Barnegat Bay Restoration, Enhancement, and Protection Strategy:

Moving Science into Action

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BARNEGAT BAY RESTORATION, ENHANCEMENT AND PROTECTION STRATEGY:
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Executive Summary

The New Jersey Department of Environmental Protection (DEP) is moving science into action in the Barnegat Bay watershed. This Barnegat Bay Restoration, Enhancement, and Protection Strategy (BB REP Strategy) is built upon the data, modeling results, and research generated by the Barnegat Bay Ten-Point Plan (Phase One) announced in 2010. DEP is building upon the accomplishments of Phase One by identifying restoration, enhancement, and protection actions as part of Phase Two (BB REP Strategy) with the continued goal of improving the ecological health of Barnegat Bay and its watershed. The BB REP Strategy provides four major components; Restoration, Enhancement, Protection and Assessment; that include short-term, mid-term, and long-term objectives and actions.

This strategic plan identifies objectives and actions aimed at restoring areas of concern (Restoration), enhancing areas wherever possible (Enhancement), and protecting healthy areas (Protection) of the Barnegat Bay and its watershed. DEP will also continue monitoring throughout this process to assess the effectiveness of implementation on water quality and biodiversity within Barnegat Bay and the Barnegat Bay watershed (Assessment).

DEP has and will continue to seek and rely upon the input and efforts of partners and stakeholders, which include Barnegat Bay municipalities; county, state, and federal agencies; local authorities; environmental advocacy groups; academia; trade associations; private entities; and the public.

During Phase Two, partners and stakeholders will continue to be instrumental in accomplishing the objectives and actions alongside of DEP; this BB REP Strategy will undergo constant re-evaluation to gauge the effectiveness of the four major components and modifications will be made as needed. The DEP will continue to provide crucial funding needed, specifically providing up to $10 Million combination low interest loans and grants and up to $10 Million in grants to begin the implementation of the BB REP Strategy.

Introduction and Purpose
The New Jersey Department of Environmental Protection (DEP) is charged with formulating comprehensive policies for the conservation of the natural resources of the State, the promotion of environmental protection, and the prevention of pollution of the environment. Specifically, the Clean Water Act (CWA) mandates States to, "restore, and maintain the chemical, physical, and biological integrity of the Nation's waters." (CWA, 2002).

In 2010, DEP was directed by Governor Chris Christie to develop a Comprehensive Action Plan to address the ecological health of the 660-square-mile Barnegat Bay watershed. A series of public meetings were held to engage stakeholders in the collaborative development of the Barnegat Bay Action Plan. On December 9, 2010, Governor Chris Christie formally announced the Ten-Point Plan. A copy of the Ten-Point Plan is available at http://www.nj.gov/dep/barnegatbay.

Through the Ten-Point Plan (Phase One), DEP launched both long-term efforts, such as closing the Oyster Creek Nuclear Generating Station, funding comprehensive research and water quality model development, and the development of post-construction soil restoration standards, and short-term actions such as municipal compliance assistance, reducing nutrient pollution from fertilizer through increased education and enforcement, and acquiring land in the Barnegat Bay watershed. Much of Phase One focused on research and the collection of sufficient hydrodynamic (flow and current), water chemistry, biological, and sediment flux data needed for model development, and to systematically assess the current condition of the bay and its watershed.

Phase One Accomplishments:
- A comprehensive water quality monitoring network was established in Barnegat Bay for both fresh and marine water. Data collected established baseline conditions and informed model development.
- Ten Barnegat Bay-specific research projects were funded, the results of which create one of the most comprehensive compilations of research on a single estuary.
- On June 12, 2017, the New Jersey Department of Agriculture and Natural Resource's State Soil Conservation Committee adopted amendments to the Soil Erosion Sediment Control Plan at N.J.A.C. 2:90 incorporating post-construction soil restoration standards which promote stormwater infiltration and reduce stormwater runoff and non-point source pollution.
- More than 11,000 acres have been acquired by New Jersey's Green Acres Program and Ocean County Natural Lands Trust since 2011.
- $24 million in loans/grants funded 31 stormwater infrastructure projects and upgrades within the Barnegat Bay watershed.
- Nearly $4 Million in grants funded 11 water quality restoration projects within the Barnegat Bay watershed since 2011.
- In 2011, legislation was enacted that established restrictive standards for nitrogen content in fertilizer and application rates, reducing excess nutrient runoff into the bay by decreasing the total amount of nitrogen in fertilizer, and increasing the amount of slow release nitrogen.
- Three green boater compliance sweeps were conducted by State Park Police with the assistance of Conservation Officers, State Police, and local police resulting in hundreds of stops where boaters were educated on reducing water craft impacts.
- Eight Barnegat Bay Blitz cleanups were conducted, engaging nearly 32,000 volunteers who cleaned up almost 5,000 cubic yards of trash and recyclables in the Barnegat Bay watershed.
- Thousands of students from more than 150 classes and youth groups participated in annual Rain Barrel Challenges.
- Island Beach State Park (IBSP) now has a full-time naturalist on staff. IBSP is continuing its commitment to add hands-on environmental education programs focused on the ecology of the bay and features multiple annual Bay-focused festivals such as the Harvest the Bay Festival and the Beach Plum Festival.

More information on Phase One accomplishments is available at http://www.nj.gov/dep/barnegatbay.

The restoration, enhancement, and protection of Barnegat Bay is critical to the State's tourism, economy, and quality of life for residents of the region and remains a DEP priority. DEP is transitioning from Phase One (Ten-Point Plan) to Phase Two. Phase Two will focus on taking what was learned and moving science into

action with a collective goal of a healthy Barnegat Bay watershed. Phase Two, hereafter referred to as the Barnegat Bay Restoration, Enhancement and Protection Strategy (BB REP Strategy), builds upon the data, modeling results, and research conducted as part of Phase One and provides a series of objectives that includes immediate on-the-ground implementation actions coupled with the groundwork for future implementation. The BB REP Strategy captures the input from Barnegat Bay stakeholders and partners and follows through to complete the original vision of Phase One.

Four Major Components of the Barnegat Bay Restoration, Enhancement, and Protection Strategy
[Each component includes short-term (immediate), mid-term (up to 2 years) and long-term (up to 5 years) objectives and actions]

Restoration	**actions needed to return Barnegat Bay to a nonimpaired (healthy) status.**
Enhancement	**actions needed to reduce the spatial extent of current impairments, improve areas "on the edge" of impairment, and/or enhance the use of Barnegat Bay.**
Protection	**actions needed to preserve and safeguard open land, valuable wetlands, and nonimpaired waters of Barnegat Bay from future degradation.**
Assessment	**monitoring to determine the efficacy of actions, re-evaluation to measure progress, and make modifications to the BB REP Strategy as needed.**

Lastly, the accomplishments to date, as well as those in the future, depend on maintaining existing partnerships and forging new ones with Barnegat Bay municipalities; county, state, and federal agencies; local authorities; environmental advocacy groups; academia; trade associations; private entities; and the public. The goals of these partners and their affiliated programs often align and overlap with the goals of the BB REP Strategy, providing mutual benefits. Partnerships strengthen the BB REP Strategy by attracting new ideas and input, increasing understanding of problems and obstacles, and building commitment to implement solutions. Partnerships are key to achieving objectives and implementing actions. DEP will continue to work with partners to finalize the BB REP Strategy and implement actions to achieve a healthy Barnegat Bay for future generations.

History
Native Americans were the first to take advantage of Barnegat Bay's resources. The Lenni Lenape would spend summers in the region harvesting shellfish. Early settlers also recognized the value of the Barnegat Bay area. Although named by Henry Hudson in 1609, active settlement did not occur until 1720. From then until the late 1800s, industries focused on the exploitation of resources from the bay and watershed which in turn began impacting the delicate ecosystems. Emerging industries of colonial times included logging and sawmills, manufacturing bog iron, whaling and charcoal manufacture (History of Barnegat, 2017) all industries that cause ecological stress and degradation. With time, other uses became more prevalent in the watershed, such as fishing, hunting, and farming. Since the mid-1800s, tourism also has been important to the economy of the Barnegat Bay communities. Land use has shifted from mostly agricultural to suburban and urban development. The change in land use has affected the quality and quantity of stormwater runoff, and has resulted in lost or modified ecological habitats.

Today, Barnegat Bay remains an important yet vulnerable resource. Nearly all 33 municipalities in Ocean County lie within the Barnegat Bay watershed, as well as four municipalities in Monmouth County. The Barnegat Bay watershed has a total area of 660-square-miles. According to a 2016 census, nearly 600,000 people populate the area year-round, while the summer months' double that number.

The Barnegat Bay is comprised of three shallow bays that have varying tidal influence: Barnegat Bay, Manahawkin Bay, and Little Egg Harbor. These bays are generally shallow, with little freshwater flow from tributaries, and limited connection to the Atlantic Ocean, which creates a lack of natural flushing and high residence

time for harmful pollutants. The natural physical shape of the bays and their hydraulics leads to eutrophication (excessive nutrients), which is amplified by centuries of anthropogenic (human) activities. Barnegat Bay has many freshwater tributaries including: Metedeconk River, Kettle Creek, Toms River, Cedar Creek, Forked River, Oyster Creek, Double Creek, Mill Creek, Westecunk Creek, and Tuckerton Creek. These tributaries all contribute pollutant loadings from their watersheds. For the purposes of this BB REP Strategy, these three bays and related tributaries will collectively be referred to as the Barnegat Bay watershed.

The Barnegat Bay watershed has important economic value for the region. According to the 2015 Economic Impact of Tourism Report, Ocean County experienced $4.58 billion in direct sales and $636 million in recreational activities from tourism (http://www.state.nj.us/state/pdf/2015-nj-economic-impact.pdf). A 2012 report on the Economic Value of the Barnegat Bay Watershed prepared for the Barnegat Bay Partnership by the University of Delaware determined that the economic value of the Barnegat Bay watershed from water quality, water supply, fish/wildlife, recreation, agriculture, forests, and public parks benefits exceeds $4 billion (http://www.ipa.udel.edu/publications/BarnegatBay_report.pdf).

MOVING SCIENCE INTO ACTION

Under Phase One, twelve research projects (listed below) were undertaken, the focusing on filling data gaps and addressing the fundamental question proposed by stakeholders, "Is the ecological health of the bay in decline?". The results of the ten projects, combined with the ambient monitoring program, have created one of the most comprehensive compilations of research on a single estuary. Project summaries may be found at http://www.nj.gov/dep/barnegatbay/plan-research.htm and http://www.nj.gov/dep/barnegatbay/plan-wqstandards.htm. A forthcoming Journal of Coastal Research Special Issue #78 entitled, "A Comprehensive Assessment of Barnegat Bay-Little Egg Harbor, New Jersey" will be dedicated to 20 peer-reviewed papers on the bay.

Barnegat Bay Comprehensive Research (2011 – 2015)

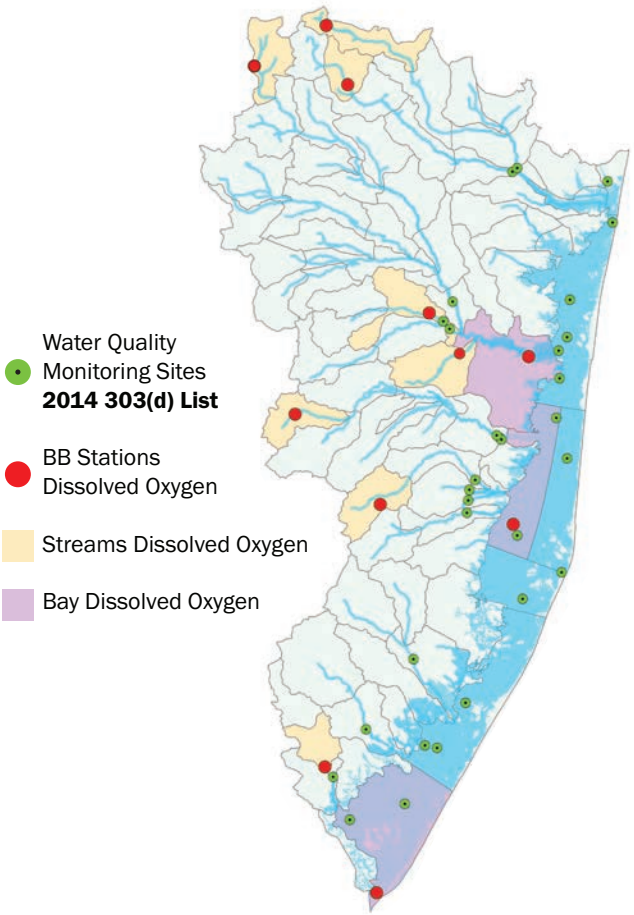
- Benthic Invertebrate Community Monitoring and Indicator Development
- Algal Diatoms as Environmental Indicators
- Assessment of Hard Clam Populations
- Assessment of the Distribution and Abundance of Stinging Sea Nettles (Jellyfishes)
- Baseline Characterization of Phytoplankton Communities and Harmful Algal Blooms (HABs)
- Baseline Characterization of Zooplankton Communities
- Assessment of Fish and Crabs
- Multi-Trophic Level Modeling
- Tidal Freshwater and Salt Marsh Wetland Studies of Changing Ecological Function and Adaptation Strategies
- Ecological Evaluation of Sedge Island Marine Conservation Area
- Barnegat Bay Ambient Monitoring Program
- Hydrodynamic – Water Quality Modeling

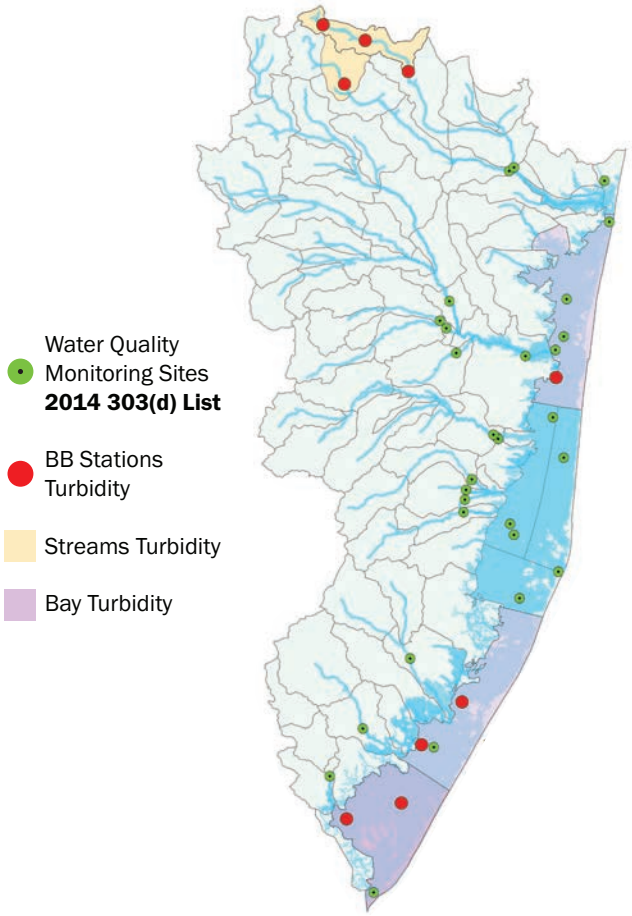
Key Research Findings

- Benthic macroinvertebrate community is healthy.
- Phytoplankton community shows signs of stress.
- Highest phosphorus loading is coming into the northern bay from more urban areas; however, we are seeing higher phosphorus concentrations in the south.
- Wetlands can remove 54% - 85% of nutrients entering the bay.
- A significant amount of this sequestered nitrogen is returned to the atmosphere through microbial action
- Sediments are a large reservoir of phosphorus, but not a source of phosphate to the water.
- Sea nettle larval DNA is found throughout the bay and natural populations fluctuate with environmental conditions. Populations may be managed with implementation of Best Management Practices (BMPs) designed to limit polyp attachment to structures.
- Sedge Island Marine Conservation Zone is an effective tool in improving habitat and species populations and diversity.
- Many areas of Barnegat Bay are negatively impacted by boating impacts, such as propeller scarring, and the impacts last much longer than anticipated.
- Shut down of Oyster Creek Nuclear Generating Station (Oyster Creek) is expected to change fish and shellfish species distribution by reducing entrapment and impingement and eliminating thermal impacts.

ASSESSMENT OF THE CURRENT HEALTH OF BARNEGAT BAY

As noted above, the fundamental question proposed by stakeholders was, "Is the ecological health of the bay in decline?" Through both the research and the Barnegat Bay Ambient Water Quality Monitoring program, DEP and its partners collected a comprehensive water quality data set for Barnegat Bay and its watershed. Using these data, DEP has a more comprehensive understanding of Barnegat Bay's overall ecological health, including its water quality biological communities and physical conditions. Additionally, the data, research, and modeling has laid the groundwork for the development of biological indicators and numeric nutrient criteria, which are currently lacking in Barnegat Bay.



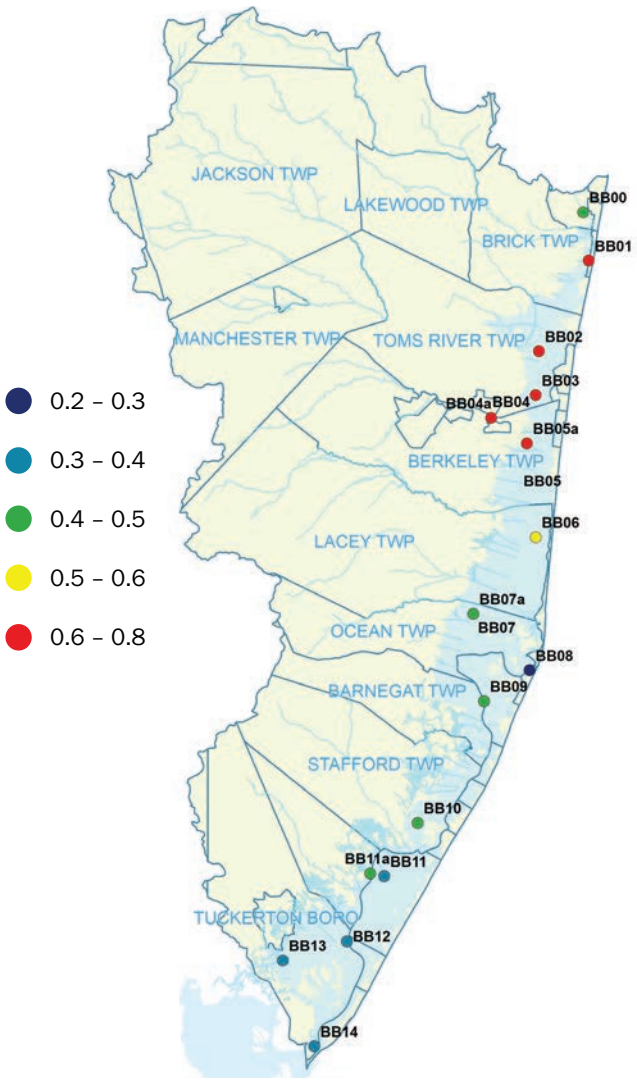


In general terms, research and monitoring clearly indicate that some areas of Barnegat Bay are impaired, some areas show stress or are "on the edge" and some areas of Barnegat Bay are healthy. These findings informed DEP's BB REP Strategy to implement appropriate measures which will help restore those impaired areas, enhance "on the edge" areas, and protect healthy areas.

More specifically, although the New Jersey Surface Water Quality Standards (SWQSs; N.J.A.C. 7:9B) do not currently include numeric nutrient criteria for Barnegat Bay, criteria are available for other related parameters, such as dissolved oxygen and turbidity. These parameters can be used as a surrogate for nutrients, in that excessive nutrients in the water column will result in depleted dissolved oxygen and excessive turbidity due to algal blooms. The water quality assessment has shown that portions of Barnegat Bay do not currently meet the SWQS for dissolved oxygen and turbidity (NJDEP, 2002).

However, water chemistry is not the only indicator of aquatic health. Whenever possible, water quality assessments include an evaluation of biological health and biodiversity in addition to water chemistry. Ongoing research from Phase One has provided two potential biological indicators for Barnegat Bay: phytoplankton (algae that grows and lives in the water; Ren, et al., 2016) and benthic macroinvertebrates (organisms without backbones that live on the bay bottom; Taghon, et al., 2016). Evaluation of these biological indicators demon-

Avg TN Conc. July to Sept 2012



strate that portions of the bay support a healthy biological community while, other areas are stressed.

Research has also shown a decrease in sensitive benthic invertebrate organisms in areas where Total Nitrogen (TN) concentrations increase in the bay (Taghon et al., 2016). This relationship will be used to develop a numeric nutrient target for TN. Comparing the current monitoring data to this target range indicates that the northern portion of Barnegat Bay would not meet a potential TN target.

Monitoring and modeling has shown that the northern portion of the bay receives the highest loading of nitrogen and is an area with the longest residence time (time it takes water to be replaced through tidal action). In these more urbanized portions of the bay much of the nitrogen loading comes from stormwater runoff via rivers and streams.

These cumulative results compiled from the research, monitoring and modeling efforts have identified those areas of the bay that are not meeting existing or potential new standards and are in need of restoration actions to improve the health of the bay. The BB REP Strategy uses this science to identify actions that can be readily implemented to mitigate impacts from nitrogen.

BARNEGAT BAY RESTORATION, ENHANCEMENT AND PROTECTION STRATEGY

The draft BB REP Strategy has four major components: Restoration, Enhancement, Protection and Assessment. Restoration is defined as actions needed to return Barnegat Bay to a nonimpaired (healthy) status. Enhancement is defined as actions needed to reduce the spatial extent of current impairments, improve areas "on the edge" of impairment, and/or enhance the use of Barnegat Bay. Protection is defined as actions needed to preserve and safeguard open land, valuable wetlands, and nonimpaired waters of Barnegat Bay from future degradation. Assessment monitoring is defined as monitoring to determine the efficacy of actions, re-evaluation to measure progress, and make modifications to the BB REP Strategy as needed. Each component may include short-term (immediate), mid-term (up to 2 years) and long-term (up to 5 years) objectives and actions. Many of the objectives and actions listed are currently ongoing and will be noted as such (ongoing, long-term). Action items from the original Phase One Ten-Point Plan that have yet to be completed are categorized and included as either a restoration, enhancement, or protection objective or may be accomplished through other approaches.

Objectives and actions under each component are not listed in any order of priority and are not conclusive. Objectives and actions may be added, expanded, modified, or eliminated as DEP initiatives adjust and/or as part of a subsequent stakeholder process.

Restoration Strategy

Actions needed to return the Barnegat Bay to an nonimpaired (healthy) status.

DEVELOPING A NUTRIENT STANDARD (ongoing, long-term)

Findings from Phase One research (Taghon, et al., 2016 and Ren, et al., 2016) and United States Geological Survey (USGS) investigations are being incorporated into a water quality model to determine the appropriate water quality targets for Barnegat Bay.

The Barnegat Bay benthic macroinvertebrate research shows a correlation between total nitrogen (TN) concentration in the water column and the abundance (percentage) of sensitive benthic macroinvertebrate species (Taghon, et al., 2016). A total nitrogen concentration is being selected with stakeholder input to ensure that a certain percentage of sensitive species, such as 20% or 25%, will remain present in the benthos. 'Reference' or 'close-to' natural condition is an important consideration when developing a nutrient standard and can be defined as the lowest level the system can possibly achieve with no anthropogenic (human) inputs. In simplest terms, close-to natural condition essentially models what nutrient levels would be if the watershed was in its natural state before humans began transforming the environment. This condition represents the best achievable condition and therefore, any water quality standard concentration would need to be above that number and capable of supporting a certain level of sensitive species.

- **Action:** Continue the development and proposal of an appropriate numeric nutrient standard.
- **Lead:** DEP – Division of Water Monitoring and Standards, and United States Geological Survey (USGS)
- **Partners:** United States Environmental Protection Agency (USEPA), and Academia

NUTRIENT TOTAL MAXIMUM DAILY LOAD (TMDL) (ongoing, long-term)

A Total Maximum Daily Load (TMDL) is the maximum amount of a pollutant from all contributing sources that a waterbody can assimilate and remain nonimpaired. As noted, a relationship has been established which indicates that as total nitrogen concentrations increase certain sensitive benthic macroinvertebrate organisms are lost (Taghon, et al., 2016). Modeling work establishes a correlation between the contributing loading from all sources and the existing nutrient concentrations in the bay. The results from this work will be used to establish TMDL reduction targets to ensure total nitrogen concentrations are at appropriate levels, thereby protecting sensitive species.

A TMDL would require load reductions from within the watershed and specific tributaries contributing to those portions of the bay not meeting the water quality targets. Reductions would be achieved through regional and local actions including additional measures to be implemented through New Jersey Pollutant Discharge Elimination System (NJPDES) municipal and industrial stormwater permits in the contributing watershed.

Potential TMDL Municipalities
Based on current monitoring and modeling information, potentially 18 of the 37 municipalities in the Barnegat Bay watershed could be affected by a TMDL. These municipalities are:

- Barnegat Township
- Beachwood Borough
- Berkeley Township
- Brick Township
- Freehold Township
- Howell Township
- Island Heights Borough
- Jackson Township
- Lacey Township
- Lakehurst Borough
- Lakewood Township
- Manchester Township
- Ocean Gate Borough
- Ocean Township
- Pine Beach Borough
- Point Pleasant Township
- South Towns River Borough
- Toms River Township

- **Action:** Continue the development of a targeted nutrient Total Maximum Daily Load.
- **Lead:** DEP – Division of Water Monitoring and Standards and Division of Water Quality, United States Environmental Protection Agency (USEPA), and United States Geological Survey (USGS)
- **Partners:** Municipal stakeholders, Barnegat Bay stakeholders

ADDITIONAL MEASURES IMPLEMENTED THROUGH A TOTAL MAXIMUM DAILY LOAD (TMDL) (long-term)

Additional Measures (AMs) is a term specifically used in the New Jersey Discharge Elimination System (NJPDES) Municipal Stormwater General Permits issued to municipalities to comply with the United States Environmental Protection Agency (USEPA) Phase II stormwater permitting requirements. AMs are measures (non-numeric or numeric effluent limitations) that are expressly required to be included in a municipality's Municipal Stormwater General Permit by an areawide or Statewide Water Quality Management Plan (WQMP). AMs may modify or be in addition to other permit requirements. Pursuant to 40 CFR 122.34(c)1, more stringent terms and conditions may be imposed, including permit requirements that modify or are in addition to the minimum control measures based on a Total Maximum Daily Load (TMDL) where such terms and conditions are needed to protect water quality. AMs, other than numeric effluent limitations, will specify the measures that must be implemented, the measurable goals, and an implementation schedule for each Best Management Practice.
DEP will work with stakeholders, including municipalities, to identify AMs which may be implemented through a TMDL. Some AMs already identified that could reduce the total nitrogen load include:

- Adoption of revised Stormwater Control Ordinance for New Development and Redevelopment

A revised ordinance may reduce the current trigger of one acre of disturbance or one-quarter of an acre of new impervious surface for stormwater management to capture smaller new development and redevelopment projects and may also include additional low impact development requirements.

- Expanded Stormwater Facility Mapping

In addition to existing Municipal Stormwater General Permit requirements to map the end of municipally owned outfall pipes, mapping requirements could be expanded to include all stormwater infrastructure. An accurate inventory of stormwater facilities and their condition will help prioritize maintenance and retrofitting, both of which are needed to reduce nutrient (pollutant) loadings into Barnegat Bay.

- Establish a Schedule to Retrofit Basins to Address Water Quality

Based on results of the mapping and analysis of data, municipalities may be required to develop a basin retrofit schedule to address water quality and reduce nutrient loading. Retrofitting basins changes the focus from retaining and delaying stormwater runoff to infiltration of stormwater and nutrient (pollutant) removal. Retrofitting would be required when funding is available either through municipal budgets, Environmental Infrastructure Financing Program (principal forgiveness/loan blending) or DEP's Water Quality Restoration Grants program.

• Illicit Connection Identification and Elimination

The discharge of sanitary sewage from aging sanitary infrastructure contributes nutrients and pathogens to the Barnegat Bay watershed. For example, pathogens in the Toms River negatively affect river beaches, resulting in advisories and beach closures. An enhanced illicit connection identification and elimination requirement could include ambient water monitoring and the application of source tracking techniques to "find and fix" cross connections and breaks in a municipal sanitary sewer system.

- **Action:** Identify, with input of stakeholders, Additional Measures for inclusion in a TMDL.
- **Lead:** DEP – Division of Water Monitoring and Standards, Division of Water Quality, United States Environmental Protection Agency (USEPA)
- **Partners:** Municipal stakeholders, Barnegat Bay stakeholders

IMPLEMENTATION OF METEDECONK WATERSHED RESTORATION PLAN (ongoing, short-term)

The Metedeconk Watershed Restoration Plan (Brick Twp. MUA et al., 2013) was released in May 2013 and includes many areas identified for restoration, ranging from retrofits of existing stormwater basins to the development of a model low-impact development ordinance. These identified restoration projects target the reduction of nutrients among other pollutants and are an important mechanism needed to reduce the nutrient load to Barnegat Bay. DEP has funded implementation of several restoration actions. Funding for additional projects would continue to be a priority within the Water Quality Restoration Grants Program, among other potential sources.

- **Action:** Continue to implement identified restoration priorities within the Metedeconk Watershed Restoration Plan.
- **Lead:** Brick Township Municipal Utilities Authority
- **Partners:** DEP – Division of Water Monitoring and Standards, United States Environmental Protection Agency (USEPA), and Municipal stakeholders

TOMS RIVER BASIN WATERSHED RESTORATION PLAN (mid-term)

Development of a Watershed Restoration Plan for the Toms River Basin has been identified as an important component of the BB REP Strategy by both DEP and partners. Monitoring and modeling indicate that the Toms River watershed contributes a significant load of nutrients into the Barnegat Bay. The development of this plan will result in a list of prioritized actions to address non-point source pollution and are specific to the Toms River watershed. The development of a watershed plan will make implementation eligible for funding through future Water Quality Restoration Grants.

- **Action:** Develop a Toms River Basin Watershed Restoration Plan.
- **Lead:** To be determined through a Request for Proposals
- **Partners:** DEP – Division of Water Monitoring and Standards, United States Environmental Protection Agency (USEPA), and Municipal stakeholders

DEVELOP WATERSHED RESTORATION/PROTECTION PLANS FOR BARNEGAT BAY TRIBUTARIES (long-term)

Development of Watershed Restoration Plans for Cedar Creek, Forked River/Oyster Creek, Mill Creek, Westecunk Creek, and Tuckerton Creek. In coordination with local partners, develop Watershed Restoration Plans that will identify specific objectives, actions, and projects within the watershed to address pollutants of concern, specifically nutrients. These plans are a key component of the BB REP Strategy and focus on addressing local stream water quality issues that will lead to enhanced water quality in the bay.

- **Action:** Develop Watershed Restoration Plans for Cedar Creek, Forked River/Oyster Creek, Mill Creek, Westecunk Creek, and Tuckerton Creek.
- **Lead:** To be determined through a Request for Proposals
- **Partners:** DEP – Division of Water Monitoring and Standards, United States Environmental Protection Agency (USEPA), Municipal stakeholders

IDENTIFY AND INVENTORY STORMWATER BASINS IN NEED OF RETROFIT: A PILOT PROGRAM (short-term)

To reduce flooding impacts, many construction codes require the installation of stormwater basins to retain and delay the discharge of stormwater runoff from new development. These basins are commonly seen in housing developments and at shopping centers. Retrofitting these basins can change the focus from retaining and delaying stormwater runoff to infiltration of stormwater and nutrient (pollutant) removal. Before retrofitting can occur, municipalities must have an accurate inventory of the basins within their municipality, including the type of basin, ownership, and the current condition (whether it functions as designed). Currently, New Jersey Discharge Elimination System (NJPDES) Municipal Stormwater General Permits require that certain municipalities (Tier A) map only the ends of outfall pipes.

The New Jersey Hydrologic Modeling Database, available at https://hydro.rutgers.edu/, contains a compilation of stormwater basins as collected by the NJ Soil Conservation Districts and the New Jersey Department of Agriculture. Along with location data, this database includes site and design data, images of site plans (where available), current basin conditions, and written documents such as operation and maintenance plans.

To assist with the outfall pipe mapping, DEP developed a free stormwater facility mapping application or "app" (http://www.nj.gov/dep/gis/apps.html). This application provides a method for municipalities and/or partners to easily create a detailed inventory and map of stormwater facilities. Information captured by the application includes data on outfall pipes, stormwater management basins, subsurface infiltration/detention systems, manufactured treatment devices, green infrastructure, and storm drain inlets. Information also includes photographs and inspection notes, such as facility condition, maintenance activity, date of inspection, and evidence of flooding.

DEP, along with our AmeriCorps New Jersey Watershed Ambassadors Program, will identify volunteer municipalities to implement use of the application to identify and inventory stormwater basins.

- **Action:** Identify municipalities and perform inventory utilizing new application.
- **Lead:** AmeriCorps New Jersey Watershed Ambassador Program
- **Partners:** DEP – Division of Water Monitoring and Standards, Division of Water Quality, and Municipal stakeholders

Enhancement Strategy

Actions needed to reduce the spatial extent of current impairments and improve areas "on the edge" of impairment, and/or enhance the use of Barnegat Bay.

SEA NETTLE MANAGEMENT PROGRAM (short-term)

Sea nettles (*Chrysaora quinquecirrha*), a type of stinging jellyfish, are present in the waters of Barnegat Bay and other coastal waterways of New Jersey. Through DEP-funded research, more information is now known about the lifecycle of sea nettles in Barnegat Bay including a better understanding of how man-made structures (e.g. bulkheads and floating docks) are providing perfect habitat for sea nettle polyps to attach and over-winter (Bologna, 2016). As a result, DEP developed targeted outreach materials and hosted numerous "Bulkhead Blitz" events, which were designed to educate property owners with hard-plastic docks and bulkheads on simple ways they can help keep stinging sea nettles in check. Periodic scrubbing or power-washing can effectively remove the speck-sized polyps that adhere to hard surfaces, and by removing floating docks for the winter, polyps are also denied potential settling habitat. By interfering with the polyps at this lifecycle stage, they are prevented from spawning into buds, which release into the water in the spring and grow to become adult sea nettles in the summer.

Continued research, including the possibility of using potential natural predators of sea nettle polyps, in addition to continued outreach to lagoon communities, is needed to reduce and maintain the sea nettle populations and enhance the use of Barnegat Bay.

- **Actions:** Continued research, outreach, and implementation.
- **Lead:** Academia and DEP – Division of Water Monitoring and Standards
- **Partners:** Community members and organizations including: Berkeley Township Underwater Rescue Squad, ReClam the Bay, Barnegat Bay Partnership, Barnegat Bay marina owners and homeowner associations, and the DEP –Division of Science, Research and Environmental Health, and Division of Fish and Wildlife

MUNICIPAL COMPLIANCE ASSISTANCE PROGRAM (ongoing, short-term)

It is important to evaluate and ensure that maximum pollutant reductions are being attained through the existing regulatory framework before requiring municipalities and other regulated entities to implement new Additional Measures under the New Jersey Discharge Elimination System (NJPDES) Municipal Stormwater General Permits. To that end, DEP will provide compliance assistance to municipalities and other regulated entities within the Barnegat Bay watershed to help advance compliance with existing NJPDES permit requirements and achieve practical and tangible reductions. This approach succeeded in working with municipalities and local partners to address pathogen impairments through a "find and fix" approach and will be used in the Barnegat Bay watershed to identify sources of nutrient loading or other water quality impairments.

DEP's Office of Compliance and Enforcement will work with municipalities and other regulated entities to improve NJPDES Municipal Stormwater General Permit compliance, including identifying unpermitted discharges and ensuring compliance with stormwater management rules. DEP will help inform appropriate municipal officials about applicable regulations and will provide technical support. Other goals include facilitating cross-media awareness, encouraging innovative approaches to compliance, providing support to municipal officials to assure compliance with all applicable rules within the municipality, establishing a working dialogue

with municipal officials to assist with best use of resources to achieve reductions, and working together on solutions to address non-compliance issues. The ultimate goals are to improve compliance, improve water quality, and achieve positive environmental outcomes.

- **Actions**: Implement a Compliance Assistance Program aimed at improving NJPDES Municipal Stormwater General Permit compliance to achieve load reductions.
- **Lead:** DEP - Division of Water and Land Use Enforcement
- **Partners:** Municipal stakeholders and other regulated entities

SUPPLEMENTAL ENVIRONMENTAL PROJECTS (ongoing, mid-term)

A Supplemental Environmental Project (SEP; NJDEP, 2017a) is an environmentally beneficial project that a violator voluntarily agrees to perform as a condition of settling an enforcement action. A SEP is an activity that the violator would not otherwise have been required to perform and which primarily benefits the public or the environment. In accordance with policy and procedures, DEP intends to work with municipal and county officials, environmental advocacy groups, and violators from the regulated community to find SEP opportunities in the Barnegat Bay watershed that are consistent with the BB REP Strategy.

- **Actions**: Identify and coordinate SEPs in Barnegat Bay watershed that are consistent with the BB REP Strategy.
- **Lead:** DEP - Division of Water and Land Use Enforcement
- **Partners:** County and Municipal stakeholders, environmental advocacy groups, and Barnegat Bay stakeholders

CONTINUE BARNEGAT BAY EDUCATION AND OUTREACH EFFORTS (ongoing, short-term)

Changing the daily habits of residents and visitors in the Barnegat Bay watershed can have significant positive impacts on the Bay and the local environment. Actions as simple as how people landscape their homes, maintain their yards, use water, dispose of pet waste, and operate their boats have cumulative impacts to the tributaries and bay's water quality and marine and estuarine habitats. This also can affect the economy, tourism, public health, and overall quality of life that residents and visitors value. Education about Barnegat Bay is designed to deepen people's understanding of the bay and how their actions can affect it. To that end DEP will continue its education and outreach efforts while leveraging and encouraging the work of so many Barnegat Bay educators past and present.

Barnegat Bay Blitz: First conducted in 2011, DEP's Barnegat Bay Blitz is a watershed-wide clean up event which is conducted to encourage the public to become involved in a clean-up of their communities. It also helps to instill ownership, pride, and stewardship of the watershed. The Blitz provides an opportunity for residents to directly participate in restoration efforts and enhances public awareness of this natural resource.

The Barnegat Bay Blitz unites people of all ages and backgrounds in a common goal – safeguarding Barnegat Bay. To date, the Blitz has engaged more than 32,000 volunteers and removed nearly 5,000 cubic yards of non-point source pollution from the bay (NJDEP, 2017b).

Barnegat Bay Rain Barrel Challenge: The Barnegat Bay Rain Barrel Challenge is a competition that encourages schools and youth groups located in the Barnegat Bay watershed to learn about the bay and what people can do to help protect its water quality and natural resources. Rain barrels capture rainwater, helping to reduce stormwater runoff and nonpoint source pollution in local waterways. Rain barrels also reduce potable water use; storing rainwater for later use on yards and in gardens. The students investigate the theme for each year's challenge then work together to design and paint rain barrels that address the theme. The

school/organization that wins the challenge receives a Barnegat Bay Festival Day sponsored by DEP and its partners. Rain barrels entered in the challenge are featured during the Blitz Opening Ceremony and are showcased at public venues throughout the watershed on the Rain Barrel Challenge Summer Tour.

United States Environmental Protection Agency (USEPA) Trash Free Waters Initiative: Common trash from consumer goods makes up the majority of what eventually becomes marine debris, polluting our waterways and oceans. Plastics in the aquatic environment are of increasing concern because of their persistence and effect on the environment, wildlife, and human health. USEPA's Trash-Free Waters program is reducing the volume of trash entering U.S. waterways (USEPA, 2017).

- **Actions:** Continue an effective education and outreach program.
- **Lead:** DEP and United States Environmental Protection Agency (USEPA)
- **Partners:** New Jersey Clean Communities, Barnegat Bay Partnership, Save Barnegat Bay, ReClam the Bay, Ocean County Vocational Technical School Marine Academy of Technology and Environmental Science (MATES), AmeriCorps New Jersey Watershed Ambassadors, Municipal Stakeholders, schools, and private entities

DEVELOP AND IMPLEMENT STEWARDSHIP PROGRAMS (short-term)

DEP will partner with entities such as Sustainable Jersey, other nonprofit organizations, and Barnegat Bay educators to create a comprehensive bay-friendly stewardship program. The program will focus on improving water quality by assisting communities, golf courses, businesses and residents in actions that they can take to lessen their individual and community impact on the bay and will include the collection and packaging of the many well-done products that have been developed for the region in the past by various educators. This past work will help to create the solid foundation needed to develop and implement a successful and comprehensive program.

In addition to the leveraging the work of so many Barnegat Bay educators past and present, this new program will also be informed by the above referenced Municipal Compliance Assistance Program with the vision of being able to assist municipalities in effectively meeting their educational requirements in their Municipal Stormwater General Permits and to extend, through voluntary action, the involvement to non-regulated members of the community such as schools and small business.

- **Action:** Develop water focused stewardship programs modified for Barnegat Bay.
- **Lead:** DEP – Division of Water Monitoring and Standards and environmental advocacy groups
- **Partners:** Sustainable Institute at the College of New Jersey, Barnegat Bay Partnership, Save Barnegat Bay, and ReClam the Bay

SHELLFISH RESTORATION FOR SHELLFISH STOCK MANAGEMENT AND NUTRIENT LOAD REDUCTIONS (mid-term)

Shellfish (hard clams, oysters, and scallops) are an important natural resource and economic driver for Barnegat Bay. There is significant potential for increased production through commercial shellfish aquaculture. Shellfish provide the added benefit of removing pollutants, specifically turbidity and nutrients, from the water column. This is important since portions of Barnegat Bay are currently impaired for turbidity and portions of the bay may be impaired for Total Nitrogen, once a standard is developed.

Research from the Chesapeake Bay (oysters) and Long Island Sound (ribbed mussels) indicate that shellfish remove nitrogen from the system when they are harvested. More specifically, reliable estimates of nitrogen and phosphorus removal can be calculated based upon the biomass of oysters harvested. Nitrogen content of oyster soft tissue and shell is estimated to be 8.2% and 0.2% of dry

weight, respectively. Denitrification rates associated with oyster reefs typically exceed background levels, but are highly variable among locations and seasons. In addition, oysters enhance the rate of nutrient flux from the water column to the bottom because of the deposition of feces and pseudofeces (Chesapeake Bay Program, 2013).

Working with experts within DEP, the New Jersey Department of Agriculture, academia, and environmental advocacy groups, and in consultation with the Atlantic Coast Shellfish Council, areas appropriate for shellfish restoration and management techniques will be identified to increase existing shellfish stock and create enticements for expansion of aquaculture within Barnegat Bay. Increasing shellfish harvest from Barnegat Bay on a large scale can account for some of the nutrient load reductions needed to improve water quality and aquatic health.

- Actions: Develop a Barnegat Bay shellfish restoration plan through a stakeholder work group.
- **Lead:** DEP
- **Partners:** New Jersey Department of Agriculture, Rutgers University, Stockton University, Barnegat Bay Partnership, ReClam the Bay, Atlantic Coast Shellfish Council, and Shellfish Industry

SUBMERGED AQUATIC VEGETATION RESTORATION (SAV) (mid-term)

Submerged Aquatic Vegetation (SAV) has several functional roles in the Barnegat Bay estuarine ecosystem. SAV provides a substantial amount of primary production for the Barnegat Bay estuary, and serves as critically important habitat for benthic epifauna and infauna (animals living on the surface of the seabed). SAV also represents valuable spawning, nursery, and feeding grounds for finfish populations in the estuary. It likewise stabilizes benthic habitats by baffling waves and currents and mitigating substrate erosion. Eelgrass (*Zostera marina*) is the dominant seagrass species in Barnegat Bay, forming dense beds (particularly on sandflats) along the backside of the barrier island system (Barnegat Bay Estuary Program, 2001). SAV beds also improve water quality by absorbing nutrients and trapping fine sediments while absorbing significant quantities of carbon dioxide from the air.

Because of the critical importance of SAV, this BB REP Strategy includes its restoration in the Barnegat Bay focusing on improving water quality, allowing SAV to grow in more areas, protecting existing beds, and restoring it to where it previously grew.

- **Actions:** Develop a SAV restoration strategy through a stakeholder work group.
- **Lead:** DEP
- **Partners:** Academia, National Atmospheric and Oceanic Administration (NOAA), and environmental advocacy groups

REDUCTION OF POLLUTANTS - CLEAN MARINAS PROGRAM (short-term)

The Clean Marinas Program encourages marina owners, yacht clubs, boatyards, and boaters to adopt practices that help prevent adverse impacts to water quality, sensitive habitats, and living resources in proximity to marinas. The Clean Marinas Program helps prevent harmful environmental practices in Barnegat Bay and throughout the state through education and outreach to boaters and marina owners. The program provides assistance and guidance to reduce the sources and impacts of nonpoint source pollution, including sewage facility management, fueling operations, fish and solid waste management, and boat cleaning. This helps to protect critical habitat areas that are home to a variety of species including algae, plankton, shellfish, and finfish.

Participation in the Clean Marinas Program demonstrates a commitment to environmental stewardship. Certified clean marinas may display the Clean Marinas Program logo on their letterhead and advertising, fly a clean marina burgee from their property, and receive recognition by the Clean Marinas Program in publications, on the official NJ Clean Marinas website (http://www.njcleanmarinas.org/), and at public events.

- **Actions:** Actively encourage more marinas to participate in the Clean Marinas Program.
- **Lead:** DEP – Office of Coastal and Land Use Planning
- **Partners:** NJ Sea Grant Consortium, Barnegat Bay Partnership, Jacques Cousteau National Estuary Research Reserve, Manasquan River Watershed Association, Marine Trades Association of New Jersey, New Jersey Department of Transportation - Office of Maritime Resources, Partnership for the Delaware Estuary, Rutgers Cooperative Extension, and the United States Coast Guard Auxiliary

Protection Strategy

Actions needed to preserve and safeguard open land, valuable wetlands, and nonimpaired waters of Barnegat Bay from future degradation.

CLOSURE OF OYSTER CREEK NUCLEAR GENERATING STATION (OYSTER CREEK) (ongoing, mid-term)

The State has negotiated and entered into an agreement with Exelon Corporation to cease electric generation operations at the Oyster Creek by December 31, 2019.

Shutdown of the plant is the best technology available to ensure that Oyster Creek withdrawals from Barnegat Bay for cooling purposes, and discharges from the plant do not damage the ecological health of the bay. The closure of Oyster Creek is expected to change fish and shellfish species distribution by reducing entrapment and impingement and eliminating thermal impacts. The plant closure agreement establishes a definite timeframe in which use of the bay for cooling water will cease. There will be a 96% reduction of water intake for cooling purposes. When all spent fuel is moved to dry cask storage, the need for water intake will be eliminated. Closure of the plant will have a significantly more beneficial environmental impact than requiring the installation of cooling towers would have produced. For additional details: http://www.nj.gov/dep/barnegat-bay/docs/oyster-creek-faqs.pdf

- **Actions:** Ensure the timely shutdown of the plant.
- **Lead:** DEP – Air Quality, Energy and Sustainability
- **Partners:** Exelon Corporation

PRESERVE AND RESTORE WETLANDS TO PROVIDE NUTRIENT REDUCTIONS AND RESILIENCY (mid-term)

Through research, we are gaining a better understanding of the importance of wetlands in the Barnegat Bay. In addition to providing upland flood protection during storm events, coastal wetlands can remove (deposition & plant growth) approximately 85% of the nitrogen and 54% of the phosphorus entering the bay from upland sources (Velinsky, et al., 2016). With more than 28% of Barnegat Bay's salt marshes having been lost to development (Rutgers, 2017), stabilizing and restoring existing wetlands and preventing the loss of any more wetlands is of significant importance.

- **Actions:** Develop a consistent strategy and guidance on wetlands restoration to be included in New Jersey's Wetland Program Plan; continue to fund and support wetlands restoration projects.
- **Lead:** DEP – Division of Land Use Regulation, Division of Water Monitoring and Standards, and Division of Science, Research and Environmental Health
- **Partners:** United States Fish and Wildlife Service, DEP – Fish & Wildlife, environmental advocacy groups, United States Army Corps of Engineers, and Municipal stakeholders

SOIL RESTORATION ORDINANCE (mid-term)

Soil restoration reduces over land flow of stormwater and allows for water to percolate into the ground, resulting in a reduction in the volume of stormwater runoff, which reduces the pollutant load to receiving waters while also increasing stormwater recharge to the groundwater. Promoting healthy soil leads to water quality improvements, habitat improvements for stream biota, and conservation of groundwater.

The Soil Restoration Act (P.L.2010 Chapter 113) was signed into law on January 5, 2011. Subsequently, the State Soil Conservation Committee, in consultation with Rutgers University, the New Jersey Secretary of Agriculture, and the DEP Commissioner Bob Martin, have developed standards that include soil restoration measures to address the potential soil compaction on all new construction regulated by New Jersey Soil Conservation Districts. The goal is to ensure soil is restored to the greatest extent possible through aeration and re-vegetation. DEP is developing a model ordinance that incorporates the soil restoration measures and standards.

- **Action:** Identify a path to expedite and implement the application of soil restoration measures and standards within the Barnegat Bay watershed for new development and redevelopment projects.
- **Lead:** DEP – Division of Water Monitoring and Standards, Division of Land Use Regulation
- **Partners:** State Soil Conservation Committee, Ocean County Planning, Municipal stakeholders, and the New Jersey Builders Association

PROTECT ENVIRONMENTALLY SENSITIVE AREAS IN THE BAY (ongoing, short-term)

In 2012, DEP designated sixteen Ecologically Sensitive Areas (ESAs) within Barnegat Bay. The ESAs are unique locations where substantial submerged aquatic vegetation (SAV) beds and wildlife are found. These areas provide shelter and feeding grounds for numerous species including shellfish, crabs, fish, and shorebirds. DEP funded research, conducted by Rutgers University and Rider University, indicating that additional protections to these ESAs, similar to the protections afforded by the Sedge Island Conservation Zone (through Senate Joint Resolution No. 30 of the 209th Legislature of the State of New Jersey and DEP Commissioner Bob Martin's Administrative Order No. 2014-09) could have positive impacts for blue crabs, shellfish, and SAV (Jivoff, 2016).

- **Actions:** Work with stakeholders to identify additional ESAs and ensure enforcement of existing ESAs.
- **Lead:** DEP - Division of Fish and Wildlife, Division of Water Monitoring and Standards, and Division of Science, Research and Environmental Health
- **Partners:** Marine Trades Association, Personal Watercraft Industry, Marine Fisheries Council, ReClam the Bay, Friends of Island Beach State Park, Ocean County, Save Barnegat Bay, and American Littoral Society

REDUCE WATER CRAFT IMPACTS (ongoing, short-term)

Many areas of Barnegat Bay are negatively affected by boating; boating discourages bird nesting and foraging, disrupts aquatic habitats, and can cause propeller scarring of submerged aquatic vegetation (SAV). A 2016 a Rutgers University report funded by DEP found that, "Island Beach South ESA, followed by Island Beach

North were identified as major hotspots of boat scarring, accounting for over 76% of the boat scarring in Barnegat Bay."

In early 2012, sixteen Ecologically Sensitive Areas (ESAs) were identified and targeted for Green Boater practices. Subsequently, a map showing these ESAs was developed for boaters which highlighted green boating practices that reduce the impact of boats and personal watercraft in ESAs. Additionally, a mobile friendly "app" was created with an interactive map to aid boaters in locating the ESAs (http://www.nj.gov/dep/barnegatbay/plan-watercraft-map.htm).

- **Actions:** Continue the distribution of Green Boater education materials to marinas and public access areas along Barnegat Bay and update mobile app as needed.
- **Lead:** DEP – Division of Fish and Wildlife, Division of Water Monitoring and Standards, and Division of Science, Research and Environmental Health
- **Partners:** Marine Trades Association, Personal Watercraft Industry, Marine Fisheries Council, ReClam the Bay, Friends of Island Beach State Park, Ocean County, Save Barnegat Bay, Littoral Society

LAND ACQUISITION AND PRESERVATION (ongoing, short-term)

While there has been extensive development in the Barnegat Bay watershed, there are still many critical lands that need protection from the impacts of development in order to prevent pollutants from entering the Barnegat Bay. Acquiring available, ecologically sensitive lands along the Barnegat Bay and its tributaries is a cost-effective and critical measure to prevent development activities that could further degrade the bay's water and ecological quality. The Green Acres Program, administered by DEP, has identified and prioritized these lands for acquisition and is working with willing sellers to purchase these lands. State Revolving Fund (SRF) monies may also be used for land acquisition, as well as resources from other ecological restoration funding programs. Since 2011, more than 11,000 acres have been acquired by New Jersey's Green Acres Program and Ocean County Natural Lands Trust. The Green Acres Program and its protection partners will continue to purchase land that helps to protect the watershed.

- **Actions:** Continue to acquire land in the Barnegat Bay watershed.
- **Lead:** DEP – Green Acres Program, Division of Fish and Wildlife, and Division of Parks and Forestry
- **Partners:** County and Municipal stakeholders and environmental advocacy groups

Assessment and Effectiveness Monitoring

Monitoring to determine the efficacy of actions, re-evaluation to measure progress, and make modifications to the BB REP Strategy as needed.

Science is the backbone of the BB REP Strategy and is used to inform the design of assessment and monitoring methodologies. Monitoring is needed throughout the process to assess conditions and determine the efficacy of actions taken. Periodic assessments are needed to determine water quality improvements and to make changes to the BB REP Strategy as needed so that the strategy continues to reflect the most up-to-date information and science. Programs/projects include:

CONTINUE THE BARNEGAT BAY WATERSHED LONG-TERM WATER QUALITY MONITORING PROGRAM (ongoing, long- term)

The Department and its partners have been implementing a long-term, Barnegat Bay monitoring program (bay and tributaries) for the last five years (NJDEP, 2013). This sampling effort, coupled with the two years of intense monitoring for modeling, has resulted in a seven-year targeted data set for Barnegat Bay and its watershed. This monitoring will be continued, as long-term data sets are needed to assess the progress and trends in water quality, and to evaluate the efficacy of various actions in the BB REP Strategy. Additionally, an analysis will be performed to optimize and ensure the adequacy of the Barnegat Bay watershed monitoring network, and identify any data gaps.

- **Action:** Continue monitoring, analyze monitoring data and data gaps, and evaluate and update the related monitoring design and Quality Assurance Project Plan (QAPP) as needed.
- **Lead:** DEP - Division of Water Monitoring and Standards
- **Partners:** Barnegat Bay Partnership, Ocean County Vocational Technical School Marine Academy of Technology and Environmental Science (MATES), and Brick Municipal Utilities Authority

DEVELOP BIOLOGICAL MONITORING PLAN PRE-AND POST-CLOSURE OF OYSTER CREEK NUCLEAR GENERATING STATION (mid-term)

In December 2019, Oyster Creek Nuclear Generating Station (Oyster Creek) will be decommissioned, resulting in a significant change in both flow of water and water temperature in the areas directly influenced by the plant. Previous ecosystem modeling, performed by Rutgers University and United States Geological Survey (USGS), has

demonstrated that the closure of Oyster Creek will cause a shift in the local ecosystem and could change the biological community structure, Various species of fish and shellfish will have different responses to the change in the local conditions caused by the removal of the thermal plume and change in flow regime. (Jensen et al, 2016).

Thus, a Pre- & Post-Closure Biological Monitoring Plan is to determine the impacts of the closure on the ecosystem. The data obtained will be used to determine the impact of the Oyster Creek closure on the Barnegat Bay ecosystem. The project will include collection of various trophic levels including fish, shellfish, benthic organisms, zooplankton, and phytoplankton, and will include five years of sampling: two years pre-closure (2018 & 2019), one year transitional (summer 2020), and two years after closure.

- **Action:** Develop a comprehensive biological monitoring plan for Oyster Creek that will include collection of organisms from various trophic levels.
- **Lead:** DEP
- **Partners:** United States Geological Survey (USGS) and Academia

TOMS RIVER STORMWATER STUDY TO EVALUATE THE EFFECT OF FERTILIZER LAW (mid-term)

A Toms River Stormwater Study will be designed to replicate the study conducted by DEP from 1994-2000. The previous study evaluated the runoff loadings of nutrients from various types of land uses. Repeating this study will allow DEP to determine if the water quality data reflects nutrient reductions realized from implementation of New Jersey's fertilizer law, which went into effect in 2011 and implemented nutrient reduction Best Management Practices (BMPs).

A multi-year stormwater monitoring initiative will calculate the non-point source loadings of nutrients, bacteria, and suspended solids from various land use areas in the watershed. Original monitoring sites representative of five specific land uses will be replicated.

- **Action:** Undertake Toms River Stormwater Study and analyze data.
- **Lead:** DEP

DEVELOP BIOLOGICAL INDICES FOR BARNEGAT BAY AND ESTABLISH ROUTINE BIOLOGICAL MONITORING PROGRAM (ongoing, short-term)

New Jersey currently has macroinvertebrate biological indices for ocean and freshwaters, but no biological index specifically for Barnegat Bay. However, based on research, a biological index using benthic macroinvertebrates was developed and is currently being refined specifically for the Barnegat Bay (Taghon et al., 2016). The long-term monitoring of the benthic macroinvertebrate community will provide insight and feedback about the health of the bay and the effectiveness of the BB REP Strategy.

In addition, based on three years of investigation on phytoplankton, a season-salinity specific phytoplankton index of biotic integrity is also being developed. This phytoplankton index is being reviewed and will be used as an additional metric of biological assessment of water quality for the bay (Ren, et al., 2016).

- **Action:** Develop routine macroinvertebrate collection network and a season-salinity specific phytoplankton index of biotic integrity in the Barnegat Bay estuary, and use the results to assess the ecological health of the bay.
- **Lead:** DEP - Division of Science, Research and Environmental Health and Division of Water Monitoring and Standards
- **Partners:** Academia

Implementation

The recognition that consistent work from all stakeholders in the Barnegat Bay region has led to a vast list of committed partners in the restoration of the Barnegat Bay. Partnerships are the foundation of the overall BB REP Strategy. Internal partners of DEP's Division of Water Monitoring and Standards include: Division of Science Research and Environmental Health; Division of Water Quality; Division of Land Use Management; Green Acres Program; Division of Fish and Wildlife; Division of Parks and Forestry, Park Police; and the Office of Compliance and Enforcement. External partners include: Barnegat Bay watershed municipalities, Barnegat Bay Partnership, Ocean County, New Jersey Clean Communities Council, ReClam the Bay, Save Barnegat Bay, Marine Trade Association, Clean Ocean Action, American Littoral Society, and Alliance for a Living Ocean, among countless other organizations, businesses, and active citizens.

The implementation of this strategy and the successful restoration and protection of Barnegat Bay relies on the continued unity of all parties involved and the engaged participation of the residents and tourist of the region. Continuing DEP's long history and belief in stakeholder involvement, DEP will continue to engage, listen and refine this strategy to meet the goals of restoration, enhancement and protection while meeting the needs of the community at large.

Funding

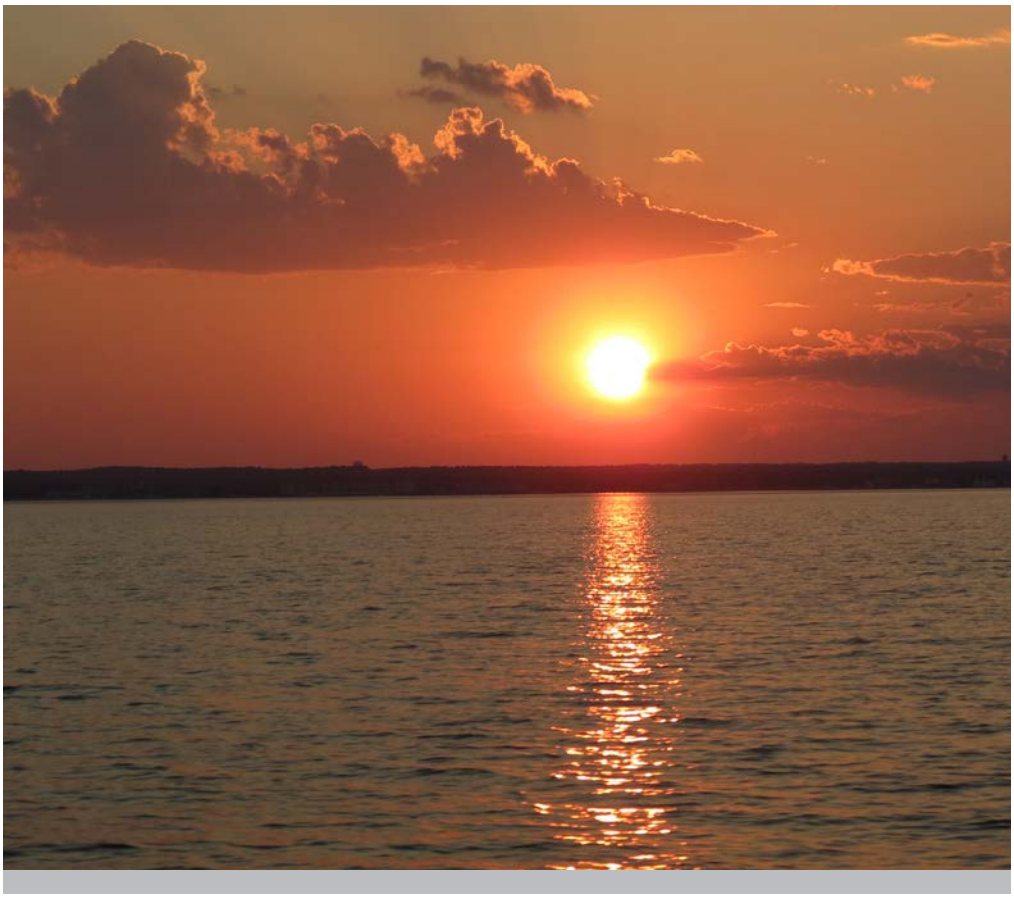
During Phase One the DEP provided $24 million in combination low interest loans and grants which funded thirty-one stormwater infrastructure projects and upgrades within the Barnegat Bay watershed. In addition, DEP provided nearly $4 Million in grants which funded eleven water quality restoration projects within the Barnegat Bay watershed since 2011. The DEP will continue to provide crucial funding needed to make improvements and will be providing up to $10 Million combination low interest loans and grants and up to $10 Million in grants to begin the implementation of the BB REP Strategy.

In addition, outside funding is also available from the United States Environmental Protection Agency (USEPA), National Atmospheric and Oceanic Administration (NOAA), New Jersey Clean Communities Council, and United States Fish and Wildlife – Department of the Interior. DEP will continue to work both internally and externally with partners and the Legislature to identify and lock-in grant and loan funding to implement the BB REP Strategy through these and other sources.

Conclusion

The Barnegat Bay watershed is a tremendous resource, both environmentally and economically, providing New Jersey residents and visitors with a place to visit, work, and live. In addition, Barnegat Bay improves residents' quality of life by offering diverse recreational opportunities including fishing, swimming, boating, hunting, birding, and sight-seeing. The ecological health of Barnegat Bay and the Barnegat Bay watershed directly affects the value of this resource. Based on concerns regarding the ecological health of the bay, DEP developed and began implementing the Ten-Point Plan. Much of the Ten-Point Plan dealt with conducting monitoring and research to assess the health of the bay to inform regulatory policy decisions and to provide DEP with regulatory tools to help with the restoration of the bay, including the development of nutrient standards and modeling needed to develop a Total Maximum Daily Load.

Research, the collection of monitoring data, and model development has given DEP the information needed to answer the fundamental question being asked by stakeholders; "Is the ecological health of the bay in decline?". In the most general terms, research and monitoring clearly indicate that there are areas of Barnegat Bay that are impaired, there are areas that show stress or considered "on the edge", and there are areas of Barnegat Bay that are healthy. These findings informed DEP's BB REP Strategy to implement appropriate measures that will help restore those areas which are impaired, enhance areas that are "on the edge", and protect those areas which are healthy.



Based on the results of the researcher's work, which created one of the most comprehensive compilations of research on a single estuary, DEP is taking the lead in identifying ways to restore, enhance, and protect the Barnegat Bay watershed with sensible objectives and actions. However, as with the development and implementation of the Ten-Point Plan, DEP cannot do it alone and will rely on the help of partners and stakeholders in the Barnegat Bay watershed in the execution of the Barnegat Bay Restoration, Enhancement, and Protection Strategy. DEP will continue to effectively engage partners and stakeholders at statewide, regional, and local levels in these efforts.

Our goal remains the same since the 2010 announcement of a comprehensive action plan: to restore, protect, and enhance the ecological health of Barnegat Bay. As stated by DEP Commissioner Bob Martin, "[r]estoration of Barnegat Bay will take years of sustained work and a great deal of commitment from many people.". Progress in the form of scientific research, water quality monitoring and analysis, and implementation of stewardship projects, as well as storm water management efforts and purchasing of important lands for open space protection have been key steps to achieving this goal. We continue, as a Department, alongside the Barnegat Bay community, to set objectives and actions to further the goal of restoring areas of decline, enhancing "on the edge" areas, protecting nonimpaired areas, and assessing the efficacy of actions. DEP must also continue to work with its partners to educate, communicate, and advocate for a healthy watershed. The BB REP Strategy brings together all the work of the Ten-Point Plan and will see it through implementation.

Barnegat Bay is one of many estuarine systems world-wide being negatively affected by nutrient over-enrichment. Addressing this challenge is not easy. It is our belief that these efforts will lessen the ecological stress within Barnegat Bay and improve the quality of life in our communities. Barnegat Bay remains a top environmental priority for the State and DEP. The BB REP Strategy takes the science that has been developed and uses it to develop actions designed to reverse the deterioration from development, stormwater runoff, and overuse of resources. The BB REP Strategy, including both short-term and long-term objectives to reverse decades of weakening ecological health, won't be realized overnight. With the commitment of DEP demonstrated by our investment in Phase One and the direction set forth in this BB REP Strategy (Phase Two), coupled with the unwavering support of all of our partners, the health of the Barnegat Bay will remain a priority for the community, DEP, and the State of New Jersey now and into the future.

State of New Jersey Department of Environmental Protection
Water Resource Management
October 2017

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