Chapter 4 Water Quality Goals, Objectives and Actions

Themes

- The bay’s water quality is critical to the bay’s overall condition, as well as coastal communities within this region and their tourism-based economies.

- Eutrophication of the bay caused by high nutrient loading is the major problem affecting the northern portions of the bay, while sedimentation is the largest issue affecting the southern portion of the bay.

- Improvements in the bay require aggressive efforts to reduce nonpoint source and other pollutant loadings to the bay.

- Our understanding of the bay has improved substantially in recent years; however, continued monitoring and science are essential to improving the bay as our world changes.

4.1 Goal

To protect and improve water quality throughout Barnegat Bay and its watershed by reducing the causes of water quality degradation to achieve swimmable, fishable and drinkable water (USEPA, Clean Water Act), and to support aquatic life.

Water Quality Objectives:
1. Reduce sources of nutrients, contaminants, debris and other pollutant loadings from point and nonpoint source pollution.
2. Assess status trends of water quality throughout the watershed.
3. Conduct studies to improve scientific understanding of new and emerging issues pertaining to the chemical, physical, and biological conditions and dynamics in the Barnegat Bay and its watershed.
4. Increase public education, engagement, and stewardship regarding water quality in the watershed.

4.2 Introduction

*Water Quality and its Connection to Other CCMP Goals*

NEPs were established in large part to address issues of water quality in estuaries of national significance. The ecology of the entire watershed, the health of people in all the communities and of the biotic resources living throughout the watershed, the economy of the region, and our quality of life are all dependent on good water quality. Water quality, because it is affected by
land use and other human activities as well as by climatic changes, has become an increasing concern over the past few decades.

The Barnegat Bay Partnership's CCMP goal for water quality is built upon the foundation provided by the Clean Water Act (USEPA, Clean Water Act), to restore and maintain the chemical, physical, and biological integrity of the nation's waters. This foundation translates into two fundamental aims: to eliminate the discharge of pollutants into the bay and its contributing watershed, and to achieve water quality levels that are fishable, swimmable, and meet all water quality criteria. The steady population growth and coastal development over the past century has not been without adverse impacts to the environment. Perhaps most troubling is the bay’s eutrophication, though concern about other issues, especially sea level rise and climate change have also increased.

**Eutrophication**

Eutrophication, an increase in the rate of supply of organic matter to an ecosystem, remains one of the most critical challenges facing Barnegat Bay, and has been the subject of much attention in recent years (Kennish M. B., 2007). Human-related activities that increased soil erosion and nutrient pollutant loadings (See Water Quality Status and Trends: Nutrient Loading) contribute greatly to the bay’s eutrophication. Recent studies (Baker, R.J., Wieben, C.M., Lathrop, R.G., and Nicholson, R.S, 2014) have quantified the increasing nutrient load from lawn runoff, especially in the northern bay. Eutrophication can lead to a cascading chain of negative environmental conditions, including blooms of drift algae or phytoplankton (See Water Quality Status and Trends: Algal Blooms), which can cause other changes in the bay such as increased turbidity (See Water Quality Status and Trends: Turbidity), hypoxia (low dissolved oxygen) or anoxia (no dissolved oxygen; See Water Quality Status and Trends: Dissolved Oxygen). It can also result in other changes in aquatic communities including loss of shellfishes, eelgrass and other submerged aquatic vegetation. Changes in temperature and other water quality conditions, such as nutrient levels, in freshwater rivers, creeks, and streams may intensify eutrophic conditions and have other ecological impacts to the bay. Nutrient and sediment loadings pose challenges from the headwaters of the bay in the westernmost reaches of the watershed to the bay itself. Addressing eutrophication requires an overall reduction in the total nutrient loading to the bay and its tributaries throughout the watershed.
Nitrogen and phosphorus are recognized as the two primary contributors to the bay’s eutrophication. From 1989-to date, estimates show an overall increase in nitrogen loading through time. Recent estimates of loading from the watershed have been more variable but approximately 25% higher (up to 857,000 kg N/yr) due to recognition of the substantial inputs of nitrogen entering the bay from the ocean, which had not been included in previous pollutant load estimates. It is important to note that the nitrogen concentration in the ocean water entering the bay is generally not high, however the tidal volume of water entering the bay is large. This component of the load had not been assessed and included in prior estimates of total nutrient loading. Nitrogen loading is far higher in the northern bay due to increasing inputs of stormwater contributions from the developed landscape.

Phosphorus loadings to the bay (17,000-32,000 kg) from northern bay tributaries are higher than from southern bay tributaries; however, the phosphorus concentrations show the reverse pattern in bay water. This discrepancy merits further study.

Algal blooms are typically characterized by explosive growth of a single plankton species, which can create a cascade of negative impacts (e.g., high turbidity shading benthic habitats, low dissolved oxygen, release of algal toxins killing plankton and fishes, changes in community composition and trophic dynamics).

Algal blooms have been recorded occurring throughout the bay at various time and spatial scales during the 2011-2015 time-period, with the largest and most frequent blooms occurring in the northern portion of the bay. While routine monitoring for Brown Tide, a harmful algal bloom, was discontinued in 2004, studies have shown various small-scale blooms of Brown Tide during the 2011-2015 timeframe. The NJDEP now conducts aerial flights over Barnegat Bay to assess chlorophyll A six days a week from May through October. Any areas with high chlorophyll A levels indicative of bloom conditions are sampled. Climate in the northeastern US is predicted to include more precipitation overall in the future, but is also predicted to be more variable.
Water Quality Status and Trends: Turbidity

There are three sections of the estuary which were listed as impaired for turbidity on the state’s 2014 List of Water Quality Limited Waters. During for 4 of the 5 years evaluated, turbidity in Manahawkin Bay limited light transmission to below one meter during the seagrass growing season, a condition that can be detrimental to seagrass growth.

Long-term trends in turbidity are difficult to discern due to confounding environmental factors, i.e., different sources of turbidity (e.g., phytoplankton, pump stations, discharges of groundwater) in different parts of the estuary. As with dissolved oxygen, variation in turbidity from year to year is affected by many factors, including weather, water temperature, nutrients, time of day, and other factors.

Water Quality Status and Trends: Dissolved Oxygen

Dissolved oxygen (DO) is a fundamental requirement for the maintenance of balanced populations of fish, shellfish, and other aquatic organisms. The nature and extent of the organism’s response to low oxygen concentrations depends on several factors, including the concentration of oxygen in the water, how long the organism is exposed to reduced oxygen, and the age and condition of the organism.

Three of the nine assessment units in the estuary were listed as impaired for dissolved oxygen on the state’s 2014 List of Water Quality Limited Waters. Between 2011 and 2014 a total of 5 sampling locations had values below 4 milligrams per liter (mg/l) in the summer, the level at which biota may begin to show signs of stress. All other stations sampled during those years did not drop below the threshold. Low dissolved oxygen is often localized in the bay and may not be low throughout the...
Over the past ten years, considerable effort has been expended to better understand the nutrient loadings to the Barnegat Bay and their impacts on the bay’s dynamic conditions. Key components of this effort have included the following:

- a comprehensive water quality monitoring program (see interactive NJDEP website (NJDEP, Barnegat Bay Mapper), several research studies focused on the major living resources of the bay (e.g., plankton in the water column (Howson, Ursula A., Buchanan, Gary A., and Nickels, James A., 2017), benthic communities living on or in the bottom sediments (Gary L. Taghon, 2017), fishes and motile invertebrates (Jessica L. Valenti, 2017),
- other targeted studies (nutrient history of the bay (David J. Velinsky, Bhanu Paudel, Thomas J. Belton and Christopher K. Sommerfield, 2017), critical habitats (Richard G. Lathrop, 2017), and
- the development of an integrated, hydrodynamic water quality model for the Bay by the USGS (NJDEP, JCR volume (Zafer Defne, 2017)

These investigations have been critical to our increased understanding of the current nutrient loadings and concentrations, the condition of the bay’s biological resources, and their relationships. Understanding those relationships is essential to developing a decision-making framework for protecting and restoring the bay and its resources.

Water quality standards provide the decision framework that is used to both determine the current condition of the bay and guide restoration efforts. New Jersey’s Surface Water Quality Standards (SWQS; N.J.A.C. 7:9B) do not currently include numeric nutrient criteria that are applicable for Barnegat Bay, though criteria are available for other related parameters, such as dissolved oxygen and turbidity. These measurable conditions can be used as a substitute for nutrients, in that excessive nutrients in the water column will result in depleted dissolved oxygen and excessive turbidity due to algal blooms (i.e., the outcomes of the bay’s excessive production). Currently, some parts of Barnegat Bay are impaired for dissolved oxygen and turbidity. Additionally, water chemistry is not the only indicator of condition. Whenever possible, water quality assessments include an evaluation of biological health and biodiversity in addition to water chemistry to obtain a more complete picture of the situation.

4.3 Objectives

Water Quality Objective 1. Reduce sources of nutrients, contaminants, debris and other pollutant loadings from point and nonpoint source pollution

This will be addressed in a variety of ways including support for: establishment and implementation of TMDLs; development and implementation of Watershed Based Plans; and effective stormwater management. Selected actions include the following.
Continue to support establishment of nutrient TMDLs and numeric nutrient criteria using existing and new science.

A TMDL is a calculation that determines the maximum amount that a particular pollutant can contribute from all sources to a waterbody without violating a water quality standard. Any Barnegat Bay nutrient TMDL should identify the nutrient load reductions needed to meet water quality targets that are selected for the Barnegat Bay. Through comprehensive monitoring, research findings, and modeling investigations, the NJDEP has been working with many partners to develop biological indicators and an appropriate numeric nutrient standard for Barnegat Bay. Benthic invertebrate research in Barnegat Bay has shown a strong correlation between total nitrogen (TN) concentration in the water column and the abundance (percentage) of sensitive benthic invertebrate species (Gary L. Taghon, 2017). This relationship between the biological community and the nutrient levels is being used to develop (1) a nutrient target to ensure sufficient survival and protection of sensitive invertebrate species, and (2) the means to assess aquatic life use in Barnegat Bay in the upcoming NJDEP Integrated Water Quality Assessment Report. Identifying a ‘reference’ or ’close-to-natural’ condition is an important consideration when developing a nutrient standard. This reference condition can be defined as the lowest pollutant level the system can achieve with no anthropogenic (human-caused) pollutant inputs. Findings from this research and the USGS water quality model potentially ensure the development of a numeric nutrient standard that can serve as a target for the bay’s restoration.

The USGS integrated water quality model (Zafer Defne, 2017) establishes a correlation between the loadings of pollutants from all sources and simulates a response in nutrient concentrations and other parameters in the bay. In addition, the model can be used to simulate various scenarios, including various climatic conditions (warm vs cold winters, wet vs dry years) or potential future conditions (turning off the Oyster Creek Nuclear Generating Station, or offshore inputs). The NJDEP has indicated that this water quality model also will be used to develop a TMDL for nutrients in Barnegat Bay (NJDEP, Barnegat Bay Restoration, Enhancement, and Protection Strategy: Moving Science into Action, 2017). Once a TMDL is established, it will include reduction targets to ensure total nitrogen concentrations are at levels that protect sensitive species and do not result in excessive algal growth. 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.

Support establishment of Watershed Based Plans (WBPs)

A watershed based plan (WBP) identifies areas in need of restoration and protection at a smaller sub-watershed level. WBPs provide detailed technical assessment and management information, including the analyses, actions, participants, and resources related to developing and implementing the plan. WBPs that include the key element information consistent with the 2013
USEPA guidance (NJDEP, Water Quality Restoration Grants for Nonpoint Source Pollution) are eligible for federal pass-through funding that is provided to New Jersey via the CWA Section 319[h] (NJDEP, Water Quality Restoration Grants). At present, only one WBP, the 2013 Metedeconk River Watershed Protection and Restoration Plan (Metedeconk River Watershed Protection and Restoration Plan, 2013) has been developed in the Barnegat Bay watershed that is in accordance with the 2013 EPA guidance. Developing more WBPs enables the BBP and other organizations to qualify for priority restoration activities. The NJDEP makes funding available, through its Water Quality Restoration Grants (https://www.state.nj.us/dep/wms/bears/npsrestgrants.html), for WBP development and to implement practices and activities designed to reduce pollutant load to a watershed. Presently, the NJDEP is funding development of WBPs for four BB subwatersheds (Toms River, Oyster Creek, Cedar Creek and Little Egg Harbor) in 2019-2020. Implementing nonpoint source and stormwater restoration projects in the BB watershed has been identified as a priority for funding over the past several funding cycles; completed projects in Barnegat Bay can be found on the map at https://www.state.nj.us/dep/wms/bears/completedprojects.htm.

Addressing nonpoint source pollution through soil restoration and fertilizer laws
Nonpoint source (NPS) pollution is caused by rainfall or snowmelt moving over and/or through the ground, where it picks up and carries various pollutants, and deposits them into lakes, rivers, wetlands, coastal waters and ground waters. Most naturally occurring soils within the Barnegat Bay watershed are relatively sandy, have minimal organic-matter content, and maintain an interconnected system of small, medium, and large pores equal to as much as half of the soil’s total volume. In the simplest terms, healthy porous soils act like a sponge, exhibit virtually no runoff, and reduce NPS pollution by increasing plant uptake of water and nutrients applied in fertilizers. However, due to low organic matter in sandy soils in many Coastal areas, nutrients can move quickly through unsaturated zone into the water table before the plants can uptake most of the fertilizer applied. The impacted groundwater contribution to surface nutrient levels will be smaller than surface runoff, but will be present and consistent in baseflow.
Common development activity often changes soil features (e.g., decreased porosity, increased compaction) and affects how water and pollutants move over or through the ground. Farmers, residential homeowners, and managers of parks, playgrounds, and athletic fields have experienced difficulty managing land areas that have been subjected to soil compaction. Compacted areas become impervious as densities approach values for concrete (Figs. 4.1 and 4.2; OCSCD et al. 2001), and become increasingly plagued by surface ponding, poor plant growth, and localized flooding.

Perhaps most importantly, soil compaction affects the quantity and quality of water reaching the bay. With increasing soil compaction, NPS pollution to nearby waterbodies increases. The nutrients in fertilizers, instead of infiltrating into the ground and assimilating into plants, run over the ground and into waterbodies where they fuel the bay’s eutrophication. Protecting and improving soil functionality (i.e., reducing soil compaction and increasing water infiltration) is
one of the most critical and basic concepts to ultimately improve water quality throughout the Barnegat Bay watershed.

*Reducing nonpoint source pollution through municipal stormwater permit (MS4) compliance and enforcement*

The NJDEP’s Municipal Stormwater Regulation Program rules were initially developed to implement USEPA rules that became effective in 1999. NJDEP issues general permits authorizing stormwater discharges from Tier A and Tier B municipalities, as well as public complexes and highway agencies that discharge stormwater from municipal separate storm sewers systems (MS4s). Tier A municipalities, generally located within more densely populated regions of the state or along/near the coast, include most municipalities in the Barnegat Bay watershed. Public complexes include most colleges, prisons, hospitals and military bases. And highway agencies include county, state, interstate, or federal government agencies that operate highways and other roadways. NJDEP has adopted stormwater management rules (N.J.A.C. 7:8) to reduce stormwater volume, flow rates, associated erosion and flooding, and pollution loadings, which are implemented through issuance of the MS4 permits. For new developments, both NJDEP and the municipality may have a role in reviewing compliance with stormwater management rules. Maintenance of stormwater systems, including best management practices, is the responsibility of the owner and/or operator, which may include state and county transportation departments, municipalities, companies, and homeowner associations. Many towns have adopted stormwater ordinances as part of their municipal permits, requiring residents to clean up after their pets, place yard waste in a container for collection and manage dumpsters to contain waste and prevent leakage. These ordinances also prohibit feeding wildlife, littering, over-fertilization, illicit connections to storm drains, and dumping to storm drains among other strategies to reduce stormwater pollution.
As part of its Phase 2 Restoration, Enhancement and Protection Plan for the Barnegat Bay, NJDEP has developed a Municipal Compliance Assistance Program to assist municipalities in complying with existing regulatory requirements to ensure that maximum pollutant reductions are being attained. The Program will be working closely with municipalities to identify sources of nutrient loading, turbidity, and other water quality impairments using a cooperative ‘find-and-fix’ approach. The main goals are to improve overall MS4 permit compliance, provide technical support to municipal officials, encourage innovative solutions to address non-compliance, and of course improve water quality in the bay. Toms River has agreed to work with the NJDEP and other local partners as the pilot project for this effort. Eventually, the process established through working with Toms River will become a model for conducting compliance assistance visits in the remaining municipalities in the watershed. The NJDEP will be providing guidance and technical assistance to municipalities as they work with other local partners (see Objectives 1-5 through 1-7 in Section 4.5 of this document). The Department will identify problems with the towns’ MS4 permit compliance which will help the towns ensure compliance with their municipal permit and regulations and assist the town in identifying other enhancements which could be implemented to reduce nonpoint source pollution and address other local problems, such as nuisance flooding and wetland loss/erosion. The Department will also provide outreach relative to the use of NJDEP stormwater mapping application to assist municipalities with mapping of all stormwater BMP’s within each municipality and work with DEP and the town to create a database that is periodically updated as part of the compliance effort. This database can be used in various ways such as ensuring scheduled maintenance and assessing needed improvements throughout the watershed.

*Addressing nonpoint source pollution through stormwater basin management and restoration.*

Stormwater basins are generally proposed as part of a large residential or commercial project to manage Stormwater on-site as “major development projects”, which triggers compliance with the
NJDEP Stormwater Management rule under N.J.A.C. 7:8. Many people consider stormwater basins as a way to also manage nutrients in stormwater; however, stormwater basins may be of several different types (e.g., retention, detention, or infiltration) which function in different ways to address specific problems. Most of the 2,000 or more stormwater basins constructed in Ocean County outside of the Pinelands Area, especially the older (pre-2004) stormwater basins, were primarily designed to control peak flows. These types of basins were designed to hold a substantial volume of water, which is slowly discharged from the basin into a municipality’s MS4, and ultimately into a stream or the bay. The primary role of these basins was to prevent flooding, especially flash flooding, and not to improve water quality. In contrast, all stormwater basins in the Pinelands Area are required to infiltrate the total runoff volume generated from the net increase in impervious surfaces from a 10-year, 24-hour storm and from which there shall be no direct discharge of stormwater to any wetland, wetlands transition area or surface water body.

The performance of many stormwater basins may be upgraded or enhanced via retrofits to increase nutrient uptake or may be simply improved through regular maintenance. The Ocean County Department of Planning and the Ocean County Soil Conservation District identified numerous stormwater basins in the Lower Toms River and Long Swamp Creek subwatersheds that did not recharge or infiltrate as designed. These basins, which held water on a permanent or nearly permanent basis, were restored to their original design function by addressing soil compaction or impermeable soil layers within the basins with Section 319 grant funds. Several organizations assessed a few problematic basins with BBP funding and then used Section 319 funds to restore capacity of basins to reduce flooding and improve nutrient management. One such example is located in Laurel Commons in Toms River. The NJDEP also funded renovation and/or construction of basins.

![Figure 4.5 - Laurel Common stormwater basin, post-restoration](image-url)
as part of New Jersey’s 2010 Barnegat Bay Initiative (NJDEP, Barnegat Bay Phase One:, 2010), and the Brick Township Municipal Utilities Authority (Brick Twp. MUA) is also restoring basins as part of its Watershed Management Plan for the Metedeconk River.

Restoration of even a fraction of the 2,000 basins in the Barnegat Bay watershed represents a considerable financial commitment. Thus, one important objective of the CCMP is to identify and map the location of all basins, develop and implement an assessment program, and prioritize basins for restoration to reduce nutrient and sediment loadings to the bay. In this way, the funding can be focused on the most problematic basins that are contributing the greatest pollutant loadings to the bay or causing other substantial problems such as flooding. By mapping and locating all basins, needed maintenance can also be identified and prioritized by each municipality. The Municipal Compliance Assistance Program will be assisting the municipalities in this process where needed.
Addressing nonpoint source pollution from roadways and public works maintenance

Roadways and related infrastructure regularly collect pollutants from the highways and adjacent lands in the form of de-icers, herbicides for roadside vegetation control, and from cars, trucks, and buses, including heavy metals from tires, brakes, and engine wear, and hydrocarbons from lubricating fluids. Because their impervious surfaces can generate considerable stormwater runoff, major roadways require considerable attention to stormwater management. Similar to Tier A and Tier B municipalities, the NJDEP issues municipal separate storm sewer system (MS4) permits to federal, state and county agencies which manage highways and related infrastructure (Highway MS4 permit). These permits also enforce statewide basic requirements. For example, the permits contain requirements that address post-construction stormwater controls, illicit discharge detection and elimination, pollution prevention and good housekeeping, use of Best Management Practices (BMPs), and public education and outreach. They address the improper disposal of waste, solids and floatable controls, maintenance yard operations, and employee training.

The Highway MS4 permit also requires that each highway agency develop a Stormwater Pollution Prevention Plan (SPPP), which describes how each agency will implement permit requirement (https://www.nj.gov/dep/dwq/highway_forms.htm). The implementation of Highway Agencies’ SPPPs, together with the other nonpoint source objectives (Objectives 1-4 to 1-7), addresses a catalog of issues (nutrient loading, flooding), identifying solutions (e.g., stormwater source controls, basins, low-impact projects) and prioritizing future funding.

Addressing pollution from marinas and boating activities

Marinas and boating activity can also result in stormwater-related pollution as well as boat-related contaminants and debris. The New Jersey Clean Marinas Program encourages and supports marina owners, boatyards, and boaters to adopt practices that help prevent harmful
impacts to water quality and living resources. The program provides assistance to marina operators to reduce the sources of pollution, including sewage facility management, fueling operations, fish and solid waste management, and boat painting and cleaning (NJDEP, NJDEP Clean Marina Program).

**Addressing pollution from agriculture, livestock, pets, and wildlife**

In the watershed, livestock numbers are low, large-scale animal farms do not exist, and agriculture lands and grasslands comprise only 1% of the landscape. However, legacy nutrient inputs from extensive historic chicken and dairy farms will continue to impact water quality due to slow transport of some nutrients in groundwater. Pets and wildlife scattered throughout the watershed also contribute substantially to bacterial and pathogenic loadings in some areas, including parks, playgrounds and lakes, some of which can no longer be used for swimming and boating (e.g., Pine Lake). Approximately 90,000 dogs are kept as pets in Ocean County, generating about 15 million pounds of waste a year. High numbers of Canada geese, estimated at close to 78,000 in NJ, produce an average of 1-3 pounds of feces a day, contributing to localized water quality impairments. Addressing these pollutant sources through enforcement of the towns’ pet waste and wildlife feeding ordinances could substantially improve water quality in some bay tributaries and coastal lakes.

**Addressing point source pollution from Oyster Creek Nuclear Generating Station, sewage conveyance systems, and septic systems.** In contrast to diffuse nonpoint pollution, point sources, such as wastewater treatment facility outfall pipes, are confined, discrete sources of pollution regulated by permits. Barnegat Bay has very few major point discharges; traditional point source discharges, such as wastewater, are generally not thought to be a significant source of nutrient loading to the bay.

**Oyster Creek Nuclear Generating Station**

Until its decommissioning began in fall 2018, the largest point source discharge to the bay was Oyster Creek Nuclear Generating Station (Oyster Creek), which used the bay’s water for cooling purposes for decades. The decommissioning the OCNGS reduced the plant’s use of 1.4 billion gallons of bay water a day for cooling purposes by 96%; moreover, this flow reduction has also reduced thermal and chlorine pollution discharges and injuries and mortality to fish, plankton and other marine life during water intake. Chlorine, along with mechanical damage during water uptake, transforms living plankton into nutrient-rich organic debris. The fates and fluxes of toxic chlorine byproducts, including chloramines, known to be toxic to some estuarine fishes in particular (e.g., mummichog, (J.M. Capuzzo, 1977), and their contributions to the bay’s eutrophication and other impacts on the bay’s biota remain known.
Modeling has demonstrated that shutting down OCNGS may cause a shift that could change the biological community and alter some fish and shellfish distributions (Jensen, 2017). A Pre- and Post-Closure Biological Monitoring Plan is being implemented to assess various impacts of closure on the ecosystem and nutrient dynamics. The project will include monitoring of biota and nutrients. Discussions are ongoing regarding including chloramine and other chlorination by-products over the next several years of sampling: pre-closure (2018), one year transitional (2018-2019), and three to five years after closure. Longer term impact monitoring is highly recommended. The impact of this discharge and the plant’s prior operation (the bay’s warming) on the bay’s eutrophication remain poorly assessed.

**Sewage Treatment Plants**

The Ocean County Utilities Authority (OCUA) operates three wastewater treatment facilities with a total capacity of 84 million gallons per day (mgd) but generally operated around 50-55 mgd. The OCUA plants remove over 90% of the pollutants from the sewage through its secondary treatment process before discharging through three ocean outfalls, all roughly a mile offshore.

Recent NJDEP-funded studies have identified that the water entering the bay with each tidal cycle is contributing about 25% to the bay’s overall nutrient loading; this is not unexpected given the large volume of water entering the bay with each tide. The contribution of anthropogenic sources in the water entering the bay is not known but is thought to be small at this time. Offshore upwelling of deep, nutrient-rich ocean waters does occur off the New Jersey coast (Kohut, 2004) (NASA, 2016). However, anthropogenic loadings offshore have been recognized as an issue in some other coastal waters (e.g., Florida (Englehardt et al, 2001) (VanVelzer, 2017). A more complete assessment of this “ocean” load, including determining the sources and amounts of any anthropogenic loadings to New Jersey (from all dischargers to the New York Bight and New Jersey coast) could potentially help identify different approaches to further reduce these sources. The discharge of treated sewage effluents offshore represents a consumptive loss of water from the system.

The OCUA collects waste from all municipalities in Ocean County and five in Monmouth County, and has an extensive preventative maintenance and capital repair and improvements program. However, aging municipal infrastructure that conveys wastewater has contributed to localized water-quality problems (e.g., pathogens in Beachwood Beach, see below) due to various problems (e.g., illicit connections, pipe exfiltration, pipe settling in filled wetlands, delayed or incomplete maintenance or repair). Some problems were made worse by Superstorm Sandy and were fixed. Because some municipal maintenance programs remain underfunded, ongoing efforts to identify problem areas and needed upgrades for municipal stormwater and sanitary systems are important to improve water quality in the bay and at local pollution
“hotspots.” The NJDEP funded Clean Ocean Action and its partners to identify pollution hotspots in the Toms River watershed.

Lastly, a substantial number of septic systems may be contributing to water quality impairments in some areas. Septic systems are underground wastewater treatment structures, often used in rural areas where centralized sewer systems do not exist. A typical system consists of a septic tank and an underground drainfield, which is a source of nutrient and may be a source of pathogen pollution to groundwater if not properly designed or operated. The Water Quality Management Planning Rule, N.J.A.C. 7:15, requires wastewater management planning agencies to develop a Wastewater Management Plan (WMP) for their WMP area. One of the components of a WMP is demonstration that areas served by septic tanks are subject to a maintenance program which ensures that septic tanks are inspected at a frequency to adequately determine if they are functioning properly. The county Board of Chosen Freeholders is the WMP agency in the Barnegat Bay watershed. Acting on behalf of the Ocean County Freeholders, the Ocean County Planning (OCPD) and Health Departments (OCHD) have developed an inventory of the roughly 22,500 septic systems in the bay watershed. Inventory data include block and lot location, septic permit type and address. In the future, the county plans on updating the inventory with installation date, maintenance updates, and abandonment information. The data can be used to develop the septic system maintenance program required by NJDEP’s Water Quality Management Planning rules (N.J.A.C 7:15-4.5(c)1.iv), to notify owners of septic systems installed after Jan. 1, 1990 of proper system operation and maintenance practices required by NJDEP’s Standards for Individual Sewage Disposal Systems (required through N.J.A.C 7:9A-3.14(a) and (b)), to guide policy, implement ordinances, guide the approval process for areas under development (e.g., septic density), and to aid in other decision making. The data can also be used to provide the requisite annual report to NJDEP on the number of septic systems present in each municipality, the types and number of inspections performed on each system, the types and number of permits issued, the number type and apparent cause of non-compliant systems and a description of the areas known to have higher than normal rate of non-compliance (required through N.J.A.C 7:9A-3.14(d)).

The data can assist in identifying areas with a history of failing systems and areas with systems that are old and will potentially need to be updated and repaired or possibly connected to the sewer system. Improving the maintenance of septic systems can potentially reduce or eliminate some impairments in the watershed. Similarly, the Monmouth County Planning Board will need to address the septic maintenance requirement as part of their WMP development. Remediating pollution from existing failing or improperly sited septic systems could be achieved by replacing them with a decentralized community treatment system which incorporate biological nutrient reduction prior to local groundwater recharge (where system density would make a community system economically feasible) or by replacing them with nitrogen attenuating individual septic systems, such as those in use in the Pinelands Area. Impacts from septic systems serving new...
development could be reduced by each of these actions and could potentially eliminate some impairments in the watershed. Eliminating all septic systems from the watershed would reduce watershed-wide recharge of ground water recharge and increase offshore discharges of treated wastewater by approximately 2 mgd.

Water Quality Objective 2 - Assess status and trends of water quality throughout the watershed.

Knowing the status and trends in water quality provides the key foundation to protecting and restoring coastal ecosystems and to protecting public health. Without the proper quantity and caliber of data, it is difficult to accurately determine the true issues as well as if any actions being taken are addressing the problems. As recent studies in the Bay (Fertig, 2014) have emphasized, assessing condition of water quality and other environmental parameter is dependent on having consistent, quality data collected over time.

For the past 16 years, the BBP’s monitoring objective has been achieved through the publication of BBP’s State of the Bay Reports (2005, 2011, 2016). Such reporting, required of all National Estuary Programs every five years, was established to take a comprehensive look at the status and trends of many bay characteristics and resources. In 2011, the BBP recognized some critical information gaps in its status and trends reporting. Many of these information gaps were addressed in the past 8 years, largely as a result of the NJDEP’s comprehensive water quality monitoring network in the Barnegat Bay (http://www.nj.gov/dep/barnegatbay/plan-wqstandards.htm) and other targeted monitoring efforts. Monitoring remains essential to provide the framework for decision-making and serve as justification for the bay’s protection and restoration. All current monitoring activities will be reviewed within the next year by the STAC for consideration into a new BBP monitoring plan to strengthen SOTB reporting and provide better coordination with NJDEP reporting requirements (NJDEP, New Jersey Water Supply Plan 2017-2022, 2017).

Water Quality Objective 3 - Conduct studies to improve scientific understanding of new and emerging issues pertaining to the chemical, physical and biological conditions and dynamic in the Barnegat Bay and its watershed

Periodic assessment of monitoring data can reveal new or recurring problems and identify data gaps that need to be addressed to improve our understanding of the bay and guide decision making to protect and improve the bay. Several studies assessing nitrogen inputs to Barnegat Bay were conducted before 2010 (Moser, 1997) (Castro, 2001) (Nicholson, 2001) (Bricker, 2007) (Bowen, 2007), however, only one of these studies considered nitrogen inputs entering the bay through inlets. This was a 3-week study in early spring at Barnegat Inlet (Guo, 2001). This
study led the NJDEP to examine nutrients flowing through all inlets as part of its comprehensive water quality monitoring network. We now recognize significant periodic influx of nutrients through inlets and that the bay’s total nutrient loadings are significantly higher than previously recognized. It is very likely that this source has long been stimulating the bay’s eutrophication; however, it remains unclear how much of this source is natural. We do know that deep, nutrient-rich waters are upwelled periodically in the summer and do contribute to algal blooms in some years (https://www.nj.com/news/2011/08/assive_algae_bloom_off_new_jer.htm). There are also unexplained differences in the loading and concentration patterns of phosphorus to the bay. Resolving the questions regarding both nutrients is an important first step to reduce these nutrient loadings into the bay.

One emerging and complex issue is the source of turbidity in the bay. Turbidity is unquestionably a problem in some parts of the bay; it can contribute to eelgrass loss, death of phytoplankton and low dissolved oxygen. However, suspended sediments, which are a contributor to turbidity, may be a “solution” to another environmental concern (i.e., wetland loss) in other parts of the bay. For example, wetlands trap suspended sediments in the water column to grow laterally and vertically, that is, to keep pace with sea level rise. Turbidity in estuaries potentially has many sources, with both natural (e.g., phytoplankton production) and anthropogenic causes (stormwater discharges). Sometimes, additional monitoring and assessment (Ganju, 2014), (Dickhudt, 2015) may be necessary to understand the many contributing sources of turbidity; moreover, addressing turbidity in different parts of the bay may require different solutions. This issue illustrates the importance of new science to address emerging issues.

The BBP STAC periodically examines monitoring, assessment, and research concerns, and revises its science prospectus to emphasize priority data gaps and emerging issues.

**Water Quality Objective 4 - Increase public education, engagement and stewardship regarding water quality in the watershed**

Public education and participation are central to the BBP’s mission to protect and restore the water quality of the bay and its contributing watershed. The BBP's Communication and Outreach Plan, which provides a blueprint for collaborative partner outreach efforts, establishes clear objectives, approaches, and methods to engage distinct target audiences important to protecting water quality. The BBP's Communication and Education Committee (CEC) oversees implementation of the Communication Plan. The BBP’s Communication and Education Grant Program funds projects that increase public understanding of human impacts on the bay, promote stewardship, and grow public participation in its
protection and restoration. Through a grant from the NJDEP, the BBP developed the Jersey-Friendly Yards website as a comprehensive resource to help NJ property owners "landscape for a healthy environment" and cleaner water. The BBP will continue to grow this website as an important tool for engaging property owners in actions that can help improve water quality in the watershed. BBP can also coordinate outreach efforts with municipalities to in relation to compliance with the public education and outreach component of the MS4 permit.

4.4 Objectives and Actions for Water Quality

Objective 1 Reduce sources of nutrients, contaminants, debris and other pollutant loadings from point and nonpoint source pollution.

- **WQ 1-1:** Support development and implementation of a Barnegat Bay TMDL(s) (Total Maximum Daily Load), including the development and use of a Barnegat Bay validated biological indices of water quality, to address nutrient and other pollutant loadings and to guide science based future management decision.

- **WQ 1-2:** Develop/revise and implement Watershed Plans (i.e. WQMP/319 and Watershed Based Plans) at the sub watershed level.

- **WQ 1-3:** Fully implement the Soil Restoration Law and associated comprehensive soil restoration procedures for various land use activities.

- **WQ 1-4:** Support implementation and enforcement of stormwater rules and ordinances at state, county and municipal levels.

- **WQ 1-5:** Encourage municipalities to (1) inventory and map [using DEP DWQ online mapping tool] the following stormwater facilities: storm drain inlets, stormwater basins, subsurface infiltration/detention systems, culverts, manufactured treatment devices (MTDs), and green infrastructure) together with NJDEP-required outfall mapping; (2) develop process/program to assess, prioritize, and implement basin/other stormwater infrastructure repairs and/or retrofits to reduce nutrient and sediment loadings to the bay.

- **WQ 1-6:** Identify sources and reduce pollution inputs from roadways and yard maintenance (pesticides, herbicides, fertilizer, deicer and automotive waste).

- **WQ 1-7:** Encourage municipalities and counties to map all stormwater BMP facilities/infrastructure within the watershed associated with major development; review mapping of stormwater BMPs as an optional element of NJDEP Municipal SW Compliance Assistance Program and a “preferred ranking element” in appropriate NJDEP funding programs.

- **WQ 1-8:** Identify sources and reduce pollution inputs from marinas and boating activities. Suggest marinas be included as part of 1-1 MSCAP or an element of other programs (e.g., Clean Marina, Clean Vessel). Assess need for enforcement of priority problems

- **WQ 1-9:** Identify sources and reduce pollution inputs from livestock, agriculture and wildlife.
Objective 2 Assess status trends of water quality throughout the watershed.

- **WQ 2-1**: Maintain, review, and revise as necessary the existing comprehensive water quality ambient monitoring program throughout the watershed.
- **WQ 2-2**: Continue to identify the current status and trends in water quality within the watershed (NJDEP Integrated Report, BBP State of the Bay (SOTB) Report) and identify pollutant sources and magnitudes.
- **WQ 2-3**: Support the existing beach monitoring program. Work with NJDEP, NJDOH, OCHD & LBI Health Department to evaluate possible monitoring strategies for known public recreational areas of high public use e.g., Tice’s Shoal, F-Cove, Pine Lake, Cedar Creek, etc. which are not recreational bathing beaches as defined in NJ State Sanitary Code, Public Recreational Bathing N.J.A.C. 8:26 Chapter IX

Objective 3 Conduct studies to improve scientific understanding of new and emerging issues pertaining to the chemical, physical, and biological conditions and dynamics in the Barnegat Bay and its watershed.

- **WQ 3-1**: Support completion and expansion of source tracking for bacteria, pathogens, and novel and other pollutants.
- **WQ 3-2**: Continue to identify and address data gaps and water quality issues of emerging concern (e.g. coastal acidification, watershed salinity increases, etc.)
- **WQ 3-3**: Continue to support research that identifies and quantifies the sources and fates of nutrients within the watershed and bay.

Objective 4 Increase public education, engagement, and stewardship regarding water quality in the watershed.

- **WQ 4-1**: Assist training and education/outreach programs to help municipalities meet permit compliance, e.g., Tier A and Tier B MS4 permits at Part IV.B.1.
- **WQ 4-2**: Share Barnegat Bay-friendly ordinances and establish a Jersey-Friendly Yards certification and training program for homeowners, businesses, and/or landscaping professionals to promote practices that reduce nonpoint source pollution.
- **WQ 4-3**: Implement components of the BBP Communications Plan related to water quality improvement.