

South Carolina Department of Health and Environmental Control

ENVIRONMENTAL AFFAIRS

SHELLFISH MANAGEMENT AREA 06B

2019 ANNUAL UPDATE

**Shellfish Sanitation Section
Environmental Affairs
2600 Bull Street
Columbia, SC 29201**

November 2019



WEB ADDRESS
<http://www.scdhec.gov/FoodSafety/ShellfishMonitoring/>

SHELLFISH MANAGEMENT AREA 06B 2019 ANNUAL UPDATE

[Data Through December 2018]



Prepared By:

Ryan Reed, Regional Shellfish Program Lead
Environmental Affairs - Office of Law Enforcement
1362 McMillan Avenue, Suite 300
Charleston, South Carolina 29405

Reviewer:

D.M. Pearson, State Shellfish Program Manager
Environmental Affairs – Office of Law Enforcement
927 Shine Avenue
Myrtle Beach, South Carolina 29577

TABLE OF CONTENTS
Shellfish Management Area 06B Annual Update

Summary	2
Introduction	3
Pollution Source Survey	7
Changes in Pollution Sources	7
Survey Procedures	7
Point Source Pollution	7
A. Municipal and Community Waste Treatment Facilities	7
B. Industrial Waste.....	7
C. Marinas	8
D. Radionuclides	8
Nonpoint Source Pollution.....	8
A. Urban and Suburban Stormwater Runoff.....	8
B. Agricultural Runoff.....	9
C. Individual Sewage Treatment and Disposal Systems	9
D. Wildlife and Domestic Animals.....	9
E. Boat Traffic	9
F. Hydrographic and Habitat Modification	9
Naturally Occurring Pathogens.....	9
A. Marine Biotoxins	9
B. <i>Vibrio parahaemolyticus</i>	10
Hydrographic and Meteorological Characteristics	10
Water Quality Studies	12
Conclusions.....	13
Recommendations.....	15
References.....	17

Figures and Tables

Figures:

(1) Shellfish Growing Area 06B	18
--------------------------------------	----

Tables:

(1) Shellfish Water Quality Sampling Stations Description	19
(2) Fecal Coliform Bacteriological Data Summary Sheet (<i>January 01, 2016 - December 31, 2018</i>).....	20
(3) Fecal Coliform Historical Trend Sheet	21
(4) Water Quality Sampling Station Data	22
(5) Rainfall Data (<i>January 01, 2016 - December 31, 2018</i>).....	23
(6) Pollution Event Closures.....	27
(7) Annual Average Flow Rates, Santee River.....	28
(8) Fecal Coliform Data Compared with River Stage and Rainfall (<i>01/2014-12/2018</i>)	29

2019 ANNUAL UPDATE
Shellfish Management Area 06B

Data Inclusive Dates:

01 / 01 / 16 thru 12 / 31 / 18

Classification Change:

X Yes ___ No

Shoreline Survey Completed: Yes

(I)ncreased/(D)ecreased/(N)one:

Prior Report & Date: 2018 Annual Update

D Approved

N Conditionally Approved

I Restricted

N Prohibited

SUMMARY

For this Annual Update, Stations 06B-07, 06B-08, 06B-09, and 06B-10 exceeded the bacteriological water quality criteria for an Approved classification. Although increases in rainfall tend to increase non-point source runoff, there are very little uplands that drain directly into Area 06B. This would seem to explain the lack of correlation between levels of observed pollution and localized non-point source runoff.

A more significant contributor to adverse water quality within Area 06B other than rainfall appears to be related to the Santee Cooper Public Service Authority (Santee Cooper) Rediversion Project. This project, implemented in 1985 by the U.S. Army Corp of Engineers, rediverts a substantial portion of the freshwater from Lakes Marion and Moultrie into the Santee River that previously was released into the Cooper River. The Atlantic Intracoastal Waterway (AIWW) is the conduit for freshwater entering Area 06B from the South Santee River.

An additional contributor to fecal coliform concentrations in the Area continues to be attributable to the extensive waterfowl and wildlife population of the Area. The majority of Area 06B's waters lay within the protected boundaries of the Cape Romain National Wildlife Refuge and the Santee Coastal Reserve Wildlife Management Area (WMA). The Santee Coastal Reserve WMA operates impoundments, which are managed for migratory waterfowl.

Area 06B was impacted in October of 2016 from heavy rains and wind associated with Hurricane Matthew. Area 06B received 8.77 inches of rain during the storm event. This excessive rainfall required a closure and subsequent sampling to reopen the area.

The Charleston area was again impacted the following year on September 12, 2017 from heavy rains and wind associated with Hurricane Irma. Area 6B only received 2.45 inches of rain during the storm event however; the opening of the 2017 Shellfish Season was delayed due to large amounts of rain in other growing areas within the Charleston area.

There is one classification change for this Annual Update. The lower portion of Alligator Creek

from Station 06B-21 to Station 06B-12 and over to Station 06B-19 which includes portions of Casino and Skrine Creek will be downgraded to Restricted.

INTRODUCTION

PURPOSE AND SCOPE

The authority to regulate the harvest, sanitation, processing and handling of shellfish is granted to the South Carolina Department of Health and Environmental Control by Section 44-1-140 of the Code of Laws of South Carolina, 1976, as amended. The Department promulgated Regulation 61-47, which provides the rules used to implement this authority and outlines the requirements applied in regulating shellfish sanitation in the State. This regulation specifically addresses classification of shellfish harvesting areas and requires that all areas be examined by sanitary and bacteriological surveys and classified into an appropriate shellfish harvesting classification.

The United States Food and Drug Administration (USFDA) uses The National Shellfish Sanitation Program's (NSSP) *Guide for the Control of Molluscan Shellfish* to evaluate state shellfish sanitation programs. The NSSP Model Ordinance requires that a sanitary survey be in place for each growing area prior to its use as a source of shellfish for human consumption and prior to the area's classification as Approved, Conditionally Approved, Restricted, or Conditionally Restricted. Each sanitary survey shall be updated on an annual basis and accurately reflect changes which have occurred within the area. Requirement of the annual reevaluation include, at a minimum, field observations of pollution sources, an analysis of water quality data consisting of the past year's data in combination with appropriate previously collected data, review of reports and effluent samples from pollution sources, and review of performance standards for discharges impacting the growing area. A brief report documenting the findings shall also be provided.

The following criteria, consistent with the NSSP Model Ordinance, are used by SC Regulation 61-47, Shellfish (2017, pp.9-12) in establishing shellfish harvesting classifications:

Approved Area - Growing areas shall be classified approved when the sanitary survey concludes that fecal material, pathogenic microorganisms, and poisonous or deleterious substances are not present in concentrations that would render shellfish unsafe for human consumption. Approved classifications shall be determined upon a sanitary survey that includes water samples collected from stations in the designated area adjacent to actual or potential sources of pollution. For waters sampled under adverse pollution conditions, the median fecal coliform Most Probable Number (MPN) or the geometric mean MPN shall not exceed fourteen per one hundred milliliters, nor shall more than ten percent of the samples exceed a fecal coliform MPN of forty-three per one hundred milliliters (per five tube decimal dilution). For waters sampled under a systematic random sampling plan, the geometric mean fecal coliform MPN shall not

exceed fourteen per one hundred milliliters, nor shall the estimated ninetieth percentile exceed an MPN of forty-three per one hundred milliliters (per five tube decimal dilution). Computation of the estimated ninetieth percentile shall be determined using National Shellfish Sanitation Program Guide for the Control of Molluscan Shellfish methodology.

Conditionally Approved Area - Growing areas may be classified conditionally approved when they are subject to temporary conditions of actual or potential pollution. When such events are predictable, as in non-point source pollution from rainfall runoff or discharge of a major river, a management plan describing conditions under which harvesting will be allowed shall be adopted by the Department prior to classifying an area as conditionally approved. Where appropriate, the management plan for each conditionally approved area shall include performance standards for sources of controllable pollution (e.g., wastewater treatment and collection systems), evaluation of each source of pollution, and means of rapidly closing and subsequently reopening areas to shellfish harvesting. Memorandums of agreements shall be a part of these management plans where appropriate. Shellfish shall not be directly marketed from a conditionally approved area until conditions for an approved classification have been met for a period of time likely to ensure the shellfish are safe for consumption. Shellstock from conditionally approved areas that have been subjected to temporary conditions of actual or potential pollution may be relayed to Approved areas for purification or depurated through controlled purification operations only by special permit issued by the Department.

Restricted Area - Growing areas shall be classified restricted when sanitary survey data show a moderate degree of pollution or the presence of deleterious or poisonous substances to a degree that may cause the water quality to fluctuate unpredictably or at such a frequency that a conditionally approved classification is not feasible. Shellfish may be harvested from areas classified as restricted only for the purposes of relaying or depuration and only by special permit issued by the Department and under Department supervision. The suitability of restricted areas for harvesting of shellstock for relay or depuration purposes may be determined through the use of comparison studies of background tissue samples with post-process tissue samples, as well as other process verification techniques deemed appropriate by the Department. For restricted areas to be utilized as a source of shellstock for depuration, or as source water for depuration, the fecal coliform geometric mean MPN of restricted waters sampled under adverse pollution conditions shall not exceed eighty-eight per one hundred milliliters nor shall more than ten percent of the samples exceed a MPN of two hundred and sixty per one hundred milliliters for a five tube decimal dilution test. For waters sampled under a systematic random sampling plan, the fecal coliform geometric mean MPN shall not exceed eighty-eight per one hundred milliliters nor shall the estimated ninetieth percentile exceed an MPN of two hundred and sixty (five tube decimal dilution). Computation of the estimated ninetieth percentile shall be obtained using National Shellfish Sanitation Program Guide for the Control of Molluscan Shellfish methodology.

Conditionally Restricted Area - Growing areas may be classified conditionally restricted when they are subject to temporary conditions of actual or potential pollution. When such events are predictable, as in the malfunction of wastewater treatment facilities, non-point source pollution from rainfall runoff, discharge of a major river or potential discharges from dock or harbor facilities that may affect water quality, a management plan describing conditions under which harvesting will be allowed shall be prepared by the Department prior to classifying an area as conditionally restricted. Where appropriate, the management plan for each conditionally restricted area shall include performance standards for sources of controllable pollution, e.g., wastewater treatment and collection systems and an evaluation of each source of pollution, and description of the means of rapidly closing and subsequent reopening areas to shellfish harvesting. Memorandums of agreements shall be a part of these management plans where appropriate. Shellfish may be harvested from areas classified as conditionally restricted only for the purposes of relaying or depuration and only by permit issued by the Department and under Department supervision. For conditionally restricted areas to be utilized as a source of shellstock for depuration, the fecal coliform geometric mean MPN of conditionally restricted waters sampled under adverse pollution conditions shall not exceed eighty-eight per one hundred milliliters nor shall more than ten percent of the samples exceed a MPN of two hundred and sixty per one hundred milliliters for a five tube decimal dilution test. For waters sampled under a systematic random sampling plan, the fecal coliform geometric mean MPN shall not exceed eighty-eight per one hundred milliliters nor shall the estimated ninetieth percentile exceed an MPN of two hundred and sixty per one hundred milliliters (five tube decimal dilution). Computation of the estimated ninetieth percentile shall be obtained using National Shellfish Sanitation Program Guide for the Control of Molluscan Shellfish methodology.

Prohibited Area - Growing areas shall be classified prohibited if there is no current sanitary survey report or if the sanitary survey report or monitoring data show unsafe levels of fecal material, pathogenic microorganisms, or poisonous or deleterious substances in the growing area or otherwise indicate that such substances could potentially reach quantities that could render shellfish unfit or unsafe for human consumption.

BACKGROUND INFORMATION

This sanitary survey evaluates the current harvesting classification of shellfish growing waters designated as Shellfish Management Area 06B (Area 06B). Area 06B consists of approximately 15,223 acres of shellfish growing area habitat located in Charleston County, South Carolina. Area 06B consists of the waters of Cape Romain Harbor, the Atlantic Intracoastal Waterway (AIWW), portions of Muddy Bay, and Alligator, Casino, Clubhouse, Congaree Boat, DuPree, Horsehead, Mill, Ramhorn and Skrine Creeks. The northern boundary of the area is the South Santee River, while US Highway 17 defines the western border. The area is bounded to the south by an imaginary line extending from AIWW Marker #32 southeastward to Cape Island and the southern portion of Cape Romain Harbor. The eastern boundary is the Atlantic Ocean.

The shellfish industry in South Carolina is based primarily on the harvest of the eastern oyster (*Crassostrea virginica*) and hard clams, which include both the northern clam (*Mercenaria mercenaria*) and several small populations of the southern clam (*Mercenaria campechiensis*). The ribbed mussel (*Geukensia demissa*) is also harvested in South Carolina on a small scale, primarily recreationally. Areas in South Carolina designated for commercial harvest by the South Carolina Department of Natural Resources (SCDNR) include State Shellfish Grounds, Culture permits, Mariculture permits and Kings Grant areas. The South Carolina Department of Health and Environmental Control will disallow the harvesting of shellfish within Area 06B, for direct marketing purposes, from the restricted waters listed below in the Recommendations.

There are three State Shellfish Grounds (S), S-336, S-295, and S-328, within Area 06B. Multiple Culture permit (C), and Mariculture permit (M) areas are located in Area 06B, as well as a single King's Grant (G). The Kings Grant lease, G-318, is located along Jeremy Island and includes portions of DuPree Creek.

The wild-stock shellfish harvesting season in South Carolina extends from October through May of the following year. The SCDNR has the authority to alter the shellfish-harvesting season for resource management purposes and grant permits for year-round mariculture operations. Additionally, the South Carolina Department of Health and Environmental Control has the authority to prohibit shellfish harvesting when necessary to ensure that shellfish harvested in South Carolina waters are safe for human consumption.

The harvesting classification of Area 06B prior to this sanitary survey was as follows:

Prohibited: None

Restricted:

1. The Atlantic Intracoastal Waterway, including adjacent marshlands, from its confluence with the South Santee River to station 07-21;
2. All portions of Area 06B north of a line extending from Station 06B-19 east to Station 06B-12, then northwest from Station 06B-19, to the AIWW at Station 06B-09;

Conditionally Approved: None

Approved: All other waters in Area 06B.

POLLUTION SOURCE SURVEY

CHANGES IN POLLUTION SOURCES

One Area 06B pollution source continues to fluctuate. Freshwater inflow from the Santee River system is highly variable and is based on rainfall and lake levels. In order to prevent flooding during periods of high flow into Lake Marion, freshwater is discharged from the Lake Marion Spillway to the Santee River. Freshwater from Lake Moultrie is also released to the Santee River by way of the Rediversion Canal. The amount of freshwater released into the Santee River negatively impacts water quality within Area 06B.

SURVEY PROCEDURES

Shoreline surveys of Area 06B are conducted by the Lowcountry Charleston Shellfish Sanitation staff, by watercraft, vehicle, and on foot, during the survey period and are ongoing. Previous shoreline survey efforts conducted by the Office of Coastal Resource Management (OCRM) will continue to be documented.

OCRM developed GIS shape files that documented rural, non-MS4 (Municipal separate storm sewer system) areas in Charleston County serviced by septic tanks. A one-mile buffer was drawn around all impaired shellfish water bodies in the county. County parcel data was cross-referenced with Department septic tank permit data in those areas to develop shape files of all parcels on septic tanks, to include the number of tanks on the property and the property owner's names(s) and address(s). A physical shoreline survey of these same areas was also conducted, including GPS coordinates of any observed animal farms, type and number of animals observed, and their distance from shellfish harvesting waters. Together, the septic data and animal farm data should provide focus for future shoreline survey efforts in locating and evaluating potential non-point source impacts near impaired shellfish harvesting waters.

POINT SOURCE POLLUTION

- A. Municipal and Community Waste Treatment Facilities** – There are no wastewater treatment facilities or discharges within the boundaries of Area 06B.
- B. Industrial Waste (Discharges)** - There are no industrial wastewater discharges located within the boundaries of Area 06B. However, Santee Cooper's spillway at Wilson Dam and the St. Stephens hydroelectric generating station near St. Stephens regulate freshwater flow into the Santee River system.

In order to prevent flooding during periods of high flow into Lake Marion, freshwater is discharged from the Lake Marion spillway to the Santee River. Freshwater from Lake Moultrie enters the Santee River by way of the Rediversion Canal. The amount of fresh water released into the Santee River negatively impacts water quality within Area 06B.

- C. Marinas** – In 2007, prompted by the Department's Office of Coastal Resource Management (OCRM) marina definition change, the Shellfish Sanitation Section incorporated the following marina definition. S.C. Regulation 61-47, Shellfish defines Marina as any of the following: (1) locked harbor facility; (2) any facility which provides fueling, pump-out, maintenance or repair services (regardless of length); (3) any facility which has effective docking space of greater than 250 linear feet or provides moorage for more than 10 boats; (4) any water area with a structure which is used for docking or otherwise mooring vessels and constructed to provide temporary or permanent docking space for more than ten boats, such as a mooring field; or (5) a dry stack facility. There are no marinas located in Area 06B.

Prior to the 2007 definition change, there were no marinas or commercial boat docking facilities located within Area 06B. Multiple commercial boat docking facilities are located in Jeremy Creek in adjacent Area 07. Sample data suggests that this creek poses minimal impact to Area 06B.

As of yet, SCDHEC has not identified any other facilities meeting the new marina definition. If identified, they will be mapped, and adequate closure zones established to protect public health.

- D. Radionuclides** - Sources of radionuclides have not been identified within Area 06B, and radionuclide monitoring has not been conducted. No other sources of poisonous or deleterious substances have been identified within the area.

NONPOINT SOURCE POLLUTION

- A. Urban and Suburban Stormwater Runoff** - Stormwater runoff impacts water quality by transporting fecal coliform bacteria from land to the shellfish growing area. Lack of urban development within Area 06B precludes this as a likely factor impacting shellfish harvesting waters.

The uplands surrounding the shellfish growing waters of Area 06B consist of various soil textures defined by the United States Department of Agriculture (USDA), Soil Conservation Service (1971) utilizing general classifications and descriptions. Although lands within Area 06B consist of numerous soil types, the area is generally comprised of Seewee-Rutlege soils, nearly level and gently sloping woodland and cropland loamy fine sand. The USDA (1971) further describes these soils as "somewhat poorly drained to moderately well drained, nearly level, sandy soils on ridges and poorly drained to very poorly drained, sandy soils in depressions."

- B. Agricultural Runoff** - There are no permitted agricultural facilities located in Area 06B. The lack of concentrated agricultural activity near the shoreline precludes contamination of shellfish waters from agricultural runoff. There were also no animal farms documented by OCRM staff during their shoreline survey efforts in Area 06B. This supports the conclusion that impacts are not related to agricultural runoff.
- C. Individual Sewage Treatment and Disposal Systems** - There has been no observed new residential construction adjacent to shellfish growing waters in this area. Existing homes utilize individual sewage treatment disposal (ISTD) systems. Each new system requires inspection and approval by the Bureau of Environmental Health Services, Low Country Charleston EQC, On-site Waste Water Section prior to final installation.
- D. Wildlife and Domestic Animals** - The majority of Area 06B's waters lies within the protected boundaries of the Cape Romain National Wildlife Refuge and the Santee Coastal Reserve Wildlife Management Area (WMA). The uplands of Area 06B from Casino creek north to the South Santee River are part of the Santee Coastal Reserve WMA. The Santee Coastal Reserve WMA operates impoundments, which are managed for use by migratory waterfowl. The water levels in the impoundments are managed using rice trunks and have set spillways that overflow at times of heavy rains to maintain consistent levels in the impoundments. The water levels in the impoundments are lowered in March through May. The impoundments are located primarily between the South Santee River and south Alligator Creek in the upper portion of the management area, draining into tidal creeks that flow to the AIWW. Dredge spoil areas along the AIWW used by the Army Corps of Engineers provide additional habitat for waterfowl and wildlife.
- E. Boat Traffic** - Recreational boat traffic is moderate throughout the area except during the winter months. Commercial traffic in the AIWW consists primarily of tugs and barges. Commercial fisheries boats, ranging in size from 16 to 50 feet, operate in the area as long as product demand exists.
- F. Hydrographic and Habitat Modification** - Hydrographic and habitat modification in estuarine areas requires both State and Federal approval. Portions of the AIWW require periodic maintenance dredging. The U.S. Army Corps of Engineers utilizes designated tracts of land adjacent to the AIWW as dredge spoil sites.

The Army Corps of Engineers has not conducted any dredging projects in Area 06B recently.

NATURALLY OCCURRING PATHOGENS

- A. Marine Biotoxins** - Bivalve shellfish contamination from marine biotoxins has not been shown to be a human health concern within Area 06B. During the winter and spring of 1988, South Carolina experienced an occurrence of "Red Tide", specifically *Ptychodiscus*

brevis (*K. brevis*), which affected water quality in Area 01. There has been no documented reoccurrences of this organism at levels requiring emergency response in South Carolina waters subsequent to the 1988 event. Due to the vast media coverage of events related to *Pfiesteria piscicida*, the Department participates in a State Task Group on Toxic Algae and operates a toxic algae emergency response team.

- B. *Vibrio parahaemolyticus*** – Because State water temperatures exceed 81 degrees Fahrenheit (F) during June through September; *Vibrio parahaemolyticus* (*Vp*) management controls must be implemented during these months. Management controls for permitted Aquaculture facilities are specifically addressed in R.61-47. The season for wild-stock harvest is currently closed from June 1 through October 1. The Department is currently opposed to issuance of special wild-stock harvest permits to Certified Shippers during the closed season. Special permit conditions for maricultured triploid oysters during the vibrio control months must include current R.61-47 and NSSP temperature control requirements to be included in the Certified Shipper's HACCP plan.

HYDROGRAPHIC AND METEOROLOGICAL CHARACTERISTICS

PHYSIOGRAPHY

Area 06B is comprised of salt and brackish marsh and includes shallow bays and meandering creeks protected by a series of offshore barrier islands. The creeks within the area range from 50 to 600 feet in width and average 3 to 9 feet in depth. Additionally, the AIWW traverses the area's entire length in a northeast-southwest direction. The AIWW is maintained at a mean low water depth of 12 feet by the US Army Corps of Engineers and is the major conduit of low salinity water into Area 06B from the South Santee River. Cape Romain Harbor, a shallow water bay, is the major conduit of high salinity ocean water into the area. The entire system is approximately eight miles wide (northwest to southeast) and eight miles long (southwest to northeast).

The South Santee River defines the northern boundary of Area 6B. The South and North Santee Rivers are the two distributaries of the Santee River Estuary, a coastal plain, drowned river valley system. Prior to 1941, the Santee River had the fourth largest streamflow of any river on the U.S. Atlantic Coast. In 1941, upon completion of a massive hydroelectric project, the Santee River was dammed behind Wilson Dam to form Lake Marion. At the time Wilson Dam was the longest earthen dam in the world. An estimated 86 to 90 percent of the Santee River's flow was diverted at that time to the Cooper River, by way of Lake Marion through the Diversion Canal to Lake Moultrie (which was formed by damming the Cooper River). The annual mean discharge of the Santee River below the Wilson dam was reduced from 18,500 to 2,600 cubic feet per second (cfs). In the 1980's, excessive silting in the Charleston Harbor from the increased stream flow from the Cooper River prompted the U.S. Army Corp of Engineers to begin work on the Rediversion Project. The Rediversion Project was completed in 1985 and much of the streamflow to the Cooper River was rediverted from Lake Moultrie back into the Santee River by way of the new Rediversion Canal. All inflow that enters the Lake Marion and Lake Moultrie system is now returned to the Santee River, except for a daily average of 4,500 cfs that goes into

the Cooper River. A minimum of 600 cfs enters the Santee River at the Wilson Dam spillway to run a small turbine. Most additional discharge to the Santee River comes from the St. Stephen Dam near St. Stephens through the Rediversion Canal, and controlled spilling from Wilson Dam during periods of high flow into Lake Marion. The North Santee is the main channel of the two distributaries, transmitting an estimated 73 to 85 percent of the Santee River's flow. (SCDNR 2004)

Tides in Area 06B are semidiurnal, consisting of two low and two high tides occurring each lunar day. Mean tidal ranges in Casino Creek are 4.6 feet during normal tides, 5.3 feet during spring tides. Wind direction and intensity, as well as atmospheric pressure, typically cause variations in predicted tidal ranges.

Precipitation in Area 06B is heaviest during late summer and early autumn. Tropical storms and hurricanes occasionally produce extremely large amounts of rainfall. During winter months, heavy rainfall events are uncommon, yet occasional intense thunderstorms associated with rapidly moving low-pressure systems generate heavy rains. Precipitation rarely occurs in the form of snow or ice. Spring weather patterns may be dynamic with associated thunderstorms and severe weather conditions.

On October 8, 2016, Hurricane Matthew made landfall southeast of McClellanville, SC. Shellfish harvest was closed by SC DHEC prior to the arrival of the storm. Hurricane Matthew dropped considerable amounts of precipitation in the Charleston area and had a storm surge that caused extensive flooding. SC DHEC reassessed the closures after the storm and conducted sampling prior to reopening the growing areas. Water sampling was used to reopen the beds once fecal coliform concentration levels were low enough to permit harvest. The widespread flooding also caused sanitary sewer overflows into harvestable shellfish areas, requiring 21 day closures and additional tissue samples prior to reopening.

In 2017, the collection of rainfall data has been improved for a more consistent, accurate, and reliable data set that can be accessed directly from a shellfish staff member's computer or phone. With assistance from the National Weather Service's (NWS), Southeastern River Forecast Center, the development of the South Carolina Shellfish Rainfall Program was introduced and utilized. This new technology provides shellfish program staff with real-time daily updates for rainfall accumulation in each of the South Carolina shellfish growing management areas, as well as providing critical triggers that alert staff to when rainfall thresholds for closures are exceeded.

The 2018 annual precipitation total recorded by NWS, Southeastern River Forecast Center was 61.41 inches.

Prevailing winds along the central portion of the South Carolina coast are from the south and west during spring and summer and from the north during autumn and winter. Wind speeds are generally less than 15 miles per hour (mph); however, strong weather systems may generate winds in excess of 25 mph. Tropical storms and hurricanes occur occasionally.

The South Santee River is the major source of freshwater inflow into Area 06B. Flow from the Lake Marion spillway, the St. Stephens hydroelectric generating station, and Lake Marion hydroelectric generating station, which discharge into the Santee River, reaches the South Santee near the AIWW approximately three to four days from the time of release. Flow rates of water released by Santee Cooper into the Santee River correlate well with gauge height and flow rate as observed downstream at the USGS Santee River Station 02171700, near Jamestown, available online at <http://waterdata.usgs.gov/nwis/uv?02171700> (SCDNR 2004).

Analysis of routine shellfish water quality sampling data showed fecal coliform concentrations for impaired Stations 06B-07, 06B-08, and 06B-09, are negatively correlated with salinity, meaning higher fecal coliform concentrations occur with lower salinities. Fecal coliform 90th percentile concentrations also generally decrease progressing in a southern direction along the AIWW and decrease drastically in the tidal creeks from the AIWW to the ocean. This suggests source(s) of fecal coliform pollution near the confluence of the South Santee River and the AIWW and that the main source of contamination is from freshwater input, likely from the South Santee River and/or waterfowl impoundments (SCDHEC 2008 Area 06B TMDL).

Annual average flow rates for the Santee River are calculated from raw data provided by Santee Cooper and are included in this report (Table #6), to monitor annual flow trends and their correlation to fecal coliform concentration trends (Table #3) in the Area.

WATER QUALITY STUDIES

DESCRIPTION OF THE PROGRAM

The Department currently utilizes a systematic random sampling (SRS) strategy within Area 06B in lieu of sampling under adverse pollution conditions. In order to comply with NSSP guidelines, a minimum of thirty samples are required to be collected and analyzed from each station during the review period. Sampling dates are computer generated prior to the beginning of each quarterly period thereby insuring random selection with respect to tidal stage and weather. Day of week selection criteria is limited to Mondays, Tuesdays and Wednesdays due to shipping requirements and laboratory manpower constraints. Sample schedules are rarely altered.

During July 1998, an updated shellfish water quality data scheduling and collection procedure was formalized. Samples utilized for classification purposes are limited to those samples collected in accordance with the SRS for a 36-month period beginning January 1 and ending December 31. This allows for a maximum of 36 samples per station, yet provides a six-sample 'cushion' (above the NSSP required 30 minimum) for broken sample bottles, lab error, breakdowns, etc. This also allows each annual report's water quality data to meet the requirements for the NSSP Triennial Review sampling criteria.

Seven hundred and twenty-five (725) routine surface water quality samples (<1.0 ft. deep) were collected for bacteriological analyses and classification purposes from twenty-two (22) active water quality sampling stations in Area 06B during the period 01/01/**16** thru 12/31/**18**.

There were multiple special samples collected for non-classification purposes, associated with reopening following precautionary closures. Samples were collected in 120 ml amber glass bottles, immediately placed on ice and transported to the South Carolina Department of Health and Environmental Control's Low Country Charleston Environmental Affairs laboratory at North Charleston, South Carolina. An additional 120 ml water sample was included with each shipment as a temperature control. At the laboratory, sample sets exceeding a 30-hour holding time or containing a temperature control in excess of 10 degrees Celsius were discarded (APHA, 1970).

Surface water temperatures are measured utilizing hand-held, laboratory-quality calibrated centigrade thermometers. Salinity measurements were measured in the laboratory using an automatic temperature compensated refractometer. Additional field data include ambient air temperature, wind direction, tidal stage and date and time of sampling.

MONITORING RESULTS

Stations 06B-07, 06B-08 and 06B-09 exceeded a fecal coliform geometric mean MPN value of 14. No station exceeded a fecal coliform geometric mean MPN value of 88. Stations that exceeded a fecal coliform MPN estimated ninetieth percentile values of 43 are 06B-07, 6B-08, 06B-09, 06B-10 and 06B-12. No station exceeds an estimated ninetieth percentile fecal coliform MPN value of 260.

Area 06B was closed on 09/03/2016 due to 4.15 inches of rainfall. Six (6) special samples collected on 09/07/2016 were used to reopen the Area on 09/09/2016.

Area 06B was closed on 10/07/2016 prior to landfall of Hurricane Matthew. Ten (10) special samples collected on 10/18/2016 were used to reopen the Area on 10/21/2016.

The 2017 Shellfish season was delayed until October 15, 2017 due to a precautionary closure brought on by Hurricane Irma.

CONCLUSIONS

Analysis of routine shellfish water quality sampling data showed fecal coliform concentrations for impaired Stations 06B-07, 6B-08, 6B-09, 06B-10 and 06B-12 are negatively correlated with salinity. Fecal coliform 90th percentile concentrations also generally decrease progressing in a southern direction along the AIWW and decrease drastically in the tidal creeks from the AIWW to the ocean. This suggests source(s) of fecal coliform pollution near the confluence of the South Santee River and the AIWW and that the main source of contamination is from freshwater input, likely from the South Santee River and/or waterfowl impoundments (SCDHEC 2008 Area 06B TMDL). Based on these findings, review of fecal coliform bacteriological data and the pollution source survey, Area 06B is impacted by two sources of actual or potential pollution.

Water quality in Area 06B appears to be negatively impacted by freshwater entering the Area via

the AIWW from the South Santee River. This can be directly observed by comparing flow rates of water released by Santee Cooper into the Santee River and fecal coliform bacteriological data. In Table #8, as the river gauge height increases, we observe more stations exceeding the Approved fecal coliform limits, even with relatively low rainfall for the days prior to sampling. This suggests that river flow in the Santee River, and not localized rainfall, has a greater impact on water quality in Area 06B and explains the observed decrease in water quality.

Predictable pollution events like increased river flows, and the early warning system that the gauge at Jamestown provides, would make Area 06B an excellent candidate to be managed as Conditionally Approved. River stage at the Jamestown location was the management tool for the previously classified Conditionally Approved portion of Area 06A. A similar management approach to river stage could be applied to Area 06B. Gauge height data at Jamestown is available online, with historical data going back to May 2001. In looking at Area 06B water quality sampling data compared to maximum gauge height at Jamestown five days prior to sampling, for impaired stations in Area 06B, a model could be created to predict when river stage might impact growing area water quality. Table #8 is included at the end of this report, comparing river stage as well as rainfall with routine water sampling data from January 2013 to present, for just such an effort. Unfortunately, due to current resource constraints, Conditionally Approved management of Area 06B is not feasible at this time.

NONPOINT SOURCE RUNOFF

Stormwater runoff is a contributing source of fecal coliform bacteria contamination in the area. Area 06B lies within the boundaries of the Cape Romain National Wildlife Refuge as well as the Santee Coastal Reserve Wildlife Management Area. Both provide suitable habitat for abundant wildlife populations. The Santee Coastal Reserve operates multiple impoundments that are used by migratory waterfowl. The water levels in the impoundments are managed using rice trunks and have set spillways that overflow at times of heavy rains to maintain consistent levels in the impoundments. The water levels in the impoundments are lowered in March through May. The impoundments are located primarily between the South Santee River and south Alligator Creek in the upper portion of the management area, draining into tidal creeks that flow to the AIWW. Water released from these waterfowl impoundments is likely a significant contributor to fecal coliform concentrations in the Area. Dredge spoil areas along the AIWW used by the Army Corps of Engineers provide additional habitat for waterfowl and wildlife.

FRESHWATER INFLOW

A more significant contributor to adverse water quality within Area 06B than rainfall appears to be related to the Santee Cooper Public Service Authority (Santee Cooper) Rediversion Project. This project, implemented in 1985 by the U.S. Army Corp of Engineers, rediverts a substantial portion of the freshwater from Lakes Marion and Moultrie back into the Santee River that previously was released into the Cooper River. This was done to alleviate excessive shoaling of the shipping channels in Charleston Harbor. The Santee River has two distributaries, the North Santee and South Santee. The South Santee defines Area 06B's northern boundary. The Atlantic Intracoastal Waterway (AIWW) is the conduit for freshwater entering Area 06B from the South

Santee River. Annual average flow rates for the Santee River are calculated from raw data provided by Santee Cooper and are included in this report (Table #7), to monitor annual flow trends and their correlation to fecal coliform concentration trends (Table #3) in the Area.

Flow from the Lake Marion spillway, the St. Stephens hydroelectric generating station, and Lake Marion hydroelectric generating station, which all discharge freshwater into the Santee River, reaches the South Santee near the AIWW approximately three to four days from the time of release. Flow rates of water released by Santee Cooper into the Santee River correlate well with gauge height and flow rate as observed downstream at the USGS Santee River Station 02171700, near Jamestown, available online at <http://waterdata.usgs.gov/nwis/uv?02171700> (SCDNR 2004).

RECOMMENDATIONS

For this Annual Update, stations 06B-07, 06B-08, 06B-09, 06B-10 and 06B-12 exceed bacteriological water quality criteria for the Approved classification. One classification change is recommended for this annual update.

The following harvesting classification for Area 06B is recommended:

Prohibited: None

Restricted:

1. The Atlantic Intracoastal Waterway, including adjacent marshlands, from its confluence with the South Santee River to Station 07-21;
2. All portions of Area 06B north of a line extending from Station 06B-19 southeast to Station 06B-21, then northwest from Station 06B-19, to the AIWW at Station 06B-09;

Conditionally Approved: None

Approved: All other waters in Area 06B.

Analysis of sampling data for Area 06B demonstrates the probability of a significant impact from rainfall exceeding 4.00" in a 24-hour period. Therefore, a precautionary closure of Area 06B will be implemented following rainfall events of greater than 4.00" in a 24-hour period, as measured at SCDHEC's Rain Gauge near McClellanville, South Carolina. This methodology is associated with the concept of the Probable Maximum Precipitation (PMP). The National Weather Service publishes PMP estimates for the coastal United States in a series of hydro-meteorological reports (HMRs) (*National Weather Service*). PMP estimates for South Carolina's growing areas are derived from HMRs 51, 52, and 53 (*National Research Council, 1985*).

REFERENCES

American Public Health Association, Inc. 1970, Procedures for the bacteriologic examination of sea water and shellfish *in* Recommended procedures for the examination of sea water and shellfish, 4th ed. Library of Congress, Washington, D.C. p. 28-47.

National Research Council 1985, Safety of Dams - Flood and Earthquake Criteria. National Academy Press, Washington DC.

National Weather Service, Precipitation-Frequency Atlas of the United States, NOAA Atlas 14 Volume II. Superintendent of Documents, US Government Printing Office Washington DC.

National Shellfish Sanitation Program (NSSP), Guide for the Control of Molluscan Shellfish, 2017 Revision. Model Ordinance. United States Food and Drug Administration.

<https://www.fda.gov/media/117080/download>

South Carolina Department of Health and Environmental Control (SCDHEC), 2017, Regulation 61-47, Shellfish. p.9-12.

<https://www.scdhec.gov/sites/default/files/media/document/R.61-47.pdf>

South Carolina Department of Health and Environmental Control (SCDHEC), Bureau of Water, 2010, 'Total Maximum Daily Load-South Santee Coastal Watershed'. p.17

http://www.scdhec.gov/HomeAndEnvironment/Docs/tmdl_sSanteeCoastal.pdf.

South Carolina Department of Natural Resources (SCDNR) 2004, Flow and Salinity Characteristics of the Santee River Estuary, report prepared by B.L. Hockensmith, South Carolina Department of Natural Resources Water Resources Report 35.

United States Department of Agriculture (USDA), Soil Conservation Service 1971, Soil survey of Charleston County, South Carolina. In cooperation with South Carolina Agricultural Experiment Station and South Carolina Land Resources Conservation Commission, National Cooperative Soil Survey, Washington, D.C. p. 78.

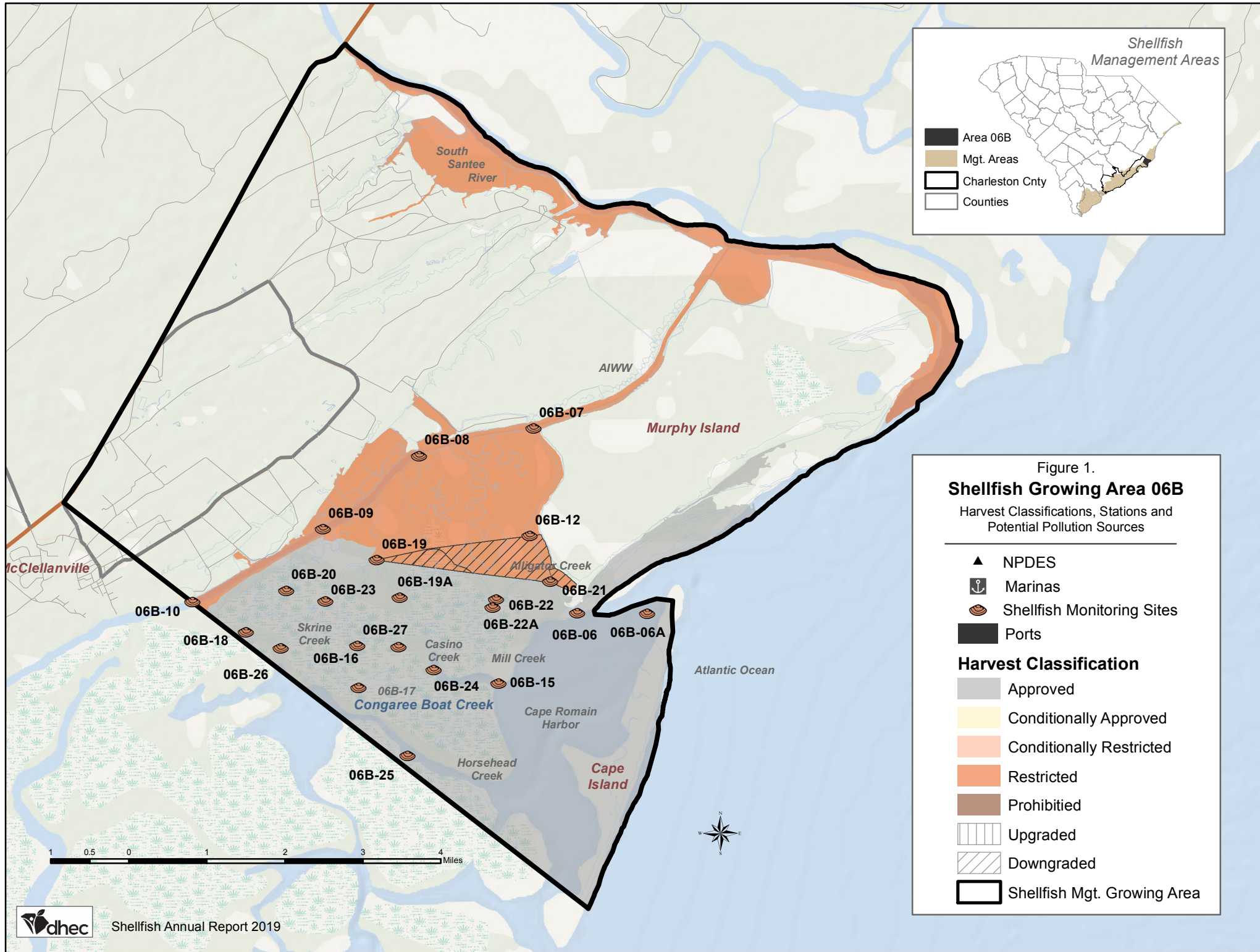


TABLE #1
Shellfish Management Area 06B
Water Quality Sampling Stations Description

<u>Station</u>	<u>Description</u>
06B-06.....	Alligator Creek at Cape Romain Harbor
06B-06A.....	North end of Cape Romain Harbor
06B-07.....	Alligator Creek at Marker #26
06B-08.....	Casino Creek at AIWW
06B-09.....	DuPre Creek at AIWW, south of Marker #30
06B-10.....	AIWW at Marker #32
06B-12.....	Alligator Creek State Shellfish Ground
06B-15.....	Casino Creek at Cape Romain Harbor
06B-16.....	Casino Creek at small, unnamed creek on right in bend south of Station 19
06B-17.....	Congaree Boat Creek at Tower Creek
06B-18.....	DuPre Creek at Clubhouse Creek
06B-19.....	Casino Creek at Skrine Creek
06B-19A.....	Casino Creek, midway between stations 06B-19 and 06B-16, at unnamed creek
06B-20.....	DuPre Creek, 1,500 yards from Clubhouse Creek
06B-21.....	Alligator Creek at Ramhorn Creek
06B-22.....	Ramhorn Creek at Mill Creek
06B-22A.....	Mill Creek at Ramhorn Creek
06B-23.....	Skrine Creek at Congaree Boat Creek
06B-24.....	Casino Creek at Congaree Boat Creek
06B-25.....	Horsehead Creek at unnamed creek south of Horsehead Island
06B-26.....	Skrine Creek at DuPre Creek
06B-27.....	Congaree Boat Creek at the first creek on the left south of Station 23

(Total Active – 22)

TABLE #2

**Shellfish Management Area 06B
Fecal Coliform Bacteriological Data Summary
From Shellfish Water Quality Sampling Stations between
January 1, 2016 and December 31, 2018**

Station #	6	6A	7	8	9	10	12	15
SAMPLES	33	33	33	33	33	33	33	33
GEOMEAN	5.5	3.9	20.4	15.8	17.9	11	10	2.6
90TH %ILE	30	17	78	79	90	62	56	8
WATER QLTY	A	A	R	R	R	R	R	A
CLASSIFICATION	A	A	R	R	R	R	R	A

Station #	16	17	18	19	19A	20	21	22
SAMPLES	33	33	33	33	33	33	33	32
GEOMEAN	3.6	2.8	3.8	8.2	5.7	3.4	7.2	5.5
90TH %ILE	14	8	15	42	33	10	41	19
WATER QLTY	A	A	A	A	A	A	A	A
CLASSIFICATION	A	A	A	R	A	A	A	A

Station #	22A	23	24	25	26	27		
SAMPLES	33	33	33	33	33	33		
GEOMEAN	3.1	5.2	3.1	2.3	3.3	3.8		
90TH %ILE	13	24	10	5	14	16		
WATER QLTY	A	A	A	A	A	A		
CLASSIFICATION	A	A	A	A	A	A		

A - Approved **CA** - Conditionally Approved **R** - Restricted
RND - Restricted/No Depuration **P** - Prohibited

Table #3
Fecal Coliform Historical Trend Sheet

Area 06B Stations 90thile Values for Annual Updates related to River Flow and Rainfall

Station #	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008
06B-06	30	21	27	33	29	18	15	14	14	12	16
06B-06A	17	12	14	15	13	10	9	7	7	6	ND
06B-07	78	61	92	170	187	126	79	87	76	82	80
06B-08	79	54	71	85	89	62	48	60	64	56	47
06B-09	90	69	76	94	93	58	33	49	46	48	55
06B-10	62	51	75	77	57	27	24	31	37	34	32
06B-12	56	25	56	78	80	37	29	26	23	22	28
06B-15	8	4	6	6	5	4	5	5	5	5	ND
06B-16	14	10	11	15	12	10	9	10	8	8	3
06B-17	8	8	11	10	7	3	5	7	9	10	7
06B-18	15	9	11	14	11	8	9	10	10	6	11
06B-19	42	26	37	38	35	18	23	23	20	13	10
06B-19A	33	20	25	29	21	11	13	13	19	2	9
06B-20	10	8	10	11	10	8	12	13	14	12	16
06B-21	41	29	39	43	39	21	23	18	18	15	13
06B-22	19	13	25	27	23	11	11	11	10	10	18
06B-22A	13	6	9	10	8	6	10	14	20	13	14
06B-23	24	14	20	18	16	7	14	15	15	7	8
06B-24	10	6	7	9	8	6	6	7	6	8	10
06B-25	5	3	3	3	3	3	4	4	4	3	3
06B-26	14	7	9	8	7	5	9	9	9	5	7
06B-27	16	8	10	9	6	5	9	10	9	7	8
Annual Rainfall (in inches)	61.41	44.49	58.63	72.29	55.52	49.34	28.79	24.34	50.11	54.05	52.7
Daily River Flow (in CFS)	8,280	4,881	8,250	12,494	7,921	13,135	1,567	8,406	8,335	8,174	3,518

ND = No Data Red=Impaired Water Quality

TABLE #4

Shellfish Management Area 06B

**WATER QUALITY
SAMPLING STATIONS DATA**

Detailed data for each shellfish monitoring station listed in this report's "Fecal Coliform Bacteriological Data Summary Table" and in other shellfish reports, can be obtained by writing South Carolina's Department of Health and Environmental Control – Freedom of Information office at the address below.

Freedom of Information
SC Dept. of Health & Environmental Control
2600 Bull Street
Columbia, SC 29201

Any explanation or clarity needed on the report's content can be obtained by contacting the preparer(s), and/or reviewer(s) listed on the cover page.

TABLE #5

RAINFALL DATA

Shellfish Management Area 06B

SOURCE:

2016 Data information provided by
SCDHEC's Rain Gauge, McClellanville, SC

2017 - 2018 Data

NOAA National Weather Service - Southeastern River Forecast Center
Location: North Inlet (Georgetown), South Carolina

2016 Annual Rainfall Summary
Source: South Carolina Department of Health and Environmental Control
Data Logger Location: McClellanville, S.C.

2016	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	0.57	0	0	0.46	0.07	0	1.15	0	0	0	0	0.07
2	0	0	0.04	0.15	0.01	0	0.01	0	4.15	0	0	0
3	0	0.73	0.39	0	0.77	0	0	2.9	0	0	0	0
4	0.01	2.23	0.66	0	0.02	0	0	0.72	0	0	0	0
5	0	0	0	0	0	0.01	0	0.6	0	0	0	2
6	0	0.43	0	0	0.02	1.44	0.47	0.17	0	0	0	2.07
7	0	1.28	0	0.18	0	0.33	0	0	0	3.33	0	0
8	0.04	0.03	0	0	0	0	0	0.03	0	5.44	0	0
9	0	0	0	0	0	0	0.03	0.23	0	0	0	0
10	0	0	0	0	0	0	0	0.08	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0.06	0	0	0	0	0	0	0	0.28
13	0	0	0	0.01	0.67	0	0	0	0.51	0	0.54	0.02
14	0	0	0	0	0.01	0	0.1	0	3.92	0	0.01	0.06
15	1.67	0.23	0	0.13	0	1.66	0	0	0.03	0	0	0.01
16	0	1.49	0	0	0	0	0	0	0	0	0	0
17	0.75	0	0	0	0.12	0.07	0.8	0	0	0	0	0
18	0	0	0	0	0	0.01	0	0.31	0	0	0	0
19	0	0	0	0	0	0	0.61	0.01	0.19	0	0	0.02
20	0	0	0	0	0.02	0	0.45	0.09	0.03	0	0	0.12
21	0	0	0	0	0.02	0	0.36	0.01	0.29	0	0	0
22	1.2	0	0	0.16	0	0	0	0	0.98	0	0	0
23	0.01	0.25	0	0	0	0	0	0	0	0	0	0
24	0	0.05	0	0.01	0	0.07	0	0	0.02	0	0	0
25	0	0	0	0	0	0.03	0	0	0	0	0	0
26	0	0	0.84	0	0	0	0	0	0.01	0	0	0
27	0	0	1.67	0	0	0	0	0	0.01	0	0	0
28	0.17	0	0.05	0	1.38	0.77	0	0	0	0	0	0
29	0.01	0	0	0	0.34	0.06	0	0.1	0	0	0.11	0.05
30	0	0	0	0	0.32	0.27	0	0.01	0.22	0	0	0.01
31	0	0	0.05	0	0.25	0	0	0.14	0	0	0	0
Total	4.43	6.72	3.7	1.16	4.02	4.72	3.98	5.4	10.36	8.77	0.66	4.71
*Days highlighted indicate 4 or more inches of rain in a 24 hour period.												
* Sample dates are indicated in blue.						ND= No Data			ANNUAL RAINFALL		58.63	

2017 Annual Rainfall Summary
Source: NWS, Southeastern River Forecast Center
Location: Area 06B, Charleston County

2017	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	0.24	0	0	0	0	0.03	0.43	0	0.05	0	0	0
2	0.06	0	0.15	0	0.26	0.41	0.01	0	0.42	0	0	0
3	0.1	0	0.04	0	0	0.06	0	1.11	0.08	0	0	0
4	0.37	0	0	0.72	0	0	0.19	0.29	0	0	0	0
5	0	0	0	0	0.23	0	0.04	0.57	0	0	0	0
6	0	0	0	2.81	0.17	0.74	0	0.16	0.13	0	0	0
7	0.24	0	0	0	0	0.77	0	0	1.36	0.11	0	0.25
8	0.01	0.16	0	0	0	2.04	0.15	0.14	0	0.18	0	0.67
9	0	0.11	0	0	0	0.08	0.36	1.2	0	0	0.01	0.56
10	0	0	0	0	0	0	0.42	0.25	0	0.12	0.4	0
11	0	0	0	0	0	0	0.17	0.68	0.31	0.01	0	0
12	0	0	0.04	0	0	0	0.01	0.26	2.45	0	0	0
13	0	0	0.03	0	0.01	0	0	0.09	0	0	0	0
14	0	0	0.37	0	1.02	0.12	0	0.48	0	0	0	0
15	0	0.22	0	0	0	0	0	0.3	0.4	0	0	0
16	0	0	0	0	0	0.08	0.03	0.15	0	0	0	0.01
17	0	0	0	0	0	0	0.86	0.2	0	0.39	0	0
18	0	0	0	0	0	0.01	1.54	0.94	0.02	0	0	0
19	0	0	0	0	0	0.08	0.01	0	0	0	0	0
20	0	0	0	0.01	0	0.06	0.52	0	0	0	0	0
21	0.01	0	0	0	0	0.27	0.02	0	0	0	0	0.66
22	0.81	0	0.3	0	0	0.16	0	0.72	0.02	0	0.36	0
23	1.1	0	0	0	1.02	0.04	0	0	0	0	0	0
24	0.02	0	0	0.18	1.7	0	0.05	0	0	0.67	0.23	0
25	0	0	0	1.44	0.21	0.14	0.21	0	0	0	0	0
26	0	0	0	0	0	0.69	0	0	0	0	0	0
27	0.02	0	0	0	0	0	0.57	1.11	0	0	0	0
28	0	0	0	0	0	0	0.06	0.29	0	0	0	0.03
29	0	0	0	0	0	0	0	0.57	0	0.07	0	0.05
30	0	0	0	0	0	0.04	0.94	0.16	0.06	0.11	0	0
31	0	0	0.17	0	0	0	0	0	0	0	0	0
Total	2.98	0.49	1.10	5.16	4.62	5.82	6.59	7.54	5.30	1.66	1.00	2.23
*Days highlighted indicate 4 or more inches of rain in a 24 hour period.												
* Sample dates are indicated in blue.						ANNUAL RAINFALL						44.49

2018 Annual Rainfall Summary
Source: NWS, Southeastern River Forecast Center
Location: Area 06B, Charleston County

2018	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1		0.00	0.21	0.00	0.00	0.01	0.01	0.07	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.11	0.68
3	0.00	0.01	0.00	0.00	0.00	1.13	0.00	1.08	0.00	0.00	0.05	1.01
4	0.30	0.00	0.00	0.00	0.00	0.00	0.04	0.49	0.00	0.00	0.00	0.04
5	0.00	0.32	0.00	0.02	0.00	0.00	0.31	0.09	0.04	0.00	0.67	0.00
6	0.00	0.00	0.00	0.00	0.17	0.00	0.03	0.05	0.14	0.01	0.02	0.00
7	0.00	0.00	0.07	0.00	0.00	0.00	0.48	0.02	0.02	0.00	0.08	0.00
8	0.00	0.12	0.00	0.63	0.00	0.00	2.33	0.00	0.06	0.07	0.31	0.06
9	0.00	0.00	0.00	0.00	0.00	1.47	0.00	0.78	0.12	0.02	0.01	1.03
10	0.00	0.27	0.00	0.00	0.00	0.04	0.00	0.09	0.04	0.28	0.11	0.60
11	0.02	0.00	0.00	0.08	0.00	0.04	0.00	0.00	0.04	0.29	0.00	0.00
12	0.03	0.15	0.15	0.00	0.00	0.25	0.00	0.37	0.21	0.00	0.00	0.00
13	0.15	0.02	0.40	0.00	0.00	0.11	0.06	0.17	0.11	0.00	0.45	0.00
14	0.00	0.00	0.00	0.00	0.00	0.09	0.01	0.00	0.15	0.00	0.00	0.66
15	0.00	0.00	0.00	0.00	0.05	0.05	0.00	0.00	1.36	0.00	0.70	2.71
16	0.00	0.00	0.00	0.68	0.01	0.32	0.00	0.00	0.73	0.00	0.04	0.20
17	0.00	0.00	0.00	0.00	0.46	0.00	0.11	0.00	2.12	0.06	0.00	0.00
18	0.00	0.00	0.04	0.00	0.34	0.00	0.17	0.00	0.51	0.00	0.00	0.00
19	0.00	0.00	0.45	0.00	0.29	0.00	0.65	0.21	0.05	0.00	0.07	0.00
20	0.00	0.02	0.23	0.00	1.75	0.00	1.15	0.05	0.00	0.00	0.00	0.09
21	0.00	0.00	0.76	0.00	0.00	0.01	3.35	0.00	0.00	0.22	0.11	0.88
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	0.23	0.00	0.00	0.20	0.00	0.00	1.17	0.21	0.00	0.00	0.00	0.00
24	0.00	0.00	0.00	2.22	0.24	0.01	0.73	0.00	0.06	0.00	0.33	0.00
25	0.00	0.00	0.12	0.00	0.10	0.31	0.63	0.00	0.24	0.00	0.39	0.00
26	0.00	0.17	0.01	0.00	0.01	0.03	0.80	0.00	0.05	0.02	0.04	0.00
27	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.07	0.01	0.20	0.00	0.00
28	0.01	0.00	0.00	0.00	0.46	0.38	0.58	0.00	0.01	0.00	0.00	0.01
29	0.80		0.00	0.00	1.06	0.00	0.06	0.30	0.84	0.00	0.00	0.73
30	0.00		0.00	0.00	0.13	0.00	3.69	0.00	1.05	0.00	0.00	0.02
31	0.00		0.16		0.04		0.74	0.00		0.00		0.00
Total	1.54	1.08	2.60	3.83	5.11	4.25	17.50	4.16	7.96	1.17	3.49	8.72
*Days highlighted indicate 4 or more inches of rain in a 24 hour period.												
* Sample dates are indicated in blue.									ANNUAL RAINFALL		61.41	

TABLE #6

**Shellfish Management Area 06B
Pollution Event Closures
2016-2018**

Event	Date(s)	Sample Date(s)	Opening Date	Comments
Rainfall Closure	09/03/2016	09/07/2016	09/09/2016	4.15 inches of rain in 24 hr period
Hurricane Matthew	10/07/2016	10/18/2017	10/21/2017	Growing Areas closed prior to Hurricane Matthew.
Hurricane Irma	09/11/2017	N/A	10/15/2017	21 day closure

TABLE #7

**Annual Average Flow Rates
Santee River**

YEAR	Average Daily Flow Rate In Cubic Feet Second (CFS)
2018	8,280
2017	4,881
2016	8,250
2015	12,494
2014	8,544
2013	13,135
2012	1,567
2011	8,406
2010	8,335
2009	8,174
2008	1,179
2007	5,004
2006	4,371
2005	10,660
2004	7,438
2003	14,806
2002	4,900
2001	2,547
2000	3,548
1999	3,703
1998	16,720
1997	10,323
1996	10,669
1995	15,978
1994	10,830
1993	14,337
1992	11,379
1991	11,541
1990	13,393
1989	11,203
Raw Data obtained from: William Gaither with Santee Cooper Public Service Authority william.gaither@santeecooper.com	

TABLE #8

**Shellfish Management Area 06B
Fecal Coliform Data Compared to River Gauge Height and Rainfall
2014-2018**

Sample Date	06B-06	06B-07	06B-08	06B-09	06B-10	06B-12	06B-19	06B-21	Gauge Ht. (Ft)	Rainfall (Inches)
12/4/2018	79	116	32	79	70	110	110	110	13.33	.04
11/5/2018	79	95	130	140	140	920	110	170	11.33	.67
10/15/2018	7.8	110	79	33	4.5	13	21	4.5	11.63	0
9/6/2018	49	33	46	49	110	23	17	23	2.54	.05
8/8/2018	1.7	49	120	2.0	14	7.8	1.7	7.8	9.34	0
7/17/2018	1.7	2.0	1.7	1.7	1.7	1.7	1.7	1.7	2.48	.11
6/18/2018	1.8	23	4.5	33	4.5	1.7	6.8	7.8	8.09	0
4/9/2018	2.0	17	4.0	13	4.5	4.0	7.8	7.8	4.32	0
3/26/2018	22	49	49	70	110	33	33	170	7.97	.01
2/26/2018	14	70	33	33	49	33	17	23	6.55	.17
1/16/2018	1.7	1.7	4.5	7.8	4.5	2.0	13	2.0	2.26	0
12/5/2017	1.7	26	13	23	4.5	2	2	2	5.49	0
11/1/2017	4	17	6.8	6.8	11	4.5	7.8	4.5	2.18	0
10/17/2017	1.7	7.8	4.5	21	7.8	6.8	2	1.7	2.32	.39
9/27/2017	1.7	11	4.5	6.8	1.7	2	1.7	2	2.29	0
8/8/2017	4.5	11	7.8	70	7.8	11	2	4.5	2.95	.14
7/18/2017	1.7	23	13	14	14	4.5	4.5	2	2.16	1.54
6/19/2017	1.7	13	33	33	2	11	7.8	7.8	3.30	.08
5/1/2017	1.8	33	23	4.5	4.5	7.8	6.1	7.8	13.08	0
4/10/2017	7.8	26	13	31	46	13	4.5	17	7.64	0
2/22/2017	4.5	33	31	46	33	11	70	4.5	3.25	0
1/10/2017	70	170	70	130	17	33	33	49	9.43	0
12/6/2016	13	39	220	170	49	4	17	7.8	3.95	2
11/28/2016	4.5	49	23	23	23	9.3	22	2	3.44	0
9/12/2016	1.7	11	33	7.8	2	4.5	2	2	3.09	0
8/30/2016	9.3	17	6.8	4.5	33	7.8	7.8	23	3.91	0.1
7/18/2016	7.8	17	7.8	4.5	7.8	7.8	2	2	2.93	0.8
6/28/2016	1.7	4.5	2	1.7	2	1.7	1.7	1.7	3.62	0.03
5/2/2016	2	7.8	1.7	4.5	2	6.8	2	2	4.15	0.07
4/26/2016	2	13	17	33	1.7	13	1.8	2	4.18	0.01
3/2/2016	7.8	33	13	11	17	17	4.5	11	12.57	0
2/22/2016	14	4.5	13	13	13	7.8	9.2	11	12.78	0
1/27/2016	14	17	23	34	26	33	49	17	13.75	0
12/6/2016	13	39	220	170	49	4	17	7.8	3.95	2
11/28/2016	4.5	49	23	23	23	9.3	22	2	3.44	0
9/12/2016	1.7	11	33	7.8	2	4.5	2	2	3.09	0
8/30/2016	9.3	17	6.8	4.5	33	7.8	7.8	23	3.91	0.1
7/18/2016	7.8	17	7.8	4.5	7.8	7.8	2	2	2.93	0.8
6/28/2016	1.7	4.5	2	1.7	2	1.7	1.7	1.7	3.62	0.03
5/2/2016	2	7.8	1.7	4.5	2	6.8	2	2	4.15	0.07
4/26/2016	2	13	17	33	1.7	13	1.8	2	4.18	0.01
3/2/2016	7.8	33	13	11	17	17	4.5	11	12.57	0
2/22/2016	14	4.5	13	13	13	7.8	9.2	11	12.78	0
1/27/2016	14	17	23	34	26	33	49	17	13.75	0
12/2/2015	7.8	31	14	26	33	2	4.5	13	15.32	0
11/2/2015	4.5	23	4	23	7.8	1.7	1.7	4.5	9.44	0.19
9/9/2015	4.5	4.5	11	7.8	7.8	6.1	1.7	2	3.4	0.31
8/10/2015	2	14	4	4.5	7.8	2	4.5	33	3.55	0.13
7/28/2015	1.7	23	4.5	1.7	1.7	2	2	1.7	3.72	0
6/16/2015	2	4.5	4.5	2	7.8	2	1.8	7.8	3.21	0

5/4/2015	220	49	140	70	110	110	79	220	13.22	0
4/13/2015	4.5	110	6.8	4.5	2	4.5	4.5	1.7	5.00	0.05
3/3/2015	11	33	33	49	170	23	49	49	9.54	0.38
2/23/2015	1.7	2	13	1.7	2	2	2	2	7.2	0.04
1/7/2015	23	49	49	33	49	33	7.8	13	10.47	0.06
12/2/14	6.8	110	46	31	14	22	13	33	8.91	0
11/3/14	2	33	17	6.8	7.8	17	4.5	15	3.83	0.17
10/20/14	33	33	23	33	46	220	33	23	3.88	0
9/30/14	1.7	140	46	23	23	1.7	1.7	2	4.86	0.03
8/11/14	33	49	49	170	49	23	7.8	33	8.15	1.03
7/14/14	4.5	13	4.5	4.5	2	2	1.7	1.7	3.48	0.79
6/16/14	1.7	6.8	2	2	2	1.7	1.7	1.7	5.04	0.7
5/13/14	7.8	46	46	23	95	70	33	13	9.13	0.19
4/8/14	17	240	23	17	17	33	22	23	9.84	0
3/5/14	11	49	17	110	27	17	21	1.7	11.47	0.62
2/5/14	7.8	23	33	13	4.5	49	46	11	13.00	0.06
1/8/14	17	33	79	79	130	79	79	33	13.29	0
Gauge Height is for Jamestown and is the maximum recorded height for 5 days prior to sampling										
Rainfall is the maximum 24hr rainfall event total for 3 days prior to sampling										
<p style="color: red; margin: 0;">Red = Impaired Water Quality</p> <p style="margin: 0;">Blue = Heavy Rainfall Green = >10.0ft. Gauge Height</p>										