0	7.2	92								
		5	200	28.0	7.1	91	143	28.0	6.8	88								
		7	210	28.0	6.8	87	140	27.8	6.7	86								
		10	260	28.0	6.7	86	--	--	--	--								
		12	260	28.0	6.6	85	--	--	--	--								
		14	--	--	--	--	--	--	--	--								
		16	--	--	--	--	--	--	--	--								

Table 5.--Field measurements of specific conductance, temperature, and dissolved oxygen of the South Santee River--continued.

[Measurements by U. S. Geological Survey]

Date	Tide	Depth (In Feet)	Mile 5.0 Specific Conductance (in micromhos at 25°C)	Mile 5.0 Temperature (°C)	Mile 5.0 Dissolved Oxygen (mg/l)	Mile 5.0 Dissolved Oxygen (percent saturation)	Mile 6.0 Specific Conductance (in micromhos at 25°C)	Mile 6.0 Temperature (°C)	Mile 6.0 Dissolved Oxygen (mg/l)	Mile 6.0 Dissolved Oxygen (percent saturation)
July 16, 1969	High	1	37,000	28.9	--	--	28,000	29	--	--
		7	--	--	--	--	--	--	--	--
		10	--	--	--	--	--	--	--	--
		11	--	--	--	--	--	--	--	--
		12	--	--	--	--	--	--	--	--
		13	--	--	--	--	--	--	--	--
		14	--	--	--	--	--	--	--	--
		15	38,000	28.9	--	--	--	--	--	--
		17	--	--	--	--	34,000	29	--	--

Date	Tide	Depth (In Feet)	Mile 7.0 Specific Conductance (in micromhos at 25°C)	Mile 7.0 Temperature (°C)	Mile 7.0 Dissolved Oxygen (mg/l)	Mile 7.0 Dissolved Oxygen (percent, saturation)	Mile 8.0 Specific Conductance (in micromhos at 25°C	Mile 8.0 Temperature (°C)	Mile 8.0 Dissolved Oxygen (mg/l)	Mile 8.0 Dissolved Oxygen (percent saturation)
July 16, 1969	High	1	28,000	29.4	--	--	26,500	--	--	--
		7	--	--	--	--	--	--	--	--
		10	--	--	--	--	--	--	--	--
		11	--	--	--	--	--	--	--	--
		12	--	--	--	--	--	--	--	--
		13	--	--	--	--	--	--	--	--
		14	30,000	29.4	--	--	--	--	--	--
		15	--	--	--	--	--	--	--	--
		17	--	--	--	--	--	--	--	--

Date	Tide	Depth (In Feet)	Mile 9.0 Specific Conductance (in micromhos at 25°C)	Mile 9.0 Temperature (°C)	Mile 9.0 Dissolved Oxygen (mg/l)	Mile 9.0 Dissolved Oxygen (percent saturation)	Mile 10 Specific Conductance (in micromhos at 25°C)	Mile 10 Temperature (°C)	Mile 10 Dissolved Oxygen (mg/l)	Mile 10 Dissolved Oxygen (percent saturation)
July 16, 1969	High	1	16,000	28.9	--	--	11,000	28.9	--	--
		7	--	--	--	--	--	--	--	--
		10	--	--	--	--	--	--	--	--
		11	15,500	28.9	--	--	--	--	--	--
		12	--	--	--	--	--	--	--	--
		13	--	--	--	--	11,300	28.9	--	--

Date	Tide	Depth (In Feet)	Mile 11 Specific Conductance (in micromhos at 25°C)	Mile 11 Temperature (°C)	Mile 11 Dissolved Oxygen (mg/l)	Mile 11 Dissolved Oxygen (percent saturation)	Mile 12 Specific Conductance (in micromhos at 25°C)	Mile 12 Temperature (°C)	Mile 12 Dissolved Oxygen (mg/l)	Mile 12 Dissolved Oxygen (percent saturation)
July 16, 1969	High	1	7,300	29.4	--	--	4,900	29.4	--	--
		7	--	--	--	--	--	--	--	--
		10	7,700	29.4	--	--	--	--	--	--
		11	--	--	--	--	--	--	--	--
		12	--	--	--	--	5,200	29.4	--	--
		13	--	--	--	--	--	--	--	--

Date	Tide	Depth (In Feet)	[1] Mile 13 Specific Conductance (in micromhos at 25°C)	Mile 13 Temperature (°C)	Mile 13 Dissolved Oxygen (mg/l)	Mile 13 Dissolved Oxygen (percent saturation)	Mile Specific Conductance (in micromhos at 25°C)	Mile Temperature (°C)	Mile Dissolved Oxygen (mg/l)	Mile Dissolved Oxygen (percent saturation)
July 16, 1969	High	1	1,550	30.0	--	--				
		7	1,730	30.0	--	--				

Date	Tide	Depth (In Feet)	Mile Specific Conductance (in micromhos at 25°C)	Mile Temperature (°C)	Mile Dissolved Oxygen (mg/l)	Mile Dissolved Oxygen (percent saturation)	Mile Specific Conductance (in micromhos at 25°C	Mile Temperature (°C)	Mile Dissolved Oxygen (mg/l)	Mile Dissolved Oxygen (percent saturation)
July 16, 1969	High	1								
		7								

1/ Measurements of specific conductance, temperature, and dissolved oxygen at mile 10.4 made at a depth of 8 feet rather than 10 feet as indicated. The following footnotes indicate the depths of measurement if different from that indicated in the table: 2/ 13 feet; 3/ 6 feet; 4/ 11 feet; 5/ 8 feet; 6/ 6 feet; 7/ 11 feet; 8/ 6 feet; 9/ 9 feet; 10/ 11 feet; 11/ 8 feet; 12/ 11 feet; 13/ 9 feet; and 14/ 9 feet.

Table 6.--Specific conductance measurements of the North Santee River during the flood of April and May, 1969.

Date	Tide	Depth (in feet)	SPECIFIC CONDUCTANCE, IN MICROMHOS AT 25°C														
			Mile 0.0	Mile 0.5	Mile 1.0	Mile 1.5	Mile 2.0	Mile 2.5	Mile 3.0	Mile 3.5	Mile 4.0	Mile 4.5	Mile 5.0	Mile 5.5	Mile 6.0	Mile 7.0	Mile 8.0
April 23, 1969	High plus 1½ hrs.	1	--	--	--	--	--	--	--	--	--	--	104	85	--	--	--
April 24, 1969	High plus 2½ hrs.	1	--	--	--	--	--	--	760	--	104	--	90	--	--	--	--
		3	--	--	--	--	--	--	940	--	99	--	89	--	--	--	--
		5	--	--	--	--	--	--	960	--	97	--	89	--	--	--	--
		7	--	--	--	--	--	--	1080	--	97	--	88	--	--	--	--
		10	--	--	--	--	--	--	5500	--	98	--	88	--	--	--	--
		12	--	--	--	--	--	--	17000	--	99	--	88	--	--	--	--
		14	--	--	--	--	--	--	32000	--	99	--	--	--	--	--	--
		16	--	--	--	--	--	--	--	--	100	--	--	--	--	--	--
April 25, 1969	Low plus 2 hrs.	1	2000	--	250	--	110	--	--	--	--	--	--	--	--	--	--
		3	5200	--	2080	--	--	--	--	--	--	--	--	--	--	--	--
		5	6100	--	3600	--	--	--	--	--	--	--	--	--	--	--	--
		7	7600	--	6000	--	130	--	--	--	--	--	--	--	--	--	--
		10	13000	--	8000	--	--	--	--	--	--	--	--	--	--	--	--
		12	23500	--	--	--	--	--	--	--	--	--	--	--	--	--	--
April 30, 1969	High tide	1	--	--	--	--	340	--	107	--	102	--	--	--	--	--	--
		3	--	--	--	--	810	--	107	--	102	--	--	--	--	--	--
		5	--	--	--	--	14000	--	107	--	102	--	--	--	--	--	--
		7	--	--	--	--	30000	--	107	--	102	--	--	--	--	--	--
		10	--	--	--	--	32000	--	108	--	102	--	--	--	--	--	--
		12	--	--	--	--	33000	--	108	--	102	--	--	--	--	--	--
		14	--	--	--	--	33000	--	109	--	102	--	--	--	--	--	--
		16	--	--	--	--	32500	--	--	--	102	--	--	--	--	--	--
		18	--	--	--	--	--	--	--	--	105	--	--	--	--	--	--
	Low tide	1	125	--	112	--	100	--	94	--	--	--	--	--	--	--	--
		3	125	--	112	--	100	--	94	--	--	--	--	--	--	--	--
		5	125	--	114	--	100	--	94	--	--	--	--	--	--	--	--
		7	--	--	114	--	102	--	94	--	--	--	--	--	--	--	--
		10	--	--	116	--	102	--	96	--	--	--	--	--	--	--	--
		12	--	--	--	--	105	--	97	--	--	--	--	--	--	--	--
		14	--	--	--	--	105	--	--	--	--	--	--	--	--	--	--
May 2, 1969	High tide	1	--	--	--	--	1500	260	225	--	188	--	--	--	--	--	--
		3	--	--	---	--	1550	270	235	--	195	--	--	--	--	--	--
		5	--	--	--	--	20000	380	280	--	205	--	--	--	--	--	--
		7	--	--	--	--	30000	440	400	--	205	--	--	--	--	--	--
		10	--	--	--	--	30000	1600	420	--	206	--	--	--	--	--	--
		12	--	--	--	--	--	1600	420	--	250	--	--	--	--	--	--
		14	--	--	--	--	--	--	1200	--	290	--	--	--	--	--	--
		16	--	--	--	--	--	--	--	--	310	--	--	--	--	--	--
May 2, 1969	Low tide	1	146	--	130	--	117	--	102	--	--	--	--	--	--	--	--
		3	146	--	130	--	118	--	102	--	--	--	--	--	--	--	--
		5	146	--	132	--	119	--	102	--	--	--	--	--	--	--	--
		7	--	--	132	--	120	--	102	--	--	--	--	--	--	--	--
		10	--	--	132	--	--	--	103	--	--	--	--	--	--	--	--
		12	--	--	132	--	--	--	--	--	--	--	--	--	--	--	--
		14	--	--	132	--	--	--	--	--	--	--	--	--	--	--	--
May 4, 1969	High tide	1	--	--	--	--	17500	4000	1050	--	600	--	550	--	--	--	--
		3	--	--	--	--	20000	7000	1100	--	610	--	575	--	--	--	--
		5	--	--	--	--	28000	10000	1200	--	610	--	580	--	--	--	--
		7	--	--	--	--	30000	18000	1400	--	650	--	600	--	--	--	--
		10	--	--	--	--	30000	20000	1800	--	700	--	600	--	--	--	--
		12	--	--	--	--	--	--	--	--	700	--	600	--	--	--	--
		14	--	--	--	--	--	--	--	--	750	--	600	--	--	--	--
		16	--	--	--	--	--	--	--	--	850	--	600	--	--	--	--
		18	--	--	--	--	--	--	--	--	--	--	600	--	--	--	--
		20	--	--	--	--	--	--	--	--	900	--	--	--	--	--	--

Table 6.--Specific conductance measurements of the North Santee River during the flood of April and May, 1969--continued.

Date	Tide	Depth (in feet)	SPECIFIC CONDUCTANCE, IN MICROMHOS AT 25°C 1/														
			Mile 0.0	Mile 0.5	Mile 1.0	Mile 1.5	Mile 2.0	Mile 2.5	Mile 3.0	Mile 3.5	Mile 4.0	Mile 4.5	Mile 5.0	Mile 5.5	Mile 6.0	Mile 7.0	Mile 8.0
May 4, 1969	Low tide	1	220	--	165	--	145	126	115	--	109	--	--	--	--	--	--
		3	220	--	165	--	148	126	115	--	109	--	--	--	--	--	--
		5	--	--	165	--	150	126	115	--	110	--	--	--	--	--	--
		7	--	--	168	--	150	--	115	--	110	--	--	--	--	--	--
		10	--	--	158	--	--	--	--	--	110	--	--	--	--	--	--
		12	--	--	168	--	--	--	--	--	110	--	--	--	--	--	--
		13	--	--	--	--	--	--	--	--	110	--	--	--	--	--	--
May 6, 1969	High tide	1	--	--	--	--	--	30,000	13,000	10,500	6,600	--	850	--	295	174	122
		3	--	--	--	--	--	30,000	14,000	11,700	7,200	--	1,100	--	660	174	122
		5	--	--	--	--	--	30,000	14,000	12,000	7,500	--	1,300	--	675	174	122
		7	--	--	--	--	--	30,000	14,500	12,200	7,500	--	1,600	--	700	174	122
		10	--	--	--	--	--	30,000	15,000	12,500	7,500	--	1,800	--	700	174	122
		12	--	--	--	--	--	--	15,000	--	8,000	--	--	--	700	172	123
		15	--	--	--	--	--	--	--	--	8,000	--	2,500	--	725	172	124
		16	--	--	--	--	--	--	--	--	8,000	--	--	--	--	--	--
		18	--	--	--	--	--	--	--	--	--	--	2,500	--	710	--	--
		20	--	--	--	--	--	--	--	--	--	--	--	--	--	--	125
May 6, 1969	Low tide	1	8,000	2,600	2,400	--	1,000	--	325	--	180	--	--	--	--	--	--
		3	8,000	3,000	2,400	--	1,000	--	325	--	180	--	--	--	--	--	--
		5	10,000	4,000	2,500	--	1,000	--	325	--	185	--	--	--	--	--	--
		7	--	7,500	2,700	--	1,000	--	325	--	190	--	--	--	--	--	--
		8	--	--	--	--	--	--	325	--	--	--	--	--	--	--	--
		10	--	11,000	4,000	--	--	--	--	--	190	--	--	--	--	--	--
		12	--	14,000	--	--	--	--	--	--	195	--	--	--	--	--	--
		14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
May 8, 1969	Low tide	1	20,000	14,000	11,500	10,000	7,000	6,000	3,000	--	1,600	--	430	--	180	122	--
		3	21,000	16,000	11,500	10,000	7,200	6,000	3,200	--	1,600	--	430	--	180	122	--
		5	23,000	17,000	13,000	11,000	7,200	6,100	3,500	--	1,600	--	450	--	185	125	--
		6	23,000	--	--	--	7,900	--	--	--	1,700	--	--	--	--	--	--
		7	--	21,000	13,500	11,000	--	--	4,000	--	1,700	--	465	--	245	125	--
		9	--	--	--	--	--	--	4,000	--	--	--	--	--	--	--	--
		10	--	21,000	--	--	--	--	--	--	1,700	--	500	--	260	127	--
		12	--	21,000	--	--	--	--	--	--	1,700	--	--	--	280	--	--
		13	--	--	--	--	--	--	--	--	1,700	--	--	--	--	--	--
		15	--	--	--	--	--	--	--	--	--	--	--	--	280	--	--
		18	--	--	--	--	--	--	--	--	--	--	--	--	280	--	--

1/ Additional specific conductance data obtained on April 23 at depth of one foot: at mile 10, specific conductance was 83 micromhos; at mile 14, specific conductance was 81 micromhos; and at mile 18, specific conductance was 133 micromhos. At high tide at mile 5.9 on May 4, specific conductance was 135 micromhos one foot below surface and 136 micromhos one foot above bottom (18 feet).

Table 7.--Specific conductance measurements of the South Santee River during the flood of April and May, 1969.

Date	Tide	Depth (in feet)	Specific conductance, in micromhos at 25°C														
			Mile 0.0	Mile 0.5	Mile 1.0	Mile 1.5	Mile 2.0	Mile 2.5	Mile 3.0	Mile 3.5	Mile 4.0	Mile 4.5	Mile 5.0	Mile 5.5	Mile 6.0	Mile 7.0	Mile 8.0
April 24, 1969	High	1	--	--	--	--	--	--	--	--	--	--	1,250	--	200	185	140
		3	--	--	--	--	--	--	--	--	--	--	1,225	--	200	185	--
		5	--	--	--	--	--	--	--	--	--	--	1,800	--	210	185	--
		6	--	--	--	--	--	--	--	--	--	--	6,000	--	--	--	--
		7	--	--	--	--	--	--	--	--	--	--	8,000	--	400	190	--
		10	--	--	--	--	--	--	--	--	--	--	10,000	--	1,600	185	--
		12	--	--	--	--	--	--	--	--	--	--	12,000	--	1,900	185	--
		13	--	--	--	--	--	--	--	--	--	--	--	--	2,000	--	--
		14	--	--	--	--	--	--	--	--	--	--	--	--	--	190	140
		18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
April 26, 1969	Low plus 3 hrs.	1	--	--	--	--	15,000	--	3,300	--	280	--	160	--	140	--	--
		3	--	--	--	--	19,000	--	3,900	--	270	--	--	--	140	--	--
		5	--	--	--	--	25,500	--	4,400	--	265	--	166	--	130	--	--
		7	--	--	--	--	26,500	--	5,500	--	270	--	--	--	120	--	--
		8	--	--	--	--	--	--	5,500	--	--	--	--	--	--	--	--
		10	--	--	--	--	27,000	--	--	--	270	--	176	--	130	--	--
		12	--	--	--	--	--	--	--	--	--	--	171	--	130	--	--
		14	--	--	--	--	--	--	--	--	--	--	171	--	--	--	--
		16	--	--	--	--	--	--	--	--	--	--	171	--	--	--	--
April 30, 1969	High	1	--	--	--	--	--	--	--	--	280	--	190	--	161	160	140
		3	--	--	--	--	--	--	--	--	280	--	190	--	165	160	139
		5	--	--	--	--	--	--	--	--	295	--	190	--	170	160	138
		7	--	--	--	--	--	--	--	--	490	--	190	--	170	160	139
		10	--	--	--	--	--	--	--	--	11,000	--	190	--	172	168	140
		12	--	--	--	--	--	--	--	--	12,200	--	190	--	170	170	--
		14	--	--	--	--	--	--	--	--	--	--	186	--	170	--	--
		16	--	--	--	--	--	--	--	--	--	--	182	--	165	--	--
		18	--	--	--	--	--	--	--	--	--	--	--	--	170	--	--
April 30, 1969	Low	1	--	--	240	215	180	--	139	--	140	--	130	--	--	--	--
		3	--	--	260	210	179	--	138	--	138	--	148	--	--	--	--
		5	--	--	--	--	176	--	140	--	136	--	148	--	--	--	--
		7	--	--	--	--	179	--	141	--	132	--	145	--	--	--	--
		9	--	--	--	--	180	--	145	--	--	--	--	--	--	--	--
		10	--	--	--	--	--	--	--	--	--	--	145	--	--	--	--
		12	--	--	--	--	--	--	--	--	--	--	145	--	--	--	--
May 2, 1969	High	1	--	--	--	--	--	--	--	8,000	4,000	1,600	500	--	--	--	--
		3	--	--	--	--	--	--	--	8,000	4,000	1,600	510	--	--	--	--
		5	--	--	--	--	--	--	--	9,000	6,000	1,600	600	--	--	--	--
		7	--	--	--	--	--	--	--	20,000	14,000	1,600	750	--	--	--	--
		10	--	--	--	--	--	--	--	21,000	18,000	1,600	925	--	--	--	--
		12	--	--	--	--	--	--	--	25,000	18,000	1,700	950	--	--	--	--
		15	--	--	--	--	--	--	--	25,000	--	2,000	1,050	--	--	--	--
		16	--	--	--	--	--	--	--	--	--	--	1,050	--	--	--	--
		17	--	--	--	--	--	--	--	--	--	2,400	--	--	--	--	--
May 2, 1969	Low	1	--	500	270	--	210	--	185	--	182	--	195	--	--	--	--
		3	--	500	275	--	212	--	183	--	182	--	195	--	--	--	--
		4	--	500	--	--	--	--	--	--	--	--	--	--	--	--	--
		5	--	--	275	--	215	--	183	--	180	--	198	--	--	--	--
		6	--	--	280	--	--	--	--	--	--	--	--	--	--	--	--
		7	--	--	--	--	218	--	180	--	160	--	190	--	--	--	--
		8	--	--	--	--	--	--	180	--	160	--	--	--	--	--	--
		9	--	--	--	--	220	--	--	--	--	--	--	--	--	--	--
		10	--	--	--	--	--	--	--	--	--	--	189	--	--	--	--
		12	--	--	--	--	--	--	--	--	--	--	190	--	--	--	--

Table 7.--Specific conductance measurements of the South Santee River during the flood of April and May, 1969--continued.

Date	Tide	Depth (in feet)	SPECIFIC CONDUCTANCE, IN MICROMHOS AT 25°C 1/ Mile 0.0	Mile 0.5	Mile 1.0	Mile 1.5	Mile 2.0	Mile 2.5	Mile 3.0	Mile 3.5	Mile 4.0	Mile 4.5	Mile 5.0	Mile 5.5	Mile 6.0	Mile 7.0	Mile 8.0
May 4, 1969	High	1	--	--	--	--	--	--	9,500	7,500	7,000	--	2,400	--	1,800	1,075	300
		3	--	--	--	--	--	--	25,000	7,500	7,000	--	2,400	--	1,600	1,075	320
		5	--	--	--	--	--	--	30,000	7,500	7,100	--	2,500	--	1,650	1,000	360
		7	--	--	--	--	--	--	30,000	18,000	20,000	--	4,000	--	1,650	1,150	400
		8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	440
		10	--	--	--	--	--	--	--	25,000	25,000	--	4,600	--	1,700	1,200	--
		11	--	--	--	--	--	--	--	--	--	--	--	--	--	1,300	--
		12	--	--	--	--	--	--	--	28,000	25,000	--	5,000	--	1,800	--	--
		15	--	--	--	--	--	--	--	27,000	--	--	5,300	--	1,800	--	--
May 4, 1969	Low	1	--	2,000	1,200	--	1,000	--	285	--	245	--	220	--	--	--	--
		3	--	2,000	1,200	--	1,000	--	308	--	240	--	220	--	--	--	--
		5	--	--	1,200	--	1,000	--	310	--	240	--	220	--	--	--	--
		7	--	--	--	--	1,000	--	320	--	242	--	223	--	--	--	--
		10	--	--	--	--	--	--	330	--	240	--	223	--	--	--	--
		12	--	--	--	--	--	--	--	--	--	--	224	--	--	--	--
		13	--	--	--	--	--	--	--	--	--	--	222	--	--	--	--
May 6, 1969	High	1	--	--	--	--	--	--	--	--	15,000	--	12,000	5,300	5,000	4,000	2,600
		3	--	--	--	--	--	--	--	--	26,000	--	13,500	6,000	8,500	5,000	3,000
		5	--	--	--	--	--	--	--	--	27,000	--	16,000	7,200	9,500	5,600	3,000
		7	--	--	--	--	--	--	--	--	30,000	--	17,000	10,000	10,000	5,600	3,500
		8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3,500
		9	--	--	--	--	--	--	--	--	30,000	--	--	--	--	--	--
		10	--	--	--	--	--	--	--	--	--	--	20,000	12,000	10,500	6,000	--
		12	--	--	--	--	--	--	--	--	--	--	--	13,000	--	--	--
		14	--	--	--	--	--	--	--	--	--	--	--	14,000	11,000	--	--
May 6, 1969	Low	1	--	15,000	13,500	--	9,000	--	5,000	--	4,000	--	1,100	--	390	285	--
		3	--	15,000	13,500	--	9,000	--	5,250	--	4,000	--	1,300	--	390	390	--
		5	--	--	13,500	--	12,000	--	5,250	--	4,000	--	1,350	--	390	300	--
		6	--	--	13,500	--	--	--	--	--	4,000	--	--	--	--	--	--
		7	--	--	--	--	13,000	--	5,250	--	--	--	1,600	--	395	305	--
		8	--	--	--	--	13,000	--	--	--	--	--	--	--	--	--	--
		9	--	--	--	--	--	--	--	--	--	--	--	--	--	305	--
		10	--	--	--	--	--	--	5,250	--	--	--	1,800	--	400	--	--
		11	--	--	--	--	--	--	5,300	--	--	--	--	--	--	--	--
		12	--	--	--	--	--	--	--	--	--	--	2,000	--	400	--	--
		13	--	--	--	--	--	--	--	--	--	--	2,100	--	--	--	--
May 8, 1969	Low	1	--	--	--	--	21,000	20,000	14,000	--	10,800	8,500	5,500	--	1,200	525	--
		3	--	--	--	--	21,000	20,000	14,000	--	10,800	--	5,750	--	1,200	515	--
		5	--	--	--	--	23,000	20,000	14,000	--	10,500	--	7,000	--	1,250	525	--
		7	--	--	--	--	23,000	20,000	14,000	--	10,500	8,500	8,500	--	1,400	525	--
		8	--	--	--	--	--	--	14,000	--	--	--	--	--	--	--	--
		10	--	--	--	--	--	20,000	--	--	--	9,500	11,000	--	1,800	--	--
		12	--	--	--	--	--	20,000	--	--	--	10,000	11,300	--	1,800	--	--
		13	--	--	--	--	--	--	--	--	--	--	11,300	--	--	--	--

1/ Additional specific conductance data obtained on May 6 at high tide at mile 8.6: 1 foot, 6600 micromhos; 3 feet, 7000 micromhos; 5 feet, 7000 micromhos; 7 feet, 7500 micromhos; 10 feet, 7600 micromhos; and 11 feet, 7700 micromhos. At mile 9.0, under same conditions, specific conductance data were: 1 foot, 500 micromhos; 3 feet, 480 micromhos; 5 feet, 480 micromhos; 7 feet, 475 micromhos; and 9 feet, 470 micromhos.

Table 8.--Chemical analyses of water, Santee River near Pineville, S. C., October 1951 to June 1969.[1/]

/Results in milligrams per liter. Analyses by U. S. Geological Survey/

	Maximum	Mimimum
Silica (SiO_2)	12	1.6
Iron (Fe)	.22	.00
Calcium (Ca)	6.4	3.6
Magnesium (Mg)	2.4	1.0
Sodium (Na)	13	4.8
Potassium (K)	2.5	.8
Bicarbonate (HCO_3)	34	17
Sulfate (SO_4)	13	3.3
Chloride (Cl)	12	3.0
Fluoride (F)	.3	.0
Nitrate (NO_3)	1.4	.1
Dissolved solids (Calculated)	70	39
Dissolved Solids (Residue at 180^0)	73	43
Hardness (as $CaCO_3$)	24	15
Noncarbonate Hardness (as $CaCO_3$)	4	0
Specific Conductance (micromhos at 25^oC)	111	52
pH (in pH units)	7.2	6.0
Color (in color units)[2/]	60	0

1/ 55 Analyses made during period of record.

2/ Based on platinum - cobalt scale (Hazen, 1892).

Table 9.--Chemical and physical properties of water of the Santee River estuary, S. C.

[Results in milligrams per liter except as indicated. Analyses by U. S. Geological Survey]

Stream	Mile	Depth (in feet)	Date of collection	Silica (SiO_2)	Iron (Fe) [1]	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Phosphate (PO_4)	Dissolved solids: Calculated	Dissolved solids: Residue on evaporation at 180°C	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Noncarbonate	Specific conductance (micromhos at 25°C)	pH	Color (units[2])	MBAS[3]
North Santee River	4.0	1	July 15, 1969	3.8	0.02	232	597	5,150	180	107	0	1,420	9,650	0.8	--	0.00	17,000	17,500	3,010	2,930	20,000	6.9	20	0.75
Do------------	6.0	1	-----do-----	3.8	.02	119	360	3,030	95	91	0	785	5,500	.6	--	.00	9,950	10,600	1,810	1,710	13,100	6.8	25	.81
Do------------	10	1	-----do-----	2.7	.01	27	43	394	12	64	0	97	710	.2	0.7	.01	[illegible]	[illegible]	211	192	2,180	6.9	20	.17
Do------------	12	1	-----do-----	2.4	.02	29	6.1	133	9.2	56	0	20	218	.2	.5	.00	176	[illegible]	196	150	871	7.0	15	.09
Do------------	14	1	-----do-----	2.7	.02	9.5	5.2	24	9.2	46	0	7.0	43	.2	.5	.00	121	121	15	8	189	6.8	15	.06
Santee River	20[4]	1	-----do-----	5.0	.01	9.0	2.0	9.0	3.3	44	0	7.2	9.2	.2	.1	.00	61	68	30	0	95	6.7	10	.03
Do------------	29	1	-----do-----	6.5	.01	7.9	2.0	12	2.0	43	0	6.4	8.0	.2	.3	.00	66	68	28	0	92	6.7	5	.04
Do------------	37	1	-----do-----	6.1	.01	6.7	2.0	10	1.5	37	0	6.8	7.7	.2	.1	.00	59	62	21	0	85	6.7	7	.17
South Santee River	5.0	1	July 16, 1969	2.5	.01	292	951	8,350	280	129	0	1,960	15,000	1.2	--	.00	26,300	27,500	4,610	4,510	27,500	7.1	10	3.4
Do------------	6.0	1	-----do-----	3.6	.02	224	696	5,850	190	114	0	1,380	11,200	.9	--	.00	18,900	20,200	3,420	3,330	22,000	7.0	20	3.1
Do------------	6.0	14	-----do-----	3.1	.02	279	711	7,050q	240	121	0	1,760	13,500	1.1	--	.00	21,200	25,000	3,620	3,520	25,500	7.2	15	2.9
Do------------	10	1	-----do-----	5.5	.03	118	342	2,870	90	94	0	715	5,200	.5	--	.06	9,390	10,000	1,700	1,620	13,300	7.2	25	1.0
Do------------	12	1	-----do-----	5.0	.04	54	155	1,230	42	79	0	320	2,310	.1	--	.00	4,190	4,560	773	708	6,670	6.7	20	.36
Do------------	14	1	-----do-----	4.1	.07	21	26	245	7.5	58	0	58	440	.1	.8	.01	845	911	169	121	1,170	6.9	30	.11

1 In solution when analyzed.

2 Based on platinum-cobalt scale (Hazen, 1892)

3 Methylene Blue Active Substance (synthetic detergents)

4 Santee River mileages based on continuation of North Santee River

Table 10.--Measurements of color, turbidity, and Secchi disc transparency, Santee River estuary, August 1969.

/Analyses by U. S. Geological Survey/

Stream	Mile	Date	Depth 1/ (in feet)	Color (units 2/)	Turbidity (as mg/l SiO_2)	Secchi Disc (in feet)
North Santee River	2.0	Aug.4, 1969	1	10	41	
			10	10	41	1.4
		Aug.5, 1969	1	20	20	1.6
			10	50	52	
	5.0	Aug.4, 1969	1	10	20	2.0
			14	25	43	
		Aug.5, 1969	1	40	30	1.6
			14	45	49	
			17	55	61	
	6.0	Aug.4, 1969	1	35	35	1.5
			14	35	46	
		Aug.5, 1969	1	50	49	1.2
			14	55	61	
			20	50	140	
	8.0	Aug.4, 1969	1	30	16	1.6
			14	20	32	
	10	Aug.4, 1969	1	60	44	0.9
			11	60	30	
	12	Aug.4, 1969	1	65	35	0.9
			13	55	35	
	14	Aug.4, 1969	1	50	23	1.0
			14	45	41	
			21	55	44	
	16	Aug.4, 1969	1	45	20	1.3
			14	35	20	
			19	40	38	
	18	Aug.4, 1969	1	30	11	2.1
			14	35	21	
Santee River	20 3/	Aug.4, 1969	1	30	11	2.5
			14	30	23	
	25	Aug.4, 1969	1	15	9	3.1
			5	20	11	
	29	Aug.4, 1969	1	20	11	3.1
			8	25	11	
	33	Aug.4, 1969	1	30	11	2.7
South Santee River	2.0	Aug.5, 1969	1	15	32	1.7
			10	10	46	
	5.0	Aug.5, 1969	1	25	15	2.3
			14	20	25	
			17	15	38	
	6.0	Aug.5, 1969	1	50	40	1.3
			14	30	25	

Table 10.--Measurements of color, turbidity, and Secchi disc transparency, Santee River estuary, August 1969 - continued.

/Analyses by U. S. Geological Survey/

Stream	Mile	Date	Depth 1/ (in feet)	Color (units 2/)	Turbidity (as mg/l SiO_2)	Secchi Disc (in feet)
South Santee River	8.0	Aug.5, 1969	1	60	38	1.0
			14	50	27	
			19	45	27	
	10	Aug.5, 1969	1	150	64	0.8
			11	150	58	
	12	Aug.5, 1969	1	180	47	0.9
			8	180	35	
	14	Aug.5, 1969	1	180	32	0.9
			7	180	32	

1/ Applicable to color and turbidity only.

2/ Based on platinum-cobalt scale (Hazen, 1892).

3/ Santee River mileages based on continuation of North Santee River.

Table 11.--Radiochemical analyses of water, Santee River estuary, July, 1969.

[Analyses by U. S. Geological Survey]

Stream	Mile	Date	Gross alpha 1/ (pc/l)	Gross beta 2/ (pc/l)
North Santee River	4.0	July 15, 1969	60	270
Santee River	37 3/	----do------	.3	2.9
South Santee River	6.0	July 16, 1969	28	830

1/ Gross alpha values reported in picocuries per liter of equivalent natural uranium.

2/ Gross beta values reported in picocuries per liter of cesium - 137.

3/ Santee River mileages based on continuation of North Santee River.

Table 12.--Pesticide analyses of water and bed material, Santee River estuary, June 1969

/Analyses by U. S. Geological Survey/

Stream	Mile	Date	Aldrin	DDD	DDE	DDT	Dieldrin	Endrin	Heptachlor	Lindane
Water (Results in micrograms per liter)										
North Santee River	7.0	June 17, 1969	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.00
Santee River	20 1/	June 18, 1969	.00	.00	.00	.00	.00	.00	.00	.00
Do-------------	29	-----do------	.00	.00	.00	.02	.00	.00	.00	.00
South Santee River	7.0	-----do------	.00	.00	.00	.01	.00	.00	.00	.00
Bed Material (Results in micrograms per kilogram)										
North Santee River	7.0	June 17, 1969	0.00	1.7	0.83	0.00	0.00	0.00	0.00	0.00
Santee River	20 1/	June 18, 1969	.00	.00	.00	.00	.00	.00	.00	.00
Do-------------	29	-----do------	.00	.00	.00	.00	.00	.00	.00	.00
South Santee River	7.0	-----do------	.00	.92	.32	.00	.00	.00	.00	.00

1/ Santee River mileages based on continuation of North Santee River.

Table 13.--Measurement of coliform bacteria, Santee River estuary, July 1969.

[Analyses by U. S. Geological Survey]

Stream	Mile	Date	Coliform (colonies/100 ml)[1/]
North Santee River	4.0	July 15, 1969	18
Do--------------	6.0	-----do------	28
Do--------------	10	-----do------	60
Do--------------	12	-----do------	50
Do--------------	14	-----do------	50
Santee River	20	-----do------	60
Do--------------	29	-----do------	58
Do--------------	37	-----do------	36
South Santee River	5.0	July 16, 1969	12
Do--------------	6.0	-----do------	4
Do--------------	14	-----do------	80

1/ Coliform determined with membrane filter and immediate M-ENDO medium. Values given are estimated because of non-ideal colony counts.

Table 14.--Analyses of suspended sediment, Santee River estuary, February, April, and May 1969.

/Analyses by U. S. Geological Survey/

Stream	Mile	Date	Depth (in feet)	Sediment (in mg/l)
North Santee River	5.9	Feb. 14, 1969	2	56
	5.9	-----do------	10	61
	5.9	-----do------	18	94
	5.0 1/	April 23, 1969	Depth Integrated	47
	5.0 2/	-----do-------	------do--------	22
	7.0	-----do-------	------do--------	71
	10.0	-----do-------	------do--------	71
	14.0	-----do-------	------do--------	47
	18.0	-----do-------	------do--------	44
	5.0	May 17, 1969	------do--------	25
	7.0	-----do-------	------do--------	30
	10.0	-----do-------	------do--------	56
	18.0	-----do-------	------do--------	20
South Santee River	7.0	Feb. 14, 1969	2	119
	7.0	-----do------	8	148
	7.0	-----do------	12	178
	5.0	April 24, 1969	Depth Integrated	47
	5.0	May 18, 1969	------do--------	16
	7.0	-----do------	------do--------	23
	10.0	-----do------	------do--------	40
Santee River	24	April 23, 1969	Depth Integrated	29
	29	-----do------	------do--------	31
	29	May 17, 1969	------do--------	15

1/ Sample obtained at left quarter point.

2/ Sample obtained at right quarter point.

Table 15.--Analyses of bed material, Santee River estuary, April and June 1969.

[Analyses by U. S. Geological Survey]

Stream	Mile	Date	Sand (percent)	Silt and Clay (percent)
North Santee River	5.0 1/	April 23, 1969	81.6	18.4
	5.0 2/	------do------	57.8	42.2
	7.0	------do------	84.0	16.0
	10.0	------do------	97.7	2.3
	14.0	------do------	97.2	2.8
	18.0	------do------	96.4	3.6
Santee River	24 3/	April 23, 1969	100	0.0
South Santee River	5.0	April 24, 1969	97.0	3.0
	6.0	------do------	5.1	94.9
	7.0	------do------	84.1	15.9
	8.0	------do------	93.6	6.4
	10.0	------do------	94.7	5.3
	14.0	------do------	98.6	1.4

1/ Sample obtained at left quarter point.

2/ Sample obtained at right quarter point.

3/ Santee River mileages based on continuation of North Santee River.

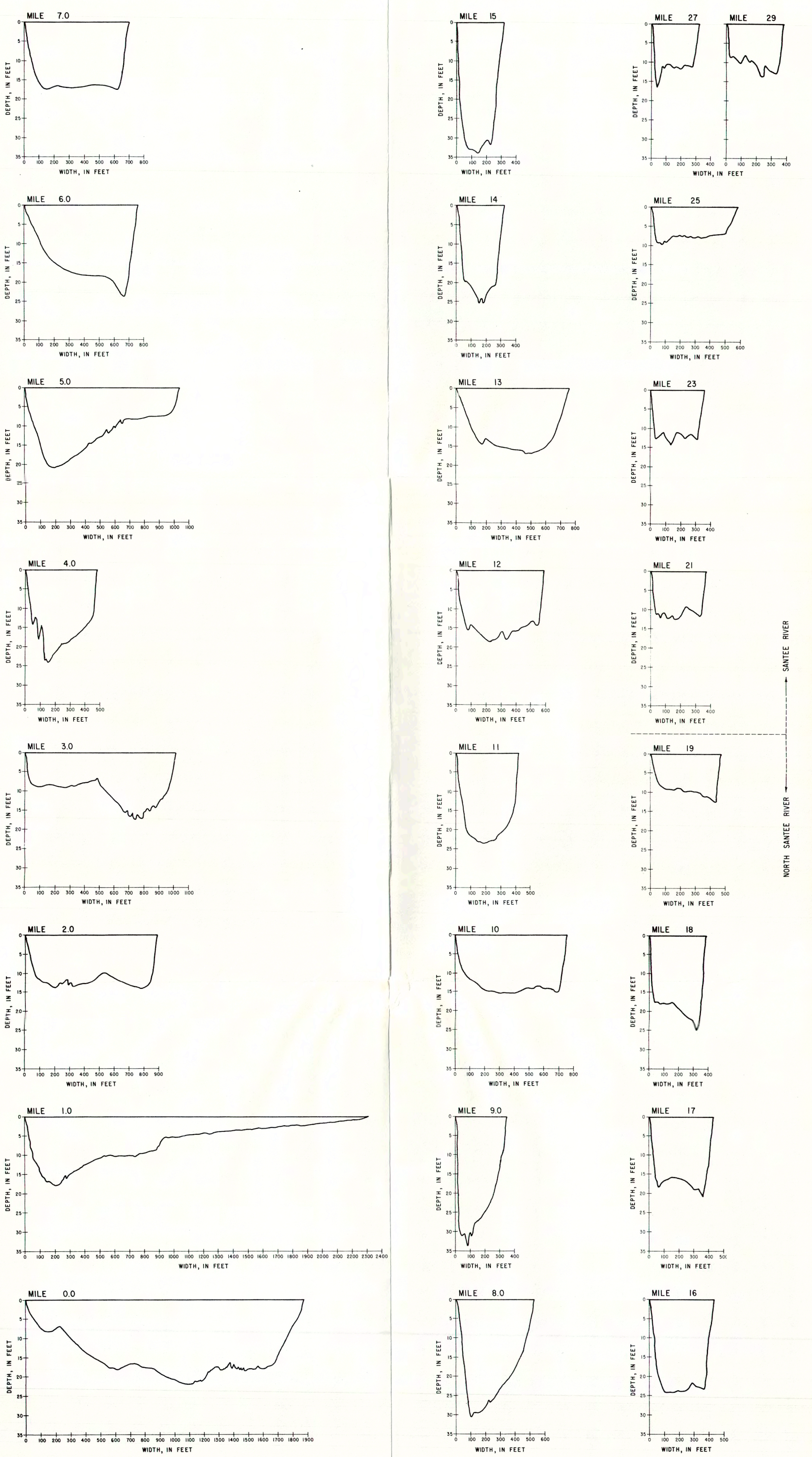
Table 16.--Limiting values for characteristics of raw water used as industrial supplies (Data from National Technical Advisory Committee, 1968).

[Results in milligrams per liter except as indicated]

Characteristic	Boiler make up water		Cooling water				Process water					
	Industrial 0 to 1,500 psig	Utility 700 to 5,000 psig	Fresh		Brackish[1/]		Textile industry	Lumber industry	Pulp and paper industry	Chemical industry	Petroleum industry	Primary metals industry
			Once through	Make up recycle	Once through	Make up recycle						
Silica (SiO_2)	150	150	50	150	25	25	--	--	50	--	50	--
Iron (Fe)	80	80	14	80	1.0	1.0	0.3	--	2.6	5	15	--
Manganese (Mn)	10	10	2.5	10	.02	.02	1.0	--	--	2	--	--
Calcium (Ca)	--	--	500	500	1,200	1,200	--	--	--	200	220	--
Magnesium (Mg)	--	--	--	--	--	--	--	--	--	100	85	--
Sodium and Potassium (Na+K)	--	--	--	--	--	--	--	--	--	--	230	--
Bicarbonate (HCO_3)	600	600	600	600	180	180	--	--	--	600	480	--
Sulfate (SO_4)	1,400	1,400	680	680	2,700	2,700	--	--	--	850	570	--
Chloride (Cl)	19,000	19,000	600	500	22,000	22,000	--	--	200[2/]	500	1,600	500
Fluoride (F)	--	--	--	--	--	--	--	--	--	--	1.2	--
Nitrate (NO_3)	--	--	30	30	--	--	--	--	--	--	8	--
Phosphate (PO_4)	--	50	4	4	5	5	--	--	--	--	--	--
Dissolved solids	35,000	35,000	1,000	1,000	35,000	35,000	150	--	1,080	2,500	3,500	1,500
Suspended solids	15,000	15,000	5,000	15,000	250	250	1,000	3/	--	10,000	5,000	3,000
Hardness (as $CaCO_3$)	5,000	5,000	850	850	7,000	7,000	120	--	475	1,000	900	1,000
pH, units	--	--	5.0-8.9	3.5-9.1	5.0-8.4	5.0-8.4	6.0-8.0	5-9	4.6-9.4	5.5-9.0	6.0-9.0	3-9
Color, units	1,200	1,200	--	1,200	--	--	--	--	360	500	25	--
Methylene blue active substance	2[4/]	10	1.3	1.3	--	1.3	--	--	--	--	--	--
Temperature, °C	49	49	38	49	38	49	--	--	35	--	--	38

1/ Water containing more than 1,000 mg/l dissolved solids.
2/ May be equal to or less than 1,000 mg/l for mechanical pumping operations.
3/ Particles must be equal to or less than 3 mm in diameter.
4/ 1 mg/l for pressures up to 700 psig.
5/ Applies to bleached chemical pulp and paper only.


SANTEE SWAMP
79°42′
33°20′
WILLIAMSBURG CO
BERKELEY CO
WILLIAMSBURG CO
GEORGETOWN CO
US 17A & SC 41
US 17A
SC 41
Tidal Gage
Jamestown
SANTEE SWAMP
SANTEE RIVER
GEORGETOWN CO
BERKELEY CO
WADMACON CREEK
FRANCIS MARION NATIONAL FOREST
Chicken Creek
NORTH SANTEE RIVER
SOUTH SANTEE RIVER
Hampton Creek
BERKELEY CO
CHARLESTON CO
SANTEE SWAMP
US 17 & 701
Sixmile Creek
Pleasant Creek
Kinloch Creek
MINIM CREEK
MINIM ISLAND
INTRACOASTAL WATERWAY
CROW ISLAND
CANE ISLAND
NORTH SANTEE RIVER
NORTH SANTEE BAY
Tidal Gage
BROWN ISLAND
GEORGETOWN CO
CHARLESTON CO
CEDAR ISLAND
BRACE ISLAND
MURPHY ISLAND
Bird Bank Creek
33°06′
79°17′
ATLANTIC OCEAN
SCALE
0 1 2 3 4 5
MILES
N
Index Map of South Carolina
EXPLANATION
5.0
Number indicates river mile upstream from mouth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MILE 6.0
MILE 5.0
MILE 4.0
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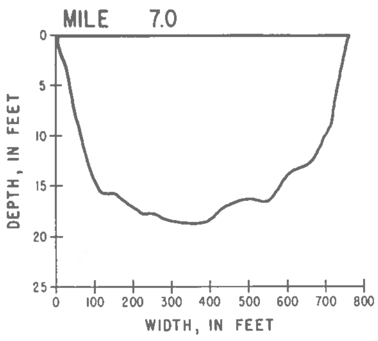
MILE 14
MILE 13
MILE 12
MILE 11
MILE 10
MILE 9.0
MILE 8.0
MILE 27
MILE 29
MILE 25
MILE 23
MILE 21
MILE 19
MILE 18
MILE 17
MILE 16
DEPTH, IN FEET
WIDTH, IN FEET
SANTEE RIVER
NORTH SANTEE RIVER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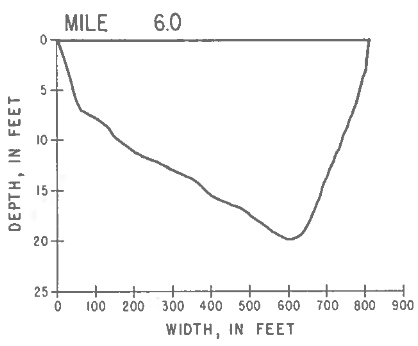
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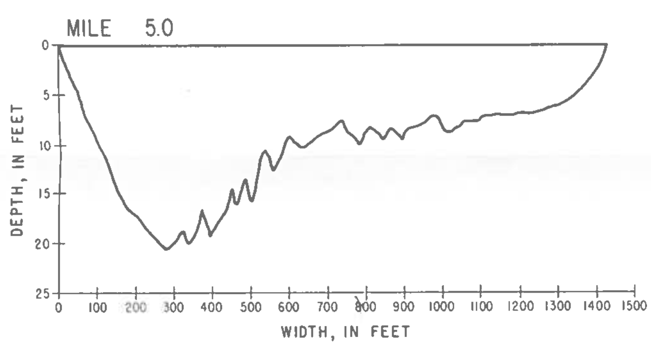
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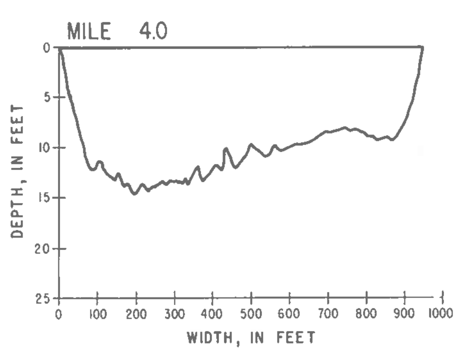
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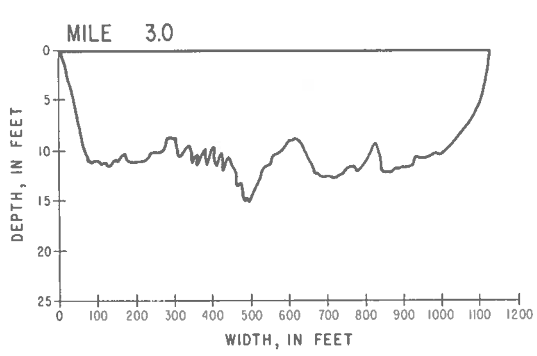
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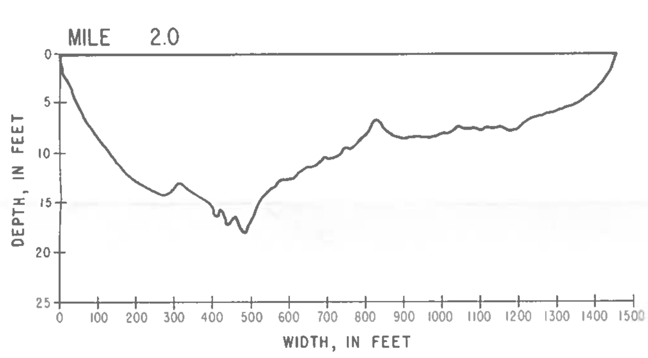
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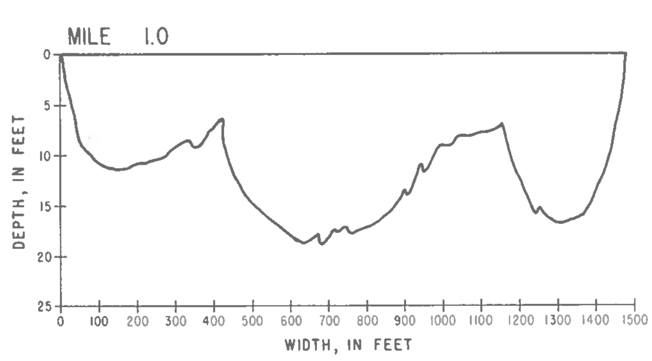
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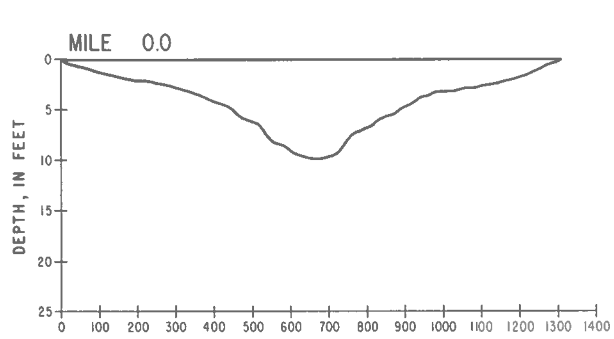
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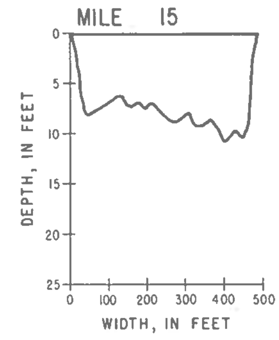
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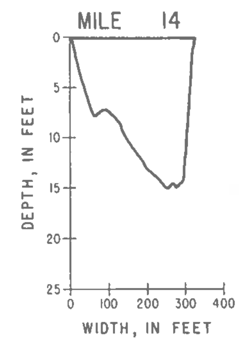
WIDTH, IN FEET


MILE 14
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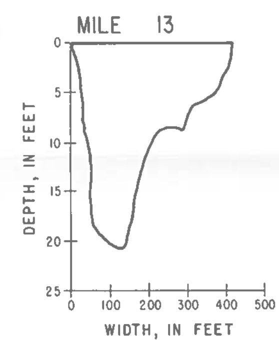
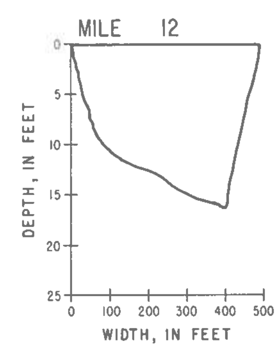
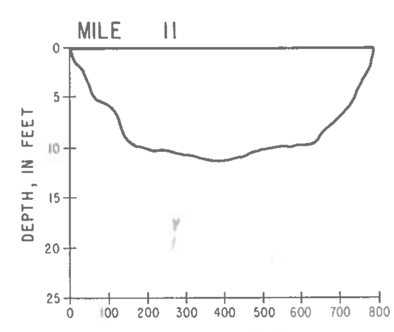
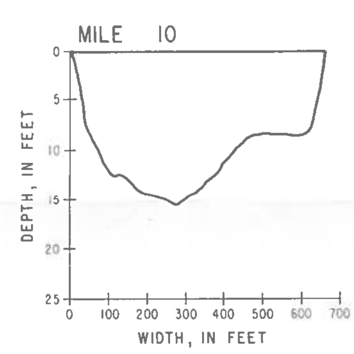
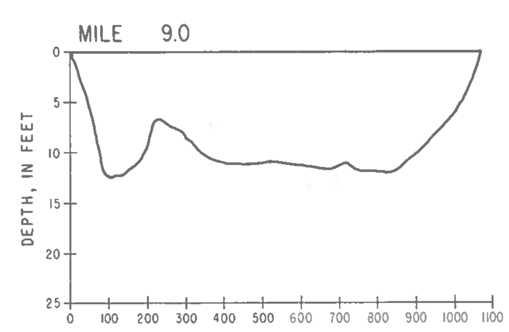
0 100 200 300 400
WIDTH, IN FEET


MILE 13
DEPTH, IN FEET
0 5 10 15 20 25
0 100 200 300 400 500
WIDTH, IN FEET


MILE 12
DEPTH, IN FEET
0 5 10 15 20 25
0 100 200 300 400 500
WIDTH, IN FEET


MILE 11
DEPTH, IN FEET
0 5 10 15 20 25
0 100 200 300 400 500 600 700 800
WIDTH, IN FEET


MILE 10
DEPTH, IN FEET
0 5 10 15 20 25
0 100 200 300 400 500 600 700
WIDTH, IN FEET


MILE 9.0
DEPTH, IN FEET
0 5 10 15 20 25
0 100 200 300 400 500 600 700 800 900 1000 1100
WIDTH, IN FEET

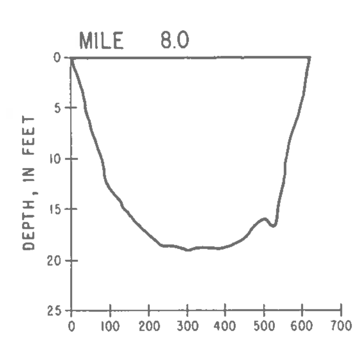

MILE 8.0
DEPTH, IN FEET
0 5 10 15 20 25
0 100 200 300 400 500 600 700
WIDTH, IN FEET

Figure 23 — Relation of Dissolved Substances and Physical Properties to Specific Conductance