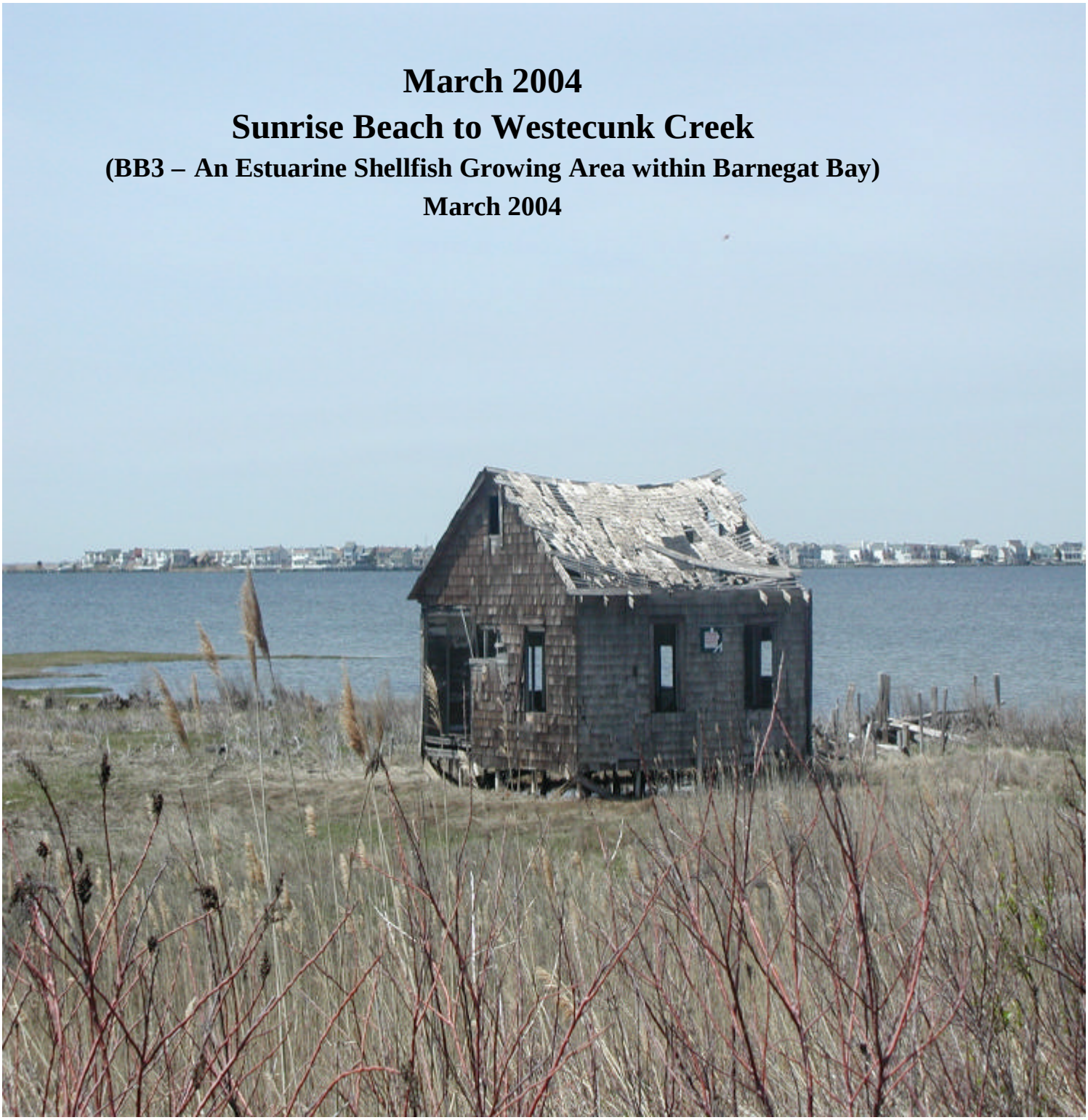
March 2004
Sunrise Beach to Westecunk Creek
(BB3 – An Estuarine Shellfish Growing Area within Barnegat Bay)
March 2004



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March 2004

PARTIAL SANITARY SURVEY

SHELLFISH GROWING AREA BB3

SUNRISE BEACH TO WESTECUNK CREEK

1997 - 2001

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1997 - 2001

New Jersey Department of Environmental Protection
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EXECUTIVE SUMMARY

The results of water quality analysis for samples collected between October 1997 and August 2001 indicate that the *Approved* waters in the shellfish growing area consisting of the bay waters extending from Sunrise Beach to Westecunk Creek (BB3) met all criteria for classification as *Approved.* All waters classified as other than *Approved* also met criteria for their respective classifications. The Oyster Creek Nuclear Generating Facility provides the one potential direct source of input to the waters in Shellfish Growing Area BB3. Aside from change in ambient temperature, there has been no apparent direct and or long-term impact to the waters of BB3 from plant error, operation or discharge. As this generating facility does not presently suggest a continuing influence on water quality, BB3 is sampled utilizing the Systematic Random Sampling (SRS) strategy. Further, there is potential for non-point source inputs such as those that might emanate from storm water outfalls located within the waters of BB3. However, the waters that surround these outfalls are appropriately classified as per public health concern and we note no sign of impact from these sources.

In this Partial Sanitary Survey, a section of BB3 located due East of Beach Haven West in Barnegat Bay with an area of 132.70 acres is proposed to be upgraded from it's current *Seasonal* (January - April) classification to *Seasonal* (November – April). Further, another area encompassing 160.46 acres of Barnegat Bay located just West of the Barnegat Inlet is recommended for upgrade from *Special Restricted* to *Approved.* The persistence of continually good data from sampling and analysis in these areas provides opportunity for recommendation of partial change in BB3 classification(s).

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 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.

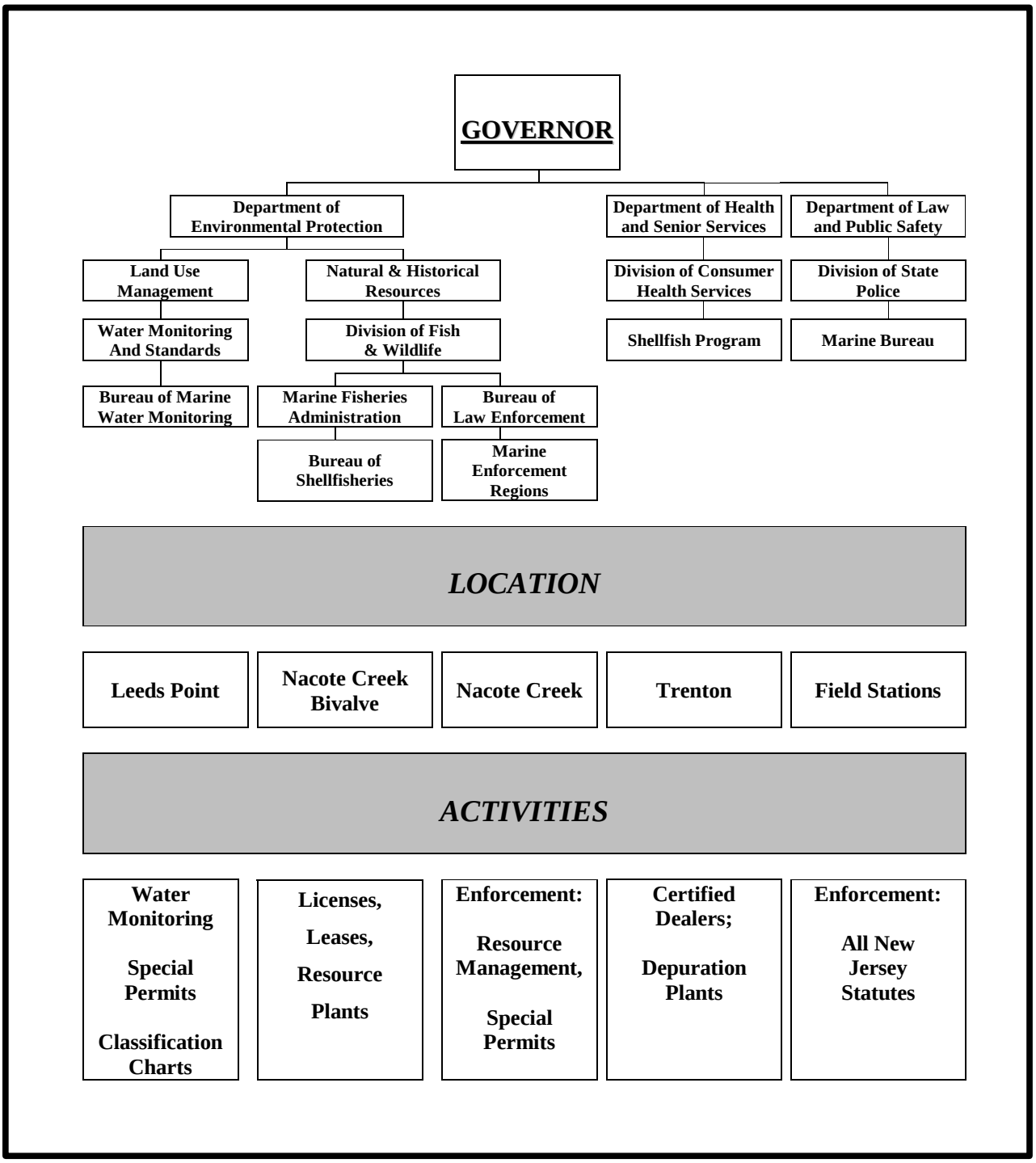

FIGURE 1: STATE OF NEW JERSEY SHELLFISH AGENCIES

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 hydrography 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 to comply with the three year reappraisal. Additionally, a partial shoreline survey was completed for the purpose of upgrading and reclassifying a portion of the shellfish growing waters.

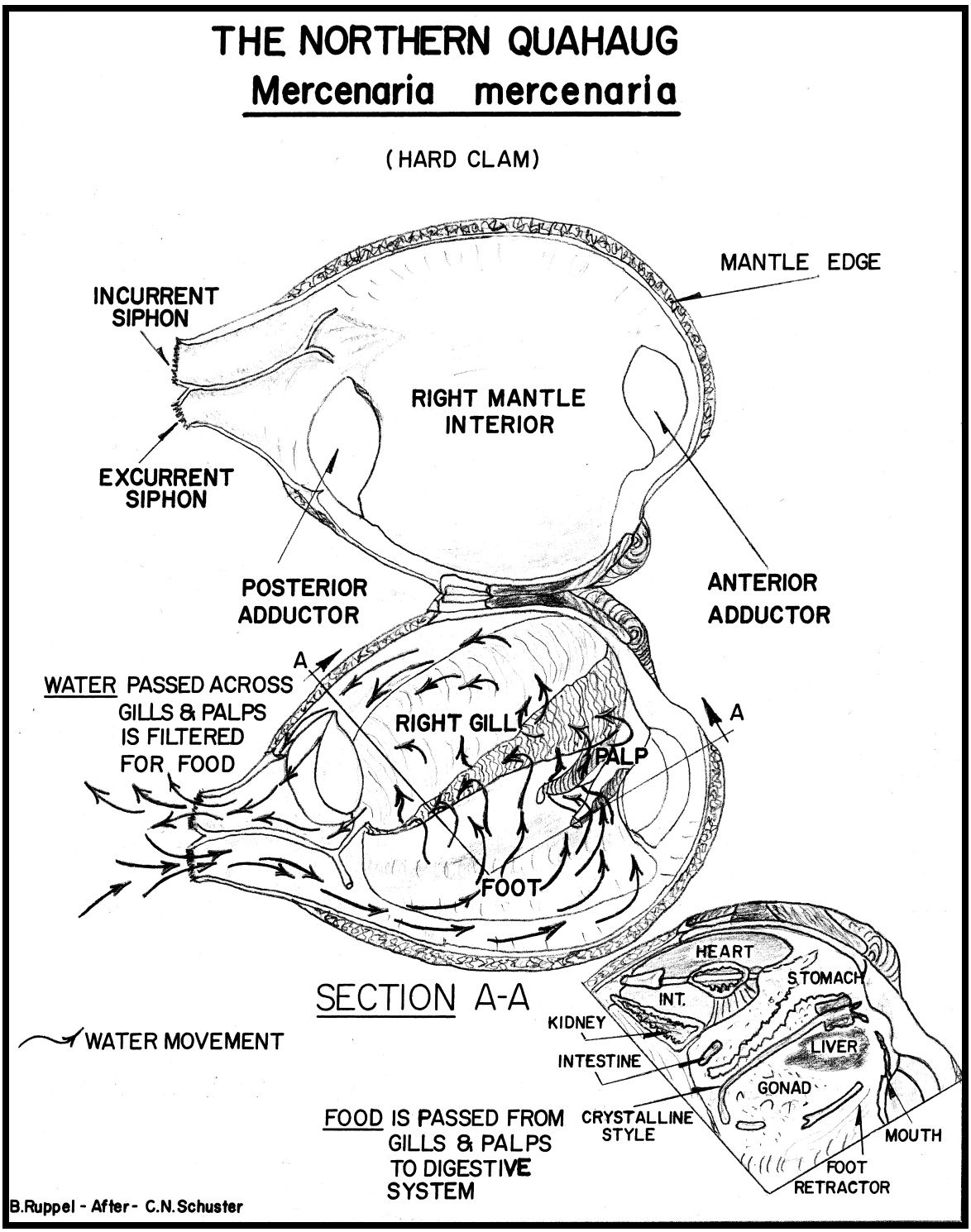

FIGURE 2: CROSS-SECTION OF MERCENARIA MERCENARIA

PROFILE

LOCATION

This Partial Sanitary Survey covers the shellfish growing waters from southern Barnegat Bay to northern Little Egg Harbor. As can be seen in Figure 3, the area extends along approximately 16 miles of back bay waters which encompass the area from Sunrise Beach in the North, then East across Barnegat Bay to Island Beach State Park, then South to Beach Haven Terrace and then West and ending at the southern base of Westecunk Creek (Please Note: all references to "miles" in this report are in Nautical Measure, whereby, one Nautical Mile equates to 6,086 feet). This area is also displayed on charts #4 and #5 of the 2002 Shellfish Growing Water Classification Charts.

This shellfish growing site has an area of nearly 40,060 acres. The approximate acreage by shellfish growing water classification (for BB3) is as follows: *Approved* - 34,709, *Seasonal* (Nov-Apr) - 3558, *Seasonal* (Jan-Apr) - 138, *Special Restricted* - 1148 and *Prohibited* - 508.

The above figures for *Special Restricted*, *Seasonal* (Nov-Apr) and *Seasonal* (Jan-Apr) acreage will be revised in this Partial Sanitary Survey. These revisions can be noted toward the end of the Description section, which follows.

DESCRIPTION

The majority of the shellfish growing waters present in this area are classified as *Approved,* with several small sections of *Seasonally Approved, Special Restricted* and *Prohibited* waters, which act as buffers for the developed sections of shoreline along the bay (see Figures 4 & 5).

The discharge from the Oyster Creek Nuclear Generating Station is located within this area. This facility does not discharge sanitary waste, instead discharging non-contact cooling water. The effluent from this facility does not impact the *Approved waters* bordering the closed safety zone surrounding the discharge pipe of the facility. As such, no dimensional adjustments which would require an increase in the size of closed safety zones or *Prohibited* areas surrounding the Oyster Creek Nuclear Generating Station are required at this time. Outside of these buffers or safety zones, the remaining waters of BB3 met the criteria for their respective

classifications as per statistical summarization.

In this Partial Sanitary Survey, the BMWM proposes that the *Seasonal* (Jan-Apr) acreage located within a portion of the waters due East of Beach Haven West become *Seasonal* (Nov-Apr). A thorough review of all statistical parameters was undertaken with specific emphasis placed on year round and *Seasonal* analyses in order to research this proposal. The presence of continually good data supporting this decision provided the opportunity for this upgrade.

The availability for clamming in the waters proposed for upgrade would increase by two months. The acreage for *Seasonal* (Nov-Apr) waters in this shellfish growing area would then become 3695. As such, there would no longer be any waters showing a classification of *Seasonal* (Jan-Apr) as these waters (138 acres) are proposed to be combined with the *Seasonal* (Nov-Apr – 3558 acres) waters as one classification (for BB3).

This report also proposes to upgrade a section of *Special Restricted* waters just West of Barnegat Inlet to *Approved* classification. With this, figures for *Special Restricted* waters in this growing area will change from 1148 to 988. Figures for *Approved* waters will be noted as 34,870 (up from 34,709).

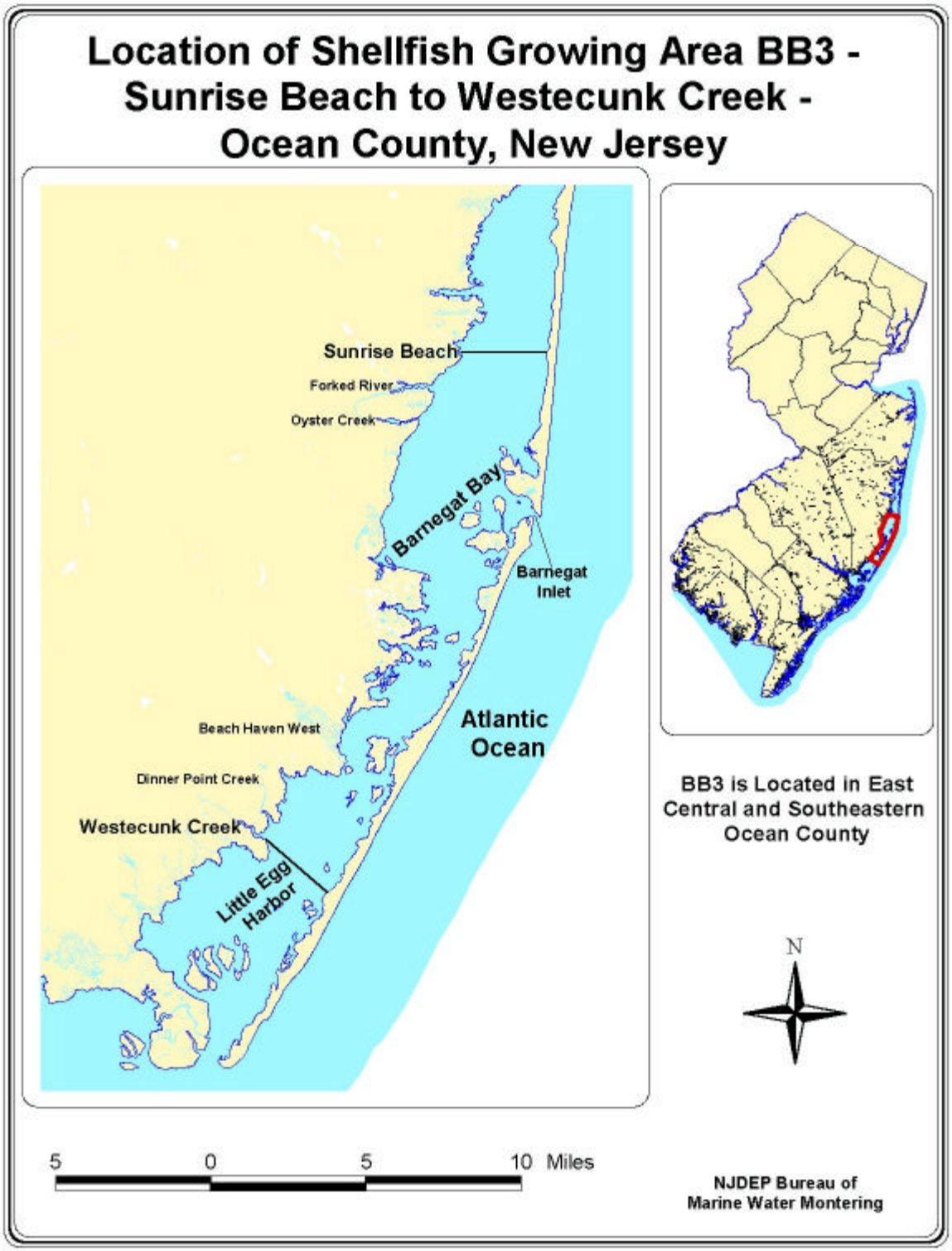

FIGURE 3: LOCATION OF SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY

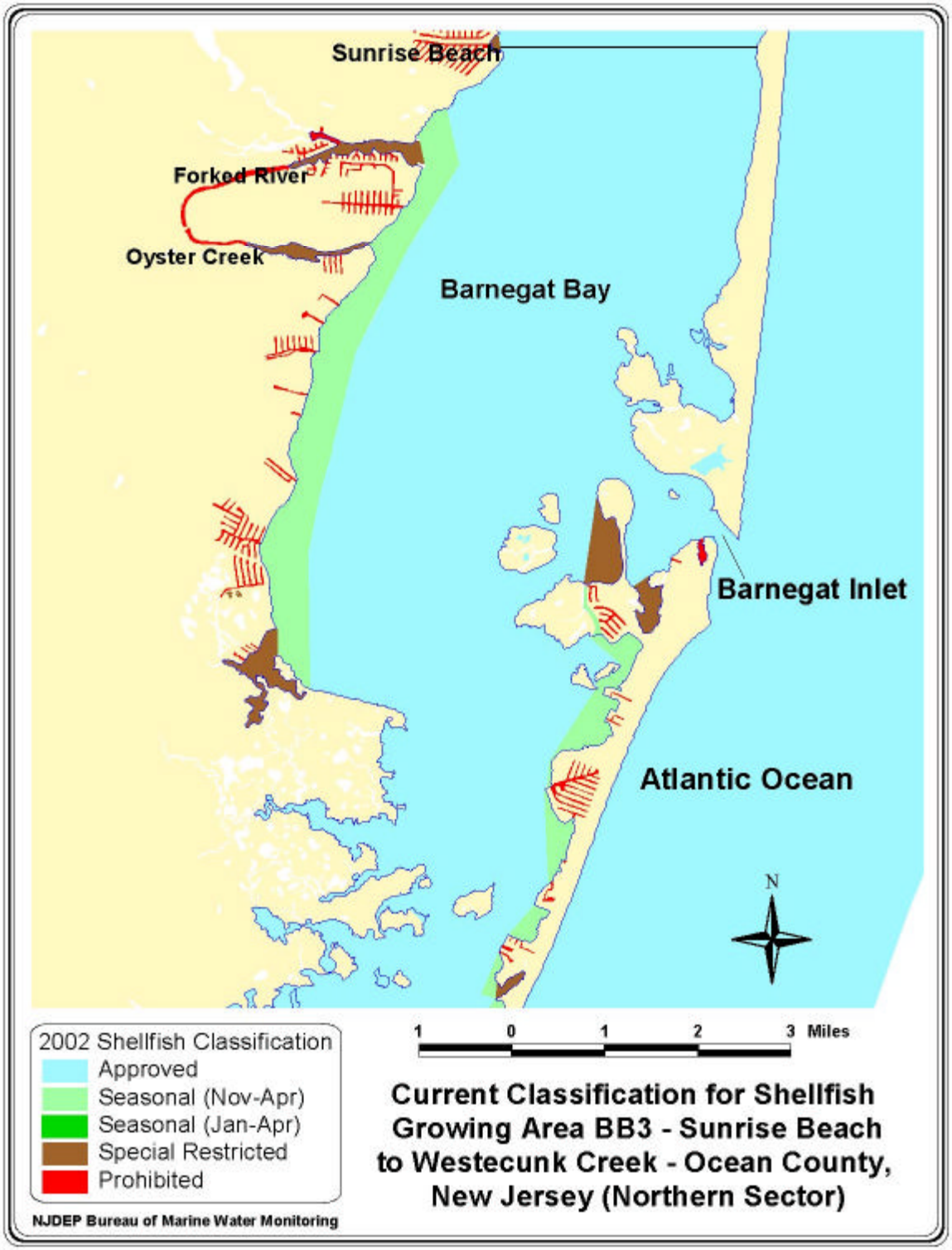

FIGURE 4: CURRENT CLASSIFICATION FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY (NORTHERN SECTOR)

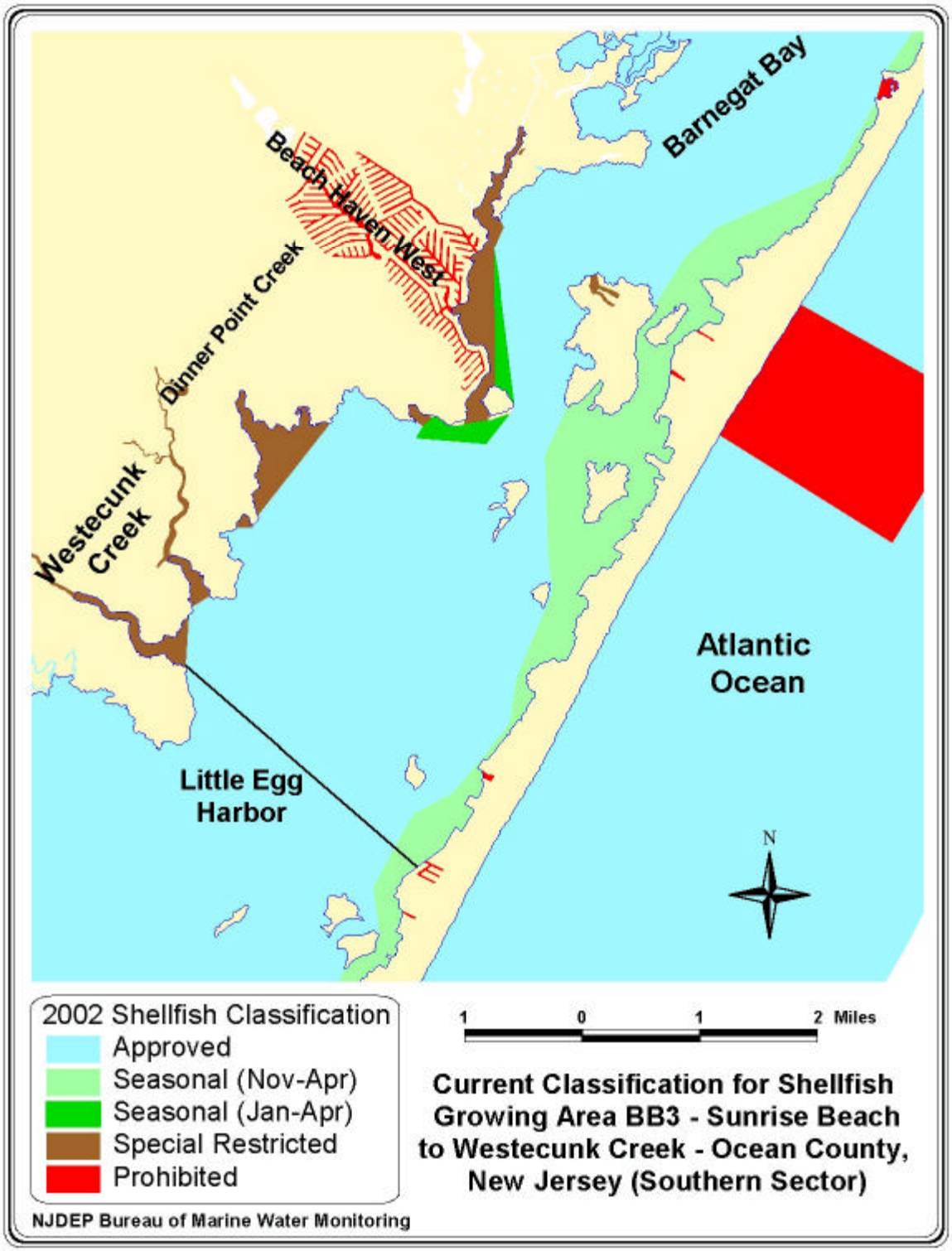

FIGURE 5: CURRENT CLASSIFICATION FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY (SOUTHERN SECTOR)

HISTORY

Historically, baymen working the *Approved* and *Seasonally Approved* sections of this shellfish growing area have harvested hard clams (*Mercenaria mercenaria*) and soft shelled clams (*Mya arenaria*). However, the dominant molluscan shellfish species in this area is the hard clam as minimal numbers of soft shelled clams are present today.

In 2001, it was suggested hard clams yielded 1.36 million pounds of meat leading to approximately 136,000 US Standard Bushels and an ex vessel value of 5.64 million dollars. These figures represent what was actually reported to the National Marine Fisheries Service. According to Jeff Normant of the Bureau of Shellfisheries (NJDEP), "there are no explicit reporting requirements so it is likely that actual numbers are a good deal higher than those shown above."

Were shellfish to be harvested from *Special Restricted* waters, they would have to undergo either depuration or relay. Depuration is a process by which shellfish harvested from areas classified as *Special Restricted* are brought to a depuration plant where they are placed in a controlled environment supplanted by ultraviolet light in order to remove coliform bacteria. Relay involves a process in which shellfish harvested from areas classified as *Special Restricted* are brought to leased plots in waters classified as *Approved*. Hard clams are required to remain in these waters for a minimum of 30 days in order to purge coliform bacteria from their systems. However, baymen have shown little interest in working the *Special Restricted* waters of BB3 within recent years as there is generally more stock within the northern sector of the state outside Monmouth County.

As previously mentioned, the Oyster Creek Nuclear Generating Station provides direct input into the waters of Shellfish Growing Area BB3. Discharge from this facility is located between Oyster Creek and Forked River.

The Oyster Creek nuclear power plant has historically not impacted the region's receiving waters with elevated total coliform levels (a pollution indicating organism), as this facility is not involved in wastewater treatment. Instead, the discharged effluent is derived from non-contact water, utilized in the operation and cooling of the power plant.

It has been suggested in previous growing area reports that this effluent source appears to have no direct impact on populations of microorganisms. Although elevated temperature of thermally polluted non-contact cooling water has the potential to promote growth of microorganisms, there is no pre-existing evidence that this has occurred over prolonged timeframes, causing problems or impacting the

Approved waters of BB3. However, it has been evidenced that significant change in ambient water temperatures, having been brought about by plant repair, can have significant impact on fish populations in the area. During time frames when the warmed effluent (i.e., non-contact cooling water) is not discharged, temperatures in surrounding waters can change by fifteen degrees in a fairly short period of time. Situations of this sort have resulted in fish kills on occasion.

The Oyster Creek generating plant is required by permit to monitor for radio nucleotide emissions on a quarterly basis. All monitoring reports must be sent to the New Jersey Department of Environmental Protection, Bureau of Environmental Radiation for review. To date, no problems which have impacted the quality of shellfish from *Approved* growing waters can be identified with the operation of the plant. None the less, a closed safety zone is still required to surround the discharge pipe from this facility. Should the Oyster Creek Nuclear Generating Station malfunction, this Bureau has sufficient time to cease shellfish harvesting in the vicinity of the plant and its discharge. As such, shellfish harvesting from contaminated waters and subsequent human ingestion is unlikely with the aid of safety zones, proper warning systems and proactive communication.

A history of "brown tide" (*Aureococcus anophegefferens)* algal blooms exists for this area. Brown tides come from Golden Brown Algae that are found in the Pelagophyceae family. They do not present a detriment to human health although brown tides can discolor back bay waters of New Jersey in an aesthetically unpleasant manner.

Previous BMWM growing reports suggest the following: Brown tides were first identified in lower Barnegat Bay in 1988. In 1995, a brown tide was identified in Little Egg Harbor. In 1997, these tides were identified in the lower Barnegat Bay and in the upper Little Egg Harbor area. In 1998 brown tides, although noted, were less pronounced in the bay areas. Brown tides have been prevalent in the years 1999, 2000 and 2001 with the 1999 tide providing an excessively large bloom over a prolonged period of time. It is likely that these Golden Brown Algae have appeared in both the Barnegat Bay and Little Egg Harbor areas on numerous occasions throughout the years as have many marine organisms. However, blooms or substantial gatherings of these brown tide organisms have been noted more readily within the last three years.

Population in the area surrounding BB3 has grown substantially during the last ten years. As such, the propensity for receiving waters to undergo an increase in nutrient loading exists. Currently, organic nutrient levels out weigh inorganic on comparison. This in turn may explain the observable presence of brown tides within the last decade. Brown tide algae utilize organic nutrients very readily, unlike many other phytoplankton which show an affinity for inorganic inputs. However, it should be noted that levels for nutrients (organic or inorganic) are not extremely high (in this growing area) when compared to some other NJ estuarine areas. Other feasible contributors for the greater presence of brown tides include the depletion of fresh water resources. As human populations grow, demand on water tables increase. This, in turn, can cause salinity level increase and temperature variation within estuarine

waters. Higher salinity levels and specific alterations regarding temperature levels (range at specific times of year) have also been considered as possible contributors to increased observations of these algae.

Combinations of water table depletion, salinity level increase, temperature change and nutrient level input leaning toward the organic side, could be providing ideal circumstances for this phytoplankton to competitively preside over other species (take hold at certain times of year).

The last Sanitary Survey covering this area was performed in 2000 and the last Reappraisal was written in 1996. All data analyzed in those reports supported current classifications for Shellfish Growing Area BB3. Results from the water quality analyses presented in these reports specifically indicated that the *Approved* waters in this shellfish growing area met all criteria for classification as *Approved*. As such, there were no stations exceeding sampling criteria on summary evaluation. Further, there were no indications of potential or actual impact from the Oyster Creek Nuclear Generating Station or its effluent discharge.

The trend for this growing area is one showing water quality improvement. This year's report (2003 Partial Sanitary Survey) found that all bacteriological data supported current classifications of the growing water but, at the same time, allowed for the upgrade for the *Seasonal* (Jan-Apr) waters located within the area due East of Beach Haven West to *Seasonal* (Nov-Apr) and the upgrade of a section of *Special Restricted* waters to the West of Barnegat Inlet to *Approved*.

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,* 1999.

A review of the records suggests that 5965 water samples were collected for total and fecal coliform bacteria between 1997 and 2001 and analyzed by the three tube MPN method (or three tube decimal dilution method) according to APHA (1970). Figures 24 and 25 show the Shellfish Growing Water Quality Monitoring Stations for Sunrise Beach to Westecunk Creek (BB3). 143 surface stations were monitored during each year and specifically analyzed for the 1997 – 2001 time frame that comprises this Partial Sanitary Survey.

The results were compiled from Assignments 102, 107, 114, 117, 121 and 122. They provide information on 39 different sampling runs. These were analyzed by the Bureau of Marine Water Monitoring at Leeds Point for total coliform and fecal coliform bacteria during the period of time from October

1, 1997 through August 30, 2001. Although water quality data was evaluated for Tc and Fc, final classification was based on total coliform.

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, 1999.*

As BB3 is an estuarine shellfish growing area within Barnegat Bay, it should be noted that classifications for back bay waters for New Jersey can encompass a broad range of designations from *Approved* to *Prohibited*. However, there are far more *Approved* waters within this growing area (BB3) than not. With this, the criteria for *Approved* waters regarding the 3-tube decimal dilution test proves to be the most frequently referenced classification criteria when considering delineation.

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 and this parameter has been used for the purpose of this report. However, New Jersey has been using fecal coliform data for analyzing and classifying its Atlantic Ocean Shellfish Growing Areas since 2003. As a general rule, New Jersey uses fecal coliform data for adjunct analysis in its shellfish growing areas, though.

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. They are utilized in determining classifications for growing areas.

The strategies are Adverse Pollution Condition (APC) and Systematic Random Sampling (SRS). 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 90th percentile. Tables 1 and 2 that follow this section are based on the 3-tube decimal dilution test 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 not exceeding 70 per 100 mL and the estimated 90th percentile shall not exceed an MPN of 330 per 100 mL (utilize 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.

Shellfish Growing Area BB3 (Sunrise Beach to Westecunk Creek) is sampled under the Systematic Random Sampling Strategy. This sampling strategy is utilized for BB3 because the discharge pipe or outfall source (i.e. the Oyster Creek Nuclear Generating Station) does not provide effluents that contribute, influence or present potential to routinely impact receiving waters.

Historically, BB3 has shown statistical trends for coliform level increase when analyzing rainfall correlations or tidal components. It has also shown seasonal variations or components most specifically related to the summer months. However, rainfall, tide and seasonal interactions have not produced

continuing high level bacterial contributions in a manner suggesting these influences are adverse and should be examined under APC strategy as opposed to SRS. As such, the SRS strategy is utilized where by *Approved* criteria is still achieved with regard to the influences noted above. Further, BB3 growing waters associated with correlations or components have been classified in a manner most appropriate for routine public health monitoring.

TABLE 1: 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 2: 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

Approximately 96 % of BB3 shellfish growing waters are currently classified as *Approved or Seasonally Approved* for the harvest of shellfish. As such, it is important to reiterate that the two molluscan species of commercial importance in New Jersey's bay waters are the hard clam (*Mercenaria mercenaria*) and the soft clam (*Mya arenaria*). One can appreciate the importance of conservation and management when considering these resources. Monitoring then becomes a primary tool when considering stock depletion from over fishing, species interaction with heavy metals, wastewater effluents or algal blooms.

There are no quotas set for the harvest of shellfish in *Approved* and *Seasonally Approved* waters. However, areas designated as *Seasonally Approved* can only be harvested during winter months. The specific months during which a *Seasonally Approved* area can be harvested are November through April (six months) or January through April (four months) depending on the variation of water quality within these time frames. An example of improved water quality prevails with this Partial Sanitary Survey as the data present an opportunity for the BMWM to extend the *Seasonal* harvesting period for the area outside Beach Haven West by two additional months. Further, a section of *Restricted* waters to the West of Barnegat Inlet is proposed for upgrade to *Approved* classification.

There are occurrences of algal blooms in the back bays and estuarine waters of New Jersey as suggested in the preceding section on history. Algal blooms tend to occur in these waters from early spring through the warmer months of summer.

In recent years, brown tides have been observed in the waters of this growing area. Brown tides usually start up in the back bays during early to mid spring. As these tides grow in size, they frequently work their way toward the ocean via inlets. This usually occurs during late spring or early summer.

There are no known threats to human health from brown tides. However, as noted previously, brown tides can create aesthetically unpleasant circumstances with regard to discoloration of our intercoastal water resources. This in turn negatively impacts recreational activities such as swimming, boating and fishing. Additionally, brown tide algal blooms can reduce shellfish growth via an inhibitory substance on the cell surface which reduces feeding response in some molluscan shellfish such as the hard clam. This inhibition of feeding or filtering response has been noted by aquaculturalists involved in farming the this clam. This can result in the loss of clam seed.

Brown tides can also reduce habitat important to many marine organisms. As the algal population grows, it reduces the available light normally provided to marine vegetation. This loss of light causes the flora (especially eelgrass) to die off. This in turn disrupts the food web causing a reduction in finfish and shellfish populations.

Again, 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 incorporate marine water monitoring for potential toxicity in shellfish with regard to any notable presence of toxic marine phytoplankton. No occurrences of algal blooms connected with the presence of biotoxins have been recorded for the time period covered by this report.

LAND USE

Two specific vegetative communities comprise the ecosystems surrounding this shellfish growing area. They are generally composed of either wetland or pineland forest species. Urban environments are interspersed and make up the primary development in the area.

There is little agriculture connected with the lands abutting BB3. As such, impact from runoff bearing fecal waste from domesticated farm animals is not generally of concern.

The mainland side of the bay as shown in Figures 6 and 7, has large areas of wetlands, which become forested lands further inland. Many of these wetlands make up the protected lands of the Edwin B, Forsythe National Wildlife Refuge. Further, there are wetlands to northeast, which make up another protected area across the Barnegat Inlet, known as Island Beach State Park. Generally, the barrier islands that make up the eastern side of BB3 have sporadic areas of wetlands located in or alongside the bay.

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. This occurs as many wetland

plant species have specific cells that provide storage areas for pollutants. They help remove excess inorganic and organic nutrients from water systems in these areas. This, in turn, provides nutrition for salt marsh vegetative species. With this, salt marsh flora frequently act as water purifiers by preventing some contaminants from making their way through the food chain.

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 less likely to impact our estuarine growing area.

Feral animal populations also make their homes in salt marsh locations or utilize these areas while migrating along the coastal waters of New Jersey. This wildlife can impact state waterways by contributing increased counts of coliform bacteria by way of fecal waste.

Specific impact to water quality can be observed from flocks of wild birds, both indigenous and migratory, utilizing wetland locations in or near our shellfish growing areas. This occurs when fecal wastes from these bird populations are deposited directly into the waters or carried by storm water runoff.

The majority of the urban developed areas on the mainland side of the bay consist of lagoon communities. These communities consist of lanes of dredged lagoons (canals) running through developed residential communities. The canals provide access to the bay for boat traffic. Pollutants from these areas are generally more prevalent during the summer with population and utilization on the increase.

Lagoon communities are frequently the choice for recreational boaters. This activity also provides impact to these waters as marina pumpout stations, although available, are not always utilized by boat owners. This results in human waste being discharged overboard. Further, petrochemicals are added to bay and lagoonfront waters during operation of boats as marine engine fuels are not fully utilized by two cycle engines during combustion. Unspent fuels can collect or be most prevalent in lagoonfront communities and marinas. Petrochemicals from automotive traffic are also washed into these areas via storm water outfalls.

Runoff can especially impact lagoon communities where pollutants can be concentrated for some time depending on rain, wind and tide. With this, lagoons are always classified as *Prohibited* waters. Further, the mouths of most lagoons have been classified as *Seasonally Approved* or *Special Restricted* waters, providing additional buffers.

Most urban communities associated with the BB3 site (including the coastal areas) have storm drains that collect runoff and convey it to outfalls, which empty into the bay. Impact also occurs from pollutants that find their way to the bay from rivers and streams located to the West. Storm water runoff from developed communities in outlying urban areas can also contain fecal waste from domestic pets, petroleum residuals from cars and other pollutants.

The eventual conveyance of pollutants from storm water drains can be maximized at times. Pollutants within these systems have often been held for some time before receiving enough water to flush or purge the infrastructure.

The barrier islands to the East of BB3 also provide impact to the waters of this shellfish growing area, as noted previously. Aside from storm water runoff, which in most cases is oriented toward the bay, barrier island communities have a substantial number of lagoonfront communities and marinas as do the communities to the West. These areas are appropriately classified though and buffers have been utilized for marinas and lagoonfront entrances. The restrictive classifications and buffers in this growing area have provided protection to *Approved* or Seasonally *Approved* growing waters as per the data presented in this Partial Sanitary Survey.

Development along the coast is also urban and presents many of the same circumstances as those discussed in the preceding paragraphs. Naturally, as populations along the shore grow during the warmer months due to increased shore rental and homeowner use, so do the impacts to the nearby waterways and shellfish growing areas.

The communities along the shore and those immediately to the West are primarily using city water and sewer. There are communities further inland that utilize septic, but the distance from these communities to this shellfish growing area provides limited impact to the waters of BB3 from septic systems.

Barnegat Inlet allows for interaction of the waters of this area with waters of the Atlantic Ocean. The ocean waters bordering this area consist of *Approved* waters and are unlikely to adversely impact the waters of this area. Rather, the tidal flow and mixing of estuarine waters with the Atlantic Ocean helps flush the waters of BB3 and prevent accumulation of pollutants.

Numerous small rivers and streams empty into these shellfish growing waters, too. These include Forked River, Oyster Creek, Dinner Point Creek, Westecunk Creek (West Creek) and multiple small streams located in the Edwin B. Forsythe National Wildlife Refuge.

The streams noted above are classified as *Prohibited* or *Special Restricted* depending on the degree of urban development and subsequent impact to the waterway. The use of *Special Restricted* or *Seasonally Approved* buffer zones are often designated (when necessary) at the mouths of these waterways to prevent adverse impact to the *Approved* waters of this shellfish growing area.

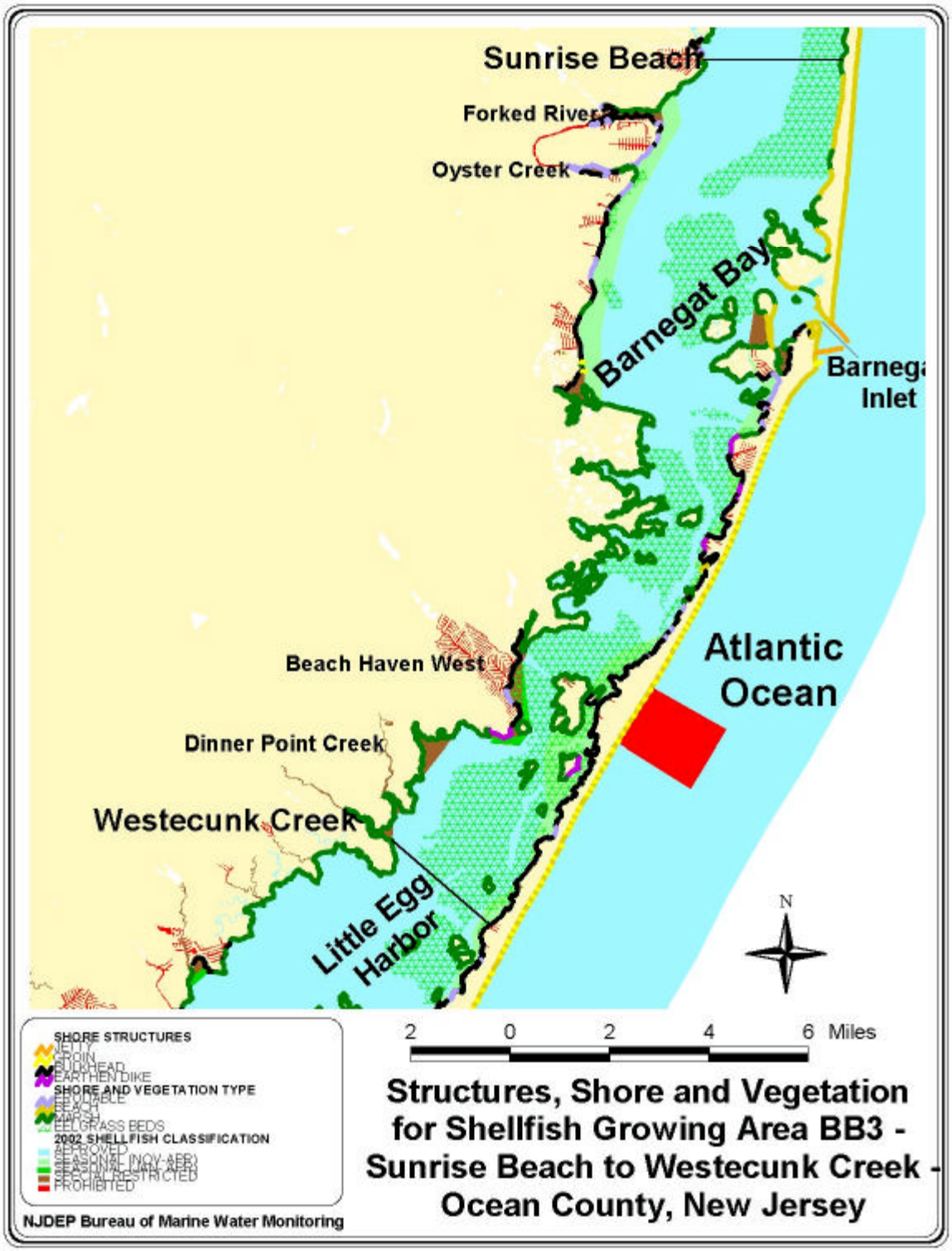

FIGURE 6: STRUCTURES, SHORE AND VEGETATION FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY

FIGURE 7: COASTAL LAND USE PATTERNS FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY

CHANGES SINCE LAST SURVEY

The last Sanitary Survey for Shellfish Growing Area BB3 was written in 2000. As such, the changes have not been that numerous. However, the two most noteworthy differences would be population increase [comparing most recent census figures (2000) with those of 1990] and water quality improvement within the area outside of Beach Haven West and West of Barnegat Inlet.

Comparisons between the 1990 Census and the 2000 Census suggest that population in Ocean County grew from 433,203 in 1990 to 510,916 as reported in 2000. This accounts for an increase of 77,713 or 17.9%. Of the municipalities shown in Figure 8 and Table 3, all but four showed an increase in population over the last ten years. The areas reporting a decrease in population were Harvey Cedars Borough (-0.8%), Long Beach Township (-2.3%), Eagleswood Township (-2.4%) and Beach Haven Borough (-13.4% - note - Beach Haven has highest tax ratable on Long Beach Island). The range for population increase was from 2.4% (Ship Bottom Borough) to 69.1% (Stafford Township). As a general rule, non-coastal communities bordering BB3 showed the largest increase in population. The average growth for these areas was 20.91%. Coastal municipalities showed an expansion in population of .67%.

Despite increased population in nearby municipalities, the enclosed data and subsequent analysis suggest a trend toward improved water quality within the area East of Beach Haven West and West of Barnegat Inlet. Improved water quality within an area experiencing population growth appears to be indicative of municipal plans and infrastructure designs (storm water management – wastewater treatment facilities, etc.) that are capable of supporting the populace or increased population they serve.

The interaction of municipal planning, design and technological improvements, when coordinated properly, can account for healthier ecosystems. This will be discussed further in the sections that follow on direct and indirect discharge sources. However, the BMWM is able to focus this Partial Sanitary Survey on reclassifying portions of BB3 (an area of waters outside Beach Haven West) from *Seasonally Approved* (Jan-Apr) to Seasonally *Approved* (Nov-Apr); reclassification for a section of *Restricted* waters just West of Barnegat inlet is also planned. Our ability to make these upgrades is based on analysis of data obtained from monitoring while coupling that information with specific site inspections and shoreline surveys.

FIGURE 8: COASTAL MUNICIPALITIES FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY

TABLE 3: POPULATION INFORMATION FOR SHELLFISH GROWING AREA BB3 – SUNRISE BEACH TO WESTECUNK CREEK – OCEAN COUNTY, NEW JERSEY

Community	Area (sq. mi.)	Population (2000 Census)	Population Density/Sq. Mi.
Lacey Twp.	99.41	25,346	254.96
Ocean Twp.	31.67	6,450	203.66
Barnegat Twp.	39.87	15,270	383.00
Stafford Twp.	55.11	22,532	408.86
Eagleswood Twp.	18.88	1,441	76.32
Little Egg Harbor Twp.	73.40	15,945	217.23
Tuckerton Boro	3.69	3,517	953.12
Berkeley Twp.	54.13	39,991	738.80
Long Beach Twp.	20.68	3,329	160.98
Barnegat Light	1.0	764	764.00
Harvey Cedars Boro	1.36	359	263.97
Surf City Boro	1.32	1,442	1092.42
Ship Bottom Boro	.99	1,384	1397.98
Beach Haven Boro	2.33	1,278	548.50

IDENTIFICATION AND EVALUATION OF SOURCES

DIRECT DISCHARGES – Nuclear Generating Facility Effluents

The Oyster Creek Nuclear Generating Station is the only direct effluent source identified in this area. The primary discharge from this facility is non-contact cooling water. This involves the discharging of thermally impacted waters (elevated temperature levels) into Oyster Creek.

The discharge location in Oyster Creek is approximately 2.33 Nautical Miles from Barnegat Bay allowing for additional mixing and dilution. Significant safety zones (*Prohibited* area classifications) have been established around the Oyster Creek canal area receiving this thermally charged water. Further, there are *Restricted* buffers located further out toward the mouth of the creek and abutting bayfront areas have been blanketed with *Seasonal* classifications, providing additional buffers.

Aside from monitoring, site visitations are important as this plant represents the only significant potential point source of contamination in the BB3 site. An updated summary of the Oyster Creek Nuclear Generating Station follows below.

Oyster Creek Nuclear Generating Station

On December 17, 1999, BMWM staff visited the Oyster Creek Nuclear Generating Station. It is located in Lacey Twp. on Route 9 in Forked River, New Jersey. Our staff met with James Vouglitois, Manager of Environmental Affairs for the plant. It should be noted that this nuclear power plant was owned by GPU, Inc. and was operated by GPU Nuclear, Inc. (subsidiary company) at the time of site inspection. In August 2000, it was purchased by AmerGen Energy Company, LLC representing a joint venture involving Exelon and British Energy.

The Oyster Creek nuclear facility as pictured in Figure 9 and evaluated in Table 4, utilizes a single boiling water reactor to produce 650 net megawatts of electricity. The plant has a NJPDES Permit (#NJ0005550) that allows them to discharge the following: non-contact cooling water from the operation of the plant, storm water runoff and water from a sump pump in the basement of the generating facility. The water from the sump pump has some contamination from radioisotopes. Previously, there had been a practice of discharging "hot water" from the sump pump but this was discontinued thirteen years ago. However, the facility's NJDPDES Permit still covers or allows for this practice. At present, the water from the sump pump is disposed of in the same manner as radioactive waste from the operation of the facility.

There is a horseshoe shaped canal connecting Forked River and Oyster Creek, which provides non - contact cooling water for this facility. One million gallons per minute (GPM) flow through the canal. The plant takes in 115,000 GPM of this water with the aid of four pumps and utilizes it as non-contact cooling water. Once utilized, the water is then returned to the canal after having been thermally impacted.

The NJPDES Permit issued to this generating station allows non-contact cooling water to have a temperature increase of no more than 23? F over the ambient temperature of the receiving water. The maximum allowable ambient temperature is 106? F. The average increase in temperature is 20? F. During the summer, warmer ambient water temperatures in the canal are such that added thermal impacts can raise the temperature of discharged waters to over 106? F. During these periods, the facility slows its operation.

Water extracted for use as non-contact cooling water is also chlorinated to prevent biogrowth from clogging the exchange pipes. The NJPDES Permit for this facility sets the chlorination limit at .2 ppm for discharged waters.

This facility is required by its operation permit to test the local environment for impacts from radiation. This provides information for an annual report that must be compiled and submitted to the United States Nuclear Regulatory Commission. Testing includes air particulates, soil, stream and bay sediments, shellfish, crustacean and finfish flesh. Two primary isotopes examined for this report include Cobalt - 60 and Cesium - 137. Comparison or background samples are taken from Great Bay.

There have been occasions when fish kills have be associated with the Oyster

Creek Nuclear Generating Facility. Rapid ambient temperature increases resulting from warm water effluents have been the cause in such instances. When reviewing research gathered from the Nuclear Regulatory Commissions' web site, www.nrc.gov/ and the Bureau of Environmental Radiation (NJDEP) site at www.state.nj.us/dep/rpp/ber/, these events have been rare. However, a recent circumstance of this nature occurred in 2002 while repairs were under way at the plant.

Aside from circumstances related to sudden increases in the ambient water temperature, the Oyster Creek Nuclear Generating Facility has not shown questionable instances of environmental impact and operational standards appear to be in order.

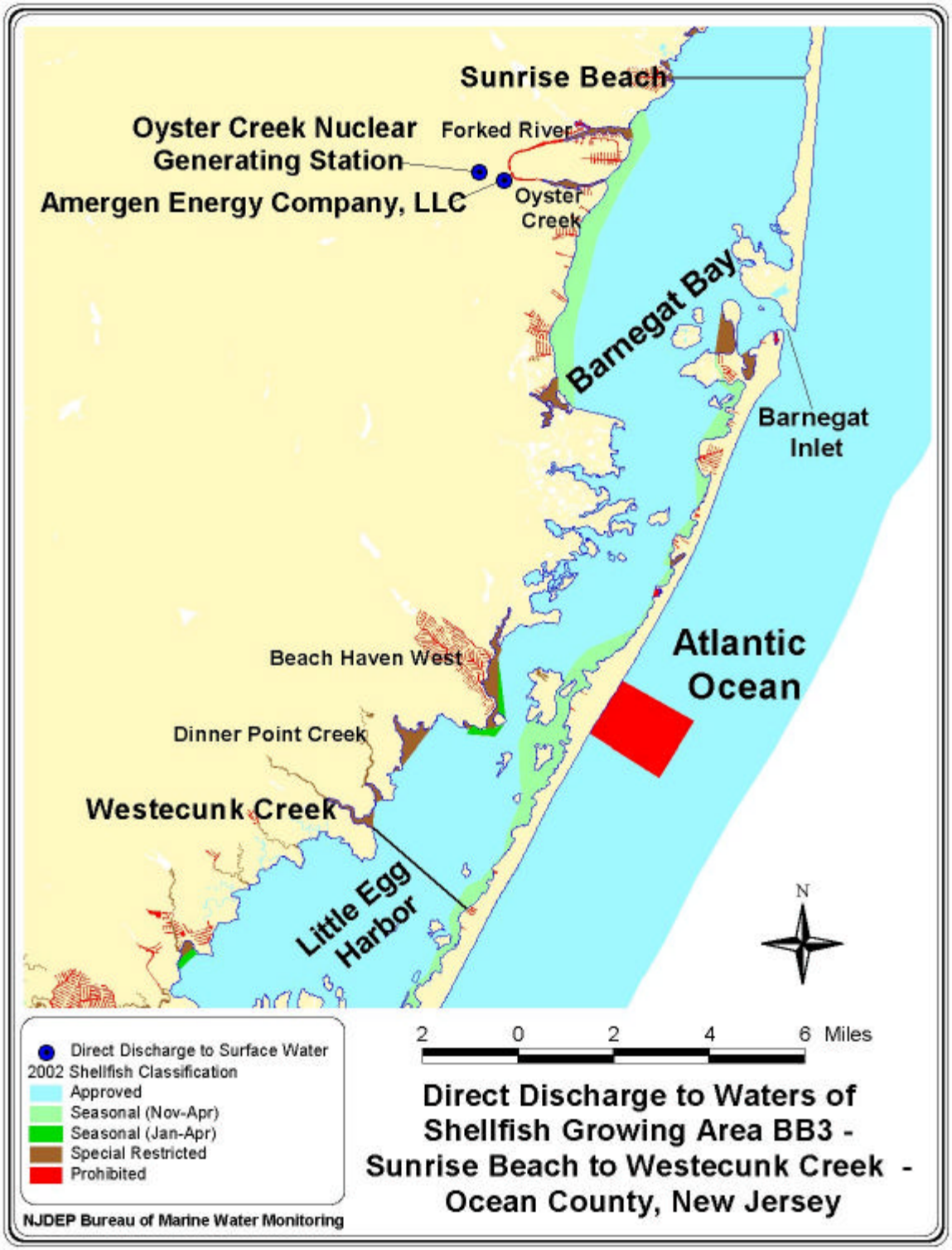

FIGURE 9: DIRECT DISCHARGE TO WATERS OF SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY

TABLE 4: DIRECT DISCHARGE TO SHELLFISH GROWING AREA BB3 – SUNRISE BEACH TO WESTECUNK CREEK – OCEAN COUNTY, NEW JERSEY

Facility Name	Waste Type	Waste Quantity (GPM)	Discharge
Oyster Creek Nuclear Generating Station	Non-Contact Cooling Water Influent w/ Chlorination Added	115,000	Thermally Impacted Water Effluent

INDIRECT DISCHARGES

In addition to the direct discharge from the Oyster Creek nuclear generating facility, additional impact to the area comes from indirect discharges via non-point sources. Storm water outfalls provide the primary conduits for non-point sources reaching the waters of BB3, although there are other sources which will be discussed in the sections that follow.

Spills or Other Unpermitted Discharges

There were no spills recorded that resulted in closure of the waters of BB3 during the time period covered in this report. However, there are contaminated sites outside the growing area and their potential to impact the waters of this site are described in the paragraphs that follow.

Of the contaminated sites identified for this region (see Figure 10), few are located in close proximity to the shoreline of BB3. Any that are closer to the shoreline have primarily been identified as service stations with storage tanks that leaked. Remedial action to eliminate any contamination is required of the responsible parties at each of these locations. The BMWM works closely with NJDEP site remediation programs to ensure that potential contaminants from these sites do not reach shellfish growing waters. Generally, the sediment surrounding the tanks will absorb any contaminants discharged to soil from underground fuel tanks. As such, there is reduced risk for these contaminants to reach marine waters per soil absorption. Further, there is considerable distance from these locations to the shellfish growing area. If ground waters were contaminated, substantial dilution would occur between the petroleum leaching source and these growing waters.

Were petroleum products to reach the waters of this shellfish growing area, they are likely to cause minimal impact to shellfisheries during the short term. Petrochemical materials do not mix well with water, having a tendency to float on the surface. As shellfish are bottom dwellers, long term inundation from petrochemical materials is unlikely.

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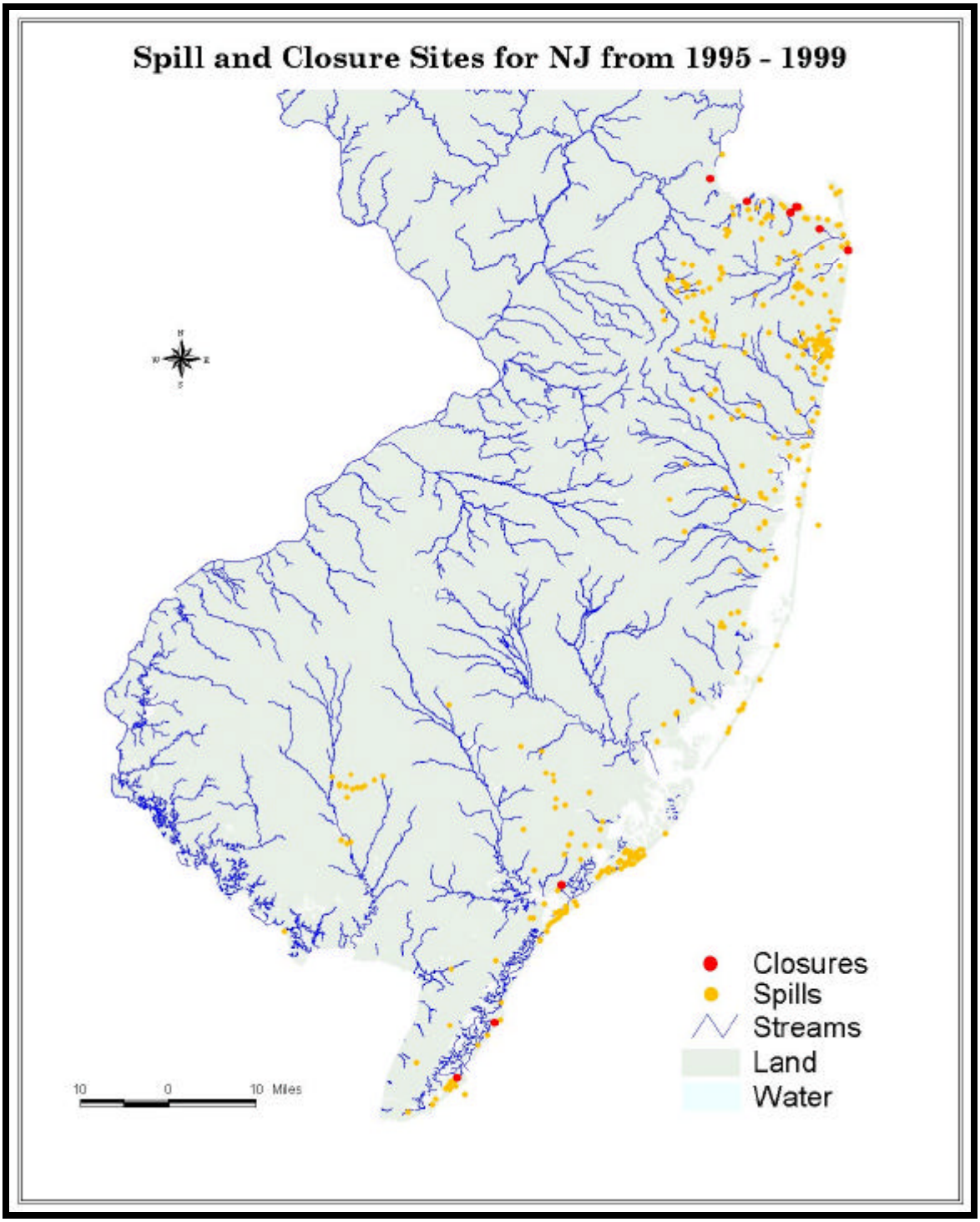

FIGURE 10: SPILLS OR OTHER UNPERMITTED DISCHARGES

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, floating docks, piers, 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 providing service to vessels such as repairing, fueling, security or other related activities" and designates the confines of the marina as *Prohibited* for the harvest of shellfish." Adjacent waters are classified utilizing a dilution analysis formula or formulas, in conjunction with marina occupancy rates and more specific criteria when necessary.

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

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

EQUATION 1: NJ MARINA BUFFER EQUATION (ADAPTED FROM FDA - 1989)

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°, 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 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 is utilized for complex configurations, calculating in tidal exchange and bacterial die-off as well.

There are 51 marinas in Shellfish Growing Area BB3. Their locations can be noted in Figure 12. Generally, the marinas are spread throughout the back

bay shorelines of this area (both western and eastern shores). The majority of the marinas are located within or outside developed urban areas. Frequently, as noted in Figure 12, marinas are located outside lagoon and bayfront communities, cove areas, streams or rivers. The largest clusters of marinas in BB3 are located in Forked River, Barnegat, Barnegat Light and Ship Bottom. There are no marinas on the most northeast section of barrier beach shown in Figure 12, as that section is part of Island Beach State Park.

As mentioned before, the waters enclosed by marinas are classified as *Prohibited*. Depending on the size of the marina and water quality, the waters immediately adjacent to said marina may be classified as *Prohibited*, *Special Restricted* or *Seasonally Approved* (no harvest during summer months when the marina is active).

Marina buffer zones were calculated using the NJ Marina Buffer equation (see equation 1 above) in conjunction (when more specific parameters are necessary) with the computer model developed by the State of Virginia and approved by the USFDA. The names of marinas, number of boat slips and size of buffer zones are shown in Tables 5, 6 and 7.

FIGURE 11: HOLIDAY HARBOR MARINA - SOUTH OF OYSTER CREEK (DEC. 19, 2002) - SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY (NORTHERN SECTOR)

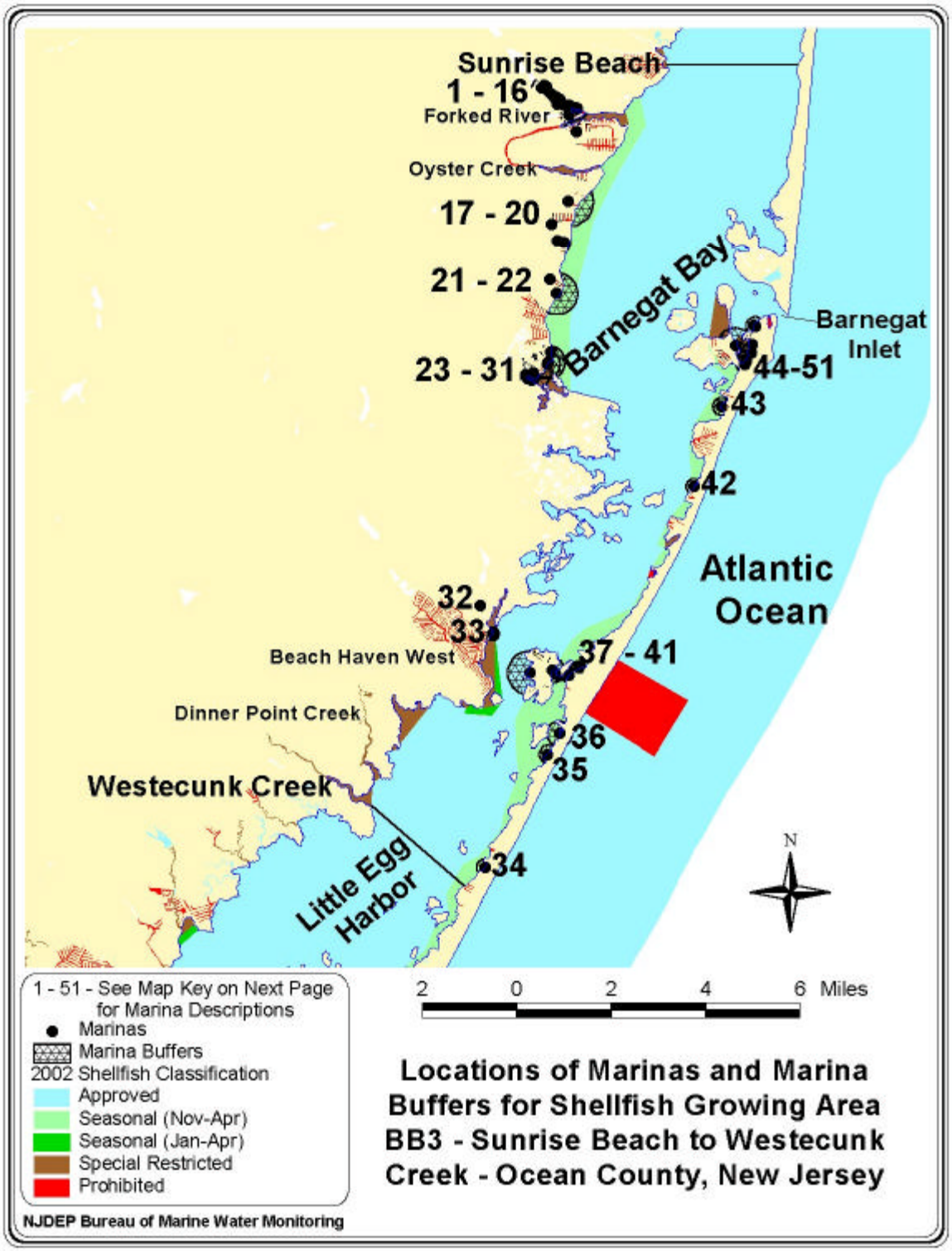

FIGURE 12: LOCATIONS OF MARINAS AND MARINA BUFFERS FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY

TABLE 5: MARINA FACILITIES LOCATED IN SHELLFISH GROWING AREA BB3 – SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY

Map Key	Marina Name	Total # of Boat Slips	# of Slips over 24 ft	Size of Buffer Area (radius; feet)
1	Lacey Elks 2518	50	50	1417
2	Southwind Marina	145	145	1206
3	Captain's Inn	30	30	549
4	Forked River Town Dock	11	11	332
5	Rick's Marina	81	81	902
6	River's Edge Marina	30	25	593
7	Townsend's Marina	100	45	771
8	Ted & Son's Marina	53	40	835
9	Tide's End Marina	31	31	596
10	Grant Boat Works	50	50	634
11	Tall Oak's Marina	104	104	1092
12	River Lights, Inc.	39	39	560
13	Baraa Marina	15	15	491
14	Silver Cloud Harbor	54	54	787
15	Wilbert's Marina	17	17	442
16	Forked River State Marina	125	115	1086
17	Holiday Harbor Marina	200	200	2834
18	Long Key Marina	130	40	1128
19	Mac's Dock	8	8	463
20	Sanborn Marine Center	210	75	1486
21	Leaming's Marina	76	31	1309
22	Cape Island Marina	265	187	2355

TABLE 6: MARINA FACILITIES LOCATED IN SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY

Map Key	Marina Name	Total # of Boat Slips	# of Slips over 24 ft	Size of Buffer Area (radius; feet)
23	Mystic Sailing Port	8	8	463
24	Iggie's Dock & Marina	135	135	1901
25	Bob's Bay Marina	82	82	1481
26	Mariner's Marina	142	142	1949
27	Dirb Boats	20	20	732
28	East Bay Marina	29	29	881
29	Bob's Dockage	9	9	491
30	Barnegat Boat Basin	13	13	590
31	Sherer's Boat Basin	60	60	1267
32	Hance & Smyth, Inc.	20	20	732
33	Margo's Inn	40	40	732
34	Haven Beach Club	50	25	918
35	Merit Marine	35	18	949
36	Sunset Marina	50	50	1417
37	Causeway Boat Rental	300	100	2470
38	Duck Inn & Marina	50	50	1417
39	Duke's Boat Rental	9	9	601
40	Hockstrasser's Marina	70	70	790
41	Surf City Marina	71	71	755
42	The Boat Yard	18	18	850
43	Loveladies Marina	50	50	1002
44	Viking Village	30	30	896

TABLE 7: MARINA FACILITIES LOCATED IN SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY - NEW JERSEY

Map Key	Marina Name	Total # of Boat Slips	# of Slips over 24 ft	Size of Buffer Area (radius; feet)
45	Barnegat Light Yacht Club	54	54	1202
46	Inlet Marine	38	38	1008
47	Bayview Marina	45	45	1097
48	High Bar Harbor Marina	150	150	2004
49	Ed's Boat Rental	58	58	1246
50	Henry's Boat Rental	12	12	401
51	Lighthouse Marina	80	80	1035

Wetlands

Mosquito ditching and the use of pesticides in wetland areas represent two practices, which may cause impact to the waters of this shellfish growing area. Specifically, scientists have questioned the cost, benefit and risk of such practices. Although this report does not attempt to assess these practices, their potential impact is brought forth for discussion purposes.

Mosquito ditching has been utilized extensively as part of insect control in New Jersey and can be found in salt marsh areas associated with BB3. Ditching is intended to reduce standing water in salt marshes. By design, ditching creates a series of tidal pathways. Small fish utilize these paths in order to feed on mosquito larvae concentrated in the ditches.

As Mosquito ditching reduces standing water associated with salt marsh ecosystems, it reduces the area mosquitoes have for propagating. However, ditching can result in reducing productivity and nutrient intake in salt marsh environs as soil and plant mass specific to these processes are removed.

The past and present use of pesticides and their potential for impacting our ecosystems is no new revelation. Again, questions of cost, benefit and risk associated with such practices arise and should always be weighed. Any introduced substance or physical altering of a biosystem can cause change to that system. With that, we can summarize by suggesting there is potential impact from pesticide use (past and present) although the BMWM is not required to assess this scenario with regard to classifying shellfish growing waters in New Jersey.

Lagoon and Bayfront Communities

The author conducted a shoreline survey for shellfish growing area BB3 on April 30, 2003. Specific attention was given to the lagoon and bayfront community of Beach Haven West and an area to the West of Barnegat Inlet, as portions of the waters within proximity to those locations are proposed for upgrade in this report evaluation.

Lagoon and bayfront communities like Beach Haven West, are of specific interest when viewing the land, development and use of environs surrounding this shellfish growing area. The potential for indirect discharge into the surrounding waters is enhanced within lagoonfront communities such as Beach Haven West.

Located in Manahawkin, Beach Haven West is the largest lagoon community within these shellfish growing waters. As mentioned in the previous section on Land Use, lagoon communities are residential developments which have dredged lanes (canals) or lagoons which allow waterborne access to the bay for most residents of the community. The canals in a lagoon community can have significant contamination from storm water runoff; generally there are numerous storm water outfalls within these types of urban areas.

Boating also contributes its share of pollutants to the waters of these intercoastal communities. Impacts can be caused by or include spills containing petroleum products utilized in motors and during fueling and reconditioning processes. Further, cleaning materials and paints used in the maintenance of marine vessels can also be contributing sources of pollution. As populations in these areas increase with warm weather, impacts of this sort generally are more prone to happen during the summer months.

In addition, the preserved wood (CCA – pressure treated lumber) used to make bulkheads and docks contains various heavy metals. CCA is utilized in lagoonfront communities, marinas and many of the stream and riverfront communities contributing to the waters of BB3.

Heavy metals such as arsenic, chromium and copper, used as preservatives in the wood making process, are readily disposed to shellfish growing waters through leaching and aging processes. In addition, a bi - product is created by this leaching process with the oxidation of hydrocarbons, which produces polyaromatic hydrocarbons (PAHs). Many PAHs are known carcinogens which can concentrate in the tissue of shellfish or other marine organisms.

Because of the potential for indirect pollution sources within lagoon and marina proper locations, the BMWM classifies these areas as *Prohibited*. In order to prevent impact to *Approved* waters outside these locations, buffers are utilized. Buffers may be *Prohibited*, *Special Restricted* or *Seasonally Approved* as per the determinations placed on water quality from routine analysis by the BMWM.

A major source of tidal exchange and interaction of waters in this area is the

Barnegat Inlet. Waters on both sides of the inlet are classified as *Approved* with the exception of some small pockets of *Restricted* waters on the western side. The interaction of Barnegat Bay with the Atlantic Ocean provides mixing for waters of this area. This process is associated with natural water quality maintenance within the BB3 growing site. There is also some interaction with Atlantic Ocean waters through Little Egg Inlet, which is further to the south and more closely associated with the next back bay shellfish growing area (BB4).

Waters immediately adjacent to shorelines where urban development exists can receive input from runoff. Further, contaminants tend to accumulate within lagoonfront communities near these shorelines due to limited mixing of the waters. With this, tidal exchange can provide an avenue for pollutants to move and interchange with waters further from these areas. Movement of waters or mixing can cause statistical variations in the data. These variations are referred to as tidal components in Bureau reports. Most of the stations impacted by tidal exchange or showing statistical tidal components are near areas of urban development. These stations are frequently noted at the mouths of lagoons, creeks and rivers. The regions of *Seasonally Approved* waters, which line the urban developed regions of this area, help to prevent impacts to water during the warmer months when these impacts would be the greatest. This will be discussed further in the section on hydrology and meteorology that begins on page 45.

FIGURE 13: LAGOONFRONT COMMUNITY FOR SHELLFISH GROWING AREA BB3 - BEACH HAVEN WEST - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY (SOUTHERN SECTOR)

Storm Water Inputs

There are storm water outfalls within lagoons, streams and waterways that empty into this area. Rain event runoff can carry a variety of materials including fecal waste from domestic pets and feral animals living in or within close proximity to urban neighborhoods near these growing waters. It also feasible

that animal remains, petroleum by-products and fertilizers find their way into our coastal and intercoastal water resources from storm water outfalls.

Bird populations living in wetland and forested areas upstream deposit fecal waste that can be picked up by runoff from storms. Flocks of waterfowl can also deposit waste directly into the waters of this area.

Storm water runoff in this area is not always channeled to storm drains but frequently flows over land and into streams. Water flowing through large wetland or wooded areas can have a cleansing effect though. This occurs when inorganic and organic nutrients are removed by the flora, which in turn utilize these nutrients for growth. Generally, storm water runoff is not as problematic in wooded and wetland regions as it is in more developed areas.

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 from waste entering stormwater collection systems.

Historical data comparing the difference between coliform levels measured after rainfall with those during dry periods were compared to generate Figure 14. The Bureau of Marine Water Monitoring has begun to identify particular storm water 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 indicates 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 of primarily rainfall data or dry weather data. In this case, if there are insufficient data points in each category, the test for significance cannot be done.
- Data collected after rainfall in the normal sampling regime may miss the effects of the “first flush.”
- Rainfall data are 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).

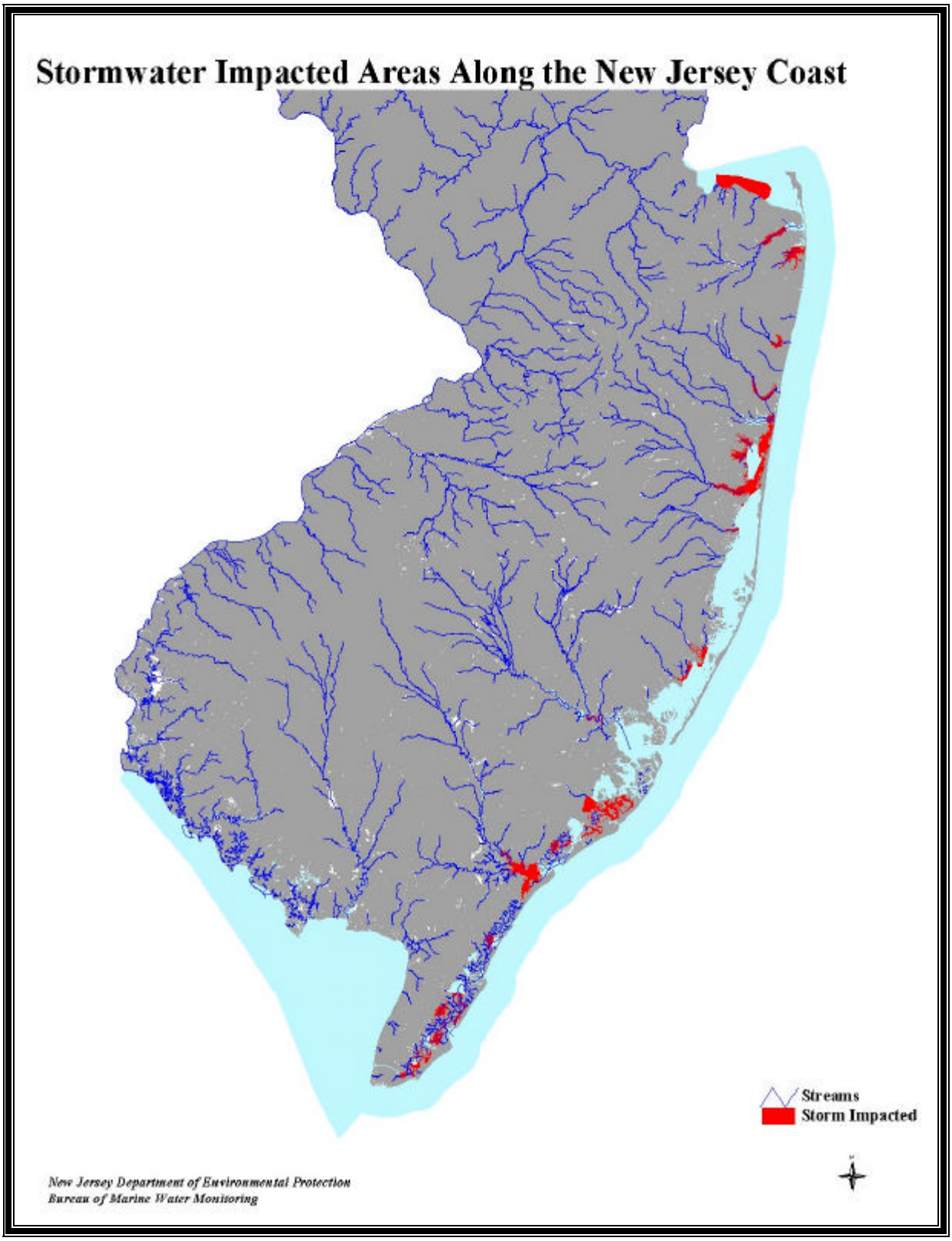

FIGURE 14: AREAS IMPACTED BY STORMWATER

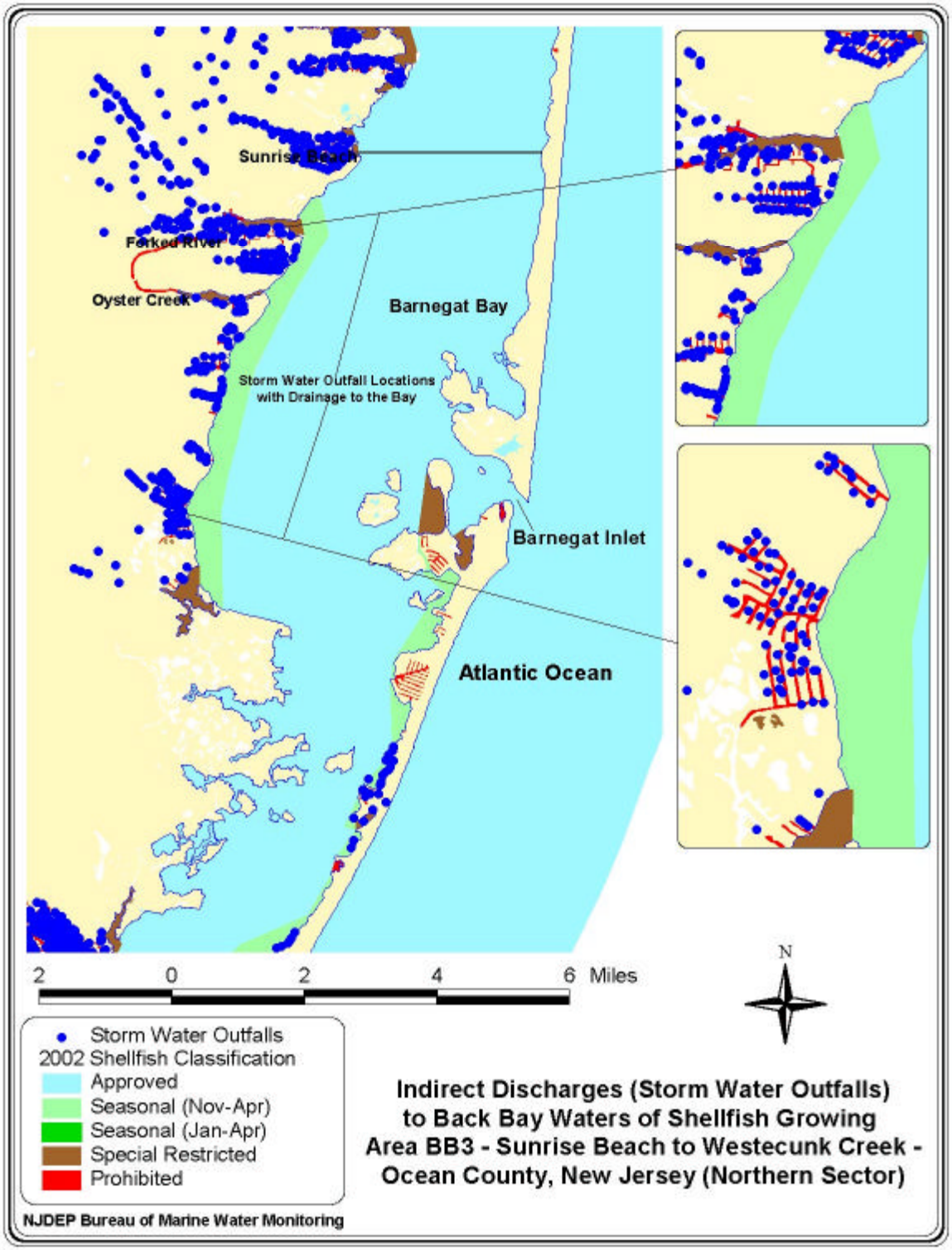

FIGURE 15: INDIRECT DISCHARGES (STORM WATER OUTFALLS) TO BACK BAY WATERS OF SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY (NORTHERN SECTOR)

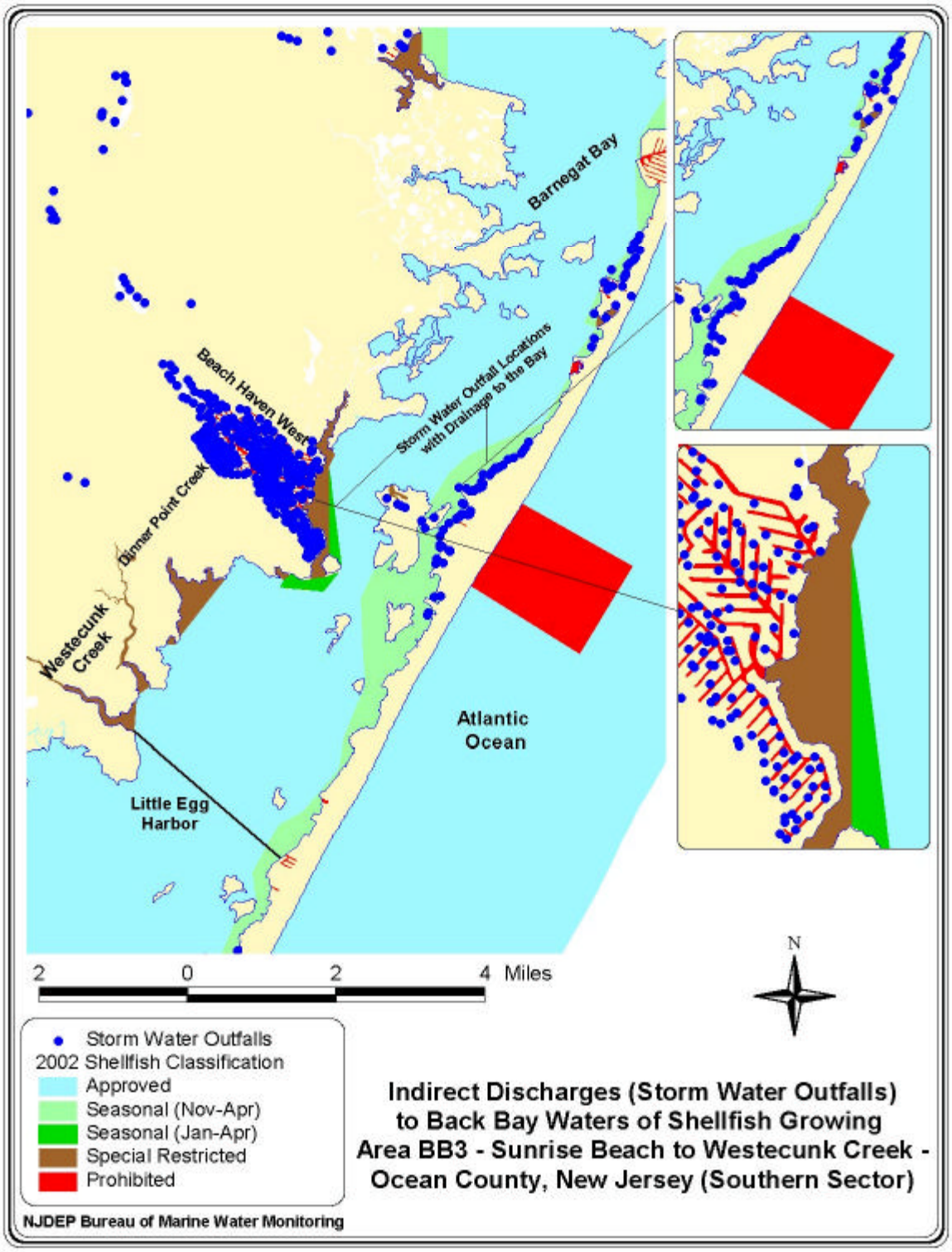

FIGURE 16: INDIRECT DISCHARGES (STORM WATER OUTFALLS) TO BACK BAY WATERS OF SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY (SOUTHERN SECTOR)

HYDROLOGY AND METEOROLOGY

PATTERNS OF PRECIPITATION

Precipitation patterns in the coastal areas of New Jersey are typical of the Mid-Atlantic coastal region. Summer storms are localized and often associated with thunder and lightening activity. Winter storms are frequently linked to northeasters. Hurricanes can occur during the summer and early fall.

TABLE 8: 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 return, 24-hour volume varies between three and four inches. Storm volumes greater than approximately 3.5 – 4.0 inches are much less frequent.

TABLE 9: 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 provides insight into the frequency for storm events of a given size.

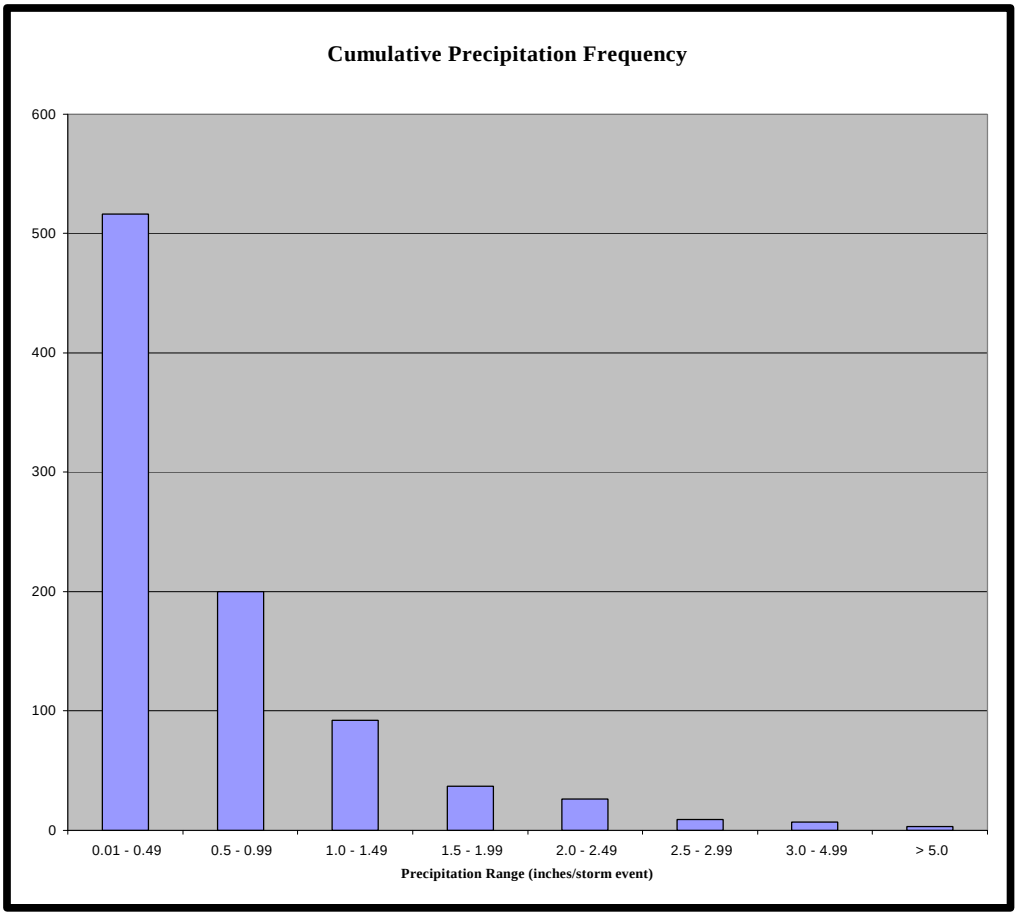

FIGURE 17: STORM EVENT FREQUENCY HISTOGRAM (SOURCE: NOAA CLIMATIC DATA)

Weather pattern change can cause drought in some areas of the world and increased storm activity in other locals. These changes can be short or long in duration.

A weather altering event such as El Nino is an example of a globally or broad ranging climatological development that can cause significant change in weather. Naturally, this can have an effect on hydrology (water tables, water flow, chemistry, etc.) and recorded precipitation amounts. However, alterations in weather patterns within the Mid-Atlantic region are generally not seen over a time frame such as that used for this report. Averages for hydrology parameters and rainfall accumulation over a span of years tends to remain fairly constant.

RAINFALL EFFECTS

New Jersey has experienced drought conditions during much of the time frame since 2000, when the last Sanitary Survey was written for BB3. Nonetheless, when averaging the data for precipitation amounts, the results do show a fairly consistent pattern for BB3 as per the time frame represented in this report.

Precipitation inputs to the area for the period 10/08/97 through 08/15/01 are shown in Tables 11 - 18. 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 station used for reporting data describing precipitation accumulation in this region of New Jersey was # 8816 (Toms River).

Larger storm events, hurricanes or winter nor'easters, can cause elevated coliform levels causing noted statistical variation within some sections of our back bay growing area classifications. With BB3, this is most true in the northwestern sector of the monitoring area (East of Barnegat Twp.).

Two stations (1670B, 1671A) showed a rainfall effect with the correlations presented as 0.6 or more (see Table 10). Both stations are located in waters classified as *Seasonal* (November – April) as shown in Figure 18. Total coliform counts for either station when combined for all sampling dates, never exceeded 40.1 MPN/100 mL.

The factors contributing to the occurrence of elevated coliform levels and statistical variation after rainfall events (for BB3) include urban runoff into streams, rivers, and lagoons. Runoff can contain domestic and feral animal waste, fertilizers, and petroleum by-products from boats, marinas and cars. With the possible exception of feral animal waste, the above inputs have a tendency to increase in warmer weather when population grows in shore areas and back bay areas.

Although the area to the East of Barnegat Twp. was most affected by rain events, coliform count increase can be noted within other areas after storm occurrence. Frequently, this can be seen in *Seasonal*, *Special Restricted* or *Prohibited* waters. However, no stations exceeded SRS year round sampling criteria (total coliform) for *Approved* waters with regard to precipitation influence within the BB3 shellfish growing area when reviewing the statistical summary.

It should be noted that the areas proposed for upgrade within this report were not affected by rainfall correlation during the 1997 – 2001 time frame represented in this report. One correlation for rainfall is presented within the context of an extended winter analysis designed for the upgrade area outside Beach Haven West. Although a rainfall correlation was noted for that time frame, it was fairly small. However, this correlation will more aptly be discussed in the section labeled Rainfall Effect with Extended Winter Analysis that follows later in this report.

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. Further, large winter nor'easters have been far less intense during the time frame covered within this report (1997 - 2001). As a result, there is no significant data collection from a period of elevated storm intensity shown for this review period.

BB3 constitutes a large bay area, which receives water inputs from numerous water sources such as Forked River and Oyster Creek. The majority of streams and rivers supplying these shellfish growing waters have their headwaters west of the Garden State Parkway, though some originate closer to the shoreline. Some water source inputs near more urbanized development, can exhibit influence from storm water runoff as per a greater presence of storm drains.

The different types of land use surrounding this growing area (primarily urban and wetland) result in varying hydrology for the waters comprising and contributing to this site. Although urban areas can strain ecosystems, the presence of significantly large regions of wetlands in this area help maintain water quality via their ability to cleanse contaminants. It should be noted that *Approved* waters constitute the majority of growing water acreage in BB3.

There is influence from wetland areas due to the presence of specific fauna or animal populations, in particular flocks of waterfowl, which deposit fecal material that impacts the waters of the area. However, the general cleansing action of wetland flora or plant species helps to maintain water quality for this shellfish growing area.

It is more common to see elevated coliform counts at sampling stations within waters classified as *Seasonal*, *Special Restricted or Prohibited*, in the back bay waters of New Jersey. Elevated coliform counts within NJ's *Approved* back bay shellfish growing areas are rare, limited in number and always short in duration as per dilution factors. In fact, there are no current stations (stations monitored or analyzed by NJDEP-BMWM) within the BB3 sector of Barnegat Bay that exceed SRS year round sampling criteria for *Approved* waters, regardless of classification.

The barrier island shoreline abutting this shellfish growing area to the East, consists of urban development (primarily residential with some commercial business supporting recreational use and commerce). The same can be said for the infrastructure along the western shoreline. Beaches within the coastal region to the East are an economic priority as with all NJ coastal regions and are maintained as a recreational resource.

Urban development almost always provides storm water runoff. Although communities along the coastal and intercoastal shorelines of BB3 are generally connected to sanitary sewers, storm water is collected and drains through outfalls. The contents of many of these outfalls eventually empty into the back bay waters from Sunrise Beach to Westecunk Creek.

There are communities to the West of these shellfish growing waters that are

not connected to sanitary sewers though. Any potential inputs from septic overflow resulting from residences utilizing this type of infrastructure is unlikely to impact this growing area per absorption, distance, and dilution factors.

In more populated areas, dilution starts to occur to storm water inputs via the rivers, streams and bay waters associated with this site. Further, the Barnegat Inlet provides additional mixing as Atlantic Ocean waters meet those of the Barnegat Bay Estuary.

Runoff from urban areas empties to back bay waters during storms and gets pulled out with changing tides. Tidal exchange provides one of the keys to mixing impacted water with higher quality water further from shore.

Rainfall's overall contribution to detectable change in coliform counts resulting in statistical correlations for rainfall within BB3 is more specific to the northwestern sector of the growing area. This area is more heavily populated on a year round basis and it lends itself to more inputs from streams and rivers. Components for tide and season and rainfall correlations connoted with storm water inputs will prevail along streams, rivers and lagoon sections of urban areas. Although tides can help dilution processes, the movement of waters via tidal cycles both during and after rain events can cause noticeable change in sampling data depending on the location of the station being sampled and the degree of mixing that has taken place.

There is a presence of seasonally classified waters (buffers) lining many of the shorelines near the urban areas of New Jersey's back bay waters. These help ensure a safe shellfish product by preventing harvest during the summer season when impacts would be greater. During the winter, potential impact is reduced as per decreased population and shellfish harvesting is then allowed within seasonally classified waters.

The more common statistical correlations noted for BB3 are the Seasonal and Tidal Components, which are fairly common within many of the urban communities lining the shoreline of Barnegat Bay and its tributaries. The significance of tide or seasonal components, and their interrelationship with precipitation inputs within the BB3 growing area, centers around urban locations where these components are derived as per population density and development. Specifically, these areas are most prone to seasonal influxes of population during the warmer months.

The tidal exchange that takes place at the mouths of lagoons, creeks and rivers becomes an important factor when analyzing intercoastal urban areas with regard to precipitation, tidal, and seasonal trends. Again, the state of New Jersey utilizes buffers of *Seasonally* classified waters and includes *Special Restricted* or *Prohibited* waters when necessary, within urban areas where precipitation, seasonal or tidal influences occur.

The impact from seasonal or tide influenced areas in BB3 is limited. This is true because there were no stations in BB3 that exceeded SRS year round sampling criteria with regard to present shellfish growing water classifications.

As mentioned previously, dilution processes start when streams and rivers begin receiving storm water runoff. Eventually, the inputs are mixed further as they reach the bay and they move steadily toward ocean outlets like the Barnegat Inlet. As a result, impact to *Approved* waters of this growing area from rain events is minimized with stream, river, back bay, inlet and oceanic mixing. Further, hydrology has changed little during the period documented in this report as per the average consistency of precipitation amounts and lack of larger impact related storms. With this, there is no reason to alter the sampling regime utilized in obtaining data for future reports.

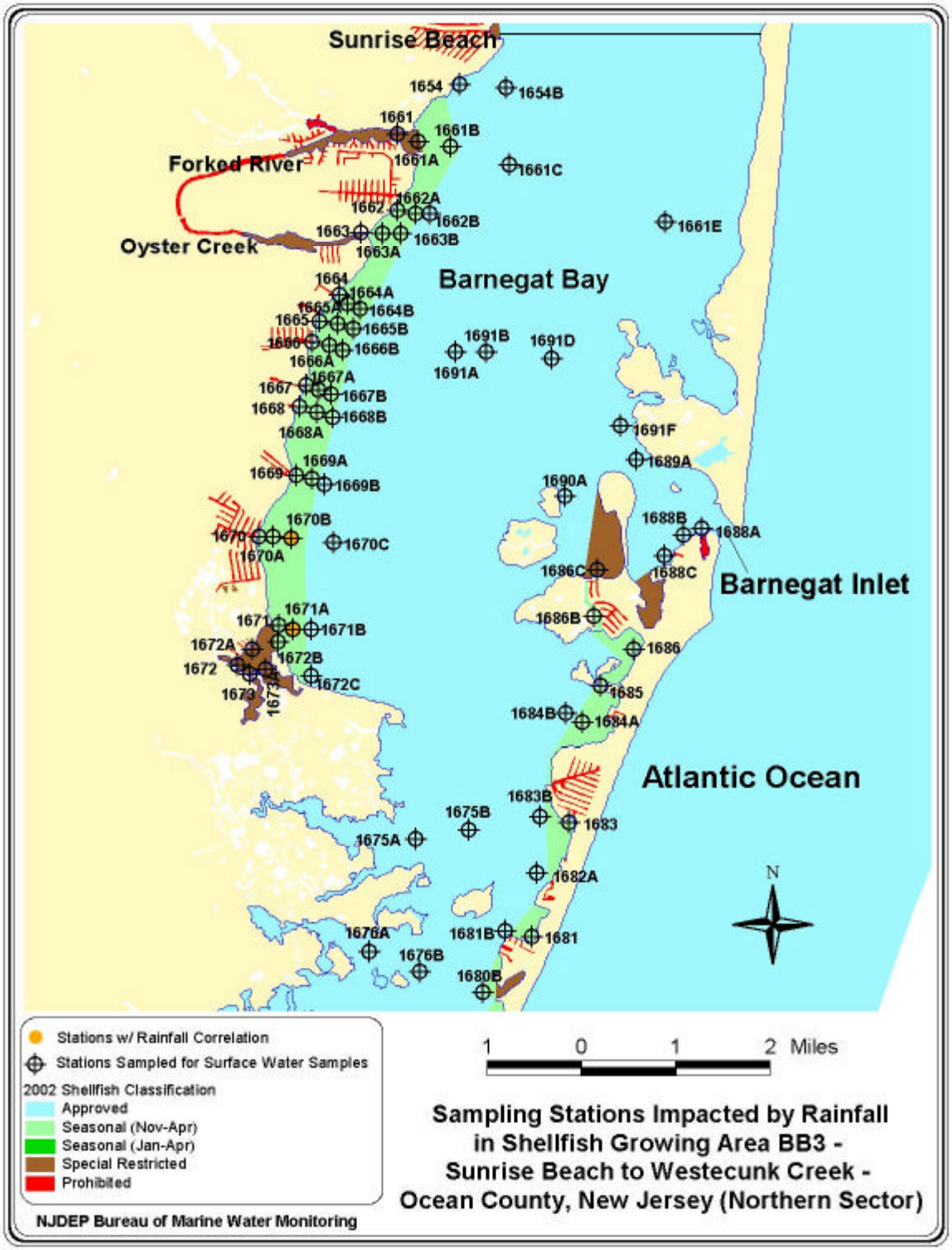

FIGURE 18: SAMPLING STATIONS IMPACTED BY RAINFALL IN SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY (NORTHERN SECTOR)

TABLE 10: SURFACE SAMPLING STATIONS WITH RAINFALL CORRELATION'S – (SHOWN IN YELLOW) – SPECIFIC FOR CUMULATIVE RAINFALL AS IT RELATES TO TOTAL COLIFORM – SHELLFISH GROWING AREA BB3 – SUNRISE BEACH TO WESTECUNK CREEK – OCEAN COUNTY, NEW JERSEY

Station	Day of Sampling	24 Hours Prior	48 Hours Prior	# of Specific Correlation's	# of Samples
1670B	0.651	0.605	0.645	3	40
1671A	0.429	0.408	0.663	1	40

TABLE 11: PRECIPITATION DATA FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY

RAINFALL RECORDED AT NOAA'S STATION 8816 (TOMS RIVER)

Sampling Date	Precipitation in Inches		
	Day of Sampling	24 Hours Prior	48 Hours Prior
10/8/97	0	0	0
10/15/97	0.55	0.55	0.55
10/16/97	0.005	0.555	0.555
10/20/97	0	0	0.1
10/22/97	0	0	0
10/24/97	0	0	0
10/27/97	0.9	0.905	2.005
10/29/97	0	0.005	0.905
11/3/97	0.04	1.74	1.74
11/6/97	0	0	0
11/10/97	0.02	0.63	1
11/18/97	0	0	0.21
11/19/97	0	0	0
11/20/97	0	0	0
12/3/97	0	0	0.15
12/4/97	0.25	0.25	0.25
12/8/97	0	0	0
12/15/97	0	0	0
12/19/97	0	0	0
1/8/98	0.45	0.455	0.455
1/12/98	0	0	0
1/15/98	0	0	0.005
1/21/98	0	0	0.05
1/22/98	0	0	0
1/27/98	0	0	0.22

TABLE 12: PRECIPITATION DATA FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY

RAINFALL RECORDED AT NOAA'S STATION 8816 (TOMS RIVER)

Sampling Date	Precipitation in Inches		
	Day of Sampling	24 Hours Prior	48 Hours Prior
1/30/98	0	0.85	1.05
2/2/98	0	0	0
2/3/98	0	0	0
2/9/98	0	0	0
2/20/98	0.005	0.005	0.105
2/23/98	3.32	3.32	3.325
2/26/98	0	0	0.2
3/2/98	0.28	0.29	0.35
3/5/98	0	0	0.005
3/6/98	0	0	0
3/24/98	0	0	0.03
3/25/98	0	0	0
4/2/98	0	0	0
4/3/98	0	0	0
4/6/98	0	0	0.11
4/8/98	0.25	0.25	0.25
4/15/98	0	0.005	0.005
4/28/98	0.005	0.405	0.805
4/29/98	0	0.005	0.405
5/18/98	0.03	0.035	0.035
5/29/98	0	0	0
6/3/98	0	0.25	0.68
6/16/98	0.12	0.25	2.88
6/24/98	0.67	0.67	0.67
7/7/98	0	0.02	0.39
7/16/98	0	0	0

TABLE 13: PRECIPITATION DATA FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY

RAINFALL RECORDED AT NOAA'S STATION 8816 (TOMS RIVER)

Sampling Date	Precipitation in Inches		
	Day of Sampling	24 Hours Prior	48 Hours Prior
7/20/98	0	0	0
8/3/98	0.005	0.005	0.01
8/11/98	0.13	0.13	0.13
8/17/98	0.05	0.05	0.055
9/15/98	0	0	0
9/29/98	0	0.01	0.01
10/7/98	0	0.005	0.305
10/14/98	0.27	0.275	0.28
10/15/98	0.005	0.275	0.28
10/16/98	0	0.005	0.275
10/28/98	0	0	0
11/10/98	0	0	0
11/12/98	0.37	0.375	0.375
11/13/98	0	0.37	0.375
11/16/98	0	0	0
12/9/98	0.4	0.405	0.405
12/10/98	0	0.4	0.405
12/11/98	0	0	0.4
12/18/98	0.05	0.05	0.05
1/12/99	0.005	0.005	0.155
1/13/99	0	0.005	0.005
1/27/99	0	0.05	1.01
2/9/99	0	0.5	0.5
2/10/99	0	0	0.5
2/24/99	0	0	0
2/25/99	0	0	0

TABLE 14: PRECIPITATION DATA FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY

RAINFALL RECORDED AT NOAA'S STATION 8816 (TOMS RIVER)

Sampling Date	Precipitation in Inches		
	Day of Sampling	24 Hours Prior	48 Hours Prior
3/9/99	0	0	0.057
3/10/99	0	0	0
3/18/99	0	0	0
3/23/99	0.04	0.04	0.04
3/29/99	0	0.58	0.58
3/31/99	0	0	0
4/12/99	0.91	0.91	2.11
4/13/99	0.005	0.915	0.915
4/14/99	0	0.005	0.915
4/26/99	0	0	0.5
4/28/99	0	0	0
5/10/99	0	0.25	0.35
5/11/99	0	0	0.25
5/12/99	0	0	0
5/13/99	0.1	0.1	0.1
6/7/99	0	0	0
6/8/99	0	0	0
6/9/99	0	0	0
6/11/99	0	0	0
7/12/99	0	0	0
7/13/99	0.42	0.42	0.42
7/14/99	0	0.42	0.42
8/9/99	0.35	0.35	0.35
8/10/99	0	0.35	0.35
8/16/99	0	0.35	2.6
8/18/99	0	0.005	0.005

TABLE 15: PRECIPITATION DATA FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY

RAINFALL RECORDED AT NOAA'S STATION 8816 (TOMS RIVER)

Sampling Date	Precipitation in Inches		
	Day of Sampling	24 Hours Prior	48 Hours Prior
9/7/99	0.005	0.065	0.065
9/8/99	0	0.005	0.065
9/9/99	0.42	0.42	0.425
9/20/99	0	0	0
10/4/99	0.005	0.005	0.005
10/6/99	0	0.92	0.925
10/20/99	0.005	0.01	1.02
10/25/99	0	0	0.2
10/28/99	0	0	0
11/17/99	0	0	0
11/18/99	0	0	0
11/19/99	0	0	0
12/7/99	0.84	0.89	0.99
12/8/99	0	0.84	0.89
12/17/99	0	0.005	1.005
1/6/00	0	0	0.7
1/7/00	0	0	0
1/10/00	0.45	0.455	0.46
1/11/00	0	0.45	0.455
2/9/00	0	0	0
2/14/00	2.5	2.5	2.5
2/15/00	0.03	2.53	2.53
2/17/00	0	0	0.03
2/24/00	0	0	0
2/25/00	0	0	0
3/1/00	0	0	1.09

TABLE 16: PRECIPITATION DATA FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY

RAINFALL RECORDED AT NOAA'S STATION 8816 (TOMS RIVER)

Sampling Date	Precipitation in Inches		
	Day of Sampling	24 Hours Prior	48 Hours Prior
3/2/00	0	0	0
3/7/00	0	0	0
3/8/00	0.005	0.005	0.005
3/27/00	0	0	0
4/10/00	0.1	0.1	0.1
4/11/00	0	0.1	0.1
4/12/00	0.17	0.17	0.27
4/27/00	0.005	0.01	0.01
4/28/00	0.005	0.01	0.015
5/1/00	0	0.05	0.05
5/2/00	0	0	0.05
5/3/00	0	0	0
5/9/00	0	0	0
6/5/00	0	0	0.3
6/6/00	0.005	0.005	0.005
6/12/00	0	0	0
6/14/00	0.35	1.37	1.37
7/5/00	0	1.1	1.1
7/12/00	0	0.005	0.005
7/13/00	0	0	0.005
8/7/00	0.08	0.08	0.85
8/8/00	0.005	0.085	0.085
8/16/00	0	0.45	0.78
8/30/00	0.13	0.13	0.13
9/6/00	0	0.25	0.66
9/18/00	0	0	0

TABLE 17: PRECIPITATION DATA FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK -OCEAN COUNTY, NEW JERSEY

RAINFALL RECORDED AT NOAA'S STATION 8816 (TOMS RIVER)

Sampling Date	Precipitation in Inches		
	Day of Sampling	24 Hours Prior	48 Hours Prior
9/19/00	0	0	0
9/29/00	0	0	0.52
10/2/00	0	0	0
10/4/00	0	0	0
10/18/00	0.1	0.1	0.105
10/26/00	0	0	0
11/13/00	0	0	0
11/14/00	0.28	0.28	0.28
11/15/00	0.05	0.33	0.33
11/16/00	0.05	0.1	0.38
12/5/00	0	0	0
12/8/00	0	0	0
12/18/00	0	0	0.55
12/19/00	0	0	0
1/17/01	0	0	0
1/26/01	0.005	0.005	0.005
2/2/01	0	0	0
2/6/01	0	0	0
2/7/01	0	0	0
2/8/01	0	0	0
2/13/01	0	0.2	0.2
2/14/01	0.11	0.11	0.31
2/22/01	0	0.7	0.7
2/26/01	0	0	0.18
3/15/01	0	0.37	0.375
3/16/01	1.5	1.5	1.87

TABLE 18: PRECIPITATION DATA FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY

RAINFALL RECORDED AT NOAA'S STATION 8816 (TOMS RIVER)

Sampling Date	Precipitation in Inches		
	Day of Sampling	24 Hours Prior	48 Hours Prior
3/19/01	0	0	0
3/26/01	0	0	0
4/16/01	0.3	0.3	0.3
4/17/01	0	0.3	0.3
4/18/01	0	0	0.3
4/19/01	0.11	0.11	0.11
4/20/01	0	0.11	0.11
4/25/01	0	0	0
4/27/01	0	0	0
5/2/01	0	0	0
5/8/01	0	0	0
5/9/01	0	0	0
5/10/01	0	0	0
5/21/01	0.6	0.6	0.6
6/5/01	0	0	0
6/6/01	0	0	0
6/7/01	0	0	0
6/11/01	0	0	0
6/13/01	0	0	0
7/3/01	0	0.45	0.45
7/11/01	0	0	0
7/13/01	0	0	0
7/24/01	0	0	0
8/7/01	0.005	0.005	0.015
8/10/01	1.3	1.3	1.3
8/13/01	0	0.74	0.84
8/15/01	0	0	0

RAINFALL EFFECT WITH EXTENDED WINTER ANALYSIS

The initial data analysis for BB3 (described above) did not include 30 or more samples for winter data when reviewing the Tc Statistical Summary. As this report summarizes a proposal for upgrading *Seasonal* waters (outside of Beach Haven West) from *Seasonal* (Jan-Apr) to *Seasonal* (Nov-Apr), the primary analysis time frame (10/8/97 – 8/15/01) was extended to include all sampling dates for November through April from 11/1/94 through 4/30/01. Although the original analysis presented relatively low total coliform counts during all winter months including November and December, an analysis which would encompass 30 or more samples taken for the proposed upgrade area was more consistent with SRS Sampling guidelines for analysis.

The data generated from this analysis was reviewed for all stations. The summary that follows however, centers around the area proposed for upgrade and stations located within that area. The results are shown in Figure 19 and Tables 19 through 22. Actual data is reported from the time frame 11/16/94 through 4/27/01.

With regard to the extended analysis, total coliform scores were highest for station 1708A, with a geometric mean of 5.9, and the highest 90th percentile ranking was 18.6 for that same station as noted in the Statistical Summary. There were no *Seasonal* or tidal components apparent with the expanded analysis. It should be noted that geometric means were highest for station 1708A at 6.8 MPN/100 mL on the ebb tide, and 6.3 for station 1708 on the flood tide.

Station 1708 showed a rainfall correlation with the expanded data set. The correlation equated to 0.741 (two days before sampling). When reviewing the Raw Data, total coliform was highest at station 1708 at 150 MPN/100 mL on 11/17/95. This was the only occasion when total coliform exceeded 70 MPN/100 mL. There was no rainfall on the day of sampling. However, there were three inches of rain recorded two days ahead of sampling (11/19/95). The geometric mean reported in the Statistical Summary for station 1708 was 5.1 MPN/100mL and the 90th percentile was 15.2 with the expanded winter analysis.

In summary, when reviewing the above correlation for rainfall and overall bacteriological analysis from the expanded analysis, there is ample data to warrant the upgrade to extended winter classification [*Seasonal* (Nov-Apr) from *Seasonal* (Jan-Apr)] for the area of waters outside Beach Haven West.

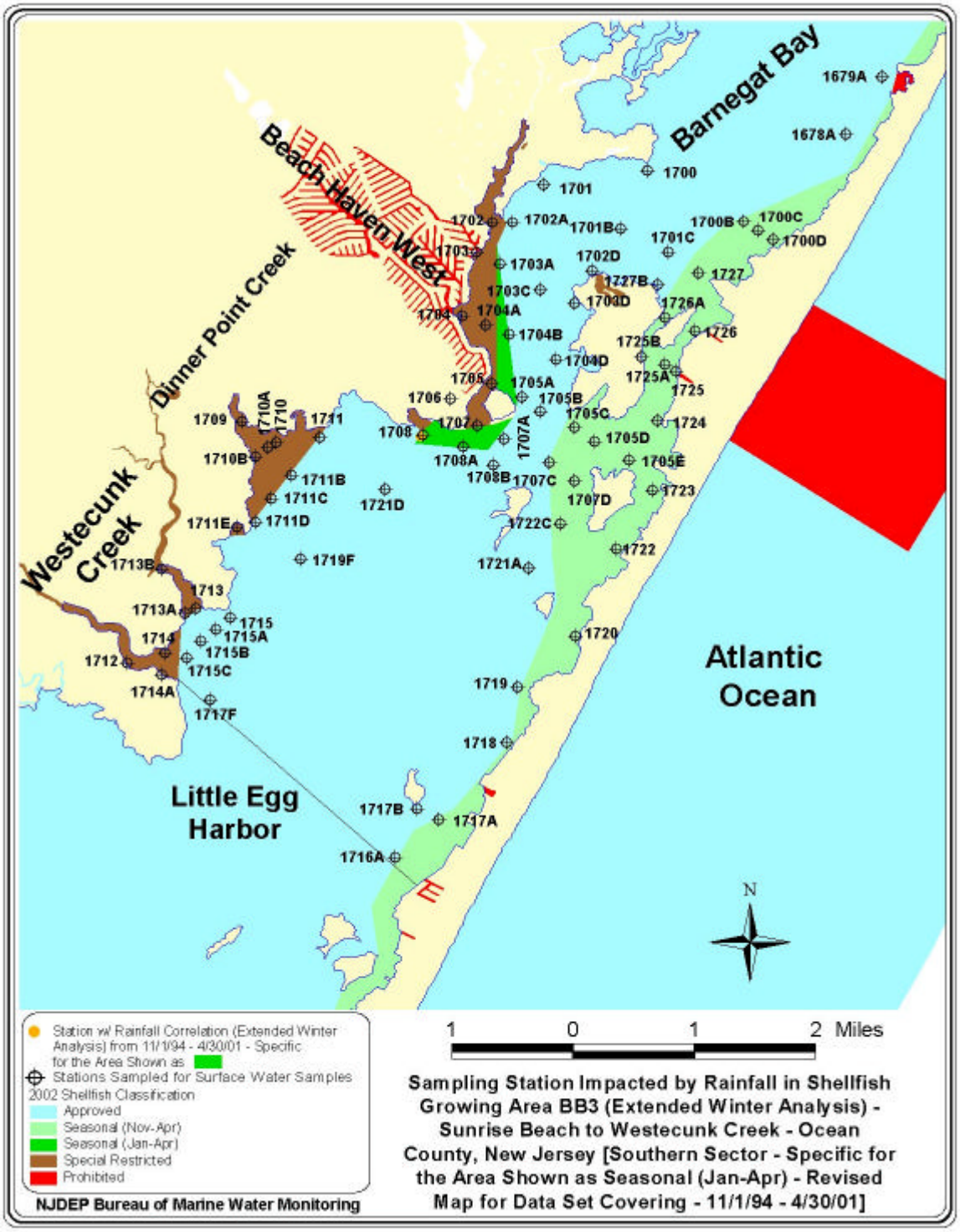

FIGURE 19: SAMPLING STATION IMPACTED BY RAINFALL IN SHELLFISH GROWING AREA BB3 (EXTENDED WINTER ANALYSIS) - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY [SOUTHERN SECTOR - SPECIFIC FOR THE AREA SHOWN AS SEASONAL (JAN-APR) - REVISED MAP FOR DATA SET COVERING - 11/01/94 – 4/30/01]

TABLE 19: SURFACE SAMPLING STATION WITH RAINFALL CORRELATION – (SHOWN IN YELLOW) **– SPECIFIC FOR CUMULATIVE RAINFALL AS IT RELATES TO TOTAL COLIFORM [FOR THE AREA SHOWN ON MAP AS SEASONAL (JAN-APR) - REVISED DATA SET - 11/01/94 – 04/30/01] - SHELLFISH GROWING AREA BB3 – SUNRISE BEACH TO WESTECUNK CREEK – OCEAN COUNTY, NEW JERSEY**

Station	Day of Sampling	24 Hours Prior	48 Hours Prior	# of Specific Correlation's	# of Samples
1708	0.120	0.470	0.741	1	54

TABLE 20: PRECIPITATION DATA FOR SHELLFISH GROWING AREA BB3 [SPECIFIC FOR AREA SHOWN AS SEASONAL (JAN-APR) – REVISED DATA SET – 11/1/94 – 04/30/01] - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY - RAINFALL RECORDED AT NOAA'S STATION 8816 (TOMS RIVER)

Sampling Date	Precipitation in Inches		
	Day of Sampling	24 Hours Prior	48 Hours Prior
11/17/95	0	0	3

TABLE 21: RAW DATA (TOTAL COLIFORM) FOR SURFACE SAMPLING STATION SHOWING RAINFALL CORRELATION [FOR THE AREA SHOWN ON MAP AS SEASONAL (JAN-APR) - REVISED DATA SET - 11/01/94 – 04/30/01] - SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY (10/08/97 - 08/15/01)

STATION	Sampling Date	WINTER
		TOTAL COLIFORM MPN/100mL
1708	11/17/95	150.0

TABLE 22: WATER QUALITY (TOTAL COLIFORM) FOR SURFACE SAMPLING STATION SHOWING RAINFALL CORRELATION [FOR THE AREA SHOWN ON MAP AS SEASONAL (JAN-APR) - REVISED DATA SET - 11/01/94 – 04/30/01] - SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY (10/08/97 - 08/15/01)

STATION	DEPTH	WINTER		
		GEO. MEAN	EST. 90TH	N
1708	Surface	5.1	15.2	54

TIDAL EFFECTS

Eighteen stations are represented in Figures 20 and 21 as being impacted by tidal changes within Shellfish Growing Area BB3. As such, they showed up as stations with tidal components where variability in data or the t-Statistic Probability was < 0.05. The stations were from surface locations and are noted as follows: 1664A, 1665B, 1666, 1666A, 1667B, 1668A, 1669A, 1670, 1670B, 1671A, 1682A, 1702, 1703, 1711B, 1711D, 1714, 1722 and 1723. The t-probability for these stations ranged from 0.002 – 0.042.

Of the stations showing tidal components, one was located in *Prohibited* waters, three were in *Special Restricted* waters, eleven stations were in waters classified as *Seasonal* (Nov. – April) and three were in *Approved* waters. Stations 1711B, 1711D, 1722 and 1723 showed higher geometric means on the flood tide as opposed to Ebb Tide. The remaining fourteen stations were higher on the ebb tide. No station had a geometric mean for TC above 26.7 MPN/100 mL when examining the statistical data for tide.

For this reporting period, none of these stations statistically exceeded the criteria for their classification with regard to geometric mean, when reviewing the statistics for tide. Further, estimated 90th percentiles were not exceeded with regard to station locations and current classifications.

This shellfish growing area also has tidal exchange with the Atlantic Ocean through Barnegat Inlet and to a lessor degree, the Beach Haven Inlet provides some dilution. However, the Beach Haven Inlet is more specifically related to the BB4 growing area.

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 that enters the waters, tidal exchange can mix inshore with offshore waters 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 the waters being classified as *Approved*.

This above information suggests tidal influence does not present an adverse situation for shellfish growing area BB3. Monitoring should continue to be structured around a systematic random strategy as opposed to adverse pollution with regard to tidal interaction for this location.

The following maps show stations impacted by tidal exchange near the areas where urban development results in increased statistical variation in the data or tidal components. Regions of *Seasonally Approved* water provide an additional measure of safety during the time period when variation would be most observable.

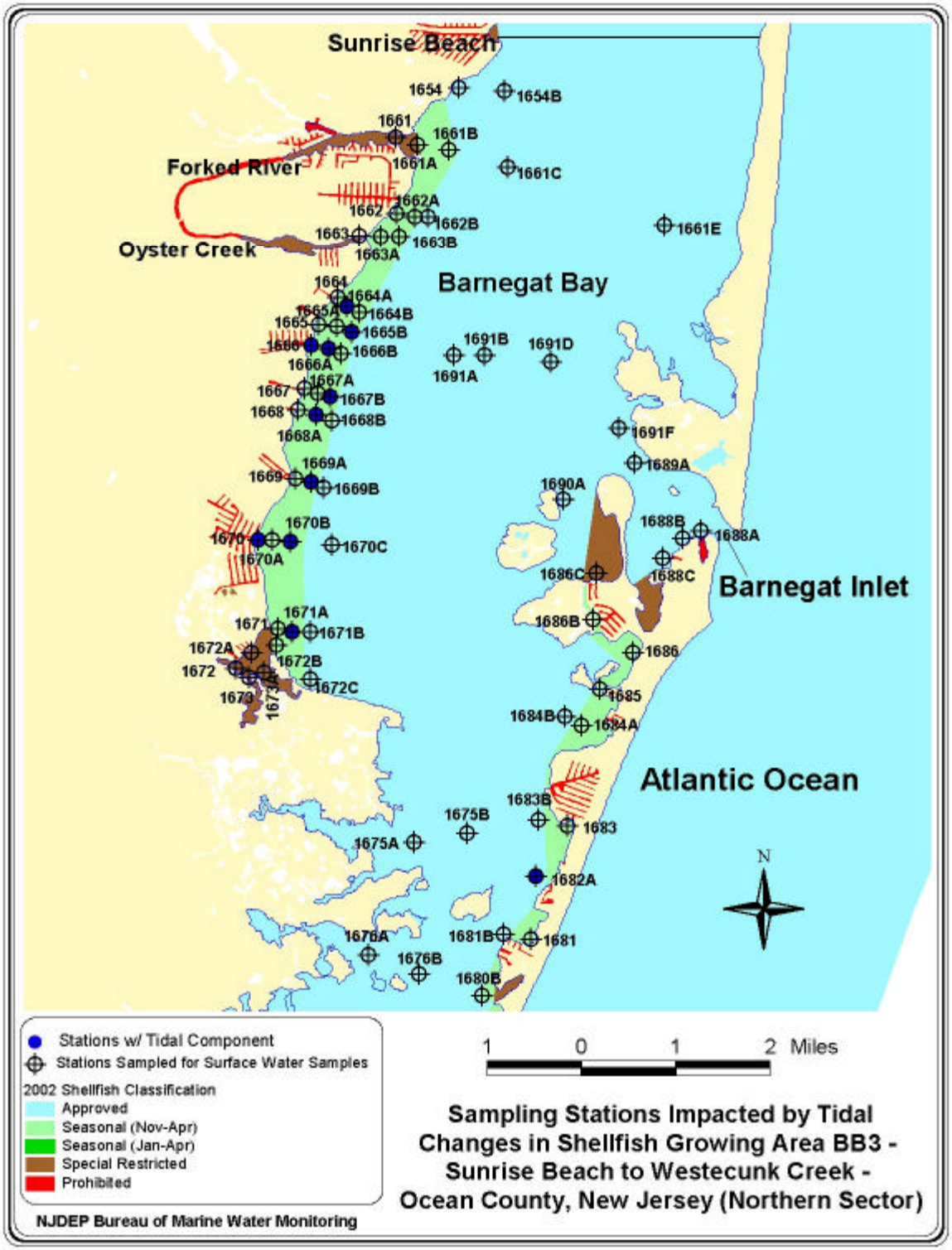

FIGURE 20: SAMPLING STATIONS IMPACTED BY TIDAL CHANGES IN SHELLFISH GROWING AREA BB3 – SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY (NORTHERN SECTOR)

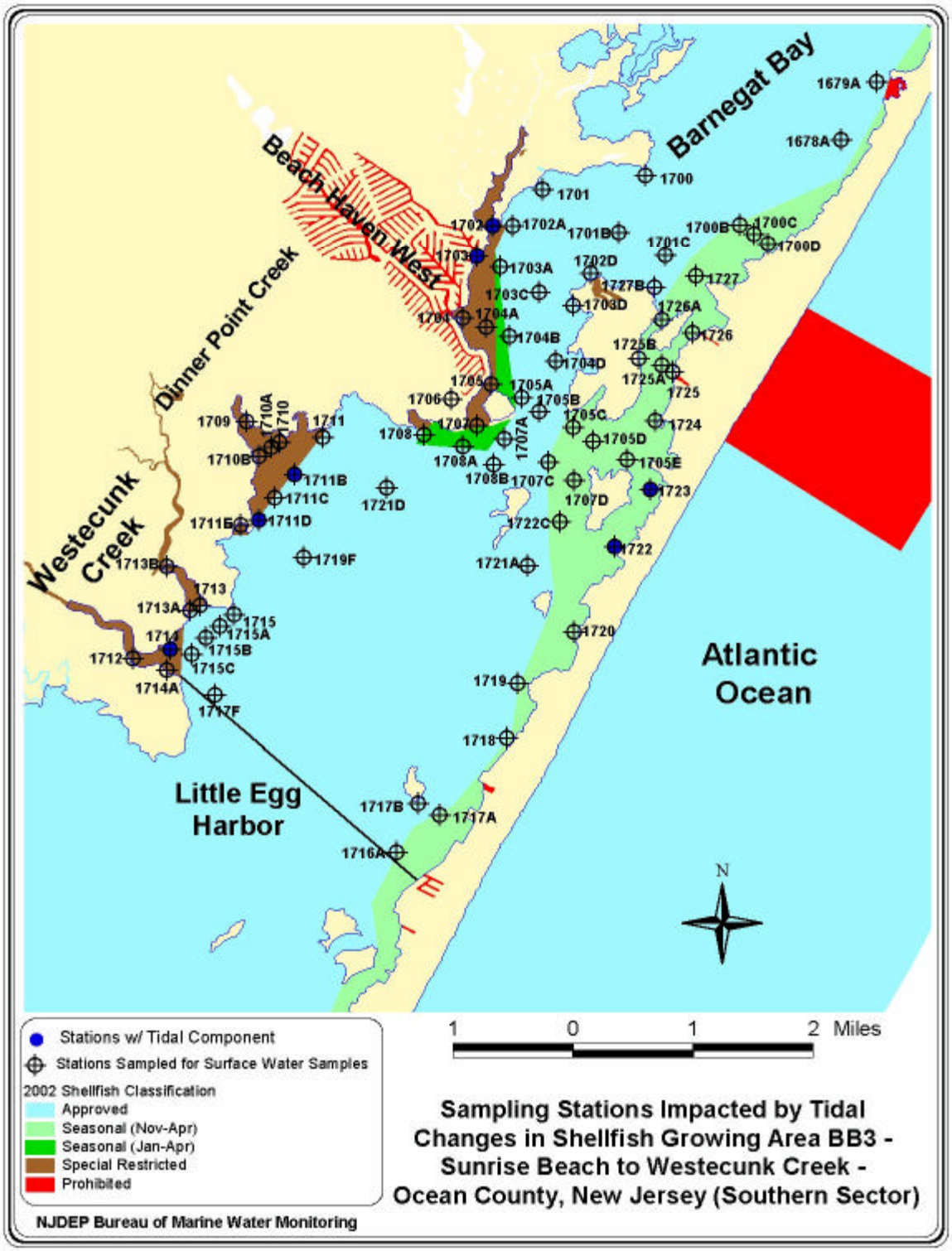

FIGURE 21: SAMPLING STATIONS IMPACTED BY TIDAL CHANGES IN SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY (SOUTHERN SECTOR)

TABLE 23: SURFACE SAMPLING STATIONS SHOWING TIDAL EFFECTS (TOTAL COLIFORM) IN SHELLFISH GROWING AREA BB3 – SUNRISE BEACH TO WESTECUNK CREEK – OCEAN COUNTY, NEW JERSEY

Station	t-Statistic Probability	Geometric Mean Ebb	Geometric Mean Flood	# Samples Ebb	# Samples Flood
1664A	0.031	6.1	3.8	23	17
1665B	0.040	5.2	3.4	25	15
1666	0.013	23.3	7.1	23	16
1666A	0.005	8.8	3.6	23	17
1667B	0.027	8.8	4.4	25	15
1668A	0.025	11.9	4.5	23	17
1669A	0.015	18.0	5.2	23	17
1670	0.002	26.7	6.2	21	19
1670B	0.008	10.1	3.9	23	17
1671A	0.016	8.8	4.1	21	19
1682A	0.042	5.7	3.4	26	14
1702	0.002	14.3	3.9	23	14
1703	0.028	14.0	5.7	26	19
1711B	0.015	4.0	9.6	22	23
1711D	0.007	4.2	9.2	22	23
1714	0.017	14.3	5.6	21	16
1722	0.024	4.2	8.8	16	21
1723	0.012	3.7	6.9	16	21

SEASONAL EFFECTS

Many urban developed lands in this area experience significant seasonal fluctuations in population. During the summer months, increased population results in increased impacts to the waters. This can be due to storm water run off which might carry greater amounts of fecal waste from domestic pets, petroleum waste from additional cars and boats or other waste residuals resulting from increased population. This is why most of the urban developed sectors in this area have designated *Seasonally Approved* waters located near them. *Seasonally Approved* waters prevent shellfish harvesting during the summer months when potential bacterial contamination would be greatest.

Forty-one stations showed seasonal variation or components as can be seen in Figures 22 and 23. These were stations 1663, 1663B, 1664, 1665A, 1666, 1667, 1672, 1672A, 1672B, 1681, 1683B, 1700D, 1702A, 1703, 1704, 1704A, 1705, 1706, 1707, 1707C, 1707D, 1708, 1708A, 1722, 1722C, 1723, 1724, 1725A, 1726, 1726A, 1710, 1710A, 1710B, 1711, 1711B, 1711D, 1711E, 1714A, 1715, 1717B and 1718.

One of the above stations with a seasonal component was located in *Prohibited* waters, fourteen were situated in *Special Restricted* waters, two were in waters classified as *Seasonal* (Jan – Apr), sixteen stations were located in seasonally classified waters (Nov – Apr) and eight sampling stations were located in waters classified as *Approved.*

Station 1683B statistically showed a higher geometric mean and estimated 90th percentile during the winter. This could have been due to avian populations that frequent this area during the winter. All remaining stations showed higher statistical correlations during the summer months (see Tables 24 and 25).

The greater majority of these stations are located along the western side of Barnegat Bay. There is a larger populace along that shoreline. With increased population comes more marinas, public docks and potentially impacting infrastructure. It stands to reason that areas along the western shoreline of Barnegat Bay would have increased variation during the summer season. However, one can see that increases in summer population also impact New Jersey's barrier islands during the summer as there are a fair amount of stations showing seasonal variation in the Ship Bottom section of Long Beach Island during the summer. Ship Bottom happens to be one of the most populated Borough's on Long Beach Island during the summer season. On summary evaluation, none of these stations statistically exceeded the criteria for their classification, though.

The following maps depict the sampling stations that were impacted by seasonal variation. It is evident that seasonally impacted sampling stations are located along the areas where more urban development is present. This demonstrates the impact of population and population fluctuation in more urbanized areas.

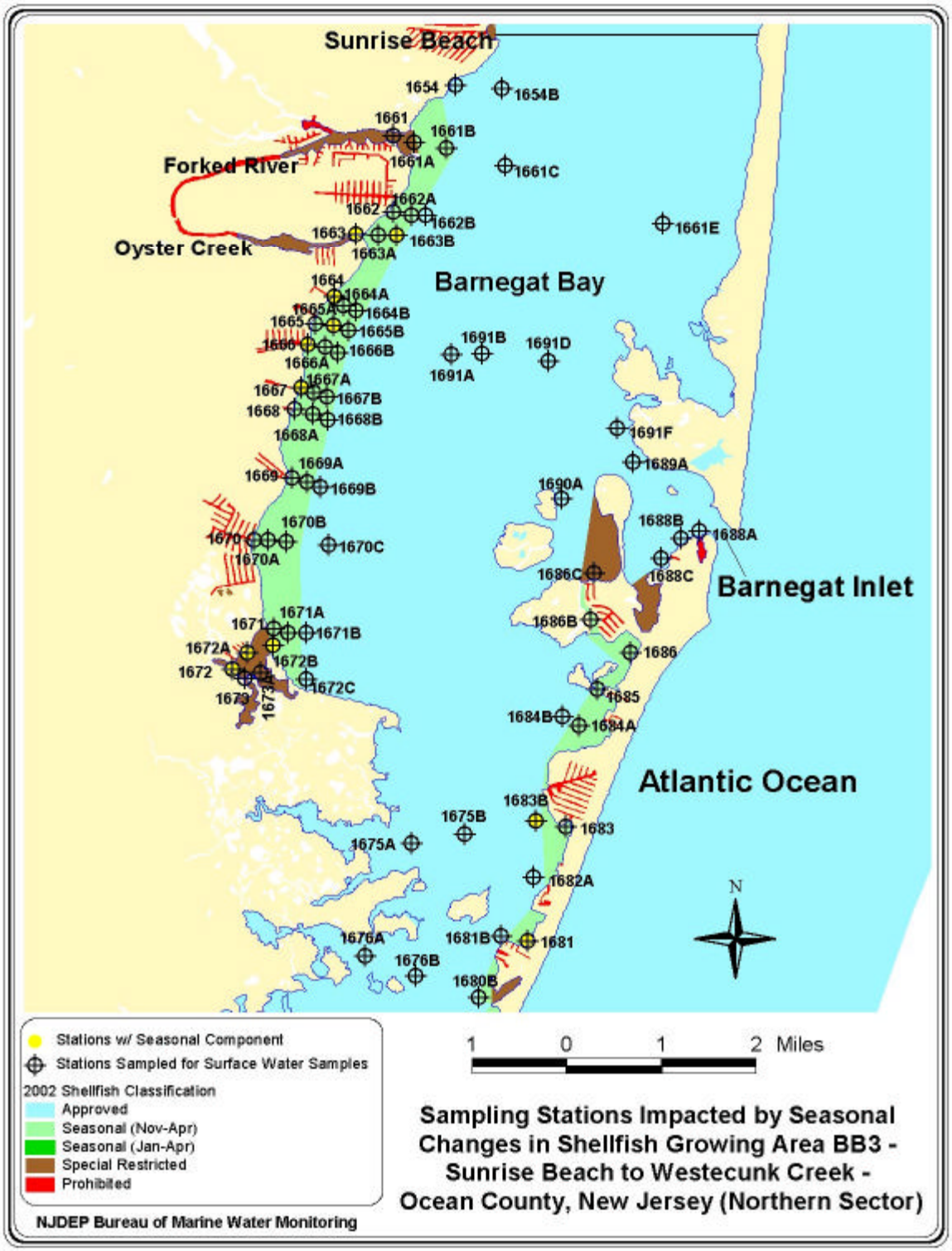

FIGURE 22: SAMPLING STATIONS IMPACTED BY SEASONAL CHANGES IN SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY (NORTHERN SECTOR)

FIGURE 23: SAMPLING STATIONS IMPACTED BY SEASONAL CHANGES IN SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY (SOUTHERN SECTOR)

TABLE 24: SURFACE SAMPLING STATIONS SHOWING SEASONAL EFFECTS (TOTAL COLIFORM) IN SHELLFISH GROWING AREA BB3 – SUNRISE BEACH TO WESTECUNK CREEK – OCEAN COUNTY, NEW JERSEY

Station	t-Statistic Probability	Geometric Mean Summer	Geometric Mean Winter	#Samples Summer	#Samples Winter
1663	0.0046	32.2	5.3	15	25
1663B	0.0157	9.3	4.3	15	25
1664	0.0176	27.9	7.2	15	25
1665A	0.0142	12.3	4.5	15	25
1666	0.0334	31.6	8.7	15	24
1667	0.0158	51.0	11.6	15	25
1672	0.0052	73.2	12.2	15	25
1672A	0.0276	38.8	10.4	15	25
1672B	0.0233	21.5	5.5	15	25
1681	0.0098	6.4	3.3	15	25
1683B	0.0139	3.1	4.3	15	25
1700D	0.0212	12.0	3.6	15	25
1702A	0.0199	10.2	4.1	18	27
1703	0.0016	25.1	5.1	18	27
1704	0.0019	24.7	5.2	18	26
1704A	0.0244	9.4	4.1	18	26
1705	0.0069	17.0	4.5	13	26
1706	0.0075	23.0	6.7	16	31
1707	0.0397	13.6	5.7	16	30
1707C	0.0291	8.6	3.4	16	29
1707D	0.0195	6.6	3.5	13	24
1708	0.0012	21.9	4.6	16	31
1708A	0.0258	15.0	4.6	13	26
1710	0.0003	19.9	4.0	15	22

TABLE 25: SURFACE SAMPLING STATIONS SHOWING SEASONAL EFFECTS (TOTAL COLIFORM) IN SHELLFISH GROWING AREA BB3 – SUNRISE BEACH TO WESTECUNK CREEK – OCEAN COUNTY, NEW JERSEY

Station	t-Statistic Probability	Geometric Mean Summer	Geometric Mean Winter	#Samples Summer	#Samples Winter
1710A	0.0019	19.3	4.3	15	22
1710B	0.0029	35.1	6.2	15	22
1711	0.0011	21.4	4.7	18	27
1711B	0.0232	11.5	4.1	18	27
1711D	0.0022	11.4	4.2	18	27
1711E	0.0008	21.5	4.3	18	27
1714A	0.0016	25.3	5.9	17	27
1715	0.0384	8.8	4.5	15	22
1717B	0.0410	7.6	3.7	15	23
1718	0.0026	12.0	3.9	16	29
1722	0.0334	11.8	4.6	13	24
1722C	0.0195	7.5	3.1	12	24
1723	0.0197	8.6	4.1	13	24
1724	0.0092	13.2	4.1	12	24
1725A	0.0482	10.2	3.9	15	25
1726	0.0193	11.4	4.6	15	25
1726A	0.0131	7.0	3.6	15	25

WATER QUALITY STUDIES

BACTERIOLOGICAL QUALITY

Compliance with NSSP Approved Criteria

The waters of this area are sampled under the Systematic Random Sampling Strategy. The Systematic Random Sampling Strategy is utilized for this shellfish growing area because there are no point sources that discharge

wastewater that may contribute coliform bacteria to the waters of the area.

Surface water samples were analyzed from 143 sampling stations. The water quality data collected for shellfish growing area BB3 between October 1, 1997 through August 30, 2001 showed that the results of analysis for samples taken from all sampling stations supported current classifications for this area.

There were no stations exceeding NSSP criteria for *Approved* classification under SRS sampling strategies for year round or seasonal time frames when analyzing the above mentioned time frame and 30 or more samples for each station. Year round results ranged from 3.1 MPN/100 mL to 23.9 MPN/100mL for geometric mean, and estimated 90th percentile was noted from the low of 3.4 to 243.9 MPN/100 mL. *Approved* criteria for total coliform shall be acceptable providing counts do not exceed 330 MPN/100 mL for estimated 90th percentile. geometric mean for total coliform SRS strategy (*Approved* waters) is not to exceed 70 MPN/100 mL.

Aside from the previously mentioned components or correlations associated with rainfall, tide and seasonal variations, the waters of this shellfish growing area exemplified exceptional water quality statistics. Further, variation is to be expected where differentiation is noted in season, tide or rainfall statistics. In cases where variation produces components or correlations, buffers of *Special Restricted* or *Seasonally Approved* classifications serve to separate waters where variation is shown to produce a direct relationship with change in coliform bacteria counts reported in the data.

Complete tabulated listings for water quality summaries represented by total coliform bacteriological data (from 10/1/97 – 8/30/01) can be found in Tables 26 - 32. As noted previously, the results were compiled from samples collected from stations within Assignments 102, 107, 114, 117, 121 and 122. Representative stations reviewed for this report and belonging to the above assignments can be seen in Figures 24 and 25. Again, all stations exhibited acceptable (*Approved*) year round water quality for total coliform on summary evaluation using SRS criteria.

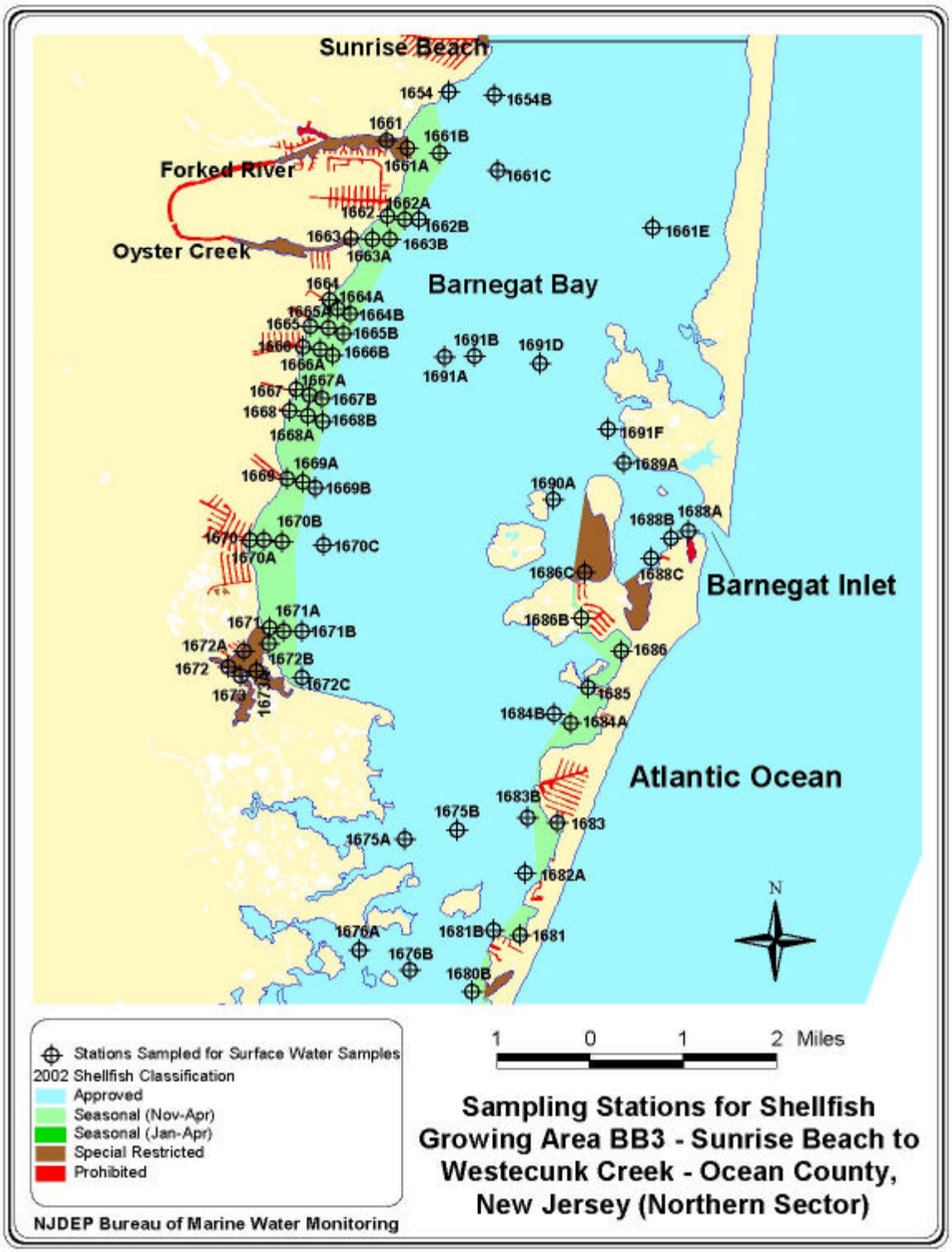

FIGURE 24: SAMPLING STATIONS FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY (NORTHERN SECTOR)

FIGURE 25: SAMPLING STATIONS FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY (SOUTHERN SECTOR)

TABLE 26: WATER QUALITY SUMMARY (TOTAL COLIFORM) FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY (10/08/97 - 08/15/01)

STATION	DEPTH	YEAR ROUND			SUMMER			WINTER		
		GEO. MEAN	EST. 90TH	N	GEO. MEAN	EST. 90TH	N	GEO. MEAN	EST. 90TH	N
1654	Surface	3.9	7.4	58	4.1	7.5	22	3.8	7.4	36
1654B	Surface	5.2	19.2	39	7.2	36.5	17	4.1	10.1	22
1661	Surface	5.7	26.7	39	7.5	59.0	14	4.8	15.6	25
1661A	Surface	5.0	19.6	40	5.7	29.0	15	4.7	15.4	25
1661B	Surface	4.1	8.5	40	4.9	11.5	15	3.7	6.9	25
1661C	Surface	3.9	7.0	31	4.4	9.1	16	3.4	4.8	15
1661E	Surface	3.1	3.4	31	3.1	3.3	16	3.1	3.4	15
1662	Surface	5.2	13.2	40	6.5	19.8	15	4.5	9.8	25
1662A	Surface	5.9	19.0	40	8.6	34.9	15	4.7	11.7	25
1662B	Surface	5.5	15.9	40	7.5	29.2	15	4.6	9.9	25
1663	Surface	10.5	82.8	40	32.2	437.2	15	5.3	13.9	25
1663A	Surface	7.1	25.4	40	11.7	38.6	15	5.3	17.3	25
1663B	Surface	5.7	17.1	40	9.3	35.7	15	4.3	8.6	25
1664	Surface	11.9	83.7	40	27.9	306.0	15	7.2	25.7	25
1664A	Surface	5.0	12.8	40	5.2	15.9	15	4.9	11.3	25
1664B	Surface	4.8	12.8	40	5.5	18.3	15	4.4	10.1	25
1665	Surface	11.4	97.2	40	29.2	286.4	15	6.5	36.4	25
1665A	Surface	6.5	25.6	40	12.3	70.2	15	4.5	9.7	25
1665B	Surface	4.4	12.2	40	4.7	15.7	15	4.3	10.5	25
1666	Surface	14.3	116.3	39	31.6	403.1	15	8.7	38.6	24
1666A	Surface	6.0	25.0	40	7.0	41.3	15	5.5	18.1	25
1666B	Surface	5.4	20.1	40	5.5	20.4	15	5.4	20.5	25
1667	Surface	20.2	174.4	40	51.0	634.0	15	11.6	55.3	25
1667A	Surface	6.6	25.6	40	9.0	33.6	15	5.5	21.1	25

TABLE 27: WATER QUALITY SUMMARY (TOTAL COLIFORM) FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN C0UNTY, NEW JERSEY (10/08/97 - 08/15/01)

STATION	DEPTH	YEAR ROUND			SUMMER			WINTER		
		GEO. MEAN	EST. 90TH	N	GEO. MEAN	EST. 90TH	N	GEO. MEAN	EST. 90TH	N
1667B	Surface	6.8	28.6	40	7.5	40.2	15	6.4	23.6	25
1668	Surface	9.5	62.4	40	10.2	77.5	15	9.1	56.8	25
1668A	Surface	7.9	53.0	40	8.1	64.0	15	7.7	49.2	25
1668B	Surface	6.5	35.8	39	6.2	34.3	15	6.7	38.1	24
1669	Surface	16.0	124.8	40	28.1	280.7	15	11.4	69.2	25
1669A	Surface	10.6	102.7	40	10.3	109.5	15	10.8	103.6	25
1669B	Surface	6.9	36.2	40	5.5	28.8	15	8.0	41.7	25
1670	Surface	13.4	103.5	40	20.2	233.7	15	10.4	59.6	25
1670A	Surface	7.5	37.2	40	6.0	23.7	15	8.7	48.3	25
1670B	Surface	6.7	33.4	40	7.4	35.3	15	6.3	33.2	25
1670C	Surface	5.3	17.5	40	5.1	15.0	15	5.4	19.4	25
1671	Surface	6.1	21.4	38	6.1	23.1	15	6.1	21.0	23
1671A	Surface	6.1	22.7	40	6.9	40.1	15	5.7	15.3	25
1671B	Surface	4.9	15.2	40	4.0	10.0	15	5.5	19.0	25
1672	Surface	23.9	243.9	40	73.2	932.6	15	12.2	67.7	25
1672A	Surface	17.0	122.9	40	38.8	506.9	15	10.4	33.7	25
1672B	Surface	9.1	62.2	40	21.5	297.2	15	5.5	13.1	25
1672C	Surface	5.5	19.1	40	5.3	27.1	15	5.6	15.0	25
1673	Surface	22.0	193.9	40	42.9	414.8	15	14.7	107.8	25
1673A	Surface	18.6	156.8	40	50.4	401.5	15	10.2	62.0	25
1675A	Surface	6.5	25.1	40	9.6	58.5	15	5.1	12.7	25
1675B	Surface	6.6	28.8	40	7.6	53.0	15	6.1	18.9	25
1676A	Surface	5.7	23.3	40	6.0	29.6	15	5.5	20.6	25
1676B	Surface	5.3	22.5	40	7.3	60.4	15	4.3	9.7	25

TABLE 28: WATER QUALITY SUMMARY (TOTAL COLIFORM) FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY (10/08/97 - 08/15/01)

STATION	DEPTH	YEAR ROUND			SUMMER			WINTER		
		GEO. MEAN	EST. 90TH	N	GEO. MEAN	EST. 90TH	N	GEO. MEAN	EST. 90TH	N
1678A	Surface	4.8	12.1	40	5.2	11.7	15	4.5	12.3	25
1679A	Surface	5.3	17.2	40	6.2	20.9	15	4.7	15.4	25
1679E	Surface	3.8	7.3	22	3.2	3.5	7	4.1	8.9	15
1680B	Surface	4.2	13.4	40	6.5	38.2	15	3.2	4.1	25
1681	Surface	4.2	9.6	40	6.4	19.5	15	3.3	4.4	25
1681B	Surface	3.5	6.7	40	4.2	11.1	15	3.2	4.0	25
1682A	Surface	4.7	16.6	40	6.0	30.0	15	4.1	10.9	25
1683	Surface	4.4	12.0	38	6.0	26.2	14	3.7	6.0	24
1683B	Surface	3.8	6.9	40	3.1	3.5	15	4.3	8.8	25
1684A	Surface	4.1	9.6	40	4.2	9.2	15	4.0	10.0	25
1684B	Surface	3.6	5.9	40	3.3	4.4	15	3.8	6.8	25
1685	Surface	5.4	22.1	40	8.4	67.7	15	4.1	7.7	25
1686	Surface	7.6	42.5	39	10.8	101.8	15	6.1	21.7	24
1686B	Surface	4.2	9.1	31	5.0	12.8	16	3.5	5.5	15
1686C	Surface	4.9	14.9	36	5.5	19.3	19	4.3	10.9	17
1686D	Surface	5.2	12.0	6	3.6	3.6	3	7.4	21.3	3
1688A	Surface	4.4	10.8	35	5.2	15.8	19	3.6	5.7	16
1688B	Surface	4.2	8.4	35	4.4	8.5	19	4.1	8.5	16
1688C	Surface	4.6	11.1	35	4.3	10.1	19	4.9	12.5	16
1689A	Surface	3.8	7.1	36	4.3	9.3	19	3.4	4.8	17
1690A	Surface	3.9	8.8	36	4.5	13.0	19	3.3	4.6	17
1691A	Surface	3.5	6.0	36	3.4	5.5	19	3.6	6.7	17
1691B	Surface	4.6	10.3	35	3.9	7.7	19	5.6	13.6	17
1691D	Surface	3.5	5.6	36	3.8	6.7	19	3.3	4.3	17

TABLE 29: WATER QUALITY SUMMARY (TOTAL COLIFORM) FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY (10/08/97 - 08/15/01)

STATION	DEPTH	YEAR ROUND			SUMMER			WINTER		
		GEO. MEAN	EST. 90TH	N	GEO. MEAN	EST. 90TH	N	GEO. MEAN	EST. 90TH	N
1691F	Surface	5.5	20.5	35	6.7	32.2	18	4.5	11.6	17
1700	Surface	4.7	16.1	36	6.3	28.5	17	3.7	8.2	19
1700B	Surface	5.4	20.9	40	8.6	47.3	15	4.1	10.7	25
1700C	Surface	6.3	38.7	40	12.8	172.8	15	4.1	8.8	25
1700D	Surface	5.6	28.4	40	12.0	121.5	15	3.6	5.5	25
1701	Surface	4.7	12.1	36	6.1	20.3	17	3.7	6.2	19
1701B	Surface	4.1	10.5	36	4.6	15.3	17	3.8	7.0	19
1701C	Surface	3.9	10.6	36	4.9	20.2	17	3.1	3.5	19
1702	Surface	8.8	60.1	37	17.0	211.1	15	5.6	17.1	22
1702A	Surface	5.9	26.0	45	10.2	65.0	18	4.1	10.6	27
1702D	Surface	4.6	17.8	36	6.4	41.2	17	3.4	5.1	19
1703	Surface	9.6	64.9	45	25.1	237.6	18	5.1	14.7	27
1703A	Surface	4.5	12.6	39	6.7	30.9	13	3.7	6.3	26
1703C	Surface	4.1	11.9	36	5.3	22.8	17	3.3	4.6	19
1703D	Surface	4.4	15.4	35	6.1	34.2	16	3.3	5.3	19
1704	Surface	9.8	68.1	44	24.7	228.2	18	5.2	16.9	26
1704A	Surface	5.7	22.3	44	9.4	55.0	18	4.1	8.6	26
1704B	Surface	4.4	12.7	39	6.5	31.6	13	3.6	6.3	26
1704D	Surface	5.3	26.0	36	7.9	66.0	17	3.8	7.2	19
1705	Surface	7.0	31.3	39	17.0	109.9	13	4.5	10.6	26
1705A	Surface	5.3	19.0	38	8.4	45.9	15	4.0	8.0	23
1705B	Surface	4.1	9.3	39	4.6	14.7	13	3.8	7.0	26
1705C	Surface	3.6	6.6	37	4.2	9.8	13	3.3	5.0	24
1705D	Surface	4.9	25.4	37	6.7	28.5	13	4.1	23.4	24

TABLE 30: WATER QUALITY SUMMARY (TOTAL COLIFORM) FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY (10/08/97 - 08/15/01)

STATION	DEPTH	YEAR ROUND			SUMMER			WINTER		
		GEO. MEAN	EST. 90TH	N	GEO. MEAN	EST. 90TH	N	GEO. MEAN	EST. 90TH	N
1705E	Surface	3.9	8.8	37	5.6	19.3	13	3.3	4.0	24
1706	Surface	10.2	55.3	47	23.0	163.9	16	6.7	23.5	31
1707	Surface	7.7	35.4	46	13.6	86.3	16	5.7	18.5	30
1707A	Surface	5.6	19.8	39	6.9	36.1	13	5.0	14.1	26
1707C	Surface	4.8	17.5	45	8.6	59.7	16	3.4	4.9	29
1707D	Surface	4.4	9.9	37	6.6	19.3	13	3.5	5.5	24
1708	Surface	7.8	39.0	47	21.9	162.2	16	4.6	9.6	31
1708A	Surface	6.8	32.8	39	15.0	120.8	13	4.6	11.7	26
1708B	Surface	4.3	12.7	38	5.6	26.2	15	3.7	6.5	23
1709	Surface	23.5	182.2	37	86.5	401.6	15	9.7	43.7	22
1710	Surface	7.7	34.7	37	19.9	101.6	15	4.0	7.2	22
1710A	Surface	7.9	40.2	37	19.3	131.5	15	4.3	8.8	22
1710B	Surface	12.8	94.9	36	35.1	360.8	15	6.2	17.6	22
1711	Surface	8.7	50.9	45	21.4	162.3	18	4.7	13.4	27
1711B	Surface	6.2	30.7	45	11.5	102.7	18	4.1	8.1	27
1711C	Surface	5.6	20.4	37	7.0	31.0	15	4.9	15.0	22
1711D	Surface	6.3	22.0	45	11.4	48.9	18	4.2	9.2	27
1711E	Surface	8.1	47.9	45	21.5	178.1	18	4.3	9.3	27
1712	Surface	16.2	140.6	37	26.1	300.0	15	11.8	77.7	22
1713	Surface	6.5	23.3	37	7.2	35.5	15	6.1	17.0	22
1713A	Surface	7.5	35.7	37	11.0	67.0	15	5.8	21.3	22
1713B	Surface	9.4	62.1	37	14.4	153.1	15	7.0	29.3	22
1714	Surface	9.5	50.7	37	9.9	58.9	15	9.3	47.5	22
1714A	Surface	10.4	61.9	44	25.3	169.9	17	5.9	21.5	27

TABLE 31: WATER QUALITY SUMMARY (TOTAL COLIFORM) FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY (10/08/97 - 08/15/01)

STATION	DEPTH	YEAR ROUND			SUMMER			WINTER		
		GEO. MEAN	EST. 90TH	N	GEO. MEAN	EST. 90TH	N	GEO. MEAN	EST. 90TH	N
1715	Surface	5.9	18.4	37	8.8	34.3	15	4.5	10.2	22
1715A	Surface	5.6	22.1	35	6.9	38.1	17	4.6	11.8	18
1715B	Surface	4.7	13.1	37	5.8	20.7	15	4.0	9.0	22
1715C	Surface	6.5	20.6	36	7.2	23.3	17	5.9	18.7	19
1716A	Surface	4.1	8.0	37	4.4	9.9	13	4.0	7.1	24
1717A	Surface	4.2	9.8	45	5.3	15.0	16	3.6	7.3	29
1717B	Surface	4.9	15.5	38	7.6	36.3	15	3.7	6.5	23
1717F	Surface	5.1	17.9	36	5.3	16.2	17	4.9	20.0	19
1718	Surface	5.8	21.2	45	12.0	56.8	16	3.9	8.3	29
1719	Surface	4.1	9.0	45	5.4	13.3	16	3.5	6.7	29
1719F	Surface	5.1	15.0	36	6.6	25.6	17	4.0	7.7	19
1720	Surface	5.4	21.3	37	8.4	56.3	13	4.3	10.3	24
1721A	Surface	4.2	10.2	38	5.6	19.7	15	3.4	5.4	23
1721D	Surface	5.4	19.1	45	7.1	34.4	18	4.5	11.8	27
1722	Surface	6.4	24.9	37	11.8	67.3	13	4.6	11.0	24
1722C	Surface	4.2	11.1	36	7.5	32.0	12	3.1	3.4	24
1723	Surface	5.3	15.1	37	8.6	29.4	13	4.1	8.8	24
1724	Surface	6.1	22.0	36	13.2	67.0	12	4.1	8.3	24
1725	Surface	12.5	155.5	40	28.7	628.4	15	7.6	51.1	25
1725A	Surface	5.6	25.7	40	10.2	89.1	15	3.9	7.6	25
1725B	Surface	5.4	22.1	40	7.7	55.7	15	4.3	10.3	25
1726	Surface	6.5	25.2	40	11.4	57.6	15	4.6	12.2	25
1726A	Surface	4.6	11.7	40	7.0	21.2	15	3.6	6.8	25

TABLE 32: WATER QUALITY SUMMARY (TOTAL COLIFORM) FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY (10/08/97 - 08/15/01)

STATION	DEPTH	YEAR ROUND			SUMMER			WINTER		
		GEO. MEAN	EST. 90TH	N	GEO. MEAN	EST. 90TH	N	GEO. MEAN	EST. 90TH	N
1727	Surface	6.6	25.3	40	11.5	46.8	15	4.7	14.7	25
1727B	Surface	4.7	11.8	40	6.6	22.2	15	3.9	6.8	25

RELATED STUDIES

The BMWM performs additional water quality studies related to the bacteriological monitoring program. Specifically, shellfish growing area BB3 has the following nutrient sampling stations: 1661A, 1661D, 1663A, 1670D, 1670F, 1674B, 1683C, 1688C, 1691A, 1700A, 1703C, 1704, 1706, 1703C, 1706, 1707C, 1712, 1718B, 1719E and 1721.

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 an altogether separate report. The nutrient station locations for BB3 are shown in Figure 26 and nutrient levels for these stations are shown in Tables 33 - 36.

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 in the following paragraph.

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 sixteen phytoplankton stations within the waters of New Jersey. Of those sixteen, 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.

Stations 1670D and 1703C are phytoplankton stations in shellfish growing area BB3. Current research (refer to *www.state.nj.us/dep/wmm/bmw*) suggests that populations of phytoplankton are sparse in this growing area and no toxic species have been associated with BB3 during recent sampling.

It should be noted that nutrient and phytoplankton stations are arranged so that samples for both are taken from matching locations. In this regard, data can be uniformly compared and analyzed. Additional projects, such as the NOAA mussel watch shown in Figure 27, are also followed by the BMWM as per incidence of toxins or metals within marine ecosystems.

FIGURE 26: NUTRIENT SAMPLING STATIONS FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY

TABLE 33: DATA SUMMARIES - NUTRIENT SAMPLING STATIONS FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY (09/01/00 - 08/30/01)

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
1661A	11/8/00	0925	9.5	5.5	29.11	9.20	15.00	4.50 K	8.64	11.71	299.99	30.25	1.26	3.0 K
1661D	11/8/00	0937	8.5	5.0	26.43	9.85	26.50	4.50 K	33.35	13.38	357.72	29.10	0.42	3.0 K
1663A	11/8/00	0951	10.0	5.5	28.09	9.25	11.00	4.50 K	8.64	11.15	280.75	28.52	1.68	3.0 K
1670D	11/8/00	1015	9.0	4.5	30.04	9.60	23.50	4.50 K	14.82	11.71	312.82	34.86	1.26	3.0 K
1700A	12/15/00	1108	3.5	4.0	27.45	11.35	16.50	4.50 K	3.88 K	10.92	284.52	32.02	2.94	3.0 K
1703C	12/15/00	1054	4.0	4.0	27.94	11.40	13.00	4.50 K	3.88 K	10.92	305.92	33.35	3.36	3.0 K
1704	12/15/00	1045	4.0	4.5	28.04	10.60	9.00	4.50 K	3.88 K	9.78	270.25	29.36	2.94	3.0 K
1706	12/15/00	1123	5.0	3.0	26.67	11.45	11.50	14.38	3.88 K	11.49	327.33	14.74	2.52	13.0
1707C	12/15/00	1036	3.8	4.0	27.74	11.20	17.50	4.50 K	3.88 K	12.06	255.98	34.02	2.52	3.0 K
1712	12/15/00	0929	3.8	2.0	26.48	11.00	15.00	8.39	12.69	24.55	280.95	52.30	2.94	13.0
1718B	12/15/00	1011	3.5	4.0	29.02	11.30	18.00	4.50 K	3.88 K	10.92	241.71	34.02	2.52	3.0 K
1719E	12/15/00	0945	3.3	4.0	28.23	11.30	16.00	4.50 K	3.88 K	10.35	99.02	33.35	2.94	3.0 K
1721	12/15/00	1023	4.0	4.5	28.23	11.20	17.50	4.50 K	3.88 K	12.06	270.25	40.00	2.52	3.0 K
1661D	3/19/01	0805	3.0	3.5	25.82	N	22.00	8.61	3.88 K	9.34	219.61	12.64	0.42 K	3.0 K
1670D	3/19/01	1330	5.5	6.5	27.70	N	27.50	6.17	3.88 K	4.60	157.35	9.62	0.42 K	3.0 K
1674B	3/19/01	1313	6.5	4.5	27.60	N	21.50	6.17	30.80	4.01	149.57	22.29	0.42 K	3.0 K
1688C	3/19/01	1258	5.5	6.0	26.94	N	23.50	6.17	3.88 K	6.97	172.91	10.23	0.42 K	3.0 K
1691A	3/19/01	1408	7.0	5.0	26.94	N	24.50	7.39	34.33	4.60	165.13	13.24	0.42 K	3.0 K
1700A	3/19/01	1235	5.5	8.0	28.07	N	26.00	4.50 K	3.88 K	9.34	204.04	21.08	0.42 K	3. K
1719E	3/19/01	1400	8.4	3.0	26.57	11.20	17.00	4.50 K	3.88 K	8.16	305.21	12.04	0.42 K	3.0
1703C	3/26/01	1017	2.0	7.0	25.22	10.20	16.00	N	N	N	N	N	2.52	3.0
1704	3/26/01	1008	3.0	5.0	25.51	10.05	20.00	N	N	N	N	N	2.94	3.0 K

Data Coding: K = Less Than, N = Data not available

TABLE 34: DATA SUMMARIES - NUTRIENT SAMPLING STATIONS FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY (09/01/00 - 08/30/01)

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
1706	3/26/01	1030	2.5	3.0	23.40	9.95	16.00	N	N	N	N	N	2.10	3.0 K
1707C	3/26/01	1039	2.0	5.5	25.60	9.90	21.50	N	N	N	N	N	0.42 K	3.0 K
1718B	3/26/01	0918	2.5	6.0	25.60	9.15	27.00	N	N	N	N	N	3.36	3.0 K
1721	3/26/01	0932	3.0	6.0	25.79	9.85	56.00	N	N	N	N	N	2.10	3.0 K
1661D	4/5/01	1038	7.0	8.0	27.13	10.50	20.50	4.50 K	14.30	3.81	115.99	9.24	1.79	3.0 K
1670D	4/5/01	1010	7.0	6.5	29.22	10.25	18.00	4.50 K	14.30	3.23	100.27	13.00	0.42 K	3 K
1670F	4/5/01	1000	6.5	4.0	28.67	9.85	14.00	4.50 K	11.05	4.39	108.13	11.12	2.10	3 K
1674B	4/5/01	0946	5.5	7.0	26.58	10.10	13.00	4.50 K	14.30	3.23	139.57	14.26	1.26	3.0 K
1683C	4/5/01	0936	6.0	7.0	25.06	10.05	13.50	4.50 K	17.55	3.81	391.10	29.93	1.68	3.0 K
1691A	4/5/01	1024	6.0	7.0	29.22	10.20	9.00	4.50 K	14.30	3.81	100.27	7.99	0.95	3.0 K
1700A	4/5/01	0920	5.5	7.0	23.34	10.00	9.50	4.50 K	11.05	3.23	155.29	15.51	1.68	3.0 K
1719E	4/5/01	1305	10.6	3.0	27.24	10.45	9.00	4.50 K	7.80	4.39	218.17	16.14	1.89	3.0 K
1661A	5/25/01	0915	16.7	N	28.06	8.50	23.00	7.95	5.88	5.99	221.92	11.86	4.20	3.0
1663A	5/25/01	0933	22.0	N	27.49	8.20	15.50	10.88	4.38	6.58	187.05	5.31	1.26	13.0
1703C	5/25/01	1015	16.4	N	30.71	9.00	14.50	5.02	3.88 K	5.40	165.25	13.75	1.26	3.0 K
1704	5/25/01	1030	17.1	N	27.72	8.75	14.00	5.02	3.88 K	4.22	182.65	9.38	2.10	3.0 K
1706	5/25/01	1042	17.4	N	31.06	8.15	11.50	5.02	3.88 K	4.22	150.08	13.12	1.68	3.0
1707C	5/25/01	1101	16.7	N	32.35	9.00	9.00	5.02	3.88 K	4.22	117.06	5.00	1.68	3.0 K
1712	6/27/01	0947	26.0	1.0	14.95	7.65	24.00	76.42	18.12	38.99	449.81	97.57	1.26	20.0
1718B	6/27/01	0915	25.7	1.5	31.86	7.80	29.50	30.25	15.48	22.79	604.63	79.83	2.52	3.0 K
1721	6/27/01	0900	25.7	1.5	31.64	6.80	19.00	32.45	16.87	28.40	1352.17	90.34	3.78	3. K
1661A	7/17/01	0905	25.5	3.0	31.04	6.80	14.00	27.14	140.12	18.18	171.13	54.81	1.05	3.0

Data Coding: K = Less Than, N = Data not available

TABLE 35: DATA SUMMARIES - NUTRIENT SAMPLING STATIONS FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY (09/01/00 - 08/30/01)

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
1661D	7/17/01	0810	23.8	3.5	30.85	7.25	23.00	20.81	6.32	13.76	201.60	47.43	0.42	3.0 K
1663A	7/17/01	0914	27.5	3.0	31.04	6.20	18.50	29.25	44.01	17.62	359.47	56.15	0.88	7.0
1670D	7/17/01	0930	24.2	4.0	32.00	7.00	21.50	25.03	3.88 K	16.52	304.59	49.44	0.70	7.0
1700A	7/24/01	0950	25.3	2.0	31.81	6.55	20.50	38.71	10.41	32.95	866.70	97.92	3.36	3.0 K
1703C	7/24/01	1004	25.3	2.0	31.53	5.70	23.50	28.32	95.79	29.98	631.94	97.25	8.83	3.0 K
1704	7/24/01	1013	25.7	2.0	31.24	7.00	32.50	53.26	10.55	52.59	1164.81	129.09	7.15	20.0
1706	7/24/01	1029	25.7	1.5	30.86	6.70	32.00	86.51	12.62	60.32	1071.01	158.56	16.82	17.0
1707C	7/24/01	1041	25.3	3.5	32.29	4.95	20.50	24.16	8.21	27.00	678.20	83.18	4.20	N
1718B	7/24/01	1109	25.7	3.5	32.86	6.85	24.50	11.70	8.10	27.00	514.43	66.44	4.63	3.0
1719E	7/24/01	1115	25.7	3.0	31.62	8.20	26.50	13.46	7.03	36.52	775.05	105.96	6.31	3.0 K
1721	7/24/01	1049	25.7	2.5	32.48	6.55	31.50	24.16	7.57	25.22	644.75	73.13	3.36	3.0 K
1712	8/21/01	0947	25.7	2.0	30.48	5.80	20.50	172.65	3.88 K	33.61	936.04	87.62	4.22	27.0
1700A	9/6/00	0906	19.0	2.0	29.71	8.00	22.00	13.27	3.88 K	17.15	679.33	34.06	5.47	3.0
1703C	9/6/00	0930	19.0	2.5	29.33	7.45	38.00	47.98	3.88 K	20.59	893.82	46.54	7.15	3.0 K
1704	9/6/00	0941	20.5	2.0	27.91	6.90	54.50	15.75	3.88 K	19.44	1047.03	115.97	13.46	53.0
1706	9/6/00	1000	21.0	3.0	20.87	6.70	19.50	57.90	14.53	14.85	875.44	76.47	5.47	33.0
1712	9/6/00	0745	18.0	2.5	19.51	6.50	15.50	51.08	3.88 K	26.33	936.72	38.03	3.78	117.0
1719E	9/6/00	0824	18.5	2.0	28.76	7.05	47.00	33.10	3.88 K	32.64	1120.56	93.64	2.94	3.0
1707C	9/7/00	0945	18.0	2.5	29.20	7.25	37.00	5.83	3.88 K	22.31	716.10	70.73	7.15	3.0 K
1718B	9/7/00	0830	18.0	2.0	28.51	7.40	20.00	4.59	3.88 K	20.02	893.82	103.89	2.52	3.0 K
1721	9/7/00	0847	18.5	2.5	29.20	7.15	42.50	4.50 K	3.88 K	20.59	857.05	91.77	4.20	3. K
1661A	9/19/00	1109	21.5	N	27.58	6.50	20.50	20.32	3.88 K	21.65	499.96	63.11	2.52	3.0 K

Data Coding: K = Less Than, N = Data not available

TABLE 36: DATA SUMMARIES - NUTRIENT SAMPLING STATIONS FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY (09/01/00 - 08/30/01)

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
1661D	9/19/00	1055	21.0	N	27.67	6.75	19.50	9.69	3.88 K	14.84	451.56	49.82	1.68	3.0 K
1663A	9/19/00	1120	24.5	N	27.21	6.15	35.00	22.68	3.88 K	22.40	520.71	60.16	1.26	7.0
1670D	9/19/00	1235	21.5	N	29.16	7.50	31.00	14.41	3.88 K	29.97	430.82	59.74	3.36	3.0 K

Data Coding: K = Less Than, N = Data not available

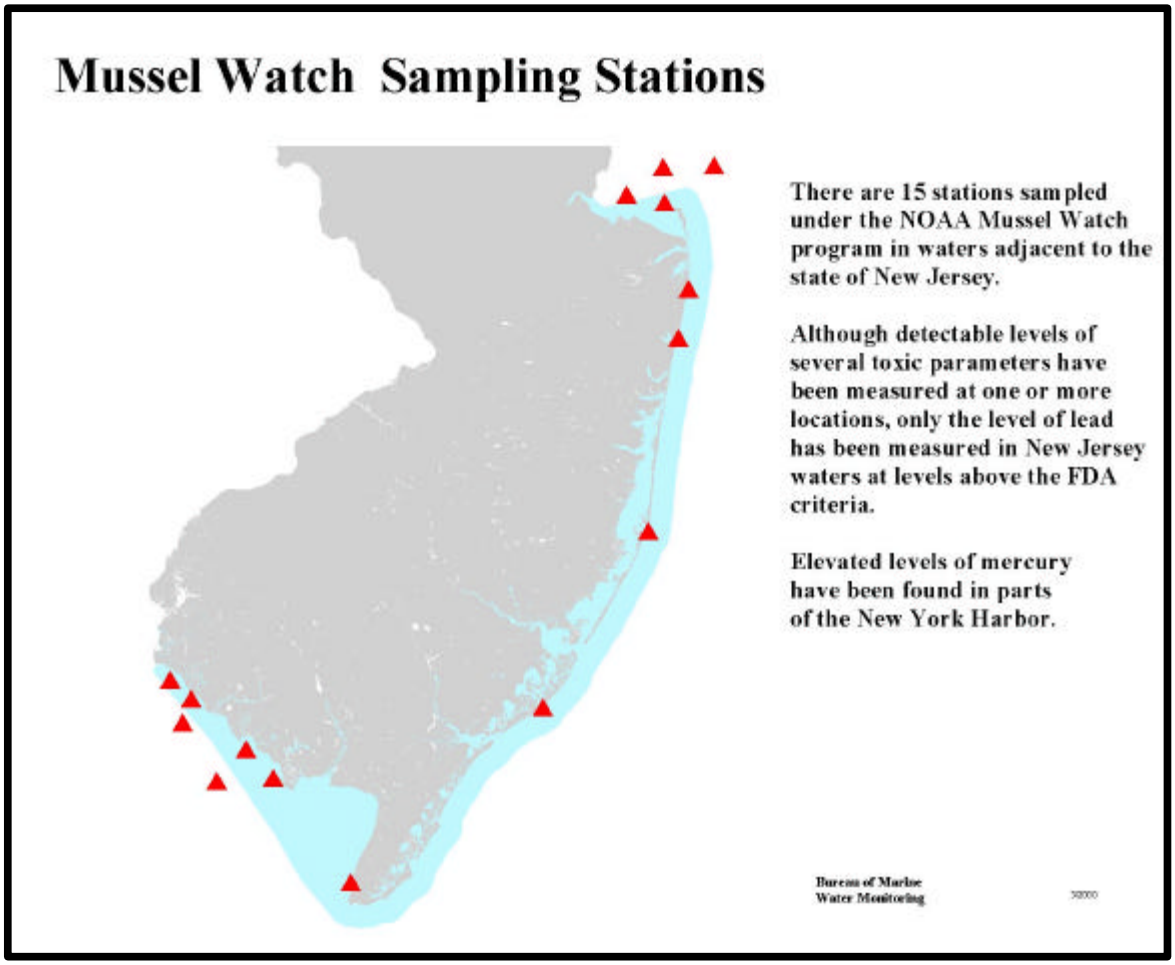

FIGURE 27: SAMPLING SITES WHERE NOAA MUSSEL WATCH DATA HAS BEEN COLLECTED

INTERPRETATION AND DISCUSSION OF DATA

BACTERIOLOGICAL

The results of the water quality data collected from sampling in this shellfish growing area indicated that all stations were within SRS year round criteria (total coliform) for *Approved* waters.

One can not say that coliform scores reflect a strong influence from rainfall, tide and change in season as the total coliform Geometric Means and estimated percentile data are relatively low within the growing area. With this, rainfall, tide or variability in season are not primary influences for the BMWM choice of SRS sampling strategy in determining classifications for this site although they do provide useful information that helps to direct us in classifying these waters. For instance, the Bureau of Marine Water Monitoring does utilize specific seasons as priorities for sampling in five of the six assignments related to this growing area.

These priorities are aligned with the seasons and locations of stations where incidence of higher bacterial counts is likely in relation to influences such as marinas and lagoon communities. Further, most of these priorities for sampling are related to the summer season as per population increases within priority locations.

CONCLUSIONS

BACTERIOLOGICAL EVALUATION

The following was concluded based on the water quality data for BB3 from October 1, 1997 through August 30, 2001. The shellfish growing waters within this area more than meet NSSP criteria for their current classification. Specifically, all stations within this 16 mile site met SRS year round criteria (total coliform) for *Approved* shellfish growing waters on summary evaluation.

Impacts from season and tide, along with correlations for rainfall were present. However, the data did not exceed NSSP criteria under any condition of tide, rainfall or season. The impact is fairly minimized within shellfish growing area BB3 per the dilution and mixing processes mentioned earlier in this report. As such, there is no reason to suggest that the sampling strategy or parameters for classification be altered for this growing area as per season, tide or rainfall influence.

For the purpose of public health and safety, the sampling strategy and classification for most back bay waters is primarily based on the indirect discharge from stormwater outfalls, marinas and lagoon sections that exist within New Jersey's intercoastal waters. With BB3, the existence of potential contributors to coliform bacteria such as marinas, lagoons and stormwater outfalls provides the primary reason for utilization of SRS Sampling Strategy. Further, these influences often dictate the degree to which portions of the site must be classified. Buffers of *Seasonal*, *Special Restricted* or *Prohibited* waters are then most useful as protective zones in areas with the above influences. Buffers are most frequent in more densely populated areas where the occurrence of marinas, lagoons and stormwater outfalls (water quality influences) are more common. However, the bacteriological data contained within this Partial Sanitary Survey suggests the BMWM has the opportunity to upgrade portions of the BB3 shellfish growing area located outside these influences while still maintaining sufficient safety or buffer zones where needed.

Significant coliform levels are not impacting the shellfish growing waters within the locations proposed for upgrade in this report. Were shellfish to be harvested from the areas recommended for reclassification in this report, the data suggest that health risks from human consumption of shellfish with regard to these upgrades would be negated.

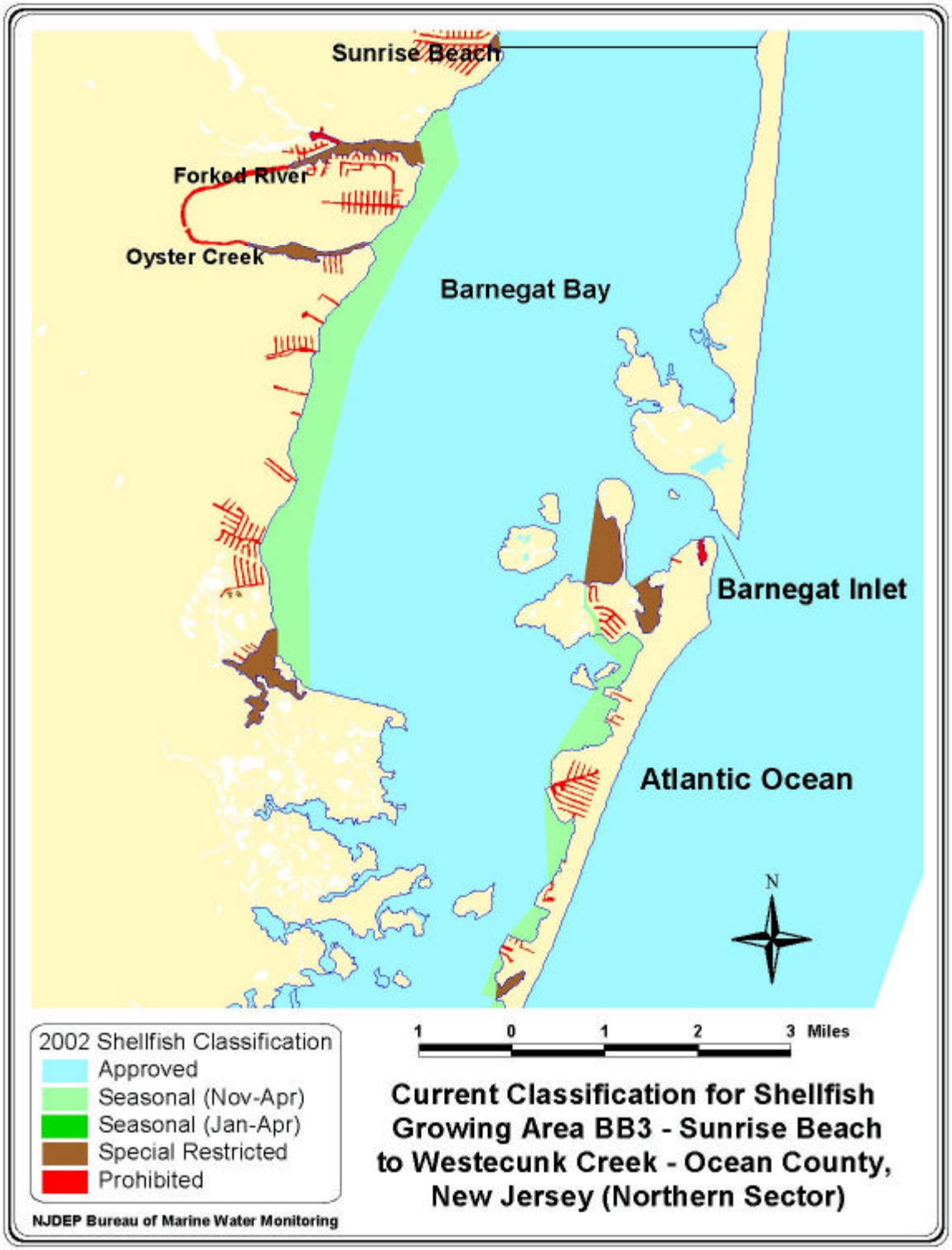

FIGURE 28: CURRENT CLASSIFICATION FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY (NORTHERN SECTOR)

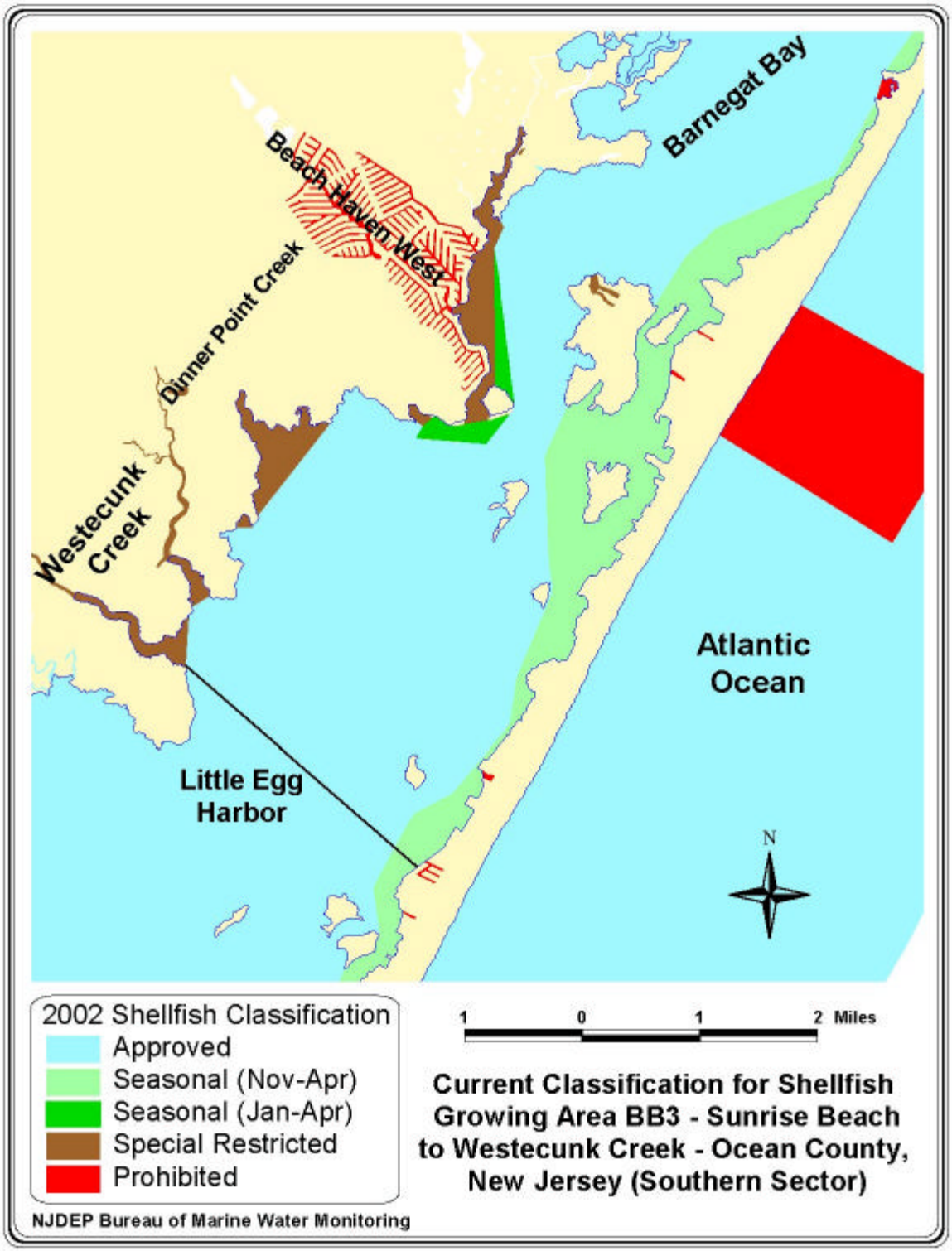

FIGURE 29: CURRENT CLASSIFICATION FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY (SOUTHERN SECTOR)

RECOMMENDATIONS

Recommended Classification Changes

It is recommended that a portion of the *Seasonal* (Jan – Apr) waters just East of Beach Haven West – (Barnegat Bay area – Manahawkin, NJ) be upgraded to *Seasonal* (Nov – Apr). It is further recommended that an area of *Special Restricted* waters to the West of Barnegat Inlet (Barnegat Bay area - High Bar Harbor, NJ) be upgraded to *Approved* classification.

The premise for classification change in these areas revolves around NSSP criteria and the consistency of acceptable water quality per SRS Sampling Strategy (total coliform). Utilization of NSSP standards for total coliform provides summary evaluations for these upgrade areas that suggest they meet criteria for year-round analyses for *Approved* water classification. However, the *Seasonal* waters outside Beach Haven West provide a buffer for a lagoon community. With this, our recommendation seeks to upgrade those waters with a conservative two month extension in the availability for clamming that section of waters currently designated as *Seasonal* (Jan – Apr) to a *Seasonal* (Nov – Apr) classification.

Again, as provided earlier in this report, all sample data reviewed, including an extended winter analysis (for the Beach Haven West area), provides that the BMWM has substantiation in recommending this upgrade along with the upgrade proposed for the *Restricted* waters to the West of Barnegat Inlet.

The favorable data presented in this Partial Sanitary Survey, along with analyses contained within former reports, helped to formulate the context from which this report was written and recommendations are made.

The recommendations specifically involve the following:

132.70 acres are recommended for upgrade from *Seasonal* (Jan – Apr) to *Seasonal* (Nov – Apr). Also proposed is the upgrade of 160.46 acres from *Special Restricted* waters to *Approved*. These changes will result in the reduction of *Special Restricted* waters (for this growing area) to 987.75 acres as compared to 1148.21 acres. Further, *Seasonal* (Jan – Apr) waters for BB3 will be eliminated entirely and the figure for *Seasonal* (Nov – Apr) acreage should increase to 3695.34 from the previous amount of 3557.64 acres. Recommendations for classification changes or acreage reconfiguration can be viewed in Figures 32 and 33 of this report.

In the interim, the New Jersey Administrative Code N.J.A.C. 7:12-4.2 (a)-3i will be held as **Reserved** and the New Jersey Administrative Code N.J.A.C. 7:12-4.1 (a)-4iii has been added. Further, the New Jersey Administrative Code N.J.A.C. 7:12-3.2 (a)-13ii will be held as **Reserved**. This will accommodate the changes in water classification shown in this report. These descriptions are shown in the section that follows.

Legal description for Recommended Changes:

In N.J.A.C. 7:12-4.2 (a)

3. **[**Manahawkin Bay, Mallard Island, Beach Haven West (Village Harbor) area: Seasonal-Special Restricted May 1 through December 31 yearly, Approved January 1 through April 30 yearly:

i. All those waters of Manahawkin and Little Egg Harbor Bays lying between a straight line beginning on the westernmost end of the most westerly island along the Manahawkin Causeway (Route 72), then bearing approximately 173 degrees T to the most easterly point of Thorofare Island, then bearing approximately 218 degrees T to Department maintained marker "J," then bearing approximately 275 degrees T to Department maintained marker "K," then bearing approximately 032 degrees T to the southeasternmost point of Oyster Point, then along the shoreline to the easternmost tip of Popular Point, then bearing approximately 080 degrees T to the southernmost tip of Thorofare Island, then northeasterly along the southern and then western shoreline to the northernmost tip of Thorofare Island, then bearing approximately 355 degrees T to the westernmost end of the most westerly island along the Manahawkin Causeway and terminating.**]** **Reserved**

In N.J.A.C. 7:12-4.1(a)4

iii. Manahawkin Bay, Mallard Island, Beach Haven West (Village Harbor) area: All those waters of Manahawkin and Little Egg Harbor Bays lying between a straight line beginning on the westernmost end of the most westerly island along the Manahawkin Causeway (Route 72), then bearing approximately 173 degrees T to the most easterly point of Thorofare Island, then bearing approximately 218 degrees T to Department maintained marker "J," at latitude 39 degrees 38 minutes 31 seconds, longitude 74 degrees 12 minutes 53 seconds then bearing approximately 275 degrees T to Department maintained marker "K," at latitude 39 degrees 38 minutes 33 seconds, longitude 74 degrees 13 minutes 34 seconds then bearing approximately 032 degrees T across the southeasternmost point at the mouth of the unnamed creek, then across the mouth of that creek to the southern shore of Popular Point, then along the shoreline to the easternmost tip of Popular Point, then bearing approximately 080 degrees T to the southernmost tip of Thorofare Island, then northeasterly along the southern shoreline to the northernmost tip of Thorofare Island, then bearing approximately 360 degrees T to the westernmost end of the most westerly island along the Manahawkin Causeway and terminating.

FIGURE 30: PROPOSED AREA FOR UPGRADE FROM *SEASONAL* (JAN-APR) TO *SEASONAL* (NOV-APR) - SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - JUST EAST OF BEACH HAVEN WEST - OCEAN COUNTY, NEW JERSEY (SOUTHERN SECTOR)

In N.J.A.C. 7:12-3.2 (a)13

ii. **[**All those waters of Barnegat Bay enclosed by a line beginning on the northernmost point of land forming the northern mouth of the most northerly lagoon located between Butler and Meadow Streets in High Bar Harbor (Long Beach Township) and bearing approximately 270 degrees T to the northeasternmost point of land on the northernmost of the two islands just offshore, (Edwin B. Forsythe National Wildlife Refuge-Barnegat Division) then bearing approximately 014 degrees T to the westernmost point of land at the northern extremity of the High Bar spoil area (also known as "The Dike") where this line terminates;**]** **Reserved**

FIGURE 31: PROPOSED AREA FOR UPGRADE FROM *SPECIAL RESTRICTED* TO *APPROVED* - SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - WEST OF BARNEGAT INLET - OCEAN COUNTY, NEW JERSEY (NORTHERN SECTOR)

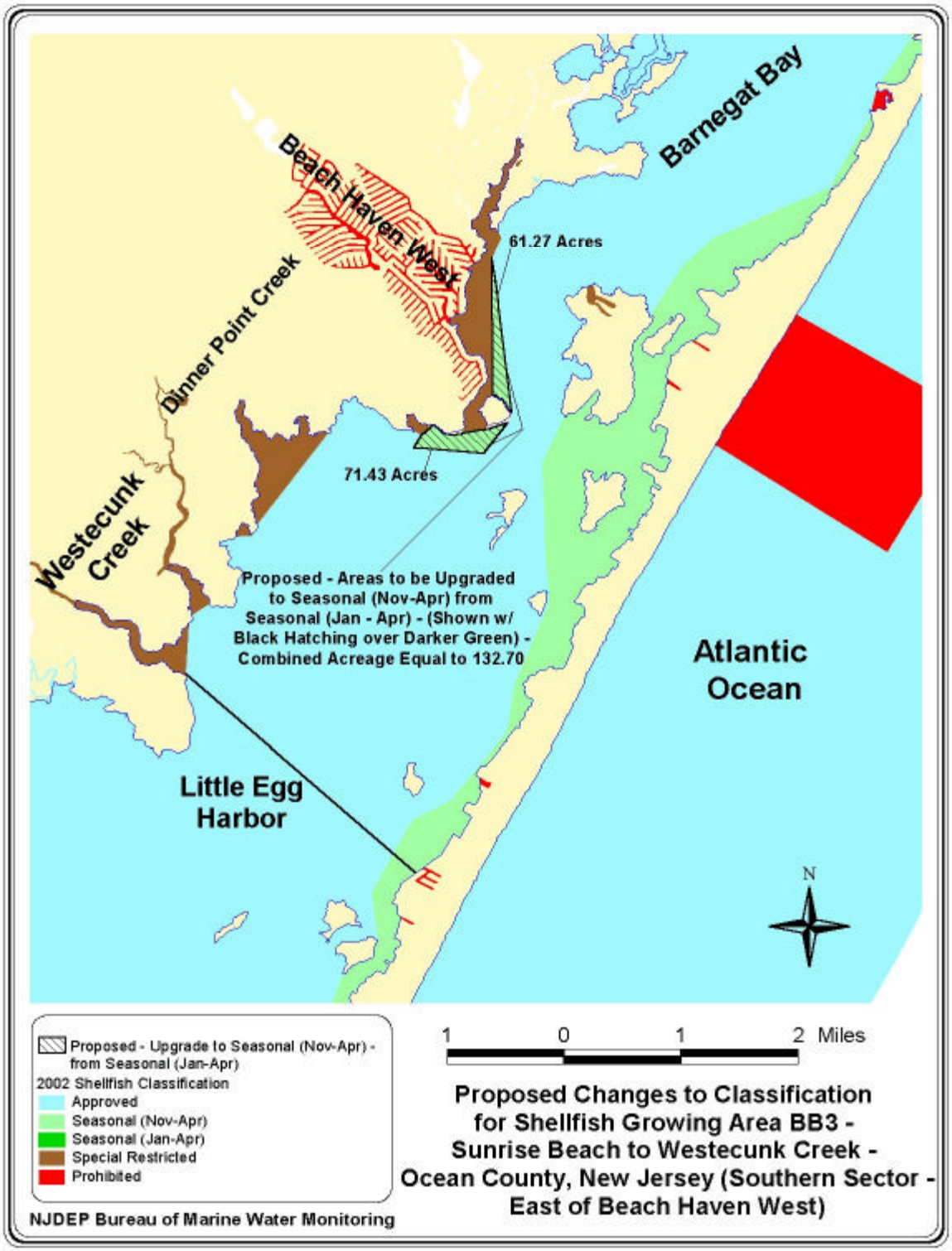

FIGURE 32: PROPOSED CHANGES TO CLASSIFICATION FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY NEW JERSEY (SOUTHERN SECTOR – EAST OF BEACH HAVEN WEST)

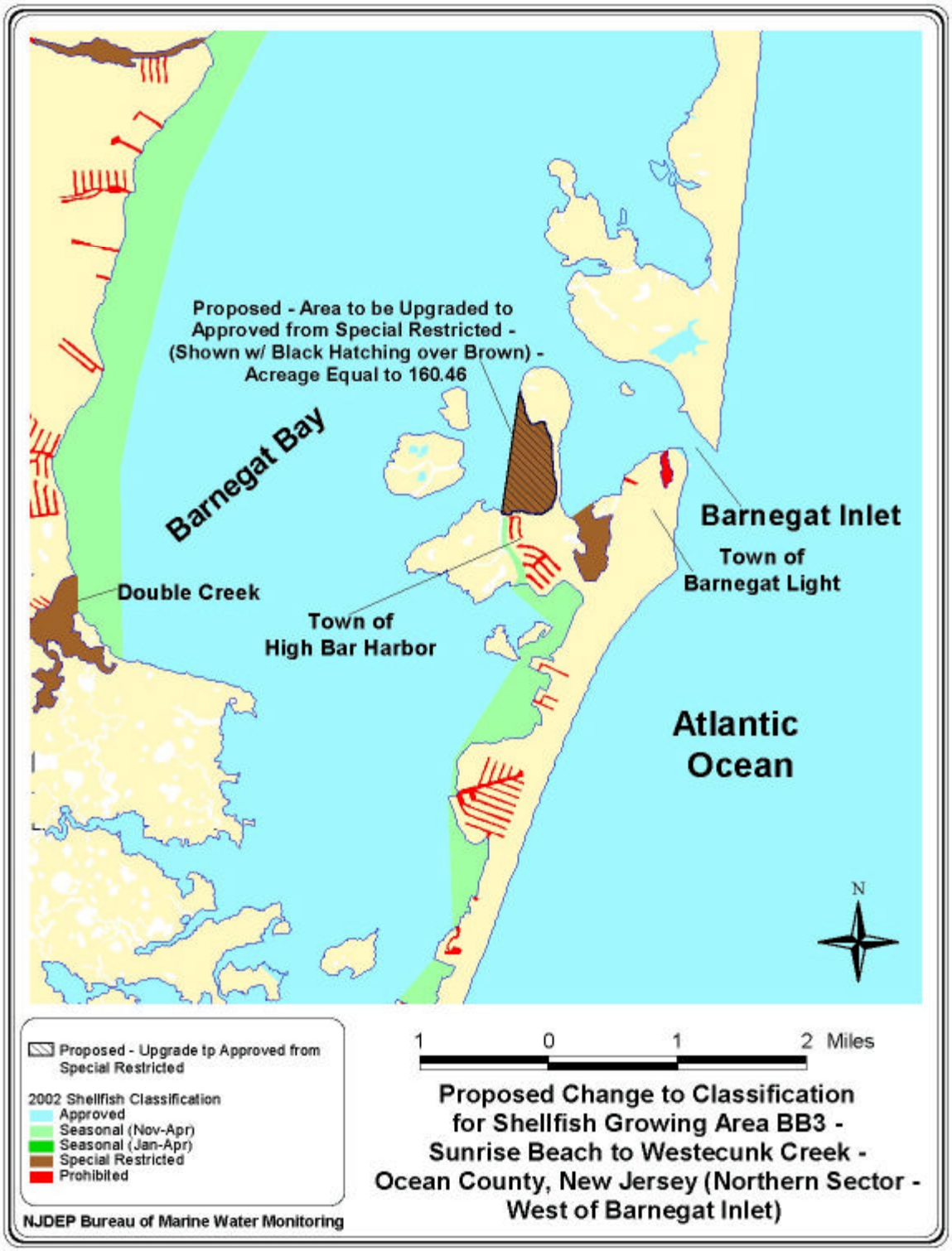

FIGURE 33: PROPOSED CHANGE TO CLASSIFICATION FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY NEW JERSEY (NORTHERN SECTOR – WEST OF BARNEGAT INLET)

Recommended Changes in Monitoring Schedule

Shellfish growing area BB3 is comprised of Assignments 102,107,114,117,121 and122. It is sampled under the Systematic Random Sampling Strategy. The recommended changes in monitoring proposed in this section would specifically affect the western sector of Assignment 121 (area outside Beach Haven West – Barnegat Bay – Manahawkin, NJ). These changes are suggested per the proposed upgrade in *Seasonal* (Nov – Apr) classification outlined within the classification change and legal description components of the Recommendations section.

These revisions will readily enable the Bureau of Marine Water Monitoring to effectively coordinate the proposed change for the currently existing *Seasonal* (Jan – Apr) classification to *Seasonal* (Nov – Apr), while providing a continuous approach to public health/safety monitoring practices.

The Recommended changes are as follows:

Activate new stations 1703E and 1704E within the actual area intended for *Seasonal* (Nov – Apr) upgrade. This will allow the BMWM more specific data retrieval from within the area proposed for upgrade and will further facilitate and refine analysis of these waters in the upgrade area. Plot coordinates for latitudes and longitudes are shown for these new stations in Figures 34.

Deactivate surface sampling stations 1705A and 1708B in order to maintain balance in the assignment and efficiency of time for BMWM boat captains collecting sampling runs from said assignment. The locations of the deactivated sampling stations are also shown in Figure 34. These changes will maintain the number of surface sampling stations for shellfish growing area BB3 and the number of sampling runs as well.

The area of *Special Restricted* waters to the West of Barnegat Inlet selected for upgrade to *Approved* will have no changes per this Partial Sanitary Survey aside from the upgrade. Monitoring stations within those waters have been deemed to be sufficiently placed so as to provide reasonable data for continued analysis at present.

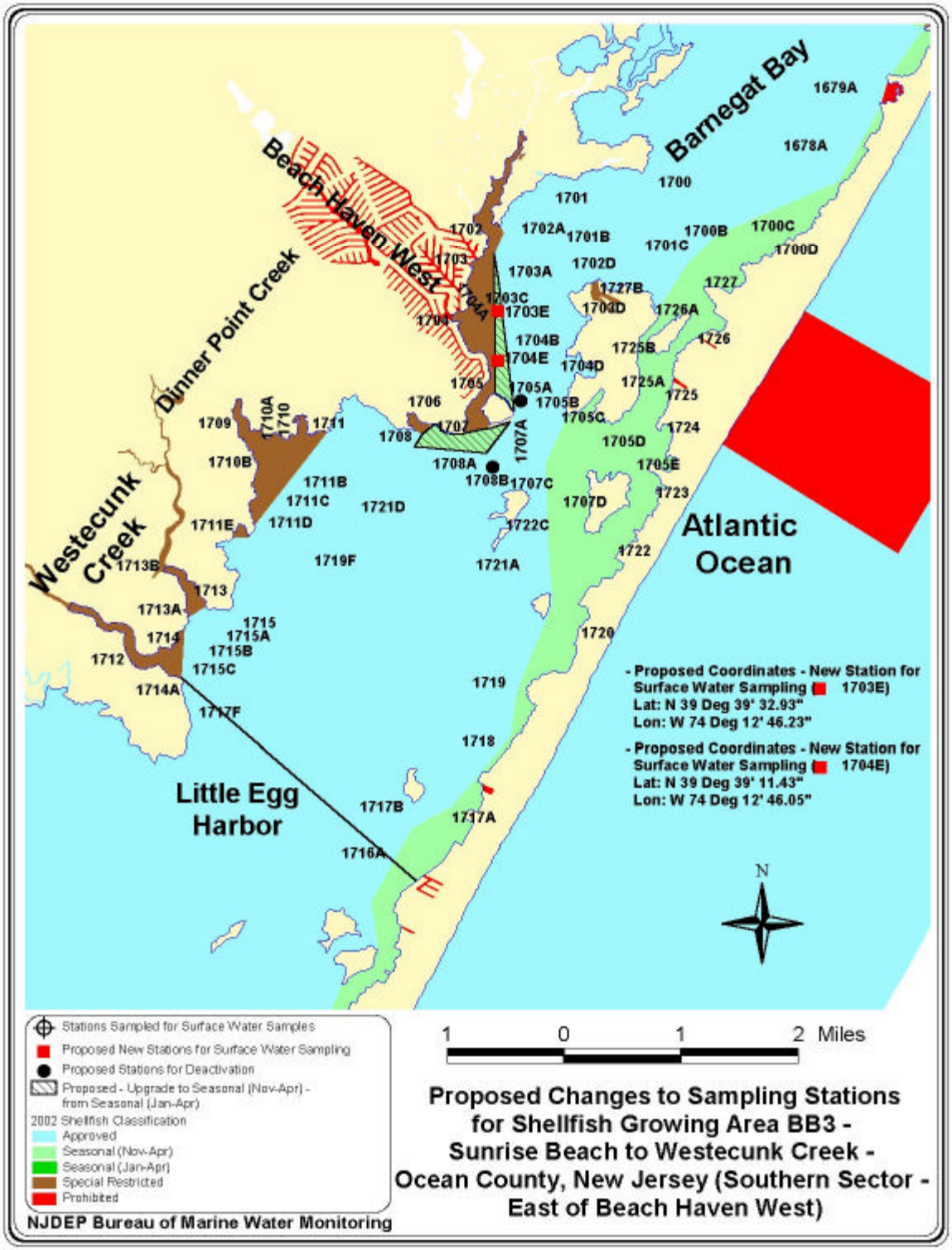

FIGURE 34: PROPOSED CHANGES TO SAMPLING STATIONS FOR SHELLFISH GROWING AREA BB3 - SUNRISE BEACH TO WESTECUNK CREEK - OCEAN COUNTY, NEW JERSEY (SOUTHERN SECTOR – EAST OF BEACH HAVEN WEST)

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. 2002. New Jersey Department of Environmental Protection, Bureau of Shellfisheries, Nacote Creek, NJ. (Personal Communication).

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.

Connell, R.C. 2002. New Jersey Department of Environmental Protection, Bureau of Marine Water Monitoring, Leeds Point, NJ (Personal Communication).

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.

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

NJDEP. 2002. Annual Summary of Phytoplankton Blooms and Related Conditions in New Jersey Coastal Waters. (Summer 2001). New Jersey Department of Environmental Protection, Freshwater and Biological Monitoring, Trenton, NJ.

NJDEP. 2001. State of New Jersey Shellfish Growing Water Classification Charts. New Jersey Department of Environmental Protection, Bureau of Marine Water Monitoring, Leeds Point, NJ.

Normant, Jeff. 2002. New Jersey Department of Environmental Protection, Bureau of Shellfisheries, Nacote Creek, NJ. (Personal Communication).

Peters, Steven. 2000. Ambient Monitoring Program Sanitary Survey for Southern Barnegat Bay Forked River to Manahawkin. New Jersey Department of Environmental Protection, Bureau of Marine Water Monitoring, Leeds Point, NJ.

Schuster, Robert S. 2002. New Jersey Department of Environmental Protection, Bureau of Marine Water Monitoring, Leeds Point, NJ (Personal Communication).

Tripet, Preston E. 2002. GPU Energy, Allenhurst, NJ (Personal Communication).

USPHS. National Shellfish Sanitation Program *Guide for the Control of Molluscan Shellfish*, 1999. US Public Health Service, Food and Drug Administration, Washington, DC.

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APPENDICES

Detailed Data Listing(s) from 10/8/97 to 8/15/01 for data pull 9/1/97 to 8/30/01

Detailed Data Listing(s) (Winter only) from 11/16/94 to 4/27/01 for data pull 11/1/94 to 4/30/01