New Jersey Department of Environmental Protection
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Water Monitoring and Standards

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REAPPRAISAL OF

SHELLFISH GROWING AREA SE-5:

LUDLAM BAY TO TOWNSENDS INLET

1999 - 2003

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New Jersey Department of Environmental Protection
BRADLEY M.CAMPBELL
COMMISSIONER

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EXECUTIVE SUMMARY

The water quality data presented in this Reappraisal of Shellfish Growing Area SE-5; Ludlam Bay to Townsends Inlet, were collected between October 1999 and September 2003 using the Systematic Random Sampling (SRS) strategy for the sampling stations from Ludlam Bay to Townsends Inlet and the Adverse Pollution Condition (APC) strategy for the sampling stations from Townsends Inlet to Great Sound. The water quality of this shellfish growing area was good, and the current shellfish classification of this shellfish growing area (*Approved*, *Seasonally Approved (November-April), Seasonally Approved (January to April*), *Special Restricted*, and *Prohibited)* meets the water quality standards as specified by the National Shellfish Sanitation Program (NSSP) concerning water quality and shellfish growing water classification criteria (USPHS, 1999 Revision).

INTRODUCTION

PURPOSE

This 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) that are established by the Interstate Shellfish Sanitation Conference (ISSC). Reports generated under this program form the basis for classifying shellfish waters for the purpose of harvesting shellfish for human consumption. As such, they provide a critical link in protecting human health.

The second purpose is to provide input to the Integrated Water Monitoring and Assessment Report, and this information is used for the Section 305(b) portion of the Federal Clean Water Act (P.L. 95-217). The information contained in the growing area reports is used for the New Jersey State Water Quality Inventory Report (305b) 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. These growing area reports provide valuable information for the 305(b) 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, these growing area reports utilize relevant information contained in the 305(b) report, since the latter assessments are based on in-stream 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 a 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.

HISTORY OF NSSP

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 the group 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. Prevention of 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 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.

The division of authority between the three agencies can be seen in Figure 1.

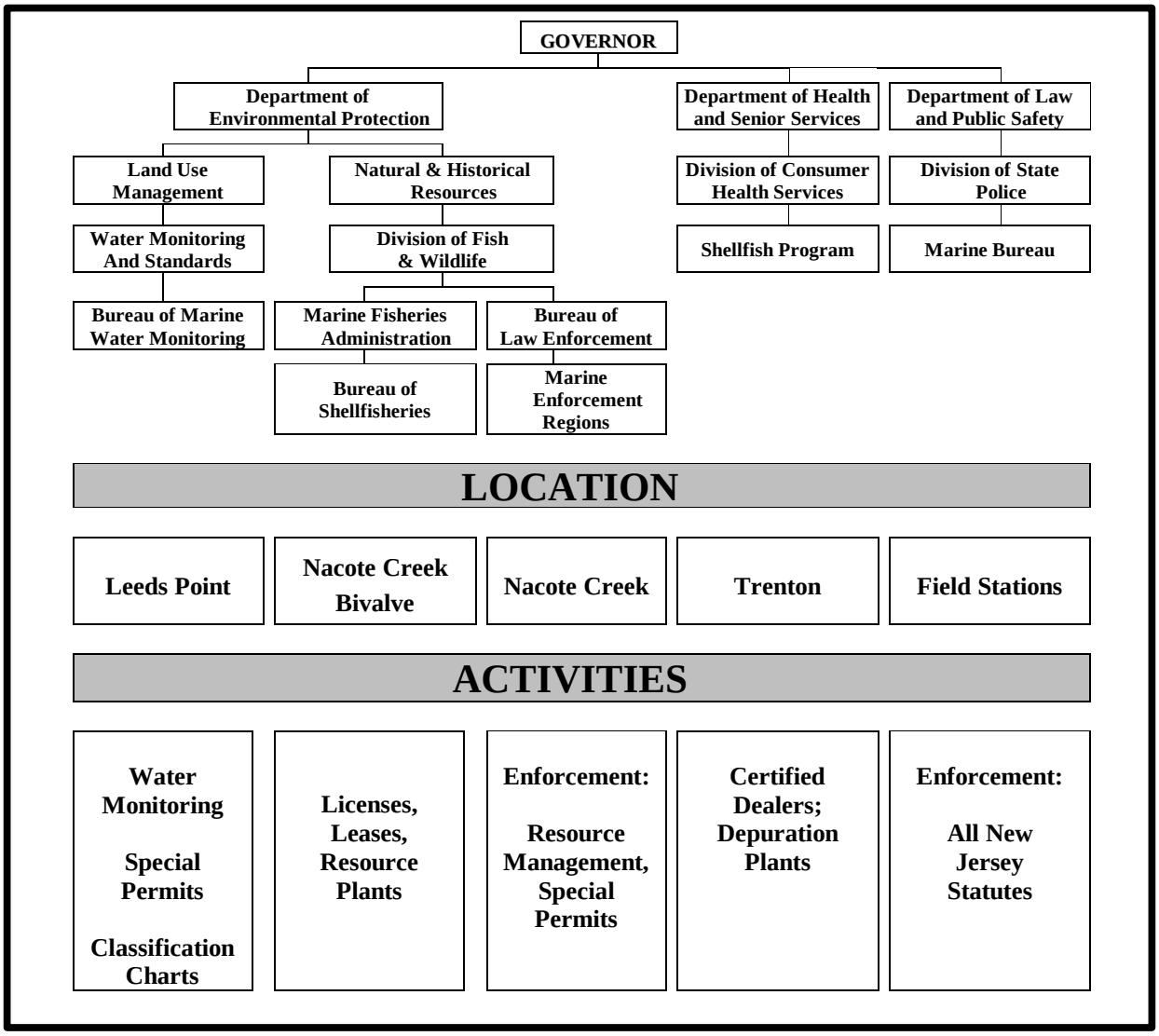

FIGURE 1: STATE OF NEW JERSEY SHELLFISH AGENCIES

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 storm water runoff from urban and agricultural areas and from direct discharges such as wastewater treatment facilities.

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 hydrography of the area and
3. An assessment of water quality. Complete intensive Sanitary Surveys are conducted every 12 years with interim narrative evaluations (Reappraisals) completed on a three-year basis. If major changes to the shoreline or bacterial quality occur, then the intensive report (Sanitary Survey) is initiated prior to its l2 year schedule. Also, if only a section of a growing area is either upgraded or downgraded from its current shellfish classification, a partial intensive report (Partial Sanitary Survey) is conducted for that shellfish growing area. Annual Reviews are written on a yearly basis for each shellfish growing area.

The following narrative constitutes this bureau's assessment of the above mentioned components and determines the current classification of the shellfish growing waters of Shellfish Growing Area SE-5, Ludlam Bay to Townsends Inlet.

GROWING AREA PROFILE

LOCATION

Shellfish Growing Area SE-5; Ludlam Bay to Townsends Inlet, is located in the southern part of New Jersey, northwest of the city of Avalon and southwest of Strathmere, in Cape May County (see Figure 2). This area includes the shellfish growing waters from Ludlam Bay in the north, to the north of Great Sound in the south. Great Sound is not included in this shellfish growing area. These estuarine and back-bay waters are bordered on the east by Sea Isle City and Avalon, and to the west by Dennis Township and Middle Township. Townsends Inlet, Townsend Sound, and Stites Sound are also located in this shellfish growing area. The locations of the adjacent municipalities are shown in Figure 2, and the population statistics for the adjacent municipalities are shown in Table 1 (NJ Department of Labor, 2001).

FIGURE 2: LOCATION AND MUNICIPALITIES OF SHELLFISH GROWING AREA SE - 5: LUDLAM BAY TO TOWNSENDS INLET.

TABLE 1: POPULATION STATISTICS FOR MUNICIPALITIES ADJACENT TO SHELLFISH GROWING AREA SE-5: LUDLAM BAY TO TOWNSENDS INLET BAY (NJ DEPARTMENT OF LABOR, 2001)**.**

Community	Area (sq. mi.)	Population (2000 Census)	Population Density (Persons/ sq.mi.)
Dennis Township	64.21 sq.mi.	6,492	101
Sea Isle City	2.59 sq.mi.	2,835	1095
Middle Township	82.81 sq.mi.	16,405	198
Avalon	4.90 sq.mi.	2,143	437

DESCRIPTION

The area from Ludlam Bay to Townsends Inlet and the waters that drain into Townsends Inlet, are located in Cape May County, New Jersey. The principal bodies of water in this area are Ludlam Bay, Townsends Sound, Stites Sound, and Townsends Inlet (see Figures 3 and 5). This area also includes Devauls Creek, Maple Swamp, Big Elder Creek, Little Elder Creek, Swimming Creek, Ludlam Thorofare, Sunks Creek, Mill Creek, Scraggy Creek, Ware Thorofare, Mill Thorofare, Townsend Channel, Clem Thorofare, Granny Creek, Mud Thorofare, Jonadab Creek, Uncle Aarons Creek, Kitts Thorofare, Bottle Creek, Middle Thorofare, North Channel, South Channel, Leonard Thorofare, Ingram Thorofare, Gravens Thorofare, Cornell Harbor, Pennsylvania Harbor, Princeton Harbor, S Creek, Deep Creek, Rachael Gut, Salt Creek, Cat Run, Deep Thorofare, and Paddy Thorofare. (see Figures 4 and 6 for photographs of Townsend Channel and Ludlam Thorofare) (USDI-GS, Photoinspected 1977-Sea Isle City, NJ, USDI-GS, Photoinspected 1977-Avalon, NJ, USDI-GS, Photorevised 1972-Woodbine, NJ, USDI-GS, Photorevised 1972-Stone Harbor, NJ). The approximate size of this shellfish growing area is 3,574.265 acres, and the shellfish classification for this growing area is *Approved, Seasonally Approved (November-April), Seasonally Approved (January-April), Special Restricted,* and *Prohibited* for shellfish harvesting. There are approximately 2,851.386 acres of *Approved* waters, 2.85 acres of *Seasonally Approved (November-April)* waters, 38.635 acres of *Seasonally Approved (January-April)* waters, 326.574 acres of *Special Restricted* waters, and 354.82 acres of *Prohibited* waters in this shellfish growing area. The *Approved* waters are located in Ludlam Bay (excluding the Special Restricted part in the south of Ludlam Bay), Main Channel, Townsend Sound, Mill Creek, Ware Thorofare, Mill Thorofare, Clem Thorofare, Townsend Channel, the south part of Ludlam Thorofare, Stites Sound, Kitts Thorofare, Middle Thorofare, North Channel, South Channel, Townsends Inlet, Deep Creek, Deep Thorofare, Leonard Thorofare, and the south part of Paddy Thorofare. The *Seasonally Approved (November-April)* waters are located in an unnamed creek on Gull Island which is west of Ludlam Thorofare and in Scraggy Creek which is

east of the central part of Ludlam Thorofare and west of Sea Isle City. The *Seasonally Approved (January-April)* waters are located in the south part of Townsend Channel, which is north of Townsends Inlet. The *Special Restricted* waters are located in the south part of Ludlam Bay, in Big Elder Creek, the east side of Townsend Channel which is north of Townsends Inlet, and the north and central parts of Ingram Thorofare. The *Prohibited* waters include the rest of the waters in this shellfish growing area. Tidal flushing of this area mainly occurs through Townsends Inlet (see Figure 3).

This shellfish growing area can be found on Chart 8 and Chart 9 of the "2003 State of New Jersey – Shellfish Growing Water Classification Charts". (NJDEP, 2003). Figure 7 shows the current classification of this shellfish growing area.

FIGURE 3: LOCATION OF TOWNSENDS INLET. PHOTOGRAPH WAS TAKEN FROM AVALON LOOKING NORTH TO SEA ISLE CITY ON MARCH 11, 2004 AT 9:01 A.M.

FIGURE 4: LOCATION OF TOWNSEND CHANNEL, NORTH OF AVALON BOULEVARD. THE JOHN F. KENNEDY BOULEVARD BRIDGE AT SEA ISLE CITY CAN BE SEEN IN THE DISTANCE. PHOTOGRAPH WAS TAKEN ON MARCH 11, 2004 AT 8:38 A.M.

FIGURE 5: LOCATION OF STITES SOUND, NORTH OF AVALON BOULEVARD. PHOTOGRAPH WAS TAKEN ON MARCH 11, 2004 AT 8:27 A.M.

FIGURE 6: LOCATION OF LUDLAM THOROFARE IN SEA ISLE CITY. THE JOHN F. KENNEDY BOULEVARD BRIDGE EXTENDS OVER LUDLAM THOROFARE FROM DENNIS TOWNSHIP TO SEA ISLE CITY. PHOTOGRAPH WAS TAKEN ON MARCH 11, 2004 AT 9:45 A.M.

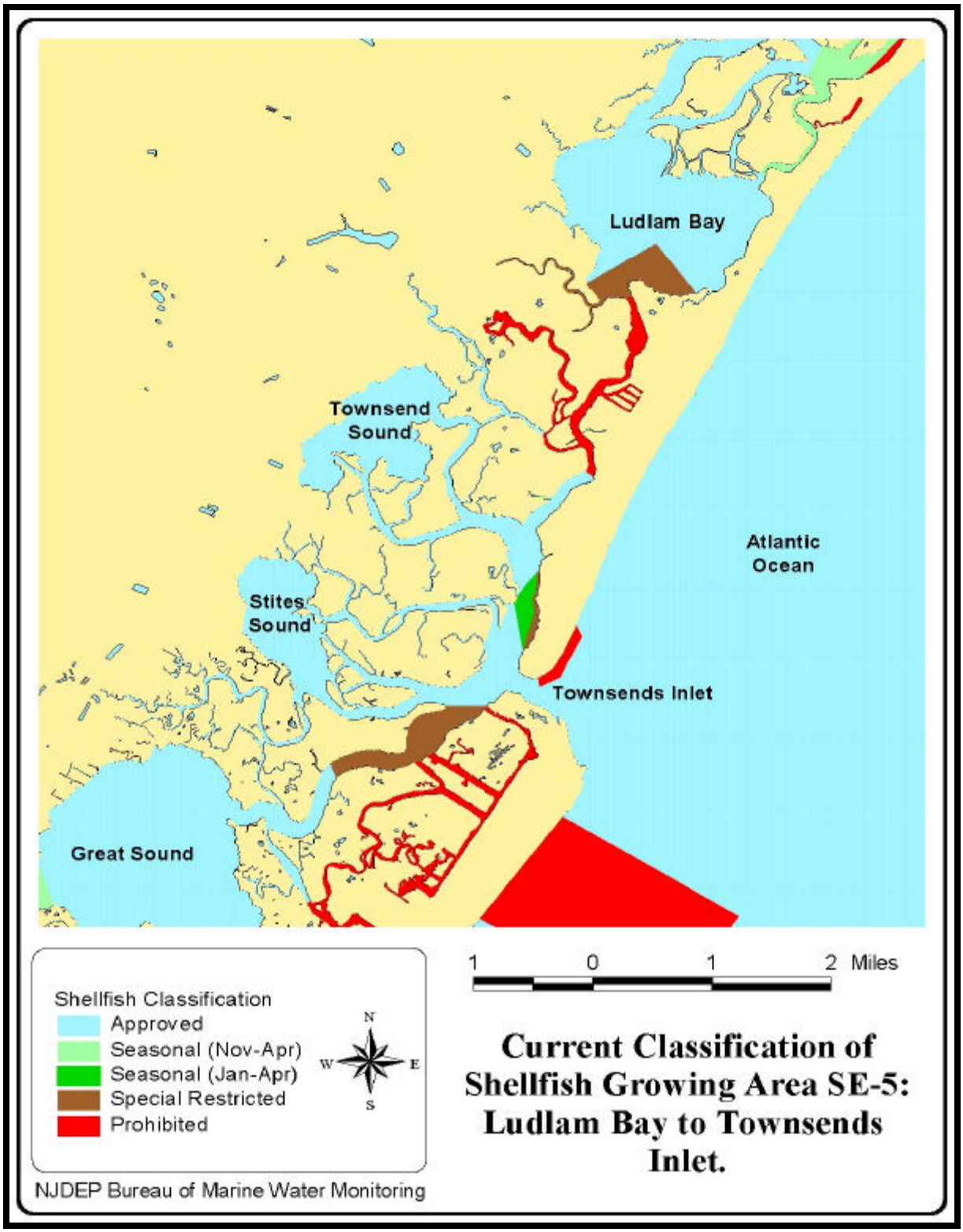

FIGURE 7: CURRENT CLASSIFICATION OF SHELLFISH GROWING AREA SE-5: LUDLAM BAY TO TOWNSENDS INLET.

HISTORY OF GROWING AREA CLASSIFICATION

In 1999, New Jersey harvested 76,789,849 pounds of shellfish meat, with an exvessel value of $61,136,981. For New Jersey, the 2000 shellfish landings total were 84,723,999 pounds of shellfish meat for an exvessel value of $75,087,167, the 2001 shellfish landings total were 88,611,198 pounds of shellfish meat for an exvessel value of $83,523,782, and the 2002 shellfish landings total were 90,768,652 pounds of shellfish meat for an exvessel value of $88,136,826. These shellfish species include blue crabs (*Callinectes sapidus*), blue crabs – peelers, hard clams (*Mercenaria mercenaria*), soft clams (*Mya arenaria*), mussels (Family: Mytilidae), bay scallops (*Aequipecten irradians*), oysters (*Crassostrea virginica*), ocean quahogs (*Arctica islandica*), surf clams (*Spisula solidissima*), and sea scallops (*Placopecten magellanicus*) (NJDEP, 2003, Morris, 1975, Gosner, 1978). However, this report primarily focuses on bivalve molluscan shellfish, not crustaceans.

The waters of this shellfish growing area are primarily classified as *Approved, Seasonally Approved (November-April), Seasonally Approved (January-April), Special Restricted* and *Prohibited.* The *Approved* waters are located in Ludlam Bay (excluding the Special Restricted part in the south of Ludlam Bay), Main Channel, Townsend Sound, Mill Creek, Ware Thorofare, Mill Thorofare, Clem Thorofare, Townsend Channel, the south part of Ludlam Thorofare, Stites Sound, Kitts Thorofare, Middle Thorofare, North Channel, South Channel, Townsends Inlet, Deep Creek, Deep Thorofare, Leonard Thorofare, and the south part of Paddy Thorofare. The *Seasonally Approved (November-April)* waters are located in an unnamed creek on Gull Island which is west of Ludlam Thorofare and in Scraggy Creek which is east of the central part of Ludlam Thorofare and west of Sea Isle City. The *Seasonally Approved (January-April)* waters are located in the south part of Townsend Channel, which is north of Townsends Inlet. The *Special Restricted* waters are located in the south part of Ludlam Bay, in Big Elder Creek, the east side of Townsend Channel which is north of Townsends Inlet, and the north and central parts of Ingram Thorofare. The *Prohibited* waters include the rest of the waters in this shellfish growing area. (see Figure 7). This shellfish growing area is classified as *Approved, Seasonally Approved (November-April), Seasonally Approved (January-April), Special Restricted,* and *Prohibited* because the shellfish waters within this area meet the *Approved, Seasonally Approved (November-April), Seasonally Approved (January-April), Special Restricted,* and *Prohibited* shellfish classification. There are also many marinas and storm water outfalls that also require buffer zones, which determine the shellfish classification of this area.

In the 2003 Annual Review of Shellfish Growing Area SE-5 for the Ludlam Bay to Townsends Inlet area, no classification change was proposed for

this shellfish growing area (NJDEP, 2003). No sampling stations in this shellfish growing area exceeded the existing shellfish classification criteria, and the data supported the existing shellfish classification for this area. The last Sanitary Survey for Shellfish Growing Area SE-5 (Ludlam Bay to Townsends Inlet) was written in 1996.

METHODS

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

Approximately 2,274 water samples were collected for total and fecal coliform bacteria between 1999 and 2003 and analyzed by the three tube MPN (Most Probable Number) method (the indicator density of bacteria colonies most likely to produce a particular combination of positive and negative results in test tubes) (American Public Health Association, 1970). Figures 28 and 29 show the Shellfish Growing Water Quality monitoring stations in the Ludlam Bay to Townsends Inlet area. Approximately 73 stations are monitored during each year in Shellfish Growing Area SE-5. Water quality sampling, shoreline and watershed surveys were conducted in accordance with the NSSP *Guide for the Control of Molluscan Shellfish,* 1999 Revision (USPHS, 1999 Revision).

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®).

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 (November to April), Seasonally Approved (January to April), Special Restricted,* or *Prohibited.* Criteria for bacterial acceptability of shellfish growing waters are provided in NSSP *Guide for the Control of Molluscan Shellfish,* 1999 Revision (USPHS, 1999 Revision).

SAMPLING STRATEGY

The State Shellfish Control Authority has the option of choosing one of two water monitoring sampling strategies for each growing area.

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 coliforms in 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. The adverse pollution conditions usually are related to tide and rainfall, but could be from a point source of pollution or variation could occur during a specific time of the year (Connell, 1991).

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.

This shellfish growing area was sampled using the Systematic Random Sampling strategy, year-round with no tidal preferences, for the stations from Ludlam Bay to Townsend Sound (Assignment 247). The stations from Townsends Inlet to Great Sound were sampled using the Adverse Pollution Condition strategy, year-round with no tidal preferences (Assignment 287).

NSSP CRITERIA

Each shellfish-producing state is directed to adopt either the total coliform criterion, or the fecal coliform criterion. While New Jersey bases its growing water classifications on the total coliform criterion, it does make corresponding fecal coliform determinations for each sampling station. These data are viewed as adjunct information and are not directly used for classification.

The criteria were developed to ensure that shellfish harvested from the designated waters would be free of pathogenic (disease-producing) bacteria. 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 (see Table 2). For the Systematic Random Sampling strategy, variability is expressed as the 90^{th} percentile (see Table 3).

Areas to be Approved under the Seasonal classification must be sampled and meet the criterion during the time of the year that it is approved for the harvest of shellfish.

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 algae that produce biotoxins (see Figure 8 for location of Phytoplankton sampling stations). Certain planktonic species have the potential to adversely affect the suitability of shellfish for human consumption. These planktonic species cause algal blooms that deplete the dissolved oxygen levels in the water. Algal blooms were reported each year for the period 1993 – 1997. The areas most severely impacted include the Raritan / Sandy Hook Bay, the Barnegat Bay, and sporadic offshore areas (NJDEP, 2001, Zimmer, 2000, Zimmer, 2001). No algal blooms capable of producing biotoxins were identified for this area during 1998, 1999, 2000, or 2001 (NJDEP, 2001). These 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.

FIGURE 8: LOCATION OF PHYTOPLANKTON SAMPLING STATIONS.

SHORELINE SURVEY

CHANGES SINCE LAST SURVEY

The shoreline survey that was performed by the author for this area on March 11, 2004 determined that there have not been any changes since the last reappraisal of this area.

There were 13 photographs taken during the shoreline survey of this shellfish growing area on March 11, 2004. Figures 3, 4, 5, and 6 show the locations of Townsends Inlet, Townsend Channel, Stites Sound, and Ludlam Thorofare, Figure 9 shows the location of the houses and private docks on Princeton Harbor, west of Sea Isle City, Figure 17 shows the storm water drainage ditch located at the end of 36th Street and Veterans Street in West Sea Isle City, and Figures 20, 21, 22, 23, 24, 25, and 26 show some of the marinas located in this shellfish growing area.

LAND USE

An extensively urbanized area to the east and north and tidal wetlands to the south and west border much of this area. The urban areas to the east are resort areas (Sea Isle City, Avalon, and Strathmere) with significant boating and marine activities during the summer months (see Figures 9 and 10). There are currently 24 marinas in this area. The wetlands to the west of the growing area act as a buffer for the communities on the western side of the bay. Devauls Creek, Mill Creek, and Deep Creek cross the Garden State Parkway into these communities, and are upstream of this shellfish growing area. Since some of these communities are still on septic systems, there is a potential for pollutant inputs into these shellfish growing waters, which is why continued monitoring of the water quality in these waters is so very important (APHA, 1995).

The area immediately west of the Garden State Parkway is part of the Pinelands Comprehensive Management Plan, and is listed as a Regional Growth Area (northwest of Townsend Sound), and a Rural Development Area (west of Stites Sound). According to the New Jersey Pinelands Commission, a Regional Growth Area is “an area that can accommodate existing and future growth while protecting the essential character and environment of the pinelands”. The Pinelands Comprehensive Management Plan permits from 1.5 to 5.25 dwelling units per developable acre of land in a Regional Growth Area. The New Jersey Pinelands Commission describes a Rural

Development Area as " an area that can attempt to protect characteristic Pinelands features, while allowing modest development to proceed, giving municipalities leeway to determine land uses". The Pinelands Comprehensive Management Plan permits one dwelling unit per 3.2 acres of private, undeveloped upland for a Rural Development Area.

FIGURE 9: LOCATION OF HOUSES AND PRIVATE DOCKS ON PRINCETON HARBOR AT THE END OF 23RD STREET IN AVALON. PHOTOGRAPH WAS TAKEN ON MARCH 11, 2004 AT 8:52 A.M.

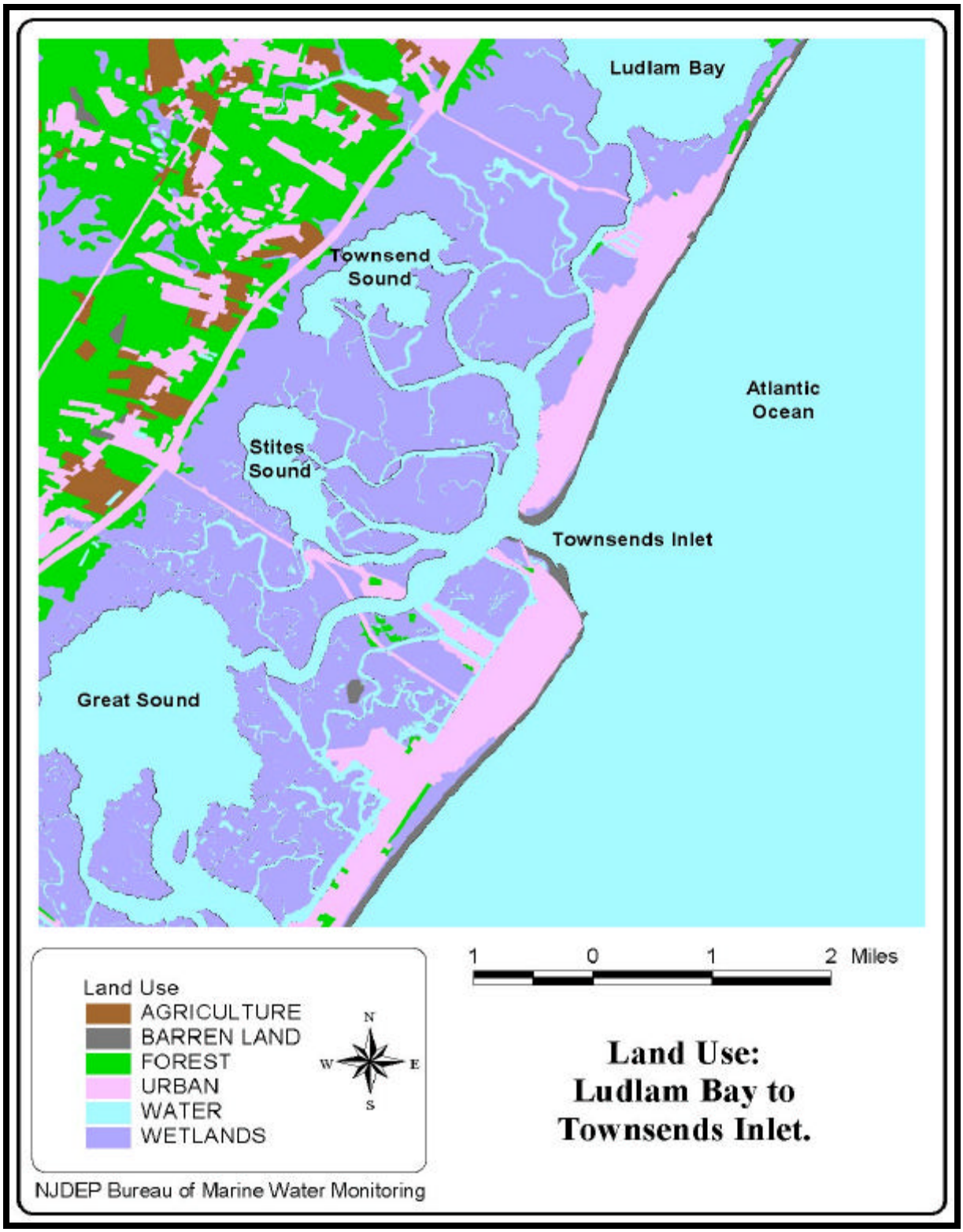

FIGURE 10: LAND USE PATTERNS FOR SHELLFISH GROWING AREA SE-5: LUDLAM BAY TO TOWNSENDS INLET.

EVALUATION OF BIOLOGICAL RESOURCES

This growing area has a wide diversity of biological resources. Hard clams (*Mercenaria Mercenaria*) exist in high densities and are privately and commercially harvested (Morris, 1975, Gosner, 1978). In New Jersey for 2002, the shellfish landings for hard clams were 1,542,445 pounds harvested for an exvessel value of $6,402,616 (NMFS, 2004). Blue crabs (*Callinectes sapidus*) are also harvested in this area. Ludlam Bay, Townsend Sound, Stites Sound, and Townsends Inlet are also utilized for fishing, boating, and other marine activities. Many species of finfish can be found in the waters of this shellfish growing area. The important finfish species caught by marine recreational anglers are Bluefish (*Pomatomus saltatrix*); Striped Bass (*Morone saxatillis*); Weakfish (*Cynoscion regalis*), Winter Flounder (*Pseudpleuronectes americanus*), Summer Flounder (Fluke) (*Paralichthys dentatus*), Tautog (*Tautoga onitis*), Scup (Porgy) (*Stenotomus chrysops*), Black Sea Bass (*Centropristus striata*), Northern Searobin (*Prionotus carolinus*), Northern Puffer (*Spheroides maculatus*) Atlantic Silverside (*Menidia menidia*) and Mummichog (killies, minnows) (*Fundulus heteroclitus*) (The Richard Stockton College of New Jersey, 2002). In 1991, the Striped Bass (*Morone saxatillis*) was classified as a gamefish in New Jersey, and this status prevents the commercial harvest or sale of this first coastal saltwater species designated as such in New Jersey (Bochenek, 2000).

Many species of animals and vegetation can be found in the marshes of this shellfish growing area. Wildlife populations (birds and animals) are actual contributors to water quality in Townsend Sound and potential contributors to water quality in Stites Sound and Townsends Inlet. Birds sometimes may accumulate around the groins, jetties, seawalls, and bulkheads on the coast of this shellfish growing area, and fecal matter from these birds could affect the water quality.

This shellfish growing area is almost completely surrounded by a shoreline of marshes, with small areas of bulkheads, erodable shorelines, and beaches composing the remainder of the shoreline. Bulkheads are located along the east and west shorelines of the upper and middle sections of Ludlam Thorofare, along the east shoreline of the lower section of Townsend Channel, along the south shoreline of South Channel, and along the east and west shorelines of Ingram Thorofare. Areas with an erodable shoreline include the northeast shoreline of Ludlam Bay, a small section of the northeast shoreline of Ludlam Thorofare, and along the east and west shorelines of the middle section of Ingram Thorofare. The Townsends Inlet area is almost completely surrounded by beaches. The shore structures and shore types for this area are shown in Figure 11.

This area also includes a wide variety of marsh types and vegetation, including vegetated salt marshes, tidal ponds, tidal waters, tidal mud flats, tidal sand flats, non-tidal ponds, sandy developed beaches, developed areas, and small areas of coastal scrub shrub. These marsh types and vegetation are located

throughout the adjacent shoreline of this shellfish growing area. Townsends Inlet is bordered on the north shore with sandy developed beaches and on the south shore with tidal sand flats. Vegetated salt marshes and tidal waters primarily border Ludlam Bay, Townsends Sound, and Stites Sound. The marsh types and vegetation for this area are shown in Figure 12.

FIGURE 11: SHORE STRUCTURES AND SHORE TYPE IN SHELLFISH GROWING AREA SE-5: LUDLAM BAY TO TOWNSENDS INLET.

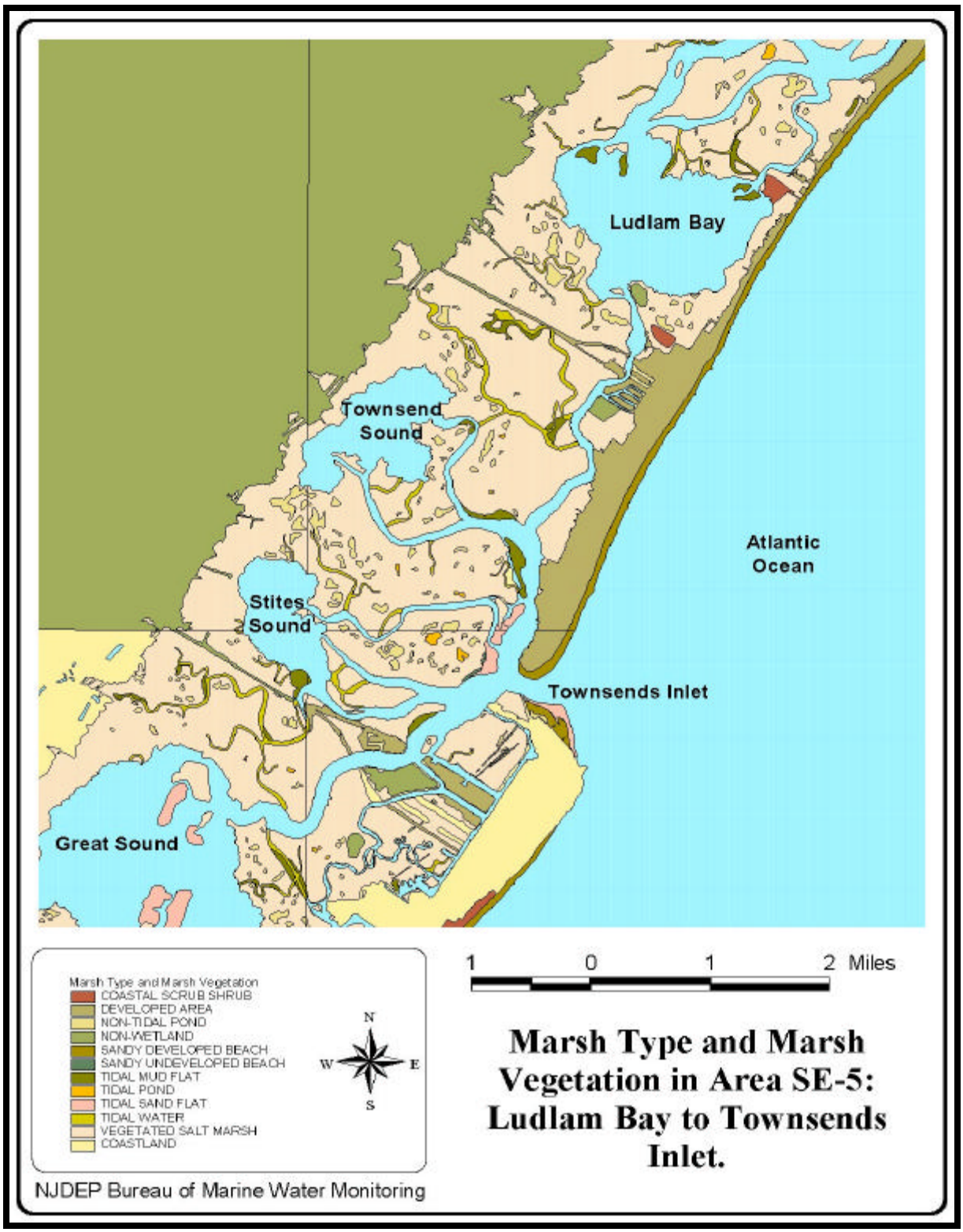

FIGURE 12: MARSH TYPE AND MARSH VEGETATION IN SHELLFISH GROWING AREA SE-5: LUDLAM BAY TO TOWNSENDS INLET.

IDENTIFICATION AND EVALUATION OF POTENTIAL POLLUTION SOURCES

There are several indirect ground water discharges, known contaminated sites, and solid waste landfills located in this shellfish growing area (see Figures 13, 14, and 15). However, there is no evidence that they currently impact the shellfish growing water quality in this area (APHA, 1995). Since there is a potential for pollutant inputs from these indirect sources to get into these shellfish growing waters, it is important to continue monitoring the water quality of these areas to determine the presence or absence of these indirect sources of pollution (APHA, 1995).

INDIRECT DISCHARGES

There are several indirect ground water discharges located in this shellfish growing area (see Figure 13). The sources of the indirect ground water discharges into this shellfish growing area include the Lake & Shore Resort, which is located to the northwest in Dennis Township, and the Lutheran Nursing Home, which is also located to the northwest in Dennis Township. The facilities to the west of this shellfish growing area include the Grace Oil – Swainton Texaco, which is located in Middle Township, and the Sea Pines Resort, which is also located in Middle Township.

This shellfish growing area, which extends from Ludlam Bay to Townsends Inlet, has several known contaminated sites located in the adjacent areas (see Figure 14). The major concentrations of these known contaminated sites are located to the northwest in Dennis Township, and to the east in Sea Isle City. The primary causes of these known contaminated sites are from leaking underground storage tanks. Most of these known contaminated sites are now closed.

There are two solid waste landfills located adjacent to this shellfish growing area (see Figure 15). These landfills are the South Seaville Landfill, which is located in Dennis Township, and the Sea Isle City Landfill, which is located in Sea Isle City. The South Seaville Landfill was closed in 1984 and the Sea Isle City Landfill was closed in 1980. However, there is always the possibility of leachate from these closed landfills indirectly flowing into the waters of this shellfish growing area.

The indirect ground water discharges, the currently active known contaminated sites, and the closed solid waste landfills have the potential to impact the water quality of this shellfish growing area. Therefore, the water quality in the Ludlam Bay to Townsends Inlet area is constantly monitored to determine the presence or absence of these contaminants (APHA, 1995).

FIGURE 13: INDIRECT GROUND WATER POTENTIALLY DISCHARGING TO THE WATERS OF SHELLFISH GROWING AREA SE-5: LUDLAM BAY TO TOWNSENDS INLET.

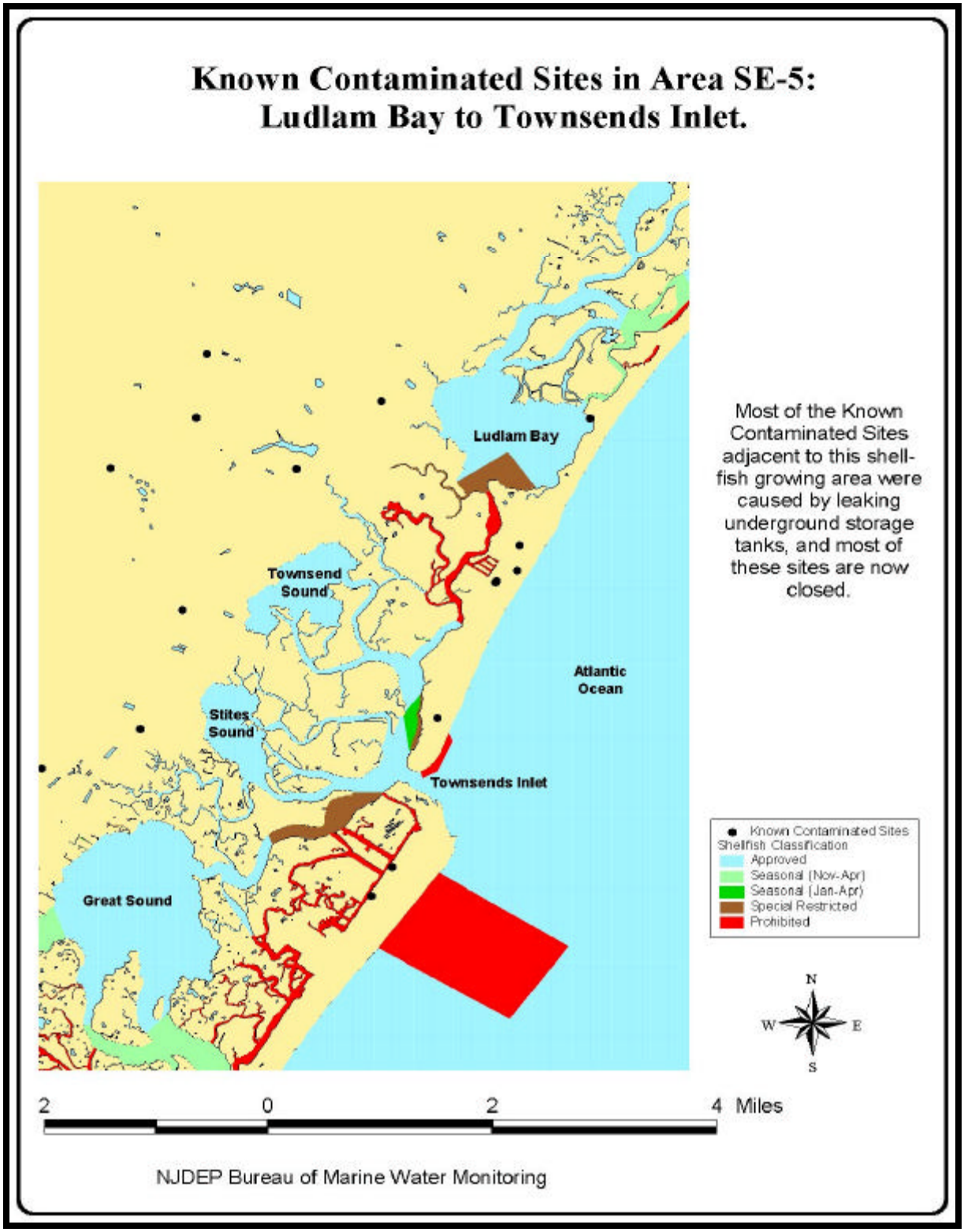

FIGURE 14: LOCATION OF KNOWN CONTAMINATED SITES ADJACENT TO SHELLFISH GROWING AREA SE-5: LUDLAM BAY TO TOWNSENDS INLET.

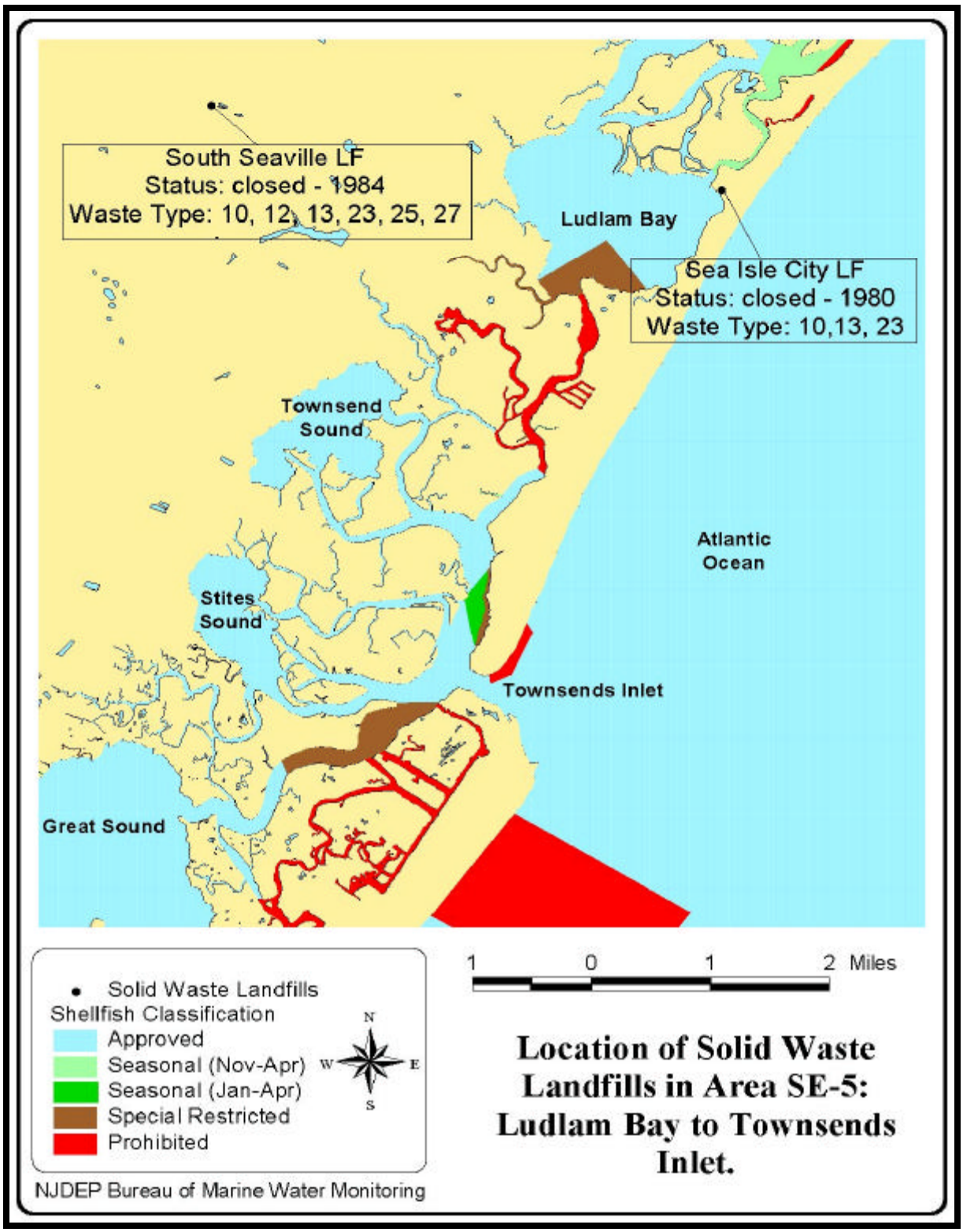

FIGURE 15: LOCATION OF SOLID WASTE LANDFILLS ADJACENT TO SHELLFISH GROWING AREA SE-5: LUDLAM BAY TO TOWNSENDS INLET.

STORM WATER INPUT

The storm water inputs to this shellfish growing area are the result of rainwater which would normally be absorbed into vegetated soils, and used to recharge aquifers, maintain stream base flow, and maintain waterway health, being collected on top of impervious surfaces, such as parking lots, rooftops, and roadways; which is temporarily collected in detention basins; and dumped into streams, creeks, wetlands, lakes, bays, and rivers. This runoff can carry a variety of waste materials, such as domestic and wild animal fecal materials, petroleum and other toxic materials spilled from automobiles, and fertilizer and pesticide materials used on neighboring lots. Floodwaters will rise, stream banks will erode, critical aquatic and terrestrial habitats will be affected, and water quality will sometimes decline (Van Rossum, 2001).

There are many storm water outfalls located along the borders of this shellfish growing area. These storm water outfalls mainly border Ingram Thorofare, Gravens Thorofare, Princeton Harbor, Pennsylvania Harbor, Cornell Harbor, Leonard Thorofare, Townsends Inlet, Townsend Channel, Ludlam Thorofare, and Ludlam Bay (see Figures 16 and 17). There are also some storm water outfalls located to the west of this area in Middle and Dennis Townships near the Garden State Parkway and Route 9 (see Figure 16). However, the storm water outfalls which are located from Great Sound to Townsends Inlet have the potential to impact the water quality of the south part of this shellfish growing area, which is why these waters are sampled using the Adverse Pollution Condition (APC) strategy.

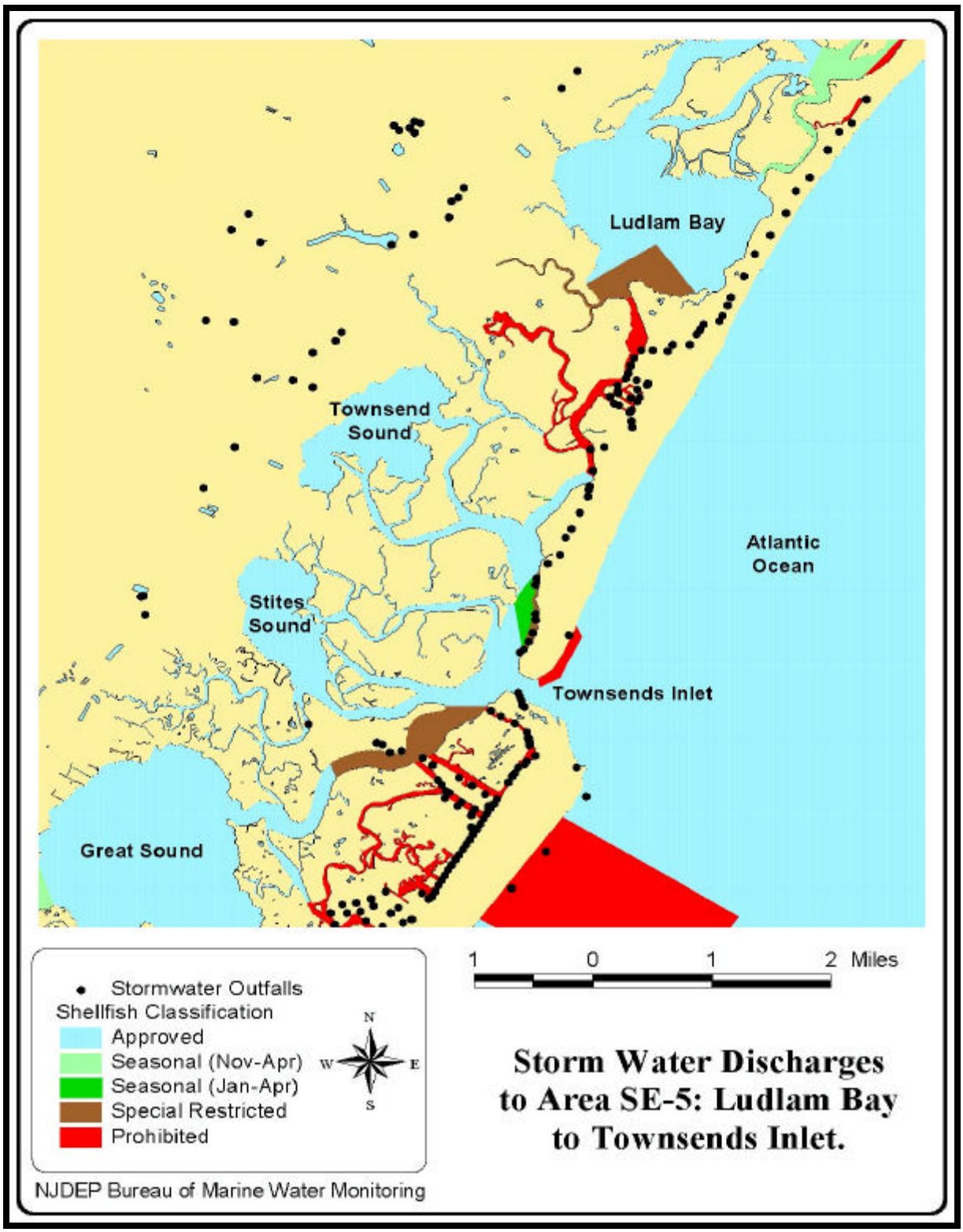

FIGURE 16: STORM WATER DISCHARGES TO SHELLFISH GROWING AREA SE-5: LUDLAM BAY TO TOWNSENDS INLET.

FIGURE 17: STORM WATER DRAINAGE DITCH LOCATED AT THE END OF 36TH STREET AND VETERANS STREET IN WEST SEA ISLE CITY. STORM WATER DRAINAGE DITCH DRAINS NORTH INTO LUDLAM BAY. PHOTOGRAPH WAS TAKEN ON MARCH 11, 2004 AT 9:50 A.M.

MARINAS

Marina facilities have the potential to affect the suitability of shellfish growing areas for the harvest of shellfish. The biological and chemical contamination associated with marina facilities may be of public health significance. New Jersey defines a marina as "any structure (docks, piers, bulkheads, floating docks, etc.) that supports five or more boats, built on or near the water, which is utilized for docking, storing, or otherwise mooring vessels and usually but not necessarily provides services to vessels such as repairing, fueling, security or other related activities." New Jersey designates the confines of the marina as *Prohibited* for the harvest of shellfish. Adjacent waters are classified using a dilution analysis formula.

It is recognized by the NSSP *Guide for the Control of Molluscan Shellfish* (USPHS, 1999 Revision) that there are significant regional differences in all factors that affect marina pollutant loading. The *NSSP Guide for the Control of Molluscan Shellfish*, therefore, allows each state latitude in applying specified occupancy and discharge rates. The NSSP guidelines assume the worst case scenario for each factor.

EQUATION 1: MARINA BUFFER EQUATION. (ADAPTED FROM FDA. 1989):

$$BufferRadius(ft) = \sqrt{\frac{2x10^{9}(FC/person/day)x2(person/boat)x[(.25slips > 24') + (0.065 * slips > 24')]x2}{140000(FC/M^{3})xdepth(ft)x0.3048(M/ft)x*x2(tides/day)}}x3.28(ft/M)$$

Explanation of terms in equation:

Fecal coliform per person per day:	2×10^{9}
Number of people per boat:	2
For slips able to accommodate boats > 24 feet (combination of factors yields multiplier of 0.25):	
Number of slips occupied:	50%
Number of boats occupied:	50%
For boats < 24':	6.5% discharge waste
Angle of shoreline:	180^{o}, which results in factor of 2
Number of tides per day:	2
Depth in meters:	depth in feet x conversion factor
Water quality to be achieved:	140000 FC/meter ^{3}
Convert meters to feet:	3.28

Marina buffer zones may be calculated using the formula above (see Equation 1), or may be determined using a dilution analysis computer program developed by the State of Virginia and the USFDA. The formula above considers only dilution and occupancy rates. The computer program, which is used for complex configurations where the formula is unlikely to provide the needed accuracy, also considers tidal exchange and bacterial die-off.

There are 24 marinas in area SE-5: Ludlam Bay to Townsends Inlet, as shown in Table 4, and Figures 18 and 19. The waters enclosed by the marina (the marina basin) are classified as *Prohibited*. Depending on the size of the marina, the water quality, flushing rates, and the depth of the water, shellfish waters immediately adjacent to each marina may be classified as *Prohibited*, *Special Restricted*, or *Seasonally Approved* (no harvest during summer months when the marina is normally active). Marina buffer zones for this shellfish growing area were calculated using the New Jersey Marina Buffer Equation (see Equation 1). For any marina buffers going into *Approved* shellfish waters, the marina buffer is currently being recalculated using a dilution analysis computer program developed by the State of Virginia and the USFDA, and the marina buffer size will be edited in future reports. The size of each buffer zone (calculated using Equation 1) is shown in Table 4. Figures 20, 21, 22, 23, 24, 25, and 26 (which are photographs taken during the shoreline survey of this area on March 11, 2004) show some of the marinas in this shellfish growing area.

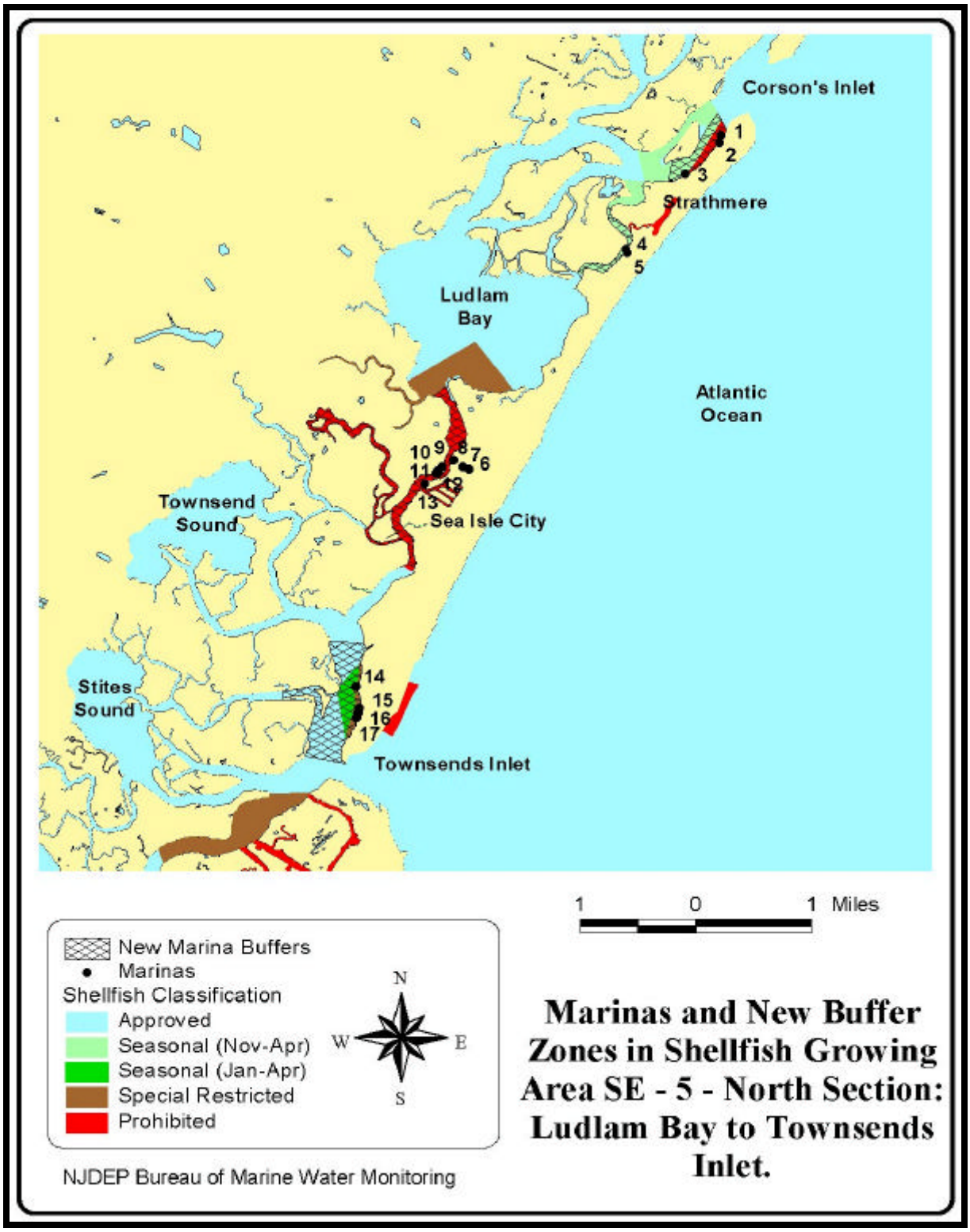

FIGURE 18: MARINA FACILITIES LOCATED IN SHELLFISH GROWING AREA SE-5 – NORTH SECTION: LUDLAM BAY TO TOWNSENDS INLET.

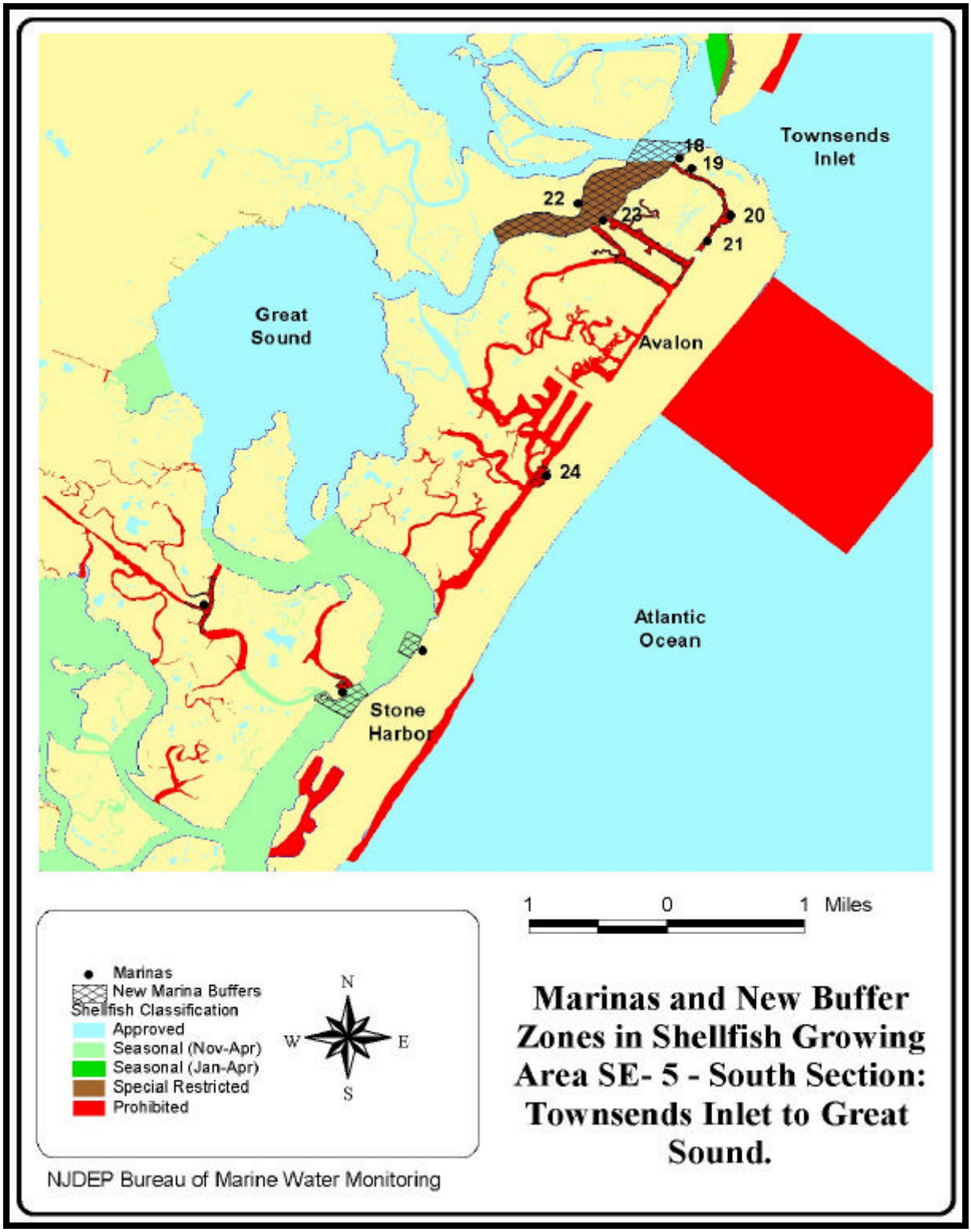

FIGURE 19 : MARINA FACILITIES LOCATED IN SHELLFISH GROWING AREA SE-5 – SOUTH SECTION: TOWNSENDS INLET TO GREAT SOUND.

TABLE 4: MARINA FACILITIES LOCATED IN SHELLFISH GROWING AREA SE-5: LUDLAM BAY TO TOWNSENDS INLET.

Map Key	Marina Name	Location	# of Wet Slips Total/Boats > 24ft.	Size of Buffer Area (radius; feet)	Average Water Depth (ft)
1	Deauville Inn Docks	Upper Township	26/12	457	6
2	Frank's Boat Yard	Upper Township	20/20	517	6
3	Corsons Inlet Marina	Upper Township	25/25	578	6
4	Jersey Cape Boat Salvage	Upper Township	10/10	366	6
5	Whale Creek Marina	Upper Township	62/4	505	6
6	Party Boat Dockage	Sea Isle City	4/4	231	6
7	Capt. Bob's Commercial	Sea Isle City	4/4	231	6
8	Sea Isle City Marina	Sea Isle City	72/33	760	6
9	Minmar Marine Basin	Sea Isle City	115/20	773	6
10	Capt. Robbins Fishing	Sea Isle City	40/40	732	6
11	Larsens Boat Rental	Sea Isle City	56/0	441	6
12	Larsens Marina	Sea Isle City	16/0	236	6
13	Sea Isle City Yacht Club	Sea Isle City	18/18	491	6
14	U.S. Coast Guard Station	Sea Isle City	1/1	116	6
15	Sunset Pier Marina	Sea Isle City	25/6	383	6
16	Yacht Club of Townsends	Sea Isle City	82/82	1283	4
17	Pier 88 Marina	Sea Isle City	75/75	1002	6
18	Avalon Yacht Club	Avalon	25/25	578	6
19	South Jersey Ship	Avalon	15/15	448	6
20	Commodore Bay Club M.	Avalon	110/110	1213	6
21	Avalon Public Marina	Avalon	15/15	448	6
22	Avalon Pointe Marina	Avalon	105/105	1185	6
23	Avalon Anchorage	Avalon	15/15	448	6
24	54th & Bay Park Marina	Stone Harbor	30/30	317	24

FIGURE 20: LOCATION OF AVALON POINTE MARINA ON INGRAM THOROFARE IN MIDDLE TOWNSHIP. PHOTOGRAPH WAS TAKEN ON MARCH 11, 2004 AT 8:39 A.M.

FIGURE 21: LOCATION OF AVALON ANCHORAGE MARINA ON INGRAM THOROFARE IN AVALON. PHOTOGRAPH WAS TAKEN ON MARCH 11, 2004 AT 8:40 A.M.

FIGURE 22: LOCATION OF COMMODORE BAY MARINA ON INGRAM THOROFARE IN AVALON. PHOTOGRAPH WAS TAKEN ON MARCH 11, 2004 AT 8:58 A.M.

FIGURE 23: LOCATION OF PIER 88 MARINA ON TOWNSEND CHANNEL IN SEA ISLE CITY. PHOTOGRAPH WAS TAKEN ON MARCH 11, 2004 AT 9:06 A.M.

FIGURE 24: LOCATION OF U.S. COAST GUARD STATION PIER ON TOWNSEND CHANNEL IN SEA ISLE CITY. PHOTOGRAPH WAS TAKEN ON MARCH 11, 2004 AT 9:10 A.M.

FIGURE 25: LOCATION OF MINMAR MARINA ON LUDLAM THOROFARE IN SEA ISLE CITY. PHOTOGRAPH WAS TAKEN ON MARCH 11, 2004 AT 9:41 A.M.

FIGURE 26: LOCATION OF SEA ISLE CITY MARINA ON LUDLAM THOROFARE IN SEA ISLE CITY. PHOTOGRAPH WAS TAKEN ON MARCH 11, 2004 AT 9:41 A.M.

SPILLS OR OTHER UNPERMITTED DISCHARGES

On September 14, 2002, a sewage spill was identified on 42nd Street in Avalon. According to the report sent to the NJDEP, Bureau of Marine Water Monitoring, approximately 100 gallons of sewage leaked into a storm drain when a pump bypass hose broke during the repair of the sewer main. The sewage from the storm drain flowed into the waters immediately west of Avalon and towards Gravens Thorofare. These waters are classified as *Prohibited* to shellfish harvesting. The nearest shellfish harvesting water is Ingram Thorofare, which is classified as *Special Restricted* and located approximately 1.5 miles from the site of the sewage spill. This sewage spill was reported as terminated and the repairs were completed at the time this report was received by the Bureau of Marine Water Monitoring.

There were no emergency closures of shellfish waters occurring in this area for the time period from October 1999 to September 2003.

HYDROGRAPHY AND METEOROLOGY

PATTERNS OF PRECIPITATION

Precipitation patterns in the coastal areas of New Jersey are typical of the Mid-Atlantic coastal region (see Table 5). Typical summer storms are localized storms associated with thunderstorms. 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 show the 2-year return 6-hour storm event to be between two and three in inches, while the 2-year 24-hour return volume varies between three and four 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. This graphical depiction (shown below in Figure 27 for Shellfish Growing Area SE-5 with measurements taken at the NOAA Atlantic City International Airport station in Pomona, NJ, for the time period from 1993 to 2003) provides insight into the frequency of cumulative precipitation of a given size.

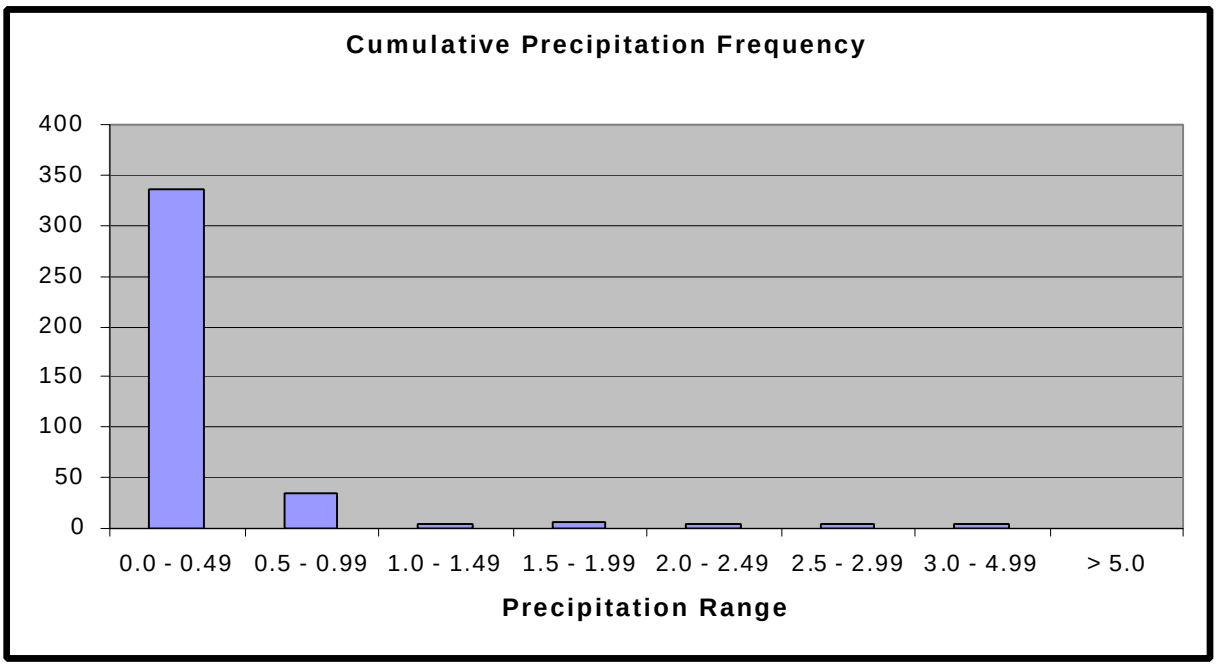

FIGURE 27: CUMULATIVE PRECIPITATION FREQUENCY HISTOGRAM (1993-2003) (SOURCE: NOAA CLIMATIC DATA)

HYDROGRAPHY

An extensively developed area to the southeast and tidal marshes to the west borders this shellfish growing area. These tidal marshes, or estuaries, are semi-enclosed coastal bodies of water freely connected with the open sea, and containing seawater measurably diluted with fresh water from land drainage. Even though these estuaries and the sea are connected, there is a continuous exchange of water between them, even with barrier islands or sandbars that may hinder this exchange. In this shellfish growing area, the barrier islands are Strathmere, Whale Beach, and Sea Isle City in the north, and Avalon, Seven Mile Beach, and Stone Harbor to the south.

The four main bodies of water in this

area are Ludlam Bay, Townsend Sound, Stites Sound, and Townsends Inlet. Ludlam Bay typically has depths ranging from 1 to 4 feet (MLW), Townsend Sound has depths ranging from 1 to 3 feet (MLW), Stites Sound has depths ranging from 1 to 2 feet (MLW), and Townsends Inlet has depths ranging from 2 to 11 feet (MLW). The depth of the water in Ludlam Thorofare, Townsend Channel, the Intercoastal Waterway, and Ingram Thorofare range from 2 to 21 feet (MLW). There is an average range of 4 feet for the tides in this area. The tidal cycle is semidiurnal, with two high tides and two low tides in a 24 hour, 50 minute period. The tides around the Atlantic Ocean occur twice a day (two high and two low) and have essentially the same range, or vertical distance from high to low water (Ingmanson and Wallace, 1989). Tidal flushing is through Townsends Inlet. (USDI-GS, Photoinspected 1977-Sea Isle City, NJ, and USDI-GS, Photoinspected 1977-Avalon, NJ).

This shellfish growing area was sampled with no tidal preferences. The tidal preferences are either ebb currents, flood currents, or neither of these two types of currents. Ebb and flood currents describe the horizontal motions associated with the fall and rise of the tide in restricted regions along the coast. Tidal currents can affect the water quality of a shellfish growing area, because hydrographic and meteorological characteristics, such as tidal amplitude and type, water circulation patterns, depth, salinity, stratification characteristics, rainfall patterns and intensity, and prevailing winds, may affect the distribution of pollutants in a specific area (Ingmanson and Wallace, 1989). This is why an evaluation of pollution sources and hydrographic characteristics are used to evaluate the water quality in a shellfish growing area.

Precipitation inputs to this area for the period 1999 through 2003 are shown in Table 7 and the Cumulative Precipitation Frequency Histogram for this area from 1993 through 2003 are shown in Figure 27. There have been no significant changes in hydrography since the last reappraisal report was written in 2000. The primary weather station for this area is at the Atlantic City International Airport in Pomona, NJ. The secondary weather station for this area is the Atlantic City Marina in Atlantic City, NJ. The secondary station data are used when data from the primary station are incomplete.

TABLE 7: CLIMATOLOGICAL DATA

Rainfall Recorded at NOAA's Atlantic City International Airport station in Pomona, NJ

Sampling Date	Precipitation in Inches		
	Day of Sampling	1 day prior	2 days prior
10/15/1999	0.000	0.000	0.005
12/08/1999	0.000	0.030	0.610
2/24/2000	0.000	0.000	0.000
3/10/2000	0.000	0.000	0.000
4/06/2000	0.005	0.005	0.205
6/15/2000	0.020	0.290	0.290
7/07/2000	0.000	0.000	0.000
7/18/2000	0.000	0.010	0.020
7/21/2000	0.010	0.360	0.800
8/01/2000	0.050	0.060	0.070
8/11/2000	0.010	0.010	0.015
8/17/2000	0.000	0.005	0.015
8/21/2000	0.010	0.010	0.020
9/13/2000	0.005	0.005	0.015
9/19/2000	0.460	0.460	0.460
10/13/2000	0.000	0.000	0.000
10/19/2000	0.010	0.010	0.010
12/12/2000	0.020	0.230	0.230
1/22/2001	0.005	0.485	1.925
2/01/2001	0.000	0.490	0.550
2/14/2001	0.060	0.150	0.200
2/26/2001	0.000	0.330	0.330
3/21/2001	1.570	1.640	1.640
4/20/2001	0.000	0.000	0.050
4/24/2001	0.010	0.010	0.010
6/07/2001	0.005	0.010	0.020
7/23/2001	0.000	0.000	0.000
7/26/2001	0.000	0.000	0.000
8/08/2001	0.000	0.000	0.000
9/21/2001	0.050	0.150	0.150
10/03/2001	0.000	0.000	0.520
12/06/2001	0.000	0.000	0.010
12/17/2001	0.190	0.190	0.190
1/10/2002	0.000	0.005	0.005
1/29/2002	0.000	0.000	0.000
2/14/2002	0.000	0.000	0.000
3/14/2002	0.000	0.290	0.340
4/10/2002	0.120	0.510	0.510
5/16/2002	0.000	0.000	0.000
6/12/2002	0.330	0.330	0.330
6/27/2002	0.330	0.330	0.340

Sampling Date	Precipitation in Inches		
	Day of Sampling	1 day prior	2 days prior
7/24/2002	0.050	0.100	0.100
8/07/2002	0.000	0.000	0.010
8/21/2002	0.000	0.000	0.000
9/04/2002	0.000	0.000	0.070
9/11/2002	0.000	0.000	0.010
10/07/2002	0.005	0.005	0.015
10/25/2002	0.300	0.340	0.340
12/17/2002	0.000	0.005	0.005
4/02/2003	0.005	0.000	0.005
6/04/2003	0.510	0.540	0.540
6/12/2003	0.310	0.340	0.340
7/31/2003	0.150	0.170	0.660
8/12/2003	0.000	0.005	0.015
8/14/2003	0.000	0.000	0.000
9/02/2003	0.030	0.080	0.090
9/08/2003	0.000	0.000	0.000
9/10/2003	0.000	0.000	0.000
9/16/2003	0.000	0.440	0.500
9/25/2003	0.000	0.000	0.540

WATER QUALITY STUDIES

BACTERIOLOGICAL QUALITY

The statistical summaries for the areas sampled according to Systematic Random Sampling (SRS) Strategy and Adverse Pollution Condition (APC) Strategy are listed in Tables 8 and 9. This shellfish growing area is composed of two assignment areas, Assignment 247 (Ludlam Bay and Townsend Sound) and Assignment 287 (Townsends Inlet to Great Sound). Assignment 247 is sampled using SRS sampling strategy year-round and Assignment 287 is sampled using APC sampling strategy year-round, with a water sample taken once a month from January to April and twice from May to October. Figures 28 and 29 show all of the sampling stations for this area. The raw data listings for each sampling station in accordance with the National Shellfish Sanitation Program (NSSP) criteria are given at the end of this report in the Appendix. There were no stations that exceeded the NSSP shellfish classification criteria for water quality in the *Approved, Seasonally Approved (November-April), Seasonally Approved (January-April), Special Restricted,* and *Prohibited* waters of this shellfish growing area.

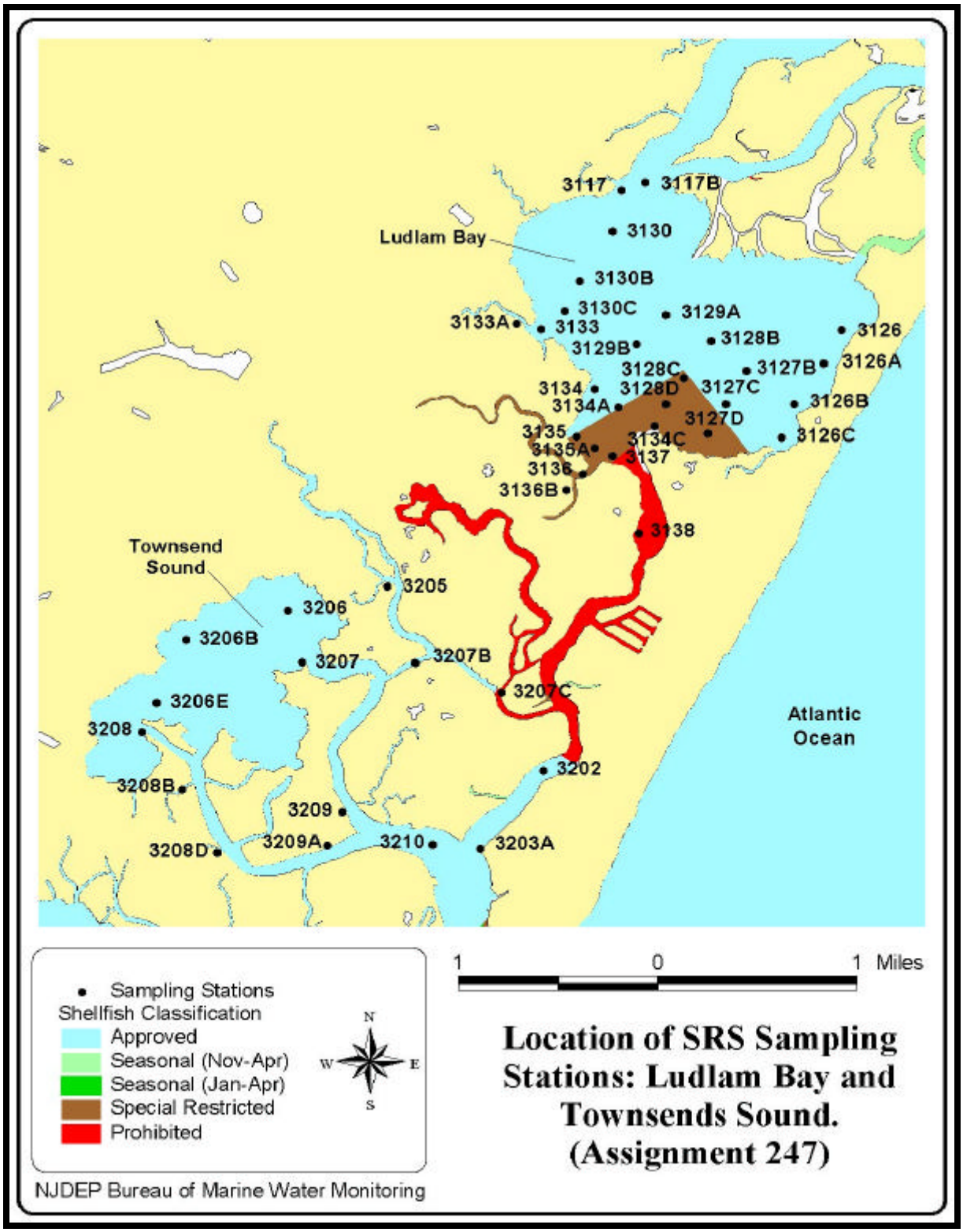

FIGURE 28: SRS SAMPLING STATIONS IN SHELLFISH GROWING AREA SE-5: LUDLAM BAY AND TOWNSEND SOUND.

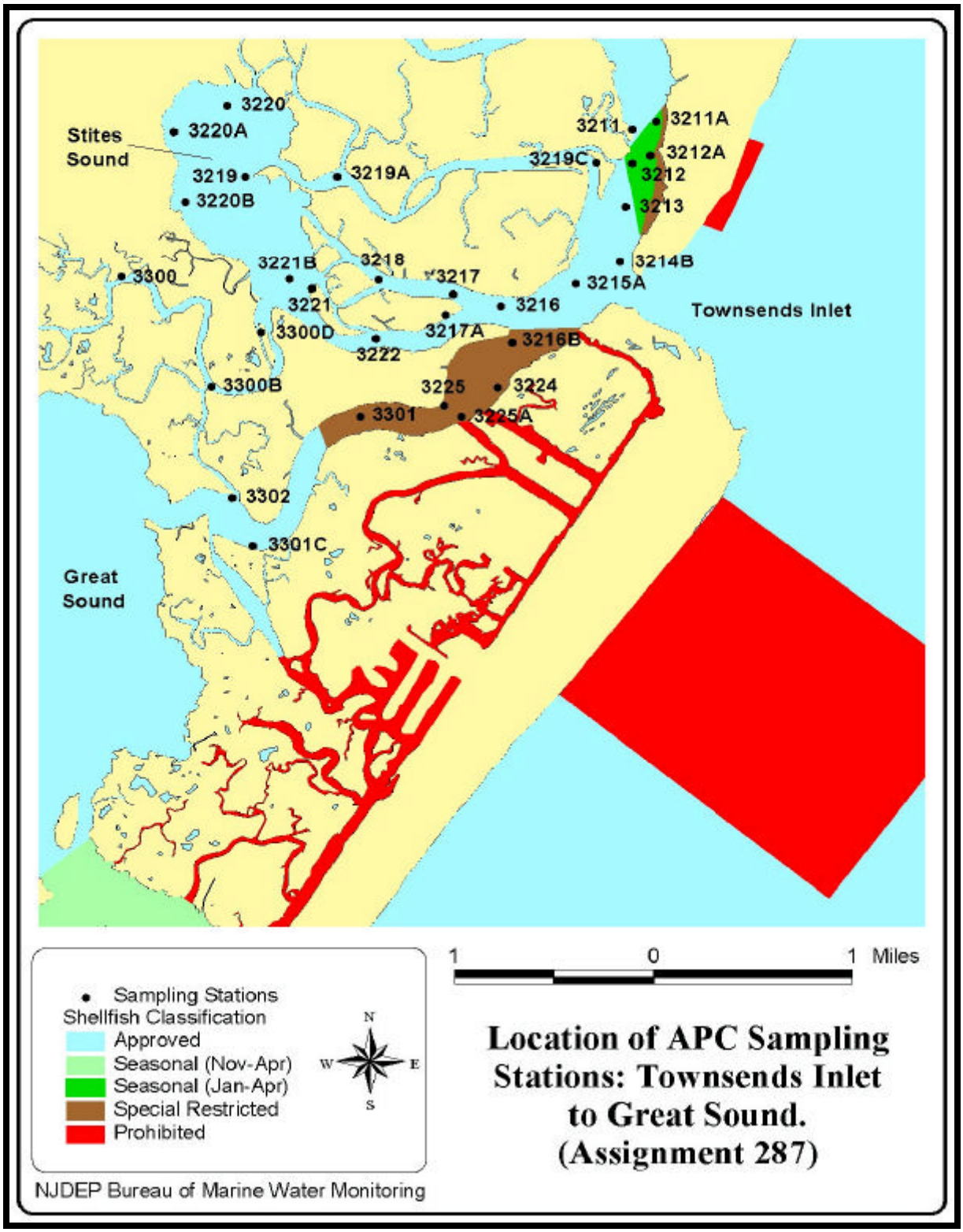

FIGURE 29: APC SAMPLING STATIONS IN SHELLFISH GROWING AREA SE-5: TOWNSENDS INLET TO GREAT SOUND.

TABLE 8: WATER QUALITY SUMMARY :SRS STATIONS (10/1/1999 - 9/30/2003)

Station	Status	Year Round			Summer			Winter		
		Geo. Mean	Est. 90th	N	Geo. Mean	Est. 90th	N	Geo. Mean	Est. 90th	N
3117	A	7.0	26.7	37	6.7	25.7	22	7.4	29.5	15
3117B	A	5.4	15.2	37	4.7	10.8	22	6.6	23.4	15
3126	A	6.8	33.4	37	4.3	11.1	22	13.1	95.2	15
3126A	A	4.4	12.8	37	3.3	4.5	22	6.7	30.4	15
3126B	A	4.9	13.7	37	3.8	9.3	22	7.0	20.7	15
3126C	A	5.5	20.9	37	4.6	15.3	22	7.2	31.8	15
3127B	A	7.1	31.4	36	4.1	7.7	21	15.0	92.4	15
3127C	A	6.8	28.9	37	4.4	8.3	22	13.0	85.5	15
3127D	SR	6.3	26.4	37	5.3	18.9	22	8.1	41.7	15
3128B	A	5.3	15.0	37	3.8	7.6	22	8.6	27.8	15
3128C	SR	5.9	19.5	37	4.2	8.0	22	9.5	44.7	15
3128D	SR	5.9	19.9	37	6.8	26.5	22	4.7	12.3	15
3129A	A	6.0	18.9	37	6.1	18.7	22	5.9	19.8	15
3129B	A	6.5	28.0	37	4.4	9.2	22	11.9	78.2	15
3130	A	6.0	20.1	37	4.7	11.4	22	8.6	37.7	15
3130B	A	6.4	26.4	37	4.5	11.4	22	11.0	61.5	15
3130C	A	4.9	14.6	37	4.6	13.0	22	5.3	17.7	15
3133	A	5.7	20.7	36	6.0	25.8	21	5.3	15.2	15
3133AC	A	5.0	13.4	37	4.3	10.0	22	6.2	19.5	15
3134	A	5.3	18.3	37	5.4	21.6	22	5.2	14.4	15
3134A	SR	7.2	33.7	37	9.2	49.3	22	5.0	17.2	15
3134C	SR	4.8	10.3	36	4.8	9.5	21	4.8	11.7	15
3135	SR	5.0	13.6	37	4.9	13.7	22	5.2	13.9	15
3135A	SR	6.4	26.3	37	6.3	21.2	22	6.5	36.3	15
3136	SR	5.6	20.2	37	5.3	18.1	22	6.1	24.5	15
3136B	SR	5.4	16.4	37	5.5	15.7	22	5.4	18.1	15

Station	Status	Year Round			Summer			Winter		
		Geo. Mean	Est. 90th	N	Geo. Mean	Est. 90th	N	Geo. Mean	Est. 90th	N
3137	SR	5.5	16.6	37	5.3	13.2	22	5.9	23.0	15
3138	P	8.1	55.6	37	10.9	103.0	22	5.2	17.2	15
3202	A	4.1	7.8	37	4.0	7.6	22	4.1	8.3	15
3203A	A	3.8	7.1	37	3.9	7.6	22	3.6	6.5	15
3205	A	5.5	17.9	37	6.3	23.6	22	4.5	11.3	15
3206	A	6.1	20.4	37	6.6	25.1	22	5.5	15.1	15
3206B	A	5.3	20.0	37	6.3	29.3	22	4.0	10.1	15
3206E	A	6.0	23.4	37	6.8	34.2	22	5.0	11.9	15
3207	A	5.0	16.3	37	4.2	9.3	22	6.4	31.1	15
3207B	A	4.9	13.0	37	5.7	16.5	22	4.0	8.6	15
3207C	P	4.8	13.3	37	5.7	19.4	22	3.7	6.0	15
3208	A	4.3	12.4	37	5.0	11.8	22	4.2	13.4	15
3208B	A	4.1	8.5	37	4.1	8.5	22	4.1	8.7	15
3208D	A	3.7	5.9	37	3.7	6.0	22	3.7	5.9	15
3209	A	3.3	4.9	37	3.3	5.0	22	3.4	4.8	15
3209A	A	4.3	9.4	36	4.1	8.9	21	4.6	10.3	15
3210	A	4.0	7.6	37	4.2	7.8	22	3.7	7.3	15

TABLE 9: WATER QUALITY SUMMARY :APC STATIONS (10/1/1999 - 9/30/2003)

Station	Status	Year Round			Summer			Winter		
		Geo. Mean	% > 330	N	Geo. Mean	% > 330	N	Geo. Mean	% > 330	N
3211	A	4.8	0.0%	23	5.1	0.0%	17	3.8	0.0%	6
3211A	S(J-A)	5.2	0.0%	23	5.2	0.0%	17	5.2	0.0%	6
3212	S(J-A)	3.9	0.0%	23	3.9	0.0%	17	3.7	0.0%	6
3212A	S(J-A)	3.7	0.0%	23	3.9	0.0%	17	3.2	0.0%	6
3213	A	3.9	0.0%	23	4.0	0.0%	17	3.5	0.0%	6
3214B	A	4.2	0.0%	23	3.6	0.0%	17	6.1	0.0%	6
3215A	A	3.6	0.0%	23	3.3	0.0%	17	4.8	0.0%	6
3216	A	4.7	0.0%	23	5.0	0.0%	17	4.0	0.0%	6
3216B	SR	5.4	4.3%	23	5.8	5.9%	17	4.5	0.0%	6
3217	A	3.6	0.0%	23	3.3	0.0%	17	4.5	0.0%	6
3217A	A	5.1	0.0%	23	6.0	0.0%	17	3.2	0.0%	6
3218	A	3.6	0.0%	23	3.5	0.0%	17	4.0	0.0%	6
3219	A	4.1	0.0%	23	4.0	0.0%	17	4.5	0.0%	6
3219A	A	5.1	0.0%	23	4.7	0.0%	17	6.3	0.0%	6
3219C	A	5.3	0.0%	23	5.7	0.0%	17	4.2	0.0%	6
3220	A	4.5	0.0%	22	4.5	0.0%	16	4.7	0.0%	6
3220A	A	4.6	0.0%	23	4.6	0.0%	17	4.7	0.0%	6
3220B	A	3.9	0.0%	23	4.2	0.0%	17	3.1	0.0%	6
3221	A	3.5	0.0%	22	3.6	0.0%	16	3.3	0.0%	6
3221B	A	3.9	0.0%	23	4.1	0.0%	17	3.2	0.0%	6
3222	A	3.3	0.0%	22	3.2	0.0%	16	3.7	0.0%	6
3224	SR	3.8	0.0%	23	3.2	0.0%	17	6.6	0.0%	6
3225	SR	4.0	0.0%	23	4.0	0.0%	17	3.7	0.0%	6
3225A	SR	3.8	0.0%	23	3.5	0.0%	17	5.0	0.0%	6
3300	A	4.1	0.0%	23	4.3	0.0%	17	3.7	0.0%	6
3300B	A	4.4	0.0%	23	4.9	0.0%	17	3.1	0.0%	6

Station	Status	Year Round			Summer			Winter		
		Geo. Mean	% > 330	N	Geo. Mean	% > 330	N	Geo. Mean	% > 330	N
3300D	A	4.4	0.0%	23	3.8	0.0%	17	6.5	0.0%	6
3301	SR	3.9	0.0%	23	3.8	0.0%	17	4.3	0.0%	6
3301C	A	4.5	0.0%	23	4.6	0.0%	17	4.3	0.0%	6
3302	A	4.6	0.0%	23	4.8	0.0%	17	4.2	0.0%	6

TIDAL EFFECTS

The tidal effects or preferences can be either ebb currents, flood currents, or neither of these two types of currents. Ebb and flood currents describe the horizontal motions associated with the fall and rise of the tide in restricted regions along the coast. Tidal currents can affect the water quality of a shellfish growing area, because hydrographic and meteorological characteristics, such as tidal amplitude and type, water circulation patterns, depth, salinity, stratification characteristics, rainfall patterns and intensity, and prevailing winds may affect the distribution of pollutants in a specific area. This is why an evaluation of pollution sources and hydrographic characteristics are used to evaluate the water quality in a shellfish growing area. Table 10 lists the sampling stations in this shellfish growing area that show a relationship between tidal effects and water quality. Figure 30 shows the locations of these sampling stations. This shellfish growing area was sampled with no tidal preferences.

TABLE 10: TIDAL EFFECTS

Station	Geometric Mean Total Coliform MPN		Probability>[T]
	Ebb	Flood	
3225A	3.4	4.5	0.045

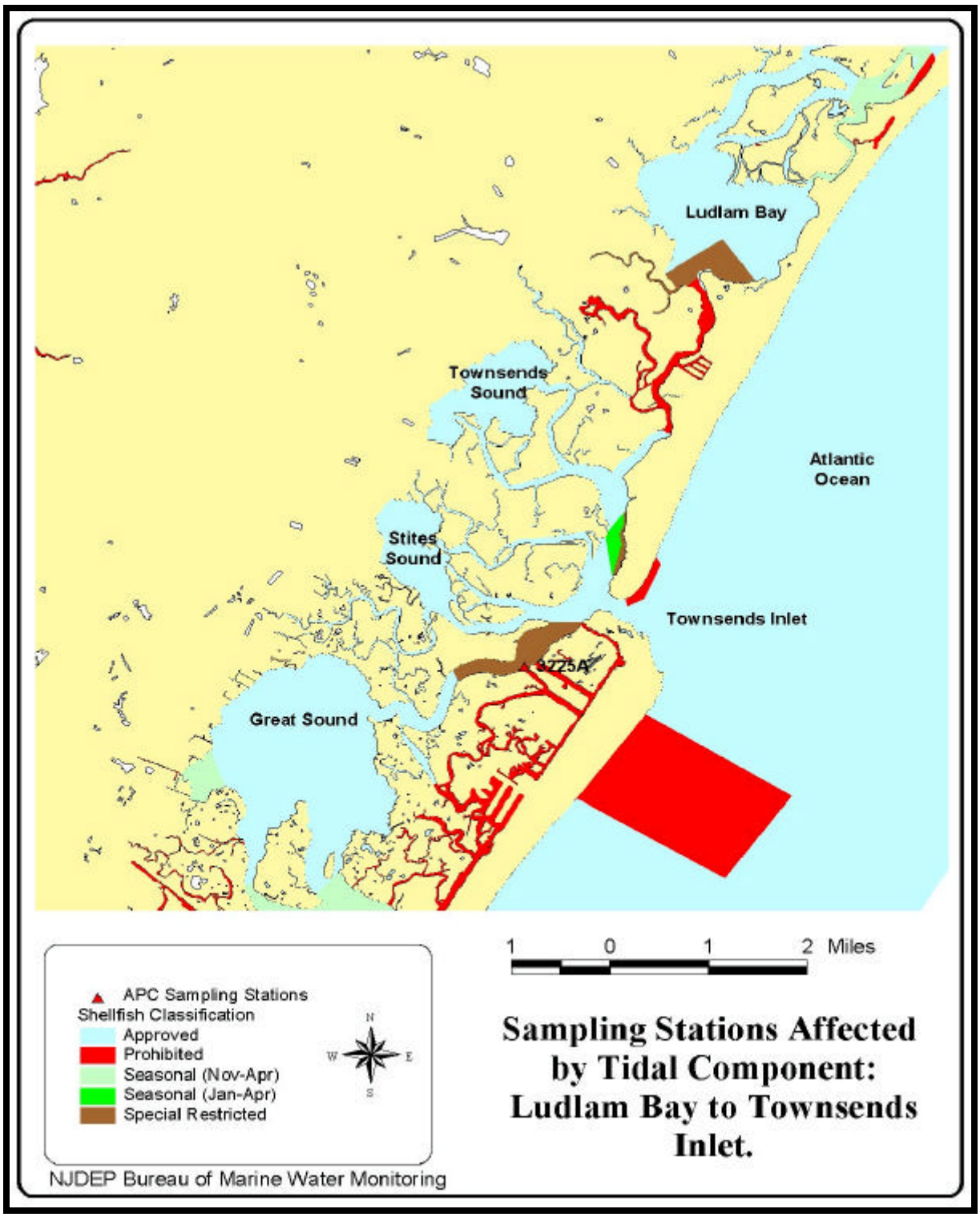

FIGURE 30: SAMPLING STATIONS AFFECTED BY TIDAL COMPONENT: LUDLAM BAY TO TOWNSENDS INLET.

SEASONAL EFFECTS

In the hydrologic cycle, the motion of all water is controlled by the sun's energy, tides, the motion of the earth, and the differing densities of water masses. The basic component of the hydrologic cycle is the energy of the sun, which moves water by evaporation, convection, and precipitation. As the earth experiences variations in the tilt of its axis and its revolution around the sun, it goes through seasonal phases of summer, spring, autumn, and winter. These seasonal phases have much variation on the atmosphere of the earth, causing changes in weather patterns. Since the atmosphere and the hydrosphere are intimately related, any variation to the atmosphere has an effect on the hydrosphere. Temperature, precipitation, wind, and the general circulation of the atmosphere have seasonal variations that also affect the marine environment.

Shellfish are filter-feeding organisms that live in the sand, silt, and mud on the bottom of oceans and bays. They have a range of tolerance to specific environmental conditions, such as temperatures, salinity levels, oxygen levels, quantity and availability of food, and water quality. Seasonal effects on these variables will have an effect on shellfish populations. For example, different species of shellfish require very specific salinity levels for survival. Since salinity levels can have an effect on the species found in certain waters of an area, the salinity level is important for a complete understanding of the complex ecological balance in the marine environment. At a time of the year when rainfall is low, where evaporation exceeds precipitation, the salinity of the marine environment in certain areas is higher than it is in regions where precipitation exceeds evaporation. This can affect the quantity and type of shellfish found in a specific area.

Seasonal variations also affect human activities, with generally more human activity in the warmer months of the year. An increase in human activities in or near the marine environment can have an impact on shellfish populations. Increased pressure from human activities on already stressed failing septic systems and overloaded wastewater treatment facilities can cause sewage to spill into the marine environment, which can negatively impact the water quality of a shellfish growing area by increasing the coliform levels in the water.

Table 11 lists the sampling stations in this shellfish growing area that showed a correlation between seasonal effects and water quality. Figure 31 shows the locations of these sampling stations.

TABLE 11: SEASONAL EFFECTS

Station	Total Coliform Geometric Mean		Probability > [T]
	Summer	Winter	
3126	4.3	13.1	0.006
3126A	3.3	6.7	0.009
3126B	3.8	7.0	0.025
3127C	4.4	13.0	0.003
3128B	3.8	8.6	0.002
3128C	4.2	9.5	0.007
3129B	4.4	11.9	0.007
3130B	4.5	11.0	0.013
3225A	3.5	5.0	0.034

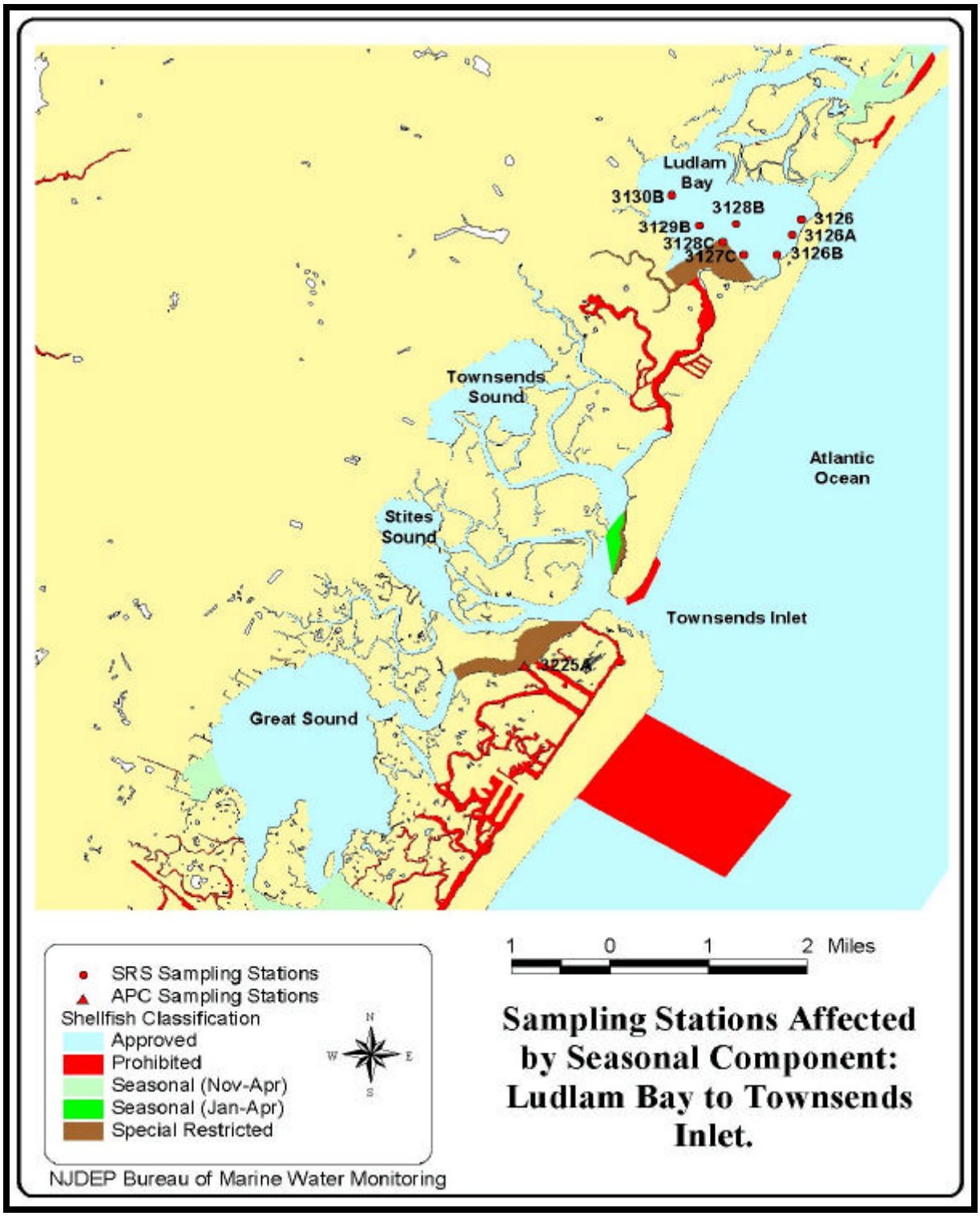

FIGURE 31: SAMPLING STATIONS AFFECTED BY SEASONAL COMPONENT: LUDLAM BAY TO TOWNSENDS INLET.

INTERPRETATION AND DISCUSSION OF DATA

BACTERIOLOGICAL

Criteria for bacterial acceptability of shellfish growing waters are provided in the National Shellfish Sanitation Program *Guide for the Control of Molluscan Shellfish* (USPHS, 1999 Revision). Each state must adopt either the total coliform criteria or fecal coliform criteria for growing water classifications. New Jersey has and continues to base growing water classifications on the total coliform criteria.

While New Jersey does make corresponding fecal determinations for each total coliform determination, these data are viewed as adjunct information and are not directly used for classification. Therefore, the data analysis is based on the total coliform results.

For the Systematic Random Sampling (SRS) strategy, the total coliform median or geometric mean MPN (most probable number) for the *Approved* shellfish water classification shall not exceed 70/100 mL and the estimated 90^{th} percentile shall not exceed an MPN of 330/100 mL for the three tube decimal dilution test (see Table 3) (USPHS, 1999 Revision). Also, the total coliform median or geometric mean MPN for the *Special Restricted* shellfish water classification shall not exceed 700/100 mL and the estimated 90^{th} percentile shall not exceed an MPN of 3300/100mL, where the three tube decimal dilution test is used for the Systematic Random Sampling (SRS) strategy (see Table 3) (USPHS, 1999 Revision).

For the Adverse Pollution Condition (APC) strategy, the data analysis is based on the total coliform results in which the total coliform median or geometric mean MPN (most probable number) for the *Approved* shellfish water classification shall not exceed 70/100 mL and not more than 10 percent of the sample shall exceed an MPN of 330/100 mL for the three tube decimal dilution test (see Table 2) (USPHS, 1999 Revision). Also, the total coliform median or geometric mean MPN (most probable number) for the *Special Restricted* shellfish water classification shall not exceed 700/100 mL and not more than 10 percent of the sample shall exceed an MPN of 3,300/100 mL, where the three tube decimal dilution test is used for the Adverse Pollution Condition (APC) strategy (see Table 2) (USPHS, 1999 Revision).

Figure 32 shows the sampling stations that meet the *Approved* total coliform criteria for water quality after being sampled with the Systematic Random Sampling (SRS) strategy and the Adverse Pollution Condition (APC) strategy. All of the sampling stations in this shellfish growing area meet the *Approved* criteria for water quality. However, some of these sampling stations are located in shellfish waters that are near the marinas of this area, and the shellfish waters around these sampling stations are classified, accordingly.

Based on the water data collected, one sampling station (APC Sampling Station **3225A**) showed a significant tidal component for water quality in this shellfish growing area (see Figure 30 and Table 10). APC sampling station **3225A** is located at the intersection of Ingram Thorofare and Princeton Harbor in *Special Restricted* shellfish waters. Tidal impacts were evaluated by performing a t-test on log-transformed total coliform MPN values. This shellfish growing area is not sampled with a tidal preference. APC sampling station **3225A** showed a higher total coliform geometric mean during the flood tide than during the ebb tide because this sampling station is located in Ingram Thorofare south of Townsends Inlet and is impacted by tidal currents flowing through the inlet. However, the total coliform level for this sampling station still meets the existing *Approved* shellfish classification criteria for these shellfish waters. Since the water quality in the north part of this shellfish growing area is not impacted by tidal effects, the north part of this shellfish growing area will continue to be sampled using the Systematic Random Sampling (SRS) strategy. The water quality in the south part of this shellfish growing area is directly impacted by tidal effects through Townsends Inlet, which is why the south part of this shellfish growing area is sampled using the Adverse Pollution Condition (APC) strategy. In the 2003 Annual Review of this shellfish growing area, 8 sampling stations (SRS sampling stations **3203A**, **3206B**, **3208B**, and **3210**, and APC sampling stations **3211**, **3213**, **3220**, and **3300**) showed a tidal component for water quality in this area (NJDEP, 2003). However, these sampling stations met the existing *Approved* shellfish classification criteria.

No correlation between total coliform MPN and rainfall occurred at any of the 73 sampling stations in this shellfish growing area. Rainfall impacts were assessed by correlating total coliform MPN values with cumulative rainfall on the day of sampling, 24 hours prior to the day of sampling, and 48 hours prior to the day of sampling. A relationship between rainfall amounts and total coliform levels is suggested if the rainfall correlation coefficient is greater than 0.6. Since the water quality in this shellfish growing area is not impacted by rainfall, this shellfish growing area will continue to be sampled using the existing sampling strategies. In the 2003 Annual Review of this shellfish growing area, no sampling stations showed a correlation between total coliform MPN and rainfall (NJDEP, 2003).

There were 9 sampling stations that showed a seasonal component for water quality in this shellfish growing area (see Figure 31 and Table 11). SRS sampling stations **3126, 3126A, 3126B, 3127C, 3128B, 3128C, 3129B** and **3130B** are located in Ludlam Bay in *Approved* and *Special Restricted* shellfish waters. APC sampling station **3225A** is located at the intersection of Ingram Thorofare and Princeton Harbor in *Special Restricted* shellfish waters. Seasonal effects were assessed using a t-test to compare log-transformed total coliform values for summer verses winter data. All of these sampling stations showed a higher total coliform geometric mean during the winter than during the summer, which could be from the impact of wild bird populations to this area. However, the total coliform levels still meet the existing *Approved* shellfish classification criteria for these shellfish waters. Since the water quality in this shellfish growing area is slightly impacted by seasonal effects but not enough to affect the shellfish classification of this area,

this shellfish growing area will continue to be sampled using the Systematic Random Sampling (SRS) and Adverse Pollution Condition (APC) strategies. In the 2003 Annual Review of this shellfish growing area, 11 sampling stations showed a seasonal component for water quality in this area and 7 of these sampling stations were the same sampling stations that were included in this report (NJDEP, 2002). However, all 11 of these sampling stations met the existing *Special Restricted* and *Prohibited* shellfish classification.

FIGURE 32: SAMPLING STATIONS MEETING APPROVED CRITERIA IN SHELLFISH GROWING AREA SE-5: LUDLAM BAY TO TOWNSENDS INLET.

RELATED STUDIES

There are 4 stations in this shellfish growing area that are sampled under the estuarine monitoring program for chemical parameters including nutrients (see Figure 33). These nutrient stations include sampling stations **3127C**, **3201**, **3214B**, and **3215A**. At these nutrient stations, the various parameters measured include water temperature (in Celsius), salinity levels, Secchi Depth, total suspended solids, dissolved oxygen levels, ammonia levels, nitrate and nitrite levels, orthophosphate levels, total nitrogen levels, and the inorganic nitrogen to phosphorus ratios (Zimmer, 2000, Zimmer, 2001).

The Department collects samples at regular intervals throughout the summer to determine the occurrence of marine algae that produce biotoxins (see Figure 8 for location of Phytoplankton sampling stations). Certain planktonic species have the potential to adversely affect the suitability of shellfish for human consumption. These planktonic species cause algal blooms that deplete the dissolved oxygen levels in the water. Algal blooms were reported each year for the period 1993 – 1997. The areas most severely impacted include the Raritan / Sandy Hook Bay, the Barnegat Bay, and sporadic offshore areas (NJDEP, 2001, Zimmer, 2000, Zimmer, 2001). No algal blooms capable of producing biotoxins were identified for this area during 1998, 1999, 2000, or 2001 (NJDEP, 2001). These 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.

NUTRIENTS

According to the 2002-2003 Marine Water Sampling Assignments Schedule for Assignments 247 and 287, there are 4 stations in Shellfish Growing Area SE-5 that are sampled under the estuarine monitoring program for chemical parameters including nutrients. These nutrient stations include sampling stations **3127C**, **3201**, **3214B**, and **3215A**. They are located throughout this shellfish growing area (see Figure 33).

At these nutrient stations, the various parameters measured include water temperature (in Celsius), salinity levels, Secchi Depth, total suspended solids, dissolved oxygen levels, ammonia levels, nitrate and nitrite levels, orthophosphate levels, total nitrogen levels, and the inorganic nitrogen to phosphorus ratios (Zimmer, 2000, Zimmer, 2001).

Water temperature (measured in degrees Celsius) is taken for each nutrient station. Water temperature is very important because warmer water has less dissolved oxygen that can trigger certain life processes (such as spawning and setting of shellfish larvae), or cause the shellfish to die. Oysters (Crassostrea virginica) can tolerate water temperatures ranging from –1.7?C to 36.0?C but has an optimum temperature range of 20.0?C to 30.0?C (Zimmer, 2000, Zimmer 2001).

Salinity levels (measured in parts per thousand) are also taken for each nutrient station because different species of shellfish require very specific salinity levels for survival. Since salinity levels can have an effect on the species found in these waters, the salinity data collected at these nutrient stations is important for a complete understanding of the complex ecological balance in these coastal waters. Oysters have a tolerance for salinity levels from 5.0 to 30.0 ppt but require salinity levels of 10.0 to 28.0 ppt for optimum growth. Oysters also grow better in waters with fluctuations in salinity levels (Zimmer, 2000, Zimmer 2001).

Secchi Depth (measured in feet) is an indicator of the relative turbidity of the coastal waters. When Secchi Depths are low, less sunlight can penetrate the water column and this sunlight is not available as an energy source for photosynthesis. The turbidity is affected by many sources, such as sediment load from anthropomorphic sources and algal cell concentrations in the water. Secchi Depth tends to be somewhat higher in the winter months (when the concentration of algal cells is diminished) and lower in the summer. The pumping rate of oysters will also decrease with the increased turbidity of the surrounding waters (Zimmer, 2000, Zimmer 2001).

Total Suspended Solids (measured in mg/L) is usually composed of clay, silt, sand, and biological sediments from many sources. An increase in the total suspended solid concentrations in the water column will cause turbidity levels to rise and Secchi Depth levels to lower (Zimmer, 2000, Zimmer 2001).

Dissolved oxygen (measured in mg/L or as percent saturation in conjunction with temperature and salinity) is an important component for the life processes of aerobic organisms such as shellfish. Oysters can only survive in anaerobic (absence of oxygen) conditions for only three days. Even though oysters can survive at oxygen concentrations of only 1.0 ppm, shellfish located in waters of low dissolved oxygen concentrations will usually have a greater potential for biological stress from insufficient oxygen levels in the water column and have a greater potential for hypoxia and death of the organism. New Jersey has a minimum standard of 4.0 mg/L for dissolved oxygen levels in marine water (N.J.A.C. 7:9B). If the percent saturation of dissolved oxygen levels drop below 50%, there is a greater potential for biological stress. Levels of percent saturation of dissolved oxygen over 100% are an indicator of algal material in the water column (Zimmer, 2000, Zimmer 2001).

The nutrient parameters that are measured include ammonia (measured in ?g N/L), nitrate and nitrite (measured in ?g N/L), orthophosphate (measured in ?g P/L), total nitrogen (measured in ?g N/L), and inorganic nitrogen to phosphorus ratios. These parameters affect the primary productivity of shellfish (Zimmer, 2000, Zimmer 2001).

The nitrogen present in the form of inorganic nitrogen (ammonia, nitrate and nitrite) is the form most readily utilized by phytoplankton. Certain planktonic species have the potential to adversely affect the suitability of shellfish for human consumption. These planktonic species cause algal blooms that deplete the dissolved oxygen levels in the water. Algal blooms were reported each year for the period 1993 – 1997. The areas most severely impacted include the Raritan / Sandy Hook Bay, the Barnegat Bay, and sporadic offshore areas (NJDEP, 2001, Zimmer, 2000, Zimmer, 2001).

Total nitrogen includes the organic nitrogen component, which often results from the discharge of pollutants from anthropogenic sources, from high levels of algal growth, the decay of organic material and other related sources. High concentrations of orthophosphate and phosphorus are usually found in waters that receive discharges from areas that use chemical fertilizers (Zimmer, 2000, Zimmer 2001).

For detailed information concerning dissolved oxygen and nutrient levels, see the Estuarine Monitoring Report published by the NJDEP. The report, New Jersey Ambient Monitoring Program: Report on Marine and Coastal Water Quality – 1993 – 1997, is available electronically at: www.state.nj.us/dep/wmm/bmw.

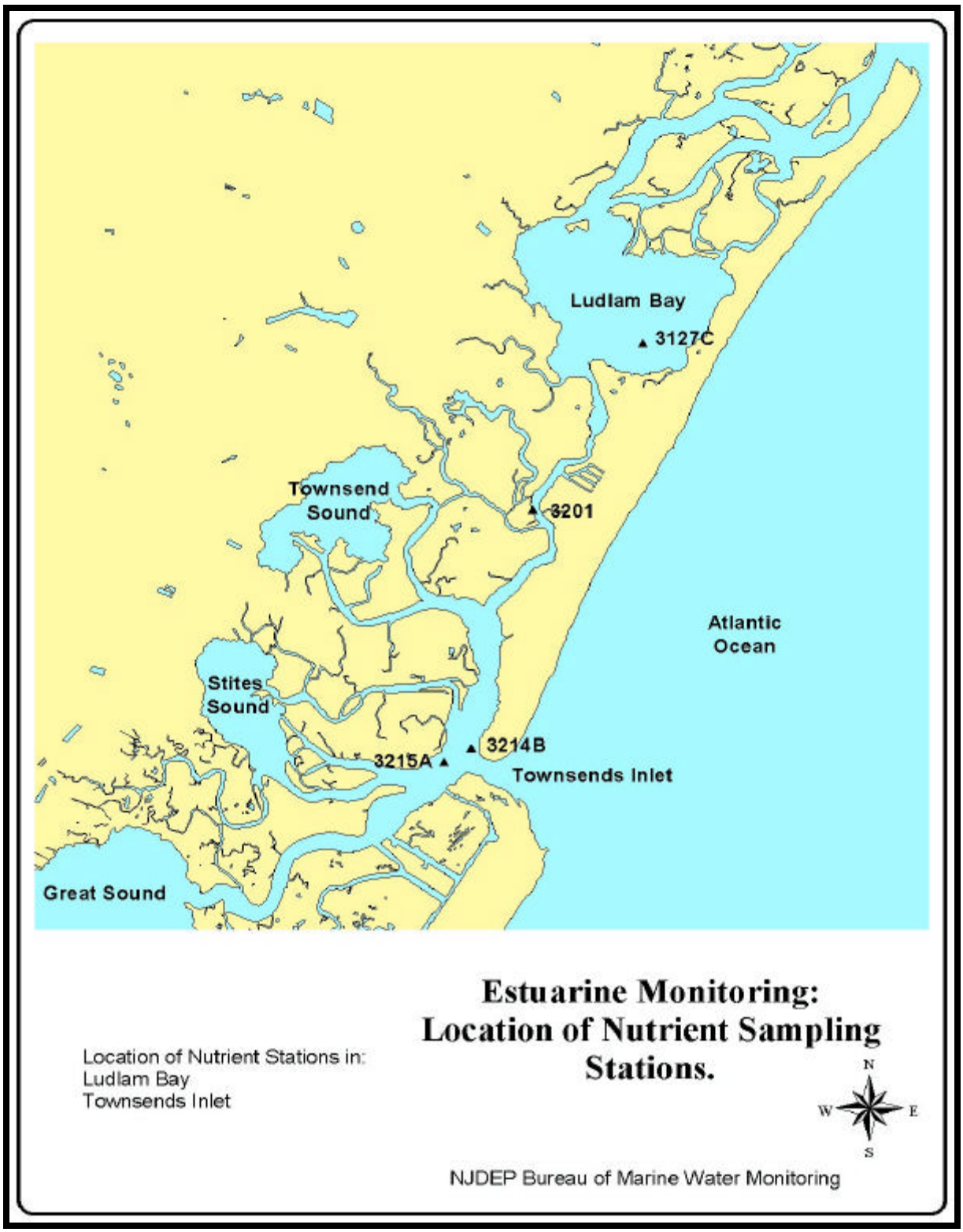

FIGURE 33: SAMPLING SITES WHERE ADDITIONAL DATA HAVE BEEN COLLECTED FOR NUTRIENTS IN SHELLFISH GROWING AREA SE-5: LUDLAM BAY TO TOWNSENDS INLET.

CONCLUSIONS

BACTERIOLOGICAL EVALUATION

Water quality in Shellfish Growing Area SE-5, Ludlam Bay to Townsends Inlet, continues to be good, with all of the sampling stations in compliance with the requirements of the *Approved*, *Seasonally Approved (November to April)*, *Seasonally Approved (Jan.-April)*, *Special Restricted*, and *Prohibited* shellfish classification for the waters in this area, based on NSSP total coliform criteria. This area was sampled using the Systematic Random Sampling (SRS) and the Adverse Pollution Condition (APC) strategies. This is consistent with a shellfish growing area which has a north part (Ludlam Bay and Townsend Sound) with no direct impacts from point sources (SRS strategy), and a south part (Townsends Inlet to Great Sound) with many direct and indirect impacts from point sources, such as marinas and storm water outfalls in this urban area (APC strategy). Also, all of the sampling stations in this shellfish growing area meet the *Approved*, *Seasonally Approved (Nov.-Apr.)*, *Seasonally Approved (Jan.-April)*, *Special Restricted*, or *Prohibited* classification for total coliform, according to the State of New Jersey total coliform criteria.

Shellfish Growing Area SE-5, Ludlam Bay to Townsends Inlet, is correctly classified as *Approved*, *Seasonally Approved (November-April*, *Seasonally Approved (January-April)*, *Special Restricted*, and *Prohibited* as currently described in *N.J.A.C. 7:12*. No classification changes are recommended. It is prohibited to harvest shellfish from the *Special Restricted* waters in this shellfish growing area without a special permit issued in compliance with the State of New Jersey's Relay or Depuration Programs.

RECOMMENDATIONS

SHELLFISH WATER CLASSIFICATION

RECOMMENDED CHANGES IN MONITORING SCHEDULE

Continue sampling using the existing Systematic Random Sampling (SRS) Strategy for Assignment 247 and the existing Adverse Pollution Condition (APC) Strategy for Assignment 287.

Reduce the number of runs collected per year from 10 to 6 in Assignment 247 (Ludlam Bay and Townsends Sound)) and from 6 to 5 in Assignment 287 (Great Sound and Townsends Inlet).

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APPENDICES

A. Statistical Summaries

- Year-round
- Winter Only
- Summer Only

B. Seasonal Evaluation

C. Precipitation

- Rainfall Correlation
- Cumulative Rainfall
- Wet Weather Statistical Summary
- Dry Weather Statistical Summary

D. Tidal Evaluation

E. Data Listing - 1999 through 2003