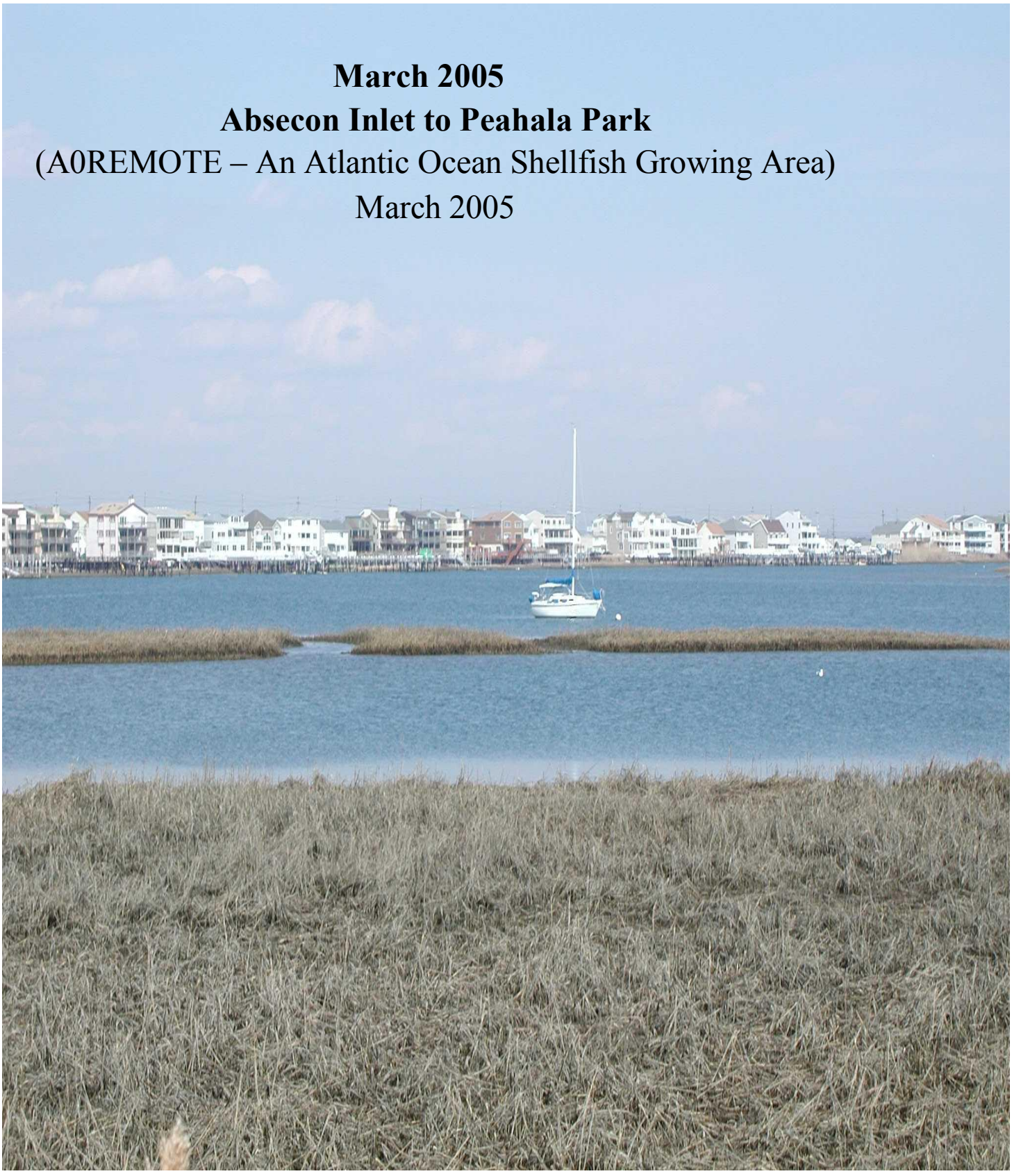
March 2005
Absecon Inlet to Peahala Park
(A0REMOTE – An Atlantic Ocean Shellfish Growing Area)
March 2005



Department Of Environmental Protection
Bradley M. Campbell, Commissioner

State Of New Jersey
Richard J. Codey, Acting Governor

New Jersey Department of Environmental Protection
Land Use Management
Water Monitoring and Standards
Post Office Box 409, Trenton
Water Monitoring Project

Leslie J. McGeorge, Administrator

October 2005

REAPPRAISAL

SHELLFISH GROWING AREA A0REMOTE

ABSECON INLET TO PEAHALA PARK

1996 - 2003

Water Monitoring Report Prepared by:

Mike Curtis

Project Manager

Bureau of Marine Water Monitoring
PO Box 405 Stoney Hill Road
Leeds Point, NJ 08220

Robert Connell, Jr., Bureau Chief

STATE OF NEW JERSEY

RICHARD J. CODEY

ACTING GOVERNOR

REAPPRAISAL

SHELLFISH GROWING AREA A0REMOTE

ABSECON INLET TO PEAHALA PARK

1996 - 2003

New Jersey Department of Environmental Protection
BRADLEY M. CAMPBELL
COMMISSIONER

This report was funded

by a State General Appropriation

and the

Federal Clean Water Act

TABLE OF CONTENTS

EXECUTIVE SUMMARY 1

INTRODUCTION 1

Purpose 1

Background 2

Functional Authority 3

Importance of Sanitary Control of Shellfish 4

PROFILE 5

Location 5

Description 5

History 9

METHODS 10

BACTERIOLOGICAL INVESTIGATION AND DATA ANALYSIS 11
Sampling Strategy - NSSP Criteria 11

Marine Biotoxins 13

SHORELINE SURVEY 13

Evaluation of Biological Resources 13

Land Use 14

Changes Since Last Survey 19

Identification and Evaluation of Sources 22
DIRECT DISCHARGES –Treatment Facility Wastewater Effluents 22
INDIRECT DISCHARGES 24
Spills or Other Unpermitted Discharges 24
Stormwater Inputs 25
Stormwater Impact Studies 26

HYDROLOGY AND METEOROLOGY 33

Patterns of Precipitation 33

Rainfall Effects 34

Tidal Effects **38**

WATER QUALITY STUDIES 41

Bacteriological Quality **41**
Compliance with NSSP *Approved* Criteria 41

Related Studies **44**

INTERPETATION AND DISCUSSION OF DATA 47

Bacteriological **47**

CONCLUSIONS 48

Bacteriological Evaluation **48**

RECOMMENDATIONS 50

LITERATURE CITED 51

ACKNOWLEDGMENTS 52

APPENDIX 53

TABLE OF FIGURES

Figure 1: State of New Jersey Shellfish Agencies 4
Figure 2: Location of Shellfish Growing Area A0Remote – Absecon Inlet to Peahala Park – Northern Atlantic and Southern Ocean Counties, New Jersey 7
Figure 3: Current Classification for Shellfish Growing Area A0Remote – Absecon Inlet to Peahala Park – Northern Atlantic and Southern Ocean Counties, New Jersey 8
Figure 4: Salt Marsh Vegetation of the Brigantine Unit of Edwin B. Forsythe National Wildlife Refuge 16
Figure 5: Coastal Vegetation at the Holgate Unit of Edwin B. Forsythe National Wildlife Refuge 16
Figure 6: Structures, Shore and Vegetation for Shellfish Growing Area A0Remote – Absecon Inlet to Peahala Park – Northern Atlantic and Southern Ocean Counties, New Jersey 17
Figure 7: Coastal Land Use Patterns for Shellfish Growing Area A0Remote – Absecon Inlet to Peahala Park – Northern Atlantic and Southern Ocean Counties, New Jersey 18
Figure 8: Typically Urban Development for Communities within Close Proximity to Shellfish Growing Area A0Remote – Absecon Inlet to Peahala Park – Northern Atlantic and Southern Ocean Counties, New Jersey 19
Figure 9: Coastal Municipalities for Shellfish Growing Area A0Remote – Absecon Inlet to Peahala Park – Northern Atlantic and Southern Ocean Counties, New Jersey 21
Figure 10: Direct Discharges to Waters Outside Shellfish Growing Area A0Remote – Absecon Inlet to Peahala Park – Northern Atlantic and Southern Ocean Counties, New Jersey 23
Figure 11: Spills or Other Unpermitted Discharges 24
Figure 12: Areas Impacted by Rainfall 27
Figure 13: Stormwater Runoff - 15th St. So. (Beach View - Brigantine) - Shellfish Growing Area A0Remote – Absecon Inlet to Peahala Park – Northern Atlantic and Southern Ocean Counties, New Jersey 28
Figure 14: Trash Dumpster Located Near Outlet for Stormwater Runoff - 15th St. So. (Oceanblock - Brigantine) – Shellfish Growing Area A0Remote – Absecon Inlet to Peahala Park – Northern Atlantic and Southern Ocean Counties, New Jersey 28
Figure 15: Stormwater Runoff - 14th St. So. (Beach View - Brigantine) - Shellfish Growing Area A0Remote – Absecon Inlet to Peahala Park – Northern Atlantic and Southern Ocean Counties, New Jersey 29
Figure 16: Older Percolation Infrastructure For Stormwater Runoff - 26th St. So. (Oceanblock - Brigantine) - Shellfish Growing Area A0Remote – Absecon Inlet to Peahala Park – Northern Atlantic and Southern Ocean Counties, New Jersey 30
Figure 17: Recently Placed Infrastructure for Percolation of Stormwater Runoff and Re-direction Away from Ocean – 20th St. So. (Oceanblock - Brigantine) - Shellfish Growing Area A0Remote – Absecon Inlet to Peahala Park – Northern Atlantic and Southern Ocean Counties, New Jersey 30
Figure 18: Indirect Discharges (Stormwater Outfalls) for Shellfish Growing Area A0Remote – Absecon Inlet to Peahala Park – Northern Atlantic and Southern Ocean Counties, New Jersey 31
Figure 19: Indirect Discharge (Stormwater Outfall) to Back Bay Waters for Shellfish Growing Area A0Remote – Absecon Inlet to Peahala Park – Northern Atlantic and Southern Ocean Counties, New Jersey 32
Figure 20: Indirect Discharge (Stormwater Outfall – Platt Ave. and West Shore Dr.) to Back Bay Waters for Shellfish Growing Area A0Remote – Shows Rubber Boot for Collection of Plastics and Debris - Absecon Inlet to Peahala Park – Northern Atlantic and Southern Ocean Counties, New Jersey 32
Figure 21: Storm Event Frequency Histogram (Source: NOAA climatic data) 34
Figure 22: Surface Station with Rainfall Correlations for Shellfish Growing Area A0Remote - Absecon Inlet to Peahala Park - Northern Atlantic and Southern Ocean Counties, New Jersey 36
Figure 23: Surface Station with Tidal Component for Shellfish Growing Area A0Remote - Absecon Inlet to Peahala Park - Northern Atlantic and Southern Ocean Counties, New Jersey 40

Figure 24: Current Sampling Stations for Shellfish Growing Area A0Remote - Absecon Inlet to Peahala Park - Northern Atlantic and Southern Ocean Counties, New Jersey **43**
Figure 25: Nutrient Sampling Station for Shellfish Growing Area A0Remote – Absecon Inlet to Peahala Park – Northern Atlantic and Southern Ocean Counties, New Jersey **46**
Figure 26: Current Classification for Shellfish Growing Area A0Remote – Absecon Inlet to Peahala Park – Northern Atlantic and Southern Ocean Counties, New Jersey **49**

TABLE OF TABLES

Table 1: Commercial Data for Surf Clams Showing Pounds of Meat and Ex-vessel Value **9**
Table 2: Criteria for Adverse Pollution Condition Sampling Strategy **13**
Table 3: Criteria for Systematic Random Sampling Strategy **13**
Table 4: Population Information for Shellfish Growing Area A0Remote – Absecon Inlet to Peahala Park – Northern Atlantic and Southern Ocean Counties, New Jersey **22**
Table 5: Average Mid-Atlantic Storm Event Information. Sources: USEPA; US Department of Commerce **33**
Table 6: Storm Event Volume for 2-Year Storm Event Recurrence. (Source: USGS**)** **33**
Table 7: Surface Sampling Station with Rainfall Correlations – (correlation shown in Yellow) **– Specific for Cumulative Rainfall as it Relates to Fecal Coliform – Shellfish Growing Area A0Remote – Absecon Inlet to Peahala Park - Northern Atlantic and Southern Ocean Counties, New Jersey** **37**
Table 8: Precipitation Data for Shellfish Growing Area A0Remote - Absecon Inlet to Peahala Park - Northern Atlantic and Southern Ocean Counties, New Jersey - Rainfall Recorded at NOAA's Station's - 311 (Atlantic City Airport) and 8816 (Toms River) **37**
Table 9: Precipitation Data for Shellfish Growing Area A0Remote (Cont. from Table 8) - Absecon Inlet to Peahala Park - Northern Atlantic and Southern Ocean Counties, New Jersey - Rainfall Recorded at NOAA's Station's - 311 (Atlantic City Airport) and 8816 (Toms River) **38**
Table 10: Surface Sampling Station Showing Tidal Effect for Fecal Coliform (Tidal effect/component shown in Yellow) **in Shellfish Growing Area A0Remote – Absecon Inlet to Peahala Park - Northern Atlantic and Southern Ocean Counties, New Jersey** **41**
Table 11: Water Quality Summary (Fecal Coliform) for Shellfish Growing Area A0Remote – Absecon Inlet to Peahala Park - Northern Atlantic and Southern Ocean Counties, New Jersey (11/19/96 – 06/05/03) **44**
Table 12: Data Summary - Nutrient Sampling Stations for Shellfish Growing Area A0Remote – Absecon Inlet to Peahala Park - Northern Atlantic and Southern Ocean Counties, New Jersey **47**

EXECUTIVE SUMMARY

The water quality in the Atlantic Ocean from Absecon Inlet to Peahala Park (A0Remote) is consistent with its current *Approved* classification. The data included in this report represents samples collected between November 1996 and June 2003. Analysis of the data indicates that the waters of this shellfish growing area met all criteria for its current classification. It should be noted that these ocean shellfish growing waters do not contain any point sources of contamination although A0Remote is flanked by point sources to the South (Atlantic County Utilities Authority – Wastewater Treatment Facility Discharge Pipe) and North (Ocean County Utilities Authority – Southern Water Pollution Control Facility Discharge Pipe). Further, the area is not detectably affected by non-point sources associated with rainfall runoff. The lack of point and non-point sources in combination with acceptable water quality support the *Approved* shellfish growing water classification currently in effect and qualifies this section of coastline for its Remote status designation. As such, the National Shellfish Sanitation Program's (NSSP) Guide for the Control of Molluscan Shellfish suggests that a minimum of 2 samples shall be collected annually and an analysis of the most recent 15 samples be undertaken to maintain an area with Remote Status designation. A Remote area, by NSSP definition, allows for a water sampling frequency reduction (minimum of two samples yearly as opposed to five) while removing concern for any public health consequences per the proven quality of the samples analyzed over time. This enables valuable sampling resources to be concentrated in areas containing pollution sources. With A0Remote, acceptable water quality prevails as noted within this report; there are no changes recommended for the classification of this shellfish growing area.

INTRODUCTION

PURPOSE

This shellfish growing area report is part of a series of studies having a dual purpose. The first and primary purpose is to comply with the guidelines of the National Shellfish Sanitation Program (NSSP), which are established by the Interstate Shellfish Sanitation Conference (ISSC). Reports generated under this program form the basis for classifying waters for shellfish harvesting while insuring public health and safety with regard to human consumption of those harvests.

The second purpose is to provide input to the Integrated Water Quality Monitoring and Assessment Report, which is prepared pursuant to Sections 305(b) and 303(d) of the Federal Clean Water Act (P.L. 95-217). The information contained in the growing area reports is used for the 305b portion of the Integrated Report, which provides

an assessment to Congress every two years of current water quality conditions in the State's major rivers, lakes, estuaries, and ocean waters. The reports provide valuable information for the 305(b) portion of the Integrated Report, which describes the waters that are attaining state designated water uses and national clean water goals; the pollution problems identified in surface waters, and the actual or potential sources of pollution. Similarly, the reports utilize relevant information contained in the 305(b) portion of the Integrated Report, since the latter assessments are based on instream monitoring data (temperature, oxygen, pH, total and fecal coliform bacteria, nutrients, solids, ammonia and metals), land-use profiles, drainage basin characteristics and other pollution source information.

From the perspective of the Shellfish Classification Program, the reciprocal use of water quality information from reports represent two sides of the same coin: the growing area report focuses on the estuary itself, while the 305(b) portion of the report describes the watershed that drains to that estuary.

The Department participates in the cooperative National Environmental Performance Partnership System (NEPPS) with the USEPA which emphasizes ongoing evaluation of issues associated with environmental regulation, including assessing impacts on waterbodies and measuring improvements in various indicators of environmental health. The shellfish growing area reports are intended to provide a brief assessment of the growing area, with particular emphasis on those factors that affect the quantity and quality of the shellfish resource. The shellfish growing area reports provide valuable information on the overall quality of the saline waters in the most downstream sections of each major watershed. In addition, the reports assess the quality of the biological resource and provide a reliable indicator of potential areas of concern and or areas where additional information is needed to accurately assess watershed dynamics.

BACKGROUND

As a brief history, the NSSP developed from public health principles and program controls formulated at the original conference on shellfish sanitation called by the Surgeon General of the United States Public Health Service in 1925. This conference was called after oysters were implicated in causing over 1500 cases of typhoid fever and 150 deaths in 1924. The tripartite cooperative program (federal, state and shellfish industry) has updated the program procedures and guidelines through workshops held periodically until 1977. Because of concern by many states that the NSSP guidelines were not being enforced uniformly, a delegation of state shellfish officials from 22 states met in 1982 in Annapolis, Maryland, and formed the ISSC. The first annual meeting was held in 1983 and continues to meet annually at various locations throughout the United States.

The NSSP *Guide for the Control of Molluscan Shellfish* sets forth the principles and requirements for the sanitary control of shellfish produced

and shipped in interstate commerce in the United States. It provides the basis used by the Federal Food and Drug Administration (FDA) in evaluating state shellfish sanitation programs. The five major points on which the state is evaluated by the FDA include:

1. The classification of all actual and potential shellfish growing areas as to their suitability for shellfish harvesting.
2. The control of the harvesting of shellfish from areas that are classified as *Restricted*, *Prohibited* or otherwise closed.
3. The regulation and supervision of shellfish resource recovery programs.
4. The ability to restrict the harvest of shellfish from areas in a public health emergency, and
5. Prevent the sale, shipment or possession of shellfish that cannot be identified as being produced in accordance with the NSSP and have the ability to condemn, seize or embargo such shellfish.

FUNCTIONAL AUTHORITY

The authority to carry out these functions (see Figure 1) is divided between the Department of Environmental Protection (DEP), the Department of Health and Senior Services and the Department of Law and Public Safety. The Bureau of Marine Water Monitoring (BMWM), under the authority of N.J.S.A. 58:24, classifies the shellfish growing waters and administers the special resource recovery programs. Regulations delineating the growing areas are promulgated at N.J.A.C. 7:12 and are revised annually. Special Permit rules are also found at N.J.A.C. 7:12 and are revised as necessary.

The Bureau of Shellfisheries, in the Division of Fish and Wildlife, issues harvesting licenses and leases for shellfish grounds under the authority of N.J.S.A. 50:2 and N.J.A.C. 7:25. This bureau, in conjunction with the BMWM, administers the Hard Clam Relay Program.

The Bureau of Law Enforcement, in the DEP (Division of Fish and Wildlife), and the Division of State Police, in the Department of Law and Public Safety, enforce the provisions of the statutes and rules mentioned above.

The Department of Health and Senior Services is responsible for the certification of wholesale shellfish establishments and, in conjunction with the BMWM, administers the depuration program.

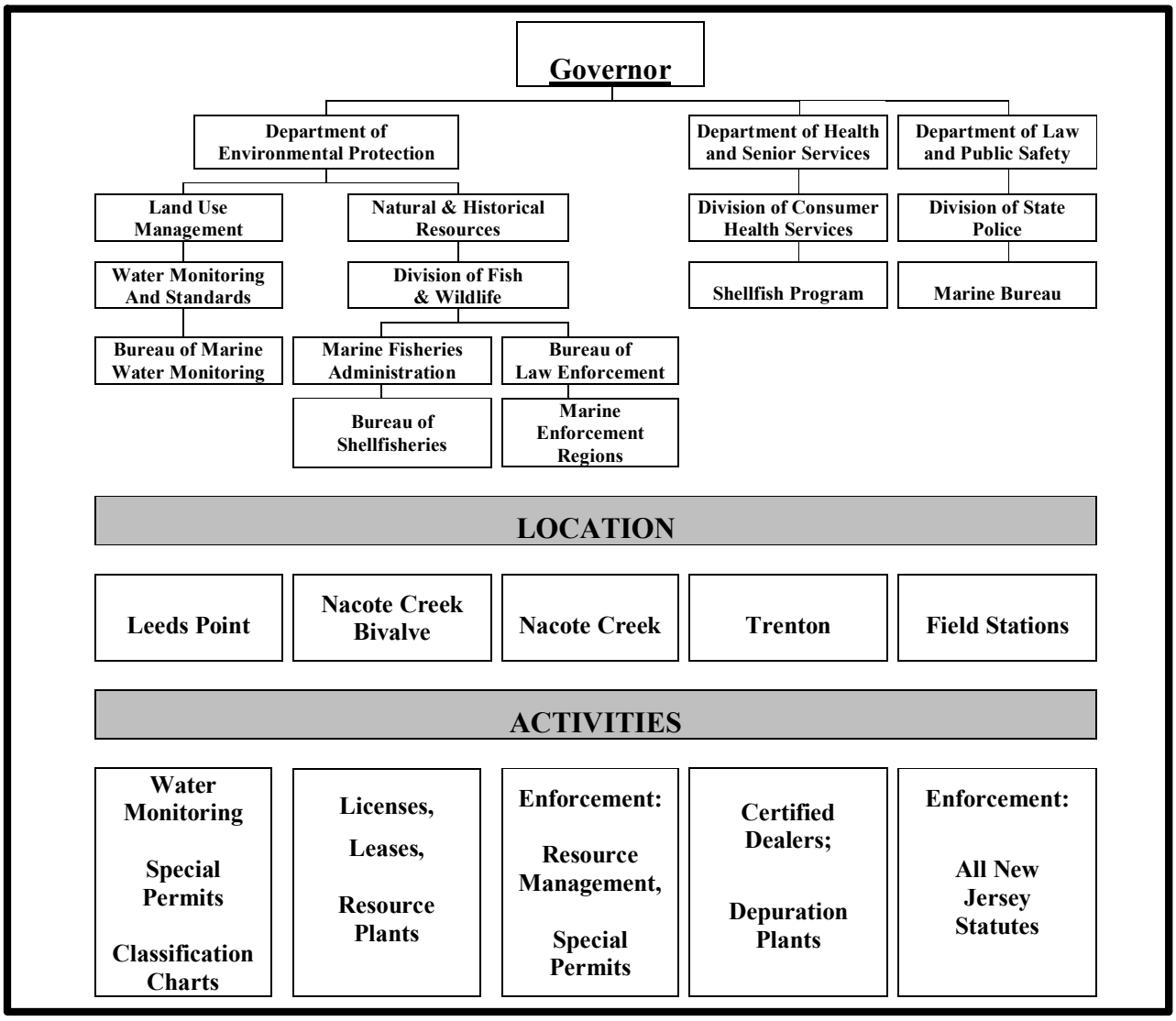


FIGURE 1: STATE OF NEW JERSEY SHELLFISH AGENCIES

IMPORTANCE OF SANITARY CONTROL OF SHELLFISH

Emphasis is placed on the sanitary control of shellfish because of the direct relationship between pollution of shellfish growing areas and the transmission of diseases to humans. Shellfish borne infectious diseases are generally transmitted via a fecal-oral route. The pathway is complex and quite circuitous. The cycle usually begins with fecal contamination of the shellfish growing waters. Sources of such contamination are many and varied. Contamination reaches the waterways via runoff and direct discharges.

Clams, oysters and mussels pump large quantities of water through their bodies during the normal feeding process. During this process the shellfish also concentrate microorganisms, which may include pathogenic microbes, and toxic heavy metals/chemicals. It is imperative that a system is in place to reduce the human health risk of consuming shellfish from areas of contamination.

Accurate classifications of shellfish growing areas are completed through a comprehensive sanitary survey. The principal components of the sanitary survey report include:

1. An evaluation of all actual and potential sources of pollution,
2. An evaluation of the hydrology of the area and
3. An assessment of water quality. Complete intensive sanitary surveys are conducted every 12 years with interim narrative evaluations completed on a three-year basis. If major changes to the shoreline or bacterial quality occur, then the intensive report is initiated prior to its l2 year schedule.

The following narrative constitutes this bureau's assessment of the above mentioned components and determines the current classification of the shellfish growing waters.

PROFILE

LOCATION

The ocean shellfish growing waters discussed in this report include approximately 16 miles of coastline from the north side of Absecon Inlet in the south to Peahala Park in the north, and offshore to the State's three (3) mile jurisdictional limit (Please Note: all references to "miles" in this report are in Nautical Measure, whereby, one Nautical Mile equates to 6,086 feet).

The shellfish growing waters contained in A0Remote have an approximate area of 38,549 acres.

A0Remote can be found on Charts 5, 6 and 7 of the New Jersey Shellfish Growing Area Classification Charts for 2004 and the location can also be reviewed in Figure 2 of this report.

DESCRIPTION

As previously mentioned, there are no direct or point sources of pollution associated with the waters of A0Remote. The closest direct sources would be the Atlantic County Utilities Authority – Wastewater Treatment Facility discharge pipe, situated 3.17 Nautical Miles to the south of the northern side of Absecon Inlet, where A0Remote begins. To the north, the Ocean County Utilities Authority – Southern Water Pollution Control Facility discharge pipe is situated 4.35 Nautical Miles from Peahala Park or the northern extent of A0Remote.

Based on sampling results, these outfalls have no significant impact on the bacterial levels of the waters of A0Remote. Lack of impact can be attributed to the significant distance

between this growing area and the above mentioned outfalls. This distance provides for considerable dilution to the effluent produced by the treatment facilities.

Rainfall runoff provides little impact to the water quality of this area as stormwater drainage is directed toward the bayside for the most part. Any waters having been impacted by stormwater runoff on the bayside of Long Beach Island or Brigantine are substantially diluted when reaching the ocean front waters of A0Remote.

A large portion of the land comprising the adjoining beachfront of A0Remote is a part of the Edwin B. Forsythe National Wildlife Refuge. As a result, there is relatively little impact from this area as stormwater and treatment facility infrastructure is absent within the coastal composition of the wildlife refuge.

Due to the lack of direct or indirect source inputs and the continually good quality evidenced by sampling results in A0Remote, the area has been designated with remote status. No changes in classification will be recommended in this report and the waters of A0Remote will remain classified as *Approved* in their entirety as can be seen in Figure 3.

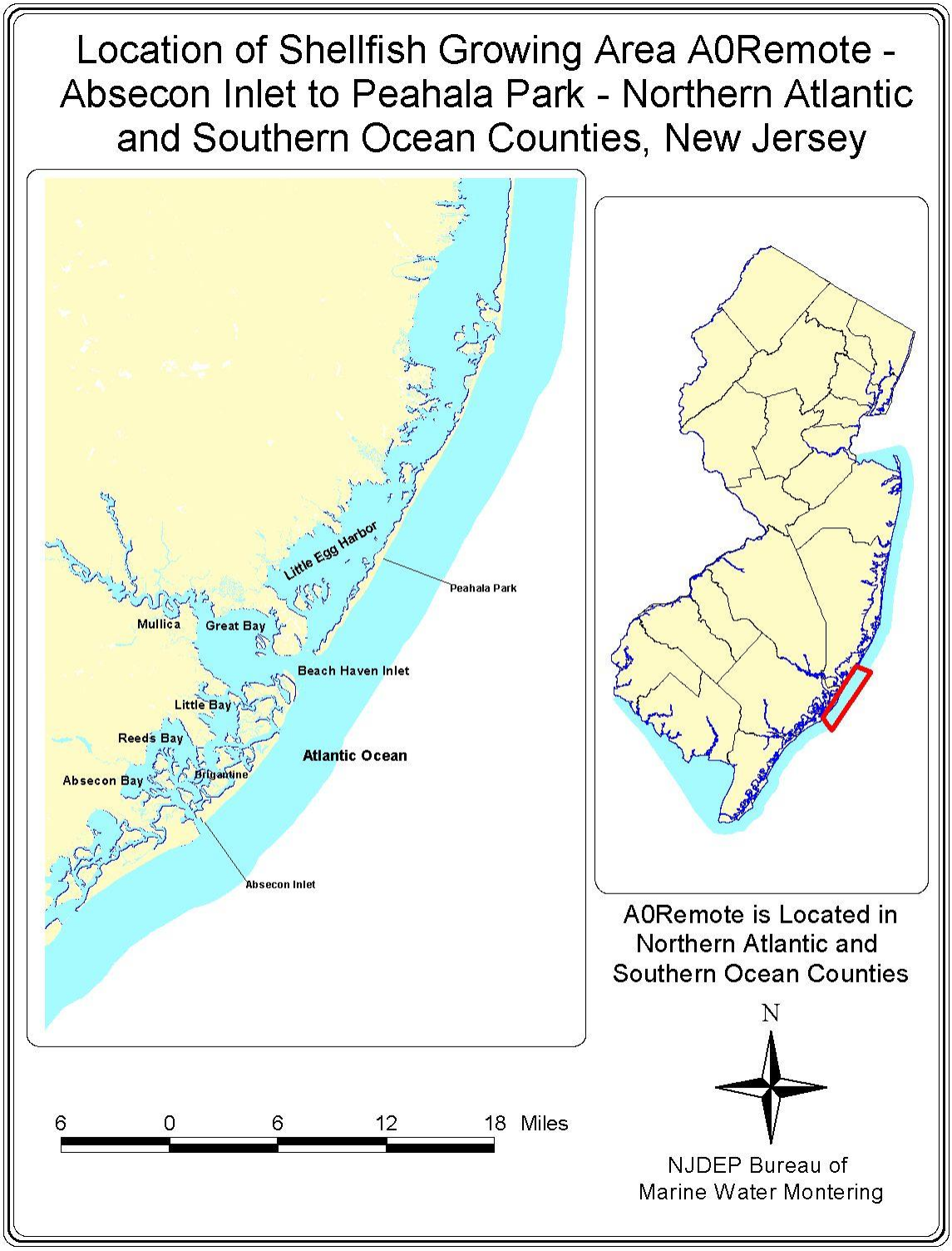


FIGURE 2: LOCATION OF SHELLFISH GROWING AREA A0REMOTE – ABSECON INLET TO PEAHALA PARK – NORTHERN ATLANTIC AND SOUTHERN OCEAN COUNTIES, NEW JERSEY

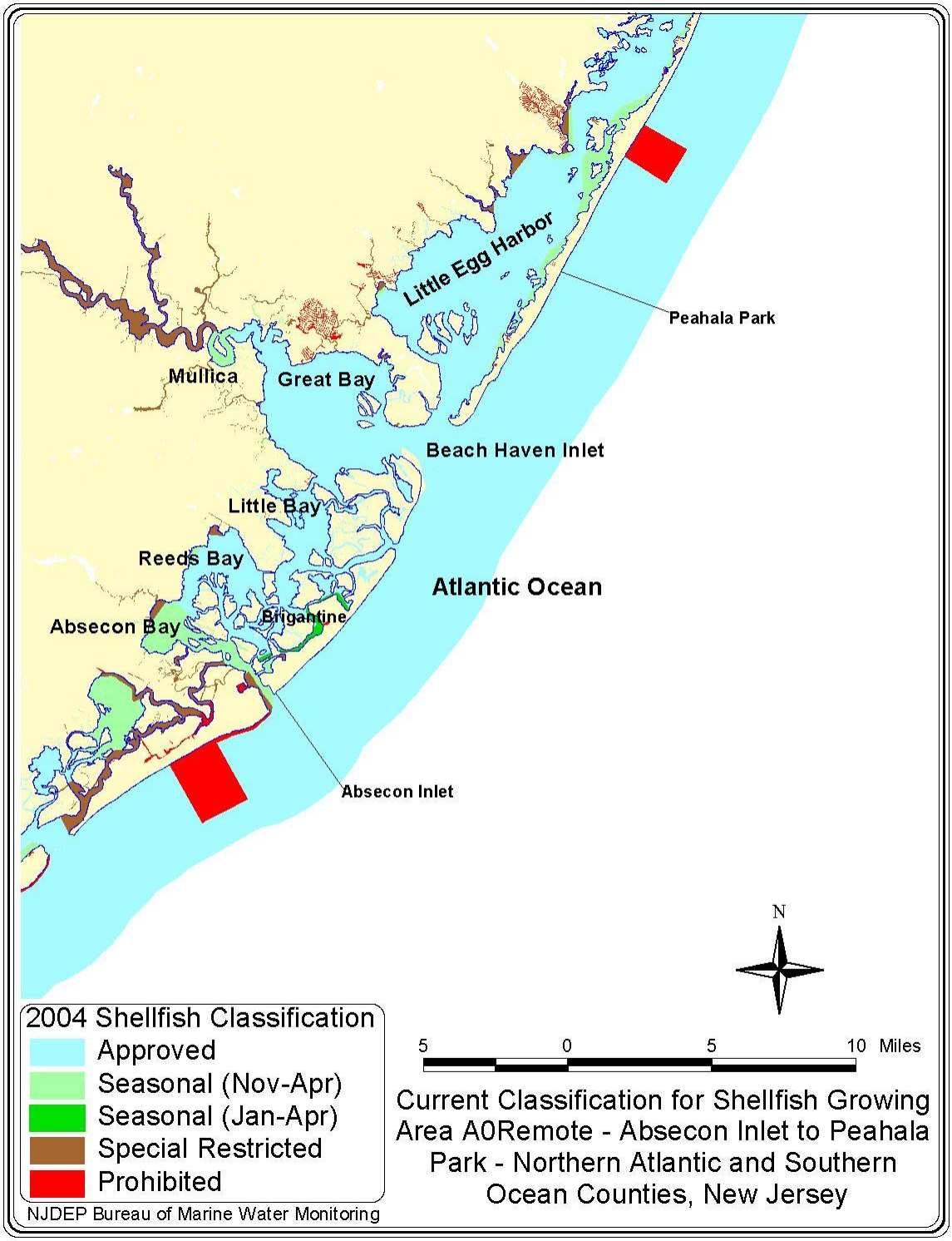


FIGURE 3: CURRENT CLASSIFICATION FOR SHELLFISH GROWING AREA A0REMOTE – ABSECON INLET TO PEAHALA PARK – NORTHERN ATLANTIC AND SOUTHERN OCEAN COUNTIES, NEW JERSEY

HISTORY

Historically, the *Approved* waters for this growing area have been used for harvesting surf clams (Spisula solidissima) and blue mussels (Mytilus edulis) by dredge boats licensed by the Division of Fish and Wildlife. Since all the waters in A0Remote are classified as *Approved*, they are available for harvesting shellfish.

In addition to being the State's largest molluscan fishery, New Jersey's surf clam fishery historically leads all other surf claming states in total landings and continued to do so in 2003 (Normant, 2004). Table 1 that follows shows commercial landings in pounds of meat and ex-vessel value for New Jersey surf clams since 1993. At the time this report was written, figures had not been released for 2003 or 2004.

TABLE 1: COMMERCIAL DATA FOR SURF CLAMS SHOWING POUNDS OF MEAT AND EX-VESSEL VALUE FOR NEW JERSEY LANDINGS

Year	Lbs. of Surf Clams Landed	Ex-vessel Value
1993	47,978,097	$ 21,802,735
1994	48,572,236	$ 26,840,477
1995	46,329,437	$ 27,443,281
1996	48,740,881	$ 28,983,170
1997	45,603,401	$ 27,168,453
1998	44,751,327	$ 23,060,750
1999	49,299,900	$ 25,371,922
2000	58,047,629	$ 31,371,354
2001	52,872,341	$ 29,326,676
2002	53,590,740	$ 29,172,373

Recent Reappraisals and, more specifically, the report covering the time frame 1991 to 1993 recommended these growing waters be designated as having Remote Status. Remote Status, as suggested in the NSSP's shellfish guide, is applicable for shellfish growing waters which are not impacted by any actual or potential pollution sources, thus meeting the *Approved* classification criteria. As such, there have been no stations exceeding NSSP criteria.

The last report written for Growing Area A0Remote was a Reappraisal covering the years 1993 –2000. At that time, all of the 16 miles of ocean waters under analysis as A0Remote met the NSSP's criteria for *Approved* shellfish growing waters.

It was determined that there were no direct source inputs to the waters of this

shellfish growing area. It was further determined that rainfall runoff was not a detrimental factor to the water quality of this shellfish growing area. Stormwater has little impact as drainage is directed primarily toward the bayside within the confines of this location. Waters having been impacted by stormwater runoff on the bayside will be significantly diluted upon reaching the ocean waters of A0Remote.

Non-point sources of contamination associated with avian populations utilizing the Edwin B. Forsythe National Wildlife Refuge do not appear to impact the *Approved* waters of A0Remote with elevated coliform levels, when reviewing the data contained in this report.

In the 1993 – 2000 Reappraisal for A0Remote, it was decided that the area's *Approved* shellfish growing water classification remain in effect and that this growing area's Remote Status designation be continued. The information contained within this report (1996 – 2003) will contend the same, as there are no changes recommended for A0Remote.

METHODS

Data management and analysis was accomplished using database applications developed for the Bureau. Mapping of pollution data was performed with the Geographic Information System (GIS: ARCVIEW).

Water sampling was performed in accordance with the Field Procedures Manual (NJDEP, 1992).

Water quality sampling, shoreline and watershed surveys were conducted in accordance with the NSSP *Guide for the Control of Molluscan Shellfish,* 2002.

Approximately 239 water samples were collected for fecal coliform bacteria between 1996 and 2003 and analyzed by single dilution, 5 mL – 12 tube analysis according to those methods stipulated in the ISSC Program Interpretation, Number I-B-1-100 (Options for 12-tube single dilution MPN Test). Figure 24 shows the Shellfish Growing Water Quality Monitoring Stations from Absecon Inlet to Peahala Park (A0Remote) where sixteen stations are monitored during each year and specifically analyzed for the 1996 – 2003 time frame that comprises this Reappraisal.

The results were compiled from Assignment 471. They comprise information collected from fifteen sampling runs. These were analyzed by the Bureau of Marine Water Monitoring for fecal coliform bacteria during the period of time from November 19, 1996 through June 5, 2003. Analysis and classification of these shellfish growing waters has been based on this data.

BACTERIOLOGICAL INVESTIGATION AND DATA ANALYSIS

The water quality of each growing area must be evaluated before an area can be classified as *Approved, Seasonally Approved, Seasonal Special Restricted* or *Special Restricted.* In New Jersey, these classifications are stated as *Approved*, *Seasonal* (Nov-Apr)*, Seasonal* (Jan-Apr) and *Special Restricted*.

Evaluation of *Prohibited* areas is not necessary unless a state intends to upgrade that area. Criteria for bacterial acceptability of shellfish growing waters are provided in the *NSSP Guide for the Control of Molluscan Shellfish,* 2002.

Sampling Strategy - NSSP Criteria

Each shellfish producing state is directed to adopt either the total coliform or fecal coliform criterion for classifying shellfish growing waters. Combinations of these classification programs may also be used. For instance, New Jersey bases most of its growing water classifications on total coliform analysis. However, for this report, fecal coliform analysis was used.

New Jersey has been using fecal coliform data for analyzing and classifying its Atlantic Ocean Shellfish Growing Areas since 2003. As a general rule, however, New Jersey uses fecal coliform data as an adjunct analysis of its shellfish growing areas.

NSSP sampling strategies and analytical criteria were developed to ensure that shellfish harvested from designated waters would have a lessor likelihood of containing pathogenic (disease-producing producing) bacteria. The authority for State shellfish control (the Bureau of Marine Water Monitoring, as related to NJ shellfish growing waters) also has the option of choosing one of two water monitoring strategies for each growing area [Adverse Pollution Condition (APC) and Systematic Random Sampling (SRS)], which are utilized in determining classifications for growing areas.

Each classification criterion is composed of a measure of the statistical 'central tendency' (geometric mean) and the relative variability of the data set.

For the Adverse Pollution Condition Sampling Strategy, variability is expressed as the percentage that exceeds the variability criteria. For the Systematic Random Sampling Strategy, variability is expressed as the 90^{th} percentile. Tables 2 and 3 are based on the 3-tube decimal dilution test (method used by the BMWM for the majority of its analysis and subsequent classification) and the statistical criterion for both APC and SRS strategies.

The Adverse Pollution Condition (APC) Strategy requires that a minimum of five samples be collected each year under conditions that have historically resulted in elevated levels of coliform for the particular growing area. The results must be evaluated by adding the individual station sample results to the preexisting bacteriological sampling results to constitute a data set of at least 15 samples for each station.

Adverse pollution conditions are usually related to tide and rainfall although they could be from a point source of pollution or variation occurring during a specific time of the year (seasonal). Under the APC strategy for *Approved* waters, the total coliform median or geometric mean MPN of the water shall not exceed 70 per 100 mL and not more than 10 percent of the samples can exceed an MPN of 330 per 100 mL with the 3-tube decimal dilution test. For *Special Restricted* waters, the total coliform median or geometric mean MPN of the water shall not exceed 700 per 100 mL and not more than 10 percent of the samples can exceed an MPN of 3300 per 100 mL with the 3-tube decimal dilution test. Areas to be *Seasonally* classified must be sampled and meet the *Approved* criterion during the time of the year that they are approved for the harvest of shellfish.

The Systematic Random Sampling (SRS) Strategy requires that a random sampling plan be in place before field sampling begins. This strategy can only be used in areas that are not affected by point sources of contamination. A minimum of six samples per station are to be collected each year and added to the database to obtain a sample size of 30 for statistical analysis.

When considering 3-tube decimal dilution with regard to the SRS strategy, the bacteriological quality of every sampling station in *Approved* areas shall have a total coliform median or geometric mean MPN that does not exceed 70 per 100 mL and the estimated 90th percentile shall not exceed an MPN of 330 per 100 mL (utilizing the same criteria for *Seasonal* classifications with regard to time of year approved for shellfish harvests). For *Special Restricted* areas, the bacteriological quality for SRS sampling strategies shall not exceed a total coliform median or geometric mean MPN of 700 per 100 mL and the estimated 90th percentile shall not exceed an MPN of 3,300 per 100 mL when utilizing the 3-tube decimal dilution test.

The shellfish growing waters in A0Remote are sampled under the Adverse Pollution Condition (APC) sampling strategy. Although this site has no direct pollutant sources within its limits and strong influences from tide, season or rainfall are absent, the proximity of treatment plant outfalls directly to the South and North, suggests APC sampling is the most appropriate strategy for this site.

Utilizing the adverse pollution strategy for A0Remote requires fifteen total samples be analyzed with a minimum of two samples accumulated each year for analysis as opposed to five (remote status provides for the reduction in required yearly samples). The single dilution (5 mL – 12 tube) analysis, currently used by the BMWM for analysis of fecal coliform in most of its ocean waters, suggests that the median or geometric mean MPN of the water shall not exceed 14 per 100mL and not more than 10 percent of the samples can exceed an MPN of 28 per 100 mL. As New Jersey's ocean shellfish growing waters are classified as either *Approved* of *Prohibited*, this is the only criterion utilized for classification review in this report.

TABLE 2: CRITERIA FOR ADVERSE POLLUTION CONDITION SAMPLING STRATEGY

	Total Coliform Criteria		Fecal Coliform Criteria	
	Geometric mean (MPN/100 mL)	No more than 10% of samples can exceed (MPN/100 mL)	Geometric mean (MPN/100 mL)	No more than 10% of samples can exceed (MPN/100 mL)
Approved Water Classification	70	330	14	49
Special Restricted Water Classification	700	3300	88	300

TABLE 3: CRITERIA FOR SYSTEMATIC RANDOM SAMPLING STRATEGY

	Total Coliform Criteria		Fecal Coliform Criteria	
	Geometric mean (MPN/100 mL)	Estimated 90th percentile (MPN/100 mL)	Geometric mean (MPN/100 mL)	Estimated 90th percentile (MPN/100 mL)
Approved Water Classification	70	330	14	49
Special Restricted Water Classification	700	3300	88	300

MARINE BIOTOXINS

The Department collects samples at regular intervals throughout the summer to determine the occurrence of marine biotoxins. The data are evaluated weekly by the Bureau of Marine Water Monitoring in accordance with the NSSP requirements. An annual report is compiled and is available electronically at *www.state.nj.us/dep/wmm/bmw*.

SHORELINE SURVEY

EVALUATION OF BIOLOGICAL RESOURCES

The primary biological resource of commercial importance for ocean waters in New Jersey is the surf clam. The New Jersey Surf Clam Advisory Committee, comprised of industry and government representatives, in conjunction with the Commissioner for the New Jersey

Department of Environmental Protection, sets the quotas for harvest.

Quotas had been set at 600,000 industry bushels for several years preceding and including 1998. 1999-2001 quotas were increased to 700,000. 2002-2003 quotas were once again set at 600,000. For 2004, quotas were reduced to 275,000 industry bushels (Normant, 2004).

As New Jersey's surf clam industry is at the national forefront in total landings, one can appreciate the importance of conservation and management when considering this resource. In that 100 % of A0Remote waters are currently classified as *Approved*, as are a good proportion of New Jersey ocean waters, it is important to view them and the food sources they provide from both a public health and economic standpoint. Monitoring, then, becomes a primary tool when considering stock depletion from over fishing, species interaction with heavy metals, wastewater treatment effluents, or algal blooms.

There are occasional occurrences of algal blooms in all ocean waters in New Jersey. Algal blooms tend to occur in ocean waters in the late summer months during periods of hot weather. Brown Tides resulting from one of New Jersey's more frequent algal blooms can be spotted in back bay waters, inlets, and some portions of the ocean near inlet passageways. There are no known threats to human health from brown tides. For this reason, they are not considered in classifying waters for shellfish harvest.

It is more frequently the discoloration of the water that causes issues along New Jersey's coastal waters rather than the toxicity of the phytoplankton. However, as noted above, New Jersey does conduct marine water monitoring for the presence of toxic marine phytoplankton with potential toxicity in shellfish. No occurrences of algal blooms connected with the presence of biotoxins have been recorded for the time period covered by this report.

LAND USE

The lands adjacent to Shellfish Growing Area A0Remote can geophysically be described as barrier islands. The predominant land use on these barrier islands is urban (see Figure 8). Non-urban development is generally not associated with and does not significantly impact the communities from Absecon Inlet to Peahala Park.

Historically, the land and adjacent waters connected with this site have provided a haven for vacationing, hunting, commercial/sport fishing, and urban real estate ventures. For some, the location provided their year-round residence but for many it was a place to relax and enjoy time away from work in a shore rental or secondary home.

Although year-round residency has grown over the years, population increase is apparent in warmer seasons associated with secondary homeowner and rental use. Increased population could cause impact to the waters of this growing area. However, higher population fluctuations in the summer months would seem unlikely to affect surf clam harvests as harvesting takes place from October 1 – May 31st.

Urban development in A0Remote has primarily reached saturation but there are some new construction projects. Further, barrier island homes and businesses are also prone to frequent reconstruction and refurbishment. Impact from construction is unlikely though as projects bordering on eco-sensitive areas are required by local, state and federal regulations to utilize specific set backs and buffers as a means of protecting flora and fauna specific to wetland, riparian, or estuarine locations. The use of these buffers can never be understated as their utilization suggests construction is unlikely to impact our ocean growing area.

Aside from contributing to productivity, wetland and estuarine zones provide valuable habitat for many marine species during some point of their life cycle. Further, plant species within these zones often cleanse contaminants from the ecosystem while enhancing water quality.

Large areas of wetlands and coastal vegetation can be found in close proximity to urban development in A0Remote. Some of the largest of these areas are located in the Brigantine and Holgate units of the Forsythe National Wildlife Refuge (see Figures 4, 5, 6, and 7).

There are numerous mainland communities situated just to the west of A0Remote. Presently, our monitoring data show they have minimal impact on the waters of this site with regard to their sewerage infrastructure and current populations.

Pockets of homes exist within the nearby Pinelands that utilize septic systems. Septic is primarily utilized in areas of lower population density. Generally, the availability for access to city sewage infrastructure is less likely in these areas. There are always concerns regarding nutrient loading and elevated coliform levels within watersheds near communities utilizing septic. However, the distance from these communities to this growing area provides a safety zone for dilution.

FIGURE 4: SALT MARSH VEGETATION OF THE BRIGANTINE UNIT OF EDWIN B. FORSYTHE NATIONAL WILDLIFE REFUGE

FIGURE 5: COASTAL VEGETATION AT THE HOLGATE UNIT OF EDWIN B. FORSYTHE NATIONAL WILDLIFE REFUGE

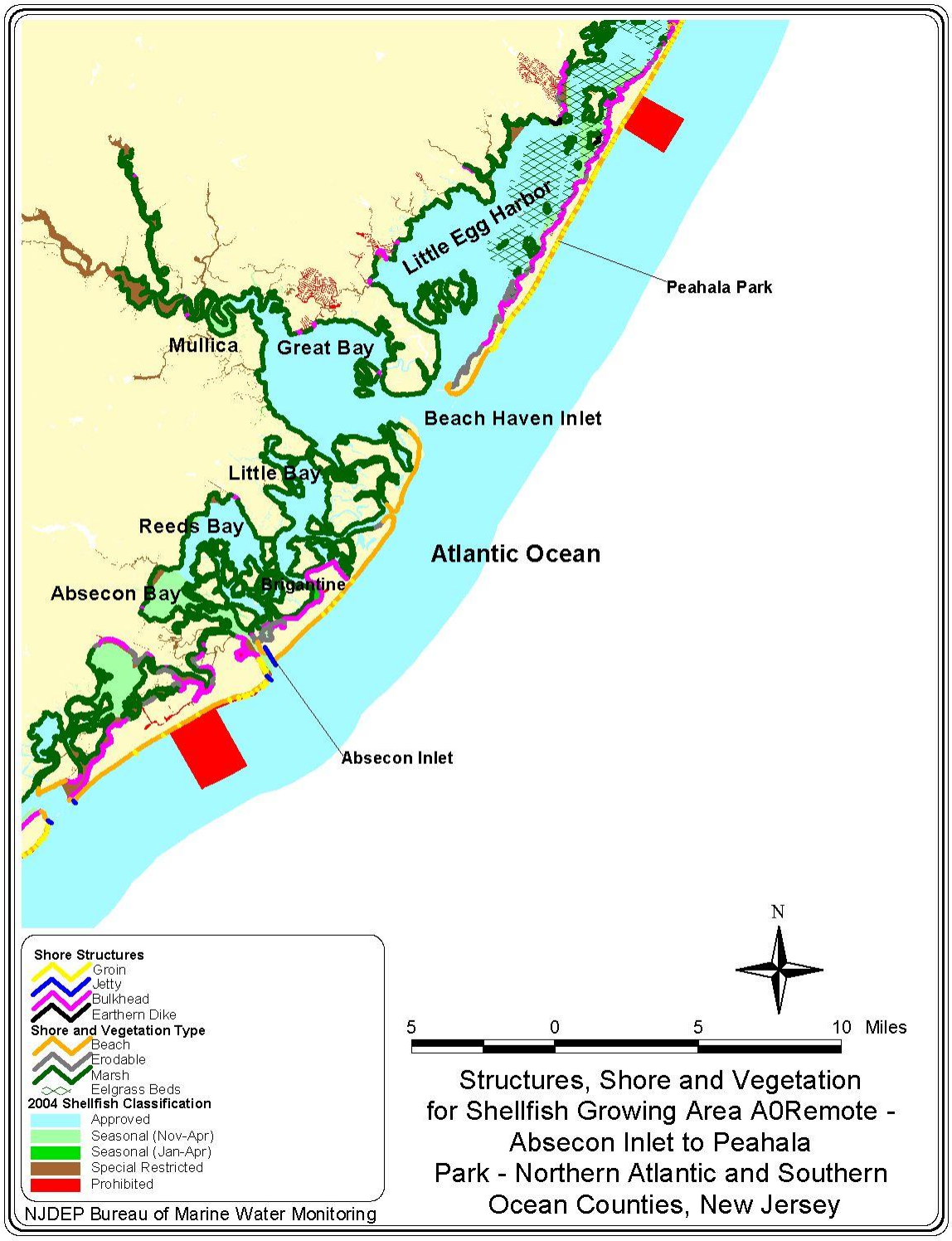


FIGURE 6: STRUCTURES, SHORE AND VEGETATION FOR SHELLFISH GROWING AREA A0REMOTE – ABSECON INLET TO PEAHALA PARK – NORTHERN ATLANTIC AND SOUTHERN OCEAN COUNTIES, NEW JERSEY

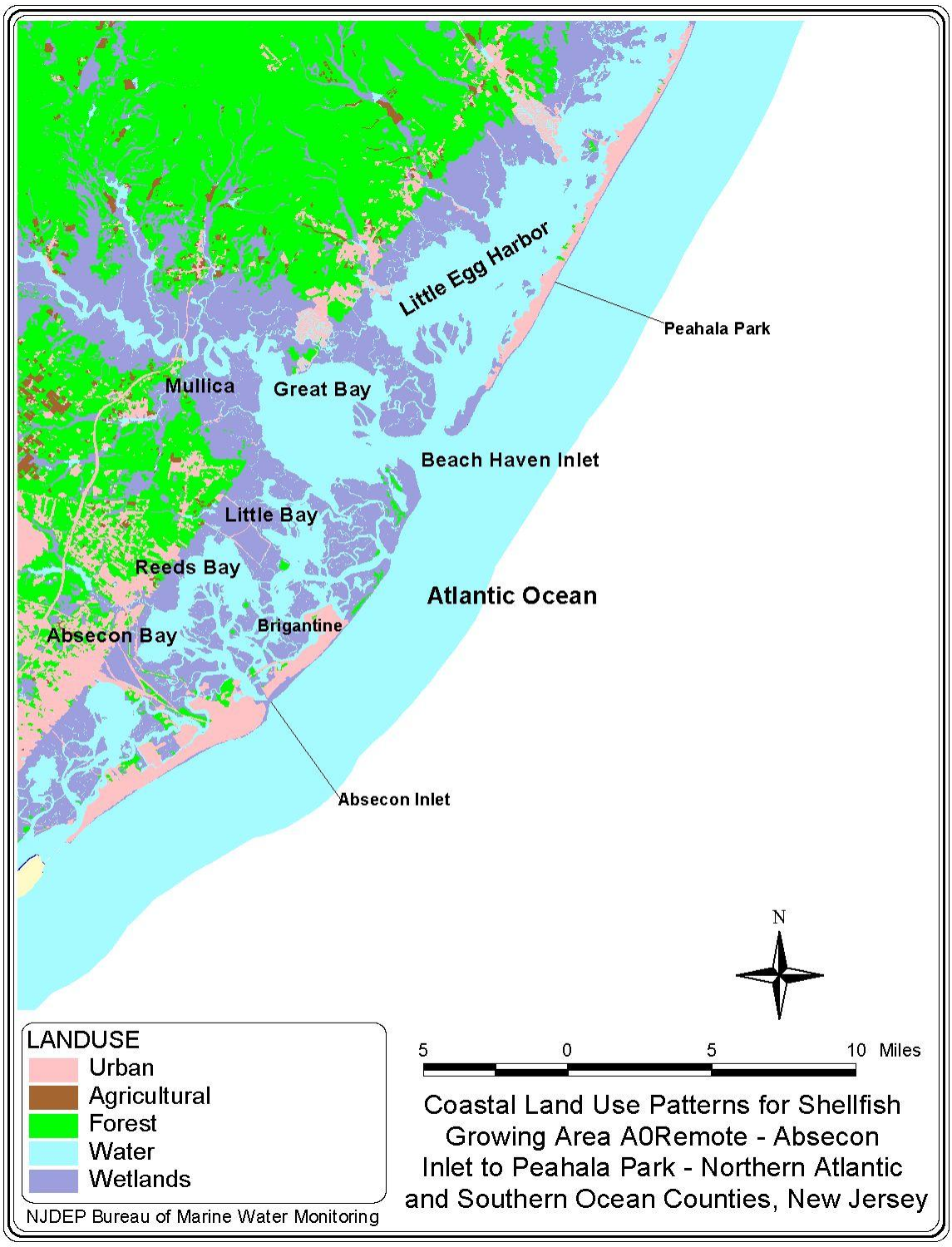


FIGURE 7: COASTAL LAND USE PATTERNS FOR SHELLFISH GROWING AREA A0REMOTE – ABSECON INLET TO PEAHALA PARK – NORTHERN ATLANTIC AND SOUTHERN OCEAN COUNTIES, NEW JERSEY

FIGURE 8: TYPICALLY URBAN DEVELOPMENT FOR COMMUNITIES WITHIN CLOSE PROXIMITY TO SHELLFISH GROWING AREA A0REMOTE – ABSECON INLET TO PEAHALA PARK – NORTHERN ATLANTIC AND SOUTHERN OCEAN COUNTIES, NEW JERSEY

CHANGES SINCE LAST SURVEY

Although the last Sanitary Survey for Shellfish Growing Area A0Remote was written in 1998, there was a substantial shoreline survey carried out with the Reappraisal written in 2001 and again in 2005. As there have been

no major changes to the area since that report, the primary consideration for any discussion of change in this year's Reappraisal pertains to population in the surrounding communities of these shellfish growing waters.

Comparisons between the 1990 Census and the 2000 Census for the counties involved in this report (see Table 4) suggest that population in Atlantic County grew from 224,327 in 1990 to 252,552, as reported in 2000. This accounts for an increase of 28,225 or 12.6 %. Ocean County grew from 433,203 in 1990 to 510,916 in 2000, representing an increase of 77,713 or 17.9 %.

Of the municipalities shown in Figure 9, all but two showed an increase in population over the last ten years. The areas reporting a decrease in population were Long Beach Township (-2.3 %) and Beach Haven Borough (-13.4 %).

The municipalities reporting a population increase were Brigantine City (10.9 %), Little Egg Harbor Township (19.6 %), and Galloway Township (33.8 %). The coastal communities of Long Beach Township and Beach Haven Boro (bordering A0Remote) showed a decrease in population (Census 2000). However, with the increase noted for Brigantine City (also a coastal area), the decrease averaged just -1.6 % overall for coastal communities. Non-coastal municipalities showed an expansion in population of 26.7 %.

Despite the greater trend toward increased population, the enclosed data and subsequent analyses suggests water quality within A0Remote remains good, indicating the *Approved* classifications currently designated for these waters are appropriate.

Acceptable water quality within an area experiencing population growth is indicative of good municipal planning. This leads to infrastructure designs that properly support stormwater management and wastewater treatment facilities capable of supporting the populous or increased populace they serve. The interaction of municipal planning, design, and technological improvements, when coordinated properly, can account for healthy ecosystems. This will be discussed further in the sections that follow on direct and indirect discharge sources.

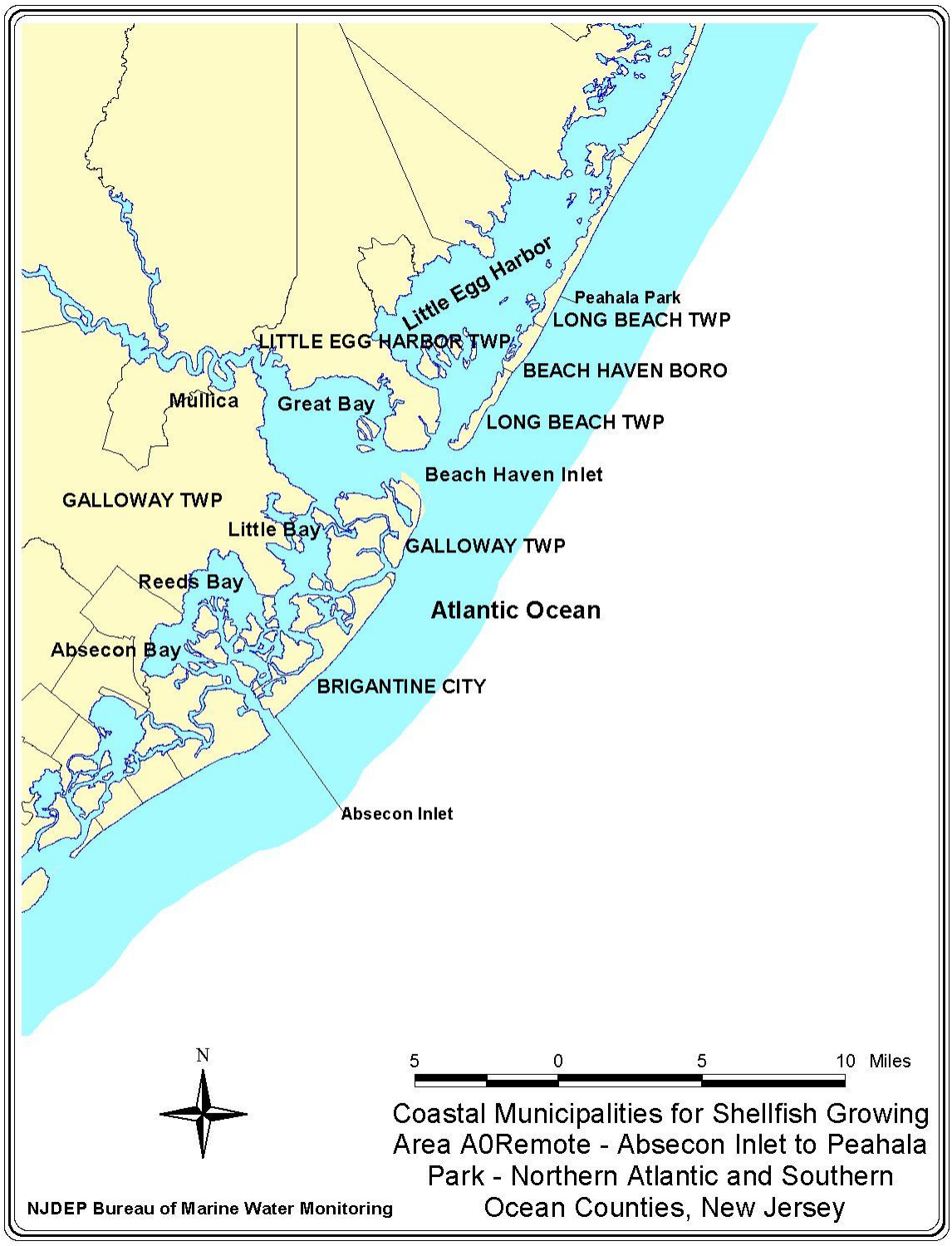


FIGURE 9: COASTAL MUNICIPALITIES FOR SHELLFISH GROWING AREA A0REMOTE – ABSECON INLET TO PEAHALA PARK – NORTHERN ATLANTIC AND SOUTHERN OCEAN COUNTIES, NEW JERSEY

TABLE 4: POPULATION INFORMATION FOR SHELLFISH GROWING AREA A0REMOTE – ABSECON INLET TO PEAHALA PARK – NORTHERN ATLANTIC AND SOUTHERN OCEAN COUNTIES, NEW JERSEY

Community	Area (sq. mi.)	Population		Population Change 1990 to 2000		Population Density	
		2000	1990	Number	Percent	2000	1990
Long Beach Twp.	16.630	3,329	3,407	-78	-2.3	200	205
Beach Haven Boro	2.332	1,278	1,475	-197	-13.4	548	633
Little Egg Harbor Twp.	73.399	15,945	13,333	2,612	19.6	217	182
Galloway Twp.	111.406	31,209	23,330	7,879	33.8	280	209
Brigantine City	10.442	12,594	11,354	1,240	10.9	1,206	1,087

IDENTIFICATION AND EVALUATION OF SOURCES

DIRECT DISCHARGES –Treatment Facility Wastewater Effluents

Sewage from A0Remote and many adjacent communities is carried to wastewater treatment facilities by sanitary sewers. In the case of Brigantine, sewage is treated by the Atlantic County Utilities Authority – Wastewater Treatment Facility for eventual ocean discharge off Ventnor (south of Brigantine and A0Remote).

Peahala Park and communities south through Holgate on Long Beach Island, utilize the Ocean County Utilities Authority – Southern Water Pollution Control Facility. Effluents from OCUA's southern facility are ultimately disposed off Ship Bottom (north of Peahala Park and A0Remote). No biologically treated effluent is discharged into these shellfish growing waters as the effluent discharge lines and outfalls for these treatment facilities are located outside the borders of A0Remote (see figure 10).

Recent site visitations and current information for the above treatment facilities suggests that they are able to and can operate efficiently with regard to design, current population demands, and emergency events (e.g., storm situations – plant/operator failure). However, the potential for impact increases as year round populations continue to grow in areas that are part of, adjacent to, or near A0Remote. With this understanding, monitoring and site visitations to treatment plants will continue to be essential with regard to the safety of this and any growing area.

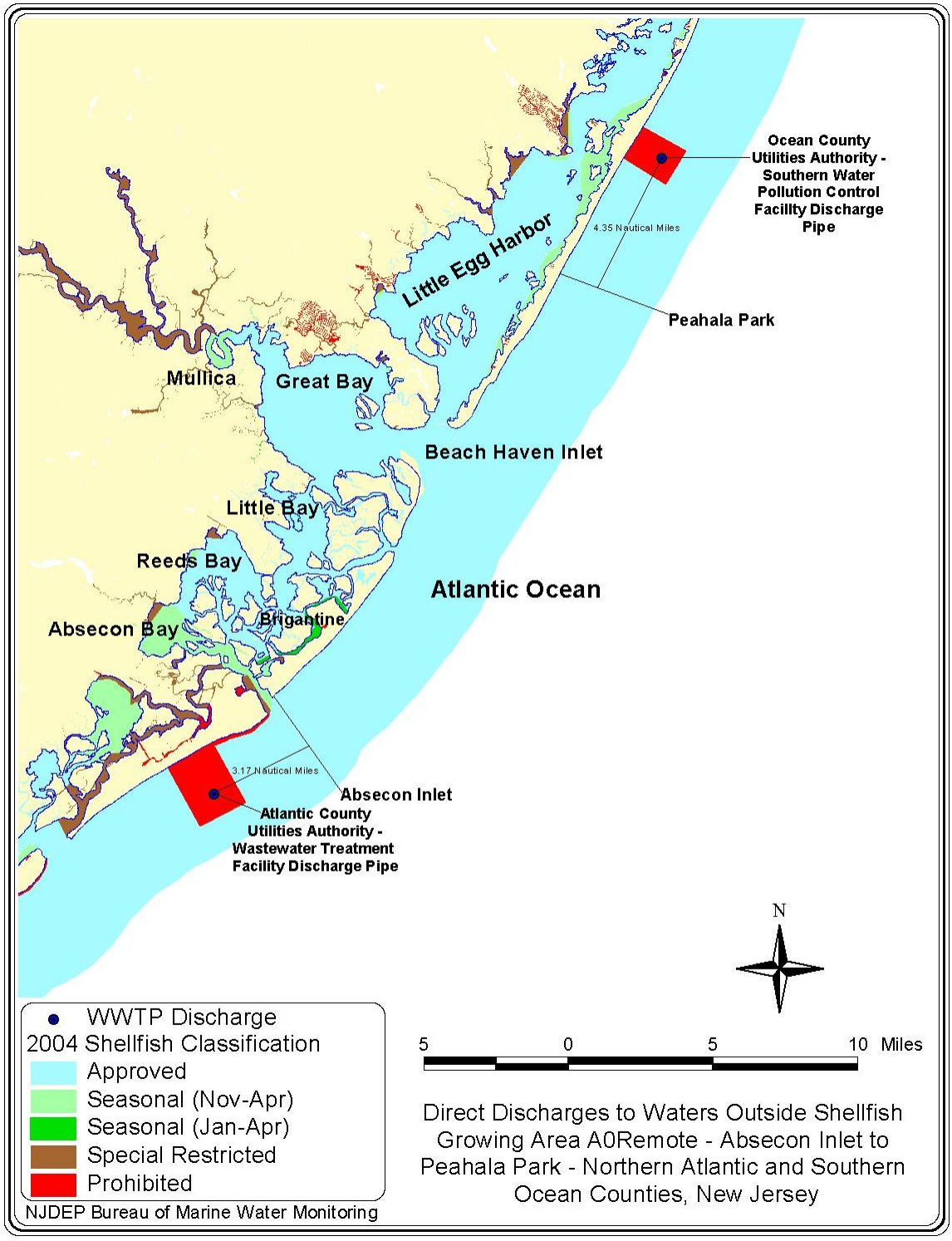


FIGURE 10: DIRECT DISCHARGES TO WATERS OUTSIDE SHELLFISH GROWING AREA A0REMOTE – ABSECON INLET TO PEAHALA PARK – NORTHERN ATLANTIC AND SOUTHERN OCEAN COUNTIES, NEW JERSEY

INDIRECT DISCHARGES

Spills or Other Unpermitted Discharges

Potential indirect sources of pollution include those areas or sites contaminated with hazardous materials or spills that might occur or have occurred in close proximity to this area. There are numerous known contaminated sites in the municipalities near the shoreline but none of them are located immediately adjacent to these ocean waters (see figure 11). Therefore, they are unlikely to have significant impact on the chemical or bacteriological water quality in this shellfish growing area. At present, there are no indications that any impact to these shellfish growing waters comes from contaminated sites. Further, there were no spills to ocean waters recorded in proximity to this area during the time period covered by this report.

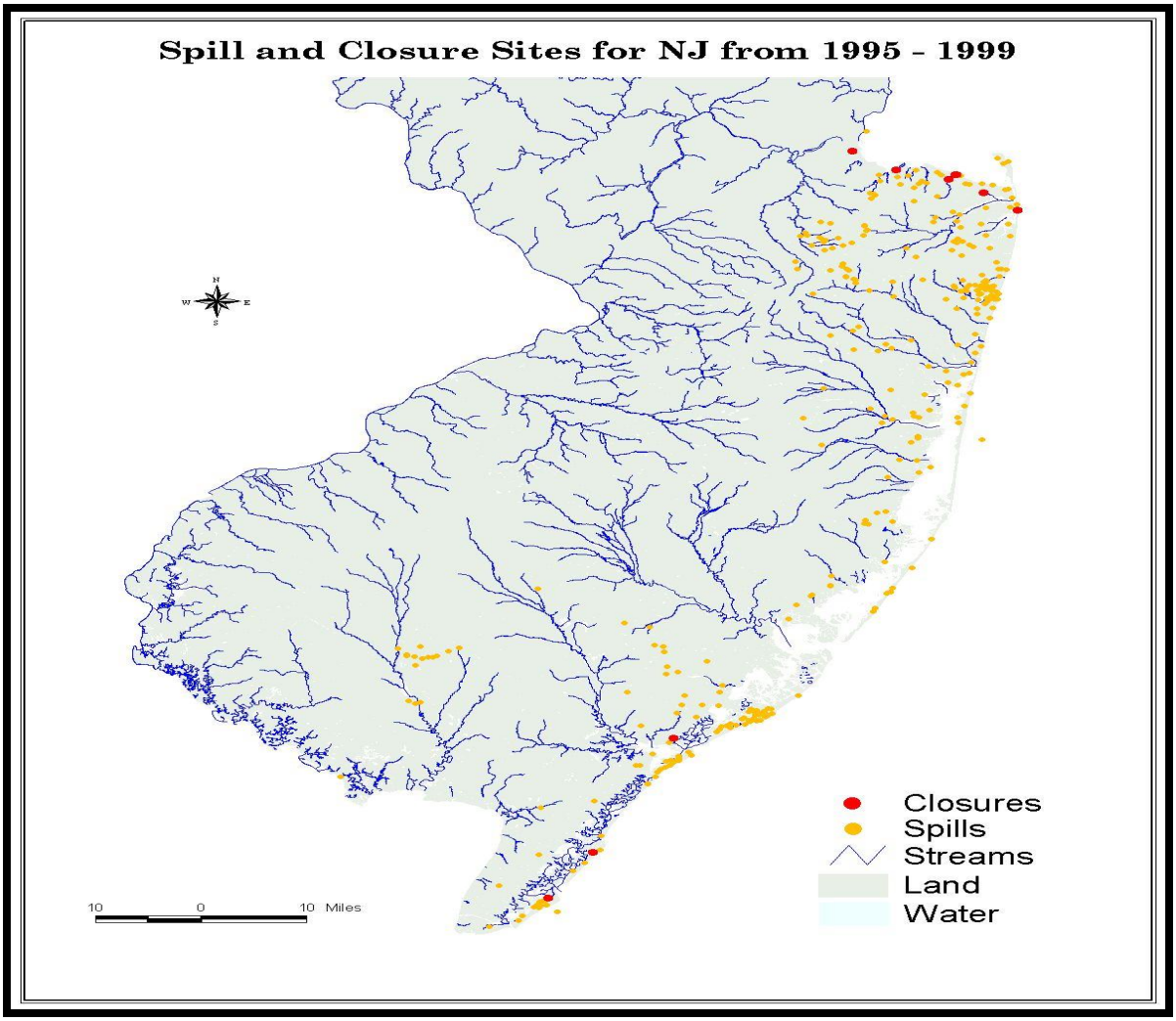


FIGURE 11: SPILLS OR OTHER UNPERMITTED DISCHARGES

Stormwater Inputs

During a shoreline survey and informative interview with Mr. Ernie Purdy (Superintendent – City of Brigantine Public Works Department) on March 11, 2005, it was evident that some changes regarding stormwater runoff had taken place and more are in the budgetary and planning stages between now and 2006.

Mr. Purdy suggested that less than 10% of Brigantine's stormwater runoff is directed towards the ocean. Further, much of this runoff has extremely limited potential for reaching the ocean. In some instances, the town's infrastructure is designed to direct stormwater towards drainage systems which empty into the base of sand dunes at the top of oceanblock streets, where percolation and filtration take place (one example – see Figure 16). Similarly located catch basins, equipped with subsurface, 24 inch perforated pipe, and stone beds for final disposal, percolation, and in many cases, redirection away from the ocean are more commonly utilized as replacement infrastructure today (approx. 16 streets are so equipped – see Figure 17).

In areas where non-redirected percolation takes place, there is nearly 200 feet of dune expanse (width) and another 300-foot width of beach for stormwaters to travel before possibly reaching the ocean. It seems likely that stormwater runoff in these areas will be absorbed through the substantial existing layers of vegetation and sand.

Previously it was reported that two storm water outlets existed and discharged at the street ends of 15th and 14th Streets South (oceanblock. – on either side of Celebrity Resorts, a beachfront location – previously known as Ramada Vacation Suites). These stormwater outlets consisted of openings through the road end bulkhead (Scuppers), which discharged the street's runoff onto the beach. The runoff was supposed to percolate into the sand before reaching and possibly impacting the ocean. As Mr. Purdy suggested in our last report, the Scuppers were removed some time ago. However, it is evident that stormwaters still run toward these street ends, through bulkheads and onto the beach surface (Figures 13 and 15). It seems apparent that a strong storm event could easily carry stormwater runoff into the ocean off this location. Further, Ramada has its trash dumpsters located beside the 15th St. South beach entrance (see Figure 14).

Mr. Purdy originally suggested that monies (for 2002) had been specifically dedicated for improving the situation at these street ends. However, he now suggests it is more likely that we will see some improvement (potential redirection of stormwaters) on one of the street ends during 2006.

Stormwater runoff previously directed toward the bay has also been structurally reconfigured in several instances within the town of Brigantine. The superintendent again suggested direct impact to the bay has been significantly reduced as bayblock outfalls have, in some cases, been reengineered in order to prevent immediate stormwater release into the bay. However, the more commonly used reengineering practice by the town (see Figure 20), is to capture stormwater debris and floatables prior to

their entering the bay. This is done with the help of rubber boots that have been placed over some outfall openings. In the end, it is the elevation above sea level (minimal for New Jersey's barrier islands) that controls much of what towns in these locations can and can't do with stormwater runoff.

In the northern sector of this growing area, we find that Long Beach Island's topography slopes away from the ocean. As such, all stormwater runoff is directed and discharged toward the bay. Although surface runoff from Long Beach Island eventually enters the ocean shellfish growing waters of A0Remote via Beach Haven Inlet, any input of this type is substantially diluted upon arrival.

As mentioned previously, major portions of the shoreline bordering the central to south central sections of A0Remote are comprised of the Holgate (2 ½ miles long – more than 400 acres) and Brigantine (approx. 1415 acres) units of the Edwin B. Forsythe National Wildlife Refuge. These refuge areas contain vast indigenous and migratory bird populations as shown by shoreline surveys. They represent a portion of more than 43,000 acres of coastal habitat specifically set-aside for migratory birds and other wildlife. Any and all bacteriological research has shown these avian populations to be of minimal concern as contributors of nonpoint pollution (specifically coliform levels). Dilution within A0Remote's back bay areas and nearby ocean appears to present the primary factor in reducing coliform contribution from bird populations.

Much of the water flowing into the southerly sector of this growing area from Beach Haven Inlet and, to a lessor degree, from Absecon Inlet, comes from estuarine areas classified as *Approved* shellfish growing waters. These *Approved* bodies of water include Little Egg Harbor, Great and Little Bays along with a large portion of Reeds Bay.

Stormwater Impact Studies

Non-point source pressures on shellfish beds in New Jersey originate in materials that enter the water via stormwater. These materials include bacteria as well as other waste that enters the stormwater collection system.

Historical data comparing the difference between coliform levels measured after rainfall with those during dry periods were compared to generate Figure 12. The Bureau of Marine Water Monitoring has begun to identify particular stormwater outfalls that discharge excessive bacteriological loads during storm events. In some cases, specific discharge points can be identified. When specific outfalls are identified as significant sources, the Department works with the county and municipality to further refine the source(s) of the contamination and implement remediation activities.

It should be noted that a particular short-term data set might not indicate significant rainfall effects even if the historical data indicate that a significant effect occurs in a particular area. This is

due to one or more of the following factors:

- Data during the short term may consist primarily of rainfall data or dry weather data. In this case, if there are insufficient data points in each category, the test for significance can not be done.
- Data collected after rainfall in the normal sampling regime may miss the effects of the "first flush".
- Rainfall data is based on the closest established NOAA station. Since rainfall patterns along the coastline, particularly during the summer months, tend to include locally heavy rainfall, the rainfall amounts recorded at the NOAA station may not accurately reflect the rainfall at the sampling station(s).

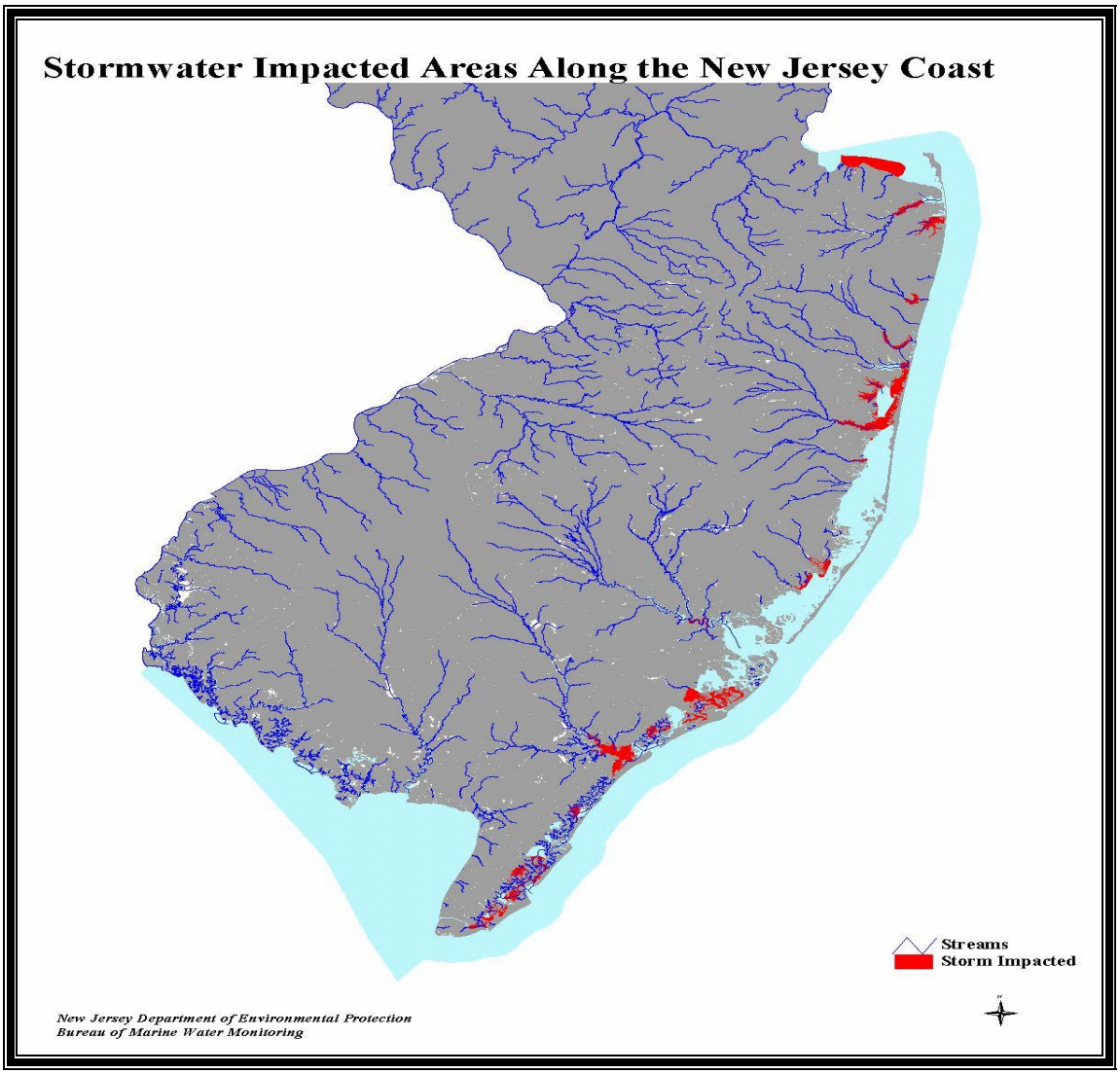


FIGURE 12: AREAS IMPACTED BY RAINFALL

FIGURE 13: STORMWATER RUNOFF - 15TH ST. SO. (BEACH VIEW - BRIGANTINE) - SHELLFISH GROWING AREA A0REMOTE – ABSECON INLET TO PEAHALA PARK – NORTHERN ATLANTIC AND SOUTHERN OCEAN COUNTIES, NEW JERSEY

FIGURE 14: TRASH DUMPSTER LOCATED NEAR OUTLET FOR STORMWATER RUNOFF - 15TH ST. SO. (OCEANBLOCK - BRIGANTINE) – SHELLFISH GROWING AREA A0REMOTE – ABSECON INLET TO PEAHALA PARK – NORTHERN ATLANTIC AND SOUTHERN OCEAN COUNTIES, NEW JERSEY

FIGURE 15: STORMWATER RUNOFF - 14TH ST. SO. (BEACH VIEW - BRIGANTINE) - SHELLFISH GROWING AREA A0REMOTE – ABSECON INLET TO PEAHALA PARK – NORTHERN ATLANTIC AND SOUTHERN OCEAN COUNTIES, NEW JERSEY

FIGURE 16: OLDER PERCOLATION INFRASTRUCTURE FOR STORMWATER RUNOFF - 26TH ST. SO. (OCEANBLOCK - BRIGANTINE) - SHELLFISH GROWING AREA A0REMOTE – ABSECON INLET TO PEAHALA PARK – NORTHERN ATLANTIC AND SOUTHERN OCEAN COUNTIES, NEW JERSEY

FIGURE 17: RECENTLY PLACED INFRASTRUCTURE FOR PERCOLATION OF STORMWATER RUNOFF AND RE-DIRECTION AWAY FROM OCEAN – 20TH ST. SO. (OCEANBLOCK - BRIGANTINE) - SHELLFISH GROWING AREA A0REMOTE – ABSECON INLET TO PEAHALA PARK – NORTHERN ATLANTIC AND SOUTHERN OCEAN COUNTIES, NEW JERSEY

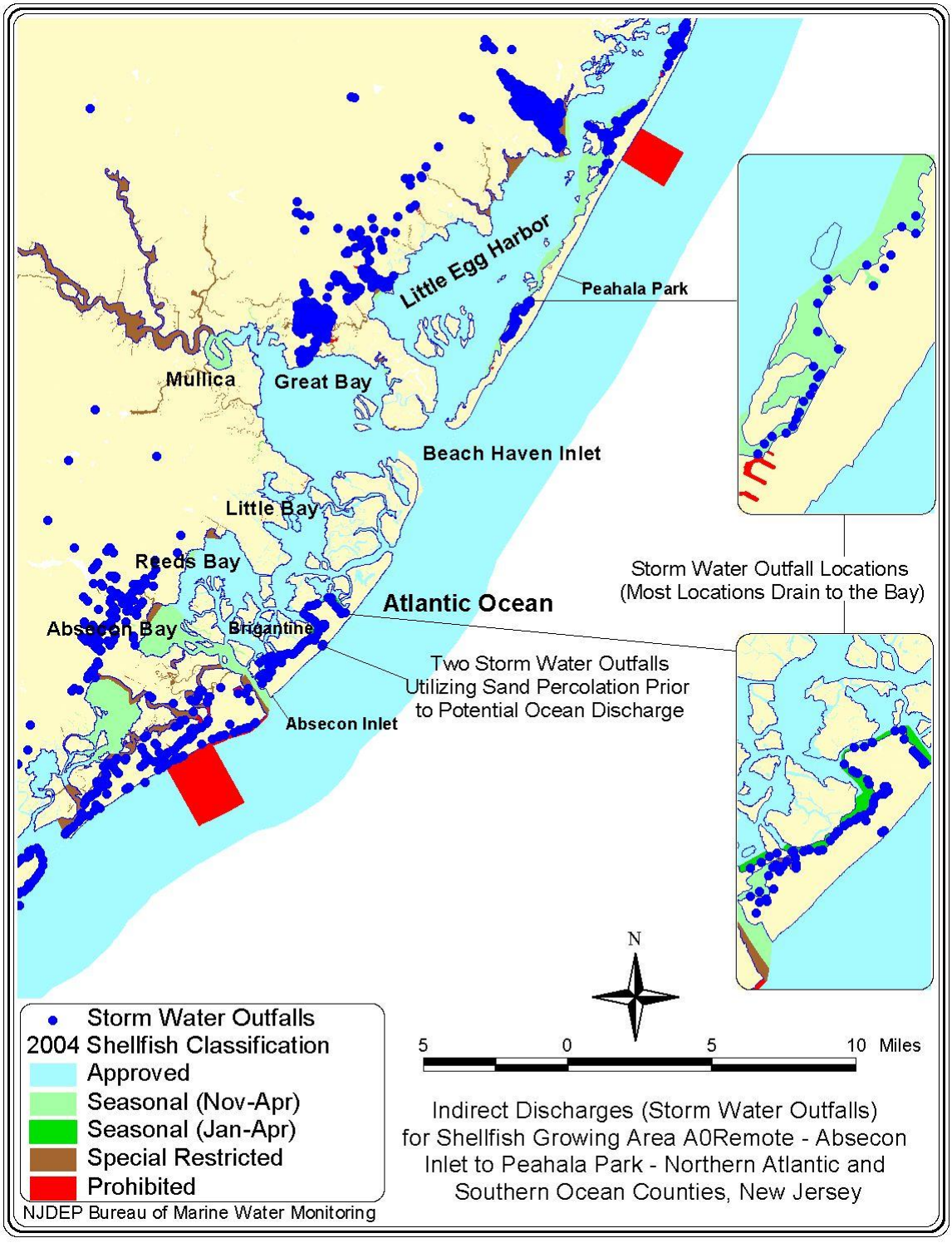


FIGURE 18: INDIRECT DISCHARGES (STORMWATER OUTFALLS) FOR SHELLFISH GROWING AREA A0REMOTE – ABSECON INLET TO PEAHALA PARK – NORTHERN ATLANTIC AND SOUTHERN OCEAN COUNTIES, NEW JERSEY

FIGURE 19: INDIRECT DISCHARGE (STORMWATER OUTFALL) TO BACK BAY WATERS FOR SHELLFISH GROWING AREA A0REMOTE – ABSECON INLET TO PEAHALA PARK – NORTHERN ATLANTIC AND SOUTHERN OCEAN COUNTIES, NEW JERSEY

FIGURE 20: INDIRECT DISCHARGE (STORMWATER OUTFALL – PLATT AVE. AND WEST SHORE DR.) TO BACK BAY WATERS FOR SHELLFISH GROWING AREA A0REMOTE – SHOWS RUBBER BOOT FOR COLLECTION OF PLASTICS AND DEBRIS - ABSECON INLET TO PEAHALA PARK – NORTHERN ATLANTIC AND SOUTHERN OCEAN COUNTIES, NEW JERSEY

HYDROLOGY AND METEOROLOGY

PATTERNS OF PRECIPITATION

Precipitation patterns in the coastal areas of New Jersey are typical of the Mid-Atlantic coastal region. Typical summer storms are localized and associated with thunderstorms (see Table 5). Winter storms are frequently associated with northeasters. Hurricanes can occur during the summer and early fall.

TABLE 5: AVERAGE MID-ATLANTIC STORM EVENT INFORMATION. SOURCES: USEPA; US DEPARTMENT OF COMMERCE

Annual Average Number of Storms	60
Average Storm Event Duration	10 hours
Average Storm Event Intensity	0.08 – 0.09 inches/hour
Average Storm Event Volume	0.65 inches

Although the average storm event lasts approximately 10 hours, with an accumulation of 0.65 inches, it is not unusual for an individual storm volume to be 2 – 3 inches. Note the data below that shows the 2-year return, 6-hour storm event to be between two and three inches, while the 2-year, 24-hour return volume varies between 3 and 4 inches (see Table 6). Storm volumes greater than approximately 3.5 – 4.0 inches are much less frequent.

TABLE 6: STORM EVENT VOLUME FOR 2-YEAR STORM EVENT RECURRENCE. (SOURCE: USGS**)**

Location	2-Year, 1-Hour Rainfall	2-Year, 6-Hour Rainfall	2-Year, 24-Hour Rainfall
Millville	1.33	2.33	3.02
Cape May	1.33	2.41	3.10
Atlantic City	1.47	2.67	3.65
Long Branch	1.55	3.02	4.15
Newark	1.21	2.34	3.25
Sandy Hook	1.37	2.73	3.68

The duration and volume of storm events can also be depicted as frequency histograms. The graphical depiction shown below provides insight into the frequency for storm events of a given size (see figure 21).

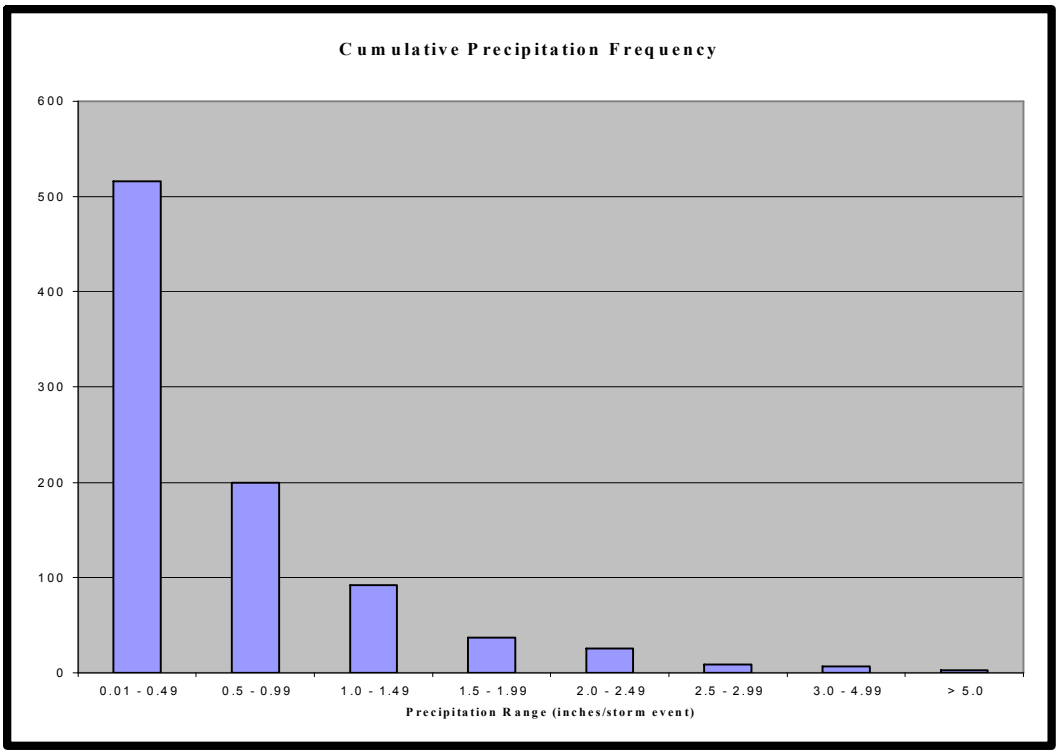


FIGURE 21: STORM EVENT FREQUENCY HISTOGRAM (SOURCE: NOAA CLIMATIC DATA)

RAINFALL EFFECTS

New Jersey has experienced drought conditions during some of the time since 2000, when the last Reappraisal was written for A0Remote. Further, as the time frame for the analysis presented in this year's report encompasses the years from 1996 – 2003, it should be noted that drought conditions were present in this state during some of the years proceeding 2000. Nonetheless, when averaging the data for precipitation amounts, the results do show a fairly consistent pattern for the time frame represented in this report.

Precipitation inputs to the area for the period 11/19/96 through 6/5/03 are shown in Tables 8 and 9. As combined yearly averages for precipitation accumulation have shown little change, there has been no drastic change in hydrology either.

The National Oceanic and Atmospheric Administration (NOAA) weather stations used for reporting precipitation accumulation in this region of New Jersey were the Atlantic City Airport # 311 and the Toms River station # 8816. The Atlantic City location is considered the primary weather station for this area

and the Toms River location is considered the secondary reporting station. Secondary station data are used when data from the primary station is incomplete.

Larger storm events, hurricanes or winter nor'easters can cause elevated coliform levels producing noted statistical variation within some sections of our ocean growing waters. Although these variations rarely represent a problematic situation for New Jersey's ocean classifications, their occurrence can present a statistical relationship worth noting when, and if, applicable.

There was one station (A69A2 – surface) that showed rainfall correlations (see Figure 22) with regard to the data presented in this Reappraisal. An observed rainfall correlation at this station (or any station) occurs when correlations exceed 0.6. Correlations were noted for this station on the day prior to sampling and two days prior to sampling. Those correlations were 0.818 and 0.770 respectively, and can be viewed in Table 7.

When reviewing the fecal coliform data for this station, the highest counts for fecal coliform for any single day of sampling were noted on 6/5/03 with that sampling date producing a geometric mean of 43.0 MPN/100 mL. The rainfall associated with the day prior and two days prior to sampling was recorded at 0.66 and 0.69 inches.

A final analysis for this station suggests that sampling dates from November 1996 through June of 2003 formulate a total geometric mean of 3.2 MPN/100 mL and the 90th percentile was 6.7 % greater than 28 MPN/100 mL. These numbers are within the confines of limitation allowed for *Approved* waters with regard to the methodology used for classification. As suggested previously, the geometric mean shall not exceed 14 MPN/100 mL and no more than 10 % of the samples shall exceed a 90th percentile of 28 MPN/100 mL. For 14 out of 15 sampling dates, there were no occurrences where the data exceeded 4 MPN/100 ml except on June 5, as mentioned previously.

The area of barrier islands which forms shorelines for this shellfish growing area consists of urban development (primarily residential with some commercial business supporting recreational use and commerce). Beaches are maintained primarily for recreational bathing purposes. All communities along the shoreline are connected to sanitary sewers.

There is no reason to alter the sampling stations utilized in obtaining future data for reports due to impact from rainfall amounts. Rainfall has had very little effect on the results obtained from samples taken from these ocean waters.

Large storms, hurricanes or severe winter, cyclonic events ("nor'easters"), have not significantly elevated coliform levels in any sections of this growing area. The only hurricane, which passed through the area in recent years, was Floyd during 1999. However, much of the hurricane's intensity had been lost prior to its reaching New Jersey. As a result, large storms have not been significant (during this review period) for determining impacts to shellfish in this growing area.

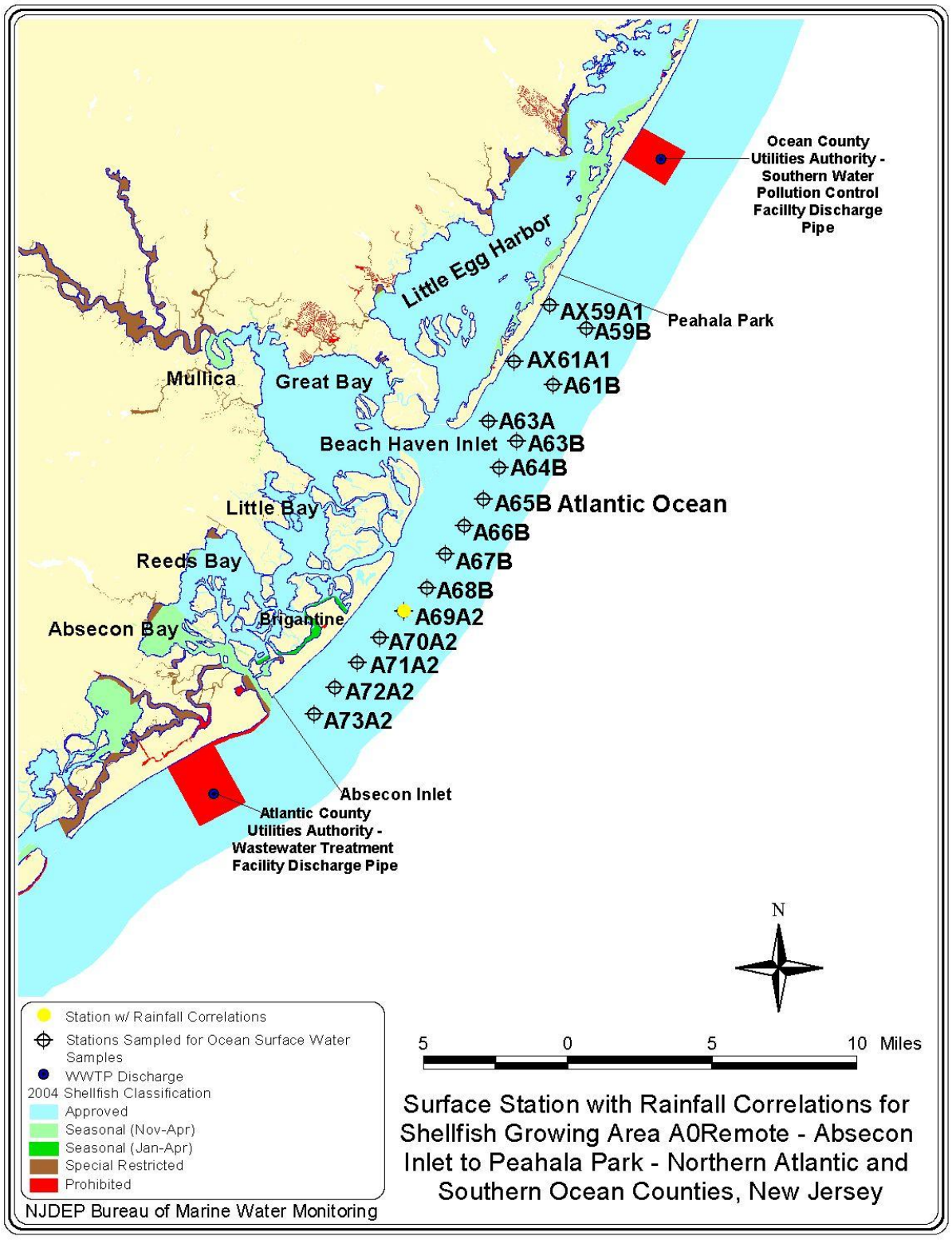


FIGURE 22: SURFACE STATION WITH RAINFALL CORRELATIONS FOR SHELLFISH GROWING AREA A0REMOTE - ABSECON INLET TO PEAHALA PARK - NORTHERN ATLANTIC AND SOUTHERN OCEAN COUNTIES, NEW JERSEY

TABLE 7: SURFACE SAMPLING STATION WITH RAINFALL CORRELATIONS – (CORRELATION SHOWN IN YELLOW) **– SPECIFIC FOR CUMULATIVE RAINFALL AS IT RELATES TO FECAL COLIFORM – SHELLFISH GROWING AREA A0REMOTE – ABSECON INLET TO PEAHALA PARK - NORTHERN ATLANTIC AND SOUTHERN OCEAN COUNTIES, NEW JERSEY**

Station	Day of Sampling	24 Hours Prior	48 Hours Prior	# of Specific Correlations	# of Samples
A69A2	0.489	0.818	0.770	2	15

TABLE 8: PRECIPITATION DATA FOR SHELLFISH GROWING AREA A0REMOTE - ABSECON INLET TO PEAHALA PARK - NORTHERN ATLANTIC AND SOUTHERN OCEAN COUNTIES, NEW JERSEY - RAINFALL RECORDED AT NOAA'S STATION'S - 311 (ATLANTIC CITY AIRPORT) AND 8816 (TOMS RIVER)

Sampling Date	Precipitation in Inches		
	Day of Sampling	24 Hours Prior	48 Hours Prior
11/19/1996	0.12	0.15	0.15
11/19/1996	0	0	0
6/13/1997	0.54	0.54	0.54
6/13/1997	0	0	0
12/16/1997	0	0	0
12/16/1997	0	0	0
6/2/1998	0.01	0.18	0.18
6/2/1998	0.25	0.68	0.685
10/15/1998	0	0.62	0.625
10/15/1998	0.005	0.275	0.28
7/21/1999	0.02	0.025	0.065
7/21/1999	0.005	0.165	0.215
9/28/1999	0	0	0
9/28/1999	0	0	0
6/21/2000	0	0	0
6/21/2000	0	0.005	0.545

TABLE 9: PRECIPITATION DATA FOR SHELLFISH GROWING AREA A0REMOTE (CONT. FROM TABLE 8) - ABSECON INLET TO PEAHALA PARK - NORTHERN ATLANTIC AND SOUTHERN OCEAN COUNTIES, NEW JERSEY - RAINFALL RECORDED AT NOAA'S STATION'S - 311 (ATLANTIC CITY AIRPORT) AND 8816 (TOMS RIVER)

	Precipitation in Inches		
Sampling Date	Day of Sampling	24 Hours Prior	48 Hours Prior
7/12/2000	0	0	0.005
7/12/2000	0	0.005	0.005
4/23/2001	0	0	0.1
4/23/2001	0	0.1	0.105
8/21/2001	0	0	0.11
8/21/2001	0	0	0.48
5/6/2002	0.01	0.01	0.02
5/6/2002	0.1	0.1	0.1
6/12/2002	0.33	0.33	0.33
6/12/2002	0.6	0.6	0.6
2/3/2003	0	0	0.25
2/3/2003	0	0	0
6/5/2003	0.15	0.66	0.69
6/5/2003	0.53	1.68	1.685

TIDAL EFFECTS

One station in A0Remote had a tidal effect (Station A72A2 - surface) and its location within the growing area can be viewed in Figure 23. For this or any other station to show up with a tidal effect, variability in the data must show a t-statistic probability ≤ 0.05 (but not zero). The t-statistic probability for station A72A2 was 0.043 (see Table 10).

The geometric mean was highest on the Flood Tide at 3.1 MPN/100 mL and was configured with a compilation of sample dates from nine flood tides. Six sample dates were comprised of ebb tide data producing a geometric mean of 2.3 MPN/100 mL. With this, no criteria were exceeded that would alter the current classification (*Approved*) for A0Remote from either flood or ebb tides, although the flood tide data did produce a tidal effect.

Tidal exchanges provide a mechanism to mix impacted water with higher

quality water. Although the waters immediately adjacent to shorelines where urban development exists can receive impacts from runoff, tidal exchange can mix inshore with offshore water which allows for dilution. As a result, significant amounts of mixing and dilution occur for the waters in this area as evidenced by the majority of waters being classified as *Approved*.

Additionally, A0Remote lacks a substantial amount of urban infrastructure when compared to other growing areas. The lack of direct inputs and the reduced number of indirect sources greatly enhance the water quality of these shellfish growing waters.

The above information suggests tidal influence does not present an adverse effect on A0Remote. However, monitoring should continue to be structured around the adverse pollution strategy discussed in previous sections due to the northerly and southerly positions of treatment facility outfalls. Although these outfalls are located outside the confines of these growing waters, a monitoring policy (APC) structured around possible input from such sources remains the optimum choice.

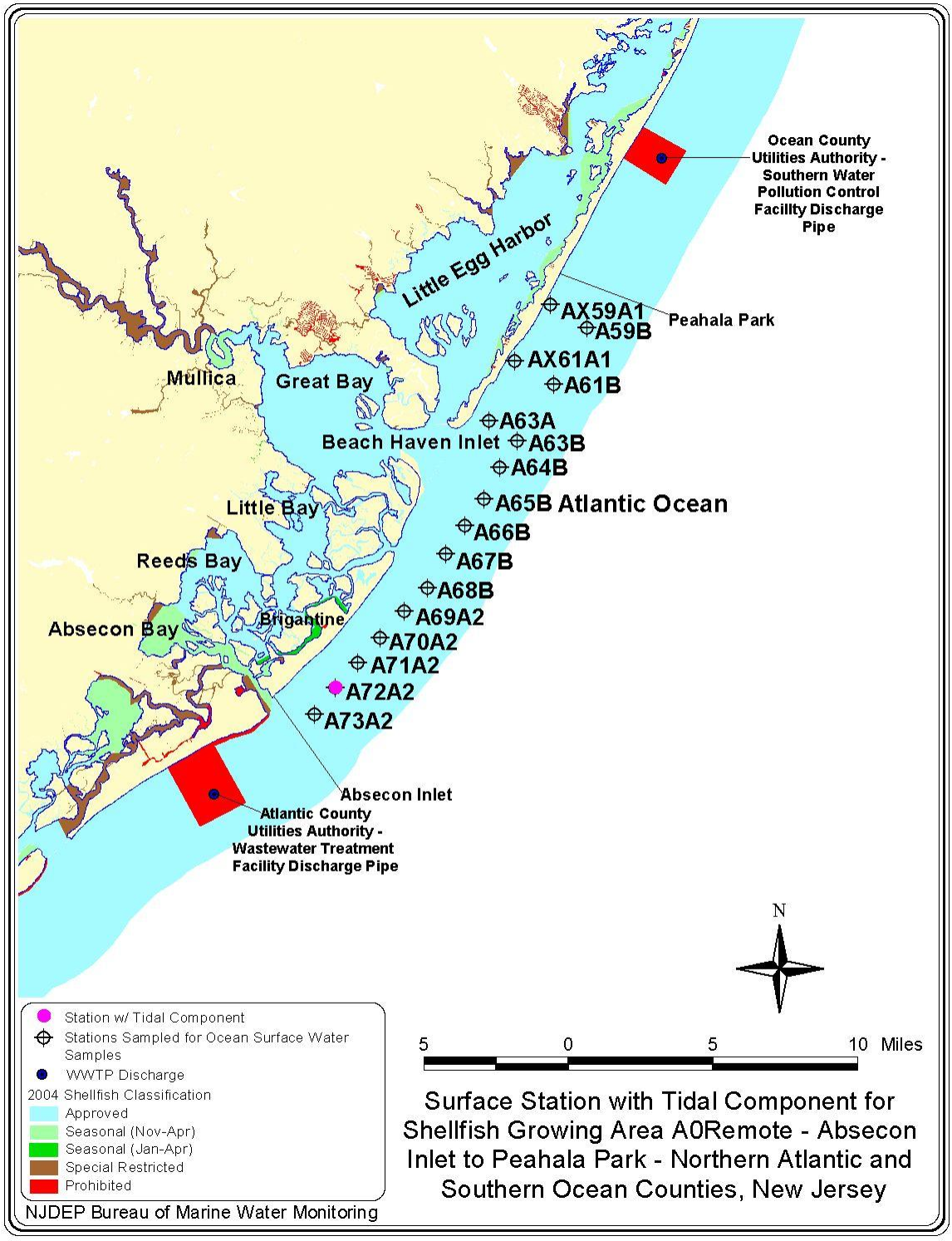


FIGURE 23: SURFACE STATION WITH TIDAL COMPONENT FOR SHELLFISH GROWING AREA A0REMOTE - ABSECON INLET TO PEAHALA PARK - NORTHERN ATLANTIC AND SOUTHERN OCEAN COUNTIES, NEW JERSEY

TABLE 10: SURFACE SAMPLING STATION SHOWING TIDAL EFFECT FOR FECAL COLIFORM (TIDAL EFFECT/COMPONENT SHOWN IN YELLOW) **IN SHELLFISH GROWING AREA A0REMOTE – ABSECON INLET TO PEAHALA PARK - NORTHERN ATLANTIC AND SOUTHERN OCEAN COUNTIES, NEW JERSEY**

Station	t-Statistic Probability	Geometric Mean Ebb	Geometric Mean Flood	# Samples Ebb	# Samples Flood
A72A2	0.043	2.3	3.1	6	9

WATER QUALITY STUDIES

BACTERIOLOGICAL QUALITY

Compliance with NSSP *Approved* Criteria

The Adverse Pollution Condition (APC) strategy was utilized to classify the waters contained within this growing area. This methodology was utilized for sampling to monitor for the possibility of contamination via the presence of direct discharges to the south and north of A0Remote. Again, these discharges come from the Atlantic County Utilities Authority – Wastewater Treatment Facility Discharge Pipe (off Ventnor - South of A0Remote and Absecon Inlet) and the Ocean County Utilities Authority – Southern Water Pollution Control Facility Discharge Pipe (off Ship Bottom - North of A0Remote and Peahala Park).

The water quality data collected for this area, between November 1996 and June 2003, showed that sample results from all stations were within the criteria for *Approved* waters. With this, the water quality for this growing area is conducive for harvesting shellfish that are safe for human consumption. Complete tabulated listings for water quality summaries represented by fecal coliform bacteriological data can be found in Table 11.

As mentioned previously, samples were compiled from Assignment 471 and detail 15 different sampling runs, representing approximately 239 samples from 16 surface stations. These stations were analyzed for fecal coliform and are represented in Figure 24.

Again, all surface stations exhibited acceptable (*Approved*) water quality for fecal coliform on summary evaluation, using APC criteria. Most stations had geometric means in the range of 3 MPN/100mL or less. MPN's that do not exceed 14/100 mL are used for measuring acceptability, while considering the geometric mean when analyzing water quality for fecal coliform. Further, no stations exceeded the percentile portion of the criteria using APC methodology (no more than 10% can exceed 28 MPN/100mL – fecal coliform). All but one station showed 0 % when considering the percentile criteria.

The raw data listings for this growing

area show rare instances of elevated fecal coliform levels (3 of 239 samples with MPN's ranging from 23/100 mL on 6/21/00, station A67B; 15/100mL on 6/2/98 for station A68B and 43/100 mL, station A69A2 on 6/5/2003). Therefore, these occurrences were minimal and registered no impact for statistical summaries on final evaluation. Further, there are no strong interactions between rainfall, tide, or seasonality. When analyzing this data, the duration of elevated counts is limited due to dilution or lack of direct and indirect inputs, and events are isolated or inconclusive.

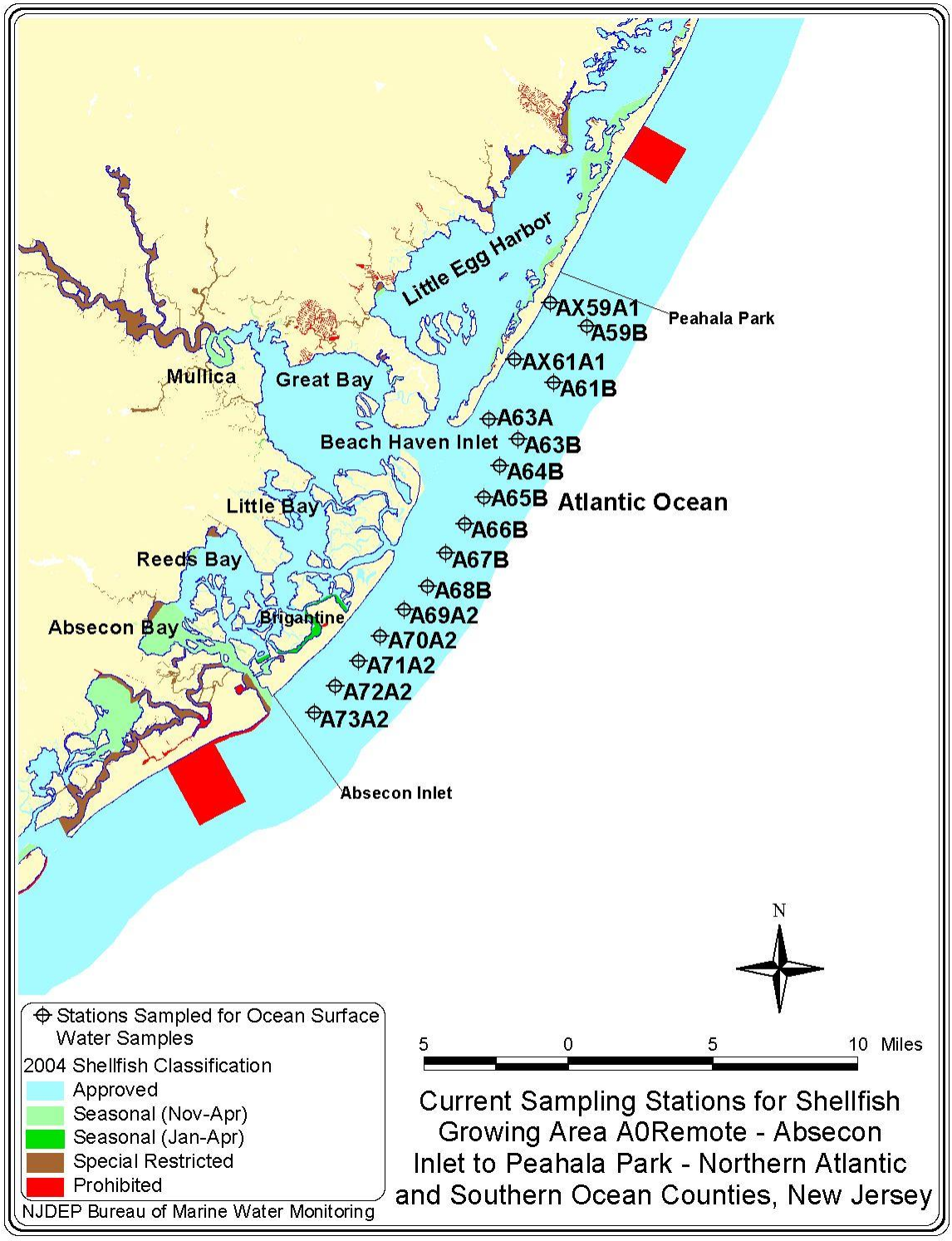


FIGURE 24: CURRENT SAMPLING STATIONS FOR SHELLFISH GROWING AREA A0REMOTE - ABSECON INLET TO PEAHALA PARK - NORTHERN ATLANTIC AND SOUTHERN OCEAN COUNTIES, NEW JERSEY

TABLE 11: WATER QUALITY SUMMARY (FECAL COLIFORM) FOR SHELLFISH GROWING AREA A0REMOTE – ABSECON INLET TO PEAHALA PARK - NORTHERN ATLANTIC AND SOUTHERN OCEAN COUNTIES, NEW JERSEY (11/19/96 – 06/05/03)

Station	Depth	Classification	Year-round			Summer			Winter		
			Geo. Mean	% > 28	N	Geo. Mean	% > 28	N	Geo. Mean	% > 28	N
AX59A1	S	A	2.6	0.0%	15	2.6	0.0%	11	2.4	0.0%	4
A59B	S	A	2.5	0.0%	14	2.6	0.0%	11	2.3	0.0%	3
AX61A1	S	A	2.6	0.0%	15	2.6	0.0%	11	2.4	0.0%	4
A61B	S	A	2.6	0.0%	15	2.6	0.0%	11	2.4	0.0%	4
A63A	S	A	2.6	0.0%	15	2.6	0.0%	11	2.4	0.0%	4
A63B	S	A	2.6	0.0%	15	2.6	0.0%	11	2.4	0.0%	4
A64B	S	A	2.6	0.0%	15	2.6	0.0%	11	2.4	0.0%	4
A65B	S	A	2.7	0.0%	15	2.8	0.0%	11	2.4	0.0%	4
A66B	S	A	3.0	0.0%	15	3.2	0.0%	11	2.4	0.0%	4
A67B	S	A	3.3	0.0%	15	3.4	0.0%	11	2.9	0.0%	4
A68B	S	A	3.0	0.0%	15	3.2	0.0%	11	2.4	0.0%	4
A69A2	S	A	3.2	6.7%	15	3.3	9.1%	11	2.9	0.0%	4
A70A2	S	A	2.6	0.0%	15	2.6	0.0%	11	2.4	0.0%	4
A71A2	S	A	2.6	0.0%	15	2.6	0.0%	11	2.4	0.0%	4
A72A2	S	A	2.7	0.0%	15	2.9	0.0%	11	2.4	0.0%	4
A73A2	S	A	2.8	0.0%	15	2.6	0.0%	11	3.2	0.0%	4

RELATED STUDIES

The BMWM performs additional water quality studies related to the bacteriological monitoring program. Specifically, shellfish growing area A0Remote has the following nutrient sampling station: A65B.

Nutrient stations are sampled on a quarterly basis. There are approximately 250 nutrient sampling stations within the coastal and inner coastal waters of New Jersey. Twenty-four of those stations are located within the ocean waters off the New Jersey coast. The 226 remaining nutrient stations are spread throughout our back bay waters. The Bureau compiles the results of nutrient levels from such stations and then prepares a separate report. The nutrient station location for A0Remote is shown in Figure 25 and nutrient levels for this station are shown in Table 12.

Chlorophyll data are also contained within the nutrient data. As such, the BMWM is able to maintain a quarterly picture of algal activity within State waters. This chlorophyll data also proves to be useful as adjunct information to the phytoplankton monitoring program described below.

As mentioned in the section on Marine Bio-toxins, data are also collected as part

of the phytoplankton monitoring program, for which, the BMWM analyzes samples bi-weekly from May through August (Memorial Day through Labor Day). This is done in order to determine the presence of marine biotoxins in accordance with NSSP requirements.

There are 16 phytoplankton stations within the waters of New Jersey. Of those 16, four are located off the coast from the southerly portion of Sandy Hook down to Cape May. The other 12 phytoplankton stations are situated within New Jersey's back bay waters.

There are no specific stations allocated to phytoplankton within the A0Remote shellfish growing area. However, the Annual Summary of Phytoplankton Blooms and Related Conditions in New Jersey Coastal Waters for the summer of 2002, shows that populations of phytoplankton are sparse to the north and south of this growing area where specific phytoplankton stations are located, and no toxic species have been associated with those locations during recent sampling (see www.state.nj.us/dep/wmm/bmw). It should also be noted that chlorophyll levels in A0Remote have been relatively low.

Nutrient and phytoplankton stations are arranged so samples for both are taken from matching locations. In this regard, data can be uniformly compared and analyzed where those stations occur and overlap.

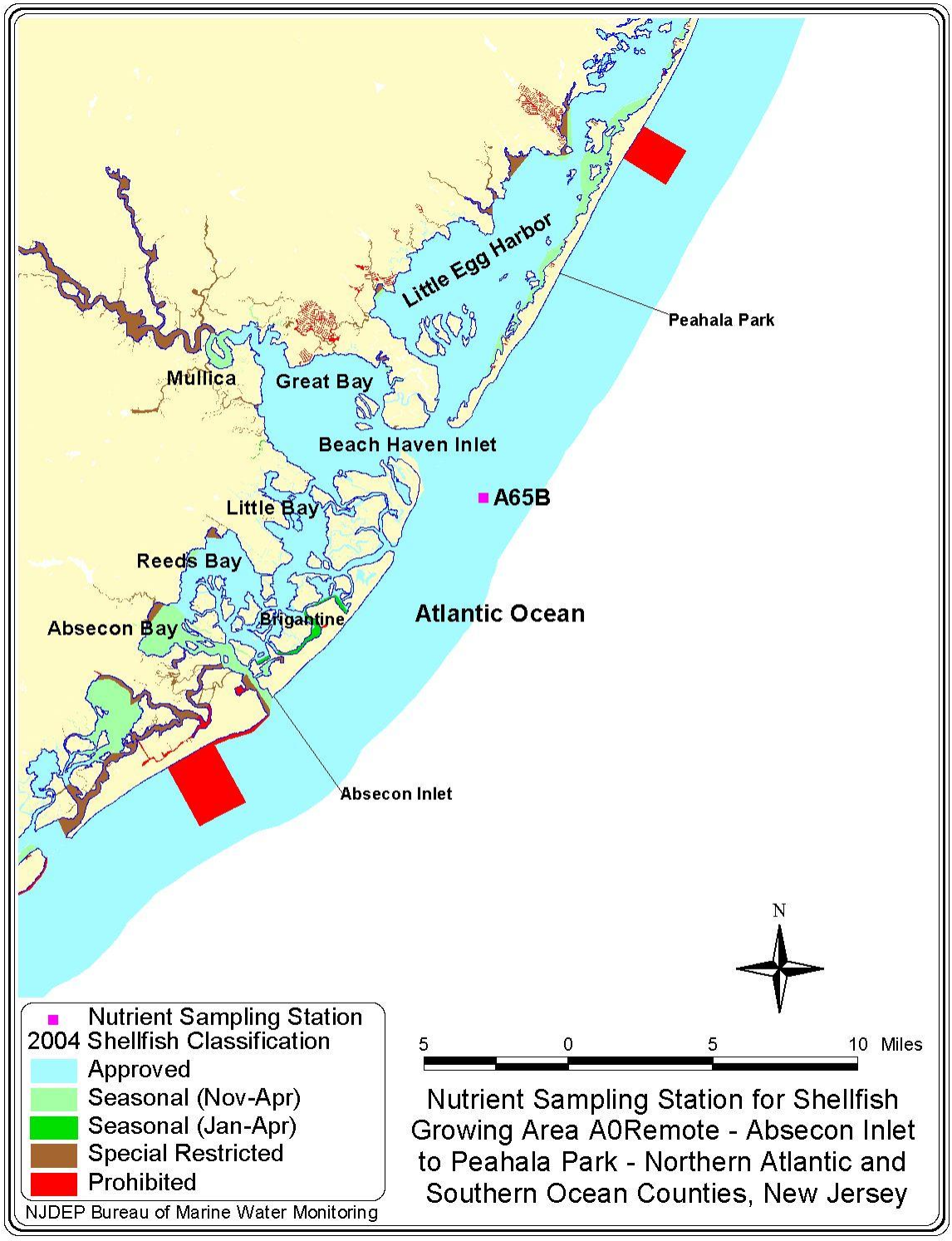


FIGURE 25: NUTRIENT SAMPLING STATION FOR SHELLFISH GROWING AREA A0REMOTE – ABSECON INLET TO PEAHALA PARK – NORTHERN ATLANTIC AND SOUTHERN OCEAN COUNTIES, NEW JERSEY

TABLE 12: DATA SUMMARY - NUTRIENT SAMPLING STATIONS FOR SHELLFISH GROWING AREA A0REMOTE – ABSECON INLET TO PEAHALA PARK - NORTHERN ATLANTIC AND SOUTHERN OCEAN COUNTIES, NEW JERSEY

Station	Date	Time	Temp (C)	Secchi	Salinity (PPT)	DO (mg/L)	TSS (mg/L)	NH3 Ammonia (µg/L)	NO3 & NO2 Nitrate & Nitrite (µg/L)	PO4 Ortho-phos-phate (µg/L)	TN Total Nitrogen (µg N/L)	TP Total Phosphorus (µg P/L)	CHL a (µg/L)	ME CFU/100 ml
A65B	12/16/97	1052	4.4	7	31.93	2.85	51.5	11.86	63.03	26.43	292.93	N	N	N
A65B	3/24/98	1105	6.1	2.5	27.98	3.3J	57	44.05	25.31	23.81	238.13	N	N	N
A65B	6/17/98	0915	18.9	8	27.11	4.6	25.5	81.67	35.49	15.05	914.77	N	N	N
A65B	12/28/98	0940	5	7.5	25.2	3.6J	29.5	16.44	18.07	30.43	145.13	N	4.44	N
A65B	3/29/99	0915	6.7	6	28.59	10.35	22.5	8.19	19.87	34.48	191.74	N	6.12	N
A65B	6/29/99	0935	20.5	N	32.53	6.9	12.5	43.44	28.38	8.9	201.56	N	2.94	N
A65B	12/15/99	1015	9.4	4.5	32.03	2.3J	30.5	4.5K	48.85	29.34	191.06	53.77	2.94	N
A65B	3/13/00	1202	6.7	N	30.15	10.65	17	4.5K	28.04	6.81	85.1	N	0.84	3K
A65B	12/18/01	0900	7	7	34.44	4.35J	19.2	40.35	9.48	47.68	429.1	47.87	0.42K	3K
A65B	5/22/02	1140	13.9	11	33.16	9.35	29.5	30.84	7.61	11.31	225.69	19.26	0.84	3K

Data Coding: J = Estimated Value, K = Less Than, N = Data not available

INTERPETATION AND DISCUSSION OF DATA

BACTERIOLOGICAL

The results of the data collected from sampling in this shellfish growing area indicated that all waters met the criteria for classification as *Approved* – Remote Status. There was little variability in the data and no ongoing significance in fluctuations between data reported for different seasons, tidal conditions, and rainfall events.

One tidal component was noted for station A72A2. Also, rainfall correlations for the day prior and two days prior to sampling were reported for station A69A2 in the section on Rainfall Effects.

Isolated data results (three dates – three samples) which were higher for fecal coliform did appear in the raw data

listings as mentioned previously. However, there were no specific patterns relating to elevated results with the following exceptions: these occurrences all took place in the month of June, although in different years. Further, the instance of higher coliform counts on 6/5/03 (43 MPN/100 mL) was summarized as being correlated with the rainfall received on the day prior and two days prior to sampling for station A69A2.

Components for season and tide or rainfall correlations are rarely noted for this growing area. As such, they are not significant in determining the classification of these waters, as all stations in this area met established criteria for *Approved* waters on summary evaluation.

CONCLUSIONS

BACTERIOLOGICAL EVALUATION

The following was concluded based on the water quality data from November 19, 1996 through June 6, 2003. The *Approved* shellfish growing waters within this 16-mile stretch, known as A0Remote, continue to meet NSSP criteria for classification.

Seasonal and tidal influences are generally absent. Remote Status had been previously designated for these waters due to the lack of direct and indirect pollutant sources, and exceptional water quality.

The effluents from outfalls of the Atlantic County Utilities Authority – Wastewater Treatment Facility Discharge Pipe (South of A0Remote) and the Ocean County Utilities Authority – Southern Water Pollution Control Facility Discharge Pipe (North of A0Remote) are not impacting the shellfish growing waters of this area with significant coliform levels.

There were no indications that indirect discharges caused significant impact to the *Approved* waters of this site. This area's limited stormwater discharge (to the ocean) is generally negligible, as an increase of fecal coliform levels at sample locations after precipitation is rarely seen. Therefore, detrimental effects from rainfall runoff are not a problem for the water quality of this growing area, although rainfall correlations were present. Stormwater discharge into back bay waters is reduced in nearby towns and fairly diluted when reaching the ocean waters of A0Remote.

Further, the significant avian populations, which utilize the area comprised by the Edwin B. Forsythe National Wildlife Refuge, do not provide substantial impact in relation to coliform bacteria counts within this growing area. Again, as in the case of indirect sources associated with A0Remote, substantial dilution occurs to coliform input by birds before reaching the waters that the BMWM monitors for this shellfish growing area.

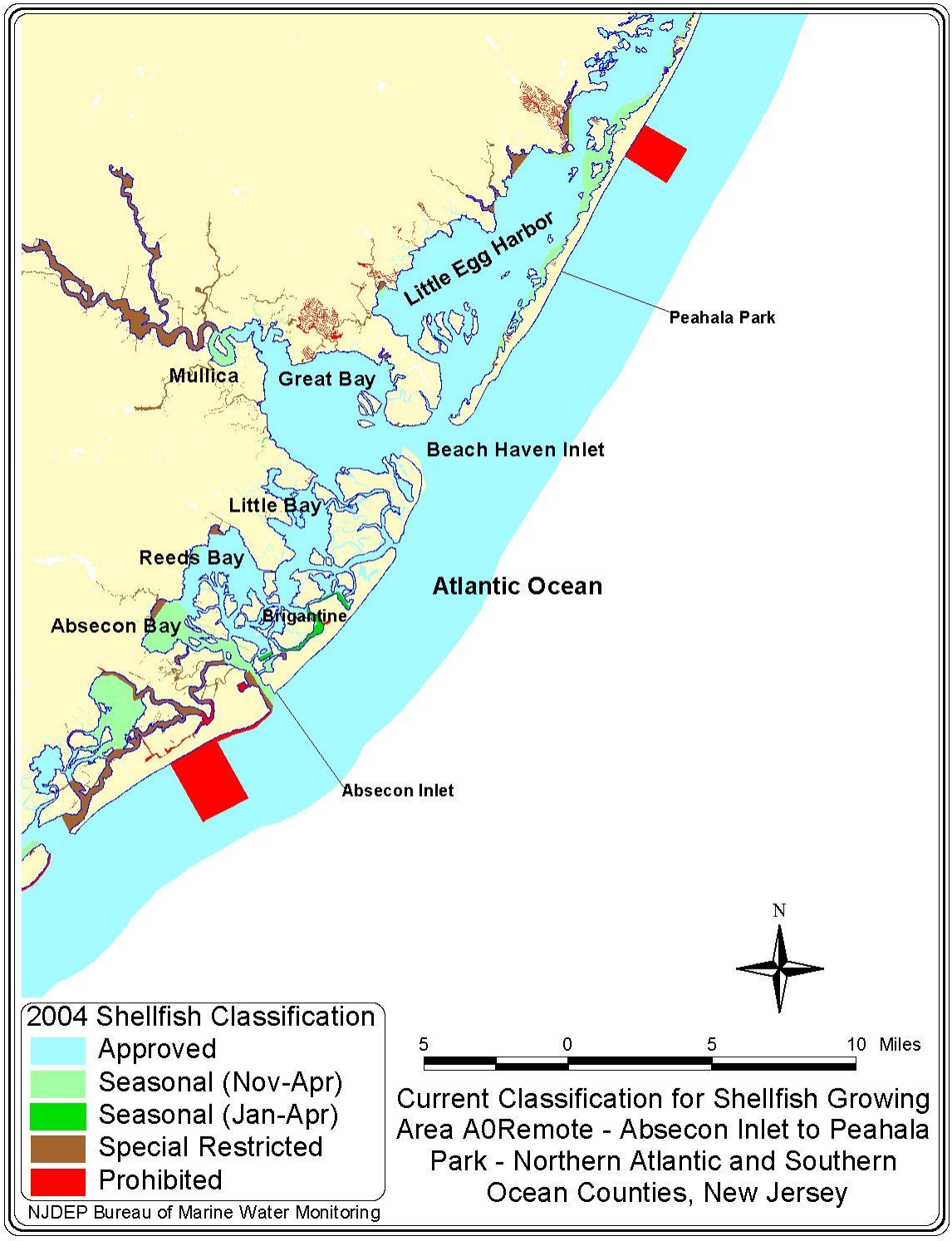


FIGURE 26: CURRENT CLASSIFICATION FOR SHELLFISH GROWING AREA A0REMOTE – ABSECON INLET TO PEAHALA PARK – NORTHERN ATLANTIC AND SOUTHERN OCEAN COUNTIES, NEW JERSEY

RECOMMENDATIONS

Shellfish growing area A0Remote is comprised of Assignment 471. It is sampled under the Adverse Pollution Condition strategy.

No changes are recommended in the monitoring performed for this growing area. The area's *Approved* shellfish growing water classification should remain in effect and the growing area's Remote Status designation should be retained.

As previously mentioned, a Remote area by NSSP definition allows for a water sampling frequency reduction, while reducing concern for any public health consequences due to the proven quality of the samples analyzed over time. Remote Status refers to a growing area that is not impacted by any actual or potential pollution sources and meets the *Approved* classification criteria. This reduces the minimum sampling frequency from five times per year to two times per year. Further, the most recent 15 samples should be analyzed in order to quantify an area as having Remote Status.

The above factors, in combination with the confirmation of acceptable water quality, support the *Approved* shellfish growing water classification (see Figure 26) currently in effect, qualifying this section of the coastline as a Remote area. With A0Remote, acceptable water quality prevails. As such, there are no changes recommended for classification in this area.

LITERATURE CITED

APHA. 1970. Recommended Procedures for the Examination of Seawater and Shellfish, 4th ed., American Public Health Association, Washington, DC.

APHA. 1998. Standard Methods for the Examination of Water and Wastewater, 20th ed., American Public Health Association, Washington, DC.

Celestino, Michael. 2004. New Jersey Department of Environmental Protection, Bureau of Shellfisheries, Nacote Creek, NJ. (Personal Communication).

Census 2000. 2001. U.S. Census Bureau, Redistricting Data Summary File, Table PL1, and 1990 Census. New Jersey State Data Center, New Jersey Department of Labor, Trenton, NJ.

Connell, R.C. 1991. Evaluation of Adverse Pollution Conditions in New Jersey's Coastal Waters. New Jersey Department of Environmental Protection, Marine Water Classification and Analysis, Leeds Point, NJ.

Curtis, Mike. 2002. Sanitary Survey Monmouth Beach to Sandy Hook. New Jersey Department of Environmental Protection, Bureau of Marine Water Monitoring, Leeds Point, NJ.

Curtis, Mike. 2001. Sanitary Survey Peahala Park to Mantoloking. New Jersey Department of Environmental Protection, Bureau of Marine Water Monitoring, Leeds Point, NJ.

Curtis, Mike. 2001. Reappraisal Brigantine to Spray Beach. New Jersey Department of Environmental Protection, Bureau of Marine Water Monitoring, Leeds Point, NJ.

Gastrich, Mary Downs. 2000. Harmful Algal Blooms in Coastal Waters of New Jersey. New Jersey Department of Environmental Protection, Division of Science, Research and Technology, Trenton, NJ.

Gianforte, Michael. 2002. Two Rivers Water Reclamation Authority, Monmouth Beach, NJ. (Personal Communication).

NJDEP. 1992. Field Sampling Procedures Manual. New Jersey Department of Environmental Protection, Trenton, NJ.

NJDEP. 2004. State of New Jersey Shellfish Growing Water Classification Charts. New Jersey Department of Environmental Protection, Marine Water Monitoring, Leeds Point, NJ.

NJDEP. 2003. Annual Summary of Phytoplankton Blooms and Related Conditions in New Jersey Coastal Waters. (Summer 2002). New Jersey Department of Environmental Protection, Freshwater and Biological Monitoring, Trenton, NJ.

Normant, Jeff. 2004. New Jersey Department of Environmental Protection, Bureau of Shellfisheries, Nacote Creek, NJ (Personal Communication).

Seaman, Gregory. 2002. Two Rivers Water Reclamation Authority, Monmouth Beach, NJ. (Personal Communication).

Suoninen, William 1994. Reevaluation Shellfish Growing Area 46 – 47 Brigantine to Spray Beach (A05/A0Remote) NJDEP, Bureau of Marine Water Monitoring, Leeds Point, NJ.

Suoninen, William. 1998. Sanitary Survey Shellfish Growing Area 46 – 47 Brigantine to Spray Beach (A05/A0Remote) NJDEP, Bureau of Marine Water Monitoring, Leeds Point, NJ.

USFWS. 2000. Edwin B. Forsythe National Wildlife Refuge, US Fish and Wildlife Service, Oceanville, NJ

USFWS, 1998. Public Use Regulations for Holgate Unit Edwin B. Forsythe National Wildlife Refuge, US Fish and Wildlife Service, Oceanville, NJ

USPHS. National Shellfish Sanitation Program *Guide for the Control of Molluscan Shellfish*, 2003. US Public Health Service, Food and Drug Administration, Washington, DC.

ACKNOWLEDGMENTS

This report was written under the direction of Leslie J. McGeorge, Administrator and Robert Connell, Jr., Bureau Chief. Mike Kusmiesz assisted in the collection and storage of statistical and GIS data used in analysis. Special acknowledgment is given to Captain Schoen for perseverance in collecting water quality samples (for A0Remote - an Atlantic Ocean shellfish growing area) during the time frame discussed in this report. This study would not have been completed without the aid of Bob Schuster (Special Projects and Field Operations Supervisor) and the analytical capabilities of our microbiology laboratory staff including Eric Feerst (Section Chief), Bruce Hovendon (Supervisor), Lisa DiElmo, Elena Heller, and Bob Seabrook along with our chemistry laboratory staff including Eric Ernst, Bill Heddendorf, and Dawn Thompson with supervision by Eric Feerst.

Special recognition is also given to Mr. Ernie Purdy, Superintendent, City of Brigantine Public Works Department for providing information (see Stormwater Inputs) that assisted in the completion of this shellfish growing water report.

APPENDIX

Detailed Data Listing(s) from 11/19/96 to 6/5/03 for data set parameter from 10/01/96 to 9/30/03